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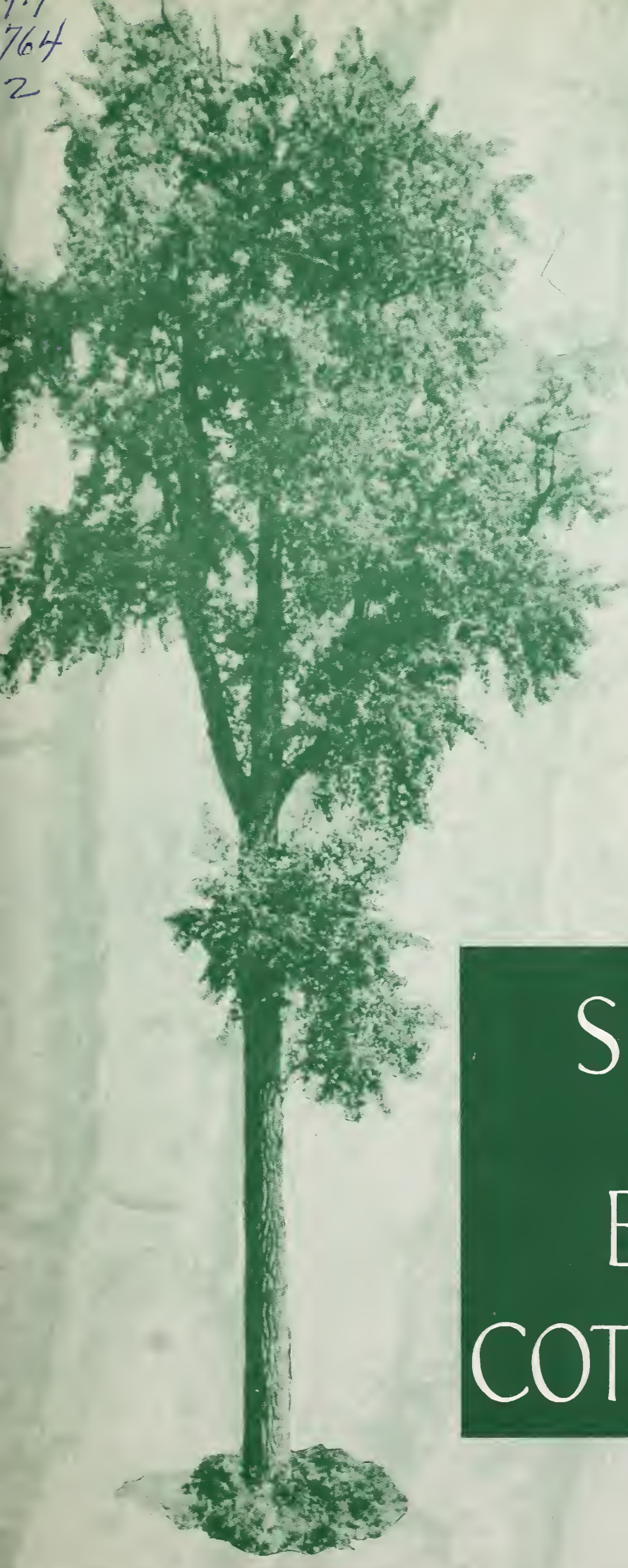
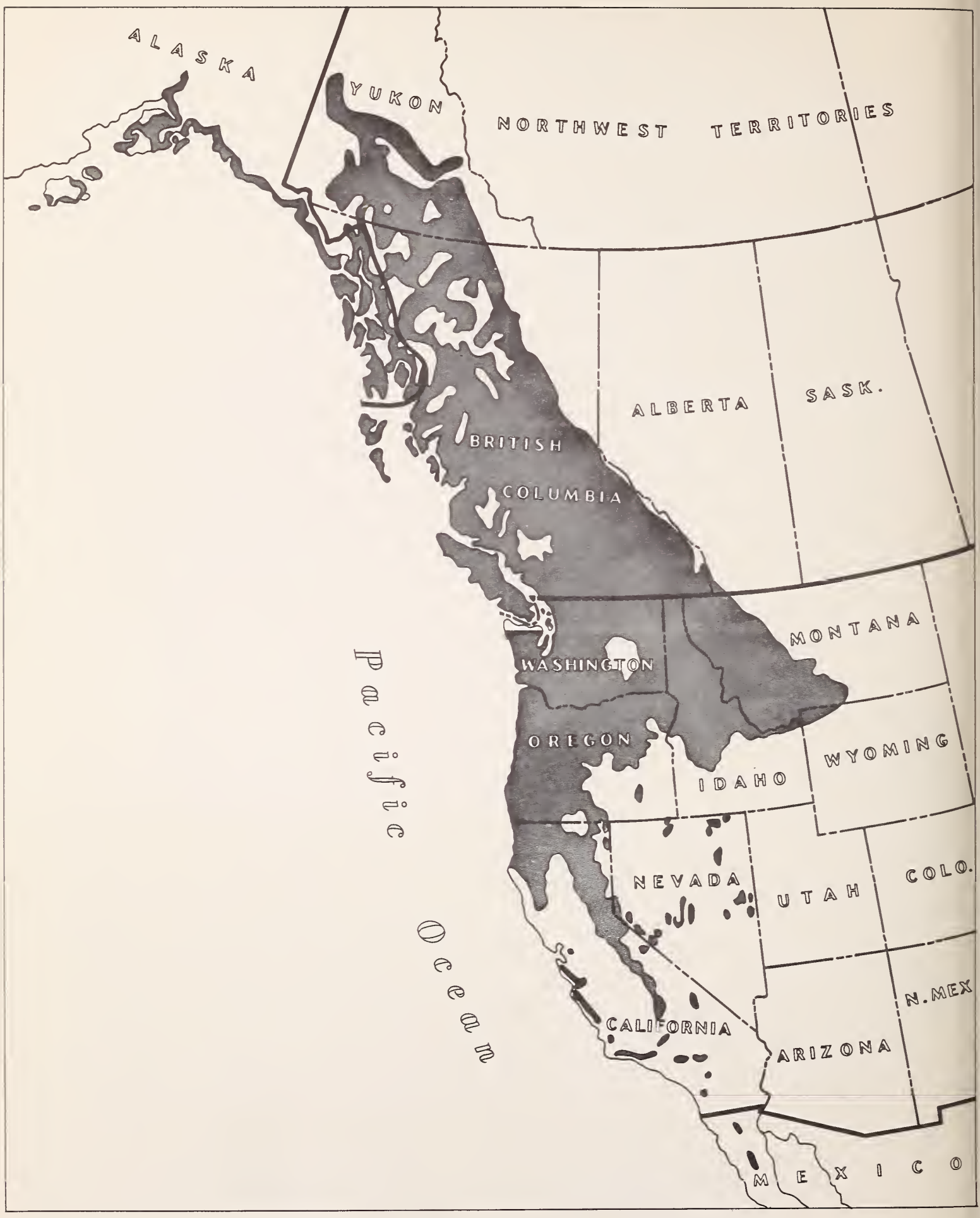


SILVICS of BLACK COTTONWOOD



Botanical range of black cottonwood.

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SILVICS OF BLACK COTTONWOOD

By

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FOREWORD

The SILVICS OF BLACK COTTONWOOD is the third publication in the series of seven silvics manuals being published by the Intermountain Forest and Range Experiment Station as part of a larger project sponsored by the U. S. Forest Service. Forest Service Experiment Stations over the Nation are issuing similar bulletins on many important North American tree species. Eventually a single publication that will include the entire series will be issued by the U. S. Forest Service.

Information in this publication is based on selected references and unpublished research data through 1957. The volume of published literature on the black cottonwood is relatively small; hence the author has had to rely heavily on unpublished data. He will appreciate having any omissions of source material called to his attention.

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SILVICS OF BLACK COTTONWOOD

By

Arthur L. Roe[1/]

Black cottonwood (Populus trichocarpa) is the largest of the American poplars. It grows to greatest size in the forests of the Pacific Northwest, where it is the largest hardwood in the region (7, 8).[2/] Trees have been reported to reach a maximum diameter of 8 feet and a height of 175 to 225 feet. However, in many parts of its range it rarely exceeds 100 feet in height (8). Not only is it distinguished by its large size, but it also exceeds all of its associates in rate of growth (16). Black cottonwood has the greatest altitudinal range in any given latitude of any tree on the North American continent. For example, in Monterey County, California, it is found at only 50 feet above sea level, while at approximately the same latitude in the Sierra Nevadas it is found growing at 8,000 to 9,000 feet above sea level (2).

Black cottonwood is known by several other common names, including California poplar, cottonwood, balsam cottonwood, and western balsam poplar (8). Some taxonomists have distinguished a variety, northern black cottonwood (P. trichocarpa var. hastata). However, this variety has not been accepted generally because the characteristics separating it from the species are too variable (13). The new Forest Service check list (10) shows P. trichocarpa as the accepted name.

The range of this species extends along the Pacific Coast from Cook Inlet, Kodiak Island, and southeastern Alaska to southern California and northern Lower California, Mexico. In Alaska this tree is most common from Stikine River north to the head of Lynn Canal at Skagway; from Glacier Bay and Yakutat Bay west to Prince William Sound, Cook Inlet, and Kodiak Island. It is widely distributed throughout British Columbia, except east of the Rocky Mountains in the northeastern part of the province; its range extends eastward into southwestern Alberta (south of the Oldman River) and to south-central Montana--its easternmost extension--and central Idaho and western Nevada. It is found mostly on bottomland, river bars, and forest meadows and streambanks, but it occurs throughout the plateau lands in north-central British Columbia (3, 6, 8, 10, 13, 18, 20, 23).

1/ Forester, Intermountain Forest and Range Experiment Station, U. S. Forest Service, Missoula, Montana.

2/ Underlined numbers in parentheses refer to Literature Cited.

HABITAT CONDITIONS

CLIMATIC

Black cottonwood grows under extremely varied climatic conditions because of its great latitudinal and altitudinal range. Weather records from selected locations where cottonwood grows show that it occurs in relatively arid to humid climates (22). It develops best in a humid climate such as that found in the Pacific Northwest. In arid climates, away from the influence of sea and fogs, it shows much poorer development (7, 19).

The climate where black cottonwood occurs has great temperature ranges. Maximum temperatures range from 59.9° F. to 117° F., and the minimum temperatures range from 32.5° F. to -53° F. Average annual July temperatures from 53.4° F. to 75.9° F. are encountered, but average January temperatures may be as low as 46.6° F. to 17.7° F. Length of growing season within its range varies from 72 days to 263 days. The average annual precipitation, likewise, shows considerable variation, ranging from as little as 9.87 inches to as much as 126 inches. Much of this precipitation falls as snow since usually only about one-third of it falls during the season from April through September (22). These variations in climate indicate that other factors, including subsurface sources of soil moisture, strongly influence the distribution of black cottonwood.

EDAPHIC

Black cottonwood grows in a variety of soils ranging from moist gravelly and sandy, to rich humus soils and even some clay soils. On poor, dry sites it is somewhat dwarfed. The largest trees grow at low elevations on deep alluvial soils. At higher elevations it occurs in moist sandy, gravelly, or loam soils and is usually much smaller (7, 8, 10, 17, 19).[3/] In Glacier County, Montana, black cottonwood is restricted generally to loam soils along streams and around ponds (11). Black cottonwood requires a generous quantity of soil moisture throughout most of its growing season. Studies made by Smith in British Columbia (16, 17) point out that black cottonwood requires abundant moisture, nutrients, and oxygen in combination with a high pH for optimum growth. Furthermore, these requirements are usually met by a combination of factors such as soil texture, proper nutrient content, porosity, soil depth, and depth to water table.

Such nutrient elements as nitrogen, potassium, and phosphorus are usually present in sufficient quantities in most loam and clay soils to support good growth. However, some marshy soils and peat bogs may not contain enough calcium, which is a required nutrient. Optimum pH is believed to lie between 6.0 and 7.0, depending upon the nutrient composition of the soil. Soils having

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3/ See also: U. S. Forest Service. Populus trichocarpa as occurring on the Modoc National Forest. 4 pp. (Typewritten) n. d.

a pH of less than 5.5 may not support good growth. Best growth occurs on soils of agricultural quality. Canadian studies (16, 17) further point out some limits of conditions for good growth as follows:

1. At least 18 inches of loam or heavier soil is required for good growth if this soil is underlain by gravel.

2. Lack of aeration limits growth. Stagnant pools and fine sediment deposited by flooding tend to reduce aeration and shorten the effective period of growth. Fine sediment also slows percolation of summer rains. Conversely, flooding by fast-moving water rich in oxygen speeds growth.

3. Summer drought may affect growth if stands occur on sand ridges that have been cut off from the main water channel.

4. Soils frequently flooded may be young and poorly developed, and the site quality may change each time flooding occurs. The poorest quality soil is found in newly formed gravel bars.

5. The best soil is deep, fine-textured material, that is, topographically higher than average but still subject to flooding in very high water.

6. Some upland soils can produce excellent growth of black cottonwood. These include: wind- or river-deposited soil that has good supplies of calcium and other nutrients when they receive abundant rainfall; glei type soils if the glei layer is fairly deep and if the pH is reasonably high; soils in depressions and on lower slopes where moving ground water, rich in oxygen and nutrients, is present; loam and loamy sands belonging to the "brown soil" group only when they have an abundant supply of nutrients; and heavy clay soils only if their structure is modified by incorporated humus.

Typical habitat for black cottonwood where soil moisture remains high through growing season. Occasional flooding occurs in high water.

PHYSIOGRAPHIC

In the northern end of its range, on the Kenai Peninsula in Alaska, black cottonwood occurs from sea level up to 2,000 feet elevation; up to 5,000 feet in Washington; and up to 7,000 feet in the valleys of the Selkirk Mountains in British Columbia (19). In the southern end of its range, in California, it is most abundant from 3,000 to 6,000 feet, but it occurs up to 9,000 feet. In California it is generally found in the higher valleys and canyons. In the drier areas the effect of physiography is striking, because there black cottonwood usually grows in protected valleys and canyon bottoms, along streambanks and edges of ponds and meadows, and on moist slopes at the foot of the mountains where the roots can reach a relatively permanent supply of soil moisture. In humid areas its distribution is not influenced as greatly by physiography (7, 11, 19, 23).

BIOTIC

Black cottonwood is found from the upper Sonoran through the Canadian life zone and is represented in five western forest cover types (13, 18). It forms limited pure stands or groups usually on newly formed river bars or bottomlands. It occurs in mixture with Douglas-fir (Pseudotsuga menziesii), western white pine (Pinus monticola), western larch (Larix occidentalis), subalpine fir (Abies lasiocarpa), white spruce (Picea glauca), Engelmann spruce (P. engelmannii), western redcedar (Thuja plicata), western hemlock (Tsuga heterophylla), white fir (Abies concolor), red alder (Alnus rubra), Sitka alder (A. sinuata), vine maple (Acer circinatum), bigleaf maple (A. macrophyllum), several birches (Betula spp.), and many willows (Salix spp.), aspen (Populus tremuloides), Oregon ash (Fraxinus latifolia), black hawthorn (Crataegus douglassii), and other bottomland species. It is found in the ponderosa pine-sugar pine type and Jeffrey pine-red fir type in California. Black cottonwood meets with balsam poplar (Populus balsamifera) in Alaska and in the Yukon Territory and northeastern British Columbia, and the plains cottonwood (P. sargentii) in western Alberta and central Montana (6, 7, 8, 11, 16, 18).

Ecological studies made in Glacier County, Montana, by Lynch (11) recognized a Populetum-Osmorhizetosum association. The most prominent plants were P. trichocarpa, P. tremuloides, Osmorhiza occidentalis, Viola canadensis, Smilacina stellata, Pedicularis bracteosa, and Heracleum lanatrum. Aspen predominated in the drier extensions, whereas black cottonwood overtopped and outnumbered it on sites that were moister than normal.

In Inyo County, California, such plants as aspen, Salix spp., California black oak (Quercus kelloggii), interior live oak (Q. wislizenii), water birch (Betula occidentalis), cascara buckthorn (Rhamnus purshiana), and Cornus spp. are common associates.4/ On the Modoc National Forest, California, Salix spp.,

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4/ Berry, James B. Black cottonwood. U. S. Forest Service Silvical report. 4 pp. (Typewritten) 1911.

aspen, Pacific dogwood (Cornus nuttallii), Klamath plum (Prunus subcordata), and common chokecherry (P. virginiana) are the predominant species found associated with cottonwood.5/

Investigations in British Columbia by J. H. G. Smith and associates have demonstrated the feasibility of using indicator plants found among the lesser vegetation to indicate site quality. Smith was able to classify the stands into three broad site classes as follows:

Good site quality.--Salmonberry (Rubus spectabilis)-stinging nettle (Urtica spp.)-fern site. At least one of the above-designated plants must be present in some quantity. The fern may be either swordfern (Polystichum munitum) or ladyfern (Athyrium felix-femina). Vigorous growth of hazel and elderberry shrubs also seems to be associated with an excellent growth of cottonwood.

Medium site quality.--Red-osier dogwood (Cornus stolonifera)-black twinberry (Lonicera involucrata) and waxberry (Symphoricarpos alba) form the dominant element of the shrub layer. Thimbleberry (R. parviflorus) and wild rose (Rosa mitkana) are also commonly found on this site.

Poor site quality.--This site is often indicated by the common horsetail (Equisetum arvense). Land of this site quality is usually much below average quality and is subject to flooding for as much as 6 weeks in an ordinary year. The common horsetail and the tall horsetail (E. hymenale) do not always indicate poor sites because they may be present on layers of clay deposited over fine sand or silt on higher ridges or edges of water courses which may be of medium or better quality. In a few areas, poor and scrubby growth of the medium site indicators has been associated with soil layers deposited over poor site quality lands.

The above site classifications are analogous to those developed in Germany.6/ The good site class is somewhat better than German site class I, and the fair and poor site classes correspond generally with German site classes II and III, respectively (17).

According to Smith presence of the following additional species may give some clue to good growth potential for black cottonwood: jewelweed, hedge-nettle, enchanters-nightshade, golden saxifrage, buttercup, bittercress, angelica, loosestrife, bedstraw, cleavers, giant fescuegrass, and tall hairgrass (16). On the other hand, he states that the presence of tall reedgrass, iris, spirea, or sphagnum moss may indicate acidic and excessively moist ground

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5/ U. S. Forest Service. op. cit.

6/ Site data are from Hesmer's Das Papelbuch; they have been verified by extensive sampling in British Columbia and are cited by Smith (17).

where conditions are not suitable for the cultivation of black cottonwood (17). Furthermore, he points out that cottonwood may not show good growth on lands occupied by some members of the willow family. But land currently supporting good stands of red alder is almost always capable of growing a much better crop of cottonwood than alder (16).

LIFE HISTORY

SEEDING HABITS

Flower and fruiting.--Flowers of black cottonwood are dioecious with both sexes borne in aments that usually appear before the leaves (11). They may begin to form from April 10 until May 30 in Washington and Oregon, and sometimes as late as June 10 in Montana and Idaho. The fruit is ripe in Washington and Oregon between May 24 and June 27, but in Montana and Idaho some years it has not ripened until mid-July.7/ These dates may be earlier in the most southerly extremities and later in the northern extremities of the tree's range.

Seed production and dissemination.--Black cottonwood is generally a prolific annual seed producer The seed is light and buoyant and can be transported long distances by wind and water (7, 8).8/ Natural seed dispersal begins from late May to early July, depending upon the lateness of the season and the locality.9/

VEGETATIVE REPRODUCTION

Black cottonwood sprouts readily both from stumps and roots.10/ Although some observers believe that under some conditions sprouts may not persist to form permanent stems,11/ others (16) have observed many trees in the 20- to 40-year age class that have originated as sprouts. On the other hand, black cottonwood is easily reproduced by cuttings (13). As early as 1893, reforestation was practiced rather extensively along the Willamette River lowlands in

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7/ Unpublished phenological data from the Pacific Northwest Forest and Range Expt. Sta., Portland, Oregon, and the Intermountain Forest and Range Expt. Sta., Ogden, Utah.

8/ See also: S. W. Allen. Silvical notes on Populus trichocarpa on the Klamath National Forest. U. S. Forest Service. 4 pp. (Typewritten) n. d.

9/ Ibid.

10/ Berry, op. cit.

11/ Allen, op. cit.

Oregon by cuttings. These cuttings, or "slips," as they were called, consisted of a section of cottonwood branch about 1 inch in diameter and 1 foot long with the bark and at least three buds left intact. The cuttings were placed vertically in the ground to a depth of about two-thirds their length and in rows spaced wide enough apart for cultivating with a horse-drawn cultivator. They remained in these beds for one year, while roots formed, and were outplanted in plantations during the following season. This method apparently worked very well for practical reforestation. Efforts at growing seedlings in the nursery in this early reforestation operation were abandoned because of the mortality caused by insects (14).

Most of the experience in cultivating black cottonwood comes from the Pacific Northwest in Washington and British Columbia. Recommendations by Beeman,[12/] Smith (16), and others (4), may be summarized as follows:

Cuttings should be made when the tree is dormant, and can be from 6 to 12 inches long, although longer cuttings may be desirable to facilitate later cultivation. Studies in British Columbia[13/] have shown that the position in the crown from which cuttings are taken has important bearing upon subsequent survival and growth. Cuttings of 1- and 2-year-old wood taken from the leaders and 1-year-old wood from primary side branches showed best growth and survival. Growth of cuttings from 2-year-old wood on side branches was much slower. Tests in the above study were made with cuttings taken from young trees, and differences in results may be more pronounced on cuttings from more mature trees. Best results have been obtained when the cuttings were rooted for one year in the nursery before field planting. Planting sets is not as good as planting rooted cuttings because the best that can be expected is that, in favorable soil only, sets will do as well as rooted cuttings (16).

Ground preparation is an important part in the success of plantings. Complete land clearing and intensive disking are recommended (16), but as a minimum practice cuttings can be planted in wide furrows made by throwing the lay to both sides.[14/] Land managers in British Columbia have practiced more intensive preparation by using a Caterpillar D-8 bulldozer and a 12-foot Rome disk with 30-inch blades. Natural reproduction, both vegetative and from seed, has been secured near Everett, Washington, when the area was scarified by bulldozer and branch segments were ground into the soil (16).

12/ Beeman, W. H. Report on hybrid poplar and native cottonwood experiments. 15 pp. (Typewritten) 1948.

13/ Smith, J. H. G. Reports on growth and yield and factors influencing cultivation of black cottonwood in British Columbia. (Information received through correspondence.) (Typewritten) 1955.

14/ Beeman, op. cit.

After planting, weeding is critical to insure good survival and growth. Grass and other vegetative competition must be held at a minimum for the first year. In British Columbia plantings, three hand hoeings and two tractor diskings had to be made during the first season. Under this practice, excellent first-year survival and growth were obtained (16). Where furrows are used two cultivations with a duckfoot cultivator or a sweep are recommended.[15/]

Recommendations for spacing have varied considerably. One land manager in British Columbia uses 9-inch cuttings at a 12-foot by 12-foot spacing (16). Others have recommended closer spacings of 3 feet by 3 feet to 6 feet by 6 feet, or at least close enough to provide a closed canopy in 2 or 3 years.[16/] However, on a large planting the wider spacing may be more practical because of lower cost and because it facilitates cultivation during the first season.

Spring is generally regarded as the best season for planting to avoid frost heaving, particularly on the heavier soils (16).

SEEDLING DEVELOPMENT

Establishment.--The seed shows a high percent of viability, and like that of other poplars it retains its germinative capacity for only a brief period under natural conditions (7, 8). However, cottonwood seed may be stored for 3 months to a year under refrigeration at low humidity (16). If the seed falls on a moist seedbed, high germination results. Wet river bars seem to offer the best medium; and moist, bare, humus or sandy soils such as those in streambanks and bottomlands are also good (6, 7).[17/] On many drier sites seedlings are rare because the seedbed was dry at the time of seed dissemination.[18/] When seedbed conditions are favorable, seedlings appear in great numbers, but they thin out naturally by the time they reach 5 years of age. This natural thinning is due to the suppression of the weaker seedlings by the more vigorous ones.[19/]

Black cottonwood does not reproduce satisfactorily on logged-over land unless special measures are taken to provide the bare, moist seedbed required for initial establishment. Cottonwood occurs in the earliest stages of succession and tends to be replaced by more tolerant vegetation unless the required seedbed is provided by flooding or management practices (16).

15/ Ibid.

16/ Ibid.

17/ See also: Allen, op. cit.; Smith, op. cit.

18/ Berry, op. cit.

19/ Allen, op. cit.

Black cottonwood seedlings developing on mineral soil seedbed bared by flooding.

Early growth.--Black cottonwood makes very rapid juvenile growth; it exceeds most of its associates when growing on good moist sites. Dominant and codominant seedlings in the Pacific Northwest on Lady Island near Camas, Washington, attained a diameter of 6.7 inches at breast height and a total height of 48.5 feet in 9 years (15).

Exceptional growth of four selected individual trees in the Fraser Valley of British Columbia has been reported by Smith (16), as follows:

Age	D. b. h.	Total height
Years	Inches	Feet
7	7.0	45
17	18.6	95
17	22.4	85
27	32.5	120

On the Klamath National Forest in California, trees grew to diameters of 8 to 13 inches and heights of 30 to 50 feet in 20 to 27 years.[20] On rocky soils on the Modoc National Forest, also in California, trees up to 12 inches in diameter grew as much as 1 inch in diameter in 4 to 7 years, whereas the rate was reduced to 1 inch in 10 to 13 years thereafter.[21]

SAPLING STAGE TO MATURITY

Growth and yield.--Age of maturity in black cottonwood has not been determined accurately, but estimates range from 60 to 200 years (8, 14).[22/] In the Willamette Valley, Oregon, it matures in about six decades or less, but on the Modoc National Forest, best development is reached in about 75 years (14).[23/] On the better soils, sawlog-size trees develop in 20 to 40 years, and trees may be free of deterioration for as long as 100 to 150 years.[24/] Growth was found to be uniformly rapid throughout the early life of trees in Inyo County, California, as illustrated by the following d.b.h. growth rates:

Period	Favorable site	Less favorable site
	Inches	Inches
First decade	5.5	2.5
Second decade	6.2	3.0
Third decade	5.3	2.7
Fourth decade	5.3	2.5
40-year total	22.3	10.2

A maximum diameter of 24 inches and a total height of 60 feet have been reported in Inyo County, California.[25/]

On the Klamath National Forest, California, mature trees may reach 24 to 30 inches d.b.h. and 50 to 60 feet high.[26/] In Glacier County, Montana, trees growing in groves on Babb loam and stony loam soils reached 12.8 inches in diameter and 45 feet in height in 82 years (11). The Montana trees were growing on the eastern extremity of the range of cottonwood bordering the grasslands and in a semiarid climate.

20/ Ibid.

21/ Wulff, J. V. Populus trichocarpa. U. S. Forest Service Silvical report. 4 pp. (Typewritten) 1912.

22/ See also: Allen, op. cit.; Wulff, op. cit.

23/ See also: Wulff, op. cit.

24/ Allen, op. cit.; Berry, op. cit.

25/ Berry, op. cit.

26/ Allen, op. cit.

Detailed studies of the yield of black cottonwood trees made in the Quesnel region (Fraser River) in British Columbia show that it grows well up to about 200 years. Culmination of periodic increment occurs beyond 200 years in age. However, a practical age of maturity for cottonwood growing in forest stands was determined to be 180 years. This figure was based on the age at which the distance from the ground level to the base of the crown (corresponding to merchantable length) reached its maximum.

In open mature stands the stem tapers only slightly, and is without branches for more than one-half its length; it then divides abruptly into large branches in the crown. In closed stands the crown is narrow, and persistent branches extend only rarely into the lower two-thirds of the bole (21). Tables 1 and 2 show basic growth and yield data for the middle Fraser region and Skeena River Valley in British Columbia.

Table 1.--Growth and yield characteristics for cottonwood in the Quesnel region, British Columbia[1/]

Total age (years)	Diameter at breast height	Height to base of crown	Gross volumes from stump height[2/] to a 10-inch top diameter	
	Inches	Feet	F.b.m.	Cu. ft.
80	15	52	235	44
90	17	56	295	54
100	19	60	365	64
110	20	62	450	76
120	22	64	545	89
130	23	67	655	105
140	25	69	780	123
150	26	70	935	146
160	28	71	1,110	173
170	29	72	1,310	200
180	31	73	1,520	225
190	32	73	1,720	250
200	33	73	1,920	273

1/ From Thomas and Podmore (21).

2/ Volumes according to British Columbia log rule and Smalian's formula.

Table 2.--Yield per acre of black cottonwood in Skeena River Valley, British Columbia[1/]

Age (years)	Net volume[2/] per acre	Mean annual increment per acre
	Board feet[3/]	Board feet
20	4,700	235
30	10,000	333
40	16,700	417
50	22,800	470
60	27,800	463
70	29,400	420

1/ Data collected in the Skeena River Valley of British Columbia by W. C. Phillips for the British Columbia Forest Service (16).

2/ Trees more than 11 inches d.b.h.

3/ British Columbia log rule.

Foresters in British Columbia recognize three site quality classes.[27/] They use the data shown in table 3, which have been checked by extensive sampling and found satisfactory for use there.

Table 3.--Black cottonwood site classification table[1/]

Age (years)	Site classes					
	I		II		III	
	Total height	Diameter breast high	Total height	Diameter breast high	Total height	Diameter breast high
	Feet	Inches	Feet	Inches	Feet	Inches
5	25	--	21	--	16	--
10	47	5.7	43	4.8	33	3.6
15	72	9.5	59	7.1	46	5.9
20	95	12.5	79	9.0	59	6.5
25	111	16.0	92	12.0	72	8.0
30	118	20.0	102	14.5	82	10.5
35	125	22.0	108	17.0	89	12.0

1/ Data from Hesmer, Das Papelbuch, cited by Smith (16, 17).

27/ See p. 5 above.

Smith (16, 17) gives the following instructions for collecting data for site classification: "The height or d.b.h. and age of at least two trees must be measured for each spot to be evaluated. The largest and tallest trees should be measured. One year should be added to the age of trees bored at a height of 1 foot. Total height and age are more reliable indicators of site quality than diameter breast high and total age. The number of plots required to classify site quality depends upon the area and uniformity of tree distribution and size in a given stand" (20).

Kennedy's recent study[28] shows that longer wood fibers are associated with faster rates of growth; thus faster growing cottonwoods produce generally better quality material for both veneer and pulpwood than do slower growing trees.

Reaction to competition.--Black cottonwood is the most shade-intolerant of its associates and is classified as being very intolerant (1). Because of this high degree of intolerance it can remain in the stand or in mixture with other species only so long as it occupies a dominant position. Where it cannot maintain dominance it is soon suppressed and replaced by other species. However, its rapid juvenile growth rate, exceeding that of most of its associates, helps it to maintain a favorable position in stands (7, 8, 19).[29] Black cottonwood occurs in the earliest stages of ecological succession and tends to be replaced by more tolerant grass, trees, or shrubs (21).

INJURIOUS AGENCIES

Weather and related agents.--Certain climatic factors, while they may not be distinctly limiting, do cause damage to the species. Since black cottonwood is among the first species to start growing and flowering in the spring, late frosts frequently injure it.[30] Many cottonwoods were killed outright or killed back from 2 to 20 feet in height by a late fall frost in British Columbia in November 1955. Frost cracking of the boles further damages cottonwood for some uses and provides entrance for decay fungi (16). Wind breakage is an important type of weather damage.[31] Wind not only breaks off trees and reduces size of the crown through branch removal, but the resulting scars form avenues of entrance for wood-destroying fungi. A serious form of wind damage has been reported by foresters in Scotland. Because of their comparatively rapid growth, black cottonwood trees often project above the protection of surrounding trees. After they reach 80 feet or more in height, the wind

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28/ R. W. Kennedy, Faculty of Forestry, University of British Columbia. Cited by Smith (16).

29/ See also: Wulff, op cit.

30/ Berry, op. cit.

31/ U. S. Forest Service, op. cit.

frequently breaks off the upper third of the tree (2). In areas of heavy snowfall, saplings have been reported badly snow bent.[32] Sleet storms may also cause considerable breakage. The "silver thaw" has been reported to cause severe damage around Chilliwack, British Columbia, as frequently as once in 20 years (16). Black cottonwood is highly susceptible to fire damage, and even light burns can cause considerable injury.[33]

Erosion may be a serious problem in stands located on the flood plains of large rivers where many of the best stands occur. Periodic flooding is not always detrimental; in fact it sometimes promotes growth. However, in some rivers islands tend to be eroded upstream and built up downstream. The total change in land area may be insignificant in such cases, but instability of the soil may pose serious problems in cultivating this species (16).

Insects.--Several insects attack this bole. Some of them have been reported from only limited portions of the tree's range, but others are more widely distributed. Oystershell scale (Lepidosophes ulmi) is especially destructive to aspen, cottonwood, and willows, and is distributed throughout the United States. This insect frequently kills twigs and branches and sometimes the whole tree. Two defoliators are known to attack black cottonwood in parts of its range. The satin moth (Stilpnotia salicis), introduced from Europe, was first reported in British Columbia and Massachusetts in 1920. It is now considered firmly established in Oregon and Washington, and feeds on many Populus species, including black cottonwood. The cottonwood sawfly (Pteronidea sp.) also feeds on black cottonwood leaves. Its reported distribution is limited to northern Idaho where it occurs commonly. A small cambium miner (Lespeyresia populana) is known to breed in the bark of black cottonwood in Montana. Several insects among the flat-headed and round-headed borers and the ambrosia beetles are known to attack the species, but these insects have economic importance as wood destroyers rather than tree killers (5, 9).

Disease.--Black cottonwood is subject to several diseases. The cytospora canker (Valsa sordida) is widespread among the poplars, including black cottonwood, under forest conditions. However, it is most prevalent in stands injured by fire or located on unfavorable sites; its occurrence is highly correlated with the vigor of the tree. This canker is primarily a disease of young trees and causes most serious damage on cuttings in nurseries and plantations (4).

The wood of this species is attacked by several wood-decaying fungi. In the middle Fraser region, British Columbia, 70 species of fungi have been found to cause decay in black cottonwoods. However, only six cause significant loss in living trees, and only two of these (Polyporus delectans and Philiota destruens) cause about 92 percent of the loss (21). As a group, the cottonwoods have been classed by the Forest Products Laboratory as nondurable with respect to decay.

32/ Wulff, op. cit.

33/ Allen, op. cit.

Many investigators have rated black cottonwood, outside of its native habitat, as highly susceptible to disease. Its use for commercial planting in Europe has been largely discontinued because the species has suffered so severely from attacks of bacterial canker (16).

SPECIAL FEATURES

Evidence indicates that trees of the cottonwood family grew in Greenland during the Cretaceous age. Some old species have disappeared, but others have presumably survived until the present without great change. Their characteristic great vitality has been credited as the factor that enabled this survival from former geological epochs (7).

RACES

Black cottonwood shows considerable ecotypic variation throughout its range both in latitude and altitude. Pauley and Perry (12) studied variations in photoperiodic response in black cottonwood and several other poplars. Their studies showed that the time of cessation of height growth on specimens collected from various parts of the tree's range, when tested in plots in the vicinity of Boston, Massachusetts, under uniform environmental conditions varied inversely with the latitude of the plant's origin. In other words, when grown under similar habitat conditions the trees of northern origin ceased height growth earlier in the season than those of southern origin. Pauley and Perry also found that in trees from a uniform day-length zone the date at which height growth ceased was directly correlated with the length of the frost-free season prevailing in the original habitat of the specimen.

They concluded that adaptation of Populus species to various habitats differing in length of frost-free season is effected by a genetic mechanism that controls the duration of seasonal period of growth. The photoperiod or length of day serves as a timing device for this mechanism.

On the basis of the above study Perry and Pauley made certain suggestions on seed source:

1. Seed from northern long-day races planted in southern latitudes having a long growing season are likely to produce trees that will stop height growth early in the season, and thereby become dwarfed.

2. Trees produced from seed of trees growing in a region having a short growing season, such as high altitude habitats of mountainous areas in the southern parts of the range, may be expected to react the same as northern long-day types. Seed collected in such habitats, therefore, are not recommended for use in the same latitude at lower elevations or at more southerly latitudes.

3. Seed from trees in a long growing season habitat in any particular latitude should be avoided for use in areas having shorter growing seasons either at higher elevations in the same latitude or at more northerly latitudes. Trees from such seed are susceptible to early autumn frost damage in the latter habitats.

POPLAR HYBRIDS

Several studies show that the use of some hybrid poplars has distinct advantages over native black cottonwood in growth and yield.[34/] Extensive testing (48 different hybrids) by the Soil Conservation Service at Bellingham, Washington, shows that some hybrids considerably exceed the growth of native black cottonwood. The following table by Beeman shows the quantitative superiority of the hybrids in these tests:

Table 4.--Comparison of growth of hybrid poplars and native black cottonwood after fifth growing season

Item	Survival	Height	Diameter
	Percent	Feet	Inches
Hybrid, average	92.8	24.6	4.2
Native black cottonwood, average	91.2	17.3	3.3
Best pulpwood-type hybrid	100.0	31.2	4.9
Best native check	92.0	24.7	4.1

Growth of the selected hybrids was 42 percent greater in height and 27 percent greater in diameter than the best growth of the black cottonwood. Also, the hybrids apparently were immune to a leaf roller that attacked the black cottonwood consistently.[35/] Black cottonwood plantations on some lands in Washington are producing pulpwood at the rate of 1.6 cords per acre per year. By contrast, hybrid plots have indicated possibilities of a total harvest of 44 cords per acre at 18 years, or 2.4 cords per acre per year.[36/]

34/ Beeman, op. cit.

35/ Ibid.

36/ Ibid.

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