THE UNIVERSITY OF ALBERTA

TURONIAN MEGAFAUNA
OF
NORTHEASTERN BRITISH COLUMBIA

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DEPARTMENT OF GEOLOGY

by

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UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES

The undersigned hereby certify that they have read and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled:

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of Northeastern British Columbia,

submitted by Wayne Ewing Moore, B. Sc., in partial fulfilment of the requirements for the degree of Master of Science.

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ABSTRACT

The fossil species described and illustrated in this work include forty pelecypods, five gastropods, seven ammonites, one belemnite and one brachiopod. Most of this megafauna is from Turonian strata of Upper Cretaceous age, a great deal of which is found in the general Murray River Area of northeastern British Columbia, where a 3322-foot composite outcrop section, from the Dunvegan formation to the Baytree conglomerate member of the Cardium formation, is exposed. Five Turonian fossil zones along with one late Cenomanian fossil zone, which lies immediately below the Turonian stage, are set up from this megafauna and shown in eight plates. As a result of this megafaunal zoning the correct identification and stratigraphic positioning of the many sandstones within the Kaskapau formation is made easier.

Two new terms for sandstones within the Kaskapau shale are introduced in this work: the "Nunki" sandstone member, which lies 528 feet below the base of the Cardium formation, and the "Nini" conglomerate unit, which forms the top of the Wartenbe sandstone member.

Correlation of the Turonian and late Cenomanian strata of this area with that of the foothills of Southern Alberta, the Cumberland Gap area of Wyoming and the Black Hills of South Dakota is attempted.

Ecologic conditions which predominated during the deposition of the Pouce Coupe, Howard Creek, Tuskoola, Wartenbe and Nunki sandstone members of the Kaskapau formation and the Cardium formation in this area are discussed.

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CHAPTER ONE

INTRODUCTION

This thesis describes and identifies the megafauna present in strata of Upper Cretaceous, Turonian age, from northeastern British Columbia, and fossil horizons are determined which may be correlated with the fossil zones set up by Cobban and Reeside (1952) for the Cretaceous of the western interior of the United States.

Outcropping strata of Turonian age in northeastern British Columbia are generally confined to an area south of the Peace River and east of the Pine and Sukunka Rivers within the Rocky Mountain foothills belt and western plains area. Particularly good outcrops of Turonian strata are present in the lower Murray River area which may be considered as the "type" area for the Turonian of northeastern British Columbia. Tuskoola and Table mountains to the west of the Murray River provide excellent sections of the lower Turonian, and Nini and Puggins mountains and Coldstream Creek on the east side of the Murray afford equally good sections of the Upper Turonian.

PREVIOUS WORK

E. M. Spieker (1921) carried out the first oil reconnaissance geological studies in the area for the British Columbia Department of Lands in 1920. He measured a section on Tuskoola mountain and on lithologic evidence erroneously concluded that Tuskoola mountain was composed of sandstones and shales of the Fort St. John formation. In his report, Spieker briefly mentions strata younger than the Dunvegan

formation, introducing the term "Sukunka member" for what he believed to be the upper part of the Dunvegan and/or the lower part of the Smoky River shale.

Williams and Bocock (1932) were the next to report on this general area and concluded that Tuskoola and Table mountains were composed of the Dunvegan formation overlain by Smoky River shale and capped by sandstones "best referred" to the Wapiti formation. They also mention outcrops of the lower Smoky River formation on the Kiskatinaw and Pouce Coupe Rivers. Williams and Bocock obtained good fossil suites from the Dunvegan sandstone and lower Smoky River shale, one of which contained Inoceramus corpulentus, indicating a Turonian age for the Lower Smoky River shale.

Warren (1930a) described a number of new species of pelecypods of Coloradoan age from northeastern British Columbia many of which specimens were obtained from a collection made on the Murray and Kiskatinaw Rivers by the Hudson Bay Marland Oil Company. The exact stratigraphic position of these fossils was not known at that time.

In 1940 Warren and Stelck, as a result of the junior author's field work in the Pouce Coupe district of Alberta and British Columbia, listed the Cenomanian and Turonian faunas as well as introducing the new ammonite genus Dunveganoceras. The finding of Dunveganoceras in and slightly above the Pouce Coupe sandstone with no associated Turonian fauna below or with it led to the definition of the Cenomanian--Turonian boundary just above the Pouce Coupe sandstone member of the Smoky River shale.

C. R. Stelck (1955) in discussing the Cardium formation of northeastern British Columbia determined the Turonian--Coniacian boundary at the unconformable base of the Baytree conglomerate member of the uppermost part of the Cardium formation. He considers this member to be the basal bed of the incoming Wapiabi sea. Stelck introduces two new sandstone members below the Cardium formation and above the Pouce Coupe member, viz: Tuskoola and Wartenbe, with the Tuskoola member marking the base of the Second White Specks shale zone and the Wartenbe member "a close equivalent to the Jumping Pound sandstone" member of the southern foothills of Alberta. He shows that the Turonian Stage, in northeastern British Columbia, is represented by the Kaskapau shale above the top of the Pouce Coupe sandstone member, and the lower, middle and upper parts (less the Baytree conglomerate member) of the Cardium formation. The reader is referred to Stelck and Wall (1954; 1955) for further discussion of the Cenomanian--Turonian boundary as considered in the light of both micro- and megafaunal evidence. In these they include the Howard Creek sandstone above the Pouce Coupe sandstone in the Cenomanian Stage.

ACKNOWLEDGEMENTS

The Turonian and Upper Cenomanian fossils used in this study are from the Paleontology Collection, Department of Geology, University of Alberta. Most of these fossils were collected by Dr. C. R. Stelck who also did the field stratigraphic studies in the Pouce Coupe, Kiskatinaw, and Murray River areas. Other fossils

available to this study were given to the University of Alberta by various oil companies who have worked in this area during the last three decades, especially Hudson Bay Marland, Union Oil, and Canada Southern Petroleum Company.

The California Standard Graduate Fellowship held by the writer during the academic year 1957-58 provided the opportunity to pursue full time research on this project.

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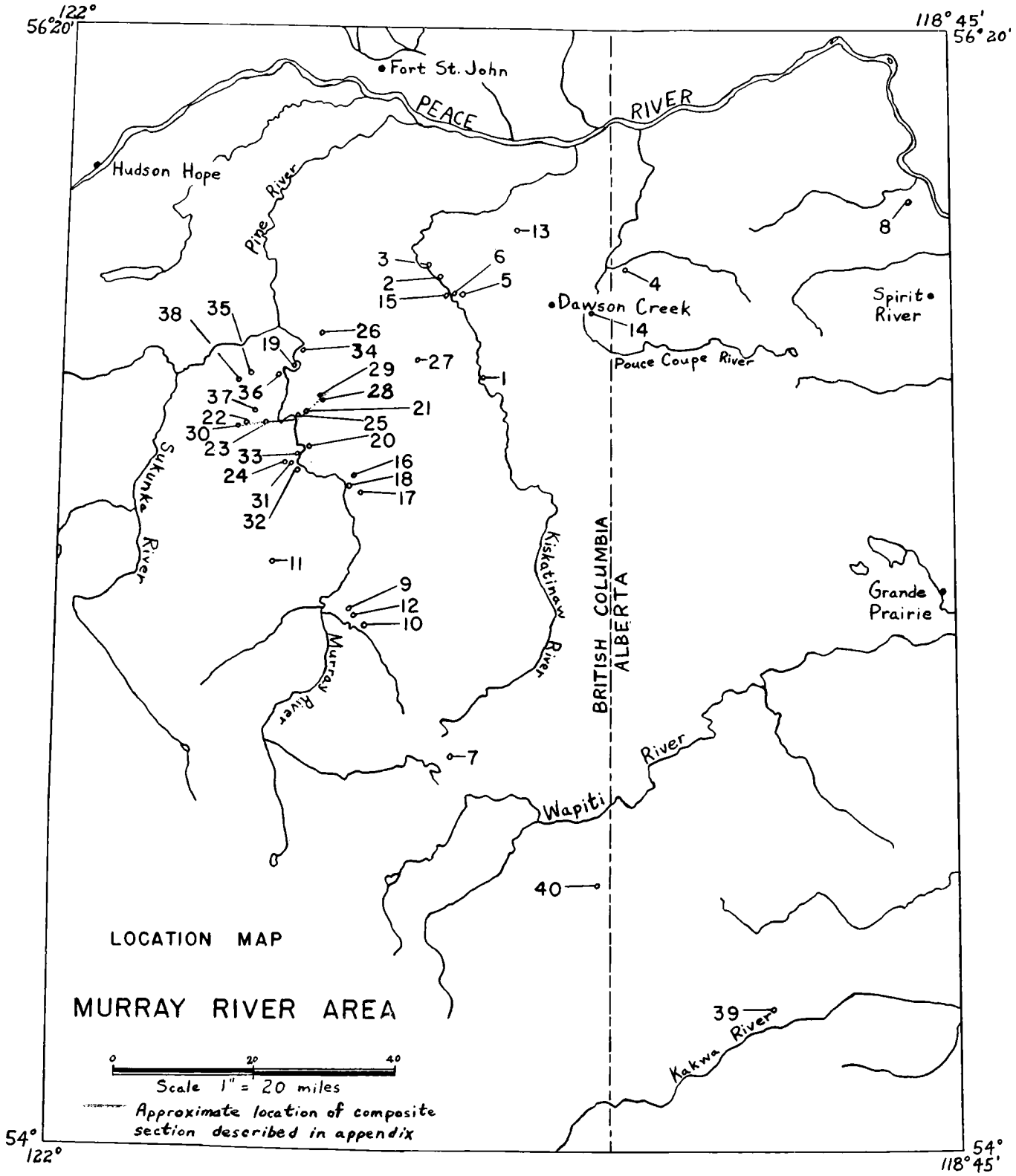

122°
56°20'
118°45'
56°20'
Fort St. John
PEACE RIVER
Hudson Hope
Pine River
Dawson Creek
Spirit River
Pouce Coupe River
Sukunka River
Murray River
Kiskatinaw River
BRITISH COLUMBIA
ALBERTA
Grande Prairie
Wapiti River
Kakwa River
1
2
3
4
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LOCATION MAP
MURRAY RIVER AREA
0
20
40
Scale 1" = 20 miles
Approximate location of composite section described in appendix
54°
122°
118°45'
54°

FIGURE 1

KEY TO LOCATION MAP

Area	Index Number	Fossil Number
Kiskatinaw River, B.C.	1	CuA_2
	2	CuF
	3	CuJ
Henderson Creek, Alberta	4	Ct826
Kiskatinaw River, B.C.	5	482
	6	498
Yoho Mountain, B.C.	7	581
Josephine Creek, Alberta	8	613
Flatbed Creek, B.C.	9	37779
	10	37784
Moose Lake, B.C.	11	37789
Flatbed Creek, B.C.	12	37790
Sweetwater, B.C.	13	37792
Dawson Creek, B.C.	14	37800
Kiskatinaw River, B.C.	15	38019
Salt Creek, B.C.	16	38028
	17	38029
	18	38032
Murray River, B.C..	19	38047
	20	38053
Nini Hill, B.C.	21	38059
Tuskoola Mountain, B.C.	22	38061
	23	38062

Gwillim River, B.C.	24	39104
Murray River, B.C.	25	39109
Coldstream Creek, B.C.	26	39116
Brassey Creek, B.C.	27	39120
Coldstream Creek, B.C.	28	39128
	29	39129
Tuskoola Mountain, B.C.	30	39131 39132 39143 39144 39145 39146 39147 39149 39150
Gwillim River, B.C.	31	39135
	32	39142
Gordon Creek, B.C.	33	39151
Murray River, B.C.	34	39156
Cowie Creek, B.C.	35	39157
Lost Canyon, B.C.	36	39159
Cowie Creek, B.C.	37	39162
Table Mountain, B.C.	38	39280
Lynx Creek, Alberta	39	40203
Mistanusk Creek, B.C.	40	40675

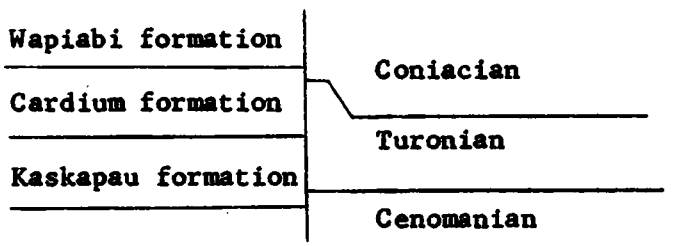
CHAPTER TWO

STRATIGRAPHY

STRATIGRAPHIC SETTING OF THE MEGAFAUNA

In northeastern British Columbia, the Turonian Stage is represented by strata of the lower part of the Smoky River Group, which group in this area is composed of the following formations:

Smoky River Group



The Kaskapau formation has several sand members such as the Doe Creek, Pouce Coupe, Howard Creek, Tuskoola, Wartenbe, as well as other previously unnamed sand beds. The Cardium in this area consists of several sand members with a capping conglomerate called the Baytree member. Most of the Kaskapau formation, with the exception of the Pouce Coupe sandstone member and underlying shale, and the Cardium formation, less the Baytree conglomerate member, comprise the strata of Turonian age in northeastern British Columbia (Table, page 9). The actual boundary between the Cenomanian and Turonian Stages is placed shortly above the Pouce Coupe sandstone member where the uppermost occurrence of Dunveganoceras is found. The boundary between the Turonian and Coniacian stages is placed at the base of the Baytree conglomerate member in the Pouce Coupe area. The Baytree conglomerate member unconformably

TABLE I

AGE	BLACK HILLS SOUTH DAKOTA	CUMBERLAND GAP WYOMING	SOUTHERN FOOTHILLS ALBERTA	MURRAY RIVER AREA B. C.	FOSSIL ZONES (Cobban & Reeside, 1952)
CONIACIAN	NIOBRARA FMTN.	HILLIARD FMTN.	WAPIABI FMTN.	WAPIABI FMTN.	
TURONIAN	CARLILE FORMATION: SAGE BREAKS MEM.	FRONTIER FORMATION: MARINE SS.	CARDIUM FMTN.	CARDIUM FMTN.: BAYTREE CGL.	Scaphites preventricosus Inoceramus deformis
				MARINE TO BRACKISH SS.	Scaphites corvensis Prionocyclus aff. reesidei
	TURNER SANDY MEMBER	NONMARINE BEDS		MARINE SH.	Scaphites nigricollensis Prionocyclus reesidei
				MARINE SS.	Scaphites whitfieldi Prionocyclus wyomingensis
	SHALE MEMBER		BLACKSTONE FORMATION: SHALE MEMBER	KASKAPAU FORMATION: SHALE MEMBER	Scaphites warreni Prionocyclus macombi
					Scaphites carlilensis Collignoniceras hyatti
		OYSTER RIDGE SS.		NUNKI SS.	Scaphites larvaeformis Collignoniceras woollgari
		MARINE SH.	JUMPING POUND SS.	SHALE MEMBER	
	GREENHORN FORMATION	CHIEFLY NONMARINE BEDS	SHALE MEMBER	NINI CGL. / WARTENBE SS. / SHALE MEMBER / TUSKOOLA SS. / SHALE MEMBER	Watinoceras reesidei Inoceramus labiatus
				HOWARD CREEK SS. / SHALE MEMBER	Scipinoceras gracile Metoicoceras whitei
CENOMANIAN				POUCE COUPE SS.	Dunveganoceras aff. albertense
				SHALE MEMBER	Dunveganoceras pondi Metoicoceras praecox

STRATIGRAPHIC RELATIONS OF THE TURONIAN OF NORTHEASTERN B.C.

overlies the upper sandstone member of the Cardium formation, and represents the basal beds of the incoming Wapiabi sea, although it is included within the Cardium formation.

For this paper a complete composite section, extending from Coldstream Creek southwestward across the Murray River to Gordon Creek (Figure, page 5), comprising approximately 3,322 feet of strata from the top of the Cardium sandstone to the base of the Kaskapau shale, is used as a standard section to which all other outcrops of similar horizons are referred. A detailed description of this section is given in the appendix of this work. Between the Pouce Coupe sandstone member and the Cardium formation, there are a number of local sandstones within the Kaskapau formation of Turonian age. These sandstones were named "Tuskoola sandstones" by Stelck (1955), and have maximum thicknesses near Tuskoola and Wartenbe (Table) mountains and in the lower Murray River area.

In ascending order these members are:

The Howard Creek sandstone, named by Stelck and Wall (1954) for a fourteen foot sandstone bed between the depths of 763 and 777 feet in the Imperial Spirit River No. 1 well. This sandstone outcrops on Howard Creek, northwest of Spirit River town, Alberta;

The Tuskoola sandstone, named by Stelck (1955) for a fifty foot massive sandstone unit lying 525 feet below the top of Tuskoola mountain, British Columbia (after E. M. Spieker);

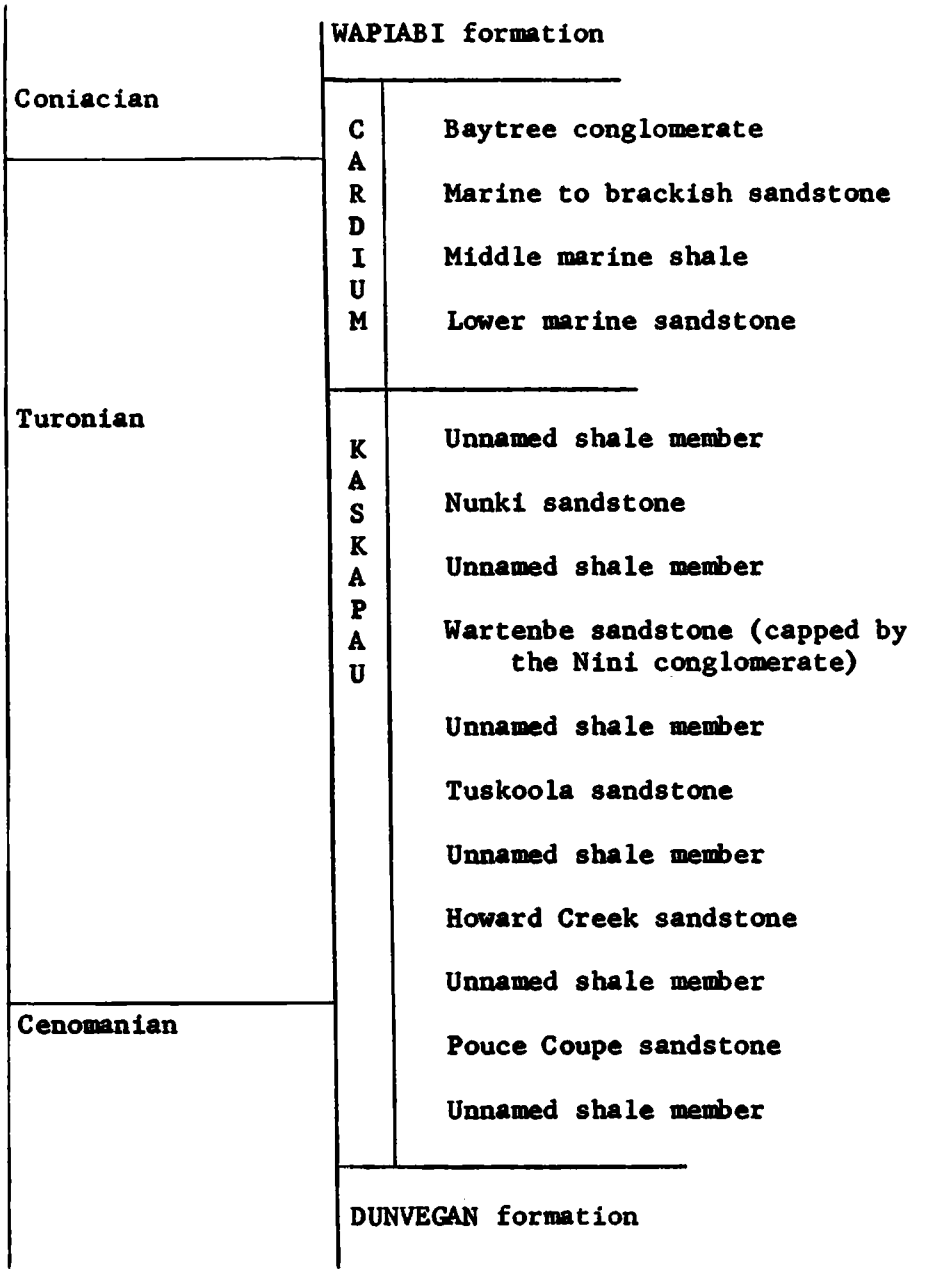
The Wartenbe sandstone (capped by the Nini conglomerate), named by Stelck (1955) for a fifty foot hard, massive sandstone unit, containing oysters and a two to five foot conglomerate at

the top, lying 235 feet below the top of Tuskoola mountain, British Columbia (after E. M. Spieker). The term "Nini" is proposed for this two to five foot conglomerate bed which is sixteen feet thick at Nini Hill, the location of which is two miles east of the Murray River, approximately thirteen miles above its mouth;

The "Nunki" sandstone is the name proposed for a sixty foot well bedded sandstone unit, containing many oysters of the genus Exogyra, which outcrops on Nunki Hill. Nunki Hill lies two miles east of the Murray River, approximately fourteen miles above its mouth. The top of this member lies 528 feet below the base of the Cardium formation which outcrops farther east near Coldstream Creek (refer to appendix).

Each of the above sandstones appears to contain diagnostic faunas and has sufficient areal extent and stratigraphic significance to be termed a "member".

Thus the following shows the Kaskapau and Cardium formations with their members, their upper and lower boundaries and their age in relation to the European stages of time.



This paper is mainly concerned with the stratigraphic assignment of these "Tuskoola" sandstone members with respect to the Kaskapau formation and the Cardium formation. The fossil zones, set up by Cobban and Reeside (1952) for the Western Interior of the United States, are used as a reference framework for this study (Table, page 9). Eight plates, representing six successive

fossil faunules, corresponding to five Kaskapau sandstone members and the Cardium formation, are shown as follows:

Plate 1: Upper Cenomanian fauna (from above the Dunvegan sandstone to the top of the Pouce Coupe sandstone member, Kaskapau formation);

Plate 2: Lower Turonian fauna (below the Inoceramus labiatus zone, including the Howard Creek sandstone member, Kaskapau formation);

Plates, 3,4,5: Inoceramus labiatus zone (lower part, including the Tuskoola sandstone member, Kaskapau formation);

Plate 6: Inoceramus labiatus zone (upper part, including the Wartenbe sandstone member, Kaskapau formation);

Plate 7: Fauna within the Nunki sandstone member, Kaskapau formation;

Plate 8: Fauna within the Cardium formation.

REGIONAL STRATIGRAPHIC CORRELATION

The Kaskapau formation of northeastern British Columbia is correlated with the upper part of the Blackstone formation of the southern foothills of Alberta. The "Second White Speckled shale" (white chalk fragments) zone together with the Inoceramus labiatus faunal zone gives a cosmopolitan marker horizon upon which the Turonian correlation is established. The Second White Specks zone is equivalent to the top of the Greenhorn formation of the Western Interior of the United States and the Favel formation of Manitoba and is easily recognizable throughout the Canadian Plains area as a marker bed within the Colorado shale. The increase of

clastics in the foothills masks this marker horizon. Sandstone members equivalent to the upper part of the Second White Specks in the foothills are the Jumping Pound sandstone in the Southern Foothills and the Nunki sandstone in the foothills of northeastern British Columbia (Stelck and Wall, 1954). Thus the Nunki sandstone may be correlated in part to the Jumping Pound sandstone (Table, page 9).

The correlation of the Nunki sandstone member is found to be with the Oyster Ridge sandstone member of the partially non-marine Frontier formation in the Cumberland Gap area of Wyoming. Both are placed within the Collignoniceras woolgari zone of Cobban and Reeside (1952). The Oyster Ridge sandstone, as the name implies, contains an abundance of fossil oysters as is the case with the Nunki sandstone which contains many oysters of the genus Exogyra wherever it outcrops in northeastern British Columbia. Thus similar shallow water, brackish environmental conditions may be implied to have occurred at about the same time at these two distant areas. The equivalent strata in the Black Hills area of South Dakota remained marine - an unnamed basal shale member of the Carlile formation (Table, page 9).

The Cardium formation correlates directly with the Cardium formation of the southern foothills of Alberta with the exception of the Baytree conglomerate member at the top of the Cardium formation which is present in northwestern Alberta and in the Pouce Coupe area of British Columbia but absent in the southern foothills

of Alberta. There are four recognizable members in the Cardium formation in the northern foothills area of Alberta and British Columbia, a lower marine sandstone, a middle marine shale, an upper marine to brackish sandstone and the Baytree conglomerate member which marks the top of the Cardium formation.

The Cardium formation is correlated with the upper part of the Frontier formation of the Cumberland Gap area of Wyoming. In the above area the Frontier formation is capped with a marine sandstone which correlates with the Baytree member of the Cardium formation. In the Black Hills of South Dakota the Cardium formation is correlated with the upper two-thirds of the Turner sandy member and the Sage Breaks member of the Carlile shale and to the lower part of the Niobrara formation (Table, page 9).

Time correlation of the Cardium formation and the lower half of the Kaskapau formation, below the Nunki sandstone, of the Murray River area, with these other areas may be done with the aid of the fossil zones set up by Cobban and Reeside (1952), (Table, page 9).

Litholologic correlation of this stratigraphic interval is more difficult as the sandstone members of the Murray River area are absent in the southern foothills of Alberta, are equivalent in age to the lower, chiefly non-marine rocks of the Frontier formation in the Cumberland Gap area of Wyoming, and are equivalent to the Greenhorn formation (predominently limestone) in the Black Hills area of South Dakota.

Stelck (1955) has given an explanation for the presence of these additional sandstones within the Colorado shale, (from the Dunvegan sandstone to the Badheart sandstone), stating that these sandstones form "skirtings" around the Omineca-Cassiar batholith area to the northwest in British Columbia. These large outwashes of sand flowed southeastward and formed the predominantly non-marine Dunvegan formation of late Cenomanian age. Then towards the end of the Cenomanian stage and especially during Turonian time as the seas advanced throughout North America (Stelck and Wall, 1954) these sand outwashes which include the Pouce Coupe, Doe Creek, Howard Creek, Tuskoola, Wartenbe and Nunki sandstone members and the Cardium formation, were deposited under marine and in some cases brackish conditions. From these sandstones an extensive megafauna has been collected, which enables a good megafaunal correlation with the fossil zones set up by Cobban and Reeside (1952). As a result of this good outcrop exposure and abundant megafauna present in the Murray River area of northeastern British Columbia, this area is considered a type reference area for the Turonian of western Canada.

IMPORTANT MEGAFAUNAL FINDINGS

Some of the more important conclusions that have resulted from this work are:

(1) An outstanding similarity is noted between the megafauna from the lowermost Kaskapau formation, below the top of the Pouce Coupe sandstone member, in the Murray River area of

British Columbia and the megafauna illustrated by Stephenson (1952) from the Lewisville and Templeton members of the Cenomanian Woodbine formation of northeastern Texas. Stelck and Wall (1955) have previously pointed out this similarity in studies of the Pouce Coupe area of British Columbia.

(2) The recognition of Exogyra suborbiculata (Lamarck). Stanton in the Nunki sandstone member is noted. This species was first illustrated by Stanton (1893) from the "Pugnellus" sandstone within the Carlile shale formation of Colorado. Cobban and Reeside (1952) do not include this species in their fossil zone correlation of the Cretaceous of the Western Interior of the United States, but they list the stratigraphic position of the lower part of the "Pugnellus" sandstone in the Collignoniceras woolgari zone. Thus the stratigraphic position of the Nunki sandstone member is pinpointed. The presence of Tragodesmoceras cf. bassi Morrow in the Nunki sandstone member confirms the above statement, as the latest occurrence of Tragodesmoceras in the United States is at the top of the Collignoniceras woolgari zone.

(3) A Vascoceras? occurrence within the Inoceramus labiatus zone marks the northernmost extension of this ammonite fauna. This fauna has not previously been reported in Western Canada and if the Vascoceras identification is correct, it will indicate that warm water conditions were probably present during at least part of Turonian time in northeastern British Columbia.

ECOLOGY

The six fossil zones described in this work, corresponding to six separate sandstones in the Murray River area show two general cyclings of ecologic conditions from marine (Pouce Coupe sandstone) to brackish (Nunki sandstone) to marine (lower and middle Cardium formation) and back to brackish (upper Cardium formation). The general distribution of the seas of these two cycles, namely Lower Turonian and Upper Turonian, are shown in Figure 2, page 19, which is an unpublished map in press by Warren and Stelck. The sandstones will be discussed in ascending order.

The megafauna of the Pouce Coupe sandstone indicates that marine conditions predominated during latest Cenomanian time in this area. However, the presence of Dunveganoceras, oysters (not shown in Plate 1) and Brachidontes in this sandstone indicate that somewhat brackish, shallow water conditions persisted in certain localities. The genus Dunveganoceras has not been illustrated in this work as species of this genus have been thoroughly discussed by Warren and Stelck (1955).

The change to marine conditions appears to have been completed during Howard Creek time as the brackish faunas have disappeared. Deep water is suggested by the large, smooth ammonite Placenticeras.

Deep marine water conditions appear to have predominated throughout the Inoceramus labiatus zone which, in this area, includes the Tuskoola and Wartenbe sandstone members. Many species

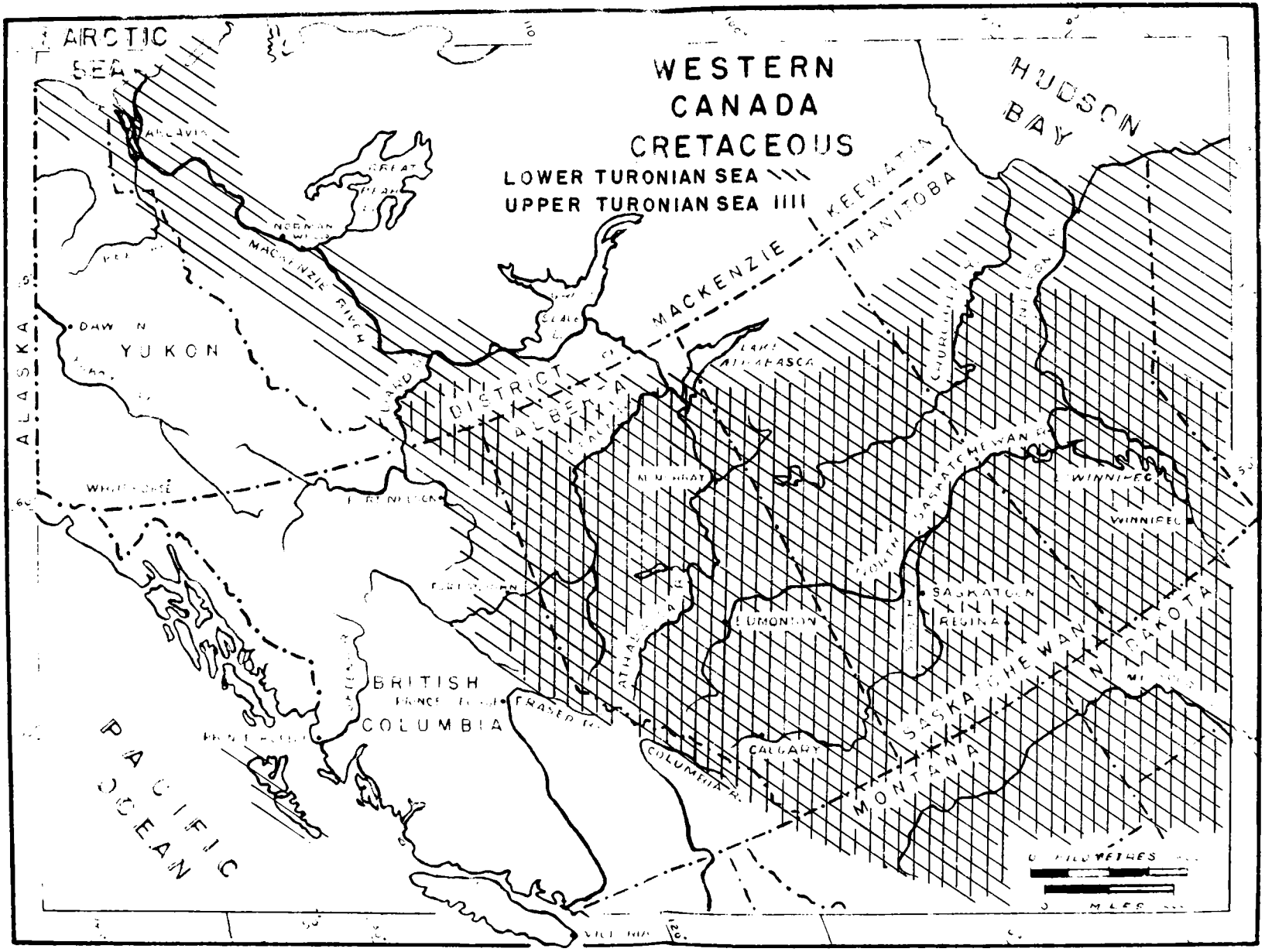

WESTERN
CANADA
CRETACEOUS
LOWER TURONIAN SEA
UPPER TURONIAN SEA
ARCTIC
SEA
HUDSON
BAY
ALASKA
YUKON
MACKENZIE
KEEWATIN
MANITOBA
DISTRICT OF MACKENZIE
BRITISH
COLUMBIA
PACIFIC
OCEAN
EDMONTON
SASKATOON
REGINA
CALGARY
WINNIPEG
SASKATCHEWAN
ALBERTA

Fig. 2

of Inoceramus with thin shells, a feature of deep water forms, occur within this zone. A distinct brackish water element, in the form of the oyster Ostrea soleniscus, however, is found in the Tuskoola sandstone. The presence of the hardy, thick-shelled form Veniella cf. mortoni in the Wartenbe sandstone also suggests a brackish water element. Thus it would appear, that while marine conditions predominated during the deposition of the Inoceramus labiatus zone in this area, brackish conditions persisted in certain near-shore localities.

Brackish water conditions appear to have returned and remained predominant throughout the deposition of the Nunki sandstone. This assumption results from the large numbers of oysters of the genus Exogyra that are found wherever this sandstone outcrops in this area. A marine element, however, persists as marine fossils as well as oysters are found in this sandstone.

The above ecologic cycle is completely repeated within the Cardium formation. The lower and middle parts of the Cardium formation contain a distinct marine megafauna. This marine state, however, is short-lived as shallow water structures and brackish conditions are observed in the upper part of the Cardium formation in this area.

Thus, in the Murray River area of northeastern British Columbia, the Turonian stage begins under marine conditions, becomes brackish shortly after the deposition of the Inoceramus labiatus zone, returns to marine during lower and middle Cardium time, and becomes brackish again in the upper Cardium formation at the close of Turonian time.

CHAPTER THREE

FORMAL DESCRIPTIONS

INTRODUCTION

The following formal descriptions deal with forty pelecypods, five gastropods, seven ammonites, one belemnite and one brachiopod.

No new names are applied to any of the figured specimens, but where a new species or variety is believed to exist, statements to this effect are made under "Remarks".

Phylum MOLLUSCA

Class PELECYPODA

Order PRIONODESMACEA

Superfamily NUCULACEA

Genus NUCULA Lamarck, 1799

Nucula sp.

Plate 7, figures 5, 13a

Shell small, subtrigonal to subovate in outline, inequilateral, moderately inflated; beaks prominent, situated near posterior extremity; anterodorsal margin very broadly arched; anterior margin sharply rounded; ventral margin broadly rounded; posterior margin nearly straight, posterodorsal margin sharply arched; internal mold surface smooth; seventeen teeth, increasing in prominence anteriorly, noted along anterior part of hingeline and seven poorly defined teeth noted on posterior part of hingeline.

Dimensions: length 7 mm., height 6 mm., convexity approximately 3 mm. (estimated).

Types: Figured specimen from 39129 suite, Geol. Mus. Coll., U. of A.

Horizon: Nunki sandstone member, Kaskapau formation.

Location: Coldstream Creek, four miles northeast of Nini Hill, Murray River Area, B.C.

Remarks: The exact identification of this species is difficult as only three imperfectly preserved internal molds are present.

Superfamily ARCACEA

Genus BARBATIA Gray, 1842

Barbatia micronema (Meek)

Plate 1, figure 17

Trapezium micronema Meek, 1873, Ann. Rept. U. S. Geol. Surv. Terr. for 1872, p. 493.
Barbatia micronema (Meek). Stanton, 1893, Bull. U. S. Geol. Surv. No. 106, p. 89, pl. 21, figs. 1 - 4.
Barbatia micronema (Meek). McLearn, 1945, Geol. Surv. Can. Paper 45-27, pl. 2, fig. 9.

Shell medium-sized, moderately inflated, inequilateral, longer than high; beak quite prominent, situated near anterior of shell; anterior margin not preserved in specimen; ventral margin nearly straight; posterior margin not preserved; dorsal margin nearly straight; posterodorsal area of shell slopes gradually from main axis of umbo to posterodorsal margin; surface ornament very indistinct on this posterodorsal area; a shallow depression is present extending from beak almost to ventral margin at an angle

of about eighty degrees to the hingeline; surface covered with fine growth lines and a few growth undulations most prominent in lower part of shell; fine radial ribs are also present, more prominent on lower (older) part of shell.

Approximate dimensions of hypotype; length 45 mm., height 35 mm., convexity of right valve 13 mm.

Types: Hypotype 38047, Geol. Mus. Coll., U. of A.

Horizon: Brackish shale member below the Pouce Coupe sandstone member, Kaskapau formation.

Location: Big Bend of Murray River, three miles below Lost Canyon, B. C.

Genus GLYCYMERIC Cost,1778

Glycymeris sp. nov.?

Plate 8, figures 1 - 3, 6

Shell obese, almost equivalve and equilateral; outline of internal mold very nearly circular; umbonal slope not defined; surface slope gently curved anteriorly and posteriorly from shell centre; anterior and posterior margins are broadly rounded, ventral margin semicircular, dorsal margin appears to be more narrowly rounded; shell material thick; shell surface covered with concentric depressions one-half to two millimetres apart; five to seven fine growth lines are present between concentric depressions; extremely fine radial lines (approximately 0.1 millimetre apart) are present giving a very fine reticulated pattern to shell surface; external structures on hingeline not seen; beak extends over hingeline near midpoint.

Hingeline straight, curved downward at posterior and anterior ends; twenty-five teeth noted; teeth are large, chevron-shaped at posterodorsal and anterodorsal positions along hingeline, decreasing toward mid-point of hingeline and where hingeline curves downward posteriorly and anteriorly; ventral margin coarsely denticulated (teeth are approximately one millimetre wide). Sharp depression present on posterior end of internal mold just above mid-height position; muscle scars evidently of approximate equal magnitude; pallial line strong, four millimetres above ventral margin, joining the two muscle scars.

Dimensions (internal mold): length 20 mm., height 20 mm., thickness approximately 15 mm.

Types: Figured specimens from 38028, 38029 and 39129 suites, Geol. Mus. Coll., U. of A.

Horizon: Lower sandstone member, Cardium formation.

Location: 38028 suite from Salt Creek, Murray River Area, B.C.
38029 suite from half-mile south of Salt Creek, Murray River Area, B.C.
39129 suite from Coldstream Creek, Murray River Area, B.C.

Superfamily PTERIACEA

Genus PINNA Linnaeus, 1775

Pinna sp.

Plate 5, figures 10, 11

Shell large, very elongate; dorsal margin appears to be straight; ventral margin very broadly convex; margins appear

inclined to each other at an acute angle; three radial costae, quite widely spaced, cover dorsal part of valve (extreme dorsal part of shell absent); line and undulations of growth prominent on ventral half of shell; faint growth lines pass over into dorsal portion of shell and are at right angles to radial costae.

Dimensions: length 140 mm. (estimated); height 28 mm.

Types: Figured specimen from 39147 suite, Geol. Mus. Coll., U. of A.

Horizon: Tuskoola sandstone member, Kaskapau formation.

Location: Tuskoola mountain, B. C.

Remarks: This specimen consists of the posterior two-thirds of an external mold, with part of the dorsal portion of the shell missing. This specimen may be related to Pinna dolosoniensis McLearn from the Bad Heart sandstone, but not enough of the shell is preserved for a detailed comparison.

The specimen shown as figure 10, plate 5 may possibly be a small variety of the above. Data on this variety are:

Dimensions: Approximate length 40 mm., height 15 mm., convexity 8 mm.

Types: Figured specimen from 39151 suite, Geol. Mus. Coll., U. of A.

Horizon: Float believed to be from the Tuskoola sandstone member, Kaskapau formation.

Location: One mile downstream from the mouth of Gordon Creek on the Murray River, B. C.

Genus INOCERAMUS Sowerby, 1814

Inoceramus allani Warren

Plate 2, figure 8

Inoceramus allani Warren, 1930, Res. Counc. Alberta, Rept. 21, appendix, p. 62, pl. 3, fig. 1.

Shell medium-sized for genus, moderately convex, higher than long; beaks anterior projecting forward; anterior margin slightly concave; ventral margin broadly rounded; posterior margin broadly rounded; dorsal margin short, nearly straight; anterior postumbonal slope very steep and slightly concave (parallel to anterior margin); posterodorsal and posterior slope moderately steep; ventral slope less steep; posterodorsal and posterior part of shell compressed; surface covered with wide, poorly defined concentric undulations interspersed with finer more distinct concentric ribbing.

Dimensions of hypotype: length 50 mm., height 67 mm., convexity of left valve 15 mm.

Types: Hypotype from 498 suite, Geol. Mus. Coll., U. of A.

Horizon: Unnamed shale member 50 feet above the Pouce Coupe sandstone member, Kaskapau formation.

Location: Lsd. 9, Sec. 29, Twp. 78, R17W6, Kiskatinaw River, B. C.

Remarks: This hypotype is very similar to specimens of *Inoceramus prefragilis* Stephenson as well as *I. allani* Warren. Upon comparing the descriptions and photographs of these two holotypes it appears that they are essentially the same species.

The above hypotype is assigned to I. allani Warren due to the proximity and close stratigraphic relation to Warren's species.

Inoceramus arvanus Stephenson

Plate 1, figure 2

Inoceramus arvanus Stephenson, 1952, U.S. Geol. Surv. Prof. Paper 242, p. 65, pl. 12, figs. 6 - 9.

Shell of medium size, subquadrate; slightly inflated; anterior margin straight to slightly concave, descending ninety degrees or more to hingeline; ventral margin semicircular; posterodorsal and posterior slopes gentle and modified by a broad radiating depression near dorsal margin; beaks terminal, a little in front of the anterior margin; surface marked with fine growth lines over coarse growth undulations.

Dimensions of hypotype: length 36 mm., height 39 mm., thickness 24 mm.

Type: Hypotype from CuA_2 suite, Geol. Mus. Coll., U. of A.

Horizon: Unnamed shale member below the Pouce Coupe sandstone member, Kaskapau formation.

Location: Upper Kiskatinaw River, B. C.

Remarks: The holotype of Inoceramus arvanus Stephenson comes from the Lewisville member of the Cenomanian Woodbine formation of Texas.

Inoceramus sp., aff. I. corpulentus McLearn

Plate 2, figure 7

Inoceramus corpulentus McLearn, 1926, Geol. Surv. Can., Mus. Bull. 42, p. 123, pl. 21, figs. 5 - 7.

Shell small, higher than long, strongly inflated; beaks missing from shell; anterior umbonal slope steep; ventral slope moderately steep; posterior part of shell missing; surface covered with distinct concentric ribs and irregular concentric undulations.

Approximate dimensions: length 15 mm., height 23 mm., convexity of left valve 9 mm.

Types: Figured specimen from 39143 suite, Geol. Mus. Coll., U. of A.

Horizon: Unnamed shale member between the Pouce Coupe and Howard Creek sandstone members, Kaskapau formation.

Location: Tuskoola mountain, B. C.

Remarks: The shape and ornament of this specimen is quite similar to Inoceramus corpulentus McLearn, but it is less than one-half the size of McLearn's holotype.

Inoceramus sp., cf. I. corpulentus McLearn

Plate 6, figures 15, 16

Shell medium-sized, obese; much higher than long; anterior slope very steep (greater than ninety degrees); posterior slope almost ninety degrees, beak is crushed; surface covered with large irregular undulations and finer distinct growth lines.

Dimensions: length 25 mm., height approx. 50 mm., thickness (left valve) 20 mm.

Types: Figured specimen from 39104 suite, Geol. Mus. Coll., U. of A.

Horizon: Wartenbe sandstone member, Kaskapau formation.

Location: Two miles above mouth of Gordon Creek on the Murray River, B. C.

Remarks: This specimen has a similar shape and outline to Inoceramus corpulentus McLearn. The distinct growth lines, not mentioned by McLearn in his original description of I. corpulentus, appear to be quite outstanding in his photographs of the species and the above specimen has similar distinct growth lines.

Inoceramus fragilis Hall and Meek var.

Plate 1, figure 6

Inoceramus fragilis Hall and Meek, 1854, Am. Acad. Arts and Sci. Man., n. s., Vol. 5, p. 388, pl. 2, figs. 6a - b.

Inoceramus fragilis Hall and Meek. Stanton, 1893, U.S. Geol. Surv. Bull. 106, p. 76, pl. 11, figs. 1 - 5.

This figured specimen is similar in most respects to Inoceramus fragilis mesabiensis Bergquist but differs in that the surface ornament consists of very strong, uniform, concentric ridges which become progressively wider apart distally. Growth lines are also present, overlying the concentric ridges and depressions. Thus, it is believed that this represents a new variation of I. fragilis Hall and Meek.

Dimensions: length 38 mm., height 48 mm., convexity of left valve 16 mm.

Types: Figured specimen from 37790 suite, Geol. Mus. Coll., U. of A.

Horizon: Unnamed shale member 400 feet below the Wartenbe? sandstone member, Kaskapau formation.

Location: Flatbed Creek, approximately five miles upstream from its mouth, B. C.

Inoceramus sp., cf. I. fragilis Hall and Meek

Plate 6, figures 9, 10

Shell moderate to small for genus, slightly to moderately inflated; beaks near anterior margin; inflation present along umbo only; umbonal slopes very gradual; anterior and ventral margins broadly rounded; posterior margin more broadly rounded; dorsal margin straight; posterodorsal area flat to broadly concave giving the appearance of a large "wing"; surface covered with quite uniform concentric undulations.

Dimensions: length 34 mm., height 27 mm., thickness of right valve 3 mm.

Types: Figured specimens from 37784 and 39135 suites, Geol. Mus. Coll., U. of A.

Horizon: Wartenbe sandstone member, Kaskapau formation.

Location: 37784 suite from the east side of Flatbed Creek, Murray River Area, B. C.
39135 suite from one-half mile above Gordon Creek, on the Murray River, B. C.

Remarks: The specimen shown as figure 10, plate 6 is believed to be a thin variety of Inoceramus fragilis Hall and Meek.

Inoceramus fragilis cf. mesabiensis Bergquist

Plate 1, figures 1, 4, 5, 18

Inoceramus fragilis mesabiensis Bergquist, 1954, Jour. Paleont., Vol. 18, No. 1, p. 12, pl. 5, figs. 3 - 6, 8.

Shell medium to large, obese, higher than long, left valve larger and more convex than right valve; beaks strongly incurved and terminal; the right beak slightly above straight hingeline; the left beak much higher and curving over hingeline; anterior margin straight to slightly concave, joining hingeline at nearly ninety degree angle in some specimens; ventral margin nearly semicircular; posterior margin straight to broadly curved, with a wing-like projection along hingeline; anterior slope approximately ninety degrees to the plane of symmetry; posterodorsal and ventral slopes steep but less than anterior slope; surface covered with growth lines and irregular coarse concentric undulations.

Dimensions (largest): length 40 mm., height 60 mm., thickness 50 mm.

Types: Figured specimens from CuF and 39163 suites, Geol. Mus. Coll., U. of A.

Horizon: Unnamed shale member below the Pouce Coupe sandstone member, Kaskapau formation.

Location: CuF suite from Sec. 6, Twp. 79, R. 17W6, Kiskatinaw River, B.C.
39163 suite from Hotchkiss River, 50 or 60 miles west of Hotchkiss, Alberta.

Remarks: These specimens appear to be very closely related to Inoceramus fragilis mesabiensis Bergquist found in the conglomerate of the Coleraine formation near Calumet, Minnesota. The age of

the Coleraine formation is early upper Cretaceous, and it is correlated with the lower Benton of the Colorado series.

Inoceramus fragilis cf. prairiensis McLearn

Plate 8, figures 9, 11

Inoceramus fragilis prairiensis McLearn, 1943, Canadian Field Naturalist, Vol. 57, p. 44.

Shell small, higher than long, obese; beaks anterior, incurved; dorsal margin straight; anterior margin broadly arched; ventral margin semicircular; posterior margin broadly arched; anterodorsal part of shell concave giving the appearance of a "wing"; anterior and posterior umbonal slopes approximately equal; very sharp and regular depression present immediately below hingeline; surface covered with strong concentric corrugations interspersed with distinct finer growth lines.

Dimensions: length 17 mm., height 20 mm., convexity 20 mm.

Types: Figured specimens from 39120 suite, Geol. Mus. Coll., U. of A.

Horizon: Lower sandstone member, Cardium formation.

Location: Near Brassey Creek, Murray River Area, B. C.

Remarks: The specimen shown as figure 11, plate 8 is a larger variety of the above described species.

Inoceramus labiatus (Schlotheim) var.

Plate 3, figure 8

Ostracites labiatus Schlotheim, 1813, Bronn's Jahrb., Vol. 7, p.93.

Inoceramus labiatus (Schlotheim). Stanton, 1893, U. S. Geol. Surv. Bull. 106, p. 77, pl. 10, fig. 4, pl. 14, fig. 2. (Includes detailed synonymy).

Shell large, elongate; anterior margin broadly rounded; ventral margin sharply rounded; posterior margin straight; dorsal margin straight; umbonal slope moderately steep posterodorsally becoming less steep towards ventral margin, where it is almost flat; beaks terminal, rising a short distance above hingeline; surface ornamented with concentric undulations superimposed with faint growth lines.

Dimensions: length 158 mm., height 85 mm., convexity 25 mm.

Types: Figured specimen from 39144 suite from Geol. Mus. Coll., U. of A.

Horizon: Beds between the Tuskoola and Wartenbe sandstone members, Kaskapau formation.

Location: Tuskoola mountain, B. C.

Inoceramus sp., aff. I. labiatus (Schlotheim)

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

Shell elongate, oval-shaped, rather compressed; anterior margin broadly curved; posterobasal margin semicircular to more narrowly rounded than a semicircle; posterodorsal margin nearly straight; umbo only slightly developed; beaks terminal, rising a short distance above hingeline, approximately equal; surface ornamented with quite regular concentric undulations with smaller growth lines.

Dimensions of largest specimen: length 75 mm., height 40 mm., convexity ≏ 20 mm. (only one valve present).

Types: Figured specimens from 37793, 37799, 39139 and 39142 suites, Geol. Mus. Coll. U. of A.

Horizon: Shale beds between the Pouce Coupe sandstone and Wartenbe sandstone members, Kaskapau formation.

Location: 37793 suite, Lsd. 4 - 5, Sec. 34, Twp. 78, R17W6, Kiskatinaw River, B. C.
37799 suite, Sec. 22 - 23, Twp. 78, R14W6, Pouce Coupe River, B. C.
39139 suite, five miles due west of Puggins mountain, Murray River, B. C.
39142 suite, one-half mile above the mouth of Gordon Creek, on the Murray River, B. C.

Remarks: This species is very often preserved as an external mold. These molds with their regular, slightly elongate concentric undulations are believed to be sufficiently diagnostic for their identification as I. labiatus (Schlotheim).

Inoceramus prefragilis Stephenson

Plate 1, figure 12

Inoceramus prefragilis Stephenson, 1952, U.S. Geol. Surv. Prof. Paper 242, p. 64, pl. 12, figs. 10 - 12; pl. 13, figs. 1, 2.

Shell large, higher than long; beaks terminal, prominent, strongly incurved, left beak curved forward more than right; inflation greater in umbonal region, becoming lower toward ventral margin; anterior umbonal slope steep, posterodorsal and posterior slopes moderate, ventral slope gradual; anterior margin nearly straight, ventral margin nearly semicircular; surface ornamented with growth lines and broad growth undulations.

Dimensions of hypotype: length 50 mm., height 80 mm., thickness 24 mm. (The length may be greater as shell is not complete).

Types: Hypotype 38019 from Geol. Mus. Coll., U. of A.

Horizon: Unnamed shale member below the Pouce Coupe sandstone member, Kaskapau formation.

Location: Kiskatinaw River, east of Progress, B. C.

Remarks: Inoceramus prefragilis Stephenson is found in the Lewisville and Templeton members which comprise the upper half of the Cenomanian Woodbine formation in Texas.

Inoceramus sp., cf. I. prefragilis Stephenson

Plate 2, figures 4, 6

Shell medium size, slightly inflated, inequilateral; beaks terminal, prominent, incurved; greatest inflation occurs in umbonal region; anterior slope steep; posterior and posterodorsal slopes moderately steep; ventral slope less steep; anterior margin nearly straight, ventral margin semicircular; posterior margin broadly rounded; dorsal margin nearly straight; surface covered with closely-spaced narrow concentric ribs along with irregular growth undulations.

Dimensions: length 35 mm., height approximately 40 mm., convexity of left valve 7 mm.

Types: Figured specimen from 39143 suite, Geol. Mus. Coll., U. of A.

Horizon: Unnamed shale member between the Pouce Coupe and Tuskoola sandstone members.

Location: Tuskoola mountain, B. C.

Remarks: These specimens appear to be related to Inoceramus prefragilis Stephenson of Upper Cenomanian Age. They may also be related to I. fragilis Hall and Meek, but they are longer with respect to height than the latter species.

Inoceramus tenuiumbonatus Warren

Plate 2, figure 9

Inoceramus tenuiumbonatus Warren, 1930, Res. Coun. Alberta, Rept. 21, appendix, p. 61, pl. 6, figs. 2, 3.

Shell large, elongate; beaks prominent, terminal, incurved; left valve much larger than right valve; surface covered with faint concentric undulations becoming coarser ventrally; anterior umbonal slope very steep; posterior slope less steep; hingeline appears straight.

Dimensions of hypotype: length 115 mm., height 85 mm. thickness 40 mm.

Types: Hypotype from 581 suite, Geol. Mus. Coll., U. of A.

Horizon: Unnamed shale member above Pouce Coupe sandstone member, Kaskapau formation.

Location: Creek west of Yoho Mountain, south side of Stony Lake, Monkman Pass Trail, B. C.

Inoceramus sp.?

Plate 7, figure 6

Horizon: Nunki sandstone member, Kaskapau formation.

Location: Coldstream Creek, Murray River Area, B. C.

Types: From 39129 suite, Geol. Mus. Coll., U. of A.

Inoceramus sp.

Plate 8, figure 10

Shell medium, obese; beaks anterior, prominent; dorsal margin straight; anterior margin small, sharply rounded; ventral margin broadly rounded; posterior margin nearly semicircular; surface covered with concentric undulations interspersed with very distinct growth lines.

Dimensions: length 33 mm., height 21 mm., convexity 20 mm.

Types: Figured specimen from 40203 suite, Geol. Mus. Coll., U. of A.

Horizon: Lower sandstone member, Cardium formation.

Location: Lynx Creek, approximately three miles upstream from its mouth on the Kakwa River, Alberta.

Remarks: This specimen appears to be related to Inoceramus coulthardi McLearn in general outline, but the concentric ornament appears more symmetrical than that of I. coulthardi McLearn.

Genus PTERIA Scopoli, 1777 (= AVICULA Bruguiere, 1792)

Pteria sp., cf. P. haydeni (Hall and Meek)

Plate 1, figure 8

Avicula haydeni Hall and Meek, 1854, Am. Acad. Arts and Sci. Man., n.s., Vol. 5, p. 382, pl. 1, fig. 5.
Pteria haydeni (Hall and Meek), 1876, U. S. Geol. Surv. Terr., 9th Ann. Rept., p. 33, pl. 16, figs. 2, a and b.

Shell small, subrhombohedral in outline, slightly inflated, inequilateral; beak prominent, rising slightly above hingeline, located one-quarter length of shell from anterior margin; hingeline (dorsal margin) straight; anterior margin moderately rounded;

ventral margin moderately rounded; posterior margin broadly rounded; inflation occurs along umbo leaving a large flattened posterodorsal area and a very small anterior "ear"; radial ribs very prominent from ventral margin for approximately three millimetres towards centre of shell; ribs are extremely faint in younger portion of shell; faint growth undulations also present.

Dimensions: length 11 mm., height 9 mm., convexity of left valve 1.5 mm.

Types: Figured specimen from 37792 suite, Geol. Mus. Coll., U. of A.

Horizon: Pouce Coupe sandstone member, Kaskapau formation.

Location: Lsd. 6, Sec. 12, Twp. 80, R16W6, east of Sweetwater, B. C.

Remarks: This hypotype appears to be quite similar to Pteria haydeni (Hall and Meek). P. haydeni (Hall and Meek), however, is from the lower part of the Fort Pierre Group which is a much higher stratigraphic position than the Pouce Coupe sandstone.

Superfamily OSTRACEA

Genus OSTREA Linnaeus, 1758

Ostrea soleniscus Meek

Plate 5, figure 8

Ostrea soleniscus Meek, 1871, Proc. Am. Philos. Soc., Vol. 11, p. 430.
Ostrea soleniscus Meek, 1873, Ann. Rept. U.S. Geol. Surv. Terr. for 1872, p. 487.
Ostrea soleniscus Meek. Stanton, 1893, U.S. Geol. Surv. Bull. 106, p. 56, pl. 2, fig. 1; pl. 3, figs. 1, 2.
Ostrea soleniscus Meek. Warren, 1933, Trans. Roy. Soc. Can., sec. 4, vol. 27, p. 112, pl. 1, fig. 1.

Ostrea soleniscus Meek. Stephenson, 1952, U.S. Geol. Surv. Prof. Paper 242, p. 74, pl. 16, figs. 1 - 4; pl. 17, figs. 7 - 10.

Shell large, elongate, thick; internal shell surface very smooth but distorted, possibly due to adherence of shell to extraneous objects; beak terminal; ventral margin broadly arched; posterior margin sharply rounded; dorsal margin slightly concave; pallial line distinct near posterior margin.

Dimensions of hypotype: length 110 mm., height 48 mm., convexity not observed.

Types: Hypotype from 37789 suite, Geol. Mus. Coll., U. of A.

Horizon: Wartenbe sandstone member, Kaskapau formation.

Location: South of Moose Lake, five miles due south of east end of Gwillum Lake, B. C.

Remarks: Above hypotype is the internal portion of a large left valve. Specimen is preserved in a medium to very coarse sandstone, which indicates the adaptability of O. soleniscus Meek into an environment of rapid deposition. The outlines of the margins may be due to post-depositional differential compaction of the sandstone.

Genus EXOGYRA Say, 1820

Exogyra sp., cf. E. columbella Meek

Plate 7, figure 7

Exogyra columbella Meek. Stanton, 1893, U. S. Geol. Surv. Bull. 106, p. 63, pl. 8, figs. 2, 3, 4.

Shell medium size, moderately inflated, subcircular in outline; umbo well-developed, forming quite steep umbonal slopes;

beak sharply coiled; external mold shows radial ribs prominent on upper part of umbo with irregular growth undulations present on ventral half of shell.

Dimensions: length 28 mm., height 30 mm., thickness of right valve 7 mm.

Types: Figured specimen from 39109 suite, Geol. Mus. Coll., U. of A.

Horizon: Nunki sandstone member, Kaskapau formation.

Location: Murray River, B. C.

Exogyra suborbiculata (Lamarck)

Plate 7, figures 1 - 4

Exogyra suborbiculata (Lamarck). Stanton, 1893, U.S. Geol. Surv. Bull. 106, p. 62, pl. 5, fig. 6; pl. 6, figs. 1, 2; pl. 8, fig. 1.

Shell large, obese, inequivalved, sub-ovate in outline; right (lower) valve commonly preserved; left (top) valve rarely preserved; right valve: umbo well-developed, often curved, forming steep anterior and posterior slopes; beaks distinctly coiled forming a sulcus below; left (upper) valve: flat, thin with concentric growth lines quite prominent; shell material thick, rarely preserved; internal molds very smooth, featureless.

Dimensions (largest specimen): length 55 mm., height 60 mm., thickness of right valve 20 mm.

Types: Figured specimens from 37786, 38059 suites, Geol. Mus. Coll., U. of A.

Horizon: Nunki sandstone member, Kaskapau formation.

Location: 37786 suite from Flatbed Creek, B.C.
38059 suite from Nini Mountain (altitude 3216'), Murray River Area, B. C.

Superfamily PECTINACEA

Genus PECTEN Osbeck, 1765

Subgenus CAMPTONECTES Meek, 1864

Camptonectes sp., cf. C. platessa White

Plate 2, figure 3

Camptonectes platessa White, 1874, Expl. and Surv. West of 100th Mer. Prelim. Rept. Invert. Foss., p. 25.
Camptonectes platessa White. Stanton, 1893, U. S. Geol. Surv. Bull. 106, p. 72, pl. 9, fig. 6.

Shell medium-sized, nearly subcircular in outline, nearly equilateral, inequivalve; right valve almost flat; left valve slightly inflated; beak and umbo of moderate size in left valve, not well defined in right valve; hingeline straight, approximately eighteen millimetres long; anterodorsal margin concave; anterior ears of both valves well-developed and about equal in size; posterior ears not preserved, but a distinct depression is present in the posterodorsal area of interior mold of left valve, possibly an indication of a byssal notch; internal molds of both valves smooth; fine, indistinct radial ornament observed where part of shell of right valve is preserved.

Dimensions: length 42 mm., height 43 mm., convexity 11 mm.

Types: Figured specimen from 39159 suite, Geol. Mus. Coll., U. of A.

Horizon: Unnamed shale member between the Pouce Coupe and Howard Creek sandstone members, Kaskapau formation.

Location: One and one-half miles upstream from mouth of Lost Canyon Creek, on the Murray River, B. C.

Superfamily MYTILACEA

Genus BRACHIDONTES Swainson, 1840

Brachidontes filisculptus (Cragin)

Plate 1, figure 7

Modiola filisculpta Cragin, 1893, Texas Geol. Surv., 4th Ann. Rept. for 1892, p. 194.
Brachidontes filisculptus (Cragin). Stephenson, 1952, U. S. Geol. Surv. Prof. Paper 242, p. 83, pl. 20, figs. 19 - 21.

Shell medium to large for genus, elongate, subtrigonal in outline, moderately inflated along umbo, inequilateral; beaks not preserved; umbonal ridge prominent, curved, sharply rounded near dorsal margin, progressively more broadly rounded ventrally; anteroventral umbonal slope steep, all other slopes more gradual; a distinct radial depression is present in front of and below umbonal ridge extending from dorsal area to near the ventral margin; between dorsal margin and the umbonal ridge a broad, shallow depression extends radially, fading near ventral margin; anterior margin not preserved, probably sharply rounded; anteroventral margin slightly concave; ventral margin semicircular; posterior and posterodorsal margins broadly rounded; surface covered with closely spaced, fine, radiating ribs of variable strength on different parts of shell and faint, irregular growth stages with very fine growth lines; intersection of growth stages and radial ribs often produces a concentric "beaded" effect.

Dimensions of hypotype: Approximate length (maximum dimension) 51 mm., height 35 mm., convexity of left valve 10 mm.

Types: Hypotype from 39162 suite, Geol. Mus. Coll., U. of A.

Horizon: Unnamed shale member below the Pouce Coupe sandstone member, Kaskapau formation.

Location: One-half mile below Applegate's farm on Wartenbe Creek, Murray River Area, B. C.

Remarks: This hypotype appears to be identical to Brachidontes filisculptus (Cragin) as illustrated by Stephenson from the Lewisville member of the Woodbine formation (Cenomanian Age) of Texas.

Brachidontes sp., cf. B. filisculptus microcostae Stephenson

Plate 1, figure 11

Brachidontes filisculptus microcostae Stephenson, 1952, U. S. Geol. Surv. Prof. Paper 242, p. 84, pl. 20, figs. 16 - 18.

Shell medium size for genus, elongate, very slightly inflated, inequilateral; beak not preserved in specimen; umbonal ridge quite prominent, straight, more sharply rounded near beak, becoming more gradually rounded posteroventrally; anterior margin not completely preserved; ventral margin nearly straight, very broadly concave near central part of shell; posteroventral margin very sharply rounded; posterior margin broadly rounded; dorsal margin not completely preserved; surface covered with very fine distinct radial ribs and fine growth lines; the umbo and posterodorsal area has radial ornament most prominent with growth lines quite indistinct;

below the umbo and in the anterior and anteroventral areas of the shell the growth lines are more prominent with less distinct radial ornament.

Approximate dimensions: length 42 mm., height 23 mm., convexity of right valve 3 mm.

Types: Figured specimen from CuJ suite, Geol. Mus. Coll., U. of A.

Horizon: Unnamed shale member below the Pouce Coupe sandstone member, Kaskapau formation.

Location: Downstream from CuF, Kiskatinaw River Area, B.C.

Remarks: This photograph is of the latex rubber cast of an external mold. This specimen appears to be very similar to Brachidontes filisculptus microcostae Stephenson as it carries very fine radial ribs (about thirty per centimetre), the much less pronounced inflation, the less prominent umbonal ridge, and a more slender and less strongly curved outline which separates it from B. filisculptus (Cragin). Stephenson.

Order ANOMALODESMACEA

Superfamily ANATINACEA

Genus ANATINA Lamarck

Anatina sp., cf. A. lineata Stanton

Plate 3, figure 11

Anatina lineata Stanton, 1893, U. S. Geol. Surv. Bull. 106, p. 117, pl. 26, figs. 3, 4.

Shell medium size, transversely elliptical in shape; anterior end produced, regularly broadly rounded; posterior end short, more

broadly rounded than anterior end; dorsal margin slightly concave behind beaks and convex in front; ventral margin broadly curved; beaks small, closer to posterior margin, with two broad shallow radial depressions on either side of beak extending one millimetre below dorsal margin; surface covered with strong concentric undulations becoming less distinct on anterior half of shell and many fine growth lines over entire shell.

Dimensions: length 40 mm., height 30 mm., convexity approximately 6 - 8 mm.

Types: Figured specimen from 38062 suite, Geol. Mus. Coll., U. of A.

Horizon: Beds between the Tuskoola and Wartenbe sandstone members, Kaskapau formation.

Location: North Point of Sandy Ridge, two and three-quarter miles above mouth of Wartenbe Creek, Murray River Area, B. C.

Genus PLEUROMYA Agassiz, 1845

Pleuromya ? sp.

Plate 7, figure 13d

Shell small, inequilateral, subrectangular in outline, strongly inflated along the umbos; beaks prominent, incurved, nearly terminal; anterior margin moderately rounded (apparently); ventral margin straight to very slightly concave; posterior margin broadly rounded, sharply rounded where it joins ventral margin; dorsal margin nearly straight; dorsal, anterior and ventral umbonal slopes steep; posterodorsal and posterior umbonal slopes more gradual; surface covered with mild growth undulations, more prominent distally.

Dimensions: length 18 mm., height 8 mm., convexity of right valve 4 mm.

Types: Figured specimen from 39129 suite, Geol. Mus. Coll., U. of A.

Horizon: Nunki sandstone member, Kaskapau formation.

Location: Coldstream Creek, four miles northeast of Nini Hill, Murray River Area, B. C.

Genus PHOLADOMYA Sowerby, 1823

Pholadomya sp., cf. P. goldenensis Stephenson

Plate 6, figure 17

Pholadomya goldenensis Stephenson, 1952, U. S. Geol. Surv. Prof. Paper 242, p. 87, pl. 21, figs. 19 - 22.

Shell medium size for genus, inequilateral; mildly inflated; beaks prominent, broadly incurved, situated one-fifth of length of shell from anterior end; anterior margin rounded with a sub-truncation near dorsal margin; ventral margin broadly rounded; posterior margin more sharply rounded than a semi-circle; dorsal margin nearly straight; surface covered with fine growth lines, more prominent near posterior and ventral margins where irregular concentric undulations appear; approximately fourteen radial ribs radiating from the beak becoming more widely spaced and less distinct distally; ribs absent near posterodorsal and anterodorsal margins.

Dimensions: length 50 mm., height 32 mm., thickness of right valve 9 mm.

Types: Figured specimen from 39149 suite, Geol. Mus. Coll., U. of A.

Horizon: Unnamed shale member between the Wartenbe and Nunki sandstone members, Kaskapau formation.

Location: Tuskoola mountain, B. C.

Remarks: This specimen is slightly larger and less inflated than Pholadomya goldenensis Stephenson, but in other respects greatly ressembles that species. Figures 8 and 9, plate 7, from the Nunki sandstone member appear to be related to the above specimen although the former are more inflated.

Pholadomya sp., aff. P. goldenensis Stephenson

Plate 7, figures 8, 9

Shell medium size, strongly inflated, inequilateral equivalve; beaks prominent, broad, situated less than one-fourth the length of the shell from the anterior end; place of greatest inflation well above midheight; surface descends steeply to the anterior margin with broad shallow radial depression in the anterodorsal area; surface descends broadly and less steeply to the ventral margin and still less steeply to the posterior margin; anterior margin regularly rounded; ventral margin broadly rounded; posterior margin evenly rounded; dorsal margin nearly straight; valves do not appear to gap; surface covered with growth lines (more distinct near margins), weakly defined irregular concentric undulations and approximately fourteen radial costae which become more poorly defined distally; growth lines and radial costae form a reticulate pattern which is more pronounced from beak to about midheight; radial costae absent near the anterior

margin and in the posterodorsal areas of valves.

Dimensions: length 46 mm., height 32 mm., convexity 28 mm.

Types: Figured specimen from 38032 suite, Geol. Mus. Coll., U. of A.

Horizon: Nunki sandstone member, Kaskapau formation.

Location: Mouth of Salt Creek at the Murray River, B.C.

Remarks: This specimen compares favorably with Pholadomya goldenensis Stephenson in size, shape and most morphological features. However, this specimen does not have as strong radial costae and does not appear to be as gaping as P. goldenensis Stephenson.

Genus THRACIA Leach, 1823

Thracia sp.

Plate 1, figure 3

Shell small, moderately inflated, inequilateral, equivalve; beaks prominent, near shell centre; inflation predominent along curved umbos; dorsal umbonal ridge very sharp; posterodorsal umbonal slope greater than ninety degrees, becoming less steep ventrally, forming a flattened posteroventral area; anterior and anteroventral umbonal slopes moderately steep; anterior margin broadly rounded; ventral margin more broadly rounded; posterior margin broadly rounded; dorsal margin sharply rounded, concave behind beaks; surface covered with fine growth lines.

Dimensions: length 35 mm., height 22 mm., convexity 15 mm.

Types: Figured specimen from 38047 suite, Geol. Mus. Coll., U. of A.

Horizon: Unnamed shale member below the Pouce Coupe sandstone member, Kaskapau formation.

Location: Big Bend of Murray River, three miles below Lost Canyon, B.C.

Order TELEODESMACEA

Superfamily CYPRICARDIACEA

Genus ARCTICA Schumacher, 1817
(= CYPRINA Lamarck, 1818)

Arctica murrayensis Warren

Plate 2, figures 1, 2

Arctica murrayensis Warren, 1933, Trans. Roy. Soc. Can., Sec. IV, Vol. 27, p. 114, pl. 2, figs. 1, 6.

Shell moderate size for the genus, sub-ovate, left valve slightly larger than right valve, a little longer than high, moderate to strongly convex; beaks prominent, approximately one-fourth the length of shell from the anterior margin, incurved; posterodorsal margin nearly straight; posterior end broadly rounded; anterior margin concave below and in front of the beaks, sharply curved at the extremity and more gently curved below to meet the ventral margin; ventral margin broadly arched; high cardinal area with an escutcheon; shell material thick (two to three millimetres), marked with fine distinct growth lines.

Dimensions: length 60 mm., height 42 mm., convexity 33 mm.

Types: Hypotypes from 38053 suite, Geol. Mus. Coll., U. of A.

Horizon: Howard Creek sandstone member, Kaskapau formation.

Location: Near mouth of creek south of Noetai on the east side of the Murray River, B. C.

Remarks: This species varies in length and convexity; some specimens are more elongate and less convex than others. Most specimens ascribed to this species are internal molds, only a few specimens having parts of the shell still preserved.

Arctica? sp., cf. A. murrayensis Warren

Plate 2, figure 5

Shell medium size for genus, subovate in outline, elongate, moderately convex; beaks prominent, incurved, extending above hinge-line, located one-third the length of shell from anterior margin; posterodorsal margin nearly straight, sloping down from beaks; posterior margin sharply rounded; ventral margin broadly rounded; anterior margin sharply rounded; anterodorsal margin broadly rounded, concave below and in front of beaks; internal mold surface smooth; part of shell material preserved shows moderately distinct fine growth lines.

Dimensions: length 45 mm., height 29 mm., convexity 19 mm.

Types: Figured specimen from 613 suite, Geol. Mus. Coll., U. of A.

Horizon: Howard Creek sandstone member, Kaskapau formation.

Location: Josephine Creek, Sec. 32, Twp. 80, Rge. 7W6, Alberta.

Remarks: This specimen is questionably referred to the genus Arctica (P. S. Warren, personal communication) because it appears to

be much longer with respect to its height and the beaks are smaller and less prominent than in most representatives of the genus Arctica.

Arctica sp., cf. A. murrayensis Warren

Plate 6, figure 12

Shell moderate size for genus, a little longer than high, slightly inflated; beaks prominent, less than one-third the length of shell from anterior margin; anterodorsal margin concave; anterior margin sharply rounded; posterodorsal margin nearly straight, shell material quite thick, with very indistinct growth lines which are made more conspicuous as a result of the weathering of shell material.

Dimensions: length 48 mm., height 33 mm., thickness of right valve 8 mm.

Types: Figured specimen from 38061 suite, Geol. Mus. Coll., U. of A.

Horizon: Wartenbe sandstone member, Kaskapau formation.

Location: East face of Tuskoola mountain, B. C.

Arctica? sp.

Plate 6, figure 13

Shell moderate to small for genus; left valve slightly larger than right valve; sub-triangular, slightly longer than high, moderately convex; beaks prominent, extending about seven millimetres above hingeline, located approximately at centre of shell, incurved; posterodorsal margin slightly concave; posterior margin sharply

rounded; anterodorsal margin moderately concave in front of beaks; anterior margin sharply rounded; ventral margin broadly arched; high cardinal area with an escutcheon; muscle scars approximately equally prominent; pallial line strong four millimetres from ventral margin; pallial sinus rounded; two strong radial depressions are present on internal mold on either side of umbo, reaching maximum strength opposite the muscle scars from where they gradually disappear ventrally; shell material thick, layered, with very fine growth line ornament.

Dimensions: length 37 mm., height 32 mm., convexity 22 mm.

Types: Figured specimen from 39135 suite, Geol. Mus. Coll., U. of A.

Horizon: Wartenbe sandstone member, Kaskapau formation.

Location: One-half mile above mouth of Gordon Creek on the Murray River, B. C.

Remarks: This specimen differs quite markedly from Arctica murrayensis Warren in that it has a centrally located beak giving a sub-triangular outline to the shell. The two radiating depressions mentioned above are also diagnostic features of this specimen.

Arctica sp.

Plate 7, figure 13c

Shell very small for genus, sub-circular, moderately convex; posterior margin broadly rounded; anterior margin broadly rounded

but more sharply rounded than posterior margin; ventral margin broadly arched; three cardinal and one posterior lateral teeth clearly visible; beak appears to be slightly anterior of middle of shell.

Dimensions: length 14 mm., height 13 mm., convexity 6 mm.,

Types: Figured specimen from 39129 suite, Geol. Mus. Coll., U. of A.

Horizon: Nunki sandstone member, Kaskapau formation.

Location: Coldstream Creek, four miles northeast of Nini Hill, Murray River Area, B. C.

Remarks: The size of this specimen is extremely small for the genus, but the dentition is clearly that of an Arctica.

Genus VENIELLA Stoliczka, 1870

Veniella sp., cf. V. mortoni Meek and Hayden

Plate 6, figures 1 - 8

Veniella mortoni Meek and Hayden, 1862, Proc. Acad. Nat. Sci. Phila., p. 27.
Veniella mortoni Meek and Hayden. Stanton, 1893, U. S. Geol. Surv. Bull. 106, p. 104, pl. 23, figs. 6 - 9.

Shell small, moderately inflated; beaks prominent, approximately one-fifth the length of shell from anterior margin; antero-dorsal (in front of beaks) slightly concave; anterior margin quite sharply rounded; ventral margin almost semicircular; posterior margin sharply rounded; posterodorsal and dorsal margin broadly arched; a prominent ridge extending from beak to ventral margin near the dorsal and posterodorsal margins is evident from internal

molds; pallial line is about five millimetres above ventral margin; indistinct pallial sinus quite small; muscle scars appear to be approximately equal; shell material very thick; shell surface covered with distinct irregular, coarse, concentric undulations; dentition appears to be made up of three cardinals in one valve and two cardinals in other valve.

Dimensions: (average -sized specimen) length 27 mm., height 25 mm., thickness of right valve 10 mm.

Types: Figured specimens from 39132 suite, Geol. Mus., Coll., U. of A.

Horizon: Wartenbe sandstone member, Kaskapau formation.

Location: Tuskoola mountain, B. C.

Remarks: These thick-shelled specimens are preserved in medium to coarse-grained sandstone and appear to be very hardy forms. They are believed to be closely related to Veniella mortoni Meek and Hayden, but lack the oblique ridge that extends from the beak to the posterior extremity, although a distinct ridge near the posterodorsal and dorsal margins is evident on internal molds of these specimens.

Superfamily CYRENACEA

Genus CORBICULA Megerle, 1811

Corbicula? sp., cf. C.?subtrigonalis Meek

Plate 3, figure 6

Corbicula? subtrigonalis Meek, 1872, Hayden's 2nd Geol. Rept. Surv. Terr., p. 305.
Corbicula? subtrigonalis Meek, 1876, U. S. Geol. Surv. Terr., 9th Ann. Rept., p. 164, pl. 2, fig. 6.

Shell outline subtrigonal, nearly equilateral; beaks centrally located; anterodorsal and posterodorsal margins very broadly rounded; anterior and posterior margins sharply rounded; ventral margin broadly rounded; dorsal margin pointed where beak rises above hingeline; posterodorsal slope moderately sharp where a radial ridge passes from beak to ventral margin on interior mold; anterodorsal slope rounded; muscle scars nearly equal size; pallial sinus moderately large; pallial line distinct, three millimetres above ventral margin; dentition consisting of two or more long lateral teeth.

Dimensions: length 29 mm., height 22 mm., convexity 8 mm.

Types: Figured specimen from 39157 suite, Geol. Mus. Coll., U. of A.

Horizon: Tuskoola sandstone member, Kaskapau formation.

Location: South side of Wartenbe (Table) mountain, five miles due west of mouth of Lost Canyon Creek, B. C.

Superfamily CARDIACEA

Genus CARDIUM Linnaeus, 1758

Cardium pauperculum Meek

Plate 8, figure 7

Cardium pauperculum Meek, 1871, Ann. Rept. U. S. Geol. Surv. Terr., for 1870, p. 306.
Cardium pauperculum Meek. Stanton, 1893, U. S. Geol. Surv. Bull. 106, p. 99, pl. 22, figs. 9 - 12.

Shell small, subcircular; beaks prominent and nearly central; external mold covered with about forty simple, distinctly defined,

radiating costae; internal mold smooth, with very faint radiating lines near middle of shell and near ventral margin; ventral margin denticulated; pallial line strong, located about one and one-half millimetres above ventral margin, muscle scars small, quite distinct. No hingeline structures seen.

Dimensions of hypotype: length 6 mm., height 6 mm., thickness 4 mm.

Types: Hypotype from 38029 suite, Geol. Mus. Coll., U. of A.

Horizon: Lower sandstone member, Cardium formation.

Location: Half-mile south of Salt Creek on anticlinal crest, Murray River Area, B. C.

Superfamily SOLENACEA

Genus LEPTOSOLEN Conrad, 1865

Leptosolen sp.

Plate 8, figure 8

Shell small, elongate, inequilateral, moderately inflated, near sub-rectangular outline, rounded at anterior end; beaks small, situated one-tenth length of shell from anterior margin; umbonal ridge long more pronounced near the beak, becoming progressively less pronounced near the posteroventral margin; shallow depression extending from beak, with increasing breadth to the middle of the ventral margin; anterodorsal margin straight to slightly concave in front of beaks to anterior margin; anterior margin sharply rounded above the midheight, becoming more broadly rounded below;

ventral margin nearly straight, slightly concave centrally; posterior margin sharply rounded below, very broadly rounded above into nearly straight posterodorsal margin; surface marked with gentle growth undulations and very fine growth lines.

Dimensions: length 30 mm., height 11 mm., convexity 4 - 5 mm.

Types: Figured specimen from 39128 suite, Geol. Mus. Coll., U. of A.

Horizon: Lower sandstone member, Cardium formation.

Location: Coldstream Creek, four miles northeast of Nini Hill, Murray River Area, B. C.

Genus LEGUMEN Conrad, 1858

Legumen sp., cf. L. planulatum (Conrad)

Plate 3, figure 10

Solemya planulata Conrad, 1853, Jour. Acad. Nat. Sci., (Phila.), 2d Ser., Vol. 2, p. 274, pl. 24, fig. 11.
Legumen planulatus (Conrad). Gabb, 1876, Proc. Acad. Nat. Sci., (Phila.), p. 304.
Legumen planulatum (Conrad). Weller, 1907, Geol. Surv. New Jersey, Vol. 4, p. 612, pl. 69, figs. 3 - 7.
Legumen planulatum (Conrad). Gardner, 1916, Maryland Geol. Surv., U. Cret. Vol., p. 684, pl. 40, figs. 5 - 7.

Shell small, compressed, transversely ellipsoidal in outline, slightly expanding posteriorly; dorsal and ventral margins sub-parallel; anterodorsal margin very broadly curved to anterior margin; anterior margin sharply curved at midheight and broadly curved where it meets the ventral margin; ventral margin very broadly curved; posterior margin approximately semicircular; dorsal margin straight; beaks small, about one-fourth of shell

length from anterior margin; interior mold with impressions of growth lines; ligamental groove long and straight, partly submarginal.

Dimensions: length 19 mm., height 9 mm., convexity 2 mm.

Types: Figured specimen from 39116 suite, Geol. Mus. Coll., U. of A.

Horizon: Tuskoola sandstone member, Kaskapau formation.

Location: Coldstream Creek, near the Murray River, B.C.

Remarks: This specimen is very similar to the holotype of Legumen planulatum (Conrad), but is approximately one-half the size of the latter. This variation in size is probably the result of two quite different seas; the Atlantic Sea, out of which the holotype of this species was deposited, was probably a much warmer sea than the one which resulted in the deposition of the above described specimen in northeastern British Columbia.

Genus SILIQUA Megerle v. Muhlfeldt

Siliqua sp., cf. S. huerfanensis Stanton

Plate 5, figures 6, 7

Siliqua huerfanensis Stanton, 1893, U. S. Geol. Surv. Bull. 106, p. 114, pl. 25, figs. 10, 11.

Shell medium size, greatly elongated, inequilateral, equivalve; beaks small, inconspicuous, situated about two-fifths the length of shell from anterior extremity; shell gaping at both ends, more widely at the anterior end; dorsal margin nearly straight;

anterior margin sharply rounded; ventral margin nearly straight to very gently convex; posterior margin very broadly rounded, more sharply rounded reaching dorsal and ventral margins; surface covered with very fine growth lines and gentle concentric undulations; on interior of shell are sharp narrow depressions extending one to two millimetres below the hingeline on either side of beak both posteriorly and anteriorly; posterior depression more prominent; depressions fade near posterior and anterior margins; on interior of shell a low broad swell extends from below and a short distance in front of the beak, obliquely forward and downward fading out within a distance of about ten millimetres; pallial line and sinus not observed.

Dimensions: length 52 mm., height 13 mm., convexity 8 mm.

Types: Figured specimens from 39150 suite, Geol. Mus. Coll., U. of A.

Horizon: Tuskoola sandstone member, Kaskapau formation.

Location: Tuskoola mountain, B. C.

Genus SENIS Stephenson, 1952

Senis sp.

Plate 7, figures 10, 13b

Shell medium size, greatly elongated, subrectangular in outline, moderately compressed, equivalved; beaks very small and inconspicuous; dorsal margin nearly straight; anterior margin sharply rounded; ventral margin nearly straight; dorsal and

ventral margins nearly parallel; posterior margin not observed; surface covered with very fine growth lines; a one-millimetre wide, approximately twenty-millimetre long, very straight and uniform depression is present, immediately below and parallel to the hingeline, on both valves.

Approximate dimensions: length 40 mm., height 12 mm., convexity 4 mm.

Types: Figured specimens from 39129 suite, Geol. Mus. Coll., U. of A.

Horizon: Nunki sandstone member, Kaskapau formation.

Location: Coldstream Creek, four miles northeast of Nini Hill, Murray River Area, B. C.

Remarks: These specimens, although possibly related to Senis (Siliqua) huerfanensis Meek, are believed to be another species of Senis because the depression under the hingeline is very straight and uniform, the dorsal and ventral margins are almost parallel and radial depressions appear to be very small or absent.

Superfamily MACTRACEA

Genus CYMBOPHORA Gabb, 1868

Cymbophora? sp., cf. C.? securis Stephenson

Plate 1, figure 16

Cymbophora securis Stephenson, 1952, U. S. Geol. Surv. Prof. Paper 242, p. 122, pl. 31, figs. 18 - 21.

Shell medium size for genus, subtrigonal in outline, slightly inflated, nearly equilateral; beak prominent, broad,

situated slightly anterior of middle of shell; anterodorsal margin descending, nearly straight; anterior margin sharply rounded, ventral margin broadly rounded; posterior margin appears to be sharply rounded below rounding into the broadly arched descending posterodorsal margin; surface covered with fine growth lines.

Dimensions: Approximate length 17 mm., height 15 mm., convexity of left valve 4 mm.

Types: Figured specimen from 38047 suite, Geol. Mus. Coll., U. of A.

Horizon: Unnamed shale unit below the Pouce Coupe sandstone member, Kaskapau formation.

Location: Big Bend of Murray River, three miles below Lost Canyon, B. C.

Remarks: This specimen appears to be very similar to Cymbophora securis Stephenson which is found in the Lewisville and Templeton members of the upper half of the Cenomanian Woodbine formation.

Superfamily MYACEA

Genus CARYOCORBULA Gardner, 1926

Caryocorbula? sp., cf. C.? ovisana Stephenson

Plate 1, figures 13 - 15

Caryocorbula? ovisana Stephenson, 1952, U. S. Geol. Surv. Prof. Paper 242, p. 129, pl. 32, figs. 9 - 15.

Shell small, subtrigonal in outline, strongly inflated, inequilateral; beaks prominent, incurved, situated from one-third to one-quarter the length of shell from anterior margin; dorsal slopes steep to slightly overhanging; anterodorsal margin short,

straight to slightly concave; anterior margin sharply rounded; ventral margin broadly rounded; posterior margin subangular at the extremity, well below midheight; posterodorsal margin long, steeply descending, nearly straight; surface covered with four to five strong concentric ridges and depressions, more common below midheight, which are believed to be formed from resting stages in the growth of the individuals; fine growth lines are present on figure 15, plate 1.

Average dimensions: length 13 mm., height 10 mm., convexity 5 mm.

Types: Figured specimens from 39162 and 39156 suites, Geol. Mus. Coll., U. of A.

Horizon: Pouce Coupe sandstone member, Kaskapau formation.

Location: 39162 suite from one-half mile below Applegate's farm on Wartenbe Creek, B. C.
39156 suite from lumber road, two miles south of Coldstream Creek, B. C.

Remarks: These three specimens are illustrated to show the extreme variable nature of this species. This species, as defined by Stephenson, occurs in the Dexter (?) and Lewisville members of the Cenomanian Woodbine formation in Texas.

Class GASTROPODA

Superorder PROSOBRANCHIA

Genus GYRODES Conrad, 1860

Gyrodes sp., cf. G. fluvianus Stephenson

Plate 6, figure 11

Gyrodes depressa Meek. Stanton, 1893, U. S. Geol. Surv. Bull. 106, p. 135, pl. 29, figs. 11 - 14.
Gyrodes fluvianus Stephenson, 1952, U. S. Geol. Surv. Prof. Paper 242, p. 152, pl. 36, figs. 20 - 23.

Shell medium size, low spire, rapidly expanding whorls; suture impressed; approximately five whorls; shoulder only poorly developed; body whorl regularly rounded from suture to the edge of the umbilicus; growth lines pronounced, possibly due in part to differential erosion; character of the aperture and the umbilicus not preserved on specimen.

Dimensions: height about 20 mm., diameter about 25 mm.

Types: Figured specimen from 39131 suite, Geol. Mus. Coll., U. of A.

Horizon: Wartenbe sandstone member, Kaskapau formation.

Location: Tuskoola mountain, B. C.

Remarks: This specimen is believed to be related to Gyrodes fluvianus Stephenson (Gyrodes depressa Meek), but exact identification of this poorly preserved specimen is very difficult.

Gyrodes sp.

Plate 5, figures 2, 3

Shell of medium size, low spire, rapidly expanding smooth, plump whorls; suture impressed; four whorls, shoulder lacking; body whorl plumply and regularly rounded from the suture to the edge of the umbilicus, where it rounds sharply into the umbilical depression; umbilicus large; specimens preserved are internal molds so that no external features are seen.

Dimensions: height 12 mm., diameter 16 mm.

Types: Figured specimens from 39150 suite, Geol. Mus. Coll., U. of A.

Horizon: Tuskoola sandstone member, Kaskapau formation.

Location: Tuskoola mountain, B. C.

Genus TURRITELLA Lamarck, 1799

Turritella? sp.

Plate 1, figures 9, 10

Shell small, elongate; small apical angle; five volutions present (incomplete specimen); sides of volutions straight or only slightly convex; sutures impressed; lower part of basal whorl forms a sharp "shoulder"; aperture not preserved; surface covered with very fine transverse growth lines.

Dimensions: Approximate length 20 mm., maximum diameter 10 mm.

Types: Figured specimens from 39162 suite, Geol. Mus. Coll., U. of A.

Horizon: Pouce Coupe sandstone member, Kaskapau formation.

Location: One-half mile below Applegate's farm on Wartenbe Creek, Murray River Area, B. C.

Remarks: Due to the incomplete nature of this specimen, exact identification is impossible.

Genus VOLUTODERMA Gabb, 1876

Volutoderma? sp., cf. V.? clatworthyi Henderson

Plate 5, figures 1, 4

Volutoderma? clatworthyi Henderson, 1908, Proc. U. S. Nat. Mus., Vol. 34, p. 260, pl. 13, figs. 1, 2.

Shell of medium size; spire one-quarter the length of body whorl; whorls convex; suture distinct, impressed; surface covered with strong fairly coarse spiral ornament of equal dimension (one millimetre) over last two whorls (probably on upper whorls also but upper whorls covered); coarse rounded nodes present near upper margin of last whorl and on next whorl; inner mold of another specimen has protuberances on last two whorls corresponding to the nodes on the external ornament of figured specimen; aperture not preserved.

Dimensions: Approximate length 40 mm., greatest breadth 24 mm. (complete length not present).

Types: Figured specimen from 39150 suite, Geol. Mus. Coll., U. of A.

Horizon: Tuskoola sandstone member, Kaskapau formation.

Location: Tuskoola mountain, B. C.

Remarks: The spiral ornament of this specimen resembles that present on Volutoderma? clatworthyi Henderson, but lacks the radial or transverse ornament present on the latter. The above specimen resembles V.? clatworthyi in general appearance and presence of nodes on the internal mold but is believed broader with respect to height than the latter, although the complete length is not present in the above specimen. Thus, this specimen may prove to be a variation or subspecies to Henderson's V.? clatworthyi.

Volutoderma? sp.

Plate 5, figures 9, 12

Shell medium size; spire approximately one-half length of body whorl; suture distinct, very deep on internal cast of shell with a broad shallow sulcus present below sutures on interior molds of last two whorls; surface covered with vertically aligned nodes on the body whorl; lower nodes very small, upper node large (four square millimetres) lying two millimetres below suture of body whorl; no spiral or transverse ornament noted on external mold; internal mold very smooth with no protuberances corresponding to nodes on external mold; columella lined with two or three strong impressions parallel to whorls near apex.

Dimensions: approximate length 50 mm., greatest breadth 22 mm.

Types: Figured specimens from 39280 suite, Geol. Mus. Coll., U. of A.

Horizon: Tuskoola sandstone member, Kaskapau formation.

Location: Table mountain, Murray River Area, B. C.

Remarks: These specimens are referred to the genus Volutoderma because of the general shape of the shell and the presence of a broad shallow sulcus along the two lower whorls of the internal mold. However, these specimens may belong to another genus as no spiral or transverse ornament was noted, and the nodes are much smaller than the nodes present on the genus Volutoderma? clatworthyi Henderson.

Class CEPHALOPODA

Subclass AMMONOIDEA

Genus PLACENTICERAS Meek, 1870

Placenticeras pseudoplacenta Hyatt

Plate 2, figure 10

Placenticeras pseudoplacenta Hyatt, 1903, U. S. Geol. Surv. Mon. 44, p. 267, pl. 43, figs. 3 - 11; pl. 44, figs. 1 - 3.

Shell large, thin; umbilicus small; whorls deeply embracing from near umbilicus to periphery, compressed laterally; keel flattened; surface smooth; suture lines crowded and complex.

Dimensions of hypotype: diameter 200 mm., thickness 30 mm.

Types: Hypotype from Ct826 suite, Geol. Mus. Coll., U. of A.

Horizon: Unnamed shale member between the Pouce Coupe and Howard Creek sandstone members, Kaskapau formation.

Location: Lsd. 5, Sec. 16, Twp. 79, Rge. 13W6, Henderson Creek, Alberta.

Placenticeras?

Plate 3, figure 2

Shell small for genus, thin; umbilicus small, whorls deeply embracing from near umbilicus to periphery, laterally compressed; keel flattened; outer whorl appears to increase in size quite rapidly; surface smooth; suture not distinguishable.

Dimensions: diameter 65 mm. maximum; thickness 15 mm.

Types: Figured specimen from 39142 suite, Geol. Mus. Coll., U. of A.

Horizon: Beds between the Pouce Coupe and Wartenbe sandstone members, Kaskapau formation.

Location: One-half mile above the mouth of Gordon Creek on the Murray River, B. C.

Remarks: This specimen was found on a siltstone slab that also contained a fairly large Inoceramus sp., aff. I. labiatus (plate 3, figure 5). The overall shape of this specimen is similar to a much larger specimen present at the U. of A. Coll., the location of which is not known. It is suggested that this distinctive shape may prove to be the basis for a new species or subspecies of the genus Placenticeras.

Genus SCHAPHITES Parkinson, 1811

Scaphites nigricollensis var. meeki Cobban

Plate 8, figures, 4, 5

Scaphites nigricollensis var. meeki Cobban, 1951, U. S. Geol. Surv. Prof. Paper 239, p. 26, pl. 5, figs. 9 -- 26.

Shell small, elliptical, stout; whorls depressed, broadly rounded at venter, sharply rounded on the flanks; shell appears to become more inflated after it begins to straighten to form the living chamber; ornament on living chamber consisting of primary ribs on the umbilical area which are sigmoidal-shaped until they give rise to three and rarely four secondary ribs; all ribs crossing the venter evenly; umbilical area of living chamber quite smooth.

Approximate dimensions of hypotype: length 35 mm., height 30 mm., maximum width 15 mm.

Types: Hypotype from 40675 suite, Geol. Mus. Coll., U. of A.

Horizon: Upper sandstone member, Cardium formation.

Location: Mistanusk Creek, approximately ten miles south of the Wapiti River, near the Alberta boundary, B. C.

Genus TRAGODESMOCERAS Spath, 1922

Tragodesmoceras sp., cf. T. bassi Morrow

Plate 7, figures 11, 12

Tragodesmoceras bassi Morrow, 1935, Jour. Paleont., Vol. 9, No. 6, p. 468, pl. 52, figs. 1a - c; pl. 53, figs. 3 - 5; text figs. 1, 3.

Shell medium-sized, slightly involute, laterally compressed; ratio of height to width of a whorl (exact position doubtful) is 5:3; venter rounded; shell ornamented with alternating primary and secondary sigmoidal ribs which cross the venter obliquely so that the line of the venter bisects a V-shaped ridge whose sides diverge away from aperture; primary ribs reach umbilicus; secondary ribs do not; suture appears quite complex and digitated.

Dimensions: Questionable, only fragements of complete shell preserved. Height of a whorl (position doubtful) 20 mm., width of whorl 12 mm.

Types: Figured specimens from 37779 suite, Geol. Mus. Coll., U. of A.

Horizon: Nunki sandstone member, Kaskapau formation.

Location: Flatbed Creek, Murray River Area, B. C.

Remarks: This specimen appears to be very closely related to Tragodesmoceras bassi Morrow. The figures shown are apparently representative of a young specimen because the sigmoidal-shaped ribs

disappear in adult life stages of T. bassi Morrow.

Genus VASCOCERAS Choffat, 1898

Vascoceras?

Plate 5, figure 13

Only a portion of the living chamber is preserved. It appears that the coarse, transverse ornament becomes pointed at the ventral terminal position of the living chamber.

Dimensions: Thickness of a portion of the shell is 75 mm.

Types: Figured specimen from 39116 suite, Geol. Mus. Coll., U. of A.

Horizon: Tuskoola sandstone member, Kaskapau formation.

Location: Coldstream Creek, near the Murray River, B. C.

Remarks: If the identification of this specimen is correct, this marks the northernmost extension of the Vascoceras fauna. Further work is required for a positive identification of this fauna, however.

Genus WATINOCERAS Warren, 1930

Watinoceras sp., cf. W. coloradoense Henderson

Plate 4, figures, 3, 9, 10, 12

Watinoceras coloradoense Henderson, 1908, Proc. U.S. Nat. Mus., Vol. 34, p. 259, pl. 13, figs. 10, 11.

Shell discoidal, whorls convex, only slightly longer than wide; dimensions of the outer whorl approximately twenty milli-

metres from living chamber: height twelve millimetres, width eleven millimetres; umbilicus well-defined; costae slightly curved to forward slanting in a straight diagonal line from umbilicus to abdomen; abdomen ornamented by two rows of longitudinally compressed nodes on either side of venter; each side of whorls ornamented by two other sets of nodes, one along umbilical shoulder, the other near the abdomen; the greater axis of the lateral nodes parallel to costae, while the greater axes of the abdominal nodes are at right angles to the costae; suture line quite simple.

Dimensions: diameter approximately 60 mm. (only part of shell present), thickness 11 mm.

Types: Figured specimens from 39150 and 39157 suites Geol. Mus. Coll., U. of A.

Horizon: Tuskoola sandstone member, Kaskapau formation.

Location: 39150 suite, Tuskoola mountain, B. C.
39157 suite, north tributary of Cowie Creek, near Murray River, B. C.

Remarks: The ratio of the height to the width of the outer whorl of this figured specimen is slightly greater than 1:1, while the ratio of the height to the width of Henderson's holotype is greater than 2:1. In most other respects this hypotype is very similar to Watinoceras coloradoense Henderson. Therefore, it is possible that this figured specimen may be a variety of W. coloradoense or a new species of Watinoceras. Only portions and external molds of this shell are present and they are believed to be of insufficient value to define a new variety or species.

Watinoceras reesidei Warren

Plate 4, figures 1, 2, 4 - 8, 11

Watinoceras reesidei Warren, 1930, Res. Coun. Alberta, Rept. 21, appendix, p. 67, pl. 3, fig. 2; pl. 4, figs. 9 - 12.

Shell discoidal, slightly involute, laterally compressed; whorls at least five volutions, higher than wide; whorls rounded gently at venter and more sharply at umbilicus; umbilicus wide, approximately one-half the diameter of the shell; costae sharply defined, generally alternating in length, sometimes bifurcating; primary costae extending over the umbilical shoulder; secondary costae usually not reaching umbilicus; costae developing two rows of nodes on each side of venter; umbilical nodes also present on primary costae; costae inclined forward, sigmoidal in earlier whorls; suture quite simple.

Dimensions of largest hypotype (39150): diameter 95 mm., thickness 15 - 20 mm.

Types: Hypotypes from 37800, 39145, 39146 and 39150 suites, Geol. Mus. Coll., U. of A.

Horizon: Tuskoola sandstone member, Kaskapau formation.

Location: 37800 suite, Dawson Creek Bridge, Pouce Coupe, B. C.
39145, 39146 and 39150 suites, Tuskoola mountain, B. C.

Remarks: Specimens of Watinoceras reesidei and W. cf. coloradoense from the Geol. Mus. Coll., U. of A., were used to aid in the identification of the author's specimens. The writer noted that W. reesidei Warren and W. cf. coloradoense Henderson were almost identical in the first three whorls, then bifurcation of the costae

occurred in W. reesidei, with alternating secondary costae not reaching the umbilical shoulder. W. cf. coloradoense showed rare secondary costae only one of which did not reach the umbilical shoulder; the rest of the costae formed larger umbilical nodes than on corresponding positions of W. reesidei. The outer whorls of W. cf. coloradoense showed very prominent primary costae and nodes, with every costa reaching the umbilical shoulder.

Subclass COLEOIDEA

Order BELEMNOIDEA

Genus BELEMNITELLA Orbigny, 1840

Belemnitella sp.

Plate 6, figure 14

Shell of average size, cylindrical; only a fragment of guard preserved; shell composed of very fine radiating calcite; a furrow or hollow, situated at centre of guard, is present extending down the whole length of preserved portion of guard.

Dimensions: length 70 mm. (estimated), diameter 10 mm.

Types: Figured specimen from 39131 suite, Geol. Mus. Coll., U. of A.

Horizon: Wartenbe sandstone member, Kaskapau formation.

Location: Tuskoola mountain, B. C.

Phylum BRACHIOPODA

Class INARTICULATA

Order ATREMATA

Superfamily OBOLACEA

Genus LINGULA Bruguiere, 1797

Lingula sp.

Plate 3, figure 9

Shell very small, shiny, elongated, ellipsoidal shape, rounded anteriorly, somewhat pointed posteriorly, moderately convex; surface marked with fine elongate, oval-shaped growth lines; growth lines more distinct on each side of shell.

Dimensions: length 6.5 mm., width 2.5 mm., convexity approximately 1 mm.

Types: Figured specimen from 39116 suite, Geol. Mus. Coll., U. of A.

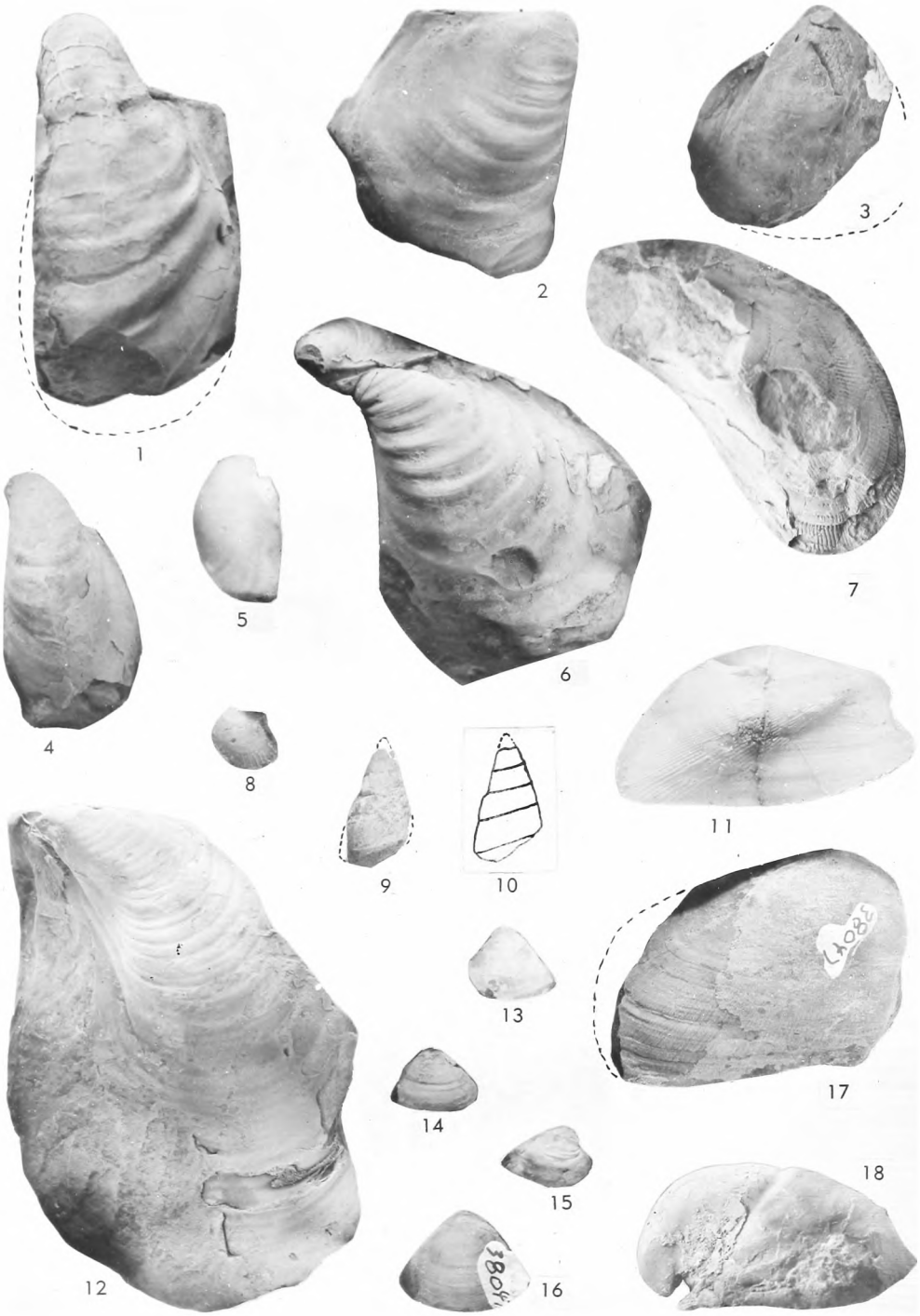
Horizon: Tuskoola sandstone member, Kaskapau formation.

Location: Coldstream Creek, near the Murray River, B. C.

Remarks: This specimen is believed to be similar to a Lingula sp. found below the base of the Baytree Conglomerate on the Pouce Coupe River (C. R. Stelck, personal communication).

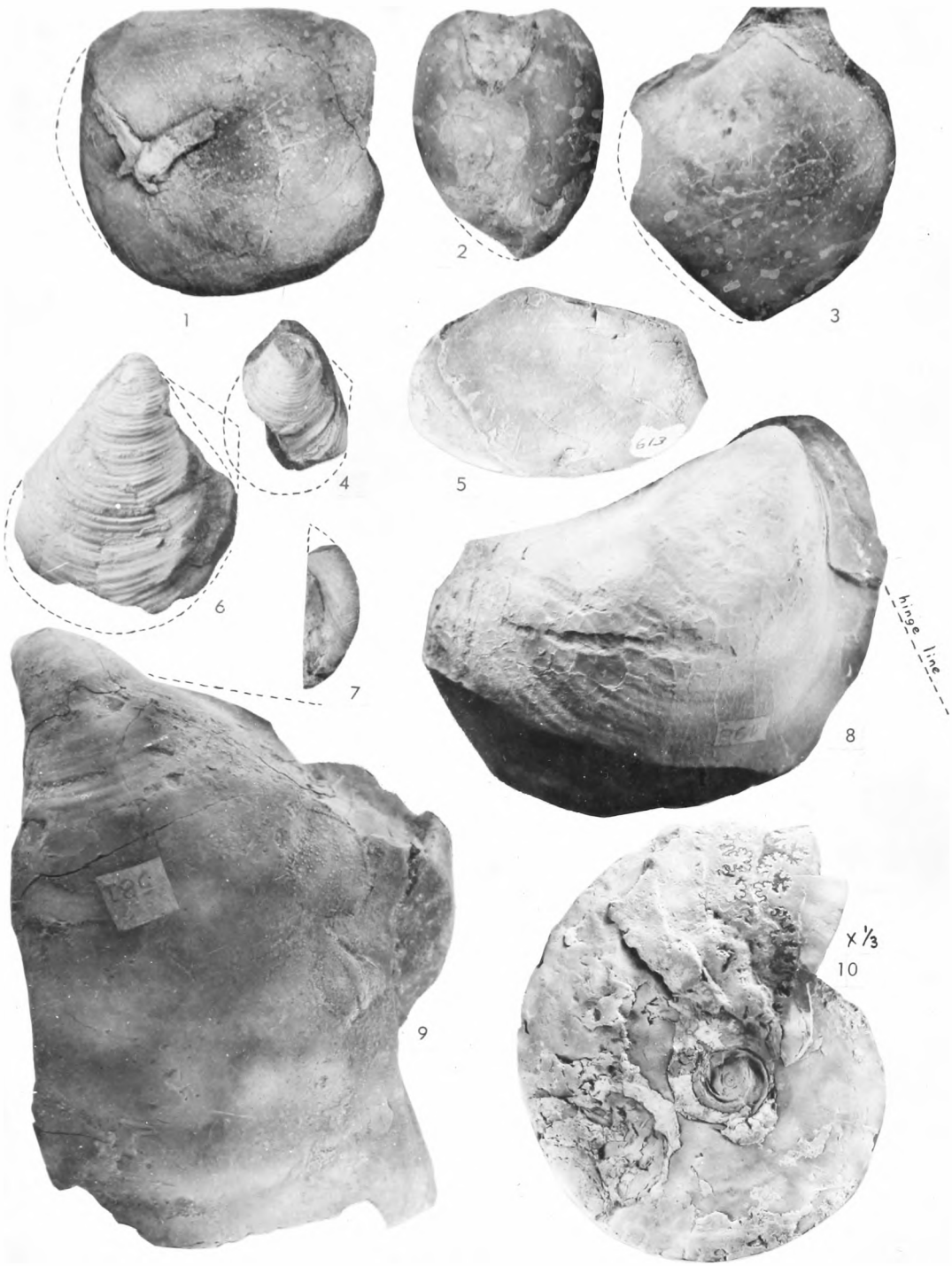
Upper Cenomanian Fauna
(from above the Dunvegan formation to top of the
Pouce Coupe sandstone member, Kaskapau formation)

PLATE I
Explanation of Plate p. 83


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Lower Turonian Fauna
(below the *Inoceramus labiatus* zone, including the Howard Creek sandstone member, Kaskapau formation)

PLATE 2
Explanation of Plate p. 84


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hinge line
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X 1/3
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Inoceramus labiatus zone
(lower part, including the Tuskoola sandstone member, Kaskapau formation)

PLATE 3
Explanation of Plate p. 84


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×4
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Inoceramus labiatus zone
(lower part, including the Tuskoola sandstone member, Kaskapau formation)

PLATE 4
Explanation of Plate p. 85



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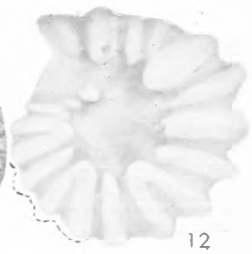
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PLATE 5
Explanation of Plate p. 86

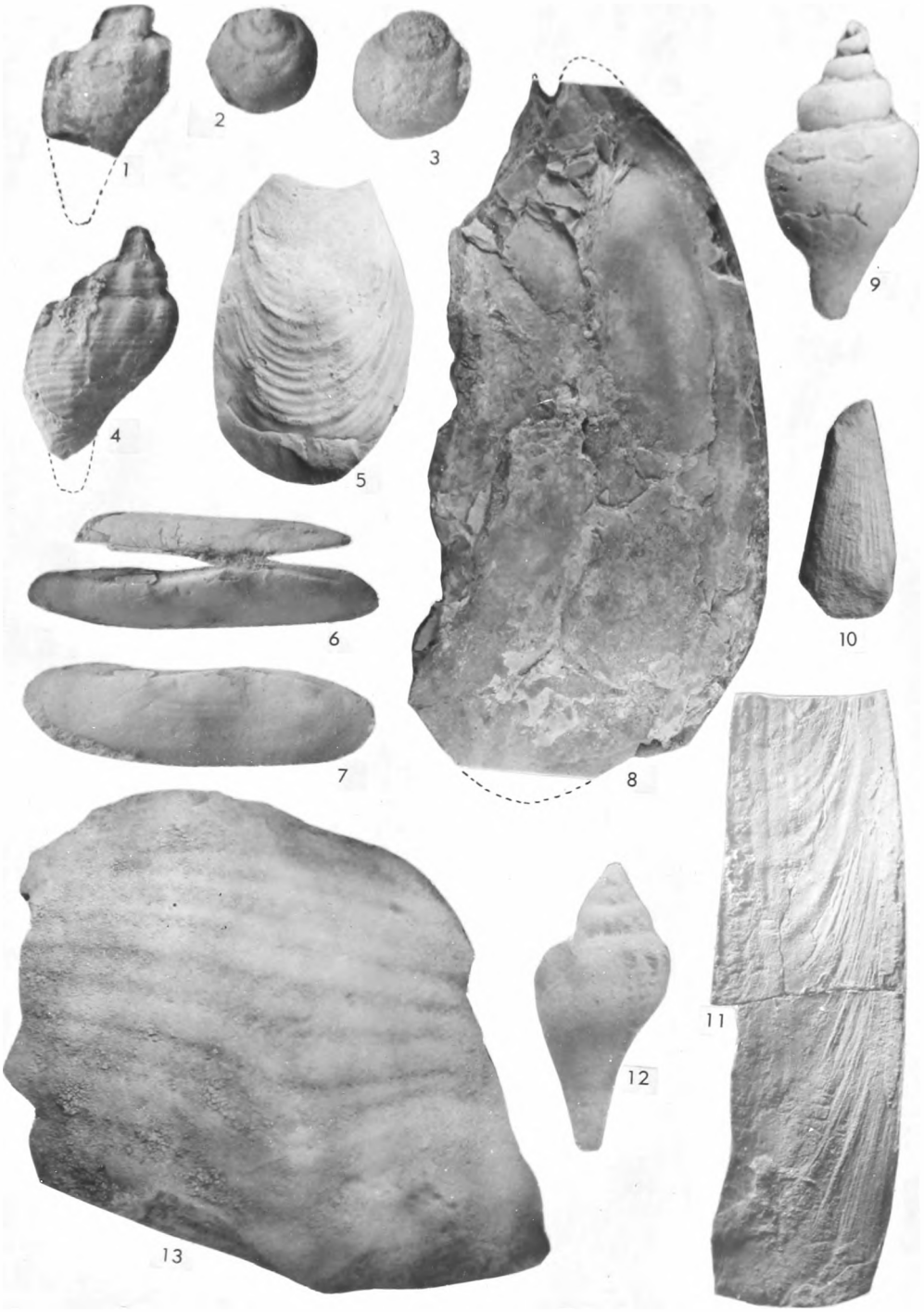

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PLATE 6

Explanation of Plate p. 86



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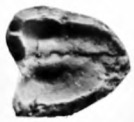
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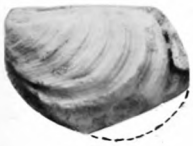
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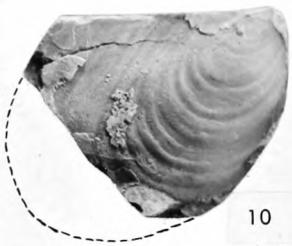
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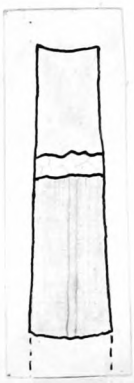
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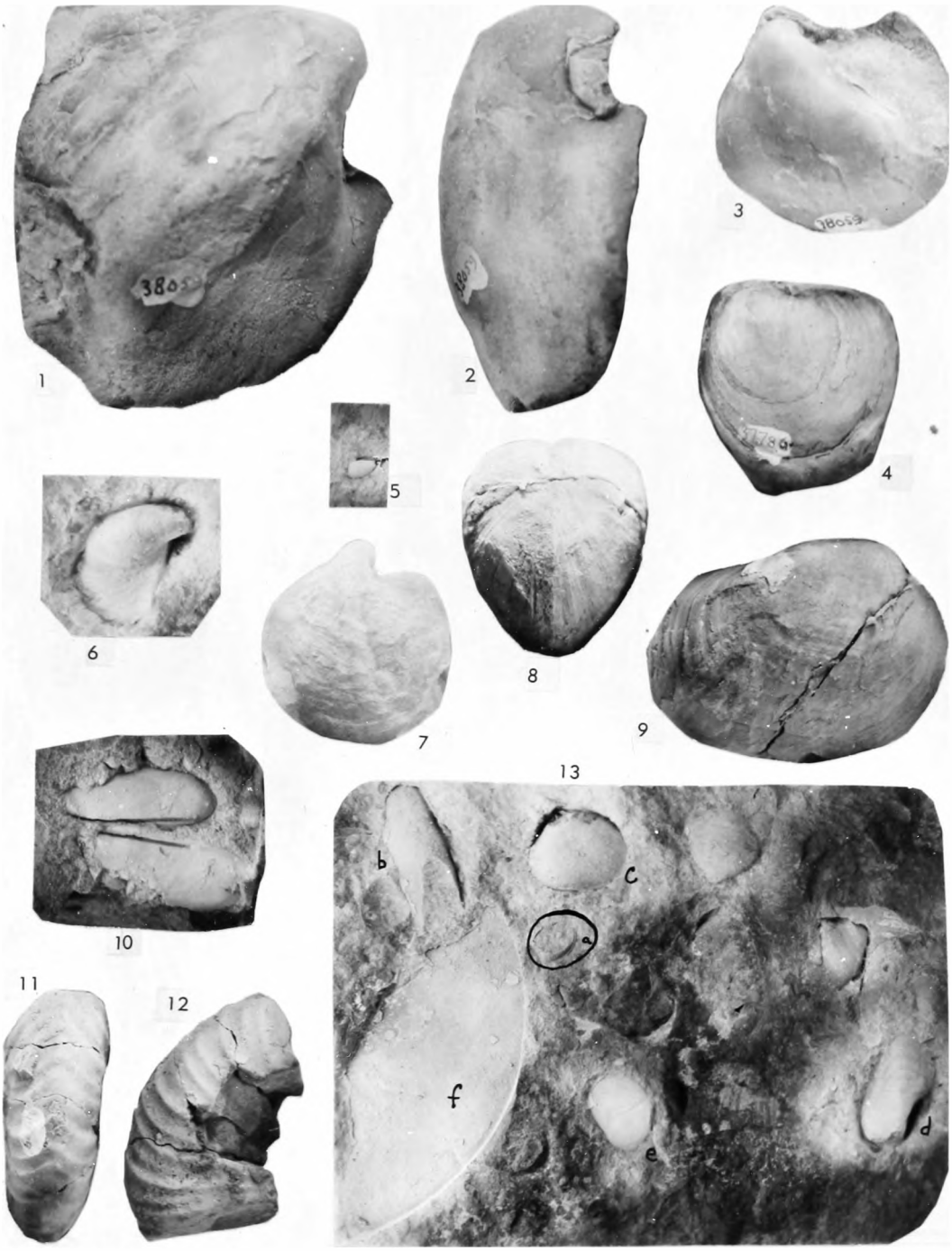
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17

Fauna within the Nunki sandstone member, Kaskapau formation

PLATE 7
Explanation of Plate p. 87


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a
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Fauna within the Cardium formation

PLATE 8
Explanation of Plate p. 88



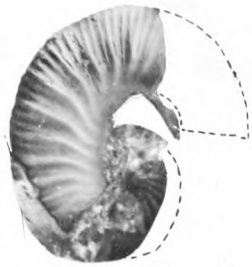
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X 1.5 2



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×2



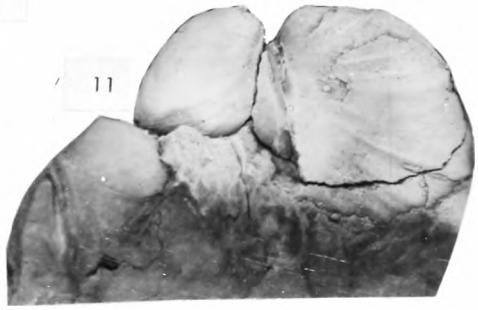
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EXPLANATION OF PLATE 1

Upper Cenomanian Fauna
(from above the Dunvegan formation
to top of the Pouce Coupe sandstone member,
Kaskapau formation)

All figures natural size

Figs. 1, 4, 5, 18: Inoceramus fragilis cf. mesabiensis Bergquist; 1, 4, 18 - from CuF suite, Kiskatinaw River, British Columbia; 5 - from 39163 suite, Hotchkiss River, Alberta; 1, 4 - left valves of large and medium specimens respectively; 5 - posterior view of left valve of small specimen; 18 - anterior view of left valve of medium-sized specimen . . (p. 31)

Fig. 2: Inoceramus arvanus Stephenson; hypotype from CuA_2 suite, Upper Kiskatinaw River, British Columbia; right valve . (p. 27)

Fig. 3: Thracia sp. from 38047 suite, Murray River, British Columbia; left valve . . . . . (p. 48)

Fig. 6: Inoceramus fragilis Hall and Meek var.; from 37790 suite, Flatbed Creek, British Columbia; left valve and dorsal view of beak of right valve . . . . . (p. 29)

Fig. 7: Brachidontes filisculptus (Cragin); hypotype from 39162 suite, Wartenbe Creek, British Columbia; left valve . . (p. 42)

Fig. 8: Pteria sp., cf. P. haydeni Hall and Meek; from 37792 suite, east of Sweetwater, British Columbia; left valve . . . (p. 37)

Figs. 9, 10: Turritella? sp.; from 39162 suite, Wartenbe Creek, British Columbia; 9 - side view; 10 - side view drawing(p. 64)

Fig. 11: Brachidontes sp., cf. B. filisculptus microcostae Stephenson; from CuJ suite, Kiskatinaw River, British Columbia; latex impression of an external mold of a right valve. . (p. 43)

Fig. 12: Inoceramus prefragilis Stephenson; hypotype from 38019 suite, Kiskatinaw River, British Columbia; left valve. . (p. 34)

Figs. 13, 14, 15: Caryocorbula? sp., cf. C.? ovisana Stephenson; 13 - from 39156 suite, Coldstream Creek, British Columbia; 14, 15 - from 39162 suite, Wartenbe Creek, British Columbia; 13, 14 - left valves; 15 - right valve . . . . . (p. 61)

Fig. 16: Cymbophora? sp., cf. C.? securis Stephenson; from 38047 suite, Murray River, British Columbia; left valve . . . (p. 60)

Fig. 17: Barbatia micronema (Meek); hypotype from 38047 suite, Murray River, British Columbia; right valve . . . . . (p. 22)

EXPLANATION OF PLATE 2

Lower Turonian Fauna
(below the Inoceramus labiatus zone,
including the Howard Creek sandstone member,
Kaskapau formation)

All figures natural size except figure 10, which is x1/3

Figs. 1, 2: Arctica murrayensis Warren; hypotypes from 38053 suite, Murray River, near Noetai Hill, British Columbia; 1 - left valve; 2 - anterior view of a slightly smaller specimen . . . . . (p. 49)

Fig. 3: Camptonectes sp., cf. C. platessa White; from 39159 suite, Murray River, British Columbia; left valve . . . . . (p. 41)

Figs. 4, 6: Inoceramus sp., cf. I. prefragilis Stephenson; from 39143 suite, Tuskoola Mountain, British Columbia; 4 - left valve of a small specimen; 6 - left valve of medium-sized specimen . . . . . (p. 35)

Fig. 5: Arctica? sp., cf. A.? murrayensis Warren; from 613 suite, Josephine Creek, Alberta; left valve . . . . . (p. 50)

Fig. 7: Inoceramus sp., aff. I. corpulentus McLearn; from 39143 suite, Tuskoola Mountain, British Columbia; posterior view of left valve . . . . . (p. 28)

Fig. 8: Inoceramus allani Warren; hypotype from 498 suite, Kiskatinaw River, British Columbia; left valve . . . . (p. 26)

Fig. 9: Inoceramus tenuiumbonatus Warren; hypotype from 581 suite, Stony Lake, British Columbia; left valve . . . . . (p. 36)

Fig. 10: Placenticeras pseudoplacenta Hyatt; hypotype from Ct826 suite, Henderson Creek, Alberta; side view (x1/3) . . (p. 67)

EXPLANATION OF PLATE 3

Inoceramus labiatus Zone
(lower part, including the Tuskoola sandstone member, Kaskapau formation)

All figures natural size except figure 9, which is x4

Figs. 1, 3, 4, 5: Inoceramus sp., aff. I. labiatus (Schlotheim): 1 - from 37799 suite, Pouce Coupe River, British Columbia; 3, 5 -

from 39142 suite, Murray River, British Columbia; 4 - from 33793 suite, Kiskatinaw River, British Columbia; 1, 5 - left valves of medium-sized specimens; 3 - right valve of small specimen; 4 - right valve of small specimen . . . . . (p. 33)

Fig. 2: Placenticeras?; from 39142 suite, Murray River, British Columbia . . . . . (p. 67)

Fig. 6: Corbicula? sp., cf. C.? subtrigonalis Meek; from 39157 suite, Wartenbe (Table) Mountain, British Columbia; right valve . . . . . (p. 54)

Fig. 7: Shark's tooth; external mold from 39145 suite, Tuskoola Mountain, British Columbia.

Fig. 8: Inoceramus labiatus (Schlotheim) var.; from 39144 suite, Tuskoola Mountain, British Columbia; right valve . . . . (p. 32)

Fig. 9: Lingula sp.; (x4) from 39116 suite, Murray River, British Columbia . . . . . (p. 74)

Fig. 10: Legumen sp., cf. L. planulatum (Conrad); from 39116 suite, Murray River, British Columbia; right valve . . . . . (p. 57)

Fig. 11: Anatina sp., cf. A. lineata Stanton; from 38062 suite, Sandy Ridge, near the Murray River, British Columbia; left valve . . . . . (p. 44)

EXPLANATION OF PLATE 4

Inoceramus labiatus Zone
(lower part, including the Tuskoola sandstone member, Kaskapau formation)

All figures natural size except figure 10, which is x2

Figs. 1, 2, 4 - 8, 11: Watinoceras reesidei Warren; hypotypes; 1, 7 - from 37800 suite, Pouce Coupe River, British Columbia; 2, 6, 11 - from 39150 suite, Tuskoola Mountain, British Columbia; 4, 5 - from 39146 suite, Tuskoola Mountain, British Columbia; 8 - from 39145 suite, Tuskoola Mountain, British Columbia; 1, 2 - side views of parts of outer whorls; 5 - cross-sectional drawing of figure 4; 4, 6 - side views of large variants; 7 - slab with small specimens; 8 - small specimen; 11 - side view of well-preserved external mold . . . . . .(p. 72)

Figs. 3, 9, 10, 12: Watinoceras sp., cf. W. coloradoense Henderson; 3, 9, 10 - from 39150 suite, Tuskoola Mountain, British Columbia; 12 - from 39157 suite, Cowie Creek, British Columbia; 3 - cross-sectional drawing of figure 9; 9 - side view of part of shell; 10 - drawing (x2) of suture of figure 9; 12 - side view of a latex mold taken from an external mold of a coarsely noded variety? . . . . . (p. 70)

EXPLANATION OF PLATE 5

Inoceramus labiatus Zone
(lower part, including the Tuskoola sandstone member, Kaskapau formation)

All figures natural size

Figs. 1, 4: *Volutoderma*? sp., cf. *V.*? *clatworthyi* Henderson; from 39150 suite, Tuskoola Mountain, British Columbia; 1 - side view of an internal mold; 4 - side view showing external ornament . . . . . (p. 64)

Figs. 2, 3: *Gyrodes* sp.; from 39150 suite, Tuskoola Mountain, British Columbia . . . . . (p. 63)

Fig. 5: *Inoceramus labiatus* (Schlotheim) var.; from 39139 suite, Murray River, British Columbia; left valve . . . . . (p. 32)

Figs. 6, 7: *Siliqua* sp., cf. *S. huerfanensis* Stanton; from 39150 suite, Tuskoola Mountain, British Columbia; 6 - dorsal view; 7 - side view of right valve . . . . . (p. 58)

Fig. 8: *Ostrea soleniscus* Meek; hypotype from 37789 suite, Moose Lake, British Columbia; side view of internal mold of left valve . . . . . (p. 38)

Figs. 9, 12: *Volutoderma*? sp.; from 39280 suite, Wartenbe (Table) Mountain, British Columbia; 9 - side view of an internal mold; 12 - side view of a latex cast of an external mold (p. 66)

Figs. 10, 11: *Pinna* sp.; 10 - from 39151 suite, (float) Murray River, British Columbia; 11 - from 39147 suite, Tuskoola Mountain, British Columbia . . . . . (p. 24)

Fig. 13: *Vascoceras*?; from 39116 suite, Coldstream Creek, British Columbia; ventral view of living chamber . . . . . (p. 70)

EXPLANATION OF PLATE 6

Inoceramus labiatus Zone
(upper part, including the Wartenbe sandstone member, Kaskapau formation)

All figures natural size

Figs. 1 - 8: *Veniella* sp., cf. *V. mortoni* Meek and Hayden; from 39132 suite, Tuskoola Mountain, British Columbia; 1, 2, 4 - left valves; 3, 8 - right valves; 5 - internal mold of a right valve; 6 - side view of a small right valve to show thickness of shell material; 7 - ventral internal view of dentition along hingeline . . . . . (p. 53)

Figs. 9, 10: Inoceramus sp., cf. I. fragilis Hall and Meek; from 37784 and 39135 suites, Murray River, British Columbia; 9 - side view of a small left valve; 10 - side view of a medium-sized, thin right valve . . . . . (p. 30)

Fig. 11: Gyrodes sp., cf. G. fluvianus Stephenson; from 39131 suite, Tuskoola Mountain, British Columbia; apical view of a latex cast of an external mold . . . . . (p. 62)

Fig. 12: Arctica sp., cf. A. murrayensis Warren; 38061 suite, Tuskoola Mountain, British Columbia; side view of right valve . . . . . (p. 51)

Fig. 13: Arctica? sp.; from 39135 suite, Murray River, British Columbia; internal mold of right valve . . . . . (p. 51)

Fig. 14: Belemnitella sp.; from 39131 suite, Tuskoola Mountain, British Columbia; drawing of incomplete specimen . . . (p. 73)

Figs. 15, 16: Inoceramus sp., cf. I. corpulentus McLearn; from 39104 suite, Murray River, British Columbia; 15 - posterior view; 16 - side view . . . . . (p. 28)

Fig. 17: Pholadomya sp., cf. P. goldenensis Stephenson; from 39149 suite, Tuskoola Mountain, British Columbia; right valve . . . . . (p. 46)

EXPLANATION OF PLATE 7

Fauna within the Nunki sandstone member, Kaskapau formation

All figures natural size

Figs. 1 - 4: Exogyra suborbiculata (Lamarck); hypotypes; 1, 2, 3 - from 38059 suite, Nini Mountain, British Columbia; 4 - from 37786 suite, Flatbed Creek, British Columbia; 1, 2 - side and anterior views of internal mold of right valve of large specimen; 3 - internal mold of right valve of small specimen; 4 - flat left valve of small specimen (p. 40)

Figs. 5, 13a: Nucula sp.; from 39129 suite, Coldstream Creek, British Columbia; left valve; 13a - left valve . . . (p. 21)

Fig. 6: Inoceramus sp.?; from 39129 suite, Coldstream Creek, British Columbia; posterodorsal view of left valve . . (p. 36)

Fig. 7: Exogyra sp., cf. E. columbella Meek; from 39109 suite, Murray River, British Columbia; latex impression of cast of right valve . . . . . (p. 39)

Figs. 8, 9: Pholadomya sp., aff. P. goldenensis Stephenson; from 38032 suite, Murray River, British Columbia; 8 - anterior view; 9 - side view of right valve of same specimen . . (p. 47)

Figs. 10, 13b: Senis sp.; from 39129 suite, Coldstream Creek, British Columbia; 10 - side view of two opened valves; 13b - side view of part of a valve . . . . . (p. 59)

Figs. 11, 12: Tragodesmoceras sp., cf. T. bassi Morrow, from 37779 suite, Flatbed Creek, British Columbia; 11 - ventral view; 12 - side view . . . . . (p. 69)

Fig. 13c: Arctica sp.; from 39129 suite, Coldstream Creek, British Columbia; internal mold of left valve . . . . (p. 52)

Fig. 13d: Pleuromya? sp.; from 39129 suite, Coldstream Creek, British Columbia; right valve . . . . . (p. 45)

Fig. 13e: Fish scale, Portheus?; from 39129 suite, Coldstream Creek, British Columbia.

Fig. 13f: Placenticeras?; from 39129 suite, Coldstream Creek, British Columbia.

EXPLANATION OF PLATE 8

Fauna within the Cardium formation

All figures natural size except figure 2 (x1.5) and figure 7 (x2)

Figs. 1 - 3, 6: Glycymeris sp. nov.? 1, 2 - from 38029 suite, Salt Creek, British Columbia; 3 - from 39129 suite, Coldstream Creek, British Columbia; 6 - from 38028 suite, Salt Creek, British Columbia; 1 - internal mold; 2 - drawing of figure 1 (x1.5); 3 - slab showing natural molds; 6 - slab with shell material still present . . . . . (p. 23)

Figs. 4, 5: Scaphites nigricollensis var. meeki Cobban; from 40675 suite, Mistanusk Creek, British Columbia; 4 - side view; 5 - ventral view of same specimen . . . . . (p. 68)

Fig. 7: Cardium pauperculum Meek; hypotype from 38029 suite, Salt Creek, British Columbia; drawing of right valve (x2)(p. 55)

Fig. 8: Leptosolen sp.; from 39128 suite, Coldstream Creek, British Columbia; latex mold of a right valve . . . (p. 56)

Figs. 9, 11: Inoceramus fragilis cf. prairiensis McLearn; hypotypes from 39120 suite, Brassey Creek, British Columbia; 9 - small right valve; 11 - posterodorsal view of two valves of a large specimen . . . . . (p. 32)

Fig. 10: Inoceramus sp.; from 40203 suite, Lynx Creek, Alberta; left valve . . . . . (p. 37)

REFERENCES

1. Bergquist, H. R. (1944): Cretaceous of the Mesabi Range, Minnesota; Jour. Paleont., Vol. 18, No.1, p. 1 - 30.

2. Cobban, W. A. (1951): Scaphitoid Cephalopods of the Colorado Group; U. S. Geol. Surv. Prof. Paper 239.

3. _____. (1952): Cenomanian Ammonite Fauna from the Mosby Sandstone of Central Montana; U. S. Geol. Surv. Prof. Paper 243-D, p. 45 - 55.

4. _____ and Reeside, J. B. (1952a): Correlation of the Cretaceous Formations of the Western Interior of the United States; Bull. Geol. Soc. Am., Vol. 63, No. 10, p. 1011 - 1044.

5. _____ ____ _____(1952b): Frontier Formation, Wyoming and Adjacent Areas; Am. Assoc. Petroleum Geol. Bull., Vol. 36, No. 10, p. 1913 - 1961.

6. Gardner, J. A. (1916): Upper Cretaceous Vol.; Maryland Geol. Surv., Baltimore, p. 371 - 733.

7. Gleddie, Joseph. (1949): Upper Cretaceous in Western Peace River Plains, Alberta; Am. Assoc. Petroleum Geol. Bull., Vol. 33, No. 4, p. 511 - 532.

8. _____. (1954): Upper Cretaceous in Western Peace River Plains, Alberta; Ralph Leslie Rutherford Memorial Volume, "Western Canada Sedimentary Basin", Am. Assoc. Petroleum Geol., Tulsa, appendix, p. 486 - 509.

9. Henderson, Junius. (1908): New Species of Cretaceous Invertebrates from Northern Colorado; Proc. U. S. Nat. Mus., Vol. 34, p. 259 - 264.

10. Hyatt, Alpheus. (1903): Pseudoceratites of the Cretaceous; U. S. Geol. Surv., Mon. 44.

11. Meek, F. B. (1876): A Report on the Invertebrate Cretaceous and Tertiary Fossils of the Upper Missouri Country; U. S. Geol. Surv. Terr. Rept., Vol. 9.

12. Moreman, W. L. (1942): Paleontology of the Eagle Ford Group of North and Central Texas; Jour. Paleont., Vol. 16, No. 2, p. 192 - 220.

13. Morrow, A. L. (1935): Cephalopods from the Upper Cretaceous of Kansas; Jour. Paleont., Vol. 9, No. 6, p. 463 - 473.

14. McLearn, F. H. (1919a): Cretaceous, Lower Smoky River, Alberta; Geol. Surv. Can., Summ. Rept. 1918, Pt. C, p. 1 - 7.

15. _____ . (1919b): New Species of Pelecypods from the Cretaceous of Northern Alberta; Geol. Surv. Can., Mus. Bull. 29, p. 9 - 12.

16. _____ . (1920): Three New Pelecypods from the Coloradoan of the Peace and Smoky Valleys, Alberta; Canadian Field Naturalist, Vol. 36, p. 53 - 56.

17. _____ . (1926): New Species from the Coloradoan of Lower Smoky and Lower Peace Rivers, Alberta; Geol. Surv. Can., Mus. Bull. 42, p. 117 - 126.

18. _____. (1937): The Fossil Zones of the Upper Cretaceous Alberta Shale; Trans. Roy. Soc. Can., Sec. IV, Vol. 31, p. 111 - 120.

19. _____. (1943): Trends in some Canadian Cretaceous Species of Inoceramus; Canadian Field Naturalist, Vol. 57, p. 36 - 46.

20. Reeside, J. B. (1923): A New Fauna from the Colorado Group of Southern Montana; U. S. Geol. Surv. Prof. Paper 132-B, p. 25 - 33.

21. Spieker, E. M. (1921): The Geology and Oil Resources of the Foothills South of Peace River in Northeastern British Columbia; Rept. of Oil Surveys Peace River District 1920, B. C. Dept. Lands, p. k11- k27.

22. Stanton, T. W. (1893): The Colorado Formation and Its Invertebrate Fauna; U. S. Geol. Surv. Bull. 106.

23. Stelck, C. R. (1955): Cardium Formation of the Foothills of Northeastern British Columbia; Can. Inst. Min. Trans., Vol. 58, p. 132 - 139.

24. _____ and Wall, J. H. (1954): Kaskapau Foraminifera from Peace River Area of Western Canada; Res. Coun. Alberta Rept. 68.

25. _____ ___ _____ . (1955): Foraminifera of the Cenomanian Dunveganoceras Zone from Peace River Area of Western Canada; Res. Coun. Alberta Rept. 70.

26. Stephenson, L. W. (1952): Larger Invertebrate Fossils of the Woodbine Formation (Cenomanian) of Texas; U. S. Geol. Surv. Prof. Paper 242.

27. _____ . (1954): Additions to the Fauna of the Raritan Formation (Cenomanian) of New Jersey; U. S. Geol. Surv. Prof. Paper 264-B, p. 25 - 43.

28. Warren, P. S. (1930): New Species of Fossils from Smoky River and Dunvegan Formations, Alberta; Res. Counc. Alberta, Rept. 21, appendix, p. 57 - 68.

29. _____ . (1930): Three New Ammonites from the Cretaceous of Alberta; Trans. Roy. Soc. Can., Sec. IV, Vol. 24, p. 21 - 27.

30. _____ . (1933): New Coloradoan Species from Upper Peace River, British Columbia; Trans. Roy. Soc. Can., Sec. IV, Vol. 27, p. 109 - 120.

31. _____ and Rutherford, R. L. (1928): Fossil Zones in the Colorado Shale of Alberta; Amer. Jour. Sci., Vol. 16, p. 129 - 136.

32. _____ and Stelck, C. R. (1940): Cenomanian and Turonian Faunas in the Pouce Coupe District, Alberta and British Columbia; Trans. Roy. Soc. Can., Sec. IV, Vol. 34, p. 143 - 152.

33. _____ ___ _____. (1955): New Cenomanian Ammonites from Alberta; Res. Counc. Alberta, Rept. 70, appendix, p. 63 - 75.

34. Williams, M. Y., and Bocock, J. B. (1932): Stratigraphy and Palaeontology of the Peace River Valley of British Columbia; Trans. Roy. Soc. Can., Sec. IV, Vol. 26, p. 197 - 224.

APPENDIX

Composite Section from Coldstream Creek to Murray River, B. C. (courtesy of Dr. C. R. Stelck)

	Feet
Coldstream Creek	
CARDIUM FORMATION	
Baytree conglomerate	--
Top of Turonian	
Covered	Not more than 20'
Sandstone, heavy crossbedded, medium to medium coarse grained, white to pinkish weathering sandstone, reddish brown in lower portion with Glycymeris sp.	106
Sandstone, brown, medium grained	20
Mainly covered	97
Shales and siltstones, acting as a spring horizon (base of Cardium formation?)	15
Shales covered in most part, but exposed in upper 250' on east fork of Coldstream Creek	528
Section continues as exposed on Nini Hill near the Murray River	
NUNKI SANDSTONE MEMBER	
Sandstone, well bedded with Exogyra sp. and large Inoceramus sp.	60
Shales interbedded with heavy sandstone	29
Sandstones and interbedded shales	4
Shales, sandy, interbedded with sandstones, sandier at top with some ironstone nodules	12
Sandstone, bedded, with ripple marks	3
Shales, sandy, interbedded with sandstones becoming sandier at top, with many ironstone nodules	22

Sandstone, well interbedded with siltstones	1
Shales, silty with ironstone bands and some siltstone lenticles	11
Sandstone, argillaceous with some thin ironstones	2
Shales, sandy with closely spaced argillaceous sandstones and ironstones	10
Shales, silty with thin lenticular stringers of fine sandstone and ironstone	17
Shales, sandy with sandstone bands closely spaced	14
Grit bed, ferruginous pebbles to thin ironstone	1
Shales, sandy with lenticules of sandstone and ironstone	49
Shales, sandy with seven bands of flaggy sandstone	10
Shale, silty with occasional ironstones, 3" sandy ironstone at base	11
Shale with occasional lenticle of fine sandstone	23
Shale with six bands of 2" sandstone flags	17
Sandstone, flaggy with worm borings.	1
Shales, silty with 2" sandstone bands	14
Shales, silty with occasional bands of siltstone and ironstone	54
Shales, silty with 3" sandstone lenticles in bands	6
Shales with occasional thin lenticle of sand	51
Siltstones, lenticular with lenticular sandstones and shales	18
Shale, very silty, some siltstones and fine lenticular sandstones to ¼"	239
Conglomerate, pebbles of chert about ¼" to 3/8"	1
Sandstone, flaggy	12

Sandstone, argillaceous	6
Sandstone, argillaceous, flaggy	15
Shale, very sandy with argillaceous sandstone	6
Sandstone, flaggy	2
Shale, sandy	2
Sandstone, flaggy	1
Sandstone, argillaceous	2
Shale, very sandy	10
Shale, very silty to sandy	30
Sandstone, argillaceous, flaggy	32
Grit	1/3
Shales	2/3
Sandstone, flaggy	7
Interbedded shale	14

WARTENBE SANDSTONE MEMBER

Conglomerate and conglomeratic sandstones, pebbles up to one inch, usually ¼ and ½ inch (Nini conglomerate)	16
Sandstone, massive fine grained showing crossbedding.	62
Sandstone, somewhat platy with some shaly beds.	24
Sandstone, argillaceous, flaggy	40
Sandstone, argillaceous, flaggy with interbedded sandy shale	12
Covered interval	25
Shales, silty with fine cross-bedded sandstone lenticles	18
Covered	24
Shales, silty with fine sandstone lenticles	30

Shales, silty with fine crossbedded sand lenticles and flat nodules	48
Covered interval, known to contain sandstone bands on Tuskoola mountain but lacking in large part on Gordon Creek (Tuskoola sandstone member present in this interval)..	554
Dip correction as section offsets up-dip	75
Covered, known to be shales, section continues on creek flowing into Murray River from Nini Hill	102
Shales, clean with occasional ironstone	18
Tuff bed with odd pebbles to ½"	½
Shales, silty with thin siltstone laminae, with ironstone nodules	39
Shales, silty with siltstones carrying Placenticeras sp.	30
Shale, clean, fissile	18
Shale, with small fine sandstone lenticles.	8
HOWARD CREEK SANDSTONE MEMBER (?)	
Sandstone, argillaceous, yellow (Waterfall-forming sand)	4
Shale, sandy with Inoceramus sp.	18
Shale, silty, soft with occasional thin ironstone bands	65
Shale, silty, platy	18
Shales, silty with bands of ironstone nodules to 3" thick	60
Shales, clean, silty.	10
Shales, with bands of ironstone	18
Shales with sporadic nodules.	36
Shale with bands of ironstone	7
Shale, silty, very clean	30
Shale, silty with stringers of grey sandstone	3

Shales, silty	24
Covered	14
Siltstones, shaly with ½" siltstone band with sporadic nodules	24
Estimated interval, all shales with ironstone nodules with Dunveganoceras sp. at base	100

Top of Cenomanian

POUCE COUPE SANDSTONE MEMBER

Sandstone, platy thin interbedded with shale	10
Shale, silty with ironstone	6
Sandstone, argillaceous with worm borings	2
Sandstone, medium to coarse grained	5
Oyster bed with Ostrea soleniscus	4
Sandstone, argillaceous with oysters	2
Shale	½
Sandstone, medium grained	4
Shale, with 3" of coal near top	8
Estimated, sandstones	30
Shales, silty	60
Coal seam	1
Shale, silty	30
Sandstone	2

DUNVEGAN FORMATION

Total section (from base of Baytree member to top of Dunvegan formation)	3322 feet