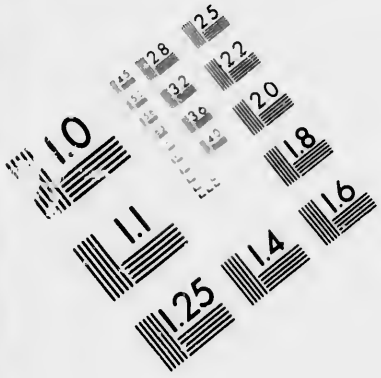

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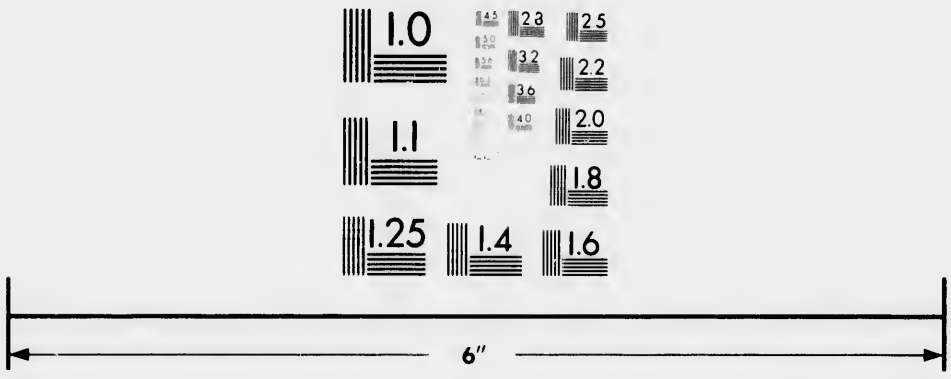

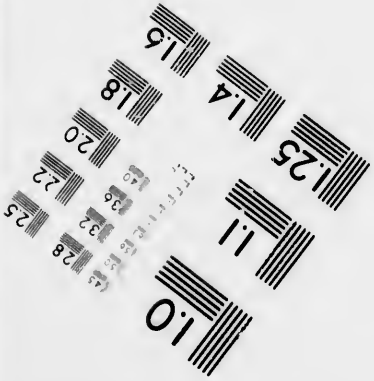

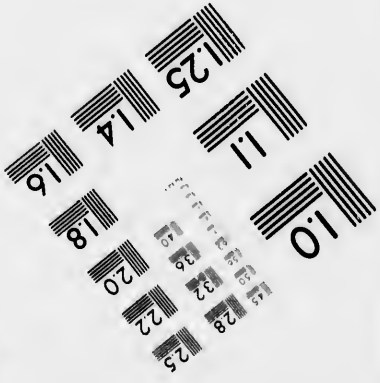

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VI.—*On Collections of Tertiary Plants from the County of the City of Vancouver, B.C.*

By Sir William Dawson, F.R.S., etc.

(Read May 15, 1895.)

In the southern part of the province of British Columbia, in the district extending from Burrard's Inlet to the United States boundary, and which has long been coloured on the maps of the Geological Survey as of Tertiary age, while the sections accompanying these maps show its rocks as overlying the Cretaceous coal measures of the Nanaimo group, fossil plants and beds of lignite have for some time been known to exist, but the former have not been specially studied. The beds have, however, been regarded as probably continuous with the lignite-bearing formation of the eastern part of Washington Territory recently designated by the geologists of the United States Survey as the Puget group.

In the Report of the Geological Survey of Canada for 1876-7,[1] notices of this formation appear by Dr. G. M. Dawson and by the late Mr. Richardson. Mr. Bowman was subsequently engaged in exploring it for coal,[2] and small collections of the fossil plants have been made by several of the officers of the Survey, and more recently a larger collection has been made by Mr. G. E. Monckton, of Vancouver.

The geological relations of the beds, as ascertained in Canada, are referred to by Dr. G. M. Dawson, in a paper published in the "American Journal of Science" for 1890 as follows:

"While referring to the Puget group, it may be added that a considerable tract of low land about the mouth of the Fraser River, and extending northward to Burrard Inlet, is underlain by rocks which, though as yet only partially examined, appear with little doubt to correspond to that group, with which they are geographically connected, and, so far as known, lithologically identical. Mr. A. Bowman has ascertained that these strata are at least 3,000 feet in thickness, and, like those of the typical area of the Puget group, they hold carbonaceous matter and more or less lignite coal at many different horizons."

In the same paper he remarks on the possibility that some of the unfossiliferous beds overlying the Cretaceous coal measures of the Nanaimo group at Comox and elsewhere in Vancouver Island, may represent this same Puget group, or in part the underlying Tejon group of California.

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[1] Pages 125 *et seq.* and 188 *et seq.*

[2] Report Geol. Survey of Canada, 1888, pt. i., p. 19 c.

Am. Jour. Science, vol. xxxix., March, 1890.

In the same year (1890) a small collection of plants made by Prof Lawson, then of the Geological Survey, was submitted to the writer, and though the specimens, too few and imperfect to form the subject of a separate paper, they were recognized as probably of Upper Laramie or Eocene age.

The supposed equivalents of these beds in the United States territory have been cursorily examined by several geologists of that country. They are known to rest on Cretaceous rocks identified by their fossils with the Nanaimo group of British Columbia, which is known to be Upper Cretaceous. Their vegetable and animal fossils are held to indicate deposition in an estuary, and their plants are regarded as Tertiary though they have been referred to different ages, extending from the Laramie to the Miocene. The latest views of Lesquereux, Newberry, White, Knowlton and other palæobotanists and geologists of the United States, seem to be that the beds are of Eocene age, and that the fossil plants may be best compared with those of the Upper Laramie or Fort Union group of the interior plains.

These points were discussed by Prof. C. A. White in the Bulletin of the United States Geological Survey, No. 51, 1889, in which he also refers to the work of Barclay Willis and the late Dr. Newberry. A later account of them is given by Prof. W. B. Clark, in the Bulletin of the same Survey No. 83, 1891. They are also referred to by Dr. Dall in his correlation papers on the Neocene, and by Fairbanks in a paper on "The Geology of the California Coast Ranges."[1]

From these papers it would appear that the beds of the Puget group may amount to 10,000 feet in thickness, and consist of yellow and gray fine-grained sandstones and gray arenaceous shales, carbonaceous shales and beds of coal or lignite. Of the latter, seventeen are said to be workable, ranging from three to fifteen feet in thickness. The group is locally overlain by beds of coarse and fine gravel, probably Pleistocene, which have in some places a thickness of 300 feet, and which attain to an elevation of 2,000 feet above the sea in the Cascade range. These superficial beds are filled with pebbles of hard volcanic rock, similar to that of beds or masses overlying the Puget group and to veins traversing it. These volcanic rocks may be of Pliocene age. They form the highest peaks of the Cascade Mountains, 14,000 feet in height, and must of course be newer than the beds of the Puget series.

Under the Puget group there appear in a few places marine Cretaceous beds, holding *Baculites*. These beds have been disturbed before the deposition of the former group. They are probably of the age of the Nanaimo series.

The animal fossils of the Puget group are fresh-water and brackish

[1] Bulletin Geol. Society of America, 1891.

water forms, indicating the prevalence of estuarine conditions. They naturally give fewer indications as to age than those afforded by marine species, but they are of Tertiary rather than Cretaceous aspect. They are described by White in the paper above referred to. The plant remains will be noticed in comparison with those of British Columbia in the sequel.

This great estuarine deposit extends from Burrard's Inlet, in British Columbia, nearly to the Columbia River, and from the coast line to the Cascade range, within which its beds rise to a height estimated at from 800 to 5,000 feet above the level of the sea.

It is evident from the above statements that the Puget group of the west occupies a stratigraphical position, and presents conditions not very dissimilar from those of the Upper Laramie east of the mountains. The species of mollusks found in it, and to some extent those of plants also, are different from those of the Laramie. But this is to be expected in estuarine deposits, which, though identical in age, belong to bodies of water emptying respectively into the Pacific and the Atlantic, and separated by a considerable breadth of continuous and probably elevated land.

Assuming, then, that we have to deal with a formation overlying the Chico and perhaps the Tejon series of the United States geologists, in California and Oregon, and the Nanaimo formation of Vancouver Island, and indicating a transition from marine to estuarine conditions, the question comes up of the identity of the Nanaimo group in age with the more southern Cretaceous formations above named. On this point White, after comparing the fossils described by Whiteaves from the Nanaimo beds with those farther south, fully admits their correspondence with those of the Chico, but not with those of the Tejon, which have a decidedly newer aspect, and may be regarded as Eocene. There is, however, in California a transition between the Chico and Tejon, but both appear to underlie the Puget, unless indeed the latter is in part an estuarine equivalent of the marine beds of the former. In like manner, in British Columbia the estuarine conditions of the Burrard's Bay beds seem immediately to succeed the Nanaimo formation. This would be natural if the Puget beds represent the estuary of a northern river.

This absence of marine fossils from the beds succeeding the characteristic Upper Cretaceous, raises the same doubts as to age which have affected the Laramie beds east of the mountains. Hence, in both cases, the fossil plants become of much importance, while the fact that they have been variously referred to Cretaceous, Eocene and Miocene ages has tended to throw discredit on their evidence. In so far as Canada is concerned, it has now been established that the Upper Laramie or Fort Union beds underlie a formation containing animal fossils of the White River

Miocene[1] period, so that there can be no doubt as to their Eocene age. In like manner in British Columbia, as will appear in the sequel, there are lacustrine beds with a flora of Oligocene or Miocene age, and which is quite distinct from that of the formation which forms the subject of this paper.[2]

At the same time it must be admitted that in the laying down of deposits of so great thickness, and covering necessarily a very long time, there may have been important changes in the flora, and that in an estuarine series in the vicinity of the Pacific coast on the one hand, and of extensive mountain ranges on the other, there may have been great local diversities, and the intermingling of plants of coastal flats with those of elevated mountain valleys. On the other hand, there may have been an equability of climate permitting the co-existence of types now widely separated. Independently of the fact that we are here near the dividing line between Cretaceous and Tertiary times, and may therefore expect a transition flora, these are circumstances which may well give rise to difficult questions, awaiting their ultimate settlement till the succession of the beds has been more definitely ascertained and larger collections have been made from different localities and horizons.

In the meantime I shall hope to show that we have in the Burrard Bay collections at least the pre-intimations of an early Tertiary flora, occupying the space between the Cretaceous flora of the Nanaimo series and the Oligocene or Miocene flora of the Similkameen district.

The specimens referred to in this paper are all from a limited locality in the vicinity of Burrard's Inlet, and therefore from near the northern margin of the estuarine formation referred to.

The earliest is a small collection made by Prof. Lawson, of the Geological Survey of Canada, a notice of which was contributed by the author to the Report of the Survey for 1890, with the remark that in so far as any conclusion could be based on so small a collection, the plants might be regarded as of Upper Laramie or Eocene age.

Some additional specimens were afterwards collected by Dr. G. M. Dawson, by Mr. James Macoun and others, in the neighbourhood of Vancouver, at Hastings Station and Stanley Park, and a few determinable leaves were obtained from the core of a bore-hole sunk at Hastings.

The somewhat larger collections made subsequently by Mr. G. F. Monckton, of Vancouver, from the shores of Burrard's Inlet, he has kindly placed in my hands for study.[3]

These collections no doubt represent very imperfectly the flora of the formation, and, owing to the fragile character of the matrix, few of

[1] Trans. Royal Society of Canada, 1886—Fossil Plants of Laramie.

[2] Trans. Royal Society of Canada, 1890—Fossil Plants of Similkameen, etc.

[3] Additional collections made by Mr. C. Hill-Tout while this paper was in preparation, will also be mentioned below.

the leaves are perfect. They suffice, however, to testify to the age of the deposit, and to enable some comparisons to be made with the plants which have been obtained from the extension of these beds to the southward. They probably represent only a limited thickness of beds near the base of the formation.

I have to acknowledge my obligation to Prof. F. H. Knowlton, of the United States Geological Survey, for information as to work now in progress on the equivalents of the Burrard Inlet beds in the United States.

NOTES ON THE SPECIMENS

LASTREA (GONIOPTERIS) FISCHERI Heer.

(Fig. 1.)

Heer, Flora Ter. Helv., i., p. 31; Lesquereux, Report U. S. Geol. Survey, vol. viii., p. 239.

This fern occurs on one of the discs of the core from the Hastings boring, and also on specimens of shale from the town of Vancouver. Lesquereux's locality is John Day, Oregon, in beds supposed to be Eocene.

NEUROPTERIS CUNEATA, n. s.

(Fig. 2.)

On light-coloured fine sandstone from the city of Vancouver. The frond or pinna is pinnate, with a thick rhachis. The pinnules are cordate and broad below, somewhat curved and tapering upward to an obtuse point. The midrib is slender and evanescent; the veins straight and once bifurcate near their bases, the margin even. This form may perhaps be referred to genus *Cladophlebis*. I do not find any described Tertiary species precisely similar. It is provisionally referred to *Neuropteris*, but should fruit be found will no doubt be placed in some more modern genus.

LYGODIUM NEUROPTEROIDES, Lesquereux.

(Fig. 3.)

Lesquereux, U. S. Geological Survey, vii., p. 61.

"Fronds cordate, two to five, palmately lobed; divisions oblong or obovate, lanceolate, obtuse; middle nerve thin; lateral veins close, numerous, dichotomous."

Burrard's Inlet (Mouckton collection), also core of Hastings borings and Stanley Park. All the specimens are imperfect, but correspond with portions of Lesquereux's figures. Lesquereux's specimens are from the

Washakie series, Burrell's Springs, Oregon, found along with palm-leaves (*Sabalites* and *Flabellaria*). Lesquereux refers the species to the Lower Eocene. In Newberry's unpublished plates very similar leaves are referred to *L. Kaulfussi*, Heer, a European Tertiary species. Our imperfect specimens may be referred to either species, if these are really distinct.

ASPLENITES, sp.

(Fig. 4.)

A little fertile pinna from Stanley Park indicates a fern of this genus, which may be merely noted in the meantime, until more perfect specimens occur.

GLYPTOSTROBUS EUROPÆUS, Heer.

A few branchlets referable to this species appear on surfaces of the core from Hastings. They appear to belong to the variety known as *G. Ungeri*, which is found in the Bad Lands of Dakota and in Alaska, in beds probably Eocene. The specimens figured by Lesquereux from Oligocene beds at Florissant are different, and most likely, as Lesquereux himself suggests, belong to a distinct species. (Lesquereux, U. S. Reports, vol. viii., p. 222.)

SABAL CAMPBELLII, Newberry.

(Fig. 7.)

Newberry's Illustrations of Cretaceous and Tertiary Floras, pl. x.; Notes on Extinct Floras, p. 19; Lesquereux, U. S. Geol. Survey, vol. viii., p. 113.

Newberry's figure, said to represent a species found at Bellingham Bay and elsewhere, corresponds with a number of fragments in Mr. Mouckton's collections from Burrard Inlet. In the unpublished plates for Prof. Knowlton's revision of Newberry's plants, the same figure is named *S. grandifolia*, and is stated to be from Yellowstone Valley, Fischer's Peak, Colorado, while another form is figured as *S. Campbellii*, and credited to Bellingham Bay. I hope that more perfect specimens from Burrard's Inlet, and reference to Newberry's original specimens before publication, may clear up this apparent difficulty.

Our specimens, so far as can be made out, correspond with Newberry's original figure, except that in it the parallel veins are not seen. In our specimens there are about twelve veins on each slope of the folds, at about six inches from the base of the leaf.

The species is quite distinct from *S. Victoriæ* of the Cretaceous coal-measures of Nanaimo, which resembles more nearly *S. Grayana* of Lesquereux. Species of *Sabal* are widely distributed through the early Tertiaries of western America, but they are known principally by mere

fragments of leaves, and require further study and revision. They probably indicate a somewhat milder climate on the Pacific coast than that which prevailed at the same time on the interior plains.

Additional specimens received from Mr. Monckton and Mr. C. Hill-Tout, while this paper was in the press, seem to confirm the identification of this species with Newberry's *S. Complota*, as described in his paper on Gibb's collections from Oregon, Boston Journal, 1863. In the Later Extinct Floras (Annals of Lyceum, 1868), he identifies this with other specimens from the Yellowstone, and as these are probably distinct, this may account for the change of name subsequently made. In these papers of 1863 and 1868, Newberry for the first time indicates the distinctness of the Tertiary flora of Oregon from the Cretaceous of Nanaimo. He naturally, however, following Heer, regards the former as Lower Miocene.

A specimen in Mr. Hill-Tout's collection, shows the petiole smooth, as in Newberry's figure, and 1 centimetres broad, and fragments of the outer part of the leaf with the folds 3.5 centimetres broad and showing 24 parallel striations on each half, which would correspond to a leaf five feet or more in diameter. There is also a fragment of a stem, possibly of this species, and 9 centimetres in diameter.

Manoarya sp.

A pinnate palm leaf, with thick smooth petiole and pinnæ at first at a somewhat acute angle and bending toward a rectangular position. The specimens are from Burrard's inlet, and are somewhat obscure. They bear some resemblance to Lesquereux's *Geonomites Unger*, but the leaves are at a less acute angle. They seem to have very fine and uniform striation. I have referred these leaves to *Manoarya*, owing to the thick rhachis and the position of the pinnæ, but better specimens are desirable, and there are in the collections many fragments of broad striate leaves which may belong to this or allied endogenous forms. A fragment in Mr. Hill-Tout's collection shows a petiole 5 centimetres in diameter.

Family CYPERACEÆ

Some very interesting fragments referable to this family occur in the collections, and as these ancient *Cyperaceæ* are of especial interest and difficulty, they were placed in the hands of Prof. Penhallow, F.R.S.C., for study. He has kindly communicated the following notes:

"Specimens of sedge-like plants from the Tertiary, probably of Eocene beds at Stanley Park, near Vancouver City, collected by Dr. G. M. Dawson and submitted to me for determination by Sir Wm. Dawson, were found to embrace the carbonized impressions of both leaves and fruit, and in

some instances important structural features were presented in a very prominent manner

"CYPERITES PALÆNERVIS, Heer.

"The leaves, represented by fragments upwards of 2 cm. in length when highly carbonized present no structure whatever, but in other instances exhibit well defined venation. They measure from 1·5 to 3 mm. in width. The midrib is in all cases obscure, but the nerves are prominent and upwards of eight in number. The venation shows no transverse union. These leaf fragments are in all cases entirely separate from their stems which, in fact, do not appear in any part of the matrix, while there is also no connection between them and the associated fruits. They may represent the foliage of either grasses or sedges, since they display no character by which they may be referred with certainty to either one family or the other, although the strongly-defined nerves may possibly incline us to regard them as more properly referable to the sedges.

"Lesquereux has already described one species of *Carex* (*C. berthoudi*) from the Tertiary of North America, but it differs materially from our specimen in its much broader leaves.[1]

"Heer has described a large number of Cyperaceous plants, under the genera *Carex*, *Cyperus* and *Cyperites*, from the Tertiary of Europe. An examination of his figures and descriptions shows that, with respect to width and number of nerves, our specimen corresponds closely with his *Cyperites paucinervis*, which is also represented wholly by leaves, and to which the plant under discussion should be referred provisionally.

"CAREX VANCOUVERENSIS, n. sp.

"(Fig. 5.)

"The fruit is represented by a single spike which is terminal to a rather stoutish stem, and measures 14 mm. in length by 3·5 mm. in width. The individual fruits are ovate, acute, with a rather broad and rounded base, 1·25 mm. long and 0·75 mm. broad, but devoid of any obvious perigynia. They are disposed in two very regular lateral ranks, in which they are slightly ascending, while a third rank occupies a central position, but in it the fruits are foreshortened and compressed, and thus appear as round or shortly oval bodies.

"On each side of the erect spike is a very narrow carbonized line. These join at the base of the spike, and probably represent either two involucral bracts, or a floral bract and the extension of the floral axis

[1] U. S. Geol. Surv., Ter. Fl., p. 92, pl. ix. 1-4.
[2] Flor. Ter. Helv., i., 74, etc.; iii., 164-165.

from which the staminate spike has been removed. There is, however, no evidences of a structural nature which will permit that conclusion on this respect, and whatever deductions are drawn must be based upon other grounds.

"The character of the fruit with its associated organs makes it clear that it represents a Cyperaceous plant belonging to one of the two genera *Cyperus* or *Carex*. Assuming the two lateral organs to be foliar, then the fruit must be that of a *Cyperus*, in which case it is to be inferred that the additional spikes of the terminal umbel so characteristic a feature of this genus, must have been removed by some mechanical process, or have become covered up in a lower stratum of the matrix—assumptions which would appear to exceed the limits of probability.

"On the other hand, the whole aspect of the specimen is exactly that of a *Carex*, and if we assume the lateral organs to be foliar and caudine one each, from the latter of which the staminate spike has been removed, as would actually be the case at the stage of growth represented by the specimen, then the correspondence to a *Carex* would be very close, and among recent species, would find an accessible ally in *Carex stricta*.

"With respect to the possible identity of fruit and leaves, there is alone the extremely uncertain ground of association on which to base a conclusion, while, on the other hand, the obvious resemblance of the fruit to that of a *Carex*, and the resemblance of the leaves to previously described species of *Cyperites*, would amply justify their separate consideration.

"The genus *Cyperacites* of Schimper appears to be excluded from present consideration, since it embraces plants which are represented by leaves of great breadth, and of which the fruit is unknown.

"The genus *Cyperites* of Heer embraces upwards of twenty four species which are represented, more or less fully, by all parts of the plant. The fruit is, however, never complete, and no one species satisfies the requirements of the specimen under consideration.

"Heer also describes several species of *Carex*, among which the isolated fruits of *Carex tertiaria* bear a strong resemblance to those of our specimen. In no case, however, is the complete spike to be found, so that it would appear more reasonable to regard our specimen as one hitherto unknown, and for it we would suggest the provisional name *Carex Vancouverensis*."

Carex Burrardiana n. sp.

(Fig. 6.)

A third specimen from Burrard Inlet, near Vancouver, collected by Mr. C. Hill-Tout, appears also to differ very materially from any species

[1] Veg. Pal., ii., 112.

[2] Fl. Ter. Helv., i., 75, etc.; iii., 161-155.

Fl. Ter. Helv., i., 74.

heretofore described. As shown in the figure, it is represented by a globular head of fruit having a total diameter of 12 mm. In detail, the head shows on one side the remnant of a stem, and otherwise is composed of a number (11) of fruit bodies, each of which shows an obvious outer sac or investment as a perigynium. These structures are rather narrowly ovate, beakless, but acute, or even somewhat acuminate and conspicuously two-nerved. Towards the centre there is a darker zone, in which the details are not clearly recognizable, but it is of such a nature as to suggest the presence of fruits internal to the perigynia. It is possible, also, that this appearance is in part due to the presence of floral scales. This zone merges at the centre into a darker region, which at once suggests a central axis or receptacle, an idea which gains force when it is found that the perigynia, with their inclosed fruits, clearly terminate at this zone.

From these details it would seem clear that we have here a Cyperaceous fruit of the genus Carex, which finds its modern representatives among those of the section Physocarpæ, and on looking over a number of herbarium specimens of this group, I find it not uncommonly happens that in pressing, the shorter, and, therefore, more globose, heads assume an appearance closely similar to that of the fossil.

None of the figures of fossil Carices, so far as I can ascertain, show any fruit at all similar to the one under consideration, and it would thus appear necessary to provide a provisional name, for which I would suggest *Carex Burrardiana*, the description reading as follows:

CAREX BURRARDIANA, n. sp.

Heads globose, 12 mm. broad; perigynia narrowly ovate, two-nerved, upwards of 2·25x0·6 mm., beakless; the apex acute or somewhat acuminate. Associated with finely and many-nerved leaves about 1 cm. broad.

POPULUS BALSAMINOIDES, Goeppert.

(Figs. 8, 9.)

Goeppert, Flora von Schless; Heer, Flora Helvetiæ; Flora Alaskana, p. 26, pl. ii.; Lesquereux, U. S. Geol. Survey, vol. viii.

I refer the leaves figured to this species, though with some hesitation. I have, however, no doubt that they are at least identical with some of those referred to this species by Lesquereux. They resemble Heer's figures in form and venation, but differ in wanting the serration on the edges, or in having it very imperfect. Lesquereux's specimens were from Corral Hollow, California, and the Bad Lands of Dakota. Von *latiloba* is credited to the Oligocene of Florissant.

The localities quoted above, if all the leaves referred to belong to one

species, show that it must have been widely distributed in Eocene times over the Northern Hemisphere, and extended upward into the Oligocene. With the exception of its cordate base, the leaves approach very nearly to those of *P. monodon*, Lesq., from Baton Mountains and Fischer's Peak.

POPULUS ROTUNDIFOLIA, Newberry.

(Fig. 10.)

One of the layers of the Hastings cores has cut around a leaf of this pretty little species so perfectly as to show nearly its whole margin. The species is characteristic of the Fort Union group, and is also found in the "Bad Lands." It is related to *P. arctica* and *P. cuneata*, which are found in the Oligocene of the Similkameen district.

SALIX VARIANS, Goeppert.

(Fig. 11.)

Goeppert, Flora Schloss; Lesquereux, vol. viii., p. 247.

In collections from Burrard's Inlet, also in those from Stanley Park, but the venation is not very distinct. It is a species credited by Lesquereux to Table Mount, California, and to Corral Hollow, Oregon, and is also found in Alaska in beds of Laramie age.

SALIX INTEGRA, Goeppert.

(Fig. 12.)

Lesquereux, vol. vii., p. 107; vol. viii., p. 248.

Leaves referable by their form to this species are scattered abundantly over some surfaces at Burrard's Inlet. The venation is not well preserved. Similar leaves, though less abundant, appear in the collections from Hastings and Stanley Park.

Lesquereux finds this species at Black Buttes, Wyoming, and at Golden, Colorado, in Lower Tertiary. He also notes it at Corral Hollow, Cal., and *C. augusta*, a closely allied form, at Old Field, Oregon.

DRYOPHYLLUM STANLEYANUM, n. s.

(Fig. 13.)

Quercus furcinervis? of Lesquereux, Geol. Survey of U. S., vol. viii.

Leaf thick, coriaceous, granulate on the surface, oblong obovate, narrowing regularly below to the petiole. Midrib and veins strong, sunken in the leaf, which swells between the veins. Veins proceeding from the midrib almost at right angles, but bending upward toward the

margin, where some of them seem to fork obtusely, though this is uncertain. Margin entire or slightly undulate, so as to give a denticulate appearance.

This remarkable leaf is dominant in the collections from Stanley Park and Vancouver, and fragments occur in those from Burrard's Inlet. It seems probable that it is the species which Lesquereux identifies with *Quercus furcinervis* of Rossmassler, and found at Bridge Creek and Cascade Mountains, Oregon, and Plumas County, California. Some of its forms might, with some latitude, be referred to Rossmassler's species, but on the whole it seems distinct. In venation it somewhat resembles *Q. castaneopsis* of Lesquereux, from Randolph County, Wyoming, in beds supposed to be Oligocene. It differs, however, in form from that species. It seems doubtful if it is an oak, but perhaps may be referred for the present to the provisional genus *Dryophyllum*. It may eventually prove to be allied to the Laurels or Magnolias.

Quercus Dentoni, Lesquereux.

(Figs. 14, 15.)

Lesquereux, vol. viii., p. 18.

I refer these leaves to Lesquereux's species above named. They certainly represent a closely allied form. They are from Burrard's Inlet and Stanley Park. Lesquereux's specimens were from the Bad Lands of Dakota.

There are some fragmentary leaves in the collections which may have belonged to another species of Live-Oak.

Platanus, sp.

Large leaves, from Burrard's Inlet, having venation similar to that of *Platanus*, but too much crumpled and defaced to be figured or described. They seem to represent a form allied to the well-known species of *Platanus* so common in the Upper Laramie east of the mountains. A somewhat similar species, *P. dissecta* of Lesquereux, occurs at Corral Hollow, California, but in beds supposed to be of later date. Additional fragments show venation similar to that of *P. Guilelmi*, Heer, a well known Tertiary species on both sides of the Atlantic, but unfortunately the margins of the leaf are not preserved.

Juglans denticulata, Heer.

Lesquereux, U. S. Reports, vol. vii., p. 289; Heer, Flor. Fos. Arct., vol. ii.

The specimens referred to this species are fragments found at Burrard's Inlet and at Hastings. It is characteristic of the Eocene flora of

Atanékerdluk, in Greenland, and is recognized by Lesquereux at Green River, Spring Cañon and Carbon, in Lower Tertiary beds.

Found by Lesquereux at Green River, Spring Cañon, and Carbon.

ÆSCULOPHYLLUM HASTINGSENSE n. s.

(Fig. 16.)

This is a fragment of the lower part of a large leaf from Burrard's Inlet. It is much crumpled and the margin is not well preserved, but it shows distinctly a septinate division into oblong leaflets, coming to a point below and articulated to the top of a common petiole. Traces of venation also show a resemblance to the modern Horse-chestnut, though the leaflets are narrower and the veins more curved. The genus *Æsculus* is represented in the Upper Laramie, east of the mountains, by a fruit (*Æsculus antiqua*) described by me in the Transactions of this Society for 1886.

FICUS SHASTENSIS? Lesq.

(Fig. 17.)

Lesquereux, Bulletin U. S. National Museum, 1888.

This leaf, from Burrard's Inlet, resembles the above-named species in form and surface character, but the venation is not preserved. Lesquereux's specimens are from Shasta, California.

FICUS OCCIDENTALIS? Lesq.

Lesquereux, U. S. Survey, vol. vii., p. 208.

Fragments of a broad-leaved *Ficus* occur in the Hastings collections which are very near to this species. Similar fragments, but of smaller size and apparently narrower, appear in the collections from Stanley Park. They evidently represent a fine species of the genus near to, if not identical with, that named above.

Found by Lesquereux at Golden, Colorado.

PLANERA CRENATA, Newberry.

Newberry, unpublished plates communicated to me by Prof. Knowlton, of the U. S. National Museum.

This species is indicated by a leaf of which half is preserved on a surface of the Hastings core. Newberry's specimens are from Tongue River, Wyoming. I do not know the precise horizon.

This plant continued in British Columbia up to the Oligocene period, since it is found in collections recently made by Dr G. M. Dawson at

Horsefly River, where it occurs in beds holding leaves of the Similkameen group. The original specimens contained in the Similkameen collections were referred by me to *P. elongata*, Lesq., but both forms occur together at Horsefly River, and possibly they are varieties of one species.

Miscellaneous Fragments.

The collections contain many fragments indicating the presence of additional genera and species. Some of them may belong to species of *Acer*, *Aralia* and *Betula*, and probably of other genera. The boring at Hastings, more especially, must have passed through some beds of shale exceptionally rich in well-preserved leaves. Should these beds ever be exposed by mining, they may be expected to yield a rich harvest of fossil plants.

One bed at Burrard's Inlet is crowded with roots of aquatic plants which resemble those found in the beds of the inland Laramie holding the leaves of *Lemna scutata*.[1]

In summing up the results of this study of fossil plants from the Tertiary of southern British Columbia, it appears, from a comparison with the flora of the Upper Cretaceous Nanaimo series, that the Burrard's Inlet species are distinct and of more modern aspect.[2] On the other hand, they are also distinct from those of the Oligocene or older Miocene deposits of the Similkameen district and other parts of the interior of British Columbia.[3] Between these they occupy an intermediate position; in this respect corresponding with the Laramie of the interior plains east of the Rocky Mountains. They also resemble this formation in the general facies of the flora, which is not dissimilar from that of the Upper Laramie or Fort Union group.

We may thus refer the plants now in question to the Paleocene or Eocene, and regard them as corresponding with those of the Atanékerdluk beds in Greenland, the lignitic series of the McKenzie River, and the beds holding similar plants in Alaska. Thus, the opinion expressed in 1890, from the very small collection then available, was substantially correct; and I find that the late Dr. Newberry had arrived at a similar conclusion from the study of the plants of the Puget group in Washington Territory.

This flora thus serves to fill up one of the gaps in our western series of fossil plants, namely, that between the Cretaceous and the Lower

[1] Flora of Laramie, Trans. R. S. C., 1887.

[2] Cretaceous Plants of British Columbia, Trans. R. S. C., 1882.

[3] Plants from Similkameen, etc., Trans. R. S. C., 1890.

Miocene. How completely it may fill this gap we do not know at present, since this would require large collections from all the beds of the group, and we can scarcely hope for these unless mining operations shall be carried on in the lignite beds. Workable beds of this kind have not as yet been found north of the United States boundary, but I do not despair of their discovery, though the superiority of the Cretaceous coal of the Nanaimo district may for some time prevent their development.

Should such opportunities be afforded for collecting these fossil plants, it is very desirable that accurate notes should be taken of the order of the beds containing the fossils, and also of their mode of occurrence, as it is to be expected that in a formation of so considerable thickness a succession of sub-floras may occur, and as the beds were probably deposited in the estuary of a river draining a large and elevated territory, differences of age may be complicated with the intermixture or alternation of species indigenous to the low country with others drifted from higher or colder districts in the interior.

It would be rash to attempt to decide definitely on the climatal conditions of the west coast of America in the Eocene period, from the plants yet known. But, so far as they can give information, we may infer that the Cretaceous climate was somewhat warmer than that of the Eocene, but that both attained a higher temperature than that of the present day in the same latitudes, while in the Miocene age the climatal conditions were not very different from those now prevailing in the region.

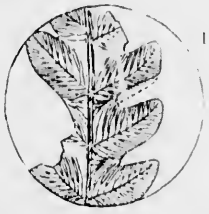
A collection of specimens made by Mr. Hill-Tout, of Vancouver, was received by the Geological Survey while this paper was in press. Notes on a few of the more important species have been introduced above, but there was not time to examine the whole of the specimens. On a hasty inspection they appear to include several forms noticed above, as *Salix varians*, *S. integra*, *Populus balsaminoides*, etc. There are also fragments referable to *Ficus Condoni*, Newby., *F. asiminifolia*, Lesq., *Quercus Evansii*, Lesq., and *Sequoia spinosa*, Newby. Other fragments indicate species of *Quercus*, *Juglans*, etc.

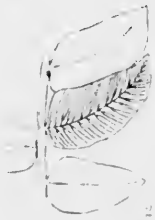
I have to thank Mr. L. M. Lambe, F.G.S., of the Geological Survey for the greater number of the figures.

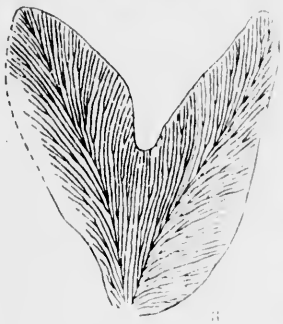
LIST OF ILLUSTRATIONS.

PLATES IV. TO VIII.

Fig. 1—Lastrea (Goniopteris) Fischeri, Heer.
2 Neuropteris civica, s. n.
3—Lygodium neuropteroides, Lesquereux.
4 Asplenites, sp.
5 Carex Vancouverensis, Penhallow.
6 Carex Burrardiana, Penhallow.
7—Sabal Campbellii, Newberry.
8, 9 Populus balsaminoides, Goept.
10—Populus rotundifolia, Newby.
11 Salix varians, Goept.
12 Salix integra, Goept.
13 Dryophyllum Stanleyanum, s. n.
14, 15 Quercus Dentoni, Lesq.
16—Æsculophyllum Hastingsense, s. n.
17 Ficus Shastensis, Lesq.







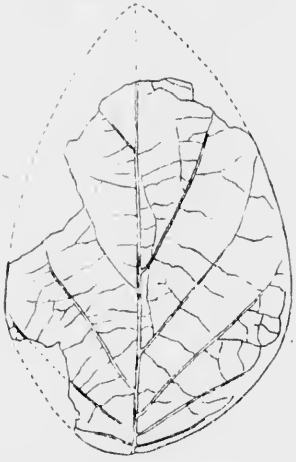
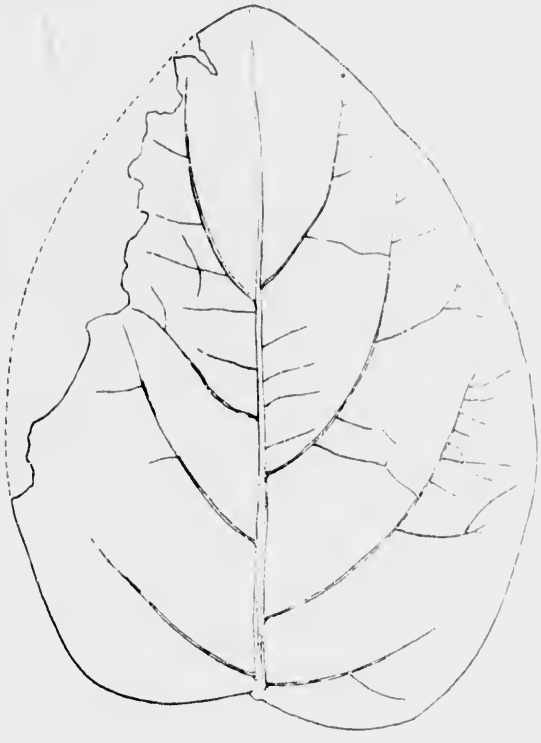


Fig. 1—Lastrea Fischeri.
3—Lygodium neuropteroides.
5—Carex Vancouverensis.
8—Populus balsaminoides.

Fig. 2—Neuropteris civica.
4—Asplenites.
6—Carex Burrardiana

Fig. 7. Sabal Campbellii.



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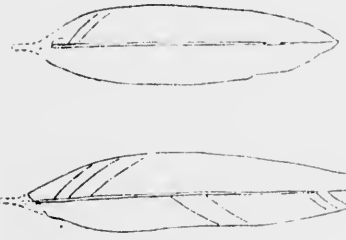

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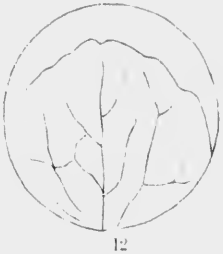

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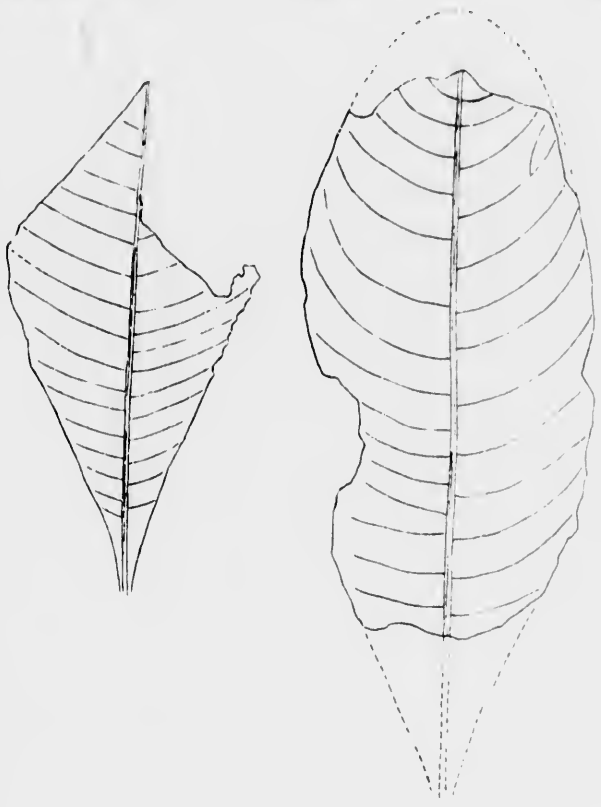
Fig. 9—Populus balsamoides.
11—Salix varians.

Fig. 10—Populus rotundi folia.
12—Salix integra.



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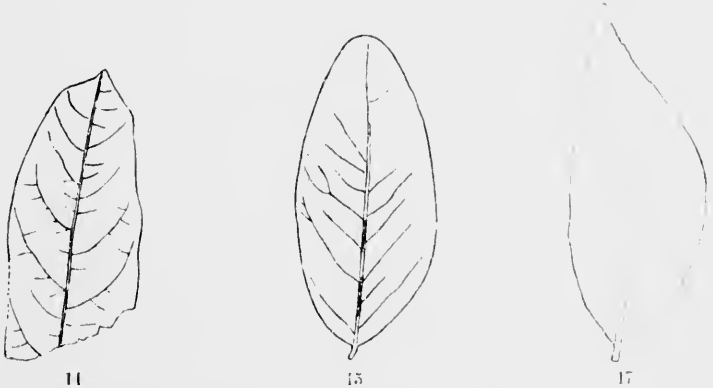

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Fig. 13—Dryophyllum Stanleyanum.
15—Quercus, sp.

Fig. 14 Quercus Dentoni.
17—Ficus Shastensis.

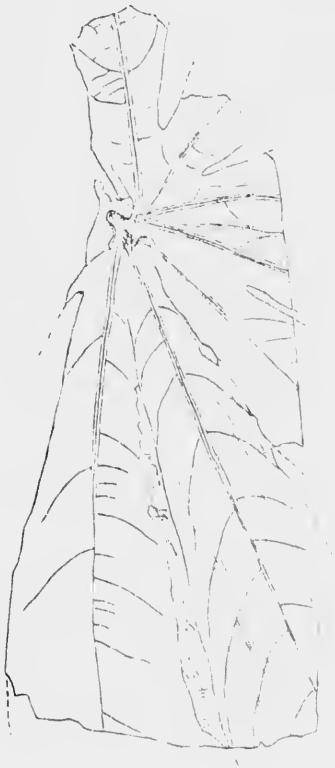

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Fig. 16 .Esculophyllum Hastingsense.

Sec. IV., 1895. 11.