

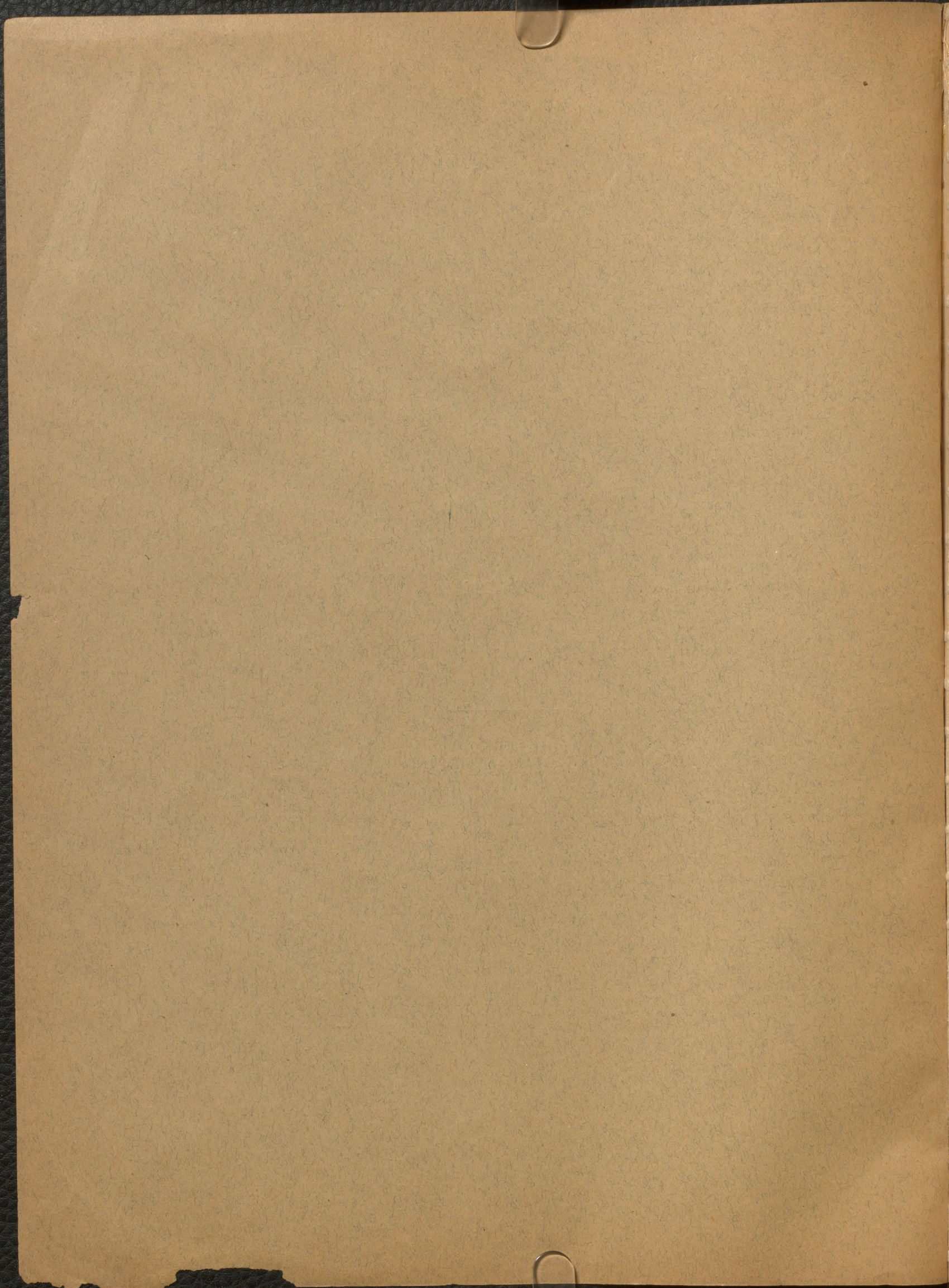
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NEW SPECIES OF CRETACEOUS PLANTS

FROM

VANCOUVER ISLAND.

SIR J. WILLIAM DAWSON, F.R.S., ETC.



VI.—*On New Species of Cretaceous Plants from Vancouver Island.*

By Sir J. WILLIAM DAWSON, F.R.S., etc.

(Read May 25, 1893.)

CONTENTS:—I. Geological Notes; II. Descriptions of Species; III. Fossil Plants in Relation to Climate and Age.

I.

The greater part of the material to which this paper relates was collected by Dr. G. M. Dawson, F.R.S., at Port McNeill, on the northeast coast of Vancouver Island, in 1885. To this has been added a collection subsequently made at the Wellington Colliery, Nanaimo, also on Vancouver Island, farther south, and some specimens obtained at the Vancouver Colliery, Nanaimo, by Mr. S. Robins, and kindly placed by him in the hands of Dr. Dawson.

A preliminary notice of the part of the collections from Port McNeill was presented to this Society in May, 1888, in which the following statements were made as to their occurrence:

“The precise locality is situated on the north shore of Port McNeill, bearing N. 65° E. (mag.) from the Eel Reef. The beds here lie at an angle of about ten degrees, or not far from horizontal; and the plants are found in shales or shaly sandstones about five feet above a small seam of coal from one to two inches thick.

“The Cretaceous rocks of the northern part of Vancouver Island appear to belong to a basin or deposition-area distinct from that of the Comox and Nanaimo districts to the south, and more closely connected with that of the Queen Charlotte Islands to the north. The best general section of the rocks in question, so far observed, is that in Quatsino Sound, where there seem to be represented the three higher members of the Cretaceous section of the Queen Charlotte Islands, as it exists in the vicinity of Skidegate Inlet. The Cretaceous rocks which extend along the northeast coast of Vancouver Island, from Port McNeill to Beaver Harbour, may in part represent the lowest or coal-bearing portion of the Quatsino section. A few fossil plants obtained at Beaver Harbour are Middle Cretaceous, and possibly referable to a horizon near that of the lowest beds at Quatsino. The Port McNeill beds are, so far as stratigraphical evidence exists, probably much later than these; but their stratigraphical position has not been fully determined, and as no fossils but plants have been found in them, these constitute the best evidence as to their precise age at present available. (See Part B, Annual Report Geological Survey of Canada, 1886.)”

This evidence, as stated in the preliminary note, would place the Port McNeill beds in the Upper Cretaceous, and not far from the horizon of the coal-measures of Comox and

Nanaimo, but probably a little higher. They certainly belong to the "Nanaimo Group" of Dr. Dawson, as defined in his paper in 'The American Journal of Science,' vol. xxxix., 1890, p. 180. This will be better understood by a reference to the following section of the Comox Cretaceous coal-field, from the report of the late Mr. Richardson, quoted by Dr. Dawson in the paper just referred to (order descending) :—

G. Upper conglomerate.....	320 feet.
F. Upper shales.....	776 "
E. Middle conglomerate.....	1,100 "
D. Middle shales.....	76 "
C. Lower conglomerate.....	700 "
B. Lower shales.....	1,000 "
A. Productive coal-measures.....	730 "
	4,902 "

The lower members (A to D inclusive) have afforded fossils both animal and vegetable, and are approximately identified in age with the Chico group of California. The higher divisions have afforded no fossils, but are evidently a portion of the same Cretaceous series, but belonging to its newest parts. The Port McNeill beds are believed to overlie those of Quatsino, and these are probably somewhat older than the Comox coal-measures. Thus the Port McNeill beds may be approximately equivalent to those of Comox and Nanaimo, either to the productive coal-measures or to one of the upper members of the section. Some of the species of plants are the same, and the differences may be merely local and accidental, though, so far as they go, they might be held to indicate a horizon slightly higher. A practical point in this connection is that it is possible that the productive coal-measures may immediately underlie the plant-bearing beds at Port McNeill.

For species previously described from the Cretaceous of the west coast of British Columbia, I may refer to my paper in the 'Transactions' of this Society for 1882.

I only add here that certain layers at Port McNeill are unusually rich in well-preserved fossil leaves, and that Dr. Dawson, when at the locality, loaded his boat with slabs from the more productive layers, to be split open with care subsequently. In this way more perfect specimens were obtained than could otherwise have been possible in the case of a material so friable.

In this, as in previous papers, I think it proper to say that I cannot be expected to pledge myself for the accuracy of the generic names attached to mere leaves. When the fruit shall be found connected with them, they may require very different reference. At present they merely stand as forms of certain types characteristic of a certain geological age, and admitting of more or less accurate comparison with modern plants.

I am indebted to Miss Cora Blanche B. Evans, B A., for the drawings reproduced in the plates.

II.

1. MACROTLENIOPTERIS VANCOUVERENSIS, s. n.

Plate V., figs. 1, 2, 3.

Leaflet large, often six inches in length, elongate obovate, obtusely pointed at the base; apex rounded or truncate. Midrib strong, straight; veins delicate, very numerous, often obscure, parallel to each other, and nearly at right angles to the midrib, except toward the distal end, where they turn with gradually diminishing angles toward the line of the midrib. Length of the largest leaflets, nine inches; breadth where widest, three inches. I give the outline of a nearly entire pinnule and two fragments, to show venation and base.

This genus has not hitherto been recognized in the Cretaceous of Vancouver Island. It is an old type, more characteristic of the Lower Cretaceous, and here probably verging on extinction. *M. giganteus*, Fontaine, from the Lower Cretaceous of the Southeastern States, is a near ally.¹

Collected by Mr. Robins at the Vancouver Colliery, Nanaimo.

2. CLADOPHLEBIS COLUMBIANA, s. n.

Plate V., figs. 4, 5.

Pinnate. Pinnules large, oblong, with waving margins, slightly bent upward, obtuse or bluntly pointed, attached by the whole base to the stout midrib. Midrib of pinnule slender, evanescent at the apex; nerves somewhat distant, apparently forking once. Terminal pinna elongated, and confluent with the upper pinnules.

A large and fine species, of a type abundant in the Cretaceous. The genus is a provisional one, and will stand only in the absence of fructification. The species is near to *Pteris frigida* of Heer, from Greenland. From the state of the specimen, the figure scarcely shows the broad attachment of the pinnules or the forking of the nerves.

3. ADIANTITES PRÆLONGUS, Dawson.

Plate VI., fig. 6.

'Transactions Royal Society of Canada, 1882,' p. 25, Plate V., fig. 19.

This leaf appears to be the same with the above named species, collected by Dr. Dawson at Baynes' Sound, in Vancouver Island, in beds supposed to be somewhat lower in the series than the coal-measures of Nanaimo. The present specimens were obtained at Wellington Mine, Nanaimo. I have regarded these fossils as ferns, but it admits of doubt whether they may not be leaves of Taxine-trees, allied to *Salisburia*, or possibly to *Phyllocladus*, a genus which occurs in the Dakota group of the United States. Their want of true petioles, their thin and delicate texture, and the great tenuity of the flabellate veins are, however, adverse to this supposition.

¹ "Report on the Flora of the Potomac Formation."

4. NÆGGERATHIOPSIS ROBINSI, s. n.

Plate VI., fig. 7.

I figure this peculiar form in the hope that other and more complete specimens may be found. It is a large parallel-veined leaf of firm texture and glossy surface, narrowing to the base, and attached directly to a ribbed or striated stem or petiole. Other fragments show that it sometimes attained to larger dimensions than the specimen figured, but unfortunately the apex is not preserved, so that we do not know its form. It may have belonged to a gymnospermous plant allied to *Næggerathia*, or to a cycad of the type of the modern *Encephalartos*, or it may have been a species of palm.

Vancouver Colliery, Nanaimo. Collected by Mr. Robins.

9. DAMMARITES DUBIUS, s. n.

Plate VI., fig. 8.

Leaf or bract curved, lanceolate, pointed, truncate at base. Surface rough, texture seemingly strong and resisting. It may be a bract or spathe of some cycadaceous plant allied to *Williamsonia*, but might also be supposed to be a leaf of *Dammarites* not showing the veins. The specimens are curved and partly doubled on the middle line, which is angular and sometimes like a midrib. If drawn diagrammatically on a plane it would present a regular lanceolate form, with a base about a quarter of an inch wide, which, however, is broken.

Wellington Colliery, Nanaimo. G. M. Dawson.

6. SEQUOIA LANGSDORFFII, Heer.

Plate VI., fig. 9.

Small branchlets of this common Cretaceous species appear in the collections both from Port McNeill and Vancouver Colliery. It was one of the species first recognized in these beds by Newberry.

I cannot distinguish the Cretaceous specimens referred to this species from those in the Laramie and Middle Tertiary. It would seem to range from Upper Cretaceous to Miocene, inclusive. The evidence of cones is usually wanting.

7. TAXODIUM, sp.

Plate VI., fig. 10.

The genus *Taxodium* has previously been recognized at Nanaimo and elsewhere on Vancouver Island, especially *T. cuneatum*, Newberry, which, however, the figured does not appear to resemble.

8. SALISBURIA PUSILLA, s. n.

Plate VI., figs. 11, 12, 13, 14.

Leaves fan-shaped, broader than long, and scarcely, if at all, distinguishable from half-grown leaves of the modern *S. adiantifolia*; but as there are numerous detached

leaflets, all small, it is probable that they belong to a diminutive Cretaceous representative. It is interesting thus to find so close an ally of the modern form in the Upper Cretaceous. It may be compared with *S. adiantoides*, Heer, from the Tertiary of Greenland, and with *S. Laramiensis*, Ward, from the Laramie of Point of Rocks, Wyoming, being about the same size and a little wider in proportion. *S. primordialis*, Heer, of the Lower Atané of Greenland (Middle Cretaceous) is a closely allied species, but larger and coarser in structure.

Common in the shales at Port McNeill. G. M. Dawson.

9. *SABAL IMPERIALIS*, Dn.

Plate XIV., fig. 61.

I figure here, of the natural size, an unusually perfect specimen of the central part of the leaf of this fan-palm, which seems to be not uncommon at Nanaimo, but always hitherto in fragments. It was probably a low-growing species, as no specimens of the stem have been seen. The specimen figured is from the collection of Mr. Robins at Vancouver Colliery.

10. *SALIX*, sp.

Plate VII., fig. 22.

The specimen figured represents a leaf somewhat rare in the collections, and for the most part imperfect. It may be a species of *Salix*; but leaves of this genus are so variable that I hesitate to give it a specific name. It resembles somewhat *S. Hayii* of Lesquereux, from the Dakota of Kansas, but is larger.

Port McNeill. G. M. D.

11. *POPULITES PROBALSAMIFERA*, s. n.

Plate VII., fig. 23.

A small, obovate, acuminate leaf, with entire margin and veins of camptodrome type, resembling that of *P. balsamifera*. It may be compared with *P. Sternbergii*, Lesq., from the Dakota group, and with *P. Broggeri*, Heer, from Greenland, and also from the Dakota group.

Port McNeill. G. M. D.

12. *BETULA PERANTIQUA*, Dn.

'Trans. Royal Society of Canada, 1883,' Pt. IV., Plate VII.

The original specimen of this species is from Baynes' Sound, and is the oldest of our known birches. Similar species are found by Lesquereux in the Dakota group. His *Betulites Westii* is near to this species.

Port McNeill. G. M. D.

13. *FAGOPHYLLUM RETOSUM*, s. n.

Plate VII., fig. 15.

Leaf ovate-oblong, cuneate at base, entire (?). Nerves simple, at an acute angle, somewhat distant, cross nervilles distinct. Apex not seen, probably obtuse. This leaf is

Sec. IV., 1893. 8.

of the type of *F. cretacea*, Lesq., of the Dakota group, but is twice as large and correspondingly coarse in venation, and with the lower nerves at a more acute angle. I hesitate in referring this leaf to *Fagus*. It may be a *Juglans*, compare *J. crassifolia*, Heer, but the venation is more near to *Fagus*.

Port McNeill. G. M. D.

14. FAGOPHYLLUM NERVOSUM, s. n.

Plate VII., fig. 16.

Leaf oval, pointed at both ends, entire, with numerous nearly straight nerves at angle of 45°. It is near to *F. polyclada*, Lesq. ("Cretaceous Flora," vol. vii., plate v.), but has even instead of wavy borders.

Port McNeill. G. M. D.

15. DRYOPHYLLUM OCCIDENTALE, s. n.

Plate VII., figs. 17, 18.

Leaf lanceolate, margins entire. Nerves numerous, slightly curved. Leaves about the size of those of the modern *Quercus virens* of the South, but more pointed. Leaves of this kind and of the species *D. elongatum* are very plentiful on the surfaces of the shale of Port McNeill, corresponding very closely to two common types of evergreen oak-trees living in Georgia. No acorns have yet been found in these shales, so that some doubt may exist as to the reference to the genus *Quercus*. *Q. multinervis* of Lesquereux may be compared, but the base is less pointed.

Port McNeill. G. M. D.

16. DRYOPHYLLUM NEILLIANUM, s. n.

Plate VII., fig. 19.

Leaf lanceolate, acuminate, pointed, obtuse at base, entire. Veins numerous, straight, at a somewhat acute angle to midrib. Of the type of *Q. salicifolia*, but broader, and with more frequent and straighter veins.

Port McNeill. G. M. D.

17. DRYOPHYLLUM ELONGATUM, s. n.

Plate VII., fig. 20.

Leaf long-ovate, somewhat acuminate, margin entire. Veins at angle of about 45°. Resembles the next species, but differs somewhat in general form, being less wide below and narrowed above, giving a more elongate and oval shape. The margin is also entire. Reminds me very much of the modern willow-leaved oak of Georgia. It is very abundant in the shale at Port McNeill, where it would seem to have been one of the most common trees.

Port McNeill. G. M. D.

18. DRYOPHYLLUM, sp.

Plate XII., fig. 59.

There are in the collections from Port McNeill several diminutive leaves which may belong to species of this genus distinct from those above named, but are too imperfect for adequate description.

19. QUERCUS HOLMESII, Lesq.

Plate VII., fig. 21.

Seems to be identical with Lesquereux's species, which, according to him, is from Cretaceous beds later than the Dakota group, and probably Upper Cretaceous.

Port McNeill. G. M. D.

20. QUERCUS VICTORIÆ, Dn.

'Trans. Royal Society of Canada, 1882,' Pt. IV., Plate VII.

This species was originally described from Nanaimo, where it seems not uncommon. In the present collections, both from Wellington Colliery and Port McNeill, there are several fragmentary specimens referable to it.

Port McNeill, G. M. D. Wellington Mine, Mr. Robins.

21. JUGLANDITES FALLAX, s. n.

Plate XI., fig. 48.

Leaf lanceolate, narrowed at the base, slightly toothed, with veins at a somewhat acute angle, turning slightly inward at the margin, and connected by delicate veinlets. Epidermis in places showing minute areolation. This is a very doubtful leaf, in so far as the genus is concerned.

Vancouver Colliery. Mr. Robins.

22. JUGLANDITES ?

Plate X., fig. 43; Plate XIII., fig. 56.

These are imperfect leaves from Port McNeill, which may be referable to this genus. They may perhaps rather belong to *Sapindus*.

23. ULMOPHYLLUM PRISCUM, s. n.

Plate VIII., fig. 28.

Leaf elongated-ovate, pointed, acutely serrate. Midrib strong. Veins numerous, straight, at angle of 45° on one side, a little less on the other. Closely allied to *U. Braunii*, Heer, a species referred to the Oligocene, but recognized by Lesquereux in the Upper Cretaceous in America. ('U.S. Geol. Survey,' vol. viii., p. 27.)

Port McNeill. G. M. D.

24. PLATANUS PRIMÆVA ? Lesq.

Plate VIII., fig. 29.

All the specimens of this species are imperfect, but the portions preserved correspond with the above species of Lesquereux, which is from the Cretaceous of the Western States. ('U. S. Geol. Survey,' vol. viii., plate vii.) The species belongs to a type largely represented in the Laramie by such forms as *P. Haydenii*, Lesq.

Wellington Mine. G. M. D.

25. *FICUS LAUROPHYLLIDIA*, s. n.

Plate X., fig. 37.

Leaf elongated-oblong and acuminate. Nerves curved, attenuate, unequal and branching at obtuse angle to midrib. It is of the type of *Ficus laurophylla* of Lesquereux. It seems to have been thin in texture, with prominent nerves. Compare also *F. macrophylla* of Lesquereux (vol. xvii.), which seems scarcely, if at all, separable from my *F. maxima* of the Dunvegan group of Peace River.

Wellington Mine. G. M. D.

26. *FICUS CONTORTA*, s. n.

Plate IX., fig. 31.

Leaf of moderate size, unequally ovate, curved, entire. Midrib and petiole stout, strongly curved, giving a falcate shape. Veins numerous, camptodrome, much curved on convex side, straight on concave side. These may be accidentally distorted leaves, but the venation is different from that of the other species associated with it.

Port McNeill. G. M. D.

27. *FICUS ROTUNDATA*, s. n.

Plate IX., figs. 32, 33 a.

Leaf small or medium size. General form roundish. Veins much curved at margins. Veinlets numerous.

28. *FICUS WELLINGTONIÆ*, s. n.

Plate IX., figs. 33, 34.

Leaf oblong, entire, pointed at base and apex. Veins at acute angle and regularly curving toward the margin, with numerous cross veinlets. Near to *F. magnoliifolia*, Lesquereux, but more elongated and less crowded veins. See fig. 35, and notice below of the species last named.

Wellington Mine and Port McNeill. G. M. D.

29. *FICUS MAGNOLIIFOLIA*, Lesq.

Plate IX., fig. 35.

These leaves seem undistinguishable from Lesquereux's species, figured by him in "Cretaceous Plants," 'Am. Geol. Survey,' vol. vii.

30. *ARTOCARPOPHYLLUM OCCIDENTALE*, s. n.

Plate XII., fig. 51; Plate XIII., fig. 52.

Fragments of large pinnatifid or palmate leaves, of the type of *Myrica Lessigii* and *Aralia pungens* of Lesquereux, now referred by Ward to the genus *Artocarpus* (or bread-fruit tree), which seems in Cretaceous and Tertiary times to have had representatives in Greenland and America. These leaves are, however, too imperfect to be identified with any described species. So far as known, such leaves are Middle Cretaceous in Greenland,

Upper Cretaceous in British Columbia, and Tertiary further south; so that the genus may have made its way from the Arctic southward at a less rapid rate than some other forms.

Vancouver Colliery. Mr. Robins.

31. *PROTEOIDES NEILLII*, s. n.

Plate XII., fig. 53.

Leaves small and narrow, margins entire, base and apex pointed, surface smooth, midrib strong, venation not apparent. These pretty little leaves are thickly scattered over some surfaces at Port McNeill. They resemble some of those described by Heer and Lesquereux from the United States, but differ somewhat in form.

Port McNeill. G. M. D.

32. *PROTEOIDES MAJOR*, s. n.

Plate XII., fig. 54.

Leaf large, elongate-oval or lanceolate, pointed below; midrib strong; venation not apparent. Compare *P. longus*, Heer, from the Dunvegan group. ('Trans. Royal Society of Canada, 1882,' plate II., fig. 7.)

Wellington Mine. G. M. D.

33. *PROTEOIDES*, sp.

Plate XIII., fig. 55.

Leaf (basal half only) abruptly pointed below. Midrib very stout. Veins distant and much curved.

Wellington Mine. G. M. D.

34. *LAUROPHYLLUM INSIGNE*, s. n.

Plate VII., figs. 24, 25.

Leaf oblong, lanceolate, acuminate, entire. Midrib slender, sinuous. Secondary nerves few and curved, especially toward the margin. This beautiful leaf has apparently some affinity with *Laurus proteaefolia* of Lesquereux, but has the veins at more obtuse angles. It has also some resemblance to Heer's *Quercus Lyelli*, from Greenland, but the venation is not that of *Quercus*.

Port McNeill. G. M. D.

35. *DIOSPYROS VANCOUVERENSIS*, Dn.

'Trans. Royal Society of Canada, 1882,' Pt. IV., Pl. VIII.

Plate X., fig. 39.

Leaves not distinguishable from this species occur in the collection from Port McNeill.

36. DIOSPYROS EMINENS, s. n.

Plate X., fig. 40.

A large and fine leaf, apparently of this genus. Very near to *D. anceps*, Lesq., but larger and with more numerous veins. It differs from the last in venation and in its more regularly oval form.

Port McNeill. G. M. D.

37. DIOSPYROS (calyx),

Plate X., fig. 41.

A small calyx resembling that of this genus.

Port McNeill. G. M. D.

38. CORNUS OBESUS, s. n.

Plate IX., fig. 30.

Leaf large, broadly oval, margin entire. Midrib strong. Nerves springing at obtuse angles, at first nearly straight, then curving regularly till parallel with the margin. Veinlets numerous and distinct, slightly oblique to veins. Remains of a petiole.

I at first considered this leaf as a species of *Ficus*, but careful comparison of its venation has led me to refer it to *Cornus*, a genus already represented by *C. Forschammeri*, Heer, in the Cretaceous of Greenland.

Vancouver Colliery. Mr. Robins.

39. PALIURUS NEILLII, s. n.

Plate XI., figs. 44, 45.

Leaves small, rounded, entire, each with three somewhat branching ribs, and apparently of thin and delicate texture. Allied to *P. membranacea* of Lesquereux, from the Cretaceous of the Western States. (Lesq., vol. viii., p. 118, pt. 20.)

Port McNeill. G. M. D.

40. MENISPERMITES, sp.

Plate XI., 50.

Allied to *M. obtusiloba* of Lesquereux ("Cret. Flora," vol. vi.). Leaves all very imperfect.

Port McNeill. G. M. D.

41. LIRIODENDRON SUCCEDENS, s. n.

Plate VIII., fig. 26.

Leaf oblong, deeply notched in the middle at both sides, so as to give an auriculate appearance. Margin entire. Veins at somewhat acute angles. It is very near in form to *L. semialatum* of Lesquereux, from the Dakota group of Kansas, but is a little narrower and more elongated. These small Liriodendron-like leaves seem to be characteristic of the Dakota group farther to the south, and here they continue in the upper member of the Cretaceous system.

Port McNeill. G. M. D.

42. LIRIODENDRON PRÆTULIPIFERUM, s. n.

Plate VIII., fig. 27.

Leaf large, cordate below. Side lobes rounded. Lateral veins not so deep as in *L. tulipiferum*. Terminal lobe very broad and deeply notched. Venation similar to that of the modern species, so far as can be seen.

In its terminal lobe this fine leaf resembles some varieties of *L. Meekii* of the Dakota group and of the Atané beds in Greenland, but the leaf is much larger and different below. It also approaches *L. giganteum*, Lesq., but has a deeper terminal notch and shorter lateral lobes (Lesq., vol. xvii.). It is perhaps as near the modern species as any of the numerous fossil forms.

Lesquereux, in his latest report on the Dakota group, remarks that while this genus, now represented by the solitary American species, occurs in the Middle Cretaceous and the Tertiary, it had not been found in the Upper Cretaceous. The two species noticed in this paper will so far fill up this gap, and this with representatives of two distinct types of these leaves.

Wellington Mine, Nanaimo. G. M. D.

43. MAGNOLIA OCCIDENTALIS, s. n.

Plate X., fig. 36.

Leaf oblong, entire. Veins regularly curved from midrib to margin. Venation and texture as in modern species of Magnolia. It is somewhat of the type of my *M. magnifica*, from the Dunvegan group of Peace River, but is smaller and with more delicate venation, and also broader in proportion. ('Trans. Royal Society of Canada, 1882,' pt. iv., p. 22, pl. iii.)

Wellington Mine. G. M. D.

44. MAGNOLIA CAPELLINI, Heer.

Plate XI., fig. 49; Plate XIII., 49 a.

I refer to this species, described by Heer, from the Dakota group of Nebraska, a large and beautiful leaf not uncommon in the shales of Port McNeill. It also occurs in the Atané group of Greenland. Whether it is allied to Magnolia, or rather to Catalpa, may admit of some doubt.

Port McNeill. G. M. D.

45. PROTOPHYLLUM, sp.

Plate XI., figs. 46, 47.

Fragments of leaves of this genus, but not showing their margins or complete forms. They resemble *P. Leconteanum* of Lesquereux, but are smaller. The genus has already been recognized at Nanaimo, in the larger species, *P. Nanaimo*, Dn. The present is, in any case, a second species.

Port McNeill, Wellington Mine, G. M. D.; Vancouver Mine, Mr. Robins.

46. *UEANOTHUS CRETACEUS*, Dn.

'Trans. Royal Society of Canada, 1882,' Plate VIII.

These leaves are not distinguishable from the above. But see *Paliurus Montana* and *P. ovalis*, Dn. ('Trans. Royal Society of Canada, 1885,' part iv., page 14, plate iv.) These leaves may belong to the same genus, and require further material and comparison.

Port McNeill. G. M. D.

47. *MACCLINTOCKIA TRINERVIS*, Heer.

Plate X., fig. 38.

These leaves scarcely differ from those figured by Heer from Greenland, where they seem to occur both in the Upper Cretaceous and Eocene or Paleocene. ("Greenland Flora," p. 483.) The genus is as yet of uncertain affinities, but seems to range from the Middle Cretaceous up into the Eocene. The present species, however, is eminently Upper Cretaceous and Eocene.

Port McNeill. G. M. D.

48. *CARPOLITHES (ZAMITES) MERIDIONALIS*, s. n.

Plate X., fig. 42.

Globular and smooth, not lobed like *Nordenskioldia*, but marked with about ten lines like meridians. It is probably a cycadaceous fruit, and is near to that figured by Heer as *Zamites globuliferus*, from the Komé group of the Cretaceous of Greenland, but this has meridional lines less marked.

Port McNeill. G. M. D.

49. *CINNAMOMUM SEZANNENSE*, Watelet.

Plate XIII., fig. 58.

This leaf is figured by Lesquereux from the Dakota group of Kansas (vol. xvii.), and by Saporta from the Eocene of Gelinden, so that if the species is really the same, it has a somewhat extensive range.

Port McNeill. G. M. D.

50. *PHYLLITES*, sp.

The leaf figured on Plate XII., fig. 60, resembles somewhat a *Magnolia*, but is of lax and delicate texture, and all the specimens are very imperfect. That represented in Plate IX., fig. 57, may be a *Salix*, but is very imperfectly preserved.

Tabular view of Species noticed in this Paper from Port McNeill and from Nanaimo, east end of Vancouver Island.

	Pt. McNeill.	Nanaimo.
<i>Macrotæniopteris Vancouverensis</i> , s. n.....		*
<i>Cladophlebis Columbiana</i> , s. n.....		*
<i>Adiantites prælongus</i> , Dn.....		*
<i>Næggerathiopsis Robinsi</i> , s. n.....		*
<i>Sequoia Langsdorffii</i> , Heer.....	*	*
<i>Taxodium</i> , sp.....		*
<i>Dammarites dubius</i> , s. n.....		*
<i>Salisburia pusilla</i> , s. n.....	*	
<i>Sabal imperialis</i> , Dn.....		*
<i>Salix</i> , sp.....	*	
<i>Populites probalsamifera</i> , s. n.....	*	
<i>Betula perantiqua</i> , Dn.....	*	*
<i>Fagophyllum retosum</i> , s. n.....	*	
<i>F. nervosum</i> , s. n.....	*	
<i>Dryophyllum occidentale</i> , s. n.....	*	
<i>D. Neillianum</i> , s. n.....	*	
<i>D. elongatum</i> , s. n.....	*	
<i>Quercus Holmesii</i> , Lesq.....	*	
<i>Q. Victoriæ</i> , Dn.....	*	*
<i>Dryophyllum</i> , sp.....	*	
<i>Juglandites fallax</i> , s. n.....		*
<i>Juglandites</i> (?).....	*	
<i>Ulmophyllum priscum</i> , s. n.....	*	
<i>Platanus primæva</i> , Lesq.....		*
<i>Ficus laurophyllidia</i> , s. n.....		*
<i>F. contorta</i> , s. n.....	*	
<i>F. rotundata</i> , s. n.....	*	
<i>F. Wellingtoniæ</i> , s. n.....	*	*
<i>F. magnoliifolia</i> , Lesq.....		*
<i>Artocarpophyllum occidentale</i> , s. n.....		*
<i>Proteoides Neillii</i> , s. n.....	*	
<i>P. major</i> , s. n.....		*
<i>Proteoides</i> , sp.....		*
<i>Laurophyllum insigne</i> , s. n.....	*	
<i>Diospyros Vancouverensis</i> , Dn.....	*	*

Tabular view of Species noticed in this Paper from Port McNeill and from Nanaimo, east end of Vancouver Island.—Continued.

	Pt. McNeill.	Nanaimo.
Diospyros, sp.....	*	
Diospyros (calyx).....	*	
Cornus obesus, s. n.....		*
Paliurus Neillii, s. n.....	*	
Menispermities, sp.....	*	
Liriodendron succedens, s. n.....	*	
L. prætuliferum, s. n.....		*
Magnolia occidentalis, s. n.....		*
M. Capellini, Heer.....	*	
Protophyllum, sp.....	*	*
Ceanothus Cretaceus, Dn.....	*	*
Macclintockia trinervis, Heer.....	*	
Carpolithes (Zamites) meridionalis, s. n.....	*	
Cinnamomum Sezannense, Wat.....	*	
Phyllites, sp.....	*	

From the above table it appears that out of thirty-three species from Port McNeill only five are common to it and the collieries farther south on the same side of the island. In the circumstances this can scarcely be a local difference, though something must be allowed for imperfection of the record and special circumstances of deposit and preservation. It probably indicates some difference of age. If, then, we consider the facies of the species peculiar to Port McNeill, we shall find that, though distinctly Cretaceous and not Laramie in aspect, they have some later features than those of Nanaimo. The numerous species of *Ficus* and *Quercus* or *Dryophyllum*, and the occurrence of *Macclintockia trinervis*, of a *Salisburia* of modern type, and of *Sequoia Langsdorffii* rather than *S. Smithiana* or *S. Reichenbachii*, tend to this conclusion. We may therefore place the date of the Port McNeill beds as Upper Cretaceous, and possibly a little later than those of Wellington and Vancouver Collieries. They would thus correspond to the upper part of the Atané or the lower part of the Patoot series in Greenland.

My visit to the Southern States, in the winter of 1892-3, very strongly impressed me with the general resemblance of the modern flora of Georgia to that of Vancouver Island in the Cretaceous period. The evergreen Oaks, Laurels, *Diospyros*, *Magnolias* and other genera common to the two floras, and the presence with these of the Dwarf Palmettos, must have given much similarity to the aspect of the forests, though there were no doubt many forms peculiar to the Cretaceous which would give distinctness. In the winter of 1892-3 the foliage of the *Diospyros*, the *Camellia*, the *Magnolia* and Dwarf Palmetto was not affected at Savannah, though the temperature often fell below the freezing-point. *Cycas revoluta* and the native *Zamia* were also uninjured. The leaves of the tall Palmetto

and of the Orange-tree were touched with frost. This was said to have been an unusually severe winter. The mean temperature of Georgia is about 65° of Fahrenheit, and the Vancouver Island flora has most resemblance to that of the lower parts of the state. We have thus an indication of the remarkable mildness which characterized the climate of the later Cretaceous period in the more northern parts of America. I propose, however, to devote the third part of this paper to the presentation of a few points bearing on the value of fossil-plants as indicators of climate and time.

III.

While this paper was in preparation, important questions have arisen and have been discussed in special works¹ and scientific periodicals, respecting the value of fossil plants as tests of climate and geological age. As I do not propose to follow up the subject of Mesozoic and Tertiary Palæobotany in these 'Transactions' any farther, until I can have an opportunity to condense into one volume the papers already published, it may perhaps be well to devote a few pages to a consideration of what we have already learned on these subjects from the fossil flora of Canada. In doing this, I may refer to the series of papers published in the 'Transactions' of this Society in 1882 and following years, and relating to the fossil floras of most of the Mesozoic and Cenozoic formations of Canada.

It will be necessary to glance, in the first instance, by way of contrast, at the condition of the vegetable kingdom in the Palæozoic period. In this part of the earth's history the problem is complicated by the peculiar character of many of the plants, as well as by the probability that the meteorological conditions were very dissimilar from those now prevailing. We may say in general terms that a flora of tree-ferns, giant lycopods and pines is akin to that of modern oceanic islands in warm climates. This is true, but the Devonian and Carboniferous plants did not grow exclusively on oceanic islands but on continental areas of considerable magnitude. They flourished also in all latitudes from the polar region to the equator, and though there are some generic differences in the plants of the period in the Southern Hemisphere, yet these do not seriously affect the general facies. There are characteristic *Lepidodendroids*, for example, in the Carboniferous of Brazil and South Africa and Australia, and though in the latter there are certain ferns allied to those of Mesozoic Europe, this is merely a local difference, not materially affecting climate, and corresponding with the fact that the European Mesozoic flora originated in the south. Nor does the doctrine of homotaxis seriously affect the question. Each geological period was sufficiently long to permit plants to migrate to every station they could occupy, and in every case the temporary and local climate must be indicated by the local flora, while the succession in any one place may be relied on as holding good over a very extensive area.

Looking at the Palæozoic plants a little more in detail, coniferous and taxine trees grow now in very different latitudes and climates. There is therefore nothing so very remarkable in their occurrence. The great group of *Cordaites* may have been equally hardy, but it is noteworthy that its geographical distribution is more limited. In

¹ Especially Seward's "Fossil Plants as Tests of Climate," and Lesquereux's "Final Report on the Plants of the Dakota Group."

Europe, for example, the genus is much more characteristic in France than in Britain, perhaps in connection with the warmer climate to the southward. Ferns and lycopods and mare's-tails are also cosmopolitan, but the larger species now belong to the warmer climates; and nowhere in the present day do they become so woody and so complex in structure as in the older geological periods.

The natural inference would be that in the old coal period the geographical and other conditions must have conspired to give a somewhat uniform and moist climate over a great part of the earth's surface. The geographical arrangements, so far as known, indicate this, and the distribution of animals points in the same direction. In America, for example, the great eastern and western ranges of mountains were yet in embryo, and a large part of the continent was occupied with shallow water or with swampy plains scarcely above the sea level. The batrachians and insects of the land and the varied forms of animal life in the sea alike point to a climate at least mild and uniform. We must also take into account the probability that there was a larger amount of carbon-dioxide in the atmosphere than at present, which would greatly impede radiation from the ground, and the moisture exhaled from the vast swamps and morasses of the period would produce a similar effect.

It would, however, be a mistake to suppose that there were not local differences of climate. I have elsewhere¹ advocated the theory that the great ridge of conglomerate on the northern border of the coal-field of Pictou, in Nova Scotia, may have been an ice-formed ridge on the margin of the deep morass in which the thirty-six feet seam was deposited. In this case a sea occasionally ice-laden may have approached within a short distance of forests of *Sigillariæ* and *Lepidodendra*, and this in the middle of the coal period. On the whole, therefore, we should postulate for the Palæozoic flora not so much a high temperature as uniformity and moisture. This seems also to accord with the prevalent character of the foliage and the structures of the remarkable acrogenous trees of this period.

As to the early Mesozoic flora, the indications are that it was an invader from the Southern Hemisphere, for which the intervening Permian period had prepared the way by destroying the preceding Palæozoic forests. This was probably effected through the agency of great earth-movements changing the geographical and climatal conditions. But as the Mesozoic ages advanced, the old conditions to some extent returned, and enabled the cycads, pines and ferns of this age to push their way almost to the Arctic regions. Being, however, derivatives from warmer climates, their vitality and powers of variation were probably not great. They flourished luxuriantly and became considerable coal-producers, and their reign was probably of long duration, extending through the Triassic and Jurassic periods and into the Lower Cretaceous. In the north they met with a new and far more advanced and varied flora, originating there, and destined, in the Middle and Upper Cretaceous, to replace them throughout the whole Northern Hemisphere. This new and most important change was undoubtedly accompanied with climatal amelioration, giving a mean temperature of probably 55° to regions within the Arctic Circle; and this, as we shall see, probably depended on geographical arrangements introducing the warm waters of the equatorial current into a vast land-locked basin in

¹ "Acadian Geology."

the interior of the American Continent, with corresponding though probably not so simple and easily understood arrangements in the Eastern Continent as well.

Thus, when we ascend from the base of the Cretaceous, we find a remarkable and apparently sudden influx of angiospermous exogens of modern generic types. The aspect of suddenness is given not merely by the rapidity with which from a very few forms the new flora expands in richness and variety, but also by the simultaneous appearance in the case of many genera, such as *Sassafras*, *Liriodendron*, *Magnolia*, *Quercus*, etc., of as many species in the Middle Cretaceous as the modern world can yet boast, and in some cases of a greater number. On the other hand, it is true that other genera, as *Populus*, *Betula*, etc., appear at first in fewer forms, and are more largely represented in the modern world. This difference is apparently not connected so much with the botanical rank of the several genera as with their degree of adaptation to the more equable climate of the earlier Cretaceous or to the more extreme climates that have succeeded. This climatal change has not only required the removal of some genera to southern habitats and the diminution of their species, but has required that they should be replaced in the north by new species of more hardy types. The southward movement of the whole flora in later Cretaceous and Tertiary times, and the introduction from behind of the modern species, is thus apparently connected with the gradual refrigeration which culminated in the Glacial period.

In Western Canada, in the Rocky Mountains and in the Queen Charlotte Islands, as well as farther north in Alaska and Greenland, we have a Lower Cretaceous flora characterized by forms approaching those of the Jurassic. One of its characteristic species is a *Dioon*, allied to *D. edule* of Mexico, (*D. Columbianus* and *D. borealis*, Dn.¹) Along with this are species of *Zamites* and *Podozamites* and primitive species of *Salisburia*, similar to those described by Heer from the Jurassic of Siberia. The lower beds of this (the Kootanie series) are not known to contain any angiosperms, but in beds a little higher (Intermediate and Mill Creek beds) these begin to occur. Newberry has found the same flora farther south in Montana, and it corresponds, in part at least, with the Potomac flora of Fontaine, which occurs over a wide area in the Southeastern States of the American Union. The geographical distribution of this flora shows an extension of warm climate up to the territory of Alaska. With other geological facts, it also shows that the habitat of the Lower Cretaceous flora was around the margin of a continent not yet elevated into lofty mountain chains, and including to the south a mediterranean sea of warm water; while the conditions in the extreme north must have excluded anything representing the present snow-clad mass of Greenland. This alone is, in my judgment, sufficient to account for the climate of the period, whose warmth extended even to Greenland. I have noticed the nature and correlation of this flora in papers published in these 'Transactions.'²

This is succeeded in the north of Canada, as far at least to the south as the latitude of 55°, by the Dunvegan series, holding a warm temperate flora containing species of *Magnolia*, *Laurus*, *Ficus* and *Quercus*, along with such temperate forms as *Fagus* and *Betula*. It also contains *Cycads* and *Sequoias*.³ It appears to be in the main parallel

¹ These two species, one represented only by leaves, the other by fruits and fragments of leaves, may possibly prove to be identical.

² 1892, section iv., p. 79; also 1885, section iv., p. 1.

³ 'Trans. Royal Society Canada, 1882,' part iv., p. 20.

with the marine Niobrara farther south. This flora is probably continued along the Rocky Mountain region by that of the Mill Creek series, which, however, has more the aspect of that of the Dakota period.¹ It is less rich in cycads and conifers, and has species of *Platanus*, *Macclintockia*, *Cinnamomum*, *Laurus*, *Magnolia* and *Aralia*. The aggregate of the Dunvegan and Mill Creek series may thus be regarded as Middle Cretaceous or Cenomanian and Senonian, and corresponding in the main to the Atané of Greenland. It belongs to the northern and western sides of the same great Cretaceous mediterranean sea on whose shores the previous Kootanie flora had flourished.

East of the Rocky Mountains this is succeeded by prevalent marine conditions, with the local interposition of the Belly River series, containing beds of coal, but so far a meagre flora, including *Sequoia Reichenbachii*, *Brasenia antiqua*, *Trapa borealis* and species of *Acer* and *Populus*.

Passing across the mountains to the Pacific coast, we meet with the abundant and interesting flora of the Cretaceous coal-measures of Vancouver Island, a truly Upper Cretaceous assemblage, to which the present paper refers as well as the earlier one cited in the note.² It evinces a still warmer climate than those previously noted, or than the succeeding Laramie; but it is not improbable that already some difference existed in this respect between the Pacific coast and the interior region of the continent. It probably coincides with the Patoot flora of Greenland.

Later than this, and in its floral character assimilated rather to the Eocene of other countries, we have the Laramie series proper, indicating a period in which the great interior plateau east of the Rocky Mountains had ceased to be an open sea, and had been reduced to the condition of swamps and lakes, the former holding a rich flora of temperate aspect, even as far north as Alaska and Greenland. The Laramie flora has been recognized locally on the west coast as well, but its greatest areas are in the interior plains, where it undoubtedly overlies the Fox Hill or Danien beds. It is, perhaps, most remarkable for its richness in coniferous trees, *Taxites*, *Sequoia*, *Thuia*, etc., and for the great development of the genus *Platanus*, as well as for its containing some ferns of modern species (*Onoclea sensibilis*, *Davallia tenuifolia*).³

The Miocene Tertiary is represented on the Canadian plains only by the gravels of the Cypress Hills, holding mammalian bones referred to the White River series; but on the Similkameen River and elsewhere in the interior of British Columbia there are beds holding an interesting insect fauna and a number of fossil plants. Among these are several swamp and aquatic species, *Equisetum*, *Azollophyllum*, etc., and conifers of the genera *Pinus*, *Taxodium*, *Glyptostrobus* and *Salisburia*, along with species of *Myrica*, *Populus*, *Salix*, *Alnites*, *Acerites*, *Carpinus*, *Nelumbium*, etc. The climate evidenced by these plants is still temperate, but probably scarcely, if at all, warmer than that of the coast of British Columbia at present.⁴

It would thus appear that, while we have no evidence of a tropical climate in Northern Canada in the Cretaceous or Kainozoic periods, the successive floras point to equable

¹ 'Trans. Royal Society Canada, 1885,' part iv., p. 11.

² 'Trans. Royal Society, 1882,' part iv., p. 24.

³ For details see 'Trans. Royal Society Canada, 1885,' sec. iv., p. 16; 1886, sec. iv., p. 19; 1887, sec. iv., p. 31; 1889, sec. iv., p. 69.

⁴ 'Trans. Royal Society Canada, 1890,' sec. iv., p. 76.

and warm temperate conditions extending very far northward, and gradually passing in time into those of the colder Miocene and Pliocene. We can also to some extent correlate these climatal conditions with the geographical features of the several periods and with the contemporary animal remains.

I may add that the validity of such deductions does not altogether depend on the accuracy of the reference of particular species to existing genera. In many cases there can be no doubt of this, as in the species of *Liriodendron*, *Sassafras*, *Platanus*, *Sequoia* and *Salisburia*, and especially in the case of all those forms of which seed or fruit has been procured; but even where the naming may be inaccurate, or where the number of species has been unduly multiplied, the deductions as to climate may hold good, though not perhaps to the extent of enabling us to fix a definite thermometrical mean temperature.

As to geological age, the primary requisite is that in some of the localities of fossil plants their position shall be fixed by stratigraphical evidence. This being done in a few cases, it is not difficult to assign to their approximate position intermediate or allied sub-floras. In Canada, though the collections of fossil plants have not been so large as would be desirable, we are fortunate in having the horizons of the leading floras accurately fixed by the officers of the Geological Survey, and the plants collected carefully referred to the beds to which they belong.

Thus, though the geographical conditions of the Mesozoic and Cenozoic are not of such a character as to enable us to refer sub-floras to their definite geological position throughout the whole Northern Hemisphere, in the manner in which this can be done for the plants of the Lower, Middle and Upper Carboniferous, a satisfactory approximation can be made, and I have no hesitation in affirming that it is possible to define with considerable accuracy the age of any collection of fossil plants from any part of our Cretaceous or Cenozoic districts.

Plants as evidence of geological age have the advantage of wide distribution over the surface of the land, and of long duration in any one place and slowness of migration when obliged or enabled to spread to new localities. They are also so closely connected with the great movements of subsidence and elevation which mark the lapse of geological time, that they are very certain indices of these, whether they affect plant life directly by elevation and submergence, or indirectly by changing climatal conditions.

As in the case of animal fossils, we have to allow for differences of station, for possible driftage and intermixture of species belonging to uplands and low levels, and varieties dependent on chances of deposition and preservation. We have also to consider that plants are more permanent and less changeable than the animal inhabitants of the land, so that they may not mark so small portions of time and so minute changes as may be indicated, for example, by mammalian remains.

On the whole there is very good reason to believe that the labours of Palæobotanists have in the United States and Canada succeeded in securing for fossil plants an important place as guides in the determination of geological age. The knowledge we have acquired needs to be collected and arranged in such a manner as to make it more available than it can be when scattered, as at present, through a great number of reports and memoirs.

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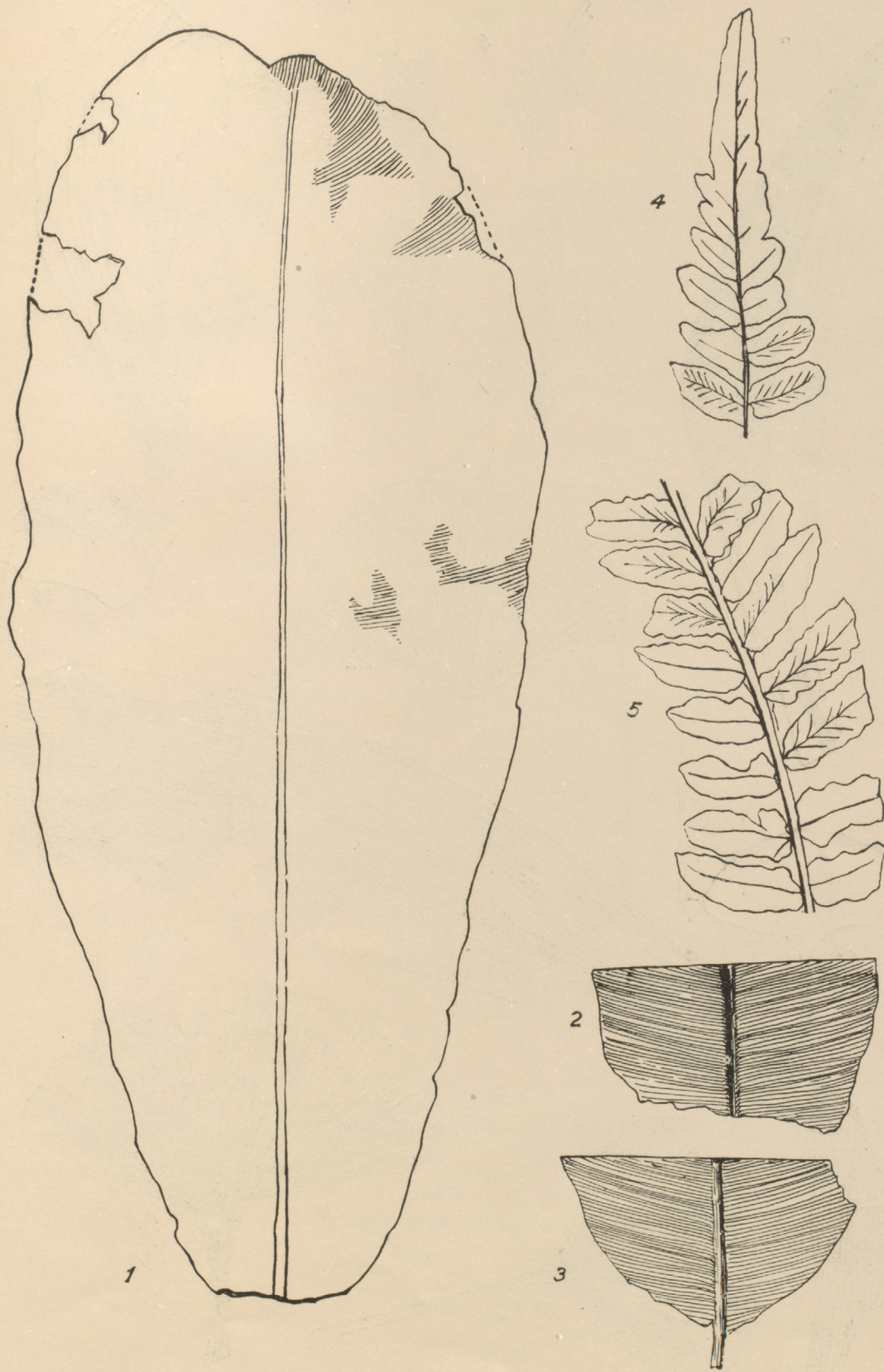
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Section IV., Plate V.

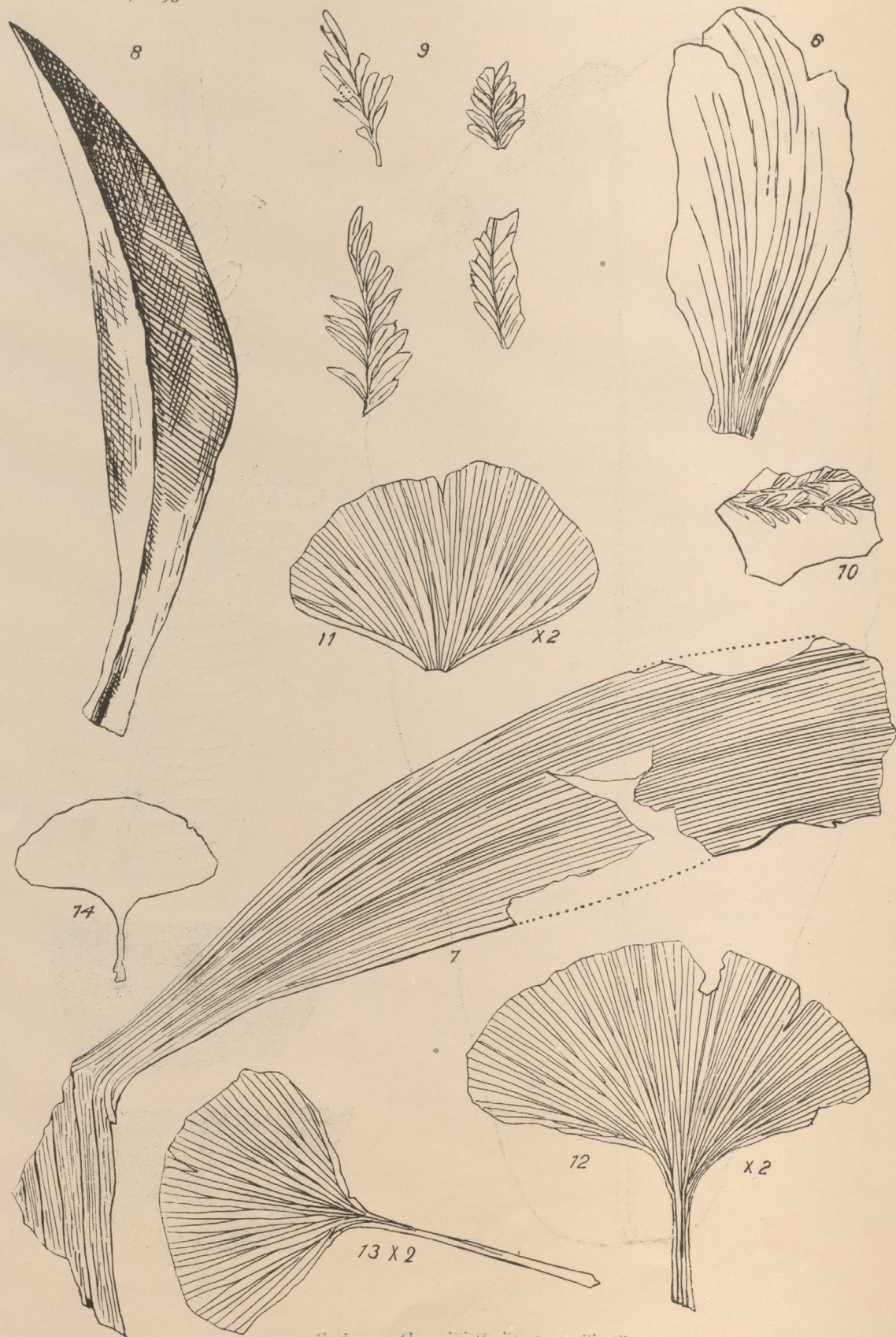


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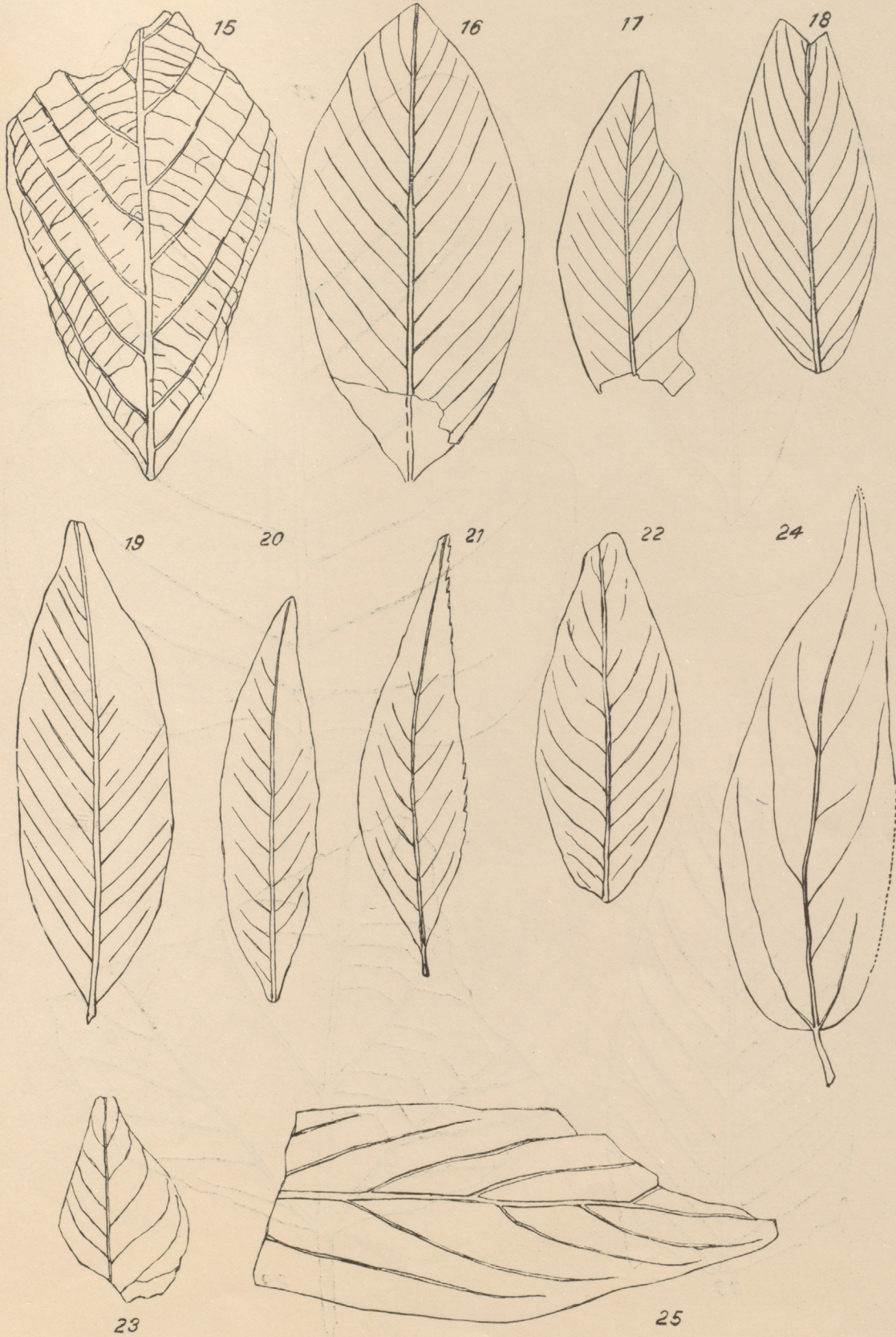


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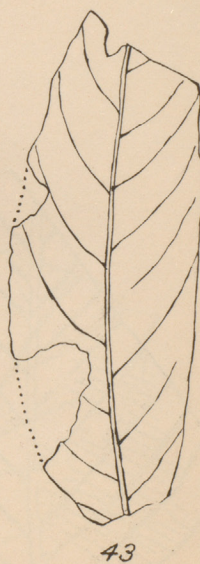
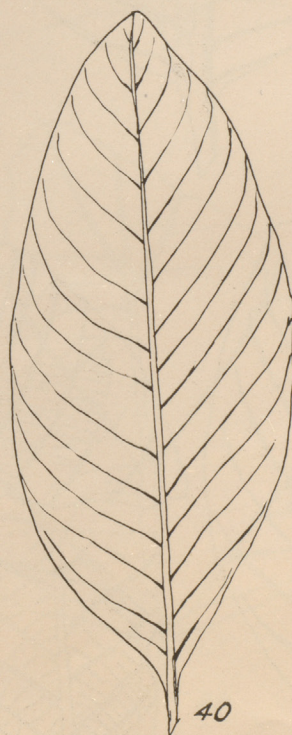
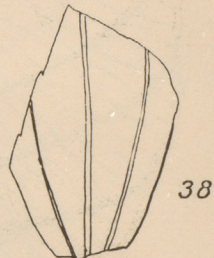
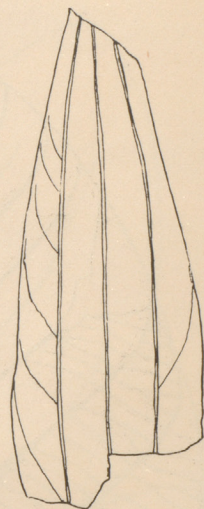
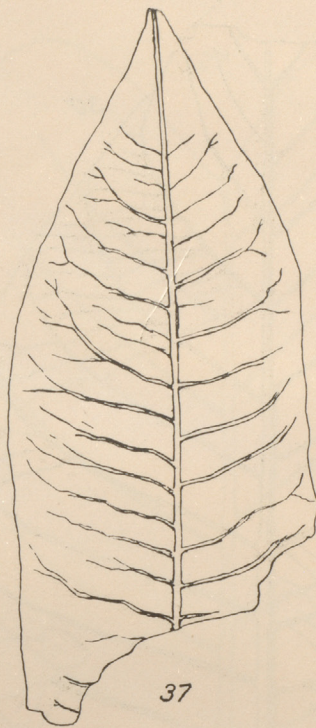
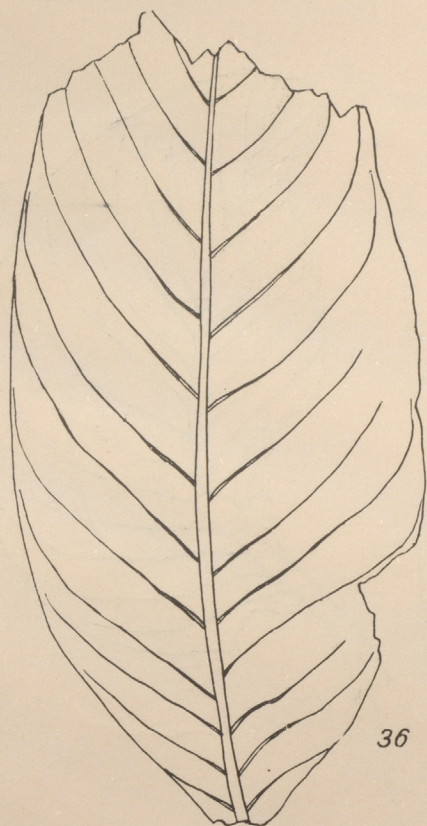


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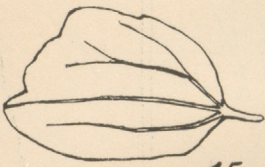
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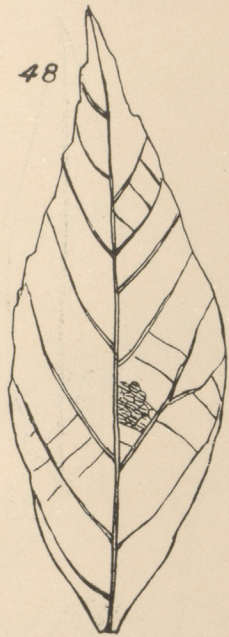
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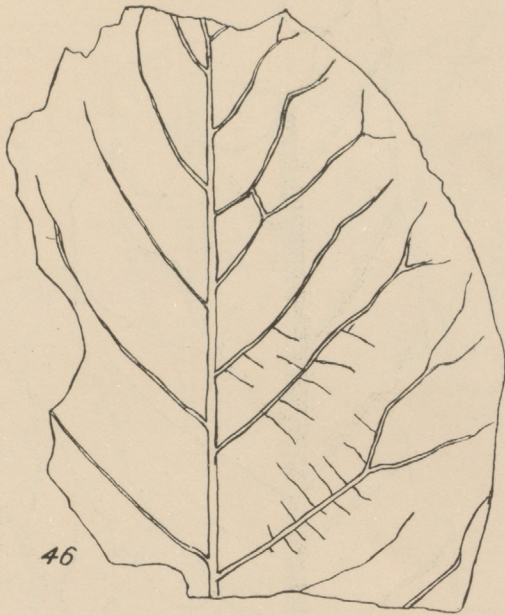
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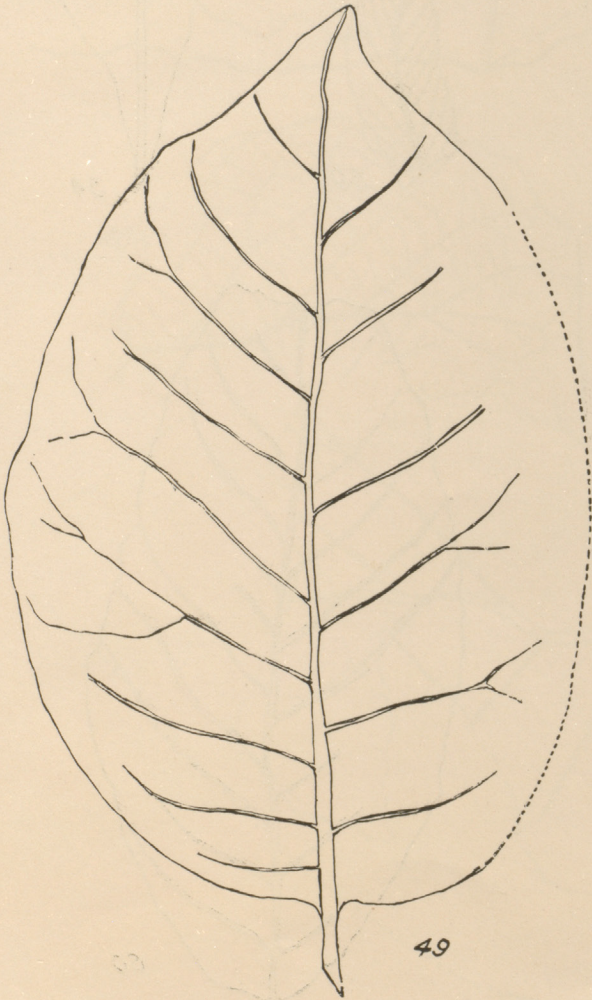
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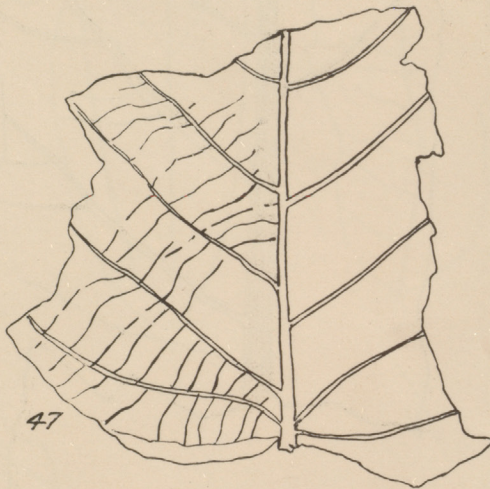
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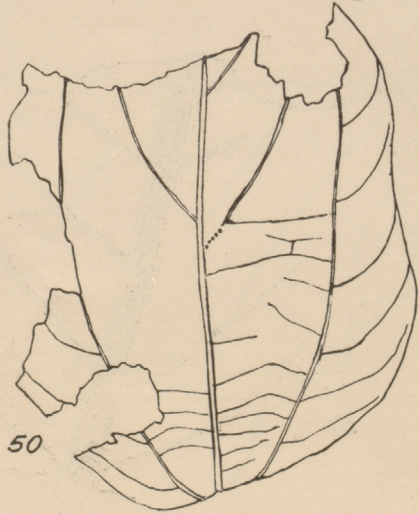
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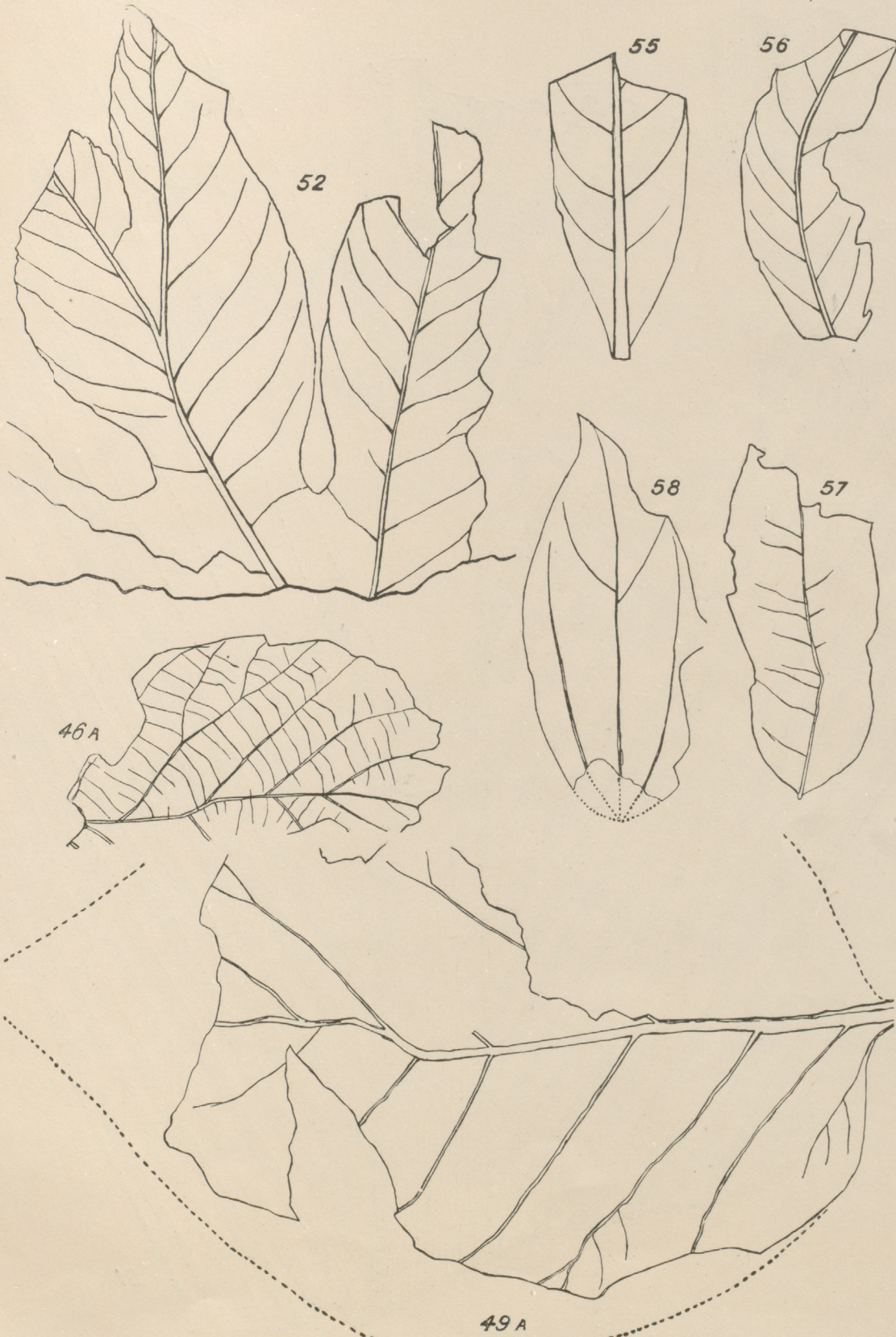


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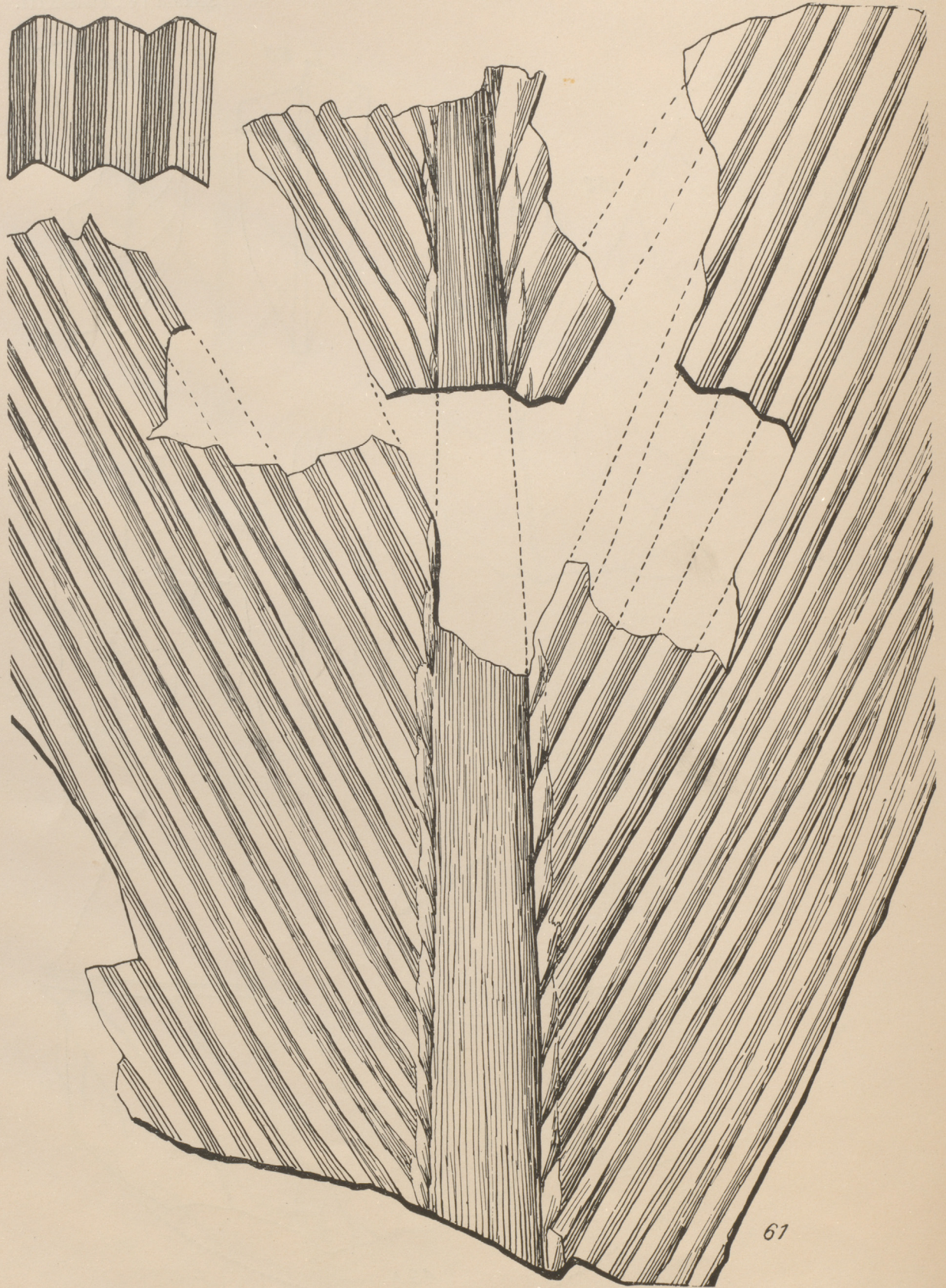


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