NOTES
ON
SOME FOREST (SITE) TYPES IN NORTH AMERICA

BY

DR. YRJÖ ILVESSALO
PROFESSOR AT THE FOREST RESEARCH INSTITUTE
HELSINKI

CONTENTS:

PREFATORY NOTE.

In 1927 the present writer received a grant from the Finnish Government for the purpose of visiting the United States and Canada for six months for study and research. It was my intention during this journey to acquaint myself with the forest research work and the forestry education of these countries and to study the present state and development of their forests. This task I performed partly through the literature on the subject which was everywhere very abundantly placed at my disposal, partly by applying to a very great number of people for personal information on these matters and to a very considerable extent by travelling through the United States and Canada and by making very numerous and long excursions along the railways into the forests themselves.

During these excursions, in the organisation and guidance of which I received ample and exceedingly kind assistance from the forest officials in the United States and Canada, I was enabled to study forests of many different species of trees. Experiments having been made to cultivate several North American species of trees in Suomi (Finland) I tried during the excursions, as far as time allowed, to study these special forests in detail. It was above all most interesting to investigate on what kind of sites these species grow in their native places. This is important for the reason that in Suomi (Finland) the classification of forest soils according to quality is founded on a natural, biological basis, on so called forest (site) types, and also the cultivation experiments of foreign species of trees are founded on this basis, that is, endeavours are being made to establish culture in a region of similar meteorological conditions, but also on a site corresponding to the site of the stand from which the seed used

hails.[1] As several North American species of trees may very possibly be used in the cultivation of forests in Suomi (Finland) it would be important from a forestry point of view to make thorough investigations concerning this sphere in the United States and in Canada. Such observations made by the writer may in this respect be considered only a small p r e l i m i n a r y s t u d y.

To this purpose which was not originally included in the programme of my journey, I could only devote comparatively little time and I therefore limited my observations chiefly to lodgepole pine (*Pinus Murrayana*) forests. This species of tree, however insignificant it may be considered in North America, which is so rich in species of trees, may possibly in the future for many reasons be a favourite foreign species in Suomi (Finland), and to this the experiments already made seem to point.[2] I also made some notes on the forests formed by jack pine (*Pinus banksiana*), closely related to lodgepole pine, but a species to all appearances of less value. I was in a position to investigate the sites of Douglas fir (*Pseudotsuga taxifolia*) closely only in a few places. For the sake of comparison I also made some notes on balsam fir (*Abies balsamea*), white pine (*Pinus strobus*) and Norway pine (*Pinus resinosa*) forests as also on the forests of some other species.

---

[1] See: A. K. Cajander, The Theory of Forest Types. (Acta forestalia fennica 29, 1926.)
A. K. Cajander, Der Anbau ausländischer Holzarten als forstliches und pflanzengeographisches Problem. (Acta forestalia fennica 24, 1923.)
Lauri Ilvessalo, On the Possibilities of Cultivation of Foreign Species of Trees, with special regard to Suomi. (Acta forestalia fennica 17, 1920.)
Lauri Ilvessalo, Cultivation of Foreign Species of Trees. (Silva fennica 4, 1927, pp. 53—66.)
A. F. Tigerstedt, Arboretum Mustila. (Acta forestalia fennica 24, 1922.)

[2] C. G. Tigerstedt, *Pinus Murrayana.* (Forstlig Tidskrift, No. 2, 1927. Helsingfors.)

For the sake of completeness the research in question should, besides meteorological conditions, embrace the composition of the vegetation of the site, a detailed explanation of the soil on the basis of soil analyses, and a description of the topography of the land and, of course, also an investigation of the biology, growth, etc. of the forest and of individual trees. On his excursions the writer was in a position to study chiefly only the composition of the vegetation of the site besides some general features. Even here difficulties arose for, not being familiar with the flora of North America, I could not easily determine the plant species. Great help in this respect was afforded me by some plant collections which I was allowed to go through during my journey, and by many obliging guides. Of those plant species which I could not determine on the spot, I took specimens and these accumulated to a collection of several hundreds. In determining them I was most kindly assisted by Doctor P. A. Rydberg in the Botanical Garden of New York and by Doctor Hill of Yale University and in Suomi (Finland), especially in the determination of mosses, by Professor V. F. Brotherus and Doctor V. Kujala, botanist at the Forest Research Institute. Mrs. Hilkka Brofeldt employed in the Finnish Legation at Washington rendered me great assistance by taking charge of the plant specimens. To all these persons and to numerous obliging guides I beg to express my most heartfelt thanks.

DESCRIPTION OF THE OBSERVATION REGIONS IN GENERAL AND THE SAMPLE PLOTS.

As already mentioned above, the observations had to be limited to such regions through which the journey, made for quite another purpose, was undertaken. These regions enumerated according to the quantity of material of observations made, are as follows:

I. In Canada: 1. The region of Sicamous—Kamloops—Ashcroft, 2. The region of Banff—Yoho Valley, 3. Cypress Hills, 4. Glenwater, Ont., 5. Petawawa Experimental Forest, 6. Kazubazua, Ont., 7. Laurentides Park, and 8. Vancouver, B.C.

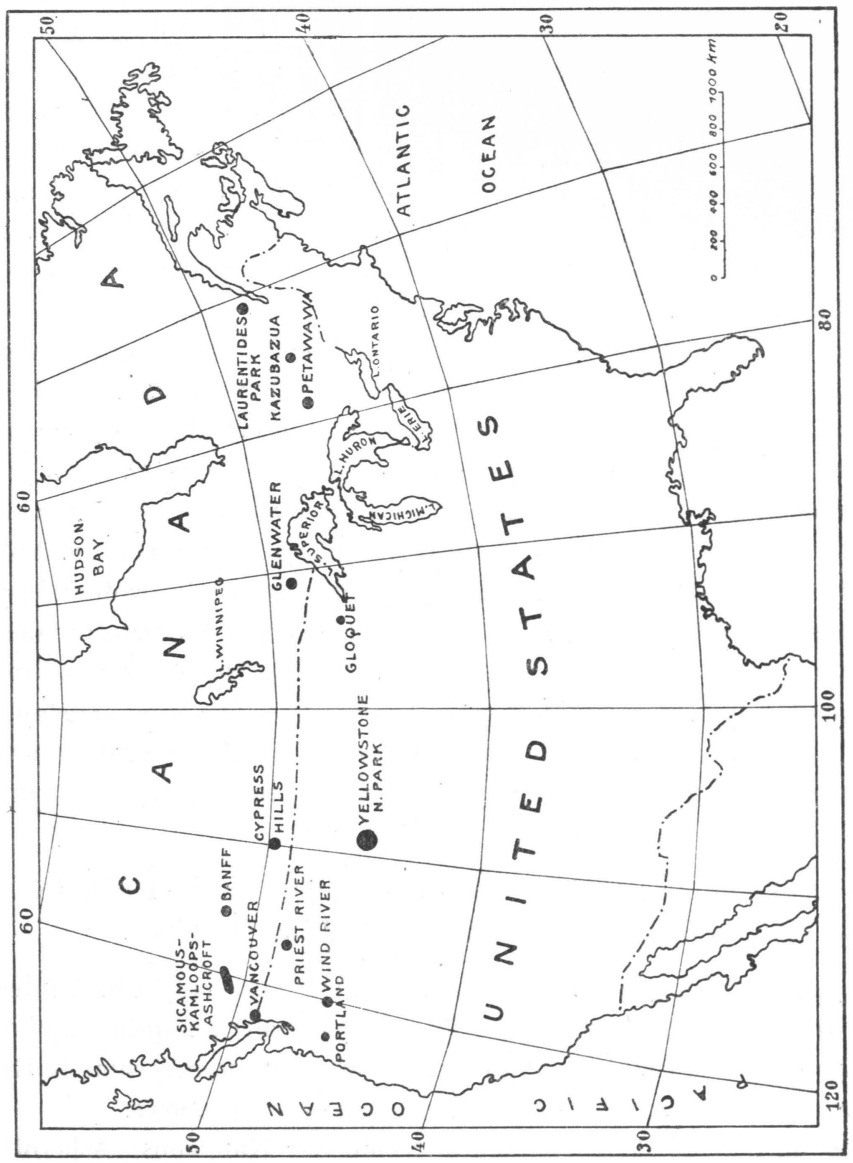

Fig. 1. Map showing the regions of observations.

II. In the United States: 1. Yellowstone National Park, 2. Priest River Experimental Forest, 3. Portland, Oreg.—Wind River Experimental Forest and 4. Cloquet Experimental Forest, Minn.

The regions of observations are all situated between about 45° and 52° N. lat., thus approximately on degrees of latitude corresponding to Central Europe. A great part of them are in the Rocky Mountains or in their neighbourhood and the importance of others is in principle restricted to purposes of comparison. On the basis of information available some main characteristics of these observation regions are described in the following and on the basis of notes made on the spot also the different sample plots.

I. CANADA.

1. The Region of Sicamous-Kamloops-Ashcroft.

This region for study is situated in the centre of the southern part of British Columbia near the banks of the upper course of Thompson river. It belongs to the Great Interior Plateau which lies between the Rocky Mountains and the Selkirk and Coastal ranges and in its southern portion known as the Interior Dry Belt.[1] This semi-aridic region is characterised by a low precipitation and great extremes in temperature. Precipitation and temperature in the valley of Thompson river are shown by the following mean values presented by the meteorological stations of Salmon Arm (12 years' observations) and Kamloops (32 years' observations).[2]

[1] See: *Forests of British Columbia.* By H. N. Whitford and Roland D. Craig, under the direction of Clyde Leavitt. Commission of Conservation Canada, Ottawa 1918.
Forests and Forestry in British Columbia, Canada. By Hon. T. D. Pattullo, G. R. Naden and P. Z. Caverhill. Victoria, B. C., 1926.

[2] See: *Monthly Record of Meteorological Observations in the Dominion of Canada and the Colonies of Bermuda and Newfoundland*, 1923. Issued by the Meteorological Service of Canada, Ottawa.

Month:	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	I—XII
						Precipitation in inches:							
Salmon Arm	3.03	1.46	1.05	1.13	1.22	1.78	1.38	1.29	1.13	1.33	2.15	2.47	19.42
Kamloops	0.90	0.80	0.32	0.36	0.93	1.23	1.27	1.05	0.94	0.59	1.05	0.85	10.29

	Mean temperature (Fahrenheit):												Max.[1]	Min.[1]
Salmon Arm	*21*	25	35	46	54	61	*67*	67	56	45	35	25	44.8	100	— 30
Kamloops	*22*	26	38	50	58	65	*70*	68	58	48	36	28	47.3	103	— 31

The annual snowfall was e.g. in the year 1923 in Salmon Arm 82 inches and in Kamloops 18 inches.

These observations made by these stations of the river valley do not, however, hold good regarding those tracts, in which the sample plots in question were investigated. With the exception of a couple they are situated at a distance of about 3 to 20 miles from Thompson river and are at an elevation of between about 3 000 and 5 000 feet above sea-level, Salmon Arm and Kamloops being at an elevation of 1 159 feet. The data obtained show that over all the areas of investigation precipitation is at least as high as in Salmon Arm and the annual mean temperature, and maximum and minimum, lower than both in Salmon Arm and Kamloops. Thus the annual precipitation on Mount Ida is about 25 inches, in the tract of Trout Lake 19—21 inches and in that of Barnes Creek 18—20 inches and in Sicamous 22.5 inches, the annual mean temperature being respectively: 40.0, 37.0 and 39.0° F., the maximum temperature: 96, 94 and 95° and the minimum temperature —35, —45 and —45°.[1] In the river valley and on slopes inclining to it and on low benches, where precipitation is lowest (about 7″) and summer temperature highest, the semi-aridic conditions very often, for instance in the tracts of Kamloops and Ashcroft, prevent the formation and development of tree vegetation. Here the principal vegetation consists of *Artemisia tridentata*. Only in such places, where streams and seepage from the hills increase the soil-moisture, the intrusion and thriving of yellow pine (*Pinus ponderosa*)

[1] According to the information of Mr. Adrian C. Thrupp, Forest Engineer at the Kamloops District Office.

is possible to any extent. In moving from this belt farther from the river and higher, the yellow pine becomes more common and (at about 2 000 feet) forms rather sparse, but fairly continuous forests. The yellow pine region is often succeeded by the Douglas fir region (at an elevation of about 3 000 feet), which together with the Douglas fir-western larch (*Larix occidentalis*) belt has probably originally comprised the chief part of the area at a high elevation. Lodgepole pine (*Pinus Murrayana*) has, however, after many devastating fires, taken possession of a great portion of the lands at a high elevation and likewise the main part of the earlier spruce (*Picea engelmannii*)-Alpine fir (*Abies lasiocarpa*)-region at the highest elevations. It has spread in many places as a mixed tree to yellow pine and Douglas fir regions.

On the excursions made in this region I was exceedingly courteously guided by Mr. Adrian C. Thrupp, Forest Engineer at the Kamloops District Forest Service. The notes were made on the 8th —13th of August.

Sample plots.

No. 1: Highland Valley. Elevation about 4000 feet. Even, dry gravel-sand soil. Uniform, in 1922 thinned lodgepole pine stand. Age about 75 years. Average height of dominant trees 40 feet and approximate average breast-height diameter of the same 4 inches.[1] Density 0.8.[2]

No. 2: As No. 1 but unthinned. Density 0.9—1.0.

No. 3: Highland Valley. Elev. about 4 000 feet. Rather even, dry soil. Somewhat open stand of lodgepole pine. Age about 80 years. Height 40 feet. Diameter 4—5 inches. Density 0.7.

No. 4: Near the former. Very open, old stand with young growth in the openings. Age about 200—250 years. Height 60—65 feet. Density 0.4—0.5.

No. 5: Near Trout Lake. Slope slightly inclining to SSE. Elev. about 4 300 feet. Uniform, unthinned lodgepole pine stand. Age 50 years. Height 40 feet. Diameter 5 inches. Density 0.9—1.0.

[1] See p. 32.

[2] See p. 32.

No. 6: As No. 5 but thinned in 1921. Density 0.8.

No. 7: Near Barnes Creek. Rather level. Elev. about 4 400 feet. Somewhat uneven, thinned stand of lodgepole pine. Age 55 years. Height 46—48 feet. Diameter 5 inches. Density varies between 0.7—0.9.

No. 8: Highland Valley. Rather even land. Elev. about 4 000 feet. Uniform and dense lodgepole pine stand. Age 65 years. Height 52—56 feet. Diameter 6 inches. Density 0.9—1.1.

No. 9: Near Barnes Creek. Elev. 4 400 feet. Rather sparse but in groups dense stand of lodgepole pine. Age 66 years. Height 54—60 feet. Diameter 7 inches. Density 0.7—0.9.

No. 10: Highland Valley. Elev. about 4 000 feet. Slope slightly inclining to W. Uniform stand of lodgepole pine. Age 128 years. Height 60—70 feet. Diameter 8—9 inches. Density 0.9—1.0.

No. 11: Near Salmon River. Elev. about 1 200—1 300 feet. Level, dry sandy soil. Lodgepole pine stand, sparse and open because of cuttings. Slightly burnt about 30 years ago and now inside pasture area. Age about 130 years. Height 80 feet. Density 0.5—0.6.

No. 12: Near Barnes Creek. Elev. 4 700—5 000 feet. Stony but, nevertheless, rather thick soil, inclined to W. Dense stand of rather tall lodgepole pine, some Douglas fir mixed. Age 230 years. Height 80—85 feet. Diameter about 13 inches. Density 0.9—1.0. — Close to this place there was another stand of the same age, but on very stony and thin soil, because of which the development of the stand was poorer and much slower.

No. 13: Near Trout Lake. Elev. about 4 300 feet. Slope, slightly inclining to E. Rather sparse lodgepole pine stand. Age about 55 years. Height 55 feet. Diameter 6—7 inches. Density 0.7.

No. 14: Near Trout Lake. Elev. about 4 200 feet. Slope slightly to N inclining. Uniform lodgepole pine stand with some mixture of poplar. Age 60—65 years. Height about 58—60 feet. Diameter 7 inches. Density 0.9.

No. 15: Near Trout Lake. Elev. about 4 400 feet. Rather level land. Uniform and very nice stand of lodgepole pine, with some small spruce and Alpine fir (*Abies lasiocarpa*) under; only dead trees have been felled. Age 127 years. Height 85—90 feet. Diameter 11—12 inches. Density 0.9—1.0.

No. 16: Highland Valley. Elev. about 4 000 feet. Slope slightly to NE inclining. Uniform and nice stand of lodgepole pine with some poplars as mixed trees. Age 140 years. Height 90—100 feet. Diameter 13—14 inches. Density 0.8.

No. 17: Barnes Creek but rather near Ashcroft. Elev. between 2 000—3 000 feet. Slope, inclined to NNW. Open and sparse Douglas fir stand with partly very dense, partly open young growth of Douglas fir. Inside pasture area. Age 200—400 years, young growth 20—40 years. Height 120—130 feet, young growth 5—25 feet. Diameter 2—3 feet. Density 0.3—0.6, young growth 0.4—1.2.

No. 18: Mount Ida.[1] Elev. about 2 000 feet. Slope, inclining to N. Uniform and nice stand of dense lodgepole pine, with some spruce, Douglas fir and in places red cedar (*Thuja plicata*) and maple under. Age 46 years. Height about 50 feet. Diameter about 6 inches. Density 0.9—1.1.

No. 19: Mount Ida. Elev. about 3 000 feet. Slope, inclining to S and SW, but sheltered from too much heat by a mountain situated on the opposite side. Fairly light loam, in places almost sandy. Uniform and nice stand of lodgepole pine with some mixture of birch and some spruce, red cedar, Alpine fir and maple under. Age 95 years. Height 95—100 feet. Diameter 15 inches. Density 0.9.

No. 20: Mount Ida. About 1/2—1 mile from the former. Uniform stand of lodgepole pine (70 %) with some mixture (30 %) of Douglas fir, spruce, and fir and red cedar, western hemlock and maple under. Age about 100 years. Height about 100—105 feet. Diameter about 15 inches. Density 0.9.

No. 21: Near Sicamous railway station. Elev. about 1 200 feet. Steep slope to N. Rather sparse stand of Douglas fir and red cedar with some pine and birch as mixed trees and dense undergrowth of red cedar, Douglas fir, maple and some poplar and birch, mostly red cedar. About 5—10 years ago many big trees have been felled. Age 100—120 years. Height about 100—105 feet. Diameter of dominant Douglas firs about 20—25 inches. Density 0.5—0.7 and of the younger undergrowth 0.8—1.2.

No. 22: Mount Ida. Elev. about 3 900 feet. Narrow valley with a small stream in the middle, inclining towards N; wet close to the stream only.

[1] Mount Ida does not belong to the proper Dry belt, but rather to a Transition belt between the Dry belt and the Wet belt.

Rather dense stand of red cedar, Alpine fir and less of some other species. Age about 100—150 years. Height 130—150 feet. Diameter about 2 feet. Density 0.7—0.9.

No. 23: Mount Ida. Elev. about 4 000 feet. On both sides of the valley (sample plot No. 22) mentioned above, and inclining partly to the same and partly to N. Very dense mixed stand of Engelmann spruce, Douglas fir, Alpine fir, red cedar, western hemlock and western white pine, with dense undergrowth of several of these species and especially of red cedar. The ground is to a great extent covered by fallen rotting trees. Age 120 years. Height about 130—140 feet. Diameter (Douglas fir) 22—23 inches. Density 0.9—1.2.

No. 24: Mount Ida. Elev. about 3 000—3 500 feet. Narrow valley with a small stream in the middle; wet close to the stream only. Mixed stand of Douglas fir, Engelmann spruce, western paper birch (*Betula papyrifera occidentalis*), mountain alder (*Alnus tenuifolia*), some red cedar and willow, with some small red cedar and western white pine. Density 0.6—0.8.

2. The Region of Banff — Yoho Valley.

This region of study is situated in the Rocky Mountains, chiefly in the neighbourhood of the town of Banff on the western boundary of Alberta and for a small part in the vicinity of Yoho Valley on the side of British Columbia. The elevation of Banff above the sea-level is 4 538 feet, but some of the sample plots are at a higher altitude. Precipitation and temperature are shown by the following mean values for Banff (28 years' observations).

Month:	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	I–XII
Precipitation in inches:	1.12	0.81	1.48	1.56	2.69	3.19	2.66	2.39	1.75	1.14	1.67	1.17	21.63
Mean temperature (F.):	*14*	17	22	36	45	51	*57*	55	46	40	24	20	35.6

The annual snowfall as a mean of Banff and Lake Louise was e.g. in 1923 76 inches.

These figures naturally do not hold good as regards the sample plots considerably higher than Banff.

The principal species of tree in the region of Banff is lodgepole pine which has become so dominant after many severe forest fires. Almost all forests were burnt in the course of the last 60—100 years and, in general, the forests belong to the age-classes 40—60, 60—80 and 80—100 years. In many places, where new forest has notcome up, the slopes are, after the fires, still full of burnt trunks lying flat on the ground. The limits of occidental fires are often very distinctly shown by the limits between the age-classes. In valleys, especially on wet soil along the riversides and brooks and also on slopes in moist draws spruce is the predominating species of tree and here and there it occurs as mixed tree in lodgepole pine forests. Even birch is not quite rare. In the tracts of Yoho Valley spruce occurs as the principal species of tree. Here and there on the slopes considerable areas of pure aspen forest are seen; here the aspen is short (10—25 feet) and often crooked. On the highest slopes and on lower mountains Engelmann spruce is found here and there and very high up some whitebark pine (*Pinus albicaulis*) and Alpine fir. The southern and southwestern slopes are in general much drier and the forest there sparser than the northern and eastern slopes.

The excursions in Banff and Yoho Valley were most courteously led by Mr. C. H. Morse, District Forest Inspector, and Mr. H. L. Holman, Forest Engineer, and on Cypress Hills by the same and Mr. H. Parker, Forest Supervisor. The notes were made during the time between July 30th and August 6th.

Sample plots.

No. 1: Between Banff and Cascade Mountain. Elev. about 4 800 feet. Slope inclining to SE and SSE, but to some extent sheltered by an opposite mountain. Uniform, rather dense lodgepole pine stand. Age 45 years. Height 30—33 feet. Diameter 4 inches. Density 0.9—1.0.

No. 2: Between Banff and Cascade Mountain. Elev. about 4 650 feet. Slope inclining slightly to SE and E. Very dense stand of lodgepole pine with some poplars as mixed trees and rather dense spruce under. Age 60 years. Height 45—47 feet. Diameter about 6 inches. Density 1.0—1.1.

No. 3: Near Golf Links. Elev. about 4 600 feet. Low part of a slope slightly inclining to NE. Dense stand of lodgepole pine with some mixture of spruce and spruce undergrowth. Age about 70 years. Height 45—48 feet. Diameter about 6 inches. Density 1.0.

No. 4: Near Spray River. Elev. about 4 600 feet. South slope, stony and in places rock-bound as the southern slopes in general. Open and sparse stand of lodgepole pine. Age 85 years. Height 40—43 feet. Density 0.6—0.7.

No. 5: Near Spray River. Elev. about 4 550 feet. Rather level ground. Uniform, nice stand of lodgepole pine, with some spruce under; thinned rather slightly about 8—10 years ago. Age 82 years. Height about 50 feet. Diameter about 7 inches. Density 0.8—0.9.

No. 6: Sulphur Mountain. Elev. about 5 500—6 000 feet. North slope. Rather dense stand of lodgepole pine. Age 90 years. Height 38—40 feet. Diameter 5—6 inches. Density 0.8—0.9.

No. 7: Sulphur Mountain. Elev. about 6 000 feet. Steep NE slope. Rather uniform and dense stand of lodgepole pine, with some spruce and Alpine fir under. Age about 200 years. Height about 55 feet. Diameter 9—10 inches. Density 0.8—0.9.

No. 8: Near Spray River. Elev. about 4 600 feet. Steep slope to NE. Slowly growing lodgepole pine stand, with mixture (about 30 per cent) of spruce. Age 200 years. Height 60 feet. Diameter about 10—12 inches. Density 0.6.

No. 9: Near Yoho Valley. Elev. about 4 600 feet. Low part of a steep slope to E. Rather sparse stand of Engelmann spruce, Alpine fir and some lodgepole pine. Age 170—220 feet. Height 70—75 feet. Density 0.7.

No. 10: South end of Cascade Mountain. Elev. about 4 850 feet. Rather steep slope to S and SE. Sparse stand of Douglas fir with some mixture of lodgepole pine and sparse spruce and Douglas fir under. About $^1/_3$—$^1/_2$ of the big trees have been cut several years ago. Some decades ago the place was slightly burnt. Age 200—250 years. Height 80—85 feet. Diameter 20—25 inches. Density 0.5—0.7.

No. 11: Yoho Valley. Elev. about 5 500 feet. Low part of NE slope. Fertile soil with rich vegetation. Rather dense stand of Engelmann spruce, white spruce and some Alpine fir with young growth of the same species under. Age 150—200 years. Height 100—120 feet. Density 0.7—1.0.

3. Cypress Hills.

This area of study is situated on both sides of the boundary between the southern parts of the provinces of Saskatchewan and Alberta. The Cypress Hills are a dissected plateau and form, as it were, a large forest island in the surrounding extensive »sea» of prairie. The main part of them, the western and centre block, which bear a stand of conifers, cover an area of 154 square miles. The general elevation of the hills varies from 4 200 to 4 800 feet. Of the whole forest reserve about 60 per cent is covered with forest which consists almost exclusively of lodgepole pine.[1] On the northern and eastern slopes the forest is in general better than on the southern and western slopes. On the richest slopes and depressions aspen and in some places white and black spruce grows. Aspen often forms the timber line on the top of the hills. It is then, in general, low and crooked like birch on the Alpine timber lines of Finnish Lapland. The top of the plateau is mostly open grazing land. The forests were burnt about 40—60 years ago, whereupon the present dense, usually about from 30 to 50 years' old even-aged lodgepole pine forests have grown.

The climate of the Cypress Hills is considerably less arid than that of the surrounding, in general, 1 500—2 500 feet lower prairies. Precipitation is shown by the 8 years' mean values given below, which are based upon measurements taken at the Headquarters of Cypress Hills National Forest, Coulee, Sask., elevation 3 756 feet.[2] Data concerning the mean temperature were not available, so that only the mean values of the observations of the adjacent prairie-stations in Maple Creek and Shaunavon are mentioned. It should, however, be remembered that their climate is considerably more arid than that of Cypress Hills.

[1] See the papers of C. H. Morse (in the October number of the Illustrated Canadian Forest and Outdoors, 1925) and H. A. Parker (The Forestry Chronicle, No. 2, 1927) on The Cypress Hills.

[2] The data were kindly supplied by H. Parker, Supervisor of the Cypress Hills National Forest.

Month:	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	I–XII
Precipitation in inches:	1.05	0.90	1.62	1.79	1.65	3.15	2.31	1.23	2.04	1.01	0.91	0.77	18.43
Mean temperature (F.):	*9*	10	20	39	51	59	*63*	62	50	40	24	19	37.2

The mean annual snowfall is according to 8 years' observations of Coulee, Sask. station 70 inches.

Sample plots.

No. 1: Near the house of the Supervisor. Slope to SW. Dense stand of lodgepole pine. Age 30 years. Height 23—26 feet. Density 0.9—1.0.

No. 2: Not far from the former. Rather steep slope to N. Here and there some conglomerates. Sparse stand of lodgepole pine. Age about 35 years. Height 28—31 feet. Density 0.6—0.8.

No. 3: Not very far from the former. Elev. about 4 200 feet. The top of a hill and its slope to E. Rather dense stand of lodgepole pine. Age 40 years. Height 29—31 feet. Density 0.8—0.9.

No. 4: As the former but W-slope. Height about 33 feet. Density 0.9.

No. 5: Dense stand of lodgepole pine on level ground. Age 40 years. Height 30—34 feet. Density 0.9—1.0.

No. 6: Near Elkwater Lake. Elev. about 4 600 feet. Exceptionally dense stand of lodgepole pine (approximately 15—20 thousand trees per acre). Age about 40 years. Height 16—20 feet. Diameter 3 inches. Density exceptional.

No. 7: Near Elkwater Lake. Elev. about 4 500 feet. Partly level, partly slope inclining to E. Dense lodgepole pine stand, thinned about 5 years ago. Age 40 years. Height 35—36 feet. Density 0.9—1.0.

No. 8: Near the former, but moister soil. Height 40—42 feet. Density 0.8—1.0.

No. 9: Not far from the former. Elev. about 4 400 feet. Rather steep slope to E. Open white spruce stand with mixture of aspen. Age 90—110 years. Height about 70—75 feet. Density 0.5—0.8.

No. 10: Near No. 3, but more fertile soil. NE-slope. Sparse aspen and some white spruce.

4. The tract of Glenwater, Ont.

The sample plots examined in this tract are situated in the neighbourhood of the Canadian National Railway station Glenwater about 40—50 miles north-west of Port Arthur and thence about 3—5 miles southward, where the writer happened to make excursions with Mr. K. JUSTIN, a Finnish-born contractor. The elevation above sea level is about 1 100—1 300 feet. The soil seems to be rather dry sandy loam. Cleared into a natural meadow luxuriant clover seems to grow abundantly here. The ground is very hilly, between the hillocks there are at times quite narrow, at others rather broad depressions in which there is often a small rivulet and the soil is somewhat wet, growing luxuriant fern. In this quite uninhabited region the forest chiefly consists of about 50—70 years old, fairly even jack pine (*Pinus banksiana*), which creeps from the foot of the hillocks up to their top. Birch, aspen and other broadleaf-trees as also spruce are found especially in the depressions. The climate is approximately shown by the following mean values calculated according to the observations of the meteorological stations of Kakabeka Falls (15 years' observations) and Savanne (21 years' observations).

Month:	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	I–XII
Precipitation in inches:	1.44	1.39	1.45	1.48	2.18	2.62	3.55	3.09	3.11	2.41	1.44	1.28	25.44
Mean temperature (F.):	*—1*	+1	16	35	47	57	*62*	58	50	38	23	8	32.8

As is shown by the figures, the climate is quite a continental one. The difference between the mean temperatures of the coldest and the hottest month is 63°, it being e.g. in Banff only 43°. The annual snowfall was e.g. in 1923 58 inches.

The notes were made on the 26th and 27th of July.

Sample plots.

No. 1: Slope slightly inclining to E. Sparse jack pine stand. Age 35 years. Height 40—42 feet. Density 0.6.

No. 2: Slope slightly inclining to E. Jack pine stand with 4—8 feet high alder under. Age 49 years. Height 50—55 feet. Diameter 7—8 inches. Density 0.6—0.8.

No. 3: The top and S-slope of a low hill. Jack pine stand. Age 60 years. Height 58—60 feet. Diameter 9—10 inches. Density 0.6—0.9.

No. 4: Slope slightly inclining to W. Nice stand of jack pine with some aspen as mixed trees. Age 60 years. Height about 60 feet. Density 0.8—1.0.

No. 5: North slope. Nice stand of jack pine. Age 65 years. Height about 60 feet. Density 0.7—0.9.

No. 6: North slope. Dense pure stand of aspen. Age 50 years. Height 55 feet. Density 0.8—1.0.

5. Petawawa Experimental Forest.

Petawawa Experimental Forest is situated in the Province of Ontario, about 120—130 miles to the west of Ottawa. The elevation above sea-level is about 400—600 feet. The present forests have come up after fires. On the main part of the area the forests are about 40—60 years old, and on a smaller part of the area, about 30 years. There are some scattered patches of older timber. The most extensively distributed types are the poplar-white birch and white pine-Norway pine forests. All degrees of mixture from pure pine to pure poplar-birch can be found. There are even considerable areas of jack pine, white spruce and balsam fir, also areas of oak and other hardwoods, the oak mostly being confined to the tops of hills.[1]

The climate is closely shown by the following mean values of Pembroke meteorological station (28 years' observations) situated rather near Petawawa:

Month:	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	I—XII
Precipitation in inches:	2.46	1.98	2.36	2.99	3.50	3.47	3.75	2.96	4.14	2.52	3.82	3.04	36.99
Mean temperature (F.):	*10*	14	22	39	54	64	*69*	66	57	45	30	18	40.7

[1] See e.g.: *British Empire Forestry Conference*, Canada 1923. Programme section 3. Ottawa, 1923.

The annual snowfall was e.g. in 1923 106 inches.

In the very interesting Experimental Forest the writer was able to make excursions during some days very kindly guided by Messrs. W. M. Robertson and G. A. Mulloy from the Dominion Forest Service at Ottawa. The notes were made on the 21st to 23rd of July.

Sample plots.

No. 1: Level ground near Petawawa River. Nice dense stand of red pine (*Pinus resinosa*) and white pine (*Pinus strobus*) and some jack pines Age 30 years. Height about 45 feet. Density 0.9.

No. 2: Rather level ground. Mixed stand of white pine and red pine with some white spruce, balsam fir, sugar maple and black oak. Age 50 years. Height about 55 feet. Density 0.8—1.0.

No. 3: Slightly inclining ground. Nice stand of white and red pine. Age 60 years. Height about 60 feet. Density 0.9.

No. 4: Level ground. Rather dense stand of white pine with some red pine mixed. Age 80 years. Height about 70—75 feet. Density 0.8—0.9.

No. 5: Level ground. Jack pine stand with some white pine, poplar and birch mixed. Age 60 years. Height about 65 feet. Density 0.7.

No. 6: Rather sparse jack pine stand with some smaller red and white pine and balsam fir. Age 70 years. Height about 70—75 feet. Density 0.6—0.7

6. The tract of Kazubazua, Ont.

The sample plots examined in this region are situated east of the C.P.R. Kazubazua Railway station about 50 miles north of Ottawa, Ont., in the vicinity of the village of Kazubazua. The elevation above sea-level is somewhat greater than that of Ottawa, which is 294 feet. The sample plots are all taken from an even, sandy area, of the extent of about 2—3 miles, where the forests have apparently grown up after fire. The forests are, as it were, islets in the midst of extensive fire areas. Farther off there are high rocky hills which are partly bare, partly covered with broadleaf-trees and thin coniferous forest.

On the basis of observations made for some considerable time the climate of these regions is shown only by the observations of the Ottawa station (for a period of 30 years). By somewhat correcting them in a direction shown by the observations of the stations of Maniwaki and Mount Laurier situated further north, the following mean values will be arrived at:

Month:	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	I–XII
Precipitation in inches:	2.68	2.36	2.46	2.61	2.48	3.00	3.43	2.85	2.86	2.89	2.58	2.76	32.96
Mean temperature (F.):	*10*	14	22	39	54	64	*69*	66	57	45	30	18	40.7

These mean values may represent the tract in question, at least in its main features. The annual snowfall was e.g. in 1923 about 106 inches.

The notes were made on the 18th and 19th of July.

Sample plots.

No. 1: Small white pine stand inside pasture area. Age 42 years. Height 50—55 feet. Density 0.8.

No. 2: A low hillock. White pine and some red pines, with some balsam fir and cedar under, inside pasture area. Age 57 years. Height 60—62 feet. Density 0.8—0.9.

No. 3: Nice stand of jack pine. Age 62 years. Height 70—75 feet. Diameter 8—9 inches. Density 0.9.

No. 4: Jack pine stand. Age 64 years. Height 70—75 feet. Density 0.7—0.8.

No. 5: As the former and rather near it.

No. 6: Slightly to E inclining ground. Jack pine stand. Age 65 years. Height 70—75 feet. Density 0.6—0.8.

No. 7: West end of the former stand. Age 65—69 years. Height 70—75 feet. Density 0.6—0.7.

7. Laurentides Park.

The observations made at Laurentides Park were concentrated on the tracts of Little Lake á l'Épaule and Lake Ruban about 50—60 miles northward from the city of Quebec. About 60—70 per cent of the forests of these tracts are estimated to be balsam fir, the remainder being white spruce and broadleaf-trees. On both sides of the lakes and river valley, hills about 150—200 feet high rise, which up to the top are usually covered with a similar forest and with a very similar ground vegetation. Only in wet places, where surface water is running, the vegetation is noticeably exceptional, comprising ferns very abundantly. The elevation above sea-level is about 2 000—2 500 feet. There is probably no meteorological observation station nearer than that in the city of Quebec to the south, whose elevation above sea-level is about 300 feet, and another 50 miles to the north in Chicoutim, the elevation of which is 150 feet only. The averages of these stations during 48 and 43 years — partly compared also with the figures of the station at Roberval — are represented by the following figures:

Month:	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	I–XII
Precipitation in inches:	2.63	2.36	2.83	2.12	2.61	3.47	4.06	3.68	3.33	2.60	2.33	2.32	34.34
Mean temperature (F.):	*3*	5	20	35	50	60	*65*	61	54	43	29	12	36.4

The annual snowfall was in Quebec e.g. in 1923 134 inches.

The notes were made on the 14th and 15th of July.

Sample plots.

No. 1: On the top of a hill near the Little Lake á l 'Épaule lumber camp. After a cutting made some years ago now only a few birches.

No. 2: Close to the former. Somewhat uneven balsam fir stand with some big birches as hold-overs. Age about 35 years. Height 35—40 feet. Density 0.6—0.9.

No. 3: A slope inclining slightly to E, on about 150 feet lower elev. than the former. Balsam fir. Age 60 years. Height 50—53 feet. Density 0

No. 4: Close to the former. Stony E-slope. The greater part of the principal stand was cut 2 years ago and now there is only a very sparse stand of old balsam fir and yellow birch, but a dense new growth of balsam fir. Age 80—100 (new growth 10—30) years. Height 65 (20 feet.) Density 0.3—0.6 (0.8—1.2).

No. 5: Between Little L. à l'Épaule and Lake Ruban. SE-slope. Balsam fir and some yellow birch. Age 120 years. Height about 70 feet. Density 0.8.

No. 6: Near Lake Ruban. Rather level ground. Old balsam fir and some birch, with a dense undergrowth of balsam fir. Age 120 years. Height 70—80 feet. Density 0.8.

No. 7: Near the former. Level, somewhat stony ground. Old balsam fir and some birch, with balsam fir undergrowth. Age about 120 years. Height 70—80 feet. Density 0.9—1.0.

8. *The tract of Vancouver, B.C.*

For the sake of comparison some notes were made in the neighbourhood of the city of Vancouver, B.C. The forest is formed in these areas chiefly of Douglas fir, red cedar, western hemlock, lowland fir (*Abies grandis*), Amabilis fir and Sitka spruce. The following mean values of precipitation and temperature show, how considerably the climate of Vancouver (22 years' observations) differs from that of all the abovementioned areas:

Month:	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	I—XII
Precipitation in inches:	8.56	6.22	4.46	3.09	3.56	2.82	1.33	1.71	4.29	5.69	11.28	7.95	60.96
Mean temperature (F.):	*35*	38	42	47	54	58	*63*	62	56	49	42	38	48.7

The annual snowfall was e.g. in 1923 44 inches.

The notes were made between the 17th and 21st of August.

Sample plots.

No. 1: »Green Timber», near New Westminster. Very heavy stand of Douglas fir, red cedar and some western hemlock and spruce. Age about 250—400 years. Height about 200 feet. Density 0.8—1.0.

No. 2: Stanley Park. A mixed stand of Douglas fir, red cedar, western hemlock and some big fir. Some big trees cut a long time ago. Old rotting trunks lying on the ground. Age varies between about 100—250 years. Height about 150—200 feet. Density 0.8—1.0.

No. 3: Grouse Mountain. Elev. about 2 500—3 000 feet. Steep slope to SE and E, but sheltered by an opposite steep slope. The ground is in places very stony. Heavy stand of Amabilis fir, lowland fir, spruce, Douglas fir and some red cedar and mountain hemlock. Age 250—300 years. Height about 170 feet. Diameter 2 feet and more. Density 0.7—1.0.

II. UNITED STATES.

1. Yellowstone National Park.

Yellowstone National Park is located, as is well known, in northwestern Wyoming, encroaching slightly upon Montana and Idaho. The central portion is essentially a broad, elevated, volcanic plateau, between 7 000 and 8 500 feet above sea-level. Surrounding it on the south, east, north, and northwest are mountain ranges with culminating peaks and ridges rising from 2 000 to 4 000 feet above the general level of the enclosed table-land. Not only the surrounding mountains, but the great interior plain is made of material once ejected, as ash and lava, from depths far below the surface.

About 85 per cent of the land area of the Yellowstone National Park is covered with forest and about 80 per cent hereof is in turn lodgepole pine. The remaining portion is Douglas fir, some spruce, poplar and some other species of trees. Almost all the descriptions of vegetation here are made in lodgepole pine forests and only for the sake of comparison a couple of observations in the forests of other species of trees. Lodgepole pine rises very high on the mountain slopes and usually only the highest tops of the mountains are quite treeless.

The climate of the Yellowstone National Park is on an average shown by the following observations of the Yellowstone Lake station (elev. 7 760 feet):

Month:	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	I–XII
Precipitation in inches:	2.90	1.98	2.73	1.66	2.64	2.20	1.83	1.23	1.58	2.28	1.56	1.83	24.42
Mean temperature: (F.):	11.9	13.8	21.1	29.8	37.2	46.2	53.5	53.4	45.2	35.5	24.6	12.4	32.0

In the region of Grand Canyon (elev. 7 800 feet) the annual precipitation is 22.15 inches and mean annual temperature 32.3°, in that of Upper Geyser Basin (elev. 7 400 feet) correspondingly 21.47 inches and 34.7° and on such a relatively low altitude as that of Mammoth Hot Spring head-quarters (elev. 6 239 feet) correspondingly 18.29 inches and 38.7°. Thus the last precipitation mentioned is noticeably lower than the average one, and the mean temperature on the contrary higher than the average.[1]

The annual snowfall is at Yellowstone Lake on an average 180 inches (Grand Canyon 165, Upper Geyser Basin 143 and at the elev. of 6 200 feet 100 inches).

The notes were made between the 1st and the 7th of September.

Sample plots.

The sample plots No. 14, 15 and 20 are located near Yellowstone Lake, No. 1, 2, 4, 5, 9, 10, 12, 13, 17 and 18 near Grand Canyon, No. 3, 6, 7, 8, 11, 16, 19 and 25 at the Upper Geyser Basin and No.21, 22, 23 and 24 near Mammoth Hot Springs. Because the notes were made during a 5 days' standard tour all the examined plots were located rather near the camps.

No. 1: Near Inspiration Point. Elev. 7 800 feet. Uneven stand of young lodgepole pine with some old hold-overs. Age about 50 years. Height 26 feet. Density 0.7—1.1 (hold-overs 0.4).

No. 2: Near Artist Point. Steep slope to N on the edge of Grand Canyon. Uneven stand of lodgepole pine and some balsam fir. Age 120 years. Height 50—55 feet. Diameter about 7 inches. Density 0.6—0.8.

[1] The meteorological data concerning the areas of study in the U.S.A. are presented according to: *Summaries of Climatological Data by Sections.* Prepared under the direction of *Charles F. Marvin.* U.S. Department of Agriculture Weather Bureau, Washington, D.C. 1926.

No. 3: Near Old Faithful Geyser. Stony NE slope. Lodgepole pine. Age 180 years. Height 55 feet. Diameter 8 inches. Density 0.7—0.9.

No. 4: Near Artist Point. Level ground between two low hills. Lodgepole pine. Lots of dry fallen trees on the ground. Age 180 years. Height about 60 feet. Diameter 8—9 inches. Density 0.7—0.8.

No. 5: Near the camps. Steep and rather stony slope to N. Lodgepole pine. Age 180 years. Height 60—65 feet. Diameter 9 inches. Density 0.8.

No. 6: Near Old Faithful camp. Stony and in places rock-bound ground, slightly inclined to N. Uneven-aged and partly open stand of lodgepole pine with some hold-overs. Age 130—190 years. Height 47—55 feet. Diameter about 8 inches. Density 0.6—1.0.

No. 7: Near the former. Level ground. Lodgepole pine. Age 170—190 years. Height 65 feet. Diameter 8—9 inches. Density 0.9.

No. 8: Near Old Faithful Geyser, but on about 300 feet higher elev. Slope inclining slightly to S near the top of a hill. Rather sparse stand of lodgepole pine. Age 180—200 years. Height 45—50 feet. Diameter 9—10 inches. Density 0.6—0.9.

No. 9: Near Inspiration Point. Uneven stony ground. Rather sparse stand of lodgepole pine. Age 190—200 years. Height 55—60 feet. Diameter 9 inches. Density 0.7.

No. 10: Near the former. Level ground. Uniform lodgepole pine. Age 190—200 years. Height 55—60 feet. Diameter 8—9 inches. Density 0.9.

No. 11: Near Old Faithful Geyser. Stony slope to NE. Lodgepole pine. Age 180—210 years. Height 57—60 feet. Diameter 8—9 inches. Density 0.8.

No. 12: Near Grand Canyon camp. Slope inclining slightly to E. Rather sparse stand of lodgepole pine. Age 100 years. Height 65—68 feet. Diameter 10—11 inches. Density 0.6—0.7.

No. 13: Near Artist Point. NE-slope. Rather sparse lodgepole pine with a few spruce and fir as mixed trees. Age 120 years. Height about 70 feet. Diameter 11 inches. Density 0.6—0.7.

No. 14: Near Yellowstone Lake camp. Level ground. Rather sparse stand of lodgepole pine. Age 120—130 years. Height 65—70 feet. Diameter about 12 inches. Density 0.6—0.7.

No. 15: Like the former, but density 0.8 and diameter 11 inches.

No. 16: Near Old Faithful camp. Slope inclining to S and W. Rather sparse lodgepole pine. Age 130 years. Height 65—68 feet. Diameter 11 inches. Density 0.6—0.7.

No. 17: Near Grand Canyon hotel. Slightly inclining to NE. Nice stand of lodgepole pine. Age 170—190 years. Height about 80 feet. Diameter about 11 inches. Density 0.8—1.0.

No. 18: Near Grand Canyon camp. N-slope. Open lodgepole pine stand with some fir under. Age 180 years. Height 80—85 feet. Diameter about 13 inches. Density 0.5—0.7.

No. 19: Near Old Faithful Geyser. Slope inclining to S. Open stand of lodgepole pine. Age 180—190 years. Height 70—75 feet. Diameter about 12 inches. Density 0.7.

No. 20: Near Yellowstone Lake hotel. Slope inclining slightly to E. Rather sparse stand of lodgepole pine. Age 180—200 years. Height about 80 feet. Diameter 12—13 inches. Density 0.7.

No. 21: NNE-slope of Bunsen Peak. Elev. about 7 700 feet. Sparse stand of poor poplar. Age 40—45 years. Height about 20—25 feet. Diameter 4—5 inches. Density 0.6.

No. 22: Near the former. Rather sparse stand of Douglas fir. Age about 80 years. Height about 60 feet. Diameter 11 (some trees 13) inches. Density 0.6—0.7.

No. 23: The same slope as the former, but on about 200—300 feet lower elev. Very dense small lodgepole pine. Age 40—45 years. Height 32—35 feet. Diameter 4—5 inches. Density 0.9—1.2.

No. 24: On about 100 feet lower elev. than the former. Young Douglas fir. Age 30—35 years. Height 20—25 feet. Diameter 4 inches. Density 0.8—1.1.

No. 25: Near Old Faithful camp. Lowest part of a NE-slope, along a small stream. Open stand of lodgepole pine and spruce on somewhat moist ground. Age about 100—120 years. Height 70—75 feet. Diameter about 14 inches. Density 0.6.

2 Priest River Experimental Forest.

his tract of study is situated in north Idaho and it comprises some notes from the Priest River Experimental Forest and adjacent forests. Common forest forming species of trees are: western larch, western white pine, lowland fir and Alpine fir, lodgepole pine, red cedar, western hemlock, Douglas fir, yellow pine, spruce, etc. A great fire devastated the forest over a large area some years ago. The elevation above sea-level is about 2 300—2 400 feet. The climate is shown by the following averages of the station (elev. 2 380 feet):

Month:	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	I–XII
Precipitation in inches:	3.79	2.96	2.77	2.18	2.55	2.00	1.34	1.30	1.96	2.28	4.30	3.63	31.06
Mean temperature (F.):	23.3	27.0	33.4	42.8	49.2	56.8	62.7	61.7	52.8	42.4	32.8	25.0	42.5

The annual snowfall is about 92 inches.

In Priest River Experimental Forest and the surrounding forests the writer was able to make excursions under the guidance of the director of the Experiment Station Mr. R. H. Weidman. The notes were made on the 8th and 9th of September.

Sample plots.

No. 1: Level ground. Lodgepole pine with some larch as mixed tree. Age about 70 years. Height about 75 feet (larch 90 feet). Diameter 10—11 inches. Density 0.8.

No. 2: Level ground. Lodgepole pine with some Douglas fir under. Age 45 years. Height 50—53 feet. Diameter 6—7 inches. Density 0.8—1.0.

No. 3: Level ground. Very dense stand of lodgepole pine. Age 40 years. Height 36—40 feet. Diameter 4 inches. Density 1.0—1.2.

No. 4: Level ground. Mixed stand of western larch, western white pine and red cedar with dense red cedar and western hemlock undergrowth. Age about 70 years. Height about 90 feet. Diameter 12 inches. Density 0.8—1.0.

No. 5: Ground inclining slightly to NE. Mixed stand of western larch, western white pine, some western hemlock, red cedar, Douglas fir and spruce. Age 65—75 years. Height 90—100 feet, (undergrowth 25 feet and less). Diameter about 13 inches. Density 0.8—1.0.

3. Portland, Oreg. — Wind River Experimental Forest.

In this tract one sample plot near the city of Portland and 3 sample plots in Wind River Experimental Forest, which is situated 60 miles to the east from Portland, were studied.

The following are especially common species of trees: Douglas fir, red cedar, western hemlock, lowland fir, western white pine, etc. The observations of the meteorological station at Portland (elev. 57 feet) are as follows:

Month:	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	I—XII
Precipitation in inches:	6.55	5.48	4.82	3.05	2.30	1.63	0.59	0.64	1.86	3.27	6.46	6.91	43.56
Mean temperature (F.):	*39.0*	42.0	47.0	51.6	57.1	62.0	*67.0*	66.6	61.5	54.3	46.4	41.5	53.0

The observations of the Wind River station (elev. 1 300 feet) are as follows:

Month:	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	I—XII
Precipitation in inches:	15.18	8.93	9.52	6.29	4.09	2.17	0.65	1.12	4.58	6.45	15.99	12.57	87.54
Mean temperature (F.):	*32.6*	35.5	40.6	45.9	51.9	58.9	*64.6*	64.6	57.1	48.8	40.8	34.6	48.0

The annual snowfall is in Portland 15 and at Wind River 115 inches.

In Wind River Experimental Forest the writer was able to make excursions under the guidance of Mr. A. G. Simson. The notes were made on the 25th and 26th of August.

Sample plots.

No. 1: Near the city of Portland. Steep slope on both sides of a deep valley with a small stream in the middle. Open forest of Douglas fir and some western hemlock and western red cedar with young growth of Douglas fir, hemlock, red cedar and some broadleaf-trees under. Age 150—250 years. Height 170—180 feet. Diameter about 2 feet. Density 0.5—0.8.

No. 2: Near Wind River Forest Experiment Station. Elev. about 1 300 feet. Level ground. Virgin forest of Douglas fir, lowland fir, western hemlock, some red cedar and western white pine. Age 250—300 years. Height about 180 feet. Diameter 3—4 feet. Density 0.7—0.9.

No. 3: NE-slope of Red Mountain. Elev. about 2 000 feet. Uniform stand of Douglas fir. Age about 85 years. Height about 90 feet. Diameter 35—40 inches. Density 0.9.

No. 4: About 1/2 mile from the former. Somewhat open and sparse stand of Douglas fir. Age about 85 years. Height about 85—90 feet. Diameter about 40 inches. Density 0.6—0.9.

No. 5: Not far from the former. W-slope. Uneven, slowly growing Douglas fir with some pine as mixed tree. Age 80—90 years. Height 50—55 feet. Density 0.6—0.9.

4. Cloquet Experimental Forest.

Cloquet Experimental Forest is located in northern Minnesota near the town of Cloquet. The Experimental Forest has representative areas of jack pine and red pine on medium sites, and a limited representation of aspen. The whole area, excepting the swamps, is situated on a sandy soil of the same geological origin, namely, the young red drift.[1] The meteorological station of Duluth (about 30 miles to the west from Cloquet Forest; elev. 1 133 feet) presents the following averages, which probably do not differ very much from those in the Cloquet Forest:

[1] *Lake States Forest Experiment Station Report to the Advisory Committee for 1926*, p. 7.

Month:	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	I—XII
Precipitation in inches:	1.04	0.97	1.56	2.03	3.41	4.16	3.78	3.27	3.48	2.53	1.52	1.18	28.93
Mean temperature (F.):	9.3	12.4	23.8	38.0	48.1	58.4	65.4	63.8	56.3	45.0	29.6	16.9	38.9

The annual snowfall is 54 inches.

Sample plots.

No. 1: Near the headquarters. Young red pine. Age 15 years. Density 0.8—1.0.

No. 2: Near the former. Dense stand of jack pine on level ground. Age 34 years. Height 30 feet. Density 0.9—1.1.

No. 3: Near the former. Rather sparse stand of jack pine. Age 60 years. Height 65—70 feet. Density 0.7—0.8.

I was able to become acquainted with the Cloquet Experimental Forest during excursions made on September 16th and 17th with Director R. Zon and Professors H. Schmitz and T. S. Hansen.

METHOD OF INVESTIGATION.

As previously mentioned I was not in a position to study forest (site) types systematically or thoroughly on my excursions, but a few cursory observations could only be made. These observations comprised some general notes on the site (compare the descriptions of sample plots), a general description of the vegetation and notes on the general quality of the stand, the age, the average height and often the average breast-height diameter of the dominant trees and the density of the stand.

In the description of the composition of the vegetation the following Norrlin's abundance scale of 10 degrees was used, which is very usually applied in Suomi (Finland) for similar purposes.[1]

[1] See e.g. A. K. Cajander, Gedächtnisrede für Johan Petter Norrlin Acta forestalia fennica 23, pp. 46—47.)

Continuously covering:

10. Subsidiary mixture ..... 1 — 4
9. » » ..... 4 — 6
8. » » ..... 6 — 7.5

Abundant:

7. Average spacing ..... 1 — 6 inches
6. » » ..... 0.5 — 1.5 feet
5. » » ..... 1.5 — 3 »

Scattered:

4. Average spacing ..... 3 — 6 feet
3. » » ..... 6 —15 »

Scanty:

2. Average spacing ..... 15 —30 feet
1. » » ..... more than 30 feet

Less than 1: Sporadic.

This scale was used in estimating the abundance of grasses, herbs and dwarf-shrubs and also lichens and mosses as well as shrubs. The abundance of the different tree species of the principal stand was not estimated separately[1], but instead, generally, the abundance of undergrowth and seedlings was noted in 5 degrees: V — I (V very abundant, IV abundant, III rather numerous, II scattered, I scanty or sporadic). The description of vegetation was usually made by walking zigzag and by examining the occurrence of plant species on an average on an area of about $^1/_2$ acre. Of unknown plant-species specimens were taken in order to determine the name later. Detailed descriptions of the vegetation of sample plots are given in the tables No. 1—6.

As to ground and soil only such ocular observations were noted down as could be easily made, as for instance: inclining (in what direction), stony and so forth and often also observations as to

[1] The density of the principal stand is mentioned in the descriptions of the sample plot stands previously presented.

superficial deposit which, however, have been omitted from the descriptions of sample plots as too imperfect.

The age of the stand was determined by counting from the stubs, by means of an increment borer or according to the information given by the guides, whenever reliable data were obtainable. The average height of dominant trees was determined by means of a hypsometer or by an ocular estimation together with the guides. In some cases notes were made on permanent sample plots on which the height and other circumstances had been previously investigated. The average breast-height diameter of dominant trees was determined by means of a diameter tape or an inch measure. In the descriptions of sample plots (pp. 9—30) the average height of dominant trees is shortly called »Height» and the average breast-height diameter of dominant trees »Diameter». In estimating the density a naturally normal stand of the species of tree in question was imagined as a basis, and its density was described as 1.0.

DESCRIPTIONS OF FOREST (SITE) TYPES EXAMINED.

As is well known, the forest types in CAJANDER's system of forest types are forest-plant-communities which are distinguished from each other in the first place on the basis of ground vegetation. The species of trees do not appear to be effective in the same degree, but will only be taken note of in the second place. All those stands[1] are referred to the same forest type, the vegetation of which at or near the age of maturity of the stands and provided the stands are normally stocked, is characterised by fairly identical floristic composition and by an identical ecologico-biological nature, as well as all those stands the vegetation of which differs from that defined above only in those respects which — being expressions of differences due to age, fellings, etc. — have to be regarded as merely accidental and ephemeral or at any rate as only temporary. Permanent differences call forth a new forest type in cases where they are sufficiently well-marked, or

[1] The stand also includes its ground vegetation.

a sub-type in cases where they are less essential but, nevertheless, noticeable.[1]

In making systematic forest type investigations, a beginning should thus be made with stands at or near the age of maturity and normally stocked and preferably in a state of nature, in which the forest type appears in a normal form. As has been previously and repeatedly pointed out during this journey — made for quite another purpose — during which the observations of this research were made, no opportunity was afforded for a systematical investigation of forest types. Observations were made as to age and density in very different forests and on the basis of these attempts were made to form some general idea of the forest types encountered. Possible researches later on may in many respects rectify the forest types here described.

In those forests where, during my journey, I was able to make observations, forest types of the following nature may be distinguished. In order to avoid confusing the forest vegetation types now investigated for the general American conception of forest types (based on tree species) the name »forest (site) type» is used here, because the sites which are colonised by the same forest vegetation type must be regarded as representing mainly biological equivalents[2] and thus the forest vegetation type closely reflects the quality of the site.

I. The group of dry forest (site) types. (Xerophile Forests.)

1) *Arctostaphylos type*[3] / *Vaccinium scoparium type* — Geographically interchangeable types.
2) *Calamagrostis-Arctostaphylos type* / *Calamagrostis-Vaccinium scoparium type* — »
3) *Calamagrostis type*[3]

[1] See: A. K. CAJANDER, The Theory of Forest Types, pp. 27—28. (Acta forestalia fennica 29,3.)

[2] See: A. K. CAJANDER, The Theory of Forest Types, p. 31.

[3] The names Arctostaphylos t., Calamagrostis t. and Pachystima t. were used by ADRIAN C. THRUPP in his paper »Scientific Seed Collection» in the Forestry Chronicle in June 1927; but without any close description of the types.

II. The group of moist forest (site) types. (Mesophile Forests.)

1) *Hylocomium-Ledum* (thick-moss) *type*
2) *Vaccinium-Gaultheria type*
   Probable sub-types: a) *Vaccinium-Myrica type* and b) *Vaccinium-Rubus-Papilionaceae type*
3) *Pachystima type*[1]
   Probable sub- or intermediate types: a) *Calamagrostis-Pachystima type* and b) *Pachystima-Grass-herb type:* (1. *Pachystima-Vaccinium parvifolium sub-type* and 2. *Pachystima-Coptis sub-type.*)
4) *Oxalis-Hylocomium type*
5) *Hylocomium-Grass-herb type, coll.*

III. The group of grass-herb (site) types. (Mesohygrophile and Hygrophile Forests.)

1) *Tiarella type*
   Probable sub-types: a) *Tiarella-Vaccinium type*, b) *Tiarella-Fern type.*
2) *Fern type*
   Probable sub-type: *Fatsia-Fern type.*

From these general descriptions presented such plant species, as have been found on less than about 3/10 of all the sample plots of the type in question have been left out, because to all appearance they are not characteristic of the type. These species are also to be seen in the detailed lists of plants in the tables No. 1—6. In some cases an exception has been made from this mode of procedure, if on the basis of the observations made on the distances between the sample plots the occurrence of a plant species has been found on the type in some degree more general than that indicated by the sample plots. In some types presented later on, of which there are only a few observations

[1] See the note on p. 33.

and the number of the species is comparatively great, only those species which have occurred in at least about half of the sample plots of the type, have been enumerated.

Of the numbers after the names of the plant species, the first denotes the occurrence of the species, that is, in how many tenth parts of all the sample plots of the type the species occurred, and the second the average abundance of the plant species in those cases, when it has been found.

The nomenclature used agrees in general with: P. A. Rydberg, *Flora of the Rocky Mountains and adjacent plains*, in which tracts the greater part of the sample plots is situated. Partly, for the sample plots in other tracts, Gray's *New Manual of Botany*, 7th Edition (A Handbook of the Flowering Plants and Ferns of the Central and Northeastern U.S. and adjacent Canada, by Benj. L. Robinson and M. L. Fernald, New York 1908) was used.

I. The group of dry forest (site) types.

(Xerophile Forests.)

1. *Arctostaphylos and Vaccinium scoparium types.*

	Arct. T	Vs T
Cladonia spp.	10 : 6	10 : 6
Peltigera spp.	10 : 6	10 : 4
Drepanocladus uncinatus / *Dicranum spp.*	—	7 : 4—5
Polytrichum juniperinum	—	9 : 4
Calamagrostis (mostly *Suksdorfii* and *rubescens*) / *Agropyron* (*caninoides* and *riparium*) [1]	10 : 5	4 : 2—3
Carex sp.	10 : 5—6	9 : 4—5
Fragaria (mostly *bracteata*)	2 : 4	4 : 3
Rosa (mostly *acicularis*)	7 : 4—5	—

Epilobium angustif.	2 : 4	7 : 3—4
Chimaphila umbellata	—	3 : 3
Pyrola chlorantha	—	4 : 2—3
Linnaea americana	10 : 4	2 : 3
Solidago spp.	10 : 2—3	4 : 3
Aster spp. / *Erigeron spp.*	4 : 3	9 : 2—3
Antennaria (mostly *neodioica*)	5 : 3—4	—
A. (mostly *flavescens*)	—	5 : 4
Arnica (mostly *cordifolia*)	—	8 : 3
Hieracium albiflorum	—	6 : 3
Arctostaphylos uva ursi	10 : 5—8	2 : 1—2
Vaccinium scoparium	—	10 : 5—8
Juniperus sp.	4 : 2	6 : 1
Spiraea (mostly *lucida* and *densiflora*)	10 : 4—5	5 : 4
Shepherdia canadensis	10 : 2	3 : 2—3
Pinus Murrayana (seedlings)	2 : I	8 : II
Picea glauca (seedlings)	—	4 : I

Characteristic of the Arctostaphylos type is the abundant dwarf-shrub *Arctostaphylos uva ursi* which is found on all the sample plots of the type. Its abundance varies, in general, considerably even on small areas from one place to another; in other places it is even lacking altogether and then almost the whole vegetation cover consists of *Cladoniae* and *Peltidea*. The latter plants are always to be found in abundance in this type. Mosses, on the other hand, occur comparatively rarely and even then, in general, very scantily. Besides *Arctostaphylos uva ursi* there are almost without exception to be found in comparative abundance some grasses (the most usual are *Calamagrostis* and *Agropyron*[1]) and a *Carex-species*. Of herbs, which are relatively scanty, *Linnaea*, *Solidago* and the semi-bush *Rosa* are the most usual. Of shrubs *Shepherdia canadensis*

[1] These grasses could not be sufficiently distinguished in certain cases (not even on the basis of specimens); they are therefore presented in a group.

and a small-sized *Spiraea* (mostly *lucida* and *densiflora*) have been found on all areas, the latter often rather abundantly. The forest consists of lodgepole pine. Arctostaphylos type has been found chiefly in the Dry Belt of the interior of B.C., where it occurs, in general, on very dry southern and southwestern slopes and on the poorest gravel-sandy soil also on level ground. Only 5 sample plots were examined.

Characteristic of the Vaccinium scoparium type is the low and very small-leaved dwarf-shrub *Vaccinium scoparium*, abundantly found on all sample plots of the type, which seems to be a plant of poor land at a high elevation. The occurrence of *Vaccinium scoparium* often varies very much, in spots. On the sample plots it is in some places very abundant and close, in other places again — often in rock-bound and almost in pure gravel-places — it is scarcely to be found and the aforesaid grass- and sedge-species form the chief vegetation cover. Sometimes such a composition of vegetation, i.e. in spots, is so clear as to render it possible plant-geographically to distinguish these small definitely limited spot-like plant-communities from each other, the area of which varies from quite small spots up to some tens of acres. From a forestry point of view the type seems, however, even in such cases to form one equivalent whole. *Cladoniae* were found abundantly on all the sample plots of this type, also *Peltigera* quite abundantly. Of mosses *Dicranum*, *Drepanocladus uncinatus* and *Polytrichum juniperinum* occur commonly and to a considerable extent. Grasses do not occur at all so generally and abundantly as in the Arctostaphylos type, of sedges there is almost an equal amount as in the latter. Of herbs the commonest are: *Aster spp.* and *Erigeron spp.*, *Epilobium angustifolium*, *Arnica* (mostly *cordifolia*) and *Hieracium albiflorum;* also *Antennaria*, *Solidago* and *Pyrola chlorantha* often occur. Juniper was found comparatively often, likewise *Spiraea* (mostly *lucida* and *densiflora*) and sometimes *Shepherdia canadensis*. The forest consists of lodgepole pine, under which there are now and then some spruce. The type was examined on 11 sample plots in the Yellowstone National Park, where it comprises the poorest forest lands.

The Vaccinium scoparium type is considerably richer in species than the Arctostaphylos type. Only 3 higher plant species, however, not occuring at all in the Arctostaphylos type, were found at least on half of the sample plots of the Vaccinium scoparium type and are thus comparatively common there. One of these is in fact *V. scoparium*, two others are *Arnica* (mostly *cordifolia*) and *Hieracium albiflorum*. It should also be remembered, that the observations of the Arctostaphylos type are only 5 in number, not sufficient to give a perfect description of the type; the observations of the Vaccinium scoparium type are considerably more numerous, namely 11. When the very considerable similarity of the development of the dominant trees of the stand, appearing later on, is taken into consideration, it seems as if the Arctostaphylos type and the Vaccinium scoparium type were geographically interchangeable types of which the former, according to the observations now made, occurs in the Dry Belt of the interior of British Columbia at an elevation of about 4 000 feet and the latter about 650 miles from there to the south-east in Yellowstone National Park, at a height of about 7 000 —8 000 feet above sea-level.

In this connection it may be mentioned that still drier than the Arctostaphylos type is such a type in the Dry Belt of the interior of B.C., where the vegetation cover consists nearly exclusively of sage-brush (*Artemisia tridentata*) and also *Achillea* and the small-leaved *Antennaria*, other species occuring but scantily and in comparatively small quantity. The forest consists of *Pinus ponderosa* which is scattered, some young growth is common in openings and beneath. This type seems, in general, to occur on the south and west slopes, in relatively hot and dry climates at some distance down from the belt of the lodgepole pine forests towards the river valley. The opposite more sheltered and moister north and east slopes are, in general, overgrown with Douglas fir. Of an even drier nature than this is a »type» found still lower down, where chiefly only *Artemisia*, a few cactus species etc. occur and here and there, especially in somewhat moist small depressions, some short and slowly growing *Pinus ponderosa* is found.

2. Calamagrostis-Arctostaphylos and Calamagrostis-Vaccinium scoparium types.

	Cal.-Arct. T	Cal.-Vs T
Cladonia spp.	7 : 4 [1]	9 : 3
Peltigera sp.	10 : 5	5 : 2
Hylocomium parietinum [2]	9 : 5	4 : 3 –4
H. proliferum	5 : 5	—
Brachythecium rutabulum	—	8 : 3 –4
Ptilium crista castrensis	5 : 3	—
Dicranum spp.	9 : 5	—
Drepanocladus uncinatus (and *Dicranum sp.*)	—	8 : 4
Polytrichum commune / *P. Juniperinum*	—	5 : 4
Calamagrostis (mostly *Suksdorfii* and *rubescens*) / *Agropyron* (mostly *caninoides* and *riparium*) (sometimes a little *Poa sp.* and *Deschampsia flexuosa*)	10: 5 –7	10 : 6 –8
Carex sp.	8 : 4 –5	—
Zygadenus chloranthus	4 : 3	—
Cypripedium montanum	—	5 : 3 –4
Thalictrum sp.	—	7 : 3 –4
Trollius albiflorus	—	7 : 3 –4
Fragaria (mostly *bracteata*)	8 : 3 –4	9 : 4 –5
Rosa (mostly *acicularis*)	10 : 4	3 : 2
Lupinus sp.	2 : 3	7 : 3 –4
Astragalus (mostly *Palliseri*)	5 : 4	—
Vicia (mostly *americana*)	4 : 3	4 : 2
Viola (mostly *canadensis* and *adunca*)	—	4 : 4
Epilobium angustifolium	9 : 3	9 : 4
Osmorrhiza divaricata	—	3 : 3
Cornus canadensis	3 : 4	—

[1] Chiefly on stones, on the driest places and on fallen, rotting trees.

[2] On the sample plots in Banff and Cypress Hills *H. parietinum*, *H. reptile* and *Thuidium abietinum* together.

Pyrola chlorantha	5 : 4	—
Ramischia secunda	4 : 4—5	4 : 2—3
Tessaranthium speciosum	—	4 : 2
Castilleja (mostly *pallida*, *sessilifl.* and *mineata*)	4 : 2	—
Galium boreale	3 : 2—3	—
Linnaea americana	10 : 5—6	2 : 3
Solidago spp.	7 : 3—4	10 : 5
Aster spp. / *Erigeron spp.*	9 : 3—5	9 : 4
Antennaria (mostly *neodioica*)	4 : 4	—
A. (mostly *flavescens* and *rosea*)	—	8 : 4
Achillea millefolium	—	5 : 2—3
Arnica cordifolia	4 : 4	10 : 4—5
Hieracium albiflorum	—	5 : 3—4
Berberis aquifolium	—	3 : 4
Arctostaphylos uva ursi	10 : 5	—
Vaccinium scoparium	3 : 4	9 : 5
V. caespitosum	5 : 4—5	—
Juniperus sp.	4 : 2—3	5 : 1—2
Ribes sp.	—	4 : 2—3
Spiraea (mostly *lucida* and *densiflora*)	8 : 3	3 : 3—4
Amelanchier sp.	—	7 : 1
Shepherdia canadensis	9 : 3	3 : 2—3

Characteristic of the Calamagrostis-Arctostaphylos type is a rich *Calamagrostis-* and other grass-vegetation and at the same time *Arctostaphylos uva ursi* occurring always and quite abundantly. Grass-vegetation is considerably more abundant and *Arctostaphylos uva ursi* appreciably scantier than in the Arctostaphylos type. *Carex* occurs more abundantly in the latter, poorer type. *Cladoniae* occur considerably less and also *Peltigera* somewhat less than in the Arctostaphylos type. Mosses, which occur only seldom in the latter type, appear in the Calamagrostis-Arctostaphylos type very frequently and even at the same time abundantly.

Of herbaceous plants (including also *Rosa*) found at least on about $^3/_{10}$ of all the sample plots of the type there are 16 species in number in the Calamagrostis-Arctostaphylos type, but on the contrary only 7 species in the Arctostaphylos type. The following occur most frequently and abundantly: *Linnaea*, *Aster* and *Erigeron*, *Rosa*, *Epilobium*, *Fragaria* (mostly *bracteata*), *Pyrola chlorantha*, *Ramischia secunda*, *Astragalus* etc. Of quite frequent occurrence is *Vaccinium caespitosum*. The shrubs are the same in both types and there is about the same quantity as in the Arctostaphylos type. The forest consists of lodgepole pine. The Calamagrostis-Arctostaphylos type is thus as to vegetation appreciably richer than the Arctostaphylos type. The type was examined on 14 sample plots in the Dry Belt of B.C. and in Banff.

Characteristic of the Calamagrostis-Vaccinium scoparium type is a rich *Calamagrostis-* and other grass-vegetation and also *Vaccinium scoparium* which is, in general, of quite frequent occurrence. *Cladoniae* and *Peltigera* occur much more scantily than in the Vaccinium scoparium type. Mosses are found more abundantly and in more species than in the latter type. Of herbaceous plant species found at least on about $^3/_{10}$ of all the sample plots of the type there are 19 in number in the Calamagrostis-Vaccinium scoparium type and only 10 in the Vaccinium scoparium type. The following occur most frequently and abundantly: *Solidago*, *Arnica*, *Fragaria*, (mostly *bracteata*), *Epilobium*, *Antennaria*, *Thalictrum*, *Trollius*, *Lupinus*, *Cypripedium*, *Hieracium albiflorum*, *Achillea* a.s.o. Besides the same bushes as those in the Vaccinium scoparium type *Amelanchier* and often also *Ribes* are of very common occurrence. The forest consists of lodgepole pine, at times some minor spruce appearing underneath. The type was examined on 9 sample plots in the Yellowstone National Park.

Though the areas for investigation of the Calamagrostis-Arctostaphylos and the Calamagrostis-Vaccinium scoparium types are very far from each other, a great similarity is noticeable in the composition of the vegetation of these types. Of higher plant species

which occur at least on about $^3/_{10}$ of the sample plots of the Cal.-Arct. and Cal.-Vs types there are 15 in number; of such, as have been found on at least $^5/_{10}$ of the sample plots of the Cal.-Arct. type, but not in a single case on the sample plots of the Cal.-Vs type, there is only *Zygadenus chloranthus*, the occurrence of which is restricted to the sample plots of the tracts of Banff; of such species, as have been found at least on $^5/_{10}$ of the sample plots of the Cal.-Vs type, but not at all on the sample plots of the Cal. Arct. type, there are only the following comparatively second-class species: *Cypripedium montanum*, *Thalictrum sp.*, *Trollius albiflorus* and *Hieracium albiflorum*. Taking into consideration these features along the same line in the composition of the vegetation and the similarity of the growth of dominant trees occurring later on in this investigation, it may be supposed that the types in question are geographically interchangeable types just as was previously ascertained as to the Arctostaphylos and Vaccinium scoparium types.

3. Calamagrostis type.

Cladonia spp.	5 : 3 [1]	*Vicia* (mostly *americana*)	3 : 3
Peltigera spp.	6 : 4	*Lathyrus ochroleucus* ..	3 : 3
Hylocomium parietinum [2]	5 : 4	*Geranium* (mostly *Richardsonii*)	4 : 3
Ptilium crista castrensis	3 : 3	*Viola spp.*	3 : 3
Calamagrostis (mostly *Suksdorfii* a. *rubescens*)	10 : 6—8	*Epilobium angustifol.* .	8 : 4—5
Agropyron (mostly *caninoides* and *riparium*)		*Cornus canadensis*	6 : 4—5
		Pyrola chlorantha	3 : 3—4
Thalictrum sp.	3 : 3—4	*Ramischia secunda*	5 : 4
Fragaria (mostly *bracteata*)	9 : 4	*Galium boreale* (*G. triflorum*)	6 : 3—4
Rosa (mostly *acicularis*)	10 : 4	*Linnaea americana*....	8 : 5
Lupinus sp.	6 : 3—4	*Solidago spp.*	8 : 4

[1] Mostly on stones, on the driest places and on fallen rotting trees.

[2] See p. 39.

Aster spp. / *Erigeron spp.*	7 : 4	*Arctostaphylos uva ursi*	4 : 3
		Vaccinium caespitosum	6 : 5
Antennaria (mostly *neodioica*)	4 : 3	*Spiraea* (mostly *lucida* and *densiflora*)	7 : 3—4
Achillea millefolium	5 : 2—3	*Shepherdia canadensis* .	3 : 3
Arnica (mostly *cordifolia*)	10 : 4	*Symphoricarpus sp.* ..	3 : 3

Characteristic of the Calamagrostis type is a very abundant and at the same time generally rich *Calamagrostis*-(and other grass-) vegetation. Mosses are, in general, scanty. *Peltigera* is not present to any great extent and *Cladoniae* chiefly only on stones, on some of the driest spots and on fallen, decayed trees; but instead various herbs are to be found quite frequently and in abundance. Of the latter those that occur most frequently and most abundantly are: *Arnica*, *Fragaria*, *Linnaea*, *Solidago*, *Epilobium*, *Aster*, *Lupinus*, *Galium*, *Cornus canadensis*, etc. Dwarf-shrubs occur in comparatively small quantity, of them *Vaccinium caespitosum* occurs most frequently and most abundantly; it, however, was not found on the sample plots of Yellowstone National Park. *Arctostaphylos uva ursi* was sometimes found, but scantily. Of shrubs *Spiraea* is the most important and comparatively common. The forest on three sample plots consisted of Douglas fir and on one of aspen, but on all other areas of lodgepole pine which is at present the real species of the type. Observations concerning the type were made on Cypress Hills, in the Dry Belt of the interior of B.C. and in Yellowstone National Park on 17 sample plots in all.

II. THE GROUP OF MOIST FOREST (SITE) TYPES.
(Mesophile Forests.)

1. Hylocomium-Ledum (thick-moss) type.

Two sample plots examined in Banff differed, because of the abundance of mosses and also in other respects, from other areas investigated to such an extent that they have been separated into

a different type, something corresponding to a type found in similar conditions in North Suomi (Finland). Characteristic of this type is very abundant (7—9) feather-moss (*Hylocomium parietinum, H. proliferum, Hypnum reptile, Thuidium abietinum, Ptilium crista castrensis, Dicranum scoparium*) vegetation. The covering formed by these mosses is, in general, very thick (about 4—8 inches). *Cladoniae* (5) chiefly occur on fallen, decayed trees, on the thick ends of trees, etc. and *Peltigera* (5) here and there amongst the mosses. Grasses are found comparatively rarely, herbs somewhat more abundantly. Of the latter the most abundant are: *Cornus canadensis* (5—6), *Linnaea* (5), *Epilobium* (2) and *Ramischia secunda* (3). Of dwarf-shrubs the most common are: *Ledum groenlandicum* (5—7), *Menziesia glabella* (4), *Vaccinium ovalifolium* (?) and *V. scoparium* (4). Shrubs occur very scantily. Only two sample plots having been examined, this description is, of course, very inadequate. In one case the forest consisted of Engelmann spruce and Alpine fir and in another of slow-growing lodgepole pine and spruce.

2. Vaccinium-Gaultheria (coll.) type.

The Vaccinium-Gaultheria type is henceforth abbreviated into V-G T and the sub-types Vaccinium-Myrica type into V-M T and Vaccinium-Rubus-Papilionaceae type into V-R-P T. Only such plant species will be enumerated as occurred at least on about half the sample plots of the type, and the frequency of the occurrence of the species is marked only as regards the V-M type, of which there is a greater abundance of observations.

	V-GT	V-MT	V-R-PT
Cladonia spp.	2[1]	—	—
Cladina (mostly *silvatica*)	—	—	3
Peltigera spp.	—	—	1—2
Hylocomium parietinum	2—3	10 : 3—6	4—6
Dicranum spp.	3	9 : 3—4	4—6

[1] On stones and rotting trees.

Polytrichum spp.	2	8 : 3—4	—
Oryzopsis sp., *Calamagrostis spp.*, *Danthonia (spicata)*	4	10 : 4—5	5—7
Carex sp.	4—5	7 : 5—6	—
Lilium philadelphicum	—	—	3—4
Maianthemum canadense	5	10 : 5—6	6
Streptopus amplexifolius, *Vagnera racemosa*	—	—	3
Clintonia borealis	—	—	4
Myrica asplenifolia	—	10 : 3—5	—
Actaea alba	—	—	1—2
Fragaria virginiana	3	10 : 3	4—5
Waldsteinia fragarioides	2	8 : 3—4	3—4
Rubus (mostly *triflorus, canadensis, allegh., arcticus*)	—	7 : 2—3	6
Rosa spp.	—	—	5
Vicia (mostly *americana*)	—	—	3
Lathyrus ochroleucus	—	—	4
Viola (mostly *striata, rotundifolia, conspersa, canadensis*)	—	—	4
Epilobium angustifolium	—	—	4
Sanicula marilandica	—	—	3
Aralia (*hispida* and *nudicaulis*)	2—3	—	3—4
Cornus canadensis	3—5	—	5
Chimaphila umbellata	—	9 : 3—4	—
Pyrola americana (and *P. elliptica*)	3	5 : 3	4
Ramischia secunda	—	—	3
Melampyrum lineare	4	10 : 5	5
Galium triflorum	—	—	3—4
Linnaea americana	4—5	10 : 5—6	5—6
Solidago spp.	2	10 : 3—4	4—5
Aster spp. (often *macrophyllus*), *Erigeron spp.*	3	10 : 3—4	5—6

Lactuca spicata	—	—	2
Pteris aquilina	5	10 : 5	2
Kalmia angustifolia	—	7 : 4	—
Gaultheria procumbens	4—5	10 : 5	3—4
Arctostaphylos uva ursi	—	—	4
Vaccinium pennsylvanicum / *V. canadense*	3—6	10 : 5—6	5—6
Salix sp.	—	—	1
Alnus sp.	—	—	3
Corylus americana	2—3	—	—
Rubus idaeus / *R. strigosus*	1	9 : 1—2	1—2
Amelanchier spp.	2	9 : 2	2—3
Lonicera (mostly *canadensis*) / *Diervilla lonicera*	1	10 : 1—2	2—3
Picea glauca	I	—	—
Abies balsamea	II	7 : I	—
Acer (often *rubrum*)	I	5 : I	—

Characteristic of the Vaccinium-Gaultheria (coll.) type is the *Vaccinium pennsylvanicum*-, *V. canadense*- and *Gaultheria procumbens*-dwarf-shrub vegetation, varying in quantity, but generally rather abundant, moreover the mostly rather abundant herb- and grass-vegetation (especially: *Maianthemum canadense*, *Linnaea americana*, *Melampyrum lineare*, *Aster*, *Solidago*, *Pyrola americana*, *Fragaria virginiana*, *Waldsteinia fragarioides*, etc.) and the feathermoss-vegetation, varying in quantity, generally not very abundant; of shrubs *Amelanchier*, *Lonicera* and *Rubus* are found almost always but, in general, sparsely. The forest consists of white pine (*Pinus strobus*), Norway pine (*P. resinosa*) and jack pine (*Pinus banksiana*). The observations as to the type were made in Ontario (Kazubazua, Petawawa and Glenwater) and to a small extent in Minnesota (Cloquet).

According to the comparatively few observations made on the

type — 22 sample plots in all — it seems that from the type could be separated two sub-types which might be called, as mentioned above: Vaccinium-Myrica sub-type, and Vaccinium-Rubus-Papilionaceae sub-type.

The Vaccinium-Myrica sub-type is specially characterised by: *Myrica asplenifolia*, which occurred on all sample plots, *Chimaphila umbellata*, which was lacking only on one sample plot, and *Kalmia angustifolia*, which was found in Ontario on al the sample plots, but not at all in Minnesota, where *Kalmia* is said to be found only in swamps; on the sample plots in Minnesota *Arctostaphylos uva ursi* occurs, comparatively scantily, in the place of *Kalmia*. Jack pine is the prevalent species of tree in this sub-type. The type makes in some measure a drier impression than the real Vaccinium-Gaultheria type. White pine and Norway pine are the prevailing species of trees in the latter type. There being especially in young and middle-aged white pine forests fallen pine needles in very great abundance on the ground, the vegetation cover is often very scanty.

The Vaccinium-Rubus-Papilionaceae sub-type may be considered as a sort of dry grass-herb forest on the clay-bottom of which the herbaceous vegetation consists of many species and is abundant, but at the same time mosses and lichens occur more frequently than in the aforesaid forms of the Vaccinium-Gaultheria type. In addition to the herbaceous plants characteristic of the collective type in general, the following species especially occur in fairly great abundance: *Rubus americana*, *Cornus canadensis*, *Lathyrus ochroleucus*, *Vicia americana*, *Clintonia borealis*, *Lilium philadelphicum*, *Viola* (*canadensis*, etc.), *Epilobium*, *Sanicula marilandica*, *Aralia* (*hispida* and *nudicaulis*), *Galium triflorum* and *Rosa sp.* etc. In open places *Trifolium* is often very abundant. The abundant occurrence of *Arctostaphylos uva ursi* is worthy of note. *Alnus* and *Lonicera* are very common. Of the 6 sample plots investigated, which are all in the neighbourhood of Glenwater, one has a forest consisting of aspen, the others of jack pine.

A type noticeably more luxuriant than the abovementioned forest types is represented by the sample plot of Cloquet No. 4, which will be touched upon on page 53.

3. Pachystima type.

In the following list again only such plant species will be enumerated, as have occurred on at least about half the sample plots belonging to the proper Pachystima type. These are 6 in number, of which one, however, in some respects approaches the Calamagrostis-Pachystima sub-type. The composition of species of the sub-types will be briefly accounted for later on.

Peltigera spp.	8 : 4	*Linnaea americana*	5 : 5—6
Hylocomium parietin. (*Brachythecium rutabul.*)	10 : 4—5	*Solidago spp.*	6 : 3
H. proliferum	7 : 5	*Aster spp.* / *Erigeron spp.*	8 : 3
H. triquetrum (*Rhytidiopsis robusta*)	7 : 5	*Arnica* (mostly *cordifol.*)	5 : 3—4
Dicranum spp.	7 : 4	*Berberis aquifolium*	10 : 4
Polytrichum commune	5 : 3—4	*Pachystima myrsinites*	10 : 5—7
Calamagrostis spp. (*Danthonia spp.*) (*Agropyron spp.*)	10 : 3—6	*Spiraea* (mostly *densiflora* and *lucida*)	10 : 5
Vagnera racemosa / *Streptopus amplexifolius*	10 : 4	*Rubus parviflorus*	10 : 1—4
Clintonia uniflora	9 : 3—4	*R. transmontanus* (?)	5 : 2—3
Peramium decipiens	8 : 4	*Amelanchier sp.*	10 : 2
Rosa (mostly *acicularis*)	10 : 4—5	*Shepherdia canadensis*	8 : 4
Epilobium angustifol.	5 : 2—3	*Lonicera involucrata*	5 : 2
Aralia nudicaulis	5 : 1—3	*Pseudotsuga taxifolia* (second growth)	8 : II
Chimaphila umbellata	10 : 4—5	*Thuja plicata* (second growth)	7 : II
Ramischia secunda	8 : 4	*Acer sp.*	7 : I

Characteristic of the Pachystima type is a generally fairly abundant dwarf-shrub vegetation, which is formed chiefly by *Pachystima myrsinites* and besides by *Berberis aquifolium* with shining leaves; especially in somewhat drier forms it is sometimes mixed with some species of *Vaccinium* and also with some *Arctostaphylos uva ursi*. The herbaceous vegetation is also abundant and comparatively rich in species, the most general species being: *Streptopus amplexifolius*, *Vagnera racemosa*, *Clintonia uniflora*, *Chimaphila umbellata*, *Ramischia secunda*, *Aster*, *Solidago*, *Peramium decipiens*, *Linnaea americana*, *Arnica* and *Rosa* etc. Shrubs are also very common; on all the plots investigated there were found: *Rubus parviflorus*, *Spiraea* (*densiflora* and *lucida*) and *Amelanchier* and on almost all plots (in B.C.) also *Shepherdia*. The moss-cover is, in general, rather abundant, comprising besides *Hylocomium parietinum* almost an equal quantity of *H. proliferum* and the comparatively pretentious *H. triquetrum*. *Peltigera* is also fairly common. On five plots out of six investigated the forest consisted either exclusively or chiefly of lodgepole pine and on one chiefly of Douglas fir and red cedar. Douglas fir, red cedar and maple occur very generally as second growth. Of 6 plots investigated 4 are in the interior of B.C. and 2 near Priest River Experiment Station in Idaho.

A sort of sub-type and at the same time an intermediate type of Calamagrostis and Pachystima types may be represented by the sample plot No. 3 of Priest River. Its grass-vegetation (*Calamagrostis rubescens* and also *Danthonia intermedia* and partly *Agropyron*) is very abundant and its herbaceous and shrub-vegetation is much scantier than in the proper Pachystima type. *Pachystima* and *Berberis* occur relatively rarely and in their place *Arctostaphylos* is found rather abundantly.

Vegetation on sample plots No. 3 and 4 of Wind River and on sample plots No. 4 and 5 of Priest River is much more abundant and richer in species than in the proper Pachystima type. As far as

can be judged on the basis of only four sample plots investigated they may represent a sort of intermediate type, Grass-herb-Pachystima.

On the sample plots of Wind River, the forest type of which might be called, e.g., Pachystima-Vaccinium parvifolium sub-type, the following plants are characteristic: e.g. *Pachystima myrsinites*, *Vaccinium parvifolium* and *Berberis aquifolium* which always occur together, and the abundant and rich herbaceous and shrub-vegetation (especially: *Cypripedium montanum*, *Cornus canadensis*, *Chimaphila umbellata*, *Linnaea americana*, *Rubus transmontanus* (?), *Viola*, *Achrys triphylla*, *Galium triflorum*, *Streptopus amplexifolius*, *Vagnera racemosa*, *Trillium ovatum*, *Sericotheca discolor*, *Gaultheria ovatifolia*, *Trientalis latifolia*, *Vancouveria hexandra*, *Petasites speciosa*, *Xerophyllum Douglasii* and *Rosa* etc.; *Spiraea*, *Rubus parviflorus*, *Symphoricarpus*, *Cornus pubescens* etc.). Mosses occur comparatively scantily (*Hylocomium triquetrum*, *Rhytidiopsis robusta*, *Dicranum spp.* etc.). On both plots the forest consisted of Douglas fir and *Alnus rubra* and maple were in abundance underneath.

On the sample plots of Priest River, the forest type of which might be called, e.g., Pachystima-Coptis sub-type, especially *Pachystima myrsinites* and *Coptis trifoliata* seem to be characteristic, they always occurring together, and at the same time the rich and abundant herbaceous vegetation (especially: *Viola spp.* *Linnaea americana*, *Fragaria* (mostly *Helleri*), *Streptopus amplexifolius*, *Vagnera racemosa*, *Epilobium*, *Cornus canadensis*, *Chimaphila umbellata*, *Galium triflorum* and *Rosa spp.* and the sporadically occurring *Tiarella trifoliata*, etc.), *Berberis aquifolium* occurring rather scantily and *Rubus parviflorus* frequently. Mosses occur very little, chiefly *Rhytidiopsis robusta*. On both plots the forest was western larch—western white pine—red cedar—western hemlock, etc. mixed forest.

For the sake of comparison observations were made on a certain burned area. The area was burnt in 1926. The forest had been almost completely destroyed, only the crowns of some trees had

remained somewhat green. A comparatively rich vegetation had already begun to grow on the burned area. At first sight there did not seem to be more than very abundant *Epilobium*. But on a closer examination the following species could be easily discerned (the abundance of the species are given after the names): *Epilobium angustifolium* 6—9, *Tiarella trifoliata* 2—6, *Fragaria* (mostly *Helleri*) 2—5, *Linnaea americana* 2—5, *Viola spp.* 2—5, *Alsine sp.* 2—4, *Atragene columbiana* 2—4, *Hieracium albiflorum* 2—4, *Cornus canadensis* 1—5, *Coptis trifoliata* 1—5, *Trillium ovatum* 1—4, *Rosa spp.* 1—3, *Berberis aquifolium* 2—5, *Pachystima myrsinites* 1—3, *Spiraea sp.* 1—4, etc. and *Marchantia polymorpha* 5—7, growing very abundantly owing to the fire. A vegetation rather characteristic of the type was thus quite clearly noticeable.

4. Oxalis-Hylocomium type.

Cladonia spp.	8 : 3 [1]	*Oxalis acetosella*	10 : 7
Hylocomium parietinum	10 : 5—7	*Cornus canadensis*	10 : 5—6
H. proliferum	10 : 4—5	*Trientalis americana*	10 : 4
Ptilium crista castrensis	5 : 4	*Linnaea americana*	4 : 3
Dicranum scoparium / *D. fuscescens*	10 : 5	*Phegopteris polypodioid.*	4 : 3
		Dryopteris spinulosa	10 : 4
Polytrichum commune	10 : 3	*Ribes lacustre*	10 : 3
Maianthem. canadense	10 : 4—5	*Rubus idaeus*	5 : 2
Streptopus roseus	4 : 1—2	*Sorbus americana*	7 : 1—2
Clintonia borealis	9 : 5	*Abies balsamea* (seedl.)	10 : IV

Characteristic of the Oxalis-Hylocomium type is a very abundant occurrence of *Oxalis acetosella* and at the same time a very continuous cover of feather-mosses. In addition to *Oxalis acetocella* on all the plots investigated, there was found *Maianthemum canadense*, *Cornus canadensis*, *Trientalis americana*, *Dryopteris spinulosa* and *Ribes lacustre*, but all to a smaller extent

[1] On the thick ends of trees and on fallen rotting trees.

than *Oxalis*. Also *Clintonia borealis* occurred almost without exception, likewise small mountain ash, but otherwise the vegetation is relatively restricted in number. The forest on the plots investigated consisted of *Abies balsamea*. One plot taken for the sake of comparison was, however, clear cut. On all the plots there was an undergrowth of balsam fir under the principal stand. Observations concerning the type were made on 7 sample plots in Laurentides Park, province of Quebec. In the area investigated this forest type is very dominant and varies very little, for instance from the lower slopes of hills 150 to 200 feet high up to their tops.

5. Transition types between the groups of moist forest (site) types and grass-herb types.

To the group of moist forest types may further be reckoned some stands investigated in which the vegetation varies considerably from the abovementioned, but is not of a perfect grass-herb type in nature. Very few observations were obtained from this collective type, so that the explanation is very defective. More thorough investigations will certainly cause some different types or sub-types to be distinguished from each other, as, for example, on the Calamagrostis or Cal.-Arct.-type, while occurring on extensive areas in fairly moist places on slopes or in depressions, there seems to be a considerable luxuriant vegetation which cannot, however, be considered as a perfect grass-herb type.

Such a stand was found on Cypress Hills. On a steep eastern slope grows an open stand (about 100 years old) of spruce covered with beard-mosses and in groups aspen as mixed trees. Mosses (*Hylocomium parietinum, H. proliferum, H. reptile, Thuidium abietinum, Ptilium crista castrensis, Dicranum spp.*) and some *Cladoniae* and *Peltigera* were often found here and there in spots rather abundantly, chiefly on decaying trees or growing round about them. Herbaceous vegetation is very rich in species and abundant (*Disporum, Streptopus, Vagnera, Thalictrum, Clematis, Actaea, Fragaria,*

Rosa, Vicia, Geranium, Viola, Epilobium, Aralia, Osmorrhiza, Cornus, Pyrola, Castilleja, Galium, Linnaea, Solidago, Arnica, Hieracium, Equisetum, Sanicula etc.). Also grasses (*Calamagrostis*, etc.) and dwarf-shrubs (*Vaccinium caespitosum*) as also shrubs (*Shepherdia, Spiraea, Cornus* etc.) occur in some measure.

On a certain slope in Banff, where some spring rivulets run, the vegetation on both sides of them on a somewhat wide belt was much more luxuriant than elsewhere on the slope. The forest chiefly consists of spruce, elsewhere on the slope of lodgepole pine. The species are for a great part the same as those previously enumerated, but the following are also found: *Heuchera, Heracleum, Campanula, Parnassia, Pedicularis, Arctostaphylos, Menziesia, Ledum, Ribes* etc.

A similar vegetation occurs in many places in B. C. Dry Belt. There, for example, some areas of the Calamagrostis type are often broken by a narrowish draw lower than its neighbourhood, where during the wet period much water runs. For instance, in one of these the forest consisted of aspen and Engelmann spruce. Mosses occurred somewhat in spots. The plant species were partly those previously mentioned, partly others, e.g. *Aquilegia, Lonicera, Viburnum*, etc.

In the Yellowstone National Park a type approaching this type was found in the lowest part of a NE slope leading to a rivulet. The open stand was formed by about 100 years old lodgepole pine and spruce. The vegetation consisted chiefly of the same species as those previously mentioned, but also of others, e.g. *Aconitum*, an *Orchidaceae*-species, *Vaccinium scoparium, Juniperus* etc. and an abundant *Lophozia*- and *Mnium*-moss-vegetation, among which also occurred *Aulacomnium palustre*.

Mention should be made in the Cloquet Experimental forest of an open Norway pine and white pine stand mixed with some birch about 200 years old, where herbaceous and other vegetation was very abundant and rich in species. It comprised partly the abovementioned species, partly e.g. the following: *Maianthemum* (5), *Clintonia borealis* (4), *Anemone hepatica* (5), *Aquilegia canadense* (5),

Fragaria virginiana (5), *Rubus* (6), *Urtica* (2—4), *Aralia* (5—6), *Galium triflorum* (5—6), *Aster sp.* (6), *Lycopodium obscurum* (3), *Pteris* (5); very scantily dwarf-shrubs (*Vaccinium pennsylvanicum* and *V. canadense*); fairly abundantly shrubs: *Rubus* (3—5), *Lonicera* (4—6), *Corylus* (5—6), *Alnus* (3—4) etc. Mosses were very scanty.

III. THE GROUP OF GRASS-HERB (SITE) TYPES. (Meso-hygrophile and Hygrophile Forests).

The unfortunately few and rapid observations which the writer had the opportunity of making during his excursions, clearly seem to point to the fact that the occurrence of, especially, *Tiarella* and *Ferns* (with the exception of *Pteris* which is found almost everywhere, e.g. on pasture and on former burnt areas, and which in this sense is not reckoned to the group of ferns) is restricted to relatively good soils, where other vegetation, too, is rich in species and abundant. With special reference to the forests in Suomi (Finland) *Tiarella* should in this sense be compared with *Oxalis acetosella*, which is very seldom found even on average forest lands. For this reason the grass-herb types found are here called Tiarella and Fern types.

1. Tiarella type.

Observations concerning this type were made in all in only seven places: 1) in Yoho Valley, B.C. situated in the western part of the Rocky Mountains, 2) on Mount Ida, B.C., 3) near Portland, Oreg., 4) in the neighbourhood of the Wind River Experiment Station, 5) in Stanley Park in Vancouver and on the Vancouver Island, 6) in »Green Timber» near New Westminster and, 7) on Grouse Mountain near Vancouver. In all these there are common features, but also considerable differences, so that the type can be divided into two or three interchangeable or sub-types.

The areas for observation in Yoho Valley and Mount Ida are situated far in the interior of the country and are of considerable height, about 4 000 feet or even more above sea-level.

The climate thus differs very much from that of the coastal region of the Pacific Ocean, where the other plots for observation are situated. Vegetation as compared to all the forest (site) types of the same regions previously described is richer in species and comprises more pretentious species. On the sample plot of Yoho Valley the vegetation cover is throughout luxuriant and abundant, but on the sample plot of Mount Ida owing to the very great density of the stand, the undergrowth of *Thuja* etc., and because of fallen and decayed trees, the cover occurs only here and there and is in some places very scanty. As general characteristics of both types may be mentioned: Of lichen there is no more than some *Peltigera* here and there. The feather-moss cover is not to be found in some places, but now and then it is continuous. Besides feather-mosses *Mnium sp.* occurs frequently. There is a comparatively small quantity of dwarf-shrubs, though they occur generally. Herbaceous and grass-vegetation is abundant and rich in species. The white-flowered *Tiarella unifoliata* is particularly conspicuous as is also often the white-flowered small *Rubus pedatus*, and the fairly common *Vaccinium*. A detailed description of the vegetation cover is contained in the table No. 6. On the sample plot of Yoho Valley the forest consists of Engelmann spruce and some *Abies* and on the sample plot of Mount Ida of Engelmann spruce with a mixture of Douglas fir, Alpine fir, western red cedar, western hemlock and western white pine.

The sample plot of Wind River is situated at a height of about 1 200 feet on the lowest parts of the western slope of Cascade Mountains, where the precipitation is about 3—4 times as great and the temperature much more favourable than in the previous regions for our observation. The vegetation is accordingly more abundant and richer in species. No lichen occurs and the mosses are, in general, of more pretentious species than those on the previous sample plots. In the vegetation cover several of the same species as those on the previous sample plots are noticeable and in addition, chiefly: *Vancouveria hexandra*, *Achrys triphylla*, *Maianthemum bifolium* (*kamtchaticum*), *Berberis aquifolium*, *Gaultheria ovatifolia*, the tall-growing *Vac-*

cinium parvifolium etc. and instead of *Tiarella unifoliata*, *T. trifoliata*. Ferns occur comparatively scantily.

The sample plot of Portland is situated on the slopes of a deep brook-valley at the edge of the city of Portland, about 50 feet above sea-level. The observations made at many points in Stanley Park (only a few feet above sea-level), on Vancouver Island and in »Green Timber», which for want of time were partly imperfect, resemble greatly the notes made on the sample plot near Portland. Mosses, such as *Hylocomium loreum*, *H. proliferum*, *H. triquetrum*, *Brachythecium rutabulum*, *Rhytidiopsis robusta*, *Plagiothecium undulatum*, *Pogonatum contortum*, *Isothecium myosuroides*, *Eurhynchium oregonum*, *Dicranum spp.*, *Mnium glabrescens* and *M. insigne* etc. occur in varying quantity and are often fairly abundant. Grasses are more numerous and copious and especially ferns as well as herbs in general, considerably more abundant and richer in species than those on the sample plot of Wind River. Among others several *Rubus*-species are conspicuous. *Oxalis* is also fairly abundant on the sample plot of Portland. The forest consists chiefly of Douglas fir, western red cedar, western hemlock, lowland fir and some broadleaf-trees, especially as undergrowth.

On the sample plot of Grouse Mountain which is situated about 3 000 feet above sea-level on a steep slope in a SE and E direction, the vegetation cover seemed to be somewhat poorer than on other sample plots of the coastal region, enumerated as belonging to the type in question, but somewhat more luxuriant than those on the sample plots of Yoho Valley and Mount Ida. The forest was thick, high lowland fir, western hemlock and to some extent mountain hemlock.

All the sample plots mentioned here seem to be of the same (collective) type, which is here called *Tiarella* type. The sample plots of Yoho Valley and Mount Ida, no doubt, represent a climatically interchangeable form which might be called, e.g., Tiarella-Vaccinium sub-type. The sample plots richest in ferns might represent the most luxuriant form of the type which might possibly be named Tiarella-fern sub-type. As previously stated, the observations concerning this type are, however, so few in number and are partly so incomplete, that the explanation of the type is defective and also inadequate. The reason of this is that during the excursions, as previously mentioned, special attention was paid to forests of lodgepole pine and partly to those formed by its nearest species and to their sites. It was only for the sake of comparison that it was interesting now and then to examine also more luxuriant sites and other species of trees.

2. Fern type.

During the excursions starting from Laurentides Park in the east, attention was paid to sites occurring along rivulets or otherwise on wet rich soils characterized by a luxuriant fern vegetation and besides by abundant other herbaceous vegetation. These so completely resemble the Finnish fern type that without even closer investigations this type seemed to be clearly distinguishable.[1] As lodgepole pine and other species of pine are not the species of this type, no time was spent in explaining this type. Only for the sake of comparison observations were made to such an extent that the existence of this type could be certainly ascertained, e.g., in Laurentides Park, in the Petawawa Experimental Forest and in the tract of Glenwater. Also in the coastal region of the Pacific Ocean a very abundant fern-vegetation seemed to be characteristic of rich, very low and somewhat wet sites.

Perhaps to this rather than to the previous (Tiarella-fern) type can be reckoned also a couple of rivulet depressions investigated in passing on Mount Ida, in which the vegetation was very luxuriant, abundant and rich in species, the ferns being particularly characteristic.

[1] It should be remembered, that *Pteris aquilina* (and, in general, also *Thelypteris Dryopteris*) are not in this sense to be compared to other ferns, as some have thought. See p. 54.

On one of these plots (No. 22) the forest chiefly consisted of western red cedar and Alpine fir. In the moss-vegetation were noticeable: *Mnium sp.* (abundance 4—7) occurring in spots and also common species of *Hylocomium* (3—6) appearing likewise in spots As to herbaceous vegetation in addition to various *ferns* (5—7) the following were most conspicuous: *Fatsia horrida* (5), *Tiarella unifoliata* (5—6), *Cornus canadensis* (6), *Equisetum* (5), *Moneses uniflora* (4), *Habenaria sp.* (4), *Linnaea americana* (4) and of shrubs *Rubus parviflorus* (4), *Ribes* (3), etc. Grasses also occurred abundantly and of several different species.

On the other plot the forest consisted of Douglas fir, spruce, western paper birch, mountain alder and some willows and western red cedar. Of mosses *Mnium sp.* was chiefly found. Of herbs in addition to various *ferns* (6—7) the following were most noticeable: *Fatsia horrida* (5), *Tiarella unifoliata* (4), *Aralia* (5), *Viola spp.* (5—6), *Equisetum* (4), *Galium triflorum* (5), *Actaea* (4), etc. and of shrubs: *Rubus parviflorus* (6), *Sambucus* (4), *Ribes* (4), *Lonicera involucrata* (3), etc. Grasses also occurred abundantly. In two or three points *Pachystima myrsinites* was found.

These plots in which the soil was wet chiefly only quite near the rivulet, may represent a (Tiarella-Fatsia-Fern-) sub-type deviating from the real fern type.

The explanation of the Fern- and Tiarella types naturally requires additional both numerous and thorough investigations.

SOME OBSERVATIONS ON THE VARIATIONS IN THE COMPOSITION OF THE VEGETATION IN THE SAME FOREST (SITE) TYPES.

The material for investigation in some degree offers an opportunity for examining, to what extent the composition of the vegetation in the same forest type or in two geographically interchangeable types varies according to such decisive circumstances as the density and the age of the stand, the dominant species of tree and the geographical

position of the place. This has previously been touched upon partly, when general descriptions of different forest (site) types were presented.

1. Density of the stand. In comparing, for instance, the two lodgepole pine sample plots of the Arctostaphylos type situated side by side in Highland Valley in B.C. Dry Belt, No. 1 and No. 2, of which the former was thinned in 1922, but the latter is still naturally dense, no difference worth noting is found in the composition of the vegetation. On the former sample plot there are only a few higher plant species which occur rather more abundantly than on the latter. The difference is just as small between the two sample plots, No. 5 and No. 6, of the Calamagrostis-Arctostaphylos type likewise situated side by side, of which the former is in a natural state, but the latter was thinned in 1921. The proportion is very much the same between the very dense sample plot No. 8 and the naturally open sample plot No. 9, there being slightly more mosses and higher plant species on the latter than on the former. The same observation can also be made in comparing the sample plots, No. 13 and No. 14, of the Calamagrostis type, of which the stand on the former plot is by nature relatively thin and that of the latter considerably denser.

On Cypress Hills the two sample plots, No. 1 and No. 2, of the Calamagrostis type are situated comparatively near each other, the stand of the former being naturally considerably denser than that of the latter. Many plant species occur on these plots in very much the same proportion, but on the whole the vegetation is, however, on sample plot No. 2 of thin forest considerably richer in species and more abundant than on sample plot No. 1 of dense forest.

An example of the way in which scantiness of vegetation cover is caused by an exceptional density, is given by sample plot No. 6 on Cypress Hills reckoned to the Calamagrostis type. The number of higher plant species is only about half and the abundance much less than that on the sample plots of the same type on Cypress Hills in general.

In comparing sample plot No. 1 of Laurentides Park on which the forest was fairly cleared several years ago, with other sample plots on which balsam fir forest grows, no essential differences are found in the composition of the vegetation. Mosses certainly occur somewhat less and especially *Carex brunnescens*, *Rubus idaeus* and *Sambucus racemosa* occur more abundantly on the open plot than on those covered with forest. *Oxalis*, *Maianthemum*, *Cornus*, *Trientalis* and *Dryopteris spinulosa* are not so luxuriant-growing on the former as on the latter.

On sample plots No. 14 and No. 15 of the Calamagrostis-Vaccinium scoparium type examined in the Yellowstone National Park, of which the forest on the latter is appreciably more regular and denser than that on the former, there is hardly any difference in the vegetation cover. The vegetation covers of sample plots No. 17 and No. 18, of which the forest on the former is of fairly normal density and that of the latter open, are also very similar. The fact that the dwarf-shrub vegetation on the former is more abundant and richer in species than that on the latter is, no doubt, due to other causes than to density.

The observations stated above as some examples, show that on the sample plots of those relatively barren forest (site) types, to which the investigation has been directed in the first place, the composition of the vegetation has not been found to vary very much according to the density of the stand, nor in any case so much as to have caused difficulty in determining the forest type. The vegetation, as is quite natural, is usually somewhat more abundant in thinner forests than that in dense stands. On the sample plots to be compared with each other the conditions such as the species of trees and the age of the stand etc. have, of course, been the same.

2. Age of the stand. In comparing the composition of the vegetation on sample plots No. 3 and 4 of the Arctostaphylos type in the B.C. Dry Belt with each other, of which the stand on the former is about 80 years old (density 0.7) and that on the latter about 200—250 years old (density 0.4—0.5), comparatively small differences are noticeable. In old stands the amount of dense *Arctostaphylos* spots and that of herbs, particularly such as *Epilobium*, *Antennaria flavescens* and *Fragaria*, is somewhat more abundant. Sample plots No. 8 and 10 are both situated at the same elevation in Highland Valley and the forest of both of them is very dense for its age, that of the former being 65 and that of the latter 128 years old. Mosses and some higher plant species are to be found somewhat more abundantly on the latter than on the former plot, but the differences are really small. The difference between the vegetation of sample plot No. 9 and that of sample plot No. 12 points in the same direction. The two sample plots are situated near Barnes Creek, the forest on the former being 66 and on the latter 230 years old. The same relation is noticeable between the vegetation of the middle-aged sample plots No. 13 and 14 (53 years and 60—65 years) and the old sample plots No. 15 and 16 (127 years and 140 years) of Calamagrostis type.

In Laurentides Park very small differences were found in the ground vegetation of balsam fir forests of 35 and 60 years' and on the other hand of 120 years' age. The same observation was made in the Yellowstone National Park in comparing the composition of the ground vegetation in a 50 years old stand of Vaccinium scoparium type with that in 120 and 180 years old stands.

The vegetation of a forest type attains its normal form, as is well known [1], when the stand is old-aged and differences are found, in general, more or less, when the stand is young or middle-aged. The different stages of age are not sufficiently represented in the sample plots of this investigation; this circumstance cannot, therefore, be examined sufficiently. But as regards the properly investigated, comparatively barren forest types the observation may be made, that the vegetation there seems to attain its normal composition already at middle age to the extent that it does not essentially differ from the composition of the vegetation of the old forest. The correct

[1] See: A. K. Cajander, The Theory of Forest Types, p. 27.

determination of the forest types investigated here will thus not cause any difficulties, at least from the period of middle age of the stand.

3. Dominant species of tree. At Banff an opportunity offered of studying the composition of the vegetation in the forests of different species of trees on sample plots No. 1, 2 and 10, these being very near each other and belonging to the same Calamagrostis-Arctostaphylos type. The comparison is, however, interfered with by the fact that on sample plots No. 1 and 2 the forest (lodgepole pine) is only 45 and 60 years old and dense, but on sample plot No. 10 (Douglas fir) 200—250 years of age and recently felled and now thin and open. In addition the latter sample plot was subjected to a slight fire a few decades ago. Notwithstanding these circumstances and also the difference in the species of trees, the composition of the vegetation is in the main very much the same on the sample plots. As the most noteworthy differences it can be mentioned that: 1) on the plots of lodgepole pine there are lacking: *Thalictrum*, *Trollius*, *Astragalus*, *Galium* and *Achillea* which occur on the Douglas fir plot, but even there to a comparatively small degree (abundance 2—3); 2) on the Douglas fir plot of such species as hav been found on the two lodgepole pine plots only *Moneses uniflora* (abundance 2) is lacking; 3) *Rosa*, *Vicia*, *Epilobium* and *Arctostaphylos* occur on the Douglas fir plot in considerably greater abundance than on the lodgepole pine plots. Lichens, mosses and grasses as well as most herbs occur on the sample plots of lodgepole pine and Douglas fir in very much the same proportion.

It is difficult to compare the Douglas fir sample plot No. 17 of the B.C. Dry Belt, near Ashcroft, with any lodgepole pine sample plot, for in its neighbourhood and at the same elevation (2 000—3 000 feet) no such investigation took place. But in comparing its vegetation cover with the vegetation cover of the same, Calamagrostis-Arctostaphylos, type in general, some differences are found, but many more similarities.

In comparing the composition of the ground vegetation on the

three sample plots (No. 18, 19 and 20) of the Pachystima type on Mount Ida, on which lodgepole pine comprises 70—90 per cent. of the stand, with that on the sample plot of the same type on Sicamous, where the stand chiefly consists of Douglas fir and western red cedar, hardly any difference is noticeable. Only some species of secondary importance will be found lacking in one of the two places or be found somewhat more abundantly in one than in the other. Owing to an abundant undergrowth the vegetation on the sample plot of Sicamous is, on the whole, rather more scanty.

In the Yellowstone National Park on the slope of Bunsen Peak in the same, Calamagrostis, type the following were found: a 40—45 years old aspen stand (sample plot No. 21), a Douglas fir stand of about 80 years old (No. 22), a 40—45 years old lodgepole pine stand (No. 23) and a Douglas fir stand (No. 24) of 30—35 years of age. The first is situated at an elevation of about 7 700 feet above sea-level and its density is 0.6; the corresponding figures being: for sample plot No. 22 7 650 feet and 0.6—0.7, for sample plot No. 23 7 400 feet and 0.9—1.2 and for sample plot No. 24 7 550 feet and 0.8—1.1. The elevation above sea-level thus varies somewhat, and the age and density vary very considerably. These differences do, of course, cause some difference in the composition of the vegetation in the different sample plots, so that it is difficult to prove the difference which is, perhaps, due only to the dominant species of tree. The occurrence of different plant species on these sample plots is as follows:

	Sample plot No.			
	21	22	23	24
Cladonia spp.	2—3	3	3	2
Peltigera sp.	4	2	3	3
Brachythecium rutab.	—	3—4	—	—
Calamagrostis sp. (and some other grasses)	7—9	5—8	5—8	4—8
Carex sp.	3—5	—	—	—
Fragaria (mostly *bracteata*)	3	3	2	3—6
Rosa spp.	—	1	2	4

Lupinus sp.	4—5	1	3	2
Astragalus sp.	3—5	—	—	—
Geranium Richards.	3—4	2	2	3—5
Viola spp.	—	—	—	3
Epilobium angustif.	2	2	—	3
Galium boreale	3—4	3—4	3	3
Campanula sp.	—	1	—	—
Solidago spp.	4—5	1	4	4—5
Aster macrophyllus	3	4—6	3—5	5—7
Aster spp. / *Erigeron spp.*	4—5	4—5	3	3
Antennaria flavescens	3	—	—	2
Balsamorrhiza saggitata	1	—	—	
Achillea millefolium	4	2	1	3
Arnica cordifolia	3	4	4	4—5
Berberis aquifolium	—	1	3	3—4
Ribes sp.	—	—	1	1
Spiraea (mostly *lucida* and *densiflora*)	—	4	4	4—6
Symphoricarpus sp. (*Vaccinium membranac.?*)	1	4	4	4—5

It is evident from the above that the main features of the composition of the vegetation are very much the same in the sample plots of different species of trees. The most noteworthy differences are that: 1) in the aspen stand the grass-vegetation as well as *Lupinus* and *Astragalus* are more abundant than on other sample plots, *Berberis* and *Spiraea* are not found and *Symphoricarpus* occurs only sporadically; 2) in the older Douglas fir stand *Lupinus*, *Solidago* and *Berberis* occur quite scantily; 3) in the young Douglas fir stand rather more plant species occur and most of the species rather more abundantly than on other sample plots.

Sample plot No. 6 in the tract of Glenwater is also worth noting, where the stand consists of aspen, the trees being jack pine on all the other sample plots. On the aspen plot *Cladina silvatica* is not found, though it occurs to some extent on all other sample plots; even mosses are found very scantily which again occur fairly abundantly on jack pine plots. Almost all grass- and herb-species are the same and occur in very much the same proportions as on the jack pine plots, but *Vaccinium* and *Arctostaphylos*, generally fairly abundant on the latter, are not found at all on the aspen plot. Shrubs occur on the lastmentioned somewhat more abundantly than, on an average, on jack pine plots.

The observations on the influence of the dominant species of tree upon the composition of the ground vegetation are too small in number and are too defective, to enable any reliable conclusion to be formed. It may, however, be said that on those comparatively poor forest (site) types which have properly been the object of examination in this investigation the composition of the vegetation is not dependent upon the dominant species of tree to such an extent as to cause any noteworthy difficulty in the determination of the forest type.[1] On rich forest (site) types the difficulty due to the species of tree may be somewhat greater and an accurate determination of the type may then require a more detailed investigation and knowledge of the various shades.

4. Geographical position. The regions, in which the most important forest types (Arct. t. and Vacc. scop. t., Cal.-Arct. t. and Cal.-Vacc. scop. t. and Cal. t.) of this study were found, are situated at a fairly great distance from each other. From the region of Kamloops-Ashcroft Banff is at a distance of about 250 miles to the east and from there to Cypress Hills is again about 300 miles westward. The Yellowstone National Park is situated at a distance of about 650 miles from the former and about 500 miles from Banff to the south-east and is about 350 miles from Cypress Hills to the south. The elevation above sea-level is also unequal to an appreciable degree: the lodgepole pine sample plots in the region of Kamloops-

[1] Compare: Yrjö Ilvessalo, Vegetationsstatistische Untersuchungen über die Waldtypen. (Acta forestalia fennica 20, Helsinki 1921.)

Ashcroft are situated, in general, at an elevation of about 4 000—4 500 feet and the main part of the sample plots of Banff are at about 4 500—4 800 and the sample plots of Cypress Hills at about 4 200—4 600, but the sample plots of the Yellowstone National Park are at about 7 400—7 800 feet above sea-level.

It is, of course, quite natural that these varying circumstances should cause differences in the composition of the vegetation, even to the extent of causing one forest type to occur as two geographically interchangeable types. The latter circumstance has already been dealt with earlier in describing the Arctostaphylos and Vaccinium scoparium types as well as the Calamagrostis-Arctostaphylos and the Calamagrostis-Vaccinium scoparium types. Other differences most worth noting are as follows.

Hylocomium proliferum occurs in the Calamagrostis-Arctostaphylos type abundantly in Banff and *H. parietinum* (together with *H. reptile* and *Thuidium abietinum*) to about the same extent, while in B.C. Dry Belt and on Cypress Hills *H. proliferum* is hardly to be found here or in the Calamagrostis type and also *H. parietinum* often occurs more scantily than in Banff. Also *Ptilium* and *Dicranum* are most abundant in Banff. These mosses are hardly to be found in the Vaccinium scoparium type, corresponding to Cal.-Arct. type in the Yellowstone National Park and in their place *Brachythecium rutabulum* and *Drepanocladus uncinatus* occur frequently, even if not very abundantly. *Carex sp.* is common and often fairly abundant in B.C. Dry Belt, but is, in general, not to be found elsewhere. *Astragalus* is common in B.C. Dry Belt, elsewhere *Vicia* and on Cypress Hills moreover *Lathyrus*. Several species, such as *Castilleja*, certain *Pyrola*-species, *Geranium*, *Cornus*, *Linnaea*, *Vaccinium caespitosum*, *Juniperus*, etc. occur in some regions much more abundantly than in the same or corresponding types in other regions, while sometimes they are entirely wanting. However, the influence of these circumstances upon the general form of the type is, in general, so small as not to cause difficulty in the correct determination of the forest type to any remarkable extent.

THE OCCURRENCE OF CERTAIN CHARACTERISTIC PLANT SPECIES IN DIFFERENT FOREST TYPES.

It is evident from the above general descriptions of the different forest types and from the lists of plants annexed to this paper that very many species occur in several, and certain species even in all the investigated forest types. Many of these occur, however, in greatly differing quantities and in different abundance in different types. Some species occur only in a definite type or in a few forest types or sub-types close to each other. The latter species are those to which attention is most drawn in determining the forest type and in comparing different types with each other. Most often it is just these that are most suitable as name-plants of the forest types. As CAJANDER emphasizes:[1] Regarding the nomenclature of the forest types, several devices are possible. E.g. the letters, A, B, C, etc., or the Roman numerals, I, II, III, etc., or combinations of these. These devices, however, being marred by several drawbacks, recourse has been had to the method of naming the forest types from the plant species which are most characteristic of them. It has, however, as CAJANDER expressly emphasizes, always to be borne in mind that such names are only names for some definite forest types which, especially in their normal condition, are characterised by vegetation associations with definite floristic compositions.

As such characteristic plant species the following occur in the above separated and described forest types of the investigated western regions of North America: *Vaccinium scoparium*, *Arctostaphylos uva ursi*, *Calamagrostis spp.* (and often some other grasses), *Pachystima myrsinites*, *Tiarella unifoliata* and *T. trifoliata*, *Vaccinium parvifolium* and several ferns and as fairly characteristic of good and fairly good forest soils also *Rubus parviflorus*.

The occurrence of these most characteristic plant species in the investigated forest types is graphically described in figure 2. All the sample plots of every type follow each other in it from the youngest

[1] A. K. CAJANDER, The Theory of Forest Types, pages 32—33.

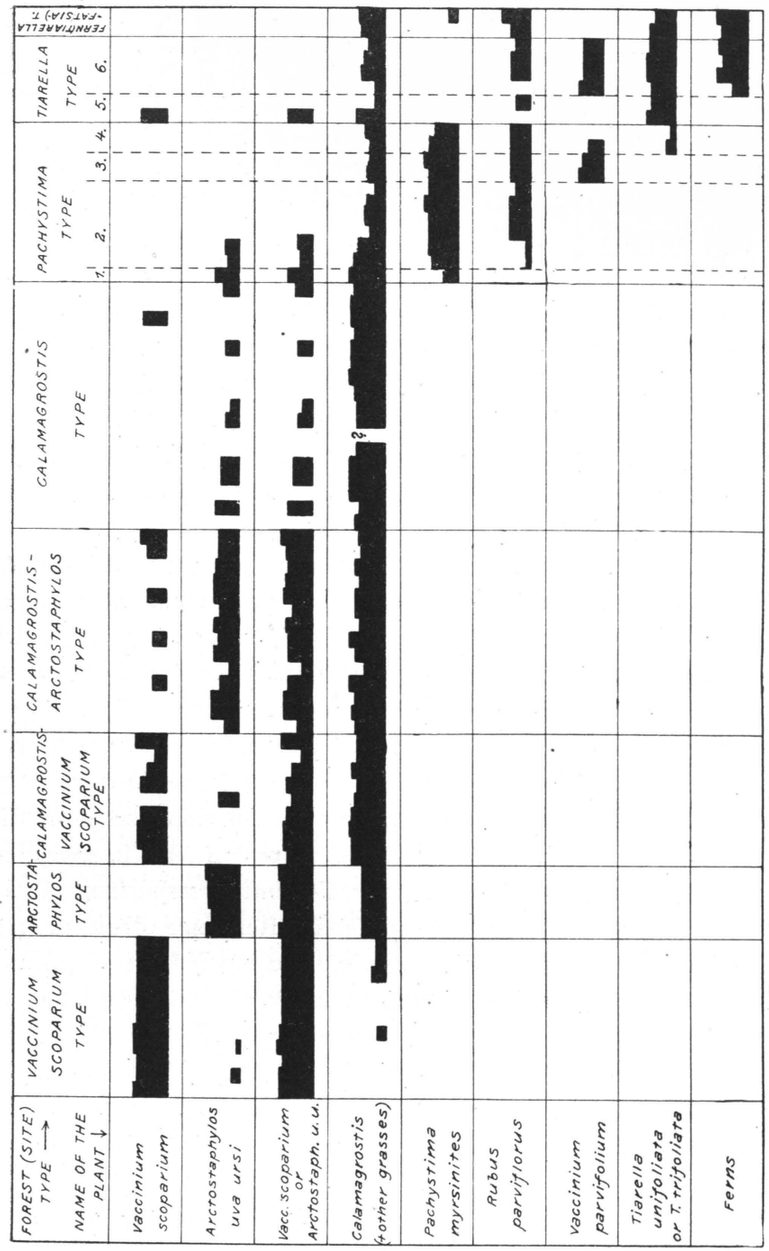

Fig. 2. Occurrence of the most characteristic plant species in the different forest types.

to the oldest and the height of the black column shows in the case of each sample plot, in what abundance (according to NORRLIN's scale) the species in question has been found on the sample plot.

Vaccinium scoparium occurs most regularly and abundantly in the Vaccinium scoparium type and next to it in the Calamagrostis-Vacc. scop. type. In some cases it occurred, too, in the Calamagrostis-Arctostaphylos type and in one case on a sample plot of the Calamagrostis type and likewise in one (at a high elevation in Yoho Valley) sample plot of the Tiarella type.

Arctostaphylos uva ursi occurs most regularly and abundantly on the sample plots of the Arctostaphylos type and next to it on those of the Calamagrostis-Arctostaphylos type. To a comparatively small degree it also occurred on several sample plots of the Calamagrostis type and on a couple of sample plots of Vacc. scop. type and on one plot of the Calamagr.-Vacc. scop. type, as also on a couple of sample plots of the Pachystima type of an exceedingly dry nature.

Calamagrostis (often several species and together with some other grasses) occurs most regularly and abundantly in the Calamagrostis, Calamagr.-Vacc. scop. and Calamagr.-Arctostaphylos types, in the latter together with the almost equally abundant *Vaccinium scoparium*- or *Arctostaphylos*-vegetation. This grass-vegetation very commonly spreads even to other types in which, however, the other plant species clearly surpass it in abundance.

Pachystima myrsinites occurs, in general, fairly abundantly in the Pachystima type (coll.) and was only found in one case on a sample plot belonging to another type.

Tiarella unifoliata or *T. trifoliata* was found on the sample plots of the Tiarella type and also on those of the Fern type and in a very small degree on two investigated sample plots of the Pachystima-Coptis sub-type near the Priest River Experiment Station. It may be mentioned that in the latter region *Tiarella* increases, when on a richer soil, where even other herbaceous vegetation is more abundant. Pachystima on the other hand seems to be more scanty.

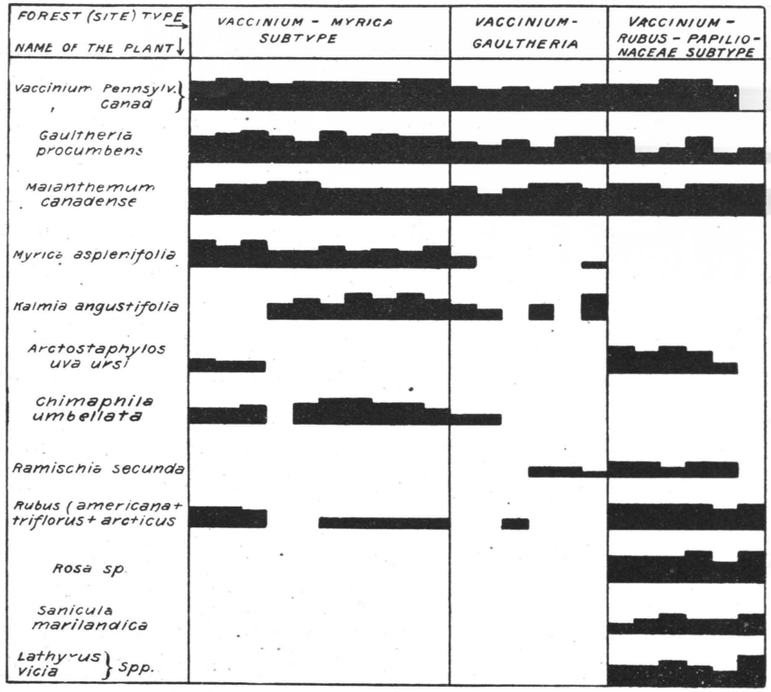

Fig. 3. Occurrence of some characteristic plant species in the Vaccinium-Gaultheria type with sub-types.

Ferns (*Dryopteris, Adiantum, Athyrium, Lomeria* etc. excluding *Pteris* and generally also *Thelypteris Dryopteris*) occur, in general, very abundantly and characteristically in the Fern type and in the Tiarella (-Fern) type closely approaching it. They were not found on sample plots belonging to other types.

In addition to the above the occurrence of *Rubus parviflorus* and *Vaccinium parvifolium* is described in figure 2. Neither of them was found in poor forest (site) types, the former beginning only from the Pachystima type and the latter only in the best sub-type of the Pachystima type and in the Tiarella type.

As a contrast to the previous species such species may be mentioned as: *Rosa, Epilobium angustifolium, Cornus canadensis, Linnaea americana, Spiraea* etc. which seem to occur frequently in all forest types, sometimes to a smaller, sometimes to a greater degree. They therefore do not seem to be characteristic plants of any special type. To these may belong also *Shepherdia canadensis*, which seems to occur in quite different forest types at a high elevation.

In figure 3 the occurrence of some plant species in the Vaccinium-Gaultheria type with sub-types is described. *Vaccinium pennsylvanicum* and *V. canadense* occur on all other sample plots except on a certain aspen plot. They occur mostly in comparatively great abundance, but somewhat more scantily on *Pinus strobus* sample plots, where there is an abundance of fallen needles on the ground. *Gaultheria procumbens* occurred on all the sample plots, but more scantily than the average in the Vacc.-Rubus-Papilion. subtype. *Maianthemum canadense* occurred on all the sample plots comparatively or even very abundantly. *Myrica asplenifolia* was found on all the sample plots of the Vacc.-Myrica sub-type, but of other sample plots only on two and even on those very scantily. *Kalmia angustifolia* is, perhaps, also chiefly a plant of the Vacc.-Myrica sub-type, but it was found also on several sample plots of the real Vacc. type. On three of the youngest sample plots of this type it is not found, the reason being that so far south as in the tracts of Cloquet, Minn., it probably occurs only in bogs. *Arctostaphylos uva ursi* occurred on the three sample plots of the Vacc.-Myrica sub-type mentioned and with the exception of the aspen plot on the sample plots of the Vacc.-Rubus-Papilion. sub-type. *Chimaphila umbellata* occurred chiefly on the sample plots of the Vacc.-Myrica- and *Ramischia secunda* on those of the Vacc.-Rubus-Papilion. subtype, but both are found to some extent on the sample plots of the real Vacc. type. The *Rubus*-species occurred fairly abundantly on all the sample plots of the Vacc.-Rubus-Papilion. sub-type and to a smaller degree even on other sample plots. *Rosa sp., Sanicula marilandica* and *Lathyrus* together with *Vicia* were restricted to the sample plots of the Vacc.-Rubus Papilion. sub-type.

THE NUMBER OF PLANT SPECIES OF DIFFERENT TYPES.

As it was often impossible to determine the names of certain grass-species quite adequately even by means of specimens and because there was uncertainty as to some other species of plants, too, and some rare species may often have been omitted from the descriptions, it was not possible to determine the number of the plant species on all the sample plots. For this reason there were not sufficient grounds for drawing up detailed statistics concerning the number of species.

In order to throw some light on this question, too, data are given below — lichens, mosses, grasses and also tree species being omitted — showing what proportion of the sample plots of each type or sub-type contained above 30, above 25, above 20, above 15 and above 10 species (herbaceous-, dwarf-shrub- and shrub-species).

More than:	10	15	20	25	30	
Forest type or sub-type:	plant species occurred in the following percentage of the total number of sample plots:					Number of the sample plots:
Arctostaphylos	40	—	—	—	—	5
Vacc. scoparium	27	—	—	—	—	11
Calam.-Arct.	100	60	—	—	—	15
Calam. Vacc. scop.	100	78	11	—	—	9
Calamagrostis	100	60	12	—	—	17
Pachystima	100	100	60	—	—	7
Pachyst.-Coptis	100	100	100	100	50	2
Pachyst.-Vacc. parvif. ..	100	100	100	100	100	2
Tiarella-Vaccin.	100	100	100	50	—	2
Tiarella (+ *T.-Fern*)	100	100	100	100	80	5

The sample plots are thus on an average the richer in species, the more luxuriant the forest type is from which they have been obtained.

In the Vaccinium-Myrica sub-type and the real Vaccinium-Gaultheria type the number of the herbaceous-, dwarf-shrub- and shrub-species in the lists drawn up varied between 21 and 26 and in the Vacc.-Rubus-Papilion. type between 33 and 40. On the balsam fir sample plots of the Oxalis-Hylocomium type in the Laurentides Park the number of species was, perhaps owing to the dense nature of the stand and the fairly thick feather-moss cover etc., very small, only between 8 and 16.

OBSERVATIONS ON THE HEIGHT AND THE BREAST-HEIGHT DIAMETER OF THE DOMINANT TREES IN DIFFERENT FOREST TYPES.

However interesting it might have been to make detailed investigations as to the growth and yield of the forest in the different forest (site) types, there was no opportunity for doing so during the rapid excursions made. In order to elucidate this question, too, in some measure some observations were, however, made and for this purpose some measurements of the age, height and breast-height diameter of dominant trees, requiring the least time and work, were carried out. An account of the manner, in which these were performed, is given on page 32.

HEIGHT OF THE DOMINANT TREES.

In *lodgepole pine* stands on a total of 55 sample plots notes were made on the height of the dominant trees. Of these 6 are of the Pachystima type, 12 of the Calamagrostis type, 13 of the Calamagrostis-Arctostaphylos type, 8 of the Calamagrostis-Vaccinium scoparium type, 5 of the Arctostaphylos- and 11 of the Vaccinium scoparium type. The figures concerning height are marked in the descriptions of sample plots previously mentioned and they are given separately also in the graphical diagram of figure 4. When the height has been marked by two limit-figures (for instance 70—75

feet), the mean value (72.5′) has been taken.[1] On the basis of points representing height the average height curves have in this diagram been drawn for different forest types. The observations of each forest type are quite naturally grouped around their own curve. It has, therefore, been possible to draw the average curves on the basis of the relatively small number of observations.

It is evident from the diagram that the points of the Calamagrostis-Arctostaphylos type and the Calamagr.-Vacc. scoparium type group themselves round the same average curve. This substantiates the opinion that these types are geographically interchangeable types. The relation is the same between the Arctostaphylos type and the Vaccinium scoparium type. According to the height curves drawn up, the development of the height of dominant trees in the lodgepole pine stand would seem to be as follows beginning with the age of 30 years, whence it has been possible to draw the curves with considerable certainty:

Age years:	Pachystima t.	Calama-grostis t.	Calamagr.-Arct. t. Calamagr.-Vacc. scop. t.	Arctostaph. t. Vaccin.scop. t.
30	28	22.5	18	12 feet
40	42	34	28	19 »
50	56	46.5	38	26 »
60	68	58	47	32.5 »
70	78	66	52	37 »
80	86.5	72	57	41 »
90	94	77.5	61	44 »
100	100	81.5	64	46 »
110	—	85	67	48 »
120	—	88	69	50 »
130	—	91	71	52 »

[1] Banff's sample plots No. 6 and 7, which are situated about 1 000—1 500 feet higher than others and are apparently for that reason quite exceptional, have been omitted from the diagram. Likewise the exceptionally dense stand No. 6 on Cypress Hills.

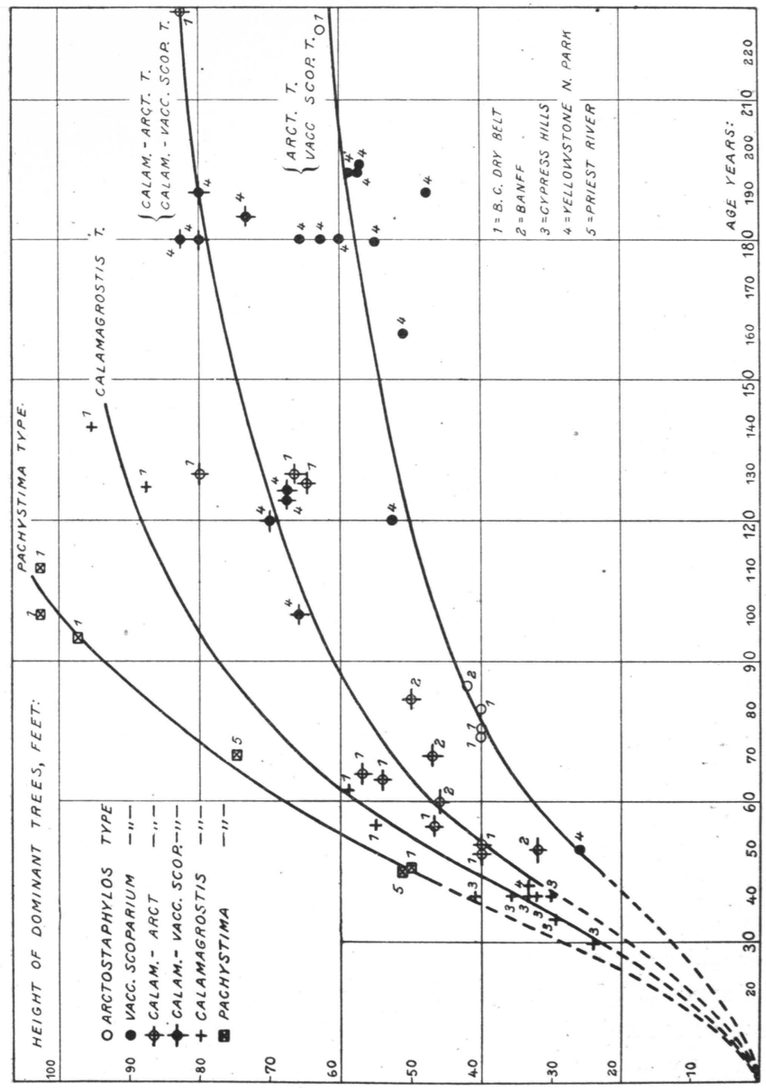

Fig. 4. Average height of dominant trees in a lodgepole pine stand in the different forest types.

140	—	93	73	53.5 feet
150	—	—	75	55 »
160	—	—	76.5	56 »
170	—	—	78	57 »
180	—	—	79	58 »
190	—	—	80	59 »
200	—	—	81	60 »

The annual height growth of the dominant trees while at its best would thus be: in the Pachystima type 17, the Calamagrostis type 14.5, the Calamagr.-Arctostaphylos and Calamagr.-Vacc. scoparium types 12 and the Arctostaphylos and Vacc. scop. types 8.5 inches. For example, the dominant trees of the lodgepole pine stand reach the height of 60 feet according to the height curves on an average: in the Pachystima type at 53 years' age, the Calamagrostis type at 63 years', the Calam.-Arct. and Calam.-Vacc. scop. types 88 years' and the Arct. and Vacc.scop. types at about 200 years' age.

In figure 5 in the same system of co-ordinates the height curves of lodgepole pine and the same of the dominant trees of the Scotch pine (*Pinus silvestris*) stand in the southern half of Suomi (Finland) are shown in those types, where Scotch pine grows most frequently in the southern half of Suomi. It appeared as if the Myrtillus (*Vaccinium myrtillus*) and Pachystima types, in general, corresponded to each other, likewise the Vaccinium (*V. vitis idaea*) and Calamagrostis types as well as the Calluna (*Calluna vulgaris*) and Calamagr.-Arctostaphylos and Calamagr.-Vacc. scop. types. The Cladina type, which occurs rarely in the southern half of Suomi (Finland) and the height curve of which is for that reason uncertain, would appear to be appreciably more barren than the Arct. and Vacc. scop. types. The development of the height of Scotch pine is much more rapid in earlier years, but later it is slower than that of lodgepole pine. This appears to be natural in comparing the stands of these different pine species with each other. The self-thinning of the lodgepole pine stand is exceedingly slow, but when the worst competition is

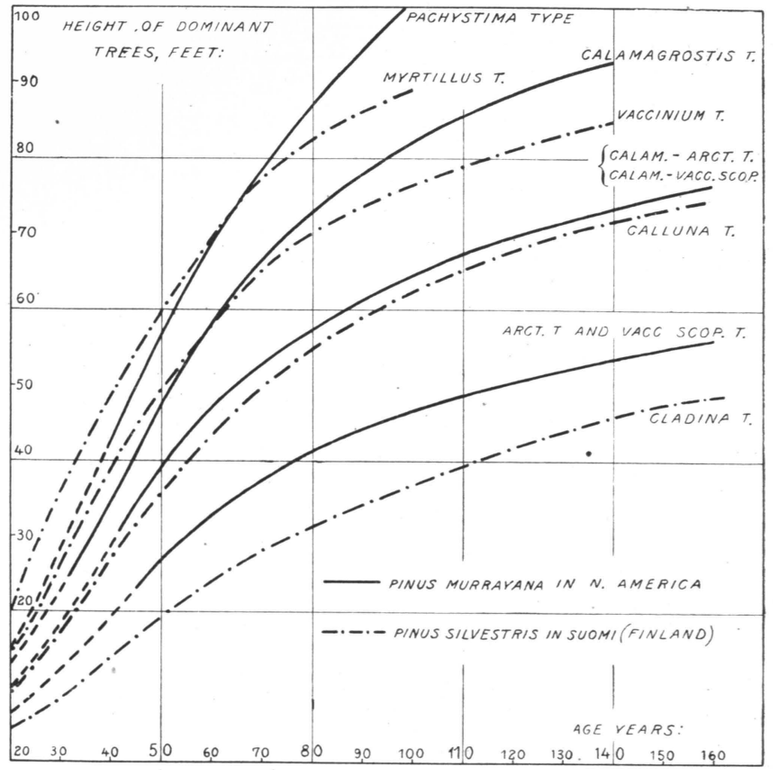

Fig. 5. Average height of dominant trees of *Pinus Murrayana* in N. America and *Pinus silvestris* in Suomi (Finland) compared with each other.

ultimately over, there is still much energy left for height growing and the height-growth continues fairly quickly for a long time. In the Scotch pine stand again self-thinning takes place comparatively well and rapidly and too great a density even at a young age does not thus greatly hamper the height growth of the dominant trees. The self-thinning of the stands of these two species of trees in forest types corresponding in general with each other is shown by the following figures: [1]

[1] According to Adrian C. Thrupp, Normal Yield Tables for Lodgepole pine in Central British Columbia, 1921, and Yrjö Ilvessalo, Growth and Yield Tables for Scotch pine, Norway spruce and Birch in Southern Half

Age years:	Lodgepole pine in Calamagr. type[1]	Scotch pine in Vaccinium type	Lodgepole pine in Cal.-Arct. t.[2]	Scotch pine in Calluna t.
		Number of trees per acre:		
30	1 830	2 436	2 540	5 040
	—330	—816	—360	—2 240
40	1 500	1 620	2 180	2 800
	—290	—594	—310	— 792
50	1 210	1 026	1 870	2 008
	—250	—294	—280	— 546
60	960	732	1 590	1 462
	—170	—165	—250	— 292
70	790	567	1 340	1 170
	—110	—112	—190	— 228
80	680	455	1 150	942
	— 50	— 78	—160	— 190
90	630	377	990	752
	— 40	— 49	—100	— 166
100	590	328	890	586

In figure 6 the height curves of the lodgepole pine obtained and the average height curves of the dominant trees drawn up by A.C. THRUPP for the same species of tree in different site classes have been placed in the same system of co-ordinates. On the basis of the diagram it appears as if Thrupp's site I corresponded generally to the Calamagrostis type, but the young sample plots were probably, on an average, somewhat better than the Calamagr. type (perhaps partly Pachyst.t.) and the old plots again on an average somewhat poorer than Calamagr. t. (perhaps partly Calamagr.-Arct. t.). The differences of site II and the Calamagr.-Arct. type are on an average very small. The curves of site III and the Arct. type differ more

of Finland, 1920. (Acta forestalia fennica 15.) A comparison as such holds good only in such a case that in THRUPP's Yield Tables the number of trees comprises all trees not less than 1.3 m high, which is not given in the Yield Tables.

[1] = Site I and [2] = Site II in THRUPP's Yield Tables.

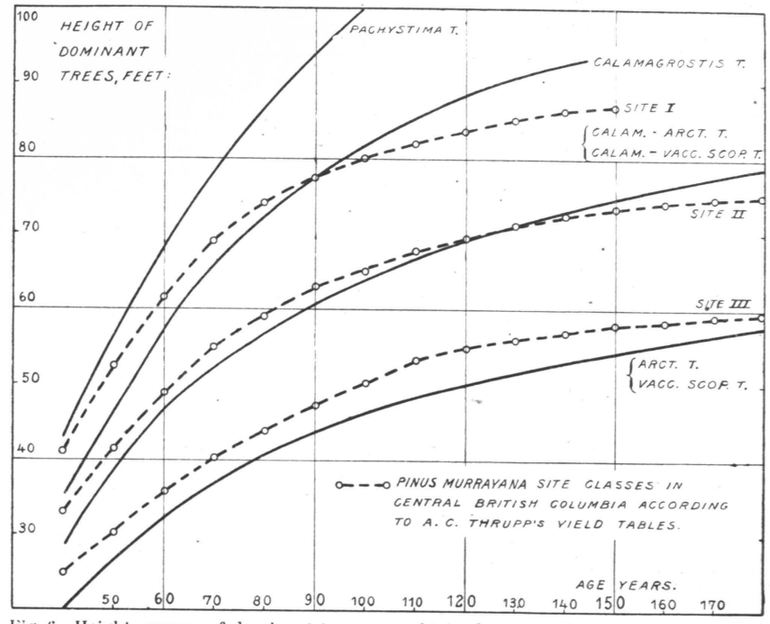

Fig. 6. Height curves of dominant trees now obtained compared with those drawn up by A. C. THRUPP for three site classes.

from each other. Possibly site III partly comprises sample plots of the Calam.-Arct. type. The differences may, of course, be explained to a certain degree also by the fact that in the investigations now made the observations, especially in young stands, are too small in number.

For the sake of comparison the height of dominant trees in lodgepole pine stands »on slightly better than average sites» in Deerlodge National forest, Mont., according to D. T. MASON and the figures now obtained for the Calamagrostis-Vacc. scop. or Cal.-Arct. type may be given:

Age years	30	40	50	60	70	80	90	100	110	120	130	140	150
Height in Deerlodge Forest	20	32	38	44	49	54	58	62	66	70	73	76	79 feet
Height on Cal.-Vacc. scop. type	18	28	38	47	52	57	61	64	67	69	71	73	75 »
Cal.-Arct. »													

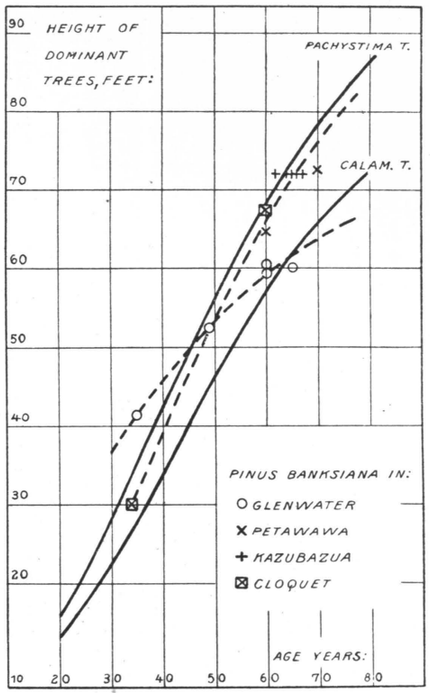

Fig. 7 Height of dominant trees in a jack pine stand compared with that of lodgepole pine in Pachystima and Calamagrostis types.

The heights agree fairly well except in old age, when the difference from the age of about 150 years becomes more and more noticeable.[1]

It seems as though we had to do here chiefly with the same forest (site) type to which, too, the names of the plants of the ground vegetation enumerated by MASON point.

In this connection it may also be mentioned that in more northern regions than those to which the observations of this investigation apply, the growth of lodgepole pine appears, according to BARR, to be very different.[2] There spruce penetrating into the lodgepole

[1] D. T. MASON, The Life History of Lodgepole pine in the Rocky Mountains. Bulletin of the U.S. Dept. of Agric. No. 154. 1915.

[2] See: C. G. TIGERSTEDT, Pinus Murrayana. Forstlig Tidskrift No. 2, 1927.

pine stands seems to be of great importance for the development of lodgepole pine. In all probability the forest types there also deviate from those described here.

In jack pine stands observations on the height of dominant trees were made only on 14 sample plots and even these only for the sake of comparison. Of these 9 are from the Vaccinium-Myrica sub-type and 5 from the Vacc.-Rubus-Papilionaceae sub-type. On the basis of these height curves have been drawn up, which are inadequate, owing to the small numbers of observations, in figure 7 and for the sake of comparison the corresponding curves of lodgepole pine in the Pachystima and Calamagrostis types have been placed in the same system of co-ordinates. The curve showing the development of the height of dominant trees of the jack pine stand in the Vacc.-Myrica sub-type deviates only slightly from the corresponding curve of the lodgepole pine in the Pachystima type. Apparently these two types are closely related. In the Vacc.-Rubus-Papilionaceae sub-type the height of the dominant trees in the jack pine stand appears to differ from the former. It seems as if the height developed very rapidly in youth, but as if the growth soon became much slower. This would, perhaps, point to the fact that this type, resembling a grass-herb type of a dry nature, may also be too good a site for jack pine. It is, nevertheless, possible that the observations are too few in number to give any adequate figures.

In Douglas fir stands observations on the height of dominant trees were made for the sake of comparison on 13 sample plots. The observations which are unfortunately altogether too few in number, have been noted in a system of co-ordinates in figure 8 and on the basis of these efforts have been made to sketch some kind of height curves. These curves are, of course, of no further importance except that they, perhaps, indicate the general direction. The height of the dominant trees appears to be higher at the same age in the Tiarella type than in the Tiarella-Vaccin. type, in this higher than in the Pachystima-Vaccin. parvif. type, in this somewhat higher than in the Pachystima type, in this again considerably higher than

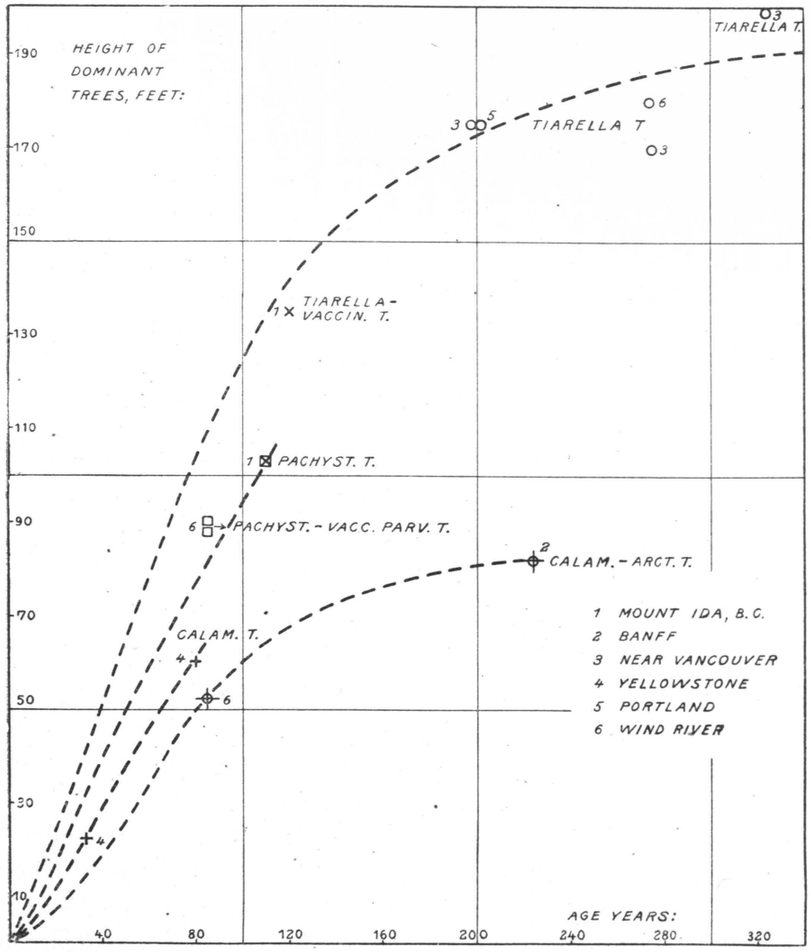

Fig. 8. Some observations of the height of dominant trees in a Douglas fir stand.

in the Calamagrostis type and ultimately in this considerably higher than in the Calamagr.-Arctostaphylos type. It is only in the Tiarella type that the average height of a dominant Douglas fir appears already from youth to be considerably higher than what was found in lodgepole pine stands. On the contrary in the Pachystima type and in types poorer than it, the height growth of Douglas fir which

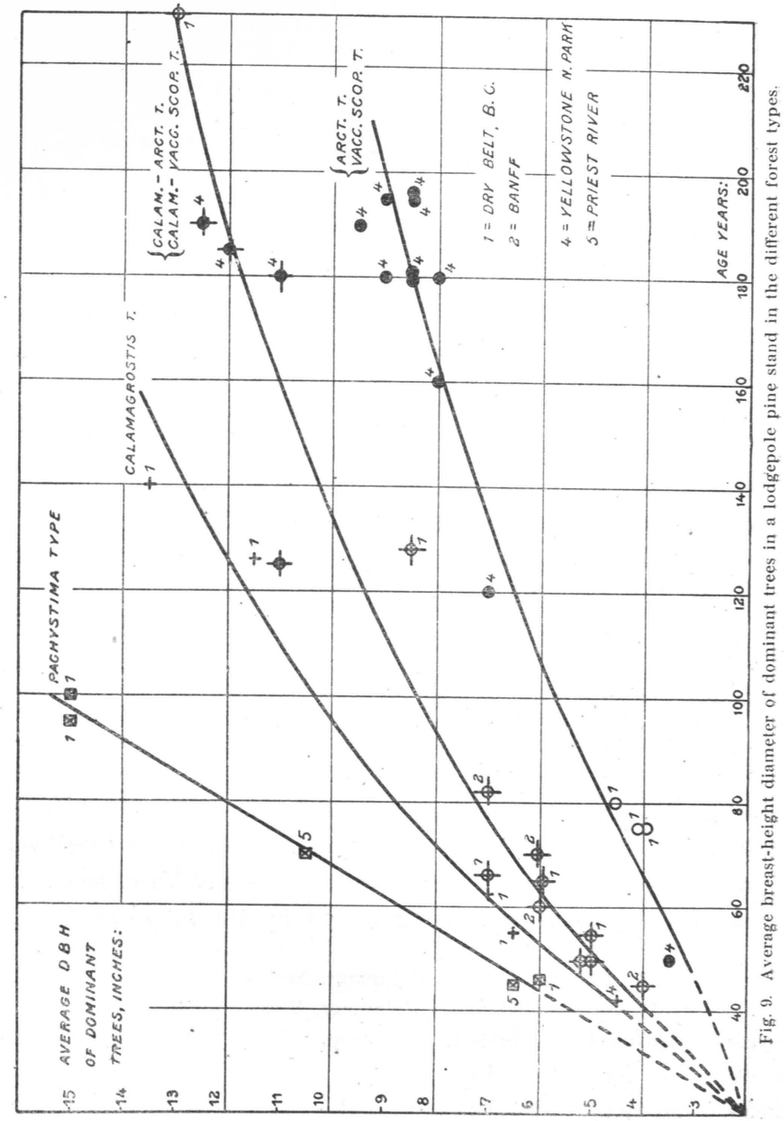

Fig. 9. Average breast-height diameter of dominant trees in a lodgepole pine stand in the different forest types.

continues for a very long period, appears only in its old age to attain that of lodgepole pine. In the latter case the mountain form of Douglas fir is referred to.

BREAST-HEIGHT DIAMETER OF THE DOMINANT TREES.

Observations of the breast-height diameter of the dominant trees were made to a smaller extent than upon height and almost exclusively on lodgepole pine sample plots. These observations have, however, also been arranged in a system of co-ordinates in the diagram in figure 9. The diameter being to a very great extent dependent on the density of the stand, those sample plots, on which the density of the stand was, on an average, lower than 0.7, have been left out in order to obtain some kind of coherence.

As figure 9 shows, it has been possible on the basis of points presenting the average breast-height diameter of the dominant trees in a fairly natural manner to draw average smoothed curves for the forest types distinguished. The observations of the different types would certainly be even nearer to their own curves, if the density did not vary so much (0.7 — above 1) as it still varies on different sample plots.

The breast-height diameter of the dominant trees in the Pachystima type at the same age is very considerably greater than in the Calamagrostis type, in this again greater than in the Calamagr.-Arctost. and Calamagr.-Vacc. scop. types and again in these very appreciably greater than in the Arctostaphylos and Vacc. scoparium types. These proportions are elucidated by the following figures:

Age years	Pachystima t.	Calamagrostis t.	Calamagr.-Arct. t. Calamagr. Vacc. scop. t.	Arctostaph. t. Vaccin. scopar. t.	
40	5.4	4.4	3.9	2.8	inches
50	7.0	5.6	4.8	3.2	»
60	8.7	6.8	5.8	3.7	»
70	10.4	7.9	6.6	4.2	»

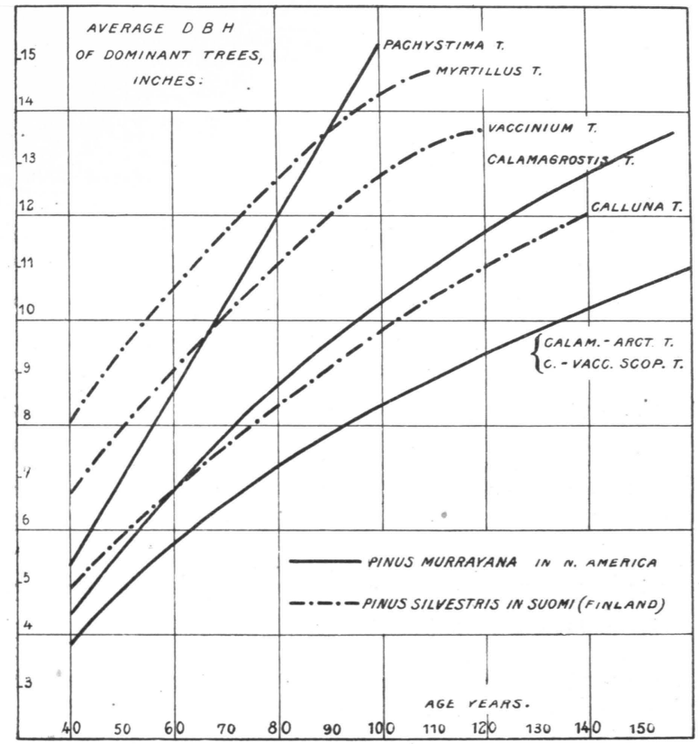

Fig. 10. Average breast-height diameter curves of *Pinus Murrayana* in N. America and *Pinus silvestris* in Suomi (Finland) compared with each other.

80	12.0	8.8	7.3	4.7	inches
90	13.7	9.6	7.8	5.2	»
100	15.3	10.3	8.4	5.7	»
110	—	11.0	8.9	6.1	»
120	—	11.7	9.4	6.5	»
130	—	12.3	9.9	6.9	»
140	—	12.8	10.3	7.3	»
150	—	13.3	10.7	7.6	»

The breast-height diameter (with the bark on) of the dominant trees seems according to the diagrams to attain, for instance, 9 inches in the Pachystima type at the age of 62 years, in the Calamagrostis

type at 83, in the Calamagr.-Arct. and Calamagr.-Vacc. scop. types at 112 years' and in the Arctostaphylos and Vacc. scoparium types only at 197 years' age.

In figure 10 the diameter curves of the lodgepole pine in the three best types and the diameter curves of the dominant trees of the Scotch pine stand in the southern half of Suomi (Finland) in the Myrtillus-, Vaccinium- and Calluna types (see p. 76) are presented in the same system of co-ordinates. In corresponding forest types the breast-height diameter of the dominant trees seems to be considerably greater at the same age in Scotch pine stands than in lodgepole pine stands. This is easily understood, when we remember how different the self-thinning is in Scotch pine and lodgepole pine stands (see p. 78). An exception is formed by the Pachystima type at an older age, but this difference may also be due to too few observations.

SOME ASPECTS TO BE TAKEN INTO CONSIDERATION IN THE STUDY OF FOREST TYPES.[1]

As has been repeatedly mentioned above, the researches on some forest (site) types in North America contained in this paper are based upon observations, defective and comparatively few in number, which were made during rapid excursions, while on a journey performed for other purposes. It only aims as being something in the nature of a first experiment in this sphere. The investigation of forest (site) types on such an enormously large area as North America naturally demands thorough investigations and intensive work by many investigators. In what manner such a work of research could

[1] The literature on forest (site) types is already very extensive and manysided. It shows manysided points of view which should be taken into consideration in investigating forest types and in carrying out experiments and investigations on these. An account of this literature cannot be given here. Reference is only made here to the bibliography on the subject contained in A. K. CAJANDER's book: The Theory of Forest Types. (Acta forestalia fennica 29.)

best be carried out it is, of course, difficult to imagine in detail. The methods of procedure to be followed depend on many different circumstances. A method which would be perfectly justified in the wooded districts of some parts of Canada or the Western United States, so very little touched by culture and still in a perfect state of nature, might possibly be difficult of application, for instance, in the Eastern United States, where culture in many regions over very extensive areas has so entirely changed the composition of the forests as to leave hardly any traces of the original species of trees.

The more the original forests have disappeared and changed their appearance owing to fellings, fires, etc. the more difficult and troublesome is reliable and thorough explanation of the forest (site) types. A forester who has had sufficient plant-geographical schooling or a plant-geographer who has had sufficient forestry schooling would be best capable of thoroughly expounding this question, as the forest types in general.

The investigation of forest types will prove most successful, when untouched natural forests or at least nearly natural forests as far as possible normally developed, and quite or almost mature, can serve as a starting-point. In such stands in which the ground vegetation, too, has for a lengthy period been able to develop in peace, the forest type occurs in its normal form.[1]

Before the investigation of the forest types even in such regions could be really commenced, it would be advisable to acquaint oneself with the whole region to be investigated and its flora and, if possible, with the biology of the species of plants. By making excursions in different parts of the region it should be ascertained which seem to be the most common forest-plant-communities in the region and what seems mostly to characterize each of them. At the beginning already we might form in our minds pictures of different forest-plant-communities that have come

[1] See: A. K. CAJANDER, The Theory of Forest Types, pages 27—28.

across, so that on their re-appearance it would, probably, be clear as to which of these pictures the forest-plant-community in question most nearly belongs to. Only after it has thus become clear, which different groups of forest-plant-communities on the area to be investigated are clearly distinguishable and what is characteristic of each of them, the forest-plant-communities of each group that seem to be typical should be described in detail. Several descriptions of each group should be obtained, so as to allow the variations to appear sufficiently clearly.

Each d e s c r i p t i o n to be drawn up ought to be sufficiently thorough and manysided, yet not so much so as to require too much time. It should concentrate upon the tree stand as well as on the ground vegetation and also upon the most important epiphytes and lianae, whenever they occur to any noteworthy degree. The sample plot to be investigated must not be too small, for then the variations cannot be taken into consideration sufficiently.[1] A size to be recommended is, e.g., half an acre. It is not necessary to limit the sample plot, unless the measurement of the trees requires it, but it should be kept strictly in mind that the plot must not be divided, for instance, on two types or come too near the boundary. Endeavours should be made to take it in as homogeneous and typical a place as possible.

Some general notes on the sample plot and the site should be made first, such as can exert influence on the composition of the vegetation, the growth of trees etc. For instance, note where the sample plot is situated and how high it is above sea-level; its position in regard to the neighbourhood: open, sheltered, hill, valley etc.; the inclination of the surface: even, sloping, steep etc. and its general direction; the stoniness of the soil, the thickness of the humus layer, the abundance and quality of the litter etc.; when the sample plot was investigated (the composition of the vegetation

[1] See, e.g.: Yrjö Ilvessalo, Vegetationsstatistische Untersuchungen über die Waldtypen, pages 55—66. (Acta forestalia fennica 20.)

varies to some extent, for instance, at the beginning, middle and end of the summer period).

It is, of course, all the better the more thoroughly the vegetation is described and analysed, but, as in such an initial investigation there is mostly an orientation in question, it is hardly worth while applying very laborious methods to it directly. These are appropriate later on in special investigations which, of course, are necessary in time. But whatever methods are used, the investigation of the composition of the vegetation should always the whole time be made a c c o r d i n g t o t h e s a m e s y s t e m in the same research and in the same manner, so as to enable all the results to be compared with each other in the right way. Thus, in determining the abundance of the occurrence of the plant species the same scale should be used all the time. For instance, Norrlin's scale of abundance has in many researches of this kind proved to be convenient and practical. Ready printed forms have been of great use in drawing up the description of the vegetation, as they contain the names of the plant species generally occurring in the region to be investigated, and on these the figures giving the abundance of the occurrence of each species are entered. The description of the vegetation renders it necessary to traverse the sample plot in all directions, at the same time making notes on the forms as to what plant species have been found and, after sufficiently examining the different parts of the sample plot, as to the average abundance of the different species as also the mode of occurrence, in brief, such as: in spots (limit-values), on stones, on thick-ends of the trees etc. Notes should also be made on the general thriving of different species, e.g. luxuriant, stunted etc., when there is special reason for it. Unknown plant species should be noted by marks easily remembered and specimens of these should be taken for a subsequent determination of their names.

As not only the ground-vegetation, but also the t r e e s belong to the forest-plant-community, sufficient attention should be given to these, too. The species of trees should be noted and also observations made on their general growth, whenever anything special is to

be noticed in that respect. In a first investigation in which an orientation is in question it is, perhaps, not yet necessary to undertake a minute measuring of the sample plots, but we can be content with, for instance, observations concerning the average height and breast-height diameter of the dominant trees and their growth and the age of the stand, which are all comparatively easy to carry out. Only when the preliminary research has elucidated the forest (site) types of the area to be investigated, would it, perhaps, be best to study thoroughly the growth of the stand and individual trees in different forest types. Then the sample plots should, of course, be carefully marked out and measured, and after sufficient data have been collected, it is then time to endeavour to draw up growth and yield tables on the basis of investigated forest types.

Whenever there is a possibility of reliably analysing soil samples, it would be advantageous to take soil samples of the different layers of the soil from the sample plots of different types. This would explain in what degree the soil of various forest (site) types differs in regard to the abundance and occurrence of the most important food-materials and its physical qualities. Photographs taken of the ground vegetation and standing crop of the different types are also of use.

After the forest-plant-communities of the natural forests or the most normal and mature forests, that is, the »normal forms» of the forest types of the area in question have been thus expounded, the forms deviating from this »normal state» should be investigated. The composition of the vegetation should be investigated and described in the different appearances of felled stands, on cleared out areas, burned areas, pasture-lands, in seedling stands and in dense young and middle-aged stands, in the densest of which the ground vegetation may be very scanty and undeveloped, yet characteristic, in the stands of different species of trees, etc.[1] These researches could most

[1] See: A. K. Cajander, Wesen und Bedeutung der Waldtypen. (Tartu Ülikooli Metsaosakonna toimetustest nr. 10.) 1927. Pp. 39—41.

advantageously be made on a rather large area belonging to exactly the same forest type, on which the standing crop in different parts varies as to density, age, etc. either naturally or because of fellings. In each case it should be definitely determined, to what forest-plant-community of a natural forest or a most normally developed mature forest, that is, to what normal type, each deviating form belongs. Thus a complete description will be obtained, as to the limits within which each forest type varies.[1] In poor forest types the variations generally move within relatively narrow limits, as Cajander has ascertained[2], and as is stated also above in this study (pages 60—65). In rich types the variations are greater and considerably more difficult to describe.[2]

Very often some forest types, comparatively few in number, occur on a certain area as dominant, and besides them we find here and there other types or sub-types restricted to relatively small areas. These rather scarce and comparatively insignificant forest types should also be investigated for the sake of completeness. From a silvicultural point of view they are not often of any particular importance and in researches concerning, for instance, the growth and yield of the forests it is not worth while treating them independently, but they can be added to those main forest types, with which they are most closely connected. Likewise it is often most convenient for practical reasons to bring together types which are floristically disjunctive, but still ecologically very close to one another and vice versa. The number of forest types treated as independent is usually comparatively small, for instance on the productive forest lands of the whole southern half of Suomi (Finland) only five or six, if swamps are not included.

[1] See: A. K. Cajander, The Theory of Forest Types, p. 28.

[2] See: A. K. Cajander, The Theory of Forest Types, p. 29 and A. K. Cajander, Über Waldtypen: Descriptions of the vegetations of the different forest types at the seedling stage, at the pole stage (when the stand is at its densest) and at the time of maturity.

According to CAJANDER it may in addition be mentioned here what is aimed at from a forestry point of view, by the forest (site) types as understood and explained in the aforesaid manner.[1] These aims are in their principal features:

1. To attain uniform site quality classes for all the species of trees instead of determining the quality classes for the forest site in different ways and on different grounds according to what species of tree is grown on it, as is usually done now-a-days. In the latter case the same site may be pine site class I, spruce site class II and so forth. Only by determining the site classes so that they are the same for all species of trees, is it possible to make, for instance, important calculations as to the profit of growing different species of trees on similar sites.

2. To attain for different countries site quality classes uniform and at least distinguished on the same ground and comparable with each other as easily as possible, instead of almost every country at present having her quality classes determined in a different way and on different grounds which, for instance, renders the attainment of uniform forest statistics impossible.

3. To bring about as natural quality classes as possible, comprising sites that are biologically as nearly related to each other as possible.

4. To make it possible that in preparing yield tables the data of each site quality class may from the very beginning be treated separately. The height-, volume- and other curves of each site quality class and the corresponding growth series are thus drawn up quite independently and they will then take their own natural form. On the contrary, all such minutely analogous curves and growth series as are usually obtained for site quality classes separated on mathematical bases, hardly ever have a correspondence in nature,

[1] See: A. K. CAJANDER, Was wird mit den Waldtypen bezweckt? (Acta forestalia fennica 25, 1923.)

so that they are, as such quality classes themselves, apparently artificial.

5. To attain a simple, but at the same time an indicative means of expression, as to the character of the site, which is important in making comparative experiments and investigations. If thus, for instance, some experiment or investigation is known to have been made in the Calamagrostis type, it would be understood more easily, than if it were said to have been performed, for instance, in the Douglas fir site class IV or in the lodgepole pine site class II etc.

6. To attain a basis for applied silviculture. For instance, a lodgepole pine stand requires different treatment on different sites, different, for instance, on dry sandy soil and on fertile, easily grass-grown soil.

7. To attain uniform site quality classes not only for different species of trees, but also a possibly uniform classification of forest soils for all forestry purposes, both for silviculture and forest politics as also for forest management, etc.

Yrjö Ilvessalo

TABLE 1. List of plants in the sample plots of Arctostaphylos and Vacc. scoparium types.

Name of the plant	Arctostaphylos type					Vaccinium scoparium type										
	Interior Dry Belt of B. C.				Banff	Yellowstone National Park										
	1	2	3	4	4	1	2	3	4	5	6	7	8	9	10	11
Cladonia spp.	6	5—6	5—7	5—7	4	5—7	5—7	5—6	6—7	4—7	5—6	5—7	5—6	6—8	6—8	5—6
Peltigera sp.	6—7	6	5—7	5—6	5	2	5	4—7	2	5	1—4	4	4	2—4	6	5
Cetraria sp.	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Stereocaulon sp.	2	—	—	—	—	—	—	—	—	—	—	—	—	—	3—4	—
Hylocomium parietinum	—	—	—	—	—	—	3—6	—	—	—	—	—	—	—	—	—
Dicranum spp.	—	—	—	—	4—6	3—6	5—7	3—5	4—7	4—6	—	—	4	3—5	3—5	3—6
Drepanocladus uncinatus																
Polytrichum juniperinum	—	—	—	—	—	3—5	3—5	3	3—5	3—5	—	3	5	3—5	3—5	4
Calamagrostis spp. [1]																
Danthonia spp. [2]	4—6	4—6	4—6	4—6	5—6	—	—	—	—	2	—	—	—	3	2	1—4
Agropyron spp. [3]																
Carex sp.	5	6	6	5	3	5—6	—	4	3—5	2	4—7	4—6	5—6	3—6	3—5	4
Fragaria (mostly *bracteata*)	—	—	—	4	—	2—5	—	—	—	—	2	—	2	4—5	3	—
Rosa (mostly *acicularis*)	5	4	4—5	2	5	—	—	—	—	—	—	—	—	—	—	—
Lupinus sp.	—	—	—	—	—	—	—	—	—	—	4	—	—	—	—	—
Astragalus (mostly *Palliseri*)	—	—	3	3	—	—	—	—	—	—	—	—	—	—	—	—
Epilobium angustifolium	—	—	—	3—5	—	5	—	4	2	4	4	2	—	3—5	2	4
Chimaphila umbellata	—	—	—	—	—	—	5	2	—	—	—	—	—	—	—	3
Pyrola chlorantha	—	—	1	—	—	—	3	—	—	—	—	—	2	—	2	4
Linnaea americana	5	3—4	2	3—6	4—6	—	—	—	—	4	2	—	—	—	—	—
Solidago spp.	2	2	4	4	3	—	—	—	—	3	3—5	3	—	—	1	—
Aster (mostly *meritus* and *conspicuus*)	—	—	—	2	3—4	3	—	2	1	4	3—5	2	3	4	1	2
Erigeron spp.						—	—	—	—	—	—	—	—	—	—	—
Antennaria (mostly *neodioica*)	—	—	4	3	—	—	—	4	—	5	3—5	3	2—4	—	—	5
A. (mostly *flavescens*)	—	—	—	3—7	—	4	3	3	1	4	—	2	3	4	—	3
Arnica (mostly *cordifolia*)	—	—	—	—	—	4	3	—	—	3	—	2	3	5	2	—
Hieracium albiflorum	—	—	—	—	—	—	—	—	—	—	1	—	2	—	—	—
Berberis aquifolium	—	—	—	—	—	—	2	—	1	—	—	—	—	—	—	—
Arctostaphylos uva ursi	5—8	5—7	5—8	6—8	5—8	—	—	4—5	—	—	—	—	—	—	—	3—5
Vaccinium membranaceum	—	—	—	—	—	6—8	5—8	5—8	6—8	6—8	5—8	5—8	5—8	5—8	5—8	5—8
V. scoparium	—	—	—	—	—	—	1	1	—	—	2	—	1	1	1	1
Juniperus sp.	1	—	—	—	3	—	—	1	—	—	—	—	—	—	—	1
Ribes sp.	—	—	—	—	—	—	—	5—6	—	—	3—5	2	3	—	—	5
Spiraea (mostly *lucida* and *densiflora*)	4—5	4	4—6	5	4	—	—	—	—	—	2	—	2	—	—	4
Shepherdia canadensis	2	2	2	2	4	—	I s.	II s.	II s.	I s.	II s.	III s.	—	III s.	II s.	II s.
Pinus Murrayana	—	—	—	III s.[5]	—	—	II s.	I s.	—	I s.	I s.	—	—	—	—	I s.
Picea glauca	—	—	—	—	—	—	I s.	—	—	I s.	—	—	—	—	—	—
Abies lasiocarpa	—	—	—	—	—											

[1] Probably mostly *C. Suksdorfii* and *C. rubescens*. — [2] Prob. mostly *D. intermedia*. — [3] Prob. mostly *A. caninoides* and *A. riparium*. — [4] Sometimes also a little *Deschampsia flexuosa* and *Poa sp.* — [5] s. = seedlings.

Remark! In all the lists some very rarely and scantily occuring plants have been omitted so to make the lists somewhat shorter. — For those types comprising only one or two sample plots the lists are not printed.

TABLE 2. List of plants in the sample plots of Calamagr.-Arctostaphylos and Calamagr.-Vacc. scoparium types.

Name of the plant	Calamagrostis-Arctostaphylos type, Interior Dry Belt of B.C.								
	5	6	7	8	9	10	11	12	17
Cladonia spp.	2	—	3 rt	5 rt	4 rt	5 st rt	—	5 rt	5 rt
Peltigera sp.	4	2	5	5—7	5—6	5—6	—	5	5—6
Cetraria sp.	—	—	—	—	—	1	—	—	1
Stereocaulon sp.	—	—	—	—	—	—	—	—	—
Hylocomium parietinum [1]	2	—	2—4	—	2—4	4—6	4—7	4—8	—
H. proliferum	—	—	—	—	—	—	—	2	—
Brachythecium rutabulum	—	—	—	—	—	—	—	—	—
Ptilium crista castrensis	—	—	1	—	2	—	—	—	—
Dicranum spp.	—	—	3	2	3	5	5	5	3—4
Drepanocladus uncinatus	—	—	—	—	—	—	—	—	—
Polytrichum commune	—	—	2	3	2	—	2—5	—	—
P. juniperinum	—	—				—		—	—
Calamagrostis spp., *Danthonia spp.*, *Agropyron spp.* [2]	6—8	6—7	7—8	5—7	7—8	4—7	5—7	4—7	4—8
Carex sp.	3—5	4—5	5	3	5—6	5	5—6	5—7	5—6
Zygadenus chloranthus	—	—	—	—	—	—	—	—	—
Allium recurvatum	—	—	—	—	—	—	—	—	—
Cypripedium montanum	—	—	—	—	—	—	—	—	—
Thalictrum sp.	—	—	—	—	—	—	—	—	—
Atragene columbiana	—	—	—	—	—	—	—	—	—
Trollius albiflorus	—	—	—	—	—	—	—	—	—
Fragaria (mostly *bracteata*)	4	4	2	4	1	3—5	4	—	4
Rosa (mostly *acicularis*)	4	4	4	4	5	4	4	3	3—4
Lupinus sp.	4—5	4—5	1	—	—	—	—	—	1
Astragalus (mostly *Palliseri*)	5	4	4	3	5	5	2	—	4—5
Vicia (mostly *americana*)	—	—	—	—	—	—	—	—	—
Lathyrus (mostly *ochroleucus*)	—	—	2	—	3	—	—	—	—
Geranium (mostly *Richardsonii*)	—	—	—	—	—	—	—	—	—
Viola (mostly *canadensis* and *adunca*)	—	—	—	2	—	—	—	—	—
Epilobium angustifolium	5	4	3	3	3	3	1	3	1
Osmorrhiza divaricata	—	—	—	—	—	—	—	—	—
Cornus canadensis	—	—	—	—	—	—	—	2—5	—
Chimaphila umbellata	—	—	—	—	—	3	—	4	—
Moneses uniflora	—	—	—	—	—	—	—	—	—
Pyrola uliginosa	—	—	—	—	—	—	—	—	—
P. chlorantha	—	—	—	2	—	—	—	4	—
Ramischia secunda	—	—	—	—	—	—	—	5	—
Tessaranthium speciosum	—	—	—	—	—	—	—	—	—

[1] In the sample plots in Banff and Cypress Hills *Hylocomium parietinum*, *Hypnum reptile* and *Thuidium abietinum* together.

[2] See table 1.

rt = on rotting trees; st = mostly on stones; s. = seedlings (and sprouts and second growth).

Calamagrostis-Arctostaphylos type, Banff							Calamagr.-Vacc. scoparium type, Yellowstone National Park								
1	2	3	5	6	7	10	12	13	14	15	16	17	18	19	20
—	4 rt	—	4 st rt	3 st rt	—	—	3 st	3	3—4	2—3	4	3	2	4	2—5
5	5	5	5	5	5	5	—	—	2	2	—	2	—	3	1
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—
5	4	5—7	4—7	5—7	5—7	3—6	—	—	3—4	3	—	—	3—6	—	3
4	3—7	5—7	4—7	5—7	6—7	4—7	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	2—4	—	3	3	4—6	4	4	4
4	4	5	3	3	—	3—5	—	—	—	—	—	—	—	—	—
4	5	—	5	5	5	5—6						3—4			
—	—	—	—	—	—	—	3—5	3	5	4—5	—	3—4	3—5	—	3—5
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	3—4	—	3—5	3—5	3—5	—	—	—	3—5
5—8	3—6	4—7	5—7	4—6	3—6	5—7	6—8	6—8	6—9	6—8	5—8	5—7	6—8	6—7	5—8
—	—	—	—	—	4	3	—	—	—	—	3—5	—	—	—	—
2	2	4	3	3	4	2	—	—	—	—	—	—	—	—	—
—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	4	—	4	4	—	—	3	—	3
—	—	—	—	—	3	—	4	2	—	2	4	4	5	—	—
2	2	—	—	—	—	3	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	2	3—4	—	3—4	3—4	3	3	3	—	—
2	4	—	3	2	—	5	5	—	5	5	3	4	5	3	5
3	3	5	4	4	5	5	—	—	—	2	2	—	—	—	2
—	—	—	—	—	—	—	3—4	4	4	3—4	—	—	—	4—5	2
—	—	—	—	—	—	3	—	—	—	—	—	—	—	—	2
2	1	3	4	3	4	5	—	—	2	2	—	—	2	—	
3	—	—	—	—	—	5	—	—	—	—	—	—	—	—	—
—	3	—	—	—	—	—	—	—	—	2	—	—	—	—	—
—	—	—	—	—	—	—	3	—	5	4—5	—	—	—	—	3—5
3	2	3	3	3	—	5	5—6	3—4	5—6	5—6	4	5	5	—	5
—	—	—	—	—	—	—	—	—	—	3	—	—	—	4	3
—	—	—	5	4	5	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	3	—	—	—	—	—	—	3
2	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	3	4	5	4	4	—	—	—	—	—	—	—	—	3	—
5	—	4	5	3	4	—	2	—	2	—	—	3	—	—	2—5
—	—	—	—	—	—	—	1	—	2	2	—	—	3	—	—

Table 2. (Contd.)

Name of the plant	5	6	7	8	9	10	11	12	17
Castilleja (mostly *pallida, sessiliflora* and *mineata*)	—	—	2	—	1	—	—	—	—
Pedicularis montanensis	—	—	—	—	—	—	—	—	—
Galium triflorum	—	—	—	—	—	—	—	—	3—5
G. boreale	3	—	—	2	—	—	—	—	—
Linnaea americana	6	5—6	5	5—6	5—6	6	5	6	2
Solidago spp.	2	3	—	3	—	3—4	1	—	—
Aster (mostly *meritus, conspicuus* and *macrophyllus*) *Erigeron spp.*	4	2	4	1	3	—	2	—	2
Antennaria (mostly *neodioica*)	4	5	3	4	3	—	—	—	5—7
A. (mostly *flavescens*)	—	—	—	—	—	—	—	—	
Balsamorrhiza sagittata	—	—	—	—	—	—	—	—	—
Achillea millefolium	—	3	—	—	—	—	—	—	5—6
Arnica (mostly *cordifolia*)	—	—	—	—	—	—	—	3—5	3
Hieracium albiflorum	—	—	—	—	—	—	—	—	—
Lycopodium complanatum	—	—	—	—	—	3	—	2—5	—
Berberis aquifolium	—	—	—	—	—	—	4	—	—
Ledum glandulosum	—	—	—	—	—	—	—	—	—
Azaliastrum albiflorum	—	—	—	—	—	—	—	—	—
Menziesia glabella	—	—	—	—	—	—	—	—	—
Arctostaphylos uva ursi	5—7	5—7	4	5—6	4—5	5—6	4—6	3—5	3—4
Vaccinium ovalifolium (?)	—	—	—	—	—	—	—	—	—
V. membranaceum	—	—	—	—	—	—	—	—	—
V. caespitosum	5	5	3	—	4	4—6	4	4	—
V. scoparium	—	—	3	—	3	—	—	4—7	—
Juniperus spp.	—	—	—	—	—	—	—	3	2
Ribes sp.	—	—	—	—	—	—	—	—	—
Spiraea (mostly *lucida* and *densifl.*)	3	4—5	4	—	3	—	5—6	5	—
Amelanchier spp.	—	—	—	—	1	—	3	—	—
Shepherdia canadensis	1	2	2	—	3	3	3	4	—
Pinus Murrayana	—	IIIs.	—	—	—	IIIs.	IIIs.	IIIs.	—
Picea glauca	—	—	—	—	—	—	—	—	—
P. engelmannii	—	—	—	—	—	—	—	—	—
Pseudotsuga taxifolia	I s.	I s.	—	—	—	—	IIIs.	I s.	—
Abies lasiocarpa	—	—	—	—	—	—	—	—	—
Populus tremuloides	—	II s.	—	II s.	—	—	—	—	—
Salix sp.	—	III	I	—	III	—	—	—	—

1	2	3	5	6	7	10	12	13	14	15	16	17	18	19	20
2	—	—	1	4	3	2	—	—	—	—	—	—	—	3	—
—	—	—	—	—	—	—	—	—	1	—	—	—	2	—	—
—	—	3	—	—	—	2	—	—	—	—	—	—	—	—	—
—	—	—	—	3	—		—	—	—	—	—	—	—	—	—
6	6	6	6	6	6	6	—	—	—	2	—	4	—	—	—
—	3	4	4	3	5	3	5	5	5	4—5	5	5	5	3	5
5—6	5—6	5	6	5	5	5—6	5	4	3	4—5	—	5	4	3—4	5
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	4	2—3	2	4	4	—	4	5
—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—
—	—	—	—	—	—	3	3	—	2	3	2	—	2	—	—
5	—	—	5	3	—	5	5	5	4	5	4	5	5	4—5	5
—	—	—	—	—	—	—	—	—	3	3	—	—	4	5	2
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	3—4	—	—	4	—	—	4	—
—	—	—	—	—	—	—	—	—	—	—	—	5	—	—	—
—	—	—	3	1	4										
—	—	—				—	—	—	—	—	—	—	—	—	—
3	2	5—6	5	5—6	4	3—5	—	—	—	—	4—5	—	—	—	—
—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	4	—	—	—	5	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	4	—	—	—
—	—	—	—	3—5	4—6	—	4—6	5—7	5—7	4—7	—	5—6	3—5	2—3	4—7
1	—	2	2	2	3	2	—	2	—	1	1	—	—	2	2
—	2	1	—	—	—	—	—	2	—	—	3	2	—	2—3	—
3	1	2	3	3	1	3	—	4	—	—	—	4	—	2—3	—
—	—	—	—	—	—	—	—	1	1	1	2	1	—	1	2
3	2	3	5	4	4	4	—	—	—	3	—	3	—	3	1
—	—	—	—	—	—	II	—	II s.	IIIs.	IIIs.	IIIs.	I s.	—	—	II s.
—	IIIs.	IIIs.	IIIs.	II s.	—	I s.	—	I s.	—	—	—	II s.	—	—	—
—	—	—	—	—	—	I s.	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	I	—	—	I s.	—	—	—	—	IIs.	—	—
—	I	II s.	IIIs.	II s.	—	—	—	—	—	—	—	—	—	—	—
II	—	I	—	—	—	—	—	—	—	—	—	—	—	—	I

TABLE 3. List of plants in the sample plots of Calamagrostis- and Pachystima types.

Name of the plant	Calamagrostis type									Pachystima type								
	Interior Dry Belt of B.C.				Cypress Hills					Cypress Hills			Yellowstone National Park				Interior Dry Belt of B.C.			Sicamous	Priest River, Idaho		
	13	14	15	16	1	2	3	4	5	6	7	8	21	22	23	24	18	19	20	21	1	2	3
Cladonia spp.	—	—	3-4st	—	—	—	—	—	3	2	3 rt	—	2—3	3	3	2	4 rt	3 rt	2 rt	—	—	—	—
Peltigera spp.	5	4—5	5	4	—	—	—	—	5	—	2	—	4	2	3	3	4	5	4	5	—	1	3—4
Hylocomium parietinum [1] / *Brachythecium rutabulum*	3—6	3—6	6—8	5—8	3—6	4	3	4	—	—	2—5	—	—	3—4	—	—	4	3—7	3—6	3—5	3—7	3—6	3—5
Hylocomium proliferum	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4	3—7	3—6	4—7	—	—	—
H. triquetrum / *Rhytidiopsis robusta*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4	3—7	4—6	4—8	3	2	3—4
Ptilium crista castrensis	—	—	3	1	4	4	—	—	—	—	2—4	—	—	—	—	—	—	—	—	—	—	—	—
Dicranum spp.	—	3	4	3—4	3	—	—	—	4	—	—	3	—	—	—	—	—	—	—	—	—	—	—
Polytrichum commune	—	3	—	—	—	3	2	4	—	—	—	—	—	—	—	—	3	—	—	—	4	4	3
P. juniperinum	—		—	—	—		—	—	—	—	—	—	—	—	—	—		—	—	—		—	—
Calamagrostis spp. / *Danthonia spp.* / *Agropyron spp.* [2]	6—8	6—8	6—8	6—8	5—6	7—8	7—8	7	4—7	?	4—7	4—7	7—9	5—8	5—8	4—8	2—4	3—6	3—5	2	5—8	4—7	7—8
Carex sp.	—	—	—	—	—	—	—	—	—	—	—	—	3—4	—	—	—	—	—	—	—	—	—	—
Lilium montanum	—	3	1	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Vagnera racemosa	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	4	5	5	5	3	3	—
Streptopus amplexifolius	—	—	—	—	—		—	—	—	—	—	—	—	—	—	—		—	—	—	—	—	—
Disporum trachycarpum	—	—	—	—	—	—	2	—	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Clintonia uniflora	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	4	3	—	4	3	2
Cypripedium montanum	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cœloglossum bracteatum	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	1	—	—	—	—
Peramium descipiens	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4	4	4	5	3	—	—
Thalictrum sp.	4	—	—	3	—	3	—	—	—	—	2	5	—	—	—	—	—	—	—	—	—	—	—
Atragene columbiana	—	—	—	—	—	4	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Fragaria (mostly *bracteata*)	5	5	5	5—6	2	4	5	4	—	—	3	4	3	3	2	3—6	—	—	—	—	4	5	5
Rosa (mostly *acicularis*)	2	5	4	5	2	5	5	5	5	3—5	5	5	—	1	2	4	3—5	5	5	4	4	5	1
Lupinus sp.	5	4—5	5	5	—	3	—	—	—	—	—	—	4—5	1	3	2	—	—	—	—	1	2	4
Astragalus (mostly *Palliseri*)	—	—	—	—	—	—	—	—	—	—	—	—	3–5	—	—	—	—	—	—	—	—	—	—
Vicia (mostly *americana*)	—	—	—	3	—	4	4	2	2	—	—	—		—	—	—	—	—	—	—	—	—	—
Lathyrus ochroleucus	—	—	—	—	—	5	4	2	2	—	2	3	—	—	—	—	—	—	—	—	—	—	—
Geranium (mostly *Richardsonii*)	—	—	—	—	—	—	4	3	—	—	—	5	3—4	2	2	3—5	—	—	—	—	—	—	—
Viola (mostly *canadensis* and *adunca*)	—	—	—	—	2	4	4	2	—	—	3	5	—	—	—	3	—	—	—	—	4	4	3
Epilobium angustifolium	4	4	4	4	3	5	5	5	4	3—5	4	5	2	2	—	3	3	—	2	—	—	3	3
Aralia nudicaulis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	4	1	—	—
Cornus canadensis	5	4	4	5—6	—	4	2	—	3	3—5	5	5	—	—	—	—	—	—	—	—	—	—	—
Chimaphila umbellata	—	—	5	—	—	—	—	—	—	—	—	—	—	—	—	—	5	5	4	5	4—5	5	—
Moneses uniflora	—	—	—	—	—	—	—	—	—	—	2	4	—	—	—	—	—	—	—	—	—	—	—
Pyrola uliginosa	—	—	—	—	—	5	2	2	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—
P. clorantha	—	—	4	4	—	—	3	4	—	3—5	—	—	—	—	—	—	3	—	—	—	—	—	—

[1] See table 2. — [2] See table 1.

Table 3. (Contd.)

Name of the plant	13	14	15	16	1	2	3	4	5
Ramischia secunda	4	3—5	5	5	—	—	—	—	3
Tessaranthium speciosum	—	—	—	—	—	—	—	—	—
Monotropa uniflora	—	—	—	—	—	—	—	—	—
Castilleja (mostly *pallida, sessiliflora* and *mineata*)	—	—	1	—	—	2	5	2	—
Pedicularis montanensis	—	—	2	—	—	—	—	—	—
Melampyrum lineare	—	—	—	—	—	—	—	—	—
Galium triflorum	—	—	—	2	—	2	4	3	—
G. boreale	—	—	—		—				—
Linnaea americana	5—6	5—6	6	5—7	5	5	2	3	4—8
Solidago spp.	3	4	—	4	—	5	4	4	5
Aster (mostly *meritus, conspicuus* and *macrophyllus*)	4	4—5	4	4	2	—	5	5	—
Erigeron sp.									
Antennaria (mostly *neodioica*)	4	—	3	—	3	—	3	3	—
A. (mostly *flavescens*)	—	—	—	—	—	—	—	—	—
Achillea millefolium	1	2	—	—	—	3	—	—	—
Arnica (mostly *cordifolia*)	4	2—4	4	5	4	4	5	5	5
Hieracium albiflorum	—	—	—	—	—	—	—	—	3
Thelypteris Dryopteris	—	—	—	—	—	—	—	—	—
Equisetum silvaticum	—	—	—	—	—	—	—	—	—
Berberis aquifolium	—	—	—	—	—	—	—	—	—
Pachystima myrsinites	—	—	—	—	—	—	—	—	—
Arctostaphylos uva ursi	—	3	—	—	4—5	—	3—4	3—4	—
Vaccinium ovalifolium (?)	3—5	3	—	—	—	—	—	—	—
V. caespitosum	—	5—7	4—6	4—6	3—6	5	4—7	5—6	3
V. scoparium	—	—	4—5	—	—	—	—	—	—
Juniperus spp.	—	—	—	—	—	—	—	—	—
Ribes sp.	—	—	—	—	—	—	—	—	—
Spiraea (mostly *lucida* and *densiflora*	—	—	1	—	3	4	4	4	3
Rubus parviflorus	—	—	—	—	—	—	—	—	—
R. transmontanus (?)	—	—	—	—	—	—	—	—	—
Amelanchier spp.	—	—	2	—	—	—	—	—	—
Shepherdia canadensis	3	2	4	4	—	—	—	1	—
Viburnum pauciflorum	—	—	—	—	—	—	—	—	—
Symphoricarpus sp.	—	—	—	—	—	—	—	—	—
Lonicera involucrata	—	—	—	—	—	—	—	—	—
Picea engelmannii	—	—	—	IIIs.	—	—	—	—	—
Abies lasiocarpa	—	—	—	—	—	—	—	—	—
Pseudotsuga taxifolia	—	—	—	—	—	—	—	—	—
Thuja plicata	—	—	—	—	—	—	—	—	—
Populus tremuloides	—	IIIs.	—	II s.	—	IIIs.	—	—	—
Salix sp.	—	—	—	—	—	—	I	—	—
Betula (mostly *papyrifera occident.*)	—	—	—	—	—	—	—	—	—
Alnus tenuifolia	—	—	—	—	—	—	—	—	—
Acer sp.	—	—	—	—	—	—	—	—	—

6	7	8	21	22	23	24	18	19	20	21	1	2	3
3	3	4	—	—	—	—	—	5	4	5	3	3	—
—	—	—	—	—	—	1	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	3	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	4	—	2	—	—	—	—
—	—	4	—	—	3	3	—	4	3	—	—	—	—
—	—		3—4	3—4			—	—	—	—	—	—	—
3—7	7	7	—	—	—	—	—	—	—	5—6	4—7	4—6	—
3	5	5	4—5	1	4	4—5	3	—	2	—	3	3	3
—	—	—	3	4—6	3—5	5—7	2—5	2	3	2	3	—	3
			4—5	4—5	3	3							
—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	3	—	—	2	—	—	—	—	—	—	3
—	—	4	4	2	1	3	—	—	—	—	3	2	4
1	5	5—6	3	4	4	4—5	—	5	3	3	—	—	—
—	—	—	—	—	—	—	—	—	—	—	4	3	—
—	—	—	—	—	—	—	—	4	3	—	—	—	—
—	—	3	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	1	3	3	3—4	4	4	4	5	4—5	3
—	—	—	—	—	—	—	5—7	5—7	6—7	5—7	4—6	5—7	3
—	3	2	—	—	—	—	—	—	—	—	3	3	5
—	—	—	—	—	—	—	—	—	—	—	3	3	3
3—5	3—6	5	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	1	—	—	—
—	—	—	—	—	1	1	—	—	—	—	—	—	—
4—5	2	2	—	4	4	4—6	5—7	5	5—7	4	3—4	3—4	—
—	—	—	—	—	—	—	4	4	4	3	1	1	—
—	—	—	—	—	—	—	2	—	1	4	—	—	—
—	—	—	—	—	—	—	2	3	2	1	1	2	1
—	—	—	—	—	—	—	4	4	4	4	—	—	—
—	1	3	—	—	—	—	—	—	—	—	—	—	—
—	—	—	1	4	4	4—5	—	—	—	—	1	1	3—4
—	—	—	—	—	—	—	3	—	1	2	—	—	—
—	—	—	—	—	—	—	—	II	I	—	—	—	—
—	—	—	—	—	—	—	—	IIIs.	2	—	—	—	—
—	—	—	—	—	—	—	II s.	—	II	IIIs.	II s.	II s.	—
—	—	—	—	—	—	—	II s.	IIIs.	IIIs.	IV s.	—	—	—
—	—	—	—	—	—	—	—	—	—	I	—	—	—
—	—	—	—	—	—	—	I	—	—	—	—	—	—
—	—	—	—	—	—	—	I	I	—	II	—	—	—
—	—	—	—	—	—	—	—	III	—	—	—	—	—
—	—	—	—	—	—	—	I	I	II	IV s.	—	—	—

TABLE 4. List of plants in the sample plots of Vaccinium-Gaultheria (coll.) type.

Name of the plant	Kazubazua, Ont.						
	1 [1]	2 [1]	3 [2]	4 [2]	5 [2]	6 [2]	7 [2]
Cladonia spp.	—	2 rt	2 rt	—	—	—	—
Cladina (mostly *silvatica*)	—	—	2 rt	—	—	—	—
Peltigera spp.	—	—	—	—	—	—	—
Hylocomium parietinum	—	2—5	3—7	3—5	3—6	3—6	4—7
Dicranum spp. (mostly *scoparium* and *undulatum*)	3	4	4	3	3	3—4	4
Polytrichum (mostly *commune*)	—	4	4	2	2	2	3
Calamagrostis spp., *Oryzopsis sp.*, *Danthonia* (mostly *spicata*)	4	4	3	3	4	3—5	4
Carex (*Richards.*, *scopar.*, etc.)	5	5	6	4—7	5	4—6	5
Lilium philadelphicum	—	—	—	—	—	—	—
Maianthemum canadense	5	5—7	6	5	5	5	5
Clintonia borealis	—	—	—	—	—	—	—
Vagnera racemosa, *Streptopus amplexifolius*	—	—	—	—	—	—	—
Cypripedium acaule	—	3	—	—	—	—	—
Myrica asplenifolia	—	—	3	4	3	3—4	3
Ranunculus acris	1	—	2	1	—	—	—
Anemone virginiana	—	—	—	—	—	—	—
Actaea alba	—	—	—	—	—	—	—
Fragaria virginiana	4	3	3	3	1	2	2
Waldsteinia fragarioides	4	2	4	4	5	4	3
Rubus (mostly *triflorus*, *canadensis*, *allegheniensis*, *arcticus*)	2	—	—	2	2	2	2
Rosa spp.	—	—	—	—	—	—	—
Vicia (mostly *americana*)	—	—	—	—	—	—	—
Lathyrus ochroleucus	—	—	—	—	—	—	—
Viola (mostly *striata*, *rotundifolia*, *conspersa*, *canadensis*)	2	—	3	1	1	1	—
Epilobium angustifolium	—	—	—	—	—	—	—
Sanicula marilandica	—	—	—	—	—	—	—
Aralia (*hispida* and *nudicaulis*)	—	2	2	—	—	—	—
Cornus canadensis	3	2	4	—	—	—	—
Chimaphila umbellata	—	—	4	5	5	4	4
Moneses uniflora	—	—	—	—	—	—	—
Pyrola americana	—	3	2	—	—	2	—
P. chlorantha	—	—	—	—	—	—	—
P. elliptica	2	—	—	3	2	3	3
Ramischia secunda	—	2	—	—	—	—	—
Monotropa hypopitys	—	—	—	2	—	—	—
Trientalis americana	—	—	3	—	—	4	—
Lysimachia quadrifolia	—	—	—	—	—	—	—
Mertensia paniculata	—	—	—	—	—	—	—
Melampyrum lineare	—	4	4	5	5	5	5
Pedicularis canadensis	—	—	—	—	—	—	—

[1] *Vaccinium-Gaultheria-*, [2] *Vaccinium-Myrica-* and [3] *Vaccinium-Rubus-Papilionaceae sub-type.* — s, rt, st : see table 2.

Petawawa, Ont.						Glenwater, Ont.						Cloquet, Minn.		
1 [2]	2 [1]	3 [1]	4 [1]	5 [2]	6 [2]	1 [3]	2 [3]	3 [3]	4 [3]	5 [3]	6 [3]	1 [2]	2 [2]	3 [2]
—	2 st	2 rt	—	2 rt st	3 rt	3	—	—	2	1	—	—	—	—
1	—	—	—	—	1	3	3	3	3	3	—	—	—	—
—	—	—	—	—	—	2	1	2	—	1	2	—	—	—
3—5	2 st	3	2	3—5	3—7	4	3—6	5	4—7	4—7	3	3—6	3—7	3—6
3—5	2 st	4	5	2	5	5	5—6	5	5—7	5	2 st	2	3—6	3—5
—	—	2	2	4	—	—	—	—	—	—	—	5	3—6	3—6
5	5	4	4	5	4	6	5—7	5—7	5—7	5—7	5—7	5—6	4—6	3—5
6	2—5	4	6	5	5	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	3	4	4	4	2	2	—	—	—
5—6	4	6	5	6	5	6	6	5	6	6	6	5	5—6	5—6
—	—	—	2	1	1	2	2	4	5	2	3	—	—	—
—	—	—	—	—	—	—	2	2	4	3	5	—	—	—
—	—	—	2	3	1	—	—	2	3	3	2	—	—	2
2	—	—	—	3	4	—	—	—	—	—	—	5	3—5	4—6
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	3	3	—	—	—	—
—	—	—	—	—	—	—	1	—	2	2	2	—	—	—
3	3	3	3	3	3	4	5	5	4	4	3	5	5	4—5
4	2	2	2	2	1	3	3	4	4	4	3	—	—	(2)
—	—	—	—	—	2	6	6	6	6	5	6	4	4	3—4
—	—	—	—	—	—	5	5	5	6	4	6	—	—	—
—	—	—	—	—	—	3	3	4	3	2	3	—	—	—
—	—	—	—	—	—	4	3	4	4	3	5	—	—	—
—	2	—	4	—	—	5	5	4	4	2	—	—	—	3
—	—	—	—	—	—	5	4	4	5	4	3	5	4	4
—	—	—	—	—	—	2	3	4	3	3	4	—	—	—
—	2	3	3	5	—	1	3	3	3	5	5	2	3	3—5
3	3	6	5	4	3	5	5	5	6	5	4	—	—	—
2	—	—	—	—	3	—	—	—	—	—	—	3	3	4—5
—	—	—	—	—	—	—	1	2	1	—	—	—	—	—
3	3	3	—	—	4	4	4	4	4	4	2	2	4	2
—	—	—	—	—	2	—	—	—	—	—	—	—	4—5	5
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	2	1	—	—	3	3	2	3	3	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	2	—	4	4	—	—	—	—	—	—	—	—	—	—
2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	2	—	—	—	—	—
3	2	—	5	5	5	4	6	6	5	3	—	5	5—6	5
2	—	—	—	1	—	—	—	—	—	—	—	—	—	—

Table 4. (Contd.)

Name of the plant	1 [1]	2 [1]	3 [2]	4 [2]	5 [2]	6 [2]	7 [2]
Galium triflorum	—	3	—	—	—	—	—
Linnaea americana	—	5	6	5	6	6	4
Solidago spp.	2	2	3	4	3	3	3
Aster spp. (often *macrophyllus*) / *Erigeron spp.*	3	3	2	3	2	3	3
Antennaria (*canadensis, plantaginifolia*)	—	—	—	—	—	1	—
Achillea millefolium	—	—	—	1	—	1	—
Lactuca spicata	—	1	—	—	—	—	—
Prenanthes trifoliata	—	—	—	—	—	—	—
Thelypteris Dryopteris	—	—	—	—	—	—	—
Dryopteris spinulosa	2	1	1	—	—	—	—
Pteris aquilina	4—5	5	5	5	5	5	5
Lycopodium obscurum	—	—	—	—	—	—	—
L. annotinum	—	—	—	—	—	—	—
L. clavatum	—	—	—	—	—	—	—
L. complanatum	—	—	—	—	—	—	—
Kalmia angustifolia	—	—	4	3	5	4	5
Epigaea repens	1	3	3	—	—	—	—
Gaultheria procumbens	4—5	5	3	6	5	5—6	5
Arctostaphylos uva ursi	—	—	—	—	—	—	—
Chiogenes hispidula	—	—	—	—	—	—	—
Vaccinium pennsylvanicum / *V. canadense*	4—5	3—6	4—7	4—7	4—7	5—6	5—7
Ribes sp.	—	2	—	—	—	—	—
Rubus (*idaeus, strigosus*)	1	—	3	2	2	2	2
Salix sp. (often *Bebbiana*)	1	—	—	1	—	—	—
Alnus sp.	—	—	—	—	—	—	—
Corylus americana	3	5	2	3	2	2	1
Prunus serotina	1	—	2	2	2	1	1
Amelanchier spp.	2	2	2	2	2	2	2
Dirca palustris	—	—	—	—	—	—	—
Cornus (*paniculata ?*)	—	—	—	—	—	—	—
Lonicera (mostly *canadensis*) / *Diervilla lonicera*	1	—	2	—	1	1	2
Pinus strobus	—	—	I s.	II s.	—	I s.	—
P. resinosa	—	—	I s.	II s.	—	I s.	—
P. banksiana	—	—	I s.	II s.	—	II s.	—
Picea glauca	I s.	II	—	—	—	—	—
Tsuga canadensis	I s.	—	—	—	—	—	—
Abies balsamea	III s.	III s.	II s.	II s.	I s.	II s.	II s.
Thuja occidentalis	—	II	—	—	—	—	—
Populus tremuloides	—	—	—	—	—	—	—
Betula populifolia	—	—	—	—	—	—	—
Quercus nigra	I	—	—	—	—	—	—
Acer sp. (often *rubrum*)	I	—	II	II	I	I	I

1 [2]	2 [1]	3 [1]	4 [1]	5 [2]	6 [2]	1 [3]	2 [3]	3 [3]	4 [3]	5 [3]	6 [3]	1 [2]	2 [2]	3 [2]
—	1	2	—	—	—	3	4	3	4	3	3	—	—	—
6	2	4	6	3	6	5	6	6	6	5	3	4	5—6	5
3	1	2	3	2	3	4	6	5—7	6	5	5	5	5—7	5—6
4	3	3	2	4	4	5	5	6	6	5	6—7	6	5	5
2	2	—	—	—	—	—	—	—	—	—	—	6—7	4—6	4
—	—	—	—	—	—	3	3	3	—	—	—	—	—	—
—	—	—	—	—	—	3	1	2	3	2	2	—	—	—
—	—	—	—	—	—	—	1	2	—	—	2	—	—	—
—	—	—	2	—	—	—	—	—	—	—	—	—	—	—
—	—	—	3	—	—	—	—	—	—	—	—	—	—	—
5	4	5	5	5	5	1	4	2	1	—	4	5	5	4
—	1	—	1	2	2	—	—	1	—	2	2	—	—	—
—	—	—	—	—	—	—	—	—	2	3	2	—	—	—
—	—	—	—	1	1	—	—	—	—	—	3	—	—	—
2	—	—	—	—	3	—	—	1	—	—	—	3	3—4	2
3	—	3	5	3	4	—	—	—	—	—	—	—	—	—
3	—	—	—	—	3	—	—	—	—	—	—	—	—	—
4	3—4	3	5	4	5	5	2	3	5	2	3	4—5	5—6	5—7
—	—	—	—	—	—	5	4	5	4	2	—	2—3	2	2
—	—	—	—	—	—	—	—	—	2	3	—	—	—	—
3—6	3—5	2—6	3—7	5	6	5	5	5—7	6	3—6	—	5—6	6	5—6
—	—	—	—	—	—	—	—	—	—	2	3	—	—	—
—	1	1	—	1	2	—	—	—	3	2	2	1	1	1
—	—	—	—	—	1	1	1	—	2	2	1	—	—	—
—	—	—	—	—	—	—	5	4	3	3	2	—	—	—
2	2	2	2	2	—	—	—	—	—	—	3	—	—	—
—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
2	2	2	1	2	2	2	3	3	2	2	2	—	1	2
1	1	2	—	2	1	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	2	—	2	3	—	—	—
1	1	1	2	1	1	2	3	2	3	3	3	3	3	3
—	—	IIs.	—	I s.	—	—	—	—	—	—	—	—	—	—
—	—	—	—	II s.	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	II	—	—	—	—	—	—	—	II	—	I s.	II s.	I s.
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	II	IIIs.	I	I	—	I s.	II s.	—	—	—	—	I s.	I s.
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
I s.	—	—	IV s.	I s.	Is.	—	—	—	—	—	—	—	—	—
—	—	II	—	I	—	—	—	—	—	—	—	—	—	—
—	—	I	—	I s.	—	—	—	—	—	—	—	—	—	—
—	I s.	III	—	III s.	—	—	—	—	—	—	—	—	—	—

TABLE 5. List of plants in the sample plots of Oxalis-Hylocomium type.

Name of the plant	Laurentides Park						
	1	2	3	4	5	6	7
Cladonia spp.	—	4 rt	3 rt	4 rt	3 rt	3 rt	3 rt
Peltigera sp.	—	—	1	1	—	—	—
Hylocomium parietinum	4	5—7	5—8	4—8	3	4—7	6—8
H. proliferum	2	3	4—7	4—6	2	5	6
Ptilium crista castrensis	—	3	—	5	—	3	5
Dicranum fuscescens and *scoparium*	4	4—6	5	5	5	5	5
Polytrichum commune	3	4	3	4	3	2	3
Mnium sp.	—	—	3	—	3	—	—
Carex brunnescens	4	—	—	3	—	—	—
Maianthemum canadense	5	2	3	5—6	4	5	5
Clintonia borealis	—	5	5	5	5	5	5
Streptopus roseus	2	—	—	1	2	—	—
Habenaria obtusata	—	—	—	—	1	—	—
Oxalis acetosella	6	7	7	5—8	6—8	7	7
Epilobium angustifolium	1	—	—	—	—	—	—
Cornus canadensis	5	5	5—7	5—8	5	6	6
Trientalis americana	5	4	3	5	3	5	3
Linnaea americana	—	—	—	4	—	2	2
Solidago sp.	—	—	—	—	5	—	—
Thelypteris Dryopteris	—	—	—	3	—	—	—
Phegopteris polypodioides	—	—	—	5	2	3	—
Dryopteris spinulosa	5	5	4	2	5	4	3
Lycopodium annotinum	—	—	2	2	—	—	—
L. obscurum	—	—	—	—	—	—	1
Ribes lacustre	5	2	2	4	3	3	1
Rubus idaeus	6	—	—	2	2	2	—
Lonicera sp.	—	—	—	1	—	—	—
Sambucus racemosa	4	—	—	3	—	—	—
Sorbus americana	2	1	—	2	2	—	1
Picea glauca	—	—	—	I	—	—	—
Abies balsamea	IV s.	IV s.	III s.	V s.	II s.	IV s.	V s.
Betula populifolia	III	III	I	III	II	II	—

rt, s. : see table 2.

TABLE 6. List of plants in the sample plots of Tiarella-, Pachystima-Coptis- and Pachystima-Vaccin.parvifol. types.

Name of the plant	Tiarella (coll.) type				Pachystima-Coptis sub-type			Pachystima-Vacc. parvifo sub-type	
	Yoho Valley	Dry Belt of B.C.	Wind River	Portland	Priest River forest	Exp.		Wind River Exp. forest	
	11 [1]	23 [1]	2	1	4	5	6	3	4
Peltigera spp.	2	—	—	—	1	—	—	—	—
Hylocomium parietinum	4—7	2—7	4—8	3—7	—	—	—	3	3
Brachythecium rutabulum	—				2	2—4	—		
Eurhynchium oregonum	—				—		—	—	
Hylocomium proliferum	—				—		—	—	
H. triquetrum	—				2—3	2—3	—	2—6	2—5
H. loreum	—								
Rhytidiopsis robusta	—								
Plagiothecium undulatum	—				—	—	—	—	—
Ptilium crista castrensis	4—6	2—6	—	—	—	—	—	—	—
Dicranum spp.	—	2—5	—	3—4	—	—	—	3-5(rt)	3-5(rt)
Funaria sp.	—	—	—	—	—	—	5	—	—
Isothecium myosuroides	—	—	—	3 rt	—	—	—	2 rt	—
Pogonatum contortum	—	—	—	3—5	—	—	—	—	—
Mnium glabrescens	3—7	2—5	4—6	4—6	—	—	—	—	—
Mn. insigne									
Marchantia polymorpha	—	—	—	—	—	—	5—7	—	—
Gramina (Calamagr., etc.)	6	1—4	1—3	3—6	2—4	3—5	—	3	3
Carex sp.	—	—	—	—	—	2	—	—	—
Xerophyllum Douglasii	—	—	—	—	—	—	—	3—5	2—4
Veratrum Eschscholtz. (?)	3	—	—	—	—	—	—	—	—
Juncoides sp.	4	—	—	3—5	—	—	—	—	—
Lilium montanum	—	—	—	—	2	—	—	2	1
Vagnera racemosa	4	1	3—5	4	4	4—6	—	4	4
Streptopus amplexifolius									
Maianthemum bifolium (kamtchaticum)	—	—	—	2	—	—	—	—	—
Clintonia uniflora	—	2	3—4	—	5	1	—	3	3
Trillium ovatum	—	—	4—5	3	2	—	1—4	4	3
Cypripedium montanum	—	3—5	3—4	—	2	1	—	5	5—6
Peramium descipiens	—	2—3	—	—	—	—	—	2—5	3
Ophrys caurina	—	—	—	—	3	—	—	—	—
Limnia sibirica	—	—	—	5—6	—	—	—	—	—
Alsine sp.	—	—	—	4	—	—	—	—	—
Moehringia macrophylla	—	—	—	5—6	—	—	—	—	—
Thalictrum sp.	5	—	—	—	—	—	—	—	—

[1] *Tiarella-Vaccinium* sub-type.

(Contd.)

Name of the plant	11	23	2	1	4	5	6	3	4
Atragene columbiana	—	—	—	—	—	4—5	2—4	—	—
Coptis trifoliata	—	—	—	—	3—6	5—7	1—5	—	—
Actaea rubra	—	—	—	4	—	—	—	2	—
Tiarella unifoliata	6	3—7	—	—	—	—	—	—	—
T. trifoliata	—	—	3—6	5—7	2	1	2—5	—	—
Heuchera micrantha	—	—	—	5—6	—	—	—	—	—
Opulaster sp.	—	—	—	—	2	—	—	—	—
Sericotheca discolor	—	—	—	—	3	—	—	3—4	3
Fragaria (mostly *Helleri*)	—	—	—	3	5	3—5	2—5	—	—
Geum oregonense	—	—	—	3	—	—	—	—	—
Rubus pedatus	6	2—6	—	—	—	—	—	—	—
Rosa spp.	—	—	3	3	4—5	3—4	1—3	4	4
Lupinus sp.	—	—	—	—	—	—	—	3	—
Geranium (mostly *Richards.*)	5	1	—	—	—	—	—	—	—
Oxalis oregona	—	—	—	3—5	—	—	—	—	—
Viola spp.	—	1	3	3—6	5	6	2—5	5	3—5
Epilobium angustifolium	4	—	1	—	3	2	6—9	—	—
Cornus canadensis	5	2—6	3—4	—	3—5	1	1—5	6—7	5—6
Chimaphila umbellata	—	—	3	—	2—5	3	—	5	5—6
Moneses uniflora	2	2—4	—	—	—	—	—	—	—
Pyrola picta	—	2—3	—	—	—	—	—	—	—
P. bracteata	—	—	—	—	3—4	—	—	—	—
Ramischia secunda	3	2—5	2	—	—	2	—	—	—
Pterospora andromeda	—	—	—	—	—	—	—	—	1
Trientalis latifolia	—	—	2—3	4—5	—	—	—	3	4—5
Vancouveria hexandra	—	—	4—7	5—6	—	—	—	5	3
Achrys triphylla	—	—	4—5	4—5	—	3	—	4—6	4
Pedicularis montanensis	4	—	—	—	—	—	—	—	—
Galium (mostly *triflorum*)	5	2—5	2—4	5	3	2	—	4	4
Linnaea americana	4	2—6	5—6	2—5	5—7	4—6	2—5	5—6	4—6
Valeriana sitchensis	5	—	—	—	—	—	—	—	—
Asarum caudatum	—	—	—	4—5	2—3	1	—	—	—
Solidago spp.	5	2	—	—	—	—	—	—	—
Aster spp.	3	1	1	3	—	—	—	—	—
Adenocaulon bicolor	—	—	—	4—5	3—4	—	—	—	—
Petasites frigida	4	—	—	—	—	—	—	—	—
P. speciosa	—	—	—	—	—	—	—	3	3
Arnica (mostly *oligolepis*)	5	1—3	2	—	—	—	—	—	—
Hieracium albiflorum	—	—	—	—	4	1	2—4	—	—
Thelypteris Dryopteris	—	2—5	—	}	—	—	—	—	—
Dryopteris spinulosa			}	5—7					
Adiantum sp. (and			2—5						
Athyrium sp. some	—	—			—	—	—	—	—
Lomeria sp. others)									

(Contd.)

Name of the plant	11	23	2	1	4	5	6	3	4
Pteris aquilina	—	—	3—4	3	—	3—4	—	3—5	4
Equisetum silvaticum	4	—	—	—	—	—	—	—	—
Lycopodium clavatum	3	—	—	—	—	—	—	—	—
Selaginella sp.	—	—	—	5	—	—	—	—	—
Berberis (mostly *aquifolium*)	—	—	5—7	3—4	2—4	3	2—5	5	5—6
Pachystima myrsinites	—	—	—	—	5—7	4—5	1—3	5—7	6—7
Gaultheria ovatifolia	—	—	5—6	3	—	—	—	5	2—5
Vaccinium parvifolium	—	—	4—5	3—5	3	—	—	5	4—5
V. scoparium	5	—	—	—	—	—	—	—	—
V. ovalifolium (and *globul.*?)	4	1—4	3 (?)	—	—	—	—	3	3
V. membranaceum (?)	—	—	3	3—5	—	—	—	—	—
Ribes (*acerifolium* ?)	4	2—3	—	3	—	—	—	—	—
Spiraea spp.	—	—	—	—	3—5	1	1—4	5	4
Rubus parviflorus	—	2—4	—	4	3—5	3—5	—	3—5	3—5
Rubus (*transmontanus* ?)	—	—	—	—	—	—	—	5	5
R. sp.	—	—	—	5	—	—	—	—	—
Amelanchier sp.	—	—	—	—	3	1	—	—	—
Cornus (*pubescens* ?)	—	—	3	—	—	—	—	3	3
Symphoricarpus sp.	—	2	3	—	3	—	—	3—4	3
Lonicera spp.	4	—	—	—	—	1	—	—	—
Sorbus occidentalis	—	—	—	—	—	1	—	2	2
Abies grandis	—	—	I s.	—	—	—	—	—	—
Abies lasiocarpa	II	—	—	—	—	—	—	—	—
Pseudotsuga taxifolia	—	—	I s.	II s.	—	—	—	—	—
Tsuga heterophylla	—	I s.	—	I s.	II s.	—	—	—	—
Thuja plicata	—	IIIs.	—	II s.	IIIs.	—	—	—	—
Taxus brevifolia	—	—	II	—	—	—	—	—	—
Alnus rubra	—	—	—	II s.	—	—	—	III	III
Acer sp.	—	—	II s.	IIIs.	II s.	—	—	IV s.	IIIs.

s, rt : see table 2.

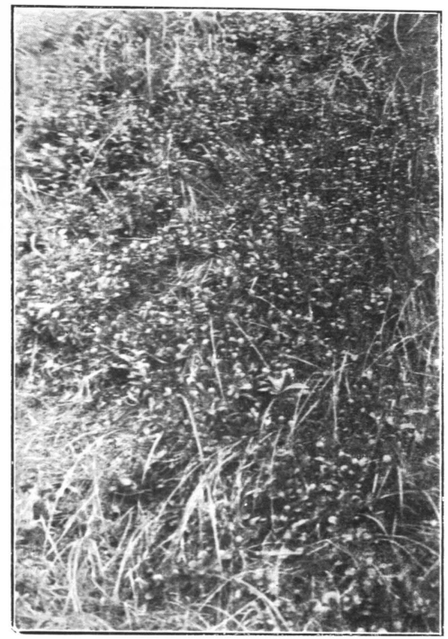

Fig. 11. Ground vegetation on Arctostaphylos type. B.C. Dry belt. Canada.

Fig. 12. Ground vegetation on Vaccinium scoparium type. Yellowstone N. Park. U.S.A.

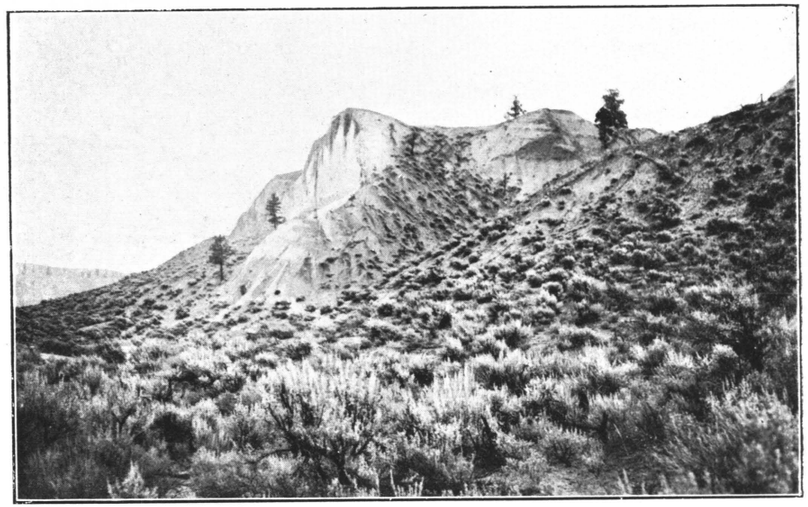

Fig. 13. *Artemisia*-vegetation on a dry slope inclining towards the Thompson River. B.C. Dry belt.

Fig. 14. Ground vegetation on Calamagrostis-Arctostaphylos type. Banff, Alta. U.S.A.

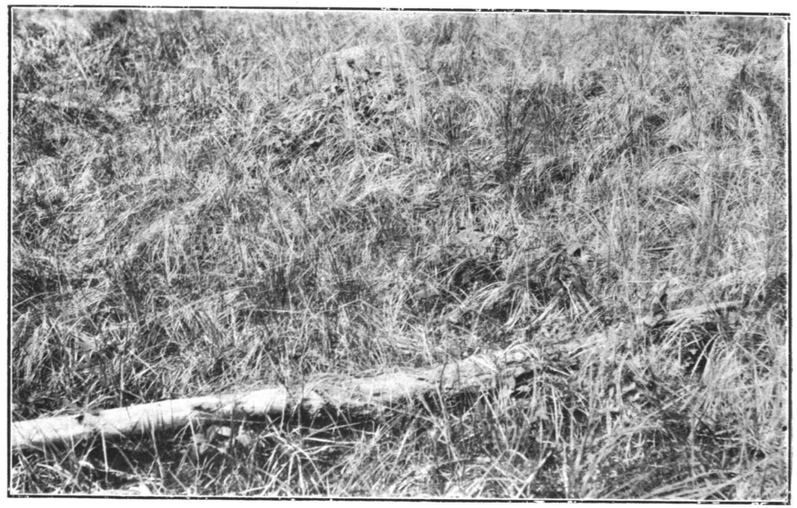

Fig. 15. Ground vegetation on Calamagrostis type. B.C. Dry belt. Canada.

Fig. 16. Ground vegetation on Oxalis-Hylocomium type. Laurentides Park, Que. Canada.

Fig. 17. Ground vegetation on thick-moss (Hyloc.-Ledum) type. Banff, Alta Canada.

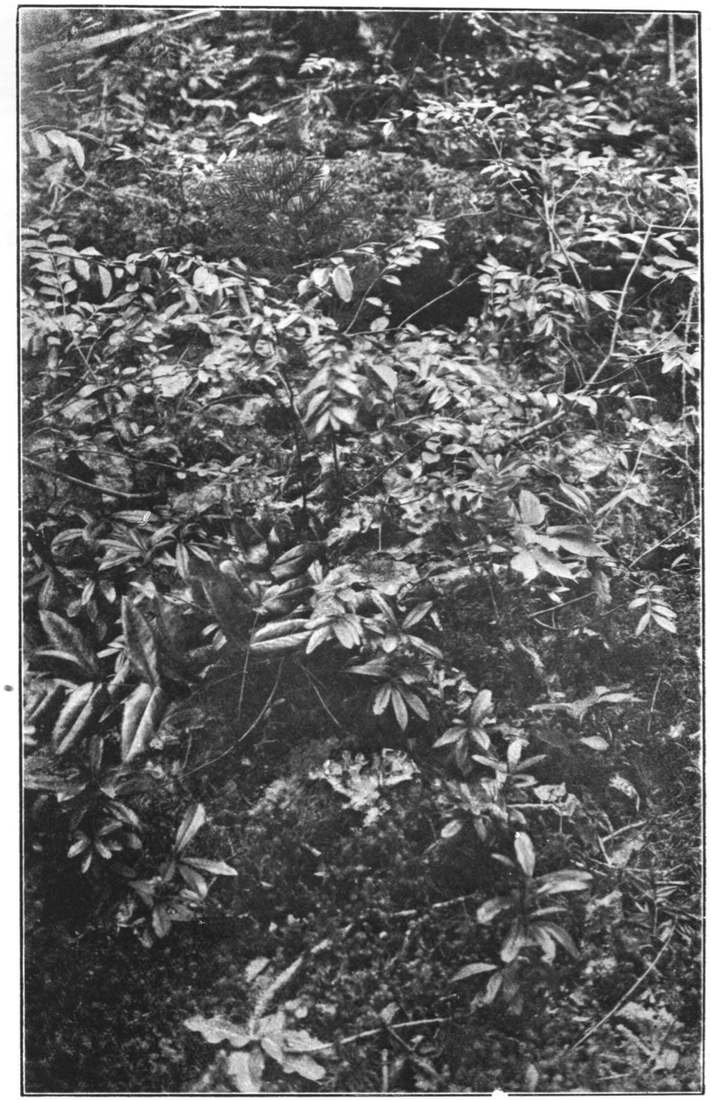

Fig. 18. Ground vegetation on Pachystima type. Sicamous, B.C. Canada.

Fig. 19. Ground vegetation on Tiarella (-Vaccinium) type. Yoho Valley, B.C. Canada.

Fig. 20. Ground vegetation on Tiarella (-Fern) type. Vancouver, B.C. Canada.

Fig. 21. Ground vegetation on Fern type. Petawawa, Ont. Canada.

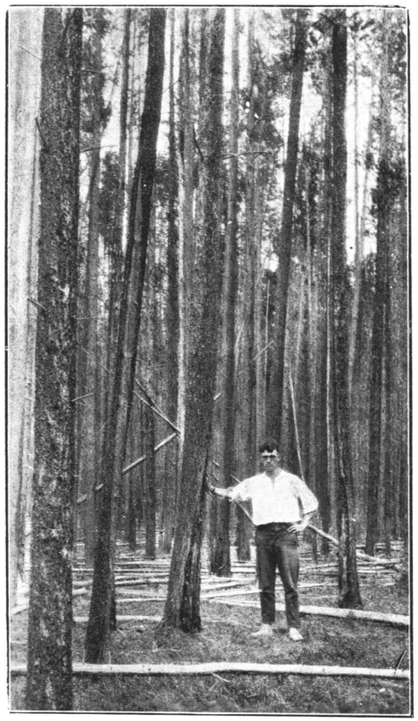

Fig. 22. About 230 years old *Pinus Murrayana* stand on Calamagr.-Arct. (+ Vacc. scop.) type. B.C. Dry belt. Canada.

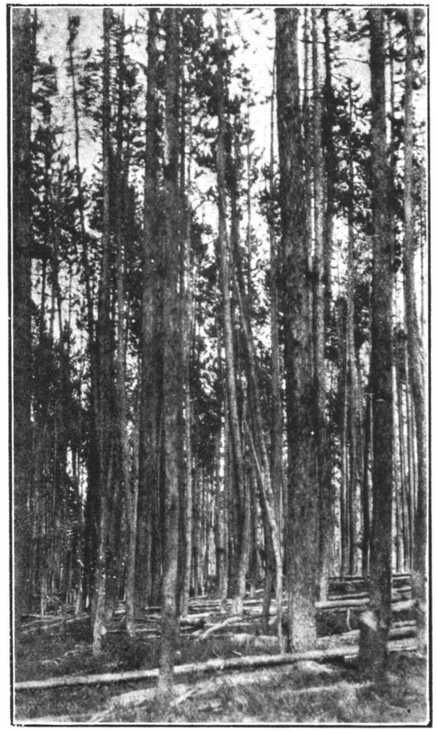

Fig. 23. About 180 years old *Pinus Murrayana* stand on Vacc. scoparium type. Yellowstone N. Park. U.S.A.

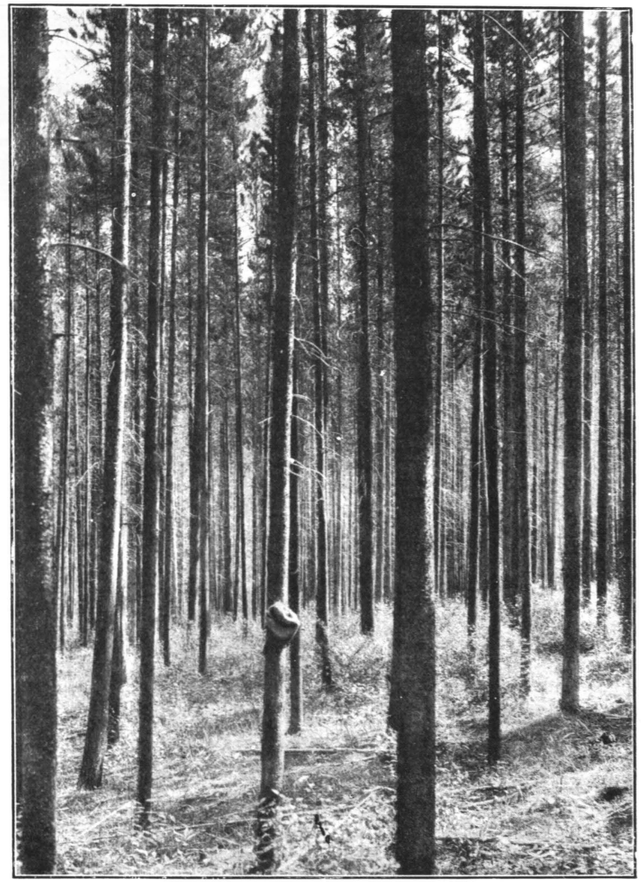

Fig. 24. 82 years old *Pinus Murrayana* stand on Calamagr.-Arct. type. (Shrub-vegetation *Shepherdia canadensis*). Banff, Alta. Canada.

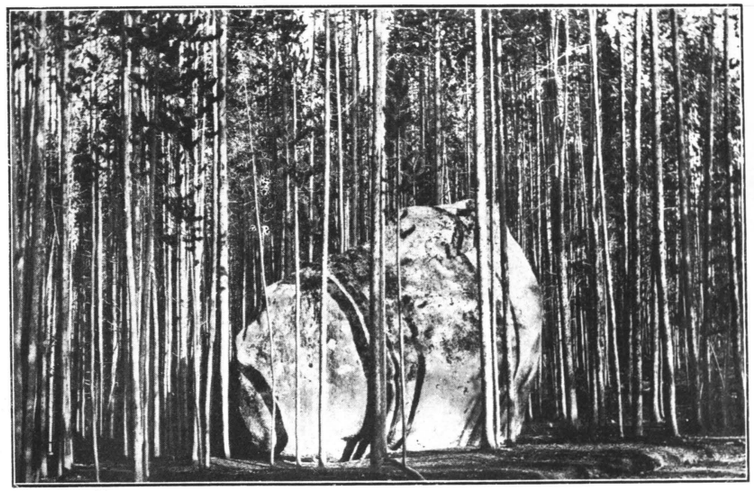

Fig. 25. About 200 years old *Pinus Murrayana* stand on Vacc. scoparium type. Yellowstone N. Park. U.S.A.

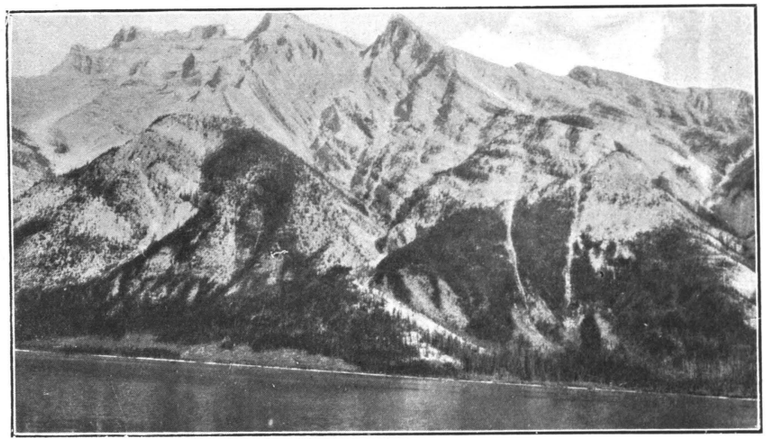

Fig. 26. *Pinus Murrayana* forest and timber lines on a southern slope in the Rocky Mountains. Banff, Alta. Canada.

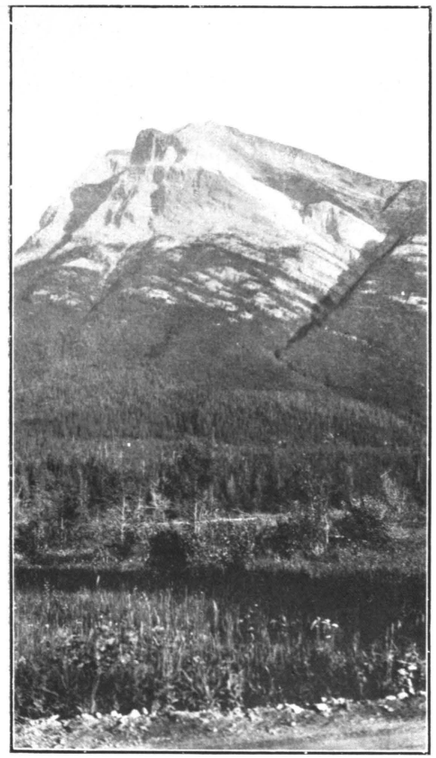

Fig. 27. *Pinus Murrayana* forest and timber lines on the slopes of the Rocky Mountains. Banff, Alta. Canada.

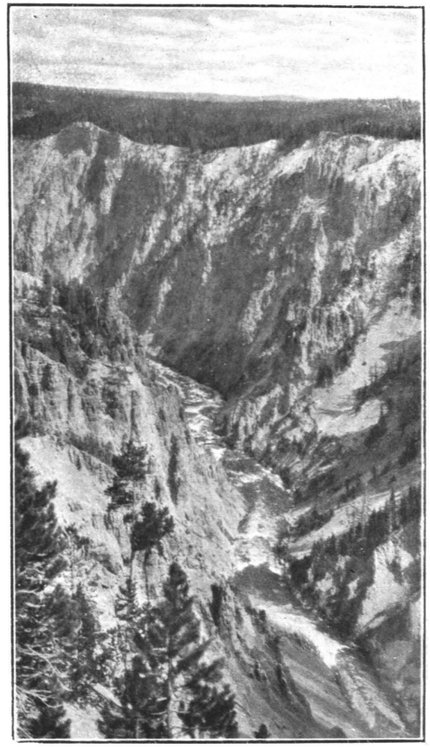

Fig. 28. *Pinus Murrayana* forest on the extreme edge of the Grand Canyon. (Mostly Vacc. scop. type). Yellowstone N. Park. U.S.A.

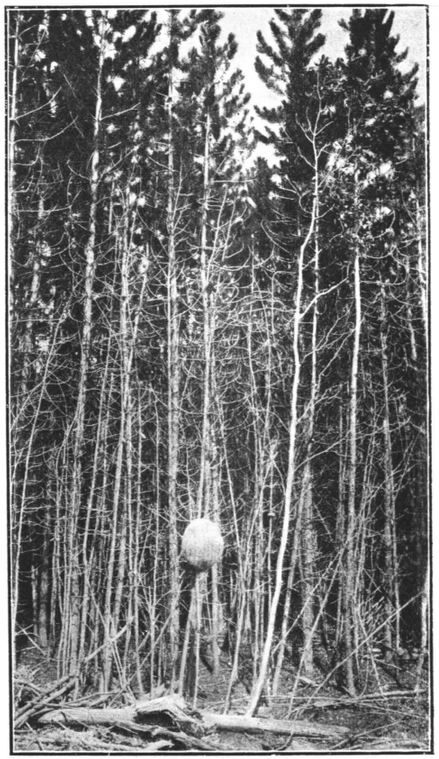

Fig. 29. Exceptionally dense *Pinus Murrayana* stand of 40 years' age on Calamagrostis (?) type. Cypress Hills, Sask. Canada.

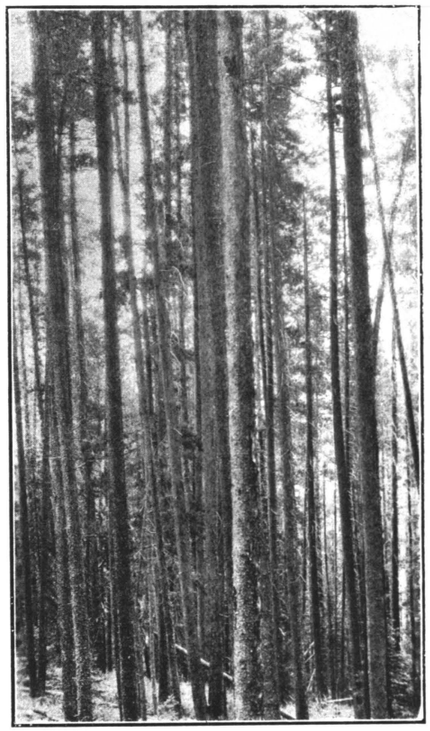

Fig. 30. About 125 years old *Pinus Murrayana* stand on Calamagrostis type. B.C. Dry belt. Canada.

Fig. 31. Park-like *Pinus ponderosa* stand on Calamagr.-(Agrop.-)Arct. type. B.C. Dry belt. Canada.

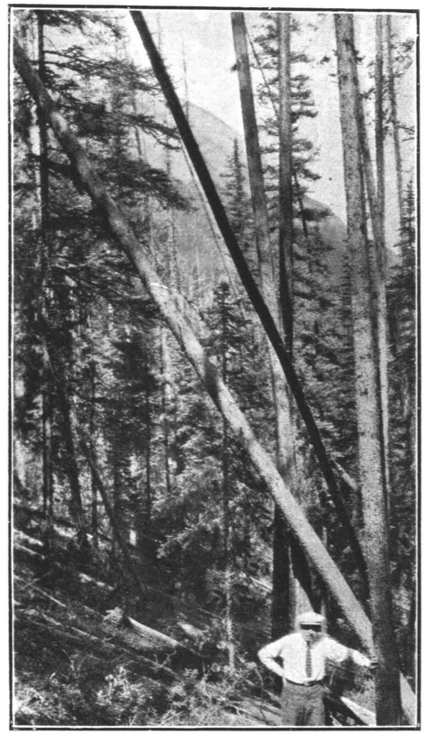

Fig. 32. About 200–250 years old *Pinus Murrayana* and *Picea engelmannii* stand on thick-moss type. Banff, Alta. Canada.

Fig. 33. Very dense 35 years old *Pinus Murrayana* stand on Pachyst. (-Calamagr.) type. Priest River, Idaho. U.S.A.

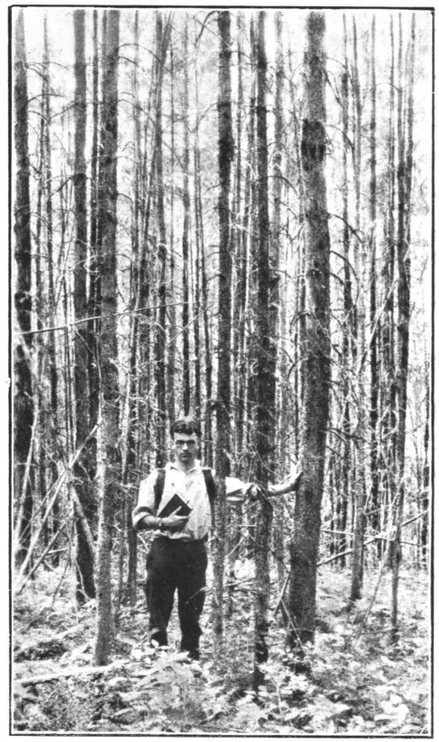

Fig. 34. 40—45 years old *Pinus Murrayana* stand on Pachystima type. Mount Ida, B.C. Canada.

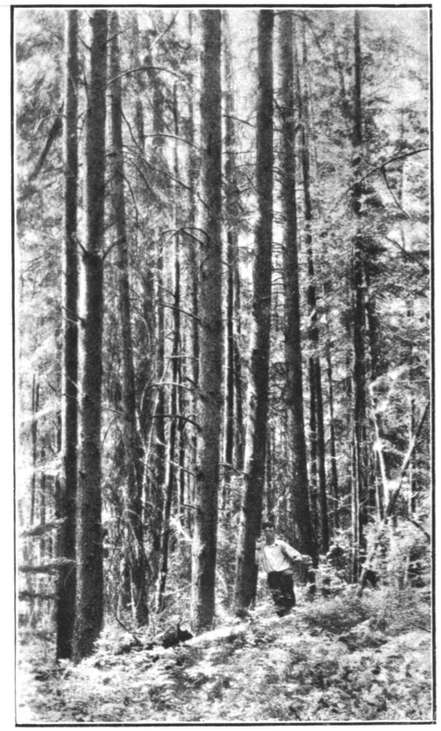

Fig. 35. 95 years old *Pinus Murrayana* stand on Pachystima type. Mount Ida, B.C. Canada.

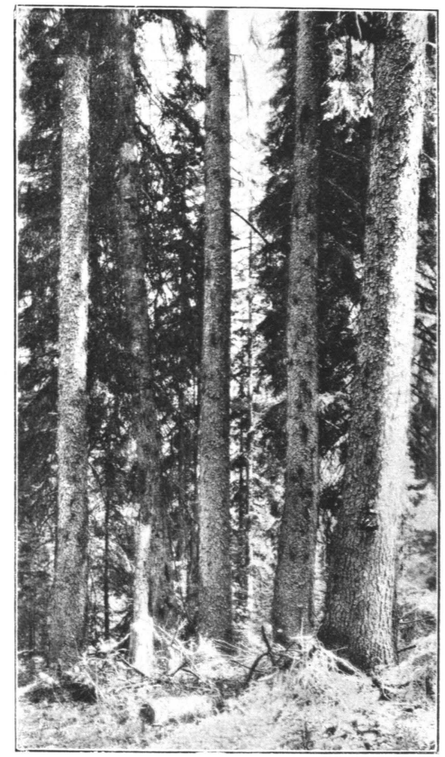

Fig. 36. 150—200 years old *Picea engelmannii* stand on Tiarella (-Vacc.) type. Yoho Valley, B.C. Canada.

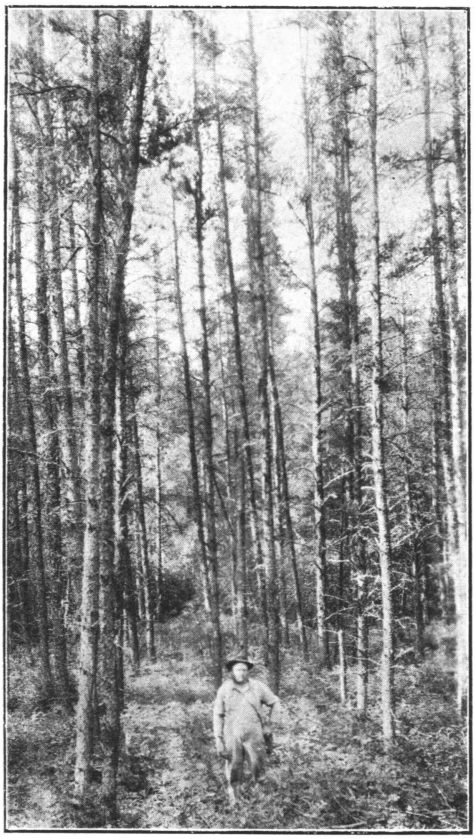

Fig. 37. 50 years old *Pinus banksiana* stand on Vacc.-Rubus-Papilion type. Glenwater, Ont. Canada.

Fig. 38. 52 years old *Pinus strobus* stand on Vacc.-Gaultheria type. Kazubazua, Ont. Canada.