

Historic, archived document

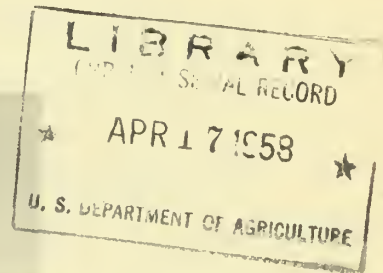
Do not assume content reflects current scientific knowledge, policies, or practices.

1.9622
R2St2

STATION
PAPER
NO.
29

February 1958

Silvical Characteristics of Rocky Mountain Juniper



ROCKY MOUNTAIN
FOREST AND RANGE
EXPERIMENT STATION
Raymond Price, Director
Fort Collins, Colorado

United States
Department of
Agriculture



National Agricultural Library

S. Depart-
silvical
ice then
d and some
cate. To

m
cl
m
ur

compile this material systematically and make it available to foresters generally, the Rocky Mountain Forest and Range Experiment Station is preparing reports on 4 individual tree species. Similar reports on other species are being prepared by other Forest Service experiment stations. A comprehensive national publication containing the silvical characteristics of all important forest trees of the United States will be issued soon by the Forest Service, U. S. Department of Agriculture.

- - - -

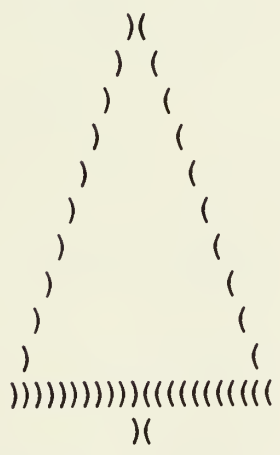
Cover Photo: A typical young Rocky Mountain juniper growing in a drainageway on calcareous soils in northern Colorado. Height: 14 feet; diameter at 1 foot: 16 inches.

SILVICAL CHARACTERISTICS OF
ROCKY MOUNTAIN JUNIPER

by

F. R. Herman, Forester

U.S.D.A., NAL
MAY 28 2003
CATALOGING PREP



7a
ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION, +7b
FOREST SERVICE +7a U. S. DEPARTMENT OF AGRICULTURE

5a
The station maintains central headquarters at Fort Collins, Colorado, in cooperation with Colorado State University.

CONTENTS

	<u>Page</u>
Distribution	1
Botanical description	3
Habitat conditions	4
Climatic	4
Edaphic	6
Physiographic	6
Biotic	7
Life history	9
Seeding habits	9
Flowering and fruiting	9
Seed production and dissemination	9
Vegetative reproduction	10
Seedling development	10
Germination and establishment	10
Early growth	10
Seedling diseases	10
Sapling stage to maturity	11
Growth rate and size attained	11
Yield	12
Competition	12
Natural enemies	12
Hybrids and varieties	13
Properties and uses	14
Literature cited	14

SILVICAL CHARACTERISTICS OF ROCKY MOUNTAIN JUNIPER

by

F. R. Herman

- - - -

Rocky Mountain juniper (Juniperus scopulorum Sarg.) is one of 12 native species of juniper that reach tree size in the United States (27). It was originally discovered by Lewis and Clark in October 1804. At first it was thought to be a western form of eastern redcedar (Juniperus virginiana L.), but was later separated as a species, because Rocky Mountain juniper matures its "berries" in two seasons instead of one (39, 40, 43).

Other common names in recent or current use include redcedar, Rocky Mountain redcedar, river juniper, and cedro rojo. Its lumber is sometimes referred to as western juniper (27).

DISTRIBUTION

Rocky Mountain juniper has a greater range than any other species of juniper found in the West, except common juniper (Juniperus communis L.) (15). It is found throughout the drier lower mountains and foothills of British Columbia and Alberta, Canada, south through the Great Basin, Rocky Mountain, and Northern Plains States, to New Mexico and northern Arizona (43, 44). It also is found on Vancouver and other islands in Puget Sound and on the surrounding mainland (fig. 1).

Rocky Mountain juniper is extensively distributed because it is adapted to a wide range of temperatures and to dry climates, and its seeds are disseminated by birds (33). It has been found as far north as Francois Lake in British Columbia at latitude 54° N. (40) and is reported in recent literature as far south as latitude 34° N. on the east side of the Continental Divide in New Mexico (56). Sudworth (44) reports it in the Trans-Pecos area of Texas at latitude 31° N. However, recent literature (11) and distribution maps (34) do not show it there.

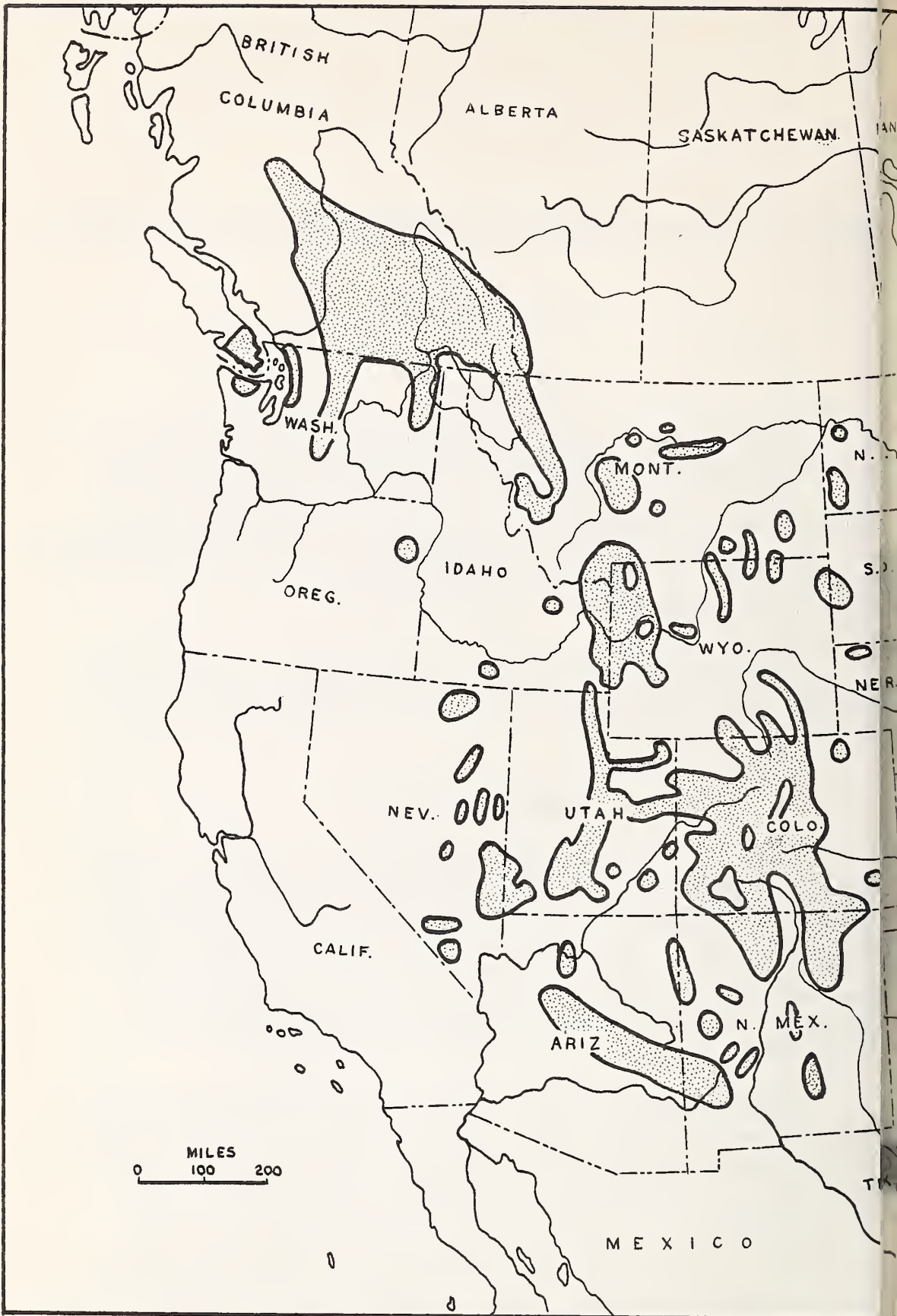


Figure 1. --Distribution of Rocky Mountain juniper.

BOTANICAL DESCRIPTION

Habit. --A shrub on exposed sites, to a tree more than 40 feet high and 15 inches in diameter on deep, fertile soils. The trunk is short and stout, frequently dividing near the ground; and the crown of thick, long, ascending branches is usually irregular and rounded. However, in canyons and on other moist sites the branches often are long and slender and tend to droop.

Leaves. --Scalelike, 1/8 inch long, acute or acuminate in shape, and obscurely glandular on back with smooth margins. Color varies from pale to dark green (fig. 2).



Figure 2. --Scalelike leaves and berrylike cones of Rocky Mountain juniper.

Flowers. -- Male and female flowers are borne on separate trees (dioecious). The former usually contains 6 stamens and the latter have spreading, acute scales.

Fruit. --Glaucous, bright blue, berrylike cones mature in 2 years and are one-fourth to one-third inch in diameter. Each "berry" contains 1 to 2 (sometimes 3) seeds in a sweet, resinous flesh (fig. 2).

Twigs. --Slender, leafy, and 4-angled, becoming smooth, round, and pale brown. Winter buds are naked and leaf covered.

Bark. --Thin, fibrous, and stringy; divided by shallow furrows into flat, interlacing ridges that are broken into persistent, shredded scales. Color is red-brown or gray-brown (34) (fig. 3).

HABITAT CONDITIONS

CLIMATIC

Rocky Mountain juniper generally occupies the dry, subhumid climatic province (45). However, it also occupies limited environments in the moist, subhumid region in the northern part of its range (7) and frequently is found in the semiarid region in the central and southern parts of its range (34, 44).

It can endure temperature extremes from -35° F. to 100° F. (35, 58), but it does best where average minimums exceed -10° F. to -5° F. (58). Mean July temperatures range from 60° F. to 75° F. and mean January temperatures, from 15° F. to 40° F. in different parts of its range.^{1/}

The growing season or average period when the mean temperature is above 42° F. varies from 140 days at high elevations to 230 days near sea level.

Average annual precipitation varies from 12 inches in the Southwest, Great Basin, and eastern slope of the Rocky Mountains in Colorado, to 26 inches in the Puget Sound area.

^{1/} Climatic data (48) adjusted to appropriate elevations by Baker's charts (3).



Figure 3. --Fibrous, stringy bark of Rocky Mountain juniper.

May-to-September precipitation is only about one-fourth the annual total in the northern part of the range, but it equals one-third to more than one-half in the central and southern parts.

Total snowfall varies from about 5 inches on the San Juan Islands in Puget Sound to 150 inches or more at other points.

Climatic data presented by other authors check reasonably well with these calculations (8, 19, 21, 25, 32, 56).

EDAPHIC

Rocky Mountain juniper seems to prefer soils that are calcareous and somewhat alkaline (19, 41). Pearson (32) reported pH 8.0 for soils in the pinyon-juniper type on Kaibab limestone in northern Arizona. Best growth is found on the moister, deeper soils (38, 43, 55). The species is considered less xerophytic than other western tree juniper associates (54, 56).

Throughout its range, Rocky Mountain juniper is found on soils derived from basalt, limestone, sandstone, and shale. It is reported on lava beds in southern Idaho and eastern Washington (47) and on limestone cliffs in southwestern Montana (23). It is found on limestone and sandstone outcrops (4, 21, 30), on limestone and adobe soils of the Rocky Mountain foothills (28), and on soils of poor moisture-holding capacity derived from shales in the central part of its range (17). It is reported on high limestone plateaus in South Dakota (33), and on limestones (32) and "malpais" lavas in the southern part of its range (25).

Rocky Mountain juniper is a characteristic plant of the McCammon-Deschutes soil group. These soils are mostly stony and shallow, with limy, cemented subsoils, and are subject to rather rapid erosion. In many places where juniper grows, the erosion loss is so great that there is no developed soil (47).

PHYSIOGRAPHIC

The range of Rocky Mountain juniper extends from the glaciated valleys of central British Columbia through the foothills of the Rockies to the mesas and tablelands of the southwestern United States. It grows from near sea level around Puget Sound (43) to 9,000 feet in the southwest (26).

Its elevational range varies with latitude and probably with local climate: In the Pacific Northwest, 0 to 3,200 feet (15); northern Idaho, 2,000 to 5,000 feet; Montana, 1,900 to 7,500 feet (23). In Utah and Nevada it is found from 3,200 to 8,400 feet, ranging generally from 3,500 to 7,400 feet on south exposures and from 3,800 to 4,600 feet on north exposures (55). In northern Wyoming it is reported at 5,600 feet (56); in Colorado, at 5,500 to 7,000 feet and even 8,500 feet in the extreme southwestern part of the State (9). On the east slope of the Rockies, it often forms a narrow band between elevations of 6,300 and 6,500 feet (52). In Arizona and New Mexico it is found between 5,000 and 9,000 feet, with local variations (25, 26, 32, 37).

Throughout its range, Rocky Mountain juniper grows on open exposed bluffs, rocky points, and southern exposures where most trees are unable to exist (28). However, it attains its best development along ravines, in sheltered canyons, and in other protected places (7, 44, 55). It is more common east of the Continental Divide than west of it (23).

BIOTIC

Rocky Mountain juniper is an important constituent of two of the forest cover types listed by the Society of American Foresters: the Rocky Mountain juniper type and the pinyon-juniper type (42). Rocky Mountain juniper forms a type only from northern Colorado and Utah northward, where it forms an open woodland in sagebrush, grass, or similar plant communities at the lower limits of tree growth. Southward it merges into the pinyon-juniper type (fig. 4), where it is but one of several species that make up the pinyon-juniper complex (8, pp. 196-200).

In the northern part of its range, Rocky Mountain juniper is found in open pure stands, or intermingled with ponderosa pine (Pinus ponderosa Laws.) on southern and western exposures, or with Rocky Mountain Douglas-fir (Pseudotsuga menziesii var. glauca (Beissn.) Franco) on north- and east-facing slopes (7, 23).

At higher elevations, it is occasionally found with limber pine (Pinus flexilis James) (31, pp. 267-268), lodgepole pine (Pinus contorta Dougl.), whitebark pine (Pinus albicaulis Engelm.), subalpine larch (Larix lyalli Parl.), Engelmann spruce (Picea engelmannii Parry), and subalpine fir (Abies lasiocarpa (Hook.) Nutt.) (23).



Figure 4. --Open pinyon-juniper woodland in the foothills of northern Colorado

On the Pacific Coast, Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) and Oregon white oak (*Quercus garryana* Dougl.) are common associates (15).

In the central and southern parts of its range it is usually found in the less xeric parts of the pinyon-juniper type (37, 54, 55) as in the upper elevational ranges (18), in protected situations (54), and on deep soils along drainageways. It is usually less abundant than other junipers (18, 42), but along waterways it may form nearly pure, uneven-aged stands (18) or mix with narrowleaf cottonwood (*Populus angustifolia* James) (43).

It typically associates with the less drought-enduring species found in the type: pinyon (*Pinus edulis* Engelm.), one-seeded juniper (*Juniperus monosperma* (Engelm.) Sarg.), ponderosa pine, and oaks (*Quercus* spp.) (18, 56). In northern New Mexico, it is

more abundant with Rocky Mountain Douglas-fir than ponderosa pine (25). It is only on the Coconino Plateau that its range overlaps the ranges of one-seeded juniper, alligator juniper (*Juniperus deppeana* Steud.), and Utah juniper (*J. osteosperma* (Torr.) Little) (53).

Common shrub associates throughout most of its range are true mountain-mahogany (*Cercocarpus montanus* Raf.) and big sagebrush (*Artemisia tridentata* Nutt.) (31, pp. 267-268). Other common shrubs found in various parts of its range are skunkbush sumac (*Rhus trilobata* Nutt.), mountain snowberry (*Symphoricarpos* A. Gray), bitterbrush (*Purshia tridentata* (Pursh.) DC), rabbitbrush (*Chrysothamnus* spp.), cliffrose (*Cowania stansburiana* Torr.), saskatoon serviceberry (*Amelanchier alnifolia* (Nutt.) Nutt.), oaks (*Quercus* spp.), American plum (*Prunus americana* Marsh.), and common chokecherry (*Prunus virginiana* L.) (4, 9, 10, 52, 56).

LIFE HISTORY

SEEDING HABITS

Flowering and fruiting

Pistillate flowers first become conspicuous during the late summer. They open the following April, when the pollen is being shed from the staminate flowers (16). The fruits ripen in November and December of the second year following pollination (50). They remain on the tree until March or April of the following spring (58).

Seed production and dissemination

Rocky Mountain juniper begins bearing seed at 10 years of age, but optimum seed-bearing age is 50 to 200 years (50). Except in parts of Idaho and Montana (23), the tree is usually a prolific seeder, especially when stunted (29) or growing in the open (44). Nearly every year some seed is borne, but particularly heavy crops are produced at intervals of 2 to 5 years (44). The seeds are small, 18,000 to 42,000 seeds to the pound (50).

Seeds are disseminated primarily by birds. The Bohemian waxwing is known to eat the berries in large numbers (33). Lines of bird migration, numbers of birds, prevalence of juniper berries, and scarcity of other food are undoubtedly factors

that affect distribution. Turkeys in the Southwest (36) and large mammals, such as bighorn sheep, may play some part in dissemination (51), but only small amounts of seed are spread by smaller mammals (33). Seed may also roll down slopes and drainageways from trees at the heads of canyons (33).

VEGETATIVE REPRODUCTION

Rocky Mountain juniper does not reproduce naturally by sprouts. However, it is reported that most junipers can be grown from cuttings and some from layers (50).

SEEDLING DEVELOPMENT

Germination and establishment

The seeds do not germinate during the first spring following maturity, but they germinate freely during the second spring. They must go through a period of "after-ripening," which may be as long as 14 to 16 months. During that period, several moisture and chemical changes occur within the seed. For that reason, the seed of Rocky Mountain juniper is sometimes referred to as belonging to the "class of 2-year seeds" (1). Germinative capacity has been found to vary from 32 to 58 percent, with an average of 45 percent (50).

Reproduction is generally sparse, possibly because of delayed germination and inability to establish readily on dry sites. Seedlings are found most often in the moist soil of rocky crevices and in canyons near perennial water (44). They do best in nurseries when provided with partial shade for the first year (50).

Early growth

According to Howell (18), seedlings reach 1 foot in height in 8 years in northern New Mexico and Arizona.

Seedling diseases

Juniper seedlings are highly resistant to damping off (50), but a juniper blight caused by Phomopsis juniperovora Hahn is

very destructive to nursery-grown Rocky Mountain junipers in both seedling and transplant beds (6, 12, 57). The disease is rare on wildlings and seldom attacks trees older than 4 years (13).

SAPLING STAGE TO MATURITY

Growth rate and size attained

Rocky Mountain junipers grow slowly and always remain small. According to Howell (18)^{2/}, they grow rather uniformly in height to age 40, when they average 13 to 14 feet. The rate of growth then declines, and 80-year-old trees are shown to average about 18 feet. Thereafter, they are shown to grow quite uniformly, about 0.55 foot per decade and reach 30 feet in about 300 years.

Diameter growth is also slow. Howell's data show a rather uniform growth of 0.79 inch per decade, at 1 foot above ground, from the time the trees are 1 foot tall until they reach an age of about 170 years. The rate then declines over a period of years to another constant rate of about 0.255 inch per decade after age 210. Diameters of trees 300 years old were found to average 17 inches at 1 foot above ground.

Sizes reported differ from place to place. In Canada, the tree is reported to reach 12 inches in diameter and 10 to 12, sometimes 30, feet in height (7). Trees on the north rim of the Grand Canyon are reported to be 15 to 20 feet high and 12 to 18 inches in diameter (10). Elsewhere in the Southwest, heights of 20 to 50 feet and diameters up to 18 inches are reported (26). Sudworth (43, 44) states that trees 6 to 8 inches in diameter are 130 to 175 years old. One extraordinary tree on the Cache National Forest in northern Utah measured 26 feet 8 inches in circumference at breast height and 45 feet in height (2).

They are long lived. Sudworth (43, 44) estimated they probably live 250 years and possibly 300 years. One specimen in Logan Canyon, Utah, is reported to be 3,000 years old (10).

^{2/} The different tables and figures in Howell's report contain some inconsistencies. The data cited here, taken from his table 6, seem most reliable. No other records of growth were found.

Yield

Howell (18) found, in northeastern Arizona and northern New Mexico, that all species in the pinyon-juniper averaged about 750 cubic feet per acre for trees with diameters of 3 inches and larger at 1 foot above the ground. Growth amounted to 9.4 cubic feet per acre per year. Rocky Mountain juniper made up 25 cubic feet or 3.3 percent of the total.

Competition

Rocky Mountain juniper on moist, cool sites endures rather dense shade during the seedling and early sapling stages. Later it requires top light for height growth because in dense, pure stands or under the deep shade or other tree species, the trunk branches die. In early life it has about the same degree of tolerance as eastern redcedar, but later is unable to endure as much shade as its eastern counterpart (44). In protected canyons and sheltered sites on the Pacific Coast, it is able to endure considerable shade of broadleaf trees (43). In the northern Rocky Mountains, it is considered more intolerant of shade than ponderosa pine, limber pine, or lodgepole pine (24).

Junipers in Utah have been observed to invade sagebrush stands on appropriate soils. Pinyon may follow the juniper and has a tendency to replace it (55).

Natural enemies

At least two cedar foliage rusts (Gymnosporangium globosum Farl. and G. juniperi-virginianae Schw.) are found on Rocky Mountain juniper (5). The latter is the destructive cedar apple blight, for which Rocky Mountain juniper is one of the alternate hosts (6).

Two similar cedar rusts (Gymnosporangium betheli Kern and G. nelsoni Arth.) cause galls on the stems of Rocky Mountain juniper. Mountain-ash (Sorbus spp.), hawthorn (Crataegus spp.), apple (Malus spp.), and other genera in the rose family act as alternate hosts for them (5). Extent of damage to wildlings is unknown, but some of those rusts are destructive to nursery-grown stock (6).

Juniper mistletoes (Phoradendron densum Torr. and P. juniperinum Engelm.) are found on Rocky Mountain juniper in Arizona and New Mexico (46). Extent of damage is not known.

Several insects attack Rocky Mountain juniper. In Nevada, Oregon, and Washington, a roundheaded borer (Callidium californicum Casey) has been found under the twig bark. A bark beetle (Phloeosinus scopulorum Sw.) attacks it in British Columbia and Washington. Cedar twig beetles (Phloeosinus spp.) kill twigs and frequently injure ornamentals and shade trees severely throughout the central and southern parts of its range. Cedar flatheaded borers (Chrysobothris spp.) have been found in the bark and wood of weakened, dying, and dead trees. A gall midge (Walshomyia insignis Felt) causes an oval, apical bud gall (22).

HYBRIDS AND VARIETIES

Two naturally occurring varieties of Rocky Mountain juniper have been reported: Juniperus scopulorum var. columnaris Fassett, found near Amidon, North Dakota, and J. scopulorum var. patens Fassett, found in the Big Horn Mountains of Wyoming and near Banff, Alberta. The former has a long, narrow crown rather than the typical wide, rounded or pyramidal crown. The latter, which may be a hybrid with creeping juniper (J. horizontalis Moench) is a depressed shrub (11).

Probably the most common hybrids of Rocky Mountain juniper are crosses with eastern redcedar. "Hybrid swarms" of the two species occur where their ranges overlap in northwest North Dakota, west central South Dakota, and northwest Nebraska. The region of hybridization extends through central Nebraska and Kansas to the Oklahoma border (11). Hall (14) refers to these hybrids as the Platte River race of eastern redcedar.

In the Southwest, near Flagstaff, Arizona, it appears that Rocky Mountain juniper crosses with alligator juniper (53).

Several horticultural and ornamental varieties have been reported. Among these are: J. scopulorum var. viridifolia D. Hill, "Chandler Blue" and "Hill Silver" (58).

PROPERTIES AND USES

The wood of Rocky Mountain juniper is fine grained with a white sapwood and a deep red heartwood with faint purplish and whitish streaks (26, 29). In color, odor, figuration, and strength properties, the wood could be substituted for eastern redcedar. It is somewhat lighter in weight and not so hard as the wood of its eastern counterpart (49).

Rocky Mountain juniper is planted in shelterbelts and as ornamentals. Because the heartwood is highly resistant to decay, the species is used locally for fence posts and poles. Other uses are for fuel, lumber, and cedar chests (17, 26, 29, 36, 41). Fuelwood volume tables for trees and stacked cordwood are available; the most accurate tree volume table is based upon diameter at 1 foot and average crown width (20).

LITERATURE CITED

1. Afanasiev, M., and Cress, M.
1942. Changes within the seeds of Juniperus scopulorum during the processes of after-ripening and germination. Jour. Forestry 40: 798-801.
2. American Forestry Association.
1955. These are the champs. Am. Forests 61(9): 31-40, illus.
3. Baker, Frederick S.
1944. Mountain climates of the western United States. Ecol. Monog. 14: 223-254, illus.
4. Beidleman, Richard G.
1953. The island of pines. Living Wilderness 18(46): 7-10, illus.
5. Boyce, John Shaw.
1943. Host relationships and distribution of conifer rusts in the United States and Canada. Conn. Acad. of Arts and Sci. Trans. 35: 366-383.
6. _____
1948. Forest pathology. Ed. 2, 550 pp., illus. New York.

7. Canada. Department of Mines and Resources.
1949. Native trees of Canada. Dominion Forest Serv.
Bul. 61, Ed. 4, 293 pp., illus.
8. Clements, F. E.
1920. Plant indicators: The relation of plant communities
to process and practice. Carnegie Inst. Wash.
Pub. 290, 388 pp., illus.
9. Costello, David F.
1954. Vegetation zones in Colorado. (Introduct. to
"Manual of the plants of Colorado" by H. D.
Harrington, 666 pp., Denver.) pp. iii-x.
10. Dodge, Natt N.
1936. Trees of Grand Canyon National Park. Grand
Canyon Nat. Hist. Bul. 3, 69 pp., illus.
11. Fassett, N. C.
1945. Juniperus virginiana, J. horizontalis, and
J. scopulorum. V. Taxonomic treatment.
Torrey Bot. Club Bul. 72: 480-482, illus.
12. Hahn, Glenn Gardner.
1941. Reports of cedar blight in 1940 and notes on its
previous occurrence in nurseries. U. S. Bur.
Plant Indus. Plant Dis. Rptr. 25: 186-190.
[Processed.]
13. _____, Hartley, Carl, and Pierce, Roy G.
1917. A nursery blight of cedars. Jour. Agr.
Res. 10: 533-540, illus.
14. Hall, M. T.
1952. Variation and hybridization in Juniperus.
Mo. Bot. Gard. Ann. 39: 1-64.
15. Harlow, William M., and Harrar, Ellwood S.
1937. Textbook of dendrology. 527 pp., illus. New York.
16. Herman, F. R.
1956. Growth and phenological observations of Arizona
junipers. Ecol. 37: 193-195, illus.

17. Hoffman, A. F.
1921. The pinon-juniper land problem. II: Plan for handling the pinon-juniper type. Jour. Forestry 19: 537-541.
18. Howell, Joseph, Jr.
1940. Pinon and juniper: A preliminary study of volume, growth and yield. U. S. Soil Conserv. Serv. Region. Bul. 71, Region 8, Forest Ser. 12, 86 pp. [Processed.]
19. _____
1941. Pinon and juniper woodlands of the Southwest. Jour. Forestry 39: 542-545.
20. _____, and Lexen, B. R.
1939. Fuel wood volume tables for Rocky Mountain red cedar (Juniperus scopulorum Sarg.). U. S. Forest Serv. Southwest. Forest and Range Expt. Sta., Res. Note 68, 2 pp.
21. Jeffers, D. S.
1921. The pinon-juniper land problem. I: Should the pinon-juniper lands be included in the national forests? Jour. Forestry 19: 534-537.
22. Keen, F. P.
1938. Insect enemies of western forests. U. S. Dept. Agr. Misc. Pub. 273, 280 pp., illus. (Rev. 1952.)
23. Kirkwood, J. E.
1922. Forest distribution in the northern Rocky Mountains. Mont. State Univ. Bul. 247, 180 pp., illus.
24. Larsen, J. A.
1930. Forest types of the northern Rocky Mountains and their climatic controls. Ecol. 11: 631-672, illus.
25. Lindsey, Alton A.
1951. Vegetation and habitats in a southwestern volcanic area. Ecol. Monog. 21: 227-253, illus.

26. Little, Elbert L., Jr.
1950. Southwestern trees, a guide to the native species of New Mexico and Arizona. U. S. Dept. Agr. Agr. Handb. 9, 109 pp., illus.
27. _____
1953. Check list of native and naturalized trees of the United States (including Alaska). U. S. Dept. Agr. Agr. Handb. 41, 472 pp.
28. Longyear, Burton O.
1925. Evergreens of Colorado. Ed. 2, 82 pp., illus. Fort Collins, Colo.
29. _____
1927. Trees and shrubs of the Rocky Mountain region with keys and descriptions for their identification. 244 pp., illus. New York.
30. Lutz, Harold J., and Chandler, Robert F., Jr.
1946. Forest soils. 514 pp., illus. New York.
31. Oosting, Henry J.
1948. The study of plant communities, an introduction to plant ecology. 389 pp., illus. San Francisco.
32. Pearson, G. A.
1931. Forest types in the Southwest as determined by climate and soil. U. S. Dept. Agr. Tech. Bul. 247, 144 pp., illus.
33. Phillips, Frank J.
1910. The dissemination of junipers by birds. Forestry Quart. 8: 60-73.
34. Preston, R. J., Jr.
1947. Rocky Mountain trees: A handbook of the native species with plates and distribution maps. Ed. 2. 285 pp., illus. Ames, Iowa.
35. Price, Raymond, and Evans, R. B.
1937. Climate of the west front of the Wasatch Plateau in central Utah. U. S. Monthly Weather Rev. 65: 291-301, illus.

36. Randles, Quincy.
1949. Pinyon-juniper in the Southwest. U. S. Dept. Agr. Yearbook 1949: 342-347.
37. Rasmussen, D. Irvin.
1941. Biotic communities of Kaibab Plateau, Arizona. Ecol. Monog. 11: 229-275, illus.
38. Sampson, A. W.
1925. The foothill-montane-alpine flora and its environment. U. S. Natl. Mus. Contrib. U. S. Natl. Herbarium 25: 24-31.
39. Sargent, Charles Sprague.
1890. The silva of North America: A description of the trees which grow naturally in North America exclusive of Mexico. 10: 93-96, illus. (Reprinted 1947.)
40. _____
1902. The silva of North America: A description of the trees which grow naturally in North America exclusive of Mexico. 14: 93-94, illus. (Reprinted 1947.)
41. Scott, Chas. A.
1929. Trees for eastern Colorado. Colo. Agr. Col. Ext. Bul. 275-A, 36 pp., illus.
42. Society of American Foresters, Committee on Forest Types.
1954. Forest cover types of North America (exclusive of Mexico). 67 pp., illus. Washington, D. C.
43. Sudworth, George B.
1908. Forest trees of the Pacific slope. U. S. Forest Serv. 441 pp., illus.
44. _____
1915. The cypress and juniper trees of the Rocky Mountain region. U. S. Dept. Agr. Bul. 207, 36 pp., illus.
45. Thornthwaite, C. W.
1948. An approach toward a rational classification of climate. Geog. Rev. 38: 55-94, illus.

46. U. S. Bureau of Plant Industry,
Soils, and Agricultural Engineering.
1950. Index of plant diseases of the United States.
Plant Dis. Survey Spec. Pub. 1: 276-281.
[Processed.]
47. U. S. Department of Agriculture.
1938. Soils and men. Agr. Yearbook 1938, 1232 pp.,
illus.
48. _____
1941. Climate and man. Agr. Yearbook 1941,
1248 pp., illus.
49. U. S. Forest Products Laboratory.
1956. Standard terms for describing wood. U. S. Forest
Prod. Lab. Rpt. 1169, 12 pp. [Processed.]
50. U. S. Forest Service.
1948. Woody plant seed manual. U. S. Dept. Agr.
Misc. Pub. 654, 419 pp., illus.
51. Van Dersal, William R.
1938. Native woody plants of the United States, their
erosion-control and wildlife values. U. S.
Dept. Agr. Misc. Pub. 303, 362 pp., illus.
52. Whitfield, C. J.
1933. The vegetation of the Pike's Peak region.
Ecol. Monog. 3: 75-105, illus.
53. Whiting, Alfred F.
1942. Junipers of the Flagstaff region. Plateau 15:
23-32, illus.
54. Woodbury, Angus M.
1933. Biotic relationships of Zion Canyon, Utah, with
special reference to succession. Ecol.
Monog. 3: 147-245, illus.
55. _____
1947. Distribution of pigmy conifers in Utah and
northeastern Arizona. Ecol. 28: 113-126, illus.

56. Woodin, Howard E., and Lindsey, Alton A.
1954. Juniper-pinyon east of the Continental Divide, as analyzed by the line-strip method. *Ecol.* 35: 473-489, illus.
57. Wright, Ernest, and Slagg, C. M.
1942. Some tentative conclusions resulting from plot analyses of *Phomopsis*-blighted juniper seedlings in Great Plains nurseries during 1941. (Abstract.) *Phytopath.* 32: 19.
58. Wyman, Donald.
1951. *Trees for American gardens.* 376 pp., illus. New York.

NATIONAL AGRICULTURAL LIBRARY



1022500799

* NATIONAL AGRICULTURAL LIBRARY



1022500799