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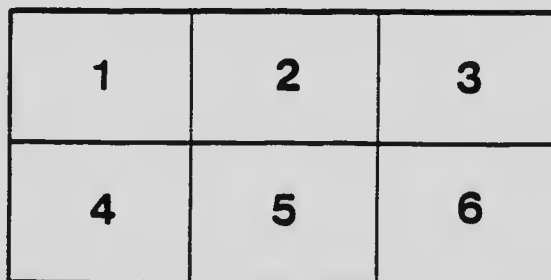
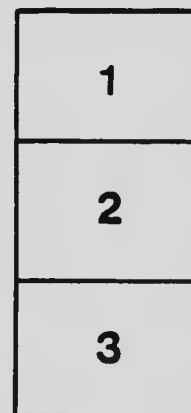
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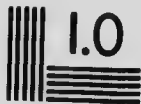
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SILVICAL CHARACTERISTICS OF CANADIAN TREES



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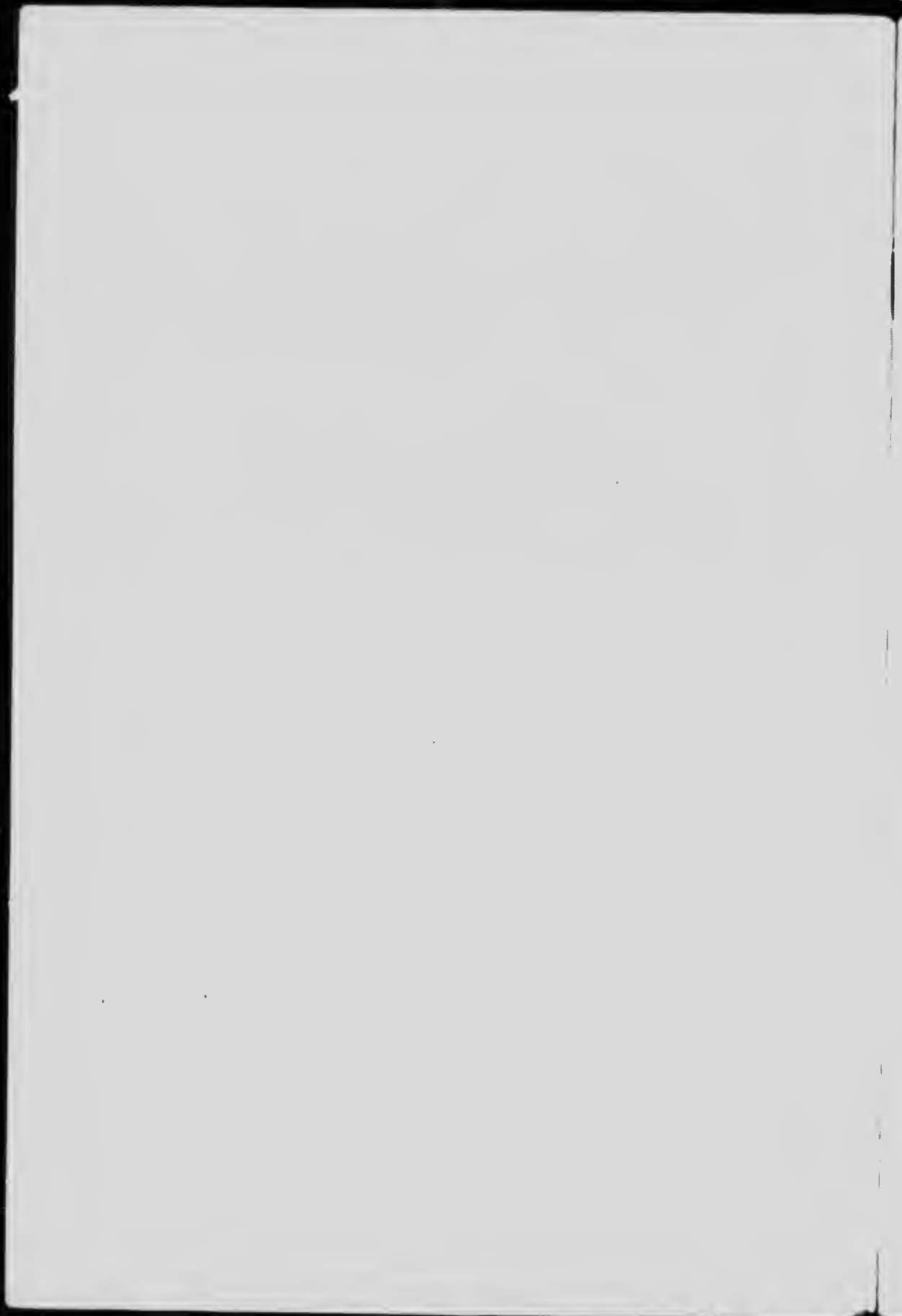
SILVICAL CHARACTERISTICS
OF
CANADIAN TREES



*With the
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SILVICAL CHARACTERISTICS OF THE FIFTY-SIX MOST IMPORTANT CANADIAN FOREST TREES.

The data were gathered and compiled by members of the classes of 1913 and 1914, Faculty of Forestry, University of Toronto. The sources of information were varied, including Dominion Forest Service Bulletins, U.S. Forest Service Silvical Leaflets, forest planting leaflets, circulars and bulletins, and the works of Sudworth, Sargent, Britton, Jepson, etc. Growth figures were furnished by Mr. A. H. D. Ross, M.A., M.F.; the diameters in all cases being "breast high", that is, 4½ feet above ground.

In general the botanical sequence and nomenclature followed by Sudworth in U.S. Forest Service Bulletin 17 have been adhered to. For each tree the information is arranged according to the schedule below.

For ready reference a table is appended to show relatively, by means of symbols, the most important silvical characteristics of the trees. Three grades are made for each silvical characteristic, and a tree's grade for that characteristic is indicated by a symbol. The method of using the table is explained at the end of the description of abbreviations used in the table.

SCHEDULE FOR SILVICAL DESCRIPTION.

Name of tree, scientific, with synonyms.

" " common, with synonyms.

Size.—Average and maximum.

Growth.—Rate and persistence; life.

Root System.

Bole.—Taper, clear length, etc.

Crown.

Tolerance.

Wood.—Strength, hardness, durability. Kiln dry weight in pounds per cubic foot.

Reproduction.

1.—By Seed,—Prolificacy—seed years; time of flowering; ripening; fall.

Seed character,—germination percent; vitality.

Seed bed,—seedlings.

2.—By coppice,—vitality of stocks, etc.

Range.—Geographical, altitudinal, optimum.

Climate.—Temperature, precipitation, humidity.

Soil.

Association.—Solitary, grouped, or gregarious.
Associates.

General.—Commercial importance, technical features, supply.
Common enemies.

Management recommended.

LIST OF TREES INCLUDED.

- | | |
|-----------------------------|---------------------|
| 1. <i>Pinus strobus</i> , | White Pine |
| 2. <i>P. monticola</i> , | Western White Pine. |
| 3. <i>P. resinosa</i> , | Red Pine. |
| 4. <i>P. ponderosa</i> , | Bull Pine. |
| 5. <i>P. contorta</i> , | Lodgepole Pine. |
| 6. <i>P. divaricata</i> , | Jack Pine. |
| 7. <i>Larix laricina</i> , | Tamarack. |
| 8. <i>L. occidentalis</i> , | Western Larch. |
| 9. <i>Picea mariana</i> , | Black Spruce. |
| 10. <i>P. rubens</i> , | Red Spruce. |
| 11. <i>P. canadensis</i> , | White Spruce. |
| 12. <i>P. engelmanni</i> , | Engelmann Spruce. |
| 13. <i>P. sitchensis</i> , | Sitka Spruce. |

- | | |
|---|--------------------|
| 14. <i>Tsuga canadensis</i> , | Hemlock. |
| 15. <i>T. heterophylla</i> , | Western Hemlock. |
| 16. <i>T. mertensiana</i> , | Black Hemlock. |
| 17. <i>Pseudotsuga taxifolia</i> , | Douglas Fir. |
| 18. <i>A. amabilis</i> , | Lovely Fir. |
| 19. <i>A. gran</i> , | Lowland Fir. |
| 20. <i>A. balsamea</i> , | Balsam Fir. |
| 21. <i>A. lasiocarpa</i> , | Alpine Fir. |
| 22. <i>Thuja occidentalis</i> , | Arborvitae. |
| 23. <i>T. plicata</i> , | Giant Arborvitae. |
| 24. <i>Chamaecyparis nootkatensis</i> , | Yellow Cedar. |
| 25. <i>Juglans cinerea</i> , | Butternut. |
| 26. <i>J. nigra</i> , | Black Walnut. |
| 27. <i>Hicoria minima</i> , | Bitternut Hickory. |
| 28. <i>H. ovata</i> , | Shagbark Hickory. |
| 29. <i>Populus tremuloides</i> , | Aspen. |
| 30. <i>P. grandidentata</i> , | Large-tooth Aspen. |
| 31. <i>P. balsamifera</i> , | Balm of Gilead. |
| 32. <i>P. trichocarpa</i> , | Black Cottonwood. |
| 33. <i>P. deltoides</i> , | Common Cottonwood. |
| 34. <i>Betula papyrifera</i> , | Paper Birch. |
| 35. <i>B. lutea</i> , | Yellow Birch. |
| 36. <i>Fagus atropunicea</i> , | Beech. |
| 37. <i>Castanea dentata</i> , | Chestnut. |
| 38. <i>Quercus alba</i> , | White Oak. |
| 39. <i>Q. macrocarpa</i> , | Bur Oak. |
| 40. <i>Q. rubra</i> , | Red Oak. |
| 41. <i>Q. velutina</i> , | Black Oak. |
| 42. <i>Ulmus americana</i> , | White Elm. |
| 43. <i>U. racemosa</i> , | Cork Elm. |
| 44. <i>U. pubescens</i> , | Slippery Elm. |
| 45. <i>Magnolia acuminata</i> , | Cucumber Tree. |
| 46. <i>Liriodendron tulipifera</i> , | Tulip Tree. |
| 47. <i>Platanus occidentalis</i> , | Sycamore. |
| 48. <i>Prunus serotina</i> , | Black Cherry. |
| 49. <i>Acer macrophyllum</i> , | Oregon Maple. |
| 50. <i>A. saccharum</i> , | Sugar Maple. |
| 51. <i>A. saccharinum</i> , | Silver Maple. |
| 52. <i>A. rubrum</i> , | Red Maple. |
| 53. <i>A. negundo</i> , | Box Elder. |
| 54. <i>Tilia americana</i> , | Basswood. |
| 55. <i>Fraxinus nigra</i> , | Black Ash. |
| 56. <i>F. americana</i> , | White Ash. |

GYMNOSPERMS OR "NAKED SEED" TREES.
TREATED AS A CLASS.

Also called the needle-leaved trees, evergreens,
softwoods and conifers.

Size.—Include largest of all forms of life. The Sequoia, most massive of all trees, is exceeded in height only by the Eucalyptus of Australia. Others, as the Douglas fir, sugar pine, Sitka spruce, western red cedar, etc., of the Pacific forest, and the white pine of the Atlantic, are larger than the largest Angiosperms of America. Sizes range down to the shrubby juniper and eastern yew.

Growth.—Rate no more rapid but more persistent, as a whole, than the angiosperms, e.g. white pine, Douglas fir. As to life, the Sequoias are the oldest forms of all life, with ages of 3000 to 4000 years.

Root System.—Shallower than angiosperms. Ranges from deep rooted pines to shallow rooted spruces.

Bole.—Normally undivided. Taper ranges from conical cedars to cylindrical white pines.

Crown.—Monopodial, non-spreading. Pines, especially the white, have a tendency to spreading habit. Evergreen, except larches and bald cypress of U.S.

Tolerance.—Very tolerant, except pines and larches.

Wood.—The "softwoods". Relatively light, soft, straight-grained, and easily worked; ranging from the hard, heavy, strong Douglas fir (and southern hard pines) to the soft, light, and weaker white pine; spruce and balsam. Durability greater than the angiosperms; ranging from cedars and cypresses, most durable of all woods, to the perishable firs.

Reproduction.—1. By seed the rule. Mostly prolific; seeds mature in one season, except pines which require two and sometimes three seasons. Seeds winged and wind dispersed. 2. By coppice the exception. Red wood, shortleaf pine, and pitch pine are known to sprout, but only in the first (and possibly the second) is this of silvicultural importance.

Range.—Tropics to Arctic Circle timber line, and sea-level to mountain timber line. Chiefly in the Temperate Zone. Optimum on the moist and humid Pacific slopes of North America.

Climate.—Indicated by range.

Soil.—Inhabit poorer soils and are more xerophytic than the angiosperms; range from the rather fastidious white pine and hemlock to the plebeian junipers and jack pine.

Association.—Far more gregarious than the angiosperms in America.

General.—Commercial importance far greater than the angiosperms because of the size, quality and quantity of the timber.

Circular 166 U.S.F.S. credits the conifers with 80%, or 20 hundred billion feet out of 25 hundred billion feet board measure, estimated as the total stumpage of the U.S. In Canada the proportion would be 95% or more. The conifers in the U.S. in 1910 supplied 78% of the total cut of over 40 billion feet board measure; and yellow pine, Douglas fir, white pine and hemlock supplied over three quarters of that 78%.

In Canada in 1912 the conifers furnished 93% of the total cut of approximately four and a half billion; and spruce, white pine, Douglas fir and hemlock supplied over 86% of the conifers. The average mill prices ranged from \$13.62 per thousand feet board measure for balsam fir to \$20.98 for white pine. Only in balsam fir does Canada's cut exceed that of the United States.

PINUS, THE PINES.

Size.—The white pine (*P. strobus*) is the largest of the eastern forest trees of Canada.

Root System.—Deeper rooted than most conifers.

Crown.—Tends to spread, especially in the white pines.

Tolerance.—Intolerant. *P. strobus* and *P. monticola* are moderately tolerant.

Range.—As a genus the pines have a wider range and cover a greater area than any other important forest genus in the world. Of the 70 known species about one-half are found in America. In Canada they do not extend as far north as the spruces, larches and firs, but farther than the other conifers.

Soil.—Xerophytic in Canada, and as a whole, except *P. strobus* and *P. monticola*, which are sometimes mesophytic.

Association.—More gregarious than other conifers of America, but second to the spruces in this respect in Canada.

General.—Commercial importance greater than that of any other genus because of the high qualities and enormous quantities of its woods.

In the U.S. the pines are estimated to comprise about one-third of the total stumpage of 25 hundred billion feet board measure. They formed 48% of the total cut of approximately 40 billion feet board measure in 1910. In Canada in 1912 they formed 24.7% of the total lumber cut of approximately 4.5 billion feet board measure, the average mill price varying from \$14.55 for jack pine to \$20.98 for white pine.

PINUS STROBUS, L.

White Pine. Weymouth Pine. Northern Pine.

Size.—150 ft. by 3 to 5 ft.

Growth.—Rapid and long sustained up to 300 years. Minnesota studies of 8764 trees showed growths of 10 inches in 87 years and 20 inches in 176 years. Life, 300 to 400 years.

Root System.—Heart.

Crown.—Moderately spreading.

Tolerance.—Excels all other pines. After 50 years the crown demands full light. Clears its branches slowly.

Wood.—Very light, soft, and easily worked; not strong; fairly durable; 24 pounds.

Reproduction.—Seed production moderately prolific; seed years every 5 to 7 years after the 30th. Flowers in June; cones mature and seeds fall during first part of September of the second season. 1 bushel of cones yields $\frac{1}{2}$ pound of seed; 1 cone averages 32 seeds; 1 pound averages 36,000 seeds. Seed light; large wing. Germination percent 65 to 85; remains viable up to 5 years. Seedling fairly frost hardy; liable to damping off.

Range.—Medium in extent. Eastern Canada, chiefly south of the height of land, the northern states and south along the Appalachians, reaching altitudes up to 2000 feet. It finds its optimum in the lake states and Ontario.

Soil.—Ranges from dry sands to moist river bottoms. More exacting as to soil moisture than any other of our pines.

Association.—Occurs singly in mixture with hardwoods; occasionally in pure stands or mixed with red pine on the sandier soils.

General.—In Canada ranks second after spruce, forming 21% of the total cut of 1912. With average mill value of \$20.98 it is the highest priced of our conifers. The estimated total stumpage in America is 100 billion feet board measure; in Ontario 12 billion feet; in Quebec 8 billion. Ontario supplies 82% of the Canadian cut of 0.9 billion feet.

In the United States, white and red pine together are estimated at 75 billion feet board measure, or 3% of the total stumpage. In the 1910 lumber cut it stood fourth with about 8% of the total.

PINUS MONTICOLA, Dougl.

Western White Pine.

Size.—In its optimum it averages from 100 to 130 feet in height and from 20 to 30 inches in diameter.

Growth.—It is in general a slow growing tree during youth, of rapid increase in height growth from 10th to 40th year, and in diameter

to the 90th year, thereafter growing more slowly but persistently until 200 to 300 years old. 34 trees in the Lake Slocan region (B.C.) grew 10 inches in 68 years and 20 inches in 140 years. In northern Idaho it grows to 12 inches in 100 years.

Root System.—Fairly deep heart root.

Bole.—Cylindrical.

Crown.—In dense stand the crown is conical with short widely spaced branches. In poorer and more open situations the tree is shorter and more spreading.

Tolerance.—Intolerant of heavy shade throughout its life. It is, however, more tolerant than the western larch, Douglas fir, etc., and less tolerant than western hemlock, Engelmann spruce, etc.,. It is more tolerant in its earlier stages than in later life. Prunes well.

Wood.—Similar to white pine; 24 pounds.

Reproduction.—Seed years every 4 to 6 years, but some each year after the age of 40 to 60 years; not prolific. Cones mature at end of second summer, about September first, and shed seed soon after. Seed winged, light, fair sized. Germination medium, 50 to 70%. Germinates poorly on heavy humus. Prefers fresh mineral soil. Seedlings require broken shade during first year.

Range.—It is distributed through the forests of the northwestern mountains from the west slopes of the Continental Divide in southern British Columbia and northern Montana to Vancouver Island and through the mountain ranges of Washington, Oregon and California. It is most abundant and attains the best development in northern Idaho. Altitude, sea-level in southern B.C. to 11,000 feet in southern California.

Climate.—Wide range. Temperature extremes -30° and 100° Fahr. Annual precipitation varying from 60 inches to a minimum of 15 inches. In the northern Rockies and mountains of California the snowfall is heavy and remains on the ground well into the summer. In the southern part of its range it is subject to long periods of summer drought.

Soil.—Adapted to a variety of soils. Best growth on deep porous soils but most common on poor sandy soils.

Association.—It rarely forms pure stands but occurs as single individuals or in small groups. In northern Idaho it often forms half of the stand, with larch, giant cedar, Douglas, lowland and alpine firs, cottonwood and white birch as secondary. In general its chief associations are western hemlock, Douglas and white firs, and larch.

General.—Although not forming pure stands, nor reaching as large sizes as many other western conifers, it is an important tree nevertheless because it produces wood of excellent quality, and also grows with other

species which are important commercially. The Canadian cut for 1912 was over 15 million feet board measure, which is 1.7% of the total white pine cut. Average mill value was \$13.54 per thousand feet board measure.

PINUS RESINOSA, Ait.

Red Pine.

Norway Pine.

Size.—70 to 80 ft. by 2 to 3 ft.

Growth.—Rapid in youth. In general intermediate between white pine and jack pine. Growth slow after 100 years. 190 trees, open and dominant stand, in Minnesota grew 10 inches in 40 years and 15 inches in 80 years. 228 trees in a crowded stand grew 10 inches in 70 years and 15 inches in 140 years.

Root System.—Heart with laterals.

Crown.—Broad irregular pyramid, open at maturity.

Tolerance.—Very intolerant throughout.

Wood.—Harder and stronger than white pine; not durable; 32 pounds.

Reproduction.—Seed years every 3 or 4 years after the 25th; not prolific. Flowers in May and June; cones mature in the fall of the next season and shed the seed. Germination percent is high. Prefers mineral seed bed. Seedlings stand little shade; hardy.

Range.—Maritime provinces, southern Quebec and Ontario to the valley of the Winnipeg River; lake states to Massachusetts, and the mountains of Pennsylvania.

Climate.—Average annual precipitation 25 to 45 inches. Temperature ranges from 110° to -59° Fahr.

Soil.—Light sandy loam and rocky ridges. Grows in more xerophytic situations than white pine.

Association.—Small groves usually mixed with other pines or deciduous leaved trees, never forming large pure stands.

General.—Ranked sixth in Canadian lumber cut of 1912, with 142 million feet board measure, or 3.2% of the total. Average mill value was \$18.16. In U.S. returns it is lumped with white pine. The U.S. Forest Service recommends as silvicultural treatment a shelter-wood system with rotations of 60 to 150 years for ties to saw-timber. From findings at Frank's Bay, Lake Nipissing, the latter figure is too high from a financial viewpoint, because growth is very slow after the 75th to 100th year.

PINUS PONDEROSA, Lawson.

Western Yellow Pine. Bull Pine.

Size.—Of western pines next to sugar pine in size. Average 125 to 140 ft. by 3 to 4 ft. Maximum 200 by 8 ft.

Growth.—Rate of growth is rapid and well sustained. A study of 45 trees in Arizona gave 10 inches for 66 years, 15 inches for 110 years and 20 inches for 173 years. Life is from 350 to 500 years.

Root System.—Tap.

Bole.—Massive, straight trunked, cylindrical.

Crown.—Long, narrow, open; branches huge and bent.

Tolerance.—Intolerant. Demands much light, especially in older age. Stands thin out rapidly after 10 to 15 years of age. Mature trees rarely closer than 30 feet. Crowns seldom touch.

Wood.—Rather light, fine grained, strong; 29 pounds.

Reproduction.—Seed production prolific; best after 50 years old. Good seed years every 3 to 5 years; some each year. Average 1 to 6 pounds of seed per tree. Cones mature early in August of the second summer; seeds shed chiefly in September and finished by early winter. Scattered 500 to 700 feet by the wind. Mature tree can seed $\frac{1}{4}$ acre in seed year. Seed fairly large; winged. Germination natural sowing 50%; artificial planting 60 to 80%. Seedlings in the south require shelter; in the north they grow in the open.

Range.—Northern Mexico and Lower California to southern British Columbia (with var. *scopulorum* in the Rocky Mountain region). Optimum, Washington, Oregon, Idaho, Montana. Altitude in north,—low foot-hills nearly at sea-level to 5000 feet; generally 1000 to 4000 feet; in south, 1000 to 9000 feet; generally 5000 to 8000 feet.

Climate.—Temperature—28° to 110° Fahr.; precipitation 10 to 50 inches; humidity, low.

Soil.—Inhabits dry and moist slopes, tops, ridges and canyon bottoms. Grows on all soils from glacial drift to clay; dry or well drained; sandy or gravelly most characteristic. Requires little soil moisture because of its very deep roots.

Association.—Occurs in pure extensive stands and in mixture with conifers and broad leaves. In Washington and Oregon, pure (with western larch and Douglas fir occasionally). In Sierras pure occasionally, and with sugar pine, incense cedar, Douglas fir, white fir, red fir, Kellogg oak, and occasionally the big tree. In British Columbia with Douglas fir and western larch.

General.—Commercial importance is very great. In Canada in 1912 it was eleventh in rank, with a cut of 54 million feet board measure, or 1.2% of the total lumber cut. Average mill price \$16.30.

In the total stumpage of the U.S. it ranks second only to Douglas fir, and is estimated at 275 billion feet board measure, or 11% of the total. In 1910 it was sixth in rank and supplied nearly 4% of the total lumber cut. For cross ties it was eighth in rank and supplied over 3% of the total.

The silvicultural treatment recommended by the U.S. Forest Service for both pure stands and mixture with Douglas fir and larch is (1) natural reproduction with seed tree or strip cutting, and (2) artificial reproduction by clear cutting and planting, or seed spot sowing.

PINUS CONTORTA, Loudon.

Lodgepole Pine.

Size.—Very variable; averages 50 ft. by 10 in.; maximum 100 ft. by 3 ft.

Growth.—Rate medium and only briefly sustained. 47 trees in the Crow's Nest Pass, Alberta, grew to 8 inches in diameter in 40 years, and 10 inches in 65 years; in New Denver, B.C., 36 trees took 70 and 94 years respectively.

Root System.—Tap.

Bole.—Little taper.

Crown.—Non-spreading.

Tolerance.—Intolerant throughout life.

Reproduction.—Production of seed prolific; begins as early as the fifth year and is annual. The cones ripen late in August or in September; some open at once and shed seeds gradually; others not until the thirteenth year. Cones open normally by drying out, not by fire. Seed is small, winged and light. Germination percent medium; vitality great. Best seed bed is exposed mineral soil after a fire.

Range.—From Alaskan coast to northern California and east to the prairies, occurring on both slopes of the Rocky Mountains. Altitudes from sea-level to 11,000 feet.

Climate.—Wide range; in general, dry and cold.

Soil.—Inhabits usually medium and poor gravelly and sandy soils. Requires less moisture than Douglas fir and Engelmann spruce.

Association.—Usually occurs gregariously. Sometimes it forms a mixture with Douglas fir and Engelmann spruce or both. Common in reproduction after burns with poplars.

General.—The commercial importance in Canada is great from the standpoint of local supply for mining timber, etc. B.C. in 1912 cut 3 million feet board measure; average price \$14.94. In U.S. lodgepole pine is estimated at 90 billion feet board measure, or 3.6% of the total stumpage.

PINUS BANKSIANA, Lamb.

PINUS DIVARICATA, Sudw.

Jack Pine. Banksian Pine. Scrub Pine. Grey Pine.

Size.—A small tree, rarely over 70 feet in height by 10 inches in diameter.

Growth.—Rate very rapid in younger years, slow afterwards. Sends out more than one set of whorls per year. Short lived; rarely over 90 years. Studies in Minnesota showed for 74 dominant trees on good soil growths of 8 inches in 31 years and 12 inches in 58 years; 91 dominant trees on poor soil, 8 inches in 45 years, and 12 inches in 82 years; 60 trees in an open stand, 8 inches in 30 years and 12 inches in 51 years.

Root System.—Very deep tap root with lateral roots spreading out a short distance and then descending vertically.

Bole.—Medium taper.

Crown.—Open trees are very scrubby and limby. Small in a dense stand.

Tolerance.—Less tolerant than red pine, white pine or any associates. Its rapid growth allows it to compete successfully with other species.

Wood.—Soft; not strong or durable; 30 pounds.

Reproduction.—Seed production prolific and annual. Sometimes begins to bear seed at an age of 5 years. Flowers in May and June, and cones mature in September. Some seeds are shed then but most cones open only after fire. Bare soil is the best seed bed, leaves and grass being a hindrance.

Range.—From Nova Scotia northwest through the Thousand Islands to Hudson Bay to Great Bear Lake, and south, but not in the Rockies. Southern limit—Maine, New Hampshire, Vermont, New York, Michigan to Manitoba. Best development in northern Saskatchewan. Tree of low altitudes.

Soil.—Coarse, dry, deep sands of flat plains are the natural home. Xerophytic, the deep root system allowing it to withstand drought.

Association.—Typically in pure stands after fire; also mixed with red pine and scrubby oaks. On better soils found with white pine, aspen and paper birch.

General.—Its use is chiefly local for ties, posts, etc. Canadian cut 1912, 28 million feet, or 0.9 of the total lumber cut; average mill price \$13.80. In cross ties it ranked first, supplying about 5.5 million or 40% of the total at an average cost of 41 cents each. The U.S. Forest Service recommended cutting in strips (sometimes in groups). Discourage on better soils.

LARIX, The Larches.

Crown.—Leaves deciduous.

Tolerance.—Very intolerant.

Wood.—Heavy, hard, strong.

Range.—Cooler part of the North Temperate Zone to the northern tree limit, and from sea-level to the mountain timber line.

Soil.—Xerophytic.

Association.—In limited pure groups and solitary.

General.—Three of the nine known species occur in both the United States and Canada. In Canada it is tenth in rank with approximately 2% of the total cut of 1912; average mill price \$15.00. In the United States less than 1% of the total cut of 1910, with an average mill price of \$13.30; of cross ties they furnished over five million, or over 3%.

LARIX LARICINA, (Du Roi) Koch.

LARIX AMERICANA, Michx.

Tamarack. Hackmatack. Larch.

Size.—Maximum 100 ft. by 30 in. Average 70 ft. by 20 in.

Growth.—Rapid under favorable conditions and fairly persistent. 130 upland trees in Manitoba grew 5 inches in 35 years and 8 inches in 56 years; 89 muskeg trees in Manitoba grew 5 inches in 68 years and 8 inches in 140 years. Greatest age probably 150 to 180 years.

Root System.—Broad and shallow.

Bole.—Medium taper.

Crown.—Small, pyramidal, fine branching; usually extending to the base until the 25th or 30th year.

Tolerance.—Intolerant, at no time enduring heavy shade.

Wood.—Hard, heavy, and elastic; 38 pounds.

Reproduction.—Prolific seeder; heavy production every 2 to 4 years. Flowers in March and April; cones mature in fall or early winter, and shed their seed gradually. Seed is minute and winged; low germination percent; vitality medium. Seedlings fairly hardy. They persist in a mixture with more tolerant but slower growing species of the same age.

Range.—Transcontinental northern limit of tree growth, south to Pennsylvania, West Virginia, Indiana, Illinois and Minnesota. Altitudes generally low; never found on high steep slopes.

Climate.—Widest range of temperature of all American conifers; precipitation may be as low as 12 inches per year; withstands almost any conditions of humidity.

Soil.—No special requirement. Physiologically xerophytic.

Association.—Frequently in pure stands, typically open. On better drained soils it associates with red and white spruce, hemlock, balsam, balm of Gilead, aspens, birches, red and sugar maples and willows.

General.—The U.S. Forest service recommends managing under a clean cutting system, leaving groups of strong seed trees when grown in pure stands.

LARIX OCCIDENTALIS, Nutt.

Western Larch.

Tamarack.

Size.—Average size of mature timber 90 to 100 ft. by 13 in. In northern Idaho it reaches its best development, 200 by 4 ft.

Growth.—Larch is a rather slow but persistent grower. In its optimum its best development in height growth occurs between 10th and 30th years, and its best diameter growth between 20th and 50th years. Height growth culminates at about 60 years, and diameter growth at about 90 to 100 years. A study of 43 trees at Summit Lake, B.C., showed growths of 5 inches in 29 years, 8 inches in 52 years, and 10 inches in 82 years.

Root System.—Deep heart roots.

Bole.—Straight, small taper, clear one-half to two-thirds in forest.

Crown.—Narrow crown, short and conical in the forest, but often reaching nearly to the ground in the open.

Tolerance.—Very intolerant throughout its life, and is more light demanding than yellow pine. More tolerant on moist than on dry soils.

Wood.—Like Douglas fir, strong, hard and stiff; 46 pounds.

Reproduction.—Seed production variable but normally prolific at intervals of one to several years after 40 to 50 years old. Cones open in August and in dry weather shed seeds readily. Seeds winged and light; germination percent relatively low as compared with its associates; vitality high. Abundant moisture required for germination. Exposed mineral soil the most suitable seed bed.

Range.—Rather limited; southwestern British Columbia, valley of the Columbia River, northwestern Montana, northern Idaho, Washington, and northern Oregon. High valleys and mountain slopes from 2000 to 7000 feet. Optimum in northern Idaho and Montana.

Climate.—Wide range of temperature, -30° to 100° Fahr., and an annual precipitation of from 20 to 50 inches, with a moderately heavy snowfall. Rains frequent in spring and fall, but the summers are hot and dry.

Soil.—Rather exacting in its soil moisture requirements, but will grow on dry mountain slopes.

Association.—Occasionally forms pure stands, but usually is found associated with other species, such as Douglas fir, western hemlock, white pine, giant arborvitae, Engelmann spruce, and lowland fir.

General.—One of the most valuable western trees. Good size, form, clearness, durability and strength. The cut for 1912 was 63 million feet at an average sale value of \$15.03 per thousand feet.

Should be grown with tolerant species for soil protection.

PICEA, The Spruces.

Root System. Very shallow.

Tolerance. Variably tolerant. Great ability to recover from suppression.

Range.—Cooler parts of the Temperate Zone, forming the bulk of the northern coniferous forest of America. Both white and black spruce extend to the northern tree limit.

Association.—Most gregarious of Canadian genera. Also occurs in a mixture.

General.—There are 18 species altogether of which there are 7 in the U.S. and 5 in Canada. In commercial importance, the spruces are first in Canada. In 1912, they headed the Canadian lumber cut with 32.1% of the total; average mill price \$14.46 per thousand. Quebec supplied 29%, and New Brunswick 25% of this. Of the pulp-wood total of 672,000 cords the spruces furnished 81.6% (of which 58% was from Quebec); average mill price was \$6.47 per cord.

In the United States, the western spruces with 60 billion feet, and the eastern spruces with 50 billion feet, together form 4.4% of the total stumpage. In 1910, they ranked seventh with a cut of approximately 1½ billion feet board measure, or 3.6% of the total; average mill price was \$16.62 per thousand. Of the domestic pulp-wood, spruces supplied about 1½ million cords or 36% of the total (domestic and imported spruces form 58% of the total).

PICEA MARIANA, Mill.

Black Spruce. Swamp Spruce.

Size.—20 to 30, or even 90 feet in height; rarely 3 feet in diameter.

Growth.—Generally very slow but persistent. Life 200 years. 34 trees in Riding Mountains in Manitoba grew 5 inches in 72 years, and 8 inches in 118 years.

Root System.—Shallow.

Bole.—Generally rapid taper and little clear.

Crown.—Open, irregular, conical crown with short pendulous branches; twigs downy.

Tolerance.—Very shade enduring; does not clear well.

Wood.—Light, soft, not strong; like red spruce; 20 pounds.

Reproduction.—Cones mature by the first of September and shed the seeds within a few weeks. Seeds small and winged; germination percent medium; vitality great. Germinates best on moist humus and mineral soils; can grow on moss, etc. Seedlings require shade for the first two years.

Range.—Labrador to Alaska, northern Alberta, Manitoba and Saskatchewan to Wisconsin and Michigan to the northeastern states; north to the tree limit.

Soil.—Well drained bottom lands and stony barrens in the north. Commonly a tree of swamps and muskegs in its median and southern range.

Association.—Large pure stands often occur, and occasionally, with tamarack, hemlock, balsam, and hardwoods.

General.—Its commercial importance is small on account of its small size.

PICEA RUBENS, S.

PICEA RUBRA, L.

Red Spruce.

Size.—40 to 75 ft. by 12 to 18 in. Occasionally over 100 ft. by 3 ft.

Growth.—Rate medium but persistent. 79 trees in Nova Scotia grew 6 inches in 87 years, and 12 inches in 130 years. Another study of 50 trees showed growths of 6 inches in 67 years and 12 inches in 117 years. Life 200 years.

Root System.—Tracing.

Bole.—Medium taper.

Crown.—Non-spreading.

Tolerance.—Tree is tolerant and does not clear.

Wood.—Soft, not strong; 32 pounds.

Reproduction.—A little seed is produced every year, but heavy seed years occur at irregular intervals varying, with the locality, from 3 to 10 years. The cones ripen and begin to discharge seed at the end of September, and continue to shed seed throughout the winter. One bushel of green cones yields 17.8 pounds of seed; one pound of seed contains 120,000 grains. The germination percent is moderate; vitality is medium. Prefers fresh mineral soil but will germinate on humus or moss.

Range.—Limited; Maritime Provinces of Canada; south from the St. Lawrence down the Appalachians to North Carolina. Optimum in Maine. Sea-level to 2000 feet.

Soil.—Rather exacting as to moisture. Rich bottoms to poor slopes.

Association.—It is grouped in nature. The associated species are white spruce, hemlock, balsam, black spruce, beech, yellow birch, and sugar maple.

General.—Of great commercial importance. On Canadian Atlantic sea-board it is the chief lumber tree.

PICEA CANADENSIS, (Mill.) B.S.P.

White Spruce.

Size.—Maximum 100 to 150 ft. by 3 to 4 ft.; rarely over 60 to 80 feet east of the Rockies.

Growth.—Medium but persistent. 30 trees in the Riding Mountains, Manitoba, on poor soils grew 6 inches in 49 years, and 12 inches in 88 years; 46 trees on good soil grew 6 inches in 47 years and 12 inches in 79 years. Life is 250 to 350 years.

Root System.—Shallow, tracing, easily transplanted.

Bole.—Straight, smooth, medium taper, clear one-half to two-thirds.

Crown.—Broad-based open pyramids; long stout branches sweeping out in graceful curves.

Tolerance.—Very shade enduring; dead limbs persist.

Wood.—Light, soft, not strong; valuable for construction; 25 pounds

Reproduction.—Moderately prolific seeder with full seed years, about 8 years apart in New England. Flowers in April and May, and the cones mature and shed seed in September. Seed is small, light winged; moderate germination percent but persistent vitality. Prefers fresh humus or mineral soil. Reproduces in its own shade, but poorly on hardwood litter. Seedlings are very tolerant, more so than most of its associates.

Range.—Labrador timber line to Bering Strait; Rocky Mountains to northern fringe of United States. Very wide range of soil and climate.

Soil.—Shores of streams and lakes, and rocky slopes of low hills. Thrives on light sands, requiring better soils in the north (finely divided but porous soils). Mesophytic.

Association.—Aspen, paper birch, balsam, etc. Forms compact groves.

General.—Commercial importance is great. Spruces lead in the Canadian lumber cut, and white spruce is the chief of the spruces.

PICEA ENGELMANNI, Eng.

Engelmann Spruce.

Size—Average 80 to 100 ft. by 1½ to 3 ft. Maximum 150 ft. by 3 to 4 ft.

Growth.—Rate moderate but persistent. Its most rapid height growth occurs between the 20th and 40th years. Its diameter growth is most rapid about the 50th year. Life up to 500 years or more.

Root System.—Horizontal; somewhat deeper than that of lodgepole pine, but still quite shallow, seldom reaching a depth of more than two feet.

Bole.—Moderate taper; straight and clear in dense stands.

Crown.—On its best sites Engelmann spruce is a tall symmetrical tree. Its crown is narrow, compact, and spire-like, and except in the closest stands, reaches almost to the ground.

Tolerance.—Very tolerant of shade, and will exceed alpine fir and most of its other associates in this respect. Great powers of reviving after suppression. It usually forms close, dense stands in which all ages are present. Rather more tolerant in youth than later on in old age.

Wood.—Light, soft, not strong, straight grained; 22 pounds.

Reproduction.—A prolific seed producer after the 25th year, with heavy seed years every three years. Cones mature in the latter part of August, and shed seed by October. Seed, small, light, and winged; germination percent high; vitality persistent. Germinates best in moist mineral soil, rarely in humus.

Range.—It extends from Yukon and British Columbia to southern Oregon and through the Rockies of British Columbia and Alberta to New Mexico and Arizona. It is also found in Montana, Idaho, and Washington. Essentially a tree of high altitudes; in Canada running from 2500 to 6000 feet, and farther south is found as high as 12,000 feet.

Climate.—Wide range. Temperatures from 95° to -40° Fahr. Annual average precipitation of over 25 inches largely in the form of snow. Daily range of temperature is also high, especially in its upper altitudinal range.

Soil.—Not very exacting as to soil provided there is sufficient moisture. Does not require such a degree of drainage as other species. Attains its best development on the deep rich soils of gulches and river valleys. With its shallow root system it can grow in wet soils.

Association.—Forms large pure stands and also grows in mixture with other species. Pure stands are more frequent in the south. Its most common associates are alpine fir and Douglas fir. This is especially true for Montana and northern Idaho.

General.—The cut for 1912 was 75 million feet approximately. In Canada its importance is great as a source of supply for the prairie provinces. The United States Forest Service recommends a selection system with clear cutting in strips as an alternative. Soil protection is necessary because of the shallow root system.

PICEA SITCHENSIS, (Bong.) Trautv. and Mayer.

Sitka Spruce.

Tideland Spruce.

Size.—Largest of all spruces; average 100 ft. by 3 to 4 ft. Maximum 200 ft. by 10 to 15 ft.

Growth.—Rapid after first few years (overtakes hemlock) and is persistent. Age up to 800 years.

Root System.—Spreading and shallow.

Bole.—Tapering, swell-butted, branchy.

Crown.—Pyramidal, two-thirds of the stem. Fairly dense.

Tolerance.—Tolerant, but less so than the giant arborvitae and the hemlocks. Very tolerant in youth but less so in later life. Forms dense stands; competes with hemlock.

Wood.—Light, weak, soft, straight grained, clear.

Reproduction.—Prolific seeder with heavy seed years every 2 to 3 years. Flowers in the spring; cones mature and shed seed in the early fall. Seed small winged, wind-scattered; germination percent high; vitality persistent. Seed beds wet soil, muck, moss, duff, etc. Seedlings frost tender for the first few years only.

Range.—Pacific coast from northern California to the base of the Alaskan peninsula, 1300 miles. Optimum, Puget Sound to middle British Columbia. On the islands and coast inland it averages 50 miles to the western slope coast mountains. Sea-level to 3000 feet. (5000 feet maximum in Alaska.) Farther north and west in Alaska than any other Pacific coast forest tree, and higher in Alaska and British Columbia than in Washington or Oregon.

Climate.—Temperature chiefly mild and uniform (Japan Current), and above zero, but 35° below zero in Alaska. Precipitation heavy, 20 inches in California to 100 inches in Alaska. Humidity high.

Soil.—Generally in moist coast alluvial and sandy bottoms and moist sea facing slopes. Deficient moisture occasions stunted growth.

Association.—Pure forests, especially in the north; also mixed forests, chiefly with *Tsuga heterophylla* (Alaska), also with redwood, *Thuja plicata*, *Abies grandis*, *Chamaecyparis nootkatensis*, *Taxus*, *Tsuga mertensiana*, *Alnus*, *Populus trichocarpa*, *Acer*, and *Salix*.

General.—Commercial importance medium; wood good; growth rapid; supply large and easily accessible. Clear cutting in strips recommended.

TSUGA, The Hemlocks.

Growth.—Slow but persistent. Fairly long lived.

Root System.—Shallow.

Tolerance.—Very tolerant.

Range.—Middle Temperate Zone.

Soil.—Mesophytic.

Association.—Occurs singly and in groups.

General.—There are 7 species of which 4 are in the United States, and 3 in Canada. The hemlocks were fourth in the Canadian lumber cut of 1912 with 7.5% of the total; average price \$13.45 per thousand feet. In pulpwood it ranked least and cheapest with 0.2 of the total, average value \$5.18 per cord. In the United States the hemlocks are estimated at 175 billion feet or 7.1% (chiefly eastern hemlock) of the total lumber cut, with an average mill price of \$13.85. Of the domestic pulpwood about 15% was hemlock. Of the 1,200,000 cords of tanbark 2/3 was hemlock.

TSUGA CANADENSIS, (Linn.) Carr.

Eastern Hemlock. Hemlock Spruce. Spruce Pine.

Size.—Average 60 to 70 ft. by 2 ft. Maximum 130 ft. by 4 ft.

Growth.—Slow but persistent. 186 trees in Michigan grew 10 inches in 120 years, and 20 inches in 220 years. 124 trees in North Carolina made the same growth in 96 and 218 years respectively. Life over 500 years.

Root System.—Heart.

Bole.—Often irregular; taper great.

Crown.—Spreading.

Tolerance.—Tolerant, especially the seedlings.

Reproduction.—Very prolific seeder with heavy seed years at frequent intervals. Cones mature by September and shed seeds rapidly through September. Seeds small, light, winged; germination percent medium; vitality moderate. Germinates well on moist litter, decaying logs, etc.

Range.—Eastern United States and Canada. Northern limit, Nova Scotia to Quebec City to Lake Temiskaming to a point about 100 miles to the west of Sault Ste. Marie. Southern limit, Delaware to Minnesota, south in the mountains. Optimum about Pennsylvania. Altitude, medium to low in the north and in the mountains to the south.

Soil.—Soil rich; two sites, moist and deep, and dry and shallow; at its best on the moist and deep site. Mesophytic.

Association.—Rarely in pure stands; generally mixed with hardwoods, spruce, and white pine.

General.—In Canada in 1912 the cut was 284 million feet, averaging \$13.40 per thousand, and forming 85% of the spruce cut. The stand in United States estimated at 75 billion feet or 3% of the total stumpage.

TSUGA HETEROPHYLLA, (Raf.) Sarg.

Western Hemlock.

Alaska Pine.

Size.—Average 120 ft. by 2 ft. Maximum 250 ft. by 8 ft.

Growth.—Slow but persistent. In southern B.C. 30, 39 and 72 trees grew 10 inches in from 60 to 100 years, and 20 inches in from 108 to 160 years, the most rapid growth being on Vancouver Island. Life up to 500 years.

Root System.—Very shallow.

Bole.—Regular cylindrical; often buttressed base.

Crown.—Spreading.

Tolerance.—Very tolerant, especially seedlings; more tolerant than any of its associates except red cedar.

Wood.—Much superior to that of eastern hemlock; 32 pounds.

Reproduction.—A very prolific seeder from the 30th year with heavy seed years at frequent intervals. Cones mature by the end of August, and shed seeds during September. Seed small, light, winged; germination percent and vitality moderate. Germinates well on moist duff; less well on mineral soil. Seedlings very tolerant and grow under parents.

Range.—Alaska to California, inland in southern B.C. and Idaho, and in the Cascades of Oregon and Washington. Optimum, moist coast of B.C., Washington and Oregon. Altitude, sea-level up to 7000 feet

Climate.—Heavy precipitation, high humidity, and long growing season. Humidity most important.

Soil.—Thrives on any soil if there is abundant moisture. Mesophytic.

Association.—In pure or mixed stands; in north with Sitka spruce; commonly with Douglas fir, western cedar and lowland fir. Also with western white pine, western larch, Engelmann spruce, etc.

General.—Commercially important. The 1912 cut was 50 million feet worth \$13.80 per thousand. In the United States, it is estimated at 100 billion feet or 4% of the total stumpage. It is very subject to disease, however, and as it occurs generally with more valuable species, should not be favored in the management.

TSUGA MERTENSIANA, (Bong.)

TSUGA PATTONIANA, (Jeffer.) Eng.

Mountain Hemlock. Black Hemlock.

Size.—Average 25 to 60 ft. by 1 to 2 ft. Maximum, 125 ft. by 3 ft.

Growth.—Slow but persistent. Trees 18 to 20 inches in diameter are 180 to 260 years old.

Root System.—Shallow, tracing.

Bole.—Tapering; base often buttressed.

Crown.—Little resemblance to other hemlocks. Narrowly pyramidal, generally extending nearly to the ground.

Tolerance.—Very tolerant, equal to western hemlock and surpassing all its associates. Even dense stands clear very slowly.

Wood.—Pale red, fine grained, soft, not strong; 32 pounds. Lighter than western hemlock.

Reproduction.—Prolific seeder from the 20th year; some seed each year and frequently heavy seed years. Flowers in May; ones mature and shed seed in September and October, and the cones fall during the winter. Seed small, light, large winged; germination percent medium; vitality transient. Seed beds,—both mineral and humus soils suitable; seedlings stand much shade and prefer some, but do not thrive under the dense shade of their parents.

Range.—Pacific coast mountains of Alaska southward through the high Sierras of California and to northern Idaho and Montana. Mainly at timber line, but in far north at sea-level.

Climate.—Severe alpine climate. Precipitation generally abundant; transpiration generally rapid.

Soil.—Generally inhabits loose, coarse, moist soils of mountains.

Association.—Occurs in limited pure stands and in mixture; in the north with Sitka spruce, western hemlock and alpine fir; southwards at high altitudes with white bark pine, alpine fir, Lyall larch, and Engelmann spruce; in southern B.C. with yellow cedar, amabilis fir, and alpine fir.

General.—Its commercial importance is small as yet, because of its small size and inaccessibility. It may be valuable for pulp in the future.

PSEUDOTSUGA TAXIFOLIA, (Poir.) Britt.

PSEUDOTSUGA MUCRONATA, (Raf.) Sudw.

Douglas Fir. Red Fir. Yellow Fir. Douglas Spruce.

Size.—Largest tree of America except the Sequoias. Coast average 150 ft. by 3 ft. Maximum 250 ft. by 10 ft. Mountain average, 100 ft. by 2 ft.

Growth.—Rapid and persistent. Southern British Columbia studies of 184, 571, 159 and 141 trees showed that 10 inch trees were grown in from 44 to 66 years, 20 inch in from 90 to 124 years, and 30 inch in from 157 to 215 years. Life over 500 years.

Root System.—Heart.

Bols.—Cylindrical, straight, and clear for 50 to 100 feet.

Crown.—Pyramidal when young; rounded and flattened when old.

Tolerance.—Moderately tolerant becoming less so with age. More tolerant than white and lodgepole pine and less so than Engelmann spruce.

Wood.—Moderately heavy; fine textured; hard, strong, and durable; 29 pounds.

Reproduction.—A prolific seeder with heavy seedlings at intervals of 3 or 4 years. Cones ripen early in August and shed seed in September and October. Germination percent moderate and vitality persistent. Germinates best on warm, moist mineral soil and also on intermixed humus. On the coast reproduces best on burned over areas.

Range.—Western North America, from central British Columbia southward to central California, to northwest Texas, southern New Mexico, Arizona, and northern Mexico. In Canada from the eastern foothills to the coast, north to lat. 55°, Skeena River. Optimum, coast of southern British Columbia. Sea-level to 6000 feet in British Columbia.

Climate.—Widely variable with range. Temperature generally mild. Precipitation from less than 15 inches to over 100 inches. Humidity varies from dry interior to moist coast. Prefers north exposures except at northern limit.

Soil.—Adapted to a wide range of soils. Avoids saturated, poorly drained, heavy soils. Moisture conditions more important than the soil.

Association.—Often forms large pure forests, but generally is associated with various other species of different habits; in Canada chiefly with western hemlock, western red cedar, Sitka spruce, lowland fir, western white pine, western larch, and lodgepole pine.

General.—Commercial importance very great. In the Canadian cut of 1912, it ranked third with about 20% of the total at \$12.33 per thousand (\$15.45 in 1910). It bids fair soon to oust white pine from second place. In the United States, Douglas fir is estimated at 525 billion feet or 21% of the total stumpage. This is nearly twice greater than the next greatest single species (western yellow pine, 275 billion), and equals the combined stumpage of the southern hard pines (350 billion), and the white and red pine (75 billion). It is greater than the

combined stands of all the hardwoods. In the lumber cut of 1910 it ranked second only to the yellow pines, with a cut of 5.2 billion feet, or 13.0% of the total. Average mill price \$13.09. It also furnished over 11½ million cross ties or over 7% of the total. The tree is remarkably free from disease.

ABIES, The Firs.

Growth.—Only moderately long lived, up to 350 years. *A. nobilis* and *A. magnifica* are longer lived.

Crown.—Very conical; dense and heavily foliated.

Tolerance.—Very tolerant. (*A. nobilis* and *A. magnifica* are only intermediate).

Reproduction.—Germination percent low, 50% or under, and vitality transient.

Range.—Cold and temperate regions; sea-level to mountain timber line; in North America chiefly in Pacific forests.

Association.—Occurs generally in groups or singly in mixture.

General.—There are 25 species of which 9 are in the United States, and 4 in Canada. In Canada in 1912, it was eighth in rank with 1.8% (at \$13.62) of the total lumber cut; and second only to spruce with 17.5% (at \$6.40 per cord) of the total pulpwood cut; spruce and fir together furnished over 99% of the total. In the United States, the western firs are cut and at 50 billion feet or 2% of the total stumpage.

ABIES AMABILIS, (Loud.) Forb.

Amabilis Fir. Red Fir. Lovely Fir.

Size.—Average 75 to 100 ft. by 18 to 30 in. Maximum 200 ft. by 5 to 6 ft.

Growth.—Fairly rapid, and is long sustained; most rapid in the first 150 years; trees 16 to 24 inches in diameter are 175 to 230 years old. More rapid than lowland fir, red cedar, hemlock or Engelmann spruce; slower than Douglas fir, Sitka spruce or western white pine. Life up to 400 years.

Root System.—Shallow and restricted.

Bole.—Straight and cylindrical on good sites.

Crown.—A long, spire-like pyramid, later becoming widely conical.

Tolerance.—Tolerant, more so than Douglas fir; less so than cedar and hemlock. Ranks with lowland fir and Engelmann spruce.

Wood.—Fine textured, soft, light, not durable; 24 pounds.

Reproduction.—A prolific seeder with heavy seed years every 2 to 3 years. Cones ripen in September of the same season and the seeds fall

in October. Seeds fairly large and winged; germination percent low; vitality very transient. Will germinate on moist duff. Seedlings prefer some shade.

Range.—Southern Alaska and the coast mountains and Cascades of British Columbia, Washington, and Oregon. Sea-level to 5000 feet in B.C. Optimum in Puget Sound region

Climate.—Temperature generally equable, 0° to 90° Fahr.; precipitation abundant, average 45 inches; humidity moderate.

Soil.—Exacting as to drainage and soil moisture. Will grow on a variety of soils from shallow gravelly sand to moist sandy loam.

Association.—Occurs pure in isolated groups on Vancouver Island, but commonly in a mixture. In B.C. in the upper slope type—above the Douglas fir forest—with western and mountain hemlock, alpine fir, and Engelmann spruce.

General.—Not at present cut except incidentally. The supply is large and will some day be utilized. It is silviculturally important in the dense lowland forest because of its tolerance and ability to form an understory below the shade of the other species.

ABIES GRANDIS, Lindl.

Lowland Fir. Grand Fir. White Fir. Silver Fir.

Size.—Average 100 to 125 ft. by 2 ft. Maximum 200 to 250 ft. by 4 ft.

Growth.—Moderately rapid and is well sustained. Life probably up to 300 years.

Root System.—Shallow (U.S.F.S. Silvical Leaflets). Deep (Sudworth).

Bole.—Straight, cylindrical.

Crown.—Round topped cone in old trees.

Tolerance.—Tolerant. Less so than western hemlock or cedar, and more so than Douglas fir and noble fir. Clears readily in dense stands.

Wood.—Light, soft, coarse grained, weak, not durable.

Reproduction.—Not very prolific; good seed years at irregular intervals. Cones mature in one summer, in the early fall, and shed their seeds at once. Seeds fairly large and winged; germination percent low; vitality medium. Seedlings will grow on humus and mineral soil, and may germinate in the fall after the seed fall. Partial shade preferred.

Range.—Southern B.C. to northern Idaho, western Montana, Oregon and northern California coast.

Climate.—Equable; temperature down to -30° Fahr., in the mountains; the precipitation is well distributed, but July and August are dry.

Soil.—A tree of moist situations and will thrive on poor soils if there is sufficient moisture. Generally inhabits rather deep soils.

Association.—Rarely in pure stands. Associates commonly with Douglas fir and is dominant over red cedar, western hemlock, etc.

General.—Of secondary importance as it is cut only incidentally. Most of its associates are more valuable and are to be favored.

ABIES BALSAMEA, (L.) Mill.

Balsam Fir.

Balsam.

Size.—Averages 25 to 60 ft. by 12 to 18 in. Maximum, 70 ft. by 2 ft.

Growth.—Rapid but briefly sustained. 28 trees in the Riding Mountains grew to 5 inches in 51 years, and 10 inches in 86 years; 39 swamp trees near Halifax, N.S., grew 5 inches in 64 years, and 10 inches in 95 years.

Root System.—Shallow.

Bole.—Considerable taper.

Crown.—Conical.

Tolerance.—Very tolerant more so than most of its associates.

Wood.—Soft, weak, perishable; 24 pounds.

Reproduction.—Very prolific with frequent heavy seed years. Flowers in May and June; cones ripen in September and shed seed rapidly. Seeds are winged; germination percent high; vitality not persistent. Germinates on humus or mineral soil. Seedlings stand much shade.

Range.—Labrador to Great Bear Lake region, south to Pennsylvania (and along the mountains to Virginia), Michigan and Minnesota.

Soil.—Inhabits wide range; is very adaptable; xerophytic.

Association.—Rarely in pure stands (Cape Breton Plateau); generally in mixture with spruces, hemlocks and hardwoods. Common with poplar after burns.

General.—Commercial importance is small except from the standpoint of its prevalence. It supplies practically all of the total fir lumber and pulpwood in Canada. It is very liable to disease and early rot.

ABIES LASIOCARPA, (Hook.) Nutt.

Alpine Fir.

Mountain Fir.

Balsam.

Size.—50 to 90 ft. by 10 to 24 in.

Growth.—Slow growth and is short lived; averages 14 inches in 140 years. Life 200 to 250 years.

Root System.—Very shallow and superficial; often killed by ground fires.

Bole.—Rapid taper.

Crown.—Non-spreading, spire-shaped, generally reaching almost to the ground.

Tolerance.—Tolerant; about the same as Engelmann spruce.

Reproduction.—Seeds^s each year; heavily every three years; begins at 20 years. Cones mature in one season and shed the seeds in the early fall. Seeds large and winged; germination percent high; vitality transient. Germinates well on duff or mineral soil.

Range.—Alaska to southern Arizona and New Mexico, and from the mountains of the Pacific coast to the Rockies; leaves the coast in Oregon and does not occur in California. From sea-level to 3000 or 4000 feet in Alaska, but is in general a timber line tree; up to 12,000 feet in the Rocky Mountains.

Climate.—Severe.

Soil.—Widely adapted; from swampy to poor, thin, dry soils. Less exacting as to soil moisture than Engelmann spruce. Does not thrive on heavy dry soils.

Association.—Occurs in small pure stands at high altitudes, and in mixture with black hemlock, Engelmann spruce, yellow cedar, white bark pine, and amabilis fir.

General.—Commercial importance is small; may be used for pulp-wood some day, but at present it is inaccessible. It is of value as a protection forest.

THUJA, The Cedars or Arborvitæ.

Growth.—Slow but persistent.

Bole.—Very tapering; often swell butted.

Tolerance.—Very tolerant.

Wood.—Soft, light, weak, very durable.

Range.—Middle Temperate Zone of North America and Asia.

Soil.—Generally inhabit wet places but can grow on dry soil.

Association.—Commonly grouped in mixture.

General.—There are 4 species of which two are in both the United States and Canada. Its commercial importance is great. In Canada in 1912, cedars ranked fifth with 3.6% of the total lumber cut at an average price of \$17.98 per thousand. Of the total shingle cut of 1.57 billion, 91% were cedar at an average mill price of \$2.00 per thousand. Of the

13.7 million ties, 5.3% were cedar at an average price of 38 cents each. Of the 585,000 poles, over 90% were cedar (chiefly eastern), at an average price of \$1.60 for eastern and \$3.00 for western cedar.

In the United States in 1910 the cedars supplied:—

- of the total lumber cut, 1%, average mill price \$15.53;
- of the total shingle cut, 78% or over 10 billion;
- of the total tie cut, over 5% or over 7 million;
- of the total pole cut (approx.), 63% or 2.4 million.

The cedars are very subject to a heart rot, causing hollow butts and a consequent great waste in sawing. The fungus responsible for this has not yet been identified.

THUJA OCCIDENTALIS, L.

Aborvita. White Cedar. Cedar.

Size.—Average 25 to 50 ft. by 1 to 2 ft. Maximum 50 to 60 ft. by 2 ft.

Growth.—Slow but persistent. Studies of 35 trees in Michigan and of 44 trees in Minnesota showed growths of 5 inches in 62 and 87 years, and 10 inches in 154 and 167 years respectively. In contrast, 30 trees in Ontario showed growths of 13 inches in 115 years, and 18 inches in 185 years. Life is 250 to 300 years.

Root System.—Heart form.

Bole.—Rapidly tapering; swell butted.

Crown.—Non-spreading.

Tolerance.—Very tolerant.

Wood.—Soft, weak, brittle, very durable; 19 pounds.

Reproduction.—Prolific seeder with frequent seed years. Flowers in May and June; cones mature in August and soon shed seed. Seed and wing are small; germination percent high; vitality transient. Organic seed bed preferred. Seedlings stand dense shade.

Range.—Northeastern United States and Canada nearly to James Bay. Low altitudes. Optimum, southern Canada and the lake states.

Soil.—Frequents swampy places or dry ridges; probably physiologically dry.

Association.—Gregarious to grouped with spruces, larch, balsam, etc.

General.—Commercial importance is great for poles, posts, ties, shingles, etc.

THUJA PLICATA, Don.

Giant Arborvita. Western Red Cedar.

Size.—Largest of the cedars; averages 100 to 150 ft. by 3 ft.; maximum 200 ft. by 15 ft.

Growth.—Slow but persistent. Studies of 170 measurements on Vancouver Island, and 46 measurements near Lake Slocan in B.C., showed growths of 10 inches in 70 and 85 years; 20 inches in 115 and 170 years; and 30 inches in 180 and 235 years respectively. Life, 800 years.

Root System.—Heart.

Bole.—Very rapidly tapering and swell butted.

Crown.—Long, irregular, open, conical, frequently two leaders. Usually very branchy and does not clean well. Crown often covers two-thirds of the stem.

Tolerance.—Very tolerant; ranks with western hemlock.

Wood.—Soft, brittle, not strong, very durable; 23 pounds.

Reproduction.—Prolific seeder with heavy seed years at irregular intervals. Cones mature at the end of August and shed seeds soon. Seed about 18 to a cone; small with small double wings; germination percent high but vitality transient; often germinate in the fall. Moist organic and mineral seed beds suitable; can grow in heavy duff.

Range.—Pacific coast, northern California to Sitka, Alaska, and east to the west slope of the Rockies. Optimum, moist coast of southern British Columbia.

Climate.—In general favorable; temperature down to -30° Fahr.; precipitation varies from 20 to 100 inches.

Soil.—Chiefly moist situations; thrives on a wide range of soils if sufficient moisture is present.

Association.—Occurs singly and in small groups with western hemlock, Sitka spruce, lowland and Douglas firs; with redwood and hemlock in California. At higher elevations with pine, larch, and Engelmann spruce.

General.—Commercial importance is great because of large supply, ease of working, and durability of wood. It is the chief shingle tree in Canada, forming over half of the cedars' total which is 91% of all shingle material. It also forms over $\frac{3}{4}$ of the total cedar lumber cut which ranked fifth in Canada in 1912. In the United States this tree, with the incense cedar, is estimated to have 100 billion feet or 4% of the total stumpage. In 1907 it supplied 7 billion shingles or over $\frac{3}{5}$ of the total.

CHAMAECYPARIS NOOTKATENSIS, (Lamb.) Spach.

Yellow Cedar. Yellow Cypress. Sitka Cypress. Alaska Cypress.

Size.—Average 80 ft. by 1 to 2 ft.; maximum 130 ft. by 5 to 6 ft.

Growth.—Slow but persistent, requiring 200 years to produce saw timber. Trees 15 to 20 inches in diameter are 200 to 275 years old. Life up to 500 or 600 years.

Root System.—Shallow.

Bole.—Base swelled and fluted, rapidly tapering, generally one or two slight bends.

Crown.—Open, narrow, conical; branches and tip drooping and persistant.

Tolerance.—Less than hemlock, cedar, and amabilis fir, but greater than noble fir, white pine or larch. Occasionally more tolerant on moist soils and in the south and in younger ages. Keeps fairly dense shade under good conditions.

Wood.—Somewhat brittle, close grained, very durable; splits and works easily; 29 pounds.

Reproduction.—Not fully known; good seed years occasionally; production not abundant or prolific. Flowers in April; cones mature and scatter seed in early fall of the same year. Seed light and large winged; germination percent moderate; vitality transient. Will germinate on duff or mineral soil. Seedlings hardy. Germinate in shade.

Range.—Northern Oregon to Prince William Sound, Alaska. Optimum, coast and islands of B.C. and southern Alaska. Usually confined to west slopes in the Cascades of Oregon and Washington at 2000 to 7500 feet elevation; B.C. and north, sea-level to 3000 feet.

Climate.—Temperature cool to below zero in the north; precipitation 20 to 100 inches from Oregon to Alaska; humidity great.

Soil.—Needs little soil but much moisture. Like the giant cedar the soil is chiefly moist, rocky or gravelly.

Association.—Occurs singly and in groups; occasionally in pure stands under favorable conditions. B.C. and southern Alaskan coast with Sitka spruce, red cedar, hemlock and swamp hard-woods; higher elevations to timber line with Sitka spruce, hemlock, jack pine, lodgepole pine, and amabilis fir. Washington coast with lowland fir and yew; at higher elevations in the Coast Ranges and Cascades with hemlock, lodgepole pine, amabilis and lowland firs, Douglas fir, western larch, white pine, alpine fir, and Engelmann spruce.

General.—Wood valuable but the supply is limited and the tree a slow grower; it is also an upper slope type and sometimes quite inaccessible. Silvicultural treatment: more valuable than amabilis fir and black hemlock; therefore to be preferred on upper slope type. Restrict to higher altitudes because it grows too slowly to compete with its lower associates.

ANGIOSPERMS OR "COVERED SEED" TREES, TREATED AS A CLASS.

Also called the broad-leaved trees, deciduous trees, and hardwoods.

Size.—In general inferior to the gymnosperms. The tulip tree is one of the largest representatives in North America.

Growth.—More rapid, but less persistent and shorter lived than the gymnosperms.

Root System.—Generally deeper than gymnosperms. Ranges from deep rooted oaks to shallow hard maple.

Bole.—Divided.

Crown.—Generally spreading; deciduous except in the south.

Tolerance.—Less tolerant than the gymnosperms. Varies from the very tolerant hard maple and beech to the intolerant oaks and ashes.

Wood.—The hardwoods are relatively heavier, harder and stronger than the softwoods. Range from soft, light, weak basswood, poplar and tulip to the heavy, hard, strong oaks and hickories. Durability is less than the gymnosperms. Ranges from the durable white oak to the perishable poplar.

Reproduction.—Seeds generally larger and heavier than those of the gymnosperms. Reproduction by coppice gives them in many cases a great advantage in pre-empting the ground after a fire. The ability to coppice varies from the vigorously coppicing long-lived stocks of oak and chestnut to the weakly sprouting and short-lived stocks of beech and birch.

Range.—From the tropics to the Arctic Circle timber line, and from sea-level to the mountain timber line, but in the latter case less common at the upper limits than the gymnosperms. Optimum in Tropical to South Temperate Zones. Deciduous forest proper, optimum in the Ohio and lower Mississippi basins and in Japan.

Soil.—Inhabit better soils and are more mesophytic than gymnosperms, ranging from the exacting sugar maple to the scrub oaks and willows.

Association.—Generally mixed individually or in groups. Mixture much more complex than with gymnosperms.

General.—Commercially they are much inferior to the gymnosperms, though individually in small quantities for special uses they are more expensive. In Canada in 1912 they supplied 300 million feet or 7% of the total cut, the prices ranging from \$12.89 for willow to \$32.04 for hickory. Ontario leads in the production of all hardwoods except birch (Quebec) and poplar (B.C.); therefore Ontario and Quebec together supply the great bulk of Canadian hardwoods. In the U.S. the hardwoods are estimated as comprising 500 billion feet or 20% of the total stumpage. In 1910 they furnished 22% of the total cut.

JUGLANS CINEREA, L.

Butternut.

Size.—Up to 60 or 70 ft. by 3 ft.

Growth.—Rate rapid, exceeding that of walnut. Persistence of growth medium.

Root System.—Tap.

Bole.—Short; medium taper.

Crown.—Spreading.

Tolerance.—Tolerant in youth; intolerant in later life.

Wood.—Light, soft, not strong, easily split and worked; 25 pounds.

Reproduction.—Only moderately prolific, bearing about every second year. Flowers in April and May; nuts ripen in September. Germination percent 65 to 75; vitality six months to a year.

Range.—Eastern United States, extending up the St. Lawrence valley in Canada to southern New Brunswick. Optimum in the Ohio River basin.

Soil.—Inhabits rich soils generally, but is less fastidious than walnut.

Association.—Solitary; associates with beech, yellow birch, maples, elm, and red spruce. (Hough.)

General.—Commercial importance is small in Canada; valuable but the supply is negligible.

JUGLANS NIGRA, L.

Black Walnut.

Size.—Average 70 to 90 ft. by 2½ to 4 ft. Maximum, 110 ft. by 5 to 6 ft.

Growth.—Rapid and long sustained.

Root System.—Tap.

Bole.—Medium taper.

Crown.—Spreading.

Tolerance.—Intolerant; fairly tolerant in early life.

Wood.—Heavy, hard, strong, durable; 38 pounds.

Reproduction.—Moderately prolific, seeding every other year. Flowers in April and May, and ripens about October. Seed, 20 nuts to a pound; germination percent 70 to 90; vitality six months to a year. Like all nut trees much fruit is devoured by animals.

Range.—New England to Minnesota and south to Texas. In Canada only in southern Ontario. Optimum in southern Ohio basin.

Soil.—Inhabits rich bottom lands. Mesogaetic.

Association.—Solitary or in groups with hickories, oaks, maples, etc., in river bottoms; oaks and chestnuts in the mountains of Carolinas and Tennessee.

General.—Commercial importance is very small in Canada as the supply is practically exhausted. Valuable however for planting because of rapid growth on good soil and high quality of wood.

HICORIA MINIMA, Britt.

CARYA CORDIFORMIS, (Wang.) K.Koch.

CARYA AMARA, Nutt.

Bitternut Hickory.

Size.—Average 50 to 75 ft. by 12 to 18 inches. Maximum 100 ft. by 3 ft.

Growth.—Medium; most rapid growing of the hickories.

Root System.—Tap.

Crown.—Large with spreading limbs.

Tolerance.—Tolerant.

Wood.—Very hard, tough, strong, and close grained.

Reproduction.—Moderately prolific. Flowers in May and June; nuts ripen in September and October. Germination percent medium and vitality small.

Range.—Southern Maine, southwestern Quebec, southern Ontario, west to southern Minnesota; the south to east half of the United States. Optimum in the bottom lands of the lower Ohio basin. Altitude low; under 2000 feet.

Soil.—Inhabits good soils. Low wet woods near the borders of streams and swamps or high rolling uplands remote from streams. Mesophytic.

Association.—Solitary with other hardwoods.

General.—Commercial importance is small because of small supply.

HICORIA OVATA, (Mill.) Britt.

CARYA OVATA, (Mill.) K. Koch.

Shagbark Hickory. Shellbark Hickory.

Size.—Averages 80 ft. by 2 ft. Reaches 130 to 140 feet with a diameter of 20 to 30 inches in the Cumberland Mountains.

Growth.—Averages one foot in height per year for 60 years when it begins to fall off. Averages one inch in 7 years in diameter growth. Extremely persistent. Life up to 300 years.

Root System.—Deep, strong tap root. When it grows in wet soils both tap and laterals are much contracted.

Crown.—Old crowns are of a few short, heavy, spreading limbs. Young trees frequently have long cylindrical crowns.

Tolerance.—One of the most tolerant of hickories, exceeded in the north only by pignut, sugar maple and beech.

Wood.—Very hard, strong, tough and elastic; 51 pounds.

Reproduction.—Fairly prolific seeder with good seed years 2 to 3 years apart. Both a sprouter and a seeder. Flowers in May and ripens in September and October. Germination percent high, but vitality is small.

Range.—Same as bitternut but goes a trifle farther north. Best growth is west of the Appalachian Mountains.

Soil.—A tree of fresh fertile soils; in the north on dry soils; in the south mostly on rich slopes and uplands, but also on moist river bottoms. Mesophytic.

Association.—Grows in groups in bottom lands or solitary on ridges. Mixed with nearly all the hardwoods on its various sites.

General.—Commercial importance is minor as the supply is small. The Canadian cut for 1912 was 667 million feet board measure.

POPULUS TREMULOIDES, Michx.

Trembling Aspen.

Aspen.

Asp.

Size.—Average 40 to 60 ft. by 8 to 12 in. Maximum 90 ft. by 2 ft.

Growth.—Very rapid but briefly sustained. Manitoba studies gave 6 inch trees in 40 years, 8 inch in 55, 10 inch in 70, and 12 inch in 90 years. Life up to 100 years.

Root System.—Tracing.

Bole.—Cylindrical; straight.

Crown.—Rounded, scanty.

Tolerance.—Very tolerant.

Wood.—Very soft, brittle, perishable; 26 pounds.

Reproduction.—Very prolific seeder; seeds annually from the 20th year. Blossoms and sheds seed in spring and early summer. Germination percent low and vitality very transient (3 weeks). Seed very minute, light, tufted; carried long distances by the wind. Exposed mineral soil after a fire preferred as a seed bed.

Range.—Widest of all American trees, and is exceeded only by the European aspen; Labrador to Alaska, and south to Mexico. Optimum, western margin of Atlantic forest north of the 49th parallel. Sea-level to 11,000 ft. (south Rockies).

Climate.—Variable; cool on the whole, since the zone rises as it extends south.

Soil.—Inhabits wide range of soils but does well only on rather fertile ones.

Association.—Occurs in pure stands with other poplars after fires; balsam poplar, largetooth poplar, birches and spruces. It is nearly always a transitory type, being supplanted by more tolerant species.

General.—Commercial importance is small (pulp and excelsior). Very susceptible to fungous disease. Its chief importance lies in its ready seeding of burned areas, which also explains its present abundance in Canada.

POPULUS GRANDIDENTATA, Michx.

Largetoothed Poplar.

Size.—Maximum 60 to 70 ft. by 2 ft. Average, 30 to 40 ft.

Growth.—Fairly rapid; not persistent. In Manitoba the average age of 6 inch trees was 43 years, of 8 inch trees 50 years, and of 10 inch trees 89 years.

Root System.—Heart.

Bole.—Medium taper.

Crown.—Moderately spreading.

Tolerance.—Intolerant.

Wood.—Light brown with thin light sapwood; 28 pounds.

Reproduction.—Very prolific with annual seed years. Flowers in April, and seeds ripen as the leaves unfold. Seeds minute and dark brown; vitality very small. Prefers mineral soil. Seedlings hardy.

Range.—Nova Scotia, New Brunswick, southern Quebec, and Ontario; south and west to central Kentucky and Tennessee. Grows at lower elevations, borders of swamps and streams. Optimum, in southern part of range.

Climate.—Temperature medium; precipitation medium; humidity medium.

Soil.—Best on rich, moist, sandy loams, and also grows on more sterile soils than aspen. Mesophytic.

Association.—Occurs mixed with trembling aspen in reproduction after fires.

General.—Not differentiated from trembling aspen in the market. Like the latter it is only important because of its abundance on burned-over areas.

POPULUS BALSAMIFERA, L.

Balsam Poplar. Balm of Gilead.

Size.—30 to 75 ft. by 1 to 3 ft. Often 100 ft. high.

Growth.—Rapid in youth; longer persistent than most poplars.

Root System.—Heart to tracing.

Crown.—Open and spreading.

Wood.—Light weight, soft, fine grained.

Reproduction.—Seeds prolifically every year. Flowers in April and May; the seeds last only a short time after falling. Germination percent is low and the vitality is small.

Range.—Newfoundland to Alaska, south to Maine and west to the Rockies. Altitude low to medium.

Climate.—Severe; high humidity and heavy precipitation.

Soil.—Alluvial, river banks, etc. Grows in all except very wet soils.

Association.—Grouped; associates with black and white spruces, birches, alders and willows.

General.—Of little commercial importance.

POPULUS TRICHOCARPA, Torrey & Gray.

Black Cottonwood.

Balsam Cottonwood.

Size.—Usually less than 100 feet in height.

Growth.—Rapid in the optimum and long sustained.

Root System.—Heart.

Crown.—Spreading.

Tolerance.—Intolerant.

Wood.—Like balsam poplar; 23 pounds.

Reproduction.—Prolific annual seeder flowering in April and May and ripening in June and July. Low vitality but high germination percent. Seed bed reproduction best on moist mineral soils.

Range.—Coast ranges from southern Alaska to southern California, also in northern Idaho and Montana. Probably extends southward into the interior of B.C. Generally a tree of low elevations.

Climate.—Optimum in great humidity and precipitation.

Soil.—Moist river bottoms. Mesophytic.

Associations.—Limited forests of pure growth. Occurs in mixture with various conifers.

General.—Of medium commercial importance in B.C., where it is largely used for pulp.

POPULUS DELTOIDES, Marsh.

Cottonwood.

Size.—Average 75 to 100 ft. by 2 ft. Maximum 125 ft. by 5 ft.

Growth.—Rapid but only briefly sustained.

Root System.—Tap root with strong laterals.

Bole.—Short, medium taper.

Crown.—Moderately spreading.

Tolerance.—Intolerant.

Wood.—Light, weak, not durable; 24 pounds.

Reproduction.—Prolific annual seeder; flowers in April and May, and sheds seeds in early summer. Seed small, light, tufted. Germination percent medium; vitality transient.

Range.—Quebec to southern Alberta, south to New Mexico and Florida. Low to medium altitudes.

Soil.—Inhabits light, well drained soils. Xerophytic to mesophytic.

Association.—Occurs individually and grouped with sycamore, hackberry, aspen, box-elder, green ash, elms, and Balm of Gilead.

General.—Commercial importance very small in Canada. Adapted to farmers' woodlots on account of its rapid growth and ability to reproduce by suckers.

BETULA, The Birches.

Size.—Many are shrubs or small trees; a few are medium-sized trees.

Growth.—Rapid but not persistent; short lived.

Tolerance.—Intolerant in Canada as a rule. *Betula lutea* is moderately tolerant.

Wood.—Fine texture, dense, quite heavy, hard, strong, perishable.

Reproduction.—Prolific seeders; flower in spring before or with the leaves. The aments mature and fall to pieces in late spring or early summer. Seed very light and winged; germination percent medium:

vitality transient. Exposed mineral soil as is found after a fire makes a favorable seed bed. The birches also coppice vigorously, but the stumps have only briefly sustained vitality.

Range.—The north and middle Temperate Zone; nearly to mountain and Arctic timber lines.

Soil.—Inhabit a wide range of soils from swamps and moist bottom lands to dry ridges.

Association.—Sometimes occur in small pure stands, and often with poplar after a fire. Generally mixed singly or in small groups.

General.—Nine tree birches grow in the United States and Canada, of which four inhabit the Pacific region. In Canada, the birches stand at the head of the hardwoods in commercial importance, and the bulk of the cut is supplied by yellow birch. In 1912 birch ranked 7th, and formed 2% of the total lumber cut. It supplied 32% of the total hardwood cut at an average mill price of \$16.36 per thousand.

BETULA PAPYRIFERA, Marsh.

Paper Birch.

Size.—50 to 100 ft. by 1 to 2 ft.

Growth.—Rapid in early life, but only briefly sustained. Short lived.

Root System.—Superficial.

Bole.—Short, medium taper.

Crown.—Medium spreading.

Tolerance.—Intolerant.

Wood.—Hard, strong, fairly tough, not durable; 37 pounds.

Reproduction.—Reproduces well on burned-over areas and on mineral soils. Seeds annually. Seed light with long, thin, membranaceous wings; germination percent medium; vitality transient. Prefers bare mineral soil to humus as a seed bed. Seedlings occur in openings. Flowers in April and May, and sheds seeds in June.

Range.—Long Island to Iowa and Nebraska; from Labrador to the Rockies; and north to the limit of tree growth. Optimum, New Hampshire and central Maine. Medium altitude.

mate.—Severe.

Soil.—Poor to medium; prefers good soil. Xerophytic to mesophytic.

Association.—Occurrence determined largely by fire on burned-over areas. Its common associates are gregarious and grouped,—spruce, balsam, yellow birch, sugar maple, and beech.

General.—Of medium commercial importance. On account of its extreme intolerance the clean cutting system must be used. The object should be to utilize the present stand to the best advantage, and at the same time to have the forest in the best possible silvicultural condition.

BETULA LUTEA, Michx. f.

Yellow Birch.

Size.—Average 50 to 80 ft. by 2 ft. Maximum 100 to 150 ft. by 4 ft.

Growth.—Medium rate and moderately persistent.

Root System.—Heart.

Bole.—Medium length and taper.

Crown.—Medium spread.

Tolerance.—Medium; most tolerant of birches.

Wood.—Hard, strong, tough, not durable; 41 pounds.

Reproduction.—Prolific seeder with annual seed years. Flowers in May and June. Seeds light and winged; germination percent medium; vitality transient.

Range.—Newfoundland to Manitoba, south to Massachusetts, Pennsylvania, North Carolina and Wisconsin. Optimum, eastern provinces of Canada and in northern New York and New England. Low to medium altitude.

Climate.—Medium to severe.

Soil.—Good to medium. Mesophytic. Likes a moist soil, but it may be thin as on the high mountain slopes in the south.

Association.—Grouped.

General.—Chief of Canadian hardwoods commercially.

FAGUS ATROPUNICEA, Sudw. FAGUS GRANDIFOLIA, Ehr.

FAGUS AMERICANA, Sweet. FAGUS FERRUGINEA, Ait.

Beech.

Size.—Usually 70 to 80 ft. by 1½ to 4 ft. Exceptionally 120 feet in height.

Growth.—Slow, but long sustained.

Root System.—Heart.

Bole.—Medium length and taper.

Crown.—Spreading.

Tolerance.—Great.

Wood.—Heavy, hard, strong, not durable; 42 pounds.

Reproduction.—Moderately prolific with full seed years at intervals of several years. Flowers appear in May. Germination percent and vitality low.

Range.—Nova Scotia to Ontario, Wisconsin south to Texas. Tree of low to medium altitudes.

Climate.—Medium to severe.

Soil.—Grows well in good, but prefers deep, rich, well drained loam. Mesophytic.

Association.—Often forms nearly pure forests; also mixed with hard maple, oak and yellow birch.

General.—Of little importance. It was 15th in the Canadian cut of 1912, forming 0.3% of the total, with an average mill price of \$15.45.

CASTANEA DENTATA, Marsh.

Chestnut.

Size.—60 to 80 ft. by 2 to 4 ft. Maximum 100 ft. by 6 ft.

Growth.—Rapid and medium sustained. Studies in Maryland and Tennessee showed growths of 10 inches in 45 to 54 years, and 20 inches in 103 to 118 years.

Root System.—Heart.

Bole.—Slight taper.

Crown.—Spreading.

Tolerance.—Rather intolerant.

Wood.—Moderately soft and strong; very durable; 28 pounds.

Reproduction.—Not very prolific. Flowers in June and July. Germination percent low and vitality small. Very little reproduction from seed occurs, but it sprouts vigorously from the stumps, and the stumps have great vitality.

Range.—Maine to Ontario and Michigan, southward to Delaware, and along the mountains to northern Alabama and Mississippi. Optimum in Pennsylvania and south.

Soil.—Prefers fertile, well drained, gravelly or rocky soil on bottoms and slopes. Mesophytic.

Association.—Occurs in pure stands and mixed with other hardwoods.

General.—It is highly prized for posts and poles and for tanning extract, but is nearly exhausted in Canada. In 1912 it formed less than 0.1% of the total cut, at an average mill value of \$22.26 per thousand. In 1910 it ranked 13th in the U.S. lumber cut with over $\frac{1}{2}$ billion feet or 1.3% of the total at an average mill price of \$16.23 per thousand. It also ranked fourth for cross ties with over 5% of the total, and second to cedar for poles, with over 17% of the total.

QUERCUS, The Oaks.

Size.—Very variable but nearly all are trees.

Growth.—Rather slow, but very persistent; very long lived.

Root System.—Deep with very strong heart and tap roots.

Bole.—Many have massive, straight, cylindrical trunks.

Crown.—Most have very large, powerful branches forming often extremely wide but storm-firm crowns.

Tolerance.—Intolerant, but too much light causes water sprouts on the bole.

Wood.—Heavy, hard, very strong generally, and porous. In general, the evergreen oaks are the strongest, followed closely by the white oaks, the black oaks being the weakest. Wood and bark both contain much tannin, the percentage varying with the species.

Reproduction.—Seed production is not prolific; more or less periodic at intervals of 1 to 3 years. Flowers in the spring, and is wind fertilized. With four exceptions the acorns of white oaks mature in one season and those of the black oaks in two seasons. Acorns are distributed by water and animals, large quantities being eaten by the latter. Germinate generally in the spring. Seedlings devote early energy to production of a very large and long tap root which enables them to survive repeated ground fires and send up new shoots. By coppice the oaks reproduce very vigorously and the stumps have very persistent vitality.

Range.—World-wide from Tropical to Middle Temperate Zone and optimum in the latter. In America in the basins of the Ohio and Mississippi rivers. Range from sea-level to nearly 10,000 feet in elevation.

Climate.—Cold to tropical; temperate preferred.

Soil.—Cosmopolitan, inhabiting dry, sterile soils as well as moist, fertile ones.

Association.—Often gregarious in optimum; also singly and in groups with other hardwoods and with conifers.

General.—About 300 species known; about 53 in the United States, all trees except three or four. There are 8 species in Canada, 4 of them restricted to the southwest peninsula of Ontario, and 1 to the south end of Vancouver Island.

In commercial importance the oaks rank the highest of all American hardwoods, because of their high technical qualities and great supplies. In Canada the supply is nearly exhausted, large quantities being imported from the United States. The Canadian commercial species are the white, bur and red oaks, which in 1912 supplied 0.2% of the total lumber cut and 2% of the hardwood cut at an average mill price of \$29.82 per thousand.

In the United States in 1910, they ranked third in the total cut and first in the hardwood cut with a production of over 3½ billion feet at an average mill price of \$18.76 per thousand. They also furnished over 68 million ties, or over 46% of the total, and 265,000 poles, or about 7% of the total.

QUERCUS ALBA, L.

White Oak.

Size.—6' to 100 ft. by 2 to 4 ft.

Growth.—Rapid, but only medium sustained. Growth in Tennessee of 132 trees was 10 inches in 107 years, 15 inches in 152 years, and 20 inches in 192 years.

Root System.—Tap with strong side roots.

Bole.—Cylindrical.

Crown.—Spreading.

Tolerance.—Intolerant; fairly tolerant in early life.

Wood.—Heavy, very hard, strong, tough, durable; 44 pounds.

Reproduction.—Not prolific; annual seed years; flowers in May and ripens in September and October. Seeds are edible acorns of medium vitality and medium germination percent.

Range.—Southern Maine to southern Quebec and Ontario, south to Florida, and west to Minnesota, Kansas and Texas.

Climate.—Mild.

Soil.—Prefers a deep, rich, well drained soil, but grows in more or less scrubby form on light sandy soils.

Association.—Mixed with other hardwoods.

General.—Most valuable of the oaks.

QUERCUS MACROCARPA, Michx.

Mossycup Oak.

Bur Oak.

Size.—Average 80 to 90 ft. by 3 to 4 ft. Maximum 170 ft. by 7 ft.

Growth.—Fairly rapid, about the same as white oak. Medium persistence.

Root System.—Tap.

Bole.—Medium taper.

Crown.—Spreading.

Tolerance.—Intolerant but less so than red or white oak.

Wood.—Heavy, hard, very strong, durable; 45 pounds.

Reproduction. Seed years frequent, and production profuse. Flowers in May and June, and acorns fall in September and October of the same year. Germination percent 65 to 75; vitality six months to a year.

Range.—Manitoba to Texas, and east to the Atlantic coast. Optimum, basin of the Mississippi River.

Soil.—Inhabits rich bottom lands usually in heavy soils, but is quite adaptable.

Association.—Solitary or grouped in association with white oak, basswood, cottonwood, black walnut and the hickories.

General.—Of very small importance in Canada, because it is nearly exhausted. It is the only oak in Manitoba.

QUERCUS RUBRA, L.

Red Oak.

Size.—Average 70 to 90 ft. by 2 to 4 ft. Maximum 150 ft. by 5 ft.

Growth.—Most rapid of all oaks. Medium persistence. Rate falls off after 50 years. 358 trees in North Carolina (slope) grew 10 inches in 73 years, 18 inches in 116 years, and 28 inches in 205 years.

Root System.—Tap.

Bark.—Medium taper.

Crown.—Spreading.

Tolerance.—Intolerant, except in early youth.

Wood.—Heavy, hard, strong, coarse grained, moderately durable.

Reproduction. Seed production abundant and frequent after the 30th year. Flowers in May and June; acorns ripen and fall in October and November of the second summer. One bushel of seed acorns weighs 48 pounds and contains about 80,000. Germination percent 60 to 70; retains vitality for six months. On account of its strong tap root it establishes itself readily on humus soils.

Range.—Nova Scotia west to Lake Superior, south to eastern Kansas and northern Georgia. Optimum, Ohio basin and north.

Soil.—Porous sandy to gravelly clays. Mesophytic.

Association.—Solitary or in groups with other oaks, basswood, elms, chestnuts and hickories.

General.—Of small importance in Canada because the supply is nearly exhausted.

QUERCUS VELUTINA, Lam.

Black Oak.

Size. 70 to 80 ft. by 2 to 4 ft. Occasionally 150 feet in height.

Growth. Rapid and vigorous in youth but the rate soon diminishes. Tree studies in Kentucky and Tennessee showed a growth of 5 inches in 24 to 38 years, 10 inches in 44 to 84 years, and 15 inches in 111 to 124 years.

Root System. Superficial.

Bole.—Medium taper.

Crown.—Wide spreading, rounded.

Tolerance.—Intolerant.

Wood.—Heavy, hard, strong, not tough.

Reproduction.—Only moderately prolific. Flowers appear early in May, and the fruit, a small acorn, matures in the second year. Germination percent low; vitality low and will keep over winter only with great care.

Range.—Maine to western Ontario, south to Florida and Texas.

Soil.—Dry, well drained soils. Inhabits poorer soils than red oak. Mesophytic to xerophytic.

Association.—Grouped with other hardwoods.

General.—Of little importance as it is nearly exhausted in Canada.

ULMUS, The Elms.

Size.—Several are large trees.

Tolerance.—Tolerant.

Wood.—Fairly heavy, hard, strong and elastic.

Reproduction.—Flowers in spring before the leaves; the light-winged fruit ripens in the spring or early summer and germinates that season. Germination percent medium and vitality rather transient.

Range.—Middle and South Temperate Zone; optimum in Ohio valley. All are trees of low elevations.

Soil.—From swamps to arid soils, but the timber trees inhabit rich, moist soils, especially along streams.

Association.—Singly or in groups in mixture.

General.—There are three species in Canada of which the American elm is the most abundant and furnishes the bulk of the lumber. The total supply is somewhat small. In 1912 elm ranked 13th and supplied 0.7% of the total cut; it was 4th and supplied 11% of the total hardwood cut at an average mill price of \$20.44. For slack cooperage elm headed the list.

ULMUS AMERICANA, L.

White Elm. American Elm.

- Size.**—50 to 110 ft. by 1 to 8 ft.
Growth.—Medium and fairly persistent. Studies in Missouri showed growths of 10 inches in 60 years and 15 inches in 100 years.
Root System.—Heart.
Crown.—Spreading fan-like.
Tolerance.—Intolerant.
Wood.—Hard, strong, fairly heavy, tough, not durable; 34 pounds.
Reproduction.—A prolific annual seeder flowering in March and April, and seed ripening in May and June. Seed small, light, winged; germination percent and vitality low.
Range.—From Newfoundland to South Dakota and south through western Nebraska to Texas. Prefers low situations.
Soil.—Rich, well drained soils. Mesophytic.
Association.—Grows sparingly in mixture with oaks, ashes, sycamores, yellow poplars and other hardwoods.
General.—Widely used where strong, tough, fibrous, but not durable wood is required.

ULMUS THOMASI, Sarg.

ULMUS RACEMASI, Thomas.

Rock Elm. Cork Elm.

- Size.**—Average 50 to 75 ft. by 2 ft. Maximum 100 ft. by 3 ft.
Growth.—Medium and fairly persistent.
Root System.—Heart.
Crown.—Spreading.
Tolerance.—Intolerant.
Wood.—Heavy, hard, very strong and tough; the strongest of the elms; 45 pounds.
Reproduction.—Flowers in April; germination percent and seed vitality small.
Range.—From Quebec through Ontario and New York to Michigan and west to Nebraska.
Soil.—Dry, gravelly uplands, rocky slopes, low heavy clay soils. Xerophytic.
Association.—Solitary or mixed with maple, white and red oak, ash, poplar, and basswood.
General.—Small use in Canada because it is nearly exhausted; used for agricultural implements, trees, hubs, etc.

ULMUS PUBESCENS, Walt.

ULMUS FULVA, Michx.

Slippery Elm.

Red Elm.

Size.—Average 60 to 70 ft. Maximum 135 ft. high.

Growth.—Rapid but briefly sustained.

Root System.—Heart.

Crown.—Spreading.

Tolerance.—Intolerant.

Wood.—Fairly heavy, hard, strong, not durable; 43 pounds.

Reproduction.—Seeds abundantly at irregular intervals of two to four years. Flowers in March and April and ripens in May and June. Seed small, winged, light; low vitality and germination percent.

Range.—St. Lawrence valley through Ontario to North Dakota, south to Kansas and Florida.

Climate.—Medium.

Soil.—Rich and well drained. Mesophytic.

Association.—May be grown in pure stands and with maple, white oak, ash, poplar, basswood, locust, red cedar, catalpa, and walnut.

General.—Comparatively unimportant except for slack cooperage and furniture. Very little in Canada.

MAGNOLIA ACUMINATA, L.

Cucumber Tree.

Size.—Average 60 to 90 ft. by 2 to 4 ft.

Growth.—Rapid and moderately persistent.

Root System.—Heart.

Bole.—Cylindrical.

Crown.—Spreading.

Tolerance.—Intolerant.

Wood.—Soft, not strong, easily worked (like Tulip); 29 pounds.

Reproduction.—Fairly prolific annual seeder. Flowers in April and May; seeds ripen and fall the same autumn; germination percent low; vitality medium.

Range.—Southern Ontario peninsula only in Canada; south along the Appalachians to Alabama. Optimum in coves of Tennessee and Kentucky.

Soil.—Low mountain slopes and rocky banks of streams. Inhabits rather good soils. Mesophytic.

Association.—Mixed with other hardwoods; never pure stands.

General.—Negligible use in Canada because of very restricted supply.

LIRIODENDRON TULIPIFERA, L.
Yellow Poplar. Tulip. White Wood.

Size.—Average 100 to 125 ft. by 3 to 6 ft. Maximum 190 ft. by 10 ft. Average clear length 70 feet.

Growth.—Rapid in early life, decreasing after 50 years. Often lives over 300 years.

Root System.—Heart.

Bole.—Nearly cylindrical.

Crown.—Spreading.

Tolerance.—Intolerant.

Wood.—Yellow or brown with thin creamy white sapwood. Light, soft, brittle, and easily worked; 35 pounds.

Reproduction.—Prolific annual seeder. Flowers in April and May, and the seeds ripen and fall in the autumn. Young trees produce worthless seed. Seed is borne in a cone-like fruit 1 to 2 inches long; should be collected in the fall. Germination percent 5 to 10; vitality medium. If planted in the spring they have a tendency to be in the ground a year before germinating. Seedlings may endure considerable shade.

Range.—Southern Ontario and westward through northern Indiana and Illinois, southward into Alabama and the other Gulf states as far as northern Florida. Optimum, in south central part of its range. Tree of medium altitudes; best developed in protected coves on the northern and eastern slopes.

Climate.—Mild; small variation of temperature; humidity medium to high.

Soil.—Demands a deep, fertile, well drained soil. Mesophytic.

Association.—Well adapted for planting in pure stands. It occurs naturally either singly or in groups associated with chestnut, oak, walnut, maples, hickories, black cherry, locust and beech.

General.—Very valuable wood but nearly exhausted in Canada. In 1912 it supplied less than 0.1% of the total cut, and its average mill price was \$13.17 (\$30.00 in 1910) per thousand. In the United States in 1910 it ranked 10th with over 700 million feet or 1.8% of the total cut at an average mill price of \$24.71 per thousand.

PLATANUS OCCIDENTALIS, L.

Sycamore.

Buttonwood.

Size.—Average 100 ft. by 2 ft. Maximum 175 ft. by 9 ft.

Growth.—Medium but persistent.

Root System.—Heart.

Bole.—Slight taper.

Crown.—Spreading.

Tolerance.—Medium.

Wood.—Hard, heavy, fairly strong, not durable; 33 pounds.

Reproduction.—Not prolific but seeds annually. Flowers in May; fruit in spherical heads remains on the branches till spring; seed a nutlet.

Range.—Maine to southern Ontario to Nebraska and south to the Gulf. Optimum in lower Ohio and Mississippi River basins.

Soil.—Inhabits rather deep moist soils on stream borders, etc.

Association.—Mixed with other hardwoods.

General.—Very small use in Canada because of the very restricted supply.

PRUNUS SEROTINA, Ehrh.

Black Cherry.

Size.—Average 40 to 60 ft. Maximum 100 ft. high.

Growth.—Moderately rapid and persistent grower, but a short-lived tree.

Root System.—Tap, with numerous surface roots.

Crown.—Has spreading habit to some extent; its sprays are slender and pendulous.

Tolerance.—Can endure moderate shade.

Wood.—Moderately hard and strong, not durable, fine textured; 33 pounds.

Reproduction.—Annual seed years; seed vitality is medium and germination percent fairly high. Seed distributed by birds.

Range.—From Nova Scotia westward through the Canadian provinces to Port Arthur; south to Florida and west to North Dakota and Texas. Rarely at high altitudes.

Climate.—Mild.

Soil.—Requires a rich moist soil. Mesophytic.

Association.—Occurs singly and with other hardwoods.

General.—Heart wood used for furniture. Very little cut in Canada owing to its scarcity.

ACER, The Maples.

Size.—Small to medium sized trees; rarely 100 ft.

Growth.—Rate not rapid but persistent; moderately long-lived.

Tolerance.—Mostly tolerant.

Wood.—Fine grained, dense; some is heavy, hard and strong.

Reproduction.—Quite prolific seeders; flower in spring; insect fertilized; samaras ripen either in spring, when the seed soon falls and germinates, or in late summer, when the seed falls late in the autumn or persists on the branches over winter and germinates in the spring.

Germination percent medium to high; vitality of spring seed transient, of autumn seed moderately persistent.

Range.—Middle and north of Temperate Zone; sea-level to 6000 feet.

Soil.—Inhabits a variety of soils from swamps to dry uplands but requires rather moist rich soils to grow timber.

Association.—Gregarious and also in mixture with other hardwoods and conifers.

General.—Of the 70 species known in the world, 13 occur in the United States (4 in Pacific region) and 9 in Canada (3 in Pacific region). In Canada the maples rank second to birches in commercial importance, and like the birches, the bulk of the cut is supplied by one species, sugar maple. In 1912 maple formed 1.8% of the total lumber cut and 25% of the hardwood cut at an average mill price of \$18.91 per thousand. In the United States in 1910 the maples ranked second to oak among the hardwoods and eighth in the total lumber cut with over one billion feet or 2.5% of the total at an average mill price of \$16.16.

ACER MACROPHYLLUM, Pursh.

Broad-leaf Maple. Oregon Maple. Big-leaf Maple.

Size.—Varies very greatly in different soils and situations, from 25 to 80 feet in height. Form varies also.

Growth.—Medium and moderately persistent. Grows 12 to 20 inches in 50 to 85 years.

Root System.—Heart.

Crown.—Spreading.

Tolerance.—Tolerant.

Wood.—Fairly hard and strong; 30 pounds.

Reproduction.—Prolific annual seeder. Flowers in June and ripens in September and October. Germination percent medium; vitality medium.

Range.—Coast of Alaska (south of lat. 55°), British Columbia, Washington, Oregon and California (south as far as San Bernardino Mountains). In B.C. it is confined to the islands and seaward side of the coast range. Optimum, Puget Sound. Grows below 3000 feet in southern British Columbia.

Climate.—Grows best where the humidity is high and the precipitation great.

Soil.—Moist, gravelly and rich humus soils. Mesophytic.

Association.—Grouped in nature; often found with California laurel and lowland fir.

General.—A timber tree of some importance in the Pacific region where commercial hardwood is scarce.

ACER SACCHARUM, Marsl

Sugar Maple.

Hard Maple.

Size.—Average 70 to 80 ft. by 2 to 3 ft. Maximum 125 ft. by 5 ft.

Growth.—Somewhat slow growing but persistent and long-lived. Studies in Michigan and New York showed growths of 5 inches in 60 to 68 years; 10 inches in 110 to 122 years; and 18 inches in 203 years.

Root System.—Shallow, tracing.

Bole.—Short and cylindrical.

Crown.—Spreading and dense.

Tolerance.—Very tolerant. Shade is advantageous to the growth of seedlings.

Wood.—Heavy, strong, dense, and hard but not durable in contact with the soil; 43 pounds.

Reproduction.—Fairly prolific with full seed years at intervals of 3 to 5 years. Vitality and germination percent medium.

Range.—Newfoundland to Georgia extending westward to Manitoba, Nebraska and Texas. A tree of medium to low altitudes.

Climate.—Temperature extremes within its range are -50° to 105° Fahr.; precipitation varies from 25 to 55 inches as a mean annual. Cool, moist climate is most suitable.

Soil.—Cannot maintain itself on poor, dry soil. Mesophytic.

Association.—Generally grouped and associated with beech, basswood, elms, hickories and oaks.

General.—Most valuable of maples; used for shade planting and sugar producing as well as for lumber.

ACER SACCHARINUM, L.

Silver Maple. Silver Leaf Maple. White Maple.

Size.—Average 70 to 90 ft. by 2 to 3 ft. Maximum 120 ft. by 5 ft.

Growth.—Very rapid for the first 50 years but is not very persistent. Studies in Nebraska (11 trees) showed growths of 6 inches in 19 years and 9 inches in 40 years.

Root System.—Heart.

Bole.—Cylindrical and of medium length for hardwoods.

Crown.—Medium spreading.

Tolerance.—Moderately tolerant, but less so on uplands.

Wood.—Hard, brittle, perishable; 32 pounds.

Reproduction.—Prolific annual seeder. Flowers from February to April, and ripens from May to June; vitality very transient and germination percent low. Seed is large winged (samara) and dispersed by the wind. Seedlings are hardy.

Range.—New Brunswick to southern Ontario and South Dakota, southward to Florida and Missouri. Optimum in lower Ohio River basin. Low to medium altitudes.

Climate.—Not adapted to vigorous climate; requires considerable moisture and humidity.

Soil.—Best suited to deep, porous alluvial soil,—river bottoms; often found in swamps. Mesophytic.

Association.—Mixed singly or in groups with sugar maple, beech and other hardwoods.

General.—Small cut in Canada, the brittleness of the wood being a serious drawback. The supply is limited.

ACER RUBRUM, L.

Red Maple.

Size.—Average 80 to 90 ft. by 2 to 3 ft. Maximum 100 ft. by 3 to 4 ft.

Growth.—Rapid but briefly sustained. 25 trees in New York grew 5 inches in 34 years and 8 inches in 60 years. Life, 150 years.

Root System.—Heart.

Bole.—Short.

Crown.—Spreading.

Tolerance.—Tolerant.

Wood.—Hard, elastic and not strong; 38 pounds.

Reproduction.—Seed years are annual but it seeds more freely every second year. Flowers in March and April, ripening in the early summer. Seed large and winged (samara).

Range.—Eastern America, Nova Scotia and Ontario to Georgia. Optimum in the river swamps of lower Ohio.

Soil.—Borders of streams and swamps; rarely on hillsides. A scrubby form occupies semi-barren areas in Nova Scotia.

Association.—In general mixed with other hardwoods.

General.—Of small commercial importance; neither valuable nor plentiful in Canada.

ACER NEGUNDO, L.

Manitoba Maple. Box Elder. Cut-leaved Maple.

Size.—Average 40 to 60 ft. by 1 to 2 ft. Maximum 75 ft. by 3 ft.

Growth.—Rapid but not persistent: short-lived

Root System.—Tap.

Bole.—Short and usually crooked.

Crown.—Spreading and round.

Tolerance.—Intolerant.

Wood.—White, soft, and weak; 27 pounds.

Reproduction.—Prolific annual seeder. Flowers in May and June and ripens in the autumn. Germination percent 40 to 60; vitality low.

Range.—Western Vermont to western New Jersey and northern Florida, westward to Ontario, Manitoba, South Dakota, Kansas, Texas and Mexico. Optimum in lower Ohio basin.

Soil.—Wide variation; grows on the rocky slopes on the semi-arid prairies. Best reproduction both by coppice and by seed is found on moist soils.

Association.—Usually solitary; mixed with white elm, hackberry, silver maple and black walnut.

General.—Of small importance except for planting as wind-breaks.

TILIA AMERICANA, L.

Basswood. Linden. Whitewood.

Size.—Average 60 to 70 ft. by 2 ft. Maximum 125 ft. by 3 to 4 ft.

Growth.—Fairly rapid and moderately persistent until old age.

Root System.—Heart.

Bole.—Usually medium length and cylindrical.

Crown.—Spreading.

Tolerance.—Moderately tolerant.

Wood.—Soft, quite tough, close grained, light brown or reddish in colour; 25 pounds.

Reproduction.—Annual light seeder. Flowers in May and June, and fruit ripens in the autumn. Seed of medium vitality. Seed dispersed by the wind for short distances. Sprouts vigorously from the stump.

Range.—Western New Brunswick to the eastern shores of Lake Superior to Manitoba, southward to Georgia and eastern Texas.

Climate.—Endures wide ranges of temperature and humidity; requires considerable precipitation.

Soil.—Can endure a wet soil but will not thrive on a dry one. Mesophytic.

Association.—Occurs singly mixed with other hardwoods.

General.—Small supply, but the wood is highly useful for interior woodwork, cabinet work, etc. In Canada in 1912 it ranked 12th with 1.2% of the total lumber cut at an average mill price of \$17.71.

FRAXINUS, The Ashes.

Size.—All except one are trees, and some are large.

Growth.—Moderately rapid and fairly persistent.

Bole.—Generally straight and evenly tapered.

Crown.—Generally narrow and thinly foliated.

Tolerance.—Intolerant.

Wood.—Straight grained, hard, strong and elastic.

Reproduction.—Moderately prolific. Flowers in the spring, generally before the leaves; fruit ripens in the early autumn but often remains on the tree for several weeks afterwards, and germinates in the spring. Seed is winged; germination percent low; vitality transient.

Range.—South and middle of Temperate Zone; optimum in Ohio basin.

Soil.—From wet, boggy swamps to poor, dry uplands. Most of the timber ashes inhabit rather rich, moist soil.

Association.—Singly or in groups with other hardwoods.

General.—There are nearly 40 species known of which 16 are in the United States (one a shrub in the Pacific region); and about 7 species in Canada. Commercially the ashes are valuable both for timber and planting. In Canada only the white and black are cut in quantities, the former being the more important. The supply is very small. In 1912 they ranked sixth among the hardwoods, forming over 4% of the total hardwood cut, at an average mill price of \$20.68 per thousand.

FRAXINUS NIGRA, Marsh.

Black Ash. Swamp Ash. Water Ash.

Size.—Average 60 to 80 ft. by 1 to 1½ ft. Maximum, 90 ft. by 2 ft.

Growth.—Slow grower; short-lived.

Root System.—Tap.

Bole.—Cylindrical and of medium length.

Crown.—Non-spreading.

Tolerance.—Intolerant.

Wood.—Dark brown with thin light sapwood; straight grained, coarse texture, strong and moderately hard; 33 pounds.

Reproduction.—Not prolific; seed years usually at intervals of three to five years; flowers from April to June and ripens in October. One-winged fruit dispersed by the wind; germination percent low; vitality medium.

Range.—Northern limit, from Newfoundland through Canada to Manitoba. Southern limit, Virginia, southern Illinois, Missouri and Arkansas.

Soil.—Swamps and river courses. Hydrophytic.

Association.—Occurs singly or in groups mixed with other swamp species.

General.—Very small use in Canada. Supply restricted and wood not of high quality.

FRAXINUS AMERICANA, L.

White Ash.

Size.—Average 70 to 80 ft. by 3 ft. Maximum 100 ft. by 4 ft.

Growth.—More rapid grower than other hardwoods but not persistent.

Root System.—Heart and tracing.

Bole.—Often free from branches for one-half its length.

Crown.—Spreading.

Tolerance.—Intolerant except in youth.

Wood.—Brownish color; thick, lighter colored sapwood; straight grained, hard, very strong, tough and elastic except in old timber; 39 pounds.

Reproduction.—Not prolific; seed years every three to five years; flowers in April and May and ripens in October. The winged seed is dispersed by the wind for short distances. Requires considerable moisture for germination.

Range.—Nova Scotia through southern Ontario to Minnesota and southward to Florida, Kansas and Texas.

Climate.—Adapted to a wide range of temperature and precipitation but in the southern part of its range with plenty of moisture, post timber may be grown in from 10 to 15 years.

Soil.—Inhabits bottom lands of river valleys and upland ravines. Mesophytic.

Association.—Occurs singly mixed with other hardwoods.

General.—It is the best of the ashes and has high economic value on account of its strength, elasticity and fair durability.

ABBREVIATIONS AND SYMBOLS.

For all characteristics in general three classes are distinguished by numbers, as follows:

- 1.—Low, small, narrow, restricted, little.
- 2.—Medium, moderate.
- 3.—High, large, broad, extensive, great.

Size—

- 1,—Small—50 to 100 ft. high.
- 2,—Medium—100 to 150 ft. high.
- 3,—Large—over 150 ft. high.

Growth—

- | | | | |
|--------------------|-----------|------------|-----------|
| Rapidity | 1,—Slow. | 2,—Medium. | 3,—Rapid. |
| Life | 1,—Short. | 2,—Medium. | 3,—Long. |

Root System—

- | | | |
|-------------|------------|----------|
| 1,—Tracing | 2,—Heart. | 3,—Tap. |
| 1,—Shallow. | 2,—Medium. | 3,—Deep. |

Bole—

- | | | | |
|-----------------|------------|------------|-----------|
| Taper | 1,—Little. | 2,—Medium. | 3,—Great. |
|-----------------|------------|------------|-----------|

Crown—

- | | | |
|----------------|------------|---------------|
| 1,—Monopodial. | 2,—Medium. | 3,—Spreading. |
|----------------|------------|---------------|

Tolerance—

- | | | |
|----------------|------------|--------------|
| 1,—Intolerant. | 2,—Medium. | 3,—Tolerant. |
|----------------|------------|--------------|

Wood—

- | | | | |
|----------------------|-----------|------------|-----------|
| Strength | 1,—Small. | 2,—Medium. | 3,—Great. |
| Weight | 1,—Small. | 2,—Medium. | 3,—Great. |
| Durability | 1,—Small. | 2,—Medium. | 3,—Great. |

Reproduction.—

- | | | | |
|-----------------------|------------|------------|--------------|
| Seed Production . . . | 1,—Meagre. | 2,—Medium. | 3,—Prolific. |
| Germination | 1,—Low. | 2,—Medium. | 3,—High. |
| Vitality | 1,—Low. | 2,—Medium. | 3,—High. |
| Seedlings | 1,—Tender. | 2,—Medium. | 3,—Hardy. |

Range—

Geographical 1,—Restricted. 2,—Medium. 3,—Extensive.
Altitudinal 1,—Low. 2,—Medium. 3,—High.

Climate—

Temperature. 1,—Low. 2,—Medium. 3,—High.
Precipitation. 1,—Little. 2,—Medium. 3,—Great.
Humidity 1,—Low. 2,—Medium. 3,—High.

Soil—

1,—Xerophytic. 2,—Mesophytic. 3,—Hydrophytic.

Occurrence—

1,—Solitary. 2,—Grouped. 3,—Gregarious.

Commercial Importance—

1,—Little. 2,—Medium. 3,—Great.

HOW TO USE THE TABLE.

Select the number of the tree desired in the horizontal row at the top of the page. The relative silvical characteristics are in the vertical column under that number.

TABLE OF SILVICAL CHARACTERISTICS OF THE MOST IMPORTANT CANADIAN TREES.

TREE NUMBER - -	1	2	3	4	5	6	7	8	9	10	11
Size	2	2	1	3	1-2	1	1	3	1	1	1
Growth—											
Rapidity.....	3	2	2	3	2	2	3	2	1	2	2
Life.....	3	3	1-2	3	1	1	2	3	3	3	3
Root System	2	2	2	2	3	3	1	2	1	1	1
Bole—											
Taper.....	1	1	1	1	1	2	2	1	2	2	2
Crown	2	2	2	2	1	1	1	1	1	1	1
Tolerance	2	2	1	1	1	1	1	1	3	3	3
Wood—											
Strength.....	2	2	2	2	1	1	2	3	2	2	2
Weight.....	1	1	1	1	1	1	2	2	1	1	1
Durability.....	2	2	2	2	1	1	3	3	2	2	2
Reproduction—											
Seed Production....	2	2	1	3	3	3	3	2	3	2	2
Germination percent	2	2	3	3	2	3	1	1	2		2
Vitality.....	2		2		3	3	2	3	3	2	3
Seedlings.....	2	2	3	3	3	3	2	3	3	3	3
Range—											
Geographical.....	2	2	2	3	3	3	3	2	3	1	3
Altitudinal.....	1-2	2-3	1-2	3	2-3	1-2	1	2-3	1	1-2	1-2
Climate—											
Temperature.....	2	1-2	2	1-2	1-2	1-2	1-2	2	1	2	1-2
Precipitation.....	2	2-3	2	1-2	2	2	2	1-2	2	2	2
Humidity.....	2	1-2	2	1	2	2	2	1	2	2	2
Soil	2	1-2	1	1	1	1	1	1	1	2	2
Occurrence	2-3	2	2	3	3	3	2	1	2-3	2-3	3
Commercial											
Importance.....	3	3	3	3	2	1	1	2-3	1	2-3	3

TABLE OF SILVICIAL CHARACTERISTICS—Continued.

TREE NUMBER	12	13	14	15	16	17	18	19	20
Size	2	3	1	2	1	3	2	2	1
Growth —									
Rapidity.....	2	3	1	1	1	3	2	2	3
Life.....	3	3	3	3	3	3	3	3	1
Root System	1	1	2	1	1	2	1	1	1
Bole —									
Taper.....	2	2	2-3	2	3	1	1	1	2
Crown	1	1	1	1	1	1-2	1	1	1
Tolerance	3	3	3	3	3	2	3	3	3
Wood —									
Strength.....	2	2	2	2	2	3	1	1	1
Weight.....	1	1	1	1	1	2	1	1	1
Durability.....	2	2	1	2	2	2	1	1	1
Reproduction —									
Seed Production ...	3	3	3	3	3	3	3	2	3
Germination percent	3	3	2	2	2	2	1	1	3
Vitality.....	3	3	2	2	1	3	1	1	1
Seedlings.....	2	1	3	3	3	3	2	2	3
Range —									
Geographical	2	2	2	2	2	3	2	2	3
Altitudinal.....	3	1	1-2	1-3	3	1-2	1-2	1-2	1-2
Climate —									
Temperature.....	1-2	2	1-2	2	1-2	2	2	2	2
Precipitation	2	3	2	2-3	2-3	2-3	2	2-3	2
Humidity.....	2	2	2	2-3	2-3	2-3	3	2-3	2
Soil	3	2-3	2	2	2	2	2	2	2
Occurrence	2-3	2-3	2	2-3	2	2-3	2	2	2-3
Commercial									
Importance.....	2	3	3	3	1	3	1	1-2	1-2

TABLE OF SILVICAL CHARACTERISTICS—Continued.

TREE NUMBER	21	22	23	24	25	26	27	28	29
Size	1	1	2	1	1	1	1	1	1
Growth—									
Rapidity.....	1	1	1	1	3	3	2	2	3
Life.....	1	3	3	3	2	3	2	3	1
Root System	1	2	2	1	3	3	3	3	1
Role—									
Taper.....	3	3	3	3	2	2	3	3	2
Crown	1	1	1	1	3	3	1	3	2
Tolerance	3	3	3	3	1	1	2	3	1
Wood—									
Strength.....	1	1	1	1	1	2	3	3	1
Weight.....	1	1	1	1	1	2	3	3	1
Durability.....	1	3	3	3	2	2	2	2	1
Reproduction—									
Seed Production ...	2	3	3	1	2	2	2	2	3
Germination percent	3	3	3	2	2	3	2	3	1
Vitality.....	1	1	1	1	2	2	1	1	1
Seedlings.....	3	3	3	3	1-2	1-2	1-2	1-2	3
Range—									
Geographical.....	2	2	2	2	2	2	2	2	3
Altitudinal.....	3	1	1-2	2-3	1	1	2	1	1-3
Climate—									
Temperature.....	1-2	2	2	2	2	2	2	2	1-2
Precipitation.....	2	2	2-3	2-3	2	2	2	2	2
Humidity.....	2	2	2-3	2-3	2	2	2	2	2
Soil	1	1	1-2	2	2	2	2	2	1-2
Occurrence	1-2	2-3	1-2	1-2	1-2	1	1	1	2-3
Commercial									
Importance.....	1	2	3	1-2	1	1	1	1	2

TABLE OF SILVICAL CHARACTERISTICS—Continued.

TREE NUMBER	30	31	32	33	34	35	36	37	38
Size	1	1	1	1	1	1	1	1	1
Growth—									
Rapidity.....	2	3	3	3	3	2	1	3	3
Life.....	1	2	2	1	1	2	3	2	2
Root System	2	2	2	2	1	2	2	2	3
Bole—									
Taper.....	2	3	3	2	2	2	2	1	1
Crown	2	1	3	2	2	2	3	3	3
Tolerance	1	1	1	1	1	2	3	1	1
Wood—									
Strength.....	1	1	1	1	3	3	3	2	3
Weight.....	1	1	1	1	3	3	3	2	3
Durability.....	1	1	1	1	1	1	1	3	3
Reproduction—									
Seed Production...	3	3	3	3	3	3	2	2	2
Germination percent	1	2	3	2	2	2	1	1	2
Vitality.....	1	1	1	1	1	1	1	1	2
Seedlings.....	3	3	2	2	3	3	3	1	2
Range—									
Geographical.....	2	3	2	3	3	2	2	2	2
Altitudinal.....	1	1	2	1-2	1-2	1	1	1	1
Climate—									
Temperature.....	2	2	2	2	1-2	2	2	2	2
Precipitation.....	2	2	2	2	1-2	2	2	2	2
Humidity.....	2	2	2	2	1-2	2	2	2	2
Soil	1-2	2	2	2	1-2	2	2	2	2
Occurrence	2-3	2	1-2	2	2-3	1-3	2-3	1-3	2
Commercial Importance	1-2	1	2	1	1	3	1-2	1	1

TABLE OF SILVICAL CHARACTERISTICS—*Continued.*

TREE NUMBER	39	40	41	42	43	44	45	46	47
Size	1	1	1	1	1	1	1	2	1
Growth—									
Rapidity.....	2	3	2	2	2	3	3	3	2
Life.....	2	2	2	2	2	1	2	3	3
Root System	3	3	1	2	2	2	2	2	2
Bole—									
Taper.....	2	2	2	2	2	2	1	1	1
Crown	3	3	3	3	3	3	3	3	3
Tolerance	1	1	1	1	1	1	1	1	2
Wood—									
Strength.....	3	3	3	3	3	3	1	1	2
Weight.....	3	3	3	3	3	2	1	1	3
Durability.....	3	2	2	1	1	1	1	1	1
Reproduction—									
Seed Production....	2	2	2	3	2	3	2	3	2
Germination percent	2	2	1	1	1	1	1	1	
Vitality.....	2	2	1	1	1	1	1-2	2	
Seedlings	2	2	2	2	2	2	2	2-3	
Range—									
Geographical.....	2	2	2	2	2	2	1-2	2	2
Altitudinal.....	1	1	1-2	1	1	1	2	1-2	1
Climate—									
Temperature.....	2	2	2	2	2	2	2	2	2
Precipitation.....	2	2	2	2	2	2	2	2	2
Humidity.....	2	2	2	2	2	2	2	2	2
Soil	2	2	1-2	2	2	2	2	2	2
Occurrence	2	2	2	1	1	1	1	1	1-2
Commercial									
Importance	1	1	1	2	1	1	1	1	1

TABLE OF SILVICAL CHARACTERISTICS—*Continued.*

TREE NUMBER	48	49	50	51	52	53	54	55	56
Size	1	1	1	1	1	1	1	1	1
Growth—									
Rapidity.....	2	2	2	3	3	3	2	1	3
Life.....	2	2	3	2	1	1	2	1	1
Root System	3	2	1	2	2	3	2	3	1-2
Bole—									
Taper.....	1	2	1	1	1	2	1	1	1
Crown	2	3	3	2	3	3	3	1	3
Tolerance	2	3	3	2	3	1	2	1	1
Wood—									
Strength.....	2	2	3	2	2	1	1		
Weight.....	2	2	3	2	2	1	1		
Durability.....	1	1	1	1	1	1	1	2	
Reproduction—									
Seed Production....	2	3	2	1	2	3	2	2	2
Germination percent	2	2	2	1	2	1		1	
Vitality.....	2	2	2	1	2	1	2	2	
Seedlings.....	2	2	3	3	2	3	2	1	1
Range—									
Geographical.....	2	2	2	2	2	3		2	2
Altitudinal.....	1	1	1-2	1-2	1	1-2	1	1	1
Climate—									
Temperature.....	2	2	2	2	2	2	2	2	2
Precipitation.....	2	3	2	2	2	2	2	2	2
Humidity.....	2	3	2	2	2	2	2	2	2
Soil	2	2	2	2	2-3	1-2	2	3	2
Occurrence	1	1-2	2	1-2		1	1	1-2	1
Commercial									
Importance.....	1	1	2	1	1	1	2	1	2

