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A LOWER MICROFAUNA
LOON RIVER FORMATION
NORTHERN ALBERTA

F. H. TROLLOPE

Thesis
1951
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A LOWER MICROFAUNA OF THE LOON RIVER FORMATION,
NORTHERN ALBERTA

A DISSERTATION
SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES
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DEPARTMENT OF GEOLOGY

BY

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ABSTRACT

Twenty-two species of Foraminifera, and four species of Radiolaria, from the Lower Cretaceous Loon River formation of Western Canada are described and figured. Eleven foraminiferal genera (9 arenaceous, 2 calcareous) include: 1 species of Ammobaculites; 1 of Ammodiscus; 2 of Bathysiphon; Cibicidella ?, 1; Discorbis, 1; Gaudryina, 3; Glomospira, 1; Gyroidina, 1; Haplophragmoides, 7; Miliammina, 1; Verneuillina, 3. Three radiolarian genera include: 1 species of Artocapsa; 2 of Lithostrobus (Conostrobus); and Cyrtocapsa, 2.

Zones of the Loon River formation, from top down, are designated by the fossils Lemuroceras, Beudanticeras, Haplophragmoides 318-B, Gyroidina 355-A, Haplophragmoides 360-A, Conostrobus 384-A, Haplophragmoides 424-A, "Spores", and Artocapsa 704-C.

The Gyroidina 355-A fauna, which occurs about 250 feet below the top of the Loon River formation, correlates with the basal Moosebar fauna of Pine River area, British Columbia.

A LOWER MICROFAUNA OF THE LOON RIVER FORMATION,
NORTHERN ALBERTA.

CHAPTER I
INTRODUCTION

PREFACE

For many years the entire Loon River formation has been correlated to the west with the Moosebar shale and to the east with the Clearwater shale. This correlation was based on megafossils, lithologic similarity and stratigraphic position. Recently a microfauna from the basal Moosebar shale was collected by C.R. Stelck. The discovery of a similar fauna in the Loon River formation demands a revision of this correlation, and indicates that the Loon River and Moosebar formations are not stratigraphically co-extensive.

The purpose of this thesis is to establish a succession of the microfaunas of the Loon River shale and to add to the knowledge of the Lower Cretaceous foraminifera of Western Canada. This microfaunal study of the Loon River formation, which outcrops in north-central Alberta along the Peace River, deals principally with foraminifera, picked from shale samples of surface outcrops. Part of the succession of microfaunal assemblages in the Loon River is here established, and morphologic types are described and illustrated. Correlation of one of the upper faunal zones of the Loon River formation with a basal zone of the Moosebar formation suggests that the lower part of the Loon River formation correlates with

the upper part of the Gething formation. Therefore, most of the microfaunas presented here are lower in the Cretaceous section than any previously dated marine microfauna of Western Canada.

FIELD WORK

Shale samples of the Loon River formation used in this microfaunal study were collected by a Pacific Petroleum's surface party, in the field season of 1950. This party consisted of P.E. Cote, chief, W. Elder, G. Dann, and J. Binnie, assistants. Samples used here were collected from thirty-one different localities, from 15 miles below the mouth of the Notikewin River to Fort Vermilion, on the Peace River.

Samples were collected by means of a discontinuous sampling procedure. The outcrop was trenched, a shallow pit was dug at each sampling point and a six-inch section was sampled. Samples were hand-picked to remove iron-stone and hard, sandy material. Samples were taken customarily with a stratigraphic interval of 5 feet between collected beds. Maximum stratigraphic interval between samples, on individual outcrops, seldom exceeded 10 feet. Samples were placed in postal-type cotton bags and shipped to the Pacific Petroleum's warehouse in Edmonton. From there a portion of each sample was sent to the Geological Department, University of Alberta.

TECHNICAL PROCEDURE

Methods of preparing samples for study, washing

samples, picking microfossils and mounting microfossils is similar to that outlined by Nielsen (ref. 21).

Study of the microfauna indicated certain morphologic types suitable for illustrating and description. One specimen of each morphologic type is chosen as a hypotype and mounted in a single cell slide. Three other specimens of similar morphologic type as the hypotype are chosen as paratypes and mounted with the hypotype. These types are filed in the University of Alberta Museum.

Photo-micrographs of all hypotypes were taken using Superpan Press film, a Leitz Wetzlar M4B camera and a Leitz Wetzlar No. 394635 microscope. Magnifications of 60x, 65x, 80x and 85x were used. The writer developed the negatives utilizing developing equipment and dark-room facilities in the Department of Geology, University of Alberta. Prints of the negatives were made by a commercial firm, Silvertone. Certain features which were not well defined in the original print are accentuated by retouching of the photographs. The retouched photographs of the fossils are cut out and mounted on a black mat background. The photographs are again retouched and the plate was then photographed, producing the illustrated plate in this thesis. The photographing of the plate was done by Bell, a commercial firm.

ACKNOWLEDGMENTS

Pacific Petroleum has donated the samples, geologic information and rendered financial assistance to the writer throughout this study. Dr. P.E. Cote performed

the field work from which this microfaunal study developed and personally provided pertinent data on the field work as required.

The writer acknowledges the assistance of the Department of Geology, University of Alberta during the writing of this thesis and throughout his undergraduate years.

The writer is grateful for the valuable assistance accorded him by Dr. C.R. Stelck under whose direct supervision this thesis was written. Dr. Stelck assisted in the final preparation of the fossil plates.

A.W. Norris, working on a companion study of the "Spores" of the Loon River formation, assembled the lower suites discussed in this thesis, and assessed supplementary paleobotanic data.

CHAPTER 11

THE LOON RIVER FORMATION

INTRODUCTION

The Loon River formation is a marine shale formation within the Cretaceous Fort St. John group of Western Canada. The type section of the Loon River formation outcrops along the Wabiskaw (Loon) River, Alberta, where it was first recognized by McConnell in 1889. Micro-faunal suites described in this thesis are from the outcrops of the Loon River formation on the Peace River, west of the type locality.

For the purpose of this thesis the Loon River formation is defined by geographical position rather than by correlation. The term "Loon River formation" refers to strata underlying the lowermost member of the Peace river formation, and overlying the Devonian limestones, outcropping along the Peace River from 15 miles below the mouth of the Notikewin River downstream to Vermilion Chutes, and along the lower Wabiskaw (Loon) River.

Strata of this formation, outcropping in the area under consideration, are recognized as marine shales, locally silty, containing discontinuous limestone and ironstone concretions. The Loon River formation carries a megafauna culminated by the ammonite genera Lemuroceras and Beudanticeras, with Lemuroceras occurring higher stratigraphically into the basal (Monias) member of the Peace River formation.

The Loon River formation is considered the lowest formation of the Fort St. John group by McLearn. For

this thesis the Loon River shales are assigned a thickness of 1,100 feet. The microfauna discussed in this thesis comes from the middle portion of the Loon River formation only, from about 200 feet below the top to about 400 feet above the base (i.e. 500 feet of shale).

The information on the Loon River formation concerning the description, lithology, thickness, extent and megafauna was obtained from published and unpublished reports by other workers.

EARLY WORK

A geological exploration was carried out by R.G. McConnell covering the Peace River area in 1888. From this work some new formation names were introduced, including the Loon River shales. In his report (ref. 13) on this area he illustrated the succession of the various divisions by the following table of formations:

Laramie	Wapiti River sandstones
Montana	Foxhill sandstone
	Smoky River shales
	Dunvegan sandstone
Colorado	Fort St. John shales
	Peace River sandstones
	Loon River shales

Thus, McConnell first introduced the term Loon River formation for the shales outcropping along the lower part of the Wabiskaw (Loon) River, and the Peace River. He delimited the upper boundary of the Loon River shales as the "alternating" contact with the series of sandstone and shales which he named the Peace River sandstone.

Although the contact was not seen, he stated that the Loon River formation appears to rest directly on the Devonian limestones.

McConnell described the Loon River formation as follows: "The Loon River shales, the lowest division of the Colorado or Peace River, consist of about 400 feet of dark grayish to nearly black, soft shales, holding calcareous and ironstone nodules, interstratified with occasional bed of sandstone, impure limestone, and ironstone..... The Loon River shales appear in descending Peace River, about twenty miles above Battle River, and are exposed on the banks of the valley nearly all the way down to the Vermilion Falls. They also occur on the lower part of the Loon River, and on the Red River. They alternate above with the Peace River sandstone, and below appear to rest directly on the Devonian limestones, although the contact was nowhere seen".

Later geological work of importance in the Peace River area was carried out by F.H. McLearn. Geological investigation by means of a series of field trips to the area in 1917, 1918, 1920 and 1922 (ref.16) resulted in publication of the table of formations in Figure 1 on the following page.

System		Group	Smoky-Peace Section	
Cretaceous	Upper	Montana	Wapiti	
		Colorado	Upper Shale	Smoky River
			Bad Heart Sandstone	
			Lower Shale	
			Dunvegan	
		St. John		
	Lower	"Lower Cretaceous"	Upper Sandstone	Peace River
			Middle Shale	
			Lower Sandstone	
			Loon River	

Figure 1: Table of formations, - McLearn 1917-18

McLearn describes the Loon River formation as follows: (ref. 15): "The Loon River shales consist of dark blue to dark grey, friable weathering shales with a few rounded or flattened ironstone concretions. To the south where they are penetrated by the wells of the Peace River Oil Company they are more arenaceous, particularly near the base. Both well No. 1 and No. 2 show a number of smaller beds of sandstone in the upper part of the formation, which are not present in the exposures downstream. Along the upper contact with the Peace River sandstones there is much replacement laterally of sandstone by shale, so that the contact rises stratigraphically northward. As exposed on the river in the north the even bedding and marine fossils point to a marine origin. It is possible, however that the thick sandstones near the base of the

formation in the south may be of non-marine origin. At the great horseshoe bend the thickness is 400 feet (estimated) and to the south in the oil wells 1,100 feet!

In 1929 R. L. Rutherford made a survey of the underground water resources of the Peace River area. In conjunction with this survey, strata outcropping in the area were geologically investigated. Terminology of the Cretaceous section in the Peace River area used by Rutherford is illustrated by the following table of formations:

Upper Smoky River shale
Bad Heart sandstone
Lower Smoky River shale
Dunvegan formation
St. John formation
Peace River formation
Loon River formation (at depth)

In 1931 L. S. Russell (ref. 23) made a survey of a portion of the eastern Peace River area. A preliminary map of the area (Bison Lake - Sexsmith) was published, although it was not accompanied by a report. The Lower Cretaceous terminology used on the map was:

Fort St. John formation
Peace River formation
Loon River formation

In 1944 McLearn (ref. 18) defined the Fort St. John group of the eastern part of the Peace River area as including the "marine shale of the Loon River, the mostly

LOCALITY		UPPER PINE RIVER, B.C.	FORT ST. JOHN B.C.	PEACE RIVER, ALBERTA	PEACE RIVER FOOTHILLS, E.C.	ATHABASKA RIVER, ALBERTA	FAUNAL ZONES
Lower Cretaceous	U. Cret.	Dunvegan fmt.	Dunvegan fmt.	Dunvegan fmt.	Dunvegan fmt.	Dunvegan fmt.	Urio dowlingi
		Cruiser formation	Upper Fort	Shaftesbury formation	"Upper"	Latiche formation	Acanthocerat
		Goodrich fmt.	St. John shales		St. John shales	Pelican ss.	Neofastroplites
		Hasler sh.		Cadotte mem. Harmon sh.	Gates sandstone	Joli Fou sh.	Haplophragmoides gigas
		Commotion formation	Peace River fmt.	"Notikewin" member		Grand Rapids formation	Gastroplites
Jur.			Gates member	"Monias" member			Lemuroceras
		Mooselar shale	Loon River formation	Loon River formation	Mooselar shale	Clearwater formation	Beudanticeras
		Gething sandstone	Gething sandstone		Gething sandstone		Inoceramus dowlingi
		Lower Bullhead sandstone		? Basal Sands		McMurray formation	
					</		

marine shales and sandstones of the Peace River formation, and the marine shales of the Shaftesbury formation". Thus McConnell's "Colorado" now becomes the Fort St. John group.

LITHOLOGY

In outcrops along the Peace River the Loon River formation consists of dark grey to black, friable, non-calcareous, locally silty shales that contain numerous discontinuous limestone and ironstone nodules or concretions. These shales become closely banded with the thin ironstone layers near the base.

The lithology of the Loon River formation is fairly uniform. Minute particles of carbonaceous material frequently are disseminated through the formation. Microflakes of white and black mica are also common. A platy cleavage is often present in the shales due to fine lamination of the shale with silt. The silt is rarely more than one-quarter of an inch thick, although locally it may come in coarser laminae. The presence of glauconite was observed, but locally and sparsely distributed.

Although non-calcareous these dark shales do contain limestone and ironstone concretionary layers and bands scattered throughout. These layers do not lend themselves readily to correlation from exposure to exposure.

The Loon River shales are considered by some workers to be near shore deposits. The writer considers that the Loon River formation is a basin deposit in the shallow to deep neritic environment.

To the north of Peace River town where the Loon River shale is penetrated by the wells of the Peace River Oil Company the formation becomes more arenaceous, especially near the base. The upper part of the formation also contains small beds of sandstone which are absent in exposures downstream.

There is some doubt whether the sandstone found at the base of the Cretaceous section in deep wells near Peace River town is a western extension of the McMurray formation of the lower Athabaska River section, or merely a sandy phase of the basal Loon River formation.

The contact of the Loon River shale with the overlying Peace River formation is gradational and alternating with much lateral replacement of sandstone by shale so that the contact ascends stratigraphically northward.

The Appendix to this thesis includes a detailed description of the lithology of the outcrops of the Loon River formation from which the shale samples, on which this microfaunal study is based, were collected.

EXTENT AND THICKNESS

McLearn (ref. 15) estimates the thickness of the Loon River formation on the Peace River at the "great bend" as 400 feet and in the wells to the south and west as 1100 feet. This indicates a great thickening to the south and west.

Based on megafaunal evidence the Clearwater and Moosebar formations, both marine sequences, have been correlated, in part, or in whole, with the Loon River

formation. The Clearwater formation outcrops along the lower Athabaska River, to the east of the Loon River outcropping area, and a thickness of 275 feet is quoted with the underlying McMurray formation assigned 180 feet. The Moosebar formation outcrops to the west of the area of Loon River outcrops, and is 800-1000 feet thick, with the underlying Gething formation 1400 feet thick. This indicates that marine shale beds deposited by the Clearwater sea increase gradually in thickness from east to west. Thus, the thickening of the Loon River formation between the "great bend" on the Peace River and the wells to the south and west seems to be overestimated due to underestimation of the thickness on the lower Peace River.

PALAEONTOLOGY

Major correlations of the Loon River formation are based mainly on the presence of a megafauna in the Loon River shales of the eastern Peace River area, Alberta, containing the ammonite genera Lemuroceras and Beudanticeras. A lower fauna of the Loon River formation contains the pelecypod species Inoceramus dowlingi.

The Lemuroceras fauna was previously known as the Beudanticeras affine fauna. Due to the fact that Beudanticeras has a much wider stratigraphic range than Lemuroceras the latter is preferred as the zone fossil. The Beudanticeras affine fauna was first described by Whiteaves (ref. 28) from collections made by McConnell in 1889-90 during his early geological investigation of the Peace River area. Whiteaves (ref. 28) originally

described this species as Desmoceras affine.

The Lemuroceras or Beudanticeras affine fauna includes Lemuroceras cf. indicum (Spath), Lemuroceras irenense McLearn, Lemuroceras belli McLearn, Beudanticeras affine (Whiteaves), Brachydontes athabaskensis McLearn, Artica limpidiana McLearn, Artica sp., Thracia kissoumi McLearn, Astarte portana McLearn, Aucellina ? dowlingi McLearn, Pinna curvimarginata McLearn, Yoldia kissoumi McLearn, Protocardia alcesiana McLearn, Tellina ? dowlingi var. silentia McLearn, Oxytoma camelli McLearn, Inoceramus dowlingi McLearn, Nucula athabaskensis McLearn, Onestia onestae McLearn, Tancredia ? dowlingi McLearn, and Entolium irenense McLearn. Elements of this fauna have been collected on the Wabiskaw (Loon) River, on the Mikkwa (Red) River, and on the Peace River.

Stelck (ref. 26) reports that Lemuroceras has been collected from the top of the Moosebar shale on Pine River; from the top of the Moosebar shale and base of the Gates formation in the western Peace River area; and from the basal (Monias) member of the Peace River formation in the eastern Peace River area. Lemuroceras ranges from the upper part of the Moosebar formation up into the lower part of the Gates formation (type section), and from the Monias member of the Peace River formation down into the upper part of the Loon River shale. The Lemuroceras fauna is also present in the Clearwater formation of the lower Athabaska River section.

F. H. McLearn (ref. 18) has discussed the European correlation of the Lemuroceras fauna establishing correlation with the Middle Albian sub-stage of England.

The faunas of the Fort St. John group correlate more readily with the European faunal assemblages for diagnostic zonal calibration than with the Cretaceous of the Gulf Coast region of North America. Stelck (ref.26) states that the base of the Middle Albian, from faunal correlation with the European Cretaceous mammillatum zone, should be drawn within the Loon River and Moosebar formations at least 200 feet below their upper contacts. Cleonicer sp., which is closely akin to Cleonicer subbaylei Spath reported by Spath (ref.25) from the Folkstone of England, is present below the horizon of Inoceramus dowlingi in the Loon River shale. The former genus belongs to the tardefurcata zone (uppermost Lower Albian) of Europe and thus Cleonicer sp. found in the Loon River formation is considered to be uppermost Lower Albian or lowermost Middle Albian.

The Lemuroceras fauna lived in the "Clearwater" Sea, a boreal sea extending down from the north and covering Northeastern British Columbia and Northern Alberta as far south as the town of Athabaska. As such the micro-fauna dealt with in this thesis should not be a near-shore or shoreline fauna. The marine sediments of the Clearwater and basal Grand Rapids formations on lower Athabaska River, the Loon River formation and the Monias (basal) member of the Peace River formation on the lower Peace River, the Moosebar and probably lower part of the Commotion formations on Pine River, probably some lower part of the Buckinghorse formation on Buckinghorse and Sikanni Chief Rivers, B.C., all show "Clearwater Sea" floodings.

CHAPTER III

PALAEONTOLOGY AND CORRELATION

PALAEONTOLOGY

Seven microfaunal assemblages are recognizable in the portion of the Loon River formation studied in this thesis. Four megafaunal zones, two coincident with two of the microfaunal assemblages, and two stratigraphically higher than the scope of this thesis, are recognizable in the uppermost Loon River strata. There is an additional marine microfaunal assemblage, stratigraphically lower than the faunas studied in this thesis, known to occur in Loon River shale outcrops below Fort Vermilion on the Peace River.

The microfaunal zones are arbitrarily set up based on the microfaunal assemblage present and designated by the name of the most common or diagnostic species present.

The succession of faunal assemblages of the Loon River formation is as follows:

Lemuroceras

Beudanticeras

Haplophragmoides 318-B*

Gyroidina 355-A

Haplophragmoides 360-A - Inoceramus dowlingi

Conostrobus 384-A - Cleonicerias

Haplophragmoides 424-A

"Spores" (Norris, ref. 22)

Artocapsa 704-C

Marine fauna below Fort Vermilion

* See p 29

Marine Fauna Below Fort Vermilion

The microfaunal assemblage occurring in the Loon River formation below Fort Vermilion carries Robulus and Miliammina. This fauna occurs between 150 feet and 270 feet above the top of the Devonian limestones. This has not been examined by the writer.

Artocapsa 704-C Fauna

^ This distinct microfaunal assemblage occurs approximately 400 feet above the top of the Devonian limestones, and is very limited in vertical extent. This fauna includes the following species:

Artocapsa 704-C

Cyrtocapsoma ? 704-A

Cyrtocapsoma 704-B

Bathysiphon ? sp.

Gaudryina sp.

Haplophragmoides 366-A

Haplophragmoides 424-A

Hyperammina sp.

The above fauna is partially illustrated on Plate I of this thesis.

This fauna is characterized by the presence of radiolarians - Artocapsa, Conostrobus, and Cyrtocapsoma, which dominate the assemblage. The radiolarians are pyritized which makes comparison with other species of radiolarians difficult. Radiolarians do not appear to be very common in the Cretaceous of Western Canada for very few genera have been reported. The three radiolarian genera reported here, to date (1951), have

not been previously reported from the Cretaceous of Western Canada.

Poorly preserved specimens of two long ranging, small Haplophragmoides appear for the first time in this fauna; only a few poorly preserved specimens of Bathysiphon ? and Gaudryina are present; one specimen of a small Hyperammina, well preserved is also present.

Fauna of the "Spore" Zone

This zone is characterized by an abundance of "spores". These spores are being investigated in a companion study of the Loon River formation by A. W. Norris.

The microfauna of the "spore" zone contains many foraminiferal genera but preservation is poor, the fauna is a dwarf one, and the individual genera are represented by few specimens. The faunal assemblage includes:

Ammobaculites sp.

Bathysiphon sp.

Cibicidella ? 483-A

Discorbis ? sp.

Haplophragmoides 366-A

Haplophragmoides 424-A

Hyperammina sp.

Marginulina ? sp.

Miliammina sp.

Proteonina sp.

Reophax sp.

Saccamina sp.

Spirillina sp.

Trochammina sp.

A few species of this fauna are illustrated on Plate I of this thesis.

These forms occur sporadically throughout the zone and are nowhere abundant. The specimens are so poorly preserved, and so small that identification in many cases is very difficult.

Presence of small, poorly preserved specimens of the two long ranging Haplophragmoides is again noted; also specimens of well preserved Spirillina and Cibicidella ?. The latter two genera are restricted to the upper part of this zone.

It is quite noticeable that when spores are abundant there is a paucity of foraminifera and vice versa. Several species of foraminifera do appear to live fairly well in an environment favouring spores, e.g. a Haplophragmoides and several Miliammina.

Haplophragmoides 424-A Fauna

This zone is divided into two sub-zones, the upper or Ammodiscus 411-A sub-zone, and the lower or "spore"-bearing sub-zone. The zone species, Haplophragmoides 424-A occurs in some abundance in both sub-zones but reaches its maximum development in the lower sub-zone. Elements of this fauna are found sporadically distributed in the zones above and below. Species included in this fauna are:

Ammodiscus 411-A sub-zone

Ammobaculoides sp.

Ammodiscus 411-A

Bathysiphon sp.

Gaudryina sp.

Glomospira 311-B

Glomospira sp.

Haplophragmoides 366-A

Haplophragmoides 414-A

Haplophragmoides 424-A

Marginulina sp.

Miliammina sp.

Saccamina sp.

Spiroplectammina sp.

Dictyomitra cf. multicostata

"Spore"-bearing sub-zone

Ammodiscus 411-A

Haplophragmoides 424-A

Miliammina 380-A

Reophax sp.

This fauna is partially illustrated on Plate I of this thesis.

Haplophragmoides 424-A is long ranging, first appearing in the Artocapsa 704-C faunizone reaching a maximum in the lower part of its own zone, and continuing up to and into the Haplophragmoides 360-A zone. Haplophragmoides 424-A seems to favour an environment in which spores are found for it appears when the "spores" appear, and continues upward until the "spores" decrease to an insignificant number in the lower sub-zone of Haplophragmoides 360-A zone.

The microfaunal assemblage of the upper sub-zone is dominated by the presence of the species Ammodiscus

411-A. This form is fine-grained, restricted to this zone with maximum development in the upper sub-zone.

The long ranging form Haplophragmoides 366-A is also present; few specimens of well preserved Glomospira, Miliammina, Spiroplectammina ?, Saccamina and Gaudryina are present; also poorly preserved specimens, or fragments of specimens of Marginulina, Reophax, Ammobaculoides, and Bathysiphon.

A radiolarian, Dictyomitra, very similar to Dictyomitra multicostata Zittel is found in the upper sub-zone of this fauna.

Fish teeth and bone material are present in the upper sub-zone of this fauna.

Conostrobus 384-A Fauna

This fauna consists essentially of two radiolarian species, restricted to this zone, which is very limited in vertical extent. Cleoniceras sp. occurs within this fauna. Species included in this fauna:

Conostrobus 384-A

Conostrobus 388-A

Gaudryina 363-A

Glomospira sp.

Elements of this fauna are illustrated on Plate I of this thesis.

The two fairly thin walled species of Conostrobus are well developed; the other species are represented by few specimens.

The absence of the underlying long ranging zone fossil, Haplophragmoides 424-A, is the most marked

change from previous faunas of the Loon River and distinguishes this fauna from the overlying Haplophragmoides 360-A zone which also carries Haplophragmoides 424-A.

The presence of radiolarians and Cleoniceras sp. indicates that more open sea conditions existed at this time, favoring pelagic faunas and European connections.

Haplophragmoides 360-A Fauna

Elements of this fauna grade upwards into the overlying Gyroidina 355-A faunal assemblage. This faunizone is divided up into an upper non-"spore" bearing sub-zone and a lower "spore" bearing sub-zone. Inoceramus dowlingi occurs in the upper sub-zone. This fauna includes:

Non-"spore" bearing sub-zone

Ammobaculites 363-C

Discorbis 355-B

Discorbis sp.

Ellipsonodosaria sp.

Gaudryina 361-B

Gaudryina 363-A

Glomospira 311-B

Guttulina sp.

Haplophragmoides 360-A

Haplophragmoides 361-A

Haplophragmoides 366-A

Hyperammina sp.

Marginulina ? sp.

Reophax sp.

Verneuilina 360-B

Verneuilina 366-B

"Spore" bearing sub-zone

Gaudryina 363-A

Glomospira 311-B

Haplophragmoides 360-A

Haplophragmoides 366-A

Haplophragmoides 424-A

Miliammina 380-A

This fauna is partially illustrated on Plate I of this thesis.)

(This fauna is characterized by several species of Haplophragmoides that have many chambers in the ultimate whorl. These forms carry on sporadically up into the overlying Gyroidina 355-A zone and disappear.

The lower, "spore" bearing sub-zone, contains few of the species of this fauna. The abundance of spores and paucity of microfauna, and vice versa, seems to hold true throughout the faunas studied in this thesis.

The presence of Haplophragmoides 424-A is noted for the last time, in the lower sub-zone of this fauna. The "spores" become sporadic in distribution in the zones above and insignificant in numbers.

Gaudryina and Verneuilina are also common; a Reophax with deeply impressed sutures, and a well developed Glomospira are represented by few specimens; also a few specimens of intermittently occurring^r calcareous forms.

The long ranging form, Haplophragmoides 366-A, after sporadic occurrences in the lower zones, reaches

maximum development in the upper sub-zone of this fauna, continues upward into the overlying Gyroidina 355-A zone and there disappears.

A well developed small Miliammina which was more abundant in the lower sub-zone of the Haplophragmoides 424-A fauna is also present in the "spore" bearing sub-zone of this fauna, where spores are in moderate to good abundance.

Gyroidina 355-A Fauna

V This microfaunal assemblage is characterized by the presence of several calcareous foraminifera. It is one of the rare calcareous faunas reported from the Lower Cretaceous of Western Canada. Species included in this fauna are:

<u>Ammobaculites</u>	363-C
<u>Bathysiphon</u>	356-A
<u>Discorbis</u>	355-B
<u>Gaudryina</u>	363-A
<u>Glomospira</u>	311-B
<u>Gyroidina</u>	355-A
<u>Haplophragmoides</u>	360-A
<u>Haplophragmoides</u>	361-A
<u>Haplophragmoides</u>	366-A
<u>Marginulina</u> sp.	
<u>Saracenaria</u> sp.	
<u>Verneuilina</u>	360-B

This fauna is well illustrated on Plate I of this thesis.

A low-spired Gyroidina has been chosen as the zone-name fossil. There is a large Bathysiphon restricted

to this fauna. Echinoid spines occur in fairly large numbers in the suite containing the maximum development of the calcareous microfauna. Few specimens of Saracenaria and Marginulina are also present. The arenaceous microfauna of this zone, except for the Bathysiphon, is that of the Haplophragmoides 360-A fauna. This fauna might be considered a sub-zone of the H. 360-A zone but due to the presence of this very distinct calcareous fauna and the large Bathysiphon the writer considers that this is a separate zone.

Haplophragmoides 318-B Fauna

This microfaunal assemblage is stratigraphically the highest reported in this thesis. It occurs about 200 feet below the top of the Loon River formation.

This fauna carries the following species:

Ammobaculites 363-C

Bathysiphon 313-A

Dentalina sp.

Gaudryina 318-A

Glomospira 311-B

Guttulina sp.

Haplophragmoides 311-A

Haplophragmoides 318-B

Haplophragmoides sp.

Hyperammina sp.

Miliammina sp.

Nodosaria sp.

Reophax sp.

Verneuilina 316-A

Verneuilina sp.

The above fauna is partially illustrated on Plate I of this thesis.

This fauna is characterized by the presence of a very distinct form, Haplophragmoides 318-B. This species is very different from any previously described from the Cretaceous of Western Canada. Verneuilina and Gaudryina are common throughout this fauna. Glomospira 311-B, which occurs sporadically in several of the lower zones, reaches its maximum development in this microfaunal assemblage. Calcareous foraminifera are present but not in significant numbers. Only a few specimens of a large Hyperammina, a small Reophax, a Dentalina, and a Miliammina are also present. The radiolarian, Dictyomitra, is represented by a few pyritized specimens.

CORRELATION OF THE LOON RIVER MICROFAUNAL ASSEMBLAGES

Correlation with Pine River Area, British Columbia

The Gyroidina 355-A faunal assemblage of the Loon River formation may be correlated with the microfaunal suites from the lower Moosebar shales in the Pine River area, British Columbia, from above the Gething member of the Bullhead group and below the Lemuroceras zone of the St. John group.

The following paired species are identical or show marked similarity:

<u>Moosebar shale</u>	<u>Loon River shale</u>
<u>Bathysiphon</u> 22-150A	<u>Bathysiphon</u> 313-A
<u>Bathysiphon</u> ? 22-160A	<u>Bathysiphon</u> 356-A
<u>Guttulina</u> 20-92A	<u>Guttulina</u> sp.
<u>Gyroidina</u> 20-51C	<u>Gyroidina</u> 355-A
<u>Marginulina</u> 22-146B	<u>Marginulina</u> sp.

The above list includes described and undescribed forms. The Moosebar shale contains other calcareous foraminifera not found in the Loon River formation probably replaced by arenaceous forms in the facies of the latter formation.

On the microfaunal evidence presented above, the Gyroidina 355-A zone of the Loon River formation is correlated with the basal Moosebar shale. Thus, the major portion of the faunas described in this thesis is found in strata stratigraphically lower than the Moosebar shale. By normal sequence, the lower beds of the Loon River formation should be correlated with the upper Gething. Beach and Spivak (ref. 2) found a conglomerate filling small channels and depressions in the top of the Gething sandstone, which indicates an interval of erosion before deposition of the Moosebar shale. Since the age of the lower beds of the Loon River formation is not definitely established the possibility arises that the lower beds of the Loon River formation are represented farther west by this period of erosion or possibly non-deposition, between the Gething sandstone and the Moosebar shale.

Correlation with Lesser Slave Lake Area, Alberta

Because there is no published information on microfaunas from the horizon of the Loon River shale the writer personally examined suites from a Northern Alberta well at correlative horizons. The Bear Villa No. 1 well was chosen because of the availability of microfaunal suites.

A dominantly calcareous microfaunal assemblage with several elements common to the Gyroidina 355-A zone of the Loon River shale, occurs in the Loon River (?) shale in Bear Villa No. 1, about 40 feet above an ostracode zone.

The following paired species from the Bear Villa well and the Gyroidina 355-A zone are identical or show marked similarity:

<u>Bear Villa No. 1 (2539'-2545')</u>	<u>Loon River formation</u>
<u>Discorbis</u> sp.	<u>Discorbis</u> 355-B
<u>Gyroidina</u> sp.	<u>Gyroidina</u> 355-A
<u>Marginulina</u> sp.	<u>Marginulina</u> sp.
<u>Saracenaria</u> sp.	<u>Saracenaria</u> sp.

Similar echinoid spines are common to both of these dominantly calcareous suites. The arenaceous forms of these two suites are not identical. Also the Bear Villa well suites contain calcareous forms not present in the Gyroidina 355-A zone of the Loon River formation.

On the basis of the microfaunal evidence presented here the section in the Bear Villa well, beginning about 40 feet above an ostracode zone and carrying this calcareous fauna, is correlated with the Gyroidina 355-A zone of the Loon River formation.

Stelck (ref.26) reports a calcareous fauna is present in the basal part of the Clearwater formation, but points out that the fauna from the base of the Clearwater formation is not equivalent to basal Moosebar suite and suggests that the basal Clearwater fauna is a slightly earlier fauna than the Lower Moosebar fauna.

The basal Clearwater fauna has not been found in the Loon River. Since the Gyroidina 355-B zone is here correlated with the basal Moosebar fauna the suggestion is also present that the basal Clearwater fauna, if it has a correlatable equivalent in the Loon River, occurs in the portion of Loon River stratigraphically lower than the Haplophragmoides 360-A zone.

Evidence from ostracodes indicates that the basal Clearwater shale correlates with the Cummings member of the Mannville formation. Since only one form similar to the Cummings member fauna was found in the Loon River formation, and the Cummings member is correlated with the basal Clearwater shale, it appears that the Cummings member fauna must be stratigraphically lower than the Haplophragmoides 360-A zone.

CHAPTER IV

FORMAL DESCRIPTION OF MICROFAUNA

The Loon River formation microfaunal suites are composed of foraminifera and radiolarians. The foraminiferal suites are composed of arenaceous and calcareous specimens, with a dominance of arenaceous forms. The microfaunal assemblages of the Loon River formation reported in this thesis are almost entirely different from any previously described fauna from North America. Specimens described in this thesis are given species rank and are designated by a number rather than a name to avoid creating manuscript names. In the event of publication these new species will be named.

The species of microfauna illustrated and described in this thesis are representative specimens of the fauna present in the portion of the Loon River formation studied.

The fauna is divided into two groups, foraminifera and radiolarians, and described in that order. The forms are described in alphabetical sequence in each group. The three numbers of the species designation refer to the suite in which the hypotype was found. The stratigraphic position of the suites, within individual outcrops, may be obtained from the appendix.

ORDER FORAMINIFERA

GENUS AMMOBACULITES CUSHMAN 1910

Ammobaculites 363-B

Plate 1, Figure 1

Test elongate, early portion closely coiled with small umbilicus; four chambers in coiled portion, five chambers in straight series constitute the later portion, last three chambers pyriform in shape, chambers increasing slightly in diameter as added; sutures depressed, straight; wall finely arenaceous with sand grains of fairly even grade of about 0.018 mm. covered by a clear cement carrying occasional sporadic sand grains in the outer layer, cement shows a pebbled surface in part reflecting the irregular surface of the inner layer of sand grains; aperture simple, terminal.

Length of hypotype - 0.68 mm., diameter of coiled portion - 0.18 mm.; length of ultimate chamber - 0.19 mm., width of ultimate chamber - 0.22 mm.

Hypotype locality: Peace River, Tp. 99, R. 19, W. 5 meridian, Alberta, locality 0 138B, 65 feet above water level, from upper part of Loon River shales,
Haplophragmoides 360-A.Zone.

Hypotype - University of Alberta Palaeontological
Type Collection

Remarks: This specimen was probably slightly elliptical to circular in cross-section previous to crushing. This species is almost identical with Ammobaculites humei Nauss, from the Cummings member of the Mannville formation, and as such the writer has little hesitation in designating

it as Ammobaculites cf. humei. The suture lines in the straight portion appear curved which differs from those of A. humei but this curving may be due to crushing of the specimen. This species differs from Ammobaculites tyrrelli Nauss, from the Lloydminster shale in that the sutures are indistinct and walls are not smoothly finished as they are in the latter form, except in the coiled portion where they are smoothly finished.

GENUS AMMODISCUS REUSS 1861

Ammodiscus 411-A

Plate 1, Figure 11, 12

Test planispiral, small, subcircular in outline, compressed, slightly concave on both sides, periphery rounded; sub-globular proloculum and a long undivided tubular second chamber, tubular chamber gradually and uniformly increasing in size with succeeding coils; sutures distinct; wall thin, composed almost entirely of cement with a smooth exterior finish; aperture simple, terminal, open end of tube; colour white to translucent.

Diameter of hypotype - 0.25 mm., to 0.23 mm., diameter of tube in ultimate coil about 0.03 mm.

Hypotype locality: Peace River, Tp. 101, R. 19, W. 5 meridian, Alberta, locality O 164A, 32 feet above water level, from middle portion of Loon River shales, Haplophragmoides 424-A zone.

Hypotype - University of Alberta Palaeontological
Type Collection

Remarks: The hypotype specimen shows a yellowish infilling which is not characteristic of the paratypes.

This species resembles Ammodiscus glabratus Cushman and Jarvis in wall makeup and appearance but differs in having fewer convolutions and in being much smaller. This form has a somewhat Glomospira - like appearance but seems to be coiled quite regularly entirely in one plane.

GENUS BATHYSIPHON M. SARS 1872

Bathysiphon 313-A

Plate 1, Figure 17

Test elongate, a straight cylindrical chamber open at both ends; with medium-thick walls composed of finely arenaceous material and a thin external coating of cement giving a poor glaze, mottled finish to the exterior; slightly oblique, irregular tranverse incipient partings 0.095 mm. apart.

Length of hypotype - 0. 37 mm., diameter of hypotype 0. 17 mm.

Hypotype locality: Peace River, Tp. 98, R. 19, W. 5 meridian, Alberta, locality O 129C, 20 feet above water level, from upper part of Loon River shales.

Haplophragmoides 318-B zone.

Hypotype - University of Alberta Palaeontological
Type Collection

Remarks: This form is very similar to Bathysiphon 22-150A, as illustrated by Stelck from the Moosebar shales 150 feet above the Gething formation, in both the wall makeup and distance between transverse partings. These two specimens are considered conspecific.

Bathysiphon 356-A

Plate 1, Figure 31

Test large, elongate, a straight cylindrical tube, open at both ends; with thick arenaceous walls composed of finely arenaceous white cement material with a smooth finish on the exterior; exterior carries subordinated, oblique, inflected wrinkles that form an irregular chevron design on one side.

Length of hypotype - 1.23 mm., diameter of hypotype - 0.47 mm., thickness of wall - 0.08 mm.

Hypotype locality: Peace River, Tp. 99, R. 19, W. 5 meridian, Alberta, locality 0 138A, 145 feet above water level, from upper part of Loon River shales,

Gyroidina 355-A zone.

Hypotype - University of Alberta Palaeontological
Type Collection

Remarks: The hypotype specimen is crushed at one end. The pattern of inflected wrinkles and a certain modification on the crushed end of the tube suggest possible generic affinities with Hyperammia but until a paratype specimen might be obtained possessing a proloculum it is retained in the genus Bathysiphon.

Bathysiphon 356-A resembles Bathysiphon vitta Nauss from the Lea Park shale, in wall makeup, indistinct constrictions at regular intervals, and in diameter. The hypotype^p differs from Bathysiphon vitta in having much thicker walls, lacking compression, and lacking external black coating. This form is similar to Bathysiphon?

22-160-A, as illustrated by Stelck from Moosebar shales, in diameter but lacks once again the black outer coating.

GENUS CIBICIDELLA CUSHMAN 1927

Cibicidella ? 483-A

Plate 1, Figure 23

Test small, assumed trochoid in early portion; primary chambers poorly expressed, later chambers well expressed, inflated, irregularly disposed, six to twelve chambers in later portion; wall calcareous, coarsely perforate; sutures depressed; aperture obscured, apparently a small opening towards inner margin of terminal chamber.

Length of hypotype - 0.20 mm., width of hypotype - 0.13 mm.

Hypotype locality: Peace River, Tp. 102, R. 19, W. 5 meridian, Alberta, locality O 175B, 12 feet above water level, from middle portion of Loon River shales, "Spore" zone.

Hypotype - University of Alberta Palaeontological
Type Collection

Remarks: This form is with hesitation referred to the genus Cibicidella as the genus is considered to be confined to the Tertiary. Nature of the wall and the tendency toward irregular behaviour of the later chambers suggest affiliation with the Family Anomaliniidae. There is some suggestion that this form may have been attached originally in the region of the primary chambers. Whether the proloculum and epionic chambers are in

simple trochoid pattern is difficult to ascertain for the above reason.

The form of the species is quite variable, at times suggesting a globigerinoid shape, slightly distorted, and at other times a mere unorganized cluster of chambers, with chambers both of regular size and smaller auxiliary chambers present in some specimens. Except for the nature of the test wall the shape of individual specimens is sometimes suggestive of bleached glauconite pellets of microcoprolitic origin. Until an ontogenic series of specimens is built up for this species, the writer does not feel justified in setting up a new genus, and therefore refers it to Cibicidella ? without implying direct phyletic relationship to the Tertiary genus Cibicidella.

GENUS DISCORBIS LAMARCK 1804

Discorbis 355-B

Plate 1, Figure 16

Test small, subquadrangular in outline, convexo-concave, dorsal side weakly convex, elliptical in vertical section, periphery rounded; test trochoid with three convolutions, chambers distinct, increasing gradually in size, five chambers in ultimate whorl, six in penultimate whorl, and four in the primary whorl; spiral suture distinct, slightly thickened, transverse sutures distinct, curved, oblique; wall calcareous, finely perforate; aperture ventral, at base of the umbilical margin on the ventral side of the chamber.

Diameter (major) of hypotype - 0.20 mm., diameter (minor) of hypotype - 0.17 mm.

Hypotype locality: Peace River, Tp. 99, R. 19, W. 5 meridian, Alberta, locality O 138A, 150 feet above water level, from upper part of Loon River shales, Gyroidina 355-A zone.

Hypotype - University of Alberta Palaeontological
Type Collection

Remarks: The last two chambers of the hypotype are broken. This species differs considerably from Discorbis 22-146A illustrated by Stelck from Moosebar shales, in having much lower spire and much less oblique transverse sutures.

GENUS GAUDRYINA D'ORBIGNY 1839

Gaudryina 318-A

Plate 1, Figure 30

Test slightly curved, tapering, rounded in cross-section, elongate; triserial in early portion, later and much the larger portion biserial, triserial portion slightly twisted, biserial portion very slightly twisted, consists of 29 chambers, 18 in triserial portion, 10 or 11 in biserial portion, chambers not inflated; sutures thickened, indistinct, slightly depressed; wall finely arenaceous with an ill-defined mosaic of grains on the outside with certain grains more apparent in the mosaic pattern, and then covered with much cement giving a somewhat smooth finish to the exterior. The external layer of sand grains and the outer layer of cement obscures the sutures and sub-ordinates the expression of the chambers; aperture low arched opening at inner margin of the terminal face of last formed chamber.

Length of hypotype - 0.70 mm., width of hypotype - 0.21 mm., length of triserial portion - 0.21 mm.

Hypotype locality: Peace River, Tp. 98, R. 19, W. 5 meridian, Alberta, locality 0 129C, one foot above water level, from upper part of Loon River shales, Haplopragmoides 318-B zone.

Hypotype - University of Alberta Palaeontological
Type Collection

Remarks: This species resembles Gaudryina hectori Nauss, from the Lloydminster shale, but the former has more chambers in the triserial portion and the latter has better expression of chambers.

Gaudryina 361-B

Plate 1, Figure 2

Test medium, elongate, widest at penultimate convolution; triserial in early portion, biserial in later portion, triserial portion strongly twisted, biserial portion only slightly so; consists of 28 chambers, 24 in triserial portion, 4 in biserial portion, chambers distinct, inflated especially in later portion; sutures distinct, depressed, with good expression of vertical rows of chambers; test wall finely arenaceous with much cement; aperture a high arched slit with raised, rounded margins, on the inner margin of the terminal chamber; colour light grey.

Length of hypotype 0.57 mm., width of hypotype - 0.17 mm., length of biserial portion - 0.19 mm.

Hypotype locality: Peace River, Tp. 99, R. 19, W.

5 meridian, Alberta, locality O 138B, 75 feet above water level, from upper part of Loon River shales, Haplophragmoides 360-A zone.

Hypotype - University of Alberta Palaeontological
Type Collection

Remarks: This species is similar to Verneuillina 360-B except that increased twisting within the triserial arrangement finally results in a biserial convolution which by definition is a generic attribute of Gaudryina.

Gaudryina 363-A

Plate 1, Figure 6

Test medium, elongate, tapering; early portion triserial, later and much the larger portion biserial, consists of 25 chambers, 15 in triserial portion, 10 in biserial portion, chambers distinct, slightly inflated in biserial portion; sutures indistinct in the triserial portion, distinct, oblique in the biserial portion, depressed, giving marginal lobate appearance; wall finely arenaceous with much cement giving a smooth finish to exterior surface; aperture terminal, a low slit on the inner margin of the ultimate chamber.

Length of hypotype - 0.57 mm., width of hypotype - 0.17 mm., length of biserial portion of hypotype 0.14 mm.

Hypotype locality: Peace River, Tp. 99, R. 19, W. 5 meridian, Alberta, locality O 138B, 65 feet above water level, from upper part of Loon River shales, Haplophragmoides 360-A zone.

Hypotype - University of Alberta Palaeontological
Type Collection

Remarks: This species is very similar to Gaudryina 318-A but differs in being thinner, shorter in length, sutures more distinct, and lacks the cylindrical shape of the later portion of Gaudryina 318-A. This form differs from Gaudryina hectori Nauss, from the Lloydminster shale in having more chambers in the triserial portion, and aperture a low slit rather than a high arched slit.

GENUS GLOMOSPIRA RZEHA 1888

Glomospira 311-B

Plate 1, Figure 21, 22

Test small, sub-circular to oblate in outline; test composed of sub-globular proloculum and a long, undivided, tubular second chamber; early turns irregularly planispiral, later turns in irregular concentric coils; sutures distinct, depressed; wall finely arenaceous, with a large percentage of cement, smooth appearance to exterior surface of test; aperture simple, terminal, at open end of tube with inner margin of aperture provided by an earlier portion of the test, usually the previous coil; colour white.

Length of hypotype - 0.37 mm., width of hypotype 0.28 mm.

Hypotype locality: Peace River, Tp. 98, R. 19, W. 5 meridian, Alberta, locality O 129C, 26 feet above water level, from upper part of Loon River shales, Haplophragmoides 318-B zone.

Hypotype - University of Alberta Palaeontological
Type Collection

Remarks: This form closely resembles Glomospira
gardialis (Jones and Parker) in wall makeup and arrange-
ment of coils but differs in being much smaller than the
latter form.

GENUS GYROIDINA D'ORBIGNY 1826

Gyroidina 355-A

Plate 1, Figure 7, 8

Test trochoid, plano-convex, dorsal side flattened,
slightly convex, ventral side bluntly conical with a
small open, excavated umbilicus; periphery with a round-
ed angle at the dorsal edge; chambers distinct, tri-
angular in side view, increasing in size as added with
ultimate chamber slightly inflated, five and a half in
the ultimate whorl, four and a half in penultimate whorl;
sutures distinct, depressed on ventral side and slightly
so in peripheral region, impressed on the ultimate whorl
of dorsal side, obscured on earlier whorls, sutures
slightly curved, radial, spiral suture distinct,
impressed; wall calcareous, smooth, finely perforate;
aperture a low arched slit at the base of the terminal
face of the ultimate chamber running from periphery
down to umbilicus on the inside edge of the terminal
face.

Diameter (major) of hypotype - 0.23 mm., diameter
(minor) of hypotype - 0.18 mm., thickness of hypotype -
0.10 mm.

Hypotype locality: Peace River, Tp. 99, R. 19, W. 5 meridian, Alberta, locality O 138A, 150 feet above water level, from upper part of Loon River shales, Gyroidina 355-A zone fossil.

Hypotype - University of Alberta Palaeontological
Type Collection

Remarks: This form is similar to Gyroidina 20-51C, illustrated by Stelck from lower part of Moosebar shales, but differs from the Moosebar species in being finely perforate and chambers visible in the spire. Gyroidina 20-51C is coarsely perforate and has a callous over the spire so that the chambers are not visible. This might be varietal difference or is possibly from difference in preservation.

GENUS HAPLOPHRAGMOIDES CUSHMAN 1910

Haplophragmoides 311-A

Plate 1, Figure 9

Test small, involute, planispiral, close coiled with small deep umbilicus; lobate periphery rounded; chambers globose, distinct, ultimate chamber inflated, four and a half chambers visible in the ultimate whorl; sutures distinct, slightly thickened, depressed, slightly curved; wall finely arenaceous with clear cement which reveals outline of some grains, smooth finish to exterior; aperture low crescentic arch at the base of terminal face of ultimate chamber; colour brown.

Diameter (major) of hypotype - 0.22 mm., diameter (minor) of hypotype - 0.18 mm., thickness of hypotype - 0.13 mm.

Hypotype locality: Peace River, Tp. 98, R. 19, W. 5 meridian, Alberta, locality O 129C, 26 feet above water level, from upper part of Loon River shales, Haplophragmoides 318-B zone.

Hypotype - University of Alberta Palaeontological
Type Collection

Remarks: This form is very similar to Haplophragmoides 366-A but four and a half chambers in the ultimate whorl is more characteristic of this form. These species probably stand in varietal relation to each other. This species is similar to Haplophragmoides linki Nauss, from Lloydminster shale, but has fewer chambers and umbilicus less well defined. Haplophragmoides 311-A bears a close resemblance to Haplophragmoides kirki Wickenden but differs from the latter form in that the sutures are slightly curved, and is smaller. These species possibly stand in sub-specific relationship to one another.

Haplophragmoides 318-B

Plate 1, Figure 27

Test small, close coiled, periphery rounded, small elliptical umbilicus, involute in early chambers becoming slightly evolute in later chambers, not bilaterally symmetrical, with terminal face set oblique to the plane of coiling; chambers indistinct, 10 or 11 visible in ultimate whorl; sutures indistinct, slightly curved; wall finely arenaceous with considerable cement, exterior surface smooth, saccharoid but not glossy; aperture a high trigonal opening at base of terminal

face of ultimate chamber.

Diameter (major) of hypotype - 0.55mm. diameter (minor) of hypotype - 0.47mm., thickness of hypotype - 0.17mm.

Hypotype locality: Peace River, Tp. 98, R. 19, W. 5 meridian, Alberta, locality O 129C, one foot above water level, from upper part of Loon River shales, Haplophragmoides 318-B zone fossil.

Hypotype - University of Alberta Palaeontological
Type Collection

Remarks: This form bears some relationship to Haplophragmoides 361-A, possibly the latter species is ancestral to H. 318-B. Haplophragmoides 318-B could have been derived by the addition of three large chambers to the form Haplophragmoides 361-A.

Haplophragmoides 360-A
Plate 1, Figure 26

Test small, somewhat compressed, closely coiled, involute becoming slightly evolute in later stages, periphery narrowly rounded, thickest part of test around umbilicus; chambers distinct, with 11 to 12 chambers visible in ultimate whorl, one and a half whorls visible; sutures indistinct, but their position emphasized by the strength of intercameral walls; sutures apparent near umbilical margin, outside chamber walls thinner than intercameral walls; wall finely arenaceous with rounded grains, considerable cement, smooth, finely pebbled surface; aperture a low arched opening at base of terminal face

of ultimate chamber, aperture extends further down from the periphery on one side than on the other (due to crushing?); colour light brown.

Diameter (major) of hypotype - 0.55 mm., diameter (minor) of hypotype - 0.47 mm., thickness of hypotype 0.17 mm.

Hypotype locality: Peace River, Tp. 99, R. 19, W. 5 meridian, Alberta, locality 0 133B, 80 feet above water level, from upper part of Loon River shales, Haplophragmoides 360-A zone fossil.

Hypotype - University of Alberta Palaeontological
Type Collection

Remarks: The thin external wall and stout intercameral walls give a depressed expression to the chambers. For this reason this form might be included under the form-species Haplophragmoides excavata. This species resembles Haplophragmoides 31-290-E, illustrated by Nielsen from lower part of Shaftesbury formation. Both forms are involute, showing evolute development on one side in later chambers but differ in H. 360-A being smaller and having more chambers in ultimate whorl than the Shaftesbury species. This form also bears a resemblance to Haplophragmoides rota Nauss, from Grizzly Bear shale, but the former is larger, has more chambers in ultimate whorl, and thicker intercameral walls. Haplophragmoides 360-A is similar to Haplophragmoides excavata Cushman and Waters but differs from the holotype in being smaller, having more chambers in ultimate whorl, and becoming evolute in later chambers of the ultimate whorl.

Haplophragmoides 361-A

Plate 1, Figure 3

Test small, slightly compressed, involute, small umbilicus, close-coiled, planispiral with slight tendency towards a polygonal development, periphery rounded; chambers distinct, with 14 chambers visible in ultimate whorl, young specimens show 12 to 13 chambers visible in ultimate coil; sutures indistinct, thickened, slightly curved, radial, sutures show on umbilical margin as slight notches; wall of finely arenaceous cement material; aperture a low arched slit at base of terminal face of ultimate chamber; colour buff to yellow.

Diameter (major) of hypotype - 0.38 mm., diameter (minor) of hypotype - 0.33 mm., thickness of hypotype 0.10 mm.

Hypotype locality: Peace River, Tp. 99, R. 19, W. 5 meridian, Alberta, locality 0 138B, 75 feet above water level, from upper part of Loon River shales, Haplophragmoides 360-A zone.

Hypotype - University of Alberta Palaeontological
Type Collection

Remarks: This form resembles Haplophragmoides 360-A but is smaller and has more chambers in ultimate whorl. Haplophragmoides 361-A is similar to Haplophragmoides 424-A in number of chambers and design but H. 361-A is stouter. These two species probably stand in sub-specific relationship to each other.

Haplophragmoides 366-A

Plate 1, Figure 10

Test small, involute, planispiral, close-coiled with small umbilicus, periphery rounded, somewhat lobate; chambers distinct, with five chambers visible in ultimate whorl; sutures distinct, depressed, straight becoming oblique at periphery; walls finely arenaceous with clear cement allowing the grains to show through, smooth finish on the exterior surface; aperture an obscure slit at base of terminal face of ultimate chamber.

Diameter of hypotype - 0.22 mm., thickness of hypotype - 0.10 mm.

Hypotype locality: Peace River, Tp. 99, R. 19, W. 5 meridian, Alberta, locality 0 138B, 50 feet above water level, from upper part of Loon River shales, Haplophragmoides 360-A zone.

Hypotype - University of Alberta Palaeontological
Type Collection

Remarks: This species is very similar to Haplophragmoides 311-A but five chambers in ultimate whorl is more distinctive of this species. These two forms probably stand in varietal relationship to each other. This form more closely resembles Haplophragmoides kirki Wickenden than does Haplophragmoides 311-A. H. 366-A differs from Haplophragmoides kirki Wickenden in that the umbilicus is larger.

Haplophragmoides 414-A

Plate 1, Figure 20

Test small, compressed, close-coiled, small umbilicus, specimen almost circular in outline, periphery rounded, thickest part of test around umbilicus, involute in early chambers becoming slightly evolute in ultimate chambers; chambers indistinct, irregularly distinguished if specimen is crushed, 11 or 12 chambers in ultimate whorl, one and a half whorls visible; sutures indistinct, slightly curved, radial; wall finely arenaceous with rounded grains and an abundance of cement; aperture a low arched opening at base of terminal face of ultimate chamber, suggestion of a slight overhanging lip on the aperture.

Diameter of hypotype - 0.65 mm., thickness of hypotype - 0.18 mm.

Hypotype locality: Peace River, Tp. 101, R. 19, W. 5 meridian, Alberta, locality O 164A, 15 feet above water level, from middle portion of Loon River shales, Haplophragmoides 424-A zone.

Hypotype - University of Alberta Palaeontological
Type Collection

Remarks: This form is similar to Haplophragmoides 360-A but has more cement and also a suggestion of a lip on the aperture. These two forms are probably in sub-specific relationship to each other.

Haplophragmoides 424-A

Plate 1, Figure 4

Test small, compressed, evolute, wide umbilicus, close-coiled, with two and a half coils visible, planispiral, periphery rounded; chambers distinct, with 13 chambers in the ultimate whorl, 11 chambers in penultimate whorl, and 5 in earliest half coil visible; sutures distinct, straight to slightly curved, radial; wall of finely arenaceous cement, very weak wall subject to crushing, smooth exterior; aperture an opening at base of terminal face of ultimate whorl; colour slightly buff.

Diameter(major) of hypotype - 0.42 mm., diameter (minor) of hypotype - 0.40 mm.

Hypotype locality: Peace River, Tp. 101, R. 20, W. 5 meridian, Alberta, locality 0 169A, 75 feet above water level, from middle portion of Loon River shales, Haplophragmoides 424-A zone fossil.

Hypotype - University of Alberta Palaeontological
Type Collection

Remarks: This form resembles the genus Trochamminoides but the writer feels that the position of the aperture retains it in Haplophragmoides. This species is similar to Haplophragmoides 361-A in that both forms have the same number of chambers and similar design but Haplophragmoides 361-A is stouter. These two forms are probably in sub-specific relation to each other.

GENUS MILIAMMINA HERON-ALLEN AND EARLAND 1930

Miliammina 380-A

Plate 1, Figure 28, 29

Test small, elliptical, compressed; chambers elongate, tubular, each chamber one half turn in length, chambers fairly distinct with a flattened quinqueloculine? arrangement; sutures slightly distinct, depressed; walls of finely arenaceous cement, with additional cement, in part obscuring earlier chambers and sutures; aperture simple, terminal; colour light buff.

Length of hypotype - 0.38 mm., width of hypotype 0.25 mm.

Hypotype locality: Peace River, Tp. 100, R. 20, W. 5 meridian, Alberta, locality 0 154A, 60 feet above water level, from upper part of Loon River shales, Haplophragmoides 360-A zone.

Hypotype - University of Alberta Palaeontological
Type Collection

Remarks: This species illustrates some relationship with Miliammina manitobensis Wickenden in the quinqueloculine arrangement of the chambers. The lack of development of a neck and noticeable constricted aperture differentiates this form from Miliammina manitobensis.

This form resembles Miliammina 32-14-B illustrated by Nielsen from the lower part of the Shaftesbury formation. It differs from the Shaftesbury form in its shorter length and its sutures being less distinct.

Miliammina 380-A resembles Miliammina 8-284H

illustrated by Stelck from the Buckinghorse formation, in arrangement of chambers, and the smooth dull finish of the exterior. It differs from the latter form in the greater regularity of its chambers.

GENUS VERNEUILINA D'ORBIGNY 1840

Verneuilina 316-A

Test small, tapering, robust, slightly twisted, bluntly sub-triangular in cross-section; triserial throughout, composed of seven convolutions of three chambers each; maximum width at ultimate convolution; transverse sutures indistinct, slightly depressed, longitudinal sutures distinct, depressed; wall finely arenaceous with grains up to 0.020 mm., moderate amount of cement in later portion; aperture at base of inner margin of terminal chamber.

Length of hypotype - 0.45 mm., width of hypotype 0.30 mm.

Hypotype locality: Peace River, Tp. 98, R. 19, W. 5 meridian, Alberta, locality O 129C, 10 feet above water level, from upper part of Loon River shales, Haplophragmoides 318-B zone.

Hypotype - University of Alberta Palaeontological
Type Collection

Remarks: This species has no comparative form recorded from the genus Verneuilina.

Verneuilina 360-B

Plate 1, Figure 5

Test small, tapering, twisted, elongate, rounded triangular in cross-section; triserial throughout, composed of nine convolutions of three chambers each; maximum width near apertural end; chambers inflated, distinct, increase in size throughout; sutures indistinct in early portion, distinct, depressed in later portion; wall finely arenaceous, grains about 0.018 mm. embedded in much cement; aperture sub-rectangular, at base of terminal chamber; color white with carbonaceous flecks on exterior surface.

Length of hypotype - 0.52 mm., width of hypotype 0.24 mm.

Hypotype locality: Peace River, Tp. 99, R. 19, W. 5 meridian, Alberta, locality 0 138B, 80 feet above water level, from upper part of Loon River shales, Haplophragmoides 360-A zone.

Hypotype - University of Alberta Palaeontological
Type Collection

Remarks: This form differs from "Verneuilina" cummingsensis Nauss, from the Cummings member of the Mannville formation, in having more chambers, being wider and the aperture sub-rectangular rather than an arched slit.

Verneuilina 366-B

Plate 1, figure 13

Test small, elongate, tapering, rounded triangular in end view; triserial throughout, five convolutions of three chambers each: maximum width at ultimate convolution; sutures distinct, impressed in early portion, becoming depressed in later portion; wall finely arenaceous, with grains up to 0.020 mm. set in a white cement; aperture a small opening at base of inner margin of last formed chamber; colour white with black carbonaceous flecks on surface accentuating sutural depressions.

Length of hypotype - 0.28 mm., width of hypotype 0.23 mm.

Hypotype locality: Peace River, Tp. 99, R. 19, W. 5 meridian, Alberta, locality 0 133B, 50 feet above water level, from upper part of Loon River shales, Haplophragmoides 360-A zone.

Hypotype - University of Alberta Palaeontological
Type Collection

Remarks: This species is similar to Verneuilina 316-A but differs from the latter hypotype in being smaller, and having fewer convolutions. The former species is considered to be either the young or ancestral form of Verneuilina 316-A.

ORDER RADIOLARIA

GENUS LITHOSTROBUS BUTSCHLI

SUBGENUS CONOSTROBUS HAECKEL

Lithostrobos (Conostrobos) 384-A

Plate 1, Figure 24

Shell small, broadly conical; apical horn tiny, terminal, slightly curved, conical, spine; cephalis rounded-conical, width about same as breadth at base, shell convexly conical with straight axis; joints with a transverse septal band and cervical indentation; cephalis, thorax, abdomen, and postabdomen (six joints) increased regularly in width, and proportionate to position in linear series in breadth; wall very thin, delicate; surface smooth, pores subcircular, freely crossing septal bands, simple perforations without accentuation, shell material clear, having an alternating reticulate meshwork, pores numerous, 3 transverse rows in each shell-joint, and seven or eight pores present in each transverse row visible from one side; aperture terminal, open end of shell.

Length of hypotype - 0.25 mm., width of hypotype - 0.13 mm., diameter of pores 0.013 mm.

Hypotype locality: Peace River, Tp. 100, R. 20, W. 5 meridian, Alberta, locality 0 154A, 55 feet above water level, from upper part of Loon River shales, Conostrobos 384-A zone fossil.

Hypotype - University of Alberta Palaeontological

Type Collection

Remarks: There is present in the paratypes a specimen with larger diameter of shell, pore number in each row is the same, but pores almost twice the size of the pores of the hypotype with skeletal meshwork of the same strength as the hypotype. It is not certain whether this paratype represents another species.

Lithostrobus (Conostrobus) 388-A

Plate 1, Figure 15

Shell small, shell slightly convexly conical with straight axis; apical horn tiny, terminal, conical, stublike spine; cephalis rounded-conical, width about same as breadth at base, with a transverse septal band, some median bulge, and indentation, nine joints increased regularly in width, according to respective positions in linear series in breadth, each joint with a distinct, transverse septal band and stricture, slight median bulge; surface with about 24 vertical striations, striations more refined towards cephalis, coarser towards distal end; pores circular?, four transverse rows in each shell-joint, pores in vertical alignment or nearly so, occupying the intercostal furrows, position of pore sometimes causing slight narrowing of linear costae.

Length of hypotype - 0.25 mm., width of hypotype 0.17 mm., diameter of pores 0.011 mm. at distal end, about 0.006 mm. on proximal end.

Hypotype locality: Peace River, Tp. 100, R. 20, W. 5 meridian, Alberta, locality 0 154C, 30 feet above water level, from upper part of Loon River shales, Conostrobus 384-A zone.

Hypotype - University of Alberta Palaeontological
Type Collection

Remarks: This species differs from Conostrobus 384-A in having more joints, longitudinal ribs, and pores arranged in vertical series in furrows between ribs. This species closely resembles the genus Dictyomitra but the presence of an apical horn places it in the genus Lithostrobus.

GENUS CYRTOCAPSA HAECKEL

SUBGENUS CYRTOCAPSOMA HAECKEL

Cyrtocapsa (Cyrtocapsoma) 704-A

Plate 1, Figure 19

Shell small, streamlined-shape with sharp apex; apical horn a tiny conical stub with sharp tip; cephalis (first joint) nearly twice as long as horn, conical; five transverse joints marked by narrow, horizontal septal bands, all joints regularly increased in width and diameter from apical to apertural end, sixth joint hemispherical, closed off at free end; pores of nearly similar size, honeycomb accentuation meshwork, three transverse rows of pores per shell-joint, and 22 pores in each transverse row, pores in part distinct, generally circular.

Length of hypotype - 0.40 mm., diameter of hypotype at sixth joint - 0.22 mm., diameter of pores - 0.013 mm.

Hypotype locality: Peace River, Tp. 108; R. 14, W. 5 meridian, Alberta, locality O 259A, at water level, from lower part of Loon River shales, Artocapsa 704-C zone.

Hypotype - University of Alberta Palaeontological
Type Collection

Remarks: The wall structure could not be determined because of pyritization. This form resembles Cyrtocapsoma 704-B but this is a complete specimen. Cyrtocapsoma 704-B is considered conspecific with this form, with the sixth joint broken off.

Cyrtocapsa (Cyrtocapsoma) 704-B

Plate 1, Figure 14

Shell small, slightly subconvexly conical with straight axis, somewhat constricted at apertural end; apical horn a tiny, terminal, conical, stublike but distally sharp; cephalis, thorax, abdomen, and postabdomen (6 to 7 joints) increased regularly in width, joints with distinct, transverse septal bands, no noticeable median bulge; pores subcircular to subelliptical, honeycomb accentuation meshwork, pores numerous, three transverse rows of pores in each shell-joint, and 22 pores in each transverse row.

Length of hypotype - 0.32 mm., maximum width - 0.23 mm., diameter of pores - 0.013 mm. at apertural end.

Hypotype locality: Peace River, Tp. 108, R. 14, W. 5 meridian, Alberta, locality O 259A, at water level, from lower part of Loon River shales, Artocapsa 704-C zone.

Hypotype - University of Alberta Palaeontological
Type Collection

Remarks: The hypotype specimen is pyritized so that wall structure is in some question. The hypotype resembles the genus Lithostrobus but it is considered to be Cyrtocapsoma 704-A with last joint broken off. This form is considered conspecific with Cyrtocapsoma 704-A from the same suite. Cyrtocapsoma 704-B resembles Conostrobus 384-A but honeycomb accentuation of pores, number of pores in each transverse row, and larger size differentiates it from the latter form.

GENUS ARTOCAPSA HAECKEL

Artocapsa 704-C

Plate 1, Figure 18

Shell small, spindle-shaped, fairly smooth with 6 joints; apical horn very short, stublike, conical; first five joints regularly increasing in length and diameter according to positions in linear series from apical to apertural ends, sixth and final chamber inflated, bulbous, much larger than other five chambers; strictures are small transverse, indistinct, indentations, apertural end with a rod-like spine; pores irregularly disposed over the surface but somewhat honeycomb in pattern, with

slight suggestion of alternating arrangement in earlier portion.

Length of hypotype - 0.33 mm., maximum width of hypotype 0.17 mm., diameter of pores 0.009 mm.

Hypotype locality: Peace River, Tp. 108, R. 14, W. 5 meridian, Alberta, locality O 259A, at water level, from lower part of Loon River shales, Artocapsa 704-C zone fossil.

Hypotype - University of Alberta Palaeontological
Type Collection

Remarks: The hypotype specimen is pyritized so that wall structure is not evident.

EXPLANATION OF PLATE 1.

- Figure 1: Ammobaculites 363-B, x65, hypotype, from upper part of Loon River formation, Peace River, Tp.99, R.19, W.5, meridian, Alberta; heavily retouched photograph of side view. p. 30
- Figure 2: Gaudryina 361-B, x65, hypotype, from upper part of Loon River formation, Peace River, Tp.99, R.19, W.5 meridian, Alberta; heavily retouched photograph of side view. p. 37
- Figure 3: Haplophragmoides 361-A, x85, hypotype, from upper part of Loon River formation, Peace River, Tp. 99, R. 19, W. 5, meridian, Alberta; heavily retouched photograph of side view..... p. 45
- Figure 4: Haplophragmoides 424-A, x65, hypotype, from upper part of Loon River formation, Peace River, Tp. 101, R. 20, W. 5 meridian, Alberta; heavily retouched photograph of side view..... p. 48
- Figure 5: Verneuillina 360-B, x65, hypotype, from upper part of Loon River formation, Peace River, Tp. 99, R. 19, W. 5 meridian, Alberta; heavily retouched photograph of side view..... p. 51
- Figure 6: Gaudryina 363-A, x65, hypotype, from upper part of Loon River formation, Peace River, Tp. 99, R. 19, W. 5 meridian, Alberta; heavily retouched photograph of side view..... p. 38
- Figure 7, 8: Gyroïdina 355-A, hypotype, from upper part of Loon River formation, Peace River, Tp. 99, R. 19, W. 5 meridian, Alberta; 7, x65, slightly retouched photographs showing spire, 8, x80, umbilical view... p. 40
- Figure 9: Haplophragmoides 311-A, x80, hypotype, from upper part of Loon River formation, Peace River, Tp. 98, R. 19, W. 5 meridian, Alberta; heavily retouched photograph of side view..... p. 41
- Figure 10: Haplophragmoides 366-A, x80, hypotype, from upper part of Loon River formation, Peace River, Tp. 99, R. 19, W. 5 meridian, Alberta; heavily retouched photograph of side view..... p. 46

Explanation of Plate 1 (continued).

- Figure 11; 12: Ammodiscus 411-A, hypotype, from upper part of Loon River formation, Peace River, Tp. 101, R. 19, W. meridian, Alberta; 11, x65, heavily retouched photograph of side view, 12, x80, heavily retouched photograph of opposite side..... p. 31
- Figure 13: Verneuilina 366-B, x85, hypotype, from upper part of Loon River formation, Peace River, Tp. 99, R. 19, W. 5 meridian, Alberta; retouched photograph of side view..... p. 52
- Figure 14: Cyrtocapsoma 704-B, x65, hypotype, from lower part of Loon River formation, Peace River, Tp. 108, R. 14, W. 5 meridian, Alberta; heavily retouched photograph of side view..... p. 56
- Figure 15: Conostrobus 388-A, x80, hypotype, from upper part of Loon River formation, Peace River, Tp. 100, R. 20, W. 5 meridian, Alberta; heavily retouched photograph of side view..... p. 54
- Figure 16: Discorbis 355-B, x85, hypotype, from upper part of Loon River formation, Peace River, Tp. 99, R. 19, W. 5 meridian, Alberta; slightly retouched photograph showing spire.....p. 35
- Figure 17: Bathysiphon 313-A, x65, hypotype, from upper part of Loon River formation, Peace River, Tp. 98, R. 19, W. 5 meridian, Alberta; slightly retouched photograph of side view..... p. 32
- Figure 18: Artocapsa 704-C, x65, hypotype, from lower part of Loon River formation, Peace River, Tp. 108, R. 14, W. 5 meridian, Alberta; heavily retouched photograph of side view..... p. 57
- Figure 19: Cyrtocapsoma 704-A, x65, hypotype, from lower part of Loon River formation, Peace River, Tp. 108, R. 14, W. 5 meridian, Alberta; heavily retouched photograph of side view..... p. 55
- Figure 20: Haplophragmoides 414-A, x80, hypotype, from middle part of Loon River formation, Peace River, Tp. 101, R. 19, W. 5 meridian, Alberta; heavily retouched photograph of side view..... p. 47

Explanation of Plate 1 (continued).

- Figure 21, 22: Glomospira 311-B, hypotype, from upper part of Loon River formation, Peace River, Tp. 98, R. 19, W. 5 meridian, Alberta; 21, x65, heavily retouched photograph of side view, 22, x80, heavily retouched photograph of opposite side.....p. 39
- Figure 23: Cibicidella ? 483-A, x80, hypotype, from middle part of Loon River formation, Peace River, Tp. 102, R. 19, W. 5 meridian, Alberta; sketch of side view.....p. 34
- Figure 24: Conostrobos 384-A, x65, hypotype, from upper part of Loon River formation, Peace River, Tp. 100, R. 20, W. 5 meridian, Alberta; heavily retouched photograph of side view.....p. 53
- Figure 25: Verneuulina 316-A, x60, hypotype, from upper part of Loon River formation, Peace River, Tp. 98, R. 19, W. 5 meridian, Alberta; retouched photograph of side view.....p. 50
- Figure 26: Haplophragmoides 360-A, x65, hypotype, from upper part of Loon River formation, Peace River, Tp. 99, R. 19, W. 5 meridian, Alberta; heavily retouched photograph of side view..... p. 43
- Figure 27: Haplophragmoides 318-B, x65, hypotype, from upper part of Loon River formation, Peace River, Tp. 98, R. 19, W. 5 meridian, Alberta; heavily retouched photograph of side view.....p. 42
- Figure 28, 29: Miliammina 380-A, hypotype, from upper part of Loon River formation, Peace River, Tp. 100, R. 20, W. 5 meridian, Alberta; 28, x65, heavily retouched photograph of side view, 29, x80, heavily retouched photograph of opposite side..... p. 49
- Figure 30: Gaudryina 318-A, x85, hypotype, from upper part of the Loon River formation, Peace River, Tp. 98, R. 19, W. 5 meridian, Alberta; heavily retouched photograph of side view..... p. 36
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PLATE I

Foraminifera and Radiolaria
Loon River Formation

APPENDIX

LOCALITY INDEX OF MICROFAUNAL SUITES

The Cretaceous section in the eastern Peace River area is as follows: (Ref.26)

Wapiti ss. and sh.	1,100'
Smoky shale	850-900'
Dunvegan sandstone	520'
Shaftesbury formation	640'
Peace River formation	380'
Loon River shale	682-800'
"McMurray" sands	25-160'

The microfaunal collections used in this thesis were made from shales of the Loon River formation.

Shale samples from which the microfaunal suites were picked for study indicate the general lithology of the formation. However, a complete picture of the lithology is not presented, since in sampling, coarser sand elements, calcareous and ironstone nodules are discarded, so that the samples contain a potential recovery of microfauna as high as possible.

The lithology of the strata from which the microfaunal suites were picked is as follows:

SUITES 311-319

Locality O 129C, Loon River formation, Peace River, Tp. 98,
R. 19, W. 5 meridian, Alberta.

4' Shale - grey, carbonaceous, micromicaceous, fairly
fissile.
Suite 311

0.2' Highly rusty layer - could not be found fresh.

11.0' Shale - dark grey, fairly coarse, slightly silty,
blocky, fissile in lower portion, carbon-
aceous particles present, micromicaceous
and microsilty.

Suite 312 1' down from base of above.

Suite 313 6' down from base of above.

Suite 314 10' down from base of above.

This last is a sandstone, dark grey, micro-
micaceous with much coarse glauconite, a mixed
sample (?).

2.0' Nodular shale - shale as above, with little
glauconite and numerous small nodules up
to 6" in diameter.

Suite 315

3.0' Shale - as above, but without nodules.

4.4' Shale - dark grey, silty, hard and somewhat blocky,
small discontinuous nodular layer 1.5' down.
Suite 316 1' down from base of above.

0.6-1.2' Ironstone layer - concretionary, discontinuous.

3.5' Shale - dark grey to black, silty, contains carbon-
aceous particles, also innumerable elongate
nodules.

Suite 317

6.7' Shale - as above but without nodules, contains carbon-
aceous particles, and is micromicaceous.

Suite 318 2' down from base of above.

Suite 319 6.7' down from base of above.

- Covered to water level.

SUITES 349-358

Locality O 137A, Loon River formation, Peace River, Tp. 99,
R. 19, W. 5 meridian, Alberta.

4.0' Silty shale - to shaly siltstone, friable.
Suite 349

3.4' Siltstone - light grey, argillaceous, contains
carbonaceous particles.
Suite 350

- 0.4' Ironstone layer - fairly discontinuous.
- 7.0' Siltstone - as above, but contains many rounded nodules.
Suite 351
- 3.0' Siltstone - as above but without nodules.
- Covered to water level.

SUITES 352-358

- Locality O 138A, Loon River formation, Peace River, Tp.99, R. 19, W. 5 meridian, Alberta.
- Recent silts
- 2.0' Shale - as below
- 15.0' Shale - grey with brownish hue, slightly silty, micromicaceous, carbonaceous to coaly particles, a few nodules for 5' below the base of above, medium blocky.
Suite 352 3' down from base of above.
Suite 353 8' down from base of above.
Suite 354 13' down from base of above.
- 1.0' Ironstone layer - concretionary, discontinuous.
- 2.0' Shale - as above, almost khaki locally.
- 16.0' Shale - drab to khaki, medium splintery, slightly silty, carbonaceous particles, micromicaceous particles.
Suite 355 1' down from base of above.
Suite 356 6' down from base of above.
Suite 357 11' down from base of above.
Suite 358 16' down from base of above.
- Covered to water level.

SUITES 359-370

- Locality O 138B, Loon River formation, Peace River, Tp. 99, R. 19, W. 5 meridian, Alberta.
- 5.0' Shale - grey, fissile to hackly, badly weathered, a few nodules.
- 5.0' Shale - blocky, medium grey to brown.
Suite 359 2' down from base of above.
- 3.5' Shale - grey, fine-grained, locally rusty.
Suite 360

- 5.0' Shale - drab, medium to fine, rusty weathering band, yellow decomposition product at base.
Suite 361
- 1.0' Ironstone layer
- 12.7' Shale - dark grey, blocky, medium to coarse, micromicaceous, carbonaceous particles, weathered into fissile shale, dark grey.
Suite 362 4' down from base of above.
Suite 363 9' down from base of above.
- 2.5' Shale - dark grey, tendency to khaki, coarsely blocky.
- 20.0' Shale - grey, medium blocky, becoming greenish grey, carbonaceous micro-particles, micromicaceous, very slightly calcareous, if any.
Suite 364 5' down from base of above.
Suite 366 10' down from base of above.
Suite 367 15' down from base of above.
- 5.0' Shale - darker grey, fissile to flaky, microsilty, micromicaceous and microcarbonaceous.
Suite 368
- 8.0' Shale - greenish grey, micromicaceous, carbonaceous, rusty weathering.
Suite 369 at base of above.
Suite 370 5' down from base of above.
- 37.3' Covered to water level.

SUITES 372-383

Locality O 154A, Loon River formation, Peace River, Tp. 100, R. 20, W. 5 meridian, Alberta.

- 11.5' Shale - dark grey, very slightly silty in lenses, weathers light grey, looks like inter-banded shale and silt, micromicaceous.
Suite 372 6.5' up from base of above.
Suite 373 1.5' up from base of above.
- 5.0' Shale - dark brownish grey, medium blocky, silty (?), micromicaceous.
Suite 374
- 2.5' Shale - hard clayey to flaky, micromicaceous, contains carbonaceous particles, a gradational phase into shale below.
Suite 375
- 5.0' Shale - dark grey to black, coarsely blocky, fissile rather platy, much yellow material stands out like sandstone on weathering.
Suite 376

- 14.0' Shale - dark grey, medium blocky, becoming fissile, micromicaceous, few carbonaceous particles.
Suite 377 5' down from base of above.
Suite 378A 10' down from base of above.
- 18.5' Shale - dark grey, becoming finely fissile to flaky, clayey, micromicaceous, carbonaceous particles, some decomposition product.
Note: drab, metabentonite layer at 3', 14' and 17' down.
Suite 378B 2' down from base of above.
Suite 379 7' down from base of above.
Suite 380 12' down from base of above.
Suite 381 17' down from base of above.
- 0.4' Indurated layer - anhydrite (?) crystals, highly rusty, sandy (?).
Suite 382
- 6.0' Shale - dark grey to black to dirty brown, coarsely blocky, and platy, some biotite and carbonaceous matter.
Suite 383
- Covered to water level.

SUITES 384-393

Locality O 154C, Loon River formation, Peace River, Tp. 100, R. 20, W. 5 meridian, Alberta.

- 8.0' Shale - grey, medium blocky, brownish hue, micromicaceous, carbonaceous particles, rusty indurated layer.
Suite 384
- 20.5' Shale - grey to black, very coarsely blocky, very coarsely flaky, resistant to weathering, very large blocks - 1.5' x 1.5' x 8" - dirty brown, greasy, micromicaceous, carbonaceous particles. There are several light buff, waxy, metabentonite layers at 10' and 15' down.
Suite 385 5' down from base of above.
Suite 386 10' down from base of above.
Suite 387 15' down from base of above.
Suite 388 20' down from base of above.
Suite 389 15' down from base of above. (Bentonite sample)
- 0.6' Bentonite layer drab, dull, metabentonite, locally shaly.
Suite 390
- 0.6' Shale - black as below.
- 0.2' Metabentonite layer

- 1.6' Shale - black, medium blocky.
Suite 391
- 0.1' Metabentonite
- 2.5' Shale - dark, somewhat clinkery, finely blocky.
- 0.3' Strongly rusted layer - brick red, indurated.
- 0.7' Shale - as above.
- 0.5' Indurated layer - rusty weathering, like
indurated metabentonite.
- 2.3' Shale - as above.
- 0.2' Indurated layer - as above, not as marked.
- 7.0' Shale - brownish becoming grey, resistant to
erosion, fissile to flaky but coarsely
so, very coarsely splintery, carbonaceous.
Suite 392 2' down from base of above.
Suite 393 7' down from base of above.
- 2.0' Shale - as above but less coarsely splintery
with fissility, rusty, carbonaceous,
semi-continuous ironstone bands 1' down.
- Covered to water level.

SUITES 404-406

Locality O 164x4, Loon River formation, on Wolverine River
above mouth, Alberta.

- 15.0' Shale - blocky, medium coarse, rusty weathering.
Suite 404
- 0.2' Rusty weathering metabentonite - yellow to dark
greenish grey.
- 27.0' Shale - black, coarsely platy and blocky,
becoming splintery in bottom 5' and
showing close interbanding of silts and
shales, not sampled.
- 0.8' Metabentonite - grey to yellow, rusty weathering,
becomes indurated due to sulphate
content (?)
- Shale - very coarsely blocky, black to brownish,
greasy.
Suite 405
Suite 406

SUITES 416 - 444

Locality O 170A, Loon River formation, Peace River, Tp. 101,
R. 19, W. 5 meridian, Alberta.

- 5' Shale - dark grey, hard, fine to medium blocky
with some coarse laminations, carbon-
aceous, sulphur or metabentonite in part-
ings.
Suite 416
- 5' Shale - as above, becoming more medium to coarsely
blocky, rusty partings.
Suite 417
- 5' Shale - as above, becoming platy as 417, weathers
well.
Suite 418
- 5' Shale - as above, slight increase of rust in
partings.
Suite 419
- 5' Shale - as above.
Suite 420
- 5' Shale - as above.
Suite 421
- 5' Shale - as above becoming finely blocky.
Suite 422
- 5' Shale - as above, softer in weathering properties,
not as many rusty partings, small amount
of sulphur or bentonite present.
Suite 423
- 5' Shale - as above.
Suite 424
- 5' Shale - as above, medium to coarsely blocky, more
rusty, weathers hard.
Suite 425
- 5' Shale - as above.
Suite 426
- 5' Shale - as above, dark brown tinge, very platy,
hard.
Suite 427
- 5' Shale - as above.
Suite 428
- 5' Shale - as above.
Suite 429
- 5' Shale - as above, rusty, platy.
Suite 430

- 5' Shale - as above, lighter shade of grey, medium to finely blocky, softer.
Suite 431
- 5' Shale - as above, medium blocky.
Suite 432
- 5' Shale - as above.
Suite 433
- 5' Shale - as above, softer.
Suite 434
- 5' Shale - as above, dark grey, coarsely laminated, metabentonite, finely dispersed in part, becoming silty in part.
Suite 435
- 5' Shale - not quite as platy as above, but becoming harder.
Suite 436
- 5' Shale - dark to medium grey, coarsely platy with sulphur in partings.
Suite 437
- 5' Shale - medium to coarsely platy, hard weathering.
Suite 438
- 5' Shale - as above.
Suite 439
- 5' Shale - as above.
Suite 440
- 5' Shale - as above but finely blocky.
Suite 441
- 5' Shale - as above but finely blocky.
Suite 442
- 5' Shale - as above, medium to coarsely platy, weathers hard.
Suite 443
- 5' Shale - as above, immediately below thin metabentonite band, very coarsely platy.
Suite 444
- Covered to water level.

SUITES 449-456

Locality 0 173A, Loon River formation, Peace River, Tp.102, R.19, W.5 meridian, Alberta.

- 3' Pebble clay
- 7' Shale - medium blocky, grey, brittle, weathered.

- 0.1' Ironstone layer - continuous.
- 1.0' Shale - brownish, blocky, micromicaceous or silty, brittle, not fissile, medium to fine blocky.
Suite 449 5' down from base of above.
Suite 450 10' down from base of above.
- 5.0' Shale - as above, but becoming somewhat coarser, but considerably more resistant weathering, cliff forming. This considered to be the top of so called Indurated shale, this shale is locally coarsely to very coarsely platy.
Suite 451
- 1.0' Concretionary layer - with metabentonite shale covering.
- 11.0' Shale - coarsely platy as above, also very coarsely blocky, strongly micromicaceous.
Suite 452 5' down from base of above.
Suite 453 10' down from base of above.
- 7' Shale - similar to above, but less coarsely platy with definitely coarse splintery, otherwise quite similar but less resistant to weathering.
Suite 454 5' down from base of above.
- 13' Shale - as above but more finely splintery to blocky, and more crumbly.
Suite 455 3' down from base of above.
Suite 456 8' down from base of above.
- 20' Covered
- 3' Shale - poorly exposed, very coarse. The "Burn".
- Covered to water level.

SUITES 465-485

Locality O 175B, Loon River formation, Peace River, at mouth of Big Buffalo River.

- 4.0' Clay - with recovered shale.
- 4.0' Shale - dark grey, a certain platiness, waxy, narrow yellow thin laminae, closely spaced, badly weathered.
- 17.0' Shale - dark grey to black, coarsely blocky, tendency to coarse splintery, not fissile, micromicaceous.
Suite 465 1' down from base of above.
Suite 466 6' down from base of above.
Suite 467 11' down from base of above.
Suite 468 16' down from base of above.

- 12.0' Shale - dark grey to black, less coarse in texture, medium.
Suite 469 4' down from base of above.
Suite 470 9' down from base of above.
- 9.0' Shale - dark grey, becoming black, coarse to very coarse, tendency to fissile, thin, could be top of "Burn".
Suite 471 3' down from base of above.
Suite 472 8' down from base of above.
- 3.0' Shale - much finer, splintery, silty.
Suite 473.
- 13.0' Shale - as previous.
Suite 474 1' down from base of above.
Suite 475 6' down from base of above.
Suite 476 11' down from base of above.
- 8.0' Shale - dark grey, not black, tendency to fissile, not coarse.
Suite 477 2' down from base of above.
Suite 478 7' down from base of above.
- 6.0' Shale - dark grey to black, medium blocky.
Suite 479 4' down from base of above.
- 5.5' Shale - dark grey to black, medium blocky, only very slightly laminated with silt.
Suite 480
- 2.5' Shale - as above but with fairly marked tendency to rusted, joint planes, only slightly laminated with silt.
Suite 481
- 9.0' Shale - dark grey, blocky, has rounded fractures, locally silty, only slightly laminated, but appears fairly silty, slightly calcareous.
Suite 482 4' down from base of above.
Suite 483 8' down from base of above.
- 2.0' Indurated layer - shale apparently with much rusty shale.
Suite 484
- 3.0' Shale - dark grey, splintery as below.
- 6.5' Shale - dark grey, splintery, tendency to rust.
Suite 485 1' down from base of above.
- 0.1' Ironstone layer - apparently continuous.
- 1.0' Covered to water level.

SUITES 485-492

Locality 0 178x5A, Loon River formation, on Little Buffalo River above the mouth, Alberta.

- 5.0' Glacial silt - honey combed.
- 50.0' Covered.
- 4' Shale - as below.
- 0.2' Ironstone layer - not continuous.
- 21.0' Shale - black, very coarsely blocky, this is the top of Burn.
Suite 492 1' down from base of above.
Suite 491 11' down from base of above.
- 0.2' Ironstone - fairly continuous.
- 10.0' Shale - dark grey to black, fissile, coarsely blocky.
Suite 490 5' down from base of above.
- 7.0' Shale - grey to dark grey, resistant to weathering, coarse, not platy nor fissile, nor very coarse, conchoidal to rounded fracture.
Suite 489 5' down from base of above.
- 13.0' Shale - black, fissile, almost flaky coarse, very slightly laminated.
Suite 488 8' down from base of above.
- 1.4' Ironstone - discontinuous, concretion.
- 20.0' Shale - black, fissile, much yellow decomposition product, very coarse, very slightly laminated.
Suite 487 4' down from base of above.
Suite 486 14' down from base of above.
- 5.0' Shale - coarse to very coarse, grey, rusty weathering, is cliff forming, clayey, micromicaceous, brittle.
Suite 485 4' down from base of above.
- Covered to water level.

SUITES 493-497

Locality 0 181x2B, Loon River formation, Keg River, Alberta

Boulder clay

- 7' Shale - as below, but highly weathered.
- 0.2' Indurated layer - rusty weathering, high in anhydrite (?).

- 11.0' Shale - dark grey to black, weathers light grey to fissile, becomes more coarse, fissile and a little clayey towards the lower part.
- 0.1' Ironstone layer - could be continuous, contains thin coaly layer.
- 9.0' Shale - dark grey to black, fairly blocky.
Suite 495 5.5' down from base of above.
- 0.1' Ironstone layer - thin and continuous.
- 7.5' Shale - as above, but more coarsely blocky, less fissile.
Suite 496
- 0.1' Ironstone layer
- 7.5' Shale - as above
Suite 497
- 0.1' Ironstone layer - discontinuous, below this to water level outcrop is mainly covered or reworked.
- Water level

SUITES 501-506

Locality 0 184B, Loon River formation, Peace River, Tp.103, R.19, W. 5 meridian, Alberta.

- 10' Boulder Clay
- 10.0' Burn-type shale - black, coarsely to very coarsely blocky, platy, weathers fissile.
Suite 501 10' down from base of above.
- 14.0' Shale - brownish black, medium to fine blocky, very finely silty. This becomes laminated downwards due to silt content.
Suite 502 5' down from base of above.
Suite 503 12' down from base of above.
- 0.1' Ironstone layer
- 6.0' Shale - as above, but mostly covered.
- 10.0' Shale - dark grey to black, brownish hue on fresh fracture, coarsely to medium rubbly, rounded fractures, not silty but micromicaceous, weathers light grey.
Suite 504 5' down from base of above.
- 0.1' Ironstone layer - discontinuous, layered with very fine sandstone.

- 3.5' Shale - as above but appears more micromicaceous
and not silty.
Suite 505
- 0.1' Ironstone layer - discontinuous.
- 2.5' Shale - as above.
- 0.1'-3.0' Ironstone layer - discontinuous.
- 10' Shale - dark grey with brownish hue, finely
blocky, finely silty.
Suite 506 4' down from base of above.
- Covered to water level.

SUITES 507-517

Locality O 185A, Loon River formation, Peace River, Tp. 103,
R. 19, W. 5 meridian, Alberta.

- 4' Boulder Clay - erosional unconformity.
- 9' Shale - black, brownish hue, strongly weathered,
much yellow decomposition, could be "Burn".
- 11.0' Shale - dark grey, micromicaceous, silty, blocky
to splintery, rusty joints, becomes
definitely platy, medium to coarse at base.
Suite 507 from base of above.
Suite 508 5.5' down from base of above.
Suite 509 11' down from base of above.
- 0.05' Metabentonite - white weathering.
- 7.5' Shale - dark grey to black, coarsely platy
"to rubbly", silt laminae, micromicaceous,
carbonaceous.
Suite 510 2' down from base of above.
Suite 511 7' down from base of above.
- 0.2' Indurated layer - rusty weathering shale.
Locally greenish hue.
- 8.0' Shale - dark grey to black, silty, slight lamina-
tion, medium to coarse, "rubbly platiness"
i.e. platy but also much rounded fractur-
ing even along plate faces.
Suite 512 5' down from base of above.
- 26.0' Shale - dark grey to black, as above, but increas-
ingly silty and brittle, also increasingly
coarse in blockiness, discontinuous
concretionary layer 7.0' down.
Suite 513 2' down from base of above.
Suite 514 7' down from base of above.
Suite 515 13' down from base of above.
Suite 516 18' down from base of above.
Suite 517 22' down from base of above.

18' Covered to Water Level.

SUITES 518-532

Locality O 187, Loon River formation, Peace River, Tp. 104,
R. 19, W. 5 meridian, Alberta.

5'-15' Boulder Clay - erosional surface.

11.0' Shale - grey to black, with brownish hue, cliff
 forming on weathering, medium blocky.
 Suite 518 3' down from base of above.
 Suite 519 8' down from base of above.

0.2' Concretionary layer - discontinuous, flat, dark
 limestone.
 Suite 520

6.0' Shale - dark grey, only finely splintery, clayey,
 soft almost fissile.
 Suite 521 4' down from base of above.

0.2' Concretionary layer - discontinuous, similar to
 that above.

12.0' Shale - dark grey to black, cliff forming on
 weathering, medium to fine blocky,
 clayey to splintery.
 Suite 522 4' down from base of above.
 Suite 523 9' down from base of above.

17.0' Shale - dark grey, as above, but coarser, more
 brittle, rounded fracture, coarse rubbly.
 Suite 524 2' down from base of above.
 Suite 525 7' down from base of above.
 Suite 526 12' down from base of above.
 Suite 527 16.5' down from base of above.

0.1' Rusty layer - prominent, may be due to highly
 weathered metabentonite. This forms base
 of cliff forming shale.

9.2' Shale - grey, medium to fine, platy to blocky,
 silty, not so prominently cliff forming.
 Suite 528 5' down from base of above.
 Suite 529 9.2' down from base of above.

0.1' Concretionary layer - flat, highly discontinuous.

8.2' Shale - dark grey to black as above.
 Suite 530 5' down from base of above.

0.2' Shale - rusty weathering, layering.

4.0' Shale - dark grey as above, but a little more
 coarse.
 Suite 531 3' down from base of above.

- 5.5' Shale - dark grey as above, but appears more cliff forming and coarser.
Suite 532
- Covered to water level.

SUITES 533-537

Locality O 192A, Loon River formation, Peace River, Tp. 104, R. 19, W. 5 meridian, Alberta.

- 75' Recent sediments - with sand at base.
- 18' Shale - black with brownish hue, hard, almost brittle, coarsely laminated, blocky, some coarse plates, micromicaceous, possibly finely silty.
Suite 533 5' down from base of above.
Suite 534 10' down from base of above.
Suite 535 15' down from base of above.
- 8' Covered - but apparently all shale.
- 0'-1.5' Concretions - elongate, built around petrified layer.
- 17' Shale - as above, but mainly covered down to water level. The shale at water's edge appears different. Brownish, rusty, softer and crumbly.
Suite 536 3' down from base of above.
Suite 537 16' down from base of above.
- 1.2' Covered to water level.

SUITES 538-559

Locality O 194A, Loon River formation, Peace River, Tp. 104, R. 18, W. 5 meridian, Alberta.

- 2.0' Shale - as below.
- 0.1' Ironstone layer - fairly continuous.
- 6.0' Shale - black, coarsely platy, slight tendency to be fissile, silty, micromicaceous, tendency to brownish hue, tough.
Suite 538
- 0.2' Rusty shale layer - partly indurated.
- 7.0' Shale - as above.
Suite 539 5' down from base of above.
- 0.2' Shale layer - rusty weathering, containing a few small concretions.

- 30.0' Shale - dark grey to black, coarsely blocky, tendency to platiness, brownish hue, silty and micromicaceous. Several discontinuous layers of small concretions and very small isolated concretions. Shale contains a few narrow white silt laminae.
Suite 540 5' down from base of above.
Suite 541 10' down from base of above.
Suite 542 15' down from base of above.
Suite 543 20' down from base of above.
Suite 544 25' down from base of above.
Suite 545 30' down from base of above.
- 18.0' Shale - dark grey to black, with brownish hue, fairly silty, micromicaceous, medium rubbly, tendency to platiness, weathers fissile, light grey. Very large isolated concretions, also a rusty layer seen from water.
Suite 546 5' down from base of above.
Suite 547 10' down from base of above.
Suite 548 15' down from base of above.
- 0.2' Indurated layer - rusty weathering.
- 13.0' Shale - dark grey to black, brownish hue, generally less tough than above and more apt to be crumbly and flaky when weathered.
Suite 549 5' down from base of above.
Suite 550 10' down from base of above.
- 31.2' Shale - as above but more coarsely blocky and platy. This could be due to the fact that it is recently eroded. Discontinuous ironstone layer 4.0' down.
Suite 551 from base of above.
Suite 552 5' down from base of above.
Suite 553 10' down from base of above.
Suite 554 15' down from base of above.
Suite 555 20' down from base of above.
Suite 556 20' down from base of above.
Suite 557 24' down from base of above.
Suite 558 29' down from base of above.
Suite 559 31.2' down from base of above. (Water level)
- 1.8' Covered to water level.

SUITES 560-562

Locality O 197A, Loon River formation, Peace River, Tp. 105, R. 18, W. 5 meridian, Alberta.

There is here a large outcrop of shale, but its upper part is covered with entirely too much detritus for it to be easy to get any markers. This shale contains numerous isolated large to very large concretions.

Suite 562 10' above water level.

Suite 561 5' above water level.

Suite 560 at water level.

SUITES 565-576

Locality O 202A, Loon River formation, Peace River, Tp. 105, R. 17, W. 5 meridian, Alberta.

11.0 Shale - black with brownish hue, coarse to very coarsely blocky, platy to fissile and almost flaky on weathering, slightly silty.
Suite 565 10' up from top of below.
Suite 566 5' up from top of below.
Suite 567 at top of below.

1.7' Calcareous concretion - quite hard, laminated.
Suite 568

11.0' Shale - black as above, much yellow decomposition product.
Suite 569 at base of above.
Suite 570 5' down from base of above.
Suite 571 10' down from base of above.

0.7' Concretionary layer - flat, discontinuous, highly rusty but otherwise similar to that above.

23.6' Shale - black as above, locally strongly fissile.
Suite 572 3' down from base of above.
Suite 573 8' down from base of above.
Suite 574 13' down from base of above.
Suite 575 18' down from base of above.
Suite 576 23' down from base of above.

0.3' Ironstone layer - flat, discontinuous, highly rusted.

3.0' Shale - cliff-forming as above.

15.5' Covered to water level.

SUITES 577-584

Locality O 206, Loon River formation, Peace River, Tp. 105, R. 17, W. 5 meridian, Alberta.

3.0' Boulder Clay

8.5' Shale - black to dark grey, weathered, coarsely blocky, almost a conchoidal fracture, not sampled.

- 9.0' Shale - black, coarse to very coarse, cliff-forming, brownish hue, micromicaceous, few silt laminae, tough.
Suite 577 1' down from base of above.
Suite 578 6' down from base of above.
- Metabentonite layer - very thin, continuous.
- 24.2' Shale - as above, but coarser, more platy on fresh fractures, more fissile where weathered.
Suite 579 3' down from base of above.
Suite 580 8' down from base of above.
Suite 581 13' down from base of above.
Suite 582 18' down from base of above.
Suite 583 23' down from base of above.
- 1.0' Concretionary layer - discontinuous.
- 5.0' Shale - as above.
Suite 584 3' down from base of above.
- Covered to water level.

SUITES 585-602

Locality O 206G, Loon River formation, Peace River, Tp. 105, R. 17, W. 5 meridian, Alberta.

- 3' Silt and cobble clay
- 2' Gravel to conglomerate - some large boulders, rusted.
- 5' Upper Burn-type shale - weathered.
- 0.2' Ironstone layer - apparently continuous.
- 4.0' Shale - Burn type, weathered.
Suite 585
- 3.0' Shale - black, medium to fine.
Suite 586 1.5' down from base of above.
- 20.2' Shale - black, medium to fine, not blocky, brownish hue, crumbly to clayey.
Suite 587 4' down from base of above.
Suite 588 9' down from base of above.
Suite 589 14' down from base of above.
Suite 590 19' down from base of above.
- 21.6' Shale - as above.
Suite 591 5.4' down from base of above.
Suite 592 10.8' down from base of above.
Suite 593 16.2' down from base of above.
Suite 594 21.6' down from base of above.

- 0.2' Bentonite - rusty weathering, also flat concretionary layer, laminated; this rock is approximately top of "Lower Burn".
- 23.6' Shale - black, coarsely platy and blocky, fissile, micromicaceous, brown black.
Suite 595 2' down from base of above.
Suite 596 7.4' down from base of above.
Suite 597 12.3' down from base of above.
Suite 598 18.2' down from base of above.
Suite 599 23.6' down from base of above.
Suite 600 29.0' down from base of above.
Suite 601 34.4' down from base of above.
- 2.0' Shale - very silty, fine.
Suite 602
- Covered to water level.

SUITES 603-621

Locality O 211A, Loon River formation, Peace River, Tp. 105, R. 16, W. 5 meridian, Alberta.

- 0.2' Shale - indurated, rusty, with much meta-bentonite.
- 22.6' Shale - dark grey, brownish hue, silty laminae, tough, medium blocky, fair weathering resistance. Ironstone layer 15' down from base of above.
Suite 603 10' down from base of above.
Suite 604 20' down from base of above.
- 0.2' Ironstone layer - flat, quite resistant.
- 14.5' Shale - as above, but more platy, parallel layering more prominent, also softer and more clayey. Shale becoming blacker and coarse towards the base.
Suite 605 7.5' down from base of above.
Suite 606 14' down from base of above.
- 0.25' Ironstone layer - quite prominent and resistant.
- 2.5' Shale - identical to above.
- 9.2' Shale - black brownish hue, medium to coarse blocky, fair platiness, hard, brittle, minute conchoidal breaks, fairly resistant to weathering.
Suite 607 5' down from base of above.

- 35.0' Shale - black as above but coarser, and notably more resistant to weathering, almost vertical cliff. Contains several narrow ironstone layers at 10', 13' and 15' down; also two narrow rusty layers at 23.5' and 26.0' down.
Suite 608 6' down from base of above.
Suite 609 16' down from base of above.
Suite 610 26' down from base of above.
- 2.5' Shale - as below but slightly more resistant to weathering.
- 11.5' Shale - black, brownish hue, fissile, blocky, soft clayey, quite crumbly.
Suite 611 3.5' down from base of above.
- 0.2' Ironstone layer - fairly micromicaceous and carbonaceous.
- 7.3' Shale - as above, but highly crumbly due to earthy platiness.
Suite 612 2' down from base of above.
- 7.0' Shale - brownish black, crumbly, clayey, contains a 6" layer of shale as below.
Suite 613
- 5.0' Shale - black to brownish, coarse but platy to fissile.
Suite 614
- 0.3' Ironstone layer - discontinuous.
- 7.0' Shale - brownish black, hard to soft varying locally, medium to fine blocky.
Suite 615 3' down from base of above.
- 6.0' Shale - with very thick silt layers, in fact interbanded.
Suite 616 1' down from base of above.
- 0.1' Ironstone layer - narrow.
- 1.4' Shale - with thin silt interlayers as above.
- 0.05' Metabentonite layer
- 0.1' Ironstone layer
- 0.3' Shale - as above.
- 0.2' Ironstone layer
- 2.8' Shale - quite silty, dark to black, coarse to very coarse.
- 0.1' Ironstone layer - quite continuous.

- 10.6' Shale - grey, coarse, flaky, black with brownish hue, silty.
Suite 619 5' down from base of above.
Suite 620 10' down from base of above.
- 0.4' Ironstone layer - unusual, made up of 0.1' of normal ironstone and 0.3' of highly weathered tectonic shale. This has a gentle dip to the east.
- 5.0' Shale - black, coarsely platy, highly fissile, crumbly in large plates.
Suite 621 sampled at water level.
- Covered to water level.

SUITES 623-639

Locality O 219F, Loon River formation, Peace River, Tp. 106, R. 19, W. 5 meridian, Alberta.

- 3' Clay shale
- 12' Boulder clay
- 0.5' Pebble clay
- 1' Gravel
- 1' Medium sand
- 4.5' Shale - black with brownish tinge, appears silty, weathered and probably reworked.
- 22.0' Shale - black with brownish hue, silty, a few thin silty laminae, coarsely blocky, cliff forming, platy.
Suite 623 3' down from base of above.
Suite 624 9.5' down from base of above.
Suite 625 21.5' down from base of above.
- 7.5' Shale - black, brownish hue, apparently blocky, but more fissile and more crumbly.
Suite 626 2' down from base of above.
- 8.0' Shale - black with brownish hue, probably coarsely blocky, cliff forming, also crumbly into coarsely splintery shale.
Suite 627 2' down from base of above.
Suite 628 8' down from base of above.
- 10.0' Shale - black, as above in all but apparently not coarsely blocky, and highly crumbly.
Suite 629 5' down from base of above.
Suite 630 10' down from base of above.
- 0.1' Ironstone layer - narrow, fairly continuous.

- 15.0' Shale - as above.
Suite 631 5' down from base of above.
Suite 632 10' down from base of above.
Suite 633 15' down from base of above.
- 15.0' Shale - as above.
Suite 634 5' down from base of above.
Suite 635 10' down from base of above.
Suite 636 15' down from base of above.
- 3.0' Shale - as above, with narrow silt laminae.
- 12.0' Shale - black brownish hue, coarsely blocky,
coarsely platy, silt laminae.
Suite 637 2' down from base of above.
Suite 638 7' down from base of above.
Suite 639 12' down from base of above.
- 3.2' Covered to water level.

SUITES 649-660

Locality O 233B, Loon River formation, Peace River, Tp. 107,
R. 16, W. 5 meridian, Alberta.

- 15' Boulder clay
- 6' Shale - dark in part, reworked.
- 0.2' Ironstone layer - thin, fairly continuous.
- 1.0' Shale - as above.
- 0.2' Ironstone layer - quite continuous.
- 5.0' Shale - black series, blocky, not cliff forming.
Suite 649
- 0.4' Concretionary layer - limestone, discontinuous,
flat.
- 2.1' Shale - as above.
- 0.2' Ironstone band - continuous.
- 7.5' Shale - black, brownish hue, hard, fairly blocky,
few silt laminae.
Suite 650 5' down from base of above.
- 2.1' Shale - as above.
- 0.05' Ironstone layer - continuous.
- 3.0' Shale - gradational between that above and below.
- 0.2' Ironstone layer - discontinuous.

- 16.0' Shale - dark grey, flaky, clayey, hard, fissile, cliff forming.
Suite 651 2' down from base of above.
Suite 652 9' down from base of above.
Suite 653 15' down from base of above.
- 2.0' Limestone - concretion, discontinuous.
- 2.5' Shale - as above.
- 0.05' Ironstone layer
- 15.0' Shale - as above, highly cliff forming, fissile to splintery, clayey, much yellow decomposition product.
Suite 654 3' down from base of above.
Suite 655 8' down from base of above.
Suite 656 14' down from base of above.
- 4.0' Shale - black brownish hue, blocky and fissile, very similar to that above, but not so coarse, more crumbly and not so markedly cliff forming.
- 1.7' Limestone layer - discontinuous.
- 1.3' Shale - as above.
- 0.4' Ironstone layer
- 1.5' Shale - as above.
- 0.2' Ironstone layer - quite continuous.
- 2.4' Shale - as above.
Suite 657
- 0.2' Ironstone layer - fairly continuous.
- 4.4' Shale - black to brownish, blocky but crumbly and fissile.
Suite 658 2' down from base of above.
- 3.0' Shale - as above but appears more blocky and cliff forming.
Suite 659
- 0.1' Ironstone layer
- 17.0' Covered - but some shale here and there.
Suite 660 13' down from base of above.

SUITE 661

Locality O 235A, Loon River formation, Peace River, Tp. 107, R. 16, W. 5 meridian, Alberta.

- 20' Shale - with much detritus.

- 5' Shale - black, coarsely blocky, platy, cliff forming.
- 2.0' Limestone concretions
- 7.0' Shale - as above but less coarse and platy.
Suite 661
- 7.0' Shale - as previous but now definitely crumbly.
- 0.4' Ironstone layer - fairly continuous.
- 13.0' Shale - as above, but slightly less crumbly.
- 0.2' Ironstone layer
- Covered to water level.

SUITES 663-673

Locality O 241A, Loon River formation, Peace River,
Tp. 107, R. 15, W. 5 meridian, Alberta.

- 3.5' Silt
- 2.0' Shale - black, weathers grey, badly weathered
and in part reworked.
- 15.0' Shale - black, brownish hue, coarsely blocky,
tendency to fissility, also platy,
contains fairly coarse silt laminae
in the upper 5.0'.
Suite 663 6' down from base of above.
Suite 664 15' down from base of above.
- 26.0' Shale - as above, numerous silt laminae, highly
cliff forming, less fissile than normal,
little yellow metabentonite.
Suite 665 8' down from base of above.
Suite 666 16' down from base of above.
Suite 667 25' down from base of above.
- 1.0' Ferruginous limestone - concretion, discontinuous.
- 3.0' Shale - as above.
- 3.0' Shale - black with brownish hue, gradational
between above and below; tendency to
coarse, but also crumbly and clayey.
- 0.3' Ironstone layer - fairly continuous.

- 29.0' Shale - black with brownish hue, clayey and crumbly, only partly blocky.
Suite 669 7' down from base of above.
Suite 670 13' down from base of above.
Suite 671 21' down from base of above.
- 0.3' Ironstone layer - fairly continuous.
- 10.0' Shale - as above.
Suite 672 5' down from base of above.
- 0.8' Coarse limestone band - bulbous appearance.
- 2.0' Shale - black, semi-platy, irregular fractures.
Suite 673
- Covered to water level.

SUITES 675-681

Locality O 248A, Loon River formation, Peace River,
Tp. 107, R. 15, W. 5 meridian, Alberta.

- 2' Humus and silt
- 2' Pebble silt
- 9.0' Shale - black, weathers grey, fairly blocky, brownish hue.
Suite 675 4' down from base of above.
- 0.5' Ironstone concretion - discontinuous, highly weathered.
- 29.5' Shale - black, coarsely to very coarsely blocky, platy to fissile, much selenite.
Suite 676 3' down from base of above.
Suite 677 7.5' down from base of above.
Suite 678 13' down from base of above.
Suite 679 18.5' down from base of above.
Suite 680 24' down from base of above.
Suite 681 29.5' down from base of above.
- 1.0' Shale - as above.
- Covered to water level.

SUITES 682-692

Locality O 251A, Loon River formation, Peace River,
Tp. 107, R. 14, W. 5 meridian, Alberta.

- 3' Pebble silty clay
- 3' Shale - grey, finely blocky, platy, layered, badly weathered but not reworked.

- 8.9' Shale - black, coarsely blocky, tough, platy to
rubbly, contains numerous thin silt
laminae, plant remains.
Suite 682 5.5' down from base of above.
- 2.5' Shale - as above but not quite so coarse and
tough.
Suite 683 2.5' down from base of above.
- 0.1' Silt layer - as below.
- 0.8' Shale - as above.
- 0.7' Silt and shale - interbanded in bands 0.08' thick.
Shale as above; silt is buff to khaki,
often rusty, fair induration and minute
cross-bedding in the silt.
Suite 684
- 6.0' Shale - khaki brown to black, good primary
layering, may be a clay-shale more than
true shale, becomes rusted on weathering,
medium splintery, good parting, and
micromicaceous.
Suite 685 4' down from base of above.
- 0.1' Ironstone layer - fairly continuous, highly
weathered.
- 1.6' Shale - as above.
- 0.1' Metabentonite layer - fairly continuous.
- 3.3' Shale - black, medium to coarsely blocky, fissile,
generally weathered.
Suite 686 2' down from base of above.
- 0.05' Ironstone layer - narrow, quite continuous.
- 4.0' Shale - black, fairly coarsely blocky, fissile,
clayey and crumbly.
Suite 687.
- 0.3'-0.4' Ironstone layer - quite continuous, flat and lensy,
apparently platy.
- 7.0' Shale - black, very coarsely blocky, highly
fissile.
Suite 688 5' down from base of above.
- 0.02' Silt - thin layer, quite continuous.
- 9.8' Shale - black, very coarsely blocky, highly
fissile.
Suite 689 2' down from base of above.
Suite 690 9' down from base of above.
- 0.1' Metabentonite layer

- 0.4' Shale - as above.
0.05' Metabentonite layer
0.3' Shale - as above.
0.05' Metabentonite layer
1.5' Shale - as above.
Suite 691
0.1' Metabentonite layer
1.5' Shale - as above.
Suite 692 1.5' down from base of above.
- Water level.

SUITES 693-699

Locality 0 254D, Loon River formation, Peace River,
Tp. 108, R. 14, W. 5 meridian, Alberta.

- 3' Recent clay
2' Shale - grey, fine, small plates weathered.
1' Shale - as below.
0.1' Metabentonite layer - highly rusted and indurated.
2.0' Shale - black, very coarsely blocky and platy,
fissile as below.
0.05' Ironstone layer - very thin but quite continuous.
3.0' Shale - black, as above, contains few narrow
layers of metabentonite.
Suite 693 2' down from base of above.
21.3' Shale - black, very coarse, highly fissile,
micromicaceous.
Suite 694 3' down from base of above.
Suite 695 8' down from base of above.
Suite 696 13' down from base of above.
Suite 697 18' down from base of above.
0.2' Metabentonite layer - coarse.
0.4' Shale - as above.
0.05' Metabentonite layer
1.5' Shale - as above.
Suite 698

- 0.15' Metabentonite layer - coarse.
Suite 699
- 0.2' Shale - as above.
- 0.4' Shale - indurated, highly rusted on weathering.
- 0.2' Shale - as above.
- 0.1' Metabentonite layer
- 0.1' Shale - as above.
- 0.05' Metabentonite layer
- 0.2' Shale - as above.
- 0.4' Shale - rusty weathering as above.
- 1.0' Shale - very coarse.
- Covered to water level.

SUITES 700-704

Locality O 257A, Loon River formation, Peace River,
Tp. 108, R. 14, W. 5 meridian, Alberta.

- 4' Pebble clay
- 0.1' Ironstone layer
- 3.5' Shale - black, very coarse, friable, almost coaly
black, badly weathered.
- 0.1' Metabentonite layer
- 0.5' Shale - as above.
- 0.1' Shale - highly rusted layer.
- 1.5' Shale - black, highly rusty, fine, friable,
crumbly, clayey, badly weathered.
Suite 700
- 0.1' Ironstone layer
- 0.1' Shale - as above.
- 0.05' Ironstone layer
- 1.2' Shale - as above.
- 0.1' Ironstone layer
- 0.3' Shale - as above.
- 0.05' Shale layer - highly rusted.

- 1.2' Shale - as above, but with thin rusty shale or thin ironstone layer.
- 0.1' Ironstone layer - as above.
- 0.3' Shale - with thin rusty laminae.
- 0.05' Ironstone layer
- 0.6' Shale - as above.
- 0.1' Ironstone layer
- 0.8' Shale - as above.
- 0.1-0.2' Ironstone layer - thin, quite prominent and carbonaceous.
- 0.3' Shale - dark grey, finely splintery, silty not rusty.
- 0.1' Ironstone layer
- 0.7' Shale - dark grey as above.
Suite 701
- 0.2-0.7' Ironstone layer - coarse, very prominent.
- 2.0' Shale - dark grey to black, contains three rusty ironstone layers.
- 0.1-0.2' Ironstone layer
- 1.0' Shale - as above.
Suite 702
- 0.1' Ironstone layer
- 15' Covered
- 0.3' Siltstone - grey, indurated.
- 1.0' Shale - grey, friable, clayey.
Suite 703
- 0.1' Metabentonite layer
- 1.6' Shale - grey, clayey, friable.
Suite 704
- Water level

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