CONTRIBUTIONS

TO

CANADIAN PALAEONTOLOGY

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INTRODUCTION AND ACKNOWLEDGMENTS.

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PART ONE.

THE

PALAEOBOTANICAL COLLECTION

FROM

KITSILANO, VANCOUVER, B.C.

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CHAPTER I.

HISTORY.

The Palaeophytological (Paleobotanical) study of the fossil flora of the Lower Cenozoic beds of the Vancouver district commenced with J. W. Dawson[1] in 1895, who worked on collections made from the Burrard strata. He pronounced the age of the beds as probably Upper Laramie or Eocene.

From 1895 until 1922 the geological study of Vancouver and district was restricted to rapid surveys of the area and oil prospecting. These took no account of fossil flora whatsoever.

In 1922, W. A. Johnston studied this area geologically, made several collections and submitted them to E. W. Berry, of Johns Hopkins University, who prepared a floral list to be published with Johnston's Memoir.[2] It was not, however, until 1926 that Berry[3] published the complete report, this was in Bulletin No. 42 of the Geological Survey of Canada.

GENERAL GEOLOGY.

The Vancouver peninsula is entirely underlain by early Tertiary deposits consisting mainly of conglomerates, sandstones and shales. These were derived from the erosion of

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1. J. W. Dawson,--Trans. Roy. Soc. Canada, Vol. I. (1895), Sec. 4, pages 137-151.
2. W. A. Johnston,--Geol. Surv. Canada, Memoir 135 (1923).
3. E. W. Berry,--Geol. Surv. Canada, Bull. 42 (1926), pages 91-116.

the land masses upheaved at the time of the Jurasside and Laramide revolutions. The main agent of transportation was the ancestral Fraser river, and this, in conjunction with smaller streams, built up a mighty delta where is now the lower mainland of British Columbia. By Cretaceous time, as shown by S. J. Schofield, the batholith was already unroofed, so that erosion of the Coast Range diorite provided part, at least, of the Tertiary sediments. These deposits have been referred to the Eocene and possibly Oligocene epochs; a fuller consideration of their age is taken up in a later chapter. The sedimentaries are cut by a series of igneous rocks known as the Prospect Point eruptives. These consist of basic dykes and sills and volcanic tuffs.

After the deposition of these sediments, uplift and erosion, on a large scale, took place and continued until the beginning of the Ice Age.

The ice came down to the coast from the east, according to evidences offered by the boulders and glacial striae. The first advance of the ice resulted in the deposition of the Admiralty Till which is only known from deep-borings and a few doubtful exposures south of the map-area. The first recession was followed by a period of comparative warmth, judging from the rather incomplete flora gathered from the interglacial deposits, both in the area and in the Puget Sound area. These are the Point Grey sediments. Following this was another advance of the ice resulting in the Vashon Till which is generally exposed all over the area.

The Recent Formation is represented by the delta and alluvial deposits of the Fraser river and other streams. They consist of gravels, sands, silts, and clays, formed since the last recession of the Pleistocene ice sheet.

TABULAR HISTORY

Era	Period	Epoch	Formation		Description
CENOZOIC	QUATERNARY	Recent		Uplift	Stratified sands, gravels, silts and clays, and peat; deltaic and alluvial in origin.
		Pleistocene	Vashon Till		Boulder clay and glacial outwash.
			Point Grey F.		Stratified sand, silt and clay, and peat.--Interglacial.
			Admiralty Sediments		Glacial outwash, sands, conglomerates.
			Admiralty Till		Boulder clay.
	Unconformity				
	TERTIARY	Pliocene		Downwarping and tilting.	
		Miocene (?)	Prospect Point		Basic dykes, sills, and volcanic tuffs.
		Intrusive contact			
		Oligocene	?-Kitsilano F.		Conglomerate, sandstone and shale.
		Eocene { Upper / Middle / Lower }	Disconformity		
			? Burrard F.		Conglomerate, sandstone and shale.

CHAPTER II.

THE KITSILANO FORMATION.

The Kitsilano Formation is the upper member of the Tertiary series exposed in the Vancouver peninsula. The lower member is known as the Burrard Formation and differs but little in lithological characteristics from the Kitsilano.

Distribution.

The formation is exposed largely only along the coast-line where wave action has formed sea cliffs. The best of these are on the north side of the peninsula where the contact with the underlying Burrard Formation is exposed, and further west where there are outcrops of the middle and upper portions of the formation.

General Character.

The rocks of this formation consist of a thick basal conglomerate (exposed at First beach, Stanley Park) overlain by sandstones and shales.

The conglomerate is largely composed of granitic pebbles derived from the Coast Range batholith exposed to the north, but it also contains schistose rocks and some shale, evidently derived from the underlying Burrard Formation.

The sandstones and shales forming the middle and upper parts of the Kitsilano Formation are mostly blue or grey and coarse-grained, the shale being frequently quite sandy. The

sandstone, where weathered, is yellow or rusty. Some small, irregular lenses of lignite are to be found in the strata.

Attitude.

The formation rests disconformably upon the eroded surface of the Burrard Formation and corresponds with it in dip and strike. The beds strike east and west with a gentle monoclinal dip to the south. The dip varies from 8 to 15 degrees in the northern portion of the map-area, decreasing to 4 or 5 degrees near Burnaby Lake. The beds exposed along the coast, west of Kitsilano, have a dip of about 10 degrees; this may be due, according to Johnston, to a number of intrusive dykes of Miocene (?) age.

Johnston[1] summarizes the probable structure of the rocks in the words,-

> "The Tertiary rocks evidently occupy a broad basin-shaped depression extending beneath the delta of the Fraser and part of the Strait of Georgia. Downwarping of the basin took place subsequently to the deposition of the Kitsilano Formation and the area was later uplifted and deeply eroded. Depression of the area of deposition relatively to the mountain area must have taken place during the time of deposition of the sediments, for they are mostly shallow water deposits. Depression was probably caused by faulting since downfolding did not occur until later."

Origin.

Fromthe general character of the formation, the rapid alternation of sandstone and shale, the lensing of the strata, and the imbricated structure in portions of the basal conglomerate, it appears that the beds were deposited on an

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1. W.A.Johnston,--Geol. Surv. Canada, Memoir 135 (1923) p.38.

alluvial plain or fan. The gravels, at any rate, were formed above sea-level indicative of river action. The beds may pass into delta and marine deposits in the central portion of the area.

VANCOUVER PENINSULA

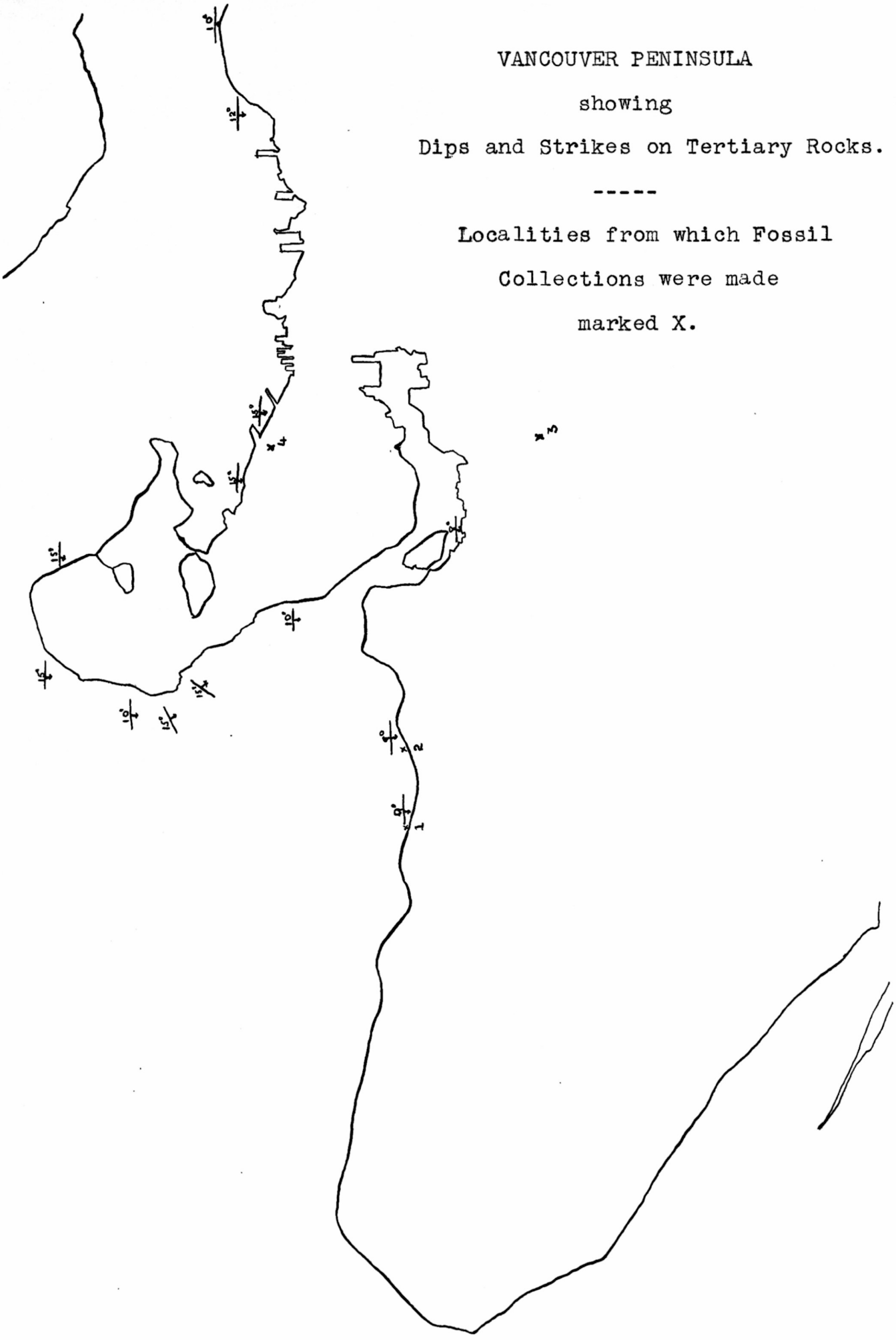
showing

Dips and Strikes on Tertiary Rocks.

Localities from which Fossil

Collections were made

marked X.



CHAPTER III.

FLORA.

TERTIARY (Kitsilano) FLORA.

The plants described in the following pages have all been collected from Tertiary strata of Eocene age. The major portion of the collection was made by members of the University of British Columbia, the writer included, and some few specimens have been presented from time to time by the Vancouver City engineers and other interested persons.

A table is here given with the list of fossil plants and the localities in which they were collected.

Locality No. 1.--Foot of Waterloo Street, Vancouver, B. C.

Collector: L. G. Millward.

Betula parvifolia Berry.

Glyptostrobus europaeus (Brongniart) Heer.

Myrica copeana Lesquereux.

Tilia populifolia Lesquereux (Two specimens).

Locality No. 2.--Kitsilano Beach, west end, Vancouver, B. C.

(a) Collector: R. Bayliss.

Planera nervosa Newberry.

Sequoia langsdorfii (Brongniart) Heer.

Locality No. 2 (continued)--

(b) Collector: Dr. S. J. Schofield.

Betula heterodonta Newberry.

Corylus macquarrii (Forbes) Heer.

Myrica copeana Lesquereux

Populus glandulifera Heer (Two specimens).

Rhamnus kitsilaniana Berry.

Tilia populifolia Lesquereux.

Locality No. 3.--Excavation, Cambie and 15th Avenue, Vancouver, B. C.

Collector: P. T. Timms.

Dryopteris nigricans (Lesquereux) Knowlton?

Locality No. 4.--Excavation, at 20 feet deep, Pender and Burrard Streets, Vancouver, B. C.

Collector: J. Carter.

Platanus aceroides Göppert.

Quercus banksiaefolia Newberry.

Phylum: PTERIDOPHYTA

Class: FILICALES

Family: Polypodiaceae

Dryopteris nigricans (Lesquereux) Knowlton ?

Plate I.

Lesquereux,-
Sphenopteris nigricans.--U. S. Geol. Surv. Terr., Vol. VII., "Tertiary Flora" (1878), page 51, plate ii, fig. 4-5a.

Description,-
"Frond polypinnate; primary pinnae narrow, linear,... pinnately deep bored; pinnules in right angle to the rachis, distinct to near their base, oblong, obtuse, deeply undulate on the borders, middle vein scarcely distinct, alternately pinnately divided in four to six pairs of veinlets, curving in passing to the borders, forking once, except the upper pair which is simple."

This is a fragmentary specimen marked in the collection as B8.

As the specimen is but poorly preserved the writer was obliged to query the specific name. If it is indeed Dryopteris nigricans it is one of the simpler forms as it has little or no indication of tertiary pinnae. The middle vein is not as distinct as the drawing shows, but it can be seen with the lens in all the pinnae.

Localities:

Denver: Golden, Colorado.

Post-Laramie: Black Buttes, Wyoming.

?Kitsilano: Vancouver, B. C.

Phylum: SPERMATOPHYTA

Class: GYMNOSPERMATA

Order: Coniferales

Sequoia langsdorfii (Brongniart) Heer.

Plate II.

Lesquereux,-
U. S. Geol. Surv. Terr., Rept., Vol. VII., "Tertiary Flora", (1878), page 76.

Knowlton,-
U. S. Geol. Surv., Monograph 32, Part II. (1898), page 657, plate lxxvii, fig. 5.

Penhallow,-
Trans. Roy. Soc. Canada, 2nd Series, Vol. IX. (1903), Section 4, page 41, fig. 2-4.

Description from Lesquereux,-
"Leaves close together, rigid, coriaceous, linear, obtusely pointed, flat, open, distichous, narrowed and decurrent at base; middle nerve strong; cones broadly oval or subglobose; scales numerous, peltate, mucronate in the middle."

The specimens submitted, B2 and B3, may be referred to this species. The literature is extremely confused in reference to S. langsdorfii. This species undoubtedly is a composite and should be divided into a number of true species. It has been described under many genera of the Gymnosperms, a few of which are Taxites, Cupressites, Chamaecyparites, Taxodium, etc. Its modern representative is Sequoia sempervirens which is indeed sometimes called by the same name as this fossil species.

Localities:

It has been recorded from almost every early

Tertiary (Eocene to Miocene) plant deposit of North America and Europe, also many places in Asia. The North American occurrences are chiefly Eocene, while the most important European localities are Miocene.

Glyptostrobus europaeus (Brongniart) Heer.

Plate II.

Lesquereux,-
U. S. Geol. Surv. Terr., Vol. VII., "Tertiary Flora", (1878), page 78, plate vii, fig. 1,2.

Newberry,-
U. S. Geol. Surv., Monograph 35 (1898), page 24, plate xxvi, fig. 6-8a; plate lv, fig. 3, 4.

Berry,-
U. S. Geol. Surv., Prof. Paper 91 (1916), page 169, plate xv, fig. 3.

Description from Newberry,-

> "Branches slender, bearing many branchlets; leaves of two forms, one short, thick, and appressed, the other longer (one-half inch), slender, divergent, acute, the shorter form carinated, the longer less distinctly, if ever so; male catkins small, terminal, globular, composed of a few shield-shaped scales; fertile cones larger, ovoid in form, scales narrow, wedge-shaped at base, at summit expanded, semi-circular, with waved or crenate margins, the dorsum of each more or less distinctly marked with 10 to 12 acute, radiating carinae."

Fragments of this form are found everywhere in the fossil beds of the Kitsilano Formation, but a good specimen is difficult to obtain. The leaves of the specimen, B9, are of the "short, thick, and appressed"type. The species is a composite, and should be divided. It is found throughout the Tertiary of both North America and Europe.

Localities:

Fort Union: Fort Union, North Dakota.
Porcupine Butte, Montana.
Other places.

Lance: Cannonball River, South Dakota.
Miles City, Montana.
Dayton, Rairden, Wyoming.

Kenai: Many localities in Alaska.

Tertiary: Birch Bay, Washington.

Paskapoo: Red Deer River, Alberta.
Similkameen and Horsefly Rivers, B. C.

Wilcox: Oxford and Early Grove, Mississippi.

Chu Chua: North Thompson, B. C.

Kitsilano: Vancouver, B. C.

Class: ANGIOSPERMATA

Order: Salicales

Family: Salicaceae

Populus glandulifera Heer.

Plate VII.

Heer,-
"Flora fossilis arctica" Vol. II. (1871), Abt. 2, "Flora fossilis alaskana", page 25, plate ii, fig. 1,2.

Lesquereux,-
U. S. Geol. Surv. Terr., Vol. VIII., "Cretaceous and Tertiary Flora" (1883) page 226, plate xlviA, fig. 3,4.

Ward,-
U. S. Geol. Surv., Sixth Annual Report (1884-85), page 550, plate xxxiii, fig. 1-4.
U. S. Geol. Surv., Bull. 37 (1887), page 19, plate iv, fig. 1-4.

Knowlton,-
U. S. Geol. Surv., Monograph 32, Part 2 (1899), page 694, plate lxxxiv, fig. 1.

Description from Lesquereux,-
"Leaves glandulose at the point of attachment of the petiole, variable in size, elliptical-ovate, pointed or generally enlarged on the sides and broadly deltoid, serrate or callous-dentate all around, five to seven palmately nerved, nerves branching outside."

These are two excellently preserved specimens in the collection, listed under B6 and B7.

The teeth are more blunt than in Lesquereux' specimen, and are more rounded, yet they show the resemblance in the dentition as well as in the definite method of branching outward nerves.

Localities:

Fort Union: Glendive, Montana.

Fort Union (continued): Badlands, North Dakota.
Yellowstone National Park.

Kenai: Port Graham, Alaska.

Ellensburg: Washington.

Kitsilano: Vancouver, B. C.

Order: Myricales

Family: Myricaceae

Myrica copeana Lesquereux.

Plate III.

Lesquereux,-
U. S. Geol. Surv. Terr., Vol. VII. (1878), "Tertiary Flora", page 131, plate xvii, fig. 5.

Description,-
"Leaves lanceolate, taper-pointed, rounded to the base, deeply double serrate; nervation penninerve, craspedodrome."

This is a large leaf, probably 6 inches long (apex and base are destroyed) and about 2 inches at its widest part. It tapers gradually to the apex and rounds off bluntly at the base. It is doubly serrate, with long sharp teeth turned up, and alternate smaller ones. The teeth become more or less equal towards the apex. The secondary veins to the larger teeth are stouter than those to the smaller teeth.

This form is practically identical with Lesquereux' form except that it is rather larger. It is peculiar that his form should be found in Miocene and this the only known occurrence, but the description and figure is unmistakable.

Specimens B5, B11, B12.

Localities:

Miocene: Florissant, Colorado.

Kitsilano: Vancouver, B. C.

Order: Fagales

Family: Betulaceae

Betula heterodonta Newberry.

Plate IV.

Newberry,-
U. S. Geol. Surv., Monograph 35 (1898), page 64, plate xliv, fig. 1-4; plate xlv, fig. 1, 6.

Berry,-
Geol. Surv. Canada, Bull. 42 (1926), page 103, plate xvi, fig. 5.

Description from Newberry,-

> "Leaf 2 to 4 inches in length, long petioled, ovate, acuminate, rounded at the base; margins coarsely and irregularly serrate, the principal denticles receiving the terminations of the nerve branches; the sinuses between these sometimes plain, sometimes set with a few small teeth; nervation delicate, about eight branches given off from each side of the midrib."

One specimen, B4, is definitely referred to this species, and some, more or less damaged, are referred doubtfully.

The specimen is lacking both apex and base, but the dentition is characteristically "irregularly serrate", and the nervation bears out the identification.

Localities:

Upper Clarno: Harney County, Oregon.

Oligocene: Quilchena, B. C.

Kitsilano: Vancouver, B. C.

Betula parvifolia Berry.

Plate IV.

Berry,-
Geol. Surv. Canada, Bull. 42 (1926), page 103, plate xv, fig. 1-3.

Description,-
"Orbicular to elliptical, nearly equilateral leaves of variable size and form, mostly small, about equally rounded at the apex and base. Margins, except near base, beset with small, even, dentate teeth. Length ranging from 2·25 cm. to 3·75 cm. Maximum width, midway between the apex and the base, ranging 1·5 cm. to 2·6 cm. Petiole stout, curved, 4 mm. to 8 mm. in length. Midrib stout. Secondaries 7 or 8 pairs, stout, craspedodrome, giving off a curved craspedodrome tertiary from the outside near their tips. Internal tertiaries percurrent."

This is a new species described by Berry from the Eocene of British Columbia. The specimen, B13, has one side completely preserved which shows the characters of this species.

Localities:

Chu Chua: North Thompson, B. C.

Kitsilano: Vancouver, B. C.

Corylus macquarrii (Forbes) Heer.

Plate V.

Ward,-
U. S. Geol. Surv., Sixth Annual Report (1884-85), page 551, plate xxxix, fig. 7.
U. S. Geol. Surv., Bull. 37 (1887), page 30, plate xiii, fig. 7.

Knowlton,-
U. S. Nat. Mus., Proceedings, Vol. 17 (1894), page 219, plate ix, fig. 4.
U. S. Geol. Surv., Monograph 32, Part 2 (1899), page 699, plate lxxxviii, fig. 3.

Newberry,-
U. S. Geol. Surv., Monograph 35 (1898), page 61, plate xxxii, fig. 5; plate xlviii, fig. 4.

Berry,-
Geol. Surv. Canada, Bull. 42 (1926), page 105, plate xvii.

Description from Newberry,-

"Leaves, large (5 to 6 inches long), short-petioled, unequally cordate at the base, pointed above, coarsely and unequally dentate; nervation strong; midrib straight or curved, not sinuous; lateral nerves, 6 to 7 pairs; lower pair diverging at a larger angle than the upper ones, and supporting a number of short, generally simple, branches, on the lower side, which terminate in the basal margin; second pair diverging at an angle of 45 degrees, reaching the margin about the middle, supporting about four branches on the outside; upper pair simple or branched once, rarely twice."

This specimen, B15, is rather poor owing to its damaged condition, but the nervation and dentition are characteristic.

The specimen most closely resembles those collected by Berry from the same beds, and from the Eocene of the Chu Chua district, B. C. As Berry says, the leaves of Corylus are "notoriously variable" and some of the illustrated specimens from the above-cited literature differ greatly from the type form. Whether these variations be of a single variable species or from a number of closely allied species is not known, and the writer has followed the concensus of opinion in naming the fossil.

Localities:

Fort Union: Fort Union, North Dakota.
Glendive, Montana.

Paskapoo: Red Deer River, Alberta.
Porcupine Creek, Saskatchewan.
Horsefly River, B. C.
Mackenzie River, N. W. T.

Upper Clarno: Bridge Creek, Oregon.

Kenai: Many localities in Alaska.

Miocene: Fossil Forest, Yellowstone National Park.

Kitsilano: Vancouver, B. C.

Chu Chua: North Thompson, B. C.

Family: Fagaceae

Quercus banksiaefolia Newberry.

Plate I.

Newberry,-
U. S. Geol. Surv., Monograph 35 (1898), page 69, plate xviii, fig. 2-5.

Berry,-
Geol. Surv. Canada, Bull. 42 (1926), page 107, plate xvi, fig. 6.

Description from Newberry,-

"Leaves very long, linear, lanceolate, long-pointed and acute at either end; margins set with numerous nearly uniform, acute, appressed teeth turned towards the superior extremity; midrib strong, running the entire length of the leaf; lateral veins numerous, simple, strongly marked, parallel, arched upward, terminating in the teeth of the margin; reticulated nervation buried in the thick parenchyma of the leaf, and generally invisible in the fossil state."

This form is on specimen B14 in connection with Platanus aceroides. It greatly resembles the leaf of the living chestnut save that it is longer and narrower than the existing species. The specimen is only fragmentary, but the nervation, dentition and shape are unmistakable.

<u>Localities:</u>

Puget: Chuckanutz, near Bellingham Bay, and Glacial coal field, Washington.

Kitsilano: Vancouver, B. C.

Order: Urticales

Family: Ulmaceae

Planera nervosa Newberry.

Plate V.

Newberry,-
U. S. Geol. Surv., Monograph 35 (1898), page 82, plate lxvii, fig. 2, 3.

Description,-
"Leaves ovate or lanceolate, pointed, wedge-shaped, or rounded at the base, petioled; margins set with coarse, appressed teeth; nervation strong, crowded, regular; lateral nerves simple, parallel, terminating in the teeth of the margins."

The specimen, B10, shows distinctly the characteristics of Newberry's species. It resembles figure 2 rather than the other in the nervation.

Localities:

Green River: Green River, Wyoming.

Kitsilano: Vancouver, B. C.

Order: Platanales

Family: Platanaceae

Platanus aceroides Göppert

Plate VI.

Lesquereux,-
U. S. Geol. Surv. Terr., Report, Vol. VII. (1878), "Tertiary Flora", page 184, plate xxv, fig. 4-6.

Knowlton,-
U. S. Geol. Surv., Prof. Paper 101 (1918), page 321, plate lxiii, fig. 4; plate xlvii, fig. 2, 3.

Berry,-
U. S. National Museum, Proceedings, Vol. LIV. (1918), page 630, plate xciv, fig. 3; plate xcv, fig. 5.

Description (Writer's),-

Leaf comparatively large, deeply trilobate; lobes sharply acuminate, the middle twice as long as the lateral ones and more or less secondary trilobed; borders dentate. Maximum length approximately 6 inches. Width nearly equal with the length.

The form, B14, belongs to this rather variable species. The types figured by Lesquereux do not show the secondary trilobation, but this is admirably depicted in Knowlton's paper. The leaf generally resembles the broad-leaf maple of the present and the likeness is noted in the specific name.

Localities:

Fort Union ?: Badlands, North Dakota.

Denver: Golden, Colorado.

Post-Laramie: Black Buttes, Wyoming.

Ellensburg: Ellensburg, Washington.

Eocene ?: Mackenzie River, North West Territories.

Kitsilano: Vancouver, B. C.

Order: Rhamnales

Family: Rhamnaceae

Rhamnus kitsilaniana Berry.

Plate VII.

Berry,-

Geol. Surv. Canada, Bull. 42 (1926), page 113, plate xix, fig. 1.

Description,-

"Leaves of relatively large size, ovate-lanceolate in outline, widest medianly, and curving almost equally distad to the acuminate tip, and proximad to the slightly decurrent base. Margins entire, evenly rounded. Texture thin. Length about 12 cm. Maximum width about 4 cm. Petiole short and stout. Midrib

stout, prominent, curved. Secondaries about 5 pairs, mediumly stout, alternate, somewhat irregularly spaced; they diverge from the midrib at angles of about 45 degrees, and curve immediately upward in regular sweeping curves, subparallel with one another and with the leaf margins. Tertiaries thin, percurrent, and mostly obsolete."

This specimen, B17, resembles some species of Cornus, but Berry, in the reference noted above, figures this specimen as one of the Rhamni. The two genera resemble each other in many ways, consequently the writer has followed Berry's nomenclature.

Localities:

Kitsilano: Vancouver, B. C.

Order: Malvales

Family: Tiliaceae

Tilia populifolia Lesquereux

Plate III.

Lesquereux,-
U. S. Geol. and Geog. Surv. Terr., Vol. VIII. "Illustrated Cretaceous and Tertiary Flora" (1883), page 179, plate xxxiv, fig. 8, 9.

Description,-
"Leaves large, round or subcordate at base, deltoid-acuminate to the apex, deeply regularly serrate, palmately five-nerved; upper lateral nerves somewhat thicker and more distant, the secondary parallel, slightly curving, branching near the borders. Leaves large, variable in size."

Two specimens of this interesting species were obtained and are both catalogued under B1.

The veining at first sight resembles that of a Populus in being "palmately five-nerved" and on account of the lateral primary nerves being much stronger than the secondary. However, the nerves and their divisions differ from the typical Populus and resemble those of the members of the Tiliaceae. The teeth are more or less deeply serrate and vary on different leaves.

Localities:

Miocene: Florissant, Colorado.

Fort Union: Yellowstone National Park.

Kitsilano: Vancouver, B. C.

CHAPTER IV.

THE AGE OF THE KITSILANO FLORA.

From a careful study of the occurrence and associations of the flora and the stratigraphy of the region, the writer has come to the conclusion that the Kitsilano Flora represents a time equivalent to the Clarno of Oregon and the Green River of Wyoming.

The reasons for this will be seen on considering the accompanying list of occurrences of the flora, and also the position of the beds themselves relative to the Burrard Formation. The latter has been definitely proved the equivalent of the Lower Puget of Washington and the Fort Union of the Great Plains.

The exact position in the geological time-table is, however, a moot point. On the Great Plains the Palaeobotanists, exemplified by Cross and Knowlton,[1] place the Cretaceous-Eocene break at the Fox Hill--Lance contact, while the Palaeozoologists, championed by Thom and Dobbin,[2] place it at the Fort Union--Wasatch contact. The former classification would place both the Kitsilano and the Burrard Formations high in the Eocene, while the latter would make the Burrard the last phase of the Cretaceous.

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1. W. Cross and F. H. Knowlton,--Science, Vol. LIII. (1921) pages 304-308.
2. W. T. Thom, Jr. and C. E. Dobbin,--Bull. Geol. Soc. America, Vol. XXXV. (1924) pages 481-506.

Between these two schools it must be confessed that, for the present, the matter must be one for personal observation and opinion, and cannot, as yet, be settled by a philosophic consideration of the literature.

To aid the reader in forming his conclusions a table of equivalents is here appended:-

	Vancouver	Great Plains	Pacific Coast
EOCENE	Kitsilano	Green River Wasatch	Clarno Roslyn
?			
"LARAMIE"	Burrard	Fort Union Denver Lance	Puget Swauk
?			
CRETACEOUS		Fox Hill Bearpaw	

Species	Raton	Lance	Denver	Equiv. of Puget	Equiv. of Fort Union	Post-Laramie	Eocene	Equi. of Kenai	Equi. of Clarno	Oligocene	Florissant	Miocene Mascall	Miocene Ellensburg
								Clairborne	Paskapoo				
Dryopteris nigricans (Lesq.) Knowlton			x			x							
Sequoia langsdorfii (Brongniart) Heer		x			x			x	x	x	x	x	
Glyptostrobus europaeus (Brongniart) Heer		x	x		x				x	x			
*Phragmites alaskana Heer					x					x			
*Sabalites campbelli (Newb.) Lesquereux				x			B.C.						
Populus glandulifera Heer					x					x			x
Myrica copeana Lesquereux											x		
*Betula angustifolia Newberry							B.C.			x			
Betula heterodonta Newberry										x	B.C.		
Betula parvifolia Berry								New Species					
*Carpinus grandis Unger (?)							Wash. B.C.			x	x		x
Corylus macquarrii (Forbes) Heer					x			x	x	x			
Quercus banksiaefolia Newberry				x									
*Quercus coriacea Newberry				x									
*Quercus groenlandica Heer										x			
Planera nervosa Newberry								Green R. Wyo.					
Platanus aceroides Göppert	x		x		x	x	N.W.T.					x	x
*Magnolia nordenskioldi Heer (?)										x			

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3. United States National Museum, Proceedings, Vol. XI. (1888).

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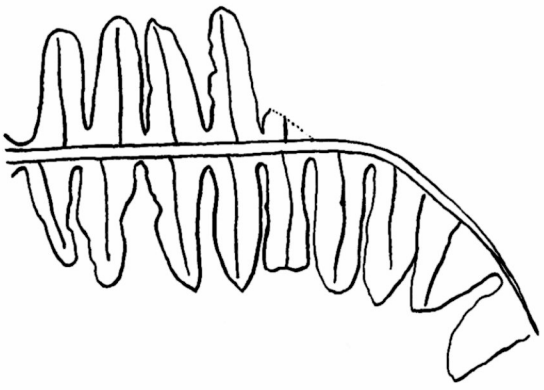
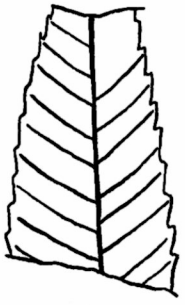
United States Geological Survey, Sixth Annual Report (1884-85), pages 399-557.
2. "Types of the Laramie Flora."
United States Geological Survey, Bulletin 37 (1887).

PLATE I.

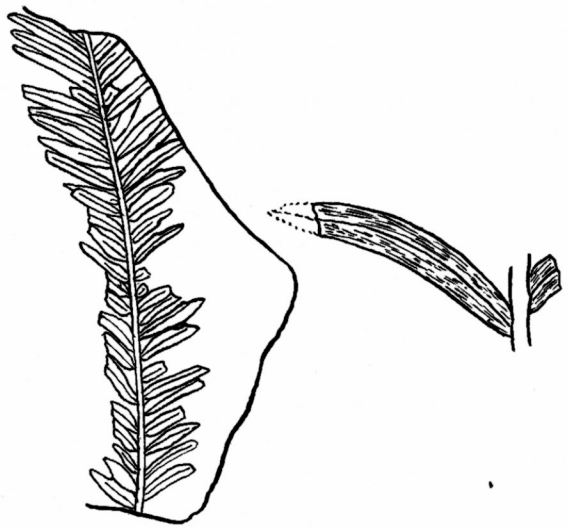


Dryopteris nigricans (Lesquereux) Knowlton ?



Quercus banksiaefolia Newberry.

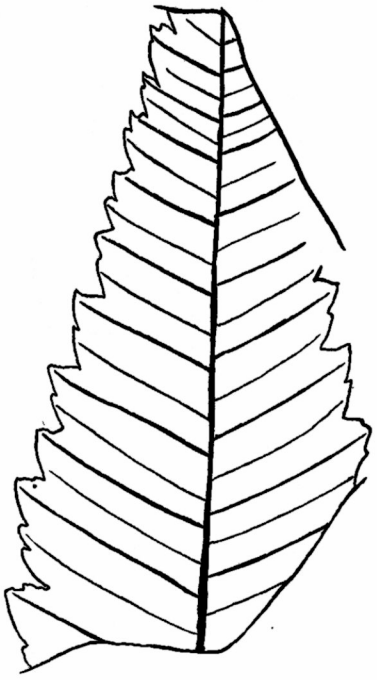
PLATE II.



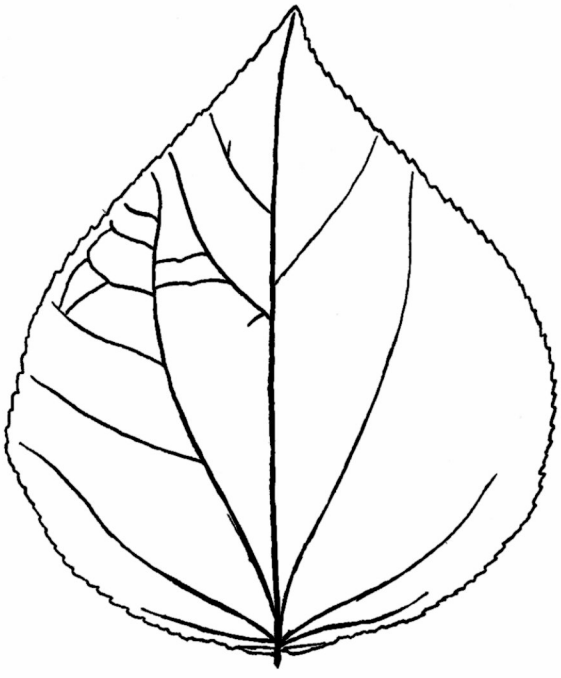
Sequoia langsdorfii (Brongniart) Heer.

Glyptostrobus europaeus (Brongniart) Heer.

PLATE III.

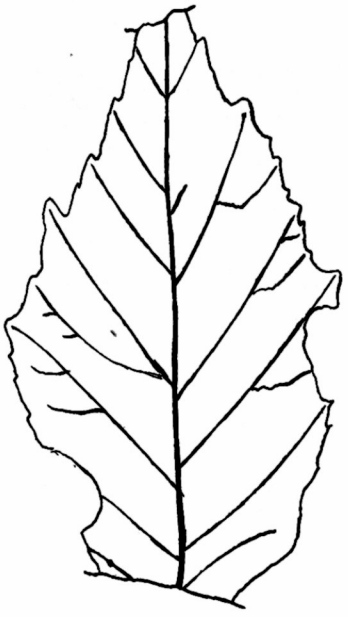


Myrica copeana Lesquereux.

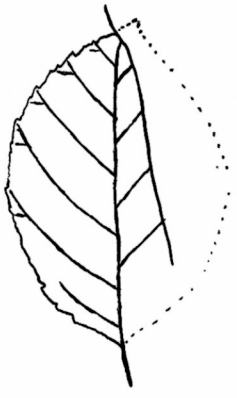


Tilia populifolia Lesquereux.

PLATE IV.

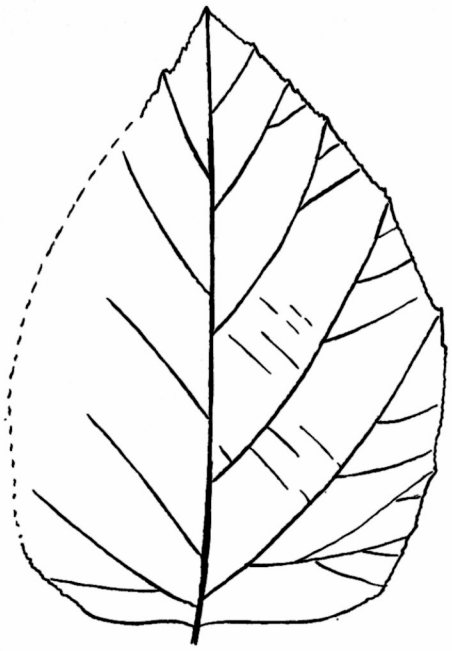


Betula heterodonta Newberry.

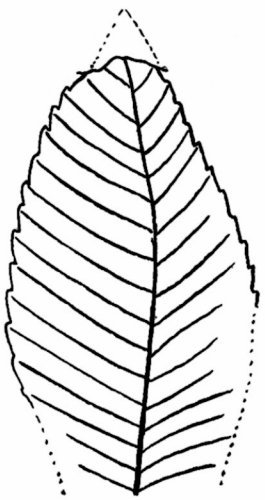


Betula parvifolia Berry.

PLATE V.

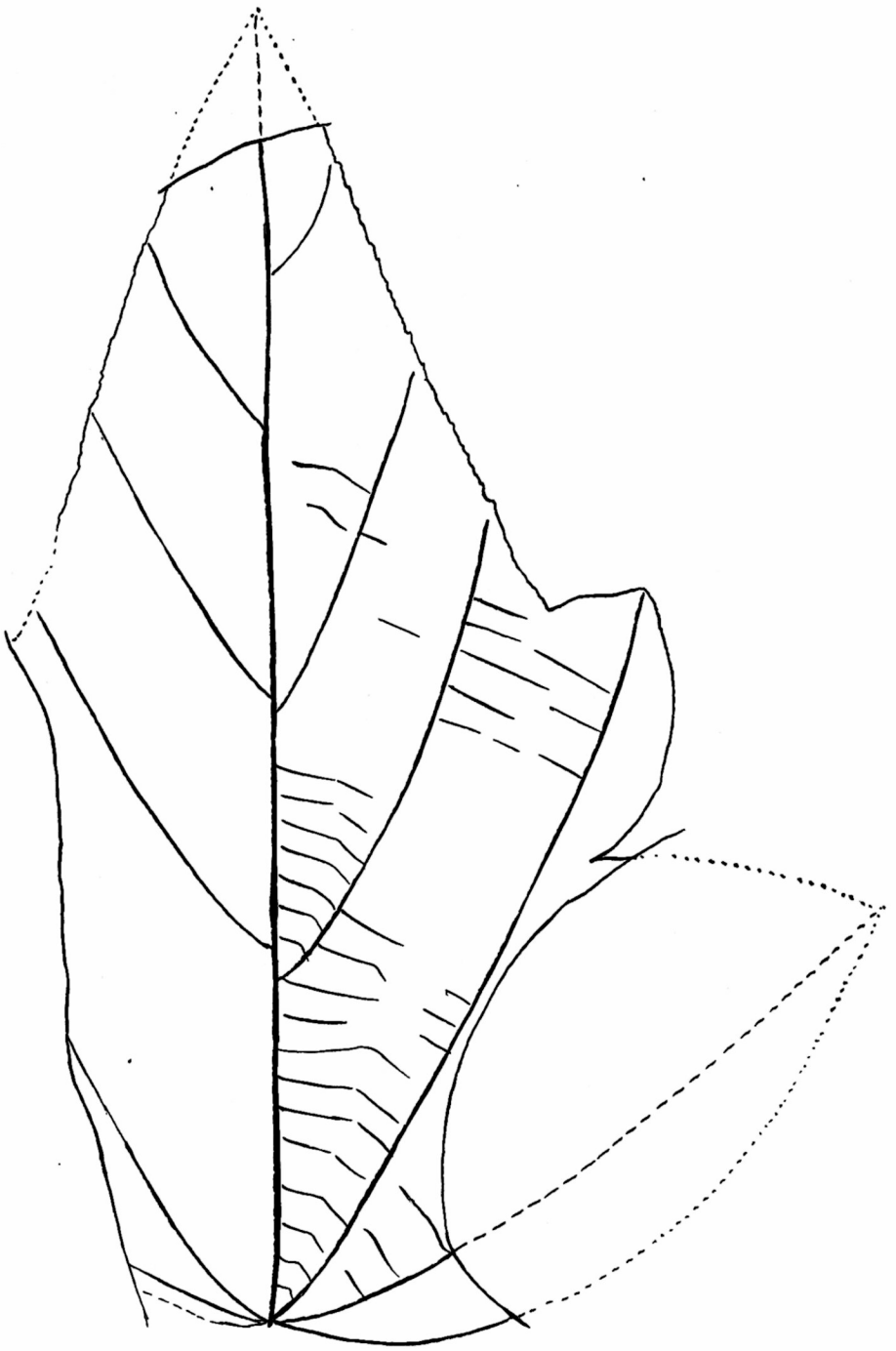


Corylus macquarrii (Forbes) Heer.



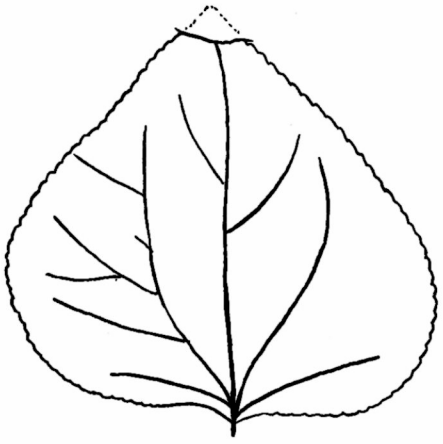
Planera nervosa Newberry.

PLATE VI.

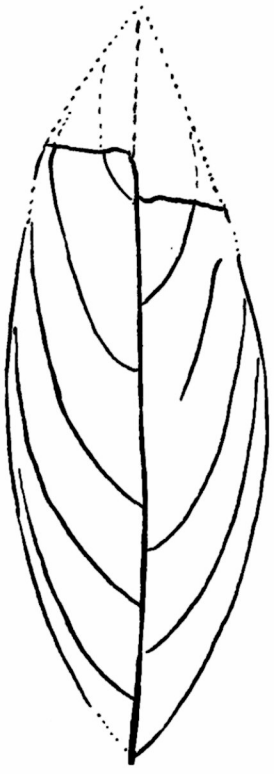


Platanus aceroides Göppert.

PLATE VII.



Populus glandulifera Heer.



Rhamnus kitsilaniana Berry.

PART TWO.

UPPER CRETACEOUS AMMONITES

FROM

SOUTHERN ALBERTA

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CHAPTER I.

HISTORICAL SKETCH.

The early geological investigation of the Great Plains was largely reconnaissance. The country was unsettled, transportation uncertain, and dangers from both man and beast were ever present. The Indians were by no means friendly, and the explorer had always to present a determined front against their depredations. The peculiar nature of the country was also a determining factor as to the kind of work done; it was hot in summer, bitterly cold in winter, water difficult to obtain, especially in the west, and game at times very scarce.

A. R. C. Selwyn[1] was the first geologist on our northern plains. He travelled from Fort Garry, Manitoba, to Rocky Mountain House, on the Peace river, and back again, making the first systematic record of means of travel, game, flora and geology. G. M. Dawson[2] followed Selwyn six years later, and in succeeding years, accompanied by R. G. McConnell, made extensive surveys in the southern portion of the plains near the International Boundary.[3] McConnell[4] also did much work by himself while Dawson was making his explorations in British Columbia.

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1. A. R. C. Selwyn,--Geol. Surv. Canada, Rept. Prog. (1873-74) pages 17-62.
2. G. M. Dawson,--British North American Boundary Commission (1875).
   Geol. Surv. Canada, Rept. Prog. (1880-81-82), Part B.
3. G. M. Dawson and R. G. McConnell,--Geol. Surv. Canada, Rept. Prog. (1882-83-84), Part C.
4. R. G. McConnell,--Geol. Surv. Canada, Ann. Rept. (New Series), Vol. I. (1885), Part C.

In later years many workers have entered the field. Among these are D. B. Dowling,[1] S. E. Slipper,[2] G. S. Hume,[3] and, more recently, M. Y. Williams and W. S. Dyer, whose report has not yet been published.

Palaeontological work in the rocks of this region has not been continuous, or indeed of much importance since the wonderful treatises by F. B. Meek[5] on the Hayden Survey of the United States Territories, and by J. F. Whiteaves[4] for the Canadian Survey. J. B. Reeside[6] and F. H. McLearn are the latest workers in this region and their contributions have been the most valuable since those of Meek and Whiteaves. Reeside has specialized in the Cephalopods of the Upper Cretaceous, and McLearn on the Pelecypods.

HISTORICAL GEOLOGY.

Upper Cretaceous time in the Great Plains region was notable for a number of alternating marine and freshwater phases, with resulting sediments. The marine formations are largely shale with some sandstone; the continental sediments are everywhere sandstones, silts and coal.

The fauna was almost totally unlike that of the present day. Mammals were few and small, giant reptiles ruled the

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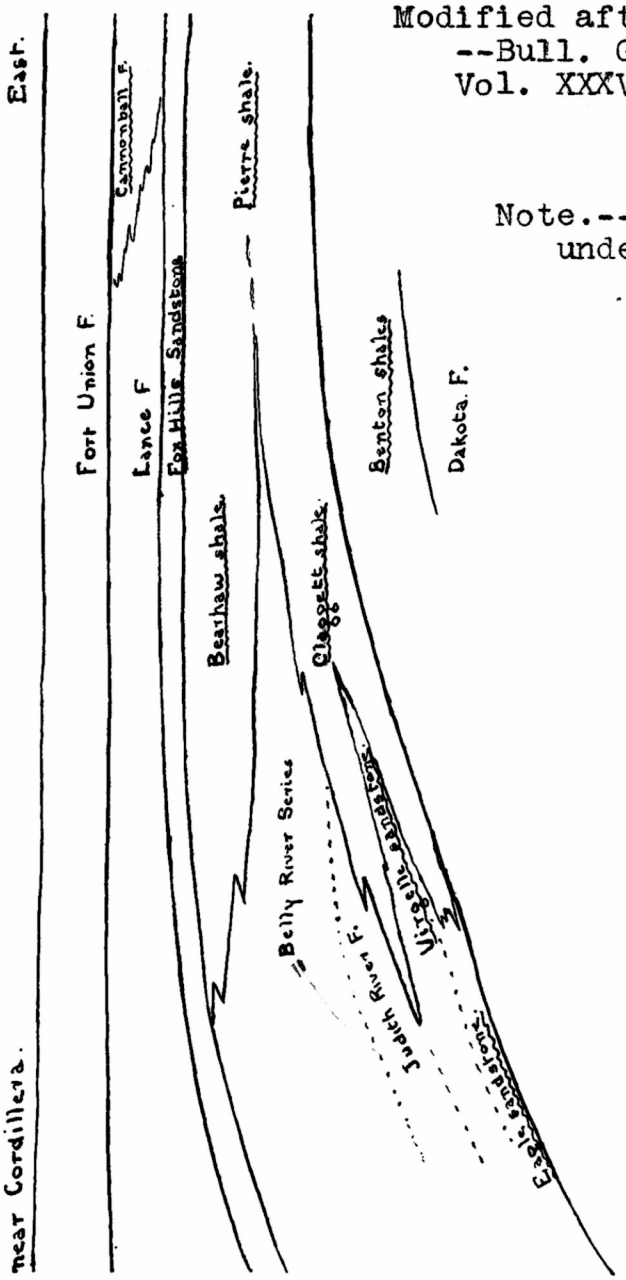
1. D. B. Dowling,--Geol. Surv. Canada, Memoir 93 (1917).
2. S. E. Slipper,--Geol. Surv. Canada, Memoir 116 (1919).
3. G. S. Hume,--Geol. Surv. Canada, Summary Reports, 1924-1926.
4. J. F. Whiteaves,--Geol. Surv. Canada, Contributions to Canadian Palaeontology, Vol. I. Part I. (1885).
5. F. B. Meek,--U.S. Geol. Surv. Terr., Vol. IX. (1876).
6. J. B. Reeside, Jr.--U.S. Geol. Surv. Prof. Paper 151 (1927)

PLATE I.

Correlation of Upper Cretaceous Formations of Great Plains near 49th parallel.



Modified after Thom and Dobbin, --Bull. Geol. Soc. America, Vol. XXXV. (1924), page 484.

Note.--Marine formations underlined.

swamps that characterized the sea-shores, while in the seas other reptiles and huge sharks took their toll from the aquatic life. Cephalopods, the scavengers of the waters, yet the highest form of invertebrate life, were in a majority. Such forms as the Belemnites (squids), Nautiloids and Ammonites--both straight and coiled--abounded, and, in some instances, attained an enormous size.

The flora bore some resemblance to that now on this continent. During Belly River times swamps were large and widespread; indeed, the Cretaceous is the second largest coal-forming period of North America.

CHAPTER II.

BEARPAW FORMATION[1]

One of the latest and most widespread of the marine invasions of the Upper Cretaceous was that of the Upper Pierre sea, now known in Canada and the Northern States as the Bearpaw submergence.

It is with the life in general, and the Ammonites in particular, of this time that this paper deals.

The Bearpaw sediments are mostly grey shales, and amount to some 900 feet in thickness; they contain fossils very similar to those of the lower member of the Pierre, the Claggett. This is confusing, as the Claggett greatly resembles the Bearpaw in lithology; however, as far as is known, Scaphites nodosus var. brevis has never been found in the lower Pierre and therefore should form an excellent guide to the Bearpaw.

Dowling[2] gives an incomplete section of the Bearpaw as follows:

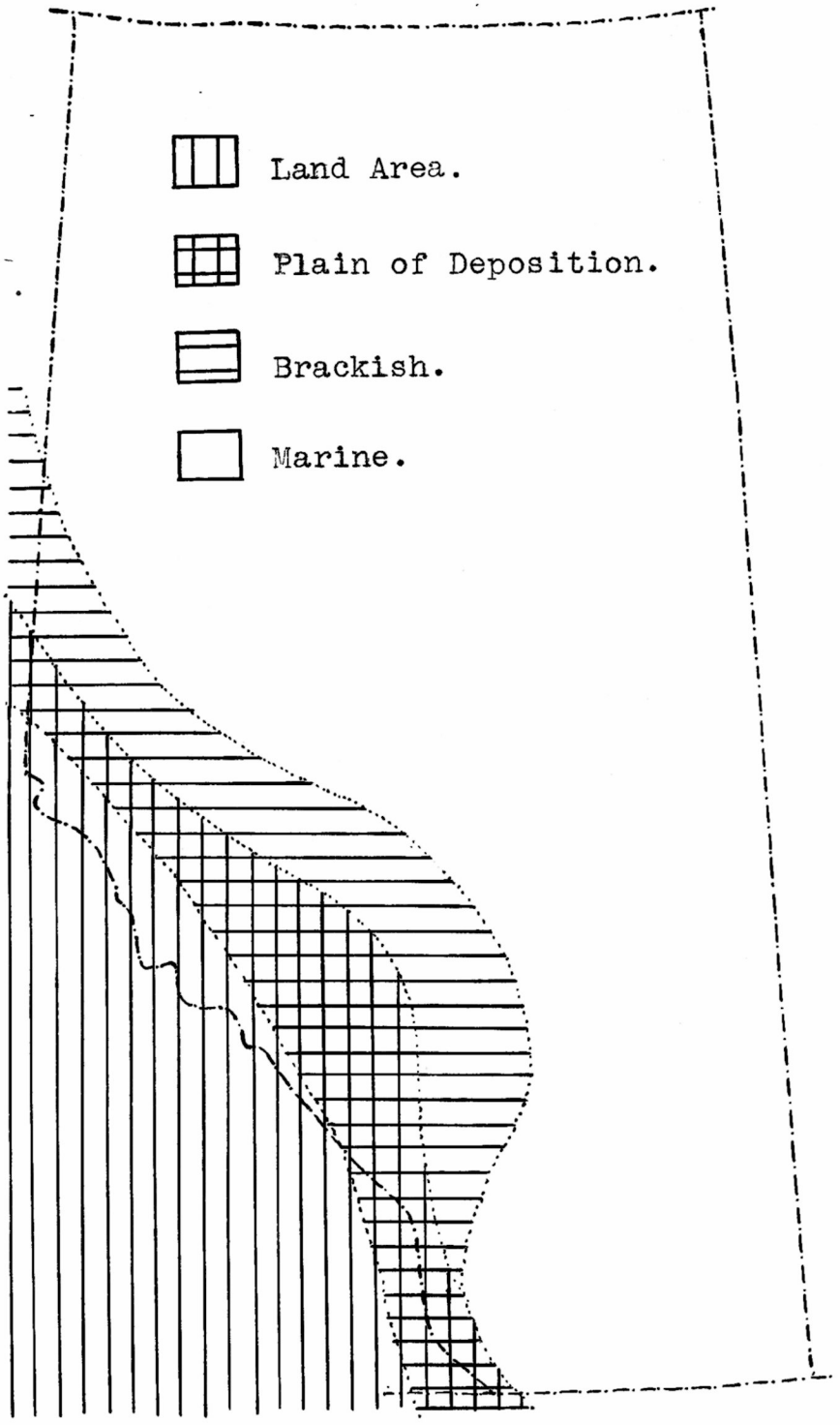
Foxhill Beds (sandstone--marine)

Bearpaw (marine)	Ft.	Ins.
Soft, dark shale - -	27	0
Dark, sandy shale - -	150	0
Hard, tough shale - -	31	0
Sandy shale - - - -	17	0
Hard sandstone - - -	2	0
Soft, grey sandstone -	30	0

---

1. See Plate II. for position in geologic succession.
2. D. B. Dowling,--Geol. Surv. Canada, Mem. 93 (1917) page 25.

PLATE II.



Outline of Province of Alberta, showing Palaeogeography of the Bearpaw submergence.

After D. B. Dowling,--Trans. Roy. Soc. Canada, Series III., Vol. IX. (1915), plate 7.

Bearpaw (marine) continued	Ft.	Ins.
Soft, dark shale - -	19	0
Hard, dark shale - -	18	0
Dark, sandy shale - -	119	0
Dark shale - - - -	93	2
Ironstone band - - -	0	10
Dark shale - - - -	70	0
Dark, sandy shale - -	36	0
Ironstone band - - -	0	10
Dark, sandy shale - -	7	6
Sandy shale - - - -	0	8
	622	0

Belly River series (continental)

CHAPTER III.

FOSSILS OF THE BEARPAW FORMATION.

INTRODUCTION.

The most characteristic fossils of the Bearpaw are Pelecypods and Ammonites. Dowling records some 38 species of Pelecypods and 10 species of Ammonites. He also notes 10 Gastropods, one Brachiopod and a single doubtful Crustacean.

The Ammonites, with which this paper deals, are large and characteristic. A fragment of Baculites reaches some 18 inches in length, while one of the coiled forms, Placenticeras, has a diameter of quite 14 inches.

The fossils are divided into four genera and seven species as follows:

Baculites compressus Say.
" grandis Hall and Meek.
" new species.
" species undetermined.
Placenticeras intercalare Meek.
" meeki Boehm.
Rhaeboceras halli Meek.
Acanthoscaphites nodosus Owen, var. brevis Meek.

Acanthoscaphites, Rhaeboceras, and the new species of Baculites are rare in the formation compared with the remaining four species. B. compressus is the commonest form in the collection.

LIST OF OCCURRENCES.

Baculites compressus Say.

Collector: M. Y. Williams and party.

1. North side of S. W. quarter, 2:8:22:4[1], in east bank of St. Mary's river.
2. Immediately north of the old C.P.R. bridge over St. Mary's river.
3. South side of N. E. quarter, 19:3:21:3.
4. Near centre of N. W. quarter, 24:6:23:4, south side of St. Mary's river.
5. S. W. quarter, 11:9:5:3, Little Rhine creek.
6. 12:3:28:3, Saskatchewan.

Collector: W. S. Dyer and party.

7. 1:11:3:4, Ross creek.
8. 30:10:29:3, Box Elder creek.
9. S. E. quarter, 6:11:29:3.
10. S. W. quarter, 7:11:29:3.

Baculites grandis Hall and Meek.

Collector: W. S. Dyer.

1. 30:10:29:3, Box Elder creek.
2. Ross creek, four miles south of Irvine, Alberta.
3. Mid-line between S. E. and S. W. quarters, 25:9:6:4.

Baculites new species.

Collector: W. S. Dyer.

1. Mid-line between S. E. and S. W. quarters, 25:9:6:4.
2. Coulee, west of road three and three-quarter miles south of Irvine, Alberta.

---

1. 2:8:22:4 is the short form of writing Section 2, Township 8, Range 22, West Meridian 4.

Baculites species undetermined.

Collector: M. Y. Williams.

1. N. E. quarter, 16:3:15:4.
2. N. E. quarter, 12:7:22:4, St. Mary's river.
3. South side of N. E. quarter, 19:3:21:3.
4. 12:3:28:3, Saskatchewan.

Placenticeras intercalare Meek.

Collector: M. Y. Williams.

1. Immediately north of the old C.P.R. bridge over St. Mary's river.

Collector: W. S. Dyer.

2. 1:11:3:4, Ross creek.
3. Mid-line between S. E. and S. W. quarters, 25:9:6:4.

Placenticeras meeki Boehm.

Collector: M. Y. Williams.

1. East side of Oldman river, Township 8, Range 22, Lot 20.
2. Immediately north of the old C.P.R. bridge over St. Mary's river.

Collector: W. S. Dyer.

3. Coulee, west of road three and three-quarter miles south of Irvine, Alberta.
4. 22:9:23:4, Oldman river.
5. 1:11:3:4, Ross creek.
6. Mid-line between S. E. and S. W. quarters, 25:9:6:4.

Rhaeboceras halli Meek.

Collector: W. S. Dyer.

1. South branch of Box Elder creek.
2. 30:10:29:3, Box Elder creek.

Acanthoscaphites nodosus Owen, var. brevis Meek.

Collector: M. Y. Williams.

1. N.E. quarter, 12:7:22:4, St. Mary's river.

Collector: W. S. Dyer.

2. 30:10:29:3, Box Elder creek.

DETAILED DESCRIPTION.

Phylum: MOLLUSCA.

Class: CEPHALOPODA.

Sub-class: TETRABRANCHIATA.

Order: AMMONOIDEA.

Family: BACULITIDAE.

Genus Baculites Lamarck.

These are shells with an extremely small initial coil rapidly becoming straight and staff-like with further growth. Cross section varies from subtriangular to subcircular, but is generally oval or laterally compressed. Living chamber large, and usually with a long rostrum on the siphonal side. The shell is smooth or with low ribs or costae distinct only on the flanks. Suture characteristic of the genus, generally six saddles and six lobes, all except the antisiphonal lobe split in two parts.

Baculites have been found in European, Asiatic and North American deposits and are limited to Upper Cretaceous beds.

Specific determination is dependent upon the cross section, the ornamentation of the surface, and the comparative complexity of the suture. A few specimens have been found with intergrading characters, these are, however, few, and regarded as abnormal and unimportant in the genetic consideration of the group.

Baculites compressus Say.

Baculites compressa Say.
T. Say,--American Journal of Science, 1st Series, Vol. II. (1820), pages 41-42.

Baculites compressus Say.
J. Hall and F. B. Meek,--Memoirs of the American Academy of Arts and Sciences, New Series, Vol. V. (1854), pages 400-402, plate 5, fig. 2a, b; plate 6, fig. 8-9.
F. B. Meek,--U. S. Geol. Surv. Terr., Vol. IX. (1876), pages 400-404, plate 20, fig. 3a-3c; text fig. 55-56.
A. P. Brown,--Proc. of the Academy of Natural Sciences, Philadelphia, Vol. XLIII. (1891), pages 159-160, text fig. 1-6, also Vol. XLIV. (1892), pages 136-141, plate 9.
A. P. Brown,--Nautilus, Vol. V. (1891), page 19, text fig. 1-6.
A. W. Grabau and H. W. Shimer,--North American Index Fossils, Vol. II. (1910), page 181, fig. 1435-1436.
J. P. Smith,--Acceleration of Development in Fossil Cephalopoda, Leland Stanford Junior Univ. Pub., Univ. Series (1914), plate 14, fig. 13.
J. B. Reeside, Jr.,--U. S. Geol. Surv., Prof. Paper 151 (1927), pages 10-12, plate 9, fig. 1-5.

Description from Meek,--

"Shell attaining a large size, rather rapidly tapering, particularly in the young, or near the smaller extremity of adult specimens, strongly compressed laterally in medium-sized examples, but more convex in the young and toward the larger extremity of large adults; non-septate portion of fully developed specimens, provided with large broad lateral undulations; lines of growth generally obscure; siphonal margin sometimes crossed by small undefined wrinkles; transverse section, like the outline of the aperture, varying with size and age, being ovate in very small specimens, strongly compressed in medium-sized examples and proportionately more broadly ovate in the large adult.

Septa usually crowded, and with lobes and sinuses deeply divided into slender branches; siphonal lobe nearly twice as wide as long and provided with two widely separated tripartite and digitate terminal branches and one smaller digitate lateral branch on each side; first lateral sinus as long as the siphonal lobe but not much more than half as wide and very deeply divided."

Baculites compressus may be easily recognized by the

compressed and tapering cross section, by the deeply digitate suture and by the smooth shell.

In the collection from the Bearpaw shale there are many specimens of this characteristic form. A few are small, but the great majority are above 35 mm. in diameter. One specimen, although fragmental, is 470 mm. in length; this one also shows the approach of the "senescent characters"[1] that preceded the extinction of the genus. From a comparison with other forms this large specimen must have been upwards of 1200 mm. in length when complete.

No specimens were found showing the minute initial coil characteristic of this genus.

Occurrences:

Baculites compressus has been reported from the Pierre Formation of the western geosyncline and from the Ripley of New Jersey. It is more characteristic of the upper or Bearpaw portion of the Pierre. However, it occurs in sufficient numbers in the Claggett to bar its use as a guide to the Bearpaw.

Baculites grandis Hall and Meek.

Baculites grandis.
J. Hall and F. B. Meek,--Memoirs of the American Academy of Arts and Sciences, New Series, Vol. V. (1854), page 402, plate 6, fig. 10; plate 7, fig. 1, 2; plate 8, fig. 1, 2.
F. B. Meek,-- U. S. Geol. Surv. Terr., Vol. IX. (1876), page 398, plate 33, fig. 1a, b, c.

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1. Note by Dr. C. H. Crickmay.

B. Wade,--U. S. Geol. Surv., Prof. Paper 137 (1926), page 182, plate 60, fig. 8, 12.

Description from Hall and Meek,--

"Shell elongate; section varying from ovate to subcordiform; surface of cast marked by very broad and strongly elevated undulations, which commence at the dorsum and pass obliquely downward, increasing rapidly in size, and, crossing the sides of the shell in a broad curve, terminate abruptly on the ventro-lateral region. Undulations less distinct toward the smaller extremity and finally become obsolete. Septa very deeply lobed, principal divisions scarcely divergent. Dorsal lobe three-fourths as long and twice as wide as the superior lateral lobe; terminated on each side by a narrow elongated branch which is irregularly sinuate and digitate at the extremity. Dorsal saddle shorter and wider than the superior lateral lobe, formed by four branches, the two terminal ones much the larger and each of them bifid at the extremity by a small sinus; the whole outline more or less sinuous and the extremities digitate. Superior lateral lobe longer by one-fifth than the inferior lateral lobe, narrower than the ventral saddle, divided at its extremity by a deep sinus into two equal parts, which are simply digitate; above these are two unequal branches on each side; terminal sinus much deeper than the lateral ones. Ventral saddle longer and about as wide as the dorsal saddle, more deeply divided at its extremity by the auxiliary lobe into two nearly equal branches, each of which is bifid and the extremities digitate, ventral side with three and dorsal side with two auxiliary branches. Inferior lateral lobe shorter and broader than the superior lateral lobe, divided at its extremity into two nearly equal branches, the one on the dorsal side bifid at the tip and the other digitate, with an auxiliary branch on the ventral side. Ventral lobe as long as the auxiliary lobe of the ventral saddle, but wider at the base, digitate at its extremity."

Unfortunately, this species is represented in the collection only by a number of rather small specimens, belying the name"grandis", but there are some huge specimens in the collection at Johns Hopkins University measuring over 5 feet in length.

According to Meek[1] the species is differentiated from B. ovatus, the form which it most nearly approaches, by its greater size and stronger and much more extended undulations which completely cross the lateral surface of the shell. These characters are not, of course, visible in the small specimens available to the writer but certain characters of the suture appear to be diagnostic. The lobes are much deeper and less divergent in their branches. In this species also, the two terminal branches of the superior lateral lobe are digitate, while in B. ovatus they are deeply bifid, with obtuse sinuosities.

Occurrences:

This species has not been widely reported from any locality but it appears to be of fairly large geographic range. It is found in the Ripley of Tennessee as well as in the Great Plains region. Here it occurs from the basal Pierre up into the Fox Hill sandstone.

Baculites, new species.

Plate III.

Fossil in the form of an internal cast. Elongated, of fairly large size and rather rapidly tapering compared with other Baculites. Cross section ovate, tapering toward the siphonal side. Surface of cast marked by broad, rounded,

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1. Hall and Meek,--Am. Acad. Arts and Sciences Memoir, New Series, Vol. V. (1854), page 402.

arcuate undulations, which commence at the dorsum and pass obliquely down and backward in a broad curve, terminating abruptly on the ventro-lateral region.

Septa not crowded, lobes and sinuses deep and divided into somewhat divergent, digitate branches. Siphonal lobe about as long as wide and provided with two terminal, more or less spreading branches, each of which has usually three, but sometimes two, nearly equal, digitate branchlets at the end, and two similar lateral ones on the other side. First lateral saddle two-thirds as wide as long, much narrower than the siphonal lobe, and divided at the anterior end into two nearly equal branches, each of which is subdivided into three or four spreading, digitate branchlets. First lateral lobe nearly twice as long as wide, and divided at its end into two, nearly equal parts, each with three spreading and digitate subdivisions. Second lateral saddle very similar in branches and subdivisions to the first and but a little larger in size. Second lateral lobe about as broad but shorter than the first, and bearing two large, equal, bipartite, digitate terminal branches, and small digitate and simple lateral branches. Third lateral saddle much smaller than either of the others, with two unequal, short,digitate terminal divisions, and a few short, irregular, smaller lateral branchlets. Dorsal or antisiphonal lobe very small, much longer than wide, with one or two small lateral branches, and a trifid extremity.

As there are but two incomplete specimens, exact

measurements cannot be obtained, but the larger specimen on hand has a greater diameter of 46 mm. and a lesser diameter of 36 mm. From the average taper of the cast the original shell must have been over 700 mm. in length when complete.

In cross section the specimen rather resembles the broad variety of B. ovatus figured by Meek[1], but it differs from that species in the well marked ridges on the shell and by the much more regular suture with its deeper lobes and saddles. Indeed the suture is much more deeply incised than any of those figured in the publications available to the author. The ornamentation resembles that of B. aquilaensis but it differs in the cross section and suture.

The smaller specimen shows that these sutural characters are distinct from soon after the larval condition. The lip of the living chamber is, apparently, like that of B. compressus.

The specimen does not resemble any Baculites even closely enough to be referred as a variety. Its closest relatives appear to be B. ovatus and B. compressus, being as much like one as the other. For these reasons the author feels justified in referring it to a new species.

To designate this species the writer wishes to propose the name Baculites crickmayi, for Dr. Colin H. Crickmay who first examined the collection.

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1. F. B. Meek,--U. S. Geol. Surv. Terr., Vol. IX.(1876), pl.20

Baculites sp. ?

There are afew fragments in the collection to which it is impossible to assign a positive determination. Among these is a portion of the living chamber of a Baculite with the rostrum somewhat similar in shape to that of B. ovatus Say. Because of this and also due to the probable shape of the cross section the writer has doubtfully assigned this specimen to some variety of "ovatus".

A number of other small Baculites were found, consisting of the living chambers only. These may possibly be referred to B. grandis or to the new species.

There are also, several with a cross section resembling that of B. compressus, but this may be due to distortion. However, they have been listed in the collection as B. compressus?.

Family: SCAPHITIDAE.

Genus Acanthoscaphites Nowak.

The genus Scaphites has, since 1912, been split up into a number of new genera. The reason for this was that the genus was composed of a large number of species of apparently differing ancestral groups. The genus Acanthoscaphites was first described by Nowak, and his description is paraphrased by Reeside,[1]--

> "Acanthoscaphites Nowak, founded on the species tridens Kner, includes shells that generally attain a large size for the group, with whorls somewhat higher than wide; ribs straight, with nodose thickening near the umbilicus, intercalated secondary ribs, and in the adults, lateral and ventral nodes; suture with long external lobe, long bifid first lateral lobe, and much shorter second lateral and auxiliary lobes; three internal saddles, decreasing regularly from the dorsal line to the line of involution; bifid lobes in the adult suture developed from trifid embryonic lobes; suture much incised."

There is but one species of Acanthoscaphites present in the collection.

Acanthoscaphites nodosus (Owen) var. brevis Meek.

Scaphites nodosus Owen var. brevis Meek.
F. B. Meek,--Smithsonian Check List of North American Cretaceous Fossils, page 24.
F. B. Meek,--U. S. Geol. Surv. Terr., Vol. IX. (1876), page 426, plate 25, fig. 1.

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1. J. B. Reeside, Jr.--U. S. Geol. Surv., Prof. Paper 150, page 26.

A. W. Grabau and H. W. Shimer,--North American Index Fossils, Vol. II. (1910), page 177, fig. 1428.

Description from Meek,--

"Shell longitudinally-oval, moderately convex; volutions generally higher than convex, inner ones forming a considerable portion of the entire bulk; deflected or body-portion moderately high, but short, or only becoming a little free at the aperture; periphery rounded throughout; umbilicus small; aperture oval-subquadrate, being higher than wide, and more or less sinuous on the inner side; surface ornamented by small, bifurcating costae, that are somewhat flexuous on the sides, but become even and nearly straight on the periphery; each side of body-portion also bearing near the periphery a row of rather prominent, subquadrangular nodes, and a few smaller ones along about one-third the height from the umbilicus.

Septa divided into rather deep lobes and sinuses; siphonal lobes longer than wide, nearly oblong in form, and provided on each side with two principal slender branches, the two terminal of which are parallel, longer than the others, and each divided into two unequal, sharply digitate branchlets, while the others are scarcely more than digitate; first lateral sinus almost as long and wide as the siphonal lobe, nearly oblong in form, and deeply divided into two unequal, variously sinuous and subdivided branchlets;.....Farther in there is a minute, simple projection, that probably represents the minute fourth lobe in some of the other varieties."

The writer has followed Reeside[1] in the generic naming of this species; a full explanation of the reasons for this is given in his paper.

There are two specimens of this species in the collection, one, the larger, is characteristic of the variety. It has lost the younger portion, leaving only a portion of the septate part and most of the living chamber. The other specimen is smaller and not characteristic.

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1. J. B. Reeside, Jr.--U. S. Geol. Surv., Prof. Paper 150 (1927), pages 21-40.

Occurrences:

All the varieties of nodosus are found only in the upper portion of the Pierre and hence form excellent guides to the Bearpaw shale.

Genus Rhaeboceras Meek.

Meek described the only species of this genus as Phylloceras? Halli, expressing a strong doubt regarding the generic name. His reasons for so doing are given in his volume on the fossils of the Western Plains.[1]

Dr. Crickmay, on examining the specimen expressed the opinion that the species was not Phylloceras, but entirely distinct. He believes that Rhaeboceras was a descendant of the Hoplitidae, but did not communicate his reasons.

Rhaeboceras halli Meek.[2]

Ammonites Halli.
F. B. Meek and F. V. Hayden,--Academy of Natural Sciences, Philadelphia, Proc., Vol. VIII. (1856), page 7; Vol. XII. (1860), page 420.
F. B. Meek,--Smithsonian Check List of North American Cretaceous Fossils (1864), page 24, fig. 64.

Phylloceras? Halli.
F. B. Meek,--U. S. Geol. Surv. Terr., Vol. IX. (1876), pages 458-462, plate 24, fig. 3a, b, c.

Description from Meek,--
"Shell attaining a rather large size, moderately compressed-discoidal; volutions with their convexity about equalling two-thirds their diameter from the ventral side to the rather narrowly rounded periphery, in young and medium-sized examples, each embracing nearly the entire breadth of the next within, but the last one in the adult becoming proportionally less deeply embracing; umbilicus very narrow, and rather deep in the young, but proportionally wider

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1. F. B. Meek,--U. S. Geol. Surv. Terr., Vol. IX. (1876), page 458-462.
2. Specimen determined by Dr. C. H. Crickmay.

> in the adult; surface ornamented with numerous small, bifurcating, slightly flexuous costae, that are larger near the umbilical side, and on the last turn of medium and large sized specimens become proportionally somewhat more prominent, more curved, and suddenly bifurcate near the umbilicus, and again divide and subdivide into numerous smaller ones, so that their number, including others intercalated between, amounts to from five to seven times as many where they pass straightly over the periphery, as near the umbilical side; body-chamber forming at least the entire outer volution."

Meek also goes into a detailed description of the septum which forms the basis for placing this species into a separate genus. While the general form and characters of the suture agree fairly well with Phylloceras, there are certain details in which they differ from that genus. The first lateral lobe, as compared with the siphonal lobe, is proportionately smaller and is more nearly bipartite.

The outer volution is apparently deflected from the regular curve, making it much less deeply embracing than the inner,--

> ".....the umbilicus is consequently much larger proportionally in the adult than in the younger and medium-sized specimens."

Meek noted this but was unable to definitely state if it was a generic character or merely due to distortion. Fortunately the specimen in the Bearpaw collection was not distorted and, though much of the living chamber is missing, this departure can be noticed.

Occurrence:

> This species has been reported only once, and that occurrence is in the Pierre Formation.

Family: PLACENTICERATIDAE

Genus Placenticeras Meek.[1]

This genus includes species that attain large size, are discoidal, involute and compressed. The whorls are stout, higher than wide and with a venter flat in the younger stages, becoming concave and bordered by sharp ridges which subsequently become tuberculated. In old age the venter may again become flat, and even rounded. The surface is smooth or tuberculated.

The umbilicus is narrow in typical forms and the sculpture weak. There may be faint ribs in the very young, and usually none in the later stages. If they are present in the adult, they are low and obscure. The tubercles, when present, are rarely strong or numerous.

There are three prominent lateral lobes, and six or seven smaller lobes.

Specific determination is made on the basis of the shape of the cross section, the sculpture, and lastly, the suture.

Placenticeras meeki J. Boehm.

Placenticeras placenta (DeKay) (part).
F. B. Meek,--U. S. Geol. Surv. Terr., Vol. IX. (1876), pages 465-468, plate 24, fig. 2.
Geol. Surv. Canada--numerous reports on Western Great Plains.

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1. J. B. Reeside, Jr.--U. S. Geol. Surv., Prof. Paper 147 (1926), pages 1-5.

Placenticeras meeki J. Boehm.

J. Boehm,--Deutsche Geol. Gesell. Zeitsche., Vol. L. (1898), page 200 (footnote).

J. B. Reeside, Jr.--U. S. Geol. Surv., Prof. Paper 151 (1927), pages 29-30, plate 22, fig. 5-7; plates 23-24; plate 25, fig. 1-2.

Placenticeras whitfieldi Hyatt.

A. Hyatt,--U. S. Geol. Surv., Mon. 44 (1903), pages 221-232, plate 45, fig. 3-16; plate 46; plate 47, fig. 1-4.

A. W. Grabau and H. W. Shimer,--North American Index Fossils, Vol. II. (1910), page 218, fig. 1493-1494.

Description from Reeside,--

"Shell attaining very large size, as much as 600 millimeters in diameter; much compressed, discoidal. Whorls at early stage (diameter of 6 millimeters) acquire a form with high triangular cross section, flat flanks, and very narrow, concave venter bordered by continuous ridges. This form is retained throughout life except that the venter in middle age becomes flat and loses the bordering ridges and later still becomes narrowly rounded. Living chamber about half a volution in length; aperture with broad, shallow lateral lappets and small ventral crest. Umbilicus very narrow, about one-seventh the diameter; umbilical shoulder well rounded in the younger stages but abruptly rounded and with steep inner wall in the later stages.

Sculpture in the very young stages, under 10 millimeters in diameter, consists of fairly numerous faint sigmoid ribs. In the later stages the whorls are smooth except for sigmoid growth lines, obscure coarse lateral folds, and latent tubercles on the umbilical shoulders.

The suture has wide external lobe; narrow first lateral saddle; first to third lateral lobes long and pointed, and included saddles narrow, almost linear; length increasing to third lobe; remaining elements of the suture gradually smaller to the line of involution. Suture much incised, and with a shallow sigmoid curvature."

In some specimens, on being broken down, lines of tubercles may be seen on the young shell. These are always small and are usually absent on the larger volutions. Hyatt, in one place[1] regards them as merely individual reversions to

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1. A. Hyatt,--U. S. Geol. Surv., Mon. 44 (1903), page 190.

the primitive type, but in the specific description[1] refers them to a variety of "tuberculatum", stating them to be intermediate between this species and P. intercalare.

The species can be distinguished from P. placenta of the Atlantic Cretaceous by certain characters which, however, can only be observed by comparing the two species. The venter is narrower throughout life and becomes less completely rounded in the gerontic stage. This rounding also comes at a much larger size than in P. placenta. Tubercles are lacking in typical forms, but when present are small, while those of P. placenta are large and elongated, much coarser and less numerous. The suture also is more complex and sinuous than that of the eastern form.

Of the specimens preserved in the Bearpaw collection, the larger specimen, when complete, had a greater diameter of 365mm. and a width of 75mm.

Occurrence:
P. meeki is reported widely from the Pierre shale and equivalent formations of the Western Great Plains. It has not been reported above or below that formation from North America.

Placenticeras intercalare Meek.

Placenticeras placenta, var. intercalare.
F. B. Meek,--U. S. Geol. Surv. Terr., Vol. IX. (1876), pages 468-472, plate 23.
Geol. Surv. Canada--numerous reports on Wespern Great Plains.

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1. A. Hyatt,--U. S. Geol. Surv., Mon. 44 (1903), pages 221, 232.

Placenticeras intercalare Meek.

A. Hyatt,--U. S. Geol. Surv., Mon. 44 (1903), pages 207-211, plates 35-37; plate 38, fig. 1.

A. W. Grabau and H. W. Shimer,--North American Index Fossils, Vol. II. (1910), page 218, fig. 1495.

Description from Meek,--

> "Shell attaining a large size, lenticular in form; umbilicus small; volutions with greatest convexity near the inner side, about three-fourths the breadth of each inner turn embraced within the deep sinus at the umbilical side of the next succeeding outer one, all with sides converging, with slight convexity, from near the umbilical margin to the very narrowly-truncated and slightly concave periphery, which is bounded on each side by a row of small, laterally-compressed nodes, or slight prominences, alternately arranged with their longer diameters parallel to the direction of the peripheral curve; aperture compressed-sagittate; outline of lip unknown; surface showing obscure sigmoid lines of growth, with a row of very small nodes or tubercles, about one-third of the way across from the peripheral margin, and another of somewhat larger ones, near the umbilicus, on each side, those of the former series numbering about two to each one of the latter."

This form is represented by several fairly well preserved specimens in the collection and is generally found in connection with P. meeki. It is a characteristic form and is fairly readily distinguished from P. syrtale, to which it bears the closest resemblence, by the smaller umbilicus and the suture. The suture also closely resembles that of P. meeki.

In the younger stages the tubercles are indistinct or absent. This was seen on partly breaking down one of the mature specimens.

One of the larger specimens had, when complete, a greater diameter of 171 mm. and a width of 48 mm., and is a larger specimen than that reported by Meek, and even this was not complete; the living chamber was largely absent.

Occurrences:

This form has been reported only from the Pierre shale and its equivalents in the Western Great Plains region of North America. One or two specimens are reported from the Upper Cretaceous of Texas.

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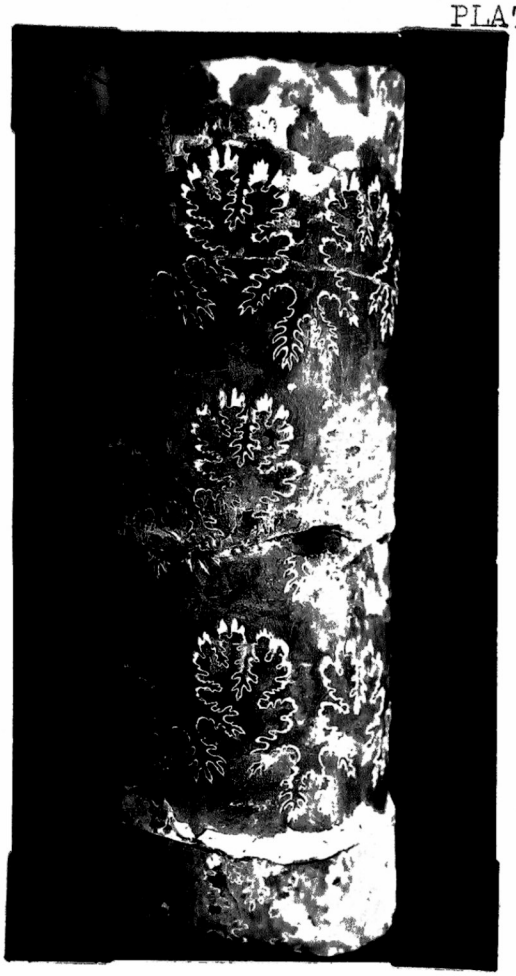
PLATE III.

Baculites new species.

1. Side view of specimen.
2. Cross section at larger end.
3. Cross section at smaller end.
4. View of anti-siphonal side of cast.

All views approximately natural size.

PLATE III.



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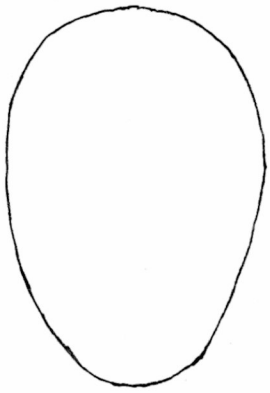

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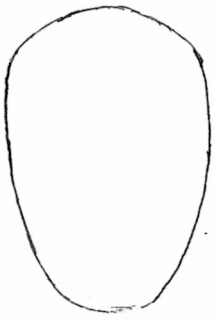

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