CANADA
DEPARTMENT OF MINES
HON. W. A. GORDON, MINISTER; CHARLES CAMSELL, DEPUTY MINISTER

BUREAU OF ECONOMIC GEOLOGY
GEOLOGICAL SURVEY

MEMOIR 182

A Preliminary Contribution to the Floras of the Whitemud and Ravenscrag Formations

BY
E. W. Berry

OTTAWA
J. O. PATENAUDE, I.S.O.
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1935

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ERRATA

Page 5. For Grewiposis *read* ***Grewiopsis.***
Page 45. For Zizyphys serrulatus Ward, etc. *read* ***Zizyphus.***
Page 50. For Plaiurus colombi *read* ***Paliurus.***

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A Preliminary Contribution to the Floras of the Whitemud and Ravenscrag Formations

INTRODUCTION

The present report discusses, in as much detail as the evidence warrants, the fossil plants thus far collected in the Whitemud and Ravenscrag formations of southern Saskatchewan. It is only fair to call attention to several considerations that render this contribution in the nature of a report of progress toward an ideal that is still many years in the future. These considerations are: (1) The rather poor preservation of much of the material that renders satisfactory identifications often hazardous and sometimes impossible. This is especially true in dealing with fragmentary remains with variable and similar marginal features, and I am not at all sure that I have not been guilty of confusing fragments of such genera as Trochodendroides, Grewiopsis, Celastrus, and Euonymus, but I have tried to indicate these uncertainties in the systematic chapter. (2) Far more of an obstacle to the correct understanding of these floras, either from the botanical or the stratigraphic point of view, is the fact that, although an extensive flora has been recorded from horizons approximately the same as those of the present contribution, the pioneer workers—Dawson, Lesquereux, Newberry, Ward, and Penhallow—had very vague ideas regarding the stratigraphy, and failed almost entirely to take into account the natural variability of foliar remains of plants, so that much of their work consisted in matching fossils with pictures of other fossils. There resulted a very great over multiplication of species, and a geographic and geologic range that covered a vast area and extended with no serious attempt at differentiation from what we now know to have been late Upper Cretaceous to more than half-way through the Eocene.

It is frequently difficult to evaluate their species, and it is usually wholly impossible to know even the approximate horizon within, for example, such a vague unit as the Fort Union. Consequently, the citations from the literature here given cannot be considered wholly trustworthy, nor can a satisfactory succession of floras be set forth at the present time in a manner comparable, for example, with what can be done in the Atlantic Coastal Plain region.

The present report does not remedy these difficulties, but it is, I believe, a step in the direction toward greater precision—both botanical and stratigraphic—and is all that can be hoped for until a complete revision of the so-called Laramie, Lance, and Fort Union floras of the United States shall have been made, and which will afford a rational basis of comparison for the development of these floras northward through western Canada.

This confusion and lack of chronologic differentiation referred to has been obvious to the palæobotanists of the present generation for years, and it has been clearly recognized that nothing short of an exhaustive restudy of the whole problem would yield results of permanent value. Such a study is a work of years, and naturally all studies of parts of this larger problem cannot be delayed until that happy time shall arrive.

STRATIGRAPHY OF SOUTHERN SASKATCHEWAN

The late Cretaceous and early Tertiary deposits of southernmost Saskatchewan are described in "Geology of Southern Saskatchewan."[1] They include the following stratigraphic units:

Ravenscrag { Upper Ravenscrag, including Willowbunch member
Lower Ravenscrag
Whitemud
Eastend
Bearpaw

Only the upper part of the Bearpaw formation is exposed. It consists of dark shale, with some sandy lenses, and contains marine fossils of late Cretaceous age. The Eastend formation includes beds transitional from the marine Bearpaw below to the non-marine Whitemud formation above and consists of 20 to 100 feet of yellowish to yellowish green, very fine to superfine, sands, some dark shales and flat ironstone concretions. In the Willows and other areas the sands and shales of Sand E lie between the Eastend and Whitemud, but may be only a phase of the latter.

The Whitemud conformably overlies the Eastend, in most places, and consists of refractory, semi-refractory, and non-refractory sandy clays, sands, clays, and shales. It contains much plant material and a well-defined flora. It is non-marine and of late Cretaceous age. In places there is a pronounced erosional unconformity between the Whitemud and Ravenscrag.

The Ravenscrag can be divided into Lower and Upper Ravenscrag. The Lower Ravenscrag consists of 20 to 190 feet of grey, greenish grey, and yellowish sands and silts and dark shales. It contains the last or *Triceratops* dinosaur fauna and a small flora, the Lower Ravenscrag flora, and is non-marine. It is of latest Cretaceous age. The Upper Ravenscrag, also non-marine, differs from the Lower in containing coal seams, lacking dinosaur remains, and possessing floras different from that of the Lower Ravenscrag. It is of Paleocene age, presumably.

Over much of southern Saskatchewan, at least from Cypress hills to Willows and to Big Muddy valley, the Upper Ravenscrag consists of:

Beds of the buff facies
Willowbunch member
Beds of the buff facies
Beds of the grey facies

Beds of the grey facies include grey, greenish grey, and yellowish sands and silts and dark shales. The buff facies includes mostly yellowish or buff, very fine sands and silts and dark shales. The Willowbunch member includes refractory and semi-refractory sandy clays and clays

[1] Geol. Surv., Canada, Mem. No. 176 (in press).

and resembles the Whitemud formation. Plant remains are common and there are two well-defined floras in the Upper Ravenscrag. The Middle Ravenscrag flora occurs in the grey facies and lower part of the buff facies. The Upper Ravenscrag flora has been found in the higher part of the buff facies just above and below the Willowbunch member.

Thus there are three Ravenscrag floras. The Lower Ravenscrag flora occurs in the Lower Ravenscrag beds. The Middle Ravenscrag flora occurs in the lower part of the Upper Ravenscrag beds and the Upper Ravenscrag flora in the upper part.

WHITEMUD FLORA

The flora found in the Whitemud formation comprises the following species:

Ampelopsis montanensis (?)
Equisetum sp.
Euonymus xantholithensis (?)
Ficus martini (?)
Ficus speciossima canadensis
Fucus lignitum
Ginkgo adiantoides
Grewia crenata
Hicoria antiquorum (?)
Leguminosites arachioides minor
Menispermites belli
Nelumbo dawsoni
Nelumbo tenuifolia
Nelumbites striata
Palmocarpon sp.
Pistia corrugata
Platanus guillelmae heerii
Sequoia nordenskiöldii
Smilax (?) *inquirenda*
Thuja interrupta
Trapa (?) *microphylla*
Viburnum antiquum
Viburnum marginatum
Viburnum sp.
Vitis dakotana
Zizyphus coloradensis

Of these 26 nominal species, 3 are indentified as to genus only; 4—*Ampelopsis montanensis, Euonymus xantholithensis, Ficus martini,* and *Hicoria antiquorum*—are doubtful determinations; and 1—*Fucus lignitum*—is without botanical significance. Only the following are confined to the Whitemud: *Equisetum* sp., *Ficus speciossima canadensis, Nelumbites striata,* and *Palmocarpon* sp.

Fourteen of the 26 forms recognized in the Whitemud have not been found in the Ravenscrag. These are:

Ampelopsis montanensis (?)
Equisetum sp.
Ficus martini (?)
Ficus speciossima canadensis
Fucus lignitum
Menispermites belli
Nelumbo dawsoni
Nelumbo tenuifolia
Nelumbites striata
Palmocarpon sp.
Pistia corrugata
Smilax (?) *inquirenda*
Viburnum marginatum
Vitis dakotana

Of these the 4 named in the preceding paragraph as confined to the Whitemud have obviously not yet been found in other regions. Of the remaining 10 species, *Fucus lignitum, Nelumbo dawsoni, Pistia corrugata,* and *Smilax* (?) *inquirenda* are confined to the Cretaceous; *Menispermites belli* and *Nelumbo tenuifolia,* although present in the Cretaceous (Laramie, Mesaverde), extend into the Denver or Raton; *Vitis dakotana* occurs in the lower Lance; *Ficus martini* and *Viburnum marginatum* occur in the Denver, and the second is also found in the Lance. Only a single form—*Ampelopsis montanensis*—and that not positively identified in the Whitemud, occurs elsewhere at a horizon as late as the Fort Union.

It is thus apparent that, despite the loose conception of most of the late Cretaceous and early Eocene species of the western interior of North America, and the uncritical determinations that have frequently been

made, the recorded forms from the Whitemud are consistent among themselves and with the published records of other areas in indicating a late Upper Cretaceous horizon, in a general way to be correlated with the Laramie, in the restricted modern sense of that term.

LOWER RAVENSCRAG FLORA

The Lower Ravenscrag is considered by the field geologists as representing the Triceratops zone, and is, therefore, supposed to be the equivalent of what is commonly called the Lance formation. Whether the stratigraphic divisions established in southern Saskatchewan are the same as those of the Lance and Fort Union formations south of the International Boundary cannot be determined from the evidence available at the present time.

Four plant-bearing outcrops in this region were tentatively considered to be Lower Ravenscrag. These are Localities 34, P-1-30, P-3-30, and P-12-30. Every one of the plants identified from these four localities occur in the Middle or Upper Ravenscrag floras except *Cornus fosteri*, *Platanus guillelmae*, *Populus daphnogenoides*, *Quercus* sp., and *Prunus mclearni*. Of these the last is new and has no known outside distribution; the *Platanus* and *Quercus* are rather uncertain entities and lack any particular significance; *Cornus fosteri* is known elsewhere from only the Fort Union; and *Populus daphnogenoides* is known from the Lance and Fort Union. The two species of *Taxodium* are otherwise unknown from floras earlier than the Middle Ravenscrag and are common in later floras. *Paranymphaea crassifolia* appears to be characteristic of the Middle Ravenscrag flora and occurs in association at Locality P-1-30 with the only forms from any of these four localities that have been found in beds of undoubted Lower Ravenscrag age. These are *Euonymus xantholithensis* and *Viburnum asperum*, and both of these are not certainly identified. I, therefore, conclude that these four localities should be referred to the age of the Middle Ravenscrag flora and the beds are not Lower but Upper Ravenscrag.

This leaves only a single plant bearing locality of Lower Ravenscrag age, namely Locality 3. This locality has furnished the following species:

Aralia notata
Euonymus xantholithensis (?)
Ficus ceratops
Fraxinus leii
Ginkgo adiantoides
Juglans rugosa
Pterospermites penhallowi
Rhamnus cleburni
Viburnum asperum (?)

There are only 2 of these 9 species that do not range up into the Upper Ravenscrag. These are *Ficus ceratops* and *Rhamnus cleburni*. The former is very conclusive as to identity and is highly characteristic of the Lance formation—to which it is confined. The latter is a Raton and Denver species, not known from later horizons. I consider the presence of these two species as sufficient evidence that the Lower Ravenscrag is of Lance age. The Euonymus and Viburnum are not positively identified and, therefore, lack significance in correlation. All of the others, except those already named, and the Pterospermites, which is new, occur in the Lance formation, although they are not confined to that horizon.

MIDDLE RAVENSCRAG FLORA

The field geologists do not recognize a stratigraphic unit corresponding to the Middle Ravenscrag flora (*See* note on Stratigraphy). What is here called the Middle Ravenscrag flora occurs in beds of the grey facies and lower part of the buff facies which are intermediate in stratigraphic position and floral facies from the Lower Ravenscrag flora below and the Upper Ravenscrag flora above, and which are stratigraphically included in the Upper Ravenscrag.

The following 47 species have been identified from outcrops, the majority of which have been referred to the Middle Ravenscrag flora with a considerable degree of confidence:

Aralia triloba (?)
Celastrus ferrugineus
Celastrus taurinensis
Cornus fosteri (?)
Dennstaedtia americana
Euonymus xantholithensis
Ficus denveriana
Ficus subtruncata (?)
Fraxinus leii
Glyptostrobus europaeus (?)
Grewiopsis mclearni
Hicoria antiquorum
Juglans nigella
Juglans rugosa
Leguminosites arachioides minor
Myrciophyllum americanum
Onoclea sensibilis fossilis
Paliurus colombi
Paliurus pulcherrimus
Paranymphaea crassifolia
Platanus guillelmae
Platanus guillelmae heerii
Platanus sp.
Prunus mclearni
Pterospermites minor
Quercus praegroenlandica
Quercus sp.
Rhamnus sp.
Saccoloma sp.
Sapindus affinis
Sapindus grandifoliolus
Sequoia nordenskiöldii
Spirodela scutata
Taxodium dubium
Taxodium occidentale
Thuja interrupta
Trapa (?) *microphylla*
Trochodendroides cuneata
Ulmus wardii (?)
Viburnum antiquum
Viburnum antiquum trinervum
Viburnum asperum
Viburnum castrae
Viburnum marginatum ravenscragensis
Xantholithes propheticus
Zizyphus coloradensis
Zizyphus serrulatus

Of these the only ones that are confined to the Middle Ravenscrag flora are the following new forms: *Grewiposis mclearni*, *Myrciophyllum americanum*, *Prunus mclearni*, *Viburnum antiquum trinervum*, and *Quercus praegroenlandica*.

There are a number of additional species described originally from other regions, which have thus far been found in only the Middle Ravenscrag flora of the Saskatchewan region. These are:

Aralia triloba (?)
Celastrus ferrugineus
Cornus fosteri (?)
Dennstaedtia americana
Ficus subtruncata (?)
Leguminosites arachioides minor
Paliurus pulcherrimus
Paranymphaea crassifolia
Platanus sp.
Pterospermites minor
Quercus praegroenlandica
Quercus sp.
Rhamnus sp.
Saccoloma sp.
Sapindus affinis
Ulmus wardii (?)
Viburnum castrae
Xantholithes propheticus
Zizyphus serrulatus

Doubtless a considerable number of these will turn up eventually at other horizons in the Ravenscrag when its flora is more fully exploited, since they have a wider chronologic range outside of this area. On the other hand, such further collecting will doubtless disclose additional forms peculiar to this horizon. *Paranymphaea crassifolia* is especially common, as well as an exceedingly well-marked type, and may be considered as characteristic of the Middle Ravenscrag flora.

The following four species are common to the Middle Ravenscrag and Lower Ravenscrag floras: *Euonymus xantholithensis, Fraxinus leii, Juglans rugosa,* and *Viburnum asperum.* Of these the first and last are doubtfully determined, and all four are recorded from the Upper Ravenscrag flora, so that they lack stratigraphic significance. The number of known species that are common to the Lower and Middle Ravenscrag floras is conditioned by the limited flora known from the Lower Ravenscrag. This is partly indicated by the fact that the following five species found in the Middle Ravenscrag are common to the Whitemud but have not been discovered in the Lower Ravenscrag: *Platanus guillelmae heerii, Sequoia nordenskiöldii, Thuja interrupta,* and *Viburnum antiquum.*

Twenty-one of the 47 species recorded in the Middle Ravenscrag flora are also in the Upper Ravenscrag flora. Four of these have already been named as common to the Lower Ravenscrag and can, therefore, be considered as lacking any precise stratigraphic significance.

The Middle Ravenscrag flora as a whole contains one species—*Trapa* (?) *microphylla*—which appears in the geologic record as early as the Montana Upper Cretaceous, and a second that makes its appearance in the Edmonton formation. Eighteen species are common to the Paskapoo formation, which is a relatively large proportion when account is taken of the lack of collecting and study of the Paskapoo plants. Seven of the Middle Ravenscrag species are recorded from the Denver formation, 8 from the Raton formation, 24 from the Lance formation, and 30 from the Fort Union formation.

The relatively small number of species common to the Raton and Denver formations and the predominance of Fort Union species affords some indication that the Middle Ravenscrag flora is of post Lance age. This conclusion is partly vitiated, however, by the fact that the student has available for comparison a large well-described Fort Union flora and very little except lists of species, many of which are not critically determined, from the Lance formation. What weight should be given to these considerations it is impossible to say at the present time.

UPPER RAVENSCRAG FLORA

What is here termed the Upper Ravenscrag flora occurs in beds of the buff facies stratigraphically above those containing the Middle Ravenscrag flora of the present report.

The known Upper Ravenscrag flora is somewhat smaller than the Middle Ravenscrag flora and only about half as many localities are represented. It comprises 38 species as compared with 47 species from the latter. These are:

Alnus grewiopsis (?)
Aralia notata
Celastrus taurinensis
Cornus impressa
Cornus newberryi
Euonymus xantholithensis (?)
Ficus denveriana
Fraxinus leii
Ginkgo adiantoides
Glyptostrobus europaeus (?)
Grewia crenata
Juglans nigella
Juglans rugosa
Laurophyllum ripleyensis
Leguminosites sp. (pod)
Magnolia pulchra
Onoclea sensibilis fossilis
Paliurus colombi
Planera microphylla (?)
Platanus basilobata
Platanus guillelmae heerii
Protophyllum canadensis
Pterospermites penhallowi
Quercus bicornis (?)
Quercus groenlandica (?)
Sapindus grandifoliolus
Sequoia nordenskiöldii
Sparganium stygium
Spirodela scutata
Taxodium dubium
Taxodium occidentale
Thuja interrupta
Trapa (?) *microphylla*
Trochodendroides cuneata
Viburnum antiquum
Viburnum asperum
Viburnum marginatum ravenscragensis
Viburnum sp.

The only species of the foregoing list that are peculiar to the Upper Ravenscrag are *Leguminosites* sp., *Pterospermites penhallowi*, and *Viburnum* sp. In so far as comparisons are limited to the Ravenscrag of this region the following additional species are confined to Upper Ravenscrag flora:

Alnus grewiopsis (?)
Cornus impressa
Cornus newberryi
Grewia crenata
Laurophyllum ripleyensis
Magnolia pulchra
Planera microphylla (?)
Platanus basilobata
Protophyllum canadensis
Quercus bicornis (?)
Quercus groenlandica (?)
Sparganium stygium

These all have an extended outside distribution. Six of the Upper Ravenscrag species are common to the Lower Ravenscrag, and two of these—*Aralia notata* and *Ginkgo adiantoides*—have not yet been discovered in the Middle Ravenscrag. There are 21 species in the Upper Ravenscrag that are common to the Middle Ravenscrag flora.

Two of the species of the Upper Ravenscrag flora appear in the geologic record as early as the Belly River formation. These are the long ranging *Ginkgo adiantoides* and *Trapa* (?) *microphylla*. Three are common to the Laramie and two of these and an additional species have been found in the little known flora of the Edmonton formation, but strangely enough none of the Upper Ravenscrag forms has been detected in the Whitemud of this region. Five species are common to the Raton and Denver formations, 20 to the Lance, 17 to the Paskapoo, and 24 to the Fort Union.

Indecisive as these figures are, they are consistent in showing a slightly younger facies than the corresponding statistics of distribution for the Middle Ravenscrag flora. It seems clear that the Upper Ravenscrag flora is of post Lance age, and is to be correlated with those of the Paskapoo and Fort Union formations.

BOTANICAL CHARACTER OF THE FOSSIL FLORA

The number of species known from the Whitemud (26) is so limited that it affords but slight basis for comment, although it is interesting to note that it contains the only representative of the palm family (Palmocarpon) known from the region, as well as several aquatic plants (Pistia, Nelumbo, Nelumbites) which have not been found in the Ravenscrag. The Whitemud has furnished no traces of Taxodium, and Ginkgo is abundant. That these features have any general significance and are not purely local cannot be proved.

The Ravenscrag flora described in the present contribution comprises 67 species, very few of which are new. It includes the following 4 species whose botanical affinities cannot be determined: *Trapa* (?) *microphylla*, *Populus daphnogenoides*, *Leguminosites arachioides minor*, and *Xantholithes propheticus*. The remaining 63 species represent 39 genera in 27 families and 19 orders.

No Bryophyta, Lepidophyta, or Arthrophyta are represented, although aerial stems of an Equisetum were encountered in the Ravenscrag of Cypress Hills area, and the absence of these phyla in the present collections must be attributed entirely to accidents of preservation and discovery.

The ferns (Pteridophyta) are very sparingly represented by three forms in three genera, and the only one of these that is at all common is the rather coarse species of Onoclea, which is not very different from our common existing temperate species *Onoclea sensibilis*. It was, however, probably a mistake of judgment on the part of Newberry to describe the fossil as merely a variety of this living species.

Ginkgo continues throughout the Ravenscrag, as indeed it does throughout the Tertiary, and the fossil species was apparently not at all different from the existing species. It should perhaps be emphasized that it was a strictly temperate type, in the past as in the present.

There are five nominal species of conifers in the Ravenscrag, supposed to represent the genera Sequoia, Taxodium, Glyptostrobus, and Thuja. There are no traces of the Abietineae. The Sequoia and Taxodium certainly represent those genera, which were Holarctic in their distribution during the early Tertiary, so that no considerations derived from their present day restricted distribution are valid in attempting to interpret the environment in southern Saskatchewan at the dawn of the Tertiary. The use of the generic term Glyptostrobus follows custom and has not, in my opinion, any botanical significance. Until its true relationship is determined, and this may be expected within a few years, I can see no advantage in renaming it generically. The Thuja might represent the genus Libocedrus, as some authors have supposed, but I think not, and here again I can see no advantage in disguising its stratigraphic significance by giving it a new and non-committal generic name.

As in all latest Cretaceous and post-Mesozoic floras, the bulk of the plants in the Ravenscrag, both as individuals and species, are angiosperms. The bulk of these in the present collections are the leaves of dicotyledonous plants, there being but two monocotyledons represented—a Sparganium

and a Spirodela. A sparing representation of monocotyledons is also the usual situation in fossil angiospermous floras, and is due to their actual minority representation, but more largely to their lack of facilities for successful preservation as fossils. Practically all of the temperate zone monocotyledons are relatively delicate herbaceous plants. These may be individually abundant, as are the grasses, rushes, and sedges, but their chances of fossilization as compared with the leaves of the deciduous trees are slight indeed.

The dicotyledons in the Ravenscrag number 56 species, some of which are satisfactory species, and some are merely nominal as set forth in the systematic chapter. Forty-nine of these belong to the Choripetalous orders, and only 7 to the Gamopetalae, and all of the latter with the exception of a single species of ash *(Fraxinus leii)* are leaves of Viburnum, and are probably over differentiated.

The two largest orders are the Urticales and the Rubiales, with 6 species each: followed in relative representation by the Fagales, Sapindales, and Umbellales each with 5 species: the Platanales, Rhamnales, and Malvales each with 4 species: and the Juglandales and Ranales each with 3 species. The largest families are the Caprifoliaceae (6 nominal species); the Fagaceae, Platanaceae, and Rhamnaceae each with 4 species; and the Juglandaceae, Moraceae, Celastraceae, and Cornaceae, each with 3 species. The largest genus is Viburnum with 6 nominal species; Platanus and Quercus, each with 4 nominal species; and Ficus and Cornus each have 3 species.

The most abundant forms individually are the leaves of Trochodendroides, Celastrus, and Viburnum. As a whole the Ravenscrag flora is a temperate hardwood forest assemblage with some glade or forest border plants such as Onoclea, perhaps Ginkgo and Thuja, alder bushes, Prunus, bittersweet (Celastrus), and Viburnum bushes. There are some few aquatics or stream bank and pond border plants such as Sparganium, Paranymphaea, Spirodela, Trapa (?), and Taxodium.

The flora as a whole is too incomplete, and much of it not sufficiently precise in its relationships to afford a basis for satisfactory ecologic conclusions. It is a part of the Holarctic flora which became widely distributed in the closing days of the Upper Cretaceous and during the time interval that intervened in many parts of the world between the Cretaceous and the Tertiary, an interval that was apparently lacking in southern Saskatchewan, as well as in most of the high plains region of the United States.

This flora was strictly temperate in character despite the presence of Figs, in some cases palms (although none is known from the Ravenscrag formation), and leaves that have been compared with southern types such as Grewia and Pterospermum. These early Tertiary, or Paleocene, floras as some students prefer to call them, are usually supposed to have been of northern origin. They are certainly replaced in lower latitudes by floras of a warmer climate, and during the Middle and Upper Eocene, the latter spread northward for considerable distances.

DISTRIBUTION

A total of 67 species are recorded from the Ravenscrag beds. The details of their distribution both within and outside this area are given in the accompanying table of distribution, and hence require no extended comment. In a brief paper[1] published in 1930 the writer discussed the Ravenscrag plants collected by Dr. M. Y. Williams in Cypress Hills region. These included the following which have not been detected in the present collections, and not included in the present paper:

Equisetum sp. (aerial stem fragments)
Ginkgo stones (?)
Cercocarpus ravenscragensis
Leguminosites williamsi
Rhamnites knowltoni
Paliurus (?) fruits
Apeiobopsis discolor
Phyllites aquaticus

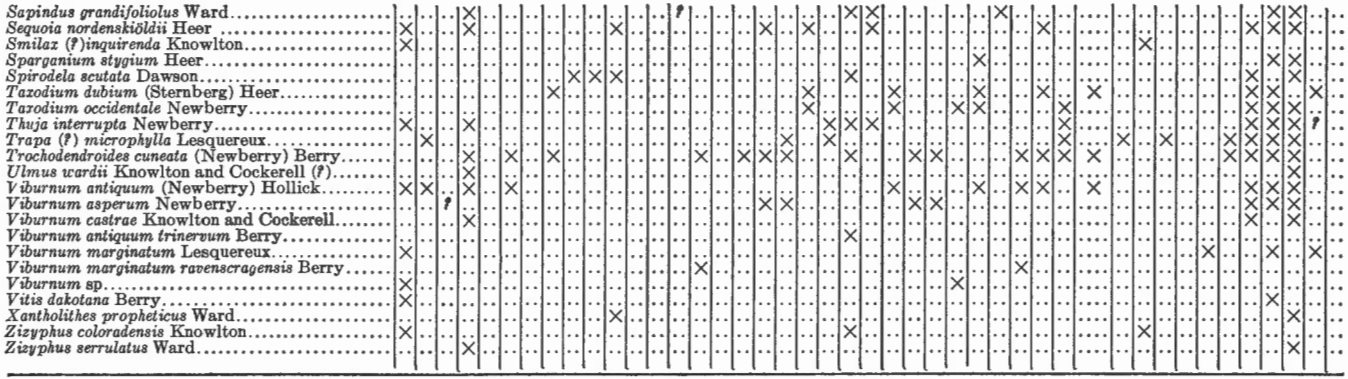
Altogether about 75 species are known from the Ravenscrag. When this number is compared with the 123 species recorded from the Lance formation or the 258 species described from the Fort Union formation, it seems clear that only a beginning has been made in the study of the Ravenscrag flora, and this conclusion is not seriously altered even though it be true that there has been an excessive duplication of species by students of the Fort Union flora.

Twenty-five of the Ravenscrag species have been recorded from the Paskapoo formation, comprising one-third of the known Ravenscrag species and about 29 per cent of the known Paskapoo species. This would indicate that the Ravenscrag and Paskapoo were of approximately the same age, although their lower and upper limits need not, and probably do not, exactly coincide.

[1]Berry, Edward W.: Nat. Mus., Canada, Bull. 63, pp. 15-28, Pls. 5, 6 (1930).

	White-mud		Ravenscrag																																								
			Lower flora	Middle Flora																			Upper Flora																				
	Loc. 7 (=30)	Loc. 3258 (P-5-30)	Loc. 3	Loc. 2	Loc. 4	Loc. 5	Loc. 6	Loc. 9 (29-229)	Loc. 10	Loc. 11=2624	Loc. 13	Loc. 17	Loc. 21	Loc. 24	Loc. 34	Loc. 36	Loc. 37	Loc. 38	P-1-30	P-3-30	P-4-30	P-10-30	P-12-30	Loc. 1	Loc. 23	Loc. 27	Loc. 31	Loc. 32	Loc. 33	Loc. 35	Loc. P-6-30	Loc. P-11-30 (=P-2-30)	Previously recorded from Ravenscrag	Mesaverde	Laramie	Belly and Judith River	Raton	Denver and Dawson	Edmonton	Paskapoo	Lance	Fort Union	Arctic Eocene	Ripley
Alnus brewiopsis Ward (?)																												X							X									
Ampelopsis montanensis Cockerell (?)	X																																									X		
Aralia notata Lesquereux			X																					X				X		X								X		X	X	X		
Aralia triloba Newberry (?)														X																												X		
Celastrus ferrugineous Ward														X						?	X												X				X				X	X		
Celastrus taurinensis Ward						X																	X						X												X	X		
Celastrus sp.																																												
Cornus fosteri Ward (?)																			X																							X		
Cornus impressa Lesquereux																								X								X						X						
Cornus newberryi Hollick																													X											X	X	X		
Dennstaedtia americana Knowlton												X																												X		X		
Equisetum sp.	X																																											
Euonymus xantholithensis Ward		X	?	X						?							X		X				X																			X		
Ficus ceratops Knowlton			X																																						X			
Ficus denveriana Cockerell							X														X			X				X							?		X	X			X			
Ficus martini Knowlton (?)	X																																					X						
Ficus speciossima canadensis Berry		X																																					?					
Ficus subtruncata Lesquereux (?)														X																								X						
Fraxinus leii Berry			X												X														X												X			
Fucus lignitum Lesquereux		X																																X										
Ginkgo adiantoides (Unger) Heer	X		X																									X					X	X		X			X	X	X	X	X	
Glyptostrobus europaeus (Brongniart) Heer (?)						?										?								?																X	X	X	X	
Grewia crenata authors		X																										X														X		
Grewiopsis mclearni Berry							X								X		X																											
Hicoria antiquorum (Newberry) Knowlton (?)	X														X						X																							
Juglans nigella Heer																				X																								
Juglans rugosa Lesquereux			X								X																																	
Laurophyllum ripleyensis Berry																													X															X
Leguminosites arachioides minor Berry	X					X									X																							X		?				
Leguminosites sp.																										X																		

	White-mud		Ravenscrag																																								
			Lower flora	Middle Flora																				Upper Flora																			
	Loc. 7 (=30)	Loc. 3258 (P-5-30)	Loc. 3	Loc. 2	Loc. 4	Loc. 5	Loc. 6	Loc. 9 (29-229)	Loc. 10	Loc. 11=2624	Loc. 13	Loc. 17	Loc. 21	Loc. 24	Loc. 34	Loc. 36	Loc. 37	Loc. 38	P-1-30	P-3-30	P-4-30	P-10-30	P-12-30	Loc. 1	Loc. 23	Loc. 27	Loc. 31	Loc. 32	Loc. 33	Loc. 35	Loc. P-6-30	Loc. P-11-30 (=P-2-30)	Previously recorded from Ravenscrag	Mesaverde	Laramie	Belly and Judith River	Raton	Denver and Dawson	Edmonton	Paskapoo	Lance	Fort Union	Arctic Eocene	Ripley
Magnolia pulchra Ward																												×						×										
Menispermites belli Berry	×																																	×				×						
Myrciophyllum americanum Berry																						×																						
Nelumbo dawsoni Hollick	×	×																																×		×								
Nelumbo tenuifolia (Lesquereux) Knowlton		×																																	×		×	×						
Nelumbites striata Berry	×	×																																										
Onoclea sensibilis fossilis Newberry				×						×		×										×			×	×												×		×	×	×		
Paliurus colombi authors				×																		×	×																		×	×	×	
Paliurus pulcherrimus Ward								×																																	×	×		
Palmocarpon sp	×																																					?		?				
Paranymphaea crassifolia (Newberry) Berry					×	×			×	×	×		×						×		×												×							×	×	×		
Pistia corrugata Lesquereux	×																																	×		×								
Planera microphylla Newberry (?)																										×																×		
Platanus basilobata Ward																																×								×		×		
Platanus guillelmae authors																				×																	×	×			×	×		
Platanus guillelmae heerii Knowlton	?														×													×									×				×			
Platanus sp						×	×								×													×									?			×				
Populus daphnogenoides Ward																							×																	×	×	×		
Protophyllum canadensis Berry																												×												×				
Prunus mclearni Berry																			×																									
Pterospermites minor Ward						×																																			×	×		
Pterospermites penhallowi Berry			×																					×				×		×														
Quercus bicornis Ward (?)																												×														×		
Quercus groenlandica Heer (?)																												×	×														×	
Quercus praegroenlandica Berry																					×																							
Quercus sp																				×																								
Rhamnus cleburni Lesquereux			×																																		×	×						
Rhamnus sp														×																														
Saccoloma sp						×																																?						
Sapindus affinis Newberry																						×															×				×	×		


Sapindus grandifoliolus Ward
Sequoia nordenskiöldii Heer
Smilax (?)inquirenda Knowlton
Sparganium stygium Heer
Spirodela scutata Dawson
Taxodium dubium (Sternberg) Heer
Taxodium occidentale Newberry
Thuja interrupta Newberry
Trapa (?) microphylla Lesquereux
Trochodendroides cuneata (Newberry) Berry
Ulmus wardii Knowlton and Cockerell (?)
Viburnum antiquum (Newberry) Hollick
Viburnum asperum Newberry
Viburnum castrae Knowlton and Cockerell
Viburnum antiquum trinervum Berry
Viburnum marginatum Lesquereux
Viburnum marginatum ravenscragensis Berry
Viburnum sp.
Vitis dakotana Berry
Xantholithes propheticus Ward
Zizyphus coloradensis Knowlton
Zizyphus serrulatus Ward

Explanation of Plant Localities[1]

Whitemud Flora

Locality—

7 (=30). From near the middle of the Whitemud formation, on the west side of Wood Mountain creek in NW. ¼ sec. 15, tp. 5, range 3, W. 3rd mer.

P–5–30. From Whitemud formation, on the north side of Big Muddy valley, in sec. 2, tp. 4, range 25, W. 2nd mer.

Lower Ravenscrag Flora

3. From Lower Ravenscrag of Morgan creek.

Middle Ravenscrag Flora

2. Grey facies, SE. sec. 3, tp. 5, range 1, W. 3rd mer.
4. Grey facies, SW. sec. 4, tp. 6, range 1, W. 3rd mer.
5. Base of Upper Ravenscrag formation, Morgan creek.
6. Base, buff facies, southeast of Pickthall.

9 (29–229). Base, grey facies, NE. sec. 8, tp. 6, range 1, W. 3rd mer.

10. Grey facies, NW. sec. 35, tp. 5, range 1, W. 3rd mer.

11 =2624. Grey facies, below Keogh seam, SW. sec. 35, tp. 1, range 22, W. 2nd mer.

13. Low in grey facies, NW. sec. 35, tp. 5, range 1, W. 3rd mer.
17. Lower part buff facies, about centre sec. 6, tp. 6, range 29, W. 2nd mer.
21. Grey facies, NW. sec. 4, tp. 6, range 1, W. 3rd mer.
24. Near top grey facies, southeast of Pickthall.
34. Base grey facies, NE. sec. 32, tp. 4, W. 3rd mer.
36. Lower part buff facies, SW. sec. 2, tp. 5, range 2, W. 3rd mer.
37. Grey facies, south arm of Big Muddy lake.
38. Buff facies, lower part?, NW. sec. 10, tp. 5, range 27, W. 2nd mer.

P–1–30. Sixty feet above Whitemud, SE. sec. 29, tp. 3, range 24, W. 2nd mer.

P–3–30. Above Whitemud, sec. 27, tp. 3, range 24, W. 2nd mer.

P–4–30. Top grey facies, over Keogh seam, sec. 4, tp. 2, range 22, W. 2nd mer.

P–10–30. Buff facies, lower part?, sec. 33, tp. 2, range 30, W. 2nd mer.

P–12–30. Just above Whitemud, NE. sec. 24, tp. 3, range 25, W. 2nd mer.

Upper Ravenscrag Flora

1. Above Willowbunch member, sec. 1, tp. 1, range 22, W. 2nd mer.
23. Top Willowbunch member, sec. 18, tp. 4, range 2, W. 3rd mer.
27. Just over Willowbunch member, near 23.
31. Above Willowbunch member, sec. 1, tp. 1, range 22, W. 2nd mer.
32. About base Willowbunch member, sec. 19, tp. 1, range 22, W. 2nd mer.
33. Above Willowbunch member, sec. 1, tp. 1, range 22, W. 2nd mer., near 31.
35. Above Willowbunch member, sec. 30, tp. 1, range 21, W. 2nd mer.

P–6–30. Base Willowbunch member, NW. sec. 5, tp. 4, range 26, W. 2nd mer.

P–11–30. Just over Willowbunch member, NE. sec. 13, tp. 3, range 24, W. 2nd mer.

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[1]Contributed by F. H. McLearn.

Order, EQUISETALES

Family, **Equisetaceae**

Genus, EQUISETUM Linné

Equisetum sp.

Plate I, figure 1

I have compared the present material with Equisetum remains recorded from the Paskapoo, Denver, Lance, and Fort Union formations and find it to be different. The material comprises stem fragments with broad, rather flat ribs, short internodes with a length of about twice the stem diameter, and teeth that are short and conical triangular in shape.

The species is probably new, but the scanty and fragmentary nature of the material is wholly inadequate for the erection or the proper characterization of a new species. It appears to be decidedly different from the Equisetum previously recorded[1] from the Ravenscrag at sec. 28, tp. 7, range 24, W. 3rd mer., which had long, slender internodes and long sheaths with long, slender, linear or lanceolate teeth.

A rhizome of Equisetum, correlated with *Equisetum arcticum* Heer of the Lance of Saskatchewan[2] is present in the Estevan formation at sec. 35, tp. 7, range 4, W. 4th mer.[3] This may, of course, represent the same botanical species as the aerial stems here.

The present form comes from the Whitemud at Locality 30.

Order, POLYPODIALES

Family, **Polypodiaceae**

Genus, SACCOLOMA Kaulfus

Saccoloma (?) sp.

Represented by a small fragment of a sterile pinnule from Locality 5.

In the recently published account of the Denver flora Knowlton[4] has been able to refer various forms described by Lesquereux as *Gymnogramma gardneri*, *Pteris erosa*, and *Pteris subsimplex* to the genera Saccoloma and Allantodiopsis. These have been recorded from the Vermejo, Raton, Denver, Clarno, and Fort Union formations, and similar remains occur in the Eocene of southeastern North America.

In the absence of specimens showing the character of the fructifications it is not possible to differentiate these genera with certainty. The present fragment appears, however, to be most similar to Saccoloma and is tentatively referred to that genus.

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[1]Berry, E. W.: Nat. Mus., Canada, Mem. 63, p. 17 (1930).
[2]Berry, E. W.: Can. Field-Nat., vol. 38, pp. 131–132, Fig. 1 (1924).
[3]Berry, E. W.: Nat. Mus., Canada, Mem. 63, p. 17 (1930).
[4]Knowlton, F. H.: U.S. Geol. Surv. Prof. Paper 155, pp. 24-27 (1930).

Genus, ONOCLEA Linné

Onoclea sensibilis fossilis Newberry

Plate I, figures 2, 3; Plate II

Onoclea sensibilis fossilis Newberry, N.Y. Lyceum Nat. Hist. Annals, vol. 9, p. 39 (1868): [Lesquereux], U.S. Geol. and Geog. Surv. Terr., Ill. Cret. and Tert. Plants, Pl. 58, fig. 1; Pl. 59, figs. 1-3 (1878): U.S. Geol. Surv. Mon. 35, p. 8, Pl. 23, fig. 3; Pl. 24, figs. 1-5 (1898).

Knowlton, Torrey Bot. Club Bull., vol. 29, p. 705, Pl. 26, figs. 1-4 (1902): Wash. Acad. Sci., vol. 11, pp. 188, 189, 198, 213 (1909).

Penhallow, Rept. Tert. Plants British Col., p. 47 (1908).

Woodwardia latiloba Lesquereux, U.S. Geol. and Geog. Surv. Terr., Ann. Rept. 1873, p. 391 (1874): Rept. U.S. Geol. Surv. Terr., vol. 7 (Tertiary Flora), p. 54, Pl. 3, figs. 1, 1a (1878).

Knowlton, U.S. Geol. Surv. Prof. Paper 155, p. 21 (1930).

Woodwardia latiloba minor Lesquereux, U.S. Geol. and Geog. Surv. Terr., Ann. Rept. 1873, p. 391 (1874): Rept. U.S. Geol. Surv. Terr., vol. 7 (Tertiary Flora), p. 54, Pl. 4, figs. 9, 9a (1878).

This characteristically coarsely veined species is similar in general aspect to the familiar existing species with which its original describer compared, but it does not seem to me to be quite as similar as Newberry thought, and its mode of preservation indicated a more coriaceous texture and the venation is much coarser. Comparisons indicate that Lesquereux's forms from the same horizon, which he referred to Woodwardia, really belong to the same species.

The type locality was the Fort Union of North Dakota, and the species is abundant and widely distributed in this formation in the Dakotas, Montana, and Wyoming. It has also been recorded from a number of localities in the Lance, from the Paskapoo of Alberta, from the Denver at Golden, Colorado, and from the Dawson Arkose of Colorado. Lesquereux recorded it from the post Laramie at Black Buttes, Wyoming, but this was a mistake as both the original specimen and original entry show that it came from Golden.

It is not at all uncommon in the Ravenscrag and has been identified from the following localities: Loc. 2, Loc. 11, Loc. 17, Loc. 23, Loc. 27, Loc. P-10-30 below Keogh seam, Ravenscrag, west side of Big Muddy valley, south of lake, specimen 11 near locality 2624. The single specimen from Locality 17 is more delicate than, and slightly different from, the normally coarse form but has the same characteristic areolate venation.

Genus, DENNSTAEDTIA Bernhardi

Dennstaedtia americana Knowlton

Dennstaedtia americana Knowlton, Smith. Misc. Coll., vol. 53, p. 492, Pl. 63, fig. 4; Pl. 64, figs. 3-5 (1910).

Sphenopteris blomstrandi Heer, Fl. Fossilis Arctica, Bd. 1, p. 155, Pl. 29, figs. 1a-e, 2a, b, 3, 4 a-c, 9a, b (1868).

Penhallow, Roy. Soc., Canada, Trans., vol. 8, p. 48 (1902): Rept. Tert. Plants British Col., p. 90 (1908).

Davalia (Stenoloma) tenuifolia Dawson, Brit. N.A. Boundary Comm., Rept. Geol. and Res. Vic. 49th Parallel, Appendix A, p. 329, Pl. 16, figs. 1, 1a, 2, 2a (1875): Roy. Soc., Canada, Trans., vol. 4, 1886, p. 21, Pl. 1, figs. 1, 1a, 1b (1887).
Penhallow, Rept. Tert. Plants, British Col., p. 52 (1908).

Asplenium tenerum Lesquereux, Rept. U.S. Geol. Surv. Terr., vol. 8 (Cretaceous and Tertiary Floras), p. 221, Pl. 46A, figs. 1, 2 (1883) (not *Asplenium tenerum* Forster, 1786).

This handsome little fern represented in the foregoing citations is now well known in both the sterile and fertile condition. It is present in some abundance in both the Paskapoo and Fort Union formations.

Two small but good sterile specimens of this species are contained in the collections from Locality 17.

Order, GINKGOALES

Family, **Ginkgoaceae**

Genus, GINKGO Linné

Ginkgo adiantoides (Unger) Heer

Salisburia adiantoides Unger, Syn. Pl. Foss., p. 211 (1845).

Ginkgo adiantoides Heer, Fl. Foss. Arctica, Bd. 5, ab. 3, p. 21, Pl. 2, figs. 7-10 (1878).
Ward, U.S. Geol. Surv. Sixth. Ann. Rept. 1884-85, p. 549, Pl. 31, figs. 5, 6 (1886); Idem., Bull. 37, p. 15, Pl. 1, figs. 5, 6 (1887).
Lesquereux, U.S. Nat. Mus. Proc., vol. 10, p. 35 (1887).
Knowlton, Idem., vol. 17, p. 215 (1894): Geol. Soc. Am. Bull., vol. 5, p. 579 (1893): Wash. Acad. Sci. Proc., vol. 11, pp. 197, 198, 204, 213 (1909): Jour. Geol., vol. 19, p. 370 (1911).
Penhallow, Rept. Tert. Plants British Col., p. 57, tf. 12 (1908).
Berry, Roy. Soc., Canada, Trans., vol. 20, sec. 4, p. 190 (1926): Geol. Surv., Canada, Bull. 42, p. 96 (1926): Nat. Mus., Canada, Mem. 63, p. 18 (1930).

Ginkgo laramiensis Ward, Science, vol. 5, p. 496, Fig. 7 (1885): U.S. Geol. Surv., Sixth Ann. Rept. 1884-85, p. 549, Pl. 31, fig. 4 (1886): Idem., Bull, 37, p. 15, Pl. 1, fig. 4 (1887).
Knowlton, U.S. Geol. Surv. Bull. 163, p. 31, Pl. 4, figs. 7-10; Pl. 5, fig. 5 (1900).

This interesting and ancient type has been recorded from a large number of localities from the late Cretaceous through the Tertiary. Whether all of these occurrences represent a single botanical species, or whether if so it is specifically distinct from the existing *Ginkgo biloba*, are mooted questions. It seem incredible that a single species should maintain itself unchanged for so many millions of years. On the other hand the leaf form fails to disclose as much variation as can be selected from a single existing tree.

Leaves, and in some cases the stones of supposed fruits, are not uncommon in the Whitemud, Estevan, and Ravenscrag formations, and have also been recorded from the Paskapoo near Calgary, Alberta, as well as from the Mesaverde, Edmonton, Belly River, Lance, and Fort Union. In the denser sediments the cuticles are frequently preserved, but as the material was thoroughly dried out between the time of collection and its coming into my hands, no satisfactory microscopic preparations could be made.

In connexion with the question of geologic climates it is worth recording that the modern tree is perfectly hardy in the grounds of the Central Experimental Farm at Ottawa, Canada, although official temperatures as low as 36 degrees below zero Fahrenheit have been recorded there (Harrison F. Lewis).

The new records are Localities 7 and 30 in the Whitemud, Locality 3 in the Lower Ravenscrag, and Locality 32 in the Upper Ravenscrag.

Order, CONIFERALES

Family, **Pinaceae**

Subfamily, TAXODIEAE

Genus, SEQUOIA Endlicher

Sequoia nordenskiöldii Heer

Sequoia nordenskiöldii Heer, Fl. Foss. Arctica, Bd. 2, abt 2, p. 36, Pl. 2, fig. 13b; Pl. 4, figs. 1a, b, 4-38 (1870).
Newberry, U.S. Geol. Surv. Mon. 35, p. 20, Pl. 26, fig. 4 (1898).
Penhallow, Roy. Soc., Canada, Trans., vol. 8, sec. 4, p. 50 (1902): Rept. Tert. Plants British Col., p. 90 (1908).
Knowlton, Wash. Acad. Sci. Proc., vol. 11, pp. 185, 189, 190, 198, 203, 211, 213, 214 (1909): Jour. Geol., vol. 19, pp. 369, 370, 371 (1911).
Berry, in Williams and Dyer, Geol. Surv., Canada, Mem. 163, pp. 63, 64 (1930).
Sequoia langsdorfii Newberry, N.Y. Lyceum Nat. Hist. Annals, vol. 9, p. 46 (1868): [Lesquereux], U.S. Geol. and Geog. Surv. Terr., Ill. Cret. and Tert. Plants, Pl. 11, fig. 4 (1878) (not Brongniart).

Foliage of this species, which is very similar to that of the existing *Sequoia sempervirens*, is not uncommon in the Whitemud, Estevan, and Ravenscrag formations. It is also common and widely distributed in the Paskapoo, Lance, and Fort Union formations. No cones have been discovered in connexion or association with the recent collections from Alberta and Saskatchewan.

Occurrence. Whitemud: Localities 7 and 30.
Estevan: SW. ¼ sec. 16, tp. 7, range 29, W. 3rd mer.
Ravenscrag: Loc. 2, Loc. 13, Loc. 38, Loc. 3426, south of Harptree, base of Willowbunch member (not uncommon); Loc. P-3-30; Loc. 3052 (P-12-30), Big Muddy valley south and west of Bengough road. In all sizes from twigs to branches and exceedingly common.

Genus, TAXODIUM L. C. Richard

Taxodium dubium (Sternberg) Heer

Phyllites dubius Sternberg, Flora der Vorwelt, vol. 1, p. 37, Pl. 24, fig. 2; Pl. 36, figs. 3, 4 (1824).

Taxodium distichum mioceum Heer, Miocene Baltische Flora, p. 18, Pl. 2; Pl. 3, figs. 6, 7 (1869).

Dawson, Roy. Soc., Canada, Trans., vol. 8, p. 79 (1882).

Knowlton, Geol. Soc. Am. Bull., vol. 5, p. 578 (1893): U.S. Nat. Mus. Proc., vol. 17, p. 214 (1893): U.S. Geol. Surv. Bull. 204, p. 27 (1902): Harriman Alaska Exped., vol. 4, p. 152 (1904): Wash. Acad. Sci. Proc., vol. 11, pp. 204, 207, 215 (1909).

Penhallow, Roy. Soc., Canada, Trans., vol. 8, pp. 51, 68 (1902): Man. N. A. Gymnosperms, p. 217 (1907): Roy. Soc., Canada, Trans., vol. 8, pp. 301, 312, 314, 315 (1908): Rept. Tert. Plants British Col., p. 91 (1908).

Berry, Jour. Geol., vol. 17, p. 22, Fig. 1 (1909).

Newberry, U.S. Geol. Surv. Mon. 35, p. 22, Pl. 47, fig. 6; Pl. 51, fig. 3; Pl. 52, figs. 2, 3; Pl. 55, fig. 5 (1898).

Taxodium nevadensis Lesquereux, U.S. Geol. and Geog. Surv. Terr., Ann. Rept. 1873, p. 372 (1874).

Taxodium distichum dubium Cockerell, Am. Nat., vol. 44, p. 35 (1910).

Taxodium dubium Heer, Fl. Tert. Helv., vol. 1, p. 49, Pl. 17, figs. 3, 15 (1855).

Lesquereux, U.S. Geol. and Geog. Surv. Terr., Ann. Rept. 1873, p. 409 (1874).

Berry, U.S. Geol. Surv. Prof. Paper 91, p. 171, Pl. 15, figs. 4-6 (1916): Roy. Soc., Canada, vol. 20, sec. 4, p. 191 (1926): Geol. Surv., Canada, Bull. 42, p. 97 (1926): Nat. Mus., Canada, Mem. 63, p. 18 (1930).

This species, which is superficially similar to *Sequoia nordenskiöldii* Heer, is apt to have somewhat wider leaves contracted to a short petiole and not conspicuously decurrent, and is somewhat later in making its appearance in the Canadian section, being unknown in the Whitemud and Estevan. It is not uncommon in the Ravenscrag, occurring also in the Paskapoo and Lance, and also recorded from a large number of later horizons throughout the Tertiary.

Occurrence. Loc. 1, Loc. 32, Loc. 9 (29-229), Loc. P-3-30, and 3426 (P-6-30).

Taxodium occidentale Newberry

Taxodium occidentale Newberry, Boston Jour. Nat. Hist., vol. 7, p. 517 (1863): N.Y. Lyceum Nat. Hist. Annals, vol. 9, p. 45 (1868): [Lesquereux], U.S. Geol. and Geog. Surv. Terr., Ill. Cret. and Tert. Plants, Pl. 11, figs. 1-3 (1878): U.S. Geol. Surv. Mon. 35, p. 23, Pl. 26, figs. 1-3; Pl. 55, fig. 5 (part) (1898).

Penhallow, Rept. Tert. Plants British Col., p. 91 (1908).

Knowlton, Wash. Acad. Sci. Proc., vol. 11, pp. 189, 195, 202, 203, 211, 214 (1909): Jour. Geol., vol. 19, p. 369 (1911).

Berry, Roy. Soc., Canada, Trans., vol. 20, sec. 4, p. 190 (1926): Geol. Surv., Canada, Bull. 42, p. 97, Pl. 10, fig. 1 (1926).

Earlier collections from Localities 1, 31, and 32 contain specimens with leaves large and broad enough to warrant their reference to this supposed species, but in both cases they are associated with material that is more properly referable to *Taxodium dubium* (Sternberg) Heer. This raises the question as to whether more than a single species is represented.

In the case of the later collections from Localities P-2-30, P-3-30, and P-11-30 all of the material seen is typical of *Taxodium occidentale* as described and illustrated by Newberry. The characteristic feature is the rapid shortening and crowding of the leaves at the tips of the twigs like that shown in Newberry's Figure 1. The leaves are also larger and relatively very much wider. Whether these features are of specific significance may perhaps be considered doubtful.

In addition to its occurrence in the Ravenscrag beds it has been recorded by Penhallow from several localities in British Columbia, some of which are probably of Paskapoo age (e.g. Red Deer river), and some younger. I have also recorded it from several localities in the Paskapoo of Alberta. It is common and widely distributed in the Lance and Fort Union of the United States.

Genus, GLYPTOSTROBUS Endlicher

Glyptostrobus europaeus (Brongniart) Heer[1] (?)

Glyptostrobus europaeus Lesquereux, U.S. Geol. Surv. Terr., vol. 7, Tertiary Flora, p. 74, Pl. 7, figs. 1, 2 (1878).

Newberry, U.S. Geol. Surv. Mon. 35, p. 24, Pl. 26, figs. 6-8a; Pl. 55, figs. 3, 4 (1898).

Knowlton, Idem., 17th Ann. Rept., pt. 1, p. 899 (1896): Wash. Acad. Sci. Proc., vol. 11, pp. 188, 197, 198, 211, 214 (1909): Jour. Geol., vol. 19, p. 369 (1911).

Penhallow, Roy. Soc., Canada, Trans., vol. 8, pp. 51, 68 (1902): Idem., vol. 1, p. 309 (1907): Rept, Tert. Plants British Col., p. 58 (1908).

Berry, U.S. Geol. Surv. Prof. Paper 91, p. 169, Pl. 15, fig. 3 (1916): Idem., 156, p. 52, Pl. 7, figs. 7-9 (1930): Roy. Soc., Canada, Trans., vol. 20, sec. 4, p. 192 (1926): Geol. Surv., Canada, Bull. 42, p. 97 (1926).

Remains identical with what is usually identified as this species are common in all sizes up to twigs 12 millimetres in diameter at Locality 1 and occur also at Localities 5 and 36 (?) in beds referred to the Ravenscrag formation. Precise identification is difficult and the question of botanical affinity or the identity of the European and American material so named has never been settled and is probably not possible of solution. On the whole there is little doubt but what is here called *Glyptostrobus europaeus* is the same as that recorded from the Paskapoo, Lance, and Fort Union whatever the relationship between these and the later material that has been referred to this species.

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[1]Since the identity of the American with the European material may be seriously questioned, I am only giving the more important American citations of this much recorded species.

Subfamily, CUPRESSEAE

Genus, THUJA Linné

Thuja interrupta Newberry

Plate III, figure 1

Thuja interrupta Newberry, N.Y. Lyceum Nat. Hist. Annals, vol. 9, p. 42 (1868): [Lesquereux], U.S. Geol. and Geog. Surv. Terr., Ill. Cret. and Tert. Plants, Pl. 11, figs. 5, 5a (1878): U.S. Geol. Surv. Mon. 35, p. 25, Pl. 26, figs. 5-5d (1898).

Dawson, Roy. Soc., Canada, Trans., vol. 4 (1886), sec. 4, p. 22, Pl. 1, figs. 3, 4 (1887).

Penhallow, Rept. Tert. Plants British Col., p. 92 (1908).

Knowlton, Wash. Acad. Sci. Proc., vol. 11, pp. 198, 202 (1909): Jour. Geol., vol. 19, pp. 369, 370, 371 (1911).

In a preliminary study of the original collections from this region W. A. Bell described a single specimen from the Whitemud at Locality 7 as *Cupressinocladus ramosus* n. sp., and the following is a quotation of his manuscript description:

"Young axis of twig, 1 mm. broad, provided with crowded opposite laterals; branches up to 5 mm. in length. Branches near apex of main axis simple, those below supplied with lateral opposite bud-like branches up to 2·5 mm. in length. The latter branches arise from axils of each pair of lateral leaves. Leaves decussate on axis and branches; lateral ones slightly falcate, adpressed and broad below, free and narrowly pointed above. The free ends lie oblique to axis, those on main axis, however, spreading to more approximate horizontal position but curved upwards. Leaves along middle of axes, adpressed, rhomboid, abruptly acuminate with pronounced raised midrib. *Remarks:* The species bears [except for its smaller size] close resemblance to *Libocedrus sabiniana* Heer [probably a composite] and may possibly be identical. The only distinguishing feature is the more finely branched condition of the single specimen to hand."

I subsequently found similar remains in the collections from Locality 2 in the Lower Ravenscrag which I recorded in my preliminary lists as *Libocedrus sabiniana* Heer. I give the references to this supposed species in the accompanying footnote.[1]

Heer's illustrations show considerable variation in both size and form and I have a suspicion that the species is composite. Most of his material seems to have been larger than that from Canada, but some of it is almost as small (e.g. his Plate 70, figure 17).

Heer also described from the Greenland Tertiary a form which he finally called *Biota borealis* which I have also cited fully in a footnote.[2] This last was cone bearing and in those cases at least seems referable to Thuja rather than to Libocedrus or Chamaecyparis in so far as one can judge from the figures.

The same year that Heer described *Thuja borealis*, and two years before he described *Libocedrus sabiniana*, Newberry described similar remains from the Fort Union at the type locality in what is now North

[1]Heer, O.: Flora Fossilis Arctica, Bd. 2, p. 34, Pl. 2, figs. 6-15; Pl. 4, fig. 4d (1870): Bd. 7, p. 58, Pl. 70, fig. 17; Pl. 86, figs. 1, 2; Pl. 87, fig. 8 (1883). Endo, Sci. Repts. Tohoku Imp. Univ., vol. 7, p. 67, Pl. 17, figs. 5, 8-11, 15 (1925) (?). The localities are the Eocene of Greenland and Spitzbergen and the Upper Cretaceous of Japan.

[2]*Thujaopsis europea* Heer (not Saporta), Flora Fossilis Arctica, Bd. 1, p. 90, Pl. 50, figs. 11a-c (1868). *Biota borealis* Heer, Idem., Bd. 3, pt. 3, pp. 7, 13, Pl. 1, figs. 13-29 (1874): Bd. 6, pt. 2, p. 9, Pl. 3, figs. 5, 5b (1882): Bd. 7, p. 58, Pl. 70, fig. 15 (1883).

Dakota as *Thuja interrupta*, although these were not figured until ten years later. This last quandom species was subsequently recorded from the Paskapoo by both Dawson and Penhallow, from the Lance by Knowlton, and from the younger Puget by Knowlton. The last record is unillustrated and may be considered as improbable.

After much study of the later collections, in which similar remains appear to be rather common in the Ravenscrag, I have decided to refer this material to Newberry's species. His latest publication contains merely the comments that he wrote thirty years earlier. The specific feature of lack of leaves on the axis, which also suggested the specific name *interrupta*, is not valid. Superficially the present material might be referred to either of the other species mentioned, but it is more like Recent Thuja than it is like Recent Libocedrus, and altogether lacks the elongation of the leaf bases that is such a prominent feature in our western *Libocedrus decurrens* Torrey. It seems also that Thuja fits into my picture of the environmental conditions rather better than Libocedrus. This is not conclusive, but a balance of probabilities, having in mind probable environment, resemblance to recent material, and the presence of Thuja-like cones on *Thuja borealis*. I do not mean to imply that all of the records of *Thuja interrupta* Newberry, *Thuja borealis* Heer, and *Libocedrus sabiniana* Heer represent a single botanical species, but I do think that they all may be mixed and that they may be in part identical.

The present collections comprise much rather faint material from Rockglen, Saskatchewan (Locality 3579, P-10-30), much material in small fragments from Big Muddy valley, south side and west of Bengough road (Locality 3052, P-12-30), hill north of road at Keoghs (P-4-30), and P-11-30.

Order, PANDANALES

Family, **Sparganiaceae**

Genus, SPARGANIUM Linné

Sparganium stygium Heer

Sparganium stygium Heer, Fl. Tert. Helv., vol. 1, p. 101, Pl. 45, figs. 1-4 (1855).

Ward, U.S. Geol. Surv., 6th Ann. Rept. 1884-85, p. 550, Pl. 32, figs. 6, 7 (1886): Idem., Bull. 37, p. 18, Pl. 3, figs. 6, 7 (1887).

Knowlton, Idem., Mon. 32, pt. 2, p. 683 (1899): Wash. Acad. Sci., vol. 11, p. 211 (1909).

One may well doubt the identity of these much earlier American remains with a European Miocene species, but differences would not be expected to be demonstrable in material of this sort. Certainly the Canadian fossil fruit-heads do not differ from those from the United States that Ward and Knowlton referred to this species. They are sparingly represented in the Upper Ravenscrag at Locality 32 and were also recorded by the writer in the 1921 Sternberg collection from Rocky creek, sec. 15, tp. 1, range 5, W., above upper coal, Saskatchewan. Previous records include the Lance and Fort Union of Wyoming, Montana, and Yellowstone park.

Order, ARALES

Family, **Araceae**

Genus, PISTIA Linné

Pistia corrugata Lesquereux

Pistia corrugata Lesquereux, U.S. Geol. and Geog. Surv. Terr., Ann. Rept. 1874, p. 299 (1876): U.S. Geol. Surv. Terr., vol. 7, Tertiary Flora, p. 103, Pl. 61, figs. 1, 3, 4, 6, 7, 9-11 (1878).

Knowlton, U.S. Geol. Surv. Bull. 163, p. 31 (1900): Idem., Prof. Paper 98, p. 334, Pl. 85, fig. 4 (1916).

Highly characteristic specimens of this species in some abundance occur at Localities 7 and 30 in the Whitemud. Earlier publications record it from the Montana and Mesaverde Cretaceous of Wyoming, the Judith River of Montana, and the Kirtland of New Mexico. Ward was of the opinion[1] that these occurrences represented the same botanical species as *Lemna scutata* Dawson, but this is certainly not true of the Canadian material which I have studied.

Pistia corrugata is larger—often very much larger—elliptical or obovate in form, with a highly characteristic flabellate-reticulate venation and a thin texture. *Lemna scutata* or more properly *Spirodela scutata*, since it is not a Lemna, has nearly orbicular, smaller leaves, of a coriaceous or subcoriaceous texture, and radiating veins.

Genus, SPIRODELA Schleiden

Spirodela scutata Dawson

Spirodela scutata Dawson, Brit. N. A. Boundary Comm. Rept. Geol. and Resources Vic. 49th Parallel, Appendix A, p. 328, Pl. 16, figs. 5, 6, 7a (1875): Roy. Soc., Canada, Trans., vol. 4, sec. 4, 1886, p. 23, Pl. 1, fig. 6 (1887).

Ward, U.S. Geol. Surv., 6th Ann. Rept. 1884-85, p. 550, Pl. 32, figs. 4, 5 (1886): Idem., Bull. 37, p. 17, Pl. 3, figs. 4, 5 (1887).

This species was described from the "Badlands south of Woody Mountain, Alberta," and I suspect came from the Paskapoo formation. It was subsequently recorded from the Fort Union near Glendive, Montana. As I have remarked under the preceding species I regard the two as perfectly distinct.

The present species was not uncommon in the earlier collections from Locality 13, and in the later collections from Localities 10 (1248), 2624, and P-10-30.

Order, LILIALES

Family, **Smilacaceae**

Genus, SMILAX Linné

Smilax (?) *inquirenda* Knowlton

Smilax (?) *inquirenda* Knowlton, U.S. Geol. Surv. Prof. Paper 130, p. 118, Pl. 4, fig. 5 (1922).

The type of this species came from the true Laramie of Colorado. A fragment from brown shale at Locality 30 in the Whitemud appears to be definitely referable to the genus Smilax, and is tentatively referred to this species, although the type was incomplete and poorly characterized.

[1]Ward, L. F.: U.S. Geol. Surv., Bull. 37, p. 17 (1887).

Order, ARECALES

Family, **Arecaceae**

Genus, PALMOCARPON Lesquereux

Palmocarpon sp.

Plate III, figure 2

A sub-spherical palm nut, slightly deformed. About 1¼ centimetres in diameter, with an umbilicate hilum. Surface finely fibrous-striate. A single specimen from the Whitemud at Locality 30 presents the obvious features of a palm fruit, but appears to differ from previously described forms.

Lesquereux described several palm fruits from the Denver formation of Colorado, among which *Palmocarpon truncatum minor* has much the aspect of the present fruit, but is slightly smaller (a not important distinction) and was said to have a smooth surface, but it was very inadequately described and figured. Rather similar fruits from the Gulf Coastal Plain early Eocene have been named *Palmocarpon butlerensis*.[1] The latter, when well preserved, show a distinctly punctate surface. The latter is certainly, and the former is probably, distinct from the present species. The larger *Palmocarpon truncatum* Lesquereux has been recorded from the Paskapoo formation of Alberta.[2]

Order, JUGLANDALES

Family, **Juglandaceae**

Genus, JUGLANS Linné

Juglans nigella Heer

Juglans nigella Heer, Fl. Foss. Arct., Bd. 2, abt. 2, p. 38, Pl. 9, figs. 2-4 (1869).
Dawson, Geol. Surv., Canada, 1875-76, p. 57.
Lesquereux, U.S. Geol. Surv. Terr., vol. 8, Cret. and Tert. Floras, p. 235, Pl. 46A, fig. 11 (1883).
Knowlton, U.S. Nat. Mus. Proc., vol. 17, p. 222 (1894): Geol. Soc. Am. Bull., vol. 5, p. 583 (1894): U.S. Geol. Surv. Prof. Paper 101, p. 292, Pl. 55, fig. 2; Pl. 63, fig. 2 (1918).
Ward, Idem., 6th Ann. Rept. 1884-85, p. 551, Pl. 40, fig. 6 (1886): Idem., Bull. 37, p. 33, Pl. 15, fig. 1 (1887).
Newberry, Idem., Mon. 35, p. 33, Pl. 51, fig. 2 (in part), 4 (1898).
Penhallow, Rept. Tert. Plants British Col., p. 60 (1908).
Berry, in Williams and Dyer, Geol. Surv., Canada, Mem. 163, p. 64 (1930): Nat. Mus., Canada, Bull. 63, p. 19 (1930).

This species is sparingly represented at Localities 33 and P-3-30. The type locality was in the Kenai formation of Alaska, but subsequent records include the Paskapoo and Ravenscrag formations of Canada, and the Fort Union and Raton formations of the United States.

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[1]Berry, E. W.: U.S. Geol. Surv. Prof. Paper 131, p. 8, Pl. 4, figs. 2-4 (1922).
[2]Berry, E. W.: Roy. Soc., Canada, Trans., vol. 20, sec. 4, p. 193 (1926).

Juglans rugosa Lesquereux

Juglans rugosa Lesquereux, Am. Jour. Sci., vol. 45, p. 206 (1868): U.S. Geol. Surv. Terr., vol. 7, Tertiary Flora, p. 286, Pl. 54, figs. 4, 5; Pl. 55, figs. 1-9; Pl. 56, figs. 1, 2 (1878).

Knowlton, U.S. Geol. Surv. Bull. 204, p. 34 (1902): Idem., Mon. 32, pt. 2, p. 687 (1899): Wash. Acad. Sci. Proc., vol. 11, p. 202 (1909): U.S. Geol. Surv. Prof. Paper 101, p. 293, Pl. 112, fig. 4 (1918).

This species, which seems to be related to *Juglans denveriana* Knowlton of the Denver formation in Colorado, has been identified at Localities 3, 13, 24, 32, and 33, or practically throughout the Ravenscrag formation. The species is not especially well characterized, which has perhaps something to do with the fact that it has been recorded from a large number of localities in the Denver, Livingston, Evanston, Raton, Lance, Fort Union, and Wilcox formations. It may be said that without reviewing all of the material that has been referred to *Juglans rugosa* one cannot place too much reliance on authors' identifications.

Genus, HICORIA Rafinesque

Hicoria antiquorum (Newberry) Knowlton (?)

Carya antiquorum Newberry, N.Y. Lyceum Nat. Hist. Annals, vol. 9, p. 72 (1868): [Lesquereux], U.S. Geol. Surv. Terr., Ill. Cret. and Tert. Plants, Pl. 33, figs. 1-4 (1878): U.S. Geol. Surv. Mon. 35, p. 35, Pl. 31, figs. 1-4 (1898).

Ward, Idem., 6th Ann. Rept. 1884-85, p. 552, Pl. 60, fig. 7 (1886); Idem., Bull. 37, p. 34, Pl. 15, fig. 2 (1887).

Knowlton, Idem., Mon. 32, pt. 2, p. 690 (1899): Wash. Acad. Sci. Proc., vol. 11, pp. 189, 190, 202, 211, 214 (1909).

Penhallow, Roy. Soc., Canada, Trans., vol. 8, p. 60, 1902: Rept. Tert. Plants British Col., p. 43 (1908).

The presence of this species in the Whitemud and Ravenscrag rests on an incomplete specimen and its counterpart in a ferruginous sandstone at Locality 30 (Whitemud), on three incomplete specimens from the Lower Ravenscrag at Locality 34, and additional material from the Upper Ravenscrag north of Keogh ranch (P-4-30).

None of this material is sufficiently complete to differentiate with certainty from the larger leaves from other localities in the Ravenscrag which I have considered to represent especially large leaves of *Euonymus xantholithensis* Ward. The species is a Paskapoo, Lance, and Fort Union form, and there is no reason why it shoud not occur in the Ravenscrag, but the present identifications must be regarded as merely tentative.

Order, FAGALES

Family, **Betulaceae**

Genus, ALNUS Linné

Alnus grewiopsis Ward (?)

Alnus grewiopsis Ward, U.S. Geol. Surv., 6th Ann., Rept. 1884-85, p. 551, Pl. 39, fig. 8 (1886): Idem., Bull. 37, p. 30, Pl. 14, fig. 1 (1887).

A single fragmentary specimen from Locality 32, which is supposed to be Upper Ravenscrag, was tentatively referred to this species in my preliminary studies. No additional specimens have been encountered and I have a strong suspicion that Ward's type, which was supposed to have come from the Laramie of Wyoming, is not an Alnus, nor even a certainly recognizable species, so that no weight, either botanical or geological, can be assigned it.

Family, **Fagaceae**

Genus, QUERCUS Linné

Quercus groenlandica Heer(?)

Quercus groenlandica Heer, Flora Fossilis Arctica, Bd. 1, p. 108, Pl. 8, fig. 8; Pl. 10, figs. 3, 4; Pl. 11, fig. 4; Pl. 47, fig. 1 (1868): Idem., Bd. 2, pp. 56, 471, Pl. 12, figs. 1-4; Pl. 45, fig. 4 (1871): Idem., Bd. 6, abt. 1, p. 10, Pl. 4, fig. 5 (1880): Idem., Bd. 7, p. 89, Pl. 49, fig. 4; Pl. 89, figs. 1, 2; Pl. 91, figs. 1, 2a (1883).

Newberry, U.S. Geol. Surv. Mon. 35, p. 75, Pl. 51, fig. 3 (in part); Pl. 54, figs. 1, 2 (1898).

Berry, Geol. Surv., Canada, Bull. 42, p. 106 (1926).

Two incomplete specimens, one from Locality 32 and one from Locality 33 and not certainly determined, were tentatively referred to this species in my preliminary studies of the Ravenscrag flora. Heer's type was from the Tertiary of western Greenland and the species was also recorded by Heer from Spitzbergen, and by Newberry from the Kenai formation of Alaska. I have recorded it from Joseph creek, British Columbia, and Kitsilano, Vancouver island. I would hardly expect it in the Ravenscrag and it is possible that the specimens from Localities 32 and 33 should be referred to the following species.

Quercus praegroenlandica Berry, n.sp.

Plate III, figures 3-7

Leaves of medium size, ovate-lanceolate in general outline, with pointed tip and broadly cuneate base. Except at the base the margin shows coarse dentate teeth, which decrease in size distad. Length up to 12 centimetres. Maximum width up to 5 centimetres. Texture sub-coriaceous. Petiole stout, curved, about 1·5 centimetres in length. Midvein stout and prominent. Secondaries about 15 subparallel pairs (occasionally one of the lower ones will fork at or near the base), diverging from the midvein at wide angles, regularly spaced, rather straight, craspedodrome. Tertiary venation quercoid.

This is a not uncommon form at Locality P-4-30 in a somewhat laminated drab clay, but the specimens as collected are all incomplete. The species is probably represented at the localities listed under the preceding species. As nearly as can be determined the present species is smaller than *Quercus groenlandica* Heer, with less deeply cut margins, and lacks a strictly percurrent tertiary venation. The secondaries are also less regularly spaced. The difficulties in making comparisons are due to the fact that I believe Heer confused what he called *Quercus groenlandica* with what he called *Castanea ungeri* from the same locality, and to a suspicion that his figures were idealized, since some show a venation like the Ravenscrag material and others do not. The small leaf figured which I consider to represent a small leaf of this species is not unlike the Arctic forms that Heer called *Planera ungeri*.

Occurrence. About the horizon of the Keogh seam, north side of hill north of road from west into Big Muddy valley near Keogh ranch (P-4-30).

Quercus bicornis Ward (?)

Quercus bicornis Ward, U.S. Geol. Surv., 6th Ann. Rept. 1884-85, p. 551, Pl. 36, fig. 8 (1886): Idem., Bull. 37, p. 24, Pl. 9, fig. 3 (1887).

A single specimen from Locality 32 agrees with this species as far as it is comparable, but lacks the apex, which is the essential critical feature of this supposed species.

Quercus sp.

Two fragments of the apical part of a rather large ovate-lanceolate leaf, with small Castanea-like teeth, craspedodrome venation, sub-parallel secondaries, and acuminate tip. It is undoubtedly new to this flora and probably to palæobotany, but is too incomplete for description.

Occurrence. Locality P-3-30.

Order, URTICALES

Family, **Ulmaceae**

Genus, ULMUS Linné

Ulmus wardii Knowlton and Cockerell (?)

Ulmus planeroides Ward, U.S. Geol. Surv., 6th Ann. Rept. 1884-85, p. 552, Pl. 46, figs. 1, 2 (1886): Idem., Bull. 37, p. 44, Pl. 23, figs. 1, 2 (1887) (not Carriere, 1875).

Ulmus wardii Knowlton and Cockerell, U.S. Geol. Surv. Bull. 696, p. 636 (1919).

A single incomplete specimen from Locality 2 is considered to represent this species. The margin of the specimen is not especially clear and the identification is tentative.

Genus, PLANERA Gmelin (?)

Planera microphylla Newberry (?)

Planera microphylla Newberry, N.Y. Lyceum Nat. Hist. Annals, vol. 9, p. 55 (1868): [Lesquereux], U.S. Geol. Surv. Terr., Ill. Cret. and Tert. Plants, Pl. 16, figs. 3, 4 (1878): U.S. Geol. Surv. Mon. 35, p. 81, Pl. 33, figs. 3, 4 (1898).

A single specimen from Locality 27 is tentatively referred to this species. This is not a Planera in my opinion, but represents either Myrica or Comptonia. It is much like some of the Arctic Eocene leaves that Heer referred to the European Miocene species *Planera ungeri* Ettingshausen, and I believe that the Alaskan and other American Eocene occurrences that have been referred to the latter should probably be referred to *Planera lingualis* Knowlton and Cockerell *(Planera crenata* Newberry).

Family, **Moraceae**

Genus, FICUS Linné

Ficus ceratops Knowlton

Palmocarpon n. sp., Knowlton in Stanton and Knowlton, Geol. Soc. Am. Bull., vol. 8, p. 136 (1897).

Ficus ceratops Knowlton, Torrey Bot. Club Bull., vol. 38, p. 389, Figs. 1-4 (1911).

Ficus russelli Knowlton, Idem., p. 392.

These remarkable fruits are sufficiently described by Knowlton in the publication cited above. They are exceedingly common in a limited area in the Ceratops beds of Converse county, Wyoming, and occur frequently at the corresponding horizon in Montana—both now referred to the Lance formation.

There are a large number of specimens in the United States National Museum and it seems perfectly clear that, as Knowlton suspected, there is only a single species represented. The only observed difference is one of size, and this is not at all constant, nor is the difference as great as in the fruits of existing species of Ficus.

Knowlton, in emphasizing the remarkable preservation of these fruits, quite unintentionally gives the impression that they have suffered but slight deformation. As a matter of fact, and as his Figure 2 shows, they are frequently considerably compressed. Usually it is the inflated portion which has suffered most, and the attitude of the specimen in the sediment determines whether the result is symmetrical or asymmetrical with respect to the axis of the fruit. An undoubted factor is the degree to which the hollow interior has been filled by sediment before the compressive force became operative.

There are two characteristic specimens from Locality 3 in the Lower Ravenscrag of southern Saskatchewan which are undoubtedly the same as the Wyoming and Montana material. Both specimens are much more compressed than are the specimens in the United States National Museum—one obliquely and the other nearly vertically. Otherwise they are entirely typical in size, form, proportions, and markings.

Ficus denveriana Cockerell

Ficus spectabilis Lesquereux, U.S. Geol. and Geog. Surv. Terr., Ann. Rept. 1872, p. 379 (1873): U.S. Geol. Surv. Terr., vol. 7, Tertiary Flora, p. 199, Pl. 33, figs. 4-6 (1878).

Ward, U.S. Geol. Surv., 6th Ann. Rept. 1884-85, p. 552, Pl. 44, fig. 6 (1886): Idem., Bull. 37, p. 38, Pl. 21, fig. 1 (1887).

Penhallow, Rept. Tert. Plants British Col., p. 56 (1908).

Knowlton, Wash. Acad. Sci. Proc., vol. 11, p. 204 (1909).

Laurus utahensis Lesquereux, U.S. Nat. Mus. Proc., vol. 11, p. 24 (1888).

Ficus goldiana Lesquereux, Idem., p. 25.

Ficus denveriana Cockerell, Torreya, vol. 10, p. 224 (1910).

Berry, U.S. Geol. Surv. Prof. Paper 91, pp. 11, 198 (1916): Idem., 155, p. 64, Pl. 24, figs. 1-3 (1930).

Knowlton, Idem., 101, p. 302, Pl. 75, figs. 1, 2 (1917).

Ficus aquilar Knowlton, Idem., 155, p. 65, Pl. 24, fig. 4 (1930) (not the Raton type of this species).

What has been referred to this species is widely distributed in the Denver, Dawson, Raton, Lance, Laramie (?), Lance, Midway (?), and Wilcox. To it should be referred the Denver forms that Knowlton called *Ficus aquilar*, the latter a probably distinct Raton species, and to it should also be referred the Upper Ravenscrag form from Locality 1 which I identified as *Ficus aquilar* in my preliminary report.

Occurrence. Localities 1, 6, 32, and P-4-30.

Ficus martini Knowlton (?)

Ficus martini Knowlton, U.S. Geol. Surv. Prof. Paper 155, p. 69, Pl. 40, fig. 5 (1930).

The type of this somewhat dubious species was from the Denver formation at Scranton, Colorado. Doubtfully determined material from Locality 30 in the Whitemud was contained in the 1929 collections.

Ficus subtruncata Lesquereux (?)

Ficus auriculata Lesquereux, U.S. Geol. and Geog. Surv. Terr., Ann. Rept. 1872, p. 379 (1873): U.S. Geol. Surv. Terr., vol. 7, Tertiary Flora, p. 206, Pl. 30, figs. 4-8 (1878) (not Loureiro, 1834).

Ficus truncata (?) Lesquereux, U.S. Geol. and Geog. Surv. Terr., Ann. Rept. 1873, p. 400 (1874).

Ficus subtruncata Lesquereux, U.S. Geol. Surv. Terr., vol. 7, Tertiary Flora, p. 205, Pl. 30, figs. 7-9 (1878).

Knowlton, U.S. Geol. Surv. Prof. Paper 155, p. 63 (1930).

A somewhat doubtful specimen of this species occurs in the collections from Locality 24.

Ficus speciossima Ward

Ficus speciossima Ward, U.S. Geol. Surv., 6th Ann. Rept. 1884-85, p. 552, Pl. 45, fig. 1 (1886): Idem., Bull. 37, p. 39, Pl. 21, fig. 3 (1887).

Knowlton, Idem., Bull. 163, p. 52 (1900): Idem., Prof. Paper 98, p. 90, Pl. 16, fig. 3 (1916): Idem., 101, p. 262 (1918).

Cockerell, Univ. Colorado Studies, vol. 7, p. 151 (1910).

Ficus leei Knowlton, U.S. Geol. Surv. Prof. Paper 101, p. 261, Pl. 39, figs. 1-6; Pl. 40, figs. 1, 2 (1918): Idem., 98, p. 338, Pl. 90, fig. 2 (1916).

It is to be supposed that the large leaves which Ward made the type of *Ficus speciossima* grew from buds and were represented in life by all smaller sizes down to the vanishing point. Notwithstanding this seemingly obvious fact the associated leaves in the Vermejo formation of Colorado and New Mexico were made the basis of a distinct species by Knowlton *(Ficus leei)*. The two are obviously identical and if correctly identified by Knowlton, as seems probable, the small leaves which he referred to *Ficus leei* may be considered to illustrate some of the variations in size or growth stages of *Ficus speciossima*. Neither is directly represented in the present Canadian collections, but a very close relative—perhaps merely a variety—is present in the Whitemud, and it seems necessary to settle the status of the present species before describing the related Canadian form.

Ficus speciossima canadensis Berry, n. var.

Plate IV A

There occurs at Locality 3258 the very fragmentary remains of a large Ficus. A reconstruction from these fragments results in the restoration shown. In general size and outline this is obviously very much like *Ficus speciossima*, but it can hardly be referred directly to that species. The chief differences are the subordination of the lateral primaries, so that in calibre, attitude, and spacing they become simply basal secondaries, even though retaining more lateral branches than the superior secondaries.

This opening out of the lateral primaries is accompanied by more numerous and more equally spaced secondaries. That these differences are not of much moment can be appreciated by comparing my restoration with what Knowlton called *Ficus leei*, especially his Plate 39, figure 1. If the angles of divergence of the lateral veins in this specimen were increased 20 degrees the result would be very much like the Canadian leaf.

The chief differential feature of the new variety remains to be mentioned. It is the forking of the laterals. In *Ficus speciossima* the laterals maintain their integrity and their branches are invariably of a lower order and from the outer side, whereas in the supposed new variety all the laterals except the lowermost are dichotomously forked and even the lowermost approximates this habit.

The material available is hardly sufficient for a more complete characterization and it is to be hoped that better material will subsequently be collected with which to effectually check my attempted restoration. This variety or the species is present in the Edmonton formation of Alberta.

Family, **Protophyllaceae**

Genus, PROTOPHYLLUM Lesquereux

Protophyllum canadensis Berry, n. sp.

Plates IV B, and V

Protophyllum sp., Berry, Roy. Soc., Canada, Trans., vol. 20, sec. 4, p. 194, Fig. 1 (1926).

In 1926 I recorded a very large leaf of Protophyllum from the Paskapoo formation near Evansburg, Alberta. The aspect was characteristic, but since neither apex, base, nor margins were preserved no specific name was assigned to it. In the collections from Locality 32 there are 6 specimens which I believe represent the same species although they average somewhat smaller in size. The peculiar base is partly or wholly preserved in 4 of the specimens and 2 specimens show most of the upper part of the leaf, except the distal third.

Leaves large, broadly elliptical in outline, widest medianly. Estimated dimensions: length 20-25 centimetres, maximum width 11-19 centimetres. Apex rounded. Base prominently auriculate. Margins undulate. Texture coriaceous. Petiole stout, preserved for a length of 3 centimetres in one specimen. The base is, perhaps, the most striking feature of this form. It is most complete in the larger of the figured specimens, but others have it more accentuated. The midvein is stout, straight, and prominent. The secondaries are numerous, unequally spaced, stout, prominent, relatively straight, and subparallel except toward their terminations and in the basal part of the leaf; they are abruptly incurved so close to the margins that if there is the slightest abrasion they appear as if they were craspedodrome; they diverge from the midvein at angles of 45 degrees or slightly more, except the two basal pairs, which may be more or less recurved. Each secondary has from one to several distal camptodrome branches on the outside. The tertiary venation is well marked and characteristic and comprises simple or more generally inosculating transverse nervilles.

The genus Protophyllum usually has a perfoliate base and craspedodrome secondaries, but the present form is so similar in size, outline, and venation with the norm that I cannot conceive of its representing an unrelated form. The forms referred to it are all somewhat protean and the botanical affinities have been much disputed. Their features seem to me to be intermediate between the Moraceae and the Platanaceae.

About 25 nominal species of Protophyllum have been described, many of these coming from the Dakota sandstone of the western interior of North America, although they occur also on both the Atlantic and Pacific coasts.

Order, PLATANALES

Family, **Platanaceae**

Genus, PLATANUS Linné

Platanus basilobata Ward

Plate VI, figure 7

Platanus basilobata Ward, U.S. Geol Surv., 6th Ann. Rept. 1884-85, p. 552, Pl. 42, figs. 1-4; Pl. 43, fig. 1 (1886): Idem., Bull. 37, p. 35, Pl. 17, fig. 1; Pl. 18, figs. 1-3; Pl. 19, fig. 1 (1887).

Aralia digitata Ward, op. cit., p. 554, Pl. 49, figs. 2-5 (1886): op. cit., p. 62, Pl. 27, figs. 3-5 (1887).

Knowlton, U.S. Geol. Surv. Bull. 204, p. 81 (1902).

Lesquereux, U.S. Nat. Mus. Proc., vol. 11, p. 20, Pl. 11, fig. 4 (1888) (not Roxburg, 1814).

Aralia wardiana Knowlton and Cockerell, U.S. Geol. Surv. Bull. 696, p. 87 (1919).

Viburnum oxycoccoides Dawson, Roy. Soc., Canada, Trans., vol. 3, sec. 4, 1885, p. 17 (1886): Idem., vol. 4, sec. 4, 1886, p. 29, Pl. 2, fig. 15 (1887).

Penhallow, Rept. Tert. Plants British Col., p. 96 (1908).

Platanus nobilis Dawson, Roy. Soc., Canada, Trans., vol 4, sec. 4, 1886, p. 24, Pl. 1, fig. 7 (1887).

The outstanding feature of this species is the pseudo-stipular lobes at the top of the petiole, which are well shown in Ward's and Dawson's figures. If these fail of preservation the species is not to be distinguished from *Platanus nobilis* Newberry or *Aralia notata* Lesquereux. In fact, the real botanical relationship between these is by no means settled. In any event the forms with these basal lobes certainly belong to a single species in a single genus and do not represent three unrelated genera.

Consequently, as a step in the rationalization of the problem I have referred them all to a single species, and retained them in Platanus as the most likely clue to their affinity. In this connexion the reader may consult Ward's speculations on the origin of stipules in Platanus.[1]

The small figured specimen comes from Locality P-11-30 and there are fragments of much larger leaves associated with it, but none showing the base. The species is a Paskapoo and Fort Union one.

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[1]Ward, L. F.: "The Paleontologic History of the genus Platanus"; U.S. Nat. Mus. Proc., vol. 11, pp. 39-42, Pls. 17-22 (1888); and "Origin of Plane Trees"; Am. Nat., Sept. 1890, pp. 797-810, Pl. 28.

Platanus guillelmae of authors

Platanus guillelmae Goeppert, Lesquereux, U.S. Geol. and Geog. Surv. Terr., Ann. Rept. 1871, p. 492 (1872): U.S. Geol. Surv. Terr., vol. 7, Tertiary Flora, p. 183, Pl. 25, figs. 1-3 (1878).

Ward, U.S. Geol. Surv., 6th Ann. Rept. 1884-85, p. 552, Pl. 44, fig. 1: Idem., Bull. 37, p. 37, Pl. 20, fig. 1 (1887).

Knowlton, U.S. Geol. Surv. Mon. 32, pt. 2, p. 727, Pl. 96, fig. 1; Pl. 97, fig. 5 (1898): Wash. Acad. Sci. Proc., vol. 11, pp. 198, 211, 215 (1909); U.S. Geol. Surv. Prof. Paper 101, p. 322, Pl. 93, fig. 1 (1918).

Acer indivisum Ward, U.S. Geol. Surv., 6th Ann. Rept. 1884-85, p. 554, Pl. 50, fig. 1 (1886): Idem., Bull. 37, p. 66, Pl. 29, fig. 5, 1887 (not Weber).

This is, of course, not the same as Goeppert's Miocene species of Europe, but it is the same as the material from the United States that Lesquereux, Ward, and Knowlton have referred to that species. It differs from the doubtful variety *heerii* Knowlton merely in having a truncate instead of a cuneate base—a feature of slight value.

It has been recorded from the Hanna, Denver, Lance, Raton, and Fort Union formations, and in the present collections comes from Locality P-3-30.

Platanus guillelmae heerii Knowlton

Platanus guillelmae heerii Knowlton, U.S. Geol. Surv. Prof. Paper 101, p. 323, Pl. 96, fig. 5; Pl. 97, fig. 1; Pl. 98, fig. 2 (1918).

This supposed variety differs from the *Platanus guillelmae* of American authors merely in having a cuneate instead of a truncate base. It was recorded by the writer in 1921 in the Sternberg collection from Rocky creek, sec. 14, tp.1, range 5, W. 3rd mer., below coal, Saskatchewan (Lance), and in the more recent collections from the Ravenscrag, doubtfully from the lower (Locality 32) and more certainly from the upper (Locality 34). The type came from the Raton formation of Colorado. A doubtful specimen is recorded from the Whitemud at Locality 30.

Platanus sp.

This is clearly a Platanus and represents a leaf of large size. The giant among early Tertiary sycamores is *Platanus nobilis* Newberry, a species said to be abundant and widely distributed in the Fort Union and not uncommon in the Lance. Without reviewing the actual specimens upon which this statement rests it is impossible to verify its accuracy. The typical *Platanus nobilis* as figured by Newberry and Ward is unlike the present Canadian material. The former, despite its often very great size, has a much more crowded and relatively more slender venation and a different margin.

Leaves referred to Platanus are abundant in the late Cretaceous and early Tertiary. They are, of course, variable, and species based upon imperfect fossil specimens are necessarily unreliable. Thus there have been

recorded 5 forms from the Denver, 9 from the Raton, 9 from the Lance, and 6 from the Fort Union. This is not only an incredible number of species but their limits are not well defined and I doubt if any two students would agree as to exactly what these limits were.

The specimen from Locality 32 is of a very large leaf with rather distant and very stout secondaries. The margin is not preserved. Among previously figured forms it is very close to the larger leaves in the Raton formation which Knowlton described[1] as *Platanus aceroides latifolia.* The latter was recorded by the writer in the 1921 Sternberg collection from Rocky creek, sec. 15, tp. 1, range 5, W. 5th mer., above upper coal, Saskatchewan.

The present form occurs also at Localities 5, 6, and 34.

Order, RANALES

Family, **Trochodendraceae**

Genus, TROCHODENDROIDES Berry

This term is used as a form genus for fossil representatives of this family and does not imply any special relationship to the genus Trochodendron.

Trochodendroides cuneata (Newberry)

Plate VI, figures 1-6

Populus cuneata Newberry, N.Y. Lyceum Nat. Hist. Annals, vol. 9, p. 64 (1868): U.S. Geol. Surv. Mon. 35, p. 41, Pl. 28, figs. 2-4; Pl. 29, fig. 7 (1898): [Lesquereux], U.S. Geol. and Geog. Surv. Terr., Ill. Cret. and Tert. Plants, Pl. 14, figs. 1-4 (1878).

Ward, Idem., 6th Ann. Rept. 1884-85, p. 550, Pl. 33, figs. 5-11 (1886): Idem., Bull. 37, p. 19, Pl. 4, figs. 5-8; Pl. 5, figs. 1-3 (1887).

Penhallow, Rept. Tert. Plants British Col., p. 77 (1908).

Knowlton, Wash. Acad. Sci., Proc. vol. 11, pp. 185-215 (1909).

Populus nervosa var. *elongata* [Lesquereux], U.S. Geol. and Geog. Surv. Terr., Ill. Cret. and Tert. Plants, Pl. 13, figs. 2-4 (1878).

Populus nebrascensis [Lesquereux], Idem., Pl. 14, fig. 7.

Populus amblyrhyncha Ward, U.S. Geol. Surv., 6th Ann. Rept. 1884-85, p. 550, Pl. 34, figs. 5-9; Pl. 35, figs. 1-6 (1886): Idem., Bull. 37, p. 20, Pl. 6, figs. 1-8; Pl. 7, figs. 1-3 (1887).

Knowlton, Wash. Acad. Sci. Proc., vol. 11, pp. 188, 189, 194, 195, 198, 201, 202 (1909).

Populus rotundifolia Newberry (not Griffith, 1847), U.S. Nat. Mus. Proc., vol. 5, p. 506 (1883): U.S. Geol. Surv. Mon. 35, p. 51, Pl. 29, figs. 1-4 (1898).

Knowlton, Wash. Acad. Sci., vol. 11, p. 189 (1909).

Penhallow, Rept. Tert. Plants British Col., p. 79 (1908).

Populus cyclomorpha Knowlton and Cockerell, U.S. Geol. Surv. Bull. 696, p. 487 (1919).

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[1]Knowlton, F. H.: U.S. Geol. Surv. Prof. Paper 101, p. 321, Pl. 92 (1918).

In Ward's account of the so-called Laramie flora he recorded 13 species of Populus, although Newberry had previously recorded 8 species, only one of which Ward had found represented in his extensive collections. In Knowlton's list of the Fort Union flora (1919, page 771), 25 species of Populus are listed. It seems obvious *a priori* that there were not 25 species of this genus in the Fort Union; and when one examines critically the published illustrations or the named specimens in the National Museum collections, it becomes equally obvious that a considerable number of these so-called species are without any basis and were frequently not recognized by their founders. Moreover, one becomes impressed with the unlikeness of any of them to the leaves of the existing species of Populus, a subject remarked upon by Ward as long ago as 1887.

Newberry described the form whose name I have taken up in 1868 and its chief feature was its more or less cuneate base. It is hardly necessary to give a detailed description of my conception of the species, suffice to say that these leaves are highly variable in size, and to a somewhat less degree in form, orbicular in general outline, bluntly pointed or rounded at the tip, and cuneate to rounded truncate or even cordate at the base, with long petioles. The margin may be entire or variably toothed. There are 3 basal or sub-basal primaries, and the lowermost lateral secondaries may be sub-primary in character. The lateral primaries are ascending and variably sub-acrodrome in character.

As can be readily appreciated by any one sufficiently interested to examine the illustrations that have been published of this species these leaves are not like those of Populus, but have every feature including like variability of margin of various existing species of Trochodendraceae, such as for example *Cercidophyllum japonicum*, which may be crenate, dentate, or entire; or *Tetracentron sinensis*.

The species is abundant and widely distributed in the Lance and Fort Union, occurring also in the Hanna formation. It has been recorded from Red Deer river in Alberta, presumably from the Paskapoo, and is rather common in the Ravenscrag. This is probably what I identified as *Populus speciosa* in 1921 in the Sternberg collection from Rocky creek, sec. 15, tp. 1, range 5, W. 5th mer., above upper coal, Saskatchewan. It is present in undescribed collections from the Edmonton of Alberta.

Occurrence. Localities 2, 5, 23, 27, 34, 35, 37, 38, 3426, P-1-30, 3579 (P-10-30), P-11-30, Ravenscrag butte near centre of sec. 27, tp. 6, range 23, W. 3rd mer. Locality 9 (29-229).

Family, **Magnoliaceae**

Genus, MAGNOLIA Linné

Magnolia pulchra Ward

Magnolia pulchra Ward, U.S. Geol. Surv., 6th Ann. Rept. 1884-85, p. 556, Pl. 60, figs. 2, 3 (1886): Idem., Bull. 37, p. 103, Pl. 48, figs. 3, 4 (1887). This species, which was described from what has since been named the Mesaverde formation at Point of Rocks, Wyoming, is represented in the Upper Ravenscrag at Locality 32.

Family, **Menispermaceae**

Genus, MENISPERMITES Lesquereux

Menispermites belli Berry, n. name

Ficus asarifolia Lesquereux (not Ettingshausen 1867), U.S. Geol. and Geog. Surv. Terr. Bull., vol. I, 1875, p. 366 (1876): Idem., Ann. Rept. 1872, p. 378 (1873): U.S. Geol. Surv. Terr., vol. 7, Tertiary Flora, p. 207, Pl. 61, figs. 18-21 (1878).
Newberry, U.S. Geol. Surv. Mon. 35, p. 85, Pl. 67, figs. 5, 6 (1898).
Knowlton, Idem., Bull. 163, p. 49, Pl. 11, fig. 4; Pl. 13, fig. 2 (1900).
Penhallow, Rept. Tert. Plants British Col., p. 55 (1908).
Ficus asarifolia minor Lesquereux, op. cit., p. 367 (1876): p. 208 (1878).

This species is based upon a considerable amount of American material which in large part has been identified with the European Miocene *Ficus asarifolia* of Ettingshausen. This material is decidedly unlike that European species, as was pointed out in some detail by Knowlton as long ago as 1900.

What is of more interest is the fact that in none of its features does it conform to Ficus. On the other hand its characters are those of the Menispermaceae, and I have consequently transferred it to the form genus Menispermites and named it in honour of W. A. Bell of the Geological Survey.

Menispermites embraces a large number of forms ranging from the late Lower Cretaceous to the early Tertiary. The present species comes from the so-called post-Laramie at Black Buttes, Wyoming, and from the Mesaverde formation at Point of Rocks, Wyoming. It was recorded by Lesquereux from the Denver formation at Golden, Colorado, but this record is unsupported by any extant material. In Canada it occurs in the Whitemud at Localities 7 and 30.

Family, **Nymphaeaceae**

Genus, NELUMBO Adanson

Although there is plenty of precedent it is with some misgivings that I refer the following species to this genus, and it would perhaps be better to refer them to the less precise genus Nelumbites[1].

Nelumbo dawsoni Hollick

Plate VII, figure 1

Brasenia antiqua Dawson (not Newberry, 1883), Roy. Soc., Canada, Trans., vol. 3, 1885, sec. 4, p. 15, text fig. (1886).
Nelumbo dawsoni Hollick, Torrey Bot. Club Bull., vol. 21, p. 309 (1894).
Nelumbo laramiensis Hollick, Idem., p. 307, Text fig.
Lemna scutata Lesquereux (not Dawson), U.S. Geol. Surv. Terr., vol. 7, Tertiary Flora, p. 102, Pl. 61, fig. 2 (1878).
Nelumbo intermedia Knowlton, U.S. Geol. Surv. Bull. 163, p. 53, Pl. 13, figs. 3-5 (1900).

[1]Berry, E. W.: Md. Geol. Surv. Lower Cretaceous, p. 462 (1912).

In the preliminary studies of these collections W. A. Bell suggested that the material from the Whitemud be described as a new species on the ground that the petiole was excentric and the margin scalloped. This material has apparently suffered some loss or destruction in the packing or unpacking and I was unable to detect any satisfactory specimens with the afore-mentioned characters. I did discover, however, one specimen, that shown in the accompanying figure, and on this basis decided that it probably represented *Nelumbo dawsoni* Hollick, and it was so named in my preliminary report on the fossils from Locality 7. It occurs also at Locality 3258 (P-5-30).

Further study has led to some modification of my expressed opinion, and I cannot believe that texture, number of primaries, or entire or undulate margins are sound specific characters. I, therefore, consider that *Nelumbo dawsoni* Hollick, *Nelumbo laramiensis* Hollick, and *Nelumbo intermedia* Knowlton represent a single botanical species. Certainly the first of these, which is from the Belly River beds of Alberta, and the third, which is from the Mesaverde formation of Wyoming, are identical. There may be more doubt about *Nelumbo laramiensis*, which is more robust and with fewer primaries, and which incidentally is from the Vermejo formation of Colorado and not from the Laramie as the specific name might lead one to believe.

Nelumbo tenuifolia (Lesquereux) Knowlton

Plate VII, figures 2, 3

Nelumbium tenuifolium Lesquereux, U.S. Geol. and Geog. Surv. Terr., Ann. Rept. 1873, p. 402 (1874): U.S. Geol. Surv. Terr., vol. 7, Tertiary Flora, p. 253, Pl. 46, fig. 3 (1878).

Nelumbo tenuifolia Knowlton, U.S. Geol. Surv. Prof. Paper 130, p. 141, Pl. 26, fig. 7 (1922): Idem., 155, p. 92, Pl. 41, fig. 2 (1930).

Nelumbium lakesianum Lesquereux, op. cit., p. 403 (1874).
Knowlton, U.S. Geol. Surv. Bull. 152, p. 151 (1898).

Nelumbium lakesii Lesquereux, op. cit., p. 252, Pl. 46, figs. 1, 2 (1878).

Nelumbo lakesianum Knowlton, U.S. Geol. Surv. Prof. Paper 101, p.308 (1918): Idem., 155, p. 91, Pl. 41, fig. 1; Pl. 42, fig. 2 (1930).

There are two incomplete specimens of a leaf of Nelumbo in the collections—one from Locality 3258 (Whitemud) and the other from above the coal seam east end of Twelvemile lake, south side, near the 1928 Locality 1269, and Middle Ravenscrag in age. These indicate a leaf very similar to what has been called both *tenuifolia* and *lakesiana*. The principal difference is that in the Ravenscrag material the radial veins (primaries) are regularly forked, whereas in the Colorado types they are not symmetrically forked but have lateral branches.

If palaeobotany is ever to become a rational science, the erection of species on fragments of leaves, and based on such insignificant differences as the number of the veins, imaginary differences in textures, and other slight variations which would not be even noticed in connexion with a living species, must be discontinued. Consequently, I feel justified in referring this new Canadian material to *Nelumbo tenuifolia* and uniting *Nelumbo lakesiana* with it. As thus conceived the present species is a Laramie, Denver, and Raton form.

Genus, NELUMBITES Berry

This genus was proposed in 1912 with *Menispermites virginiensis* Fontaine from the Patapsco formation (Albian) of Maryland and Virginia as the genotype. The principal diagnostic features are the excentric petiole, undulate or obscurely toothed margins, and the tendency for some of the primaries to have branches rather than to fork dichotomously. Such features may or may not be of real generic value, but restricted as we are to foliar remains, they deserve emphasis. The name Nelumbites was perhaps unfortunate, since it does not necessarily imply any ancestral relationship to Nelumbo.

Nelumbites striata Berry, n. sp.

Plate VIII, figures 1-3

Considerable new material from the Whitemud at Locality 3258, north side of Big Muddy valley, leads me to perpetuate the manuscript name *striata* proposed by W. A. Bell for material from the Whitemud at Locality 7, but which was lost or destroyed as stated under my discussion of *Nelumbo dawsoni*.

Leaf sub-peltate, orbicular to elliptical in outline, about 5 centimetres in diameter. Margins more or less decidedly scalloped. Petiole more or less excentric. Primaries 15 to 26 in number, relatively thin, branching at about half their length and again near the margin, or several times, forming a loose areolation immediately within the margin. Secondaries fine, reticulate between the primaries. Surface radially striate independent of the venation around the petiolar scar.

The specific name alludes to the radial striation alluded to above. I have examined all of the Nymphaeaceae in the National Herbarium without finding comparable forms. None, so far as I know, has an excentric petiole, which is a mechanical defect if the leaves had a floating habit.

These leaves are not uncommon, but are for the most part not especially well preserved. The venation is weaker and the texture thinner than in any recent forms, and true dichotomies are frequently replaced by curved branches at acute angles.

The areolation is radially elongated much like that in the larger leaflets of the associated *Trapa? microphylloides* Lesquereux and the texture is rather similar, so that one gets the impression that there may be some relationship between the two. If this is the case it does not help very much, since what is called Trapa is certainly not that genus, nor related to it, and its real botanical relationship is wholly problematic.

Genus, PARANYMPHAEA n. gen.

The following and only known species will serve for the present, not only as the genotype, but also to characterize the genus.

Paranymphaea crassifolia (Newberry)

Plate VII, figures 4, 5; Plates IX, X A, and X B

Catalpa crassifolia Newberry, N.Y. Lyceum Nat. Hist. Annals, vol. 9, p. 56 (1868): [Lesquereux], U.S. Geol. and Geog. Surv. Terr., Ill. Cret. and Tert. Plants, Pl. 22 (1878).

Penhallow, Rept. Tert. Plants British Col., p. 44 (1908).

Aristolochia cordifolia Newberry, op. cit., p. 74 (1868): Lesquereux, op. cit., Pl. 25, fig. 7 (1878): U.S. Geol. Surv. Mon. 35, p. 90, Pl. 39; Pl. 40, fig. 7; Pl. 60, fig. 4 (1898).

Cocculus haydenianus Ward, U.S. Geol. Surv., 6th Ann. Rept. 1884-85, p. 556, Pl. 59, figs. 1-5 (1886): Idem., Bull. 37,p. 100, Pl. 47, figs. 1-4; Pl. 48, fig. 1 (1887).

Knowlton, Wash. Acad. Sci. Proc., vol. 11, pp. 189, 198, 200, 213, 215 (1909).

Cebatha haydenianus Knowlton, U.S. Geol. Surv. Bull. 152, p. 62 (1898).

Aristolochia crassifolia Cockerell, Am. Mus. Nat. Hist. Bull., vol. 24, p. 90 (1908).

Berry, in Williams and Dyer, Geol. Surv., Canada, Mem. 163, p. 64 (1930): Nat. Mus., Canada, Bull. 63, p. 20, Pl. 6, figs. 1-3 (1930).

Leaves oblong-ovate to sub-orbicular, sometimes inequilateral, invariably cordate; the sinus more open in the small leaves. Tip usually acute, rounded in some specimens. Margins entire, frequently slightly undulate in the larger leaves. Length ranging from 3 to 27 centimetres. Maximum width, in the lower half of the leaf, ranging from 2·75 to 23 centimetres. Petioles very stout, fleshy, long, preserved for lengths of 12 centimetres. Venation peculiar and highly characteristic. Midvein inordinately stout and fleshy. In the very young leaves the laterals are much subordinated to the midvein and a pair of lateral primaries and one or two additional pairs of much thinner veins diverge from the top of the petiole. In the larger leaves these increase in size to rival the midvein, and one or more additional may develop so that there are from 7 to 9 primaries radiating from the top of the petiole, the latter as preserved being sometimes as much as 10 millimetres in diameter.

The primaries diverge at approximately equal angles and usually fork at from one-quarter to one-third the distance to the margin, the primary forks again forking two-thirds of the distance distad. Secondaries stout, regularly spaced, three or four opposite or sub-opposite pairs, forking at least once. The ends of all forks are usually joined by broad arches, from which rather straight veins proceed outward at regular intervals, and these fork near the margins and their tips are joined by flattened arches which form a distinct marginal hem, close to, and parallel with the margin. This marginal vein, which is characteristic of the species, was first noticed by Ward, who coined the term paryhodrome for it. The internal venation is open and apt to comprise straight sided tertiary loops with straight radiating veinlets.

Textures are difficult to make out, all of the material showing a much flattened and apparently thin lamina, but the way this is sometimes compressed over miscellaneous plant fragments, and the way the coarse venation is smoothly flattened seems to indicate that in life these leaves were

somewhat fleshy. None of the material seen enables me to determine the character of the stomata, or whether they were confined to one or the other surfaces, or absent from both surfaces, which might permit an opinion as to whether the habit was one of immersion, floating or emersion.

Among existing Nymphaceae the leaves of certain species of Nymphaea approach the fossils most closely in form, the principal difference being the much more numerous and closely spaced veins of the former. This is true in spite of a certain variation in this feature among existing species. Thus *Nymphaea advena* Soland has very closely spaced veins, *Nymphaea rubrodisca* (Morong) Greene has them less crowded, and *Nymphaea kalmiana* (Michaux) Sims has the venation still more open. A somewhat similar form is seen in the seedling leaves (after the first) in Nymphaea, Castalia, and Victoria, and some mature leaves of Castalia are also similar, as for example, the old world *Castalia pygmaea* Salisbury, the Texas and Mexican *Castalia elegans* (Hooker), and to a certain extent *Castalia tetragona* (Georgi) Lawson.

An argument in favour of an immersed rather than a floating habit is furnished by the apparent flaccidity of the fossils, in appearance being rather closely comparable with the submerged leaves of *Nymphaea lutea* Linné. Floating leaves in order to keep from being torn in rough water or by rain drops, require a coriaceous texture, and all existing floating Nymphaceae do have such a texture.

One adaptation that an efficient floating leaf must acquire is the situation of the petiole at approximately the centre of gravity of the leaf. This is usually accomplished in this family by the leaves becoming orbicular or elliptical and peltate, or by approximating this form with a slit base as in Castalia. Certainly the young leaves of Paranymphaea do not fulfil this requirement, but there is an approximation to it in the larger leaves.

Another feature characteristic of this species and of the Nymphaceae in general is the marginal vein, already described as formed by the flattening of the arches of the ultimate areolation. This is a mechanical adaptation to prevent tearing and serves to relate the present form to the Nymphaceae and to contrast it with Aristolochia and other genera with which it has been compared. In addition to this feature the venation in its entirety is wholly different from that of Aristolochia, Cocculus, Catalpa, etc., and the mature leaves of the fossil are much larger than in these genera; especially is this true of the new world species of Aristolochia.

The rather complete adaptation of the Nymphaceae to an aquatic habit, particularly the perenniating rhizome, are indicative of a considerable geologic history, as indeed is their present wide geographical range. Members of the family under a variety of generic appellations are known from the Upper Cretaceous to the present, and in the lower Eocene there are well-marked and strictly modern looking species of Nelumbo, a genus that some students regard as the most evolved of the family. Castalia is also known to have an even longer geologic range.

Paranymphaea crassfolia is locally abundant in the Lance, Paskapoo, Ravenscrag, and Fort Union of Alberta, Saskatchewan, Montana, Wyoming, Dakota, etc.

Occurrence. Ravenscrag Butte, sec. 27, tp. 6, range 23, W. 3rd mer., Localities 4, 5, 10 (1248), 11, 13, P-1-30, and P-4-30, 2624.

Order, ROSALES

Family, **Drupaceae**

Genus, PRUNUS Linné

Prunus mclearni Berry, n. sp.

Plate XI, figures 1, 2

Leaves of variable size, narrowly ovate-lanceolate, usually slightly falcate, and sometimes considerably inequilateral. Base, rounded, ultimately decurrent. Tip acuminate. Texture of medium consistency. Margins entire for a greater or less distance proximad and frequently also in the acuminate tip; elsewhere with fairly prominent and rather closely and evenly spaced serrate teeth. The spacing of the teeth becomes less regular and more distant both toward the base and toward the tip. Average size about 6 centimetres in length but about 2 centimetres in maximum width. One fragment of not certain identity indicates a leaf at least twice this length and about 3 centimetres in maximum width. No complete petioles preserved; incomplete length up to 5 millimetres indicates that it was stout and curved. Midvein stout and prominent. Secondaries stout and prominent, numerous, and fairly regularly spaced; they diverge from the midvein at acute angles and ascend in sweeping curves, coming to be nearly parallel with the margins toward their ends; prevailingly camptodrome, although a few toward the tip of the leaf appear to be craspedodrome. Tertiary branches enter some of the marginal teeth. Internal tertiaries thin, closely spaced, and percurrent.

This species is represented by several specimens which are mostly incomplete. Nothing exactly like it has heretofore been discovered from the late Upper Cretaceous or early Tertiary. Perhaps the most similar previously described form is a species, *Prunus denverensis*, described recently by Knowlton[1] from the Dawson arkose of Colorado. This is about the same size except for a rather improbable fragment which has been so named but the identity of which I would seriously question. *Prunus denverensis* has the same form, a similar tip, but a slightly narrower base. The secondaries are fewer and less ascending, and the serrate marginal teeth are finer and more evenly spaced throughout.

A considerable number of fossil forms, both leaves and stones, have been referred to Prunus. The oldest of these are leaves from the Raritan and Dakota formations of the United States, and the Chlomeker sandstone of Silesia. At least a half dozen species have been recorded from the Eocene of Europe, America, Greenland, and Spitzbergen. Two of these, namely: *Prunus staratschinii* Heer[2] from Spitzbergen and *Prunus nabortensis* Berry[3] from the Wilcox of Louisiana are based upon stones, and the last is highly characteristic. There are 8 to 10 Oligocene species, recorded for the most part from European localities. Miocene species number more than 30 and many of these, both leaves and stones, are entirely convincing. There are 18 species recorded from the Pliocene, all but Alabama and California forms being European, and mostly positively determined. Nine or ten species are recorded from scattered Pleistocene localities in both Europe and America.

Occurrence. Locality P-1-30.

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[1]Knowlton, F. H.: U.S. Geol. Surv. Prof. Paper 155, p. 97, Pl. 44, figs. 3, 4, 6, 11 (?) (1930).
[2]Heer, O.: Fl. Foss. Arctica, Bd. 2, p. 69, Pl. 14, fig. 18 (1870).
[3]Berry, E. W.: U.S. Geol. Surv. Prof. Paper 91, p. 221, Pl. 116, fig. 1 (1916).

Order, ROSALES

Family, **Leguminosae**

Genus, LEGUMINOSITES Bowerbank

Leguminosites sp.

A fragment of a small undeterminable leguminous pod was found at Locality 27. It is compressed, about 4·5 millimetres wide, of unknown length, and prominently transversely veined. Comparisons with such inadequate material are entirely futile, but it is worth recording as more complete material may subsequently be collected.

Order, SAPINDALES

Family, **Celastraceae**

Genus, CELASTRUS Linné

Celastrus taurinensis Ward

Celastrus taurinensis Ward, U.S. Geol. Surv., 6th Ann. Rept. 1884-85, p. 555, Pl. 52, figs. 15, 16 (1886): Idem., Bull. 37, p. 79, Pl. 34, figs. 5, 6 (1887).

(?) Hollick, Geol. Surv. La., Special Rept. 5, p. 285, Pl. 46, fig. 1 (1899). Knowlton, Wash. Acad. Sci. Proc., vol. 11, p. 213 (1909).

(?) Berry, U.S. Geol. Surv. Prof. Paper 91, p. 267, Pl. 60, figs. 1-3 (1916): Nat. Mus., Canada, Bull. 63, p. 24 (1930).

Celastrus ovatus Ward, op. cit., p. 555, Pl. 53, fig. 7 (1886): op. cit., p. 71, Pl. 36, fig. 1 (1887).

Knowlton, op. cit., p. 190 (1909) (not Hill, 1865).

Celastrus wardii Knowlton and Cockerell, U.S. Geol. Surv. Bull. 696, p. 160 (1919).

Berry, in Williams and Dyer, Geol. Surv., Canada, Mem. 163, p. 64 (1930): Nat. Mus., Canada, Bull. 63, p. 24 (1930).

Celastrus curvinervis Ward, op. cit., p. 555, Pl. 53, figs. 9, 10 (1886): op. cit., p. 82, Pl. 36, figs. 3, 4 (1887).

Knowlton, op. cit., p. 189 (1909).

This species is rather widespread in the Lance, Fort Union, and Ravenscrag formations. The base may be rounded, truncate, or cuneate. The tip may be short or somewhat produced. Outline ranges from subelliptical and pointed to ovate-lanceolate. The secondaries are more or less ascending according to the relative width of the lamina. Especially common in all sizes and shapes at Locality 3052, Big Muddy valley, south side and west of Bengough road (P-12-30). Also found at Localities 5, 24 (?), and 33.

Celastrus ferrugineous Ward

Celastrus ferrugineous Ward, U.S. Geol. Surv., 6th Ann Rept. 1884-85, p. 555, Pl. 52, figs. 11-14 (1886): Idem., Bull. 37, p. 78, Pl. 34, figs. 1-4 (1887).

Knowlton, Wash. Acad. Sci. Proc., vol. 11, p. 215 (1909).

Celastrus serratus Knowlton, U.S. Geol. Surv. Prof. Paper 101, p. 329, Pl. 98, fig. 3; Pl. 99, fig. 4; Pl. 100, fig. 1 (1917).

If what is called by this name has any objectivity, which is doubtful, it is to be distinguished by its relative shortness, rather abrupt tip, and crowded secondaries. I believe that Ward inextricably mixed the Celastrus leaves that he described from Montana, and much doubt if there was more than a single variable species of Celastrus represented. I am keeping the present form separate tentatively, since my material, although abundant, is fragmentary. It is a supposed Lance, Fort Union, and Raton species.

Occurrence: Horizon of Keogh seam, hill north of road at Keoghs (P-4-30), and doubtfully at Locality P-3-30.

Genus, EUONYMUS Linné

Euonymus xantholithensis Ward

Euonymus xantholithensis Ward, U.S. Geol. Surv., 6th Ann. Rept. 1884-85, p. 555, Pl. 54, figs. 1, 2 (1886): Idem., Bull. 37, p. 82, Pl. 37, figs. 1, 2 (1887).

The material, despite its great variation in size, and to a less extent in marginal characters, seems to represent a single species. It may be regarded as doubtfully distinct from Celastrus, and this statement applies to Ward's types from the Fort Union of Montana quite as much as to the Canadian material. It is possible that the larger leaves may be related to what has been called *Hicoria antiquorum* (Newberry) both in the present and in other connexions.

The solution of such vexing questions is a problem for the future and rests upon ample and complete comparative material, such as is not yet available. The present species, if it is a species, is variable, especially in size, and rather widely distributed. It occurs at Localities 1, 2, and 3 sparingly and doubtfully, at Locality 37, abundantly at Locality 3258, and also at Localities 3052 (P-12-30) and P-1-30.

Order, SAPINDALES

Family, **Sapindaceae**

Genus, SAPINDUS Linné

Sapindus grandifoliolus Ward

Plate XI, figure 3

Sapindus grandifoliolus Ward, U.S. Geol. Surv., 6th. Ann. Rept. 1884-85, p. 554, Pl. 50, figs. 4-8 (1886): Idem., Bull. 37, p. 67, Pl. 30, figs. 3-5 (1887).

Knowlton, Idem., Mon. 32, pt. 2, p. 737, Pl. 99, figs. 1, 2; Pl. 102, fig. 4 (1899): Wash. Jour. Sci. Proc., vol. 11, pp. 190, 195, 198, 211, 213, 214 (1909): Jour. Geol., vol. 19, p. 369 (1911).

This rather widespread Lance and Fort Union species is represented at several localities in Canada. The incomplete leaf figured and its counterpart from Rockglen, Saskatchewan (Locality 3579, P-10-30) differs somewhat from the type in being larger and more inequilateral. Nevertheless it shows the same general facies and agrees in the character of the venation, and I regard it as representing this species, especially as more normal forms occur at Locality 33 and Locality 3052 (P-12-30). The material from these two localities is not uncommon and is somewhat under normal size, that from the first locality being less acutely tipped.

Locality 2 (?), Locality 24 (?).

Sapindus affinis Newberry

Sapindus affinis Newberry, N.Y. Lyceum Nat. Hist. Annals, vol. 9, p. 51 (1868): [Lesquereux], U.S. Geol. and Geog. Surv. Terr., Ill. Cret. and Tert. Plants, Pl. 24, fig. 1; Pl. 25, fig. 2 (1878): U.S. Geol. Surv. Mon. 35, p. 116, Pl. 30, fig. 1; Pl. 40, fig. 2 (1898).

Knowlton, Idem., Mon. 32, pt. 2, p. 736, Pl. 102, figs. 1-3: Wash. Acad. Sci. Proc., vol. 11, pp. 185, 189, 191, 201, 202, 211, 214 (1899): U.S. Geol. Surv. Prof. Paper 101, p. 331: Pl. 99, fig. 3 (1918).

Ward, Idem., 6th Ann. Rept. 1884-85, p. 554, Pl. 50, figs. 2, 3 (1886): Idem., Bull. 37, p. 67, Pl. 31, figs. 1, 2 (1887).

Sapindus angustifolius Ward (not Lesquereux), op. cit., p. 554, Pl. 51, figs. 1-3 (1886): op. cit., p. 68, Pl. 31, figs. 5-7 (1887).

This species was originally described from the Fort Union, in which it is widespread and common. Subsequently it was found to be equally common in the underlying Lance. It has also been recorded from the Raton formation, and from Porcupine creek and Great valley, Saskatchewan.

There are three specimens from Rockglen, Saskatchewan (Locality 3579, P-10-30) that are the same as the specimens from the Fort Union at Glendive, Montana, which Ward referred to *Sapindus angustifolius* Lesquereux, but which are not that Miocene species, but should be included in *Sapindus affinis* Newberry.

Order, RHAMNALES

Family, **Rhamnaceae**

Genus, RHAMNUS Linné

Rhamnus cleburni Lesquereux

Rhamnus cleburni Lesquereux, U.S. Geol. Surv. Terr., Ann. Rept. 1872, p. 381 (1873): Idem., vol. 7, Tertiary Flora, p. 280, Pl. 53, figs. 1-3 (1878).

Knowlton, U.S. Geol. Surv. Bull. 204, p. 80 (1902) (?): Idem., Prof. Paper 101, p. 332, Pl. 113, fig. 3 (1918): Idem., 155, Pl. 104, Pl. 40, fig. 6; Pl. 46, figs. 10, 11 (1930).

Berry, Idem., Prof. Paper 91, p. 283 (1916).

This species has been recognized at only Locality 3 among the Canadian collections. The original material came from the Denver formation, and later records include the Raton, Wilcox, and Clarno (?). It has not been encountered in either the Lance or Fort Union formations, in fact no species of Rhamnus is known from the Lance, Kenai, Livingston, or Paskapoo; and but a single species from the Evanston and Fort Union. On the other hand there are 6 species recorded from the Raton and the same number from the Denver. These peculiarities of representation, if they are valid, raise an interesting question of environmental factors, the answer to which is not at all clear.

An undeterminable Rhamnus occurs at Locality 24.

Genus, ZIZYPHUS Adanson

Zizyphus serrulatus Ward

Zizyphys serrulatus Ward, U.S. Geol. Surv., 6th Ann. Rept. 1884-85, p. 554, Pl. 51, figs. 14, 15 (1886): Idem., Bull. 37, p. 73, Pl. 33, figs. 3, 4 (1887).

Knowlton, Idem., Mon. 32, pt. 2, p. 740, Pl. 101, figs. 4, 5 (1899).

This species is represented at Locality 2. The leaves so named are ovate and relatively broad. They agree with Ward's type, but on the other hand they are doubtfully distinct from various so-called species of Zizyphus and Paliurus. The entire record of the occurrence of these two genera in western North America is in a state of utmost confusion, not only as to specific limits, but also as to generic separation, which, in most cases, is extremely hazardous and unconvincing.

Zizyphus coloradensis Knowlton, emend.

Zizyphus coloradensis Knowlton, U.S. Geol. Surv. Prof. Paper 130, p. 157, Pl. 15, fig. 5 (1922).

This species was based upon a single incomplete specimen from the Laramie at Popes Bluff, Colorado, which probaly should never have been dignified with a name. Identical material, also incomplete, is contained in collections from the Ravenscrag at Rockglen (locality 3579, P-10-30). The latter material, however, enables me to somewhat amplify Knowlton's diagnosis.

Leaves ovate (not elliptical), with a broadly rounded cuneate base and an acute tip. Texture thin but apparently stiff. Margins entire below; above with broad, shallow, crenate teeth. Length 4·5 to 6 centimetres. Maximum width 1·8 to 2·5 centimetres. Petiole stout, not preserved. Primaries five, from the top of the petiole, fairly prominent. Midvein slightly stouter than the laterals: the inner pair of laterals run into the tip of the leaf, but their distal course is obscure: the outer pair, but slightly thinner than the inner, maintain their integrity for one-third to one-half their length, above which they thin and arch from the ends of the short lateral branches from the inner pair of laterals. There is a marginal series of small camptodrome arches, branches from which run to the marginal teeth. If there are secondaries from the distal part of the midvein they are few and small.

This species is also represented by two incomplete specimens from the Whitemud at Locality 7 and from the Ravenscrag at Locality 3579 (P-10-30).

Genus, PALIURUS Jussieu

Paliurus colombi Heer

Paliurus colombi Heer, Fl. Foss. Arctica, Bd. 1, p. 122, Pl. 17, fig. 2d; Pl. 19, figs. 2-4 (1868).

Lesquereux, U.S. Geol. and Geog. Surv. Terr., Ann. Rept. 1871, p. 288 (1872): U.S. Geol. Surv. Terr., vol. 7, Tertiary Flora, p. 273, Pl. 50, figs. 13-17 (1878).

Ward, U.S. Geol. Surv., 6th Ann. Rept. 1884-85, p. 555, Pl. 52, figs. 4-6: Idem., Bull. 37, p. 75, Pl. 33, figs. 8-10 (1887).

Knowlton, Idem., Mon. 32, pt. 2, p. 740, Pl. 101, fig. 7 (1899): Jour. Geol., vol. 19, p. 269 (1911).

There are specimens from two Canadian localities that have been tentatively identified as this species. It was proposed by Heer for Arctic material that was apparently widely distributed in that region since it is recorded from Greenland, Spitzbergen, Sakhalin, Siberia, and Alaska.

American authors have identified it from the Lance, Hanna, and Fort Union. Much of this material is most uncertain as to both species and genus, since the original characterization was not precise, the generic reference doubtful, and subsequent authors have been careless, and have maintained a great variety of species of Paliurus, Zizyphus, Grewiopsis, Populus, etc., which cannot be recognized with certainty. Certain of the leaves from the Ravenscrag which I have referred to *Trochodendroides cuneata* (Newberry) are much like what authors have referred to *Paliurus colombi*, as are also certain others referred to *Grewia crenata*. It is not possible to settle the problem of their inter-relationship in the present connexion, but it is fully recognized.

Occurrence. Localities 2, 3579 (P-10-30), and 3052 (P-12-30).

Paliurus pulcherrimus Ward
Plate XI, figures 5-8

Paliurus pulcherrimus Ward, U.S. Geol. Surv., 6th Ann. Rept. 1884-85, p. 555, Pl. 52, fig. 7 (1886): Idem., Bull. 37, p. 75, Pl. 33, fig. 11 (1887).
Knowlton, Wash. Acad. Sci. Proc., vol. 11, p. 213 (1909).

I doubt very much if the various small leaves that have been referred to *Paliurus colombi* Heer, *Zizyphus serrulata* Ward, *Zizyphus meekii* Lesquereux, *Zizyphus cinnamomoides* Lesquereux, *Paliurus pealei* Ward, and *Paliurus pulcherrimus* Ward are distinct as they stand in the literature. Certainly as there defined and illustrated no specific lines can be drawn satisfactorily.

In order not to go beyond the observed facts I am referring the present material to *Paliurus pulcherrimus* Ward, although there is no evidence that it represents this genus rather than Zizyphus, Ceanothus, or even Rhamnus, or that this species is an objective reality.

The present material is fairly abundant and ranges in form from lanceolate to ovate. All have crenulate margins but the toothing is so slightly incised that, at first glance, the margins appear entire. The petioles, when complete, are always relatively long and curved, and the disposition of the principal veins at the base appears to be palmately five veined, but only one pair of these—the inner— are acrodrome. The species has been previously recorded from the Hanna and Lance formations.

Occurrence. Locality 9 (29-229).

Family, **Vitaceae**

Genus, VITIS Linné

Vitis dakotana Berry, n. sp.
Plate XII, figures 1, 2

Leaf petiolate, ovate-orbicular, with a deeply cordate, or exceptionally a straight base, palmately triveined. Margin with regular mucronate to serrate teeth separated by broader, rounded, sub-equilateral, shallow sinuses, except in the vicinity of the petiole where it is entire. Petiole stout, 5 centimetres long in a minimum-sized leaf. Midvein straight to slightly flexuous, tip of leaf rounded or pointed. Lateral primaries of same calibre as the midvein, diverging from it at the top of the petiole at angles of from 30 to 50 degrees. Sometimes the lateral primaries are slightly supra basilar, in which case a pair of veins the size of secondaries may diverge from the top of the petiole, giving the leaf a palmately five-veined appearance. Lateral primaries usually curve upward but may curve in a reverse direction, they give rise to from 5 to 9 secondaries from their outer side, and all except occasionally the lowermost are craspedodrome and terminate in the marginal teeth. The secondaries from the midvein may be simple or give rise to one or more outer branches, all being craspedodrome. The basal secondaries below the lateral primaries have 5 to 9 outer branches, the distal ones craspedodrome, the proximal ones where the margin is entire camptodrome. Tertiaries well defined, mostly simple,

straight, and percurrent, more rarely forked. Aerolation distinct, mostly open and quadrangular.

W. A. Bell, who made a preliminary study of the earlier collections before they were submitted to me, was the first to differentiate this species in the Canadian material, and proposed in manuscript the name *Luhea mcconnelli* for it, having compared it with the existing Peruvian species *Luhea paniculata* Martin of the family Tiliaceae. This resemblance is undoubted, but it is not botanically convincing for the reason that I happen to have a large suite of perfect specimens in a great variety of sizes of a similar form from the lower Lance of Harding county, South Dakota, which unquestionably should be referred to the genus Vitis, and which I had described in manuscript as *Vitis dakotana*,[1] which name I have decided to use for the Canadian material, which is identical with some of the leaves of the lower Lance form. This agreement is complete except in the case of the very large, and consequently coarse, leaves from the Dakota Lance.

Occurrence. Whitemud at Locality 7.

Genus, AMPELOPSIS Michaux (?)

Ampelopsis montanensis Cockerell (?)

Vitis cuspidata Ward, U.S. Geol. Surv., 6th Ann. Rept. 1884-85, p. 554, Pl. 51, figs. 9-11 (1886): Idem., Bull. 37, p. 71, Pl. 32, figs. 6-8 (1887).

Ampelopsis montanensis Cockerell, Am. Mus. Nat. Hist. Bull., vol. 24, p. 103 (1908).

This is a small, palmately five-veined leaf with finger-like, acute teeth, which agrees fairly well with Ward's figures of this supposed species. The teeth are somewhat blunter. The lateral primaries are not especially well marked and the upper secondaries are simple and few in number. All are ascending and craspedodrome. The only recorded occurrences are this one and the type one in the Fort Union of Montana. The real botanical affinity is entirely problematical.

Occurrence. Whitemud at Localities 7 and 30.

Order, MALVALES

Family, **Sterculiaceae**

Genus, PTEROSPERMITES Heer

Pterospermites minor Ward

Plate XI, figure 4

Pterospermites minor Ward, U.S. Geol. Surv., 6th Ann. Rept. 1884-85, p. 556, Pl. 56, figs. 7-9 (1886): Idem., Bull. 37, p. 95, Pl. 42, figs. 1-3 (1887).

Knowlton, Wash. Acad. Sci. Proc., vol. 11, p. 198 (1909).

A single specimen from Locality 5 appears to represent this species. The three specimens from the Fort Union of Montana figured by Ward show an inequilateral, more or less cordate base, but in no case show the

[1] Since described and figured in Prof. Paper 185-F, U.S.G.S., pp. 130, 131, Pl. 26, figs. 4-6, Pl. 27 (1934).

upper half of the leaf. The present specimen is somewhat larger than the type, and is complete except for the extreme base. It is very faint, however, so that most of the tertiary venation is obscure, and one side of the lamina has been deformed since burial, especially toward the base.

The form is asymmetrically ovate, and the marginal teeth are somewhat irregular. It is difficult to decide on the texture, but it gives the impression of having been somewhat flaccid. The midvein and secondaries are decidedly stouter than they appear on casual inspection. On the whole the specimen agrees fairly well with the type. The species is also recorded from the Lance of Montana.

Pterospermites penhallowi Berry, n.sp.

Plate XIII

Leaves of large size, ovate in general outline. Margins entire for the lower third or half; above with prominent dentate teeth, diminishing in size distad, and occasionally with interspersed smaller teeth of the same character. Tip acute, either short or extended. Base cordate, possibly varying to truncate or widely cuneate. Length 15-17 centimetres. Maximum width 7·5 to 9 centimetres. Petiole stout, always incomplete. Midvein stout, prominent. Secondaries of medium size, numerous, fairly regular in spacing, varying in angle of divergence from the midvein according to the relative proportions of the individual leaves; rather straight, camptodrome where the margins are entire and craspedodrome where they are toothed. Upper secondaries simple; lower with several lateral branches, which are, for the most part camptodrome; the basal two or three pairs have numerous branches on the outside, as shown in the accompanying figures. Tertiaries thin but well marked, transverse to the secondaries, simple percurrent or inosculating midway between the secondaries.

Among the numerous Upper Cretaceous and early Tertiary leaves that have been referred to the genus Pterospermites there is none closely similar to the present species unless it be *Pterospermites spectabilis* Heer.[1] This is recorded from a number of localities and including a variety of forms, including a variety *dentatis* from the Greenland and Mackenzie River Eocene. The latter is not exactly the same as the present species, but the two are certainly congeneric.

The genus Pterospermites was founded by Heer for fossil leaves supposed to be related to the existing genus Pterospermum. This remains as doubtful today as it was in 1859 when Heer first suggested it. The genus, possibly composite, has about 10 American Upper Cretaceous species, 1 in the Denver, 3 in the Lance, 4 in the Fort Union, and 5 in the Kenai.

Occurrence. Localities 1, 3, 32, and 35.

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[1]Heer, O.: Fl. Foss. Arct., Bd. 2, abt. 4, p. 480, Pl. 43, fig. 15b; Pl. 53, figs. 1-4 (1869).

Family, **Tiliaceae** (?)

Genus, GREWIA Linné (?)

Grewia crenata of American authors

Grewia crenata Ward, U.S. Geol. Surv., 6th Ann. Rept. 1884-85, p. 555, Pl. 54, fig. 13 (1886): Idem., Bull. 37, p. 85, Pl. 39, fig. 1 (1887).
Newberry, Idem., Mon. 35, p. 120, Pl. 46, fig. 2; Pl. 48, figs. 2, 3 (1898).
Knowlton, Idem., Bull. 204, p. 80 (1902).
Penhallow, Rept. Tert. Plants British Col., pp. 58, 66 (1908).

Plaiurus colombi Lesquereux, U.S. Nat. Mus. Proc., vol. 11, p. 16 (1888).
Knowlton, U.S. Geol. Surv. Bull. 108, p. 104 (1893).

It should be clearly recognized that the present material is different from the European Miocene *Grewia crenata* (Unger) Heer, and also that it is not, in all probability, related to the existing genus Grewia. It is, however, identical with what Ward called by this name from the Fort Union of Bull mountain, Montana.

Rather similar leaves from the Fort Union, lacking, however, the cordate base, have been referred to *Zizphyus serrulata* Ward and *Zizyphus meekii* Lesquereux, as well as to the genus Populus. The present identification is, therefore, of merely stratigraphic significance, and has no botanical value. If other proof were needed to corroborate this statement it is furnished by the great chronologic range of the records.

Occurrence. Localities 32 and 3258.

Genus, GREWIOPSIS Saporta

Grewiopsis mclearni Berry, n.sp.

Plate XII, figure 3; Plate XIV A

Leaves variable in size and outline, ranging from ovate to approximately orbicular. Tip pointed but not produced. Base varying from rounded-truncate to slightly cordate. Length ranging from about 7 to 13 centimetres. Maximum width, slightly below the middle, ranging from about 5 to 13 centimetres. Margin, except near the base which is entire, with rather uniform, large, closely spaced, inequilateral, crenate teeth. Petiole long and stout, total length not preserved. Midvein stout, prominent. Lateral primaries stout, prominent, sub-acrodrome, from the top of the petiole. In the ovate leaves there is a single lateral primary on each side, but in the large, wide leaves the basal outer secondaries may become stout and diverge from the top of the petiole, and resemble primaries, although they never have the long ascending course of the true lateral primaries. Internal secondaries thin, more or less transverse and inosculating. External secondaries stout, camptodrome. Tertiaries mostly obsolete in the material, which is preserved in clay-ironstone, a few are seen entering the teeth.

This species is common in all sizes at Localities 34 and 37, which is in the middle part of the Ravenscrag formation. It occurs also at Locality 6. It is much like *Grewiopsis tennesseensis* Berry of the Wilcox lower Eocene in southeastern North America, but lacks the extended acumen of the

latter. It also resembles several of the protean forms from the early Eocene of the western United States and Canada which have been ascribed, I believe wrongly, to the genus Populus. Recently I identified[1] similar although somewhat smaller leaves from the Ravenscrag beds of the Cypress Hills region as *Trochodendroides speciosa* (Ward). These may represent the present species, which possibly may be more properly referable to Trochodendroides than to Grewiopsis.

Order, LAURALES

Family, **Lauraceae**

Genus, LAUROPHYLLUM Goeppert

Laurophyllum ripleyensis Berry

Plate XV, figures 1, 2

Laurophyllum ripleyensis Berry, U.S. Geol. Surv. Prof. Paper 136, p. 80, Pl. 18, figs. 4-8 (1925).

Laurus coloradensis Knowlton, Idem., Prof. Paper 98, p. 340, Pl. 88, fig. 5 (not fig. 4) (1916).

Leaves elongate-lanceolate and generally falcate, variable in size and proportions. Tip generally extended and acuminate. Base gradually narrowed and acuminate like the tip. Margins entire. Texture coriaceous. Petiole very stout, curved, enlarged proximad, 1 to 1·5 centimetres long in the larger leaves. Midrib, stout, prominent, curved. Secondaries relatively thin, numerous, sub-parallel and camptodrome. Tertiaries mostly obsolete.

This characteristic species belongs to a type of leaf that is abundant in most of the Upper Cretaceous and early Eocene deposits of the world and one commonly referred to Laurus or Laurophyllum, since its true generic relationship among the existing genera of this family cannot be determined, although the present species have some of the features of existing leaves of the genus Nectandra. However, there is so much convergence in the foliar characters in this family that the more non-commital form genus Laurophyllym is preferable.

This is the plant that was reported in manuscript as common at Locality 33 in the Upper Ravenscrag as *Nectandra pseudocoriacea* (?), a Wilcox species.[2] This identification was regarded as unsatisfactory and a survey was made of all of the known lauraceous forms of this character in order to reach more certain conclusions, with the result that it is now referred to *Laurophyllum ripleyensis*. This species is very abundant in the Ripley formation of western Tennessee, and what appears to me to be the same thing was recorded by Knowlton under another name from the Fruitland formation of San Juan county, New Mexico.

Naturally there are a variety of previously described forms that resemble it to a greater or less degree, and there is a great deal of uncertainty in the differentiation of these, the older work being especially loose. Among

[1]Berry, Edward W.: Contributions to Canadian Palæontology; Geol. Surv., Canada, Bull. 63, p. 22, Pl. 5, fig. 8 (1930).

[2]Berry, Edward W.: U.S. Geol. Surv. Prof. Paper 91, p. 311, Pl. 87, fig. 2; Pl. 88, figs. 1-3 (1916).

similar forms that may be mentioned are *Laurus wardiana* Knowlton from the Laramie at Golden, Colorado, formerly referred to *Laurus ocoteoides* Lesquereux. This is a somewhat larger leaf with a less acuminate apex and base. Another resemblance is to some of the leaves from Evanston, Wyoming, that have been referred to the European *Laurus primigenia* Unger. The Laramie species, now called *Ficus navicularis* Cockerell, formerly *Ficus lanceolata* of Lesquereux, but not of Heer, is also much like the present species in appearance.

I am satisfied that *Laurophyllum ripleyensis* belongs to the Lauraceae, and not in the Moraceae, and it is undoubtedly not very distinct from the Wilcox *Nectandra pseudo-coriacea*. In my final discussion of the Wilcox flora[1] it was pointed out that the latter was probably a direct descendant of *Laurophyllum ripleyensis*.

Order, MYRTALES

Family, **Myrtaceae**

Genus, MYRCIOPHYLLUM Engelhardt

Myrciophyllum americanum Berry, n. sp.

Plate XV, figure 3

Leaves small, lanceolate, falcate, widest below the middle, with an acuminate or narrowly acute tip and a cuneate, decurrent base. Margins entire. Texture thin but relatively coriaceous for the size of the leaf. Length about 3 centimetres. Maximum width about 7·5 millimetres. Petiole relatively very stout, curved, about 5 millimetres in length. Midvein stout, prominent, curved. Secondaries relatively stout, diverging from the midvein at angles approaching 90 degrees and running straight to the relatively stout marginal acrodrome veins, which are parallel with the margins.

This leaf shows a close resemblance to the leaves of the existing and fossil species of Myrcia, and had it come from the equatorial or some tributary region I would not hesitate to refer it to that genus. There are, however, certain considerations that suggest caution. The principal of these is that although Myrcia-like leaves are common in the Atlantic Coastal Plain from the Upper Cretaceous through the older Tertiary, they appear to have disappeared in western North America after the mid-Cretaceous.

The present species represents the sort of a leaf that Lesquereux or Newberry would unhesitatingly have referred to the genus Eucalyptus, but there are many and cogent reasons for believing that this genus was never present in North America[2].

The only records of late Cretaceous or Tertiary Eucalyptus-like leaves from western North America are *Eucalyptus haeringiana* Lesquereux (not Ettingshausen) from Black Buttes, Wyoming, which is a leguminous leaflet in all probability, and *Eucalyptus americana* Lesquereux from the Green River Eocene, the botanical affinity of which is in doubt.

[1]Idem., Prof. Paper 156, p. 16 (1930).
[2]Berry, Edward W.: Bot. Gazette, vol. 59, pp 484-490 (1915): Science, vol. 49, pp. 91-92 (1919).

In searching for a generic appellation for the present species a number of form genera suggest themselves. The name Myrtophyllum proposed by Heer in 1869 would be admirable as indicative of the leaves belonging to the Myrtaceae but of unknown generic identity were it not for the fact that Turcz in 1863 used this name for a living genus in the family Flacourtiaceae. The term Myrtiphyllum of Dusén, 1899, is objectionable as being too much like the preceding and also because the genotype is a species of Myrcia. The term Myrtonium of Ettingshausen, 1886, was based upon Australian fossil material which it seems certain is generically different from the present material. I have, therefore, used the pseudogeneric term Myrciophyllum proposed by Engelhardt in 1891 as implying a Myrcia-like leaf belonging to the family Myrtaceae.

The present species is based upon a single specimen and its counter part from Rockglen, Saskatchewan, at Locality 3579, P-10-30.

Order, UMBELLALES

Family, **Araliaceae**

Genus, ARALIA of authors

Aralia notata Lesquereux

Plate XIV B

Platanus dubia Lesquereux, U.S. Geol. and Geog. Surv. Terr., Ann. Rept. 1873, p. 406 (1874): Schimper, Pal. végét., tome 3, p. 35 (1874) (not Ettingshausen).

Aralia notata Lesquereux, U.S. Geol. Surv. Terr., vol. 7, Tertiary Flora, p. 237, Pl. 39, figs. 2-4 (1878): U.S. Nat. Mus. Proc., vol. 11, p. 40, Pl. 17, fig. 1 (1888).

Ward, U.S. Geol. Surv., 6th Ann. Rept. 1884-85, p. 553, Pl. 48, fig. 8 (1886): Idem., Bull. 37, p. 60, Pl. 27, fig. 1 (1887).

Knowlton, Idem., Mon. 32, pt. 2, p. 745, Pl. 100, fig. 1 (1899): Torrey, Bot. Club Bull., vol. 29, p. 706 (1902): Wash. Acad. Sci. Proc., vol. 11, pp. 194, 196, 198 (1909).

Penhallow, Roy. Soc., Canada, Trans., vol. 8, p. 70 (1902): Rept. Tert. Plants British Col., p. 38 (1908).

Berry, U.S. Geol. Surv. Prof. Paper 91, p. 327, Pl. 97, fig. 4 (1916).

Aralia sp., Knowlton, Idem., Bull. 204, p. 81 (1902).

The materials upon which the original description of this species were based came from strata since referred to the Denver formation of Colorado and the Fort Union formation of Montana. From the first it has been more or less confused with similar large lobate leaves showing more or less toothed margins and more or less craspedodrome venation, of a type usually regarded as platanoid. There can be but slight doubt that this species is not the same as *Platanus nobilis*. Whether or not it belongs to the Araliaceae or represents the order Platanales, which last appears to be related to the Urticales rather than to the Rosales, and to be abundant and varied in the Upper Cretaceous and early Tertiary, cannot be definitely settled.

A closely similar form from the Midway (?) of Texas has been referred to the still existing genus Pourouma. What has been done with the small leaves of *Aralia notata* that must have existed and some of which could scarcely escape fossilization, can only be surmised. Large leaves of this species, mostly imperfect, are very common at certain horizons in the Ravenscrag beds. It is widespread in the Lance, Fort Union, and Paskapoo.

Occurrence. Localities 1, 3, 32 (very abundant), and 35.

Aralia triloba Newberry (?)

Aralia triloba Newberry, N.Y. Lyceum Nat. Hist. Annals, vol. 9, p. 58 (1868): [Lesquereux], U.S. Geol. and Geog. Surv. Terr., Ill. Cret. and Tert. Plants, Pl. 25, figs. 4, 5 (1878): U.S. Geol. Surv., Mon. 35, p. 121, Pl. 40, figs. 4, 5 (1898).

This species, which was described from the Fort Union formation of North Dakota, is doubtfully identified from Locality 24.

Family, **Cornaceae**

Genus, CORNUS Linné

Cornus impressa Lesquereux

Cornus impressa Lesquereux, U.S. Geol. and Geog. Surv. Terr., Ann. Rept. 1873, p. 408 (1874): U.S. Geol. Surv. Terr., vol. 7, Tertiary Flora, p. 243, Pl. 42, fig. 3 (1878).

Cornus emmonsii Ward, U.S. Geol. Surv., 6th Ann. Rept. 1884-85, p. 553, Pl. 48, fig. 2 (not fig. 3) (1886): Idem., Bull. 37, p. 55, Pl. 26, fig. 2 (not fig. 3) (1887).

This Denver species is represented by several specimens from Localities 1 and P-11-30.

Cornus fosteri Ward (?)

Cornus fosteri Ward, U.S. Geol. Surv., 6th Ann. Rept. 1884-85, p. 553, Pl. 47, fig. 8 (1886): Idem., Bull. 37, p. 54, Pl. 25, fig. 5 (1887).

This Fort Union species is represented somewhat doubtfully at Locality 5 and by several more convincing specimens at Locality P-1-30.

Cornus newberryi Hollick

Cornus acuminata Newberry, N.Y. Lyceum Nat. Hist. Annals, vol. 9, p. 71 (1868): [Lesquereux], U.S. Geol. and Geog. Surv. Terr., Ill. Cret. and Tert. Plants, Pl. 20, figs. 2-4 (1878) (not Weber, 1852).

Cornus newberryi Hollick in Knowlton, U.S. Geol. Surv. Bull. 152, p. 76 (1898).

Newberry, U.S. Geol. Surv. Mon. 35, p. 124, Pl. 37, figs. 2-4 (1898).

Knowlton, Idem., Mon. 32, pt. 2, p. 749, Pl. 103, fig. 6 (1899): Wash. Acad. Sci. Proc., vol. 11, p. 189 (1909): Jour. Geol., vol. 19, p. 370 (1911).

This is a Lance, Paskapoo, and Fort Union species. It occurs in the Ravenscrag beds at Locality 33.

Order, GENTIANALES

Family, **Oleaceae**

Genus, FRAXINUS Linné

Fraxinus leii Berry, n.sp.

Plate XV, figure 4

Fraxinus leii Berry, U.S. Geol. Surv., Prof. Paper 185-F, p. 132, Pl. 25, figs. 1-5 (1934).

Leaflets relatively narrow and elongated, often falcate, lanceolate and slightly imequilateral in outline, petiolulate, with acuminate tips and rounded-cuneate bases. Margins entire at the base; above with somewhat variable and irregularly spaced serrate teeth, directed upward, often so finely pointed and extended as to almost deserve the term spinous-serrate, although not thickened like true spines. Texture sub-coriaceous. Length ranging from 5·5 to 13 centimetres. Maximum width ranging from 1·25 to 3·25 centimetres. Petiolule usually not preserved, short and stout, not over 7 millimetres in length. Midvein stout and prominent. Secondaries relatively thin, sub-parallel, camptodrome. Tertiaries obscure, except for the veinlets entering the marginal teeth.

Leaves or leaflets similar to these have frequently been referred to Rhus, Myrica, or to some proteaceous genus. They are much like the leaflets of the existing Old World *Fraxinus tamariscifolia*. Chronologically comparable fossil species in North America comprise 2 from the Denver, 1 from the Fort Union, and an Arctic species found in the Wilcox Eocene, the last associated with unmistakable samaras of Fraxinus. Many Tertiary species have been described and there are about two score existing species of the North Temperate zone that reach their southern limit of range on the islands of Java in the Eastern, and Cuba in the Western, Hemispheres.

Rather large leaflets of the present species are present at Localities 3, 33, and 34. The species is abundant and of all sizes in the lower Lance of Harding county, South Dakota, and the foregoing description is partly based on the more abundant Dakota material. The species is named in honour of the original collector, Mr. Henry E. Lee of Rapid City, South Dakota.

Order, RUBIALES

Family, **Caprifoliaceae**

Genus, VIBURNUM Linné

The same situation prevails in regard to the fossil species that have been referred to the genus Viburnum as in "Populus" and numerous other so-called genera of the late Cretaceous and early Tertiary. No account has been taken of the normal variation in the leaves of a single species, or of the improbability of several distinct botanical species being represented at a single outcrop.

Thus there are recorded in the literature of palæobotany 13 species of Viburnum from the Montana group, 3 from Black Buttes, Wyoming,

5 from the Paskapoo, 7 from the Denver, 6 from the Lance, and no less than 20 from the Fort Union. It seems to me that such practices make the science ridiculous, as they certainly make it baffling to the student seeking to identify fossil forms or to use them stratigraphically.

It is not possible without much more material than I have at my disposal to entirely clear up the present confusion among the fossil species of this genus, but the following treatment is, I believe, a step in the right direction.

Viburnum castrae Knowlton and Cockerell

Plate XV, figure 5

Viburnum lanceolatum Newberry, N.Y. Lyceum Nat. Hist. Annals, vol. 9, p. 54 (1868): Lesquereux, U.S. Geol. and Geog. Surv. Terr., Ill. Cret. and Tert. Plants, Pl. 16, fig. 10 (1878): U.S. Geol. Surv. Mon. 35, p. 131, Pl. 33, fig. 10 (1898).

Penhallow, Rept. Tert. Plants British Col., p. 96 (1908) (not Hill, 1868).

Viburnum castrae Knowlton and Cockerell, U.S. Geol. Surv. Bull. 696, p. 641 (1919).

There is a complete specimen and its counterpart of this species from Locality 2. The narrowed base and ascending basal secondaries give this small leaf the appearance of a Zizyphus, and it has a superficial resemblance to *Zizyphus cinnamomoides* Lesquereux[1] of the Green River Eocene to which Ward referred a somewhat doubtful specimen from the Fort Union of Montana.[2] The resemblance is entirely superficial, however. There is also some resemblance to the Fort Union forms that Ward named *Viburnum oppositinerve* Ward and *Viburnum asperum* Newberry, the differences being the wider base and the more numerous and sub-parallel secondaries of these two nominal species. I do not believe that either is a true botanical species, but that they represent merely small leaves of which the larger leaves were given different specific names by Ward, but I am not in a position to verify this at the present time. The present species is recorded from the Fort Union and the Paskapoo.

Viburnum asperum Newberry

Plate XVI

Viburnum asperum Newberry, N.Y. Lyceum Nat. Hist. Annals, vol. 9, p. 54 (1868): Lesquereux, U.S. Geol. and Geog. Surv. Terr., Ill. Cret. and Tert. Plants, Pl. 16, fig. 8 (1878): U.S. Geol. Surv. Mon. 35, p. 129, Pl. 33, fig. 9 (1898).

Ward, U.S. Geol. Surv., 6th Ann. Rept. 1884-85, p. 557, Pl. 64, figs. 4-9 (1886): Idem., Bull. 37, p. 113, Pl. 55, figs. 4-9 (1887).

Viburnum newberryanum Ward, op. cit., p. 557, Pl. 64, figs. 10-12; Pl. 65, figs. 1-3 (1886): op. cit., p. 113, Pl. 56, figs. 1-6 (1887).

Knowlton, Wash. Acad. Sci. Proc., vol. 11, p. 313 (1909).

[1]Lesquereux, Leo.: U.S. Geol. Surv. Terr., vol. 7, Tertiary Flora, p. 277, Pl. 52, figs. 7, 8 (1878).
[2]Ward, L. F.: U.S. Geol. Surv. Bull. 37, p. 74, Pl. 33, fig. 7 (1887).

Viburnum finale Ward, op. cit., p. 557, Pl. 65, fig. 8 (1886): op. cit., p. 115, Pl. 57, fig. 5 (1887).

Berry, Nat. Mus., Canada, Bull. 63, p. 27, Pl. 5, fig. 4 (1930).

Viburnum nordenskiöldi Ward (not Heer, 1869), op. cit., p. 557, Pl. 65, figs. 4-6: op. cit., p. 114, Pl. 57, figs. 1-3 (1887).

Leaves ovate-lanceolate, acuminate, with a broadly rounded to slightly cordate base. Margin finely and sharply simple serrate. Texture subcoriaceous. Length ranging from 3 to 12 centimetres. Maximum width, below the middle, ranging from 1·5 to 7 centimetres. Petiole stout, curved, up to 4·5 centimetres in length. Midvein stout, prominent, often somewhat flexuous. Secondaries stout, from 6 to 12 pairs, usually rather straightly ascending; their angle of divergence depending on the relative proportions of the leaf, usually fewer in number in the young leaves. The basal secondaries, which diverge from the top of the petiole or a short distance above, may be stouter and sub-primary in aspect, since they give off on the outside, numerous, rather closely spaced, straight or curved, craspedodrome branches, which may also branch, all ultimately ending in the marginal teeth. Veinlets well marked, closely spaced, prevailingly simply percurrent at right angles to the secondaries and consequently obliquely to the midvein; occasionally curved or forked.

The chief variations in this species as I conceive its limits are in the number and angle of divergence of the secondaries, some leaves having minimum number, and some having them less ascending, as in the type of leaf which Ward called *Viburnum finale*, which last approaches a Celastrus in appearance.

This species is widespread in the Lance, Paskapoo, and Fort Union formations, as well as at certain horizons in the Ravenscrag. Where present at an outcrop it is apt to be abundant, and varying widely by slight gradations.

Occurrence. Localities 3 (a single doubtful specimen), 23 (exceedingly abundant), 27 (exceedingly abundant), 38 (not rare), and P-1-30 (several specimens).

Viburnum marginatum Lesquereux

Viburnum marginatum Lesquereux, U.S. Geol. and Geog. Surv. Terr., Ann. Rept. 1872, p. 395 (1873): Idem., 1873, pp. 382, 401 (1874): Idem., 1874, p. 306 (1876): Idem., 1876, p. 510 (1878): Idem., Bull., vol. 1, p. 380 (1875): Idem., vol. 7, Tertiary Flora, p. 223, Pl. 38, figs. 1, 4 (not figs. 2, 3, 5) (1878): Mus. Comp. Zool. Bull., vol. 16, p. 51 (1888).

Knowlton, Geol. Soc. Am. Bull., vol. 8, p. 145 (1897): Jour. Geol., vol. 19, p. 361 (1911).

Platanus marginata Heer, Fl. Foss. Arctica, Bd. 7, p. 97, Pl. 98, figs. 3-5; Pl. 99, figs. 2, 3; Pl. 101, fig. 5 (1883).

Jankó, Engler's bot. Jahrb., Bd. 11, p. 454 (1889).

Viburnum dichotomum Lesquereux (not Buch-Ham, 1825), U.S. Geol. and Geog. Surv. Terr., Ann. Rept. 1872, p. 399 (1873): U.S. Geol. Surv. Terr., vol. 7, Tertiary Flora, p. 225, Pl. 38, fig. 6 (1878).

Viburnum melaenum Knowlton and Cockerell, U.S. Geol. Surv. Bull. 696, p. 644 (1919).

Although both Heer and Jankó consider this species to be referable to Platanus I believe them to be mistaken, and the true affinity of these leaves to be with Viburnum, as Lesquereux supposed. The last author, in describing what he called *Viburnum dichotomum*, remarked that it might be merely a variety of *Viburnum marginatum*, and I can see no valid reason for maintaining any distinction, both even coming from the same horizon (Black Buttes, Wyoming).

The species is a highly variable one, and there are innumerable gradations between the extremes. Except for Heer's record from the Eocene of Greenland, which may be a mistaken identification, the species is characteristic of those beds whose age is disputed and which lie near the boundary between the Upper Cretaceous and the Eocene (Black Buttes, Medicine Bow, Lance, Dawson).

Occurrences. Whitemud at Localities 7 and 30.

Viburnum marginatum ravenscragensis Berry, n. var.

This rather doubtful variety has the features of the type of this species but the base is less narrowly cuneate and there are usually five primary-like veins from the top of the petiole. It suggests also the leaves that I have referred to *Trochodendroides cuneata* (Newberry), but the primaries are straighter, and both primaries and secondaries are more dichotomous in their endings, and more distinctly craspedodrome.

Except for its occurrence in slightly younger beds, and the inconsiderable differences noted above, there is but slight reason for recognizing a varietal rank for these leaves.

Occurrence. Abundant at Locality 34 and sparingly at Locality 35.

Viburnum antiquum (Newberry) Hollick

Plates XVII, XVIII A, and XVIII B

Tilia antiqua Newberry, N.Y. Lyceum Nat. Hist. Annals, vol. 9, p. 52 (1868): [Lesquereux], U.S. Geol. and Geog. Surv. Terr., Ill. Cret. and Tert. Plants, Pl. 16, figs. 1, 2 (1878).

Viburnum tilioides Ward, U.S. Geol. Surv., 6th Ann. Rept. 1884-85, p. 556, Pl. 61, figs. 1-7; Pl. 62, figs. 1-6 (1886): Idem., Bull. 37, p. 107, Pl. 50, figs. 1-3; Pl. 51, figs. 1-8; Pl. 52, figs. 1, 2 (1887).

Viburnum antiquum Hollick in Newberry, Idem., Mon. 35, p. 128, Pl. 33, figs. 1, 2 (1898).

Knowlton, Wash. Acad. Sci. Proc., vol. 11, pp. 186, 189, 213 (1909).

Viburnum perfectum Ward, op. cit., p. 556, Pl. 62, figs. 7-9 (1886): op. cit., p. 109, Pl. 52, figs. 3, 4; Pl. 53, fig. 1 (1887).

Viburnum elongatum Ward, op. cit., p. 557, Pl. 63, figs. 8, 9 (1886): op. cit., p. 112, Pl. 54, figs. 4, 5 (1887).

Knowlton, Wash. Acad. Sci. Proc., vol. 11, p. 370 (1909).

Platanus guillelmae Ward (not Goeppert), op. cit., p. 552, Pl. 44, fig. 1 (1886): op. cit., p. 37, Pl. 20, fig. 1 (1887).

Viburnum limpidum Ward, op. cit., p. 556, Pl. 63, figs. 1-4 (1886): op cit., p. 110, Pl. 53, figs. 3-6 (1887).
Berry, Nat. Mus., Canada, Bull. 63, p. 26 (1930).

Grewiopsis viburnifolia Ward, op. cit., p. 555, Pl. 55, fig. 7 (1886): op. cit., p. 89, Pl. 40, fig. 2 (1887).

Populus grewiopsis Ward, op. cit., p. 550, Pl. 36, fig. 6 (1886): op. cit., p. 23, Pl. 9, fig. 1 (1887).

Grewiopsis canadensis Bell (MS.) and in my preliminary list of species.

Leaves highly variable in size, form, marginal characters, and venation. Outline ranging from ovate to orbicular. Apex rounded to acuminate. Base cuneate to cordate. Margins dentate, crenate, or serrate. Teeth large or small. Length ranging from 5·5 to 15 centimetres. Maximum width ranging from 4 to 15 centimetres. Petiole long and stout, enlarged and curved at the base in the few specimens in which it is preserved. Midvein stout, prominent, and often flexuous. The secondary and tertiary venation is essentially similar in all of the leaves which I have referred to this species, but the varying attitude of the secondaries according as the leaf is narrow or broad gives them a great but superficial difference in appearance. The ground plan is one of from 6 to 10 pairs of opposite to alternate, rather straight, and for the most part sub-parallel secondaries, which are craspedodrome, and all but the uppermost ones give off from one to several outside, craspedodrome branches, which may or may not be pseudodichotomous. The basal secondaries may be slightly stouter than the others and give off several, outside, craspedodrome branches, and this gives the appearance of a palmately tri-veined leaf. If the leaves are relatively wide there may be a pair of secondaries below the pseudo-primary pair, which diverge at wider angles, and also have outside, craspedodrome branches. The tertiaries are thin but well marked, closely spaced, running transverse to the secondaries that they connect, and mostly straight or curved percurrent; occasionally forked.

I am figuring very few of these leaves, since the normal variations are sufficiently illustrated in the figures cited above. I am figuring 3 specimens from Locality 3426 which illustrate one of the extremes of variation of the pseudo-palmate type, which are similar to the leaves that Ward called *Platanus guillelmae* and *Grewiopsis viburnifolia*: a fourth from Locality 32 like what Ward called *Viburnum elongatum:* and a fifth from Locality 35 which is a reconstruction from five broken specimens, and which shows a very broad, almost orbicular leaf, with extreme reduction of marginal teeth. This last is a form that was reported in my preliminary list of identifications as *Protophyllum* n. sp.

Viburnum antiquum is very abundant at certain localities in the Ravenscrag beds, where whole collections from an outcrop may contain little else, as at Locality 3426, and a similar situation prevails at many of the Lance and Fort Union localities. In all such cases there are innumerable gradations in form, margin, and aspect of venation, which is the basis for considering all of them to represent the variations of a single botanical species.

What I consider to be this species is, as I have mentioned above, exceedingly abundant at Locality 3426, south of Harptree, at the base of the Willowbunch member of the Upper Ravenscrag. The leaves, in all sizes, are packed in the brown, finely sandy clays associated with twigs of *Sequoia nordenskiöldi* Heer. All of the leaves are incomplete, due to accidents of collecting and the impossibility of uncovering entire specimens. They show much variation in their general proportions, and in the size and form of the marginal teeth, but I cannot conceive that they represent other than a single botanical species, an opinion long since arrived at in connexion with Ward's specific differentiation of Viburnum, an opinion concurred in by every palæobotanist who has had occasion to work with these forms.

The material from the Ravenscrag, although it is for the most part poorly preserved, is exceedingly important since it has enabled me to satisfy myself that the specific names cited as synonyms of *Viburnum antiquum* were applied to what are really nothing more than the variants of a single botanical species. In the preliminary account of the flora of the Cypress hills I identified rather small leaves as *Viburnum limpidum* Ward. I now think that this represents simply small leaves of *Viburnum antiquum* and this, I am sure, is also the status of Ward's types from the Fort Union of the United States.

Occurrence. Localities 1, 2, 5 (very abundant), 32, 35, 3258, 3426; Whitemud Localities 7 and 30 (*Grewiopsis canadensis* MS.).

Viburnum antiquum mutation *trinervum*

Plate VII, figure 6; Plate XV, figure 6

In the light-coloured Ravenscrag clays at Rockglen (Locality 3579, P-10-30) there occur quantities of the leaves of a supposed Viburnum, nearly all of which are incomplete as to tip, blade, or margin, which belong within the specific limits of *Viburnum antiquum*, as I conceive it. Although these leaves show great variation in size, and a less variation in the size and shape of the marginal teeth, they invariably have a more or less pronounced cordate base, and the supra-basilar pair of secondaries are apt to be slightly stouter than the others and to curve upward into the upper part of the leaf, giving the appearance of a palmately veined leaf, and suggesting comparisons with various contemporaneous leaves that have been referred to Grewia (including Grewiopsis) and Trochodendroides (including various so-called species of Populus).

This pseudo-palmate venation reduces the number of distal pairs of secondaries, and no specimens of *Viburnum antiquum* that I have seen have so few. That the present leaves represent a Viburnum is shown by the tertiary venation and by the characteristic forkings and craspedodrome endings of the secondaries. That this represents a distinct taxonomic entity I regard as highly doubtful, but until it has been conclusively tied to *Viburnum antiquum* by insensible gradations, and shown by subsequent discoveries to lack any precise chronologic value, it seems best to differentiate it in some way from the bulk of variable leaves that I have referred

to that comprehensive and highly variable species. Without any conclusion on the points mentioned I propose to call this type a mutation under the trinomial designation of *trinervum*. It may be briefly characterized as follows: leaves ovate-cordate, of thin texture, with stout petioles of undetermined length, of which the maximum preserved is slightly in excess of 2 centimetres. Marginal teeth small or large, closely spaced, serrate to dentate. The two basal pairs of secondaries have their proximal ends approximated at, or not far above, the top of the petiole, giving a quinquepalmate appearance. The basal pair curve laterally and the suprabasilar pair sweep upward; all fork and are craspedodrome, and the two basal pairs give off on the outside, similarly disposed branches. Sizes vary from 4 to 11 centimetres (indicated by fragments) in length by 4 to 8·5 centimetres in maximum width.

Viburnum sp.

Plate XIX, figure 12

This is based upon a fragment of a single leaf, and appears to me to represent something entirely new to these floras. Leaf spatulate and somewhat rhombic in outline, being straight sided, apparently flattened distad, and truncate and ultimately slightly decurrent at the base. Margins, except the basal, which is entire, with regularly spaced mucronate teeth directed upward. Length about 9 centimetres. Maximum width, in the upper half of the leaf, about 4·5 centimetres. Petiole stout, length unknown. Primaries three, from the extreme base, the midvein slightly stouter than the laterals, diverging at acute angles, ascending, craspedodrome. Secondaries from the midvein few and ascending: from the lateral primaries, numerous, sub-parallel and craspedodrome, and giving off several distal craspedodrome branches, except the basal one which may have camptodrome branches that give off veinlets to the marginal teeth. Internal tertiaries thin but distinct, mostly simple and percurrent, but sometimes inosculating.

This species although probably new is not represented by sufficient material to warrant a specific name, or for a reasonably complete diagnosis. It is unlike anything known to me from this horizon either in Canada or the United States, and not especially close to any described fossil species, although it is something like the Arctic Eocene form described by Heer as *Viburnum multinerve*.

Occurrence. Whitemud at Localities 7 and 30.

INCERTAE SEDIS

Trapa (?) *microphylla* Lesquereux

Plate XIX, figures 1-11

Trapa microphylla Lesquereux, U.S. Geol. and Geog. Surv. Terr. Bull., vol. 1, 1875, p. 369 (1876): Idem., Ann. Rept. 1874, p. 304 (1876): U.S. Geol. Surv. Terr., vol. 7, Tertiary Flora, p. 295, Pl. 61, figs. 16-17a (1878).

Ward, U.S. Geol. Surv., 6th Ann. Rept. 1884-85, p. 554, Pl. 49, figs. 2-5 (1886): Idem., Bull. 37, p. 64, Pl. 28, figs. 2-5 (1887).

Knowlton, Idem., Mon. 32, pt. 2, p. 661, Pl. 77, figs. 3, 4 (1898): Idem., Bull. 163, p. 62, Pl. 5, fig. 7 (1900): Bull. 257, p. 144 (1905): Wash. Acad. Sci. Proc., vol. 11, pp. 189, 201, 207 (1909).

Neuropteris (?) *angulata* Newberry in Ives, Rept. Col. River of the West, pt. 3, p. 131, Pl. 3, fig. 5 (1861).

There is much material belonging to this interesting plant in the collection and it seems incredible that so characteristic a form should defy the systematist, since it can hardly be considered a true Trapa in spite of its occurrence in association with aquatic plants, and in spite of the fruits of Trapa being found, at least in one instance, in the same bed.

Although this species has been known since 1861 it has never been carefully described, except by Lesquereux in 1878, and he had only the detached leaflets and, consequently, could know nothing of the general habit. The plant was evidently a rosette and floating, with a completely foreshortened stem—at least when young. This is shown by the preservation of the complete plants like the one from the lower Edmonton here figured for the first time, or that from Yellowstone Park figured by Knowlton (op. cit.) or those figured by Ward (op. cit.) There are a number of such specimens from various localities in the collections of the United States National Museum. Most of these are of minimum sizes or relatively small, and so far as I know all the maximum sized specimens are either leaflets or detached leaves. However, since some of these larger leaflets show what must be interpreted as air cavities, I think it is safe to assume that the larger plants were also floating in habit.

The leaves are palmately compound, trifoliate, or, more often, quinquefoliate, and there is some evidence that there may have been as many as 7 leaflets in exceptional cases. The normal form is that shown in the accompanying figure of a leaf from Locality 21. A broad and rather flat petiole becomes trifid about half-way from the base to the tip of the central leaflet, the branches diverging at angles of about 45 degrees. The central branch terminates in a symmetrical leaflet which would be almost orbicular except for a distal flattening and a slight basal narrowing. The lateral branches fork about half-way between their origin and the tips of the lateral leaflets, the distal branch of this dichotomy being shorter than the proximal, and one or the other being more curved than its fellow, and each bears an inequilateral leaflet. These last usually have the lamina flattened on the side toward their fellow leaflet, but sometimes one or the other of the leaflets will be abbreviated on the opposite sides. The central leaflet is normally somewhat larger than the lateral leaflets and there is usually, but not invariably, some disparity in size among the lateral leaflets. Certain forms from the Edmonton formation (here figured) show a single terminal leaflet as a straight continuation of the proximal main petiole and a single lateral branch, twice forked and with three leaflets, as if it represented but a half of a complete trifid form with a central and three pairs of lateral leaflets. I could not observe any trace of a missing other half, and the evidence points to these specimens having been complete as figured.

The individual leaflets vary considerably in outline from almost orbicular to squarish. They never merit the term coriaceous and generally

appear thin, although some preserved in sandstone seem to indicate considerable consistency and these usually fail to preserve the details of venation. The leaflets range in size from diameters of 3 millimetres to about ten times this dimension. The largest complete leaflet in the present collection, figured to show the venation, has a length of 3 centimetres, and a maximum width, in the distal third of the leaflet, of 2·4 centimetres. The base is usually rounded, although it may be more truncate, or broadly cuneate, and is entire. The balance of the margin is beset with regularly spaced, usually small, mucronate teeth. Many of the leaflets from Locality 3258 show a central, somewhat raised area, more or less circular or elliptical, but extending outward along the principal veins, that appears to be an air chamber. Several of these are figured and I can think of no alternative explanation for them. The venation is fine and close-set, somewhat flabellate from the base, but with a sort of a midvein that is somewhat stouter than its fellows, and which gives off acutely diverging branches at various levels. The main branches end in marginal teeth. Toward the margins the veinlets are much branched and these appear to end in the margins. There is a finely meshed areolation throughout between the larger veins that is approximately isodiametric, although there is a slight tendency towards some radial elongation. Some of the small leaves in the present collection have the venation beautifully preserved, and it is especially fern-like in appearance.

Newberry, who was apparently the first one to see leaflets of this plant considered them to represent fern pinnules and referred them with a query to the form genus Neuropteris. Lesquereux, fifteen years later, with only the leaflets before him, referred them to Trapa, a not inept identification. Ward in 1887 (page 64) expresses himself with great confidence that his ample material confirms the relationship with Trapa, although it is this and similar material showing the compound nature of the leaves which, it seems to me, precludes such an identification, since Trapa has simple leaves, as do all the members of the alliance to which it belongs. In 1886 Dawson figured a typical leaflet associated with fruits which he referred to *Trapa borealis* Heer, but this is by no means proof that the leaflets are those of Trapa. Among the many fossil records of undoubted Trapa fruits none has been found associated with the foliage, possibly because the floating fruits come to rest far removed from the foliage. In recent species, such as *Trapa natans*, which has been introduced into the Potomac river the fruits commonly accumulate miles down stream from where the plants are growing. In the course of time, however, it would seem that a continuous area of distribution will be established.

Trapa microphylla is commonly found in association with aquatic plants. This fact, the observed habit, and the discovery of what are considered air cavities in the leaflets render it reasonably certain that the plants were floating. This species has a considerable geologic as well as geographic range, and is abundant in the Mesaverde, Belly River, Judith River, Lance, Fort Union, Edmonton, and Paskapoo formations. It is found from Alaska to Wyoming and Dakota. It occurs abundantly in the Whitemud at Locality 3258, north side of Big Muddy valley; and in the Ravenscrag at hill north of road at Keoghs (P-4-30) and at Localities

P-1-30 (60 feet above the Whitemud), and at Locality P-11-30 (Upper Ravenscrag just above the Willowbunch member). Obviously in Canada, as well as in the United States, this species disregards the boundary between the Triceratops horizon and the Fort Union.

Populus daphnogenoides Ward

Populus daphnogenoides Ward, U.S. Geol. Surv., 6th Ann. Rept. 1884-85, p. 550, Pl. 35, figs. 7-9 (1886): Idem., Bull. 37, p. 20, Pl. 7, figs. 4-6 (1887).

Penhallow, Roy. Soc., Canada, Trans., vol. 8, p. 57 (1902): Rept. Tert. Plants British Col., p. 77 (1908) (?).

Knowlton, U.S. Geol. Surv. Mon. 32, pt. 2, p. 696, Pl. 84, fig. 2 (1899): Wash. Acad. Sci. Proc., vol. 11, pp. 189, 194, 213 (1909).

There are two nearly complete specimens from Locality 3052, Big Muddy valley, south side and west of Bengough road (P-12-30), which are identical with this species as it was conceived by Ward. They are included in the present study because of their possible value for purposes of correlation. Botanically they are worthless. I am sure that they do not represent the genus Populus, but I have been unable to satisfy myself of their definite relationship among the plexus of variants that have been referred to Populus, Trochodendroides, Grewiopsis, Viburnum, etc. Except for their cuneate base they are not unlike the small leaves that I have called *Viburnum antiquum* mutant *trinervum*. All American students of late Cretaceous and early Tertiary leaves, notably Ward, have greatly confused and intricately mixed the fossil leaves of this type, and excessively multiplied specific names. In some cases it has been possible to remedy h is situation, but this so-called Populus is still an outcast. It has been recorded from the Lance, Fort Union, and Paskapoo formations.

Leguminosites arachioides minor Berry

Leguminosites arachioides minor Berry, U.S. Geol. Surv. Prof. Paper 156, p. 89, Pl. 14, figs. 2-6 (1930).

Leguminosites arachioides Penhallow (not Lesquereux), Rept. Tert. Plants British Col., p. 61, Fig. 14 (1908).

Nyssa (?) racemosa Knowlton, U.S. Geol. Surv. Bull. 152, p. 153 (1898).

Berrya racemosa Knowlton, Idem., Prof. Paper 155, p. 134, Pl. 41, figs. 4, 5 (1930).

Back in 1873 Lesquereux described certain rather characteristic fruits from Evanston, Wyoming, first as Carpolithes, and five years later as *Leguminosites arachioides*—this specific name suggesting a similarity with the existing genus Arachis, a comparison wholly illusory, both as to either resemblance or relationship. This species was subsequently recorded from the Lance, Fort Union, Raton, Denver, Paskapoo (?), and Wilcox formations.

Recently similar remains in the Wilcox formation of the Gulf Coastal Plain were described as a variety-*minor*. These are uniformly smaller, more slender, and more prominently ornamented. About the same time Knowlton, in his revision of the Denver flora, unaware of the presence of these forms in the Wilcox, proposed the generic name Berrya for them.

The latter, which are recorded from the Denver, Black Buttes, Raton, and Animas formations, appear to me to be identical with the Wilcox fossils, and as the generic term Berrya is preoccupied, I am including Knowlton's species in the synonymy of the above variety.

These fruits appear to me to be definitely referable to the leguminous alliance, but their true botanical relationship in that alliance remains uncertain. They are not uncommon at Localities 5, 30, and 34, particularly in the ferruginous sandstone at Localities 30 and 34.

Fucus lignitum Lesquereux

Fucus lignitum Lesquereux, U.S. Geol. and Geog. Surv. Terr. Bull., vol. 1, 1875, p. 364 (1876): U.S. Geol. Surv. Terr., vol. 7, Tertiary Flora, p. 42, Pl. 61, figs. 24, 24a (1878).

Ward, U.S. Geol. Surv., 6th Ann. Rept. 1884-85, p. 549, Pl. 31, figs. 1, 2, (1886): Idem., Bull. 37, p. 13, Pl. 1, figs. 1, 2 (1887).

Knowlton, Idem., Bull. 163, p. 17, Pl. 3, fig. 4 (1900).

The objects referred to this species obviously do not represent the genus Fucus, and may be merely rootlets or the submerged dissected foliage of some aquatic. They are not determinable but may represent some member of the family Podostemaceae, e.g. the genus Mourera Aublet (with a few existing tropical American species). This is, however, merely a guess. They are listed because they may have some stratigraphic significance even though they are botanically worthless. They are recorded from the Mesaverde formation, and very doubtfully from the Fort Union formation. They are not uncommon in the Whitemud on the north side of Big Muddy valley (Locality 3258).

Xantholithes propheticus Ward

Plate XX

Xantholithes propheticus Ward, Glimpses of the Cosmos, vol. 4, p. 150 (1915)[1].

These objects when complete consist of a crowded rosette of strap-shaped leaves with finely fluted margins which give them the appearance of being beset with short spines. These expand distad into a halbert-shaped blade bearing a double row of squarish structures that resemble sporangia. They were first encountered by Ward in the Fort Union of Montana in 1883 and briefly mentioned in volume 37 of the Proceedings of the American Association for Advancement of Science, but not named except in the posthumous work cited above. The implied conclusion was that they represented a "comprehensive type of vascular cryptogam" possibly related to Ophioglossum. This seems to me a most unlikely relationship as is a relationship with the algæ which is advocated by Cockerell. I have a considerable amount of material under investigation and am unwilling to commit myself until this study is finished.

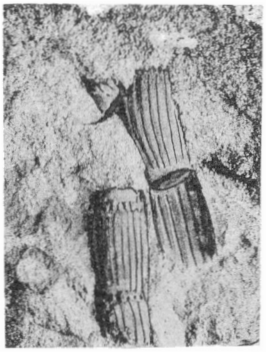
The species is rather common but not especially well preserved at Locality 13 in Alberta.

[1]*See also* Cockerell, T. D. A.: Torreya, vol. 24, p. 19 (1924); vol. 26, p. 11 (1926), and Berry, E. W.: Idem., vol. 24, p. 49 (1924): U.S. Geol. Surv. Prof. Paper 165, p. 78 (1930).

Plate I

Figure 1. *Equisetum* sp. Whitemud, Locality 30. Holotype, No. 7392, Geol. Surv., Canada. (Approximately natural size.) (Page 15.)

Figures 2, 3. *Onoclea sensibilis fossilis* Newberry. Ravenscrag, Locality 11. Plesiotypes, Nos. 7393, 7394, Geol. Surv., Canada. (Page 16.)



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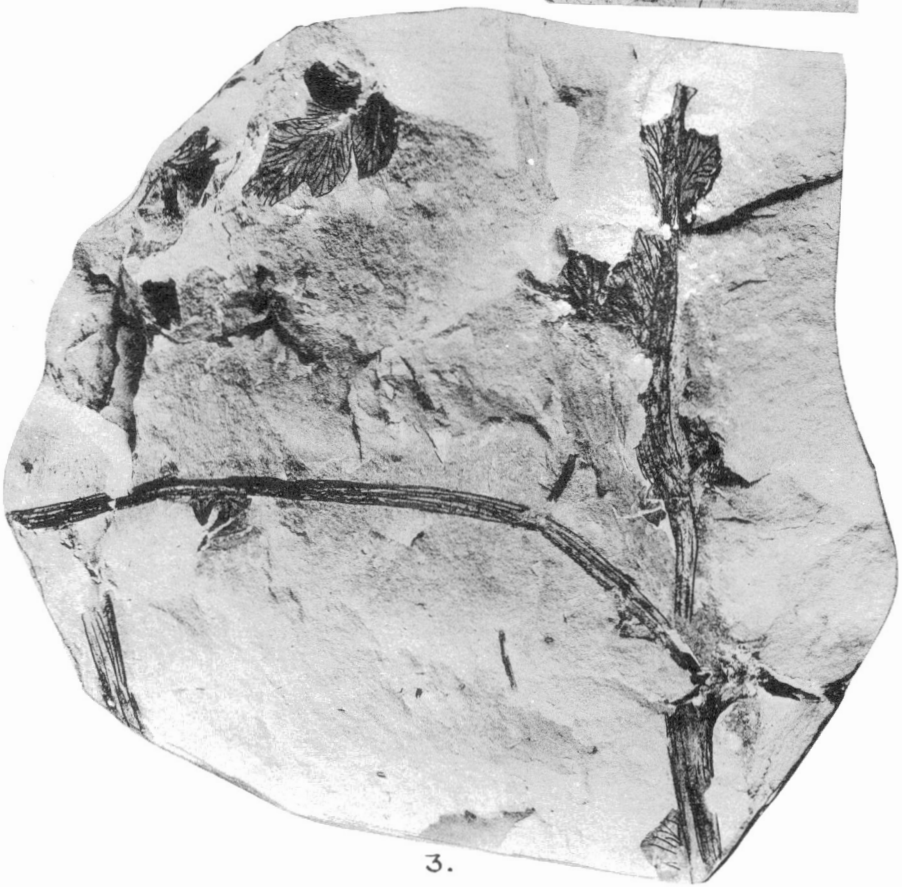

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PLATE II

Onocela sensibilis fossilis Newberry. Locality 11. Plesiotype, No. 7395, Geol. Surv., Canada. (Page 16.)

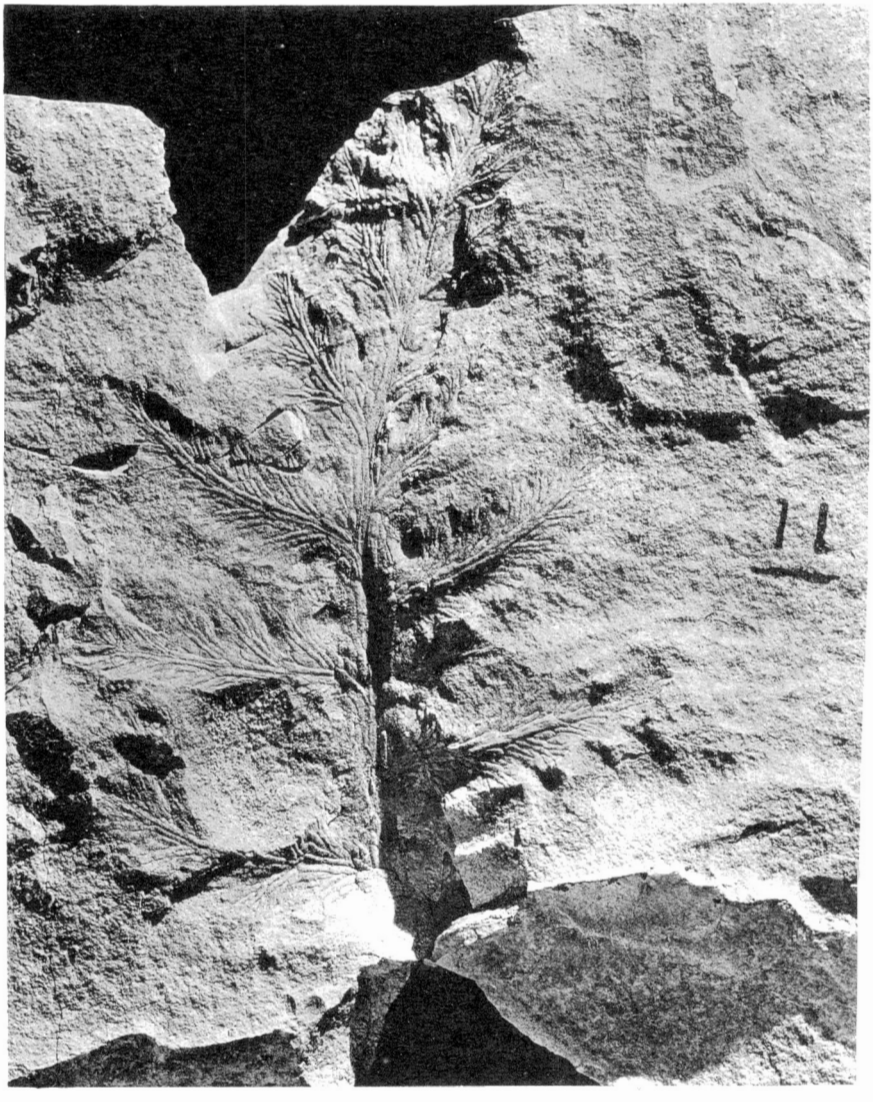

Plate III

Figure 1. *Thuja interrupta* Newberry X 4. Locality 3052. Plesiotype, No. 7396, Geol. Surv., Canada. (Page 21.)

Figure 2. *Palmocarpon* sp. Whitemud, Locality 30. Holotype, No. 7397, Geol. Surv., Canada. (Page 24.)

Figures 3-7. *Quercus praegroenlandica* Berry. Locality P-4-30. Figures 3, 4, 5, 6, types, Nos. 7398, 7399, 7400, 7401, Geol. Surv., Canada. (Page 26.) Figure 7 is a reconstruction.

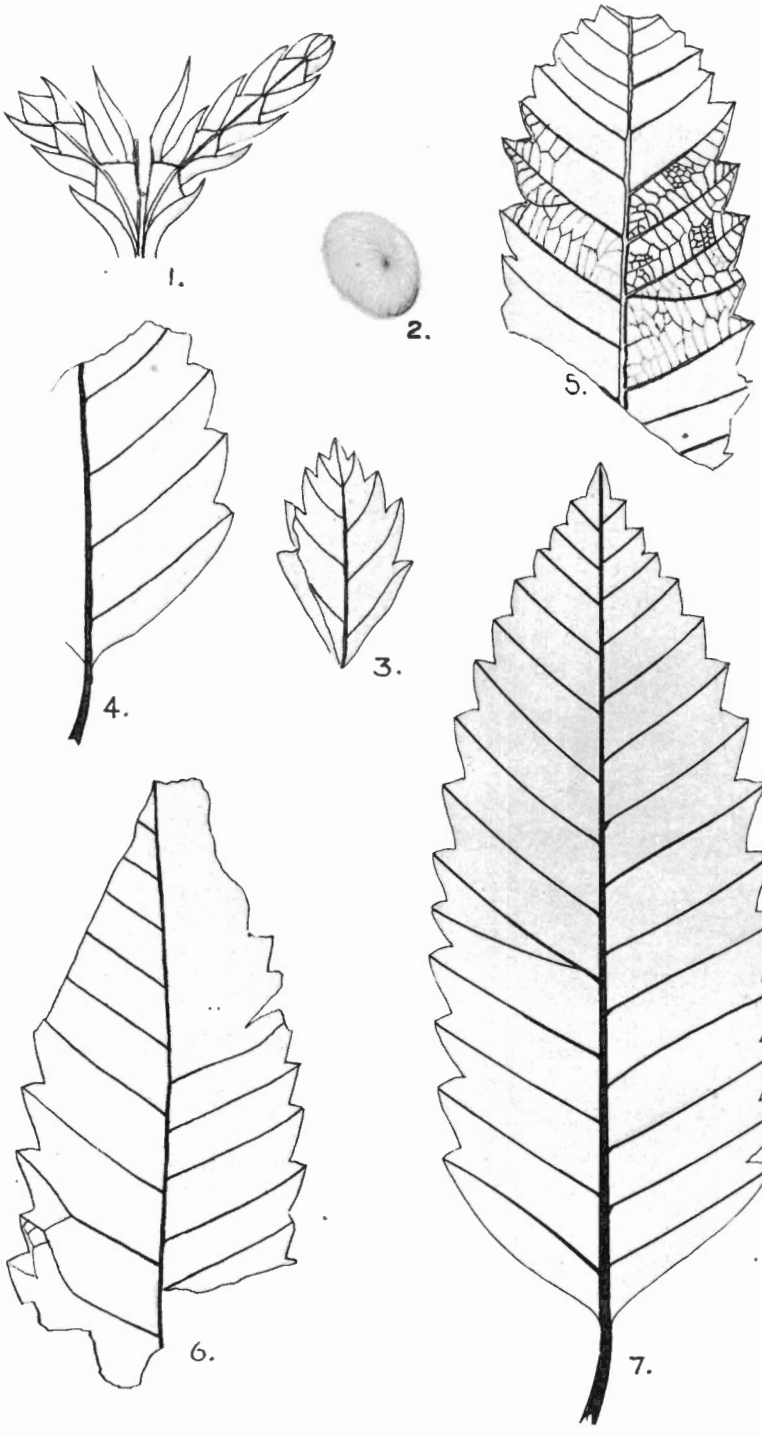
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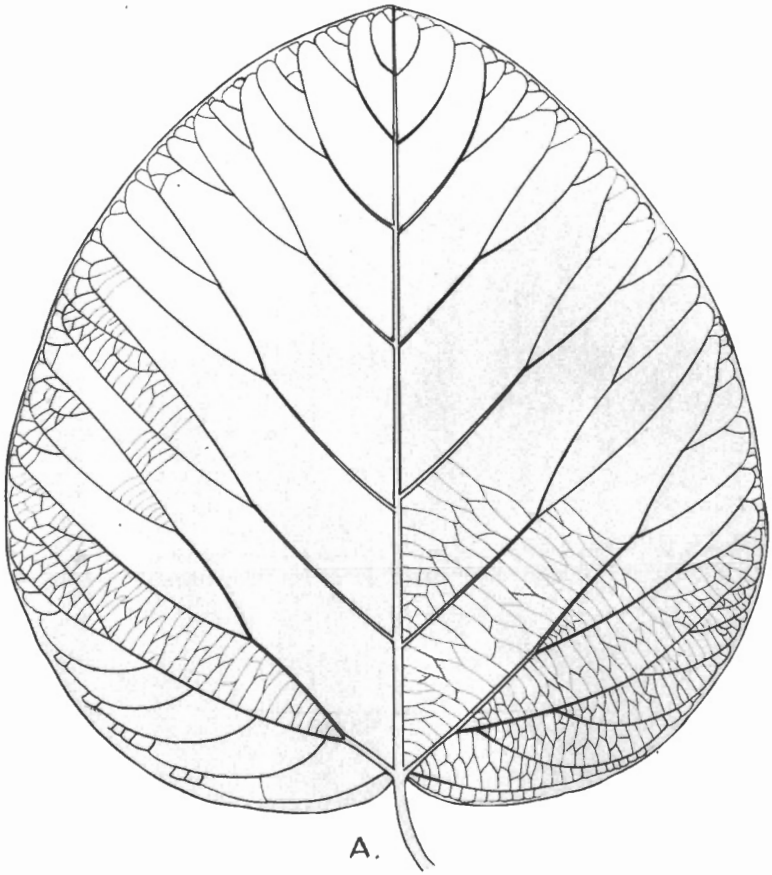
Plate IV

A. *Ficus speciossima canadensis* Berry. Whitemud, Locality 3258. Holotype, No. 7402, Geol. Surv., Canada. (Half natural size.) (Page 30.)

B. *Protophyllum canadensis* Berry. Locality 32. Cotype, No. 7403, Geol. Surv., Canada. (Half natural size.) (Page 31.)



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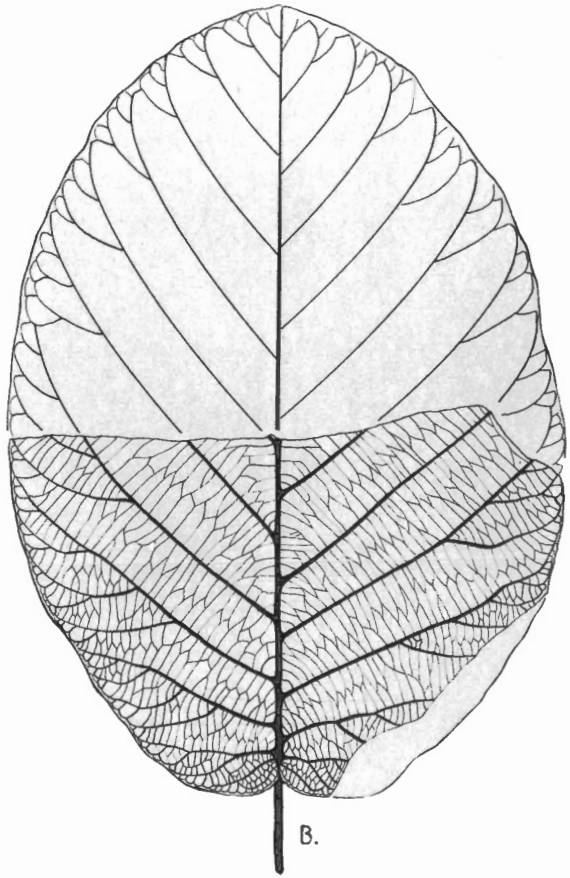

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PLATE V

Protophyllum canadensis Berry. Locality 32. Cotype, No. 7404, Geol. Surv., Canada. (Page 31.)

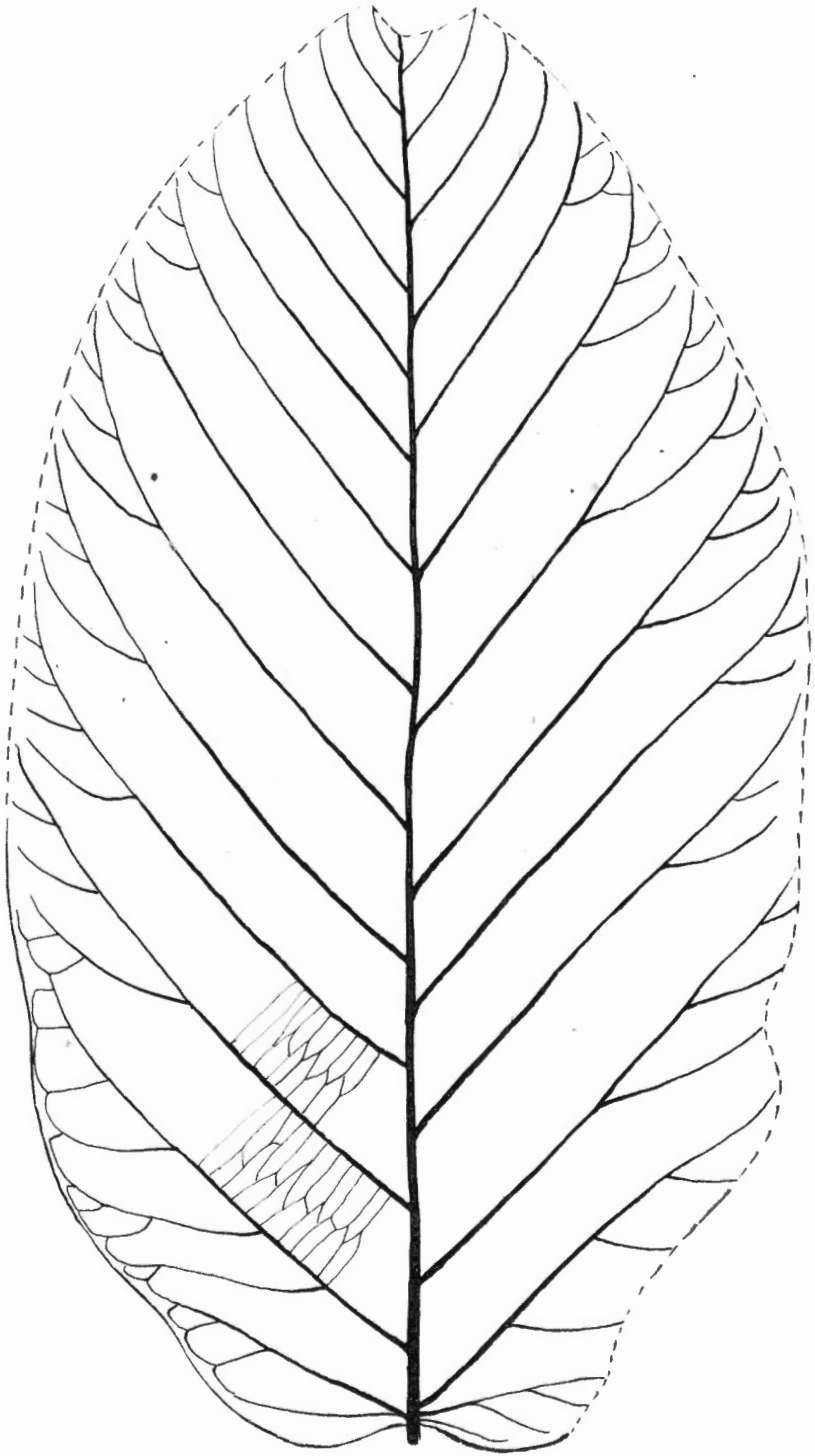

PLATE VI

Figures 1-6. *Trochodendroides cuneata* Newberry. Locality 27. Plesiotypes, Nos. 7405, 7406, 7407, 7408, 7409, 7410, Geol. Surv., Canada. (Page 34.)

Figure 7. *Platanus basilobata* Ward. Locality P-11-30. Plesiotype, No. 7411, Geol. Surv., Canada. (Page 32.)

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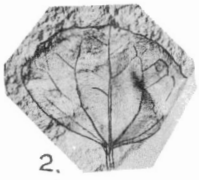

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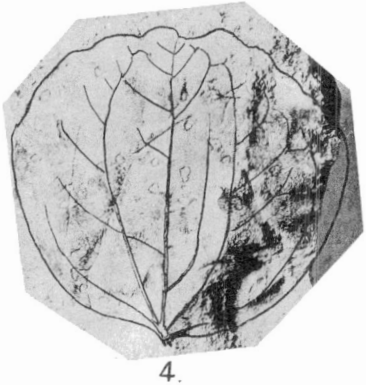

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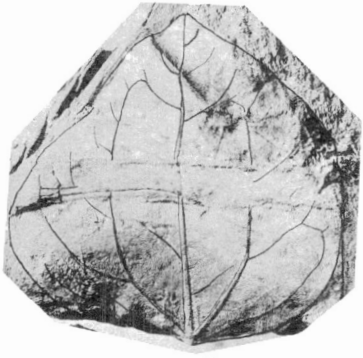

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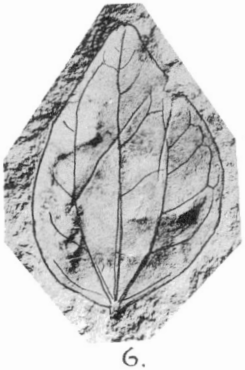

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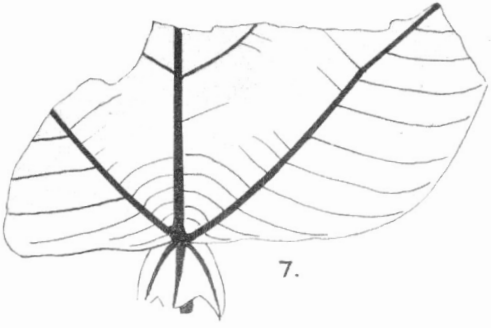

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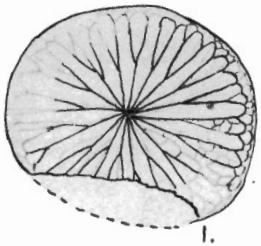
Plate VII

Figure 1. *Nelumbo dawsoni* Hollick. Whitemud, Locality 7. Plesiotype, No. 7412, Geol. Surv., Canada. (Page 36.)

Figures 2, 3. *Nelumbo tenuifolia* (Lesquereux) Knowlton. (Page 37.)
Figure 2. Locality 3258. Plesiotype, No. 7413, Geol. Surv., Canada.
Figure 3. Locality 1269. Plesiotype, No. 7414, Geol. Surv., Canada.

Figures 4, 5. *Paranymphaea crassifolia* (Newberry) Berry. Young leaves from Locality P-1-30. Plesiotypes, Nos. 7415, 7416, Geol. Surv., Canada. (Page 39.)

Figure 6. *Viburnum antiquum* mutant *trinervum*. Locality 3579. Holotype, No. 7417, Geol. Surv., Canada. (Page 60.)



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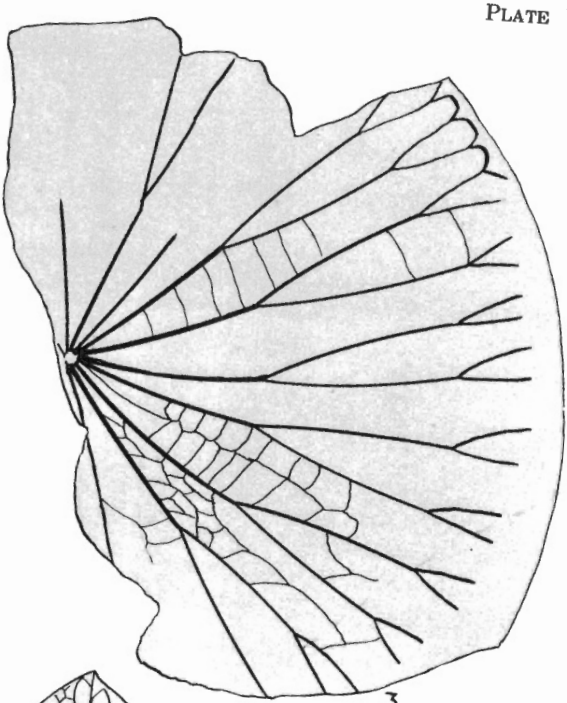

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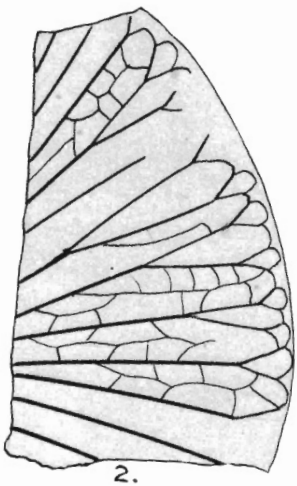

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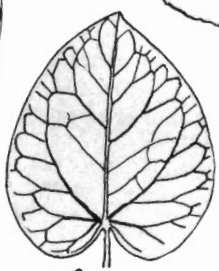

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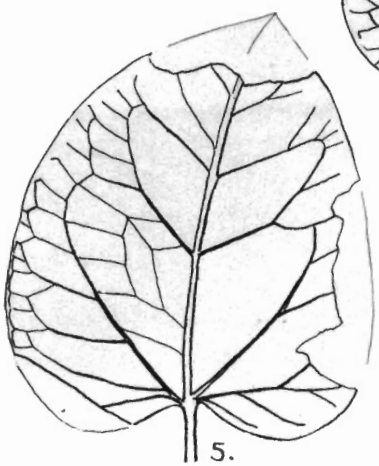

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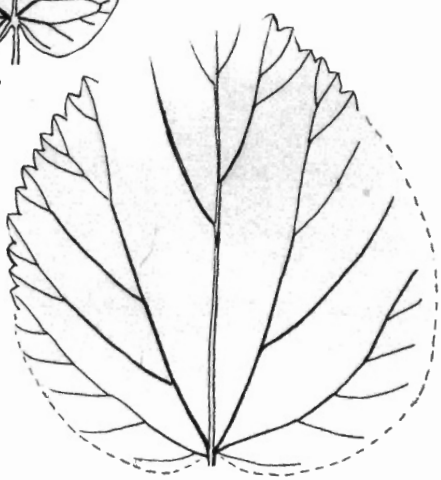

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PLATE VIII

Figures 1-3. *Nelumbites striata* Berry. Whitemud, Locality 3258. Cotypes, Nos. 7421, 7422, Geol. Surv., Canada. (Page 38.)

Figure 3. Camera-lucida drawing to show venation, X 5. Cotype, No. 7421, Geol. Surv., Canada. (Approximately natural size.)

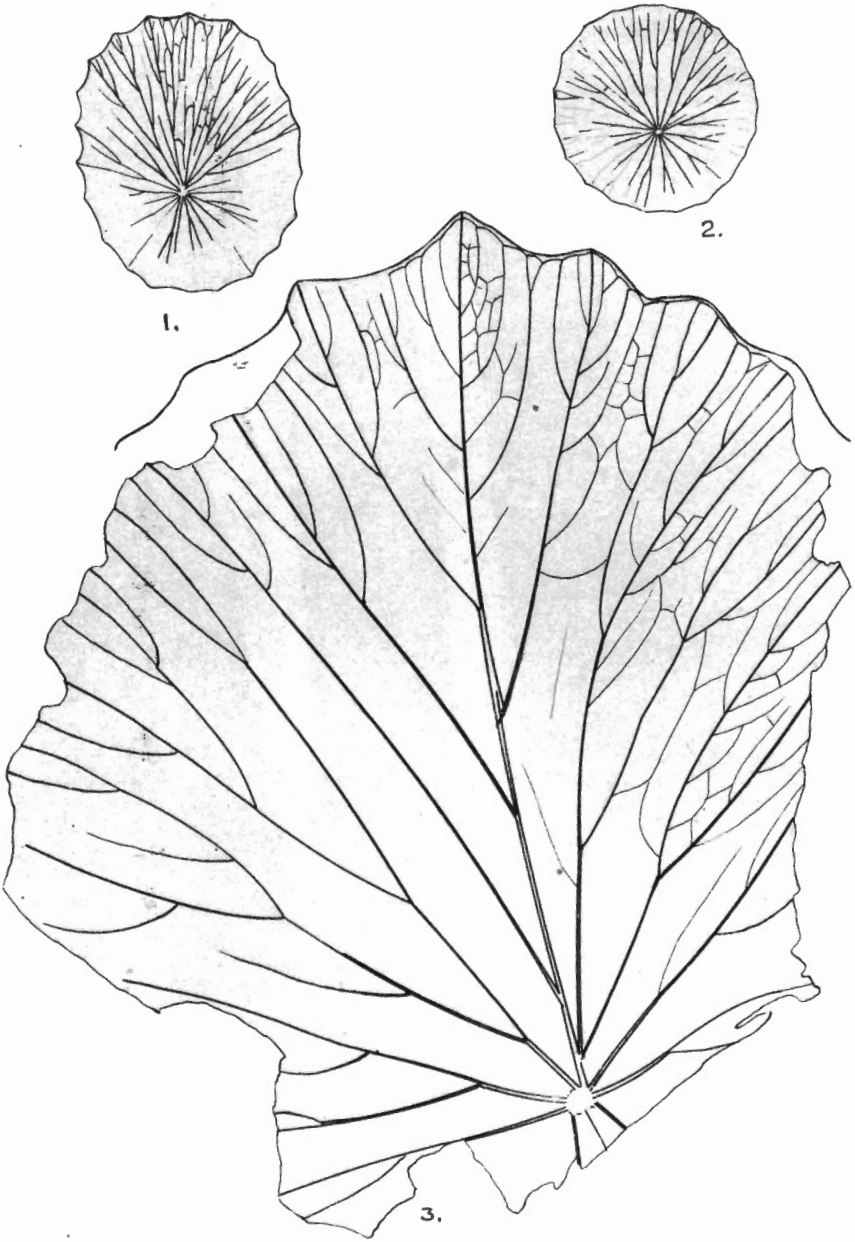
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PLATE IX

Figures 1, 2. *Paranymphaea crassifolia* (Newberry) Berry. (Page 39.)

Figure 1. Specimen from Locality 21 showing part of petiole. Plesiotype, No. 7423, Geol. Surv., Canada.

Figure 2. Narrow leaf from Locality P-1-30. Plesiotype, No. 7424, Geol. Surv., Canada.

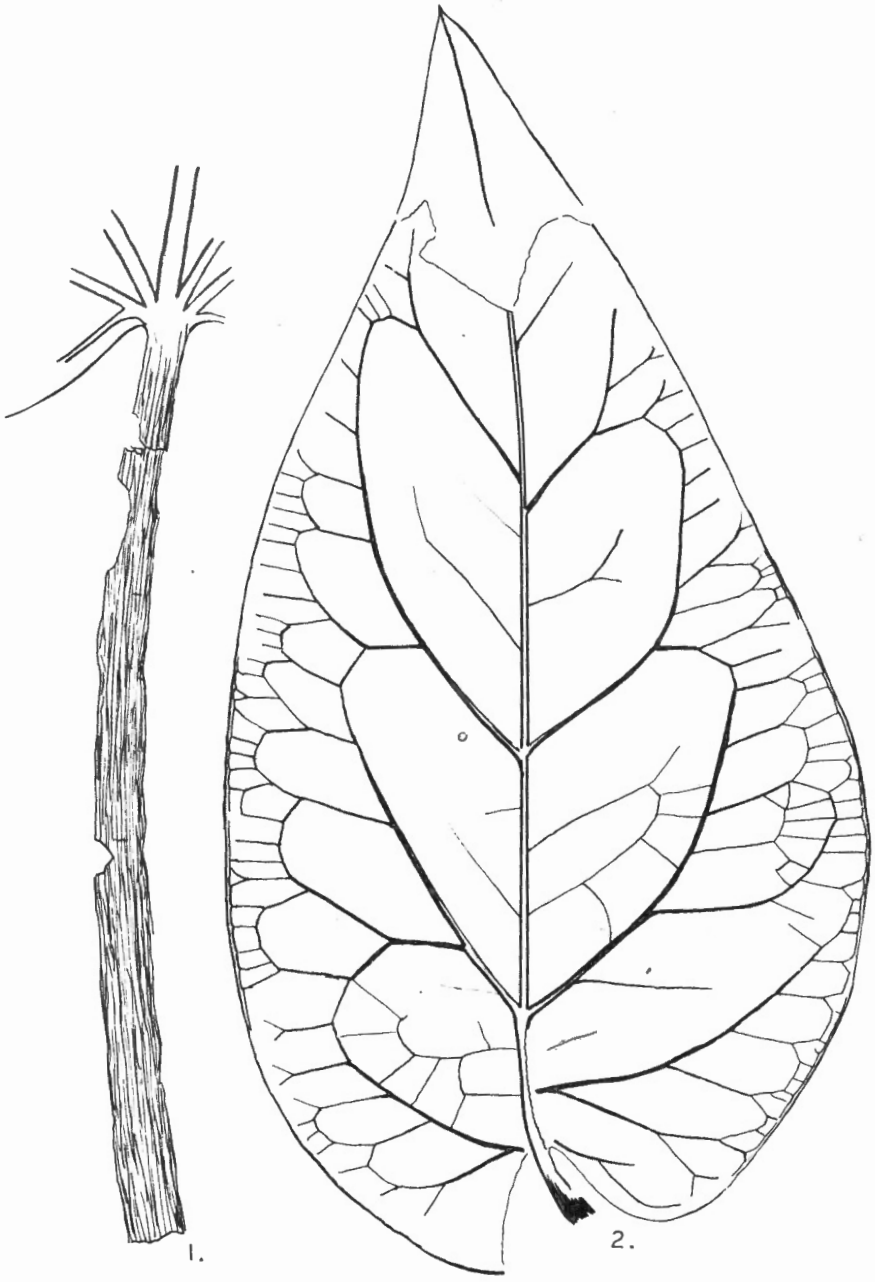

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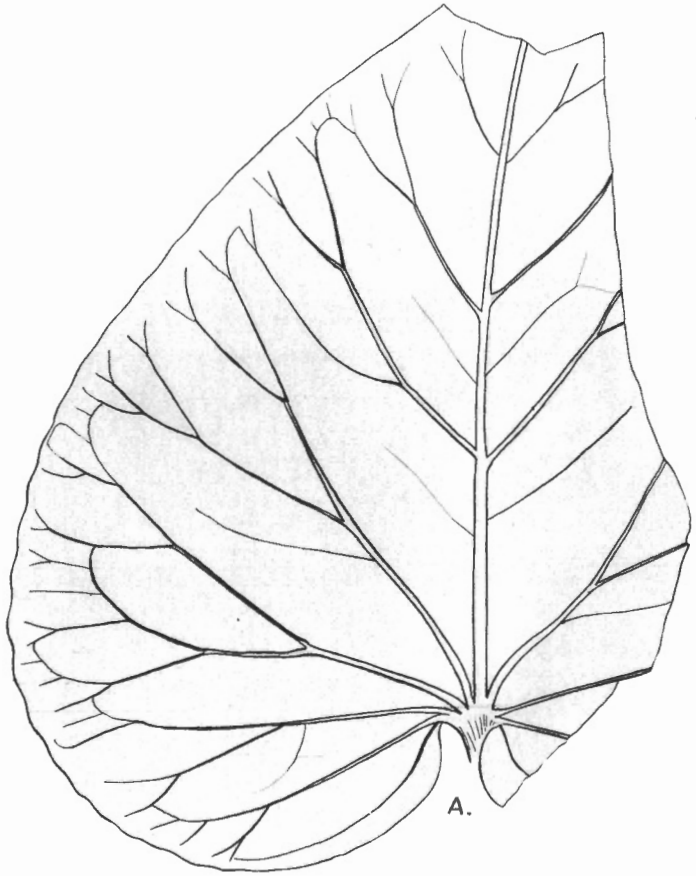
Plate X

A. *Paranymphaea crassifolia* (Newberry) Berry. Locality 21. Plesiotype, No. 7425, Geol. Surv., Canada. (Half natural size.) (Page 39.)

B. *Paranymphaea crassifolia* (Newberry) Berry. Locality 21. Plesiotype, No. 7426, Geol. Surv., Canada. (Half natural size.) (Page 39.)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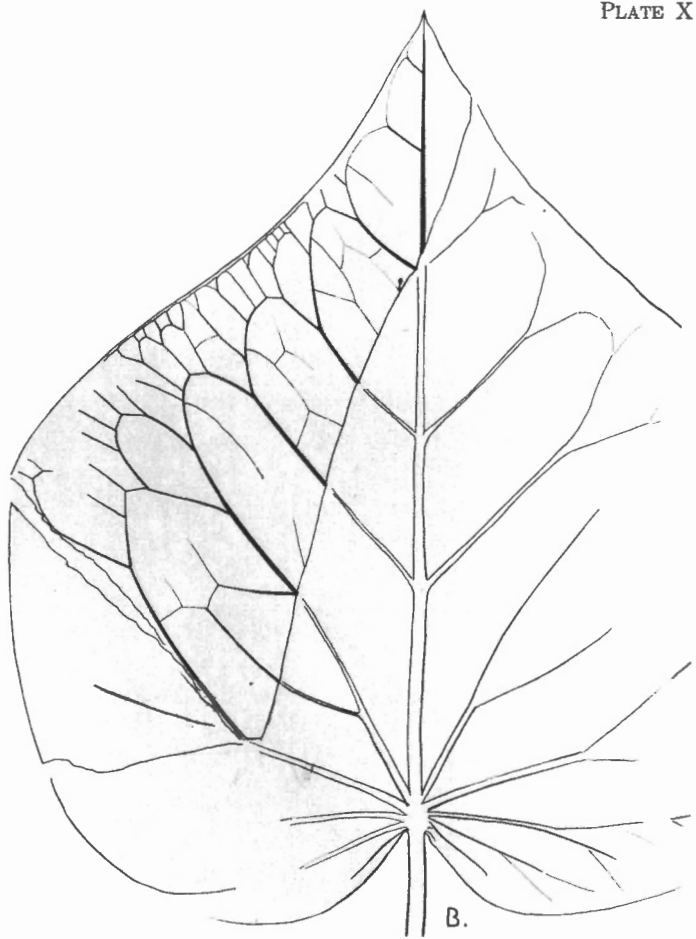
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Plate XI

Figures 1, 2. *Prunus mclearni* Berry. Locality P-1-30. Holotype and paratype, Nos. 7427, 7428, Geol. Surv., Canada. (Page 41.)

Figure 3. *Sapindus grandifolius* Ward. Locality 3579. Plesiotype, No. 7429, Geol. Surv., Canada. (Page 44.)

Figure 4. *Pterospermites minor* Ward. Locality 5. Plesiotype, No. 7430, Geol. Surv., Canada. (Page 48.)

Figures 5-8. *Paliurus pulcherrimus* Ward. Locality 9 (29-229). Plesiotypes, Nos. 7431, 7432, 7433, 7434, Geol. Surv., Canada. (Page 47.)

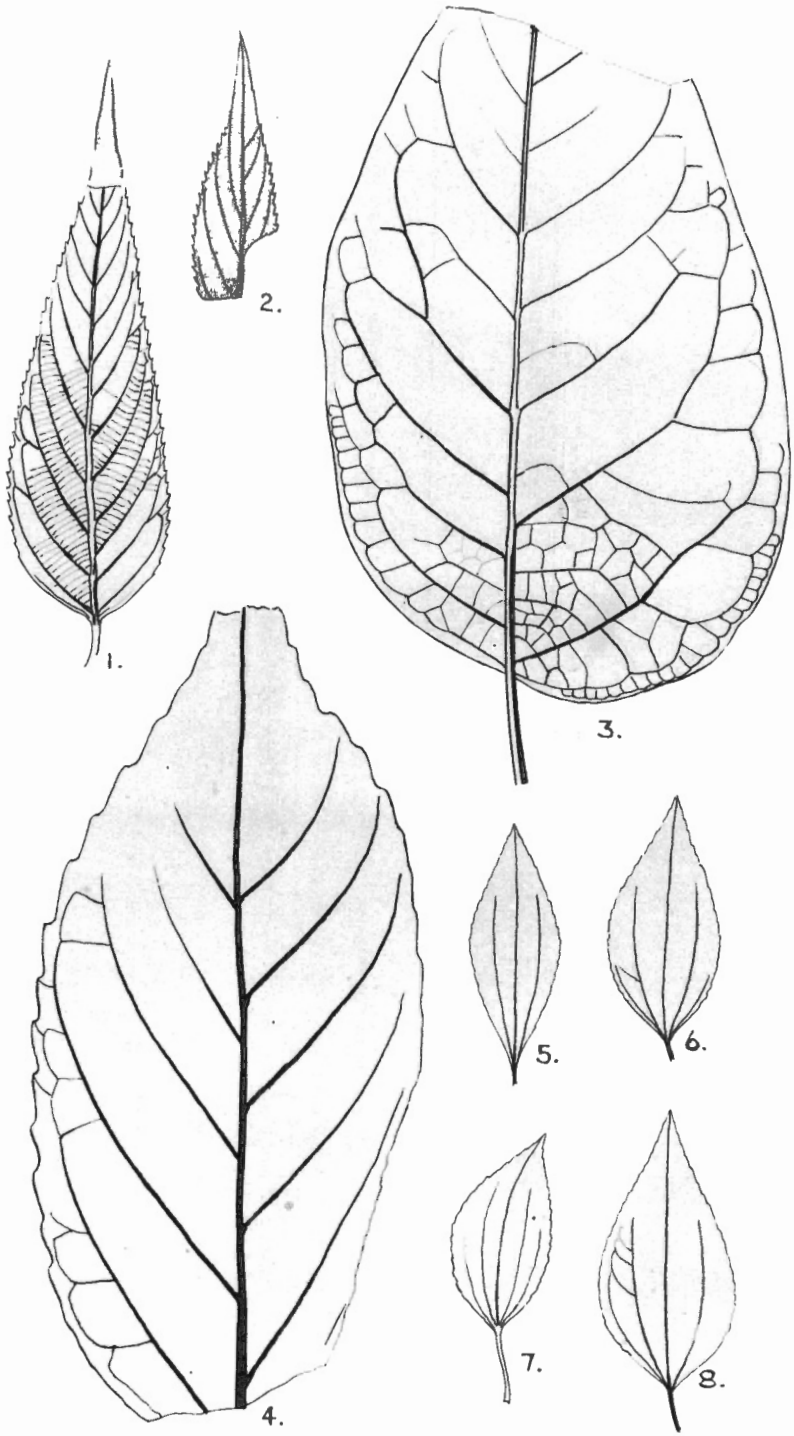
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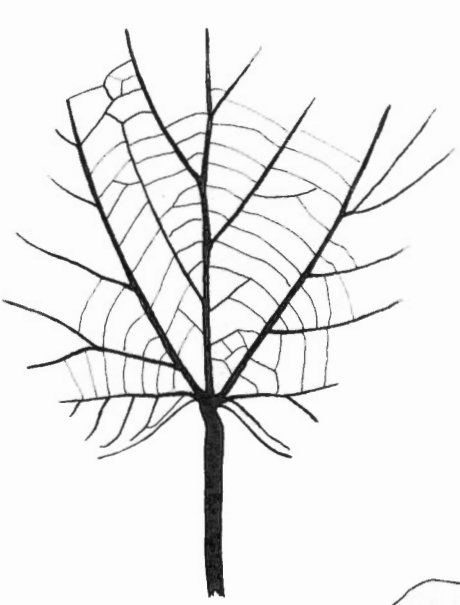
Plate XII

Figures 1, 2. *Vitis dakotana* Berry. Whitemud, Locality 7. Heautotypes, Nos. 7435, 7436, Geol. Surv., Canada. (Page 47.)

Figure 3. *Grewiopsis mclearni* Berry. Locality 37. Holotype, No. 7437, Geol. Surv., Canada. (Page 50.) (Approximately natural size.)



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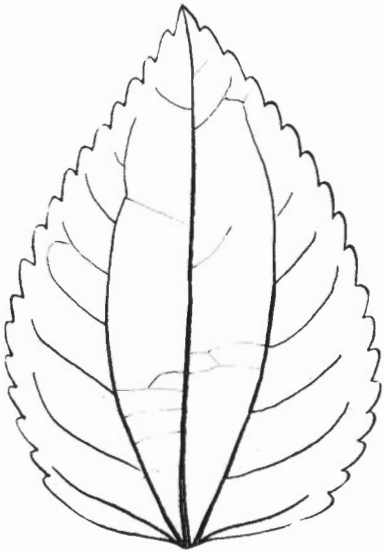

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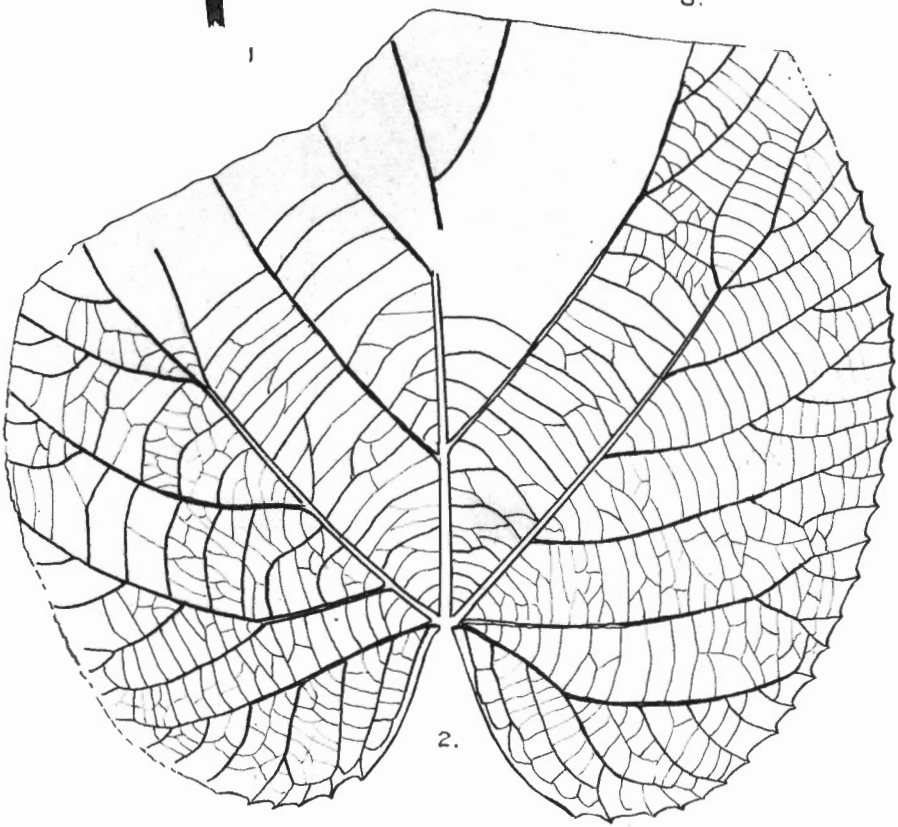


2.

Plate XIII

Figures 1, 2. *Pterospermites penhallowi* Berry. Locality 32. Cotypes, Nos. 7438, 7439, Geol. Surv., Canada. (Approximately natural size.) (Page 49.)

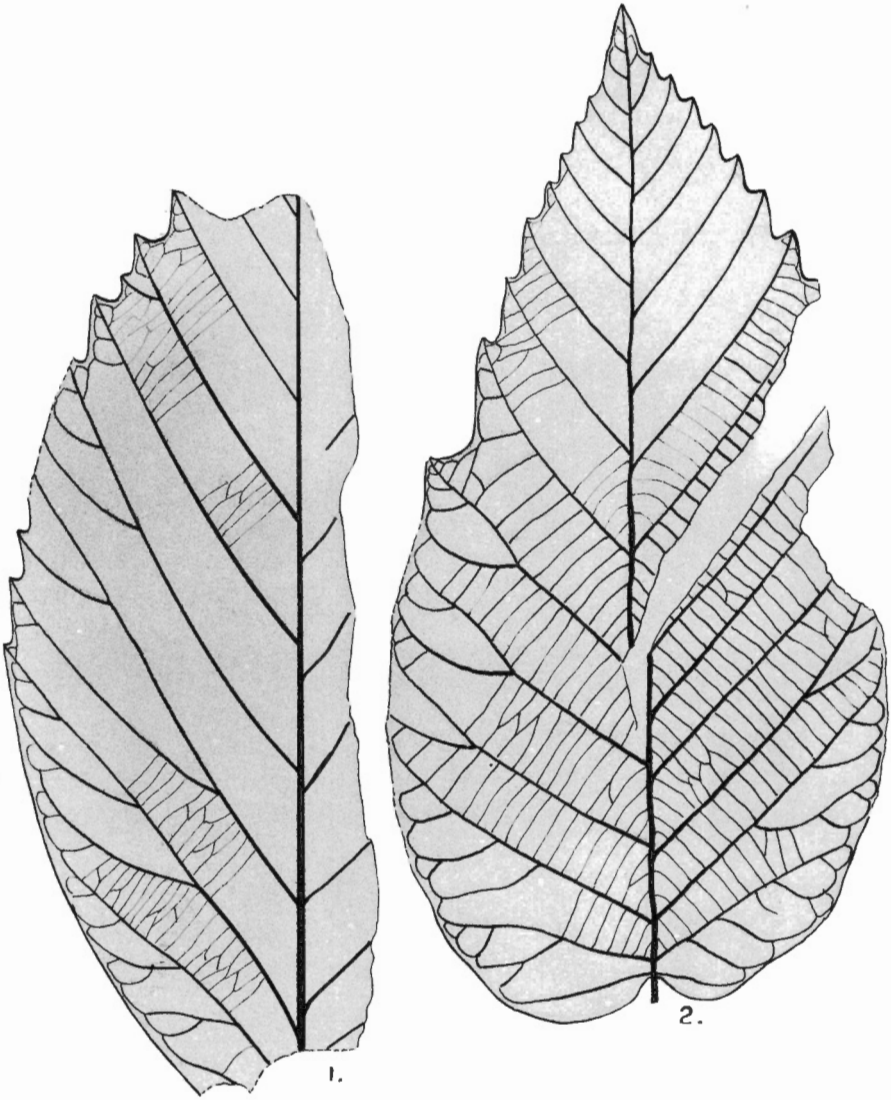
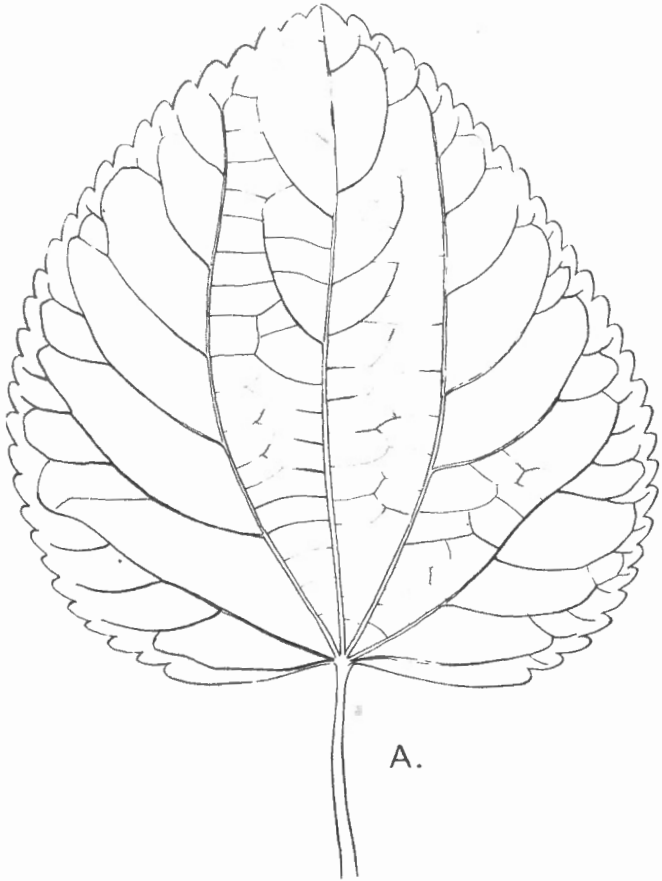

1.
2.

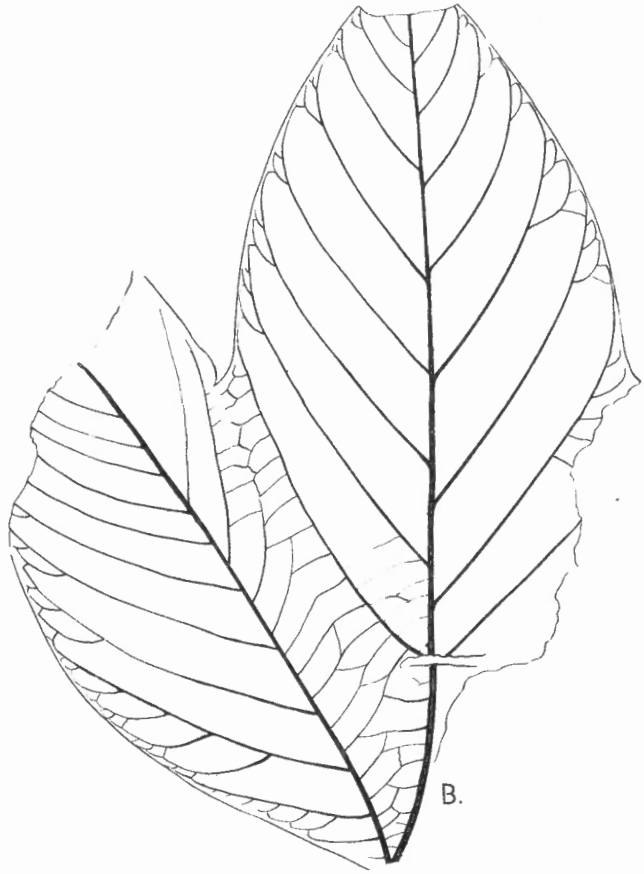
Plate XIV

A. *Grewiopsis mclearni* Berry. Locality 37. Holotype, No. 7440, Geol. Surv., Canada. (Half natural size.) (Page 50.)

B. *Aralia notata* Lesquereux. Locality 32. Plesiotype, No. 7448, Geol. Surv., Canada. (Half natural size.) (Page 53.)



A.



B.

Plate XV

Figures 1, 2. *Laurophyllum ripleyensis* Berry. Locality 33. Heautotypes, Nos. 7441, 7442, Geol. Surv., Canada. (Page 51.)

Figure 3. *Myrciophyllum americanum* Berry. Locality 3579. Holotype, No. 7443, Geol. Surv., Canada. (Page 52.)

Figure 4. *Fraxinus leii* Berry. Locality 33. Heautotype, No. 7445, Geol. Surv., Canada. (Page 55.)

Figure 5. *Viburnum castrae* Knowlton and Cockerell. Locality 2. Plesiotype, No. 7446, Geol. Surv., Canada. (Page 56.)

Figure 6. *Viburnum antiquum* mutant *trinervum*. Locality 3579. Holotype, No. 7447, Geol. Surv., Canada. (Page 60.)

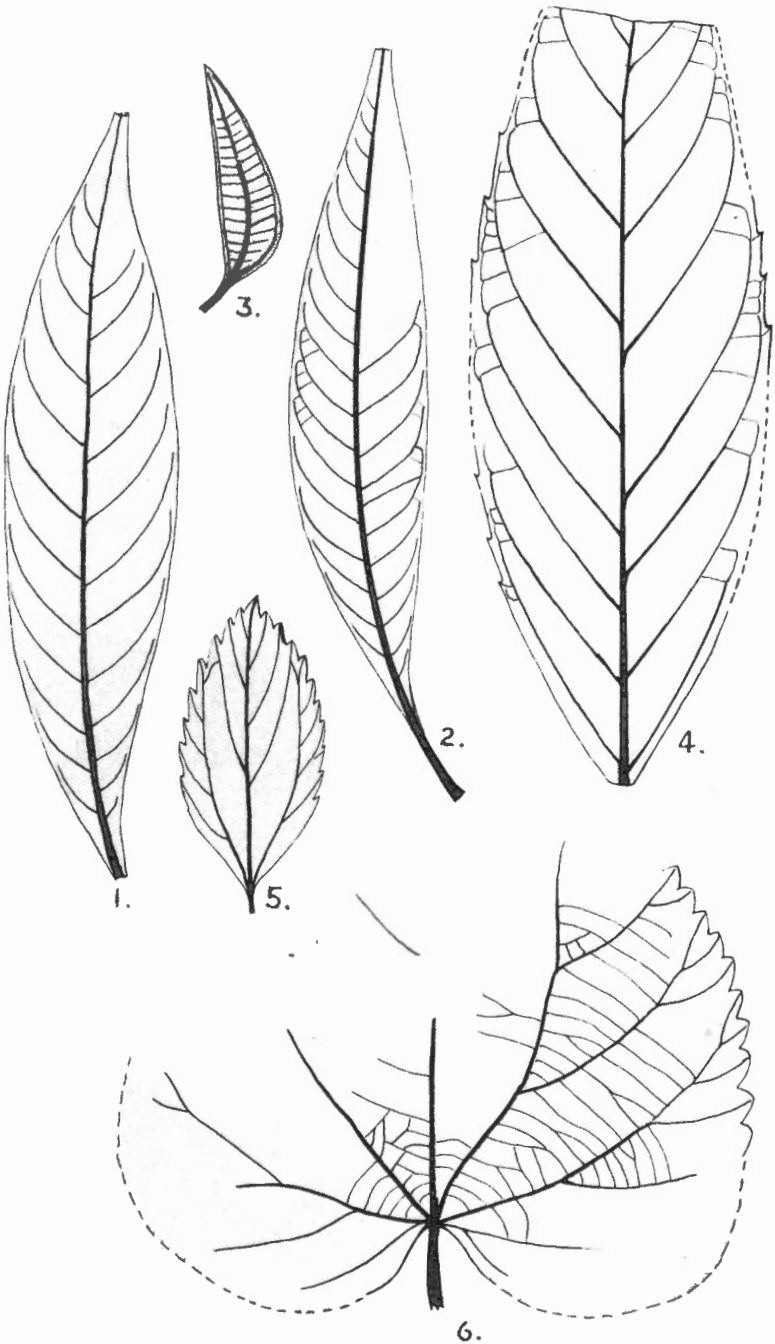
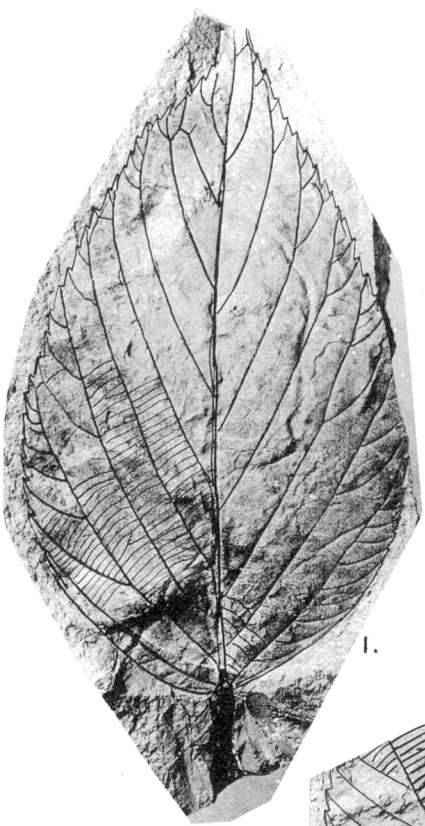
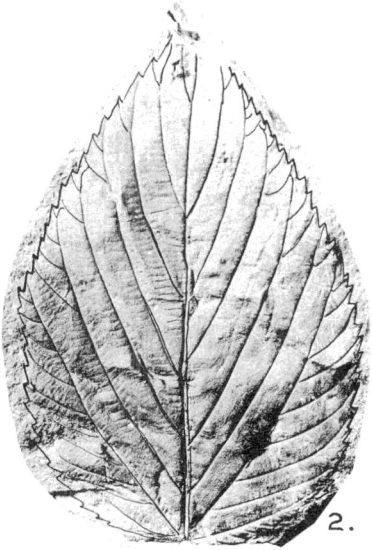

1.
2.
3.
4.
5.
6.

PLATE XVI

Viburnum asperum Newberry. Locality 23. Plesiotypes, Nos. 7449, 7450, 7451, 7452, Geol. Surv., Canada. (Page 56.)

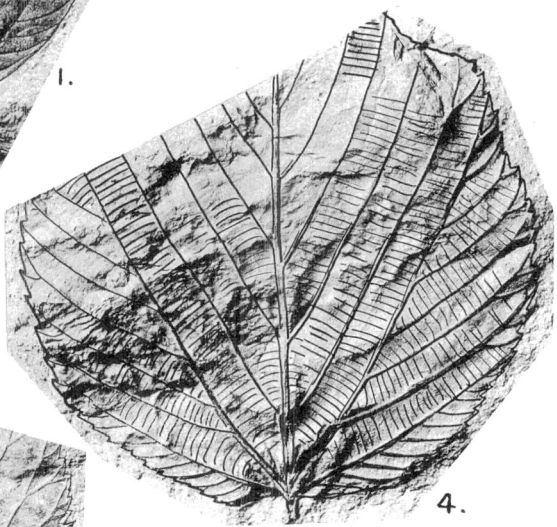


1.



2.

3.

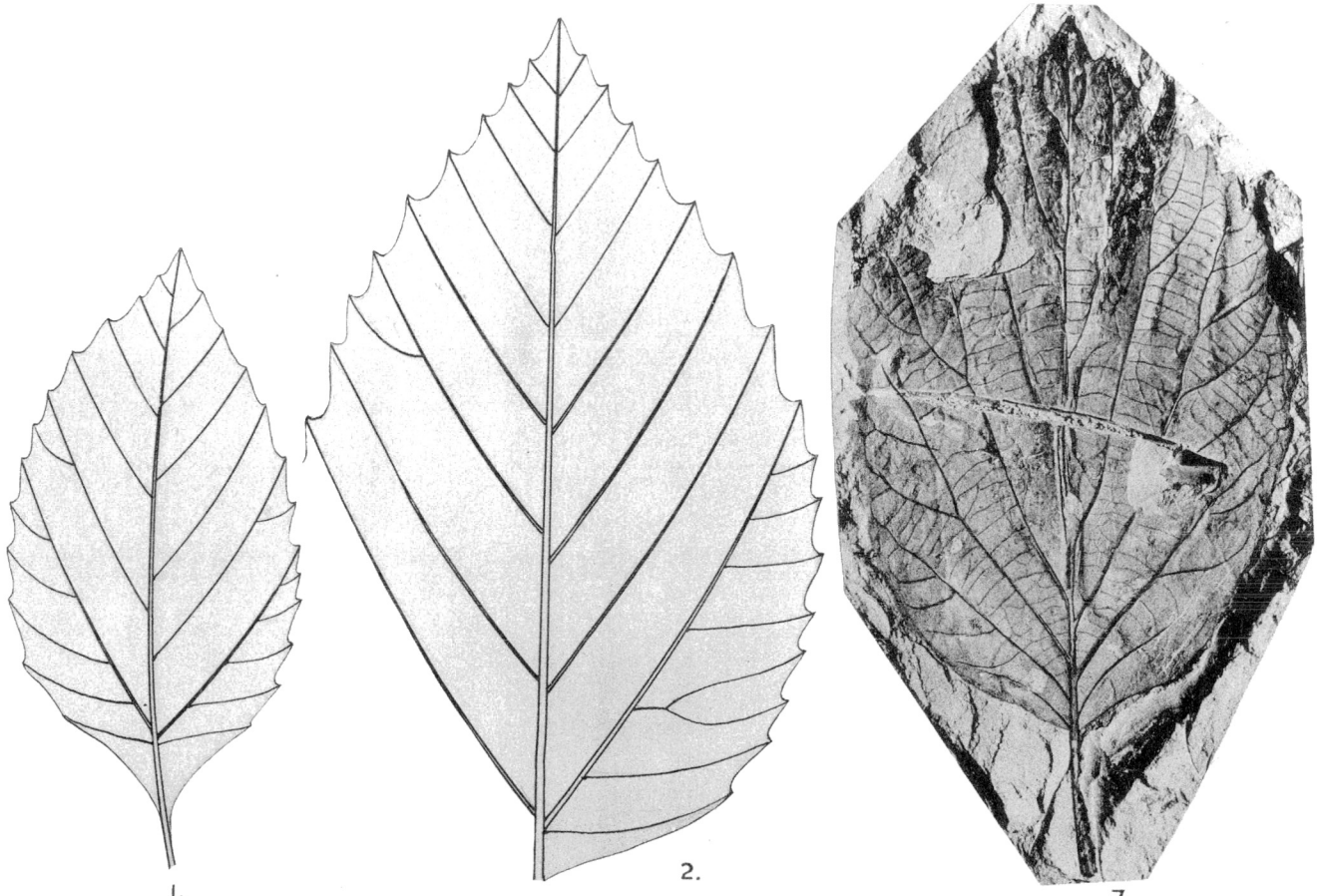


4.

Plate XVII

Viburnum antiquum (Newberry) Hollick. Plesiotypes, Nos. 7453, 7454, Geol. Surv., Canada. (Page 58.)

Figures 1, 2. Locality 3426; Figure 3. Locality 32. Plesiotype, No. 7455, Geol. Surv., Canada. (Approximately natural size.)



1.

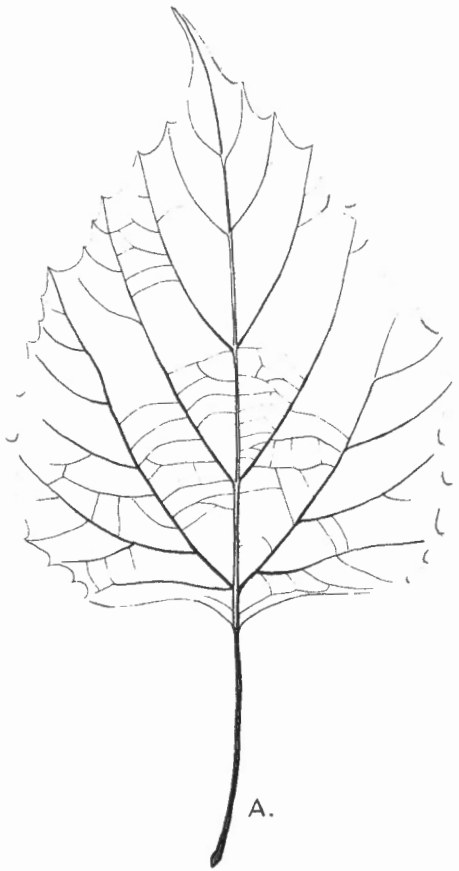
2.

3.

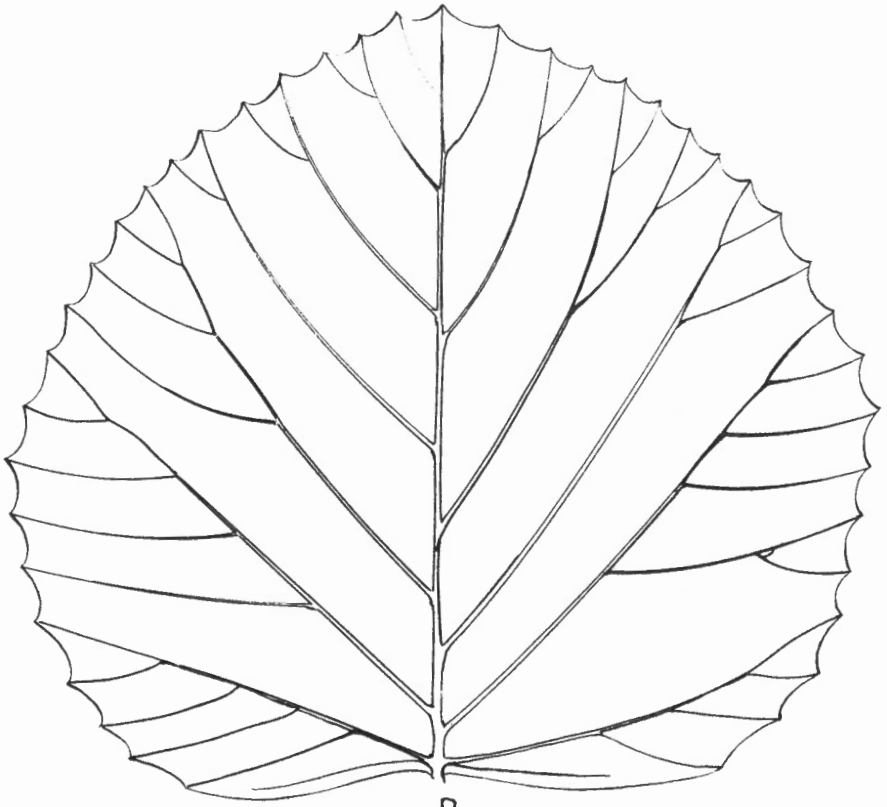
Plate XVIII

A. *Viburnum antiquum* (Newberry) Hollick. Locality 3426. Plesiotype, No. 7456, Geol. Surv., Canada. (Half natural size.) (Page 58.)

B. *Viburnum antiquum* (Newberry) Hollick. Locality 35. Plesiotype, No. 7457, Geol. Surv., Canada. (Half natural size.) (Page 58.)



A.



B.

PLATE XIX

Figures 1-11. *Trapa* (?) *microphylla* Lesquereux. (Page 61.)

Figure 1. Group of small leaflets from Locality 3258. Plesiotype, No. 7458, Geol. Surv., Canada.

Figure 2. Typical large leaf. Locality 21. Plesiotype, No. 7459, Geol. Surv., Canada.

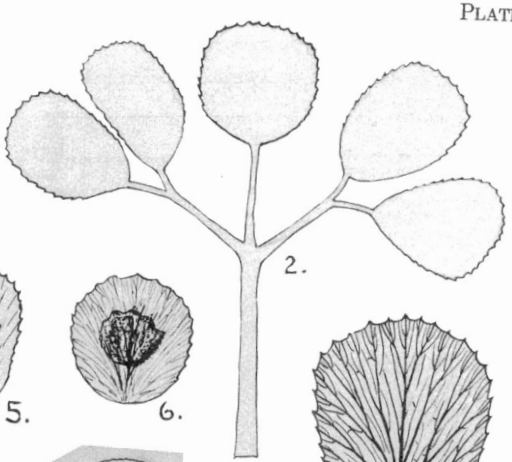
Figures 3-6. Leaflets with air bladders. Locality 3258. Plesiotypes, Nos. 7460, 7461, 7549, 7551, Geol. Surv., Canada.

Figure 7. Maximum-sized leaflet showing venation. Locality 3258. Plesiotype, No. 7552, Geol. Surv., Canada.

Figures 8-11. Plant and leaves from the lower Edmonton. Hay River crossing of Grand cache, sec. 29, tp. 52, range 27, W. 5th mer., Brûlé map.

Figure 12. *Viburnum* sp. Locality 7. Holotype, No. 7553, Geol. Surv., Canada. (Page 61.)

1.



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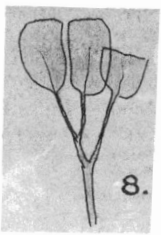

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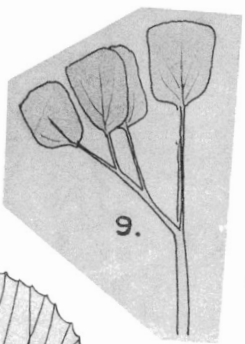

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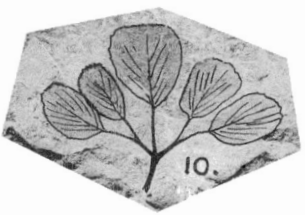

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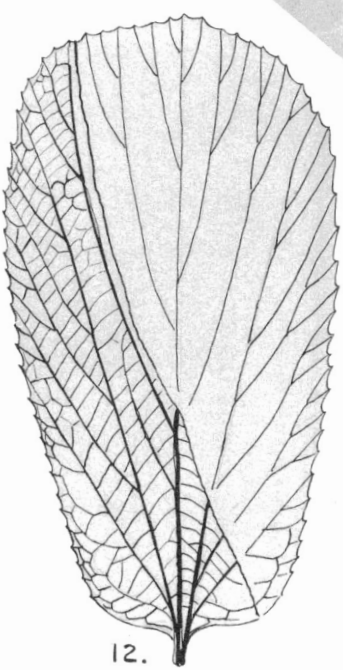
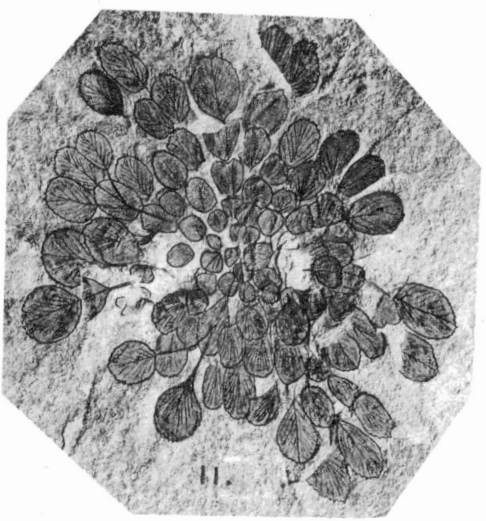


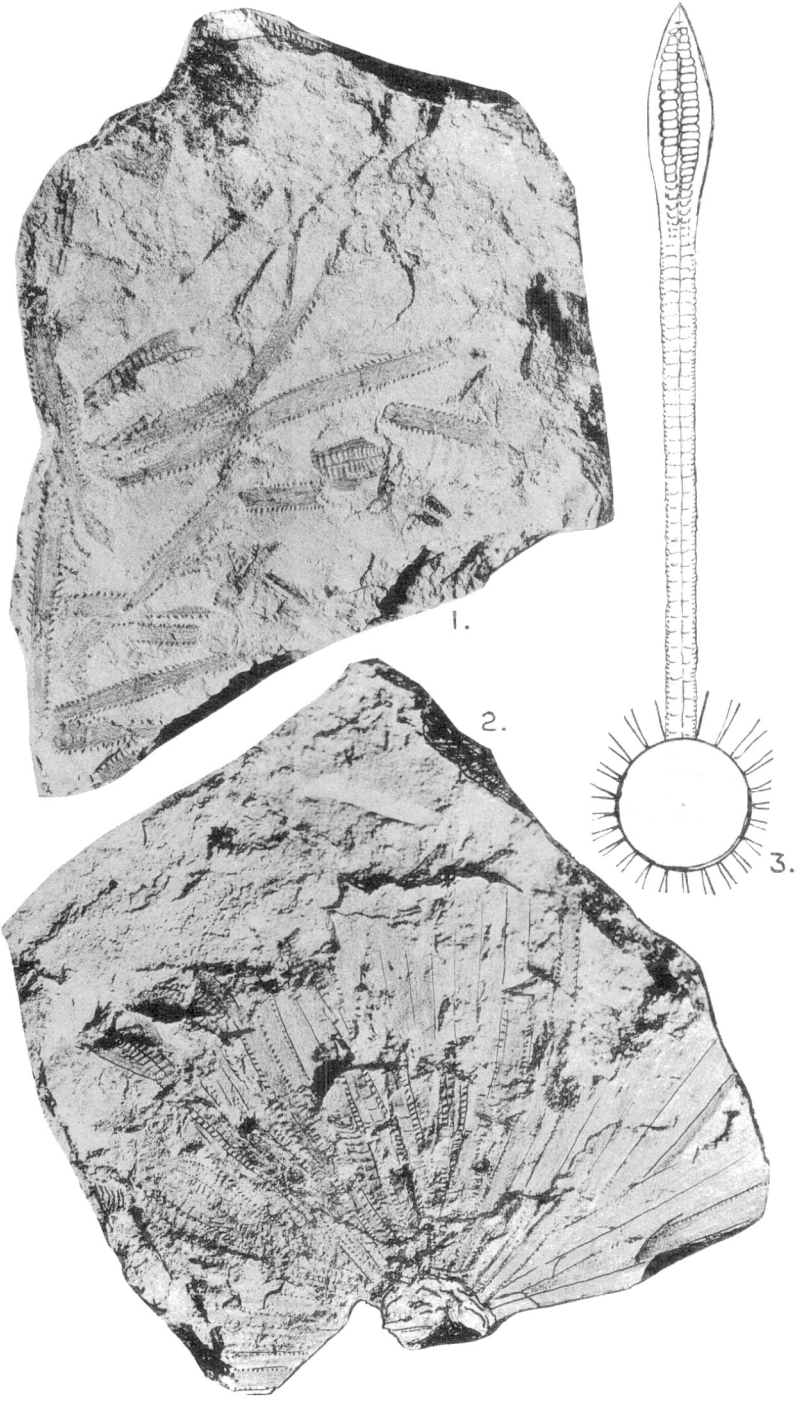
12.



11.

PLATE XX

Figures 1-3. *Xantholithes propheticus* Ward. Locality 13. (Page 65.)
Figures 1, 2. Plesiotypes, Nos. 7554, 7555, Geol. Surv., Canada.
Figure 3 shows reconstruction of base and a single appendage.


1.
2.
3.

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