

III.—*On the Fossil Plants of the Laramie Formation of Canada.*

By SIR J. WILLIAM DAWSON, C.M.G., LL.D., F.R.S.

(Presented May 27, 1886.)

I.—INTRODUCTORY.

The following paper is a continuation, and in so far a completion, of those on the Mesozoic Floras of Canada contained in Vols. I and III of these Transactions.

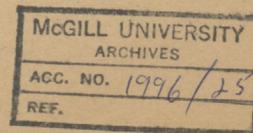
On the geological map of Canada, the Laramie series, formerly known as the Lignitic or Lignite Tertiary, occurs, with the exception of a few outliers, in two large areas west of the 100th meridian, and separated from each other by a tract of older Cretaceous rocks, over which the Laramie beds may have extended, before the later denudation of the region.

The most eastern of these areas, that of the Souris River and Wood Mountain, extends for some distance along the United States boundary, between the 102nd and 109th meridians, and reaches northward to about thirty miles south of the "elbow" of the South Saskatchewan River, which is on the parallel of 51° north. In this area, the lowest beds of the Laramie are seen to rest on those of the Fox Hill group of the Upper Cretaceous, and at one point on the west they are overlaid by beds of Miocene Tertiary age, observed by Mr. McConnell, of the Geological Survey, in the Cypress Hills, and referred by Cope, on the evidence of mammalian remains, to the White River division of the United States geologists, which is regarded by them as Lower Miocene.¹ The age of the Laramie beds is thus stratigraphically determined to be between the Fox Hill Cretaceous and the Lower Miocene. They are also undoubtedly continuous with the Fort Union group of the United States geologists on the other side of the international boundary, and they contain similar fossil plants. They are divisible into two groups,—a lower, mostly argillaceous, and to which the name of "Bad Lands beds" may be given from the "bad lands" of Wood Mountain where they are well exposed, and an upper, partly arenaceous member, which may be named the Souris River or Porcupine Creek division. In the lower division are found reptilian remains of Upper Cretaceous type, with some fish remains more nearly akin to those of the Eocene.² Neither division has as yet afforded mammalian remains.

The western area is of still larger dimensions, and extends along the eastern base of the Rocky Mountains from the United States boundary to about the 55th parallel of latitude, and stretches eastward to the 111th Meridian. In this area and more especially in its southern part, the officers of the Geological Survey of Canada have recognized three

¹ Report of Geol. Survey of Canada, 1885.

² Cope in Dr. G. M. Dawson's Report on 49th parallel.



divisions as follows:—(1) The Lower Laramie or St. Mary River series, corresponding in its character and fossils to the Lower or Bad Lands division of the other area. (2) A Middle division, the Willow Creek beds, consisting of clays, mostly reddish, and not recognized in the other area. (3) The Upper Laramie or Porcupine Hills division, corresponding in fossils and to some extent in mineral character to the Souris River beds of the eastern area.

The fossil plants collected by Dr. G. M. Dawson in the eastern area were noticed by the writer in an appendix to Dr. Dawson's Report on the 49th parallel, in 1875, and a collection subsequently made by Dr. Selwyn was described in the report of the Geological Survey of Canada for 1879-80. Those of the western area, and especially collections made by myself near Calgary in 1883, were shortly noticed in my paper in Vol. III of these Transactions. The present paper includes a revision of this former work, with the results of the study of new material collected, principally by Mr. J. B. Tyrrell and Mr. T. C. Weston of the Geological Survey, in the western area, and submitted to me along with the previous collections by the Director of the Geological Survey.

In studying these fossil plants, I have found that there is a close correspondence between those of the Lower and Upper Laramie in the two areas above referred to respectively, and that the flora of the Lower Laramie is somewhat distinct from that of the Upper, the former being especially rich in certain aquatic plants, and the latter much more copious on the whole, and much more rich in remains of forest trees. This is, however, possibly an effect rather of local conditions than of any considerable change in the flora, since some Upper Laramie forms recur as low as the Belly River series of the Cretaceous, which is believed on stratigraphical grounds to be considerably older than the Lower Laramie.

With reference to the correlation of these beds with those of the United States, some difficulty has arisen from the tendency of palaeobotanists to refer the plants of the Upper Laramie to the Miocene age, although in the reports of Mr. Clarence King, the late Director of the United States Geological Survey, these beds are classed on the evidence of stratigraphy and animal fossils, as Upper Cretaceous. More recently, however, and partly perhaps in consequence of the views maintained by the writer since 1875, some change of opinion has occurred, and Dr. Newberry and Mr. Lesquereux seem now inclined to admit that what in Canada we recognize as Upper Laramie, is really Eocene, and the Lower Laramie either Cretaceous or a transition group between this and the Eocene. In a recent paper,¹ Dr. Newberry gives a comparative table, in which he correlates the Lower Laramie with the Upper Cretaceous of Vancouver Island and the Faxœ and Maestricht beds of Europe, while he regards the Upper Laramie as equivalent to European Eocene. Except in so far as the equivalence of the Lower Laramie and Vancouver Island beds is concerned, this corresponds very nearly with the conclusions of the writer in his paper read to this Society last year,² namely, that we must either regard the Laramie as a transition Cretaceo-Eocene group, or must institute our line of separation in the Willow Creek or Middle Laramie division, which has, however, as yet afforded no fossil plants. I doubt, however, the equivalence of the Vancouver beds and the Lower Laramie, except

¹ Newberry, Trans. N. Y. Academy, Feb., 1886.

² *Ibid.*, Vol. iii.

perhaps in so far as the upper member of the former is concerned.¹ I have also to observe that in the latest report of Mr. Lesquereux² he still seems to retain in the Miocene certain formations in the west, which from their fossil plants I should be inclined to regard as Eocene.

In my original studies of the specimens described in this paper, I had examined and noted separately the collections from the eastern and western areas; but as these obviously correspond in their divisions, and several of the species are identical, I have, to avoid repetition, placed the whole together; noting, however, the localities in which the specimens were obtained, and their reference to the Lower or Upper divisions.

I may state here my obligations to the reports of Lesquereux on the Tertiary Flora of the United States, and more especially to Dr. Newberry's Memoir on the Later Extinct Floras of America,³ and to the volume of plates published in illustration of it by the United States Geological Survey⁴ as these, referring to localities adjoining the Canadian boundary and to beds continuous with ours, have proved of the greatest value for purposes of comparison.

II.—DESCRIPTIONS OF SPECIES.

1. *Filices*.

ONOCLEA SENSIBILIS, *Linn.*

Newberry, Later Extinct Floras of America, p. 39, and Volume of Illustrations, published by the Geological Survey of the Territories of the United States, 1878. Report by Dr. G. M. Dawson, on the Geology of the 49th Parallel, Appendix A.

Leaves of this species are abundant in the beds of Porcupine Creek, (long. 106°) near the international boundary, which are of Upper Laramie age. They are also found in the Lower Laramie of the same district at the Bad Lands of Wood Mountain. The species has also been recognized in the plant beds of the Isle of Mull on the Scottish coast. These were at one time regarded as Miocene, but are now recognized by Mr. Starkie Gardiner as Eocene. It is a very common American fern at the present day, ranging from Northern Canada to Pennsylvania and southward, and from the Atlantic coast into the interior. It vindicates its claim to be a long-lived species by its present wide distribution, and the considerable varieties of station in which it can flourish. Though living in America it has become extinct in Europe. Newberry describes it from the Fort Union group, in which, as well as at Porcupine Creek, it is very abundant. Dr. Newberry notices the fact that the fossil fronds are intermediate between the common modern variety and var. *obtusiloba* of Torrey.

Collected by Dr. G. M. Dawson, whose collections in the remainder of the paper will be indicated by the letters G. M. D.

DAVALLIA (STENOLOMA) TENUIFOLIA, *Linn.* (Plate I, Fig. 1.)

Report on 49th Parallel, p. 329, Pl. XVI, Figs. 1 and 2.

This species is found at Porcupine Creek with the preceding, but is more rare. I

¹ Protection Island beds of my paper, Trans. Roy. Soc. Can., Vol. i.

² Cretaceous and Tertiary Plants.

³ Annals of New York Lyceum, 1868.

⁴ Illustrations of Cretaceous and Tertiary Plants, 1878.

have compared this plant with recent specimens from the Himalayas in the collection of Mr. D. A. P. Watt of Montreal, and find no difference. The genus is not now known to be represented in America. Ferns of this type are not uncommon in the early Tertiary of other countries, but being known only by barren fronds have usually been referred to the genus *Sphenopteris*. *Sphenopteris Brunstrandii* of Heer, from the so-called Miocene of Spitzbergen is one of these species, and also *S. eocenica* of Ettingshausen.

In regard to distribution, this plant affords a curious contrast to the last. It is now confined to Asia, whereas in the Laramie period it was associated in America with our common *Onoclea*. It has not been found in the Laramie of the United States.

Collected by G. M. D.

2. *Equisetaceæ*.

EQUISETUM, Sp.

In the Upper Laramie of Porcupine Creek, are many fragments of stems of an *Equisetum* about a quarter of an inch in diameter, and with twenty to thirty ribs. It is near to *E. arcticum* of Heer, from Spitzbergen, and to *E. Wyomingense* of Lesquereux, but cannot be certainly identified.

Collected by G. M. D.

EQUISETUM, (Roots and bulblets). (Plate I, Fig. 2).

Physagenia Parlatorii, Report of 49th Parallel, p. 329, Pl. XVI, Figs. 3 and 4.

There can be little doubt that the plants designated by Heer, *Physagenia*, are really roots and tubers of *Equisetum*. The specimens are from the Upper Laramie of Great Valley (lat. 49°, long. 105°); but these objects occur in this formation in various places in Canada and the United States.

Collected by G. M. D.

3. *Coniferaæ*.

THUJA INTERRUPTA, *Newberry*. (Plate I, Fig. 3).

Newberry, *loc. cit.* p. 42. Dawson, Report on 49th Parallel, Ap. A.

This species is, according to *Newberry*, very characteristic of the Fort Union group, and is equally so of the Upper Laramie at Porcupine Creek. One of the specimens shows scales of the cone, which resemble those of *T. gigantea* of the west coast, while the foliage is nearer to that of *T. occidentalis*, the common "cedar" or arbor-vitæ of Canada. Wood, having the structure of that of *Thuja*, is found in the lignites associated with these beds, and probably belongs to this species.

Collected by G. M. D.

SEQUOIA NORDENSKIOLDII, *Heer*.

Heer, *Flora Foss. Arctica* (Spitzbergen.)

The common species of *Sequoia* found at Porcupine Creek and Great Valley seems referable to this species, and it is still more abundant in the same Upper Laramie formation at Red Deer River. Specimens of the same species from the Fort Union group, presented to me by Dr. *Newberry*, are labelled as this species, though in his memoir *S. Langsdorffii* alone is mentioned. Our specimens cannot be distinguished from those from Spitzbergen figured by *Heer*, though in form and size the leaves are somewhat variable. Cones also

are found, which, so far as can be made out, are similar to those described and figured by Heer. Some of the specimens might, it is true, be referred to *S. Langsdorffii*, but there seem so many gradations that I doubt if any specific distinction can be made out. I have already indicated in Vol. III of these Transactions that the specimens from Vancouver Island which have been referred to *S. Langsdorffii*, probably belong to *S. Smittiana* of Heer, a Cretaceous species.

This species also occurs on the Mackenzie (Richardson). Along with *S. Langsdorffii*, it is abundantly distributed in the older Tertiary of Europe and America. So far as known, it is limited in Canada to the Laramie series.

Porcupine Creek and Great Valley, collected by G. M. D.; Cones, Dirt Hills, collected by R. Bell; Red Deer River and Bow River, J. B. Tyrrell.

GLYPTOSTROBUS EUROPEUS, *Brngt.*

Heer, Flora Helvetica.

Fragments of branches and of strobiles, referable, though not very certainly, to this species in its wider acceptation among palæobotanists, occur in the Upper Laramie of Porcupine Creek. It is found, according to Newberry, in the Fort Union group of Dakota, and also, according to Heer, in the so-called Miocene of Greenland. Cones, probably of *Glyptostrobus*, occur rarely in the Porcupine Hill beds.

Collected by G. M. D.

TAXODIUM OCCIDENTALE, *Newberry.*

Newberry, *loc. cit.*

This species is found in the eastern division of the Laramie (Selwyn); and in the western division, fragments probably referable to it have been found in several places.

TAXITES OLRIKI, *Heer.* (Pl. I, Fig. 5.)

Heer, Flora Alaskana, Flora Foss. Arctica, Report of Geological Survey of Canada, 1879-80.

Leaves and branches referable to this fine species, collected by Dr. Selwyn in the sandstones of the Upper Laramie at Roche Percée, Souris River, were noticed by the writer in the report of the Geological Survey of Canada of 1879-80. It was originally described by Heer, from Alaska and Spitzbergen, and does not seem to have been noticed in the Laramie of the United States. It may have been a northern form.

SALISBURIA, *Sp.*

At least one species of *Salisburia* belongs to our Laramie Flora. Nutlets occur in some of Mr. Tyrrell's specimens from the Lower Laramie, and fragments of leaves and also nutlets were collected by the writer in the Upper Laramie sandstone of Shaganappi Point near Calgary. In so far as venation is concerned, these leaves might belong to Lesquereux's species *S. polymorpha*; but their size and form cannot be made out any further than that they represent a broad-leaved species not unlike the modern *S. adiantoides*.

4. *Monocotyledones.*

LEMNA (SPIRODELA) SCUTATA, *Dawson.* (Pl. I, Fig. 6.)

Report on 49th Parallel, p. 529, Pl. XVI, Figs. 5 and 6. Lesquereux, Tertiary Flora.

Fronde, round, kidney-form or sometimes tending to trilobed, undulate at the edges; half an inch to nearly an inch in diameter. Single or grouped, veinless or with very faint veins radiating from a marginal spot. Roots long, filiform, proceeding apparently from a slight notch on the edge of the frond.

This was evidently an aquatic plant, producing rounded or rarely trilobed fronds about three-quarters of an inch in diameter, and having numerous rootlets proceeding from a marginal or submarginal thickened spot. The fronds were evidently fleshy but not vesicular, and cellular with extremely delicate radiating veins which can seldom be seen. Whether this plant is truly a Lemna it is impossible to decide, in the absence of fructification, but I feel certain that it should not be confounded with Lesquereux's *Pistia corrugata*, with which that botanist compares it. This I have not seen, but as figured by him it differs in size, form, and venation.

The plant is plentiful and very constant in its characters in the Lower Laramie of the Bad Lands of Wood Mountain (G. M. D.); also in the Lower Laramie of Pincher Creek (T. C. Weston).

PHRAGMITES, Sp.

Many leaves referable to plants of this genus occur in all the collections, from both Upper and Lower Laramie, but can only be characterized as stems and leaves of large grass-like or sedge-like plants of uncertain affinities.

SCIRPUS, Sp.

Report on 49th Parallel.

Spikes small, numerous, less than a line long, and with from four to five pairs of incurved lanceolate scales.

Lower Laramie, Bad Lands of Wood Mountain.

Collected by G. M. D.

SCIRPUS, Sp.

Report on 49th Parallel.

Spikes with about six pairs of scales and about two lines long.

Upper Laramie, Porcupine Creek.

Collected by G. M. D.

5. *Dicotyledones.*

PLATANUS NOBILIS, *Newberry.* (Plate I, Fig. 7.)

Newberry, Later Extinct Floras; Dawson in Report Geol. Survey of Canada, 1879-80.

This magnificent leaf, of which many very good specimens have been obtained, was first described by Dr. Newberry in the Annals of the Lyceum of New York for 1868. His specimens were from the Fort Union series, near Fort Clarke, on the Upper Missouri, and were found in beds then regarded as Miocene Tertiary, though now known to be much older, and which are on the horizon of the Lignite Tertiary series of the Souris River. A figure of the leaf is given in Dr. Newberry's later work, "Illustrations of Cretaceous and Tertiary Plants," Geological Survey of the Territories, 1878. There can be little doubt that this plant is the same with that named by Lesquereux, *Platanus dubia*, in 1878, and subsequently described in his report on the Tertiary Flora of the Western Territories, as

Aralia notata. Fragments of this leaf were obtained by Dr. G. M. Dawson in the region of the Souris River in 1874, but they were too imperfect for description. Dr. Selwyn, however, found in 1878 in the Upper Laramie sandstones of Roche Percée, on Souris River, very perfect specimens, which I noticed in the Report of the Geological Survey for 1879-80, Dr. Selwyn having kindly placed his specimens in my hands for study. Some of these are a foot in diameter, and they show some points of structure not before noticed.

I may, before referring to these, quote Newberry's description, which is very full and accurate.

"Leaves large, one and a half feet in length and breadth, petioled, 3 lobed, or sub-5 lobed, lobes acute, margins of lobes and base entire, or near the summits of the lobes delicately sinuate-toothed; nervation strongly marked, generally parallel; medial nerve straight, two basilar nerves of nearly equal length and strength diverge from it at an angle of 30°-35°, are straight throughout and terminate in the apices of the principal lateral lobes. Above the basilar nerves about 16 pairs of lateral nerves are given off from the midrib at about the same angle; these are nearly straight and parallel, terminating in the teeth of the margin. From each of the basilar nerves diverge about the same number of pairs of branches as from the mid-rib, and these are nearly straight and parallel terminating directly in the margin. Of these the second and third exterior one on each side, is often much the strongest of the series, and is then prolonged into a small but distinct lateral, triangular, acute lobe, giving the leaf a somewhat pentagonal form. From this basilar branch of the lateral nerves, 12 or more short, generally simple branchlets, spring on the lower side, and 4-5 on the upper side, near the summit, all of which terminate in the margins. The tertiary nerves connect the adjacent secondary nerves nearly at right angles. Sometimes they are straight and parallel, but oftener more or less broken and branching where they meet, near the middle of the interspaces. Where the systems of nervation of the lateral and middle lobes come in contact, the tertiary nerves are stronger and form a somewhat irregular network, of which the areolæ are large and sub-quadrated."

The above description corresponds perfectly with Dr. Selwyn's specimens except that only the right basilar nerve sends off a large branch terminating in a lobe; that on the left side having somewhat equal branches.

As to the affinities of the leaf, Newberry remarks that the texture is thicker and the surface smoother than most sycamores, resembling in this some tropical leaves; but as the radical structure is that of *Platanus*, and the associated plants indicate a temperate climate, he refers the plant to that genus.

Lesquereux, in describing his *Aralia notata*, gives nearly the same characters, except that he characterizes the secondary nerves as camptodrome, or bending before they reach the margin. He admits that he would consider it identical with Newberry's species but for this feature, and further adds that in one of his specimens the outer veins appear to be craspedodrome and to terminate in small teeth, and he refers to other cases in which such characters are inconstant. In Dr. Selwyn's specimens, while in the basal part of the leaf the veins bend somewhat toward the margin, which is entire, in the upper part they run straight to the margin, and terminate in short teeth, separated by broad, shallow sinuses. Thus these specimens satisfactorily unite Newberry's and Lesquereux's species.

Dr. Selwyn's specimens, however, and others subsequently collected by myself at

Shaganappi Point, exhibit a peculiarity which seems to have been absent or concealed in the specimens studied by Newberry and Lesquereux, in the presence of two short basal lobes, extending backward on the petiole. Each of these is about an inch in length, pointed, and with one strong exterior tooth and two delicate nerves, one extending to the point and the other to the tooth. It does not certainly appear whether these basilar lobes are separate or united in the middle. If the latter, they would present some resemblance in mode of attachment to the Cretaceous leaves known as *Protophyllum*, and to the Tertiary species of Pterospermites, from which, however, this leaf differs materially in other respects. These peculiar basal lobes are preserved only in a few of the specimens.

In Dr. Selwyn's specimens the petiole is four inches long in a specimen about a foot in diameter. It is channelled, woody in texture, and with an articulating surface at the proximal end. This and its great abundance on certain surfaces, shows that the leaf belonged to a deciduous tree, which, from the localities cited by the authors already named, must have been widely distributed, though as Lesquereux remarks, especially abundant to the north.

It is to be hoped that further research will disclose the fruit of this remarkable tree, and thus make its affinities more certainly known. In the meantime, I think it well to retain Newberry's name, as having priority, and quite as likely to be correct as any other. If a *Platanus*, the tree must, as Newberry remarks, have borne somewhat the same relations to our sycamores which *Acer macrophyllum* of the West Coast bears to the other maples. This species would seem to be specially abundant in the "Second Group" (Evanston, Mount Brosse, etc.) of Lesquereux's arrangement of the Lignitic flora.

In the sandstones and shale of the Upper Laramie at Shaganappi Point, near Calgary, I found these leaves very abundant, and showing the same characters with Dr. Selwyn's specimens from the Souris. Fragments referable to this species also appear in Mr. Tyrrell's collections from another locality on the Bow River, and from disturbed beds in the foot-hills to the north; and a very similar, if not the same species, occurs in the Belly River series, near Medicine Hat.

PLATANUS RAYNOLDSII, Newberry.

Newberry, *loc. cit.* Lesquereux, Tertiary Flora. Dawson, *loc. cit.*

Very abundant with the last at Shaganappi Point. The leaves present many differences in size and form, but all of these fall within the limits of the descriptions and figures of Newberry and Lesquereux. This is a well known species of the Fort Union division in the United States.

Collected by G. M. D.

PLATANUS HAYDENII, Newberry.

Newberry, *loc. cit.* Lesquereux, Tertiary Flora.

A leaf not well preserved, but identical, so far as venation and general form are concerned, with the Fort Union species named above, occurs in Mr. Tyrrell's collections from sandstones of the Upper Laramie on the Bow River. It is associated with leaves of *P. nobilis*.

CORYLUS ROSTRATA, Ait.

Newberry, *loc. cit.* Report on 49th Parallel.

Specimens of leaves so near to the above modern species that they cannot be separated from it occur on the Upper Laramie of Porcupine Creek. Newberry has recognized this species in the Fort Union group.

Collected by G. M. D.

CORYLUS McQUARRII, *Heer*.

Heer, Flora Foss. Arctica.

Fragments pretty certainly belonging to this species appear in the collections from the Upper Laramie of Porcupine Creek. The species occurs in the Fort Union group, on Mackenzie River, and also in the so-called Miocene of Alaska and Greenland.

Collected by G. M. D.

CASTANEA, Sp.

Quercus. Report Geol. Survey of Canada, 1879-80.

Leaf elongate oblong, margin obtusely dentate at ends of veins, which are rather less than a quarter of an inch apart, and at angle of 45° to 47°. Texture coriaceous.

This leaf occurs in the Upper Laramie of Souris River. It may be the same with Lesquereux's *C. intermedia*.

Collected by Dr. Selwyn.

QUERCUS, Sp. (Plate I, Fig. 8.)

Leaf long, narrow, with simple straight nerves and entire edges.

Upper Laramie of Great Valley.

Collected by G. M. D.

POPULUS GENETRIX, *Newberry*.

Newberry, *loc. cit.*

In the Upper Laramie of Souris River, Great Valley and Shaganappi Point. In the publications of Lesquereux and Newberry there are several nearly allied species to which this leaf may have belonged; but Newberry's figure, named as above, has the same characters.

POPULUS ACERIFOLIA, *Newberry*.

Newberry, *loc. cit.*

Found in Dr. Selwyn's collections from Souris River; also in Mr. Tyrrell's collections from the foot-hills of the Rocky Mountains, north of Bow River, and in my collections from Shaganappi Point.

POPULUS RICHARDSONII, *Heer*.

Fragments of leaves from the Upper Laramie of Porcupine Creek appear to represent this species, also found on Mackenzie River.

Collected by G. M. D.

POPULUS ARCTICA, *Heer*. (Plate I, Fig. 9.)

Heer, Flora Foss. Arctica. *Newberry*, *loc. cit.*

In the specimens in my possession I cannot certainly separate *P. arctica* from leaves having the character of *P. cuneata* of Newberry, which may be merely a smaller form.

Great Valley, G. M. D. Souris River, Dr. Selwyn.

SALIX RAEBANA, Heer.

Heer, Flora Foss. Arctica.

This species, occurring in Greenland and on the Mackenzie River, is represented by a few specimens in the collections from Great Valley.

Collected by G. M. D.

SALIX LARAMIANA, S. N. (Plate I, Fig. 10).

Leaf moderately large and wide, veins few, at angle of 45° , forking at an obtuse angle toward the margin, which is entire, surface finely reticulate.

This species, except in its entire margin, resembles very nearly the *S. varians*, Heer, from Alaska. It occurs in the Upper Laramie of Great Valley.

Collected by G. M. D.

ULMUS PRÆCURSOR, S. N. (Plate II, Fig. 11).

Leaves small, thin, inequilateral and rounded at the base. Apex acute, margin sinuate. Veins numerous, slightly curved, and dividing toward the margin to enter into the unequal serrations.

This species is nearly related to the *U. tenuinervis* of Lesquereux, from Florissant, Colorado. It does not seem to have been found in the recognized Laramie or Fort Union group of the United States.

SASSAFRAS (ARALIOPSIS) BURPEANUM, Dawson. (Plate II, Fig. 12).

Dawson, Mesozoic Floras, Trans. Roy. Soc. Can., Vol. III.

This leaf will be found described in the paper above cited. It is from the Upper Laramie of Shaganappi Point, and is named after Mr. Burpee, who aided in my explorations there.

SASSAFRAS SELWYNII, Dawson. (Pl. II, Fig. 13).

Dawson, Report Geol. Survey of Canada, 1879-80.

Leaf somewhat rough on the under side; three lobed, three ribbed, with the central lobe longest; ribs and nerves strong and woody; margin entire and slightly waved; breadth, 4.5 centimetres; length, 5 centimetres. The two lateral nerves diverge at an angle of 40° from the midrib. Each lateral rib gives off three small curved veins at its base, and these six strong curved veinlets which bend round and become parallel with the margin. Slender parallel veins are given off from the inner sides of the lateral ribs, and join those of the midrib up to a height of 1.5 centimetres, when the midrib gives off 6 strong slightly curved parallel lateral veins on each side, at angles of 40° .

This species is represented by only one well-preserved example and some fragments, in Dr. Selwyn's collections from the Souris River. Its form and venation are very peculiar, and I think entitle it to be referred to *Sassafras* with quite as much probability as many of the leaves from the Cretaceous referred to that genus. It is indeed very near to *S. cretaceum*, Newberry, especially the variety *obtusum* of Lesquereux. It is to be observed, however, that this common Cretaceous species has also been referred to *Araliopsis*. If a *Sassafras*, it is of interest as being the first representative of that genus in the Laramie period.

Collected by Dr. Selwyn.

VIBURNUM ASPERUM, *Newberry*.

This Fort Union Species is quite abundant in the Upper Laramie of Red Deer River. Fragments also occur in the Souris River collection and in those from Shaganappi Point, where are also fruits which may have belonged to some species of Viburnum. It also occurs at Porcupine Creek.

VIBURNUM CALGARIANUM, *Dawson*. (Plate II, Fig. 14.)

Described in the Transactions of the Royal Society of Canada, Vol. III, from specimens collected at Shaganappi Point.

VIBURNUM OXYCOCCOIDES, *Dawson*. (Plate II, Fig. 15.)

Described as above from specimens collected at Shaganappi Point. Accompanied by fruits like those of Viburnum. This species is very near to the modern *V. opulus*.

VIBURNUM LANCEOLATUM, *Newberry*.

Newberry, loc. cit.

A leaf from Porcupine Creek seems to represent this Fort Union species.

CATALPA CRASSIFOLIA, *Newberry*.

Fragments of leaves in the Upper Laramie of Bow River are similar to the above species, whose generic relations are doubtful.

Collected by J. B. Tyrrell.

SAPINDUS AFFINIS, *Newberry*.

Newberry, loc. cit.

Leaves of this characteristic Fort Union species occur in the Lower Laramie of the Bad Lands of Wood Mountain, and also in the Upper Laramie of Great Valley.

Collected by G. M. D.

ÆSCULUS ANTIQUA, *Dawson*. (Plate II, Fig. 16.)

Report on 49th Parallel, 1875.

Pericarp $1\frac{1}{2}$ inches in length and one inch in breadth; obovate, truncate at the base, regularly rounded above with several strong woody spines on the upper half. Seed of similar form, but smooth or with a few tortuous impressions. This fruit seems to be an *Æsculus*, but with characters somewhat intermediate between those of the horse-chesnut and those of the American buckeye.

Lower Laramie, Bad Lands, Wood Mountain.

Collected by G. M. D.

SYMPHOROCARPOPHYLLUM, G. N.

I place under this name certain leaves from the Upper Laramie of Great Valley, which at first I had named *Hederophyllum*, but now find them so near in form, venation and texture to the leaves of the common snowberry that I can scarcely doubt their affinity to these. On the same slabs there are remains of berry-like fruits, which probably belong to some caprifoliaceous plant, and possibly to the species described below.

SYMPHOROCARPOPHYLLUM ALBERTUM, S. N. (Plate II, Fig. 17.)

Leaf about an inch in length, obovate, pointed below, rounded at apex, with two blunt teeth on the sides. Midrib obscure, veins at very acute angles and evanescent, surface finely netted. Upper Laramie of Great Valley.

Collected by G. M. D.

S. LINNÆIFORME, S. N. (Plate II, Fig. 18.)

Leaf very small, rounded, with five very obtuse lobes, the terminal lobe by much the largest. The leaves are tortuous and dichotomous, with a fine reticulation between. Has much the general aspect of the leaf of *Linnæa borealis*. Upper Laramie, Porcupine Creek.

Collected by G. M. D.

PALIURUS COLOMBI, *Heer*.

Heer, Flora Foss. Arctica. Lesquereux, Tertiary Flora.

Described originally by Heer from Greenland and Spitzbergen, and found along with *Populus arctica* at Carbon, Wyoming. Upper Laramie, Great Valley.

Collected by G. M. D.

CARYA ANTIQUORUM, *Newberry*.

Newberry, *loc. cit.* Lesquereux, Tertiary Flora.

Described by Newberry from the Fort Union beds, in which its leaves are abundant. Lesquereux finds it in the Yellowstone Valley and at Evanston. Upper Laramie of Porcupine Creek.

Collected by G. M. D.

JUGLANS RUGOSA, *Lesquereux*.

Lesquereux, Tertiary Flora.

In the Report on the 49th Parallel I referred these leaves to *Juglans nigella* of Heer, but they are still nearer to Lesquereux's figures, if these represent a true species and not merely a varietal form.

In confirmation of the reference of this and the following species to *Juglans*, I may mention that, in some of the silicified wood of the district which affords the leaves, there are trunks which have been sliced by Mr. Weston and show the structure of the modern butternut. Porcupine Creek, Upper Laramie.

Collected by G. M. D.

JUGLANS SCHIMPERI, *Lesquereux*.

Lesquereux, Tertiary Flora.

Lesquereux's description is as follows:—"Leaves lanceolate, gradually acuminate, broadly cuneate, and rounded at the inequilateral base to a short petiole; borders slightly undulate, secondary veins numerous, parallel, curved, closely following the borders, nervilles distant, areolation subquadrate." Leaves answering to this description occurs in the Upper Laramie shale of Great Valley. Lesquereux's specimens were from the Green River group, which is reported as typical Eocene, and may be newer than the Upper Laramie.

Collected by G. M. D.

JUGLANS RHAMNOIDES, *Lesquereux*.

Lesquereux, Tertiary Flora.

This species is thus described by Lesquereux:—"Leaves oval, narrowed in a curve or rounded to the petiole, very entire; lateral veins thin, distant, curved in passing to the borders, camptodrome."

Lesquereux's specimens were from Spring Cañon, Montana, also Black Butte, Wyoming, and Point of Rocks, Wyoming, all belonging to his Lower Lignitic or Laramie group, and he regards Newberry's species from the Fort Union group, *Cornus acuminata*, as the same. The species is closely related to, if not identical with, *Juglans acuminata*, Brongt., of the European Tertiary. My specimens are from the Upper Laramie, Porcupine Creek.

Collected by G. M. D.

TRAPA BOREALIS, *Heer*. (Plate II, Fig. 19).

TRAPA MICROPHYLLA, *Lesquereux*.

Heer, Flora Alaskana. Dawson, Report on 49th Parallel, 1875. Lesquereux, Tertiary Flora.

Fruits of *Trapa*, or water chestnut, referred by me to Heer's Alaska species, were recognized in 1876 in the collections of Dr. G. M. Dawson from the 49th parallel, from beds belonging to the Lower Laramie group. More recently, Lesquereux has found, in beds probably of Laramie age at Point of Rocks, leaves which he has named *Trapa microphylla*, and attributes to this genus. In Mr. Tyrrell's collections from the Red Deer and Rosebud Rivers, there are fruits similar to those of Heer's species, 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.

Lesquereux's description of the leaves is as follows:—"Leaves small, (round?) or broadly ovate and obtusely rounded to the petiole, borders denticulate from below the middle upward, nervation ternate from the top of the petiole, or irregularly pinnate, lateral nerves at an acute angle (15° to 20°), flexuous with dichotomous branches, all craspedodrome, areolation distinct, polygonal, minute, by subdivisions of the veinlets at an acute angle." Heer's description of the fruit is as follows:—"Nuts two-horned, narrowed at base, striate longitudinally, widened in the middle, with two spines which are long, divergent and acute; the apex exsert and narrowed."

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. (G. M. D.) Red-deer and Rosebud Rivers (Tyrrell), and Pincher Creek (Weston). In some of these localities the leaves and fruits occur together, and in some they are associated with *Lemna scutata* and *Phragmites*.

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

PHYLLITES VENOSUS, *Newberry*.

Newberry, *loc. cit.*

A leaf of very uncertain affinities; but it furnishes another point of accordance between the Canadian Laramie and the Fort Union group, Upper Laramie, Porcupine Creek. Collected by G. M. D.

PHYLLITES, Sp. (Pl. II, Fig. 20).

This is a small oblong leaf, with a mid-rib and a few veins curving toward the margin. Near the apex, the sides suddenly curve inward, giving a shouldered or almost three toothed aspect. Upper Laramie, Great Valley.

Collected by G. M. D.

PHYLLITES CAPARINOIDES, *Newberry*.

Newberry, loc. cit.

Another uncertain species common to the Fort Union and Upper Laramie of Great Valley.

Collected by G. M. D.

CARPOLITHES, Sp.

In Mr. Tyrrell's collections from Antler Hill, probably Upper Laramie, are several kinds of fruits, some of which seem to have been smooth two-valved nuts, and others drupes, like those of *Viburnum*. They are not sufficiently perfect for certain determination; but the locality is one deserving the attention of collectors, as likely to afford useful information respecting the fruits of the trees of the Laramie forests. It is an interesting but somewhat unfortunate circumstance that the sorting action of water has usually distributed fruits in different places from the leaves of the same plants.

III.—GENERAL REMARKS.

As the relation of the Belly River series (which on stratigraphical grounds is regarded as inferior in position to the Fort Pierre group) to the Laramie is of some interest, it may be well to state here that this series closely resembles the Lower Laramie in its physical features and in its fossils. The number of species which it has afforded is, however, small, and about half of these are distinct from those of the Laramie.

The species observed in the collections from this group are the following:—

- Sequoia Reichenbachii*, *Heer*.
- Salisburia*? fruits of
- * *Lemna scutata*, *Dawson*. (Trans. Roy. Soc. Can., III.)
- Brasenia antiqua*, *Dawson*. (*Ib.*)
- * *Platanus nobilis*, *Newberry*.
- Acer Saskatchewanense*, *Dawson*. (*Ib.*)
- * *Populus acerifolia*, *Newberry*.
- “ *latidentata*, *Dawson*. (*Ib.*)
- * *Trapa* (probably *T. borealis*), *Heer*.

These few species are scarcely sufficient to afford a basis for definite conclusions. Those marked with asterisks are found in the Laramie. The others are distinct, but their general aspect does not indicate any great difference of age. It is to be hoped that further explorations may disclose a larger number of species, but sufficient is known to indicate that the conditions of deposit and of vegetable life were very similar.

Of the plants found in the Laramie itself only the following occur in the lower division, those marked with asterisks being found in both divisions:—

- * *Onoclea sensibilis*, *Linn.*
- * *Lemna scutata*, *Dawson.*
- * *Phragmites*, *Sp.*
- * *Scirpus*, *Sp.*
- * *Sapindus affinis*, *Newberry.*
- Æsculus antiqua*, *Dawson.*
- * *Trapa borealis*, *Heer.*
- Carpolithes.*

This little flora bespeaks aquatic conditions not favorable to the preservation of land plants, but showing that exogenous trees, akin to those of the Upper Laramie above and the Cretaceous below, existed. It may be hoped that within our district some locality more prolific in plants may be discovered. The Lower Laramie would seem to correspond with some of the localities in the United States referred by Lesquereux to his first or oldest Tertiary series, though, as already stated, the beds hold remains of Saurians of Cretaceous aspect.

The Upper Laramie flora is decidedly richer, including all the other species described in this paper. Its plants are in the main identical with those of the Fort Union group of the United States geologists, which it would seem that Lesquereux still holds to be of Middle Tertiary age, along with those of the Bad Lands of Dakota and of Carbon, and with the so-called Miocene of Alaska, Greenland and Mackenzie River, as described by Heer. To this I cannot agree. The evidence of stratigraphy and fossils seems to refer all these to the Eocene period. If with Lesquereux we regard the Lower Laramie flora as Lower Eocene, and corresponding to that of Sessanne in Europe, then the Upper Laramie will be Middle or Upper Eocene. If on the other hand the Lower Laramie be regarded as the highest member of the Cretaceous, the Upper Laramie may be Lower Eocene. In the meantime I cannot help believing that, notwithstanding the large amount of material collected, and the valuable work done by the palæobotanists of the United States Geological Survey, there is still some confusion in the arrangement of the successive floras which may require revision in the future.

With this third paper I close for the present my sketches of the Cretaceous and Early Tertiary floras of Canada. I have been induced to leave for a time my favourite Palæozoic plants, and to notice the collections made in the less ancient formations of the west, by the intrinsic interest of the subject, by the wish to trace up the vegetable kingdom in its later stages, and by the belief that some misunderstandings existed which the distinct sequence of formations in this country might clear up.

The material at my disposal has been from several horizons well fixed by geological work, and thus, though not in itself large, its study has I think been fruitful of important results; and when in future the flora of the several successive formations from the Lower Cretaceous to the Eocene shall have been more fully worked out, though what I have been able to do in the infancy of collection in these regions, may be eclipsed by the rich additions which will be made, it will I think be found that a good foundation has been laid for the understanding of the true succession of vegetable life from the earlier Cretaceous onward.

A short explanation may be necessary as to nomenclature. In this I have followed the methods heretofore used by others. I have, however, done so under protest and with certain qualifications as stated in my last paper, to the effect that generic names applied to fragments of plants must be merely tentative and provisional, and that they are liable to large corrections when more perfect specimens shall be procured.

In this matter I sympathise very strongly with Dr. Nathorst in his objection to the use of modern generic names for mere leaves, and would be quite content to adopt some non-committal termination, as that of *-phyllum*, suggested by him. I feel, however, that almost as much is taken for granted if a plant is called *Corylophyllum*, as if called *Corylus*. In either case a judgment is expressed as to its affinities, which if wrong under the one term is wrong under the other, and after so much has been done by so many eminent botanists, it seems inexpedient to change the whole nomenclature for so small and questionable an advantage. I wish it, however, to be distinctly understood that the leaves described in this paper are for the most part referred to certain genera on evidence necessarily imperfect, and their names are, therefore, subject to correction as new facts may be obtained.

In the work which I have done on Palæozoic fossil botany, I have laboured by much digging to get together all the parts of the plants described, though, after doing this, I have often had the mortification to find that botanists accustomed only to hand specimens of fossil plants have regarded my statements with suspicion, as if relating to merely imaginary restorations. In the case of the deciduous trees of the later formations, it is less easy to obtain evidence of this kind, and in the exploration of our Western territories the difficulty of transporting bulky specimens has been too great to allow as much to be done as in the Devonian and Carboniferous districts of the East.

I may add that, since the publication of my first memoir, Dr. G. M. Dawson has made important collections in the Cretaceous coal formation of Vancouver Island. These, while more fully illustrating previously described material, will add a number of new species which await study and illustration.

By the kind permission of Dr. Selwyn, the drawings for this and for the previous paper have been executed by Mr. L. M. Lambe, artist to the Geological Survey.

NOTE.—Owing to the absence of the author when the foregoing sheets were passing through the press, a few trifling errors have occurred which are now corrected.

Page 22, after "THUJA INTERRUPTA," read "(Pl. I. Figs. 3 and 4.)"

" 27, insert "(Pl. I. Fig. 8.)" after "CASTANEA, Sp.," instead of after "QUERCUS, Sp."

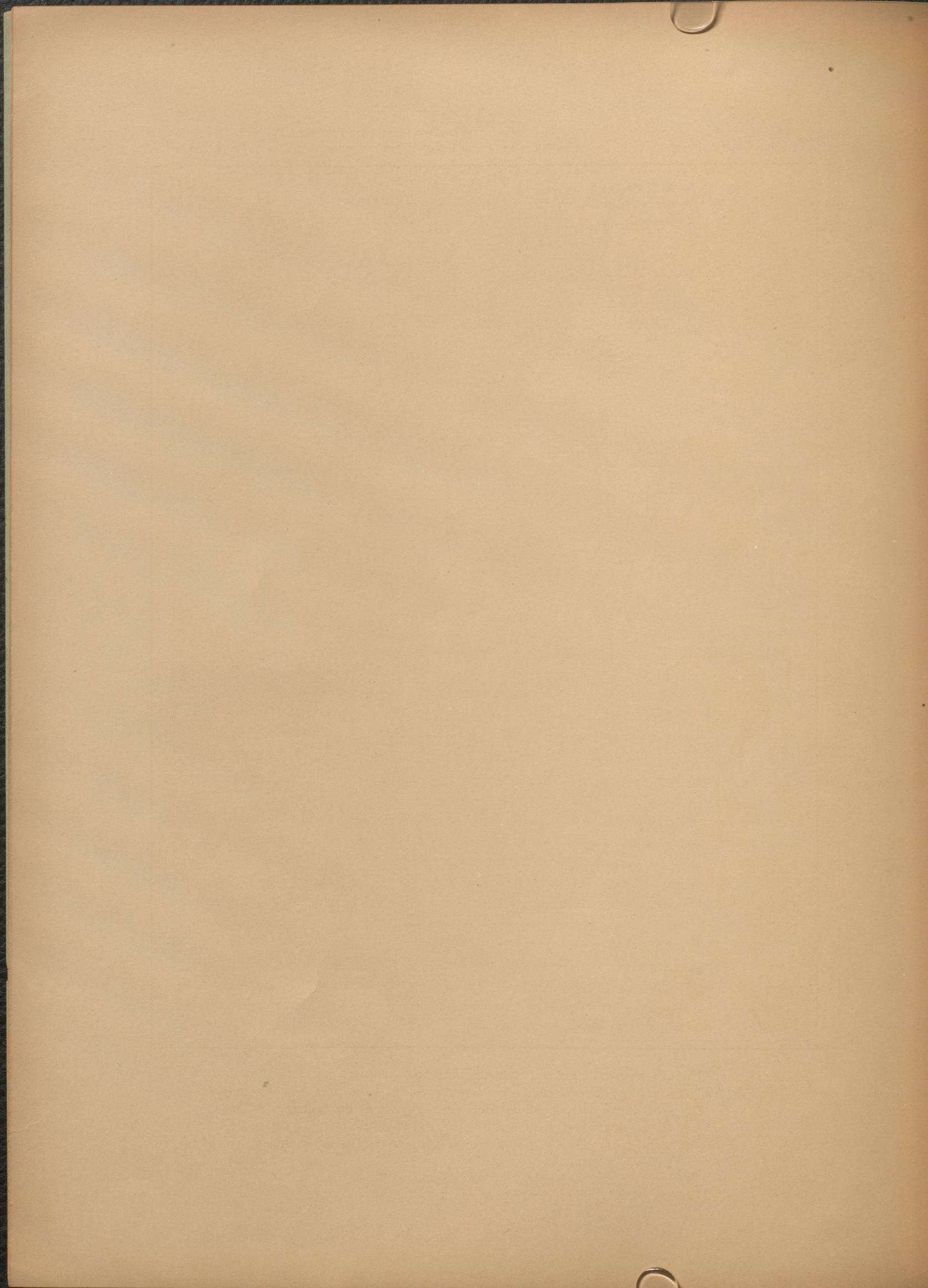
" 30, under "S. LINNÆIFORME," read "the veins are tortuous" for "the leaves are tortuous."

In Plate II, Figs. 15 and 18 are in part restorations, in consequence of the best specimens having been mislaid.



THE BURLAND LITHOGRAPHIC CO. MONTREAL

L.M. Lambe, del.
 Fig. 1. *Davallia tenuifolia*. Fig. 2. *Equisetum* (root.) Fig. 3. *Thuja interrupta*.
 Fig. 4. Fruit of the same. Fig. 5. *Taxites Olriki*. Fig. 6. *Lemna scutata*. Fig. 7. *Platanus nobilis* (reduced).
 Fig. 8. *Castanea*. Fig. 9. *Populus arctica*, var. Fig. 10. *Salix Laramiana*.



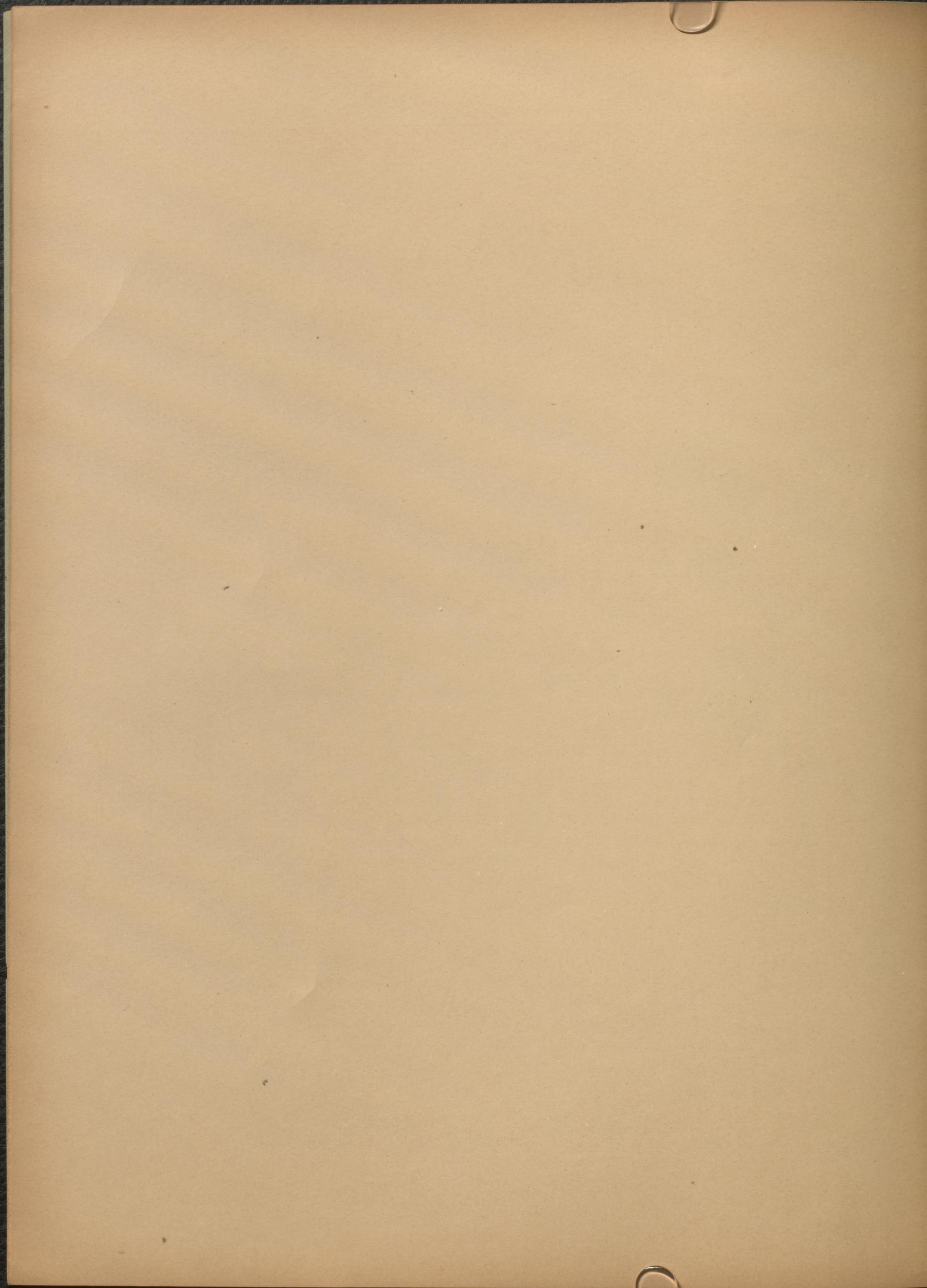


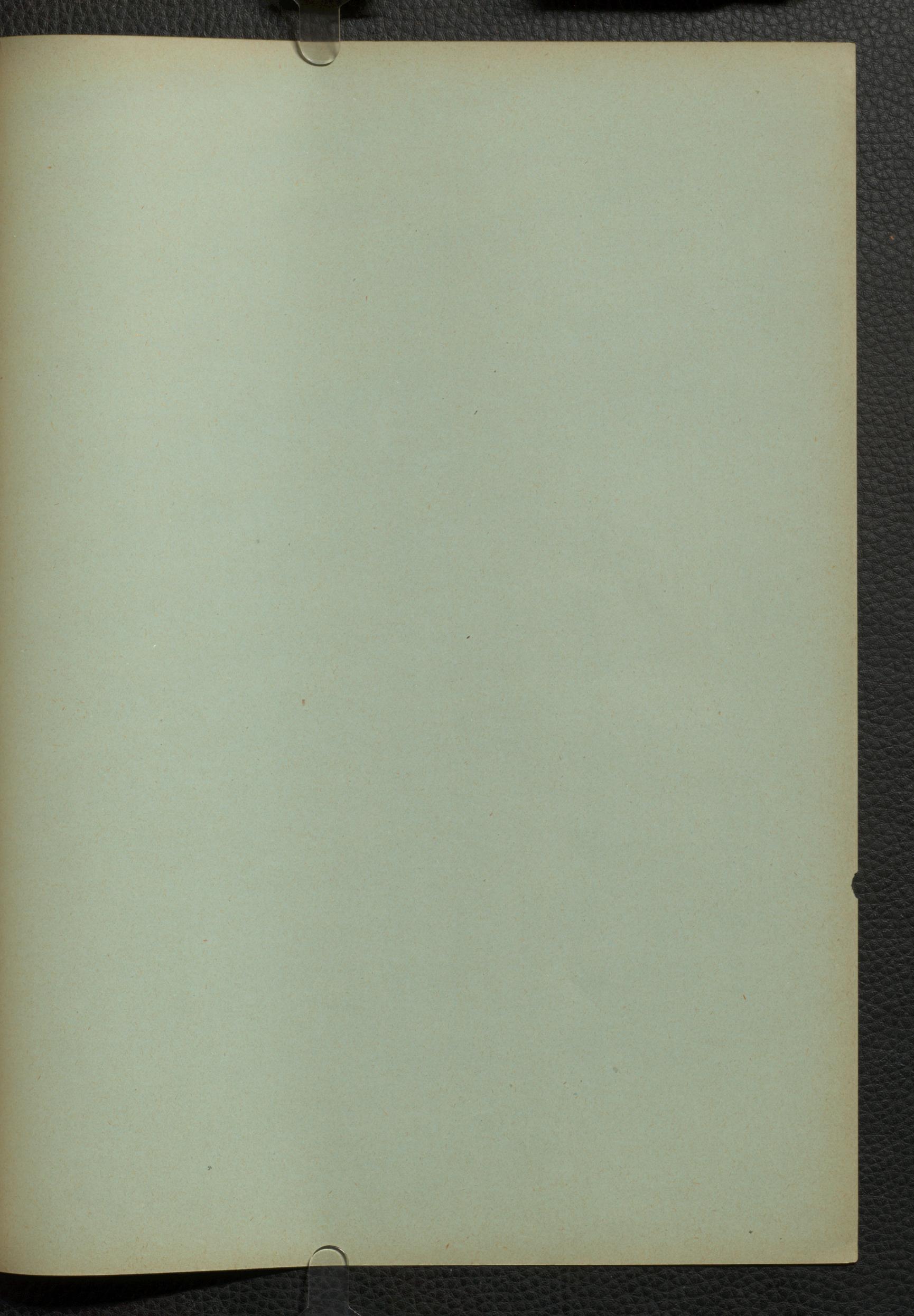
THE BURLAND LITHOGRAPHIC CO. MONTREAL.

L.M. Lambé, del.

Fig. 11. *Ulmus præcursor*. Fig. 12. *Sassafras Burpeana*. Fig. 13. *Sassafras Selwynii*.
 Fig. 14. *Viburnum Calgarianum*. Fig. 15. *V. oxycoccoides*. Fig. 16. *Aesculus antiqua*.
 Fig. 17. *Symphorocarpophyllum Albertum*. Fig. 18. *S. Linnæiforme*.
 Fig. 19. *Trapa borealis*. Fig. 20. *Phyllites*.

Note.—Fig. 14. This species is near to *V. Nordenskiöldi*, Heer. Figs. 15 and 19 (b.) are partially restored.





64