

MEMOIR 293

**FLORA OF THE
UPPER CRETACEOUS NANAIMO GROUP
OF VANCOUVER ISLAND,
BRITISH COLUMBIA**

**BY
W. A. BELL**

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PREFACE

The Nanaimo group of sedimentary rocks, restricted to the eastern part of Vancouver Island, contains all the known workable coal seams of the island. A knowledge of the stratigraphy, age, and geological history of this group of rocks is consequently of both scientific and economic importance.

This report deals with fossil plants collected from the Nanaimo group over the past three-quarters of a century. Its main purpose is to aid in the elucidation of problems connected with rocks of this group, but it will also assist in unravelling the complicated sequence of geological events that took place in the Cordilleran region of Western Canada, a region particularly rich in mineral resources.

GEORGE HANSON,
Director, Geological Survey of Canada

OTTAWA, June 29, 1956

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FIGURE 1. Index map showing areas underlain by Nanaimo group.

Flora of the Upper Cretaceous Nanaimo Group of Vancouver Island, British Columbia

CHAPTER I

INTRODUCTION

Upper Cretaceous alternating marine and non-marine, clastic sediments, collectively called the Nanaimo group and having a maximum thickness of 5,000 to 10,000 feet, underlie narrow coastal belts and off-shore islands of eastern Vancouver Island, B.C. Two of these Cretaceous areas, each about 75 miles long with maximum widths of 20 to 30 miles, form the greater part of the western border of the Strait of Georgia and comprise the Nanaimo and Comox coalfields. These fields are separated only by a narrow ridge of pre-Upper Cretaceous metamorphic and igneous rocks. Several much smaller coastal areas, together comprising the Suquamish coal-area, border parts of Queen Charlotte Strait in the northeastern part of Vancouver Island. These northern areas are not presently known to contain workable coal seams, but, owing to an extensive drift and forest cover, little is known about their detailed stratigraphy.

Much of the plant material dealt with in this paper was collected during reconnaissance geological explorations of the last century; other collections were made in recent years by geologists of the Geological Survey of Canada in the course of more detailed stratigraphic surveys in the Nanaimo and Comox areas. Most of the material was gathered from the waste dumps of coal workings, and information on the stratigraphic position of collections made from rock outcrops is generally lacking.

PLANT-BEARING FORMATIONS

Nanaimo Coalfield (*J. L. Usher 1952*)

Only a lower part of the Nanaimo group has yet furnished identifiable plant remains. In the Nanaimo coalfield they have been gathered from two coal-bearing formations, the Extension, 600 to 800 feet thick, and the Newcastle, 200 to 400 feet thick, as well as from the Protection formation, about 650 feet thick, which overlies the Newcastle. The Extension formation, the oldest of the plant-bearing rock units, lies upon the Haslam formation, 600 to 1,500 feet thick, which contains a marine molluscan fauna. The Haslam in turn lies upon the basal formation of the group, the Benson formation, an unfossiliferous conglomerate, 100 feet thick. Sandstone and conglomerate, 200 to 600 feet thick, assigned to a separate lithological unit, the Cranberry formation, lies between the Extension and Newcastle formations, but has furnished no identifiable plants. No marine fossils are known either from the Extension or the overlying Cranberry, but a marine molluscan fauna occurs above one of the coal seams in the Newcastle formation, and an *Inoceramus* occurs sparingly

within the Protection formation. The Protection itself is overlain by another marine formation, the Cedar District, which contains a molluscan fauna and which is comparable in thickness to the earlier Haslam formation.

Comox Coalfield (J. L. Usher 1952)

In the Comox coalfield, owing to pronounced lateral variations in lithology, geologists have found it necessary or expedient to apply a terminology to formational divisions different from that used in the Nanaimo field. Eight formational units are recognized as compared with ten in the Nanaimo area. Identifiable plant remains, however, are again confined to a lower part of the group, and indeed to a single coal-bearing rock unit, the Comox formation, which is about 600 feet thick. In the northern part of the field the Comox forms the base of the group, lying directly upon a very uneven surface of erosion developed upon pre-Upper Cretaceous rocks. In the southern part of the field, however, the Comox lies upon an older basal formation of the Nanaimo group, the Qualicum.

The Qualicum underlies a low, drift-covered area, but is believed to be well over 1,000 feet thick, and its upper part is known to contain a marine molluscan fauna.

Suquash Coal-area

In the Suquash area on Queen Charlotte Strait the stratigraphic position of plant-bearing beds within the Nanaimo group is unknown. All plants in Survey collections from this area were gathered by G. M. Dawson, during an exploratory survey in 1885. Most of them came from the roof of a seamlet of coal on the north shore of Port McNeill (Dawson, 1887, p. 61B)¹, but a few were collected from near Fort Rupert (now Port Hardy) on Beaver Harbour.

PREVIOUS WORK

The first published record of fossil plants from the Nanaimo group was based on a small collection made in the vicinity of Nanaimo by Dr. John Evans, at that time United States Geologist of the Territory of Oregon. The plants were reported upon by L. Lesquereux (1859, pp. 360-362) who recognized a total of nine species, of which six were regarded as new, viz., *Populus rhomboidea*, *Quercus benzoin*, *Quercus multinervis*, *Quercus platinervis*, *Cinnamomum heeri*, and *Salisburia polymorpha*; three additional forms were generically identified as *Platanus*?, *Chamoerops*, and *Lastrea*. The new species must all be considered *nomina nuda*, for Lesquereux's descriptions were totally inadequate for subsequent recognition in other collections, and were unaccompanied by figures.

The Nanaimo plants submitted to Lesquereux were accompanied by others collected from Bellingham Bay, Washington Territory. In evaluating the age of the former, Lesquereux, unfortunately, united them to the Bellingham plants as members of a single flora, which he dated as Miocene. As an early Tertiary age for the Bellingham Bay plants is now generally recognized, it is not surprising that O. Heer, to whom Lesquereux submitted drawings of plants from both areas, should have commented

¹Names and dates in parentheses are those of references cited at the end of this report.

in terms very favourable to a Tertiary age of the flora considered as a unit (Heer in Lesquereux, 1859, pp. 85-89).

J. S. Newberry as early as 1858 recognized that the Nanaimo plants were Cretaceous and not Tertiary, although publication of this did not take place until 1863, in which year Newberry described two new species from Nanaimo, *Aspidium kennerlyi* and *Taxodium cuneatum* (Newberry 1863, pp. 508, 513, 517). A Cretaceous age for the Nanaimo group was also advocated by F. B. Meek (1864, p. 37) on evidence of marine fossils.

In 1865 Heer (pp. 6-7; Pl. 1, figs. 2, 3?, 4?) described and figured as *Sequoia langsdorfii* some specimens from Nanaimo and Vancouver. Here again, as in the case of the Nanaimo-Bellingham collections, members of two distinct floras were intermingled, and it is not certain which specimens figured by Heer, except that represented by figure 2, actually came from Nanaimo. The last mentioned was stated as coming from beneath the Newcastle coal, and, if so, it was derived from the Cranberry formation.

In 1872 J. W. Dawson (p. 98) after a preliminary study of plants collected by J. Richardson from the Nanaimo group, published the following list:

Taeniopteris ? n. sp.
Taxodium cuneatum Newberry
Sequoia langsdorfii Heer (or an allied sp.)
Sabal sp.
Palmacites—fragments of leaves
Populus—fragments of leaves
Quercus—fragments of leaves
Platanus—fragments of leaves
Cinnamomum heeri Lesquereux
Taxites—possibly *Salisburia*
Cupressinoxylon sp.

The most interesting part of this record is the inclusion of both *Taxodium cuneatum* and *Sequoia langsdorfii*, which are now considered to be different forms of the single species, *Metasequoia cuneata* (Newberry).

In 1873 J. W. Dawson (pp. 66-71) reported on some fossil wood from the Nanaimo coalfield. Among coniferous wood, a *Cupressinoxylon* was stated to resemble *Sequoia gigantea*, and two species were allocated to *Taxoxylon*. Dicotyledonous wood was believed to be represented by three genera, *Quercus*, *Betula*, and *Populus*.

In 1883 J. W. Dawson (pp. 24-29; Pls. 4-8, figs. 14-36) presented a more comprehensive view of the flora of the Nanaimo group after examination of additional collections made by J. Richardson and G. M. Dawson, mostly from the Nanaimo and Comox coalfields. In all, 30 species were noted, of which 24 were illustrated by drawings.

The flora, comprising plants from various localities, as now listed by Dawson was as follows:

Neuropteris castor Dawson. Loc. Beaver Harbour
Taeniopteris plumosa Dawson. Loc. Comox (Baynes' Sound)
Nilssonina lata Dawson. Loc. Comox (Baynes' Sound)
Pteris (Oleandra) glossopteroides Dawson. Loc. Protection Island
Sphenopteris elongata Newberry. Loc. Protection Island
Davallites richardsoni Dawson. Loc. Protection Island
Adiantites praelongus Dawson. Loc. Comox (Baynes' Sound)
Pecopteris sp. Dawson. Loc. Comox (Baynes' Sound)
Aspidium kennerlyi Newberry. Loc. not given
Torreya densifolia Dawson. Loc. Protection Island

- Glyptostrobus* sp. Dawson. Loc. Comox (Baynes' Sound)
Taxodium cuneatum Newberry. Locs. Nanaimo and Protection Island
Salisburia baynesiana Dawson. Locs. Comox (Baynes' Sound) and Beaver Harbour
Phragmites cordaiformis Dawson. Locs. Comox (Baynes' Sound), Nanaimo, and North Saanich
Sabal imperialis Dawson. Loc. Nanaimo
Salix pacifica Dawson. Loc. Comox (Baynes' Sound)
Populus rhomboidea Lesquereux. Loc. Newcastle Island
Populus protozadachii Dawson. Loc. Newcastle Island
Populus trinervis Dawson. Locs. Nanaimo and Comox (Baynes' Sound)
Populus reclinervata Dawson. Loc. Comox (Baynes' Sound)
Populus longior Dawson. Locs. Nanaimo and Comox (Baynes' Sound)
Populus sp. Loc. Comox (Baynes' Sound)
Betula perantiqua Dawson. Loc. Comox (Baynes' Sound)
Quercus victoriae Dawson. Locs. Nanaimo R., Newcastle Island and Protection Island
Ulmus dubia Dawson. Loc. Comox (Baynes' Sound)
Sassafras sp. Dawson. Loc. Comox (Baynes' Sound)
Juglans harwoodensis Dawson. Loc. Comox (Baynes' Sound)
Diospyros vancouverensis Dawson. Loc. Comox (Baynes' Sound)
Ceanothus cretaceus Dawson. Loc. Comox (Baynes' Sound)
Anisophyllum sp. Dawson. Loc. Comox (Baynes' Sound)
Protophyllum nanaimo Dawson. Locs. Nanaimo and Comox (Baynes' Sound)
Alnites insignis Dawson. Loc. Nanaimo
Carpolithes sp. Dawson. Locs. Beaver Harbour and Comox (Baynes' Sound)

For revision of recognizable species of the above list the reader is referred to pages 6, 7 of present report. Some of them were too fragmentary to have warranted specific recognition, and most were inadequately described or poorly figured. Dawson, nevertheless, showed great discernment in evaluating their age significance in concluding that the florules from the Nanaimo and Comox areas were late Senonian or Danian. He considered those from Comox possibly a little older than those from Nanaimo. Admitting that material from Beaver Harbour was too scanty for reliable judgment as to age, he thought it might be somewhat older than the Nanaimo or Comox material, but younger than the Lower Cretaceous of Queen Charlotte Islands.

In 1889 G. M. Dawson and J. W. Dawson (1889, pp. 71-72) contributed a joint note on fossil plants from Port McNeill and Quatsino Sound. Port McNeill is near the southern border of the Suquash coal-area, about 20 miles southeast of the locality (Port Hardy) on Beaver Harbour where a few plants had been collected previously. The collection from Port McNeill presented the first satisfactory view of the Cretaceous flora in the Suquash area, and it was stated by J. W. Dawson to be probably somewhat the same age as that from the Nanaimo and Comox fields or about the age of the florule from Protection Island. The few plants from Beaver Harbour were considered by Dawson to be earlier, and possibly as early as those from the Quatsino Sound area. Actually the plants collected from both Beaver Harbour in the Suquash area and Coal Harbour in the Koskeemo coal-areas of Quatsino Sound were too few and fragmentary for reliable judgment on age. To the present writer those from Coal Harbour suggest Lower Cretaceous (Neocomian), and those from Beaver Harbour, Upper Cretaceous and, in the present report, the Beaver Harbour florule alone is considered to be part of the flora of the Nanaimo group. In his preliminary note on the Port McNeill plants J. W. Dawson records the occurrence of *Sequoia* of the type of *Sequoia langsdorffii* Heer, *Torreya*, *Ginkgo*, *Ficus*, *Alnus*, *Betula*, *Quercus*, *Diospyros*, *Cinnamomum*,

Ceanothus, *Populus*, *Salix*, *Proteoides*, *Juglans*, *Rhamnus* and *Aralia*, including several species identical to those found in Nanaimo area.

In 1894 J. W. Dawson (pp. 53-73; Pls. 5-14) presented a fuller and illustrated account of the Port McNeill florule, together with descriptions of some additional species that were collected at Nanaimo. These plants comprised the following:

Macrotaeniopteris vancouverensis Dawson. Loc. Nanaimo
Cladophlebis columbiana Dawson. Loc. Nanaimo
Adiantites praelongus Dawson. Loc. Nanaimo
Noeggerathiopsis robinsi Dawson. Loc. Nanaimo
Dammarietes dubius Dawson. Loc. Nanaimo
Sequoia langsdorffii Heer. Locs. Nanaimo and Port McNeill
Taxodium sp. Dawson. Loc. Nanaimo
Salisburia pusilla Dawson. Loc. Port McNeill
Sabal imperialis Dawson. Loc. Nanaimo
Salix sp. Dawson. Loc. Port McNeill
Populus probasamifera Dawson. Loc. Port McNeill
Betula perantiqua Dawson. Loc. Port McNeill
Fagophyllum retosum Dawson. Loc. Port McNeill
Fagophyllum nervosum Dawson. Loc. Port McNeill
Dryophyllum occidentale Dawson. Loc. Port McNeill
Dryophyllum neillianum Dawson. Loc. Port McNeill
Dryophyllum elongatum Dawson. Loc. Port McNeill
Dryophyllum sp. Dawson. Loc. Port McNeill
Quercus holmesii Lesquereux. Loc. Port McNeill
Quercus victoriae Dawson. Loc. Port McNeill
Juglandites fallax Dawson. Loc. Nanaimo
Juglandites ? sp. Dawson. Loc. Port McNeill
Ulmophyllum priscum Dawson. Loc. Port McNeill
Platanus primaeva ? Lesquereux. Loc. Nanaimo
Ficus laurophyllidia Dawson. Loc. Nanaimo
Ficus contorta Dawson. Loc. Port McNeill
Ficus rotundata Dawson. Loc. Port McNeill
Ficus wellingtoniae Dawson. Locs. Nanaimo area and Port McNeill
Ficus magnoliifolia Lesquereux. Loc. Port McNeill
Artocarpophyllum occidentale Dawson. Loc. Nanaimo
Proteoides neillii Dawson. Loc. Port McNeill
Proteoides major Dawson. Loc. Nanaimo area
Proteoides sp. Dawson. Loc. Nanaimo
Laurophyllum insigne Dawson. Loc. Nanaimo
Diospyros vancouverensis Dawson. Loc. Port McNeill
Diospyros eminens Dawson. Loc. Nanaimo
Diospyros sp. Dawson. Loc. Port McNeill
Cornus obesus Dawson. Loc. Nanaimo area
Paliurus neillii Dawson. Loc. Port McNeill
Menispermiles sp. Dawson. Loc. Port McNeill
Liriodendron succedens Dawson. Loc. Port McNeill
Liriodendron praetuliipiferum Dawson. Loc. Nanaimo
Magnolia occidentalis Dawson. Loc. Nanaimo
Magnolia capellini Heer. Loc. Port McNeill
Protophyllum sp. Dawson. Locs. Port McNeill and Nanaimo
Ceanolhus cretaceus Dawson. Loc. Port McNeill
Macclintockia trinervis Heer. Loc. Port McNeill
Carpolithes (Zamites) meridionalis Dawson. Loc. Port McNeill
Cinnamomum sezannense Watelet. Loc. Port McNeill
Phyllites sp. Dawson. Loc. Port McNeill

On comparing the above list of species with a revised list given below, it is evident that there was much overspeciation. Dawson noted that many of the species occurring at Port McNeill were lacking at Nanaimo, and thought that the Port McNeill florule was perhaps a little later in age than that of Nanaimo. He also concluded that the Nanaimo group flora as a whole indicated a warm temperate climate.

COMPOSITION OF THE FLORA

Revision of Previously Recorded Species

The following list presents synonyms and changes of names of species previously recorded from the Nanaimo group.

- Adiantites praelongus* Dawson = *Protophyllocladus polymorpha* (Lesquereux) Berry
Alnites insignis Dawson = *Viburnum insigne* (Dawson) n. comb.
Anisophyllum sp. Dawson = *Quercus* ? *richardsoni* n. sp.
Artocarpophyllum occidentale Dawson = *Artocarpus occidentalis* (Dawson) n. comb.
Betula perantiqua Dawson = *Alnus perantiqua* (Dawson) n. comb.
Ceanothus cretaceus Dawson = *Zizyphus cretaceus* (Dawson) n. comb.
Cinnamomum sezannense Dawson (non Watelet) = *Cinnamomoides buckhami* n. sp.
Cornus obesus Dawson = *Rhamnites eminens* (Dawson)
Dammarites dubius Dawson = ? *Dammarites robinsoni* (Dawson)
Diospyros eminens Dawson = *Rhamnites eminens* (Dawson) n. comb.
Diospyros vancouverensis Dawson = *Rhamnites eminens* (Dawson)
Diospyros victoriae Dawson = *Rhamnites eminens* (Dawson)
Dryophyllum neillianum Dawson = *Dryophyllum elongatum* Dawson
Dryophyllum occidentale Dawson (pars) = *Dryophyllum elongatum* Dawson
Dryophyllum occidentale Dawson (pars) = *Rhamnites eminens* (Dawson)
Fagophyllum nervosum Dawson = *Rhamnites eminens* (Dawson)
Fagophyllum retosum Dawson = *Rhamnites eminens* (Dawson) forma *wellingtoniae*
Ficus contorta Dawson = *Rhamnites eminens* (Dawson)
Ficus laurophyllidia Dawson = *Ternstroemites harwoodensis* (Dawson)
Ficus magnoliifolia Dawson (non Lesquereux) = *Rhamnites eminens* (Dawson)
Ficus rotundata Dawson (pars) = *Rhamnites eminens* (Dawson)
Ficus rotundata Dawson (pars) = *Rhamnites eminens* (Dawson) forma *wellingtoniae*
Ficus wellingtoniae Dawson = *Rhamnites eminens* (Dawson) forma *wellingtoniae*
Glyptostrobus sp. Dawson = *Glyptostrobus comoxensis* n. sp.
Juglandites fallax Dawson = *Dryophyllum fallax* (Dawson) n. comb.
Juglandites sp. Dawson = *Phaseolites manihassettensis* Hollick
Juglans harwoodensis Dawson = *Ternstroemites harwoodensis* (Dawson) n. comb.
Liriodendron praetulipiferum Dawson = *Liriodendron giganteum* Lesquereux
Macclintockia trinervis Dawson (non Heer) = *Cinnamomum trinervis* (Dawson) n. comb.
Macrolaeniopsis vancouverensis Dawson = *Nilssonia vancouverensis* (Dawson) n. comb.
Magnolia capellini Dawson pars (non Heer) = *Combretum cordifolia* (Lesquereux) Berry
Magnolia capellini Dawson pars (non Heer) = *Pterospermites* sp.
Magnolia occidentalis Dawson = *Rhamnites eminens* (Dawson)
Menispermites sp. Dawson = *Trochodendroides* (*Cercidiphyllum*) *arctica* (Heer) Berry
Neuropteris castor Dawson = *Cladophlebis* (*Gleichenites* ?) *castor* (Dawson) n. comb.
Nilssonia lata Dawson = *Pseudoclenis latipennis* (Heer) Seward
Noeggerathiopteris robinsoni Dawson = *Dammarites robinsoni* (Dawson) n. comb.
Paliurus neillii Dawson (pars) = *Zizyphoides neillii* (Dawson) n. comb.
Paliurus neillii Dawson (pars) = *Zizyphus cretaceus* (Dawson)
Pecopteris sp. Dawson = ? *Cladophlebis* (*Gleichenites* ?) *usherii* n. sp.
Platanus primaeva ? Dawson (non Lesquereux) = *Platanus affinis* Lesquereux
Populites probalsamifera Dawson = *Leguminosites probalsamifera* (Dawson) n. comb.
Phragmites cordatiformis Dawson = *Dammarites robinsoni* (Dawson)
Populus longior Dawson = ? *Viburnum insigne* (Dawson)
Populus protozadachii Dawson = *Trochodendroides* (*Cercidiphyllum*) *arctica* (Heer) Berry
Populus rectinervata Dawson = ? *Viburnum insigne* (Dawson)
Populus rhomboidea Lesquereux = ? *Platanus affinis* Lesquereux
Populus rhomboidea Dawson (non Lesquereux) = *Viburnum insigne* (Dawson)
Proleoides sp. Dawson = *Laurus asiminoides* ? Berry
Protophyllum nanaimo Dawson = *Platanus nanaimo* (Dawson) n. comb.
Pteris (*Oleandra*) *glossopteroides* Dawson = *Saccoloma gardneri* (Lesquereux) Knowlton
Quercus benzoin Lesquereux = ? *Rhamnites eminens* (Dawson)
Quercus holmesii Dawson (non Lesquereux) = *Dryophyllum elongatum* Dawson
Quercus ? (*Dryophyllum*) *occidentalis* (Dawson) Knowlton = *Dryophyllum elongatum* Dawson
Quercus platineris Lesquereux = ? *Dryophyllum whitmani* (Knowlton)
Quercus vancouverensis Trelease = *Rhamnites eminens* (Dawson)
Quercus vancouveriana Trelease = *Dryophyllum elongatum* Dawson

Quercus victoricae Dawson = *Rhamnites eminens* (Dawson)
Sabal imperialis Dawson = *Geonomites imperialis* (Dawson) n. comb.
Sabal sp. Newberry = *Geonomites imperialis* (Dawson)
Salisburia baynesiana Dawson = *Protophyllocladus polymorpha* (Lesquereux) Berry
Salisburia polymorpha Lesquereux = *Protophyllocladus polymorpha* (Lesquereux) Berry
Salisburia pusilla Dawson = *Ginkgo dawsoni* Knowlton
Salix pacifica Dawson = *Sapindus pacificus* (Dawson) n. comb.
Salix sp. Dawson = *Rhamnites eminens* (Dawson)
Sequoia cuneata Newberry = *Metasequoia cuneata* (Newberry) Chaney pars
Sequoia langsdorfii Dawson (non Brongniart) = *Metasequoia cuneata* (Newberry) Chaney
 pars
Sequoia langsdorfii Heer pars (non Brongniart) = *Metasequoia cuneata* (Newberry) Chaney
 pars
Sphenopteris elongata Dawson pars (non Newberry) = *Aneimia fremonti* Knowlton
Sphenopteris elongata Dawson pars (non Newberry) = *Dryopteris kennerlyi* (Newberry)
 Knowlton
Taeniopteris plumosa Dawson = *Nilssonia vancouverensis* (Dawson)
Taxodium cuneatum Dawson = *Metasequoia cuneata* (Newberry) Chaney pars
Taxodium cuneatum Newberry = *Metasequoia cuneata* (Newberry) Chaney pars
Taxodium sp. Dawson = *Metasequoia cuneata* (Newberry) Chaney pars
Torreya densifolia Dawson = *Metasequoia cuneata* (Newberry) Chaney pars
Tumion densifolia (Dawson) Knowlton = *Metasequoia cuneata* (Newberry) Chaney pars
Ulmophyllum priscum Dawson = *Dryophyllum elongatum* Dawson
Ulmus dubia Dawson = *Alnus perantiqua* (Dawson)
Zamites albertensis Berry = *Dammarnites robinsi* (Dawson)

The total number of species presently known to occur in the Nanaimo group is 92, of which 66 are specifically named and 26, from lack of good or sufficient material, are given only generic status. The named species include 16 new ones described and illustrated in this report. The flora comprises 14 ferns, 5 cycadeoids, 1 ginkgo, 7 conifers, 2 monocotyledons and 63 dicotyledons.

The collections were gathered too much at random and contain far too few specimens of each species for comparative numerical counts of individuals to have any significance as an index of dominant species. Yet specimens of *Rhamnites eminens* occur in collections from all formations except that of the Beaver Harbour locality, and it may reasonably be inferred that it at least was one of the dominant elements in the flora. Some species, e.g., *Glyptostrobus comoxensis*, *Thuites corpulentus*, *Cupanites crenularis*, *Sapindus pacificus* and *Zizyphus cretaceus* are common at one or more localities in the Comox formation, but rare or lacking in collections from other formations. Most of the other species are represented by only a few specimens. Moreover, each formation except the Newcastle, from which only scanty collections are available, has a relatively large number of species restricted to it, viz., 10 out of a total of 31 species from the Extension formation, 15 out of a total of 35 from the Protection, 22 out of a total of 48 from the Comox, 7 out of a total of 20 from Port McNeill, and 1 out of a total of 4 from Beaver Harbour. The stratigraphical significance of this localized distribution cannot presently be evaluated. In the first place it is not known to what extent the present collections are fairly representative of the florule that may actually occur within each of the formations. Secondly, the amount of sandstone or coarser clastic material in each formation is sufficiently large to infer that conditions generally were unsuitable for burial and preservation of recognizable plant species and that stratigraphic sequences suitable for determining the range of most species within the known plant-bearing part of the Nanaimo group are probably lacking. Most of the collections were gathered

from waste dumps from a very few coal workings in the Nanaimo and Comox areas, and the remainder, except a collection from the roof shales of a thin seam of coal at Port McNeill, may be assumed to be little more than random samples of the plants from any bed or zone. Outcrops suitable for extensive collections are apparently rare and restricted to a few coastal sections and to streams. The last mentioned, draining a mountainous terrain and running through a drift-covered, forested, low-lying coastal belt, do not present favourable conditions for collecting.

CONSIDERATIONS OF CLIMATE

The flora of the Nanaimo group includes a number of genera that are now confined to warm temperate, subtropical or tropical floras. Chief among these are *Saccoloma*, *Artocarpus*, *Ficus*, *Liriodendron*, *Cinnamomum*, *Laurus*, *Chrysobalanus*, *Sapindus* and *Zizyphus*. The occurrence of these genera certainly militates against a cold temperate climate. In recent years certain leaf characters of dicotyledons have been utilized by palæobotanists to indicate probable climatic conditions of growth. E. W. Bailey and I. W. Sinnott (1915, p. 832) pointed out that in living floras the proportion of entire-leaved to non entire-leaved species increased gradually from the forests of the cold temperate zone southward into the warm temperate, subtropical and tropical zones. However, the proportion of entire-leaved species within any single climatic region itself was shown to vary widely between areas of different physiological environment. Within a cold temperate region, for instance, the proportional number of entire-leaved species was greater than normal in arid or other physiological, dry environments, whereas in the tropics the proportion of entire-leaved species was much less on cool uplands. This factor of variation due to heterogeneous environments may have particular importance in any quantitative analysis of the flora of the Nanaimo group, because the containing deposits were presumably laid down on a coastal plain forming part of a basin of deposition that lay between bordering mountainous terrain in the interiors of both Vancouver Island and of the British Columbia mainland. It is, therefore, considered most likely that some upland species would be carried onto the plain of deposition of the Nanaimo group by streams arising in nearby mountains to the west, and would be buried in association with lowland forms. The relative proportions of upland species would be expected to be particularly high in plant-bearing parts of a deltaic deposit of generally rapid deposition, whereas conditions permitting lowland forest growth would be expected to be of relatively short duration.

The percentage ratios of entire- to non entire-leaved species of dicotyledons in the florules of each formation and in the flora of the Nanaimo group considered as a unit is as follows:

	Entire	Non-entire	No. of Species
Nanaimo flora.....	44	56	61
Florule of Extension formation.....	50	50	20
Florule of Comox formation.....	50	50	30
Florule of Port McNeill formation.....	56	44	18
Florule of Protection formation.....	29	71	24

The florule of the Newcastle formation and that from Beaver Harbour are excluded, because collections from the former contain only 5 species of dicotyledons and that from Beaver Harbour none. It will readily be seen that the ratio in the Nanaimo group flora taken as a whole is lowered by inclusion of the florule of the Protection formation. The Protection formation consists mainly of thick-bedded, medium- to coarse-grained sandstones, made up largely of subangular to angular grains of quartz and feldspar (Usher, 1952, p. 15). Although a few seamlets of coal recur sporadically in the lower part of the formation, its general character indicates rapid, probably deltaic deposition. Compared with all the other plant-bearing formations of the group, it might be expected to contain a much greater number of species brought down by streams draining the cooler uplands.

The percentage ratios of entire- to non-entire dicotyledonous leaves in the Extension, Comox, and Port McNeill florules fall well within the range of those given by Bailey and Sinnott for floras of warm temperate regions, and are comparable to those for southeastern United States (49:51), Italy (50:50), Los Angeles (54:46) and Spain (56:44). In comparison with Tertiary floras the ratios agree rather closely with that of the Weaverville (early Oligocene) flora of California, which is 47:53, based on 36 species (MacGinitie, 1937, p. 113). It may be concluded, therefore, both from the occurrence of genera largely confined today to tropical or subtropical regions, and from the proportion of entire dicotyledonous leaves, that the climate of this part of Vancouver Island at the time of deposition of the plant-bearing formations of the Nanaimo group was probably warm temperate, and considerably warmer than the cool temperate climate of the area today.

AGE OF PLANT-BEARING FORMATIONS

Marine Evidence

In the Nanaimo coalfield the three plant-bearing formations, Extension, Newcastle and Protection, lie between two major marine formations, the Haslam below and Cedar District above. The Haslam on the basis of its marine fauna has been dated by J. L. Usher (1952, p. 37) as Campanian or Santonian, more probably the former. R. W. Imlay and J. B. Reeside Jr. (1954, pp. 233, 239), however, considered the Haslam to be early Santonian, and possibly in part, late Coniacian. The Cedar District formation was regarded by Usher (op. cit. p. 16) as Campanian. As controlled by marine fossil evidence, the age of the plant-bearing formations may range from late Coniacian to late Campanian.

In the Comox area the single plant-bearing formation, the Comox, contains no marine fossils. It is underlain in places, however, by marine beds of the Qualicum formation and overlain by the marine Trent River formation. Usher (op. cit. p. 38) concluded that both the Qualicum and Trent River formations were of Campanian age, and he correlates the latter with the Cedar District of the Nanaimo area. However, his correlation was admittedly influenced by similarities between the lithological sequences in the Comox and Nanaimo fields, and he pointed out

that faunally the Trent River was closely allied to the Haslam. If the Trent River formation is actually the same or nearly the same age as the Haslam, it would follow that the florule of the underlying Comox formation would be older than that of the Extension formation of Nanaimo, and might, therefore, on the correlation of Imlay and Reeside, be as old as Coniacian.

No evidence based on marine faunas is available to indicate the ages of the plant-bearing beds of Port McNeill and Beaver Harbour.

Plant Evidence

The formational distribution of plant species of the Nanaimo group is given in Figure 2. Species known to occur elsewhere in either North America or Greenland, or species that are very similar to those having such an outside distribution, may be grouped in four categories as follows:

- (1) Fourteen long-ranging species or similar species that survived from Cenomanian or Turonian:

Aneimia fremonti Knowlton—Frontier formation, Wyoming; (Cenomanian)
Pseudoclenis latipennis (Heer) Seward—Atane series, Greenland; (Cenomanian-Turonian)
Nilssonia cf. *mehli* Berry—Frontier formation, Wyoming; (Cenomanian)
Nilssonia vancouverensis (Dawson)—cf. *N. johnstrupi* Heer from Atane series, Greenland; (Cenomanian-Turonian)
Dammarites microlepis (Heer)—Atane series, Greenland; (Cenomanian-Turonian)
Dammarites robinsi (Dawson)—cf. *Podozamites marginatus* Heer from Atane series, Greenland; (Cenomanian-Turonian); Allison formation, Alberta; (Campanian)
Protophyllocladus polymorpha (Lesquereux)—Raritan formation, New York; (Cenomanian); Magothy formation, Maryland, New Jersey; (Coniacian?): Tuscaloosa formation, Alabama; (Cenomanian); Eagle formation, Montana; (Santonian); Livingston formation, Montana; (Campanian-Maestrichtian)
Menispermites acutitubus Lesquereux—Dakota, Kansas; (Albian?-Cenomanian); Magothy, Massachusetts; (Coniacian?); cf. *Phyllites* sp. Dorf from Lance, Wyoming; (Maestrichtian)
Liriodendron giganteum Lesquereux—Dakota, Kansas; (Albian?-Cenomanian)
Liriodendron succedens Dawson—cf. *L. semialatum* Lesquereux from Dakota, Kansas; (Albian?-Cenomanian)
Bauhinia? gigantea Newberry—Raritan, New Jersey; (Cenomanian)
Leguminosites probalsamifera (Dawson)—cf. *L. phaseolatus?* Lesquereux from Dakota, Kansas; (Albian?-Cenomanian)
Phaseolites manhattanensis Hollick—Raritan formation, New Jersey; (Cenomanian); Magothy formation, New York; (Coniacian?)
Dewalquea sp. cf. *trifoliata* Newberry from Raritan formation, New Jersey; (Cenomanian)

- (2) Seventeen Santonian-Maestrichtian species or similar species:

Asplenites tenellus (Knowlton) Dorf—Mesaverde formation, Wyoming; (Campanian)
Cladophlebis (Gleichenites) vahliana Heer—Patoot series, Greenland; (Santonian-Campanian)
Dryopteris kennerlyi (Newberry) Knowlton—Allison formation, Alberta; (Campanian)
Cladophlebis usheri n. sp.—cf. *Asplenium calopectis* Heer from Patoot series, Greenland; (Santonian-Campanian)

Cladophlebis castor (Dawson)—cf. *C. scrobiculatum* Heer from Patoot series, Greenland; (Santonian-Campanian)
Cladophlebis columbiana Dawson—cf. *Raphaelia neuropteroides* Berry from Ripley formation, Tennessee; (Campanian-Maestrichtian)
Melasequoia cuneata (Newberry) Chaney pars—cf. *Sequoia heterophylla* ? Knowlton from Judith River formation, Montana; (Campanian)
Dryophyllum ripleyensis (Berry)—Ripley formation, Tennessee; (Campanian-Maestrichtian)
Dryophyllum furcinervosum n. sp.—cf. *D. bruneri* Ward from Mesaverde formation, Wyoming; (Campanian)
Quercus sp.—cf. *Q. pseudowestphalica* Berry from Black Creek formation, South Carolina; (Campanian?)
Dalbergites borealis (Heer) Seward from Patoot series, Greenland; (Santonian-Campanian)
Celastrphyllum perryi Berry—Ripley formation, Tennessee; (Campanian-Maestrichtian)
Celastriniles wardii (Knowlton)—Mesaverde formation, Wyoming; (Campanian); Vermejo formation, Colorado; (Maestrichtian)
Cupanites crenularis n. sp.—cf. *Ternstroemiles cretaceus* Berry from Ripley formation, Tennessee; (Campanian-Maestrichtian)
Zizyphoides neillii (Dawson pars)—cf. *Cinnamomum newberryi ellipticum* Berry from Ripley formation, Tennessee; (Campanian-Maestrichtian)
Ternstroemiles harwoodensis (Dawson)—cf. *T. ripleyensis* Berry from Ripley formation, Tennessee; (Campanian-Maestrichtian)
Devalquea sp.—cf. *D. smithi* Berry from Black Creek formation, South Carolina; (Campanian?)

(3) Four Maestrichtian species or similar species:

Sphenopteris hollicki Knowlton—Vermejo formation, Colorado
Arlcarpus occidentalis (Dawson)—cf. *A. lessigiana* (Lesquereux) Knowlton from Laramie formation, Colorado
Trochodendroides (Cercidiphyllum) arctica (Heer) Berry—Lance formation, Wyoming
Dombeyopsis ovata Knowlton—Laramie formation, Colorado

(4) Twelve early Tertiary species or similar species:

Amentotaxus sp.—cf. *A. campbelli* (Gardner) Florin; (Eocene); also cf. *A. florini* Krausel from Rhineland; (Oligocene), and *A. californica* (Potbury) from La Porte formation, California; (Eocene or Oligocene)
Saccoloma gardneri (Lesquereux) Knowlton—Denver formation, Colorado; (Paleocene)
Allantodiopsis erosa (Lesquereux) Knowlton and Maxon—Denver formation, Colorado; (Paleocene) Ratan formation, New Mexico; (Paleocene)
Onoclea hebridica (Forbes)—Fort Union formation, North Dakota; (Paleocene)
Geonomites imperialis (Dawson)—cf. *G. tenuirachis* Lesquereux from Raton formation, New Mexico; (Paleocene)
Dryophyllum whitmani (Knowlton)—Middle Park formation, Colorado; (Paleocene)
Ficus sp.—cf. *F. mississippiensis* (Lesquereux) Berry from Wilcox group Mississippi, Texas, Tennessee; (Eocene); Green River formation, Wyoming (Eocene)
Staphylea usheri n. sp.—cf. *S. acuminata* Lesquereux from Middle Park formation, Colorado; (Paleocene)
Koelreuteria prenigricans n. sp.—cf. *K. nigricans* (Lesquereux) Brown from Green River formation, Wyoming; (Eocene)
Dilleniites paucidentatus n. sp.—cf. *D. ovalus* Berry from Wilcox group, Louisiana and Mississippi; (Eocene)
Combretum sp.—cf. *C. leve* Berry from Holly Springs and Granada formations, Tennessee; (Eocene)
Combretum cordifolia (Lesquereux) Berry—'Eolignitic' Mississippi; (Eocene); Raton formation, Colorado; (Eocene)

The numerical distribution of species, listed in above categories, within the Nanaimo group is as follows:

	Beaver Harbour	Port McNeill	Extension formation	Comox formation	Newcastle formation	Protection formation
(1)						
(a).....	2	2	3	4	0	3
(b).....	0	1	2	6	1	0
Total...	2	3	5	10	1	3
(2)						
(a).....	0	1	2	2	0	4
(b).....	1	3	4	6	1	4
Total...	1	4	6	8	1	8
(3)						
(a).....	0	1	1	1	1	1
(b).....	0	0	1	1	0	0
Total...	0	1	2	2	1	1
(4)						
(a).....	0	1	1	0	0	3
(b).....	0	0	3	5	1	2
Total...	0	1	4	5	1	5

Note: (1) = Cenomanian-Turonian; (2) = Santonian-Maestrichtian; (3) = Maestrichtian; (4) = Early Tertiary; (a) = Conspecific, and (b) = Related species.

Judging solely from distribution, within the Nanaimo group, of species known to occur outside Vancouver Island or of species closely related to those having an outside distribution, the writer is forced to conclude that present collections afford no reliable evidence for intergroup age relationships. For, in consideration of regional correlation, the florules of each formation have a sufficient number of species in common to justify the conclusion that only a single flora or floral group is presently available for comparison. To what extent the present collections are fairly representative of the florule of each formation is not known, although it is a fair assumption that the collections are little more than random samples, and not sufficiently complete for comprehensive study of successive florules.

The greatest number of species or related species having a distribution outside of Vancouver Island falls within the chronological range Santonian-Maestrichtian. In chronological correlations great stress is ordinarily placed upon the occurrence of species that become more characteristic of younger floras, and associated long-ranging species are discounted. Application of this procedure to the Nanaimo flora would almost certainly lead to the conclusion that it was probably late Campanian or Maestrichtian in age, because the large number of Cenomanian-Turonian survivors would scarcely be discounted to the extent of accepting a Paleocene age. Of the 17 Santonian-Maestrichtian species enumerated above 6 are held in common with the Ripley formation, which L. W. Stephenson *et al.* (1942, Correlation Chart No. 9) consider to be mainly Maestrichtian,

although E. W. Berry (1925, p. 23) considered it on plant evidence alone to be not younger than Campanian, and more probably Coniacan-Santonian. A Campanian age for the Nanaimo flora seems more probable, because its 11 Santonian-Maestrichtian species that do not occur in the Ripley are elsewhere mainly Campanian in their distribution.

A Maestrichtian age for the Nanaimo flora is apparently invalidated by the testimony of the marine fauna. Hence the occurrence of 12 early Tertiary species in a Senonian stage is rather remarkable. They make up about 12.5 per cent of the total flora of 93 species, whereas the Maestrichtian Lance flora of the western interior of the United States, as analysed by E. Dorf (1942, p. 107), has a maximum of only 7 species out of 70, or 10 per cent of that flora.

The most important Tertiary elements from the standpoint of reliability of identification are *Amentotaxus* sp., *Saccoloma gardneri*, *Allantodiopsis erosa*, *Onoclea hebridica* and *Combretum cordifolia*. Their living relatives are all subtropical or tropical. Three of the remaining Tertiary precursors in the Nanaimo flora, viz., *Ficus* cf. *mississippiensis*, *Dilleniites paucidentatus*, *Combretum* cf. *leve*, have close Tertiary allies that occur in the subtropical Wilcox group of southeastern United States. The remaining four of this group occur in more temperate Paleocene floras. The writer thinks that tropical species may have migrated to Vancouver along the Pacific coast in Santonian or Campanian time, well in advance of their appearance in the western interior of North America.

INTERBASIN CORRELATION

The succession of florules within the Nanaimo basin is established by stratigraphic sequence as Extension-Newcastle-Protection, the Extension being the oldest. In the Comox coalfield the only known florule is confined to a single coal-bearing formation, the Comox. On lithological grounds the Comox formation has been correlated with the Protection formation. The question naturally arises whether the Comox florule supports such a correlation, or whether it is indicative of an alternate correlation with either the Newcastle or the Extension. The Newcastle florule as presently known comprises only 9 species; as 4 of these occur also in the Extension, Protection and Comox formations comparisons between it and the Comox florule are of no consequence. The Newcastle contains only one species that is restricted to it and the Comox.

In comparing the Comox with the Protection florule any evaluation must be discounted to some degree owing to a higher proportion of probable upland types in the latter (see page 9) and to its probable lack of many lowland species, the amount of correction being unknown. The Comox has 11 species held in common with the Protection, but, eliminating those species that occur also in the Extension formation, there remain only 6 species common to both florules, viz., *Glyptostrobus comoxensis*, *Alnus perantiqua*, *Menispermum dauricumoides*, *Chrysobalanus nervillosus*, *Sapindus pacificus* and *Dombeyopsis ovata*. The Comox and Extension florules have 14 species in common. Eliminating 5 species that also occur in the Protection florule, there remain 9 species common to Comox and Extension, viz., *Cladophlebis* sp. A, *Pseudoclenis latipennis*, *Nilssonina vancouverensis*, *Dammarites robinsi*, *Geonomites imperialis*, *Artocarpus*

occidentalis, *Nymphaeites* sp., *Combretum* cf. *leve*, *Viburnum* *insigne*. Were it not for the inferred anomaly in the composition of the Protection florule, the conclusion would be that the Comox is more nearly the age of the Extension than that of the Protection. Such a conclusion would seem to be supported by the occurrence within the Comox florule of 10 species which are the same or most closely allied to Cenomanian-Turonian species, as compared with 5 such species in the Extension and 3 in the Protection (page 10). On the other hand, the Comox has 7 species comparable to species in Maestrichtian or early Tertiary floras as compared to 6 such species in the Extension and 6 in the Protection. Moreover, if the physical environmental conditions for lowland plant growth at the site of deposition of the Protection formation were more like those prevailing at the sites of deposition of both the Comox and Extension plant-bearing beds, the number of lowland species common to the three florules would presumably be higher. The inevitable conclusion, therefore, is that a comparison of the presently known florules does not yield conclusive evidence of the precise age of the Comox formation relative to that of the Extension or Protection formation, although the evidence as it stands slightly favours an age nearly the same as that of the Extension, if not slightly earlier.

The florule from Port McNeill has 8 species in common with that of the Comox formation and only 3 in common with that of the Extension formation. Eliminating from this common element 2 species that occur in all formations, viz., *Metasequoia cuneata* and *Rhamnites eminens*, the Port McNeill florule has 6 species in common with the Comox and only one in common with the Extension. The Port McNeill florule has only 2 species in common with the Protection florule that do not occur in either Comox or Extension formation, as compared with 6 species held in common between the Comox and Protection formations and not occurring in the Extension. The Port McNeill flora on this evidence is considered to be about the same age as that of the Comox, or possibly somewhat older.

CHAPTER II

DESCRIPTION OF SPECIES

Summary List

Phylum Pteridophyta

Class **FILICINEAE**Order **FILICALES**Family **SCHIZAEACEAE***Aneimia fremonti* KnowltonFamily **GLEICHENIACEAE***Cladophlebis (Gleichenites) vahliana* HeerFamily **PTERIDACEAE***Saccoloma gardneri* (Lesquereux) KnowltonFamily **DAVALLIACEAE***Davallites richardsoni* DawsonFamily **ASPIDIACEAE***Allantodiopsis erosa* (Lesquereux) Knowlton and Maxon*Dryopteris kennerlyi* (Newberry) Knowlton*Onoclea hebridica* (Forbes) BellFamily **ASPLENIACEAE***Asplenites tenellus* (Knowlton) Dorf*Incertae sedis:**Sphenopteris hollicki* (Knowlton) n. comb.*Cladophlebis (Gleichenites ?) castor* (Dawson) n. comb.*Cladophlebis (Gleichenites ?) usheri* n. sp.*Cladophlebis (Dennstaedtia ?) columbiana* Dawson*Cladophlebis* sp. A.*Cladophlebis* sp. B.

Phylum Spermatophyta

Class **GYMNOSPERMAE**Orders **CYCADALES** and **BENNETTITALES***Pseudotsuga latipennis* (Heer) Seward*Nilssonia vancouverensis* (Dawson) n. comb.*Nilssonia serotina* Heer*Nilssonia* cf. *mehli* Berry*Zamites* sp.Order **GINKGOALES**Family **GINKGOACEAE***Ginkgo dawsoni* Knowlton

Order CONIFERALES

Family TAXACEAE

Amentotaxus cf. *campbelli* (Gardner) Florin
Metasequoia cuneata (Newberry) Chaney pars
Glyptostrobus comoxensis n. sp.

Family ARAUCARIACEAE

Dammarites robinsi (Dawson) n. comb.
Dammarites microlepis (Heer) n. comb.

Family CUPRESSACEAE

Thuites corpulentus n. sp.

Incertae sedis:

Protophyllocladus polymorpha (Lesquereux) Berry

Class ANGIOSPERMAE

Subclass MONOCOTYLODONES

Order PANDANALES

Family SPARGANIACEAE

Sparganium sp.

Family PALMAE

Geonomites imperialis (Dawson) n. comb.

Subclass DICOTYLEDONES

Order SALICALES

Family SALICACEAE

Populus sp.

Order FAGALES

Family BETULACEAE

Alnus perantiqua (Dawson) n. comb.

Family FAGACEAE

Dryophyllum elongatum Dawson
Dryophyllum fallax (Dawson) n. comb.
Dryophyllum furcinervosum n. sp.
Dryophyllum ripleyensis (Berry) n. comb.
Dryophyllum whitmani (Knowlton) n. comb.
Quercus ? *richardsoni* n. sp.
Quercus cf. *pseudowestfalica* Berry

Order URTICALES

Family ULMACEAE

Zelkova sp.

Family MORACEAE

Artocarpus occidentalis (Dawson) n. comb.
Ficus cf. *mississippiensis* (Lesquereux) Berry

Order RANALES

Family NYMPHAEACEAE

Nymphaeites sp.

Family CERCIDIPHYLLIACEAE

Trochodendroides (Cercidiphyllum) arctica (Heer) Berry

Family MENISPERMACEAE

Menispermum dauricumoides n. sp.*Menispermites acutilobus* Lesquereux*Menispermites torosus* n. sp.

Family MAGNOLIACEAE

Liriodendron giganteum Lesquereux*Liriodendron succedens* Dawson

Family LAURACEAE

Cinnamomum trinervis (Dawson) n. comb.*Cinnamomoides buckhami* n. sp.*Laurus asiminoides* ? Berry*Laurophyllum insigne* Dawson

Order RHOEADALES

Family CAPPARIDACEAE

Capparites sp.

Order ROSALES

Family SAXIFRAGACEAE

Philadelphus normalis n. sp.

Family PLATANACEAE

Platanus affinis Lesquereux*Platanus nanaimo* (Dawson) n. comb.

Family ROSACEAE

Chrysobalanus nervillosus n. sp.*Pyrus* sp.

Family LEGUMINOSAE

Bauhinia ? *gigantea* Newberry*Dalbergites borealis* (Heer) Seward*Leguminosites rhamnifolioides* n. sp.*Leguminosites probalsamifera* (Dawson) n. comb.*Leguminosites (Cassia)* ? sp.*Phaseolites manhassetensis* Hollick

Order SAPINDALES

Family CELASTRACEAE

Celastrinites wardii (Knowlton) n. comb.*Celastrophyllum perryi* Berry

Family STAPHYLEACEAE

Staphylea usheri n. sp.

Family ACERACEAE

Acer sp.

Family SAPINDACEAE

Cupanites crenularis n. sp.*Koelreuteria prenigricans* n. sp.*Sapindus pacificus* (Dawson) n. comb.

Order RHAMNALES

Family RHAMNACEAE

- Rhamnites eminens* (Dawson) n. comb.
Zizyphus areolatus n. sp.
Zizyphus cretaceus (Dawson) n. comb.
Zizyphoides neillii (Dawson pars) n. comb.

Family VITACEAE

- Ampelopsis* ? sp.
Cissites pseudoplatanus Hollick

Order MALVALES

Family STERCULIACEAE

- Dombeyopsis ovata* Knowlton
Pterospermiles sp.

Order PARIETALES

Family DILLENIACEAE

- Dillenites paucidentatus* n. comb.

Family THEACEAE

- Ternstroemites harwoodensis* (Dawson) n. comb.

Order MYRTIFLORAE

Family COMBRETACEAE

- Combretum* cf. *leve* Berry
Combretum cordifolia (Lesquereux) Berry

Order EBENDALES

Family SAPOTACEAE

- Sapotacites* sp.

Order CONTORTAE

Family OLEACEAE

- Fraxinus* sp.

Order RUBIALES

Family CAPRIFOLIACEAE

- Viburnum insigne* (Dawson) n. comb.

Dicotyledonae *incertae sedis*:

- Dewalquea* cf. *trifoliata* Newberry
Dewalquea sp.
Dicotylophyllum sp. cf. *Quercus rhamnoides* Lesquereux
Dicotylophyllum sp.
Calycithes sp.
Carpites sp.

Systematic Descriptions

Aneimia fremonti Knowlton

Plate I, figures 1-5

Sphenopteris elongata Dawson pars (non Newberry), Roy. Soc. Canada, Trans. 1882-83, vol. 1, sec. 4, p. 24, Pl. 5, fig. 17a (non fig. 17) (1883).

Remarks. Knowlton described his species as follows:

"Outline of whole frond not known; stipe, long, slender, dichotomous; frond bipinnate, possibly tripinnate; pinnae narrowly deltoid; pinnules arising at an acute angle, linear-lanceolate, sessile and decurrent or lower ones nearly free; pinnules cut, especially near the base, into deep, sharp-toothed, entire, forward-pointing lobes, which decrease apically so that the terminal fourth is entire or merely crenulate; middle and upper pinnules becoming more and more entire toward the apex, which is only crenulate; nervation rather sparse, at a very acute angle, nerves once or twice forked; fertile frond not found" (Knowlton, 1917a, p. 84).

The material from Vancouver Island presently to hand is fragmentary, but agrees perfectly with figures given by Knowlton (op. cit. Pl. 31, fig. 6; Pl. 32, figs. 1-3). The pinnules are less robust than those of *Aneimia elongata* (Newberry) Knowlton (1922, Pl. 2, fig. 2), but the two species may be closely allied. In the larger pinnule-like lobes a single vein enters the base at a very acute angle to the parent rachis, and divides close to the point of origin, the posterior branch dividing again, the resulting arms running close to, and parallel with the lower margin of the lobe; the anterior branch forms the midvein of the lobe, and has two or three alternate pairs of once divided or simple, strongly ascending laterals.

Dawson's specimen illustrated as fig. 17 of above reference belongs to *Dryopteris kennerlyi* (Newberry).

Occurrence. Protection formation, localities 1580 (2243), 3826, 3858.

Types. Hypotypes, G.S.C. Nos. 676, 5605 (Fig. 17a Dawson 1883), 6550, 6551, 6684.

Cladophlebis (Gleichenites) vahliana Heer

Plate I, figures 7, 9; Plate V, figure 3

Remarks. Ultimate pinnae, alternate, inserted normal or at open angles to stout parent rachis, linear-lanceolate, apically acutely pointed, more than 5 cm. long by 1.5 cm. wide. Pinnules, pectopteroid, rectangular-ovate except near apex where small and deltoid, mostly about normal to axis, oblique near apex, mainly free and slightly rounded and constricted at base, the largest about 7 mm. long by 4 mm. wide; apex, broadly or bluntly obtusely rounded, except in the small ones near apex which may be pointed; some pinnules may curve slightly towards apex. Midvein, moderately prominent to apex; laterals, comprising about 5 alternate, oblique pairs, mostly divided twice.

Specimen No. 6677 (Pl. I, fig. 9) shows part of a fertile pinna with pinnules similar to sterile ones, but marked on each side of midrib about midway to margin by a row of small cicatrices that apparently indicate position of sori.

Occurrence. Comox formation, localities 3768, 3860.

Types. Hypotypes, G.S.C. Nos. 6392, 6671, 6677 (on same rock fragment as 6671).

Saccoloma gardneri (Lesquereux) Knowlton

Plate I, figures 6, 8

Pteris (Oleandra) glossopteroides Dawson, Roy. Soc. Canada, Trans. 1882-83, vol. 1, sec. 4, p. 24, Pl. 4, fig. 16 (1883).

Remarks. Lesquereux's original description was as follows:

"Fronde, large, simply pinnate; pinnae, large, linear, broader in the middle, in right angle to the rachis, rounded to the base; borders deeply undulate; middle nerve, broad, grooved in the middle, flattened to the borders; veins in an obtuse angle of divergence, abruptly curving downward at the base or decurving to the rachis, forking once or twice, joined by anastomoses and forming by cross-branches irregular, long areolae" (1878, p. 581).

An incomplete fragment of a sterile pinna shows clearly anastomoses of the veins near the midrib, and a rare anastomosis beyond towards the margin. The margin itself is too poorly preserved to reveal the veins. A fertile fragment shows only a small part of the margin; it is too obscure for details, but there is seemingly a sub-marginal row of small circular or oval sori; one at distal end of each vein, is bordered by an elevated ridge, possibly representing a coalescent indusial border (cf. living *Saccoloma elegans*, F. O. Bower, 1926, p. 272, p. 273, text-fig. 541A).

Notwithstanding its earlier age, little doubt exists that the Canadian form belongs to Lesquereux's species. It has a similar broad, grooved rachis, lateral veins originating at an acute angle, dividing once near their origin, deflected outwards at a wide angle, simple or once divided in this outwards course, and sparsely united by oblique cross-bars.

Occurrence. Protection formation, locality 1580.

Types. Hypotypes, G.S.C. Nos. 5602, 6547.

Davallites richardsoni Dawson

Plate II, figures 1-10; Plate III, figures 1, 8

Davallites richardsoni Dawson, Roy. Soc. Canada, Trans. 1882-83, vol. 1, sec. 4, p. 25, Pl. 5, figs. 18, 18a, 18b (1883).

Description. Penultimate pinnae, only partly known; rachis, stiff, but slender, 1.5 mm. or more broad. Ultimate pinnae, normal or at very open angles to parent rachis, alternate to sub-opposite, linear-lanceolate, acutely pointed, up to 4 or 5 cm. long; commonly 7 or 8 mm. wide, but

may be 1 cm.; rachis, winged. Sterile pinnules, seemingly coriaceous, variable in form from sub-ovate to sub-rectangular or sub-rhomboid, entire or obscurely lobed marginally, united basally by wing of rachis, becoming more and more united towards apex of pinna. Surface of pinnules, microscopically roughened, as if villous. Veins, few, stout, semi-immersed; a single, strongly ascending vein curves outwards; close to its origin it gives off a main anterior branch, which divides once or twice, the lowest division meeting the margin at, or close to sinus separating the pinnule from the next forward one; other laterals are more obscure, oblique, once divided or simple.

Fertile pinnules, generally small and seemingly derived from a sub-apical position in a frond, obscurely lobed, bearing commonly two marginal sori, one at end of midvein and other of anterior lateral, but more rarely an additional one lies at end of posterior lateral. Sori, circular to sub-oval, marked by a prominent raised rim, 0.5 to 0.75 mm. diameter, seemingly indicating an indusium.

Remarks. *Sphenopteris* sp. Seward and Conway (1936, p. 7, text-fig. 1) may belong to Dawson's species, although it seems to resemble somewhat more closely *Dennstaedtia* ? *fremonti* (Hall) Knowlton.

Occurrence. Protection formation, localities 1580, 2245; Extension formation, localities 3771, 4210.

Types. Syntypes, G.S.C. Nos. 5603, 6676; hypotypes, G.S.C. Nos. 5604 (*Aspidium kernerlyi* Dawson pars, non Newberry), 6674, 6675, 6682, 6683, 6685, 6686.

Allantodiopsis erosa (Lesquereux) Knowlton and Maxon

Plate III, figures 3, 6, 9

Description. Pinnules, apparently sessile, oblong-lanceolate, somewhat inequilateral at base, which is broad and unequally truncated or slightly rounded on either side; apex, acute. Margin, lacinulate-serrate above entire base. Middle vein, strong; laterals, oblique, once divided, most commonly near midrib, rarely more distantly, and rarely divided a second time; when divided only once the anterior or anadromous division curves gently backwards so as to parallel the nearly straight posterior fork, and enters a tooth, whereas the posterior commonly curves upwards distally close to the lower margin of a tooth, thus converging towards the other fork.

Remarks. Of four specimens to hand only one is fertile. The largest, incomplete, sterile fragment is 8 cm. long by 2.3 cm. wide, and has elongate, apically narrowly rounded teeth about 2 mm. long, separated by rounded sinuses. The veins arise at an acute angle from midrib, fork a short distance from their point of origin, the upper arm running to the middle of a tooth while the lower enters it close to its lower margin where it curves gently upwards. In the fertile fragment, G.S.C. No. 6546 (Pl. III, fig. 6), elliptical sori, about 2.5 mm. long by 1 mm. broad, lie on anadromous fork of a lateral vein about midway to margin.

Occurrence. Extension formation, localities 1304, 3239, 3771.

Types. Hypotypes, G.S.C. Nos. 6461, 6465, 6546.

Dryopteris kennerlyi (Newberry) Knowlton

Plate III, figures 5, 7; Plate IV, figure 8

Sphenopteris elongata Dawson pars (non Newberry), Roy. Soc. Canada, Trans. 1882-83, vol. 1, sec. 4, p. 24, Pl. 5, fig. 17 (non fig. 17a) (1883).

Remarks. The type material came from roof shales of the Newcastle coal seam at Nanaimo, the original description being as follows:

"Fronde pinnate, pinnae deeply pinnatifid; pinnules oblong, obtuse, somewhat curved upwards, united at their bases, margin acutely denticulate, sometimes entire; nervation strongly marked; secondary nerves mostly once-forked, basal nerve of each pinnule on lower side often twice-forked" (Newberry, 1863, p. 513). Type specimens were subsequently well illustrated (Newberry in Hollick, 1898, Pl. 16, figs. 4, 5).

Although Newberry stated that the species was extremely abundant at the locality of the Newcastle coal, it occurs in the Canadian Survey material only in a few collections from the Protection formation. A chief characteristic of the species is the broad basal confluence of the somewhat falcate pinnules, and their distally, rather sparingly serrulate margins. The specimens are poorly preserved, and the lateral veins, which are rather highly ascending and once divided, commonly obscure.

Occurrence. Protection formation, localities 2245, 3826, 3858.

Types. Hypotypes, G.S.C. Nos. 5631, 6691.

Onoclea hebridica (Forbes) Bell

Plate III, figures 2, 4; Plate IV, figure 10

Onoclea sensibilis Dawson, British N. Amer. Boundary Comm., Rept. Geol. 49th Parallel, p. 328 (1875).

Onoclea sensibilis Dawson, Roy. Soc. Canada, Trans. 1885, vol. 3, sec. 4, p. 21 (1886); Geol. Surv., Canada, Ann. Rept., n. ser., vol. 2, Pt. E, p. 136 (1887).

Onoclea sensibilis Penhallow, Rept. Tert. Plants British Columbia, p. 64, (1908).

Onoclea hebridica Bell, Geol. Surv., Canada, Bull. B, p. 40, Pl. 20, fig. 5; Pl. 24, figs. 3, 5; Pl. 25, fig. 2 (1949).

Remarks. No criteria could be found to differentiate this form from *Onoclea hebridica* that is so common in early Tertiary deposits. It is, so far as the writer knows, the first recorded appearance of the species from late Cretaceous beds, unless the very similar *Onoclea neomexicana* Knowlton (1917b, p. 332, Pl. 84, figs. 1, 2) is actually conspecific.

Occurrence. Protection formation, locality 3826.

Types. Hypotypes, G.S.C. Nos. 539, 675, 6509.

Asplenites tenellus (Knowlton) Dorf

Plate IV, figure 6

Remarks. The species is represented only by a few fragments that are not very well preserved. Penultimate axis, bearing alternate pinnae, is very slender. Ultimate pinnae, lanceolate, with slender axis consisting

of central chord and narrow, flat, wing-like margins, up to 4 or more cm. long by 1 to 1.5 cm. broad. Pinnules, up to 9 mm. long by 6 mm. wide, the largest subovate and contracted to slender stalk, alternate, openly oblique to rachis, commonly with two pairs of oblique, obtuse, lateral lobes and an obtuse, smaller, terminal lobe; smaller pinnules, sub-rhomboidal with a single pair of lateral lobes. A midvein of a pinnule gives off a branch to each lobe, which in largest lobes has one or two pairs of lateral branches.

Occurrence. Comox formation, locality 3768.

Types. Hypotype, G.S.C. No. 646.

Sphenopteris hollicki (Knowlton) n. comb.

Plate IV, figures 1, 5

Remarks. A single apical part of a pinna is considered to belong undoubtedly to *Osmunda hollicki* Knowlton (1917b, p. 246, Pl. 30, fig. 6). The lowest pinnule on this fragment has an obtuse, anterior, basal lobe, the margin of the remaining part of the pinnule being entire or sub-lobate. The attachment of this pinnule is not preserved, but was apparently sphenopteroid. The next higher pinnules preserved have a sphenopteroid base, the upper margin being constricted nearly to midrib, and the lower, slightly decurrent; these pinnules are comparable to the distal ones in Knowlton's type. The pinnules in the Canadian specimen decrease in length up to the apical lamina, which is broader than the pair of pinnules below it and obtuse. The venation is similar in all respects to that of the type.

Occurrence. Extension formation, locality 1304; (?) Comox formation, localities 1722, 3032.

Types. Hypotype, G.S.C. No. 6405.

Cladophlebis (*Gleichenites* ?) *castor* (Dawson) n. comb.

Plate IV, figures 2, 4, 7

Neuropteris castor Dawson, Roy. Soc. Canada, Trans. 1882-83, vol. 1, sec. 4, p. 24, Pl. 4, figs. 14, 14a (1883).

Description. Ultimate rachis, microscopically striated, more or less winged. Pinnules, alternate, connate by wing of rachis, touching or rather distant, attached by whole base, normal or at open angles to rachis, rectangular-lanceolate, slightly narrowing distally to bluntly obtuse apex, 7 or 8 mm. long by 2 to 4 mm. wide. Midvein, delicate, running to apex; laterals, delicate, rather highly ascending, divided once, the resulting arms nearly parallel and straight. Surface of pinnules marked by microscopic postulae arranged in rows parallel to the veins, giving a striated appearance.

Remarks. Dawson's figures (erroneously recorded on Plate as *Neuropteris curta*) are entirely misleading. *Aspidium scrobiculatum* Heer (1883, p. 4, Pl. 48, figs. 10, 10b) was described the same year, and,

although the type is unsatisfactory, the pinnules have a venation comparable to that of *C. castor*, and the writer considers it probable that Heer's species is conspecific. Although Heer recorded that the lateral veins are curved forward, his figures show them to be almost straight, as they are in the Canadian material. The venation resembles that of some species of *Neuropteris* e.g. *N. tenuifolia*, which may explain Dawson's otherwise peculiar assignment to that genus. The relation of *C. castor* to *Gleichenites porsildi* Seward (1927, p. 78, Pl. 6, figs. 18, 19, 24, 27, 29-31; Pl. 12, figs. 122, 124) is doubtful. Some pinnules, having a venation like *C. castor*, were included by Seward in his species, whereas others have fewer and less ascending lateral veins, which divide at wider angles. The pinnules of *G. porsildi* also are apparently free to an unwinged axis.

C. castor has some pinnules slightly recurved backwards, and in this respect are like those occurring in some species of *Gleichenites*, but whether *C. castor* is a true *Gleichenites* can only be learned when fertile specimens are discovered.

Occurrence. Beaver Harbour, locality 1584.

Types. Holotype, G.S.C. No. 5606; hypotype, G.S.C. No. 6673.

Cladophlebis (Gleichenites ?) usheri n. sp.

Plate IV, figures 3, 9; Plate V, figures 1, 7

? *Pecopteris* sp. Dawson, Roy. Soc. Canada, Trans. 1882-83, vol. 1, sec. 4, p. 25 (1883).

Description. Ultimate pinnae, alternate, at wide angles to a right angle to parent rachis, linear-lanceolate, about 3 cm. long by 4 or 5 mm. wide; rachis, winged. Pinnules, seemingly coriaceous, up to 2.5 mm. long by 1.3 mm. wide, sub-oblong to semi-ovate, broadly rounded at apex, connate by wing of rachis, a few rarely recurved backwards, particularly the basal pair, which may have a rounded, basal posterior lobe; pinnules at apex of pinna coalescent so as to form a narrow, crenulated apical laminae, in one instance at least a little over 1 cm. long. Midvein, when preserved, stout to near apex where it bifurcates; laterals, about 3 pairs in largest pinnules, divided once at rather wide angle, or in smallest pinnules mainly simple.

Remarks. Macroscopically the species resembles *Benizia calopteris* Debey and Ettingshausen (1859, Pl. 5, figs. 13-17) = *Asplenium calopteris* Heer; 1883, Pl. 48, figs. 5a, 6a, b, 7, 8, and possibly may be conspecific with that species; separation is based chiefly on the crenulated prolonged apical part of the pinnae, and lack of knowledge on character of fertile organs. The species is named after its collector, Dr. J. L. Usher.

Occurrence. Comox formation, locality 3768.

Types. Holotype, G.S.C. No. 6389; paratypes Nos. 677, 6672.

Cladophlebis (Dennstaedtia ?) columbiana Dawson

Plate V, figures 2, 4-6; Plate VI, figures 1-3, 5, 6; Plate VII, figure 3

Cladophlebis columbiana Dawson, Roy. Soc. Canada, Trans. 1893, vol. 11, sec. 4, p. 55, Pl. 5, figs. 4, 5 (1894).

Description. Frond, tripinnate (?). Ultimate pinnae, normal or openly oblique to rachis, alternate, lanceolate-acuminate, ending in a slightly crenulate or crenulo-dentate, elongated, apical laminae, up to 8 cm. or more long by 3 cm. or more wide; rachis, distally winged. Largest pinnules, subopposite to alternate, at open angles to parent rachis, oblong-elliptical, free, contracted at base to sessile, stout attachment, gently contracted to rounded, obtuse apex, obtusely lobate marginally to crenulate or crenulo-dentate distally, the basal ones, particularly the anterior one, being commonly longer than the rest. Pinnules holding more distal position on a pinna are progressively more and more united by wing of rachis; the margins may be slightly crenulo-dentate or appear entire. Midrib of largest pinnules, stout; laterals, oblique, one to each marginal lobe, rather flexuous, provided with one or two pairs simple or more rarely once divided, highly ascending, inwardly curved branches; the smaller, non-lobate pinnules have a flexuous midrib, which curves posteriorly, and two or three pairs, generally once divided, oblique laterals.

Remarks. Specimen G.S.C. No. 6393 (Pl. VI, fig. 5) shows what appears to be two sub-apical parts of a primary pinna, the secondary pinnae passing apically into pinnatifid long pinnules. Specimen 5679, which was one of Dawson's syntypes, is interpreted to be an apical part of a primary pinna from a middle part of a frond; the largest pinnules preserved are basally lobed. G.S.C. No. 5658, the other syntype, came apparently from a somewhat lower position on a frond than No. 5679, and the pinnules are all more or less lobate; the basal attachment of the lowest ones is less than half their greatest width.

One poorly preserved apical part of a pinna (Pl. V, fig. 4; Pl. VI, fig. 3), doubtfully belonging to the species, appears to have circular, marginal sori, about 1.3 mm. diameter, at the ends of the veins. If actually belonging to *C. columbiana* the species may be referable to *Dennstaedtia*.

Raphaelia neuropteroides Berry (? non Debey and Ettingshausen; Berry, 1925, Pl. I, fig. 1) from the Ripley formation is perhaps specifically identical with *C. columbiana*. *Phegopteris jorgenseni* Heer (1882, Pl. 35, figs. 1-3), *Phegopteris grothiana* Heer (1883, Pl. 49, fig. 3) and *Raphelia neuropteroides* Heer (1883, Pl. 60, fig. 3) have all more elongated pinnules than *C. columbiana* and the marginal lobes are not minutely crenulo-dentate as in Dawson's species.

Occurrence. Protection formation, localities 3826, 3858; Extension formation, localities 1304, 3771.

Types. Syntypes, G.S.C. Nos. 5658, 5679; hypotypes, G.S.C. Nos. 672, 6393, 6466 (?), 6473, 6484, 6678.

Cladophlebis sp. A

Plate V, figures 8, 9

Remarks. Material consists of fragments of ultimate pinnae with bluntly pointed or obtusely rounded, openly oblique, sub-falcate pinnules, resembling, although smaller, those of *Osmunda arctica* Heer (1883, p. 7, Pl. 49, figs. 4-7; Pl. 50, figs. 6, 8). The largest pinnules are about 8 mm. long by 3.5 or 4 mm. wide; they are united at base by a narrow wing of rachis, becoming more united near apex of pinna, which is a bluntly pointed lamina that is marginally and obtusely lobed proximally, the lobes representing united pinnules. Midvein, strong, most of them downwardly curved to rachis; laterals, where visible, once divided.

The form of the apical lamina of the pinnae and the slightly falcate, more or less forwardly directed and bluntly pointed pinnules with midribs commonly bending downwards to rachis of the pinna, differentiate this species from *Cladophlebis* (*Gleichenites*) *vahlana*. It may be compared with *Polystichum hillsianum* Hollick (1902, p. 146, Pl. 4, fig. 7), its smaller pinnules being possibly due to a position nearer apex of a frond, or to *Cladophlebis septentrionalis* Hollick (1930, p. 39, Pl. 2, figs. 1-3).

Occurrence. Comox formation, locality 3768; Extension formation, locality 4210.

Types. G.S.C. Nos. 687, 6391.

Cladophlebis sp. B

Plate VI, figure 4

Remarks. The material consists of fragments of two pinnae from separate localities. The largest pinnules are falcate, apically acute, about 1 cm. long by 3.5 mm. wide, entire, united only at extreme base; the lateral veins are numerous and seemingly once divided. The species is practically indistinguishable from *Cladophlebis virginensis* forma *acuta*, and are only worthy of record in the event that better material may eventually be found.

Occurrence. Comox formation, localities 1576, 4211 (depth 1,080 feet); Beaver Harbour, locality 1584.

Types. G.S.C. specimen No. 6672.

Pseudoctenis latipennis (Heer) Seward

Plate VII, figure 7; Plate VIII; Plate IX; Plate X, figure 3

Nilsson *lata* Dawson pars, Roy. Soc. Canada, Trans. 1882-83, vol. 1, sec. 4, p. 24, Pl. 4, fig. 15 bis (non fig. 15a) (1883).

Description. Leaf, of unknown length, probably up to, or exceeding 25 cm. broad, obtusely rounded at apex; rachis, stout, irregularly ridged, up to 1 cm. broad, decreasing to 1.5 mm. in apical region of slender leaves. Pinnae, free except in apical region where united at base, oblique, or the lower ones spreading up to nearly right angles to rachis, alternate to

subopposite, sessile, generally more or less constricted anteriorly close to rachis, and more or less decurrent posteriorly, tapering acuminate in distal half to acute apex, up to 11 cm. or more long by 2 cm. broad. Margins, subparallel for more than half their length, entire except for occurrence in tapering apical part of some specimens of scattered, minute, serrate teeth. The pinnae at apex of leaf are narrow, confluent at base, and the leaf in one specimen is terminated somewhat asymmetrically by two upright pinnae, 2 mm. broad by about 1 cm. long, each with 3 parallel veins of which inner divides once. Veins, most commonly 0.4 to 0.5 mm. apart, those in lower half of base of pinna bent downwards to rachis, parallel or slightly divergent throughout remainder of pinna, the outermost running to margin; a few bifurcate at, or near base and rarely distally, and there are rare, irregularly scattered anastomoses.

Remarks. The pinnae are smaller than those of *Ctenophyllum wardii* Fontaine (1900, p. 357, Pl. 59, Pl. 60, Pl. 67, fig. 5), less decurrent on rachis, the veins bifurcate less commonly, and the rachis is relatively stouter. The general shape of the pinnae is like those of the Jurassic *Pseudoctenis eathiensis* (Richards) Seward and of *Pseudoctenis ensiformis* Halle, but a basal anterior constriction of the pinnae is more common and the veins are closer. The decurrence of the pinnules is variable, some extending downwards as a narrow wing of the rachis of the pinna below. The Canadian specimens are comparable in all respects to most of those figured by Heer (1882, Pl. 14, figs. 1-9) and to specimen described and figured by Seward (1925, p. 239, Pl. B, fig. 16). A few specimens show several striae between the veins, recalling similar striae on pinnae of *Podozamites lanceolatus*.

Pseudoctenis latipennis is apparently closely allied, if not actually conspecific with *Dioon inopinus* Hollick (1936, p. 43, Pl. 9, fig. 4a; Pl. 10, fig. 2a), from supposedly early Tertiary beds of Alaska. *Dioon praespinulosum* Hollick (op. cit. p. 43; Pl. 10, fig. 1a; Pl. 11, figs. 1a, 2-5; Pl. 110a), which is doubtfully distinct from *Dioon inopinus*, is another possible synonym of *Pseudoctenis latipennis* (Heer).

Occurrence. Comox formation, localities 1722, 3035, 3120, 3768, 4211 (depth 1,000 feet); Extension formation, locality 3771; Beaver Harbour, locality 1584.

Types. Hypotypes, G.S.C. Nos. 5608a (*Nilssonina lata* Dawson), 6396, 6398, 6426, 6690.

Nilssonina vancouverensis (Dawson) n. comb.

Plate XI, figures 1, 2, 4; Plate XII, figure 5

Taeniopteris plumosa Dawson, Roy. Soc. Canada, Trans. 1882-83, vol. 1, sec. 4, p. 24, Pl. 4, figs. 15, 15a (non fig. 15 bis) (1883).

Macrotaeniopteris vancouverensis Dawson, Roy. Soc. Canada, Trans. 1893, vol. 11, sec. 4, p. 55, Pl. 5, figs. 1, 2, 3 (1894).

Description. Pinnae, reaching large size, up to 20 cm. or more long by 8 cm. broad, petiolate, oblong-elliptical or slightly obovate-elliptical, rounded or bluntly cuneate at base, which may be inequilateral, seemingly rounded at apex; rachis, thick, outstanding, straight or slightly curved;

lamina attached to upper surface of rachis. Veins, prominent, running from centre of upper surface of rachis where they abruptly bend downwards; over broader parts of lamina running at very open angles or at right angles to rachis almost to margin of pinna where they curve gently upwards, 17 to 22 per centimetre, unbranched.

Remarks. *Nilssonia gibbsi* (Newberry) Hollick (Newberry in Hollick, 1898, p. 16, Pl. 15, figs. 2, 2a) is considered to be conspecific with Dawson's species. Newberry's original description of *Taeniopteris gibbsi* was unaccompanied by figures, and had little value as a specific diagnosis until 1898 some years after *Macrotaeniopteris vancouverensis* was figured. *Taeniopteris plumosa* Dawson was founded on a fragment of a small pinna entirely inadequate for specific recognition; although small, it shows the characters of *N. vancouverensis*. In the types of *N. gibbsi* the base is more rounded than is generally the case in the Vancouver Island material to hand, but this is not considered to be a character of specific importance. Although Hollick (1930, p. 42) united *Nilssonia johnstrupi* Heer to *N. gibbsi*, the writer regards the former as a separate species, being differentiated by its acutely cuneate base, straighter veins and a tendency to division of the lamina. The two species, however, are apparently closely related, and may ultimately be shown to be conspecific.

Occurrence. Extension formation, localities, 1304, 3239, 3771; Comox formation, localities, 1722, 3768.

Types. Syntypes, G.S.C. Nos. 5657 and 5657a (types of *Macrotaeniopteris vancouverensis* Dawson); hypotypes, G.S.C. Nos. 5620 (type of *Taeniopteris plumosa* Dawson), 6402, 6403.

Nilssonia serotina Heer

Plate XIII, figure 1

Remarks. This species was well illustrated by A. Hollick (1930, Pl. 4, figs. 1-7, etc.) and was described as follows:

"Fronds varying in size, broadest at or near the summit, narrowed to the base, irregularly dissected or pinnatifid; segments subtriangular, rhomboidal, or liguliform, cuneate, rounded or bluntly acuminate, mostly curved, slightly upward, lowest ones more or less distinct, upper ones gradually becoming approximated and ultimately merging into a truncate or broadly emarginate summit; nervation fine, simple, uniform, parallel" (Hollick, 1930, p. 43).

A single specimen from Nanaimo shows a middle part of a leaf. Individual pinnae are alternate, irregular in outline and size, varying in length from 2 to 3 cm., in width from 9 to 15 mm. and in outline from subtriangular or ligulate to semi-elliptical. The veins are generally obscure, but where seen are about 0.5 mm. apart; one or two of those observed bifurcate near point of origin, and one bifurcation was noted in middle part of a pinna. The lamina was apparently attached to upper side of the rachis.

Occurrence. Newcastle formation, locality 3770; Comox formation, locality 1576.

Types. Hypotype, G.S.C. No. 6463.

Nilssonia cf. *mehli* Berry

Plate XIV, figure 3

Remarks. Material consists of scattered, disconnected pinnae of a cycadophyte believed to belong to a species of *Nilssonia* allied to *Nilssonia mehli* Berry (1930b, p. 132, Pl. 20). Pinnae coriaceous, variable in form and in size, from 3 to 6 cm. long and 10 to 37 mm. wide; their upper margin is commonly nearly straight, the lower well curved to a broadly rounded or rounded-truncate apex, or variable to more liguliform or rectangular. They were attached by whole base to a rachis, small fragments of which occur at the base of two or three of them. Veins, seemingly immersed and obscured by crowded longitudinal striations.

Occurrence. Comox formation, locality 3768.

Types. G.S.C. specimen No. 6406.

Zamites sp.

Plate XII, figures 4, 6

Remarks. A few, rather poorly preserved, unattached pinnae are considered referable to *Zamites*. They are lanceolate, 9 to 12 mm. broad and 5 cm. and more long, the base obscure, seemingly little constricted; apex narrowly rounded. Veins 0.5 to 1 mm. apart, slightly diverging from base, the peripheral ones terminating at margin.

Occurrence. Comox formation, locality 3038.

Types. G.S.C. Nos. 595, 596.

Ginkgo dawsoni Knowlton pars

Plate VII, figures 1, 2, 4

Salisburia pusilla Dawson, Roy. Soc. Canada, Trans. 1893, vol. 11, sec. 4, p. 56, Pl. 6, figs. 11-14 (1894).

Ginkgo pusilla (Dawson) Knowlton, U.S. Geol. Surv., Bull. 152, p. 111 (1898).

Ginkgo dawsoni Knowlton pars, U.S. Geol. Surv., Bull. 696, p. 302 (non Penhallow 1907) (1919).

Description. Petiole, slender, up to 2 cm. long by 1 to 1.5 mm. wide. Blade, hemispherical to sub-elliptical to deltoid, decurrent on petiole, up to 3 cm. or more broad by 1.8 cm. long, although generally smaller; basal margin, truncated and nearly normal to petiole, nearly straight except for decurrent junction with petiole and rounded junction with remainder of blade, or in deltoid blades the two lateral margins rise from

petiole at variable angles; upper margin, rather flatly arched and generally with single, apical, shallow notch, rarely with an additional, shallow notch on one or both sides, and more rarely still with additional notches. Venation, flabelliform, with commonly 3 dichotomies of veins from petiole to margin; about 11 veins in 5 cm. near upper margin.

Remarks. *Ginkgo minor* Hollick (1930, p. 50, Pl. 2, fig. 4b; Pl. 13, fig. 107; Pl. 19, figs. 6b, 7b; Pl. 29, figs. 2c, 4c, 6a) is indistinguishable from *G. dawsoni* and must be considered conspecific. For *Ginkgo* leaves the amounts of variation are not marked. Compared to other described leaves the species resembles most closely *Ginkgo laramiense* Ward (1885a, p. 496, fig. 7), but is much smaller. Except in size the species is still more like many leaves of the *Ginkgo adiantoides* from the Paleocene, and was united to that species by Seward (1919, p. 32).

Penhallow (1902, p. 43, Pls. 12, 13) had no justification for assigning a specimen of petrified wood to *G. pusilla*. This specimen came from Queen Charlotte Islands from beds of probable Lower Cretaceous or earlier age and was not associated with leaves of *G. pusilla*.

Occurrence. Port McNeill, locality 3240.

Types. Syntypes, G.S.C. Nos. 5609, 5683; hypotype, G.S.C. No. 6558.

Amentotaxus cf. *campbelli* (Gardner) Florin

Plate XIII, figures 3, 4

Description. Detached leaves, up to 4 cm. or more long by 5 mm. wide, straight or slightly curved, linear-lanceolate, contracting close to apex to a mucronate tip, rather abruptly rounded and contracted at base to a short stalk that is about 1 mm. wide. Midvein, commonly not preserved, bordered on each side by a conspicuous, evidently stomatiferous band, about 0.75 mm. wide, which on imprints is differentiated from remaining surface by persistent occurrence of carbonized tissues.

Remarks. The leaves resemble *Amentotaxus campbelli* (Gardner) Florin, differing mainly in the more abruptly contracted apex. They may be compared also to *Amentotaxus florini* Krausel (1935, p. 139, fig. 1a) and to the living *A. argotaenia* (Hance) from Formosa. The abrupt contraction of the base is comparable to that of *Amentotaxus californica* (Potbury) (1935, Pl. 1, fig. 2) from La Porte flora of California, which was considered to be Eocene or Lower Oligocene. The resemblance to these species is too close to warrant new specific designation on macroscopic characters.

Occurrence. Comox formation, locality 3768.

Types. G.S.C. Nos. 6400, 6401.

Metasequoia cuneata (Newberry) Chaney pars

Plate XI, figures 3, 5, 6; Plate XII, figures 1-3; Plate XIII, figure 2;
Plate XVII, figures 1, 7

Taxodium cuneatum Newberry, Boston J. Nat. Hist., vol. 7, p. 517 (1863).

Sequoia langsdorffii Heer pars (non Brongniart), All. Schweiz. Gesellschaft, Soc. Hel. Neue Denksch., Bd. 21, p. 6, Pl. 1, figs. 2, 3 (?), 4 (?), 5 (?) (non fig. 1) (1865).

Taxodium cuneatum Dawson, Roy. Soc. Canada, Trans. 1882-83, vol. 1, sec. 4, p. 25 (1883).

Torreya densifolia Dawson, ibid. p. 25, Pl. 5, figs. 20, 20a (1883).

Sequoia langsdorffii Dawson (non Brongniart), op. cit. Trans. 1893, vol. 11, sec. 4, p. 56, Pl. 6, fig. 9 (1894).

Taxodium sp. Dawson, ibid. p. 56, Pl. 6, fig. 10 (1894).

Sequoia cuneata Newberry, U.S. Geol. Surv., Mon. 35, p. 18, Pl. 14, figs. 3-4 (1898).

Tumion densifolia (Dawson) Knowlton, U.S. Geol. Surv., Bull. 152, p. 234 (1898).

Metasequoia cuneata Chaney pars., Amer. Phil. Soc. Trans. 1950, n.s., vol. 40, pt. 3 (1951).

Original description. "Leaves numerous, short, broad, spatulate in form, rounder or sub-acute at summit, wedge-shaped below, narrowed into a very short petiole, or sessile upon the branchlets" (Newberry 1863, p. 517).

Emended description. Freely to sparingly branched leafy axes; branches alternate or rarely opposite, situated in axils of leaves that are generally persistent. Leaves, appearing distichous and opposite, almost straight-sided and elongate-lanceolate, or on young short shoots may be elongate-elliptical, contracted anteriorly at base, very slightly if at all contracted posteriorly, decurrent, abruptly or more gradually contracted distally to acute or bluntly acute apex. Surface marked by microscopic striae. Female cone, about 2 cm. wide when open, with scales opposite.

Remarks. Dawson's type specimen of *Torreya densifolia* (reproduced on Pl. XI, fig. 5 of this report) is poorly preserved, and only a few leaves at its base show that the leaf apices were not rounded, but bluntly acute. Dawson's drawing, therefore, gives a false impression that the leaves were obovate and obtuse. As may be seen from shoots reproduced on Pl. XI, figs. 3, 6; and Pl. XIII, fig. 2, the species may be separated from *Metasequoia occidentalis* (Newberry) Chaney with some difficulty, because the leaves show a comparable variation. However, the writer considers that *M. cuneata* differs from *M. occidentalis* in the following characters: (1) the short shoots were much less freely deciduous; (2) present lack of evidence for scale-like leaves at the base of the short shoots, similar to those so commonly found in *M. occidentalis*; (3) the leaves of *M. cuneata* in the axils of which the short shoots occur are generally persistent; (4) the leaves of long shoots are commonly curved somewhat backwards giving the foliage a more lax appearance than that of *M. occidentalis*, and more like that of *Elatocladus* (*Metasequoia* ?) *smithiana*.

In the synonymy of *Metasequoia cuneata* given by Chaney (1951, p. 229) the writer would admit among specimens that had been figured only *Sequoia heterophylla* ? Knowlton (1905, Pl. 16, fig. 5). The remainder, with possible exception of *Sequoia nordenskiöldi* Dorf (non Heer) (1938, Pl. 1, fig. 10) he considers conspecific with *Sequoia obovata* Knowlton, and distinct from *M. cuneata*. *Metasequoia obovata* (Knowlton) Chaney is readily differentiated from *Metasequoia cuneata* by its normal leaves being consistently shorter and generally enlarged above the middle, giving

them an obovate appearance. The confusion of the two species has resulted from the scanty material in the hands of Newberry or Dawson, so that the figures of the leaves in both instances are misleading or not representative of the prevailing normal leaf form. The type specimens of *M. cuneata* (Newberry in Hollick, 1898, Pl. 14, figs. 3, 4) show quite convincingly that these specimens were young shoots with elliptical leaves similar to those on some short shoots from Nanaimo (cf. shoot opposite X in Pl. XVII, fig. 7 of this report). Such leaves are not representative of those prevailing on many other short shoots, and still less so of normal leaves which from near base to near apex are of even breadth. Nor does the material presently to hand from Nanaimo and from other localities on Vancouver Island lead to the conclusion that more than one species of *Metasequoia* occur in these deposits.

A single and obscure imprint of the cross-section of an open cone occurs unattached, but in association with a vegetative shoot. It is illustrated on Pl. XII, fig. 1.

Occurrence. Extension formation, localities 3771, 4210; Comox formation, locality 3768; Protection formation, localities 1580, 3826, 3858; Port McNeill, locality 3240.

Types. Hypotypes, G.S.C. Nos. 606, 5610 and 5611 (actually parts of a single specimen, recorded by Dawson as *Taxodium cuneatum*), 5618 (*Torreya densifolia* Dawson), 5639 (*Sequoia langsdorfii* Dawson, non Brongniart), 6388, 6476, 6497, 6505, 6507, 6529, 6694.

Glyptostrobus comoxensis n. sp.

Plate VII, figures 5, 6; Plate X, figures 1, 2; Plate XIV, figures 1, 2; Plate XV, figures 1-6; Plate XVI, figures 1-9; Plate XVII, figures 2, 5, 6

Glyptostrobus sp. Dawson, Roy. Soc. Canada, Trans. 1882-83, vol. 1, sec. 4, p. 25 (1883).

Description. Coniferous twigs, sparingly to moderately branched at acute angles. Leaves, small, cupressoid on most shoots, cryptomeroid on some, spirally disposed, or, where cryptomeroid, pseudodistichous, decurrent, acutely pointed, the cupressoid ones imbricate, with a basal part appressed to axis of branchlet, and upper half or so free and highly ascending to obliquely spreading, varying from nearly straight to sub-falcate; cryptomeroid leaves, acicular-lanceolate, not contracted at base, strongly decurrent, straight, or apex slightly incurved, ascending obliquely, up to 6 mm. long by 0.7 mm. wide. No midvein observed, but in some leaves a narrow prominent keel suggests that they may be triangular in cross-section. Axes of largest shoots are marked by spirally disposed obovate leaf scars, which have prominent median keels.

Female cones, terminal, globular to slightly oval, about 1 cm. diameter, or 8 or 9 mm. long by 7 or 8 mm. wide. Scales, flatly concavo-convex, 7 or 8 mm. long by 6 mm. wide, expanded and broadly rounded distally with thickened margins, lightly corrugated, contracted proximally to stout footstalk. Seeds, possibly belonging to species, rounded, sub-quadrangle in outline, up to 6 mm. long by 4.5 mm. wide, compressed, smooth, but with somewhat crescent-shaped elevation bordered by flat wing-like area of varying width.

Remarks. The shoots with more acicular or cryptomeroid foliage are much less common in occurrence. They may readily be mistaken for shoots of *Sequoia fastigiata* (Sternberg) Heer. G.S.C. specimens 6376, 6381 and 6536 show, in profile or cross-section, unattached, open or partly opened cones with five to seven scales exposed, whereas Nos. 6383 and 6697 are closed cones at termini of leafy shoots. A few isolated cone scales, as in specimen No. 6696 are found associated with vegetative shoots. G.S.C. No. 6695 shows what may be a terminal male ament, which is about 2.5 mm. diameter.

The cones are similar to those assigned by Heer to *Sequoia fastigiata* (Heer, 1882, Pl. 17, fig. 4; Pl. 41, fig. 5). The sterile foliage, too, is comparable to that of many specimens of *Sequoia fastigiata* figured by Heer, particularly to those from Patoot (Heer, 1883, Pl. 51, fig. 12; Pl. 53, figs. 3, 4). They are smaller than those of *Glyptostrobus europaeus* Brongniart, and the distal margins of the few scales are almost smooth. In the last mentioned character they differ also from species of *Glyptostrobus dakotensis* Brown (1936, p. 355, figs. 2, 3, p. 354).

Specimen G.S.C. No. 656 shows fragments of 4 scales attached to a short section of a leafy (?) shoot, one of which has a seed (Pl. XVI, fig. 3) apparently adherent to it. A second specimen, G.S.C. No. 657 (Pl. XVII, fig. 5) seemingly shows a scale with a pendant seed at 's'. Isolated seeds are shown on Pl. XVI, fig. 2 and Pl. XVII, fig. 2.

Occurrence. Comox formation, localities 1576, 3036, 3768, 3769, 4211 (depths 1184 and 1290 feet); Protection formation, locality 3858.

Types. Holotype, G.S.C. No. 680; paratypes, G.S.C. Nos. 656-659, 678, 679, 6376, 6377, 6379, 6381, 6383, 6384-6386, 6412, 6536, 6695, 6696, 6697.

Dammarites robinsi (Dawson) n. comb.

Plate XIX, figures 2, 4, 6

Phragmites cordaiformis Dawson, Roy. Soc. Canada, Trans. 1882-83, vol. 1, sec. 4, p. 26, Pl. 5, fig. 22 (1883).

Noeggerathiopsis robinsi Dawson, Roy. Soc. Canada, Trans. 1893, vol. 11, sec. 4, p. 56, Pl. 6, fig. 7 (1894).

? *Dammarites dubius* Dawson, *ibid.* Pl. 6, fig. 8 (1894).

Zamites albertensis Berry, Geol. Surv., Canada, Bull. 58, p. 68, Pl. 11, figs. 1, 2 (1929).

Description. Leaf, coriaceous, nearly straight or somewhat falcate backwards, or curved only at stalk-like base, elongate-linguiform, constricted more or less gradually in lower half of leaf to a stout, stalk-like base, well rounded or bluntly pointed at apex, inserted either laterally or more probably with spiral phyllotaxy, on a longitudinally ridged axis, but generally occurring detached, up to 20 cm. or more long and 3 or 4 cm. wide. Veins, strong, parallel with margins, dichotomosing freely in narrow basal part of leaf, rarely in distal parts, 0.5 to 1 mm. apart. Surface marked by 2 or 3 finer, vein-like striae between adjacent veins.

Remarks. The type specimen of *Phragmites cordaiformis* Dawson G.S.C. No. 5613 (see Pl. XIX, fig. 2), although inadequate for specific recognition, shows the venation and striation characteristic of the type of *Noeggerathiopsis robinsi* (G.S.C. No. 5659). In Dawson's description

"veins distant from each other about 5 millimetres" the number "5" is obviously a typographical error for 0.5. Dawson's drawing of *Noeggerathiopsis robinsi* on the other hand is an adequate reproduction; the axis bearing the pinna has been partly broken off and lost since Dawson's figure was drawn; yet sufficient remains to suggest a spiral phyllotaxy rather than a lateral attachment. Berry misinterpreted the correct orientation of *Zamites albertensis*, because the apices of his two types are actually the broader rounded ends as revealed in one specimen by bifurcation of the veins; moreover, the specimen reproduced in figure 2 does not contract to an acute end, but to a pseudo-stalk, of which probably about half was lost during collecting; the true width of this end was seemingly about 6 or 7 mm. or comparable to that of specimen No. 5659.

Dammarites emarginatus Lesquereux (1892, p. 33, Pl. 1, fig. 11) and *Dammarites caudatus* Lesquereux (op. cit. Pl. 1, figs. 9, 10) are considered to be probably conspecific with *Dammarites robinsi*. The emargination of the apex in the first mentioned species is not an uncommon or specific character in leaves of this nature. The drawing (figure 9) of *Dammarites caudatus* gives the impression that the leaf was partly inrolled.

It is possible that this species is conspecific with the *Podozamites marginatus* Heer (1882, p. 43, Pl. 16, fig. 10), although Heer's figured specimen is inadequate for present union. It is significant that *Dammarites microlepis* (Heer) (1882, p. 55, Pl. 40, fig. 5) and *Podozamites marginatus* Heer both occur in the Atane series of Greenland.

The leaf substance of *D. robinsi* was thick and commonly preserved as a film of coal. Spacing of the veins in imprints is commonly obscured by the rather strong vein-like striae, which seemingly represents hypodermal strands.

Occurrence. Extension formation, localities 296, 1304, 3239; Newcastle formation, locality 1723; Comox formation, locality 3768.

Types. Holotype, G.S.C. No. 5659 (type of *Noeggerathiopsis robinsi* Dawson); hypotypes, G.S.C. Nos. 5613 (type of *Phragmites cordaiformis* Dawson), ? 5689 (type of *Dammarites dubius* Dawson), 4990 and 5006 (syntypes of *Zamites albertensis* Berry), 6401.

Dammarites microlepis (Heer) n. comb.

Plate XVIII, figure 9

Description. Coniferous cone-scales, having a rhomboidal to semi-circular, expanded, slightly concavo-convex distal end which is abruptly contracted to a pedicle-like proximal end. The distal end is about 11 or 12 mm. high by 12 mm. broad, obtusely rounded on top with reflected or flattened border, about 1 mm. broad, and elsewhere marked by obscure longitudinal furrows. Pedicle, up to 10 mm. long and 2 or 3 mm. broad at distal end.

Remarks. Only two scales of this species were observed, neither of which shows any sign of an apiculate apex, nor any indication of seeds. These specimens agree closely in size and form with the type of *Dammara microlepis* Heer (1882, p. 55, Pl. 40, fig. 5).

Leaves described elsewhere in this report as *Dammarites robinsi* (Dawson) occur in the same formation, although not as yet collected from the same beds, and that these two forms may belong to a single species of plant related to the living *Agathis* is probable.

Occurrence. Protection formation, locality 3858.

Types. Hypotype G.S.C. No. 660.

Thuites corpulentus n. sp.

Plate XVI, figure 10; Plate XVII, figure 3;

Plate XVIII, figures 1, 2, 4, 6, 8, 11-13

Description. Coniferous twigs, profusely branched; branches alternate to opposite, prevailing the former. Leaves, decussate, scale-like, closely appressed to stem throughout their length, the lateral pair keeled, apically pointed, with bases almost meeting before being overlapped by a medial pair, about 3 mm. long; medial leaves with rhomboid, exposed areas, acute upper angles, and faint to well marked keels.

Unattached female cones, probably belonging to species, are globular, about 5 mm. diameter, exposing four scales in opposite pairs in cross-section. Scales, flatly concavo-convex, subtriangular in cross-section, rounded distally, 2.5 mm. long by 3 or 3.5 wide. Male cones, globular, about 2 or 2.5 mm. diameter, at ends of very short shoots.

Remarks. The species differs from the very similar *Libocedrus cretacea* Heer (1882, Pl. 29, figs. 1-3), if Heer's figure is correct, in that the lateral leaves do not meet above the apices of the underlying pair of medial leaves, and also in the more acute apices of the medial leaves. Moreover, a specimen referred by Seward (1927, p. 101, text-fig. 13) to Heer's species shows lateral leaves with their tips free from the axis of the branch.

Occurrence. Comox formation, localities 3036, 3120, 3768, 4211 (depth 1,000 feet).

Types. Holotype, G.S.C. No. 6372; paratypes, G.S.C. Nos. 597, 631, 686, 6373, 6374, 6375, 6376, 6379, 6381

Protophyllocladus polymorpha (Lesquereux) Berry

Plate XIX, figure 5; Plate XX, figures 1, 2, 4; Plate XXI, figures 1, 3, 5;

Plate XXV, figure 4

Salisburia polymorpha Lesquereux (nomen nudum), Am. J. Sci., 2nd ser., vol. 27, p. 362 (1859).

Adiantites praelongus Dawson, Roy. Soc. Canada, Trans. 1882-83, vol. 1, sec. 4, p. 25, Pl. 5, fig. 19 (1883); op. cit. Trans. 1893, vol. 11, sec. 4, p. 55, Pl. 6, fig. 6 (1894).

Salisburia baynesiana Dawson, Roy. Soc. Canada, Trans. 1882-83, vol. 1, sec. 4, p. 25, Pl. 5, fig. 21 (1883).

Description. Leaves or phylloclades, up to 20 cm. or more long and 6 cm. wide, but very variable, petiolate, oblong-obovate to oblong-lanceolate, tapering acuminate to short petiole which is about 1.5 or 2 mm. wide at proximal end before a slight expansion; apex, obtuse or in

linear leaves possibly acute; margin, irregularly lobate, or sub-lobate, or undulate to undulo-crenate, or entire except for a few scattered sharp teeth. Midvein, flat, moderately well marked, extending nearly to apex or disappearing in upper half of leaf at variable distance from apex; lateral veins at very acute angles to midrib, generally slightly curved to margin, simple or bifurcated at very acute angle close to midrib or more rarely beyond, of variable strength and distance apart and commonly difficult to trace individually owing to close vein-like striae running parallel with them.

Remarks. Although the species is fairly abundant and widespread in the Nanaimo group, the material to hand does not include a complete leaf. The largest fragment is about 20 cm. long. The so-called venation is well marked, but difficult to determine whether certain more prominent ones, from 0.5 to 1 mm. or more apart, are main laterals, and whether accompanying close vein-like striae, of which 5 or 6 occur in 1 mm. are also veins or hypodermal strands. The leaf substance is well carbonized and was apparently thick, although seemingly not necessarily coriaceous. Dawson's figure of *Adiantites praelongus* is misleading because it fails to show the divergence of highly ascending veins from a midvein, although this is indicated to some extent in his later figures. The same criticism applies to his figure of *Salisburia baynesiana*.

Protophyllocladus lanceolatus (Knowlton) (1893, Pl. 5, fig. 5) and *Protophyllocladus subintegrifolius* (Lesquereux) (1874, Pl. 1, fig. 12; 1892, Pl. 2, figs. 1-3) are evidently conspecific with *Protophyllocladus polymorphus* (Lesquereux). *Thinnfeldia lesquereuxiana* Heer (1882, Pl. 49, figs. 9, 10; Pl. 46, figs. 1-12a, 12b) is probably also conspecific, although the leaves are considerably smaller than normal to the species.

Occurrence. Extension formation, localities 1304, 3771; Comox formation, localities 1576, 3036, 3768, 3769; Protection formation, locality 3858; Beaver Harbour, locality 1543 (1584).

Types. Hypotypes, G.S.C. Nos. 611, 5619 (holotype of *Salisburia baynesiana* Dawson), 5621 (holotype of *Adiantites praelongus* Dawson), 5681 (hypotype of *Adiantites praelongus* Dawson), 6407, 6408, 6409, 6411, 6413, 6506, 6693.

Sparganium sp.

Plate XVII, figure 4; Plate XVIII, figures 3, 5, 7, 10; Plate XIX, figures 1, 3; Plate XX, figure 3

Remarks. Collections from Round Island provided several fragments of monocotyledonous leaves, of which the best (Pl. XX, fig. 3) is about 12 cm. long by 5 cm. wide. Numerous, longitudinal, parallel veins, averaging about 12 per 5 cm., are connected at intervals of 0.3 to 1 mm. by almost as strong, transverse connections (Pl. XIX, figs. 1, 3). Carbonized parts of the leaf, occurring in places, show microscopic striae, about three of which lie between an adjoining pair of veins. Although the principal veins vary somewhat in strength, no uniform differentiation was detected.

Two fructifications, apparently belonging to *Sparganium*, were collected from Protection Island and Comox. The smaller is about 7 mm. diameter, and consists of a circular cluster of numerous beaked fruits, each having a diameter of about 0.5 mm., around a central receptacle; other details are obscure. The second specimen, from Comox, is much larger, the cluster of fruits being about 1.7 mm. diameter consisting of radially arranged, apically pointed, individuals each 8 or 9 mm. long and 1 to 2 mm. wide. This specimen may be compared with one of *Sparganium stygium* Heer (1869, p. 467, Pl. 42, fig. 5).

The venation of the leaves is similar to that of *Cannophyllites magnifolia* (Knowlton) (Bell 1949, p. 81, Pl. 64, fig. 2, Pl. 65), but any evidence of a midrib is lacking in the fragments to hand, and the transverse veins are stouter and spaced more closely.

Occurrence. Leaves from Protection formation, locality 3826; fruits from Protection formation, locality 3858, and Comox, locality 3768.

Types. G.S.C. Nos. 540, 582, 662, 668, 670.

Geonomites imperialis (Dawson) n. comb.

Plate XXII, figure 5; Plate XXIII, figure 2; Plate XXIV, figure 3

Sabal sp. Newberry, Boston J. Nat. Hist., vol. 7, p. 515 (1863).

Sabal imperialis Dawson, Roy. Soc. Canada, Trans. 1882-83, vol. 1, sec. 4, p. 26, Pl. 6, figs. 23, 23a (1883); op. cit. Trans. 1893, vol. 11, sec. 4, p. 57, Pl. 14, fig. 61 (1894).

Description. Leaves very large; complete outline unknown. Rachis, up to 2.5 cm. broad to a few mm. at summit, longitudinally striated. Rays, 8 to 27 mm. broad, all united so far as known, although some specimens show distal splits, separated from one another by narrow sinus, marked by prominent median carina, at wide angle to rachis near base of frond, about 30 degrees in middle part and 10 to 15 degrees at summit, contracting slightly to a decurrent or semi-sheathing attachment to sides and upper surface of rachis. Veins, parallel, generally about 0.3 to 0.75 mm. apart, with 3 or 4 close intermediate vein-like striae between them.

Remarks. The species seems closest to *Geonomites tenuirachis* Lesquereux (1878, p. 117, Pl. 11, fig. 1; Knowlton, 1917b, p. 291, Pl. 62), but has much stouter rachis and more decurrent rays. In *Geonomites schimperi* Lesquereux (1878, p. 116, Pl. 10, fig. 1; Berry, 1925, p. 37, Pl. 2) the rachis is also comparatively thin and more like that of *G. tenuirachis*. Incomplete rays of *Geonomites imperialis* are 30 cm. long.

Occurrence. Extension formation, localities 1304, 2244, 3239, 3771, 3772; Comox formation, locality 3768; Newcastle formation, locality 1723.

Types. Holotype, G.S.C. No. 5622a; hypotypes, G.S.C. Nos. 5622, 6464 (types of *Sabal imperialis* Dawson).

Populus sp.

Plate XXV, figure 5

Remarks. A single leaf, long-petiolate, with crenulate margin; crenae, asymmetric, pointing upwards and extending below the middle of the blade; apex and part of base missing. General outline of blade is deltoid, the base being truncate, and perhaps even emarginate at petiole. The midrib is fairly stout, secondaries 8 or 9 alternate pairs, open, making angle of about 60 degrees with midvein, camptodromous close to margin, with short branches to crenae. It is a very similar leaf to the living *Populus fremontii* Watson of the Pacific slope of North America and of New Mexico.

Occurrence. Protection formation, locality 3826.

Types. G.S.C. No. 584.

Alnus perantiqua (Dawson) n. comb.

Plate XXI, figures 2, 4, 6; Plate XXII, figures 1-4

Betula perantiqua Dawson, Roy. Soc. Canada, Trans. 1882-83, vol. 1, sec. 4, p. 27, Pl. 7, fig. 27 (1883).

Ulmus dubia Dawson, *ibid*, p. 27, Pl. 7, fig. 29 (1883).

Description. Leaf, petiolate, elliptical, with greatest width about midlength of blade; apex, acute and base more or less broadly cuneate; margin, serrulate well above base, the teeth simple, triangular, subequal in strength. Midrib, straight or slightly curved. Secondaries, 8 to 10 pairs alternate to subopposite, craspedodromous, except basal or basal and next pair above, which run close to margin and are connected by looped tertiaries with secondaries above, inserted 45 to 70 degrees to midrib, those near base commonly at more open angles than rest, curving gently upwards and mostly ending in marginal teeth; one or two distal, upwardly curved, abaxial branches end also in teeth. Tertiaries, moderately spaced to rather distant, nearly at right angles or slightly oblique to secondaries, straight or more commonly slightly bowed, percurrent or once divided.

Remarks. *Ulmus dubia* Dawson was founded on a mere fragment of a leaf that shows all the characters of *A. perantiqua*. The species has much the same form as the Tertiary *Alnus corallina* Lesquereux (1883, Pl. 51, figs. 1-3), but the more open pattern of both secondaries and tertiaries is quite distinctive, and shows some approach to that of some early Tertiary species of *Celastrinites*. G.S.C. specimen 6448 (Pl. XXII, fig. 3) is considered a young leaf, which has an entire margin and all secondaries camptodromous.

Occurrence. Comox formation, localities 1576, 1722, 3036, 3768; Protection formation, locality 3826.

Types. Holotype, G.S.C. No. 5632; hypotypes, G.S.C. Nos. 5635 (*Ulmus dubia* Dawson), 5645, 6446, 6447, 6448, 6449.

Dryophyllum elongatum Dawson

Plate XXIII, figure 1; Plate XXIV, figures 1, 2, 4; Plate XXV, figure 2

Dryophyllum elongatum Dawson, Roy. Soc. Canada, Trans. 1893, vol. 11, sec. 4, p. 58, Pl. 7, fig. 20 (1894).

Dryophyllum neillianum Dawson, *ibid.*, p. 58, Pl. 7, fig. 19 (1894).

Dryophyllum occidentale Dawson *pars*, *ibid.*, p. 58, Pl. 7, fig. 17 (? non fig. 18) (1894).

Quercus holmesii Dawson (non Lesquereux), *ibid.*, p. 59, Pl. 7, fig. 21 (1894).

Ulmophyllum priscum Dawson, *ibid.*, p. 59, Pl. 8, fig. 28 (1894).

? *Dryophyllum* sp. Dawson, *ibid.*, p. 59, Pl. 12, fig. 59 (1894).

Quercus ? (*Dryophyllum*) *occidentalis* (Dawson) Knowlton, U.S. Geol. Surv., Bull. 152, p. 195 (1898).

Quercus vancouveriana Trelease, Brooklyn Bot. Gard., Mem., vol. 1, p. 499 (1918).

Description. Leaf, petiolulate, lanceolate to elliptical-acuminate, with acutely cuneate base and acuminate apex. Margin, entire in basal region, rather regularly serrulate above, with subequal teeth pointed upwards. Midrib, moderately stout. Secondaries, up to about 15 pairs, opposite to alternate, 30 to 45 degrees to midrib, about parallel, straight or slightly curved forwards, craspedodromous and ending in teeth, except for one or two pairs at base which are camptodromous, mostly with one, or more rarely, two distal, abaxial branches, which also enter teeth. Tertiaries, generally not preserved; when seen, slightly oblique to secondaries and percurrent. Leaf substance, apparently firm but membranaceous.

Remarks. The holotype G.S.C. No. 5646 (Pl. XXIV, fig. 2) was incorrectly figured by Dawson as having an entire margin; part of the margin is poorly preserved, but other parts are clearly serrulate. It is about 7.5 cm. long by 1.6 cm. wide in middle part. One of the syntypes of *Dryophyllum occidentale* Dawson (Dawson's fig. 18) is missing, but if its margin is entire, probably belongs to *Rhamnites eminens* (Dawson), as do some other specimens labelled by Dawson *Dryophyllum occidentale*. The other syntype, G.S.C. No. 6700, has a pronounced serrulate margin, and was consequently incorrectly figured; it is reproduced here on Pl. XXIII, fig. 1. The type of *Ulmophyllum priscum* (Pl. XXV, fig. 2 of this report), except for its larger size, shows all the characters of the species; it lacks, however, base and tip. The specimen of *Dryophyllum* sp. Dawson is missing, and it is not known whether the margins are serrulate. *Quercus holmesii* Dawson (non Lesquereux) is reproduced here on Pl. XXIV, fig. 4; it is quite similar to the holotype of *D. elongatum* and differs from *Quercus holmesii* Lesquereux in its acutely cuneate base and acuminate acute apex, as also by its craspedodromous and distally branched secondaries.

Occurrence. Port McNeill, locality 3240; Protection formation, locality 3858.

Types. Holotype, G.S.C. No. 5646; hypotypes, G.S.C. Nos. 5596 (type of *Dryophyllum neillianum* Dawson), 5599 (type of *Dryophyllum holmesii* Dawson), 5601, (type of *Ulmophyllum priscum* Dawson), 6700 (syntype of *Dryophyllum occidentale* Dawson).

Dryophyllum fallax (Dawson) n. comb.

Plate XXVI, figures 2, 3

Juglandites fallax Dawson, Roy. Soc. Canada, Trans. 1893, vol. 11, sec. 4, p. 59, Pl. 11, fig. 48 (1894).

Description. Leaf blade, elliptical-lanceolate, acuminate at apex, cuneate and decurrent at base, with greatest breadth near middle. Type is 8.5 cm. long by 2.9 cm. wide in middle. Margin, entire below, provided with rather broad, low, triangular, nearly straight or forwardly directed, subequal teeth above, the teeth separated by shallow sinuses. Texture, firm. Midvein, moderately stout, slightly curved at apex. Secondaries, 8 to 10 pairs, subopposite to alternate, nearly straight or slightly curved upwards, rather irregularly spaced, the basal pair at more acute angle of insertion than the rest; the basal and next succeeding pair, camptodromous, the remainder running to teeth, mainly simple, but one or two with an abaxial branch which enters an intermediate tooth. Tertiaries, moderately to distantly spaced, percurrent, nearly straight and mainly simple, transverse to secondaries. Nervilles, where preserved, form a small quadrangular mesh between the tertiaries.

Remarks. A second specimen from same beds as type is relatively broader, being about 8 cm. long by 4 cm. wide. The leaf closely resembles *Quercus primordialis* Lesquereux (1874, p. 64, Pl. 5, fig. 7), but is relatively broader or more ovate in outline, and shows a rare branching of the secondaries. It may be compared also with *Quercus pseudowestfalica* Berry (1914, p. 35, Pl. 9, fig. 5), the latter differing mainly in possessing larger and rounded teeth. The teeth are similar to those in the oblong-lanceolate leaves of *Dryophyllum gracile* Berry (1919, Pl. 32, fig. 2).

Occurrence. Extension formation, locality 3239.

Types. Holotype, G.S.C. No. 5660; hypotype, G.S.C. No. 653.

Dryophyllum furcinervosum n. sp.

Plate XXV, figure 3

Description. Leaf, short-petiolate, oblong-lanceolate, with abrupt, broadly cuneate base and rather abrupt contraction at summit to acuminate apex. Margin, smooth at base, serrate above, the teeth being short, broadly triangular, outwardly pointed. Midrib, moderately strong. Secondaries, about 15 pairs, mainly alternate, inserted about 50 degrees to midrib, those in lower part of leaf nearly straight, the higher ones slightly curved upwards, mainly once forked, all craspedodromous except a short sub-marginal basal pair. Tertiaries, mainly not preserved; where seen, normal to the secondaries, and percurrent.

Remarks. The species resembles most closely *Dryophyllum bruneri* Ward (1887, Pl. 10, figs. 5-8), which R. W. Brown places as a synonym of *Dryophyllum subfalcatum* Lesquereux (1878, Pl. 63, fig. 10), but differs in the fact that all but the uppermost secondaries are forked. Although Brown showed that *D. subfalcatum* was extremely variable in leaf characters,

branching of most of the secondaries is generally rare, and there is a tendency towards a mixed camptodromous and craspedodromous venation.

Occurrence. Extension formation, locality 4210.

Types. Holotype, G.S.C. No. 6486.

Dryophyllum ripleyensis (Berry) n. comb.

Plate XXV, figure 1

Description. Leaf, petiolate, ovate, about twice as long as wide, broadly cuneate and somewhat inequilateral at base. Petiole, about 11 mm. long, slightly curved. Margin, entire below, prominently and regularly crenulo-dentate above. Midrib stout. Secondaries, about 12 pairs, alternate, regular, nearly straight, inclined 40 to 45 degrees to midrib, craspedodromous. Tertiaries, closely spaced, transverse, percurrent, once divided or simple; the most distal tertiary given off from upper side of a secondary runs subparallel with margin for half or more the distance to secondary above.

Remarks. The species was originally allocated by Berry (1925, p. 47, Pl. 5, fig. 6; Pl. 7, fig. 1) to *Fagus*, but without confirmation of its fruits it would seem better to consider it in the comprehensive form genus *Dryophyllum*. The close Tertiary venation is similar to that of the living *Fagus silvatica* Linnaeus.

Occurrence. Protection formation, locality 3826.

Types. Hypotype, G.S.C. No. 538.

Dryophyllum whitmani (Knowlton) n. comb.

Plate XXIX, figures 1, 2; Plate XXX, figure 1

Description. Leaf, large, elliptical-lanceolate, up to 25 cm. long by 7 cm. broad, short petiolate as far as known; base, cuneate; apex, seemingly narrowly cuneate, but tip missing. Margin, obscurely toothed, the teeth remote, very low, triangular, separated by shallow sinuses. Midrib, moderately stout, prominent, straight or slightly flexuous. Secondaries, alternate or rarely opposite or subopposite, up to 12 pairs or more, arising 45 to 65 degrees to midrib, slightly flexuous or gently curved upwards, in lower half of leaf generally camptodromous and united by tertiaries, with short branches to teeth where these occur; in upper half mixed camptodromous, or craspedodromous to teeth. A few secondaries may have an abaxial branch in their upper half, the branching at a wide angle, and simulating dichotomy. Tertiaries, well marked, openly spaced, percurrent simple or once divided, joining secondaries at right angles.

Remarks. The only observable difference between the Vancouver Island leaves and Knowlton's type specimen is in the more spreading secondaries. The transverse tertiary venation is precisely similar, whereas

the tertiaries of *Dryophyllum subfalcatum*, to which R. W. Brown united *Quercus whitmani* Knowlton are characteristically somewhat oblique to the secondaries, resembling more the tertiary venation in some species of *Celastrinites*. Whether this is a specific character may be considered doubtful, but the writer, taking into consideration the fact that the Vancouver Island leaves, as well as the type of *Quercus whitmani*, are relatively longer and broader than normal leaves of *Dryophyllum subfalcatum*, prefers to retain Knowlton's species.

Occurrence. Round Island, Nanaimo, locality 3826.

Types. Hypotypes, G.S.C. Nos. 610, 6534, 6535.

Quercus ? richardsoni n. sp.

Plate XXVI, figure 1; Plate XXVII, figures 1-3;
Plate XXVIII, figures 1-3; Plate XXXI, figures 3, 4

Anisophyllum sp. Dawson, Roy. Soc. Canada, Trans. 1882-83, vol. 1, sec. 4, p. 28, Pl. 8, fig. 34 (1883).

Description. Leaf, petiolate, with petiole up to 3.5 cm. or more long membranaceous, querciform, ovate-elliptical or obovate-elliptical; base of blade, cuneate; apex, cuneate or narrowly rounded. Margin, entire in basal region, irregularly crenate or creno-serrate above. Midrib, moderately stout, commonly somewhat curved. Secondaries, moderately stout, about six pairs, alternate to subopposite, inclined 40 to 50 degrees to midrib, the basal one or two pairs may be curved downwards and lowermost may possibly be camptodromous; next succeeding pair, craspedodromous, the longer with one or two abaxial branches. Tertiaries, partly percurrent, mostly divided, commonly bowed or flexuous, enclosing rather prominent fine network of nervilles.

Remarks. The general type of leaf is much like that of *Quercus rhomboidalis* Hosius and von der Marck (1880, p. 165, Pl. 31, fig. 83). Somewhat similar Upper Cretaceous leaves have variously been assigned to *Quercus* (e.g. *Q. raviana* Heer, 1883, Pl. 66, fig. 3) and *Quercus judithae* Knowlton (1905, Pl. 18, fig. 2), to *Fagus* (e.g. *F. ripleyensis* Berry, 1925, Pl. 7, fig. 1), to *Populus* (e.g. *Populus cretacea* Knowlton, 1905, Pl. 17, fig. 1), and to *Platanus* (e.g. *Platanus ? grewiopsoides* Hollick, 1930, Pl. 28, fig. 5b).

The Vancouver Island species cannot be reliably identified with any of these, and is, accordingly, given a specific designation in remembrance of James Richardson, who was one of the first to make an extensive investigation of the coal-bearing formations of the islands.

Occurrence. Comox formation, localities 1576, 3032.

Types. Syntypes, G.S.C. Nos. 6553 a, b, c; paratypes, G.S.C. Nos. 586, 587, 598, 629, 638, 639, 5607 (*Anisophyllum* sp. Dawson), 6511, 6555.

Quercus cf. *pseudowestfalica* Berry

Plate XXVI, figure 5; Plate XXVII, figure 4

Remarks. Two specimens only of this leaf are to hand, and both lack an apex. One has a slightly curved petiole, 1.5 cm. long. Outline of leaf, rhomboidal-ovate; base cuneate with nearly straight sides making angle of 80 to 100 degrees. Margin, regularly crenodentate with large, obtuse teeth separated by asymmetric, rounded sinuses. Midvein, moderately stout and prominent. Secondaries, thin, 7 or 8 pairs, subopposite to alternate, about 40 degrees to midrib, straight or slightly curved upwards, each entering a tooth. Only a few percurrent tertiaries are preserved.

Except for its greater relative breadth, a factor of doubtful specific importance, the leaf is evidently very close to *Quercus pseudowestfalica* Berry (1914, Pl. 9, fig. 5), but lack of apex precludes confident identification with that species. The teeth are more rounded and more regular than those of *Quercus hexagona* Lesquereux (1874, Pl. 5, fig. 8).

Occurrence. Protection formation, locality 3858.

Types. G.S.C. Nos. 6510, 6511.

Zelkova sp.

Plate XXVI, figure 4

Description. Leaf, ovate to cuneate-ovate, with slightly inequilateral, cuneate base, and seemingly acuminate apex. Margin, smooth at base, single-serrate or cuspidate. Midvein strong. Secondaries, 14 to 15 pairs, subopposite to alternate, parallel, slightly curved upwards, craspedodromous, originating at angle of about 40 degrees to midrib or 30 degrees in apical part, provided with a distal, short, curved branch on under side, which terminates marginally or submarginally at asymmetric, rounded sinuses between the teeth. Tertiaries, poorly preserved, somewhat oblique to the secondaries, rather close, and seemingly dominantly percurrent.

Remarks. Only a single specimen, which lacks extreme base and apex, occurs in present collections. The teeth, although less mammillate-cuspidate, resemble those of the living *Zelkova ulmoides* Schneider (Brown, 1937, Pl. 51, fig. 18), which also possesses short, distal, abaxial branches of the secondaries.

Occurrence. Extension formation, locality 4210.

Types. G.S.C. specimen No. 6485.

Artocarpus occidentalis (Dawson) n. comb.

Plate XXX, figure 2; Plate XXXI, figures 1, 2, 5

Artocarpophyllum occidentale Dawson, Roy. Soc. Canada, Trans. 1893, vol. 11, sec. 4, p. 60, Pl. 12, fig. 51; Pl. 13, fig. 22 (1894).

Description. (Based on parts of two leaves.) Leaf, coriaceous, large, elongate-oblong, deeply dissected into several (presumably 2 or 3 pairs) of large lobes, which are separated by narrow rounded sinuses; apex, elliptical or asymmetrical, with a broad lobe on one side. Lobes, seemingly in opposite or subopposite pairs, in apical region about 45 degrees to midrib, lower down about 60 degrees, asymmetrical, with lower margin curved upwards, and upper margin almost straight or only gently convex. Midrib, very stout, 4 mm. wide, decreasing gradually to apex. Main secondaries, entering lobes and craspedodromous, strong, although much weaker than midrib, the outermost provided with oblique, camptodromous branches, which curve upwards close to margin; other secondaries from midvein, camptodromous, splitting where directed towards a sinus and providing two sub-marginal veins along sinus borders. Tertiaries, mostly immersed; where seen, percurrent, simple or once divided, at open angles to midrib and secondaries.

Remarks. The species is evidently closely allied to *Artocarpus lessigiana* (Lesquereux) Knowlton (1876, p. 386; 1878, p. 136, Pl. 64, fig. 1), but the fragmentary nature of the material to hand precludes close comparison with that or other similar fossil species. A small fragment of doubtful affinity, possibly a fruit or inflorescence, is illustrated enlarged on Pl. XXXI, fig. 2, to show its resemblance to a much more complete specimen that Nathorst (1890, Pl. 1, fig. 4) considered to be part of a male inflorescence of an *Artocarpus*. It shows an imprint of part of postulose body, on which are remnants of some coalized tissue, the larger postules being about 0.5 mm. or comparable to those illustrated by Nathorst.

Occurrence. Extension formation, locality 3239; Comox formation, locality 3768.

Types. Syntypes, G.S.C. Nos. 5671, 5671a (types of *Artocarpophyllum occidentale* Dawson); hypotype (?), G.S.C. No. 674.

Ficus cf. *mississippiensis* (Lesquereux) Berry

Plate XXXIII, figures 1, 5

Description. Leaf blade, ovate-acuminate, about 9 cm. long by 7 cm. wide. Base, truncate to broadly cuneate; apex, more or less abruptly acuminate. Venation, trinerved-pinnate. Midrib, moderately stout, nearly straight. Primary laterals, seemingly slightly supra-basal, inserted at 35 to 50 degrees to midrib, opposite, curving gently inwards and running into upper half of leaf, looping close to margin with tertiary branch from secondary above, provided on outer side with 6 or more upwardly curved, seemingly brachiodromous branches. Remaining secondaries, 4 to 6 pairs, alternate or more rarely subopposite, unevenly spaced, about parallel with primary laterals, distally curving almost parallel with midrib and

looping close to margin. Tertiaries, at right or very open angles to midrib and secondaries, rather closely spaced, simple or once divided, nearly straight or very slightly bowed. Nervilles, not preserved.

Remarks. E. W. Berry (1923, p. 9) discussed the variations in form of leaf of *Ficus mississippiensis* including as synonyms eight other species. Among the latter the Vancouver Island form is practically indistinguishable from *Ficus occidentalis* Lesquereux (1878, Pl. 32, fig. 4; Berry, 1916, Pl. 28, fig. 3), and, if it came from Paleocene beds, would unquestionably be considered conspecific. Owing, however, to the considerably earlier age of the Vancouver Island leaves, and to the fact that only two specimens are presently available for comparison, it is considered wise at present not to insist on this identity.

Occurrence. Extension formation, locality 3771; Protection formation, locality 3858.

Types. G.S.C. Nos. 6470, 6498.

Nymphaeites sp.

Plate XXXII, figures 1, 2

Remarks. Two fragments only of a nymphaeaceous leaf are included in collections from the Nanaimo group. Their margins where preserved are entire, the base cuneate to broadly truncate. One has a stout, short petiole, 7 mm. long by 2 mm. wide. Venation, palmate from top of petiole, with 5 or 7 primaries, which may have a few distal branches; the distal ends of primaries are missing. Tertiary venation, obscure, but seemingly consists of a pattern of angular areolae, of which many of the individual components are elongated in direction of the primary veins.

Occurrence. Extension formation, locality 3239; Comox formation, locality 1576.

Types. G.S.C. Nos. 651, 652.

Trochodendroides (Cercidiphyllum) arctica (Heer) Berry

Plate XXXV, figure 2

Populus protozadachii Dawson, Roy. Soc. Canada, Trans. 1882-83, vol. 1, sec. 4, p. 26, Pl. 17, fig. 25 (1883).

Menispermites sp. Dawson, Roy. Soc. Canada, Trans. 1893, vol. 11, sec. 4, p. 62, Pl. 11, fig. 50 (1894).

Trochodendroides arctica Bell, Geol. Surv., Canada, Bull. 13, p. 56, Pl. 4, fig. 2; Pl. 9, fig. 4; Pl. 20, fig. 3; Pl. 44, fig. 2; Pl. 45, figs. 1, 2; Pl. 46, figs. 1-3 (1949).

Remarks. The allocation of *Populus protozadachii* Dawson to *Trochodendroides arctica* (Heer) is an addition to the Canadian synonymy of the latter species, which was formerly presented (1949, p. 56). The leaves of *T. arctica* in known populations are so variable that specific differentiation on the basis of leaf characters alone would be impracticable. The species in collections to hand from Vancouver Island is represented by only a few specimens, the best of which is Dawson's type. Dawson's

figure, however, is an incorrect representation, because it fails to show the looping of the abaxial branches of the lateral primaries. The venation on this specimen is particularly well preserved, down to a network of nervilles that enclose polygonal cells about 0.2 to 0.3 mm. diameter.

The specimen is a fragment of a leaf that was comparable in size to the larger Tertiary leaves allocated to the species, which is rather surprising inasmuch as later Cretaceous specimens are generally much smaller.

Occurrence. Newcastle formation, locality 1721; Port MacNeill, locality 3240.

Types. Hypotype, G.S.C. No. 5627 (holotype of *Populus protozadachii* Dawson).

Menispermum dauricumoides n. sp.

Plate XXXIII, figure 6; Plate XXXIV, figures 1, 3

Description. Leaf, peltate, dentate-lobate, sub-pentagonal to sub-hexagonal in general outline, 5 to 9 cm. across, with commonly 5 or 6 principal, triangular, bluntly pointed lobes, between which may be an intermediate shorter lobe or crena. Venation, palmate from an excentric petiolar area of attachment, 1.5 to 2 mm. diameter. Three primary veins run to the margin of the upper part of the leaf, and these may be sub-equal in length or the central one may be the longest; these primaries may have one or two pairs, subopposite or alternate, straight or more commonly inwardly curved, craspedodromous branches, which enter intermediate lobes or crenae. The smaller lower area of the blade has 3 to 5 primaries, some of which may fork or be provided with a pair of distal branches.

The tertiaries are generally obscure, but where seen form a loose network between the primary veins and their branches.

Remarks. The species is named after its resemblance to the living *Menispermum dauricum* from eastern Asia. It also is much like the living North American species *Menispermum canadense*, although more markedly peltate. The writer could find no record of fossil species that are so closely comparable to the living forms.

Occurrence. Comox formation, locality 3768; Protection formation, locality 3826.

Types. Holotype, G.S.C. No. 6442; paratypes, G.S.C. Nos. 583, 6443.

Menispermites acutilobus Lesquereux

Plate XXXV, figure 3

Original description. "Leaf large, triangular in outline, broadly rounded or nearly truncate at base, deltoid, dentate-lobate, five-nerved from near the base, coriaceous; nerves more or less branching on the lower side, craspedodrome, with their divisions; nervilles at right angles to the nerves, anastomosing in the middle of the areas" (Lesquereux, 1883, p. 78).

Remarks. A single, but large fragment agrees very well with the single and equally fragmentary type specimen. The principal characters are the large size, deltoid outline, dentate-lobate margin, palmately five-nerved from base or near it, rare secondaries, craspedodromous primary and secondary nerves, and open inosculating network of tertiaries.

Phyllites sp. Dorf (1942, Pl. 17, fig. 16) is rather suggestively like a very small leaf of this, or a closely allied species.

Occurrence. Comox formation, locality 3769.

Types. Hypotype, G.S.C. No. 6479.

Menispermiles torosus n. sp.

Plate XXXVI, figure 5

Description. Leaf blade, broadly ovate to orbicular, inequilateral at base, which is truncate and seemingly slightly cordate. The apex and petiole are missing. Venation, primarily five-palmate, with an additional pair of thin basal secondaries. Midvein, stout, straight. Secondaries, few, remote from base, alternate. Inner pair of lateral primaries, almost as stout as midrib, to which they are attached at an angle of about 40 degrees, curved inwards and strongly ascending, so as to become nearly parallel with midvein, provided on abaxial side with 2 or 3 strong, camptodromous branches. Outer primaries, likewise strong, 70 or 80 degrees to midrib, curved slightly inwards, and looped close to margin with branch of primary above, provided on under side with about 4 pairs camptodromous branches, which unite by simple loops close to, or well within margin. Tertiaries, fairly strong, transverse to main nerves, percurrent, simple or less commonly once divided, slightly bowed, rather distant. Nervilles, not preserved, except for a few transverse and simple veins connecting the tertiaries.

Remarks. The leaf resembles some entire leaves referred to *Dombeyopsis* e.g. *D. obtusa* Dorf (1938, Pl. 15, figs. 1, 2), except that it is palmately five-nerved. The primary venation resembles that of *Cercidiphyllum* and of *Hyperbaena*, but the tertiary venation is more like that of the latter genus, and some branches of the primaries simulate dichotomy as in many members of the Menispermaceae.

Occurrence. Comox formation, locality 3768.

Types. Holotype, G.S.C. No. 6451.

Liriodendron giganteum Lesquereux

Plate XXXII, figure 3

Liriodendron praetulipiferum Dawson, Roy. Soc. Canada, Trans. 1893, vol. 11, sec. 4, p. 63, Pl. 8, fig. 27 (1894).

Description. Leaf, petiolate, coriaceous, about 9.5 cm. broad by 11.5 cm. long, horizontally truncate at base, deeply emarginate at apex, quadrilobate, the two lower lobes transverse, subquadrate, occupying about half a leaf, separated from upper lobes by a rounded sinus that

extends two-fifths the way to midrib; upper pair of lobes, obtuse, oblique to long axis of leaf, subrhombic, separated at apex by an open-angled (about 80 degrees) sinus. Midrib, straight, about 2 mm. wide in lower half of leaf, decreasing to half that width at apex. Secondaries, about 8 pairs, the upper ones alternate, lowermost 2 or 3 pairs subopposite, the basal pair parallel to the lower margin at right angles to midrib, the remainder at very open angles, mostly slightly curved distally as if camptodromous close to margin, but not visible in this region in single specimen to hand. Tertiaries, not preserved.

Remarks. No differences, likely to be of specific importance, separate Dawson's species from *Liriodendron giganteum* Lesquereux (1868, p. 99; 1874, p. 93, Pl. 22, fig. 2; 1892, p. 206, Pl. 25, fig. 1; Pl. 26, fig. 5; Pl. 28, fig. 1).

Occurrence. Extension formation, locality 1304.

Types. Hypotype, G.S.C. No. 5669 (holotype of *Liriodendron praetulipiferum* Dawson).

Liriodendron succedens Dawson

Plate XXXIV, figures 2, 4, 5

Liriodendron succedens Dawson, Roy. Soc. Canada, Trans. 1893, vol. 11, sec. 4, p. 62, Pl. 8, fig. 26 (1894).

Remarks. Dawson's type specimen G.S.C. No. 5692 (Plate XXXIV, fig. 4), is seemingly a young leaf. It has a cuneate base, a pair of high-shouldered rounded, basal lobes and a bluntly pointed, ovate, apical lobe. The midrib is slender, secondaries all brachiodromous or camptodromous, and percurrent tertiaries mainly simple and transverse or openly oblique to the secondaries and midrib.

Two fragments of large leaves from the Comox area, owing to the shape of the apical lobe that is preserved in one of them, are considered to belong to this species. In one, G.S.C. No. 6440 (Pl. XXXIV, fig. 2), which has an apex much like that of specimen No. 5692, only a small upper part of a lobe is seen below the apical region; it is assumed to belong to a basal lobe; the secondaries in the upper lobe are in part at least brachiodromous. The other specimen G.S.C. No. 6441 (Pl. XXXIV, fig. 5), has a midrib about 3 mm. wide; parts of two lobes, presumably basal ones, are shown as well as a lower part of what could be an apical lobe, but which is more probably the base of another pair of lateral lobes, to judge from the size of the midrib, and, if so, it is possible that No. 6441 is only a basal part of the same leaf as No. 6440, both having the appearance of being derived from the same bed. The basal lobes in No. 6441 are at an angle of 70 degrees to the midrib, and are fed by four principal, probably craspedodromous, secondaries from the midrib. Additional thin secondaries (or tertiaries) in the area of the sinus loop together and send off a branch to each side of the sinus. Both simple and divided tertiaries connect the principal secondaries, and tertiaries from the secondaries loop together within the margin.

The outline of the apical lobe recalls that of *Liriodendron semialatum* Lesquereux (1892, Pl. 25, figs. 2, 3; Pl. 29, fig. 3) to which described species *L. succedens* seems to be most closely allied.

Occurrence. Port McNeill, locality 3240; Comox formation, locality 3768.

Types. Holotype, G.S.C. No. 5692; hypotypes, G.S.C. Nos. 6440, 6441.

Cinnamomum trinervis (Dawson) n. comb.

Plate XXXIII, figures 2-4

Macclintockia trinervis Dawson (non Heer), Roy. Soc. Canada, Trans. 1893, vol. 11, sec. 4, p. 64, Pl. 10, fig. 38 (1894).

Description. Petiole, unknown. Blade, coriaceous, entire, lanceolate, probably 9 or 10 cm. long by 2.3 cm. wide; apex, seemingly acuminate, and base cuneate. Venation, trinerved. Midvein rather delicate, straight. Lateral primaries, slightly supra-basal, opposite, inserted about 20 degrees to midrib, slightly curved inwards so as to be nearly parallel with midvein about half-way between it and margin, reaching well into apical region, but terminations unknown. These lateral primaries are nearly as strong as the midrib, and are provided with camptodromous branches, which distally ascend parallel with, and close to, margin so as to join secondaries above, giving appearance of sub-marginal veins. Secondaries from midrib, lacking. Tertiaries obscure, but seemingly mainly percurrent and moderately spaced.

Remarks. The species is apparently close to, if not conspecific with *Cinnamomum middendorffensis* Berry (1914, p. 55, Pl. 8, fig. 14; Pl. 9, fig. 1). Dawson's figure 38 of above reference seemingly reproduces parts of a single specimen, although actually two specimens are represented.

Cinnamomum sezannense Heer pars (non Watelet) (1883, Pl. 61, fig. 1a) in the writer's opinion is probably conspecific with *Cinnamomoides trinervis* (Dawson) and not with *Cinnamomum newberryi* Berry, the latter species having secondaries in the upper half of the leaf. *Daphnogene cocculoides* Hollick (1930, Pl. 45, fig. 5) is probably also conspecific with Dawson's species.

Occurrence. Port McNeill, locality 3240; Comox formation, locality 3038.

Types. G.S.C. syntypes, Nos. 5690, 5691 (syntypes of *Macclintockia trinervis* Dawson, non Heer); hypotype, G.S.C. No. 599.

Cinnamomoides buckhami n. sp.

Plate XXXV, figure 1

Cinnamomum sezannense Dawson (non Watelet), Roy. Soc. Canada, Trans. 1893, vol. 11, sec. 4, p. 64, Pl. 13, fig. 58 (1894).

Description. Leaf blade, elliptical-acuminate, entire, coriaceous; extreme base and petiole unknown. Lateral primaries, nearly as strong as rather slender midrib, camptodromous, curving gently inwards, highly

ascending and traceable to near the margin to upper third of leaf; no regular ascending branches on their abaxial sides, but irregularly looping tertiaries. Secondaries, about three pairs, alternate to subopposite, restricted to upper half of leaf, camptodromous, disappearing in tertiary network very close to margin. Tertiaries, closely spaced, resembling those of *Zizyphus*, trending nearly at right angles to long axis of leaf, simple and once divided in middle region of leaf, more inosculating and irregular on outer side of lateral primaries.

Remarks. The above description is based on the single leaf from Nanaimo that formed the basis of Dawson's type of above reference. The leaf is apparently more coriaceous than *Laurophyllum insigne* Dawson, has a thinner midrib and fewer secondaries, which occur in a more apical position. The tertiary venation, however, is similar, and it is possible that the species is only a variant of *Laurophyllum insigne*.

Superficially the specimen resembles some illustrated leaves of *Cinnamomum newberryi* Berry, differing, however, in the lack of a series of regular, ascending branches from the abaxial side of the lateral primaries.

The species is named after A. F. Buckham, who has contributed to knowledge of the stratigraphy of the Comox and Nanaimo coalfields.

Occurrence. Extension formation, locality 3239.

Types. G.S.C. No. 5670 (holotype of *Cinnamomum sezannense* Dawson, non Watelet).

Laurus asiminoides ? Berry

Plate XXXVI, figure 4

Proteoides sp. Dawson, Roy. Soc. Canada, Trans. 1893, vol. 11, sec. 4, p. 61, Pl. 13, fig. 55 (1894).

Remarks. A single fragment of a basal part of a coriaceous, lauraceous leaf, characterized by a very stout, irregularly striated midrib (2 mm. broad), a pair of strongly ascending basal veins attached about 30 degrees to midrib, and rather remote, opposite or subopposite secondaries attached at much broader angles (about 50 degrees). The last mentioned curve upwards in their course, and are apparently camptodromous, although their distal ends are not preserved. No tertiary veins are discernible.

The species differs from *Laurus eocenica* ? Knowlton (non Lesquereux) (Knowlton, 1900, Pl. 14, fig. 3) in its more remote and more spreading secondaries, and in the stronger midvein. In the character of the secondaries it approaches much more closely *Laurus asiminoides* Berry (1925, Pl. 18, figs. 1, 2), which Berry considered conspecific with Knowlton's species.

Occurrence. Port McNeill, locality 3240.

Types. Hypotype (?) G.S.C. No. 5646 (type of *Proteoides* sp. Dawson).

Laurophyllum insigne Dawson

Plate XXXVI, figures 1, 2; Plate XXXVII, figure 1; Plate LXV, figure 3

Laurophyllum insigne Dawson, Roy. Soc. Canada, Trans. 1893, vol. 11, sec. 4, p. 61, Pl. 7, figs. 23, 25 (1894).

Description. Leaf, entire, with rather thick petiole of unknown length. Blade, up to 10 or 12 cm. long by 3 or 3.5 cm. broad, elongated, ovate-acuminate, rounded at base to short, cuneate insertion on petiole, acuminate contracted to long pointed apex, which is commonly deflected. Venation, trinerved-pinnate. Midvein, flat, relatively broad in lower half of leaf, thinning rapidly in apical region, nearly straight or slightly curved. Secondaries, 5 or 6 pairs, considerably thinner than midrib, the lowest pair simulating lateral primaries, opposite and slightly supra-basal, strongly ascending generally to upper half of leaf, where they disappear in tertiary network close to margin. The outer sides of these primary laterals give off no regular series of ascending branches; a thin, short basal pair of veins may lie below them, and ascend close to margin. Remaining secondaries, mainly alternate, attached 30 to 40 degrees to midrib, curving inwards and highly ascending, disappearing close to margin in tertiary network. Tertiaries, thin, rather closely spaced, those in part of leaf, percurrent, simple or once divided, transverse to long axis of leaf; tertiaries on outside of primary laterals more inosculating, some appearing as inconspicuous branches to these laterals, which originate at right angles, then abruptly curve upwards within or close to margin to meet tertiaries above, the whole forming an irregular network.

Remarks. The pattern of venation suggests *Litsea* or *Ocotea* rather than *Cinnamomum*.

Occurrence. Port McNeill, locality 3240.

Types. Syntypes, G.S.C. Nos. 6424, 5675; hypotypes, G.S.C. Nos. 681, 6425.

Capparites sp.

Plate XXXVIII, figure 3 (upper left)

Description. Leaf blade, coriaceous, elliptical with broadly cuneate base and rounded at summit to medial sinus, 7.5 cm. long by 5.5 cm. broad. Midrib, moderately stout. Secondaries, obscurely preserved, at least 5 alternate pairs, inserted 50 to 70 degrees to midrib, seemingly looping together well within margin. Tertiaries, not preserved.

Remarks. The size of leaf and rather stout midrib resemble more closely *Capparites cynophylloides* Berry (1919, p. 95, Pl. 22, fig. 1) than species of *Dalbergites* in which the secondaries are more crowded and more highly ascending. The details of venation are too obscure for adequate comparison with described fossil species.

Occurrence. Extension formation, locality 4210.

Types. G.S.C. specimen No. 6487.

Philadelphus normalis n. sp.

Plate XXXIX, figure 6; Plate XL, figure 4

Description. Leaf, petiolulate, the petiole where preserved on one specimen being 3 mm. long and curved. Blade, ovate, with broadly rounded or rounded-truncate base and abruptly pointed apex; margin, entire at base, serrulate above, the shallow teeth being moderately spaced or more remote, sharp and upwardly pointed. Midvein, moderately strong; secondaries, 4 or 5 pairs, the two basal pair close together, opposite or subopposite, and only slightly supra-basal, imparting a pseudo-palmate appearance, strongly curved upwards, camptodromous, and united by a tertiary or tertiaries within margin of upper half of leaf; remaining secondaries, distant, alternate to subopposite, curved, highly ascending, camptodromous like the basal pair. Tertiaries, where preserved, simple, percurrent, at right angles to secondaries.

Remarks. The leaves may be compared with those of the living *Philadelphus latifolius* and *P. insignis*. Although the genus to the writer's knowledge has not hitherto been reported from Cretaceous deposits, the identification of the material seems justified in view of the characteristic dentition, leaf form, and peculiarities of the basal venation.

Occurrence. Protection formation, locality 3858; Port McNeill, locality 3240.

Types. Holotype, G.S.C. No. 6500; paratype, G.S.C. No. 6501.

Platanus affinis Lesquereux 1873 (non *Cissites* Lesquereux 1876)

Plate XXXVII, figure 5; Plate XXXIX, figures 1, 4, 5; Plate XLII, figure 6

? *Populus rhomboidea* Lesquereux, Am. J. Sci., 2nd ser., vol. 27, p. 360 (1859).

Platanus primaeva ? Dawson (non Lesquereux) Roy. Soc. Canada, Trans. 1893, vol. 11, sec. 4, p. 59, Pl. 8, fig. 29 (1894).

Description. Leaves, petiolate. Petiole, moderately stout, of unknown length, but over 2.5 cm. in some specimens. Blade, subrhombic or sub-orbicular, up to 12 cm. long and 11 cm. wide, longer than wide or wider than long, with base broadly or narrowly cuneate, or cuneate and decurrent on petiole, or truncate to broadly rounded. Margin, entire for variable distance in basal part of leaf, the remainder provided with shallow, broadly triangular teeth, with almost inconspicuous, upwardly directed, possibly glandular tips. Midvein, moderately stout. Venation, trinerved-pinnate with primary laterals basal or more commonly supra-basal, less strong than midrib, to which they are attached at angles of 30 to 45 degrees, opposite or offset, nearly straight, or curving gently upwards, meeting margin about mid-length or more, craspedodromous, provided with 4 to 6 pairs abaxial, nearly straight or slightly upwardly curved branches; these branches may be simple or have one or two subordinate branches on their lower sides which may be camptodromous (when margin is entire) or

enter teeth. Remaining secondaries, 3 or 4 pairs, alternate or subopposite, parallel with primary laterals, craspedodromous, simple, or with one or two short, distal, abaxial branches; the spaces along midrib between secondaries may be roughly equal or may vary. Where primary laterals are supra-basal a pair of thin basal veins may lie below them, and run about parallel with margin for varying distance. Tertiary veins, percurrent, generally bowed, mixed simple and once divided, nearly at right angles, or more commonly openly oblique to secondaries and midrib. Nervilles, not preserved.

Remarks. It is possible that the largest leaves included here in *Platanus affinis* belong to a separate species, but in the 15 specimens to hand the outline of base, size of leaf, and position of the primary laterals did not afford satisfactory criteria for consideration of more than one species. The margin, too, may be shallowly serrate, or almost smooth owing to the teeth being exceedingly small and inconspicuous. Similar fossil leaves have been assigned variously to *Populites*, *Cissites*, *Platanus* and even *Credneria* e.g. *Populites vitiformis* Hollick (1930, Pl. 34, figs. 3-4), *Credneria grewiopoides* Hollick (1930, Pl. 52, fig. 3; Pl. 53, fig. 1) and *Platanus heeri* Hollick (1930, Pl. 55, fig. 2). Although proof is lacking that *Platanus affinis* Lesquereux is actually a *Platanus* and not a member of the Vitaceae, the common supra-basal origin of the lateral primaries and common decurrence of the blade on the petiole favours *Platanus*. At any rate the species bears little resemblance to *Cissites insignis* Heer (1867, Pl. 2, fig. 4) on which *Cissites* was based, and the resemblance to commonly trilobed species of *Platanus* e.g. *Platanus heeri* Lesquereux (1874, Pl. 8, fig. 4; Pl. 9, figs. 1-2) and *Platanus newberryana* Heer pars (Heer 1883, Pl. 59, figs. 1-3) is close. A. C. Seward (1927, p. 128) considered *Platanus affinis* Heer from Patoot beds to be conspecific with Greenland specimens Heer assigned to *Platanus* ? *newberryana*. The type of *Platanus* ? *newberryana* Heer (1867, Pl. 1, fig. 4) from the Dakota was too fragmentary for specific diagnosis. The writer prefers to separate the Greenland *Platanus newberryana* from *Platanus affinis*, owing to the common occurrence of trilobed forms, and to the more closely spaced, straighter and more ascending secondaries, which gives the venation a more *Viburnum*-like appearance.

Populus rhomboidea Lesquereux from Nanaimo may well be conspecific with *Populus affinis*, and, if so, would have priority, but the original description, unaccompanied by a figure, is too meagre for recognition of the species. Of the specimens from the Puget Sound group that Newberry (1898, Pl. 20, figs. 1, 2) assigned to *Populus rhomboidea*, neither can unquestionably be referred to *Platanus affinis*.

Occurrence. Extension formation, localities 1304, 4210; Protection formation, localities 3826, 3858; Newcastle formation, locality 1721; Comox formation, localities 1722, 3032, 3036, 3768.

Types. Hypotypes, G.S.C. Nos. 544, 5685 (type of *Platanus primaeva* ? Dawson, non Lesquereux), 6513, 6444, 6556.

Platanus nanaimo (Dawson) n. comb.

Plate XL, figure 5

Protophyllum nanaimo Dawson, Roy. Soc. Canada, Trans. 1882-83, vol. 1, sec. 4, p. 28, Pl. 8, fig. 35 (1883).

Remarks. The type of this species shows a very small part of the margin too obscurely to be certain of its characters. The specimen was, accordingly, too fragmentary to be worthy of specific recognition. It has a platanoid venation and the parts of the primary laterals and secondaries preserved suggest *Platanus* rather than *Protophyllum*.

Occurrence. Comox formation, locality 1576.

Types. Holotype, G.S.C. No. 5637.

Chrysobalanus nervillosus n. sp.

Plate XXXVI, figure 3; Plate XXXVII, figures 2-4; Plate XXXVIII, figures 1, 2; Plate XXXIX, figure 3; Plate XLI, figures 1, 2

Description. Leaf, coriaceous, entire, petiolate, elliptical, about 7 cm. long by 3 or 4 cm. broad. Petiole, about 2.5 cm. long by 1.5 mm. broad, striated. Apex of leaf, narrowly to rather broadly rounded; base cuneate. Midrib, stout in lower half, commonly thin in apical region. Secondaries, seven or eight pairs, alternate, thin, sub-immersed and commonly obscure, making angles of 45 to 55 degrees with midrib, curving upwards and simply looped near margin. Tertiaries, not readily differentiated from a microscopically coarse, well defined network of nervilles, partly comprising areolae elongated subparallel with secondaries, and enclosing by means of transverse connections a band of minute quadrangular cells.

Remarks. The most characteristic feature of the venation under a hand lens is the outstanding network of nervilles in contrast to the obscure secondaries. This venation is comparable in many respects with that of the living *Chrysobalanus oblongifolius* Michaux. Although the leaves to hand are admittedly not very satisfactory for specific designation, the venation is so characteristic that the species should be readily identifiable.

Occurrence. Port McNeill, locality 3240; Protection formation, locality 3858; Comox formation, locality 3768.

Types. Holotype, G.S.C. No. 626; paratypes, G.S.C. Nos. 627, 642, 643, 645, 650, 5642, 6541, 6552.

Pyrus sp.

Plate XL, figure 1; Plate XLI, figure 3

Remarks. Leaf, compound, odd-pinnate; terminal leaflet, larger than the laterals, about 6 cm. long by 2.5 cm. broad, equilateral, acuminate. Lateral leaflets, 4 cm. long by 1.3 cm. broad, inequilateral, oblong-lanceolate, contracting rather abruptly to acute apex, sessile or possibly with very

short petiole; one side of base rounded, other obliquely truncate; margin of leaflets, simply serrulate to near base. Midvein, slender; secondaries, obscure, seemingly simple and craspedodromous.

The single incomplete specimen to hand shows only one lateral leaflet, so it is not definitely known whether leaflets were opposite.

Occurrence. Protection formation, locality 3826.

Types. G.S.C. No. 6523.

Bauhinia ? gigantea Newberry

Plate XLIII, figures 2, 3

Remarks. Two fragments from Comox add little to Newberry's description of a fragment upon which the type was based (Newberry, 1895, p. 93, Pl. 20, fig. 1), except that one shows a somewhat flexuous, basal secondary, which gives off 5 or 6 openly oblique branches that are looped together well within the margin. The leaflets or lobes are large, markedly asymmetrical, elongate, presumably about 18 cm. long by 6 or 8 cm. broad; margins, undulate. Midrib, strong. Secondaries, 5 or 6 on external larger part of lobe, camptodromous close to margin or irregularly looping within margin. Total number of secondaries on internal part of lobe unknown. Only a few tertiaries are preserved, mostly oblique to the secondaries, and simply bowed or irregularly branching.

Occurrence. Comox formation, locality 3768.

Types. Hypotypes, G.S.C. Nos. 6453, 6454.

Dalbergites borealis (Heer) Seward

Plate XXXIX, figure 2

Description. Leaflet, small, elliptical, with acute apex and probably cuneate base, about 6 cm. long by 3 cm. wide. Margin, entire. Midrib, prominent, but rather thin. Secondaries, thin, numerous, about 65 to 70 degrees to midrib, nearly straight, but distally near margin branching or merging with tertiaries. Tertiaries, thin but making a prominent, close network of irregular angular areolae, elongated parallel to, or making acute angles with secondaries.

Remarks. A single leaf from the Nanaimo coalfield has extreme tip and base missing, but shows clearly the characteristic venation of the species, as illustrated by Heer (1874, Pl. 32, fig. 23b), and by Seward (1927, p. 135, text-fig. 33).

Occurrence. Extension formation, locality 3239.

Types. Hypotype, G.S.C. No. 650.

Leguminosites rhamnifolioides n. sp.

Plate XXXVIII, figure 3 pars; Plate XL, figure 3;
Plate XLII, figures 3, 4

Description. Leaflets, petiolulate, entire, sub-elliptical; lateral ones with broadly rounded or inequilaterally truncate base and rather abruptly contracted to short acuminate apex; terminal (?) leaflet, petiolate, with nearly equilateral cuneate base. Midvein, straight or slightly curved, in strong relief, but rather slender. Secondaries, 5 or 6 pairs, opposite to alternate, arising 35 to 50 degrees to midrib, strongly ascending, inwardly curved, camptodromous close to margin. Tertiaries, mostly obscured, where seen, simple, percurrent, nearly transverse to long axis of leaf.

Remarks. Most of the specimens are inequilateral, suggesting leaflets rather than leaves. They resemble those of *Leguminosites dakotensis* Lesquereux (1892, Pl. 38, fig. 5), but the secondaries are camptodromous close to margin, without clear indication of looping, and the tertiaries, where preserved are more nearly at right angles to the long axis of a leaflet.

Occurrence. Comox formation, locality 1576; Extension formation, localities 1304, 4210; Protection formation, locality 3858.

Types. Holotype, G.S.C. No. 6488; paratypes, G.S.C. Nos. 563, 564, 565.

Leguminosites probalsamifera (Dawson) n. comb.

Plate XL, figure 2; Plate XLII, figures 1, 2, 7

Populites probalsamifera Dawson, Roy. Soc. Canada, Trans. 1893, vol. 11, sec. 4, p. 57, Pl. 7, fig. 23 (1893).

Remarks. The specimen (Pl. XLII, fig. 1) on which Dawson based his species is too fragmentary to serve as an adequate type. Only about three-fourths of a leaflet is preserved, and the narrower side is inrolled to some extent. The leaflet is asymmetrically ovate, acutely or apparently acuminate pointed; base, unknown, but seemingly was broadly rounded on one side. Midrib, slender, standing in relief. Secondaries, about 6 pairs, very slender, alternate, camptodromous, leaving midrib at angle of 30 to 45 degrees, nearly straight proximally, but distally curving abruptly upwards to meet secondaries next above near margin. The lowest pair of secondaries, as revealed on one side, have 3 or 4 camptodromous, seemingly looped, branches on lower side. A few of the tertiaries that are preserved, are simple or once divided and transverse to secondaries, but others are nearly at right angles to long axis of leaf.

The part of leaflet preserved resembles *Phaseolites coloradensis* Knowlton (1930, p. 97, Pl. 45, fig. 1), except that the apex was probably acuminate and more like that of *Leguminosites phaseolatus* Lesquereux (non Heer) (Lesquereux, 1892, Pl. 55, fig. 10).

Occurrence. Port McNeill, locality 3240; Comox formation, locality 3038 (= 3034).

Types. Holotype, G.S.C. No. 5641; hypotypes, G.S.C. Nos. 603, 604, 640.

Leguminosites (*Cassia* ?) sp.

Plate XLII, figure 5

Remarks. The single specimen lacks the basal point of attachment, and consequently is considered scarcely adequate for specific designation. It is apparently an imprint of a leaflet, seemingly membranaceous, inequilateral, asymmetrically elliptical, widest near middle on one side and above the middle on the other, about 5 cm. long by 2.7 cm. wide, bluntly pointed at apex, cuneate towards base, with margin entire. Midrib, slightly curved, stout in basal part of leaf, thinning to apex. Secondaries, about 10 pairs, subopposite, 40 to 45 degrees to midrib on one side and about 60 degrees on other, looping well within the margin and with additional peripheral loops. Tertiaries not preserved.

The species resembles in form and secondary venation *Sapindus couchatta* Berry (1916, Pl. 65, fig. 5) from the Wilcox group. Berry, however, stated that the leaflet of his species was coriaceous. Possibly the Vancouver Island species is conspecific with *Salix hayei* Lesquereux (1892, Pl. 3, fig. 7), but until specimens are found proving it to be petiolulate, this must remain doubtful.

Occurrence. Port McNeill, locality 3240.

Types. G.S.C. No. 6543.

Phaseolites manhassetensis Hollick

Plate XLIII, figure 1; Plate XLIV, figures 3, 4

Juglandites ? sp. Dawson, Roy. Soc. Canada, Trans. 1892, vol. 11, p. 59, Pl. 10, fig. 43; Pl. 13, fig. 56 (1893).

Original description. "Leaf about 7.5 cm. long, including a petiole of 6 mm., entire, inequilateral, slightly falcate, one side abruptly rounded and broadest at the base and curving to the apex, the other side broadest at about the middle and tapering unequally to the base and apex; midrib slightly flexuous and curved towards the narrow or concave side of the leaf; secondaries irregularly disposed, diverging from the midrib at varying, acute angles, subparallel, curved upwards and camptodrome near the margin" (Hollick, 1904, p. 414).

Remarks. Three detached leaves from Port McNeill agree very closely with Hollick's figures (op. cit., Pl. 78, figs. 1, 2); the convex side, however, is more uniformly curved and is broadest near the middle. The midvein is stout; secondaries about 10 pairs, 35 to 50 degrees to midrib, camptodromous, their distal extremities, which lie close to margin, and the tertiaries not preserved. Heer's figured specimens of *Dalbergia rinkiana* (Heer, 1882, Pl. 26, figs. 1, 2) are too fragmentary to indicate whether Hollick's species is conspecific.

Occurrence. Port McNeill, locality 3240.

Types. Hypotypes, G.S.C. Nos. 560 (*Juglandites* ? sp. Dawson), 561, 628.

Celastrinites wardii (Knowlton) n. comb.

Plate XLIV, figure 2; Plate XLV, figures 2, 5; Plate XLVI, figure 4

Description. Leaves, petiolate; blade, elliptical-cuneate, the largest about 15 cm. long by 6.5 cm. wide, with base more or less broadly cuneate, and apex acute or acuminate. Margin, entire in basal region, serrate above, the teeth being short, broadly triangular, mainly directed outwards, separated by shallow asymmetric sinuses. Midrib, stout in lower half, gradually thinning to apex. Secondaries, 8 or 9 pairs, alternate or sub-opposite, mainly camptodromous, inclined in a few specimens about 40 degrees to midrib, but more generally at 50 to 70 degrees, or in basal part of leaf almost at right angles; the basal pair are short; several pairs near them are closer together and more spreading than those more remote; they curve upwards distally and may loop together by tertiary branches well within the margin, or be united more irregularly by bent tertiaries; short branches from these tertiary connections enter the teeth, although in upper part some secondaries may be craspedodromous. Remaining tertiaries, mainly simple and percurrent, nearly at right angles or somewhat oblique to secondaries.

Remarks. The leaves of the closely related *Celastrinites insignis* (Heer) Bell (1949, p. 71) are so variable in form of base that Knowlton's statement that the leaves of his *Pterospermites wardii* (Knowlton, 1900, p. 66, Pl. 15, fig. 4; Pl. 16, fig. 1) were regularly rounded at base does not preclude allocating the above-described forms to his species. Actually both of Knowlton's types have the extreme base missing. The leaves are more elliptical than those of *Celastrinites insignis*, which generally have their greatest width below the middle, and the transverse tertiaries of *C. insignis* are commonly divided.

Occurrence. Protection formation, localities 3826, 3858; Extension formation, localities 3771; Port McNeill, locality 3240.

Types. Hypotypes, G.S.C. Nos. 6477, 6496, 6499, 6512.

Celastrophyllum perryi Berry

Plate XLV, figure 1

Remarks. The species is represented in collections from Vancouver Island by a middle part only of what was an entire, apparently elliptical leaf. The leaf substance was thin, and the midrib, which is fairly stout, stands out in relief. The secondaries are rather remote, unevenly spaced, arise about 45 degrees to midrib, ascend strongly and commonly abruptly in their outer half, and are united well within the margin by tertiaries that form a series of loops. The remaining tertiaries are broken and form a loose, irregular network of areoles between the secondaries.

The pattern of nervation agrees so closely with that of the type (Berry, 1925, p. 65, Pl. 12, fig. 12) that little doubt exists as to correct identification. The allocation of the species to *Celastrophyllum*, however, is questionable, but for want of a better is permitted to stand, although the venation

resembles fairly closely that of some living species of *Calycanthus*. A smaller leaf, *Diospyros judithae* Knowlton (1905, p. 146, Pl. 18, figs. 4, 5; Pl. 19, fig. 3), shows a somewhat similar venation, although the lowermost two or three pairs of secondaries, being much closer together than the succeeding ones, give it a distinctive appearance.

Occurrence. Protection formation, locality 3858.

Types. Hypotype, G.S.C. No. 6514.

Staphylea usheri n. sp.

Plate XLV, figures 3, 4, 6

Description. Leaflets (?), petiolate, with petiole up to 5 cm. long, more or less curved, oblong-ovate, about twice as long as wide, with broadly rounded or truncate, inequilateral base and abruptly pointed or acuminate apex. Margin, entire at base, creno-serrulate or crenoserrate above. Midrib, moderately strong, nearly straight or slightly curved or flexuous. Secondaries, 10 to 12 pairs, subopposite or alternate, inserted 55 to 90 degrees to midrib, more closely spaced in lower part of leaf, camptodromous, distal half curved upwards and apparently looping with secondaries next above; rare, short, intermediate secondaries occur. Tertiaries, obscurely preserved, but a few form looped, distal, abaxial branches to the secondaries, whereas others are simple and transversely percurrent.

Remarks. The asymmetry of the base of these forms suggests that they are leaflets, and not members of the Celastraceae. Compared to other families of the Sapindales they most resemble members of the Staphyleaceae, and are very much like the Tertiary leaflets referred by Lesquereux (1878, p. 267, Pl. 48, figs. 4, 5) to *Staphylea acuminata*, differing mainly in the submucronate or acuminose, rather than acuminate apex, and thereby approaching closer to the form of the living *Staphylea trifolia* or of *S. bolanderi*. The species is named after its collector, Dr. J. L. Usher.

Occurrence. Protection formation, localities 3826, 3858.

Types. Holotype, G.S.C. No. 6531; paratypes, G.S.C. Nos. 541, 542.

Acer sp.

Plate LIV, figure 3

Description. Leaflet (?) elliptical-lanceolate, with acuminate tip and narrow, cuneate base, slightly inequilateral and trilobate. Margin, irregularly serrate. Midrib, pronounced, not quite straight. Secondaries, rather thin, probably about 7 pairs, alternate to subopposite, craspedodromous, arising 30 to 35 degrees to midrib, subparallel, but irregularly curved, seemingly provided with one to three abaxial craspedodromous branches which enter teeth. Tertiaries, mostly not preserved; some connect with midrib at open angles.

Remarks. The generic allocation of this species is not certain, but it resembles some members of the group of *Acer negundo* e.g. the living *Acer negundo* var. *interius* (Britton) Sargent, and the Tertiary species *Acer negundoides* Lamotte (= *Acer crataegifolium*) (LaMotte 1936, Pl. 12, fig. 4).

Occurrence. Comox formation, locality 3035.

Types. G.S.C. No. 588.

Cupanites crenularis n. sp.

Plate L, figures 2, 3, 7; Plate LI, figures 2, 3; Plate LII, figures 2-4; Plate LIII, figure 2; Plate LV, figure 6

Description. Leaf compound, odd-pinnate. Leaflets, elongate-elliptical, petiolulate, the terminal one, however, having a longer petiole or naked stipe. Lateral leaflets, inequilateral, particularly at base where one side is rounded or broadly cuneate, whereas other is narrowly cuneate; apex, gradually narrowed to an acuminate tip; margins, entire at base, mammillate-serrate to mammillate-cuspidate above, with points or cusps turned upwards. Largest leaflets up to 4 cm. or more broad by 15 cm. or more long. Midrib, prominent, commonly slightly curved. Secondaries, up to 10 or more alternate pairs, irregularly spaced, moderately strong proximally, thin distally, inserted 40 to 60 degrees to midrib, curving gently, although not uniformly upwards to enter teeth, or in some instances divided near base of a tooth, one short branch entering tooth and other longer one running camptodromously close to margin; rarely a branch from a secondary enters a tooth, or where no tooth occurs runs camptodromously. Tertiaries, mainly divided, some transverse or oblique to secondaries, others subparallel to the secondaries, forming a loose irregular network containing nervilles mainly transverse to them, and enclosing a finer network of quadrangular or polygonal areolae.

Remarks. It is questionable to which living genus of Sapindaceae this species is most closely related. It resembles in some respects Tertiary fossil species that have been assigned to *Koelreuteria*, *Cupania*, *Cupanites* or *Allophylus*. The distant and commonly irregular spacing of mammillate-cuspidate teeth resemble those of *Allophylus wilsoni* Chaney and Sanborn (1933, Pl. 24, figs. 1-4, 6). The leaflets, however, are more elongate-elliptical in outline and taper much more gradually to the apex.

Ternstroemites cretaceus Berry (1925, Pl. 16, fig. 2) from the Ripley formation, as figured, is slightly inequilateral and its form, together with its rather remote and mammillate-crenulate teeth, which are slightly cuspidate, are comparable to the Canadian leaflets, but the secondaries are stated to be brachiodromous.

Occurrence. Comox formation, locality 3768.

Types. Holotype, G.S.C. No. 682; paratypes, G.S.C. Nos. 665, 6415, 6432-6436, 6438, 6439.

Koelreuteria prenigricans n. sp.

Plate LI, figure 1; Plate LIV, figure 2; Plate LV, figures 1, 4, 7

Description. Leaf, compound, odd-pinnate. Leaflets, opposite, elongate-lanceolate, petiolulate, cuneate at base and perhaps acuminate at apex, up to 15 mm. or more wide, of unknown length but up to 8 cm. or more, commonly inequilateral. Margin, entire for short distance from base, crenate-serrate above, the teeth separated by asymmetrical, shallow sinuses. Midrib, pronounced, of moderate thickness. Main secondaries, fairly numerous, up to 10 alternate or subopposite pairs, craspedodromous to teeth, arising 40 to 50 degrees to midrib, distally curving gently upwards; other secondaries are more obscure, although one enters lower part of a crenate tooth and is camptodromous close to margin. Tertiary venation, obscure, although a few transverse to the secondaries are preserved, and in general there is a fine network of nervilles.

Remarks. The species resembles *Rhus obscura* (Lesquereux) MacGinitie (1953, Pl. 54, fig. 1) from the Florissant Tertiary beds, except for its more crenate teeth, which are much like those found in some forms of *Koelreuteria nigricans* (Lesquereux) Brown, (Brown, 1934, Pl. 11, figs. 1-4), although the outline of leaf is more rectangular than in that species.

Occurrence. Comox formation, localities 3035, 3038.

Types. Holotype, G.S.C. No. 592; paratypes, G.S.C. Nos. 589, 593, 594, 602.

Sapindus pacificus (Dawson) n. comb.

Plate L, figures 1, 4, 6; Plate LII, figure 1; Plate LIII, figures 1, 3-5;
Plate LIV, figures 1, 5

Salix pacifica Dawson, Roy. Soc. Canada, Trans. 1882-83, vol. 1, sec. 4, p. 26, Pl. 7, fig. 24 (1883).

Description. Leaf, compound, odd-pinnate. Leaflets, entire, coriaceous, those near apex at least, opposite, elongate, acuminate-lanceolate, straight or slightly curved, more rarely sub-falcate, sessile or petiolulate, generally with narrowed cuneate base and acuminate to acute apex, rarely rounded at base; the lateral leaflets are slightly inequilateral, more so at base. Midvein, strong. Secondaries, thin, commonly not preserved or only obscurely, leaving midrib at angle of 40 to 90 degrees, camptodromous, distally curving upwards more or less abruptly well within the margin, and united by transverse tertiaries that form a single series of quadrangular loops or those in apical region of leaf united by a single loop. Tertiaries, commonly not preserved, in mid-region transverse to middle, elsewhere transverse to secondaries, some simple and percurrent, others divided, enclosing a close network of irregular nervilles.

Remarks. The specimen that formed Dawson's type is inadequate for specific diagnosis, revealing no veins except the midrib; it is comparable in form to leaves named *Eugenia ? anceps* by Berry (1919, p. 125, Pl. 32, figs. 3-5) from the Ripley formation. However, at Comox, leaves like Dawson's type are undoubtedly Sapindaceous. The best of these, G.S.C.

No. 6414 (Pl. LIII, fig. 5) is the apex of a compound leaf; the pair of lateral leaflets are sessile, but a few associated detached leaflets from the same bed have short, stout petioles. The largest leaflet observed is 3.5 cm. broad, and others are at least 12 cm. long.

The tertiary venation resembles that of the living *Sapindus drummondii* Hooker and Arnott, which grows in southwestern United States and northern Mexico. The venation of G.S.C. No. 641 resembles also that of *Juglans laurifolia* Knowlton (1899, Pl. 83, figs. 2, 3), which has, however, a remotely denticulate margin; it may also be compared with the venation of some species referred to *Anona* (e.g. *Anona wilcoxensis* Berry 1916, Pl. 41, figs. 1, 2).

The relation between *Sapindus pacificus* and *Sapindus morrisoni* Lesquereux (1883, Pl. 16, figs. 1, 2) from the Dakota group is doubtful. The latter species has alternately arranged leaflets of like form, but nothing is known of its tertiary venation.

Occurrence. Comox formation, localities 1576, 1722, 3032, 3768; Protection formation, localities 3826, 3858.

Types. Holotype, G.S.C. No. 5629 (*Salix pacifica* Dawson); hypotypes, G.S.C. Nos. 566, 567, 568, 569, 641, 644, 648, 6414, 6416, 6417, 6557.

Rhamnites eminens (Dawson) n. comb.

Plate XLIV, figure 1; Plate XLVI, figures 1-3, 5; Plate XLVII, figures 1-5; Plate XLVIII, figures 1-5; Plate XLIX, figures 1-4; Plate L, figure 5; Plate LVI, figure 5

? *Quercus benzoin* Lesquereux, Am. J. Sci. 1859, 2nd ser., vol. 27, p. 360 (1859).

Quercus victoriae Dawson, Roy. Soc. Canada, Trans. 1882-83, vol. 1, sec. 4, p. 27, Pl. 7, fig. 28 (1883); *ibid.*, Trans. 1893, vol. 11, sec. 4, p. 59 (1894).

Diospyros vancouverensis Dawson, Roy. Soc. Canada, Trans. 1882-83, vol. 1, sec. 4, p. 29, Pl. 8, fig. 32 (1883).

Salix sp. Dawson, Roy. Soc. Canada, Trans. 1893, vol. 11, sec. 4, p. 57, Pl. 7, fig. 22 (1894).

Fagophyllum nervosum Dawson, *ibid.*, p. 58, Pl. 7, fig. 16 (1894).

Dryophyllum occidentale Dawson *pars*, *ibid.*, p. 58, Pl. 7, fig. 18 (non fig. 17) (1894).

Ficus contorta Dawson, *ibid.*, p. 60, Pl. 9, fig. 31 (1894).

Fagophyllum retosum Dawson, *ibid.*, p. 57, Pl. 7, fig. 15 (1894).

Ficus magnoliifolia Dawson (non Lesquereux), *ibid.*, p. 60, Pl. 9, fig. 35 (1894).

Ficus wellingtoniae Dawson, *ibid.*, p. 60, Pl. 9, figs. 33, 34, (1894).

Ficus rotundata Dawson, *ibid.*, p. 60, Pl. 9, figs. 32, 33a (1894).

Diospyros eminens Dawson, *ibid.*, p. 62, Pl. 10, fig. 40 (1894).

Cornus obesus Dawson, *ibid.*, p. 62, Pl. 9, fig. 30 (1894).

Magnifolia occidentalis Dawson, *ibid.*, p. 63, Pl. 10, fig. 36 (1894).

Quercus vancouverensis Trelease, Brooklyn Bot. Garden, Mem., vol. 1, p. 499 (1918).

Description. Leaves, petiolate, entire, commonly inequilateral, elliptical to oblong-elliptical, more or less broadly cuneate at base, acuminate at apex or commonly rounded at summit to an abrupt, almost cuspidate extension or drip-point, up to 11 cm. long by 4.5 cm. wide. Petiole, stout, up to 2 cm. long. Midrib, stout, prominently in relief on lower surface, nearly straight to markedly curved. Secondaries, strong, camptodromous, 10 to 15 pairs, alternate to subopposite, commonly more closely spaced in basal part of leaf, leaving midrib at angles of 30 to 60

degrees in different leaves, nearly straight proximally, curving distally and commonly abruptly so as to parallel midrib close to margin, where they are connected by simple or single series of loops to secondary next above by means of a few short tertiaries. Tertiaries, fairly strong, percurrent, generally more or less oblique to secondaries and nearly at right angles to long axis of leaf, particularly in upper half of leaf, mainly simple, although scattered ones are once divided. Nervilles, generally obscure or not preserved; those seen were transverse to tertiaries and simple or divided.

Remarks. The allocation of these variable leaves to the Rhamnaceae is doubtful, and it is possible that they belong to the Anonaceae; the outline of the more slender forms resembles that of the *Anona prereticulata* Chaney and Sanborn (1933, Pl. 14, figs. 2-5) as well as that of *Polyalthia chaneyi* Sanborn (1935, Pl. 3, fig. 4), and the tertiary venation is very close to that of the latter species. The thick petiole and midrib, however, together with secondary and tertiary venation, are much like those of *Rhamnus marginatus* Lesquereux, particularly of *Rhamnus marginatus apiculatus* Berry (1916, Pl. 71, fig. 1; Pl. 72, fig. 1; Pl. 69, fig. 1). Comparison may also be made with *Rhamnus elegans* Newberry (1898, Pl. 50, fig. 2), *Rhamnus* ? *pealei* Knowlton (1922, Pl. 15, fig. 7), *Cornus praeimpresa* Knowlton (1922, Pl. 14, fig. 5; Pl. 19, fig. 2a), and *Ficus rhamnoides* Knowlton (1900, p. 47, Pl. 10, figs. 1-3; Pl. 11, fig. 1).

The leaves are very variable in relative breadth, acuteness of apex, occurrence or lack of an apical acumen, lateral symmetry, angle between secondaries and midrib, and spacing of secondaries. Constant characters are strong midrib, distally abrupt ascent of secondaries close to margin, and percurrent tertiaries that are most commonly oblique to the secondaries. The main variants of form which led Dawson to creation of such a large number of species include: (a) elliptical, nearly equilateral leaves with cuneate apex and base, e.g. *Fagophyllum nervosum*, *Diospyros eminens*, *Diospyros vancouverensis* and *Magnolia occidentalis*; (b) narrow, elliptical-acuminate, young leaves with numerous, relatively highly ascending secondaries, e.g. *Salix* sp. Dawson; (c) relatively large and broad, elliptical leaves with apex commonly prolonged into an acumen, and secondaries at wider angles to midrib, e.g. *Quercus victoriae* and *Cornus obesus*; (d) markedly inequilateral, more or less falcate leaves, e.g. No. 6527 (Pl. XLVII, fig. 1) and *Ficus contorta* Dawson; and finally (e) leaves with more widely spaced secondaries and tertiaries more nearly at right angles to secondaries, e.g. *Ficus wellingtoniae* Dawson, *Fagophyllum retosum* Dawson and *Ficus rotundata* Dawson.

Occurrence. Port McNeill, locality 3240; Comox formation, localities 3120, 3768, 3769; Extension formation, localities 1304, 1724, 3771; New-castle formation, locality 1721; Protection formation, localities 298, 2245, 3826, 3858.

Types. Holotype, G.S.C. No. 5667 (type of *Diospyros eminens* Dawson); hypotypes, G.S.C. Nos. 5687 (type of *Diospyros vancouverensis*), 5594 (type of *Fagophyllum retosum* Dawson), 5634 (type of *Quercus victoriae* Dawson), 5645 and 5645a (syntypes of *Dryophyllum occidentale* Dawson), 5649 and 6489 (syntypes of *Ficus rotundata* Dawson), (specimen missing); type of *Cornus obesus* Dawson), 5694 (figured specimen of *Salix*

sp. Dawson), 5597 (type of *Fagophyllum nervosum* Dawson), 5647 (type of *Ficus contorta* Dawson), 5600 and 5676 (syntypes of *Ficus wellingtoniae* Dawson); 6490 (type of *Ficus magnoliifolia* Dawson, non Lesquereux), 5663 (type of *Magnolia occidentalis* Dawson), 558, 559, 5648, 6419, 6420, 6421, 6423, 6473, 6526, 6527.

Zizyphus areolatus n. sp.

Plate LVII, figures 2-4; Plate LXI, figures 1, 2;
Plate LXII, figure 3 (lower right)

Description. Leaf, large for the genus, petiolate. Petiole, striated, thick, up to 3 mm. broad by more than 2 cm. long. Blade, up to 14 cm. or more long by 7 cm. broad, elliptical, entire, with rounded or rounded-cuneate base, and apex rounded to a short acumen. Venation, palmately trinerved. Primary veins, arising from top of petiole. Lateral primaries, almost as strong as midrib and making an angle of about 30 degrees with it, slightly curved inwards and ascending subparallel with midrib to apical part of leaf where they fade out close to margin, provided on outer side with about 10 oblique, upwardly curved, camptodromous branches that are mainly simple, although rarely some have one or two branches on lower side. Secondaries, 2 or 3 pairs in upper half of leaf, alternate or lowermost subopposite, highly ascending subparallel with midvein to disappear close to margin within the area of the lateral primaries. Tertiaries, extremely close together (4 to 7 per mm.), transverse to long axis of leaf, which, together with almost equally strong veins transverse and oblique to them, form a close network of irregular areoles.

Remarks. The leaf in gross characters resembles closely *Ficus pseudo-populus* Lesquereux (1878, Pl. 34, figs. 1a, 2; especially Knowlton 1917b, Pl. 72, figs. 2-4; Pl. 73, figs. 1, 2; Pl. 112, fig. 3), although the tertiary venation and pattern of areoles is distinctive. *Zizyphus daphgenoides* Knowlton (1930, Pl. 48, figs. 5, 6) is a more acuminate leaf with less crowded tertiaries, whereas *Zizyphus beckwithii* Lesquereux (1883, Pl. 19, fig. 5) is a smaller, obovate leaf.

Occurrence. Extension formation, localities 1304, 1724, 4210; Protection formation, locality 3826; Newcastle formation, locality 1723.

Types. Holotype, G.S.C. No. 6481; paratypes, G.S.C. Nos. 551, 633, 6482, 6483.

Zizyphus cretaceus (Dawson) n. comb.

Plate LIV, figure 4; Plate LV, figures 2, 3, 5; Plate LVI, figures 1, 4, 6
Ceanothus cretaceus Dawson, Roy. Soc. Canada, Trans. 1882-83, vol. 1, sec. 4, p. 28, Pl. 8, fig. 33 (1883).
Paliurus neillii Dawson pars, Roy. Soc. Canada, Trans. 1893, vol. 11, sec. 4, p. 62, Pl. 11, fig. 45 (non fig. 44) (1894).

Description. Leaf, coriaceous, petiolate. Petiole, stout, 2 to 2.5 mm. wide, of unknown length. Blade, entire, elliptical, with rounded to broadly cuneate base, and rounded summit to a short acumen, up to 10 cm. long by 5 cm. wide. Venation, palmately trinerved. Midvein, strong,

straight or gently curved. Lateral primaries, arising at top of petiole making angle of about 30 degrees to midrib, about as strong as midrib, subacrodromous, disappearing sub-marginally in apical part of leaf, provided on outer side with five branches that are somewhat upwardly curved and camptodromous. A pair of thin basal veins arise at foot of lateral primaries and run sub-marginally parallel with lower border of leaf. Secondaries from midrib, lacking or restricted to one or two inwardly curved thin veins in apical part of leaf. Tertiaries, close together, simple or once divided, nearly at right angles to long axis of leaf, sparingly inosculating by means of oblique or transverse connections, nearly straight or slightly curved.

Remarks. The rarity or lack of secondaries, and the close tertiary venation are characters more like *Zizyphus* than of *Paliurus* or *Ceanothus*. *Paliurus cretaceus* Lesquereux (1892, p. 165, Pl. 35, fig. 3) is quite distinct from Dawson's species. The largest leaf of *Z. cretaceus* observed is about 10 cm. long by 5 cm. broad. Commonly they are 5 or 6 cm. long by 3 or 3.5 cm. broad.

Occurrence. Comox formation, localities 1722, 3032, 3034, (3038), 3036, 3768, 3769, 4211 (depths 1,025, 1,183-1,184 feet).

Types. Holotype, G.S.C. No. 5638; hypotypes, G.S.C. Nos. 637, 5693 (syntype of *Paliurus neillii* Dawson), 6428, 6429, 6430, 6431.

Zizyphoides neillii (Dawson pars) n. comb.

Plate LV, figure 8; Plate LVI, figure 3

Paliurus neillii Dawson pars, Roy. Soc. Canada, Trans. 1893, vol. 11, sec. 4, p. 62, Pl. 11, fig. 44 (non fig. 45) (1894).

Description. Leaf, coriaceous, sub-oval, broadly cuneate at base; petiole and apex unknown, although apex seemingly rounded, or broadly cuneate. Venation, palmately trinerved. Lateral primaries, basal or slightly supra-basal, camptodromous, inclined about 30 degrees to midrib, gently curving inwards and ascending to upper part of leaf, where they fade close to margin, provided on outer side with 6 or 7 upwardly curved, fine, camptodromous branches. Secondaries, 3 or 4 pairs, alternate, the lowest pair more distant from the primary laterals than from the next succeeding pair. Tertiaries, where preserved, percurrent, simple, transverse to long axis of leaf, moderately spaced.

Remarks. The leaf of this species differs from that of *Zizyphus cretaceus* (Dawson) in the occurrence of secondaries from near the middle to summit of leaf. Moreover, the lateral primaries do not reach to apical part of leaf. It is a less elongate leaf than that of *Cinnamomoides buckhami*, and the lateral primaries unlike that species have a much more regular series of gently curved camptodromous branches. The venation resembles that of *Cinnamomum newberryi ellipticum* Berry (1925, Pl. 16, fig. 7) from the Ripley formation.

Occurrence. Port McNeill, locality 3240; Comox formation, localities 3032, 3038, ? 3768.

Types. Lectotype, G.S.C. No. 5636; hypotype, G.S.C. No. 553.

Ampelopsis ? sp.

Plate LVI, figure 2

Remarks. Material comprises a single leaflet (?), possibly belonging to a palmately compound leaf. Blade, almost sessile, elliptical-lanceolate, with acuminate, markedly decurrent base and acuminate tip; the greatest width on one side is about its middle, being slightly higher on the other; margin is serrulate, with rather remote, short, narrow, inconspicuous teeth, except in basal region which is entire. Secondaries, about 8 pairs, alternate, making angles of about 30 degrees to midrib, rather unevenly spaced, nearly straight, or slightly curved upwards, camptodromous close to margin, with very short branches to the teeth. Tertiaries, mainly percurrent, simple or once divided, rather close, almost transverse to long axis of leaf, except those in more basal parts of leaf, where they are nearly at right angles to the secondaries.

The specimen resembles fairly closely a leaflet of the Eocene species, *Ampelopsis tertiaria* Lesquereux (1878, Pl. 43, fig. 1; Berry 1931, Pl. 11, fig. 15; Pl. 14, fig. 4), except that its teeth are smaller and more distant, and its secondaries more ascending.

Occurrence. Protection formation, localities 299, 3826.

Types. G.S.C. specimen No. 630.

Cissites pseudoplatanus Hollick

Plate LXII, figure 2

Remarks. Leaf, petiolate, orbicular to sub-rhomboid, about 6 cm. long by 6 cm. wide, with broadly cuneate base and partly crenate, partly coarsely serrate margin. The apex is missing. A pair of primary laterals, about equal in strength to midrib, arise from top of petiole at angle of about 30 degrees to midrib, are slightly curved upwards, and enter a marginal tooth in upper half of leaf; they have 3 or 4 nearly straight branches on abaxial side. Subopposite secondaries comprise 2 or 3 pairs, and are craspedodromous. The tertiaries are strongly bowed, simple or once divided, and lie at right angles or openly oblique to the secondaries. An additional pair of basal veins arise from the top of the petiole and run to the margin parallel with the abaxial branches of the lateral primaries.

The assignation of this species to *Cissites* rather than *Platanus* is doubtful.

Occurrence. Port McNeill, locality 3240.

Types. Hypotype, G.S.C. No. 6532.

Dombeyopsis ovata Knowlton

Plate LVIII, figures 1-3, 5

Description. Petiole, unknown. Blade, ovate, with rounded or slightly cordate base, and broadly rounded at summit to an abrupt, short, and narrowly rounded-triangular apex. The best specimen is 11 cm. long by 8 cm. wide. Margin, entire for variable distance from base, coarsely crenate, crenulo-dentate or undulate above, the crenulations being separated by shallow, rounded sinuses. Venation, trinerved-pinnate. Midrib, slender or moderately stout, nearly straight or slightly flexuous. Primary laterals, nearly as strong as midrib, basal or supra-basal, 35 to 40 degrees to midrib, slightly curved upwards and somewhat flexuous, running to margin generally well above midlength of leaf, provided on abaxial side with up to 9 branches, which are mainly camptodromous or simply looped within margin, or distal ones may enter marginal crenae. A thin pair of short basal veins may lie below the primary laterals. Secondaries, irregularly spaced, subopposite or alternate, slightly curved upwards, the two lower pairs inclined to be forked, mainly craspedodromous, or united to secondary above by means of short tertiary-like branches, and sending short branches to marginal crenae. Tertiaries, percurrent, simple or once divided, commonly slightly bowed, openly oblique to secondaries or nearly at right angles to midrib. Nervilles, not preserved.

Remarks. Except for the margin being crenulate or crenulo-dentate rather than undulate, these leaves agree fairly closely with the types (Knowlton, 1922, Pl. 24, figs. 1-3, 9).

Occurrence. Protection formation, locality 3858; ? Port McNeill, locality 3240; Comox formation, localities 3032, 3768.

Types. Hypotypes, G.S.C. Nos. 543, 6493, 6515, 6516.

Pterospermites sp.

Plate LIX, figure 3; Plate LXIII, figures 2, 4

Magnolia capellini Dawson pars (non Heer), Roy. Soc. Canada, Trans. 1893, vol. 11, sec. 4, p. 63, Pl. 13, fig. 49a (non Pl. 11, fig. 49) (1894).

Remarks. Several fragments of a large, oblong-elliptical leaf, 14 cm. or more long by 9 or 10 cm. broad, are characterized by a very thick petiole and midrib. The petiole is at least 2 cm. long, and its width and that of lower part of midrib is 3 mm.; both are marked by inosculating, longitudinal striae. Base of leaf, truncated to slightly cordate, decurrent slightly on petiole; apex, seemingly rounded. Margin entire at base of unknown character above. Midrib, thinning rapidly in upper half of leaf. Secondary veins, pinnate, alternate or subopposite, perhaps 8 or 9 pairs, relatively thin, the lowermost 2 or 3 pairs more crowded than rest and looped together close to margin by tertiary veins. Whether remaining secondaries are camptodromous or craspedodromous is unknown. Tertiaries, mainly transverse to secondaries and midrib, irregularly flexuous and percurrent, some simple, some divided, enclosing finer network of irregular polygonal cells.

These leaves are too fragmentary to identify, but comparisons may be made with *Pterospermites* sp. Knowlton (1916, Pl. 89, fig. 3; Pl. 90, fig. 1), *Pterospermites whitei* Ward (1885b, Pl. 56, figs. 5, 6) and *Pterospermites cordatus* Ward (ibid. Pl. 56, fig. 4).

Occurrence. Port McNeill, locality 3240.

Types. G.S.C. Nos. 684, 5653 (*Magnolia capellini* Dawson pars, non Heer), 5678.

Dillenites paucidentatus n. sp.

Plate LXII, figure 3 (upper left)

Description. Leaf, sub-elliptical, with rather abrupt, acuminate, but little extended apex, and broadly rounded to truncate base, 9.5 cm. long by 4.5 cm. broad; character of petiole, unknown. Margin, entire in basal region, shallowly creno-serrate above, the teeth being rather remote and triangular-crenate. Midrib, prominent, but narrow, slightly curved at apex. Secondaries, about 10 pairs; those in basal region of leaf are more closely spaced and more nearly straight, making angles of about 45 degrees to midrib; upper secondaries, about 30 degrees to midrib, more strongly ascending than lower and with pronounced inward curvature. The larger secondaries have one or two distal, abaxial branches. Tertiaries, where preserved, are mainly simple and decurrent, oblique to the upper secondaries, more nearly at right angles to the lower ones.

Remarks. The species is based on a single leaf. Its affinities seem closer to leaves of the form genus *Dillenites* Berry than to those generally assigned to *Dryophyllum* or *Quercus*. Except for greater size and more elliptical outlines the leaf most closely resembles *Dillenites ovatus* Berry (1916, Pl. 68, fig. 2), having similar, although more remote, creno-serrate teeth, and similar differentiation of the secondaries.

Occurrence. Comox formation, locality 3769.

Types. Holotype, G.S.C. No. 635.

Ternstroemites harwoodensis (Dawson) n. comb.

Plate LIX, figure 4; Plate LX, figures 1, 3; Plate LXI, figure 4;
Plate LXII, figure 1

Juglans harwoodensis Dawson, Roy. Soc. Canada, Trans. 1882-83, vol. 1, sec. 4, p. 28, Pl. 8, fig. 31 (1883).

Ficus laurophyllidia Dawson, Roy. Soc. Canada, Trans. 1893, vol. 11, sec. 4, p. 60, Pl. 10, fig. 37 (1894).

Description. Leaf of firm consistency, seemingly sub-coriaceous. Petiole, 2 cm. long, stout. Blade, oblong-lanceolate, with acuminate apex and cuneate base that is slightly decurrent on petiole, up to 20 cm. long by 5 cm. wide. Margin entire in basal part, serrulate or crenulo-serrulate above, the teeth being closely set. Midrib, thick, in relief on lower surface, straight or slightly curved apically. Secondaries, up to more than 20 pairs, subopposite to alternate, generally 70 to 90 degrees to midrib, commonly slightly flexuous distally, abruptly looping by short

branches well within the margin, forming one or two series of external festoons from which short branches go to teeth. One or two intermediate secondaries commonly occur between the main ones. Tertiaries, thin, some transverse or oblique to secondaries and percurrent, others divided and forming a loose tertiary network.

Remarks. The species is relatively much broader and more robust than *Ternstroemites ripleyensis* Berry (1925, p. 74, Pl. 15, figs. 3, 4) and has shorter, more closely spaced and more serrate teeth. In the last-mentioned character, as well as in outline, it resembles more closely *Ternstroemites ovatus* Berry (1916, Pl. 77, figs. 2-4) from which, however, it departs widely in the spreading character of the secondaries.

Occurrence. Extension formation, localities 1304, 1724, 3771, 4210; Protection formation, localities 3826, 3858.

Types. Holotype, G.S.C. No. 5623; hypotypes, G.S.C. Nos. 5662 (type of *Ficus laurophyllidia* Dawson), 6462, 6491, 6495.

Combretum cf. *leve* Berry

Plate LXIV, figures 1-3; Plate LXVI, figure 3

Remarks. Fragments of a large coriaceous or sub-coriaceous leaf are included here. Outline of leaf, ovate, seemingly broadly cuneate at base. The length evidently exceeded 15 cm., greatest width was 10 or 12 cm. The margin above an entire, basal region is slightly undulate, and bears remote, almost microscopic 'teeth', perhaps glandular. The midrib is very stout, up to 3 mm. broad. Secondaries, at least 5 or 6 pairs, rather remote, alternate to subopposite, inclined 35 degrees to 50 degrees to midrib, the lower ones at the greater angle, curving upwards so as to become highly ascending; their distal termination is obscure, but they seem to be camptodromous very close to margin. Tertiaries, where preserved, mainly simple, transverse, or distal ones oblique to secondaries, those external to lowermost secondaries and to distal ends of the higher secondaries united by simple loops.

The material to hand is too scanty for adequate comparison with described fossil species, although it resembles fairly closely *Combretum leve* Berry (1930a, p. 118, Pl. 29, figs. 3, 4) from the Wilcox Eocene.

Occurrence. Extension formation, locality 1304; Comox formation, locality 3768.

Types. G.S.C. Nos. 554, 555, 556, 5666.

Combretum cordifolia (Lesquereux) Berry

Plate LXIII, figure 1; Plate LXV, figures 1, 2, 3 (right)

Magnolia capellini Dawson (pars) non Heer, Roy. Soc. Canada, Trans., 1893, vol. 11, sec. 4, p. 63, Pl. 11, fig. 49 (non Pl. 13, fig. 49a) (1894).

Remarks. The base as well as most of the midrib and of one side of the specimen illustrated by Dawson (reference above) is now missing. What remains, in conjunction with Dawson's drawing of the missing parts,

shows that the leaf is so like *Magnolia cordifolia* Lesquereux (1869, Pl. 22, figs. 1, 2) from early Tertiary beds as to lack satisfactory distinguishing characters. Berry (1916, p. 321) united *Magnolia cordifolia* Lesquereux to *Magnolia ovalis* Lesquereux, referring to both as *Combretum ovalis*. Knowlton (1917b, p. 315), however, questioned this union, and the spacing of the secondaries, together with the abruptly pointed apex in the type specimens of *Combretum cordifolia* seems to justify Knowlton's belief that two species are represented. G.S.C. No. 608 from the same beds as the type (G.S.C. No. 5677) is considered to belong to this species, although the midrib is more slender, secondaries more ascending, and its base much more narrow.

Occurrence. Port McNeill, locality 3240.

Types. Hypotypes, G.S.C. Nos. 5677 (one syntype of *Magnolia capellini* Dawson), 608, 654, 5652 (*Catalpophyllum* sp. Dawson).

Sapotacites sp.

Plate LVII, figure 1

Remarks. A single fragment of an asymmetrical, entire, seemingly coriaceous, obovate leaf, with narrow, cuneate base. Apex, broadly but asymetrically rounded, seemingly not emarginate. Midrib, relatively stout in lower half of leaf. Secondaries, rather closely spaced, more crowded in basal part of leaf, inclined about 40 degrees to midvein, united by a loose festoon of veins well within the margin. Tertiary veins where exposed form an open network of areolae, many of which are elongated parallel to the secondaries.

Occurrence. Comox formation, locality 3768.

Types. G.S.C. No. 6452.

Fraxinus sp.

Plate LX, figure 2; Plate LXIII, figure 3

Description. Leaflet (?), elliptical, with somewhat inequilateral base, which is cuneate on a stout petiole that is at least 1 cm. long. Apex, missing in the only two specimens to hand, but summit as a whole obtuse, and apex, if acute, presumably short. Margin, entire below, distantly serrate above, the teeth being short, sharp and upwardly directed. Secondaries about 8 pairs, subopposite to alternate, arising 50 to 60 degrees to midrib, slightly curved upwards, either entering teeth or camptodromous close to margin with a short branch to a tooth. A distal set of tertiaries form irregular loops between the secondaries close to margin; they may include an abaxial branch to a secondary, which enters an intermediate tooth; remaining tertiaries, openly oblique or transverse to the secondaries, simply percurrent, or divided; enclosing an irregular network of nervilles.

Remarks. In venation and teeth the species resembles most closely those of *Fraxinus* than members of the Celastraceae. It may be compared with the living *Fraxinus coriacea* Watson, which inhabits desert regions from Utah to southeastern California.

Occurrence. Extension formation, locality 3771; Protection formation, locality 3826.

Types. G.S.C. specimen Nos. 585, 6471.

Viburnum insigne (Dawson) n. comb.

Plate LIX, figure 2; Plate LXVI, figures 1, 2, 4; Plate LXVII, figures 2-4

? *Populus rectinervata* Dawson, Roy. Soc. Canada, Trans. 1882-83, vol. 1, sec. 4, p. 27, Pl. 7, fig. 26 (1883).

? *Populus longior* Dawson, *ibid.*, p. 27 (1883).

Alnites insignis Dawson, *ibid.*, p. 28, Pl. 8, fig. 36 (1883).

Populus rhomboidea Dawson (non Lesquereux), *ibid.*, p. 26 (1883).

Description. Leaf, petiolate; petiole, slender, up to 1.5 cm. long at least. Blade, obovate to elliptical, with rather abrupt acute apex and cuneate base, strongly decurrent on petiole. Margin, entire for variable distance from base, sharply serrate or serrulate above. Venation, pinnate, with primary laterals giving trinerved appearance. Midrib, moderately strong, straight or somewhat flexuous. One or 2 pairs of basal, camptodromous veins lie below primary laterals. Primary laterals, subopposite or more rarely alternate supra-basilar, nearly straight or slightly flexuous, 30 or 40 degrees to midrib, provided with 5 or 6 camptodromous, or distally craspedodromous branches on abaxial side. Remaining secondaries, alternate or opposite, craspedodromous, the larger provided with one or two short distal branches on lower side, nearly straight or slightly curved upwards; upper ones simple. Tertiaries, transverse or openly oblique to secondaries and about right angles to midrib, moderately spaced, percurrent, straight or very slightly bowed, mostly simple, a few once divided.

Remarks. The species is characterized by marked decurrence of blade on petiole, not common with *Viburnum*. It resembles some other Cretaceous species, e.g. *Viburnum hollicki* Berry (especially *V. whymperi* Knowlton (non Heer) 1900, Pl. 19, fig. 3); *Viburnum montanum* Knowlton (1900, Pl. 19, figs. 1, 2); *Viburnum* ? *problematicum* Knowlton (1900, Pl. 19, fig. 4) and *Viburnum simile* Knowlton (1917, Pl. 49, fig. 3). From all these it differs in a more pronounced decurrence of blade on the petiole and in straighter and less branched secondaries, which rarely branch by dichotomy.

Dawson's figure of the type (G.S.C. No. 5633) is very misleading in that the teeth are shown to be coarse and blunt and to extend down almost to the petiole; the specimen is refigured here on Pl. LXVII, fig. 2.

Occurrence. Extension formation, localities 1304, 3239; Comox formation, localities 1722, 3120, 3768; Newcastle formation, localities 1721, 2383.

Types. Holotype, G.S.C. No. 5633; hypotypes, G.S.C. Nos. 605, 685, 5684 (*Populus rhomboidea* Dawson, non Lesquereux), 6450, 6544, 6545.

Dewalquea cf. *trifoliata* Newberry

Plate LXVII, figure 5

Remarks. Leaf, trifoliate, petiolate. Leaflets, elongate, elliptical, entire, acuminate, coriaceous, sessile, the middle one slightly inequilateral, the outside pair more so, particularly their bases. Midveins, thick, particularly their lower halves. Secondaries, immersed and not visible.

Dewalquea trifoliata Newberry (1895, p. 129, Pl. 22, fig. 6) has both sessile and petiolulate leaves, and, if more material were collected from Vancouver Island, this might prove to hold for the Vancouver Island species. Further material of the latter species showing the pattern of secondary venation, will be necessary before adequate comparison with Newberry's species can be made.

Occurrence. Comox formation, locality 3038.

Types. G.S.C. No. 562.

Dewalquea sp.

Plate LXVII, figures 1, 6

Remarks. Only three specimens of this species are to hand; two are mere fragments of coriaceous, acuminate, inequilateral leaflets, 1.7 and 2 cm. broad, respectively. The third specimen is an apical part of a section of a leaf, and comprises two sessile, acuminate-elliptical leaflets, one of which is inequilateral, about 2 cm. broad in middle and about 8 cm. long; the other leaflet is equilateral, 1.5 cm. broad by 7.5 cm. long. The base of both leaflets is narrowly cuneate, the margins regularly and finely crenoserrate. The leaf substance is coriaceous, the midribs prominent, but secondaries, which leave midrib at angle 50 to 60 degrees, obscure or immersed.

The species is closest to *Dewalquea insignis* Hosius and von der Marck (1880, p. 172, Pl. 32, figs. 111-113; Pl. 33, fig. 109; Pl. 34, fig. 110) from late Senonian deposits of Germany, and to *Dewalquea smiths* Berry (1914, p. 41, fig. 1; Pl. 8, figs. 3-9) from the Black Creek formation of the Upper Cretaceous of South Carolina. Lack of venation pattern precludes close comparison.

Occurrence. Comox formation, locality 3768; Port McNeill, locality 3240.

Types. G.S.C. Nos. 570, 571.

Dicotylophyllum sp. cf. *Quercus rhamnoides* Lesquereux

Plate LXI, figure 3

Remarks. Both base and apex of this specimen are missing, which precludes a satisfactory generic assignment. The part preserved indicates an elliptical leaf with entire margin and firm texture. The midvein is moderately stout, thinning gradually. Secondaries numerous, mainly alternate, subparallel, arising at angles of 50 to 60 degrees to midrib,

proximally nearly straight or only slightly curved upwards, those in basal part of leaf slightly curved downwards in vicinity of midrib, abruptly curved upwards near margin, where each loops with secondary above, the loops in upper part of leaf being simple, in lower part comprising a simple series of tertiaries. Tertiaries, rather prominent, slightly oblique to secondaries, mainly divided near middle, but some simple and percurrent.

The venation is very like that figured in one specimen of *Diospyros wilcoxiana* Berry (1916, Pl. 101, fig. 2) from the Wilcox group, but resembles, too, that of *Quercus rhamnoides* Lesquereux (1892, Pl. 48, fig. 4) from the Dakota group. The Vancouver Island leaf is roughly about twice the size of *Quercus rhamnoides*, being 7 cm. wide near the middle, and probably at least 15 cm. or more long.

Occurrence. Extension formation, locality 4210.

Types. G.S.C. No. 607.

Dicotylophyllum sp.

Plate LXII, figure 4

Description. (Based on single leaf or leaflet with apex and petiole missing.) Leaf or leaflet, entire, ovate or sub-elliptical, inequilateral and broadly cuneate at base, sub-coriaceous, probably about 10 cm. long by 4 cm. wide near middle. Midrib, stout, about 1.5 mm. wide in lower half. Secondaries, thin, 30 to 40 degrees to midrib, those on one side leaving midrib at more acute angles than those on other, slightly flexuous or curved upwards, the upper ones ascending about half-way to margin so as to run almost parallel with midrib, probably about 6 pairs, the lowermost two or three pairs subopposite and more closely spaced than the higher ones which are alternate and remote, apparently camptodromous, but distally not traceable, so that character of union is not known; several show traces of upwardly curved branches in their distal halves. Tertiaries, not preserved.

Remarks. The outline, except possibly that of the unknown apex, as well as the ascending remote secondaries resembles that of *Laurus socialis* Knowlton (non Lesquereux) (1917b, Pl. 91, fig. 5) from the Raton formation; the secondaries, however, ascend more remotely from the margin.

Occurrence. Comox formation, locality 3768.

Types. G.S.C. specimen No. 632.

Calycithes sp.

Plate LVIII, figure 4

Remarks. A single specimen is considered to be the remains of a coriaceous calyx. It consists of an obscure coalized central disk, about 5 mm. diameter, which is surrounded radially by remains of 10 rigid, lanceolate sepal-like segments, each about 1 cm. long by 2 mm. wide;

seemingly at least two additional segments were lost during extraction, making at least 12 in all. Some of the segments show a strong midrib and obscure traces of a parallel vein on each side.

Somewhat similar remains of a calyx-like organism, but with 5 or 6 segments, were figured and described by Berry (1919, p. 139, Pl. 29, fig. 8) from the Tuscaloosa formation, and by Chaney (1933, p. 59, Pl. 9, fig. 5) from the Tertiary Trout Creek flora.

Occurrence. Comox formation, locality 3768.

Types. G.S.C. No. 663.

Carpites sp.

Plate LIX, figure 1

Remarks. Seed, sub-ovate, compressed, about 1 cm. long by 4 mm. wide, with traces of narrow wing-like border, about 0.5 mm. wide. Except for narrow border, the surface is prominently reticulate, with about 9 longitudinal, minutely flexuous and rarely bifurcated ribs on exposed sides, between which are numerous cross-ribs of nearly equal strength, producing between them a network of nearly equidimensional depressions.

Occurrence. Comox formation, locality 4211.

Types. G.S.C. No. 664.

INDEX TO LOCALITY NUMBERS

Beaver Harbour

- 1543 Port Hardy, Beaver Harbour. Coll. G. M. Dawson, 1878.
1584 =1543.

Comox Coalfield

- 1576 Baynes' Sound. Coll. G. M. Dawson, 1878.
1722 Baynes' Sound, Division A. Coll. G. M. Dawson, 1878.
3032 From sandstone on south bank Trent R., 100 chains in direction S81W degrees east from junction of main Trent R. and South Fork. Coll. A. F. Buckham, 1939.
3034 Talus from south bank Brown's R., 197 chains in direction S87W degrees east from junction of Brown's and Puntledge Rivers. Coll. A. F. Buckham, 1939.
3035 From sandstone on T Sable R. east bank, about 5 chains above junction with Tumble Water Creek. Coll. A. F. Buckham, 1939.
3036 No. 8 mine; roof of No. 2 coal seam from in place in mine. Coll. A. F. Buckham, 1939.
3038 =3034.
3120 Roof of No. 2 coal seam. Coll. H. M. Grey, 1941.
3768 No. 8 mine dump, Cumberland Coal (1) Ltd., Cumberland, B.C. Roof of No. 2 coal seam. Coll. J. L. Usher, 1945.
3769 No. 5 mine dump, Cumberland Coal (1) Ltd., Cumberland, B.C. Coll. J. L. Usher, 1945.
3860 Float from South Fork of T Sable R. Coll. J. D. Mackenzie, 1921.
4211 Borehole No. 185, placed to test lowest seam ahead of No. 8 mine; total depth, 1330 feet; elevation, about 212 feet above sea-level. Hole started Aug. 5, 1940. Located about 1 mile northeast of Comox No. 8 mine. Section 0-625 ft. Trent R. Shale 625 ft.-1330 ft. mainly ss. of Comox formation (at 1023 No. 1 coal seam; at 1092 No. 2 coal seam; at 1190 No. 3 coal seam and at 1302, No. 4 coal seam). (N.B.—Shells occur down to 735 feet.) Coll. H. M. Grey, 1940.

Extension Formation

- 1304 Wellington colliery, Nanaimo. Coll. G. M. Dawson, 1885.
1724 Harwood colliery, Nanaimo. Coll. J. Richardson, 1875.
2244 =1724.
3239 Vancouver colliery, Nanaimo. Coll. Mr. Robins, 1885.
3771 White Rapids mine, Nanaimo. Coll. J. L. Usher, 1945.
3772 Furnace Portal mine (J. Brigg operator), 500 feet southeast of N.W. corner sec. 20, rge. 1, Cranberry district near Nanaimo. The old Harwood mine or Little Wellington seam of 1874 is about 35 feet above the main Wellington. Coll. A. F. Buckham, 1946.
4210 Jingle Pot mine, Nanaimo, from dump of Wellington coal seam (lowest seam at Nanaimo). Coll. H. M. Grey, 1940.

Newcastle Formation

- 1721 Newcastle Island. Coll. J. Richardson, 1873.
1723 Nanaimo. Coll. J. Richardson, 1875.
2383 Nanaimo. Coll. J. Richardson, 1875.
3770 No. 10 mine, roof of coal seam, Cumberland Coal (1), Nanaimo. Coll. J. L. Usher, 1945.

Port McNeill

- 3240 North shore, Port McNeill, bearing north 65 degrees east magnetic from Eel Reef; from shales or shaly sandstone about 5 feet above seamlet of coal, 1 inch to 2 inches thick. Coll. G. M. Dawson, 1885.

Protection Formation

- 298 Two miles up Nanaimo R. Coll. J. Richardson, 1872.
 299 Two and one half miles up Nanaimo R. Coll. J. Richardson, 1873.
 1580 Protection Island. Coll. J. Richardson, 1873.
 2243 = 1580.
 2245 Two and one quarter miles up Nanaimo R. Coll. J. Richardson, 1873.
 3826 Round Island, below Dodds Narrows. Coll. J. L. Usher, 1948.
 3858 Protection Island. Coll. J. L. Usher, 1948.

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