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UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

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# FLORA

OF THE

# MONTANA FORMATION

BY

FRANK HALL KNOWLTON



WASHINGTON  
GOVERNMENT PRINTING OFFICE  
1900

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## LETTER OF TRANSMITTAL.

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DEPARTMENT OF THE INTERIOR,  
UNITED STATES GEOLOGICAL SURVEY,  
*Washington, D. C., June 27, 1899.*

SIR: I have the honor to transmit herewith the manuscript and illustrations of a paper entitled "Flora of the Montana Formation," and to request its publication as a bulletin of the Survey.

Very respectfully,

F. H. KNOWLTON,  
*Assistant Paleontologist.*

Hon. CHARLES D. WALCOTT,  
*Director United States Geological Survey.*

IX

Bull 163—II



# FLORA OF THE MONTANA FORMATION.

By FRANK HALL KNOWLTON.

## INTRODUCTION.

The history of the so-called Laramie and allied formations of the Rocky Mountain region has been an intricate and interesting one, and much literature exists on the subject. As summaries have recently been presented<sup>1</sup> it is deemed unnecessary again to go over this ground, except in the briefest manner and in so far as it is essential to an understanding of the reasons for separating the present paper from my contemplated monograph on the Laramie floras.

The series of strata which has in recent years been known as the Laramie group or formation, was first called the Lignitic group and was believed to contain all the coal of the region in which it occurs. The Lignitic also included certain lower Tertiary beds, now known as the Fort Union beds, and the whole was at that time regarded as Tertiary in age. Later the Laramie was differentiated as a single formation, by Mr. Clarence King<sup>2</sup> and Dr. F. V. Hayden, and characterized as the uppermost division of the conformable Cretaceous series, and the Fort Union was ultimately associated with the lower Tertiary, although still regarded by some as belonging to the Laramie series. As thus defined, the Laramie was thought to be very sharply circumscribed, but later investigations have shown that this view requires modification. Thus it was found that instead of being uniformly underlain by marine Cretaceous, certain of the coal seams were intercalated in marine beds, or, in other words, there had been alternations of fresh and brackish or salt water before the true Laramie age prevailed. The evidence for this phase of the subject will be more fully presented in the following pages.

As investigation progressed it became evident that certain beds of the upper portion of the Laramie series could not be satisfactorily harmonized, and this led to the separation of the Arapahoe and Den-

<sup>1</sup>Ward, Synopsis of the flora of the Laramie group: Sixth Ann. Rept. U. S. Geol. Survey, 1884-85, pp. 399-557, Pls. XXI-LXXV (1886).

White, Correlation papers—Cretaceous: Bull. U. S. Geol. Survey No. 82, pp. 140 et seq. (1891).

<sup>2</sup>See U. S. Geol. Expl. 40th Parallel, Vol. I, p. 331 (1878).

ver beds, by Cross and Eldridge, in Colorado, and of the Livingston beds, by Weed, in Montana. It thus becomes necessary to readjust the lower and upper limits of the so-called Laramie series. For present purposes the fixing of the lower limit of the Laramie is of most importance, and will receive prominent attention.

Most of the typical localities in which the complications mentioned have arisen are in eastern and central Wyoming, in eastern Utah, and at various places in Colorado. These localities have been frequently visited and studied by geologists, but not since much of the important work of differentiation has been accomplished; and with the view of ascertaining the bearing of this newer information on the problems in question, Mr. T. W. Stanton and I spent the field season of 1896 in a restudy of this general area. The results of our investigations were presented in a joint paper entitled *Stratigraphy and Paleontology of the Laramie and Related Formations in Wyoming*.<sup>1</sup> The general conclusion is reached, following the example of King, Hayden, and others, that the base of the true Laramie in the Rocky Mountain region should be placed at the top of the Fox Hills, or in other words that nothing below the marine Cretaceous should be regarded as Laramie. While this view has some objections, as, for example, the difficulty sometimes experienced in locating the exact top of the Fox Hills, it seems, on the whole, simple and most logical, since if all the Upper Cretaceous coals were included there would be a practical abandonment of the Laramie as a distinct series, and a return to the old Lignitic group, which, as already stated, included all the coals of the region. The Montana formation or division is thus made to include certain intercalated beds carrying important coal veins, a quite extensive land flora, and occasional brackish and fresh-water mollusks. This flora, which embraces at least 80 species, has for many years been regarded as a true Laramie flora.

The localities within the Montana formation which have afforded the most extensive flora will be first considered. They are located in southwestern Wyoming, along the line of the Union Pacific Railroad, and in northeastern Utah, in the vicinity of Coalville. These localities have been often visited by geologists, and have given rise to much discussion.

The geologists connected with the exploration along the fortieth parallel appear to have been the first to call attention<sup>2</sup> to the fact that the Fox Hills beds, as exposed within this area, embrace numerous coal seams and sandstones containing abundant plant remains, as they constantly found above them beds containing characteristic marine invertebrates. This view did not, however, obtain very wide acceptance, or, rather, recognition, which was doubtless largely due to the difficulty in fixing the upper limit of the Fox Hills beds. In this way the coal

<sup>1</sup> Bull. Geol. Soc. Am., Vol. VIII, pp. 127-156 (1896).

<sup>2</sup> U. S. Geol. Expl. 40th Parallel, Vol. II, pp. 85 et seq. (1877); Vol. I, pp. 320 et seq. (1878).



seams of the region came to be regarded as belonging to the Laramie, and the flora associated with them was naturally regarded as a true Laramie flora. It is this so-called "true Laramie flora" that has given rise to much misunderstanding and confusion regarding the distribution and geological significance of the fossil plants of the Rocky Mountain region.

After the announcement of the fortieth parallel geologists, as before mentioned, the presence of well-defined plant-bearing strata below the marine Cretaceous seems not to have attracted much attention until it came to the notice of Prof. W. C. Knight, of the University of Wyoming, at Laramie. Professor Knight, as State geologist and mining expert, has visited and become intimately acquainted with the geology of the entire State, but more particularly with the area known as the Laramie Plains. As early as 1894, in a letter to me, he called particular attention to the presence of a well-defined coal and plant horizon below typical marine Cretaceous.

In July, 1896, Professor Knight generously guided Mr. Stanton and me to a number of localities on the Laramie Plains, at a distance of 25 to 30 miles northwest of Laramie, in the vicinity of Rock Creek and Cooper Creek, where we were abundantly able to confirm his claims. One of the first sections visited in which the relations are best exhibited, is within a mile or two of Harpers Station, on the Union Pacific Railroad, and not far from the old Miser Station, which is frequently referred to in the early accounts of the region. One mile northwest of Harpers is an exposure of white sandstone and clay, with coal seams, having a thickness of about 40 feet. Fossil plants of the following species were found near the base of the exposure and in a band some 20 or 25 feet higher:

*Geinitzia formosa* Heer.

*Brachyphyllum macrocarpum* Newb.

*Cinnamomum affine* Lx.

*Quercus Lesquereuxiana* Kn.

The beds immediately overlying this coal and plant-bearing series are obscured by the disintegration of the beds above, but, fortunately, an exposure was found about 200 yards south of the plant locality and at least 100 feet higher. From this exposure the following characteristic Cretaceous invertebrates were obtained:

*Chlamys nebrascensis* M. & H.

*Inoceramus crispus* var. *barabini* Morton.

*Baculites ovatus* Say.

These species, Mr. Stanton says, "occur in both the Fort Pierre and Fox Hills beds, which are not very clearly differentiated in this region, but the fauna of the underlying beds shows that we are here probably in the Fox Hills beds." Since our return from the field Professor Knight has informed us that he has again visited the locality and found a typical Fox Hills fauna a mile farther south, and probably 1,000 feet higher than the coal and plant-bearing beds.

This same coal and plant horizon is exposed on the west side of the railroad, extending westward several miles toward Rock Creek from a point about 1 mile west of Harpers. The light-colored sandstones associated with the coal are here exposed to a thickness of about 75 feet, dipping 17° south and forming a prominent line of cliffs. In the upper part of the exposure, at a locality about 5 miles west of Harpers, a few fossil plants were collected, including *Geinitzia formosa* Heer and *Cinnamomum affine* Lx.

The stratigraphic relation of the plant bed to the overlying marine strata was again confirmed by finding a fossiliferous horizon in brown and gray sandstone from 500 to 600 feet above the plant zone, and apparently conformable with it. The following Montana species were obtained here:

*Ostrea* sp.

*Avicula nebrascana* E. & S.

*Baculites ovatus* Say.

*Baculites compressus* Say.

*Scaphites* sp.<sup>1</sup>

The beds below the coal and plant-bearing horizon are well exposed on both sides of the railroad near Harpers, where they outcrop in narrow ridges of hard limestone. There are several highly fossiliferous bands, and collections made at points 400 to 500 feet below the coal yield over 30 Montana (probably Fort Pierre) species. The horizon, probably 300 or 400 feet still lower, yields nearly 50 species, some of which are found also in the upper horizon.

Another locality affording a number of fossil plants is at Dunn's ranch, on the Laramie River, about 6 miles east of Harpers. The plants are preserved in a soft, fine-grained, yellowish sandstone. The following species were obtained:

*Pinus Quenstedti* Heer.

*Myrica Torreyi* Lx.

*Quercus Lesquereuxiana* Kn.

*Ficus planicostata* Lx.

*Celastrus* sp.

*Salix* sp.

*Spathites* sp.

It was not possible, in the limited time at our disposal, to attempt to trace the connection between this locality and the one just discussed, and it is doubtful if it can be done, for the exposures are extremely limited and the country much obscured by overlying material. There is every reason to suppose, however, that the two localities are nearly if not quite in the same horizon, a view which finds support in the fact that at least two of the species of plants are common to both.

A third locality on the Laramie Plains which has afforded fossil plants is near the old overland stage road, on the north fork of Dutton Creek between Rock and Cooper creeks. At this point is a small coal vein that has been mined to some extent for local uses. It is probably the coal spoken of by the fortieth parallel geologists<sup>2</sup> as the "Cooper Creek coal." The shales immediately overlying the coal, as well as a light-colored sandstone some 25 feet higher, contain plants as follows:

*Dryopteris duttoniana* n. sp.

*Woodwardia crenata* n. sp.

*Brachyphyllum macrocarpum* Newb.

*Geinitzia formosa* Heer.

*Trapa* ? *microphylla* Lx.

*Ficus* sp.

*Castalia* sp.

*Asimina eocenica* Lx.

*Diospyros* ? *ficoidea* Lx.

<sup>1</sup> Stanton and Knowlton, op. cit., p. 138.

<sup>2</sup> U. S. Geol. Expl. 40th Parallel, Vol. I.

There is no satisfactory exposure of the overlying strata near this coal, but at a point about 3 miles to the southwest, near the old stage crossing of Cooper Creek, and certainly higher in position, the beds are very fossiliferous and contain a typical Fox Hills fauna of about twenty-five species. It is of course possible that there is a fault or other disturbance between these two points, but no evidence of it appeared, and the relations before mentioned are probably correct. The evidence afforded by the plants, while somewhat conflicting, tends to place this plant horizon well down in the series, or approximately similar to the plant horizon of Harpers, for at least two of the species (*Geinitzia formosa* and *Brachyphyllum macrocarpum*) are common to both localities. These are very characteristic species and can not well be mistaken. Of the other species two (*Trapa ? microphylla* and *Diospyros ? ficoidea*) are found at Black Buttes and at Point of Rocks, while the remainder of the forms previously named have a higher distribution. These latter, however, rest on single examples and are not entitled to the weight that should be allowed the others, which are represented by numerous specimens. For the present at least it seems best to regard this flora as belonging to the Montana formation.

The remaining coal and plant-bearing horizon that we visited on the Laramie Plains, now known as the "Dutton Creek mine," is similar in age to the coal of Carbon, and is regarded as Laramie.

#### LOCALITIES IN BITTER CREEK VALLEY.

The stratigraphy and paleontology of the Bitter Creek Valley and immediate vicinity have been much studied and have given rise to prolonged discussion. The exposures are in most cases extensive, and the fossils, both plant and animal, are very abundant.

Black Buttes Station is one of the most important of these localities, and has been frequently visited by geologists. It is introduced into the present discussion only on account of the geological and paleontological bearing it has on certain other points in the Bitter Creek Valley.

The following brief account of the geology at Black Buttes is taken from the paper before referred to by Mr. T. W. Stanton and myself (p. 143):

The most prominent feature of the section of Black Buttes is the massive bed of sandstone, somewhat over 100 feet thick at the base of the exposure, forming steep hills and cliffs northeast of the railroad opposite the station, and passing beneath the surface by its dip of 9 or 10 degrees near the coal mine. The upper portion of it is also exposed on the south side of Bitter Creek Valley, about a mile from the station.

All of the Laramie fossils, whether plants, invertebrates, or vertebrates, that have hitherto been described or listed as coming from Black Buttes, were obtained from the overlying beds within about 100 feet of the top of this massive sandstone. The original specimen of *Agantheum sylvestris* was found about 20 feet above it, and the plants that have been described came from the same horizon and from several higher bands up to the bed overlying the principal coal, some 60 or 75 feet higher. The invertebrates from this locality have about the same range. Most of the beds

vary considerably in character and thickness within short distances, but the fossiliferous and overlying portions of the section may be described in general terms as a series of variable sandstones, clay, and coal beds, exposed in low hills and ridges, with a dip of 9 or 10 degrees eastward at the base, but decreasing in the upper portions to 5 or 6 degrees, which is about the same as the dip of the overlying Wasatch beds.

The section at Black Buttes as thus defined is referred without hesitation to the Laramie, and the flora is considered a true Laramie flora, as now understood. The flora and invertebrate fauna are practically identical with that of the Laramie of Converse County, Wyoming,<sup>1</sup> a locality in which the geological relations are much plainer than at Black Buttes, since the section is continuous from the Fort Pierre slates to and perhaps above the Fort Union beds.

Point of Rocks, Wyoming, 11 miles northwest of Black Buttes, has afforded an extensive fossil flora which has, until recently, been regarded as a true Laramie flora. The section is somewhat similar to that at Black Buttes, having at the base a massive light-colored sandstone about 100 feet in thickness, the presence of which, together with the evidence of certain local faulting between the two points, has led several geologists to regard them as representing about the same horizon. Powell, in his *Geology of the Uinta Mountains*, page 48, named his "Point of Rocks group" from this section, and drew the line separating it from the Bitter Creek group above at the top of the heavy sandstone, where the somewhat uneven surface was regarded as representing an erosive interval. The base of the Point of Rocks group as defined by him is observed about 6 miles west from Point of Rocks Station, near where the comparatively narrow valley broadens into that of the Salt Hills Valley. The base was placed at the base of the massive sandstone, which is quite different lithologically from the thinly laminated beds of the summit of the Salt Hills group below. The Point of Rocks group of Powell was therefore supposed to correspond more or less closely with the Laramie,<sup>2</sup> but this has since been shown to be an entirely wrong conception.

The Point of Rocks section had been previously visited and somewhat hastily studied by Messrs. Meek and Bannister, of the Hayden survey,<sup>3</sup> and they would place the coal beds several hundred feet lower than those at Black Buttes. The observations of Mr. Stanton and myself are abundantly confirmatory of this latter view, for not only did a comparative study of the two sections seem to indicate differences, but, in addition, we found marine Cretaceous shells above the coal. The beds containing this fauna occupy a position near the top of the bluff in front of the Point of Rocks Station, and about 260 feet above the top of the massive sandstone. The dip of the beds is about 6° a little north of east, and almost parallel with a valley that joins that

<sup>1</sup> See Stanton and Knowlton, op. cit., pp. 128-137.

<sup>2</sup> See White, Bull. U. S. Geol. Survey No. 82, p. 156.

<sup>3</sup> Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1872, pp. 529 et seq.

of Bitter Creek just east of the station. The first fossiliferous horizon in front of the station, clearly belonging to the Fox Hills, is about 200 yards back from the edge of this bluff. The dip brings this horizon down to the level of the valley a little more than a mile from the station. Immediately overlying it is a brown ferruginous sandstone containing the following marine Cretaceous forms:

*Ostrea glabra* M. & H.

*Inoceramus crispus* var. *barabini* Morton.

*Cardium speciosum* M. & H.

*Mactra alta* M. & H.

*Mactra warrenana* M. & H.

*Dentalium gracile* H. & M.

About 4 miles eastward a line of cliffs is reached. The exposures are somewhat obscured between the two places, but nearly 700 feet of strata are passed, and then the characteristic Fox Hills fauna is again found near the base of the cliffs, showing that the formation is still marine Cretaceous. In other words, it is shown that there are more than 700 feet of typically marine Cretaceous above the coal-bearing series in the Point of Rocks section.

The Point of Rocks flora is the richest and most important thus far discovered in the Montana formation. It embraces no fewer than 58 species belonging to 33 genera. The greater part of the plants were obtained in lenticular argillaceous masses in the upper portion of the massive sandstone, and a few have been found in the shales over the coal. Another locality which has afforded a number of species is southeast of the station, in strata apparently as low as in the locality above mentioned, and possibly even lower.

The plant-bearing localities of Carbon, Rock Springs, Hams Fork, and Evanston were also visited by us, and a brief account of them is given in the joint paper above referred to.<sup>1</sup> They are all regarded as being above the Montana.

### COALVILLE, UTAH, AND VICINITY.

The geology in the vicinity of Coalville is somewhat complicated, and extensive differences of opinion have prevailed among geologists. The following brief historical account is given by Mr. T. W. Stanton:<sup>2</sup>

The coal-bearing Cretaceous beds exposed at Coalville, Utah, and on Bear River, near the mouth of Sulphur Creek, Wyoming, have been the subject of considerable discussion, and various opinions concerning their precise age have been published by the several geologists and paleontologists who have visited the localities or examined collections from them. They were referred to the Cretaceous by Messrs. Meek and Engelmann<sup>3</sup> in 1860, and were compared with certain Cretaceous beds at the mouth of the Judith River, then regarded as belonging to No. 1 (Dakota), but afterwards proved to be of Fox Hills age. When Captain Simpson's report<sup>4</sup> was published in 1876, Mr. Engelmann again expressed the opinion that these beds are probably "Lower Cretaceous" [Dakota].

<sup>1</sup> Bull. Geol. Soc. Am., Vol. VIII, pp. 148-150.

<sup>2</sup> The Colorado Formation: Bull. U. S. Geol. Survey No. 106, pp. 37, 38, 1893 (1894).

<sup>3</sup> Proc. Acad. Nat. Sci. Phila., Vol. XII, p. 130 (1860).

<sup>4</sup> Exploration across the Great Basin of Utah in 1859, p. 291 (1876).

They were first regarded as Tertiary by Messrs. Hayden<sup>1</sup> and Lesquereux.<sup>2</sup> In 1870 Messrs. Meek and Hayden<sup>3</sup> adopted the view that the Coalville beds are Cretaceous, but that they "occupy a higher horizon in the Cretaceous than even the Fox Hills beds of the Upper Missouri Cretaceous series."

Mr. Meek visited Coalville in 1872, and after making larger collections and studying the stratigraphy, he decided that the entire Upper Missouri Cretaceous section, with perhaps some older beds, is represented here. The detailed section that he published<sup>4</sup> shows correctly the essential features of the stratigraphy. The opinions that he then expressed concerning the correlation of these beds were repeated in subsequent publications.<sup>5</sup>

Messrs. King and Emmons<sup>6</sup> assigned the Cretaceous strata at Coalville to the Colorado, Fox Hills, and Laramie formations, and so mapped them in the atlas accompanying their report. The principal (lower) coal bed is included in the Colorado formation and the upper one in the Fox Hills, the line between these two formations being drawn in the second ridge above the lower coal bed. It should be remembered that the Colorado formation was then made to include the Fort Pierre division.

Dr. White studied the section in 1877, and, after discussing the fossils collected in it, he states<sup>7</sup> that it is impracticable to refer the strata to any one or more of the established Cretaceous groups with certainty, but he thinks there is no reason to doubt that the greater part of the series at least is referable to the Fox Hills.

Mr. Stanton spent several months studying the geology and paleontology of Coalville and vicinity, and observed many new and interesting facts. He carefully prepared a detailed section which shows the presence of about 6,000 feet of strata below the recognized Tertiary. Of this column about 1,700 feet are assigned to the Colorado, about 2,800 feet to the Montana, and approximately 1,500 feet to the Laramie, or the nonfossiliferous strata which occupy the position that should be taken by the Laramie if it is present.

None of the investigators previous to Mr. Stanton had noted the presence of fossil plants, but he, fortunately, found a rich deposit nearly 1,000 feet above the base of the Montana, and overlain by fully 1,800 feet of often richly fossiliferous marine Cretaceous, representing the upper portion of the Montana formation. The full details of his section and the lists of invertebrates may be found in his paper above cited.<sup>8</sup> There can, therefore, be absolutely no doubt as to their stratigraphic position.

The plants collected by Mr. Stanton were submitted to me for study, and a brief report on them is printed on page 42 of his bulletin. In that report I stated that the most important of the species "belong clearly to the Laramie group," and it should be remembered that this statement was in accord with the current conception of the Laramie when the Point of Rocks flora was regarded as typical. But, as

<sup>1</sup> Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1869, p. 91 (1870).

<sup>2</sup> Ibid., 1873, pp. 366, 371 (1874).

<sup>3</sup> Ibid., 1870, pp. 163, 291.

<sup>4</sup> Ibid., 1872, p. 439 (1873).

<sup>5</sup> U. S. Geol. and Geog. Surv. Terr., Vol. IX, p. xxx; U. S. Geol. Expl. 40th Parallel, Vol. IV, p. 11.

<sup>6</sup> U. S. Geol. Expl. 40th Parallel, Vol. I, pp. 316-319, 327-330 (1878); Vol. II, pp. 330-337 (1877).

<sup>7</sup> Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1877, p. 239 (1879).

<sup>8</sup> Bull. U. S. Geol. Survey No. 106, pp. 38-46.

already pointed out, it has since been shown that the Point of Rocks flora belongs also to the Montana formation, being below some 700 or 800 feet of marine Cretaceous. In the light of this information a new comparison of the plants from the two localities emphasizes their similarity and evident affinity. Thus the plants from Coalville have been referred to ten species, of which number two or three are either new to science or not specifically determinable, and of the remainder three or four are found at Point of Rocks.

#### OTHER LOCALITIES.

The Montana formation has an extensive geographical distribution beyond the areas before treated, being especially prominent in southern and western Colorado and in northern New Mexico; yet within all this vast area not a single fossil plant has been reported, with the possible exception of the more or less doubtful *Halymenites major*. Coal beds of greater or less extent occur, and plant-bearing horizons have often been noted, or there has been at least some hint of their presence. All paleobotanical work in this area remains for the future, and the most that can be done at present is to indicate a number of localities which would seem to promise favorable results when suitably exploited.

The upper portion of the Cretaceous within this area consists of coal-bearing sandstones and shales that have been referred to the Fox Hills, on the ground that marine Cretaceous invertebrates were found above the coal. This condition was noticed by Holmes<sup>1</sup> and Newberry<sup>2</sup> in southwestern Colorado, and by Peale<sup>3</sup> and White<sup>4</sup> in western Colorado—observations that have been abundantly confirmed by R. C. Hills.<sup>5</sup> In the Geological Atlas of Colorado, prepared by the Hayden survey, the formations are marked "Fox Hills," as above indicated. In 1893, Mr. T. W. Stanton<sup>6</sup> found, in Mancos Canyon, characteristic Fox Hill invertebrates from 800 to 1,000 feet above the base of the coal-bearing sandstones.

Prof. J. J. Stevenson, in his report on the geology of Colorado in Wheeler's survey,<sup>7</sup> noted the presence of *Halymenites major* in numerous localities in southern Colorado, and also spoke of dicotyledonous leaves in the Upper Cretaceous; but it should be remembered that he referred the whole of the Rocky Mountain coal beds to the Cretaceous, a contention that was long ago abandoned.

#### BELLY RIVER FLORA AND ITS RELATION TO THE MONTANA FLORA.

It seems necessary, in the present connection, to say something of the Belly River flora and its probable relation to the Montana flora.

<sup>1</sup>Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1875, pp. 242-267.

<sup>2</sup>Rept. Macomb's Expl. Exped., p. 77 (1876).

<sup>3</sup>Ibid., 1874, pp. 128-155, 1876, pp. 170-180.

<sup>4</sup>Ibid., 1876, pp. 19, 28-34.

<sup>5</sup>Proc. Colo. Sci. Soc., Vol. III, No. III, pp. 379 et seq. (1890).

<sup>6</sup>Bull. U. S. Geol. Survey, No. 106, p. 32 (1893).

<sup>7</sup>Répt. on the Geog. and Geol. Expl. and Survey West of the 100th Meridian, pp. 307-488 (1875).

According to Dr. G. M. Dawson, the discoverer and namer of this somewhat anomalous series of coal-bearing beds, the stratigraphic position of the Belly River series is between the Colorado and Montana formations. If this is strictly true, it would obviously be out of place to consider the flora of these beds in connection with that of the Montana formation, except, perhaps, for purposes of comparison. Other observers, however, would regard the Belly River series as synchronous, in part at least, with the Montana formation, and one geologist, Dr. C. A. White,<sup>1</sup> inclines to the opinion that it is completely so, thus passing from the top of the Colorado to the base of the Laramie.

The Belly River series, which takes its name from the Belly River, a tributary of the South Saskatchewan, has, according to the Canadian geologists, a large areal extent. It is found occupying the surface in the Canadian districts of Assiniboia, Saskatchewan, and Alberta, extending for a distance of about 300 miles. It is composed of sandstones, clays, shales, and important coal seams, and has a maximum thickness of fully 1,000 feet.

As long ago as 1886 the presence of this formation in the United States was suggested by Mr. W. Lindgren,<sup>2</sup> who noted the presence of strata in the upper part of the valley of the Musselshell River in Montana which, although referred by him to the Laramie, in all probability belong to the Belly River.

In August, 1883, Dr. C. A. White and Prof. Lester F. Ward also noted the presence of certain plant-bearing strata on the Missouri River, about 7 miles below the Coal Banks, below the mouth of Bear Creek, which belong, with little doubt, to the Belly River series. They made at this time a small collection of fossil plants, which I have studied and incorporated descriptions of in the following pages.

Mr. T. W. Stanton and Mr. W. H. Weed visited this same locality in 1894, and Mr. Stanton has kindly prepared the following notes on its stratigraphy and paleontology:

On the Missouri River near Fort Benton the dark shales of the Fort Benton formation are exposed. The same formation is seen for many miles down the river, but as there is a slight dip in that direction, higher beds are in turn exposed, and some of those that have usually been called Fort Benton are now recognized by the fossils to more nearly represent the Niobrara. The beds gradually become more sandy, and in the upper portion of the shales forms are found that seem to be intermediate between the Colorado and Montana formations. Immediately above this zone is a massive light-colored sandstone, 100 feet or more in thickness, associated with coal seams and ferruginous bands. This is exposed at Coal Banks and for many miles below. The fossil-plant locality on the right bank of the river, 7 miles below Coal Banks, must be just above this sandstone. Farther down the Missouri, near the mouth of Arrow River, the dark Fort Pierre shales, with a characteristic fauna, are clearly seen to overlie the sandstone, and still above that comes the section near the mouth of Judith River, as published by Cross from my notes,<sup>3</sup> which includes the Fox Hills or Upper Montana and the Judith River beds, which are true Laramie. We were not

<sup>1</sup>Bull. U. S. Geol. Survey No. 82, p. 176 (1891).

<sup>2</sup>Tenth Census U. S., Vol. XV, pp. 743-746.

<sup>3</sup>Geology of the Denver Basin: Mon. U. S. Geol. Survey Vol. XX, p. 240.



able to estimate the thickness of an intermediate portion of the section lying between Arrow and Judith rivers, but there is no doubt as to the relative stratigraphic position of the beds studied. It is evident from the stratigraphy and from the marine invertebrate fauna of the underlying and overlying strata that the sandstones and associated coal beds and plant-bearing horizons in the neighborhood of Coal Banks on the Missouri River are on essentially the same horizon to which the Belly River series was assigned by Dr. G. M. Dawson, and to which a part of the Canadian beds so named undoubtedly belong. But in Dr. Dawson's full and careful description of the Belly River series it is pointed out that in certain areas referred to that series the stratigraphy is not clear, and the beds may overlie the Montana shales instead of underlying them. It happens that most of the Belly River fauna, which consists chiefly of Laramie species, was collected in these doubtful areas. I suspect that in Canada two distinct formations, separated by marine beds, have been confused under the term Belly River series, and that a large part of the fauna, and possibly also of the flora, was collected from the upper horizon, which included the Laramie and possibly even later beds.

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DESCRIPTION OF PLANTS COLLECTED BY LESTER F. WARD ON THE RIGHT BANK OF THE MISSOURI RIVER, 7 MILES BELOW THE COAL BANKS, AUGUST 24, 1883.

THINNFELDIA MONTANA Kn.

Pl. I, figs. 1-3.

*Thinnfeldia montana* Kn., Bull. U. S. Geol. Survey No. 152, p. 227 (1898).

*Salisburia polymorpha* Lx., Am. Jour. Sci., 2d ser., Vol. XXVII, p. 362 (1869) [nomen nudum]; Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1872, p. 404 (1873).

*Thinnfeldia polymorpha*<sup>1</sup> (Lx.) Kn., Proc. Biol. Soc. Wash., Vol. VII, p. 153 (1892); Bull. U. S. Geol. Survey No. 105, p. 47, Pl. V, figs. 1-4 (1893).

It is impossible to separate the specimens from below the Coal Banks from those found in the Bozeman coal field and figured as already mentioned. They are, perhaps, a little smaller, but have the identical lacinate margin and the same nervation. The Bozeman specimens are from the head of Fir Canyon, near the Fort Ellis Reservation, in true Laramie strata.

*Habitat*.—Right bank of Missouri River, 7 miles below the Coal Banks. Collected by Lester F. Ward, August 24, 1883.

QUERCUS? MONTANENSIS n. sp.

Pl. I, fig. 10.

Leaf narrowly ovate-lanceolate, broadest at about one-fourth of its length above the base, from which point it tapers below into an obtusely wedge-shaped base; apex long and apparently slender; margin remotely and obtusely toothed above the middle; petiole rather stout for the size of the leaf; midrib strong; secondaries probably about eight or nine

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<sup>1</sup> This combination—*Thinnfeldia polymorpha* (Lx.) Kn., 1892—is antedated by *T. polymorpha* Ett., 1860, which is a totally different plant. It becomes necessary to rename the Montana species, and I have called it, as shown above, *Thinnfeldia montana*.

pairs, subopposite, arching upward for some distance; remainder of nervation not preserved.

This species is represented by the single specimen figured. Its length is about 4 cm. and its width a little more than 1 cm. It is with some hesitation that I refer this to *Quercus*, for it is very fragmentary and has little of the nervation preserved. It has, however, a resemblance to certain forms that have been so referred, and I therefore venture to place it as above indicated. It is hardly possible to make any comparisons between this and known forms that will be of value.

*Habitat*.—Right bank of Missouri River, 7 miles below the Coal Banks. Collected by Lester F. Ward, August 24, 1883.

*FICUS MISSOURIENSIS* n. sp.

Pl. I, fig. 5.

Leaf thick, elliptical in outline, slightly inequilateral, apparently broadest at or a little above the middle, rounded rather abruptly below, apex not preserved; midrib very thick, straight; secondaries very numerous, thin, emerging at an obtuse angle, camptodrome, anastomosing well inside the margins with the secondary next above; intermediate secondaries numerous, passing nearly or quite half the distance to the margin, then vanishing; other nervation not preserved.

This leaf is not well preserved, lacking probably the upper third. The part remaining is about 6 cm. in length; the complete leaf was probably about 8.5 cm. in length. The width is 3.75 cm. This species is evidently allied to *Ficus glascœana* Lx.,<sup>1</sup> from the Dakota group of Kansas. The Kansas species is, however, three times the size, is broadest below the middle, and has the close parallel secondaries at a more acute angle. In general appearance these leaves are very similar, and the Montana species may well have been the modified descendant of the Dakota group species. It appears to be quite unlike anything heretofore reported from the Belly River or allied beds.

*Habitat*.—Right bank of Missburi River, 7 miles below the Coal Banks. Collected by Lester F. Ward, August 24, 1883.

*JUGLANS ? MISSOURIENSIS* n. sp.

Pl. I, figs. 7-9.

Leaflets membranaceous, broadly elliptical-lanceolate in outline, inequilateral, base not preserved, narrowed above into an acuminate apex; margin entire or very slightly undulate; midrib very thin, flexuose; secondaries numerous, alternate or subopposite, curved upward, camptodrome, anastomosing by a series of small loops with the one next above; other nervation not preserved.

The three leaflets referred to this species unfortunately all lack the lower portion. They all have the same shape and nervation, and probably are correctly placed together. As nearly as can be made out, they

<sup>1</sup> Fl. Dak. Gr., p. 76, Pl. XIII, figs. 1, 2.

are broadly elliptical-lanceolate in outline, and range in size from 4 to 10 cm. in length and from 2 to 3.5 cm. in width.

It is difficult to settle on the real affinities of these leaves. The fact that they are undoubtedly unequal-sided makes it probable that they are leaflets of a large compound leaf. Their general shape and nervation is similar to that in certain species of *Juglans*, and I have provisionally referred them to that genus. They have, for example, quite a strong resemblance to certain leaves from the Laramie that have been referred by Lesquereux to his *Juglans rugosa*.<sup>1</sup>

*Habitat*.—Right bank of Missouri River 7 miles below the Coal Banks. Collected by Lester F. Ward, August 24, 1883.

LAURUS ? sp.

Pl. I, fig. 4.

This form is represented by the single fragment shown in the figure, which is obviously too imperfect to permit certain identification. It is, for example, scarcely distinguishable from *Laurus Knowltoni* Lx.,<sup>2</sup> from the Dakota group of Kansas. It is also somewhat like the upper portion of *Persea Hayana* from the same place. It is too fragmentary, however, to permit further generalizations.

*Habitat*.—Right bank of Missouri River 7 miles below the Coal Banks. Collected by Lester F. Ward, August 24, 1883.

LIRIODENDRON ALATUM Newb., MSS., Hollick.

Pl. I, fig. 6.

*Liriodendron alatum* Newb., MSS., Hollick, Bull. Torr. Bot. Club, Vol. XXI, p. 467, Pl. CCXX (1894).

The collection from below the Coal Banks contains the single example figured, which is, with little hesitation, referred to the *Liriodendron alatum* of Newberry described from the Laramie of Walsenberg, Colorado. It is, unfortunately, not all preserved, lacking the side and all of the apex. It is slightly smaller than the figured specimens, but it has the same general shape, the thick midrib and the thick, strong petiole with its characteristic broad wing. The secondaries are alternate or subopposite, as in Newberry's species. The lowest pair are very thin and arise at the very base of the leaf at the top of the petiole. The other secondaries are similar, emerging at a low, almost right, angle, and occasionally forking near the margin. Not enough of the margin is preserved to show the nervation, which in *L. alatum* is distinctly camptodrome by broad arches well inside the margin. Numerous intermediate secondaries are present in Newberry's specimens, but if present they are not preserved in the specimen under consideration. As the apex is not preserved, it is impossible to know whether it agrees in this particular with the Walsenberg specimens.

This specimen was at first thought to represent a new species of

<sup>1</sup>Tert. Fl., Pl. LVI, fig. 1.

<sup>2</sup>Fl. Dak. Gr., p. 94, Pl. L, fig. 4.

*Liriophyllum*, being in some respects like *L. populoides* as figured by Hollick;<sup>1</sup> but more careful comparison shows it to be more like the form to which it is here referred.

*Habitat*.—Right bank of Missouri River, 7 miles below the Coal Banks. Collected by Lester F. Ward, August 24, 1883.

PLATANUS ? WARDII n. sp.

Pl. II, figs. 1-4.

Leaves evidently of firm texture, broadly ovate in general outline, slightly three-lobed, truncate or slightly cordate at base, the lobes acute, apex not preserved; margin undulate or obscurely and obtusely toothed; petiole very thick and strong; midrib strong, straight; secondaries four or five pairs, opposite or subopposite, at an angle of about 45°, the lowest pair strongest, opposite, arising from the top of the petiole, branching outside, entering the lateral lobes; upper secondaries simple, or with one or two branches on the lower side, all apparently craspedodrome; branches of lower pair of secondaries simple or, rarely, once-forked, craspedodrome (?); nervilles strong, percurrent; finer nervation not retained.

This form appears to be the most abundant one in the collection, and besides the most perfect specimens, which have been figured, there are a great number of fragments, but as not one is preserved entire it is impossible to be perfectly certain of the outline. In general, however, it may be described as broadly ovate, with a truncate or very slightly cordate base and a rather abruptly obtuse apex. There appears to be small lateral lobes, one on each side, which are entered by the lowest secondaries. The margin is not well preserved above the base, but appears to be shallow-toothed or undulate. It is probable that it has more pronounced teeth in the upper portion. The petiole, as stated in the diagnosis, is very thick, but as only about 2 cm. of its length is preserved the complete character can not be ascertained. The nervation is strong and well marked. The lower pair of secondaries arise at the very base of the blade, and pass nearly straight to the lateral lobes. Below this pair of secondaries, next the lower margin of the blade, is a pair of thin nerves, quite as in *Populus*; they soon disappear.

In size these leaves appear to be from 4 to 11 cm. in width, and from 5 to 12 cm. in length.

When this collection was first brought to public attention by Prof. Lester F. Ward,<sup>2</sup> he regarded these leaves as "nearly allied to *Platanus latiloba* of Newberry (*Sassafras mirabile* Lesqx.) and perhaps connecting this with *Platanus nobilis* Newb." An examination of these species shows a decided resemblance, yet there are, on close inspection, important points of difference. Take first the case of *P. latiloba*. As

<sup>1</sup> Bull. Torr. Bot. Club, Vol. XXI, Pl. CCXXI.

<sup>2</sup>Am. Jour. Sci., 3d ser., Vol. XXVII, pp. 292-303 (1884).

figured by Newberry<sup>1</sup> it is seen to be a larger leaf with large lateral lobes. It is prominently three-nerved or tri-palmate, the two laterals branching freely on both sides. The margin is also different.

From *P. nobilis* it differs still more, being less than half the size of the ordinary leaves of that species.

In some respects these leaves approach certain species of *Populites*, as for example *P. litigiosus* (Heer) Lx.,<sup>2</sup> from the Dakota group of Kansas. It was about the same size, configuration of base, and margin, but differs in shape and strongly in nervation.

In his account of the plants of the Belly River series Dawson<sup>3</sup> describes a new species of *Populus* (*P. latidentata*) that may be allied somewhat to the leaves under consideration. It is not figured, however, and is only briefly described. He also speaks of leaves of a *Platanus* that seemed to be close to *P. nobilis* Newb.

It seems best, however, to consider the Missouri specimens as new, and I have named the species in honor of Professor Ward, the collector.

*Habitat*.—Right bank of Missouri River, 7 miles below the Coal Banks. Collected by Lester F. Ward, August 24, 1883.

#### DISCUSSION OF THE BELLY RIVER FLORA.

The plants of the Belly River series from the Canadian localities were submitted to Sir William Dawson for study.<sup>4</sup> Only about twenty forms have been detected, and many of these, as may be seen from the following complete list, are more or less unsatisfactory:

##### *List of Canadian Belly River plants.*

- Pistia corrugata* Lx. (leaves).
- Pinus* or *Abies*, type of *Pityoxylon* (wood).
- Sequoia*, type of *S. gigantea* [now called *S. Washingtoniana*] (wood).
- Sequoia*, type of *S. sempervirens* (wood).
- Sequoia Reichenbachii*? (Gein.) Heer (leaves and branches).
- Thuja*, type of *T. occidentalis* (wood).
- Taxites*, type of *Taxus baccata* (wood).
- Ginkgo*, type of *G. biloba* (wood).
- Ginkgo* (*Salisburia*)? (fruit).
- Lemna scutata* Dn. (leaves).
- Populus acerifolia* Newb.? (leaf).
- Populus latidentata* Dn. (leaves).
- Populus* sp. (wood).
- Betula* sp. (wood).
- Ulmus* sp. (wood).
- Carya* sp. (wood).
- Nelumbo Dawsoni* Hollick (*Brasenia antiqua* Dn.) (leaves).
- Trapa* cf. *T. borealis* Heer (fruit).
- Platanus nobilis* Newb. (leaves).
- Platanus*? sp. (wood).
- Acer saskatchewanense* Dn. (leaf).

<sup>1</sup> Ill. Cret. and Tert. Fl., Pl. II, fig. 4.

<sup>2</sup> Fl. Dak. Gr., p. 46, Pl. XLVII, fig. 1.

<sup>3</sup> Trans. Roy. Soc. Canada, Vol. III, Sect. IV, p. 16.

<sup>4</sup> Trans. Roy. Soc. Canada, Vol. III, Sect. IV, p. 18 (1885); *ibid.* Vol. V, Sect. IV, pp. 32, 33 (1887).

The forms that are specifically named, or so designated that it is possible to make use of them in determining their bearing on the question of age, are as follows:

<i>Pistia corrugata</i> Lx.	<i>Populus latidentata</i> Dn.
<i>Sequoia Reichenbachi</i> (Gein.) Heer.	<i>Nelumbo Dawsoni</i> Hollick.
<i>Lemna scutata</i> Dn.	<i>Platanus nobilis</i> Newb.
<i>Populus acerifolia</i> Newb.	<i>Acer saskatchewanense</i> Dn.

Of these, three species (*Nelumbo Dawsoni*, *Populus latidentata*, *Acer saskatchewanense*) were described as new to science, thus leaving only five species having an outside distribution. Of these *Sequoia Reichenbachi* is found from the Jurassic to the top of the Cretaceous. It is, however, most abundant and best developed in the Lower Cretaceous. *Lemna scutata* was described by Dawson from the so-called "Lignitic-Tertiary" near the forty-ninth parallel. It has since been found by him in the Canadian Lower Laramie (true Laramie) of the Bad Lands of Wood Mountain and Pincher Creek. It was obtained by Professor Ward in Fort Union beds near the mouth of the Yellowstone, and by Lesquereux in the Montana formation at Point of Rocks, Wyoming. It has, therefore, considerable range, and it is impossible to fix definitely its most characteristic horizon. *Pistia corrugata* has been found only in the Montana formation at Point of Rocks, Wyoming. The remaining species—*Populus acerifolia* and *Platanus nobilis*—are characteristic Fort Union or Upper Laramie forms.

The two species of *Sequoia* (of the types of *S. gigantea* and *S. sempervirens*), the Ginkgo of the type of *G. biloba*, and wood of dicotyledons of the types of modern genera, would seem to indicate somewhat recent age, perhaps not older than Tertiary; but this is more or less a matter of conjecture. The affinities of the three species peculiar to the Belly River series appear to be with the flora of Upper Laramie or Fort Union beds of the United States geologists.

This Canadian Belly River flora has been supposed to be most closely allied to that of the Lower or true Laramie, as it logically should be if it occupies a position just below the Laramie, but careful examination shows that the evidence of the plants is conflicting. Several of the species are found in the Lower Laramie, but only one is confined to it and the Belly River series, while perhaps the larger number are characteristically Upper Laramie or Fort Union forms. This at least suggests the possibility that there may have been a mixture of horizons represented in the collections of plants, the more so from the fact that the invertebrate fauna seems to point so clearly to Laramie affinities. Whiteaves has the following to say<sup>1</sup> regarding the bearing of the invertebrates:

In conclusion, it may be remarked that the invertebrate fauna of the "Belly River series" seems to be essentially the same as that of the "Laramie" of the United States and Canada, unless more than one formation has been confounded under the

<sup>1</sup> Contributions to Canadian Palæontology, Vol. I, p. 89 (1885).

latter name, and that it is at present scarcely possible to separate the "Lower Dark Shales" of Dr. Dawson's Bow and Belly River Report from the "Fort Pierre and Fox Hills" groups on purely palæontological grounds.

An examination of the plants that have been identified from the supposed Belly River horizon on the Missouri (see pp. 11-15) brings out some interesting facts. I have identified seven forms. Of these only two have been identified with previously known species. *Thinnfeldia montana* and *Liriodendron alatum*, both of which are true Laramie species and have never before been found outside of this horizon. The remaining species have been described as new. Of these *Ficus missouriensis* is closely allied to *Ficus glaucescens* Lx., a well-known species of the Dakota group. *Juglans missouriensis* is like certain of the leaves of *J. rugosa*, a Laramie species. *Laurus* sp. is hardly to be separated from *L. Knowltoni*, a Dakota group form. *Platanus Wardii* has a number of affinities, the strongest being with Dakota group forms. The species described as *Quercus ? montanensis* is too poor to permit comparisons that would have any weight. From this it appears clear that not one of the seven forms identified from the Missouri River horizon has yet been found in or has particular affinity with species from the Fort Union. They appear to be either true Laramie, as the term is now understood, or to have unmistakable affinity with the Dakota group.

## DESCRIPTION OF THE PLANTS OF THE MONTANA FORMATION.

### FUCUS LIGNITUM Lx.

#### Pl. III, fig. 4.

*Fucus lignitum* Lx., Bull. U. S. Geol. and Geog. Surv. Terr., Vol. I, No. 5, p. 364, (1875); Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1876, p. 296 (1878); Tert. Fl., p. 42, Pl. LXI, figs. 24, 24a; Ward, Syn. Fl. Laramie Gr., p. 549, Pl. XXXI, figs. 1, 2 (1886); Types Laramie Flora, p. 13, Pl. I, figs. 1, 2 (1887).

The type specimens of this species, together with additional ones from the type locality, are preserved in the United States National Museum. The recent material adds nothing to our knowledge beyond the fact that the new specimens are sometimes a little larger than those figured by Lesquereux.

The single specimen obtained by Professor Ward at Burns's ranch on the Yellowstone River, below Glendive, Montana, while not a perfect example, is with little doubt the same as that from Point of Rocks.

*Habitat*.—Point of Rocks, Wyoming; moderately abundant. Burns's ranch, Yellowstone River, near Glendive, Montana; apparently rare.

### HALYMENTES MAJOR Lx.

*Halymenites major* Lx., Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1872, pp. 373, 390 (1873); *ibid.*, 1873, pp. 379, 384 (1874); *ibid.*, 1876, p. 496 (1878); Tert. Fl., p. 38, Pl. I, figs. 7, 8 (1878).

*Halymenites minor?* F. O., Lesquereux in Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1872, p. 373 (1873); Tert. Fl., p. 39, Pl. I, fig. 9 (1878).

This species was first described from the Raton Mountains, New Mexico, but it has since been found to be the most widely distributed and abundant plant fossil of the Upper Cretaceous of the Rocky Mountain region. It has by some been held to characterize the Laramie group, but as it has been found from the middle of the Colorado formation to the Eocene, it is manifestly worthless for indicating exact age.

It was found, in a collection made by Mr. T. W. Stanton in Huerfano Park, Colorado, in sandstone between the Fort Benton shales and the Niobrara limestone of the Colorado formation. It was also found by Mr. Stanton to be abundant in the Durango coal field, Colorado, where it occurs in a brownish sandstone below the coal and associated with numerous marine shells (*Inoceramus*, *Cardium*, etc.) of undoubted Fox Hills age.

According to Prof. J. J. Stevenson,<sup>1</sup> it characterizes what he identifies as the Fox Hills formation of Colorado, occurring abundantly from the bottom to the top of this series as exposed along the South Platte, at Greeley, Canyon, and southward near Trinidad. The horizons at these places have usually been referred to the base of the Laramie, but the correctness of this is not without some question.

This species was obtained by Prof. F. B. Meek at Coalville, Utah, and was also found by Mr. Stanton during his later investigations of this interesting region. It has been found in abundance at Black Buttes, Carbon, Evanston, Fort Steele, and Point of Rocks, in Wyoming, and at Golden (Denver group ?), at the mouth of the St. Vrain Creek, and at other places in Colorado.

The presence of *H. minor* Fisch.-Ost., in American strata seems to depend entirely on a single fragment less than 1 inch long found associated in the same beds with *H. major* at Raton Mountains. This specimen has never been in the Museum collection and its whereabouts is unknown. It is said to differ from *H. major* by its smaller size and flattened tubercles. A comparison of the figures of the two species given by Lesquereux in Tertiary Flora (Pl. I, figs. 8 and 9) shows that *H. minor* is really larger than one of the types of *H. major*, and, so far as can be made out from the figures, has exactly the same character of tubercles. That it was regarded as extremely doubtful by Lesquereux himself is shown both by the question mark placed after it and by the following statement in the original mention of the fossil:<sup>2</sup> "As they are, however, found in connection with the former species (*H. major*), at least in the same beds of sandstone, they may represent mere divisions of it." I have therefore deemed it best to include it under *H. major*.

*Habitat*.—As given on page 17.

<sup>1</sup> Bull. Geol. Soc. Am., Vol. I, p. 532 (1890).

<sup>2</sup> Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1872, p. 374 (1873).



## ASPLENIUM WYOMINGENSE n. sp.

Pl. III, fig. 12.

*Asplenium?* n. sp. Kn., Bull. Geol. Soc. Am., Vol. VIII, p. 140 (1897).

Frond pinnate; rachis delicate, striate; pinnae oblong-lanceolate, broadest above the middle, thence tapering above to an obtuse apex and below to a wedge-shaped base; margin entire below, rather remotely toothed above, the teeth small, sharp, upward-pointing; mid-vein thin, striate; veins at an angle of about 40°, moderately close, parallel, simple, or mostly once-forking at or very near the midvein; fruit unknown.

The specimen figured is, with the exception of a small fragment, all that was found of this species. It consists of a portion of the rachis, about 1 cm. in length, and parts of two pinnae. The most perfect pinna is 5 cm. in length, and 1.5 cm. in width at the broadest point, which is just above the middle. This species is evidently closely related to what Lesquereux called *Osmunda affinis*.<sup>1</sup> It differs in being sharply serrate, and in having closer veins, which branch near the mid-vein and usually again near the margin.

It is very similar to certain of the forms that have been referred to *Pteris subsimplex* Lx.,<sup>2</sup> but this latter is only a very small, imperfect example of a large, different-appearing fern. It is also suggestive of what has been called *Pteris erosa* Lx.,<sup>3</sup> now *Asplenium erosum*, but this latter differs in being twice the size, and in having more numerous and blunter teeth and twice-forking veins. It would, therefore, seem warrantable to keep them distinct, at least until more material can be obtained.

*Habitat.*—Near old stage road, on north fork of Dutton Creek, between Rock and Cooper creeks, Wyoming. Collected by Knowlton, Stanton, and Knight, 1896.

## ASPLENIUM TENELLUM n. sp.

Pl. III, figs. 1, 2.

Fronds slender, of delicate texture, outline unknown; bipinnate; rachis slender, slightly flexuose; pinnae opposite or alternate, lanceolate in outline, pinnatifid, with few coarse, blunt lobes; veins slender, forking, about one to each lobe.

The fragments figured represent all that was found of this form. It was a slender, delicate fern, at least twice pinnate, but the true outline can not now be determined. The pinnales are somewhat ovate-lanceolate in outline, with few large, rather blunt lobes.

This species has some resemblance to *Asplenium tenerum* Lx.,<sup>4</sup> from the Fort Union beds of Dakota.

<sup>1</sup> Tert. Fl., p. 60, Pl. IV, fig. 1.<sup>2</sup> Ibid., Pl. IV, fig. 8.<sup>3</sup> Ibid., Pl. IV, fig. 6.<sup>4</sup> Cret. and Tert. Fl., p. 221, Pl. XLVI, A, figs. 1-3.

*Habitat*.—Coal mine on north fork of Dutton Creek, near old stage road, Laramie Plains, Wyoming. Collected by Knowlton, Stanton, and Knight, July, 1896.

ASPLENIUM sp.

Pl. III, fig. 11.

This fragment is so small that it is hardly worthy of notice, yet it appears to differ from any form found, either in these beds or in allied horizons. It is a fragment, evidently from a large pinnule, only 2 cm. in length. The rachis or midvein is very broad and serrate-striate. The veins are close, parallel, emerging at a very low angle, and forking once at or near the rachis, or, rarely, unforked. Further description it is impossible to give.

This form is evidently quite close to *Asplenium subsimplex* (Lx.) Kn., and may be the same. It seems to differ, however, by the closer veins emerging at a lower angle and unforked or forking near the base.

*Habitat*.—Coal mine on north fork of Dutton Creek, near old stage road, Laramie Plains, Wyoming. Collected by Knowlton, Stanton, and Knight, July, 1896.

#### ANEMIA SUBCRETACEA (Sap.) Gard. and Ett.

*Anemia subcretacea* (Sap.) Gard. and Ett., Mon. Brit. Eocene Fl., Vol. I, Pt. II, p. 45, Pls. VIII, IX (1880.)

*Asplenium subcretaceum* Sap., Fl. Foss. Sézanne: Mém. Soc. Géol. d. France, 3d ser., Vol. VIII, p. 315, Pl. XXIII; fig. 4 (1868).

*Gymnogramma Haydenii* Lx., Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1871, p. 295 (1872); Tert. Fl., p. 59, Pl. IV, figs. 1-3 (1878).

?*Lathræa arguta* Lx., Am. Jour. Sci., 2d ser., Vol. XLV, p. 207 (1868).

Stipe dichotomous; frond bipinnate or tripinnate; pinnae ovate-oblong; pinnules sessile, subdecurrent, or sometimes slightly stipitate, long-lanceolate or linear-lanceolate, acuminate, pinnately divided to near the rachis into oblong-lanceolate, mostly acute, lobes; lower lobes distantly, sometimes rather sharply, toothed; upper lobes gradually becoming crenulate or sometimes entire; rachis narrow; middle nerve thin; lateral veins moderately close, at an acute angle of divergence, usually once-forking.

The above description is combined, with slight modifications, from the descriptions given by Lesquereux and by Gardner and Ettingshausen, for after a thorough examination of the types *Gymnogramma Haydenii*, together with a number of recently collected specimens, and the drawings and descriptions of *Anemia subcretacea*, I am convinced that the English authors are right in uniting them. They have had, as they say, abundant and exceptionally well-preserved material for comparison, and have submitted specimens and drawings to several well-known authorities, so that there can be little doubt as to the correctness of their conclusions. Saporta, who first named the species from

Sézanne, was certain that his plant was identical with those from Bournemouth (British Eocene), and Lesquereux was unable to "see any difference whatever" between the English specimens and his *Gymnogramma Haydenii*. Dr. Newberry, the only one, so far as I know, who has expressed an opinion, while admitting the probable correctness of this identification, still inclines to regard the American specimens as varietally distinct. In a recent paper on the Laramie group<sup>1</sup> he writes: "Two ferns, *Anemia subcretacea* Saporta and *Lygodium Kaulfusii* Heer, are considered by Mr. J. Starkie Gardner the same with Lesquereux's *Gymnogramma Haydenii* and *Lygodium neuropteroides*. This is possible and probable, but our plants are more robust than the European and may be considered as distinct varieties if specifically identical." Again: "So I have what Mr. Gardner would probably regard as fronds of *Anemia subcretacea* from Point of Rocks, Hams Fork, Carbonado, and Tschuckernuts, Washington; but most of these are much more robust than the European forms, and constitute at least distinct varieties."

I have not had opportunity to examine the specimens to which Dr. Newberry refers, but the specimens in my possession, while in some cases slightly larger than the figures of the European specimens, do not seem to me to be uniformly large enough to warrant this separation even as varieties. Merely slight differences in the size of plants are usually of little diagnostic value, since, as is well known, environment plays an important part in their development. The English specimens are not of a uniform size, as the authors say (op. cit., p. 47): "This fern is found more especially to the east of Bournemouth Pier, and appears to have attained its greatest luxuriance when growing with Aroids and Conifers. It decreases in size and abundance in the beds westward, toward Poole Harbor, and at Branksea small pinnæ only are met with." It is, however, possible that it may eventually be found expedient to separate the American specimens under a varietal name.

The presence of this species in the Montana formation rests, as pointed out above, on the authority of Dr. Newberry, who reports having it from Point of Rocks, Wyoming. I have not seen specimens from that locality.

*Anemia subcretacea* was first described from this country (under the name of *Gymnogramma Haydenii*) from the continental divide between the Flat Mountain arm of Yellowstone Lake and what was then regarded as the head waters of the Snake River but what is now known to be only a small tributary of Snake River. The age of these beds is regarded as Laramie by the members of the United States Geological Survey who have made investigations in the Yellowstone National Park.

It has also been found at a number of other localities, viz, at Golden, Colorado; at Potato Hill Gap, on Grand River, near Hot Sulphur Springs, Grand County, Colorado; at Hams Fork, Wyoming; and at Carbonado and Tschuckernuts, Washington.

<sup>1</sup> Bull. Geol. Soc. Am., Vol. I, p. 526 (1890).

All of these localities are either in or above the Laramie, Point of Rocks forming the only exception.

The generic name has been selected for this fern more on account of its general resemblance to the Schizæaceæ than from close resemblance to any existing species of *Anemia*. As no trace of fructification has ever been detected, it is inferred that the fertile and sterile portions were distinct and that only the latter have been preserved. This circumstance, together with the evident dichotomy of the frond, seems to indicate, according to Gardner and Ettingshausen, an affinity with the Schizæaceæ. Saporta and Heer, on the other hand, do not agree with this view. Saporta, who first described this plant under *Asplenium*, would now regard it as a new genus allied to *Todia*. Dr. Stur, to whom specimens and drawings were sent, would call it *Osmunda*. In the absence of any additional information, it is probably as well to retain the specimen under *Anemia*, notwithstanding the fact that its affinities with this genus are not very marked.

WOODWARDIA CRENATA n. sp.

Pl. III, fig. 3.

Frond?; pinnae opposite (?), probably deltoid in outline, deeply lobed; lobes 2.5 to 3 cm. long, 1 cm. broad, obtuse, round-crenate, the crenatures sharply serrate; middle nerve very prominent, even to the extremity of the lobes; secondary veins parallel to the rachis and to the midvein, branching upward and by anastomosis forming two or three rows of rectangular or irregular areolations.

I have hesitated to describe this as a new species, for the only specimen known is the fragment figured, but the nervation and outline are very perfectly preserved and differ from any known species. It is evidently allied to *Woodwardia latiloba* Lx., from which it differs in having the lobes of the pinnae obtuse and deeply crenate, with the crenatures finely and sharply serrate. The secondary nervation forms more regularly quadrate or rectangular areoles, but otherwise it is almost identical.

The outline of the frond is probably somewhat like that of the sterile portion of the living *W. areolata* Moore (*W. angustifolia* Sm.), but from the mere fragment it is impossible to be certain of this. It is evidently allied to *W. areolata*, which has the lobes of the pinnae finely, sharply serrate, but not crenulate, as in the fossil, though there are quite marked indications of crenatures in some specimens. The nervation is also quite similar to that of the living species, which differs by having the secondary nerves more branched, thus producing more numerous smaller meshes, there being uniformly three and not rarely four rows on each side of the middle nerve.

A fossil species with which our form shows some affinity is *Woodwardia arctica* Heer<sup>1</sup> from the Miocene of Greenland. The Greenland

<sup>1</sup> Fl. Foss. Arct., Vol. I, p. 86; Pl. I, fig. 16; Pl. XLV, fig. 2c; Pl. XLVIII, fig. 9; Vol. II, Pt. IV, p. 462, Pl. XL, fig. 6.

species, however, has the pinnules lobed, rather than crenate, and the teeth more obtuse. The secondary nervation is more copiously branched, producing more numerous smaller areolations, and thus approaching the nervation of *W. areolata*.

*Habitat*.—Point of Rocks, Wyoming, base of bluff, northwest of station. Collected September 2 and 3, 1881, by Lester F. Ward.

WOODWARDIA sp.

Pl. III, fig. 9.

Outline of frond unknown; pinna oblong, slightly undulate, very obtuse at apex; midnerve very strong, grooved; finer nervation of numerous irregularly hexagonal areolæ, becoming smaller toward the margin.

The single fragment figured is all that was found. It is 4 cm. long and about 2.5 cm. wide at the base, where it is broken. As may be seen, it is very obtuse at the apex. The nervation is that of Woodwardia, although in the figure it has been somewhat idealized, the actual nervation being somewhat less regular than shown.

At first I supposed that this might be related to the preceding species, but the two specimens appear so different that it seems best to keep them separate, at least until further material can be obtained. I have not ventured to name it specifically.

*Habitat*.—Coal mine on north fork of Dutton Creek, near old stage road, Laramie Plains, Wyoming. Collected by Knowlton, Stanton, and Knight, July, 1896.

MARSILEA? ATTENUATA (Lx.) Hollick.

*Marsilea attenuata* (Lx.) Hollick, Bull. Torr. Bot. Club, Vol. XXI, p. 256, Pl. CCV, fig. 10 (1894).

*Salvinia attenuata* (Lx.), Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1874, p. 396 (1876); Tert. Fl., p. 65, Pl. LXIV, figs. 14, 14a (1878).

The type of this species is, unfortunately, lost and no other specimens have been obtained. It consists of two small leaves or leaflets joined at the base, one of which, the larger, is perfectly circular, 1 cm. in diameter, the other being oblong and measuring 8 mm. in length and 5 mm. in width. They have, according to Lesquereux—

no trace of a middle nerve or of a separation in the middle, the surface being composed of areolæ exactly square, formed by veinlets ascending from the base and diverging, and from parallel veinlets crossing them in right angle from the borders. These secondary veins are indistinct, and the surface of the leaves appears, with the glass, like a small checkerboard, with squares marked in the middle by an obscure spot apparently formed of round pores, or like a very small wart.

This description would make out a plant which seems to differ from any known living species of the genus *Salvinia*. It is hardly closer to *Marsilea*, yet it is perhaps more like that than *Salvinia*, and for this

reason Dr. Hollick proposed its transfer. Its status can hardly be better fixed without additional material.

*Habitat*.—Point of Rocks, Wyoming.

LYCOPODIUM LESQUEREUXIANA n. sp.

*Selaginella falcata* Lx., ex p., Bull. U. S. Geol. and Geog. Surv. Terr., Vol. I, p. 365 (1875); Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1874, p. 297 (1876); Tert. Fl., p. 46, Pl. LXIV, figs. 13, 13a [non Pl. LXI, figs. 12-15] (1878).

Stem thick, 10.5 cm. long, 1 cm. broad, round but flattened by compression, covered with densely imbricate, falcate, linear-lanecolate, acuminate leaves, each with a distinct central nerve.

The single specimen upon which this species is founded was referred by Lesquereux to his *Selaginella falcata* with the following remarks:

Though the stem, Pl. LXIV, fig. 13, was not found connected with any fragment of branches, the leaves which cover it all around, imbricating at the base, but generally directed toward both sides, are so exactly of the same character as those of the branches of Pl. LXI, figs. 12 and 14, that one can but consider these fragments as representing the same kind of vegetable, [being] its stem and some of its divisions.

A careful reexamination of the type specimen (No. 91, U.S.N.M.) shows clearly that Lesquereux's conclusions can not be sustained. The leaves are not especially directed toward both sides, thus becoming dichotomous, but are evenly distributed all around the stem, only appearing to be two-ranked because the whole stem is flattened by compression. The leaves are longer, narrower, and provided with a strong central or median nerve. A still stronger objection to their representing different parts of the same species lies in the fact that, so far as the living species are concerned, it is impossible to have a *Selaginella* with the primary stem bearing multifarious leaves, and the branches having the leaves strictly two-ranked.

There are several living species of *Selaginella* that have multifarious leaves, as *S. spinosa* P. Br., *S. ruprestis* (L.) Spring., *S. deflexa* Bracken., etc., but they are all very small and slender, while the species under consideration is large and thick. It is clearly a *Lycopodium*, as shown by the leaves being continuous with the stem and by its general habit. It is very similar to several living species, but especially to *L. selago* L., from the sterile stems of which it can hardly be distinguished.

I have named this species in memory of Leo Lesquereux, who has done so much to make known the fossil flora of this country.

*Habitat*.—Point of Rocks, Wyoming. Collected by William Cleburn.

SELAGINELLA LACINIATA Lx.

Pl. III, figs. 5-8.

*Selaginella laciniata* Lx., Bull. U. S. Geol. and Geog. Surv. Terr., Vol. I, p. 378 (1875); Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1874, p. 297 (1876); *ibid*, 1876, p. 499 (1878); Tert. Fl., p. 47, Pl. LXIV, figs. 12, 12a (1878).

Branches regularly, pinnately arranged at right angles to the main rachis; leaves (?) close, two-ranked, deeply laciniate; laciniae linear, slightly inflated toward the point, either simple from the base or dichotomous.

The type specimens of this species, as well as many better-preserved ones, are in the United States National Museum collection. The species was well described by Lesquereux, except that the recent specimens show it to have been pinnate.

The generic reference of this fossil is by no means satisfactory. It appears to have been a weak plant, probably growing in or near water, and this is a suggestion that it belongs to the algæ. In order to obtain the opinion of an authority on algæ, specimens and drawings were sent to Mr. F. S. Collins, of Malden, Massachusetts, the well-known algologist, who replied as follows:

I have never made much study of fossil algæ, and would hardly feel qualified to pronounce on one, but my impression in this case is rather against the specimen in question belonging to the algæ. In some respects the appearance reminds one of a *Ptilota*, but the branching is more regularly pinnate than in any species of *Ptilota* with which I am acquainted.

From this it appears unlikely that the specimens are algæ, notwithstanding the fact that they much resemble plants of that character. Lesquereux was well aware of the doubtful nature of these plants, and likened them to certain partly submerged plants in which the submerged leaves differ from the aerial ones, such as *Nasturtium lacustre*, etc. He also suggested the possibility of their being aquatic ferns. That they really represent *Selaginella* seems equally doubtful, but as this form may be readily recognized, its name matters little in geology; hence the name given by Lesquereux is retained.

*Habitat*.—Point of Rocks, Wyoming.

#### SELAGINELLA FALCATA Lx., emend.

*Selaginella falcata* Lx., Bull. U. S. Geol. and Geog. Surv. Terr., Vol. I, p. 365 (1875); Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1874, p. 297 (1876); Tert. Fl., p. 46, Pl. LXI, figs. 12-15 [non Pl. LXIV, figs. 13, 13a] (1878).

Frond small, dichotomous (?); pinnae, or branches, narrow, linear, 1 to 4 cm. long, 6 to 7 mm. broad; leaves two ranked, close, sessile, generally covering each other at the borders, falcate upward, entire, lanceolate-pointed, suddenly narrowed to the point of attachment, membranaceous in texture, without middle nerve.

This description, which is somewhat emended from that given by Lesquereux, applies to the typical form with distichous leaves, and is represented by numerous but rather obscure specimens. As Lesquereux has pointed out (Tert. Fl., p. 47), this plant does not entirely accord with living *Selaginella*, and hence it may not be correctly referred to this genus; but as it agrees in general habit and appearance with *Selaginella* better than with any other form of vegetation with which

I am familiar, I have preferred to retain it under that genus until more perfectly preserved material may possibly clear up its relationship.

It is also very similar to *S. Berthoudi*, from which, however, it differs in having apparently two-ranked foliage leaves. It can hardly belong to any fern type of vegetation, as Lesquereux has suggested, nor can it be a conifer.

Lesquereux has also referred to this species a single specimen (cf. Tert. Fl., Pl. LXIV, figs. 13, 13a), with a thick stem closely covered with leaves of the same shape as those of the typical form of *S. falcata*, with the remark that it probably represented a primary stem of the species. As above noted, this has been referred to *Lycopodium*, under the name of *L. Lesquereuxiana*.

*Habitat*.—Point of Rocks, Wyoming. Originally collected by F. V. Hayden and William Cleburn, and later by Lester F. Ward.

### PINUS QUENSTEDTI Heer.

Pl. III, fig. 10.

*Pinus Quenstedti* Heer, Fl. v. Moetein: Neue Denkschr. Schw. Gesel. Naturwiss., Vol. XXIII, mem. 2, p. 13, Pl. II, figs. 5-9; III, figs. 1-2 (1869); Lesquereux, Bull. U. S. Geol. and Geog. Surv. Terr., Vol. I, p. 392 (1875); Cret. and Tert. Fl., p. 33, Pl. I, figs. 3, 4 (1883 [1884]).

The specimens which Lesquereux referred to this species were obtained from the Dakota sandstones of Fort Harker and Clay Center, Kansas. While they much resemble the specimens described and figured by Heer, there are certain differences which render the identification more or less doubtful. The cone in the Moravian examples is always straight, while in the Kansas specimens, according to Lesquereux, they are always curved. The scales in Heer's specimens are rhomboidal, being scarcely wider than they are high, while in the American specimens they are decidedly wider than high. The spines or tubercles also differ. These are, perhaps, minor differences, but they are such as may be observed in closely allied living species.

The single fragment figured is the only one found in the Wyoming material. It obviously comes from near the middle of a large cone, but there is hardly a sufficient length of it to show whether or not it was curved. The form of the scales and, as nearly as can be made out, the tubercles or spines, are also the same. There is, therefore, not much doubt that it is the same as the American specimens referred to this species. It is more than likely, however, that when sufficient material is obtained it can be shown beyond reasonable question that the American material is not identical with the European.

The specimen figured has been kindly loaned by Prof. W. C. Knight, of the University of Wyoming.

*Habitat*.—Near Fort Harker and Clay Center, Kansas. Dunn's ranch, 6 miles east of Harpers Station, Wyoming.



## SEQUOIA BREVIFOLIA Heer.

Pl. IV, figs. 1-4.

*Sequoia brevifolia* Heer, Fl. Foss. Arct., Vol. I, p. 93, Pl. II, fig. 23 (1868); Vol. II, p. 37, Pl. IV, figs. 2, 3 (1870); Vol. III, Pt. 3, p. 5, Pl. II., figs. 7, 8, (1874); Vol. VII, p. 62, Pl. LXVI, fig. 8, 8 f (1884); Lesquereux, Bull. U. S. Geol. and Geog. Surv. Terr., Vol. I, p. 365 (1875); Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1874, p. 289 (1876); *ibid*, 1876, p. 500 (1878); Tert. Fl., p. 78, Pl. LXI, figs. 25-27 (1878).

The specimens referred to this species and figured by Lesquereux are in the United States National Museum (No. 80). It is with a great deal of hesitation that they are permitted to stand under this name, but it was thought that less confusion would be created by retaining the nomenclature of Lesquereux. Schenk is of the opinion<sup>1</sup> that all the specimens referred by Lesquereux to *Sequoia brevifolia* should properly be united with *S. Langsdorfii*, and possibly this should be done, for, according to the figures given by Heer of his *S. brevifolia*, it approaches closely to *S. Langsdorfii*, differing merely by the shorter, more wedge-shaped leaves. From notes left by Dr. Newberry it appears that he was inclined to refer this species to his *Sequoia cuneata* (*Taxodium cuneatum*)<sup>2</sup> from Nanaimo, Vancouver Island. But Newberry's species is founded on small fragments, which do not clearly show the complete character, although it does, so far as can be made out, much resemble Lesquereux's specimens. Under these circumstances it appears best to keep them separate.

*Habitat*.—Point of Rocks, Wyoming.

## SEQUOIA sp.

*Glyptostrobus europæus*? Heer, Knowlton in Stanton's Colorado Form., Bull. U. S. Geol. Survey No. 106, p. 42 (1893); Stanton and Knowlton, Bull. Geol. Soc. Am., Vol. VIII, p. 150 (1897).

The collection made by Mr. Stanton at Coalville, Utah, contains a minute fragment that was questionably referred to *Glyptostrobus europæus*. A reexamination of the specimen leads to the conclusion that this determination was probably incorrect, and that it is much more likely it represent a species of *Sequoia*. It has some resemblance to small branchlets of *S. affinis* Lx., *S. Couttsia*, etc., but it is too fragmentary to be of value.

*Habitat*.—Coalville, Utah. (No. 3567, United States National Museum.)

<sup>1</sup> Zittel, Handbuch d. Palæontol., Abth. II, p. 298 (1890).

<sup>2</sup> Bost. Jour. Nat. Hist., Vol. VII, p. 517; Ill., Pl. XIV, figs. 3, 4, 4a.

## GEINITZIA FORMOSA Heer.

Pl. V, figs. 1, 2.

*Geinitzia formosa* Heer, Kreide Fl. v. Quedlinburg: Neue Denkschr. Schw. Gesel., Vol. XXIV, p. 6, Pl. I, fig. 9; Pl. II (1871); Newberry, Flora Amboy Clays, p. 51, Pl. IX, fig. 9 (1896).

*Sequoia Reichenbachii*? Gein., Stanton and Knowlton, Bull. Geol. Soc. Am., Vol. VIII, p. 137 (1897).

We were fortunate in obtaining a large series of this material near Harpers, Wyoming, during the season of 1896, and after much study and comparison I am unable to separate it satisfactorily from Heer's *Geinitzia formosa*. There is great range in size of branches and branchlets, but in all particulars the specimens agree with Heer's figures.

These specimens were referred to *Sequoia Reichenbachii* of Geinitz in the preliminary notice, and it is a matter of some difficulty always to separate them. In general, *S. Reichenbachii* may be distinguished by more slender branchlets, the leaves of one kind being decurrent, rigid, strongly incurved, acuminate at apex, while *Geinitzia formosa* has thicker branchlets, with decurrent, arched, pointed, not very rigid leaves, and with smaller intermediate scale-like leaves. When the leaves have fallen the scars or bolsters are quite regularly quadrangular. The cones, of course, differ considerably and are easily separated when sufficiently well preserved.

The material referred to this species from the Amboy clays of New Jersey, by Dr. Newberry, while not extensive, is sufficient for positive identification.

*Habitat* (in the United States).—Amboy clays, New Jersey. Near Harper Station, on the Union Pacific Railroad, Wyoming.

## GEINITZIA LONGIFOLIA Lx. sp.

*Sequoia longifolia* Lx., Ann. Rept. U. S. Geol. and Geog. Surv. Terr. 1874, p. 298 (1876); Tert. Fl., p. 79, Pl. VII, figs. 14, 14a; Pl. LXI, figs. 28, 29 (1878).

The type specimens of this species are preserved in the United States National Museum (Nos. 61, 73, 74), as are also a number obtained by Professor Ward at Point of Rocks. The specimens were well described by Lesquereux, and have simply been transferred to the genus *Geinitzia*, with which they clearly have greater affinity than with *Sequoia*, as already pointed out by Schenk.<sup>1</sup>

*Habitat*.—Point of Rocks, Wyoming. Coalville, Utah. Marshall's mine, Boulder County, Colorado.

## GEINITZIA BIFORMIS Lx. sp.

*Sequoia biformis* Lx., Bull. U. S. Geol. and Geog. Surv. Terr., Vol. I, p. 366 (1875); Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1874, p. 298 (1876); Tert. Fl., p. 80, Pl. LXII, figs. 15-18a (1878); Ward, Syn. Fl. Lar. Gr., p. 550, Pl. XXXI, figs. 7-12 (1886); Types Lar. Fl., p. 16, Pl. II, figs. 1-6 (1887).

<sup>1</sup>Zittel, Handbuch d. Palaeontol., Abth. II, pp. 301, 302.

All of the type specimens of this species are in the United States National Museum (Nos. 75, 76, 77, 78), together with several since obtained. They are very characteristic, and when sufficiently well preserved are readily distinguishable.

This species bears an unmistakable resemblance to *Geinitzia cretacea* Ung., and were it not for the fact that this latter species is still in a state of uncertainty as to its nomenclature, the specimens under consideration might perhaps be referred to it. As Schenk has pointed out,<sup>1</sup> the *S. biformis* of Lesquereux is undoubtedly a *Geinitzia*, and I have therefore assigned it to this genus.

*Habitat*.—Point of Rocks, Wyoming.

#### CUNNINGHAMITES? sp.

Pl. V, fig. 3.

The example figured is all of this form that could be found in the collections, and, unfortunately, it is so obscure that its character can not be satisfactorily made out. It appears to be a relatively thick terete branch, rather thickly set with large, lanceolate, acuminate leaves. The branch is about 13 cm. in length and 5 cm. in diameter. The leaves are a little more than 3 cm. in length and from 4 to 6 mm. in width. They are provided with a single central nerve. The bolsters or scars left by the fall of leaves can not be made out, if, indeed, they are present.

I am very uncertain as to the proper generic reference of this specimen. It seems, however, to approach most closely to *Cunninghamites elegans* as figured by Heer,<sup>2</sup> and I have placed it tentatively in this genus. Its exact position must be determined by subsequent material.

*Habitat*.—Coal mine on north fork of Dutton Creek, near old stage road, Laramie Plains, Wyoming. Collected by Knowlton, Stanton, and Knight, July, 1896.

#### BRACHYPHYLLUM MACROCARPUM Newb.

Pl. IV, figs. 5, 6.

*Brachyphyllum macrocarpum* Newb., Fl. Amboy Clays, p. 51, Pl. VII, figs. 1-7 (1895 [1896]).

*Brachyphyllum crassum* Lx., Proc. U. S. Nat. Mus., Vol. X, p. 34 (1887) [as nomen nudum]; Fl. Dak. Gr., p. 32, Pl. II, fig. 5 (1891). [Non *B. crassum* Tenison-Woods, Proc. Linn. Soc. N. S. Wales, Vol. VII, p. 660 (1883)].

*Thuites crassus* Lx., Cret. and Tert. Fl., p. 32 (1883 [1884]).

*Brachyphyllum* sp., Stanton and Knowlton, Bull. Geol. Soc. Am., Vol. VIII, p. 137, 140 (1897.)

After careful examination I am unable to distinguish this plant satisfactorily from the well-known *Brachyphyllum* of the Dakota group and

<sup>1</sup> Zittel, Handbuch d. Paläontol., Abth. II, p. 299.

<sup>2</sup> Fl. v. Moletsein in Mähren: Neue Denkschr. Schw. Gesel. Naturwiss., Vol. XXIII, mem. 2, p. 12, Pl. I, fig. 14 (1869).

Amboy clays. The only possible point of difference is in size, the specimens under consideration being somewhat smaller than most of the figured examples of this species from Kansas and New Jersey. They are at best only fragments which might have come from the tips of small branches. In any case the arrangement of branchlets and scale-like leaves is the same. It is also possible that the reduction in size may be due to the fact that the species was nearing extinction, a view somewhat supported by the fact that the specimens from the Amboy clays of New Jersey are in general smaller than the original specimens from Kansas.

*Habitat.*—Dakota group, Salina, Kansas. Amboy clays, South Amboy, New Jersey. One mile northwest of Harpers on the Union Pacific Railroad, Wyoming. Coal mine on the north fork of Dutton Creek, between Rock and Cooper creeks, Wyoming.

#### WIDDRINGTONIA? COMPLANATA Lx.

*Widdringtonia? complanata* Lx., Bull. U. S. Geol. and Geog. Surv. Terr., Vol. I, p. 336 (1875); Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1874, p. 299 (1876); *ibid.*, 1876, p. 499 (1878); Tert. Fl., p. 72, Pl. LXII, figs. 13, 14 (1878).

The two figured types of this species are preserved in the United States National Museum (Nos. 85, 86). The species is a very clearly marked one, and can not possibly be confounded with any known American fossil. It is reported as being abundant at Point of Rocks, Wyoming, its only known habitat, yet comparatively large recent collections fail to contain it.

The question as to generic relationship is still an open one. The specimen was doubtfully referred by Lesquereux to *Widdringtonia*, but as he supposed it to be related to *W. antiqua* Sap.,<sup>1</sup> he provisionally placed it in this genus. Saporta, to whom specimens were evidently sent, was inclined to regard it either as a new type or as possibly belonging to *Arthrotaxis* or even *Dacrydium*. Schenk,<sup>2</sup> judging from the figures alone, was of the opinion that it could not properly be referred to *Widdringtonia*, and concluded that the smaller specimens (figs. 13, 13a) should be referred to *Moriconia*. The figures seem to be very unlike, but when they are compared with the specimen, fig. 13 is found to be wrong. It is not regularly marked, as indicated in the figure, but has more the appearance of fig. 13a. The leaves are more pointed and less regular, and not so closely appressed, thus removing much of its resemblance to *Moriconia*. Even then it seems quite unlike fig. 14, but the latter is the reverse, and it was only by removing a piece of the covering of a small branch that the general similarity to the other could be made out.

In the absence of new material, and hence of conclusive evidence, I have preferred to retain the species as indicated by Lesquereux.

*Habitat.*—Point of Rocks, Wyoming.

<sup>1</sup> *Étude*, 2, p. 69, Pl. I, fig. 4.

<sup>2</sup> *Zittel, Handbuch d. Palaeontol.*, Abth. II, p. 313 (1890).

## GLYPTOSTROBUS? sp.

Pl. V, fig. 4.

The material from the Dutton Creek coal mine contained the single small branch figured. Unfortunately, since the drawing was made the specimen has been lost, having been thrown away by an attendant. In view of the uncertainty, I have not attempted specific identification, and simply present this note and the drawing, which was fairly accurate, as an indication that a *Glyptostrobus*, or possibly a *Sphenolepidium*, was present at this locality. Its proper identification must remain for subsequent investigators.

*Habitat*.—Coal mine on north fork of Dutton Creek, near old stage road, Laramie Plains, Wyoming. (Specimen lost.) Collected by Knowlton, Stanton, and Knight, July, 1896.

## GINKGO LARAMIENSIS Ward.

Pl. IV, figs. 7-10; Pl. V, fig. 5.

*Ginkgo laramiensis* Ward, Science, Vol. V, June 19, 1885, p. 496, fig. 7. (1885); Syn. Fl. Lar. Gr., p. 549, Pl. XXXI, fig. 4 (1886); Types Lar. Fl., p. 15, Pl. I, fig. 4 (1887).

This species, as Professor Ward has pointed out, is undoubtedly very closely related to *Ginkgo adiantoides* (Ung.) Heer, the main difference being in size, the leaves of *G. laramiensis* ranging from 30-40 mm. to 60-70 mm. in width and those of *G. adiantoides* from 75 mm. to 90 mm. They are, moreover, not so abruptly narrowed to the petiole, being more nearly wedge-shaped than *G. adiantoides*. In outline the leaves of this species differ among themselves, as do the leaves of the living *G. biloba*. Thus, fig. 5 of Pl. V is wedge-shaped at base and is simply lobed, while fig. 10, from the same place, is reniform, with undulate or merely crenate borders.

*Habitat*.—Point of Rocks, Wyoming.

## PISTIA CORRUGATA Lx.

*Pistia corrugata* Lx., Ann. Rept. U. S. Geol. and Geog. Surv. Terr. 1874, p. 299 (1876); Tert. Fl., p. 103, Pl. LXI, figs. 1, 3, 4, 6, 7 (1878).

The recent collections contain a few fragments of this plant, but do not add anything to our knowledge of its life history, which has already been well characterized by Lesquereux.

The two leaves referred by Lesquereux (Tert. Fl., p. 102) to *Lemna scutata* Du., have been carefully reexamined. The smaller one (Pl. LXI, fig. 5) is undoubtedly nothing but a small leaf of *Pistia corrugata*, as Schenk has already suggested,<sup>1</sup> while the larger petiolate leaf (op. cit., fig. 2) is clearly a *Nelumbo*, and is described and illustrated in its proper systematic position (ante, p. 53). It is clearly similar to *Brasenia*

<sup>1</sup> Zittel, Handbuch d. Palaeontol., Abth. II, p. 378 (1890).

*antiqua* Dn., or *Nelumbo Dawsoni* Hollick, as it is now called, from the South Saskatchewan River, British Columbia.

*Habitat*.—Point of Rocks, Wyoming.

#### OTTELIA AMERICANA Lx.

*Ottelia americana* Lx., Ann. Rept. U. S. Geol. and Geog. Surv. Terr. 1873, p. 300 (1874); *ibid.* for 1876, p. 501 (1878); Tert. Fl., p. 98, Pl. LXI, fig. 8 (1878).

The type of this species, and the only specimen ever obtained, is preserved in the United States National Museum (No. 549). It has been satisfactorily described by Lesquereux, but the drawing is not so full as it should be. The outline and wrinkled appearance of the wing are well shown, but the fine longitudinal striation is omitted.

Schenk<sup>1</sup> is of the opinion that this species should be united with *Pistia corrugata* Lx. and *Lemna scutata* Dn. Judging from the figures alone, this view may seem probable, but an examination of the specimen shows at once that it is quite distinct from these species. The spathe is oval, thick, narrowed to a striate petiole, and is surrounded by an undulate wrinkled wing, which is provided, as indeed is the spathe, with numerous fine longitudinal striæ. There is no trace of the areolation so characteristic of *Pistia corrugata*.

*Habitat*.—Point of Rocks, Wyoming.

#### CYPERACITES sp.

Pl. V, fig. 8.

The specimen figured is a mere fragment that appears to belong to this so-called genus. It is preserved for a length of 3.5 cm., is about 1 cm. wide, and, as may be observed from the drawing, is strongly keeled. The veins are obscure and can hardly be made out with certainty. It is too fragmentary for further characterization.

*Habitat*.—Point of Rocks, Wyoming.

#### SABALITES GRAYANUS Lx.

Pl. VI, fig. 5.

*Sabalites Grayanus* Lx., Tert. Fl., p. 112, Pl. XII, figs. 1, 2 (1878); Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1876, p. 502 (1878).

*Sabal Grayana* Lx., Trans. Am. Phil. Soc., Vol. XIII, p. 412, Pl. XIV, figs. 4-6 (1869); Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1870, p. 381 (1871); *ibid.*, 1873, p. 380 (1874); *ibid.*, 1874, p. 301 (1876).

This species has been reported by Lesquereux from a large number of localities, and most of the specimens are in the United States National Museum. These determinations are based on fragments of greater or less size, and in most cases must be regarded as open to grave doubt. The specimens upon which the species is founded came

<sup>1</sup> Zittel, Handbuch d. Palæontol., Abth. II, p. 378 (1890); Die Fossilen Pflanzenreste, p. 203, (1888).

from the soft, white clay of the Eocene of Mississippi, and represent specimens apparently hardly half the size of the large ones usually referred to it. Fragments supposed by Lesquereux to belong to this species have been found on Vancouver Island, but this identification is not at all satisfactory, and it is more than likely that they belong to another species. More complete material is necessary before the exact status of the Vancouver specimens can be made out.

This species is also reported from Point of Rocks, Wyoming, and the fine large specimen that is the original of Lesquereux's figure in the Tertiary Flora (Pl. XII, fig. 1) is in the collection of the United States National Museum (No. 108). During the season of 1896, Mr. T. W. Stanton and I fortunately secured a second example from the same locality. It was found at the base of the cliff, in the vicinity of coal mines northeast of the station, and is hardly to be distinguished from the specimen figured by Lesquereux. It is even larger than Lesquereux's specimen, yet hardly adds to our knowledge, as it simply exhibits a little more of the blade of the leaf.

The other figured type is said to be from the "hard sandstone between coal banks" at Golden, Colorado, and the National Museum fortunately contains this type (No. 109), which is the original of Pl. XII, fig. 2, in the Tertiary Flora. This specimen of a large petiole is, as the matrix clearly shows, not from the sandstone but from the andesitic material, and must have come from South Table Mountain in the Denver formation. It is the one specimen on which the presence of this species in the Denver depends, for no leaves have been found there that could be referred to that formation. That the specimen under discussion is the petiole of a palm is clear, but beyond that it is impossible to go. It might as well belong to any of the other large palms as to *Sabalites Grayanus*, and as a factor in the distribution of this species it must be dismissed.

Specimens have been found, however, in the hard white sandstone near Golden. The recent collection obtained by Rev. Arthur Lakes from Hoyt's coal mine, 1 mile south of Golden, contains several specimens which I have referred to this species with little hesitation. Among the material collected by Professor Ward in 1881 is a fine large leaf (fig. 5) that seems to belong here. It was collected one-fourth of a mile west of Golden, in the characteristic white sandstone.

From this it appears that *Sabalites Grayanus* has never, in the Colorado region, been found in other than true Laramie strata. It may be distinguished by its large size, its broad, thick rachis, which is taper-pointed and long acuminate, and by its very numerous rays. The intermediate veinlets are from 1 to 4 or even 10 in number.

*Habitat:* Point of Rocks, Wyoming. Golden, Colorado (white sandstone). Hoyt's coal mine, near Golden, Colorado. Mississippi (Eocene?). Vancouver Island. Golden, Colorado (Denver beds?). Pleasant Park, Colorado.?

## MYRICA TORREYI Lx.

Pl. VI, figs. 1-3.

*Myrica Torreyi* Lx., Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1872, p. 392 (1873); *ibid.*, 1873, p. 399 (1874); *ibid.*, 1876, p. 503 (1878); Tert. Fl., p. 129, Pl. XVI, figs. 3-10 (1878).

All but two of the figured types of this species are in the United States National Museum (Nos. 138, 139, 140, 141, 142). The species has been well described by Lesquereux, and none of the material since obtained adds to our knowledge of it.

The collections made by Professor Ward at Point of Rocks, Wyoming, in 1881, contain a number of leaves that undoubtedly belong to this species. They have the same size, shape, and nervation, but differ slightly in having more numerous and finer teeth. Figs. 1 and 2 are undoubtedly *M. Torreyi*, but fig. 3 has finely serrate margins and may possibly represent a new species. Leaves of this species were also obtained by Mr. Stanton and myself in 1896, on the Laramie Plains, near Dunn's ranch, 30 miles north of Laramie, Wyoming. The nervation in these specimens is not well preserved, but otherwise there seems to be no difference.

*Habitat.*—Black Buttes, Wyoming (type locality). Point of Rocks, Wyoming (figs. 1 to 3), north of station and midway of cliff; collected by Lester F. Ward, September 3, 1881. Dunn's ranch, 30 miles north of Laramie, Wyoming, and 6 miles east of Harpers Station; collected by Knowlton, Stanton, and Knight, July 24, 1896.

## MYRICA? sp.

Pl. VI, fig. 4.

The small fragment figured was all of this form that could be found in the collection. It represents a part of the base of a leaf, only 3.5 cm. being preserved. The midrib is very thick for the size of the leaf, and there are numerous close, slender, parallel secondaries arising at an angle of about 45°. Their termination can not be made out nor can any of the finer nervation be seen.

It seems probable that this specimen belongs to *Myrica*, but it is so fragmentary and obscure that it obviously can have little value.

*Habitat.*—Coal mine on north fork of Dutton Creek, near old stage road, Laramie Plains, Wyoming. Collected by Knowlton, Stanton, and Knight, July 28, 1896.

## POPULUS OBOVATA n. sp.

Pl. VII, fig. 4.

Leaf of firm texture, obovate or nearly elliptical in general outline, abruptly wedge-shaped at base, obtuse at apex; margin entire; nervation nearly equally 4-palmate from the base, middle rib straight, second



pair arching around and passing toward the apex, other pair dividing the distance between the second pair and the margin, all apparently craspedodrome and forking; finer nervation not preserved.

This fine leaf is the only specimen found. It is, fortunately, nearly all preserved, lacking only the apex and a portion of the margin of one side. In outline it is obovate or nearly elliptical, being 7.5 cm. in length and 4.5 cm. in width, without the petiole, which is not preserved. It is rather abruptly wedge-shaped. The nervation consists of four palmately arranged, occasionally forked, ribs.

I have been somewhat in doubt as to the proper generic reference of this leaf. It has, for example, some affinity with certain Dakota group species of *Hedera*, but on the whole seems more like *Populus*, being in shape quite like *P. nervosa elongata* Newb., but differing much from that species in nervation.

This is of the more ancient type of the genus, that having the palmate nervation.

The specimen was found by Prof. W. C. Knight, of the University of Wyoming, and is now preserved in the museum of the university. It comes from the lowest fossiliferous horizon at Harpers, being associated with numerous Fort Pierre invertebrates. It occurred in a nodule, and was the only plant observed.

*Habitat*.—Harpers Station, Union Pacific Railroad, Wyoming. Collected by W. C. Knight.

#### POPULUS MELANARIOIDES Lx.

*Populus melanarioides* Lx., Bull. U. S. Geol. and Geog. Surv. Terr., Vol. I, p. 379 (1875); Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1874, p. 302 (1876); *ibid.*, 1876, p. 507 (1878); Tert. Fl., p. 147, Pl. LXII, fig. 5 (1878).

*Populus melanaria* Heer, Fl. Tert. Helv., Vol. II, p. 16, Pl. LIV, fig. 7; Pl. LVII, fig. 1; Lesquereux, Bull. U. S. Geol. and Geog. Surv. Terr., Vol. I, p. 370 (1875); Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1874, p. 302 (1876); *ibid.*, 1876, p. 507 (1878); Tert. Fl., p. 173, Pl. LXIV, fig. 5, (1878).

The leaf described and figured by Professor Lesquereux under the name of *Populus melanaria* Heer is preserved in the United States National Museum. The type of *P. melanarioides* Lx. does not appear to have ever been in the National Museum, and its present location is unknown. The species, however, is represented by several fragments, one of which was obtained by Professor Ward from the type locality.

The type and only American specimen of *P. melanaria* Heer, as shown by the figure of it in Tertiary Flora (Pl. LXIV, fig. 5), is a mere fragment, showing only the lower part of the leaf with the petiole. The margin of this fragment is to be made out in one place only, and even here with some question. If what appears to be the margin is really such, it is provided with small teeth, and this would seem to relegate it to the European species; but the presence of teeth is so much in doubt that this feature can not be entitled to much consideration. The nervation, so far as can be made out, agrees well enough with that

of *P. melanaria*, but it is also exactly the same as *P. melanarioides*, the only difference being the more or less hypothetical teeth. If other specimens should be found which possess teeth, the retention of *P. melanaria* would of course be rendered necessary, but as no other examples have ever been obtained, I have decided to refer the specimen to *P. melanarioides*.

The fragment agrees in every particular, so far as can be made out, with Lesquereux's type, and there can be no doubt of their identity.

This species, as Lesquereux has pointed out (Tert. Fl., p. 147), is evidently related to *P. tremulæfolia* Sap.,<sup>1</sup> from which it differs in having an entire or slightly undulate margin, and in having all the branches of the secondaries enter the margin. Its suggested resemblance to *P. Massiliensis* Sap.<sup>2</sup> is less plain than its resemblance to the former species. The nervation and shape are quite different. *P. obtrita* Dn.,<sup>3</sup> from the Similkameen Valley, British Columbia, is thought by its author to be allied to the species under discussion, but while this may be true, it differs in so many important particulars that it can not be regarded as at all closely related. Some of the leaves described as *P. arctica* possess not a little resemblance to *P. melanarioides*, but this can not be regarded as specific.

*Habitat*.—Point of Rocks, Wyoming.

#### POPULUS WARDII n. sp.

Pl. VI, fig. 7.

Leaf of firm texture, approximately circular in general outline, truncate at base (apex destroyed); margin regularly, rather coarsely dentate, the teeth obtuse; nervation strong, coarse, palmately five-nerved; the middle nerve or midrib slightly stronger than the others, straight, with two pairs of remote, opposite secondaries, these flexuose and anastomosing; second pair of basal nerves nearly as strong, straight, flexuose, and freely anastomosing with the lower pair of secondaries on the midrib, and branching on the lower side and joining with the lower pair by basal nerves, which are small and become lost before reaching half the distance to the margin; other nervation coarse, irregular, and forming large areolæ.

The specimen figured appears to be all that was obtained of this species. As may be seen from the drawing, it lacks the apex and much of the side. It would seem to be approximately circular in outline, being about 5 cm. in length and the same in width. The nervation is very prominent, appearing on the stone in strong raised lines. It has the palmate nervation, with the smaller basal nerves of the well-known ancient type of *Populus*.

<sup>1</sup> Études sur la Vég. d. Sud. Este France, Vol. III, p. 158, Pl. III, fig. 4 (1867).

<sup>2</sup> Ibid., p. 162, Pl. II, figs. 6-8; Pl. III, fig. 1 (1867).

<sup>3</sup> Trans. Roy. Soc. Canada, Vol. VIII, Sec. IV, p. 82 (1890).

This species has strong affinities with several well-known forms, as, for example, *Populus nervosa* Newb., from the Fort Union beds of Montana. The shape, size, dentation, and strong, coarse nervation are practically the same in both, *P. nervosa* differing, however, in being only three-nerved and in a tendency to be slightly three-lobed. *Populus nebrascensis* Newb., from the same beds, is apparently quite similar, but differs in having the first pair of basal nerves arching around and ascending to near the summit of the leaf. In the leaf under discussion they appear to be lost long before reaching the margin.

I take pleasure in naming this species in honor of Prof. Lester F. Ward, by whom it was collected.

*Habitat*.—Point of Rocks, Wyoming, base of bluff northeast of station. Collected September 2, 3, 1883.

### POPULUS MUTABILIS OVALIS? Heer.

Pl. VII, fig. 3.

*Populus mutabilis ovalis* Heer, Fl. Tert. Helv., Vol. II, p. 22, Pl. LXI, figs. 1, 3, 6, 9; Pl. LXIII, fig. 4; Lesquereux, Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1871, pp. 292, 401, 405; 1873, p. 397; Tert. Fl., p. 177, Pl. XXIV, figs. 3, 4.

The leaves referred by Heer to this form of this polymorphous species vary considerably, and as Lesquereux has said, "it is extremely hazardous to identify single leaves" with either of the forms. We are therefore permitted a certain degree of latitude in admitting forms under this name. They are all so connected by intermediate links that it may sometimes be difficult to decide to which form a particular specimen shall be relegated. The example here figured, from Point of Rocks, is with hesitation referred to this form. With more than one specimen in hand a more definite conclusion could undoubtedly be reached.

*Habitat*.—Point of Rocks, Wyoming.?

### POPULUS sp.

Pl. VII, fig. 5.

As stated under *Glyptostrobus?* sp. and under *Phyllites* sp., a specimen was obtained from the coal mine on Dutton Creek which had three plants preserved on it—the one here figured and the specimens above referred to. As the piece of matrix in which these three forms was preserved is now lost, the figure is given simply to call attention to the fact that such a plant existed at that place, and to impress subsequent collectors with the desirability of obtaining further material.

*Habitat*.—Coal mine on the north fork of Dutton Creek, near old stage road, Laramie Plains, Wyoming. Collected by Knowlton, Stanton, and Knight, July, 1896.

## SALIX ANGUSTA Al. Br.

Pl. VII, fig. 6.

*Salix angusta* Al. Br. Cf. Heer, Fl. Tert. Helv., Vol. II, p. 30, Pl. LXIX, figs. 1-11 (1856); Lesquereux, Ann. Rept. U. S. Geol. and Geog. Surv. Terr. 1871, Suppl., p. 6 (1872); *ibid.*, 1872, p. 405 (1873); *ibid.*, 1873, p. 384 (1874); *ibid.*, 1876, p. 506 (1878); Tert. Fl., p. 168, Pl. XXII, figs. 4, 5 (1878); Cret. and Tert. Fl., pp. 157, 247, Pl. LV, fig. 6 (1884); Proc. U. S. Nat. Mus., Vol. XI, p. 13 (1888).

In its European distribution this species is mainly Miocene. It has been identified by Lesquereux from a number of localities in the United States, ranging in age from the Montana formation and the true Laramie to the Eocene or possibly the Miocene. It was first detected in the Green River group, occurring near the town of Greenriver above the so-called "fish beds." Fragmentary specimens referred to this species were also obtained from the locality known as "6 miles above Spring Cañon, Montana," now called the Bozeman coal field. The recent collections from the latter place contain a large number of more or less fragmentary examples in which the nervation is mainly obsolete, and which are consequently referred to this species with some hesitation. There can be no doubt, however, that they are the same as the specimens regarded by Lesquereux as belonging to *S. angusta*, but their absolute identity with the European forms is by no means so clear.

This species is also reported by Lesquereux from Wickliffe, Ballard County, Kentucky, in the so-called Eo-Lignitic or Lower Eocene. This identification depends upon a single imperfect leaf, and must also be open to more or less question.

This species was found at Point of Rocks, Wyoming, by Professor Ward. The example figured lacks both base and apex, yet it agrees as closely as do others that have been referred to this form. In fact, it may be said that the leaves of this willow are so often poorly preserved and without positive characters that its value as a stratigraphic mark is of little importance.

*Habitat.*—Coalville, Utah, and Point of Rocks, Wyoming (north of station and midway of cliff); collected by Lester F. Ward, September 3, 1881. Bozeman coal field, Montana, both in true Laramie and Livingston formations. Greenriver, Wyoming (above the fish beds). Wickliffe, Ballard County, Kentucky.

## SALIX STANTONI n. sp.

Pl. VI, fig. 6.

Leaf evidently of firm texture, elliptical-lanceolate in outline, rather abruptly narrowed to a rounded, obtuse base, and narrowed above to an obtuse apex; margin entire; petiole not preserved; midrib rather thick, straight; secondaries about eight pairs, alternate or subopposite,

arising at an angle of from  $25^{\circ}$  to  $45^{\circ}$ , curving upward, camptodrome; finer nervation not preserved.

The leaf figured is the only specimen obtained of this species. With the exception of the petiole it is preserved entire, being 7.5 cm. in length and 2.5 cm. in width at the broadest portion, which is about the middle.

I take pleasure in naming this species in honor of Mr. T. W. Stanton, by whom it was collected.

*Habitat.*—Coalville, Utah.

SALIX sp.

Pl. VII, fig. 2.

*Salix elongata*, O. Web., Knowlton, Bull. U. S. Geol. Survey No. 106, p. 42 (1893); Bull. Geol. Soc. Am., Vol. VIII, p. 150 (1897).

In the papers above mentioned these forms were doubtfully referred to *Salix elongata*, but a reexamination shows that this determination is not satisfactory enough to warrant retaining them under this name. Hardly more than the outline is preserved, and it is impossible to go with certainty beyond the statement that they are probably leaves of *Salix*.

*Habitat.*—Coalville, Utah.

QUERCUS LESQUEREUXIANA Kn.

Pl. VII, fig. 1.

*Quercus Lesquereuxiana* Kn., Bull. U. S. Geol. Survey No. 152, p. 194 (1898).  
*Quercus acrodon* Lx., [non Massalonge 1853], Am. Jour. Sci., 2d ser., Vol. XLV, p. 205 (1868); Tert. Fl., p. 158, Pl. XIX, figs. 11-13 (1878).

This species was originally described by Lesquereux in 1868 from specimens obtained by Dr. F. V. Hayden from "Rock Creek on the Laramie Plains." Of the three figured specimens (Tert. Fl., l. c.), only two, the original of Pl. XIX, fig. 13, and what appears to be the counterpart of fig. 12, are preserved in the United States National Museum, both bearing the number 178. The matrix is a hard grayish shale.

In the annual report of the United States Geological and Geographical Survey of the Territories for 1872, page 389, Lesquereux describes another leaf of this species from Carbon, Wyoming, but this specimen is not now, and appears never to have been in the collection of the National Museum. It is described as follows: "The ovate pointed leaf, wedge-shaped to the petiole, has the borders deeply cut into large, sharp teeth, with straight, mostly simple, secondary veins, passing at an acute angle to the point of the teeth. In this new specimen, the upper secondary veins are slightly curved in ascending to the borders." This agrees in the essential characters with the original description, but in the absence of that specimen or of any since found at this locality, it is more or less open to question. The collections made at

this time were often poorly labeled, and without a particular specimen in hand it is hazardous to assign it to a definite locality or horizon.

A single example from Bridge Creek, Oregon, was referred to *Quercus acrodon* by Lesquereux, but this reference is undoubtedly incorrect, it being a species well known from those beds, viz, a sharp-toothed form of *Q. pseudo-alnus*.

The locality known as "Near Rock Creek on the Laramie Plains" has long been a puzzle to paleobotanists. A number of plants were recorded from a place thus described, and hence it was a matter of importance to fix their horizon. Investigation has shown that there is no locality in the vicinity of Rock Creek Station on the Laramie Plains that could have afforded these plants, and they came to be regarded as practically worthless, because unidentifiable. To Prof. W. C. Knight, of the University of Wyoming, is due the honor of solving this question. He is perhaps the best-informed geologist on the history of early exploration in this locality, for, by going over every part of the country with the early reports in hand, he has been able to fix nearly all of the old localities and sections. He informs me that when the explorations were first begun by Hayden and his assistants, the Laramie Plains was almost entirely unsettled and without local names, and the specimens were labeled with the name of the nearest known locality. As the old stage crossing of Rock Creek was then well established, the material collected at the various coal seams, near what is now known as Dutton Creek, was labeled "Near Rock Creek on the Laramie Plains." The locality has, therefore, no connection with Rock Creek Station or vicinity.

Professor Knight discovered a locality for fossil plants near Dunn's ranch on the Laramie River, 6 miles east of Harpers Station on the Union Pacific Railroad. This locality afforded a number of fairly well-preserved examples of *Quercus Lesquereuxiana*, and once more this species becomes a known stratigraphic mark. The matrix in which the specimens are preserved is a friable yellowish sandstone.

*Habitat*.—Carbon, Wyoming.? "Near Rock Creek, Laramie Plains." Dunn's ranch, 6 miles east of Harpers Station, Wyoming.

#### QUERCUS DENTONOIDES n. sp.

Pl. VII, fig. 7.

*Quercus Dentoni* Ward, non Lx., Syn. Fl. Lar. Gr., p. 551, Pl. XXXVII, fig. 2 (1886);  
Types Lar. Fl., p. 26, Pl. X, fig. 1 (1887).

After some hesitation I have decided to describe this leaf under another name. At first sight it does have a strong resemblance to Lesquereux's species from the Bad Lands (Fort Union) of Dakota. As Professor Ward has pointed out, this leaf differs in several particulars. It is, for instance, more narrowed upward, and was evidently acute

instead of decidedly obtuse. It has also a much thicker petiole, and, moreover, is a much larger leaf and has secondaries at a greater angle. But these forms are undoubtedly closely related, and were it not for their widely separate geographic and geologic positions they might possibly be considered as identical.

*Habitat*.—Point of Rocks, Wyoming.

#### DRYOPHYLLUM SUBFALCATUM Lx.

*Dryophyllum subfalcatum* Lx., Bull. U. S. Geol. and Geog. Surv. Terr., Vol. I, p. 379 (1875); Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1874, p. 301 (1876); *ibid.*, 1876, p. 506 (1878); Tert. Fl., p. 163, Pl. LXIII, fig. 10 (1878).

*Dryophyllum Bruneri* Ward, Syn. Fl. Lar. Gr., p. 551, Pl. XXXVII, figs. 6-9 (1886); Types Lar. Fl., p. 27, Pl. X, figs. 5-8 (1887).

The type specimen of Lesquereux's *Dryophyllum subfalcatum* should be the property of the United States National Museum, but the records do not show that it has ever been there, and its present location, even if it is in existence, is unknown. We have, therefore, to depend entirely upon the figure given by Lesquereux in the Tertiary Flora, which represents only the upper portion of a small leaf. It is linear-lanceolate in shape, with a narrowly taper pointed apex, and has the borders regularly serrate with short blunt teeth which are turned outward. The nervation was well preserved, and shows the lateral nerves to be oblique, close, parallel, and running straight to the teeth. An upper branch from near the apex of the secondaries passes under the sinuses and, closely following the borders, anastomoses with the fibrillæ. The nervilles are numerous, close, percurrent, and form nearly regular rectangular areas.

I have united with this the *Dryophyllum Bruneri* of Ward, probably obtained in part from the same locality that afforded Lesquereux's specimen of *D. subfalcatum*. This is represented by a large number of very perfectly preserved specimens, four of which have been figured by Professor Ward (*op. cit.*, Pl. X, figs. 5-8). Of these, fig. 7 agrees perfectly with Lesquereux's figure, and there can be no doubt of the identity of the forms. These later specimens are much better preserved, and from them we are able to make out the form of the base. *D. Bruneri* was described as follows by Professor Ward:

Leaves lanceolate or oblong-lanceolate, pointed, abruptly narrowed to a short thick petiole, coarsely and obscurely sinuate-toothed except near the entire base; nervation craspedodrome; midrib strong, straight, or a little curved; secondary nerves numerous (fifteen to twenty on each side) and close together, proceeding from the midrib at an angle varying from 35° to 80°, slightly curving upward, rarely forking or forming arches, the ultimate ramifications entering the teeth; nervilles faint, slender and wavy, percurrent, joining the secondaries only.

This elaborate description agrees perfectly with that of *D. subfalcatum* so far as this species can be made out, and supplies the deficiencies of our knowledge concerning it.

*Habitat*.—Point of Rocks, Wyoming. Hodges Pass, Wyoming.

DRYOPHYLLUM FALCATUM? Ward.

Pl. VIII, fig. 1.

*Dryophyllum falcatum* Ward, Types Lar. Fl., p. 27, Pl. XI, fig. 1.

The specimen here figured agrees, except in one particular, with the figured type specimen of this species, the difference being that the margin is sinuate-toothed nearly or quite to the base instead of to some distance above it. The teeth are also a little more prominent, but otherwise the specimen scarcely differs. It is much narrower and more acuminate than *D. subfalcatum* Lx., yet it is evidently allied to it.

*Habitat*.—Point of Rocks, Wyoming, opposite the station and midway of the bluff. Collected by Lester F. Ward, 1881. Also Hodges Pass, Wyoming.

DRYOPHYLLUM CRENATUM Lx.

*Dryophyllum crenatum* Lx., Bull. U. S. Geol. and Geog. Surv. Terr., Vol. I, p. 371 (1875); Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1874, p. 301 (1876); *ibid.*, 1876, p. 506 (1878); Tert. Fl., p. 162, Pl. LXII, figs. 10, 11 (1878).

The type specimens of this species, and so far as known all that have been found, are in the United States National Museum (Nos. 195, 196). They are somewhat fragmentary, and their reference to this genus is not without doubt.

*Habitat*.—Point of Rocks, Wyoming.

FICUS TRINERVIS n. sp.

*Cinnamomum affine* Lx. ex. p., Tert. Fl., p. 219, Pl. XXXVII, fig. 5 [non figs. 1-4, 7] (1878); Ward, Types Lar. Fl., p. 50, Pl. XXIV, figs. 3-5.

Much confusion exists in regard to what has been known as *Cinnamomum affine* Lx. It was first described<sup>1</sup> from Marshall's mine, near Denver, Colorado, but unfortunately the specimen or specimens can not now be found and it has not since been collected there. It was also said to be present at Raton Pass, New Mexico, but there is only a single fragment in the United States National Museum collection (No. 843), which is evidently the same specimen referred to by Lesquereux<sup>2</sup> as *Cinnamomum mississippiense*. It was next reported<sup>3</sup> from Golden, Colorado, and the specimens upon which, presumably, this determination was made are in the National Museum (No. 312). There are two specimens, the originals of figs. 5 and 7 of Pl. XXXVII in Tertiary Flora. They are preserved in hard, whitish sandstone, and are rather obscure, yet show the essential characters. In the following year it was again reported<sup>4</sup> from Golden, and it is possible that these specimens were the originals of figs. 1-3, but they are not in the

<sup>1</sup> Am. Jour. Sci., 2d ser., Vol. XLV, p. 206 (1868).

<sup>2</sup> Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1871, Suppl., p. 14 (1872).

<sup>3</sup> *Ibid.*, 1872, p. 383 (1873).

<sup>4</sup> *Ibid.*, 1873, p. 401 (1874).



National Museum and their location is unknown, unless possibly they are in the Museum of Princeton College, New Jersey. I found there a small slab on which six or eight fine leaves are preserved, the back of the slab bearing the label "La. South Park, Col." The matrix is the same as that of the Golden specimens mentioned above, and they may all belong together. In any case much uncertainty exists as to the actual type locality of this species.

Professor Ward obtained some very fine material from Black Buttes, Wyoming, which he referred to *C. affine*. The specimens agree perfectly with the fig. 5 mentioned above, except that they are somewhat larger; they are quite unlike what may be called typical *C. affine* as depicted in figs. 1-4, 7.

I have long been of the opinion that there were two well-marked species included under *Cinnamomum affine* as figured in the Tertiary Flora, Pl. XXXVII. The joining of the secondaries to the midrib at some distance above the base is distinctly a character of *Cinnamomum*, and all known species possess it. The form represented in fig. 5, together with those of Professor Ward already mentioned, do not possess this character. The secondaries pass to extreme base of the blade and arise with and at the same point as the midrib.

In a letter to Professor Ward, commenting on his Types of the Laramie Flora, Lesquereux distinctly objects to the reference of the Black Buttes leaves to his *Cinnamomum affine*, saying that they could not belong to the genus *Cinnamomum* as above characterized, but should probably be allied to *Ficus* of the type of *F. planicostata*.

The National Museum contains several rather poor specimens (Nos. 312a, b, c) of what is apparently this species from Point of Rocks, Wyoming.

#### FICUS MULTINERVIS Heer.

*Ficus multinervis* Heer, Fl. Tert. Helv., Vol. II, p. 63, Pl. LXXXI, figs. 6-10 (1856); Lesquereux, Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1871, p. 300 (1872); Tert. Fl., p. 194, Pl. XXVIII, figs. 7, 8 (1878).

*Ficus irregularis*? Lx., Knowlton, Bull. Geol. Soc. Am., Vol. VIII, p. 150 (1897).

*Ficus lanceolata*? Lx., Knowlton, Bull. Geol. Soc. Am., Vol. VIII, p. 150 (1897).

The first American specimens referred to this species were mentioned by Lesquereux in Hayden's Annual Report for 1871 (p. 300), having probably been collected the previous year. He wrote as follows of the collection of which they form a part: "Hard, shaly, fine-grained whitish sandstone. About the same consistence and color as the specimens from Carbon Station. The precise locality is *unknown*, the labels having been *lost or forgotten*." They are thus shown to be from an unknown locality, yet in all subsequent mention of the species they are said to have come from the Green River group. The nature of the matrix entirely precludes the probability of this, and this view is further confirmed by the accompanying species, none of which are Green River group species.

This species does not appear to have been since collected with certainty until found by Mr. Stanton at Coalville. The collections from the coal mine on Coal Creek, Boulder County, Colorado, obtained by Lakes in 1890, contain a number of fragments that seem to belong here, but they are more or less doubtful. They are similar in shape to *F. lanceolata*, but have more numerous secondaries at a more acute angle of divergence.

The specimens from Coalville, Utah, are fairly well preserved in regard to outline, but not so well preserved in regard to nervation. Enough can be made out, however, to make it reasonably certain that they belong to this species.

The reference of these same leaves to *Ficus irregularis* in the Bulletin of the Geological Society of America, Vol. VIII, page 150, is lapsus pennæ for *F. multinervis*, and the mention in the same place of *F. lanceolata* is not borne out by more careful study. The close, parallel nerves are made out with difficulty, but under strong light they are ascertained to be present.

*Habitat*.—Coalville, Utah. Coal Creek, Boulder County, Colorado.?

FICUS POPULOIDES n. sp.

Pl. VIII, fig. 3.

Leaf thick, broadly ovate in outline, rounded at base, regularly rounded to a short obtuse apex above; margin undulate; palmately five-nerved from the base; midnerve or midrib somewhat flexuose, with about three alternate pairs of slender secondary branches well above the middle of the leaf; lowest pair of nerves smallest, forking, anastomosing with branches from the second pair, camptodrome; second pair strongest, passing to near the apex, dividing the distance between the midrib and margin about equally, flexuose above, then there are three or four strong branches which arch and anastomose near the margin; nervilles well defined, mainly percurrent.

The beautiful leaf upon which this species is based is nearly perfect, lacking only a portion of the base and one side. It is very broadly ovate in outline, being 9.5 cm. in length and 7.75 cm. in width.

This species is evidently closely allied to *F. incompleta* (ante p. 46), and it is possible that if the latter were preserved entire they might be found to be the same. The one described as *F. incompleta* is a larger leaf, but the arrangement of the secondaries in the apex is very similar to that in the leaf under discussion. The finer nervation is also similar in both, but *F. populoides* has no lobes.

There is a general resemblance of this species to *F. squarrosa*. The latter has slight lobes and differs somewhat in the number and arrangement of the secondaries. The finer nervation is also a little different.

*Ficus populoides* has at first sight a striking resemblance to certain forms of *Populus arctica* Heer, such, for example, as Pl. V, figs. 1, 3, and 8, in Heer's *Flora Fossilis Arctica*, Vol. I, and Pl. XXIII, figs. 1 and 3, in Lesquereux's *Tertiary Flora*. The size, shape, and general

nerivation are nearly identical, but the large pair of secondaries is much more flexuose, and the finer nervation is that of *Ficus* rather than that of *Populus*.

*Habitat*.—Point of Rocks, Wyoming.

*FICUS HESPERIA* n. sp.

Pl. IX, fig. 5.

*Ficus* sp. Kn., Stanton and Knowlton, Bull. Geol. Soc. Am., Vol. VIII, p. 140 (1897).

Leaf rather broadly elliptical, about equally rounded from the broadest point at the middle of the leaf to both base and apex; base wedge-shaped, apex very obtuse; margin perfectly entire; midrib very thick, slightly undulate; secondaries, about ten pairs, alternate, emerging at a very low angle, camptodrome, arching far inside the margin and joining by a broad regular bow to the one next above; apparently with a series of bows outside the secondary arches; ultimate nervation not preserved.

The Dutton Creek material contains of this form the single example figured. It is 6 cm. in length and 3 cm. in width. It is broadly elliptical in outline, broadly wedge-shaped at base, and obtuse and rounded at apex. The midrib is very thick, with about ten pairs of regular parallel secondaries, which join well inside the margin.

*Habitat*.—Coal mine on north fork of Dutton Creek, near old stage road, Laramie Plains, Wyoming. Collected by Knowlton, Stanton, and Knight, July 28, 1896.

*FICUS SQUARROSA* n. sp.

Pl. VIII, fig. 2.

Leaf of medium size, thick, irregularly quadrangular in outline, broadly rounded at base, truncate at apex with short obtuse point, leaf three-lobed, with very small, obtuse lateral lobes; palmately three-nerved; secondaries, about seven pairs, alternate, at an angle of about 45°, all camptodrome, the lowest pair passing into the lateral lobes, provided with six or eight camptodrome branches on the outside; second pair of secondaries forked just above the middle; all secondaries above the lowest pair much arched toward the apex; nervilles strong, percurrent or forked, approximately at right angles to the secondaries.

This species is characterized by its nearly square outline, small obtuse lateral lobes, rounded base, and short, obtuse apex. It is 8.5 cm. long and about 7.5 cm. broad. The upper secondaries arch very strongly in the upper portion of the leaf, each joining by a series of short bows the secondary next above.

This leaf is the only one observed in the collection. It is not quite perfect, lacking the central portion of the base and a portion of one

side. It was, with little doubt, strongly palmately three-nerved as well as three-lobed. It appears unlike any form before reported from these beds.

*Habitat*.—Point of Rocks, Wyoming, north of station and midway of cliff. Collected by Lester F. Ward, September 3, 1881.

FICUS INCOMPLETEA n. sp.

Pl. IX, fig. 2.

Leaf large, thick, palmately three-lobed (?), lateral lobes small, obtuse; terminal lobe large, rounded; base?; midrib thickish, straight; palmately three-nerved (?), lateral secondaries (?); secondaries in upper portion of leaf distant, alternate, camptodrome, arching up and joining ones next above, producing large, irregularly quadrangular areas; arching in small loops inside the margin; nervilles irregular, mostly broken.

The small fragment figured is all that was obtained of this form. It is really insufficient for proper characterization, but it appears unlike any form before reported, unless it be the upper portion of a leaf of *Dombeyopsis trivialis* Lx.,<sup>1</sup> and is perhaps best described tentatively as new. If the whole leaf were preserved, it might be shown to belong to some known species.

*Habitat*.—Point of Rocks, Wyoming, north of station and midway of cliff. Collected by Lester F. Ward, September 3, 1881.

FICUS PROBLEMATICA n. sp.

Pl. IX, fig. 3.

Leaf large, thick, palmately five-nerved, heart-shaped at base; margin with scattered obtuse teeth; central nerve or midrib straight, very thick; next pair of nerves also very thick, arching around; outer pair thinner, emerging at right angles to the midrib, curving slightly upward and each entering a lobe; midrib with scattered thick secondaries at right angles; inner pair of nerves with secondaries on the outside at right angles to the midrib, and again branching near the margin, some of the branches entering the lobes; nervilles numerous, thin, broken; finer nervation irregular, producing peculiar irregular areolation.

The fragment figured is the only portion of this leaf preserved, and could hardly be sufficient for characterization if it were not particularly well marked. It must have been a large leaf, at least 12 cm. broad. It has a broad, heart-shaped base and a few remote, obtuse teeth. It is strongly three-nerved, with the lowest pair of secondaries coming out at a point so near the petiole as to become practically five-nerved. The three middle nerves are very strong, with branches at right angles to the midrib.

<sup>1</sup> Tert. Fl., p. 255, Pl. XLVII, fig. 3 (1878).

This leaf is entirely different from any heretofore reported from the American Cretaceous. It is remotely suggestive of *F. latifolia* in shape, but differs in being lobed or toothed, and in having secondaries at right angles to the midrib, as well as in the finer nervation. It may not even belong to the genus *Ficus*. It is, for example, somewhat like *Dombeyopsis islandica* Heer,<sup>1</sup> *D. obtusa* Lx.,<sup>2</sup> *Sterculia variabilis* Heer,<sup>3</sup> etc., yet is not close enough to warrant putting it in any of these genera.

*Habitat*.—Point of Rocks, Wyoming, north of station and midway of cliff. Collected by Lester F. Ward, September 3, 1881.

*FICUS RHAMNOIDES* n. sp.

Pl. X, figs. 1-3; Pl. XI, fig. 1.

Leaves thickish, oblong-lanceolate in outline, about equally narrowed to base and apex; margin perfectly entire; petiole thick; midrib thickish, straight; secondaries about 12 pairs, alternate, at an angle of 45° to 50°, camptodrome, arching just inside the margin and joining the one next above; nervilles very numerous, at right angles to the secondaries, mainly broken, although many are percurrent.

These leaves are from 9 to 11 cm. long and from 3.5 to 5 cm. broad. The secondaries are at an angle of about 45°, and camptodrome by means of a few small, simple loops.

At first sight these leaves appear to be referable to *Rhamnus Cleburni* Lx.,<sup>4</sup> a species very abundant in the Denver beds at Golden, Colorado. They have exactly the same size, shape, and arrangement, the main difference being in the nervilles. In *Rhamnus Cleburni* they are very fine and close together, mainly percurrent, and in general at right angles to the midrib, while in *Ficus rhamnoides* they are coarser, mainly broken, and at right angles to the secondaries. These are characters hardly sufficient for generic separation were it not for the fact that it is more than probable that the *Rhamnus Cleburni* and *R. goldianus* of Lesquereux really belong to the genus *Ficus*. Lesquereux says<sup>5</sup> that the European authors, presumably Saporta and Heer, to whom he had submitted specimens, were inclined to regard them as belonging to the *Urticaceæ*. They have also some resemblance to *Cornus*.

It is with regret that I am obliged to describe this as a supposed new species of *Ficus*, but if they belong to this genus they are certainly new, at least in this flora. It is to be hoped that specimens will some time be found that will settle more clearly the proper generic position of these interesting leaves.

*Habitat*.—Point of Rocks, Wyoming, north of station and midway of cliff. Collected by Lester F. Ward, September 3, 1881.

<sup>1</sup>Fl. Foss. Arct., Vol. I, Pl. XXVII, fig. 10 (1868).

<sup>2</sup>Tert. Fl., p. 255, Pl. XLVII, fig. 5 (1878).

<sup>3</sup>Fl. Foss. Arct., Vol. VII, Pl. LVII, fig. 7 (1884).

<sup>4</sup>Tert. Fl., p. 280, Pl. LIII, figs. 1-3 (1878).

<sup>5</sup>Ibid., p. 280.

## FIGUS MONTANA n. sp.

Pl. XI, figs. 2, 3; Pl. XII, fig. 1.

Leaves thick in texture, broadly ovate, entire, slightly decurrent onto the petiole; palmately three-nerved from a little above the base of the lamina; midrib thick, flexuous; lateral nerves as thick as midrib, at an angle of  $50^{\circ}$ , with numerous irregular camptodrome branches on the outside, which arch just inside the margin or join one another, or again branch on the lower or outer side; occasionally with a strong secondary so low as to make the leaf appear four- or five-nerved; upper secondaries, three or four pairs; alternate, at the same angle as the lateral nerves, frequently branched; nervilles strong, approximately at right angles to the secondaries, some percurrent, but many are branched or broken; finer nervation produced by branches between and at right angles to the nervilles.

None of the specimens referred to this species are preserved entire. They appear to be broadly ovate in outline, with perfectly entire margins. They must have been at least 10 cm. long and from 5 to 6 cm. wide. The petiole is preserved in two specimens, the longest being 1 cm. in length.

This species appears to be allied to *Ficus planicostata* Lx.,<sup>1</sup> which differs from it in being rounded at base, and with the three principal nerves arising at the base of the lamina, instead of above. The secondaries, especially the upper ones, are not so much branched as in the one under discussion.

*Habitat*.—Point of Rocks, Wyoming, north of station and midway of cliff. Collected by Lester F. Ward, September 3, 1881.

## FIGUS WARDII n. sp.

Pl. IX, fig. 1.

Leaf of firm texture, gracefully oval in outline, perfectly entire, slightly heart-shaped at base; palmately five-nerved from the base, camptodrome; lateral nerve with about eight secondaries on the outside, all arching inside the border and joining; next pair of nerves with few strong secondaries in the upper portion, on the outside; central nerve or midrib, so far as can be made out, without secondaries; nervilles mainly forking.

This fine leaf, which unfortunately is the only one observed, is 6.5 cm. broad and must have been about 8 or 10 cm. long, the upper portion being destroyed. It was probably oval, or possibly more nearly round, in outline, with a slightly heart-shaped base. It is equally five-nerved from the base, the lateral, or outside nerves, with eight or more secondaries on the outside, the next or inner pair with several

<sup>1</sup> Tert. Fl., p. 201, Pl. XXXI, figs. 1-8, 10-12 (1878).

larger secondaries above, and the central nerve or midrib apparently unbranched. Nervilles mostly forking and only preserved within the outside pair of nerves.

This species is suggestive of *Ficus planicostata* Lx.,<sup>1</sup> but differs from it markedly in having five instead of three palmately arranged nerves. It approaches in shape to *Ficus planicostata* var. *latifolia* Lx.,<sup>2</sup> [now *F. latifolia* (Lx.) Kn.] the main difference being the number of nerves. The two lower secondaries on the outside are much stronger, but they are true secondaries and arise from the lateral nerves some distance above the base. The finer nervation is the same in both.

This species resembles a number of other fossil leaves, as, for example, *Smilax grandifolia-cretacea* Lx.,<sup>3</sup> from the Dakota group of Kansas; but the resemblance is only superficial. It is perhaps much closer to *Dombeyopsis Herberti* Wat.,<sup>4</sup> which has the same shape and base, as well as the five nerves, but differs in not having the outer pair with numerous secondaries, and also in the finer nervation.

It is possible that this may be only a small leaf of *Ficus speciosissima* Ward,<sup>5</sup> which comes from the same beds. This latter species is about five times the size of *F. Wardii*, and is probably only a slight form of *F. planicostata latifolia*. It differs, however, from *F. Wardii* in being really three-nerved, although appearing five-nerved. The lowest pair of secondaries on the outside are copiously branched, but not so in *F. Wardii*.

*Habitat*.—Point of Rocks, Wyoming, north of station and midway of cliff. Collected by Lester F. Ward, September 3, 1881.

### FICUS ASARIFOLIA Ett.

Pl. XI, fig. 4; Pl. XIII, fig. 2.

*Ficus asarifolia* Ett., Foss. Fl. v. Bilin, Pt. I, p. 80, Pl. XXV, figs. 2, 3 (1867); Lesquereux, Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1872, p. 378 (1873); *ibid.*, 1874, p. 303 (1875); Bull. U. S. Geol. and Geog. Surv. Terr., Vol. I, p. 366 (1875); Tert. Fl., p. 207, Pl. LXI, figs. 18–21 (1878).

This species was first identified by Lesquereux from specimens obtained at Golden, Colorado, presumably from the tuffaceous deposits of Table Mountain, but as these specimens can not be found in the United States National Museum collections, it is impossible to be certain of this. Not one of the recent collections contains even a fragment of it, but a single example is reported by Lesquereux<sup>6</sup> in the large collection made by Rev. Arthur Lakes for the Cambridge Museum.

There is also in the United States National Museum collection from

<sup>1</sup> Tert. Fl., p. 201, Pl. XXXI, figs. 1–8, 10–12 (1878).

<sup>2</sup> *Ibid.*, Pl. XXXI, fig. 9 (1878).

<sup>3</sup> Fl. Dak. Gr., p. 40, Pl. XLVI, fig. 3 (1892).

<sup>4</sup> Pl. Foss. Paris Basin, Pl. LV, fig. 3 (1866).

<sup>5</sup> Types Lar. Fl., Pl. XXI, fig. 3 (1887).

<sup>6</sup> Bull. Mus. Comp. Zool. Cambridge, Vol. XVI, p. 50 (1888).

Black Buttes, Wyoming, a single badly preserved example that appears to belong to this species, which seems to have escaped observation until now. This leaf has the same cordate shape and areolate nervation as those from the American type locality. It has a short petiole, which seems to be attached to it. The impression of this specimen is nearly effaced from the stone, but so far as can be made out it is clearly this species. None of the other collections from Black Buttes contains specimens.

The question as to the correctness of the generic determination of this species is still an open one, as is also the question of the exact identity of the American material with the type of *F. asarifolia* from Bilin. The leaves figured by Ettingshausen (op. cit.) are nearly circular or broadly oval in outline, while ours are much broader than long, being reniform. The base is approximately the same shape in both. The Bilin specimens have a finely crenulate border, while the American specimens have from five to seven quite marked rounded lobes, especially the larger leaves. Some of the smaller leaves, spoken of by Lesquereux<sup>1</sup> as variety *minor*, are usually entire, without either lobes or crenations. The primate nervation is practically the same in the European and American specimens, although there are slight minor differences. The ultimate nervation, however, is quite different, there being in the Bilin specimens well-marked free venules within the quadrangular meshes, as in the *Drymaria*<sup>2</sup> type of ferns. These differences seem strong enough to exclude the probability of the European and American specimens being specifically identical, but for the present I have decided to retain them as established by Lesquereux.

These leaves seem to have a strong resemblance to the genus *Menispermum*, some of the larger leaves being especially like *M. canadense* of the eastern United States. This living species has the same form and lobed outline, and the same primary and finer quadrate nervation. It has the free venules, however, like the Bilin specimens, thus differing from the American, and, further, the quadrate nervation, while being much the same shape, is not raised, as in the American specimens. It may possibly represent an allied species of *Menispermum*.

It has been suggested that the American leaves resemble and are possibly related to leaves of *Bowlesia*, a small delicate umbellifer from southwestern United States, but careful examination fails to reveal more than a superficial resemblance between them. The leaves of *Bowlesia* are smaller, more markedly lobed, and with a coarser nervation, which is not at all raised, as in the Point of Rocks specimens. The leaf of *Bowlesia* is thin and delicate, while the fossil leaves under discussion were evidently thick.

*Habitat*.—Point of Rocks, Wyoming. Black Buttes, Wyoming (single obscure specimen). Golden, Colorado?

<sup>1</sup> Bull. U. S. Geol. and Geog. Surv. Terr., Vol. I, p. 367 (1875).

<sup>2</sup> Cf. Gard. and Ett., Brit. Eoc. Fl., Vol. I, p. 25 (1880).



## FICUS DALMATICA Ett.

Pl. VIII, fig. 4.

*Ficus dalmatica* Ett., Eoc. Fl. Mt. Promina, p. 29, Pl. VII, fig. 11 (1855); Lesquereux, Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1874, p. 303 (1875); Tert. Fl., p. 199, Pl. LXIII, figs. 3-5 (1878).

This European species was identified by Lesquereux with specimens from Point of Rocks, Wyoming. One of these specimens (No. 294; original of Pl. LXIII, fig. 4) is in the United States National Museum, and agrees exactly with the figures of this species in Ettingshausen's paper (loc. cit.). A single specimen is contained in Professor Ward's material from Point of Rocks.

In the recent collection from the true Laramie at the coal mine on Coal Creek, Boulder County, Colorado, I find a single leaf that is almost the exact counterpart of figs. 3 and 4 of Lesquereux's plate (op. cit.). There can be no doubt of the correctness of this determination.

*Habitat*.—Point of Rocks, Wyoming. Coal Creek, Boulder County, Colorado.

## FICUS IRREGULARIS Lx.

*Ficus irregularis* Lx., Bull. U. S. Geol. and Geog. Surv. Terr., Vol. I, p. 368 (1875); Tert. Fl., p. 196, Pl. XXXIV, figs. 4-7; Pl. LXIII, fig. 9 (1878). [Non Ward. Types Lar. Fl., p. 38, Pl. XX, fig. 4 (1887).]

*Ulmus? irregularis* Lx., Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1872, p. 378 (1873).

This species was originally described from specimens obtained at Golden, Colorado, and as the type specimens are preserved in the United States National Museum (Nos. 296, 297), it is seen that they came from the Denver formation, probably of South Table Mountain. The species is also reported by Lesquereux in numerous well-identified specimens from Point of Rocks, Wyoming, but of these specimens only a single one (No. 295a, the original of Pl. LXIII, fig. 9) is now to be found in the Museum collection. This example represents only the petiole and a small portion of the base of the leaf, but as nearly as can be made out it really belongs to this species. So far as I know, no other specimens have been obtained from Point of Rocks, although Professor Ward and others have made quite extensive collections from that place.

Lesquereux also reports this species from Black Buttes, Wyoming, but the specimen or specimens from which his determination was made can not now be found in the Museum collection, and in fact does not appear to have ever been there; and as no other specimens have been collected in that locality, the determination is more or less open to question.

The leaf referred to *Ficus irregularis* by Ward<sup>1</sup> is, with little doubt,

<sup>1</sup>Types Lar. Fl., p. 38, Pl. XX, fig. 5.

*Rhamnus goldianus* Lx.<sup>1</sup> It has a slightly heart-shaped base, with a number of short tertiaries going out from the lower side of the first pair of secondaries, exactly as Lesquereux describes for *R. goldianus*, and quite unlike typical *Ficus irregularis*. The latter has a narrowed or wedge-shaped base, with no tertiaries on the lower side of the first pair of secondaries.

*Habitat*.—Point of Rocks, Wyoming. Black Buttes, Wyoming.? Golden, Colorado.

#### FICUS TILIÆFOLIA Al. Br.

Pl. XIII, fig. 1.

This species is reported by Lesquereux from a large number of localities, including in age the Montana formation, true Laramie, Denver, and Eocene or Miocene, and it can not therefore be regarded diagnostic of any formation.

The recent collections contain a somewhat fragmentary leaf from Point of Rocks, Wyoming, which I refer with some hesitation to this species. It is very similar to a figure of *Ficus tiliæfolia* given by Heer,<sup>2</sup> except that it has slenderer intermediate secondaries and more irregular areolation. It may represent a new species, but as it is quite imperfect I have preferred to keep it under *F. tiliæfolia* rather than make it a supposed new species.

*Habitat*.—Point of Rocks, Wyoming.? Golden, Colorado. Burns's ranch, Montana.

#### FICUS PLANICOSTATA? Lx.

Pl. X, fig. 4; Pl. XII, figs. 2-4.

*Ficus planicostata* Lx., Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1872, p. 393 (1873); Tert. Fl., p. 201, Pl. XXXI, figs. 1-8, 11, 12 (1878).

The collections from various localities contain a number of specimens that are referred with more or less hesitation to this species. They differ considerably in size, yet on the whole it seems best to place them under this species, at least until more complete material can be obtained.

*Habitat*.—Coalville, Utah; collected by T. W. Stanton. Point of Rocks, Wyoming; collected by Lester F. Ward. Dunn's ranch, Wyoming; collected by Knowlton, Stanton, and Knight.

#### FICUS SPECIOSISSIMA Ward.

*Ficus speciosissima* Ward, Types Lar. Fl., p. 39, Pl. XXI, fig. 3 (1887).

*Habitat*.—Point of Rocks, Wyoming, gray sandstone bed north of station. Collected by Lester F. Ward, September, 1881.

<sup>1</sup> Tert. Fl., p. 281, Pl. LIII, figs. 4-8 (1878).

<sup>2</sup> Fl. Tert. Helv., Vol. II, Pl. LXXXIII, fig. 7 (1856).

## NELUMBO INTERMEDIA n. sp.

Pl. XIII, figs. 3-5.

*Lemna scutata* Dn., Lesquereux, Tert. Fl., p. 102, Pl. LXI, fig. 2 [non fig. 5] (1878).

Leaf thinnish, nearly circular, slightly undulate on the margin; centrally peltate, nerves about twelve or thirteen, regularly radiating, rather weak and tortuous, forking near or below the middle and again near the margin, where they form an irregular polygonal network of large areoles; finer or cross nervation not well preserved.

This species is represented in the collections by some five or six more or less fragmentary examples. They vary in diameter from about 26 mm. to 34 mm. and are almost regularly circular, with slightly undulate margins. The point at which the petiole was attached is at or very near the center, from which point the twelve or thirteen veins radiate in a regular manner. They fork near or below the middle.

Much interest attaches to this species. Fig. 5 of Pl. XIII is redrawn from Lesquereux's original specimen (No. 540, United States National Museum), which was identified with the *Lemna scutata* of Dawson in the Tertiary Flora, page 102, and figured on Pl. LXI, fig. 2. In his discussion of *Pistia corrugata* on page 104 of the same work Lesquereux says:

This [the peltate character] is remarked especially in the two specimens which I have described as representing *Lemna scutata* Daws., but which seem positively referable to this species.

And again:

It is not so easy to explain the central appearance of the pedicel or base of the leaf of fig. 2 [the one here redrawn] just in the central part of an exactly round outline, if this specimen represents a leaf of the same kind. This could be done only by supposing that the lower part of the leaf with its pedicel has been folded up, compressed, and effaced by maceration, leaving only the space marked in the upper part of the leaf as trace of its existence.

It is therefore clear that Lesquereux recognized its anomalous character, and while referring it to *Lemna scutata* he argued strongly as to its affinity with his *Pistia corrugata*. It clearly belongs to neither, but is undoubtedly a *Nelumbo*.

In seeking for affinities among fossil forms of *Nelumbo*, the *N. Dawsoni* of Hollick,<sup>1</sup> which was originally named *Brasenia antiqua* by Dawson,<sup>2</sup> but was preoccupied by the earlier *B. antiqua* of Newberry,<sup>3</sup> is immediately suggested. Dawson's species comes from the Belly River series of the Canadian Geological Survey, near Medicine Hat, British Columbia. In order to obtain Dawson's opinion as to the probable relationship

<sup>1</sup> Bull. Torr. Bot. Club, Vol. XXI, p. 309 (1894).

<sup>2</sup> Trans. Roy. Soc. Canada, Vol. III, Sec. IV, p. 15, fig. in text (1885).

<sup>3</sup> Proc. U. S. Nat. Mus. 1882, Vol. V, p. 514 (1883).

between them, the original specimen was sent to him, and his reply is as follows:

On comparing your species with *B. antiqua*, there seems no characteristic difference except in the venation. That, however, in your specimen is different not only in the fewer nerves, but in their feeble and more tortuous development. It is just possible that your leaf may be a young depauperated or bleached leaf of *B. antiqua*; but if the others are like it in their characters this would not be likely.

An examination of the material shows that the specimens all agree perfectly among themselves as to number and character of the nerves, and it is on this character alone that the species are separated. They are certainly very closely allied, and it is possible that more extensive material would show a variation sufficient to unite them.

The differences may be briefly stated as follows: *N. Dawsoni* has eighteen rather strong nerves, while *N. intermedia* has only twelve or thirteen relatively weak, tortuous nerves. Dawson has described, but not figured, another leaf under the name of *Nelumbium saskatchuense*,<sup>1</sup> which is about the same size as those under discussion, but which has only seven nerves.

The age of this last species is not stated positively, but it appears to belong to the Fort Union or the Upper Laramie of the Canadian geologists. He has described still another species (*N. pygmæum*<sup>2</sup>) from the Tertiary of the Similkameen River, British Columbia, which is not widely different.

This genus appears to have been introduced in North America in the lower part of the Upper Cretaceous and to have continued until the present time. Following is a list of the North American species with the horizon of each:

*Nelumbium arcticum* Heer, Atane beds, Greenland.

*Nelumbo Dawsoni* Hollick, Belly River series.

*Nelumbo intermedia* n. sp., Montana formation, Point of Rocks, Wyoming.

*Nelumbo laramiensis* Hollick, Laramie formation, Florence, Colorado.

*Nelumbium tennifolium* Lx., Laramie formation, Sand Creek, Colorado.

*Nelumbium Lakesianum* Lx., Denver group, Golden and Sedalia, Colorado.

*Nelumbium saskatchuense* Dn., Canadian Upper Laramie?, Saskatchewan.

*Nelumbium pygmæum* Dn., Miocene, Similkameen River.

*Habitat*.—Point of Rocks, Wyoming. Original Hayden collection, and also found by Lester F. Ward in 1882.

NELUMBO? sp.

Pl. XIII, fig. 6.

*Castalia* sp. Kn., Stanton and Knowlton, Bull. Geol. Soc. Am., Vol. VIII, p. 140 (1897).

Leaf nearly circular in outline; peltate but not quite centrally so; ribs radiating, apparently numerous, and forking.

The fragment figured is the only one of this form obtained. It appears

<sup>1</sup> Trans. Roy. Soc. Canada, Vol. V, Sec. IV, p. 35 (1887).

<sup>2</sup> Ibid., Vol. VIII, Sec. IV, p. 87, fig. 22 (1890).

to have been approximately circular in outline, being about 17 mm. in diameter. It is peltate, but not quite centrally so, and appears to have had numerous radiating ribs, which apparently forked near the middle. They are so faintly preserved that it is quite impossible to count them. The finer nervation can not be made out.

This little leaf belongs without much doubt to *Nelumbo*, but it is so poorly preserved that I have hesitated to give it a specific name. It is smaller and seems to have had a greater number of ribs than *N. intermedia*, but this is obscure. They may possibly be the same.

*Habitat*.—Point of Rocks, Wyoming.

### CASTALIA? DUTTONIANA n. sp.

Pl. XIII, fig. 7.

*Castalia* n. sp. Kn., Bull. Geol. Soc. Am., Vol. VIII, p. 140 (1897).

Leaf of firm texture, nearly circular in outline, slightly heart-shaped at base, rounded above; midrib thin, irregular, flexuous, with several forks or branches above; secondaries palmate, about three pairs on each side, of equal strength, arising at the apex of the petiole, two or three times forked, the ultimate branches uniting to form irregularly polygonal meshes or areas of various sizes, the outer series or row apparently entering the margin; finer nervation obscure, but apparently reticulated.

Besides the leaf figured, with its counterpart, there is only one other fragment that can be referred to this form. The leaf is nearly circular, being about 4.75 cm. in length and 5 cm. in width. It is very obtuse and rounded at the apex, and is slightly but plainly heart-shaped at the base. The margin is perfectly entire. The petiole is long and slender.

*Habitat*.—Near old stage road on north fork of Dutton Creek, between Rock and Cooper creeks, Wyoming. Collected by Knowlton, Knight, and Stanton, July, 1896.

### MAGNOLIA TENUINERVIS Lx.

Pl. XIV, fig. 1.

*Magnolia tenuinervis* Lx., Am. Jour. Sci., 2d ser., Vol. XLV, p. 207 (1868); Ann. Rept. U. S. Geol. and Geog. Surv. Terr. 1869, p. 96 (1869) [Reprint 1873, p. 196]; *ibid.*, 1870, p. 383 (1872); *ibid.*, 1876, p. 518 (1878); Tert. Fl., p. 249, Pl. XLIV, figs. 5, 6; Pl. XLV, figs. 1-5 (1878); Cret. and Tert. Fl., p. 124, Pl. XIX, fig. 6 (1884); Bull. Mus. Comp. Zool., Vol. XVI, p. 53 (1888).  
*Magnolia Inglefeldi* Heer, Lesquereux, Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1872, p. 196 (1873).

All but two of the type specimens of this species as figured in the Tertiary Flora are preserved in the United States National Museum; but there appears to have been some confusion as to the localities from which some of them came. Thus, the original of fig. 3 (Tert. Fl., Pl. XLV) is recorded in the Museum catalogue as coming from Golden,

Colorado, but the matrix proves beyond doubt that it came from Black Buttes, Wyoming. The same is the case with another duplicate specimen of this species (No. 366).

The original of fig. 2 (loc. cit.) is undoubtedly from Golden, Colorado, and that of fig. 5 from Hodges Pass, Wyoming, although this latter locality has been erased from the Museum catalogue. The originals of figs. 1 and 4 can not be found, nor can that of fig. 6, Pl. XIX, in the Cretaceous and Tertiary Flora, which is said to be in the National Museum.

This species is also represented in the collection of leaves obtained by Mr. T. W. Stanton at Coalville, Utah. This determination rests upon the single specimen here figured. It is a very perfect leaf, more perfect in fact than any heretofore referred to this species. It is regularly and broadly ovate in shape, rounded abruptly to a slightly wedge-shaped base, and tapering above into a rather acute apex. The midrib is very thick and prominent, and the whole leaf evidently coriaceous and thick. The secondaries are alternate, parallel, and curve along the borders in simple bows. They do not appear to be branched as described for *M. tenuinervis*, and on this account may possibly represent another species.

This Coalville leaf is undoubtedly very similar to fig. 5 of Pl. XLV of the Tertiary Flora, which is said to have come from Bridger Pass, Wyoming. The secondaries can not all be made out, but none appear to branch as shown in the leaf from Bridger Pass. The Coalville specimen is also suggestive of *M. pseudoacuminata* Lx., from the Dakota group of Kansas.<sup>1</sup> The outline and apparent thickness of midrib are the same, yet the Dakota leaf has the secondaries at a more open angle, and they are often forked in the upper portion. *M. pseudoacuminata* is undoubtedly related to *M. tenuinervis*, Tertiary Flora, Pl. XLV, fig. 5, and intermediate in some particulars stands the leaf from Coalville. It is altogether likely that this may represent a case of direct descent. If this supposition be correct, our knowledge of the development may stand as follows:

*Magnolia pseudoacuminata* Lx., Dakota group.

*M. tenuinervis*? Lx., Montana formation.

*M. tenuinervis* Lx., Laramie and Denver groups.

*M. Inglefeldi* Heer, Tertiary.

*M. acuminata* L., living.

This species is apparently rare at Golden, Colorado, for so far as known only three specimens, including one of the figured types, have been found there. Only one appears to have come from Bridger Pass, Wyoming, while the most abundant distribution is at Black Buttes, Wyoming.

*Habitat*.—Coalville, Utah. Black Buttes and Hodges Pass, Wyoming. Golden, Colorado (Denver beds).

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<sup>1</sup>Fl. Dak. Gr., p. 199, Pl. XXIV, fig. 2 (1891).

## MAGNOLIA PULCHRA Ward.

*Magnolia pulchra* Ward, Syn. Fl. Lar. Gr., p. 556, Pl. LX, figs. 2, 3 (1886); Types Lar. Fl., p. 103, Pl. XLVIII, figs. 3, 4 (1887).

*Habitat*.—Point of Rocks, Wyoming.

## LIRIODENDRON LARAMIENSE Ward.

*Liriodendron laramiense* Ward, Syn. Fl. Lar. Gr., p. 556, Pl. LX, fig. 1 (1886); Types Lar. Fl., p. 102, Pl. XLVIII, fig. 2 (1887).

The specimen figured is the only one thus far obtained. It lacks the upper portion of the leaf, but the portion preserved has the nervation of *Liriodendron*, and it is therefore reasonably safe to consider it as belonging to this genus.

*Habitat*.—Point of Rocks, Wyoming, gray sandstone cliff north of station. Collected by Lester F. Ward, September, 1881.

## ASIMINA EOCENICA? Lx.

Pl. XIV, fig. 3.

*Asimina eocenica* Lx., Tert. Fl., p. 251, Pl. XLIII, figs. 5-8 (1878); Stanton and Knowlton, Bull. Geol. Soc. Am., Vol. VIII, p. 140, 1897.

The collection contains a single specimen that with little doubt belongs to this species. It has, as may be seen, the same shape, the same very thick petiole and midrib diminishing in size above, and approximately the same nervation. The secondaries are at a little more acute angle of divergence, and perhaps pass up along the margin for a greater distance; the difference is slight, and I have placed it under this species. The finer nervation is not retained.

*Habitat*.—Coal mine on north fork of Dutton Creek, near old stage road, Laramie Plains, Wyoming. Collected by Knowlton, Stanton, and Knight, July 28, 1896. The species has also been found in the Denver beds at Golden, Colorado, and at Black Buttes, Wyoming.

## MALAPOENNA MACROPHYILLOIDES n. sp.

Pl. XIV, figs. 4, 5.

Leaf large, firm in texture, oblong in outline, entire, slightly inequilateral at base; petiole short, thick; midrib thick in the lower part, becoming thinner above; secondaries about eight pairs, opposite or rarely alternate; intermediate secondaries thin, extending half the distance to the margin; lower secondaries at an acute angle, those in the upper part of the leaf at a broader, all camptodrome, arching in a series of large regular bows, from the outside of which proceed frequently a series of smaller bows nearly or quite filling the space between the secondaries and the margin; nervilles broken, producing a very peculiar irregularly rectangular areolation.

This species is based on the two specimens figured. These are undoubtedly the same species, and they are well characterized by the peculiar irregular quadrangular areolation, as well as by the peculiar manner of the looping of the secondaries.

Not one of these leaves is preserved entire. The best-preserved, fig. 5, must have been fully 10 cm. long and 4 cm. broad. The upper portion of this leaf is almost all preserved; it is rather abruptly acuminate. The other leaf, fig. 4, has only about 5 cm. in length of the basal portion preserved. It has a thick petiole nearly 1 cm. long, and shows the base to be slightly inequilateral. The midrib is also quite thick, but its most marked character is the peculiar looping of the secondaries.

This species is so strikingly similar in outline and nervation to *Litsea macrophylla* as figured by Ettingshausen<sup>1</sup> that I can but regard them as related. The living leaf has the same thick petiole, the secondaries alternate below and at an acute angle. The peculiar looping of the secondaries may also be observed in the living leaf.

There are also a number of well-known fossil leaves of various genera to which their species has more or less resemblance. For example, it resembles in one or more important particulars *Magnolia Inglefeldi* Heer,<sup>2</sup> *M. primigenia* Heer,<sup>3</sup> *M. tenuinervis* Lx.,<sup>4</sup> etc. It has also been likened to *Ficus*, but as it seems closer to the above mentioned *Litsea*, I have preferred to place it in this genus.

*Habitat*.—Point of Rocks, Wyoming, north of station and midway of cliff. Collected by Lester F. Ward, September 3, 1881.

#### LAURUS PRIMIGENIA Ung.

*Laurus primigenia* Ung.: Lesquereux, Tert. Fl., p. 214, Pl. XXXVI, figs. 5, 6, 8; Ward, Syn. Fl. Lar. Gr., p. 553, Pl. XLVI, figs. 8-10; Types Lar. Fl., p. 48, Pl. XXIII, figs. 8-10.

The specimens referred to this species from the type locality for *L. socialis* can not now be found in the National Museum collections, if they have ever been there. They differ very slightly from that species, being "more narrowly lanceolate, more distinctly acuminate, and narrowly cuneate," characters which are of little weight. The nervation and areolation are said by Lesquereux to be of the same character.

This species is reported by Lesquereux<sup>5</sup> from the Denver beds of Golden, Colorado, and by Professor Ward<sup>6</sup> from Carbon and Point of Rocks, Wyoming. The specimen from Golden I have not seen, nor have I been able to detect the species among the recent material from there. The example from Carbon is of the same shape as many leaves

<sup>1</sup> Blatt-Skeltete, d. Dikotyledonen, Pl. XIII, fig. 2 (1861).

<sup>2</sup> Fl. Foss. Arct., Vol. II, Abth. IV, Pl. LI, figs. 4-7.

<sup>3</sup> Ibid., Vol. VII, Pl. LXXXVI, fig. 8.

<sup>4</sup> Tert. Fl., p. 249, Pl. LIV, fig. 2.

<sup>5</sup> Bull. Mus. Comp. Zool., Vol. XVI, p. 50.

<sup>6</sup> Types Lar. Fl., p. 47, Pl. XXIII, figs. 8-10.



referred to *L. primigenia*, and has much the same nervation. It appears to have been correctly determined. Of the two fragments from Point of Rocks, probably only one (the original of fig. 10) can be correctly referred to this species. With Ettingshausen,<sup>1</sup> I must regard fig. 9 as more like *L. ocoteæfolia* Ett., and quite unlike typical forms of *L. primigenia*.

*Habitat*.—Point of Rocks and Carbon, Wyoming. Golden, Colorado. Evanston, Wyoming.

#### LAURUS PRÆSTANS Lx.

Pl. XVI, fig. 2.

*Laurus præstans* Lx., Bull. U. S. Geol. and Geog. Surv. Terr., Vol. I, p. 368 (1875); Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1874, p. 305 (1875); *ibid.*, 1876, p. 510 (1878); Tert. Fl., p. 215, Pl. LXIII, fig. 7 (1878).

The type specimen of this species is preserved in the United States National Museum (No. 311). It represents a large, finely preserved leaf that is broadly elliptical-lanceolate in shape, being narrowed in about the same degree upward to a sharp-pointed, slightly scythe-shaped apex, and downward to the prominent petiole. The midrib is very thick, and the strong, equidistant parallel secondaries emerge at an angle of about 40°.

This leaf is very suggestive generically of *Ficus*, yet, as Lesquereux has pointed out, it is evidently quite closely connected with various Lauraceæ, as *Persea speciosa* Heer, *Laurus princeps* Heer, *Laurus Canariensis* Web., etc.

I have referred to this species the single small specimen obtained by Professor Ward at Point of Rocks, which, although fragmentary, seems to belong to it.

*Habitat*.—Point of Rocks, Wyoming.

#### CINNAMOMUM AFFINE Lx. emend.

Pl. XIV, fig. 2.

*Cinnamomum affine* Lx., Tert. Fl., p. 219, Pl. XXXVII, figs. 1-4 [non fig. 5], 7 (1878).

The discussion of much that relates to the early history of this species has been given under *Ficus trinervis*, page 42. It was there shown that two species appeared to have been confused under the name of *C. affine*, and an attempt was made to remove the forms showing so marked differences from the type.

The original locality whence came what may be called typical *C. affine* (Tert. Fl., Pl. XXXVII, figs. 1-4) is unknown, as is also the location of the type specimens. The Princeton Museum contains a slab bearing several finely preserved leaves, which has a label attached reading as follows: "La. South Park, Col." The matrix is a hard white sandstone unlike anything with which I am familiar from South Park, but quite

<sup>1</sup> Ward: Types Lar. Fl., p. 48.

like certain material from the true Laramie of the vicinity of Golden, Colorado. Moreover, Lesquereux, in speaking of this species in the Tertiary Flora (p. 220), says:

Golden, Colorado, where the fine large specimen was discovered and communicated by Capt. E. Berthoud. A specimen, also, with a number of leaves of the same character, has been lately sent by Rev. A. Lakes.

The "La." of the Princeton slab obviously stands for "Lakes," but the remainder of it is quite unintelligible. The single example from Golden is in a hard sandstone, but whether this and the Princeton specimen are from the same locality can never be known, and therefore new lines must be adopted for it.

In no authenticated instance has this species been reported from a younger horizon than the true Laramie, except when what was called *C. mississippiense* has been united to it. The type specimens of this latter species are in the museum of the State University at Oxford, Mississippi, and not a single example has become the property of the National Museum. Lesquereux appears to have been inclined to put these two forms together, but in absence of material for comparison I have hesitated to do so. Judging from the figures of the two species they are close, if not actually identical.

The collection made by Mr. Stanton at Coalville, Utah, contains numerous finely preserved examples of *C. affine*, of the types shown in figs. 1-4 op. cit. They are entirely different from the form separated under the name of *Ficus*.

*Habitat*.—Coalville, Utah.

#### CINNAMOMUM ? STANTONI n. sp.

Pl. XV, fig. 1.

Leaf elongated, elliptical in outline, narrowed from about the middle of the leaf to a wedge-shaped base and in the same manner above to an acuminate apex; petiole short, rather slender; midrib thick below, becoming slender above, straight; secondaries, four pairs, the lowest pair strongest, opposite, arising high above the base at an angle of about  $45^{\circ}$ , camptodrome, running well inside the margin for one-third the length of the blade and joining the secondaries next above; upper secondaries thin, alternate, also arching inside the margin and joining; finer nervation not preserved.

The leaf figured is the only one observed. It is absolutely perfect so far as outline goes, being 5.5 cm. in length, including the petiole, which is about 3 mm. long and 2.5 cm. in width. It is elliptical in shape and about equally narrowed below to the rather long, wedge-shaped base and above to the acuminate apex.

This leaf is associated with large numbers of very perfectly preserved leaves of *Cinnamomum affine*, but clearly differs from them in shape and nervation.

Among fossil species a number may be mentioned that have more or less resemblance to the one under consideration. Thus *Cinnamomum polymorphum* Heer<sup>1</sup> may be mentioned. This species has much the same shape as the Coalville example, but differs in having the lower pair of secondaries at a sharper angle. They branch on the outside, and also ascend higher toward the point of the blade. Perhaps the closest species is *C. ellipsoideum* Sap. and Mar., as figured by Lesquereux<sup>2</sup> from the Dakota group of Fort Harker, Kansas. This leaf is very much like *C. Stantonii*, being, however, more nearly ovate in outline, with a thicker, much larger petiole, and with the lower pair of secondaries nearer the base of the blade and passing up for a longer distance. It is certainly very suggestive of the Montana species.

The species is named in honor of the collector of the specimen, Mr. T. W. Stanton.

*Habitat*.—Coalville, Utah.

#### RHUS MEMBRANACEA Lx.

*Rhus membranacea* Lx., Bull. U. S. Geol. and Geog. Surv. Terr., Vol. I, p. 369 (1875); Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1874, p. 306 (1876); *ibid.*, 1876 (1878), p. 518; Tert. Fl., p. 292, Pl. LXIV, figs. 6, 7 (1878).

The only specimens ever obtained of this species are the two figured in the Tertiary Flora, both of which are preserved in the United States National Museum (Nos. 530, 531). They were well described and their affinities pointed out by Lesquereux, to which there is nothing to add.

*Habitat*.—Point of Rocks, Wyoming.

#### GREWIOPSIS CLEBURNI Lx.

*Grewiopsis Cleburni* Lx., Bull. U. S. Geol. and Geog. Surv. Terr., Vol. I, p. 380 (1875); Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1874, p. 306 (1876); *ibid.*, 1876, p. 514 (1878); Tert. Fl., p. 259, Pl. LXII, fig. 12 (1878).

The type of this species is not now, and according to the records has never been, the property of the United States National Museum. It appears to have been carefully described and figured, and as no additional material has been obtained from the type locality, its present status must remain.

*Habitat*.—Point of Rocks, Wyoming.

#### MENISPERMITES KNIGHTII n. sp.

Pl. XV, fig. 2.

Leaf evidently thick in texture, broadly cordate, with rounded base and very deep sinuses, rounded, truncate at apex; margin undulate lobed, the lobes very short, obtuse, and entire or erose; nervation palmate, with about seven primary nerves of equal strength which appar-

<sup>1</sup> Fl. Tert. Helv., Vol. II, Pl. XCIV, figs. 1-26 (1856).

<sup>2</sup> Fl. Dak. Gr., p. 105, Pl. LI, fig. 8 (1892).

ently pass to the rounded lobes or are once or twice forked, the branches passing to the lobes; finer nervation not preserved.

This fine leaf was the only dicotyledon found in these beds after much search. It is much broader than long, being 6.5 cm. broad and about 4 cm. long. The base is regularly rounded to a very deep, sharp sinus, appearing almost peltate. The apex is very obtuse, even truncate. The margin has about six or seven broad, short, obtuse, entire or erose lobes, separated by very shallow sinuses. The palmate nervation apparently passes directly, or once forking, to the lobes. The nervation is very obscure and none of the finer details can be made out.

It is with some hesitation that this leaf is referred to the genus *Menispermites*, but it appears to resemble that genus more closely than any other with which I am familiar. It is, for example, in general appearance not greatly unlike *M. grandis* Lx.,<sup>1</sup> from the Dakota group of Kansas. This latter species differs, however, in being more rounded and distinctly peltate. The nervation is quite similar.

I take pleasure in naming this species in honor of Prof. W. C. Knight, of the University of Wyoming, who indicated the locality at which the specimen was found and assisted in making the collection.

*Habitat*.—Near Harpers Station, on the Union Pacific Railroad, Wyoming.

#### TRAPA ? MICROPHYLLA Lx.

Pl. V, fig. 7.

*Trapa ? microphylla* Lx., Bull. U. S. Geol. and Geog. Surv. Terr., Vol. I, p. 369 (1875); Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1874, p. 304 (1876); *ibid.*, 1876, p. 518 (1878); Tert. Fl., p. 295, Pl. LXI, figs. 16, 17, 17a; Newberry, Trans. N. Y. Acad. Sci., Vol. IX, p. 30 (1889); Bull. Geol. Soc. Am., Vol. I, p. 525 (1890); Dawson, Trans. Roy. Soc. Canada, 1886, p. 31 (1886).

? *Neuropteris angulata* Newb., Rept. Colorado Exploring Exped., under Lieut. J. C. Ives, p. 131, Pl. III, fig. 5 (1861).

Only one of the figured specimens, the original of fig. 17 of Pl. LXI, Tertiary Flora, is now found in the collection of the United States National Museum. The other figured type has never been there, and inasmuch as Lesquereux speaks of having seen specimens belonging to Mr. William Cleburn, it is more than probable that it was in his collection, the whereabouts of which is unknown. A number of fairly good specimens were obtained by Professor Ward at the type locality.

The original specimens came from Point of Rocks, Wyoming. After describing them carefully, Lesquereux writes (Tert. Fl., p. 295) as follows:

These leaves, represented in numerous specimens, vary in size from a little more than one centimeter long, and nearly as large, to about two and a half centimeters long and nearly two broad. They are generally oval, very obtuse and somewhat enlarged upward; the borders are minutely dentate, except at or near the base, rounded to a comparatively long and slender petiole, the only one of the leaves

<sup>1</sup> Cret. and Tert. Fl., p. 80, Pl. XV, figs. 1, 2.

where it is preserved, not even to its base, being eighteen millimeters long and the petiole nine millimeters. The areolation is clearly defined in very small square or polygonal meshes, formed by close, thick nervilles anastomosing with veinlets parallel to the nerves and their divisions, the parietes being as thick as the veins. The same kind of nervation is observable upon the lower surface of the leaves of the living *Trapa natans* L., which, though comparable to these fossil ones, have the borders deeply toothed and are of much thicker texture. In this species the leaves appear as membranaceous and pellucid, for the nervation and areolation seem drawn in black on the yellowish substratum of the laminae.

On comparing the fossil leaves with the living *T. natans* many points of resemblance are found. They have apparently the same habit, and, with certain limitations, the nervation is quite similar. Strong confirmatory evidence is supplied by the fact that this plant is always associated with undoubted aquatic plants, such as *Lemna*, *Pistia*, *Equisetum*, etc., and in Canada Sir William Dawson has found the leaves associated in the same beds with fruits of *Trapa*. He speaks of them as follows:<sup>1</sup>

These fruits and leaves are all from the Lower Laramie, with the exception of one doubtful example from the Upper Laramie of Great Valley. The localities are Bad Lands, Red Deer and Rosebud rivers, and Pincher Creek. In some of these localities they are associated with *Lemna scutata* and *Phragmites*.

The leaves seem to be very variable in form and dimensions, and in Mr. Tyrrell's collection there are fragments of much larger leaves than any figured by Lesquereux.

In another place he says:

In Mr. Tyrrell's collections from Red Deer and Rosebud rivers there are fruits similar to Heer's species (*Trapa borealis*) and leaves not distinguishable from those described and figured by Lesquereux. We have thus a probability that the fruits and leaves belong to the same species.

From the above statement it appears that this species has been found in Wyoming and in various Canadian localities under practically similar conditions—that is, associated with aquatic plants and, in one, with fruits of *Trapa*. The presumption of their identity is thus strengthened, and also their reference to the genus *Trapa*.

During the season of 1896 large numbers of leaves in a very perfect state of preservation were found by Mr. T. W. Stanton and myself in Converse County, Wyoming, in clay beds in the lower portions of the true Laramie.

In 1883 Professor Ward obtained at Burns's ranch, on the Lower Yellowstone River, Montana, a large number of finely preserved leaves which he referred to Lesquereux's *Trapa? microphylla*.<sup>2</sup> In describing them he said:

The size, shape, and nervation of these leaves are substantially identical with those of Point of Rocks, and until fruit is found for both it will be necessary to regard them as the same species.

I have examined all of Professor Ward's material and have reached results somewhat opposed to this determination. The size and shape

<sup>1</sup>Foss. Fl. of Lar. Form. of Canada, Trans. Roy. Soc. Canada, Vol. IV, p. 31. (1886).

<sup>2</sup>Types Lar. Fl., p. 64, Pl. XXVIII, figs. 2-5 (1887).

are, as he has pointed out, in agreement with the Point of Rocks specimens, but in nervation there are quite important differences. In the Point of Rocks specimens the finer nervation consists of fine quadrangular areolations, whereas the Montana specimens have a more open nervation with no evidence of the quadrangular arrangement. But the most important point of difference is in the leaf character of the Montana examples, which precludes absolutely their reference to the genus *Trapa*—that is, the leaves are compound, being trifoliolate, while the original specimens from Point of Rocks are simple so far as now known. It is of course possible that these latter examples represent detached leaflets, but against this supposition we have the fact that among numerous specimens, both from Point of Rocks and from the Canadian localities, not one has been found that showed any indication of being compound. On the other hand, few detached leaflets are found in the Montana material, most of them indicating in one way or another the fact that they are compound.

In the living *Trapa* the leaves are arranged in the form of a rosette, similar in appearance to what must have been the habit of the Montana specimens, but in no case are they compound. The Montana specimens are not only trifoliolate, but are compound in a very peculiar manner. The normal or typical form appears to consist simply of three similar leaflets, but in some exceptional instances both lateral leaflets have been again divided into two perfect leaflets, thus possessing five leaflets but still retaining the trifoliolate character. This is incompatible with *Trapa*, and it would seem that Professor Ward's specimens from Montana must receive a new name. Just what their affinities are is difficult to say.

Since the above was written a number of specimens referable to the Montana form have been obtained in Wolverine Creek, in the Yellowstone National Park. They formed the characteristic rosette, and thus differ from the true *Trapa* ? *microphylla*.

*Habitat*.—Point of Rocks, Wyoming. Bad Lands, Red Deer and Rosebud rivers, and Pincher Creek, Canada. Lance Creek, Converse County, Wyoming, base of "Ceratops beds."

#### TRAPA? CUNEATA n. sp.

Pl. V, fig. 6.

Leaf obovate-cuneate, regularly rounded above, wedge-shaped below; margin entire for lower two-thirds of leaf, coarsely crenate-toothed at apex; midrib slender, somewhat flexuose, with several very slender, flexuose, often forking, branches; finer nervation, consisting of very numerous small quadrangular areolæ.

This form is represented only by the example figured. It is obovate-cuneate in outline, being 2 cm. in length and a little more than 1 cm. in width at the broadest point, which is far above the middle of the

blade, from which point it is regularly wedge-shaped to the apparently sessile base. The nervation consists of a thin, somewhat flexuose midrib, which has some three or four very thin, often forking, branches, a copious fine nervation of minute quadrangular areolæ.

It is with some hesitation that I venture to describe this as a new species, but it appears to differ in essential characters from the well-known *T. ? microphylla*. The latter is always rounded to the truncate base, and has very minute denticulations above. The one under consideration is strongly wedge-shaped at base and has large obtuse or very obtusely pointed teeth. I have seen nothing intermediate between these two forms, and have therefore described it as new. It is obviously very closely related to *T. ? microphylla*, particularly in the finer nervation.

*Habitat*.—Point of Rocks, Wyoming.

#### PODOGONIUM AMERICANUM LX.

*Podogonium americanum* Lx., Tert. Fl., p. 298, Pl. LIX, fig. 5; Pl. LXIII, fig. 2; Pl. LXV, fig. 6 (1878); Cret. and Tert. Fl., p. 202 (1884); Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1876, p. 519 (1878).

*Podogonium* sp. Lx., Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1873, p. 417 (1874).

Two of the type specimens of this species as figured by Lesquereux are preserved in the United States National Museum (No. 485, original of Pl. LIX, fig. 5, and No. 581, original of Pl. LXIII, fig. 2). The original of Pl. LXV, fig. 6, is not and, so far as the records show, has never been in the Museum collection.

The first of the above-mentioned specimens (No. 485) is said to have come from Black Buttes, Wyoming, and is so recorded in the Museum register. As it is preserved on the hard, red, baked shale well known to be characteristic of a certain horizon at this locality, this statement is undoubtedly correct. The other example (No. 581) is recorded in the Tertiary Flora (p. 299) as having come from Middle Park, Colorado, while in the Museum register it is recorded as coming from Point of Rocks, Wyoming. A glance at the matrix is sufficient to show that it could not have come from any recognized locality in Middle Park, while on the other hand it is similar to material from Point of Rocks. The surmise that it must have come from Point of Rocks is still further strengthened by the fact that preserved on the same stone with it is one of the figured specimens of *Ficus dalmatica* Ett., a species that is only recorded by Lesquereux<sup>1</sup> from Point of Rocks. It is, therefore, without doubt safe to assume that it came from this locality and not from Middle Park.

As already stated, the other figured specimen can not now be found, and it is altogether probable, judging from the figure, that it does not belong to this species. It has, it is true, the same shape, but appears to have been a thicker leaf with a quite different nervation. It has

<sup>1</sup> Tert. Fl., p. 199 (1878).

more resemblance to certain leaves of *Eucalyptus* than to the genus *Podogonium*. It is proper, however, to dismiss it from present consideration.

In the Cretaceous and Tertiary Floras (p. 202) this species, from all the localities recorded in the Tertiary Flora, is referred to the Green River group, seemingly on the statement that they had come from Middle Park, White River, etc. No additional information is given on this point, and it may safely be set down as an error.

In the Annual Report of the United States Geological and Geographical Survey of the Territories for 1873 (p. 417), Lesquereux described a fruit and a leaflet from Middle Park and Florissant, Colorado. The first was not figured and is now lost, and the leaf referred to is probably one of those before mentioned.

*Habitat*.—Point of Rocks and Black Buttes, Wyoming.

PTEROSPERMITES WARDII n. sp.

Pl. XV, fig. 4; Pl. XVI, fig. 1.

Leaf oblong-oval, rounded at base, abruptly acuminate at apex, margin serrate above the base, teeth numerous, sharp or obtuse, pointing upward; petiole long; midrib flexuose or nearly straight; secondaries alternate, six to eight pairs, at an angle of  $40^{\circ}$  or  $45^{\circ}$ , camptodrome, each joining the one next above by a series of small loops, from the outside of which slender branches enter the teeth; at the base there is frequently a slender nerve starting below the lowest pair of secondaries, follow the margin in a series of short loops, and ultimately join the lowest pair of secondaries; nervilles prominent, mostly percurrent and at right angles to the secondaries; finer nervation not preserved.

These leaves vary in length from 8.5 cm. and in width from 4.5 cm. to nearly 6 cm. The longest petiole is 3.5 cm. They appear to have been serrate only at some distance above the base, which is regularly rounded. The secondaries are all camptodrome, joining by arches from the outside of which short branches enter the teeth.

The leaves referred to this species are somewhat anomalous, and it is with much uncertainty that they are referred to this genus. They have some resemblance to *Pterospermities minor* Ward<sup>1</sup> from the Fort Union group near the mouth of the Yellowstone River. This is excluded, however, by the heart-shaped base and coarser teeth.

Certain of these leaves have some resemblance to *Cratægus antiqua* Heer<sup>2</sup> and also to *Euonymus Proserpineæ* Engelhardt,<sup>3</sup> but the resemblance is only superficial.

*Habitat*.—Point of Rocks, Wyoming (north of station and midway of cliff), and Black Buttes, Wyoming. Collected by Lester F. Ward, September, 1881.

<sup>1</sup> Types Lar. Fl., Pl. XLII, figs 1-3.

<sup>2</sup> Fl. Foss. Arct., Vol. VI, Abth. II, Pl. VI, fig. 11.

<sup>3</sup> Fl. Braunkohlen Tertiärsch. v. Dux., Nova Acta Kaisl. Leop. Caro. Deutsch. Akad. d. Naturf., Vol. LVII, No. 3, Pl. XLIV, fig. 4 (1891).



## PTEROSPERMITES UNDULATUS n. sp.

Pl. XVI, fig. 3; Pl. XVII, fig. 2; Pl. XVIII, fig. 4.

Leaf large, oblong-oval, wedge-shaped at base, margin undulate; midrib thick, straight, or slightly flexuose; secondaries seven or eight pairs, opposite (or alternate in middle of leaf), at an angle of  $50^{\circ}$ , camptodrome; lowest pair of secondaries with about seven camptodrome branches on the outside; upper secondaries sometimes branching; nervilles strong, at right angles to the secondaries, often forking.

Neither of the three leaves referred to this species is perfect. The larger one, which represents the upper portion of a leaf, is 8 cm. broad and has 11 cm. in length preserved. The smaller and more perfect one (fig. 3, Pl. XVI) is nearly 6 cm. broad and must have been 12 or 13 cm. long. In fig. 2 the secondaries above the lowest pair are branched. Both have the undulate margin and similar nervation.

This species differs from the preceding, *P. Wardii*, in being much larger, in having an undulate instead of a serrate margin, a wedge-shaped instead of a rounded base, and the lowest pair of secondaries with numerous branches on the outside.

*Habitat*.—Point of Rocks, Wyoming, north of station and midway of cliff. Collected by Lester F. Ward, September, 1881.

## CORNUS RHAMNIFOLIA O. Web.

*Cornus rhamnifolia* O. Web.: Lesquereux, Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1871, Suppl., p. 9 (1872); *ibid.*, 1873, p. 387 (1874); *ibid.*, 1876, p. 513 (1878); Tert. Fl., p. 244, Pl. XLII, fig. 6; McBride, Pop. Sci. Mo., Vol. XXIII, p. 641, fig. 12 (1883).

This common European Miocene species is represented in American strata by a small number of more or less imperfect leaves. The specimen figured by Lesquereux in the Tertiary Flora is preserved in the United States National Museum (No. 357), together with a single additional specimen from the Bozeman (Montana) coal field. The type specimen is recorded as having come from Camp Station, near Point of Rocks, Wyoming, but judging from the matrix the specimen seems much more likely to have come from Evanston. This matrix is unfamiliar from any Point of Rocks locality, yet in absence of further proof it must remain, nominally at least, a Point of Rocks species.

The specimen from the Bozeman coal field (No. 933) is in the hard whitish sandstone of the true Laramie beds. It is similar to a number of doubtful specimens obtained in recent years at the mouth of Fir Canyon, 3 miles southeast of Bozeman, Montana.

The specimens referred to this species by McBride (*loc. cit.*), from the Bad Lands of the Little Missouri, are doubtful. The exact locality is not stated, although it is probably in Fort Union strata. The upper portion of the leaf figured is destroyed, and it is not possible to be certain that it is a *Cornus*.

It is extremely doubtful if this is the true *Cornus rhamnifolia*. The European leaves differ in size, also slightly in nervation, and, moreover, it is doubtful if much value should be attached to the identification of specimens so widely separated geographically and geologically as are these.

*Habitat*.—Point of Rocks, Wyoming.? Fir Canyon, near Bozeman, Montana.

#### CORNUS IMPRESSA Lx.

*Cornus impressa* Lx., Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1873, pp. 385, 408 (1874); *ibid.*, 1876, p. 513 (1878); Tert. Fl., p. 243, Pl. XLII, fig. 3 (1878).

*Cornus Emmonsii* Ward, Syn. Fl. Lar. Gr., p. 553, Pl. XLVIII, figs. 2, 3 (1886); Types Lar. Fl., p. 55, Pl. XXVI, figs. 2, 3 (1887).

Leaves coriaceous, oblong-oval, entire, rounded to a very short, scarcely distinct acumen, regularly rounded to a short petiole; nervation pinnate, camptodrome, and acrodrome.

The original type of this fine species is preserved in the United States National Museum (No. 354). It came from Mount Bross, Middle Park, Colorado, and is the only example yet obtained from that locality. The figure given of it by Lesquereux (*loc. cit.*) is good, except that the lower left-hand side is really preserved, and has a faint marginal vein.

The *Cornus Emmonsii* of Ward rests upon two specimens, both of which are again figured on Pl. XXVI of his work. The first of these, fig. 2, is from North Denver, Colorado, in a ravine in front of St. Luke's Hospital,<sup>1</sup> and the other, fig. 3, is from one of the upper beds at Point of Rocks, Wyoming. At first sight, these two leaves appear to differ from the type specimen, but a careful study shows that they do not differ from it essentially. The larger one, fig. 3, has the two lower pairs of secondaries springing from near the base of the leaf, but they arch in the same manner as in the type specimen. In the other smaller leaf from Denver, the lower pair of secondaries branch on the lower side, forming a series of short bows. Both of these characters are observable in living species of *Cornus*.

The near affinities of *C. impressa* are undoubtedly with *C. orbifera* Heer,<sup>2</sup> as Lesquereux long ago pointed out.

*Habitat*.—Mount Bross, Middle Park. and North Denver, Colorado. Point of Rocks, Wyoming.

#### CORNUS STUDERI? Heer.

Pl. XV, fig. 3.

*Cornus Studeri* Heer, Lesquereux, Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1871, p. 293 (1872); *ibid.*, 1873, pp. 382, 385 (1874); *ibid.*, 1876, p. 513 (1878); Tert. Fl., p. 244, Pl. XLII, figs. 4, 5 (1878); Bull. Mus. Comp. Zool., Vol. XVI, p. 52 (1888); Ward, Syn. Fl. Lar. Gr., p. 553, Pl. XLVIII, fig. 1; Types Lar. Fl., p. 55, Pl. XXVI, fig. 1 (1887).

<sup>1</sup> Wrongly stated by Professor Ward (Types Lar. Fl., p. 55) to be from Golden, Colorado.

<sup>2</sup> Fl. Tert. Helv., Vol. III, Pl. CV, fig. 15 (1859).

Both of the specimens figured by Lesquereux as the American types of this species are preserved in the United States National Museum (Nos. 355, 356). They are both somewhat fragmentary, yet are sufficiently preserved to show their general character. Both come from the andesitic beds at Golden, Colorado, and are like a number of more or less fragmentary specimens obtained at the same place in recent years.

The specimen obtained at Point of Rocks, Wyoming, by Professor Ward, is fortunate in having the base and petiole preserved. It appears to agree closely with the specimen figured by Lesquereux, except that it has a thicker petiole, and the nervilles are not strictly at right angles to the midrib.

As Lesquereux has pointed out, and as further emphasized by the question mark placed by him after the species, there is some doubt as to the correctness of the specific determination. They are much larger than the European specimens, and differ in having the nerves branched near the borders. According to Schenk<sup>1</sup> there is also doubt as to the generic reference of certain of the leaves described as *Cornus*, especially *C. Studeri*. The American specimens appear to be closely allied to leaves from the same beds that have been called *Ficus*. Thus they may be compared with certain leaves of *F. spectabilis* Lx.,<sup>2</sup> *F. irregularis* Lx.,<sup>3</sup> *F. uncata* Lx.,<sup>4</sup> and *F. artocarpoides* Lx.<sup>5</sup> From the latter they differ, however, in being wedge-shaped instead of heart-shaped at base. The nervation and outside branching of the nerves near the margin are quite similar in both.

The thick petiole mentioned above in connection with the Point of Rocks specimen is a further argument for referring them to *Ficus*. The leaves from Golden are also suggestive of certain large examples of *Rhamnus Cleburni* Lx.,<sup>6</sup> which, however, may possibly have to be referred to *Ficus* also.

Taking everything into consideration, it would probably be best to abandon *Cornus Studeri* as an American plant, and either refer the various specimens to some known species of *Ficus*, or possibly create a new species for them. But I have hesitated to make this change, as nothing certain has been discovered since the original work of Lesquereux.

Professor Ward's collection from Point of Rocks contains also another fine leaf which I refer to this species. It is narrower than the one shown in fig. 3, but has the same arrangement of secondaries as Lesquereux's.

*Habitat*.—Golden, Colorado. Point of Rocks, Wyoming.

<sup>1</sup> Die Fossilen Pflanzenreste, p. 236.

<sup>2</sup> Tert. Fl., Pl. XXXII, fig. 4.

<sup>3</sup> Ibid., Pl. XXXIV, fig. 4.

<sup>4</sup> Ibid., Pl. XXXIV, fig. 2.

<sup>5</sup> Cret. and Tert. Fl., p. 227, Pl. XLVII, figs. 1-5.

<sup>6</sup> Tert. Fl., Pl. LIII, figs. 1-3.

## RHAMNUS SALICIFOLIUS Lx.

*Rhamnus salicifolius* Lx., Am. Jour. Sci., 2d ser., Vol. XLI, p. 206 (1868); Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1869, p. 196 (1869); *ibid.*, 1872, p. 400 (1873); *ibid.*, 1873, p. 382 (1874); *ibid.*, 1876., p. 517 (1878); Tert. Fl., p. 282, Pl. LIII, figs. 9, 10 (1878).

This species was first described from specimens obtained from Marshall's coal mine, Boulder County, Colorado. This type specimen is the original of fig. 9, Pl. LIII, of the Tertiary Flora. It is No. 446 of the United States National Museum collection, but, unfortunately, it can not be found at the present time. There is in its place another specimen with the same number, which may have been the counterpart of the one figured, although, as it is very fragmentary, it is impossible to be sure of this. It is exactly like fig. 9 (*loc. cit.*) in its characters, so far as can be made out, and is preserved in the whitish sandstone characteristic of the locality.

The other figured type (Tert. Fl., Pl. LIII, fig. 10) is said by Lesquereux to have come from Black Buttes, Wyoming, at which place it was obtained by Professor Meek (Ann. Rept. 1872, p. 400), but as the Museum catalogue, made up by Lesquereux, does not record this species from Black Buttes, this is probably an error. But as the type of this figure can not be found among specimens of this species from any other locality, it is impossible to do anything but ignore it until it is found or is again collected from the locality mentioned.

The Museum catalogue records a specimen from Golden, Colorado, which is evidently the one referred to by Lesquereux in the Annual Report for 1873, page 382. It is No. 837a, and is preserved on the same stone with *Salix integra* Göpp. (No. 837). The matrix is a hard, fine-grained, whitish sandstone, not unlike that from Marshall's coal mine, and undoubtedly belongs to the true Laramie. A specimen is also recorded from the roof of a coal mine on Sand Creek, Colorado (now known as Coal Creek). This example (No. 935) bears the impression of two leaves which are very much larger than the figured specimens, being 11 or 12 cm. long and 4 or 5 cm. wide, whereas the largest type (as figured) is 9.5 cm. long and only 2 cm. wide. The base is also different, being broader and less wedge-shaped. It is doubtful whether they really belong to this species.

The only other specimen recorded in the Museum catalogue (No. 936) is said to have come from "Basaltic rocks, Yellowstone." This specimen is missing, and is disregarded in the present discussion, especially as abundant recent collections from Yellowstone Park do not contain it.

The material obtained by Lakes in Colorado fortunately contains a number of fairly well-preserved fragments of this species from the coal mine on Coal Creek, Boulder County, Colorado, not far, it is conjectured, from the type locality, as they agree most closely with the figured specimen from that place.

The material collected by Mr. T. W. Stanton and myself near Har-

pers, Wyoming, contains a single example that appears to belong to this species. It is not well preserved, and the finer nervation can not be made out with satisfaction, but it resembles this more closely than any other. It may, however, represent an undescribed species, but it must remain for subsequent material to settle this point.

*Habitat*.—Near Harpers, Wyoming. Black Buttes, Wyoming.? Boulder County, Colorado. Golden, Colorado (Laramie).

VIBURNUM? PROBLEMATICUM n. sp.

Pl. XIX, fig. 4.

*Viburnum marginatum* Lx., Tert. Fl., p. 223, Pl. XXXVIII, fig. 2 [non figs. 1, 3-5].

*Platanus marginata* (Lx.) Heer, Fl. Foss. Arct., Vol. VII, p. 97, Pl. XCVIII, fig. 3 [non fig. 4, 5; Pl. XCIX, figs. 2, 3; Pl. CI, fig. 5].

Leaves broadly ovate, rounded and wedge-shaped at base, similarly narrowed above to an abruptly acuminate apex; margin for the upper two-thirds of blade remotely shallow-toothed; petiole slender; midrib thin, straight; secondaries four or five pairs, the lowest pair opposite, arising at an angle of about  $45^{\circ}$  a short distance above the base of the blade, with three or four branches on the outside which enter the teeth; upper secondaries alternate, simple or once-forked, entering the teeth; nervilles very prominent, mainly percurrent at right angles to the secondaries or their branches; finer nervation not preserved.

The leaf figured here is 6 cm. in length and 4.5 cm. in width, while the one figured by Lesquereux in the Tertiary Flora (Pl. XXXVIII, fig. 2) is about 7 cm. in length and 3.5 cm. in width. They are very similar in shape, margin, and general arrangement of nervation, the most important difference being the simple upper secondaries in the former leaf, as compared with the forked secondaries in the latter. It seems hardly justifiable to keep them distinct on this character.

These leaves are undoubtedly very closely allied to *Viburnum? montanum*, as just described. The latter differs somewhat in shape and in the number of secondaries and their origin, but in spite of these minor differences it is possible that they should properly be placed together.

*Viburnum marginatum* of Lesquereux has long been considered a composite species. It is, of course, well recognized that a single tree may have considerable variety in size and shape of leaves, but it is hardly probable that specific variation in an individual will be as great as these drawings would indicate. The larger, broader form (Pl. XXXVIII, fig. 1) was evidently the one taken by Heer as the basis of his transfer of the species to the genus *Platanus*, but the forking of the secondaries is one prominent reason against that reference. This is not a *Platanus* character, and on the whole the leaves do not suggest that genus. The question of the propriety of referring these leaves to *Viburnum* is also brought up. They may not properly belong there, but they are clearly not *Platanus*, and are not *Viburnum marginatum*, as originally defined.

*Habitat*.—Coalville, Utah. Black Buttes, Wyoming.

## VIBURNUM ANOMALUM n. sp.

*Viburnum rotundifolium* Lx, Tert. Fl., p. 225, Pl. LXI, fig. 22 (1878). [Non Pl. XXXVII, fig. 12, and Pl. XXXVIII, fig. 10.]

Leaf nearly round in outline, the margin slightly toothed; midrib strong, slightly flexuose; secondaries about five pairs, arising at an angle of about 45°, the lower branching on the outside, the branches entering the teeth; nervilles strongly marked, percurrent or often broken.

This leaf is 3.5 cm. in length and 3 cm. in width, being nearly circular. The marginal teeth are faint. They are entered by the secondaries or their branches. The nervation is strongly marked, and is well shown in Lesquereux's figure.

This species, as shown by the synonymy, was described as *Viburnum rotundifolium*, but even the author was a little in doubt as to its belonging with the leaves from Black Buttes. A careful examination of all the specimens leads me to the belief that they are not the same. The two leaves from Black Buttes are slightly heart-shaped and decidedly unequal-sided at base, while the leaf from Point of Rocks is rounded and equal at base.

It does not appear that any additional specimens of this form have been collected.

*Habitat*.—Point of Rocks, Wyoming.

## VIBURNUM WHYMPERI Heer.

Pl. XVII, fig. 1; Pl. XVIII, fig. 1; Pl. XIX, fig. 3.

*Viburnum Whymperi* Heer, Fl. Foss. Tert., Vol. II, Abth. 4, p. 475, Pl. XLVI, fig. 1b; Lesquereux, Tert. Fl., p. 225, Pl. XXXVIII, fig. 7 (1878).

It is with some doubt that the specimens here figured are referred to *Viburnum Whymperi*, and by this species is meant the *V. Whymperi* as defined and illustrated by Lesquereux and not the original of Heer. It is more than doubtful whether the leaf from Black Buttes referred to *V. Whymperi* by Lesquereux is correct. It is much more likely to prove a new species.

The example from Point of Rocks is twice the size of the Black Buttes specimen, and, moreover, differs slightly in nervation; but rather than make a new species on insufficient material, I have decided to keep them together, at least for the present. Among the material obtained during the season of 1896 in Converse County, Wyoming, from the so-called Ceratops beds, were numerous leaves that are evidently the same as the leaf from Black Buttes mentioned above. They are decidedly different from the original species of Heer, and when they come to be thoroughly worked up it will probably be found best to separate them.

The leaf shown in fig. 1, Pl. XVIII, is slightly anomalous, being more

obtuse and not having the lower pair of secondaries opposite and so strongly branched. They are probably the same, however.

The leaf depicted in fig. 3, Pl. XIX, is also anomalous, and may not be the same. It is incomplete, but has practically the same nervation, the main difference being in the outline, this one being more acuminate than the typical form.

*Habitat.*—Point of Rocks, and Black Buttes, Wyoming.

VIBURNUM MONTANUM n. sp.

Pl. XIX, figs. 1, 2.

Leaves broadly ovate in general outline, wedge-shaped at base, obtuse at apex; margin with numerous shallow teeth; petiole short, thick; midrib rather thin, straight or slightly flexuose; secondaries five or six pairs, the lower pair strongest, springing from near the base of the blade, much branched on the outside, the branches all entering the teeth; upper secondaries alternate, flexuose, forked, the branches entering the teeth; nervilles prominent, mainly percurrent, approximately at right angles to the secondaries; finer nervation not preserved.

The two examples figured appear to be all that were obtained of this species. Neither of them is perfect, yet they are sufficiently well preserved to permit the character to be made out. They are about 10 cm. in length and 6 cm. in width, are broadly ovate in general outline, with numerous shallow teeth above the base. In nervation they have the appearance of being palmately three-nerved, but the lowest pair of secondaries is simply the largest, and they are copiously branched on the outside, the branches entering the teeth. The upper secondaries are alternate and forked, the branches passing to the teeth.

These leaves were at first referred to *Viburnum marginatum* Lx.,<sup>1</sup> with which they undoubtedly have considerable affinity, but inasmuch as they differ in important particulars it seemed best to regard them as distinct, at least until further material could be obtained. *Viburnum marginatum* or *Platanus marginata*, as it is called by Heer, is undoubtedly a composite species, and should be divided.

This species is also quite similar to *Platanus Newberryana* Heer<sup>2</sup> from the Dakota group of Nebraska, which differs in not being palmately three-nerved. The secondaries are all of nearly equal size, and the branches end in the small teeth. Its facies is more distinctly Platanoid than the one under discussion.

*Habitat.*—Point of Rocks, Wyoming.

<sup>1</sup>Tert. Fl., Pl. XXXVIII, figs. 1-5 (1878).

<sup>2</sup>Lx., Cret. and Tert. Fl., p. 72, Pl. IX, fig. 3 (1874).

## DIOSPYROS BRACHYSEPALA Al. Br.

Pl. XVIII, fig. 3.

*Diospyros brachysepala* Al. Br., Leon and Bronn, Jahrb. f. Mineral, 1845, p. 170 (1845); Heer, Fl. Tert. Helv., Vol. III, p. 11, Pl. CII, figs. 1-14 (1859); Lesquereux, Ann. Rept. U. S. Geol. and Geog. Surv. Terr., 1872, p. 394 (1873); *ibid.*, 1873, pp. 387, 401 (1874); *ibid.*, 1874, p. 306 (1876); *ibid.*, 1876, p. 511 (1878); Bull. U. S. Geol. and Geog. Surv. Terr., Vol. I, p. 367 (1875); Tert. Fl., p. 232, Pl. XL, figs. 7-10; Pl. LXIII, fig. 6 (1878); Cret. and Tert. Fl., p. 174, Pl. XXXIV, figs. 1-2 (1884); Proc. U. S. Nat. Mus., Vol. X, p. 41 (1887); Ward, Syn. Fl. Lar. Gr., p. 556, Pl. LX, figs. 4, 5 (1886); Types Lar. Fl., p. 104, Pl. XLIX, figs. 1, 2 (1887).

This species is very widely distributed, being especially abundant in the European Miocene. The specimens upon which its presence in American strata rests are preserved in the United States National Museum (Nos. 339, 340, 792, etc.), and, although not present in the numbers that apparently characterize certain European formations, they agree fairly well with many that have been referred to this species.

In America, however, this species can not be used as a stratigraphic mark, for specimens referred to it have been found in the Montana formation, lower or true Laramie, Denver beds, Fort Union, Green River group, and Miocene. It seems probable, therefore, that if we could have a representative series of specimens from each of the above horizons we should be able to separate them into more than one species. It is a noticable fact, however, that although found in several horizons it is most abundant in the Laramie, and the specimens about which there is the most doubt occur in the overlying formations.

*Habitat*.—Point of Rocks, Wyoming, and many other localities, as indicated in the above diagnosis.

## CARPITES TRIANGULOSUS Lx.

*Carpites triangulosus* Lx., Tert. Fl., p. 302, Pl. LX, fig. 4; Pl. LXII, figs. 19, 20 (1878).

Only one of the figured types of this species, the original of Pl. LX, fig. 4, appears to be in the United States National Museum collection (No. 496). This specimen is recorded in the Museum register as having come from Carbon, Wyoming, and in the Tertiary Flora (p. 303) as having come from Golden, Colorado. The matrix proves that it came from the latter locality.

The other specimens are said to have come from Point of Rocks, Wyoming, but as they can not be found there can be no certainty as to their habitat.

*Habitat*.—Golden, Colorado (Denver formation). Carbon, Wyoming? Point of Rocks, Wyoming?

## PHYLLITES TRILOBA n. sp.

Pl. XVIII, fig. 2.

Leaf of very thin texture, broadly ovate in general outline, three-lobed, the lateral lobes short, rounded, separated from the larger ovate



middle lobe by broad, rounded sinuses; margin perfectly entire; petiole short, rather thick; nervation palmate, three- or four-branched, the middle branch straight, apparently passing directly to the apex of the middle lobe (broken), the other lateral nerves straight, ending below the obtuse apex of the lateral lobes; middle nerve with several pairs of opposite secondaries in the upper lobe, these curving upward and probably camptodrome; nervilles rather strong, percurrent.

This little leaf as preserved is 2.5 cm. in length, and was probably fully 3 cm. long when perfect. It is a little more than 2 cm. in width between the lobes, which are about 7 mm. in length. The petiole is about 4 mm. long and has the appearance of being entirely preserved.

This leaf is very thin and delicate, and is made out with great difficulty, being of the same color as the matrix. The nervation, which appears strong in the figure, is in reality very delicate.

At first sight this little leaf appears identical with certain of the regularly three-lobed leaves of the common *Sassafras sassafras* (L.) Karst., but a closer inspection shows that it can hardly belong to that genus. The lobes of the sassafras are always acute, and the nerves which pass to them are never basal, but arise at some distance above the petiole.

On the same piece of matrix with this leaf are numerous aquatic rootlets, but this may be only chance association.

*Habitat*.—Point of Rocks, Wyoming. Collected by Lester F. Ward, September 2 and 3, 1881.

PHYLLITES sp.

Pl. IX, fig. 4.

Leaf elliptical-oblong, rounded regularly below (apex destroyed); margin entire, petiole strong, straight, passing evenly into the straight midrib; secondaries opposite below, alternate above, curving slightly upward, apparently craspedodrome; nervilles strong, percurrent; finer nervation not preserved.

This leaf is too fragmentary to permit of satisfactory diagnosis and disposition. It is 6 cm. in length, including the petiole, which is 2 cm. long, and a little more than 3 cm. in width.

*Habitat*.—Point of Rocks, Wyoming. Collected by Lester F. Ward, September 2 and 3, 1881.

PHYLLITES sp.

Pl. XIX, fig. 5.

Among the material from the Dutton Creek coal mine was a single piece of matrix in which three distinct plants were preserved—the one here figured, a *Glyptostrobus*, and a doubtful leaf of *Populus*. Since the drawings were made this specimen was thrown away by an attendant. Without the specimen before me for study, and depending, therefore, entirely on the drawing, I do not care to express an opinion

regarding its affinities. The drawing is probably accurate, but without the specimen I am unwilling to venture an opinion. The drawing is given in this place simply to call attention to the fact that a curiously lobed leaf was present at this place, in the hope that later collectors may look for it. Until then it can have no proper status.

*Habitat*.—Coal mine on north fork of Dutton Creek, near old stage road, Laramie Plains, Wyoming. Collected by Knowlton, Stanton, and Knight, July, 1896. (Specimen lost.)

### DISCUSSION OF THE MONTANA FLORA.

In the introductory chapter the extent and distribution of the Montana flora was stated and a brief account was given of the early more or less conflicting views concerning it. The reasons for separating this account of the plants from that in my proposed monograph on the Laramie and related formations were also given. The systematic enumeration of the plants themselves has been given in the immediately preceding pages, and it now remains to discuss briefly the apparent affinities of the Montana flora and the conclusions that may be drawn.

The flora of the Montana formation, as at present known, embraces 89 forms, distributed among the plant groups as follows: Algæ, 2 species; Pteridophytes, 10 species; conifers, 10 species; monocotyledons, 4 species; dicotyledons, 63 species. These plants have been afforded by five localities, among which they are distributed as follows: Point of Rocks, Wyoming, 58 forms; coal mine on north fork of Dutton Creek, Laramie Plains, Wyoming, 14 species; Harpers Station, on the Union Pacific Railroad, Wyoming, 6 species; Dunn's ranch, 6 miles east of Harpers Station, 3 forms; Coalville, Utah, 10 forms. Of the 89 species or forms comprising this flora, 28 are described as new to science, and 10 forms have not been named or identified specifically, leaving 51 forms previously named. It appears that 29 of these 51 species are found outside the limits of the Montana formation, leaving, therefore, 22 forms as peculiar.

Turning now to the 29 species enjoying an outside distribution, we find that 2 (*Pinus Quenstedti* and *Brachyphyllum macrocarpum*) have been found also in the Dakota group; 2 (*Geinitzia formosa* and *Brachyphyllum macrocarpum*) in the Amboy clays of New Jersey; 1 (*Salix angusta*) in the Livingston beds of Montana and the Green River group at Fairmont, Colorado; 1 (*Sabalites Grayanus*) in the Eo Lignitic of Mississippi; 8 (*Ficus asarifolia*, *Ficus irregularis*?, *Magnolia tenuinervis*, *Podogonium americanum*, *Pterospermites Wardii*, *Rhamnus salicifolius*, and *Viburnum*? *problematicum*) at Black Buttes, Wyoming; 1 (*Quercus Lesquereuxiana*) at Carbon, Wyoming; 1 (*Fucus lignitum*) in the lowest Fort Union beds, near the mouth of the Yellowstone River, in Montana; 4 (*Magnolia tenuinervis*, *Cornus impressa*, *C. Studeri*, and *Carpites triangulosus*) in the Denver beds; 1 (*Halymenites major*) common from

the middle of the Colorado formation to the Eocene; and 1 (*Ficus tiliaefolia*) from the Laramie to the Miocene.

From this it appears that the species found beyond the present limits of the Montana formation are rather widely scattered, varying from the Dakota group to the Miocene, and suggesting the possibility that they may not all have been correctly identified, either within the Montana flora or in the horizon outside. As might perhaps be expected, the greatest affinity is shown to be with the Black Buttes locality, this being nearest to Point of Rocks, the principal plant-bearing locality in the Montana formation. Of the eight species mentioned above as common to the two localities, several are open to more or less question, as they depend on one or two fragments. That is, species have to be admitted as common to the two that may be represented at one or the other place by one or, at most, few and often insufficient, specimens.

Among the five plant-bearing localities within the Montana formation, there appears to be little in common. This is, perhaps, to be explained by the fact that the places are mostly quite widely separated, and only one, namely, Point of Rocks, has thus far afforded a large flora. Coalville, Utah, which is over 100 miles from Point of Rocks, has a flora of about ten species, of which number only two or three have been found at Point of Rocks. Several, however, have been found in strata of supposed Laramie age.

Among the localities on the Laramie Plains there is naturally more agreement, although the affinity is not so close as it undoubtedly would be if these localities had been more fully exploited.



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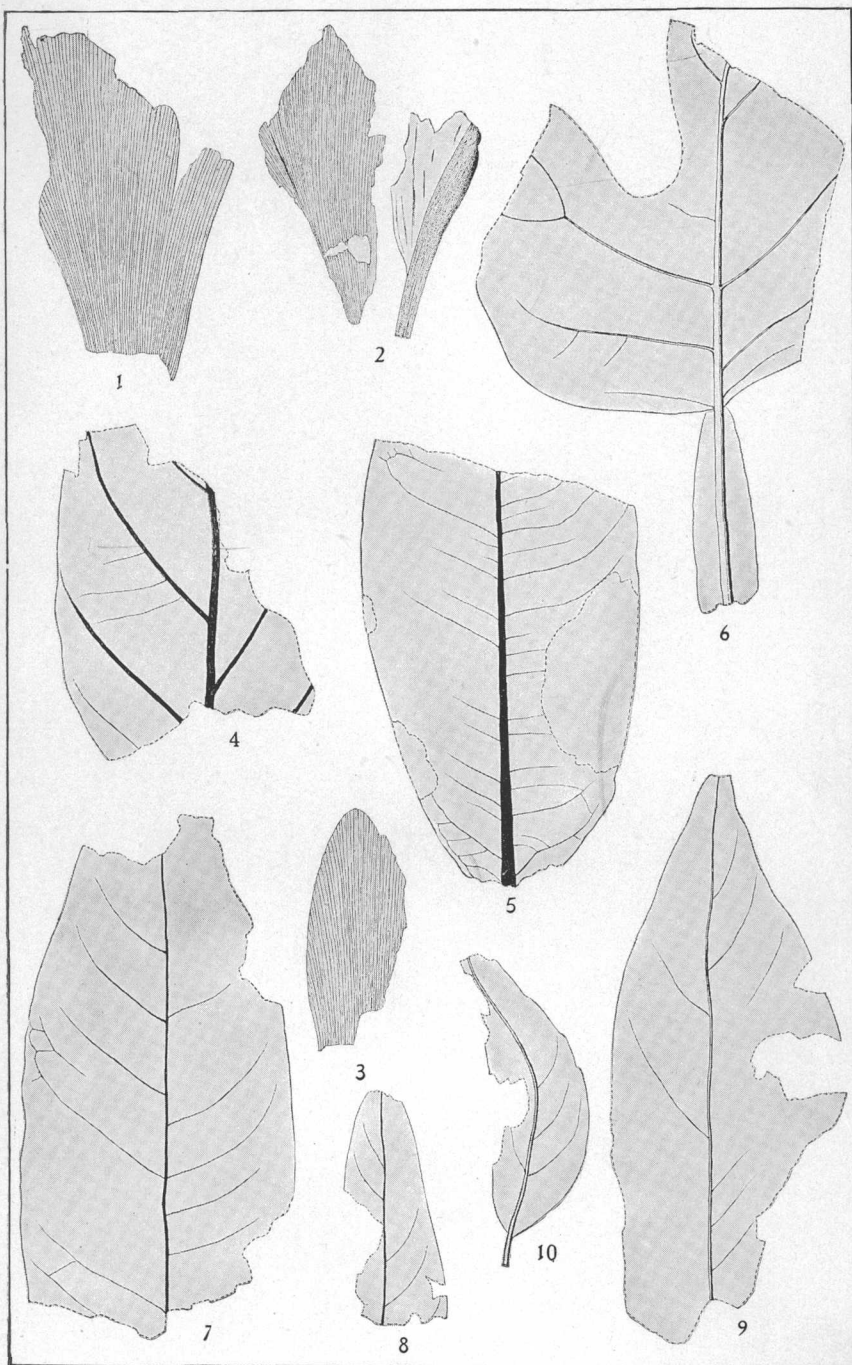
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# PLATE I.

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FLORA OF THE BELLY RIVER SERIES.

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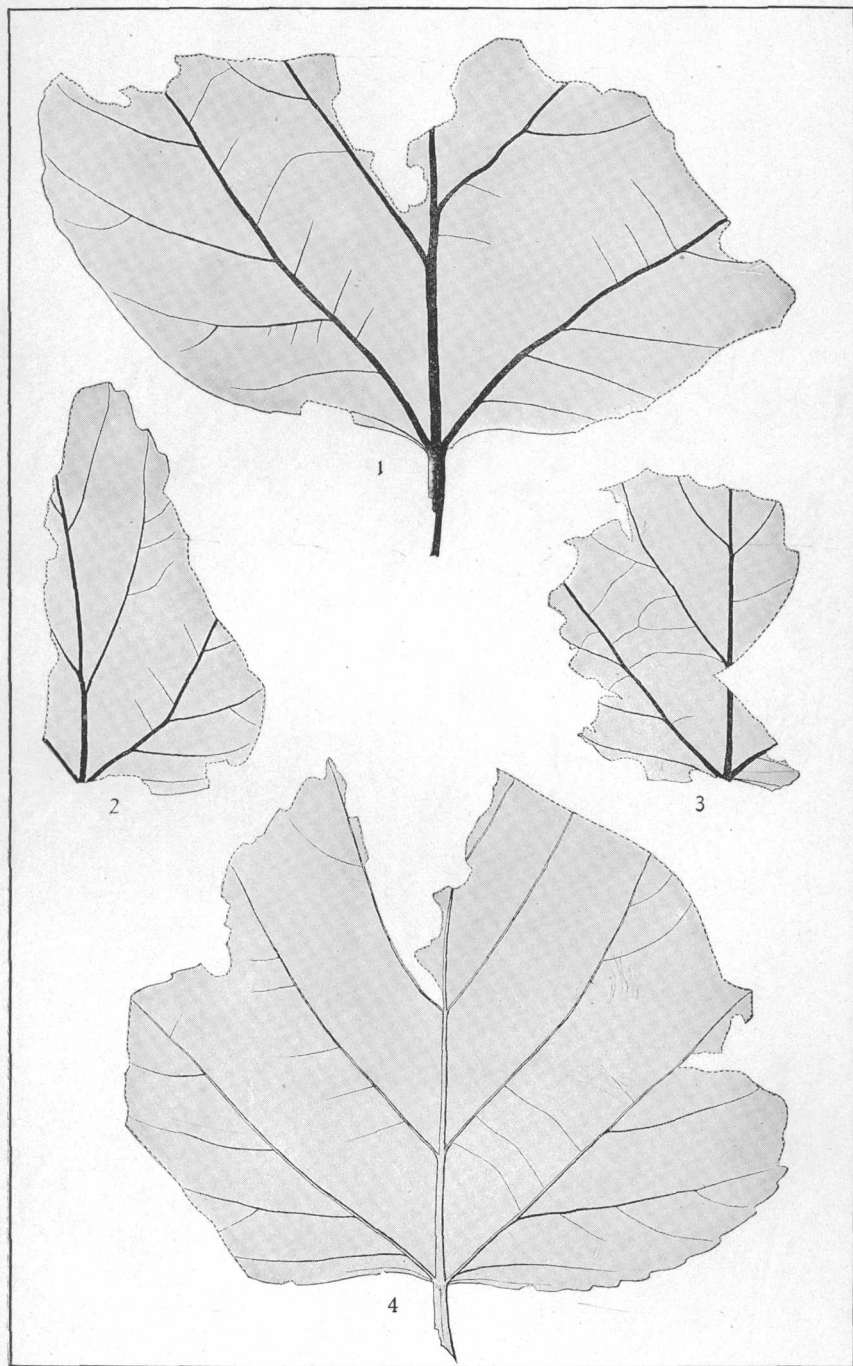
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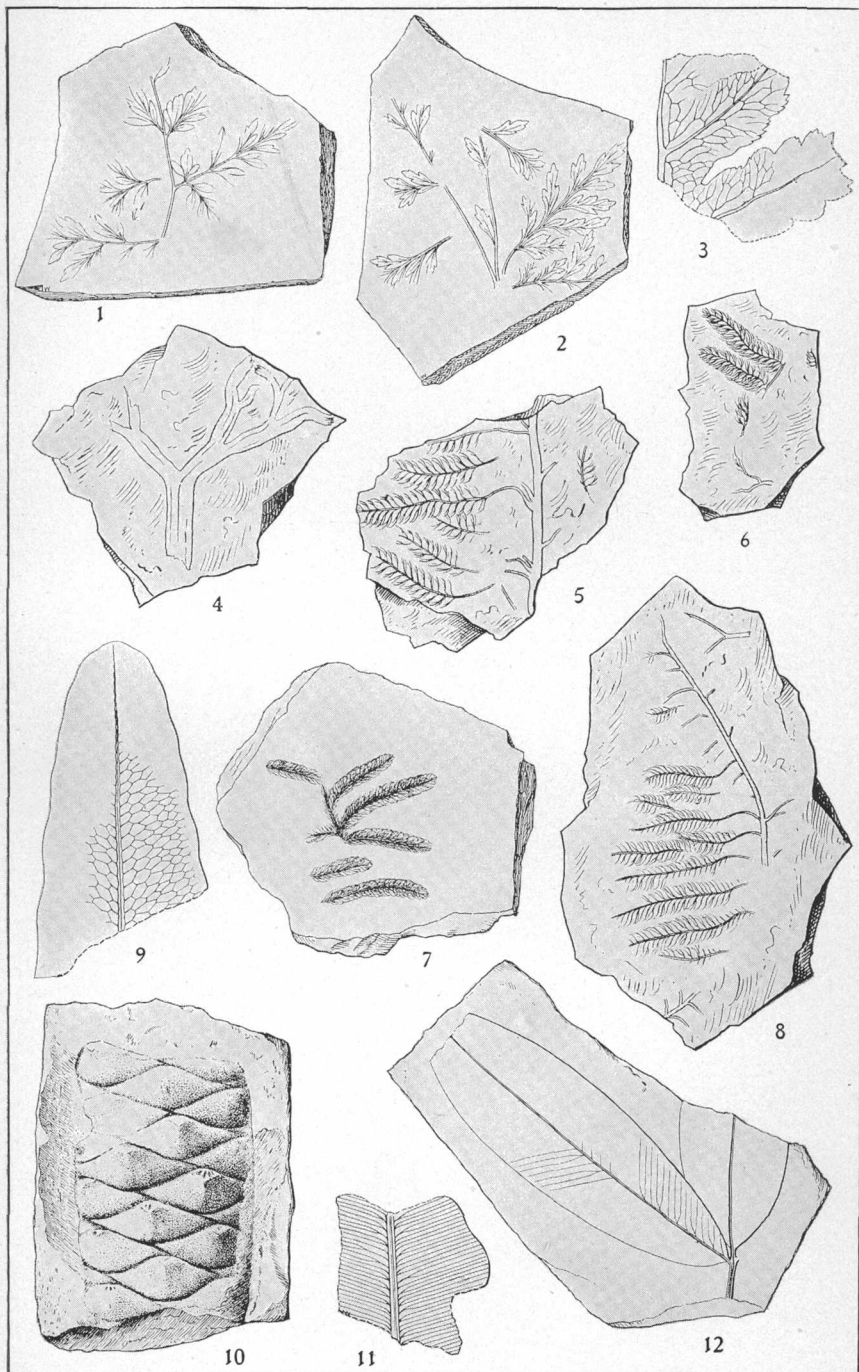
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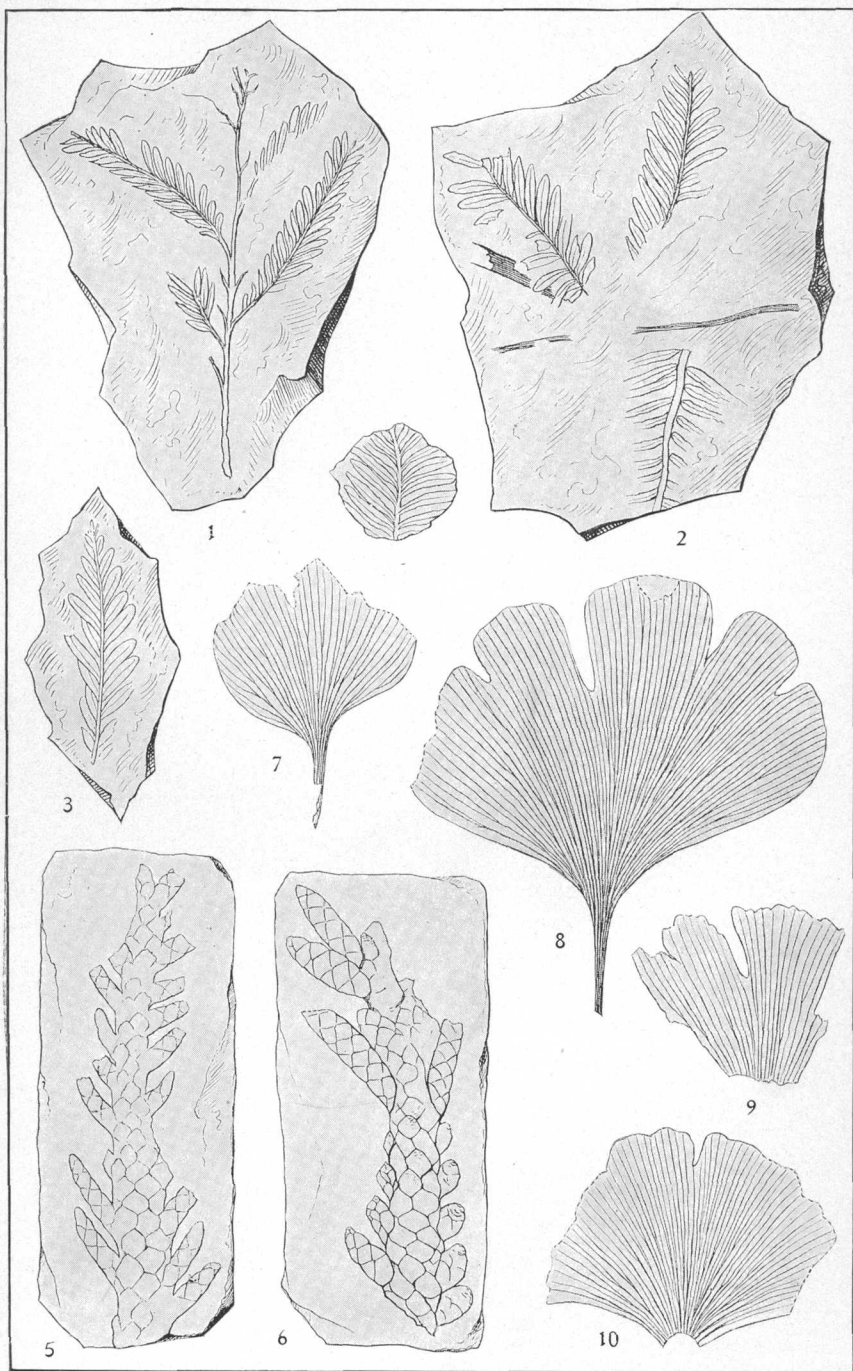
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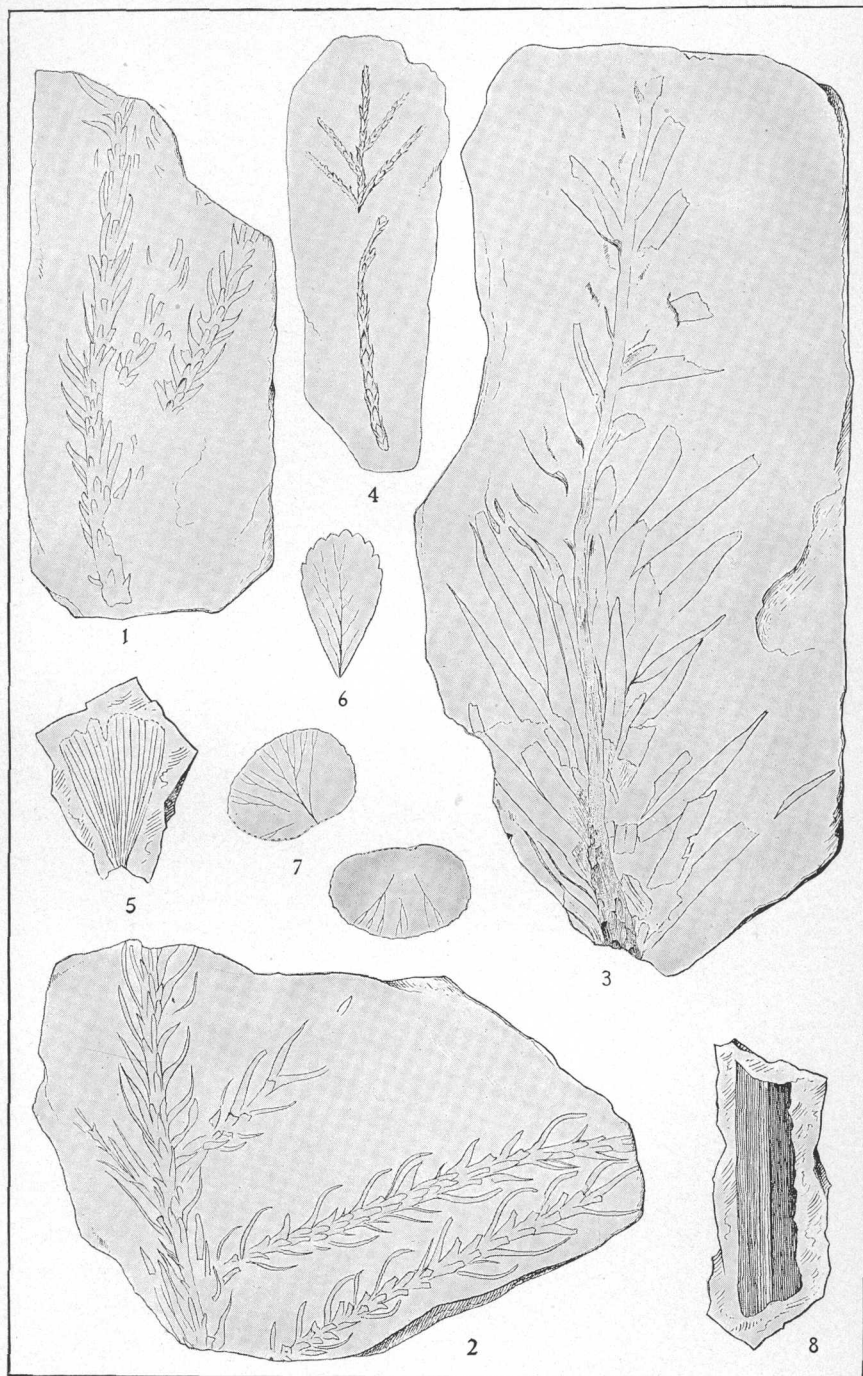
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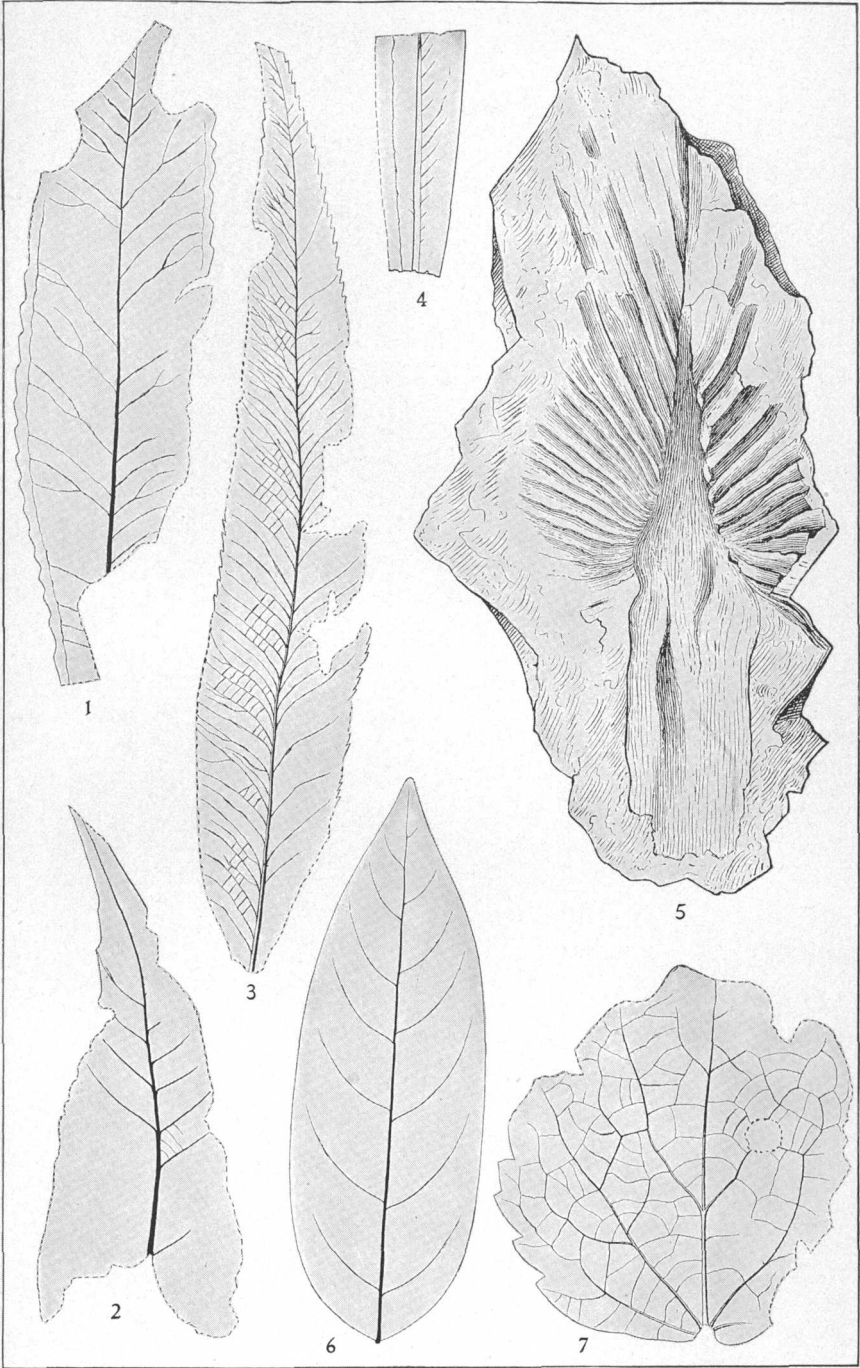
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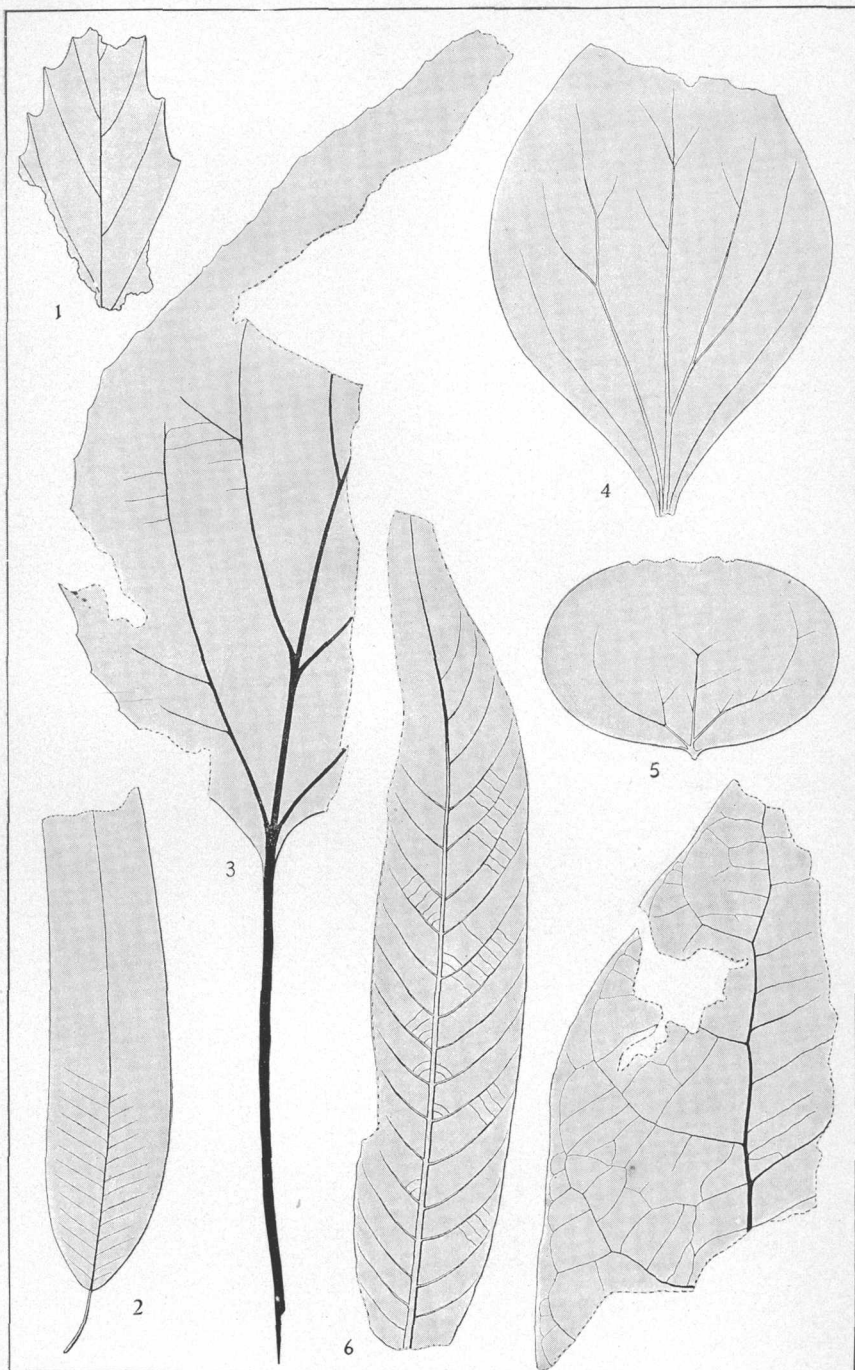
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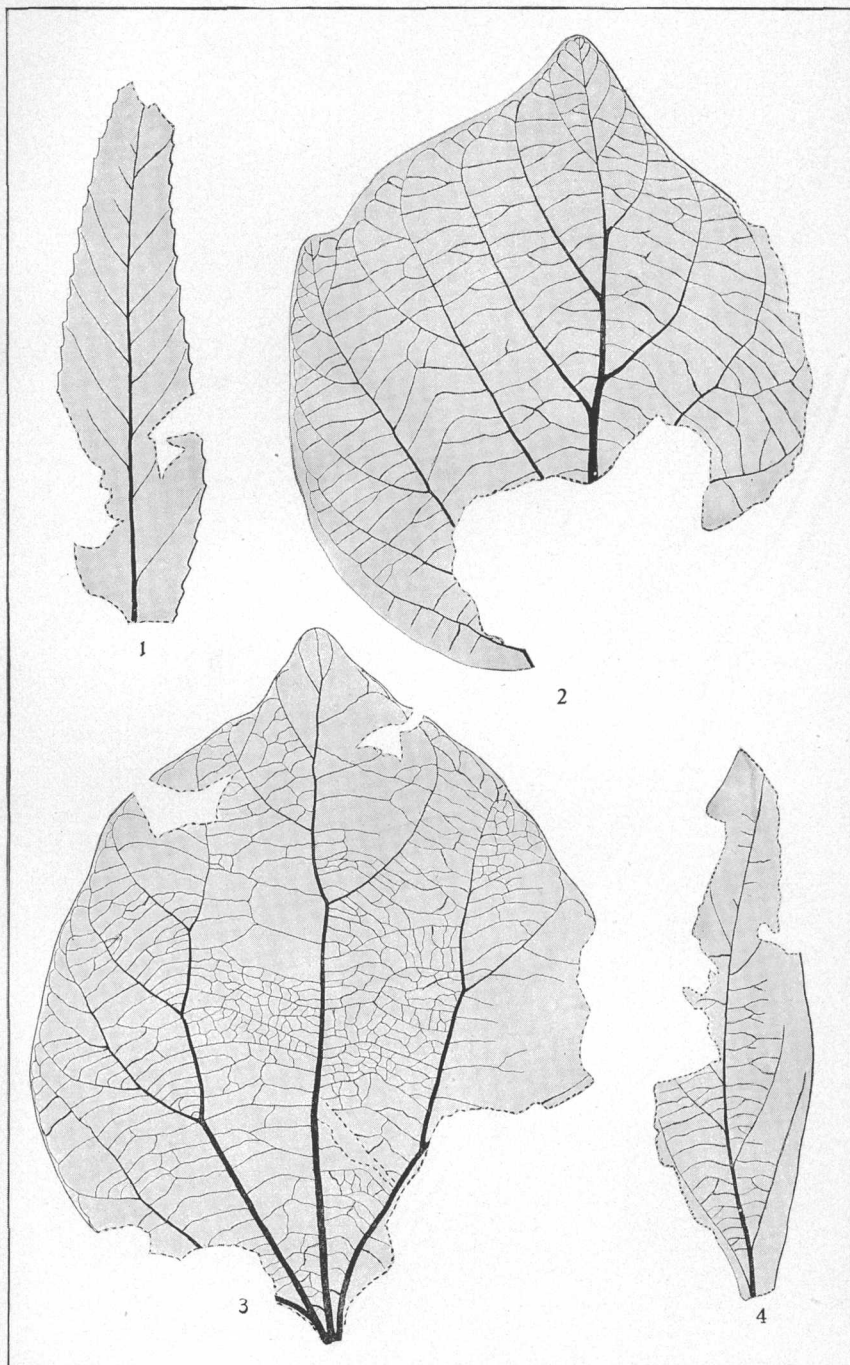
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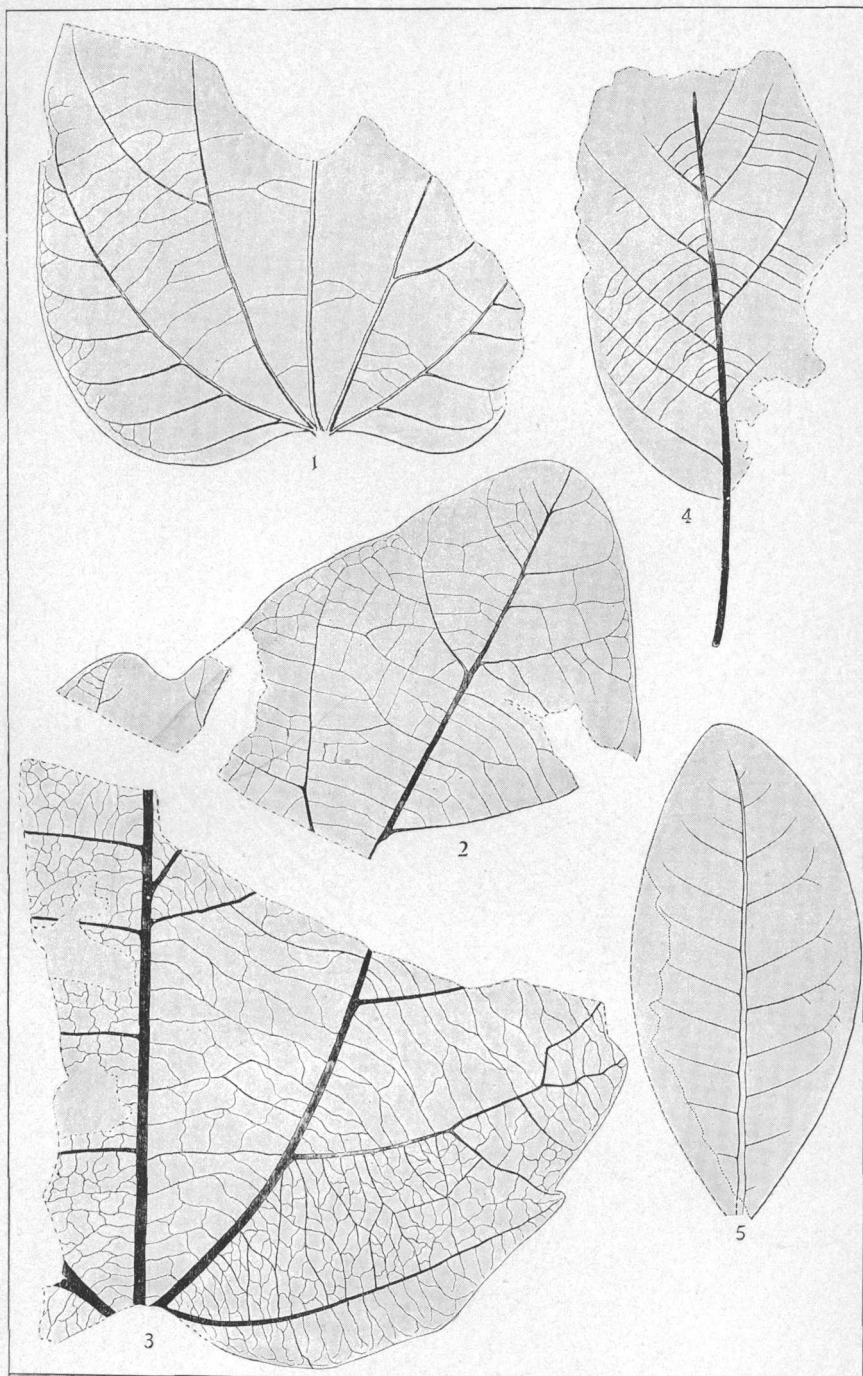
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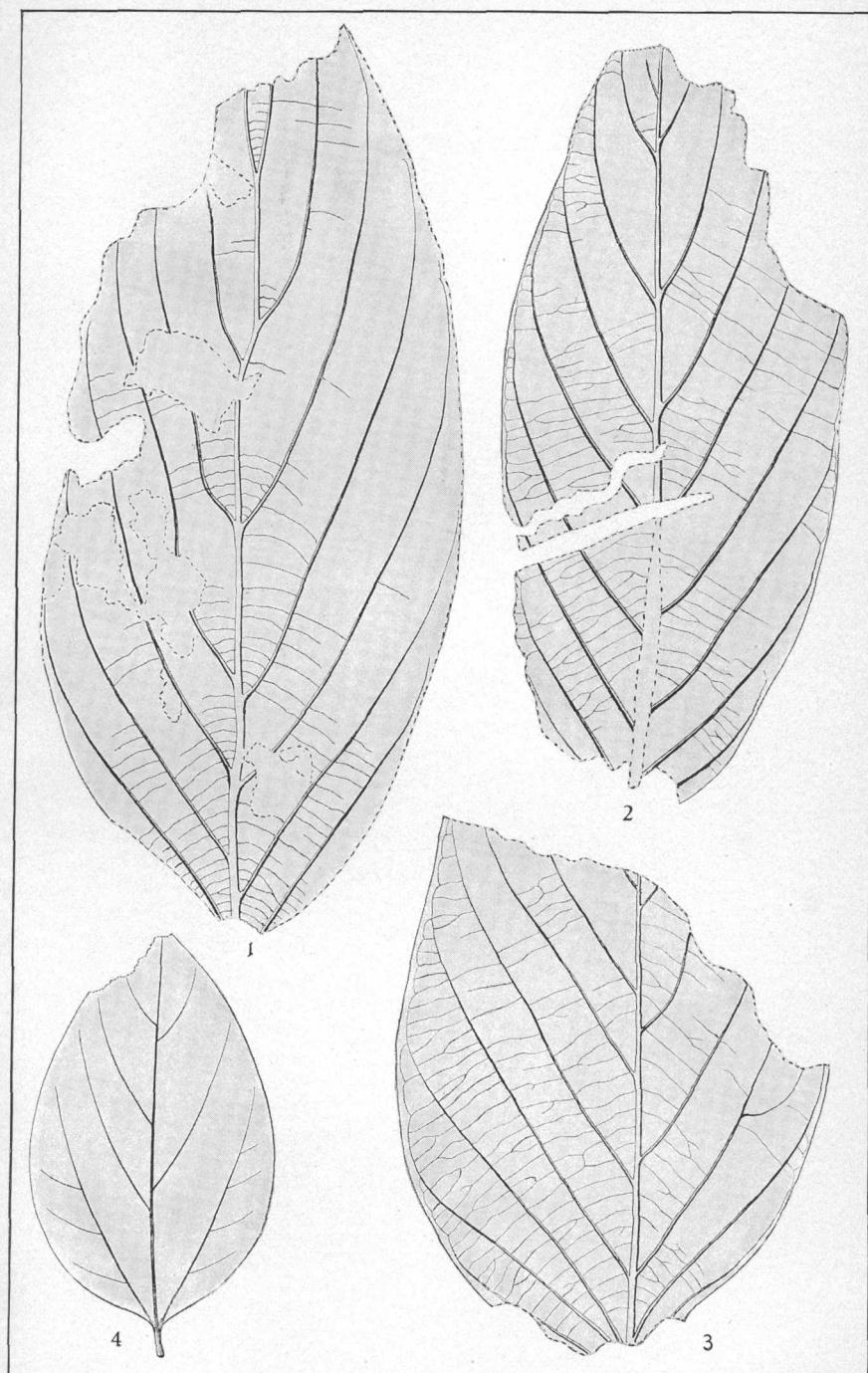
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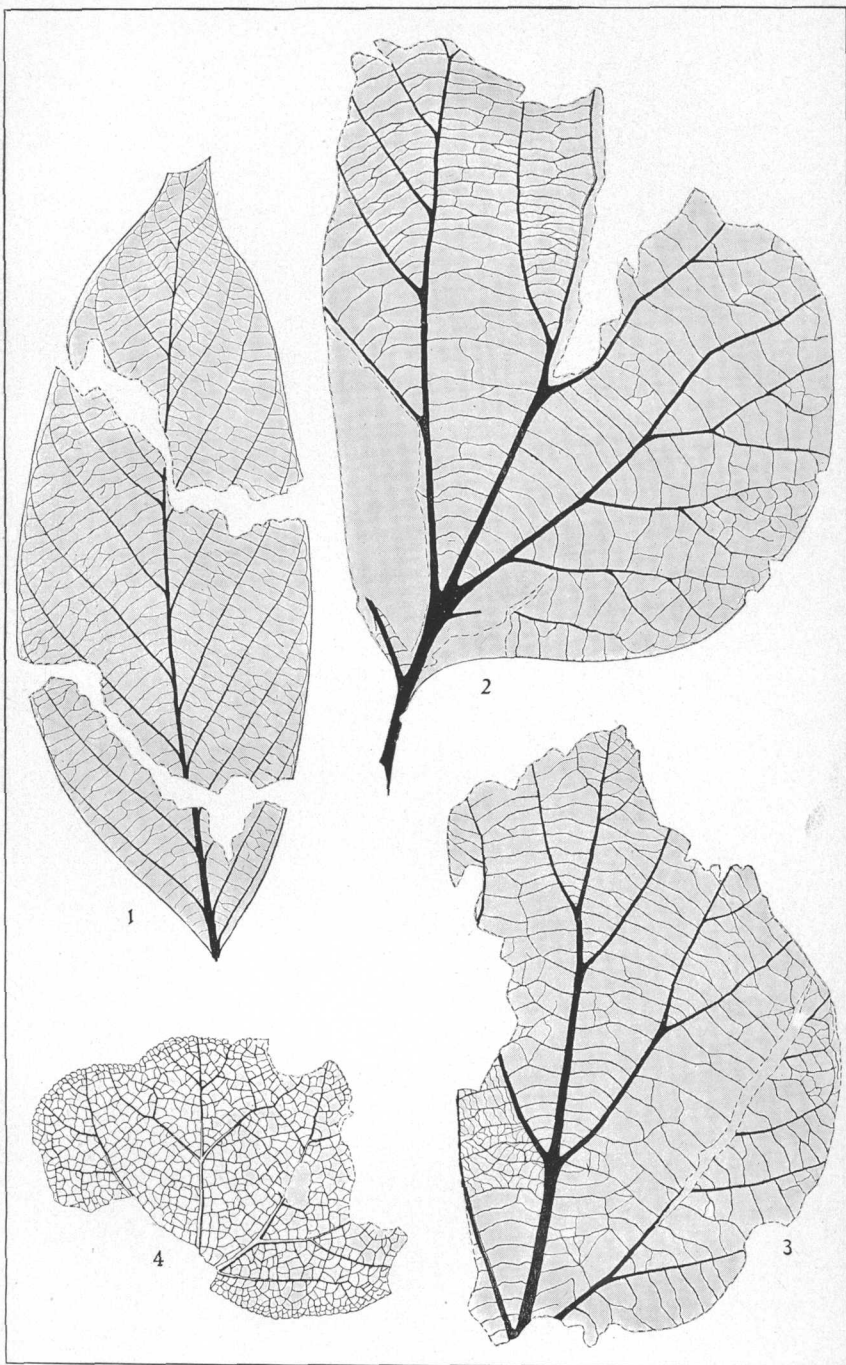
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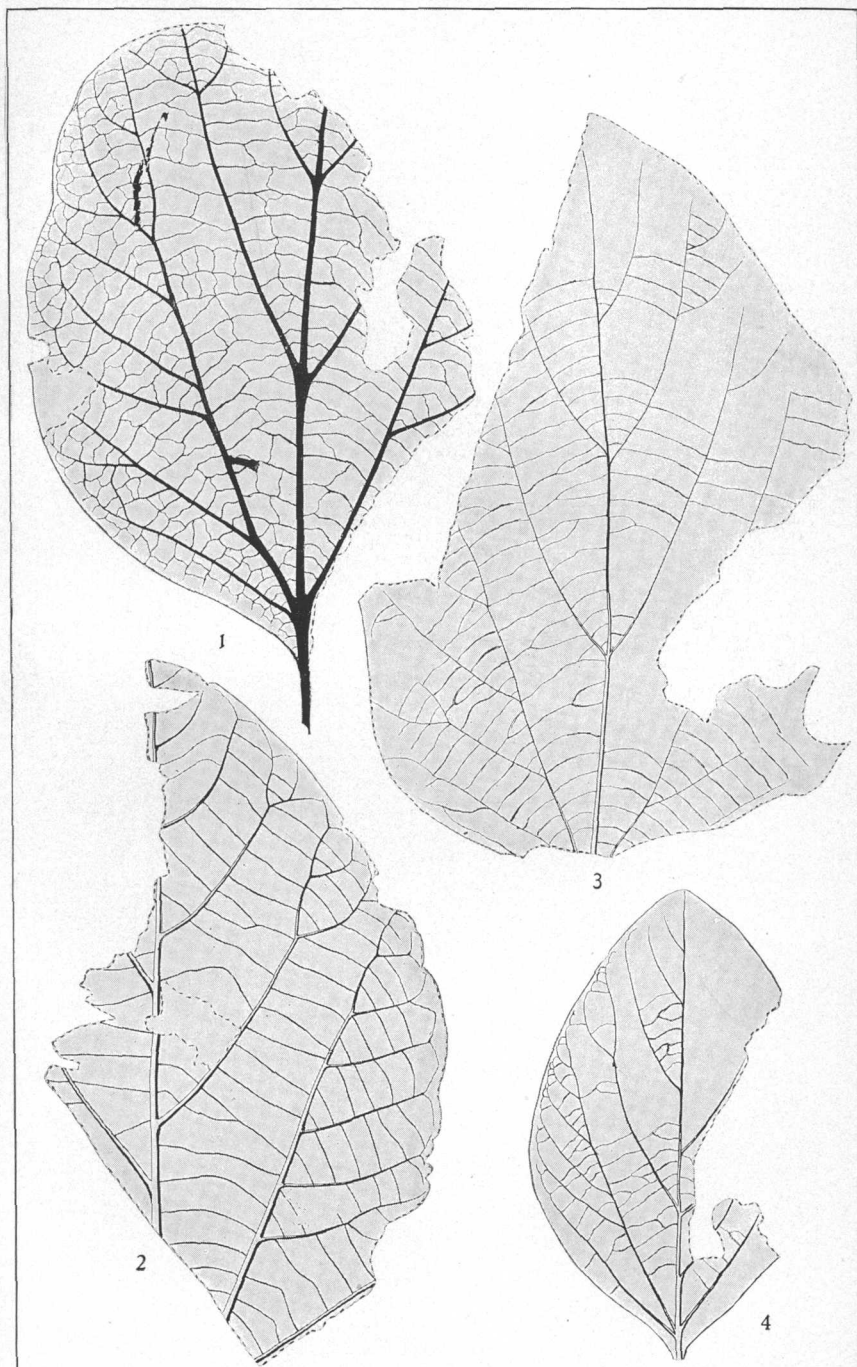
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FLORA OF THE MONTANA FORMATION.



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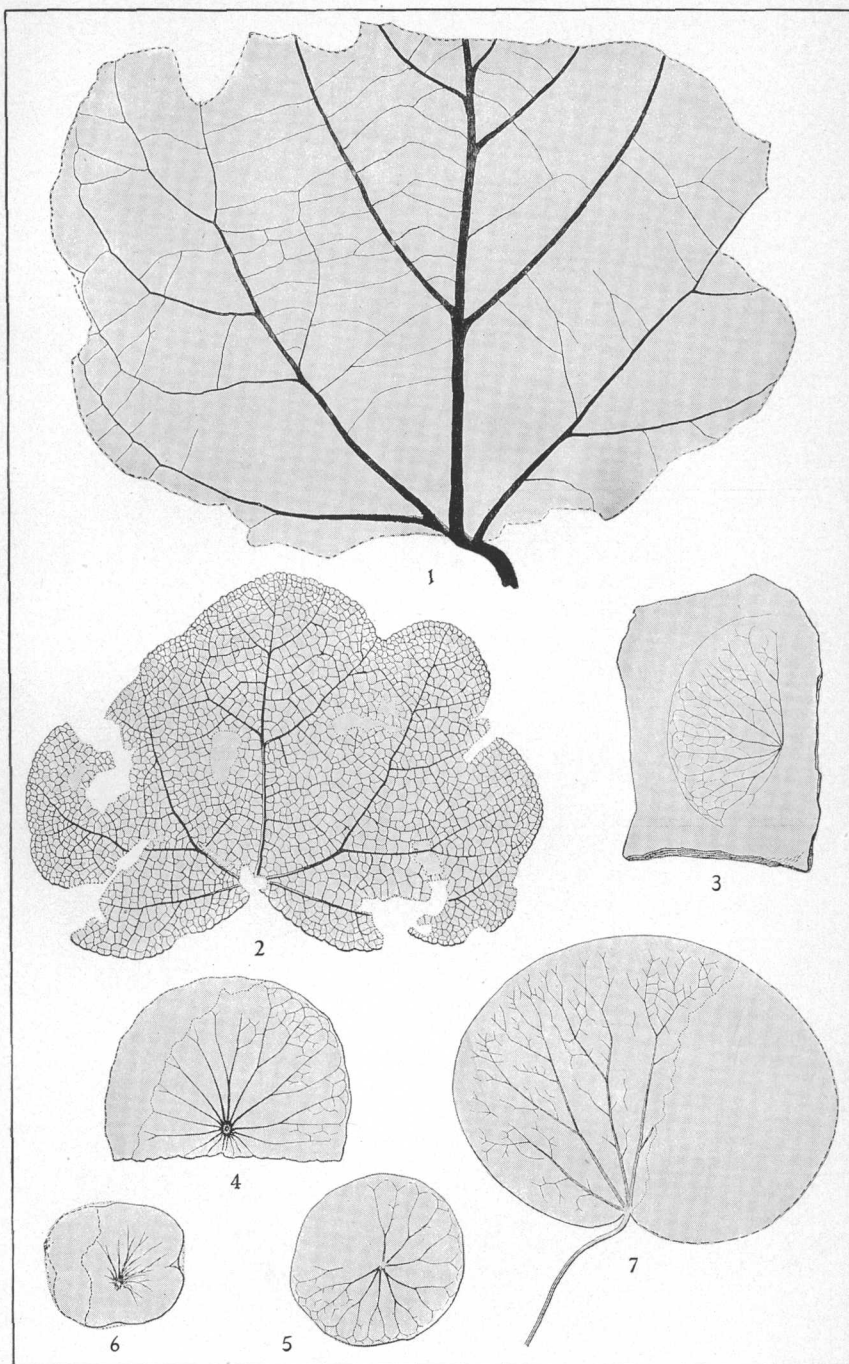
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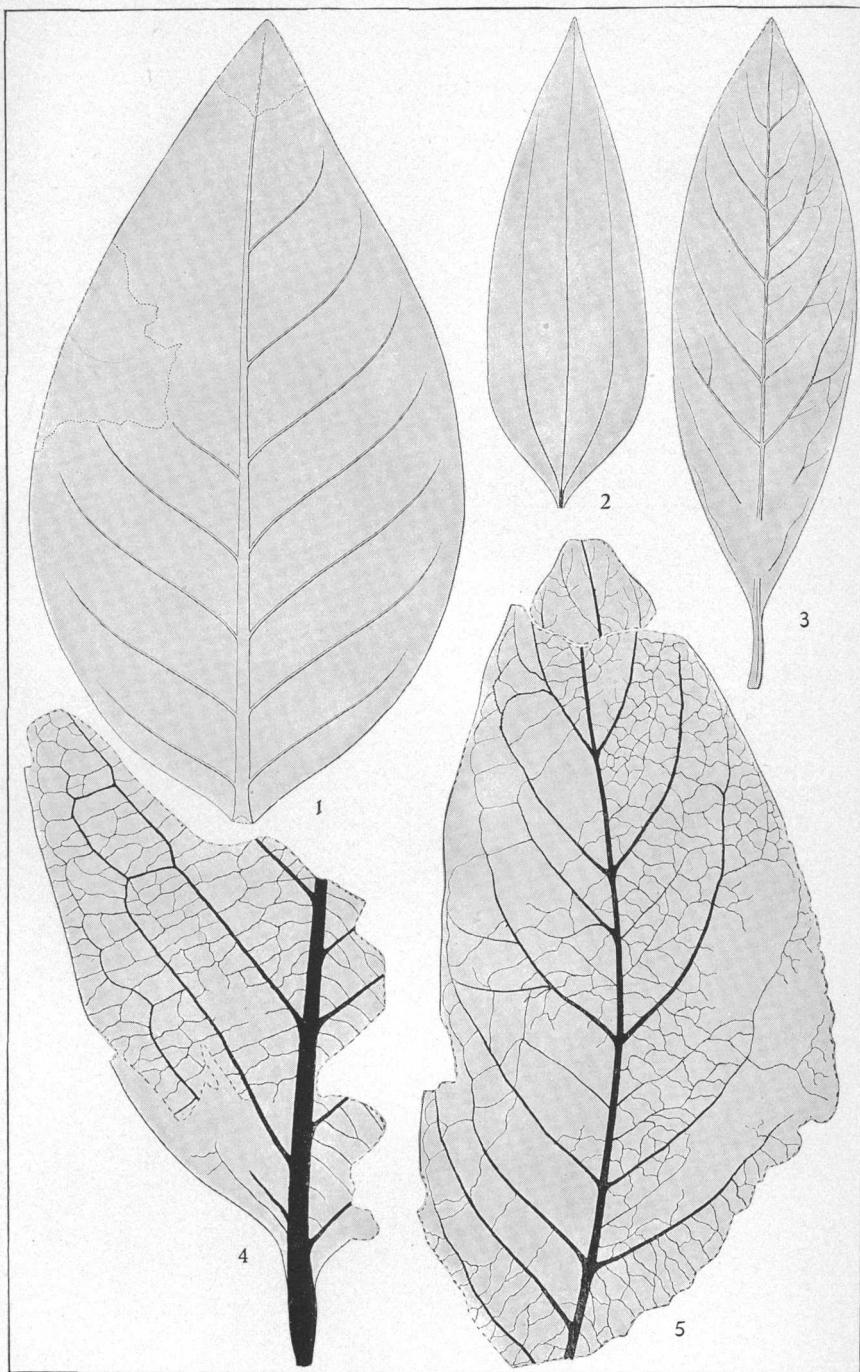
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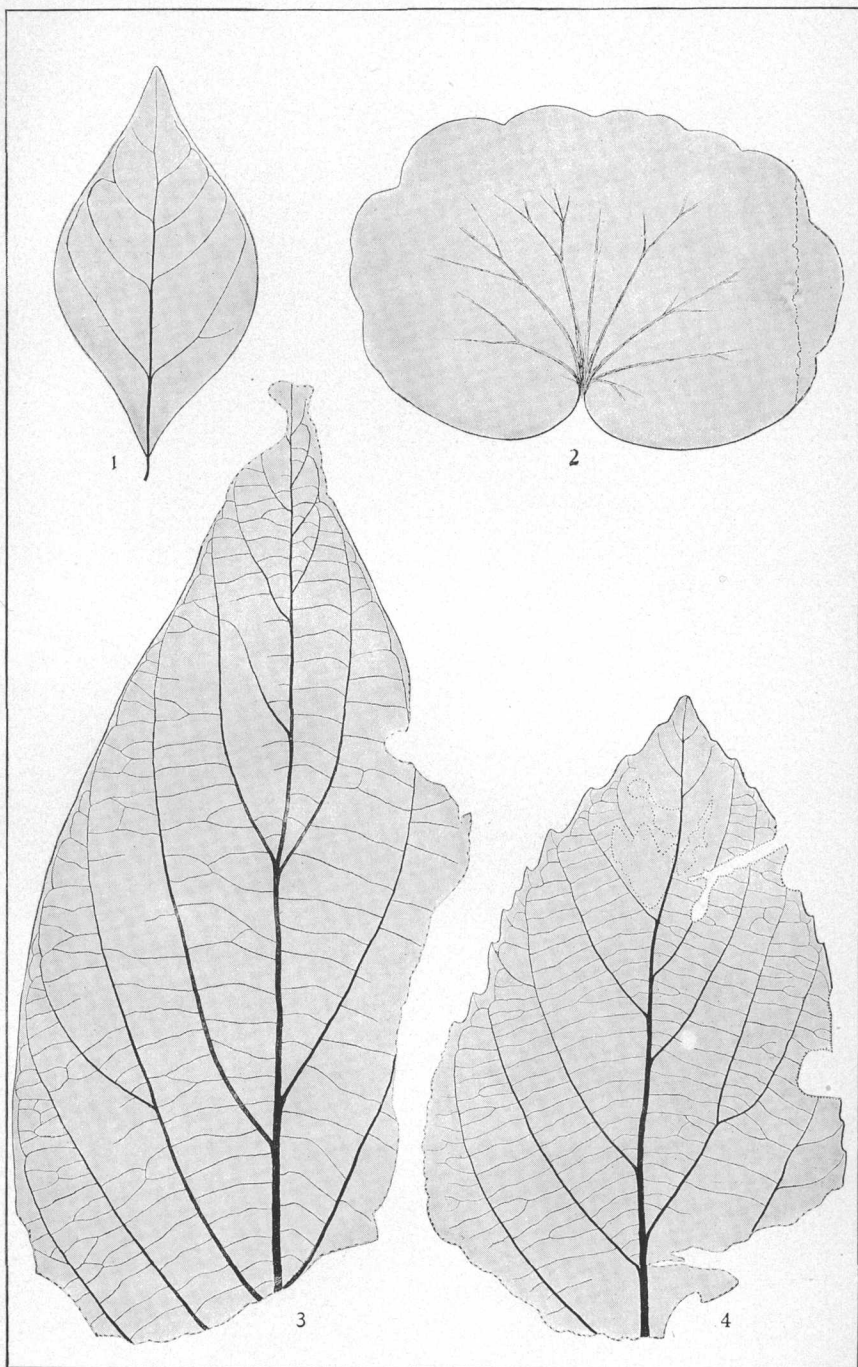
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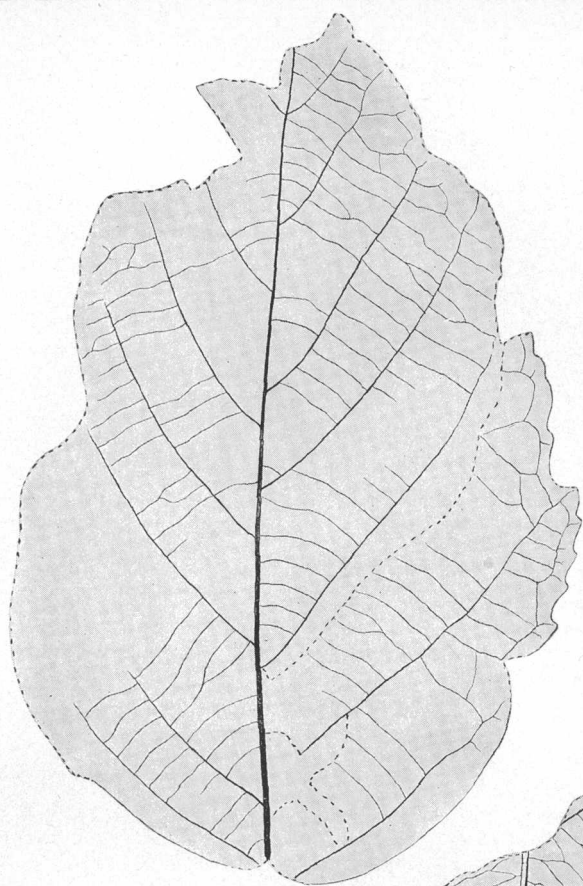
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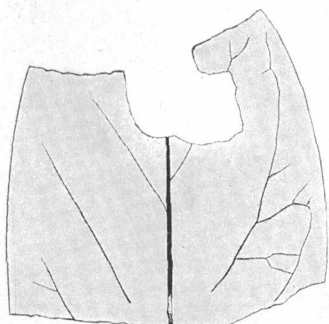
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# PLATE XVI.

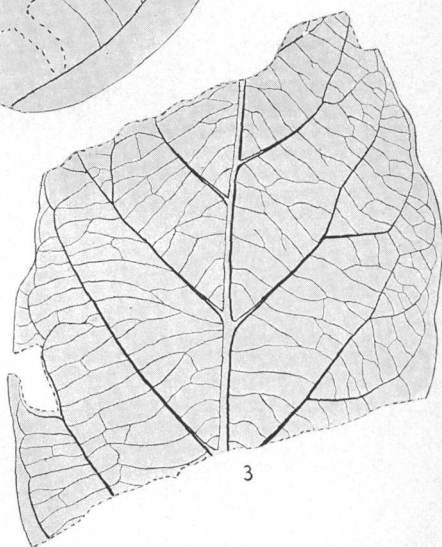
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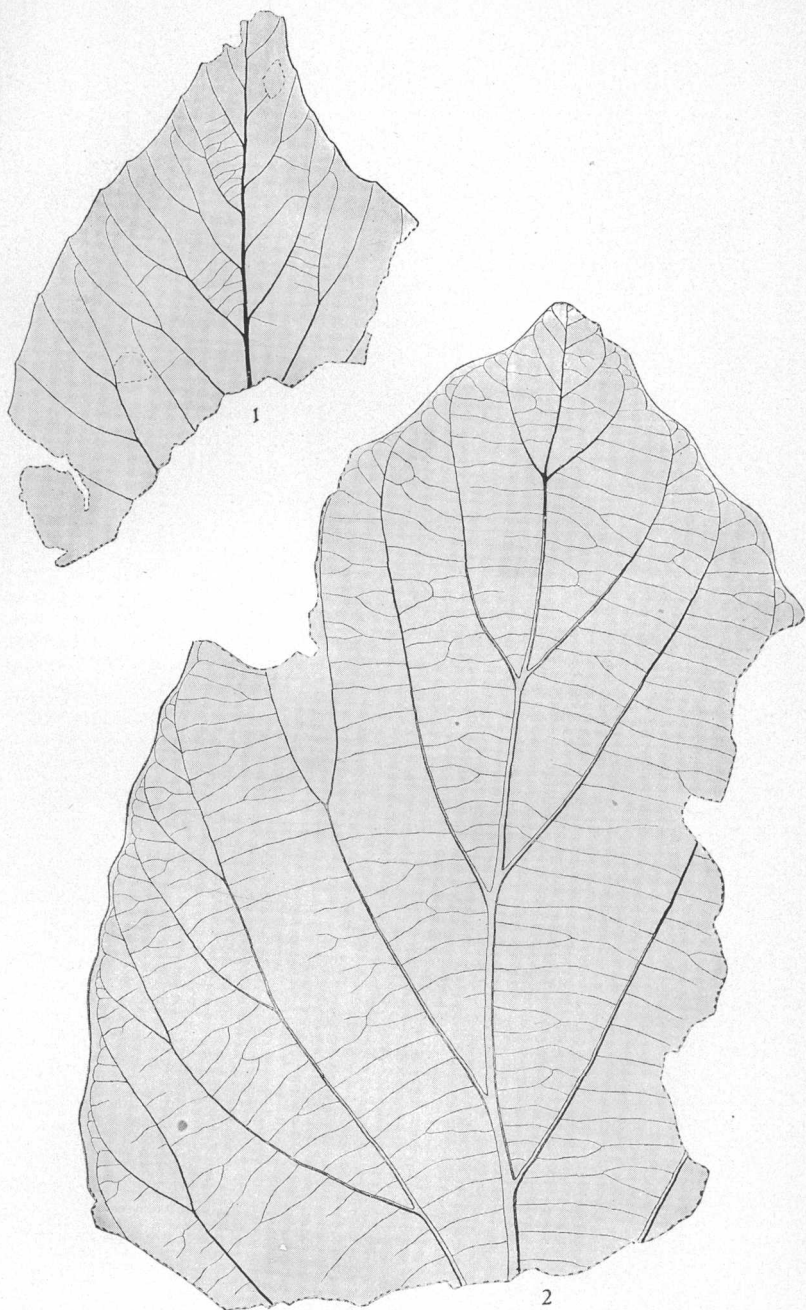
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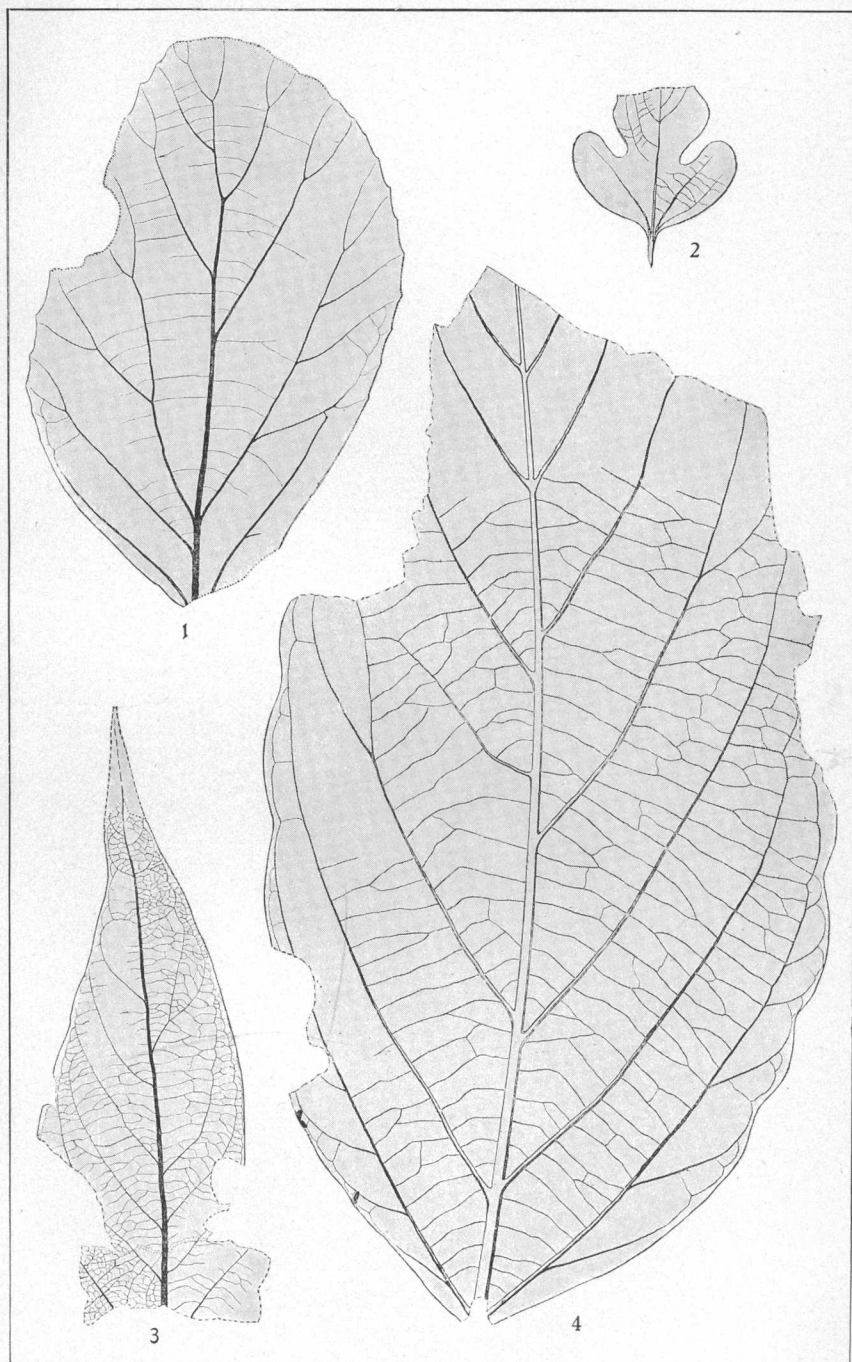
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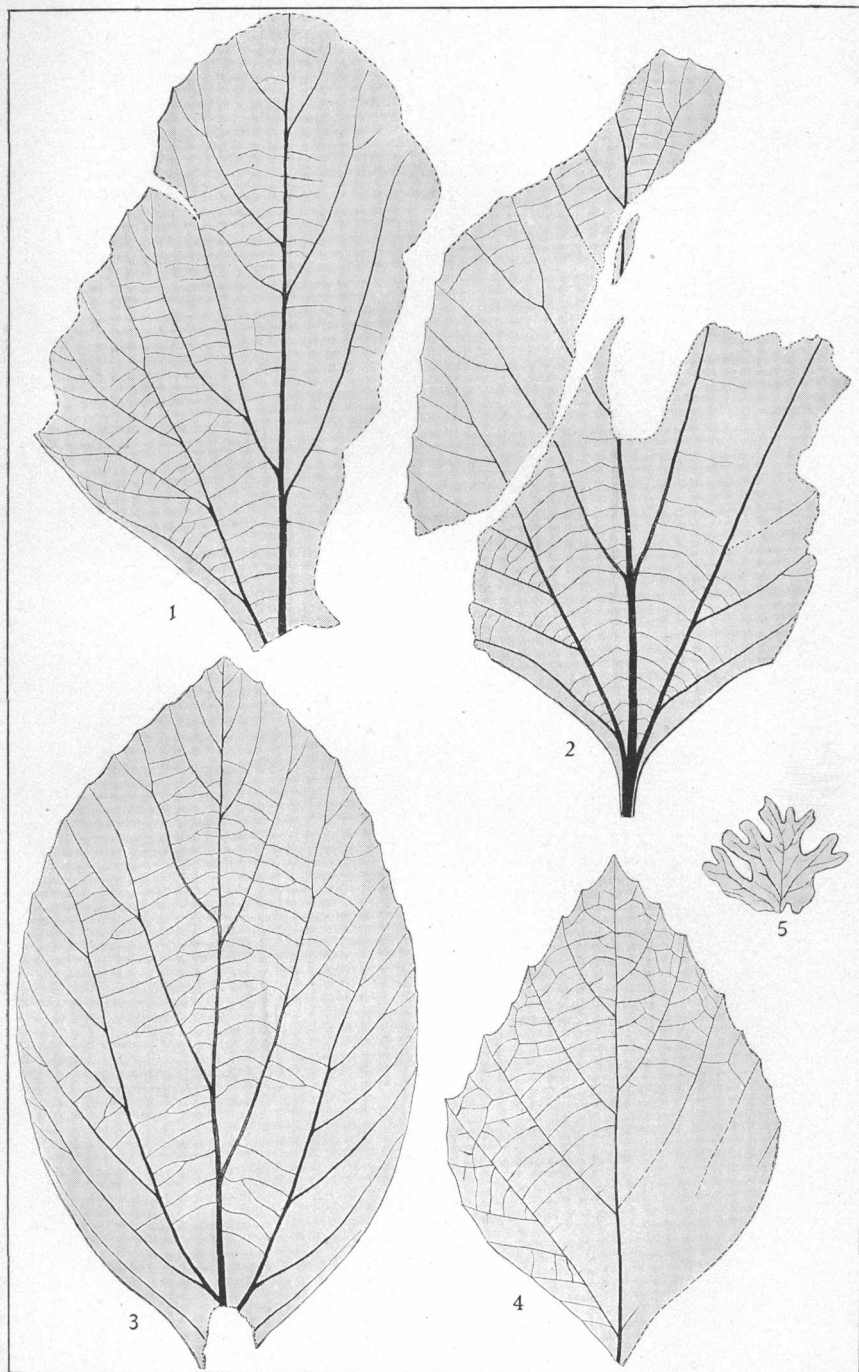
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