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Juniperus of Canada and the United States: Taxonomy, Key and Distribution

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Abstract: The taxonomy of *Juniperus* of Canada and the United States is reviewed and keys to the 18 species, 5 varieties and 3 formas are presented as well as distribution maps.

Keywords: *Juniperus*, Cupressaceae, taxonomy, keys, distribution, Canada, United States.

The genus *Juniperus* consists of approximately 76 species and 27 varieties (Adams, 2014). All the taxa grow in the northern hemisphere, except *J. procera* Hochst. ex Endl. which grows along the Rift Mountains in east Africa, thence into the southern hemisphere (Adams, Demeke and Abulfatih 1993). Some of the Mediterranean *Juniperus* such as *J. oxycedrus* L., *J. phoenicea* L., and *J. thurifera* L. grow in the mountains of the northernmost part of Africa (Morocco, Algeria).

Juniperus of Canada and the United States was treated in the Flora of North America North of Mexico (Adams, 1993) and more recently in Adams (2008c) and in the monograph of *Juniperus* (Adams, 2014). This paper is presented to update recent changes in nomenclature that have resulted from new information obtained from DNA sequencing.

Juniperus L., Sp. Pl. 2: 1038. 1753. – Juniper, Cedar (the classical Latin name).

Perennial, evergreens, dioecious (or sometimes monoecious), prostrate to erect shrubs or trees. Roots fibrous, often exposed along cracks in rocks. Crowns strict (in young *J. virginiana*) to rounded or flat-topped (*J. virginiana* var. *silicicola*); branches variously oriented but not planar; bark reddish brown to gray, fibrous and exfoliating in strips, or rarely exfoliating in rectangular plates (*J. deppeana*). Twigs variously oriented, not flattened (not planar). Leaves persisting 3-5 years, of four types: (1) subulate (acicular or awn-shaped); (2) decurrent-blade deciduous (with an abscission layer between the blade and sheath, sections *Caryocedrus* Endl. and *Oxycedrus* Spach); (3) whip-leaves, (decurrent without an abscission layer between the blade and sheath, section *Sabina* Spach); and (4) scale leaves (section *Sabina* Spach). Whip-leaves are found on juvenile foliage and/or at the tips of rapidly growing shoots (but occasionally an entire mature tree will have only whip-leaves, and one species, endemic to Cuba, *J. saxicola*, has only whip-leaves). Scale leaves are closely appressed, decussate or ternate, often both decussate and ternate on the same branch. Foliage light to dark green, or often blue or silver glaucous, turning reddish to purple in some species in the winter. Leaf margins entire to denticulate (at 20-40× magnification). Stomatal bands on the adaxial surface of the leaves range from none (apparent) to one or two. All leaves have a single gland sometimes not visible, the glands vary from elongate to hemispherical (*J. ashei*), several species have ruptured glands that exude a white crystalline deposit. Pollen cones oblong, 3-5 mm, light tan to brown. Seed cones maturing in 1 or 2 years, persisting for several months to a year after maturity depending on bird predation pressure. Seed cones axillary or terminal, sessile to short peduncled, globose and "berry-like"; 3-20 mm in diameter, scales all fused, fleshy to fibrous to obscurely woody, indehiscent,

blue black, blue, rose, copper red, brown, brownish blue, purplish brown, usually with a blue or glaucous hue. Seeds wingless, 1-13 per cone, light tan to brown, with two hilum scars covering from ¼ to ¾ of the seed. Cotyledons several to numerous.

The genus is the source of numerous cultivars that are widely used for landscaping around the world. Mutants or "sports" are very common and are likely due to single gene mutations. Rare mutations affecting the plant habit and foliage are present in all species. Many of the "sports" have been given formal names or else incorrectly ascribed to hybridization or introgression. Due to the widespread exaggerations of the degree of hybridization, this topic is discussed after each treatment. Gymnocarpy (bare seeds protruding from the cone) is occasionally found in most junipers, particularly in the SW United States. This condition is due to insect larvae predation (see Zanoni, 1978).

Finally, it should be noted that aberrant specimens may be almost impossible to identify without chemical or molecular data. At present, I recognize 18 species, 5 varieties, and 3 formas of *Juniperus* in Canada and the United States.

Key to *Juniperus* of Canada and the United States

1. Leaves all acicular (subulate, jointed at the base), spreading (appressed in *J. jackii*); seed cones sessile, axillary; decumbent or rarely upright shrubs or shrubby trees (in the western hemisphere)
2. Seed cones globose, shorter or about equal leaf length (larger in vars. *charlottensis* and *megistocarpa*); Spreading, prostrate or upright shrubs (or shrubby tree in New England and NE US); leaves straight to curved, flat or V-shaped, not boat-shaped (boat-shaped in vars. *charlottensis* and *megistocarpa*), free from stem (25-90°), found in old abandoned fields and on fence rows; sand dunes (*megistocarpa*), muskeg swamps (*charlottensis*), mountain rocky areas (*kelleyi, depressa*)..... ..... ***J. communis***
2. Seed cones elongated ovoid (ellipsoid), especially when immature, as long as, or longer than leaf length; shrub, low to prostrate; leaves curved, boat-shaped, usually appressed to stem; found on serpentine or volcanic (ultramafic) rocks..... ***J. jackii***
1. Leaves decurrent (not jointed at the base), both whip- and scale-like; seed cones sessile to short peduncled, trees or decumbent to upright shrubs.
3. Whip- and scale-leaf margins entire (40× magnification) or with irregular teeth (40× magnification) and then with scale leaves with acuminate tips and tan-brown to brownish purple seed cones.
4. Whip- and scale-leaf margins with irregular teeth (40× magnification), scale leaves acuminate; seed cones (4-)6-10(-13) seeded, and tan-brown to brownish-purple; branches pendulous ... ***J. flaccida***
4. Whip- and scale-leaf margins smooth (entire) (40× magnification), scale leaves obtuse to acute to apiculate; seed cones 1-2(3) seeded, bluish black to brownish blue when mature; branches not drooping (but ultimate branchlets are often flaccid).
5. Prostrate to decumbent shrub; scale-leaves apiculate; both whip- and scale-leaves growing along the branchlets (on mature trees); peduncles generally curved ..... ***J. horizontalis***
5. Tree with 1(2-3) stems and rounded, flattened, pyramidal, or strict crowns; scale-leaves obtuse to acute; whip-leaves growing only at branchlet tips (on mature trees); peduncles generally straight.
6. Scale leaves not overlapping, or, if so, not by more than 1/5 the length, obtuse to acute; seed cones globose to reniform, maturing in 1 or 2 years.
7. Twigs (3-5 mm diameter) with smooth bark, twigs (6-15 mm diameter) with bark exfoliating in plates, reddish copper beneath; seed cones maturing in 2 years, most seed cones normal, rarely with exserted seeds W USA, Canada ..... ***J. scopulorum***
7. Twigs (3-5 mm diameter) with persistent dead whip-leaves, twigs (6-15 mm diameter) reddish brown beneath; seed cones maturing in 1 yr (14-16 months), often the seed cones with exserted (naked) seeds; Pacific northwest near the seaside in Georgia Straits and Puget Sound ..... ***J. maritima***

6. Scale leaves overlapping more than 1/4 length, acute; twigs (3-5 mm diameter) with persistent dead whip-leaves, twigs (6-15 mm diameter) with bark not exfoliating in plates, or, if so, brownish beneath; seed cones ovoid, maturing in 1 year. E USA, Canada ..... ***J. virginiana***
3. Whip- and scale-leaf margins denticulate (20× magnification).
8. Seed cones with (1-)2-6 seed, fibrous to obscurely woody; trunk bark in square or quadrangular plates (except in fo. *sperryi* with bark that exfoliates in strips)..... ***J. deppeana***
8. Seed cones 1-2(-3) seeded, fleshy to fibrous (when mature and fresh), fibrous to woody only in *J. californica*; trunk bark exfoliates in thin strips.
9. Scale leaves with a raised hemispherical gland, whip-leaves with raised gland.
10. Whip-leaf glands hemispherical and raised (dome-shaped), scale leaf glands hemispherical to oval; 1 seed /cone (rarely 2, avg. 1.01), seed cones (8) 9 (10) mm diameter; bark on branches often with patches of white fungus..... ***J. ashei***
10. Whip-leaf glands oval to elliptical and raised; 2 seeds /cone (avg. 1.7), seed cones (5) 6 (-8) mm diameter ..... ***J. ovata***
9. Scale leaves without a raised hemispherical gland, glands oval to elongate, flat or sunken.
10. Mature seed cones orange, reddish orange, red, bronze, or reddish brown, appearing pink or rose-color if covered with bloom; glands on whip-leaves visible, raised.
11. Mature seed cones orange to red, with light bloom appearing pink or rose colored; whip-leaf ventral side white glaucous, glands on whip leaves elongated and divided (often 3 glands); often single stemmed shrub-trees with stocky, clumpy foliage
12. Whip-leaf glands half or less as long as the associated sheath; large shrub to small tree with ascending limbs ..... ***J. arizonica***
12. Whip-leaf glands more than half as long as the associated sheath; shrub to small tree with upper limbs spreading, not usually ascending..... ***J. coahuilensis***
11. Mature seed cones copper to reddish brown, with no bloom; whip leaf ventral side not white glaucous, glands on whip-leaves oval, not divided; shrubs with elongated terminal whips (except in extreme desert conditions)..... ***J. pinchotii***
10. Mature seed cone dark blue, dark bluish black to bluish brown, with a light to heavy coat of bloom appearing light blue; glands on whip-leaves visible or not visible.
13. Glands on scale leaves visible (conspicuous) or barely visible (in *J. monosperma*), ruptured or not ruptured; plants dioecious (50% monoecious in *J. occidentalis*, then with ruptured leaves); seed cones 5-10 mm diameter, glaucous or not, 1-2(3) seeded.
14. Seed cones 5-10 mm long; maturing in 2 yrs, 1-2(3) seeded; bark on twigs (5-10 mm diameter) reddish and exfoliating in scales or flakes; single-stemmed tree to 20(-30) m; dioecious or monoecious.
15. Trunk bark red-brown; seeds cones avg. 7.6 mm (5-9); approx. 95% of the plants dioecious; leaf glands usually not ruptured, if ruptured with clear to light yellow exudate ..... ***J. grandis***
15. Trunk bark brown; seeds cones avg. 8.3 mm (7-10); approx. 50% of the plants dioecious; leaf glands ruptured with yellow exudate turning dark brown to black..... ***J. occidentalis***
14. Seed cones 6-10 mm long, maturing in 1 year, 1(2-3) seeded; bark on twigs brown to ash, not exfoliating in scales or flakes; shrubs to small trees, mostly dioecious.
16. Seed cones with a fibrous to woody pericarp, (7-)9-10(-13) mm diameter, bluish brown under glaucous bloom; dioecious (very rarely monoecious); scale leaf glands conspicuous, whip-leaf glands seldom ruptured with a clear exudate, ultimate twigs approx. as wide as scale-leaf length ..... ***J. californica***
16. Seed cones with a soft, juicy pericarp, 6-8 mm diameter, reddish blue to brownish blue, globose to ovoid; dioecious, scale-leaf glands barely visible, not conspicuous, few (less than 1/5) of the whip-leaf glands with a white crystalline exudate (visible without a lens), ultimate twigs approx. 2/3 as wide as scale-leaf length ..... ***J. monosperma***
13. Glands on scale leaves not conspicuous (embedded in the leaf, therefore not visible), not ruptured; plants monoecious; seed cones bluish brown, very glaucous, 8-9 mm diameter 1(2)-seeded..... ***J. osteosperma***

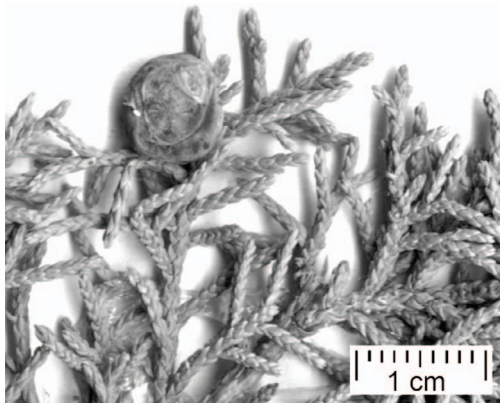

FIG. 1. *Juniperus arizonica*. Leaves and seed cone (*R. P Adams 2132*, BAYLU).

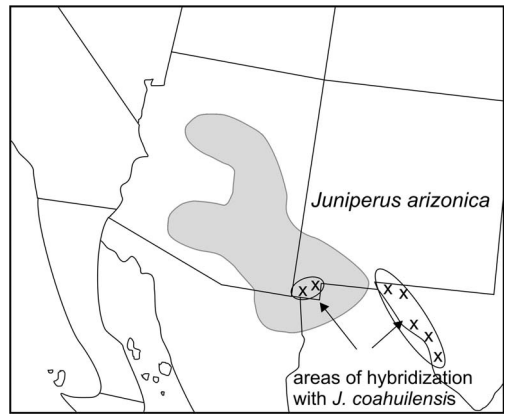

FIG. 2. Distribution of *Juniperus arizonica*.

Juniperus arizonica R. P. Adams, Phytologia 88(3): 306 (2006). *Juniperus coahuilensis* (Martínez) Gaussen ex R. P. Adams var. *arizonica* R. P. Adams, Biochem. Syst. Ecol. 22 (7): 708 (1994). TYPE: United States, Arizona, Yavapai Co., 72 km south of Flagstaff, 1160 m, *R. P. Adams 2132* (HOLOTYPE: BAYLU!).

DIOECIOUS. LARGE SHRUB TO SMALL TREE, 3-8 m, often with a single stem to 1 m, with flattened-globular or irregular crowns. TRUNK BARK brown, thin, exfoliating in long ragged strips. BRANCHES ascending to erect in shrubs, but spreading in trees. Branch bark scaly, ashy gray. Stumps sprouting after burning or cutting. LEAVES decurrent (whip) and scale. Whip- and scale-leaf margins denticulate (20× magnification), white glaucous on adaxial leaf surface. At least ¼ or more of the whip-leaf glands with a white crystalline exudate. SEED CONES rose to pinkish but yellow orange, orange or dark red beneath the white-blue glaucous bloom, soft and juicy, globose to ovate, 6-7 mm diameter, 1(-2) seeded. SEEDS 4-5 mm long, the hilum scar pale brown, approx. ½ as long as seed. POLLEN SHED late fall to early winter. Fig. 1.

COMMON NAME: Arizona juniper.

DISTRIBUTION: United States. Arizona: South of the Mogollon Rim; southwestern New Mexico. Mexico. (Fig. 2).

HABITAT: *Bouteloua* grasslands and adjacent rocky slopes; 980-1600 (-2200) m. Northeastern Sonora.

STATUS: abundant and weedy in many areas. It sprouts from cut stumps.

USES: fence posts.

Adams et al. (2006) recently reviewed the taxonomy and on the basis of combined nrDNA and *trn*C-*trn*D sequence data, plus Random Amplified Polymorphic DNAs, and terpenoids and concludes that *J. coahuilensis* var. *arizonica* merits recognition at the species level as *J. arizonica*. *Juniperus arizonica* and *J. coahuilensis* hybridize in the trans-Pecos, Texas area and in southwestern New Mexico (Adams, 2017).

Juniperus ashei J. Buchholz, Bot. Gaz. 90(3): 329. 1930. TYPE: UNC, Sylamore, Arkansas, *W.W. Ashe s.n.* 1923-1925, (LECTOTYPE, 22520 UNC! Limestone bluffs on the White River, near Sylamore, Arkansas, Hall, Rhodora 56: 176. 1954).

The type for *J. ashei* consisted of one male and three female specimens (Hall, 1954). Hall (1954) selected a female specimen (acc. number 22520, dated Sept. 16, 1923, UNC) and designated it as the lectotype.

Cupressus sabinoides Kunth, Nov. Gen. Sp. 2: 3. 1817. *Juniperus sabinoides* (Kunth) Nees, Linnaea 19: 706. 1847, *non* Griseb. (1846)

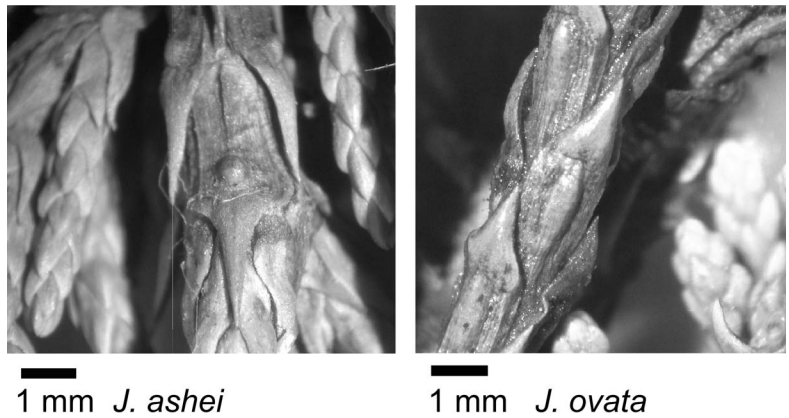

FIG. 3. Comparison of whip-leaf glands for *Juniperus ashei* (*R. P. Adams 10399*, BAYLU) with raised hemispherical gland and *Juniperus ovata* (*R. P. Adams 11309*, BAYLU) with oval shaped glands.

Sabina sabinoides Small, Fl. S.E. U. S. 33: 1326, (1903).

Juniperus sabinoides Sarg., Silva 10: 91. 1896, *non* Griseb. (1846).

Juniperus occidentalis Hook. var. *texana* Vasey, (Cat. Forest Trees U.S. 37) Rep. Commiss. Agric. 1875: 185. 1876.

Juniperus occidentalis Hook. var. *conjugens* Engelm., Trans. Acad. Sci. St. Louis 3: 590. 1878

Juniperus tetragona Moench var. *oligosperma* Engelm., Trans. Acad. Sci. St. Louis 3: 590. 1878

Juniperus mexicana Spreng. in part, see Zanoni, 1978.

DIOECIOUS. TREES with broad, bushy rounded or irregularly open crown, to 15 m, with a single trunk branching at 1-3 m or occasionally branching at the base. TRUNK BARK exfoliating in thin brown strips. BRANCHES brown but usually with a grey-white fungus. LEAVES both whip- and scale-like. Whip-leaves with a raised, hemispherical gland (not prominent on scale leaves). Whip- and scale-leaf margins denticulate (20× magnification). SEED CONES ovoid to subglobose, maturing in one year, dark blue and glaucous, 6-9 mm in diameter 1(2-3) seeded. SEEDS 4-6 mm long. CHROMOSOME NUMBER $2n = 22$ (Irving, 1980). POLLEN SHED Dec-Feb. Fig. 3.

COMMON NAMES: Mountain cedar, rock cedar, post cedar, Mexican Juniper, Ashe juniper.

DISTRIBUTION: United States: Arkansas, Oklahoma, Texas. Northern Mexico, Fig. 4.

HABITAT: limestone glades and bluffs, 150-600 m.

STATUS: abundant on limestone in central/west Texas, range is expanding; regarded as a weed in Texas.

USES: source of Texas cedar wood oil (Adams, 1987), fence posts.

All of the material cited by Buchholz (1930) was collected on limestone bluffs, above the White River, near Sylamore, Arkansas. It is clear in Buchholz (1930) that his illustration is of *J. ashei* var. *ashei*, with the hemispherical glands on the whip-leaves (Fig. 3). See Adams and Baker (2007), Adams (2008a), Adams (2014) for further taxonomic considerations.

Juniperus californica Carrière, Type: illustration in Rev. Hort. Ser. 4, 3: 352. 1854. United States, California, location unknown, lectotype chosen by Farjon (p.252, 2005), P! Fig. 5.

Sabina californica (Carrière) Antoine, Cupress.-Gatt.: 52. 1857.

Juniperus pyriformis A. Murray ex Lindl., Gard. Chron. 1855: 420. 1855.

Juniperus cedrosiana Kellogg, Hesperian 4: 3. 1860.

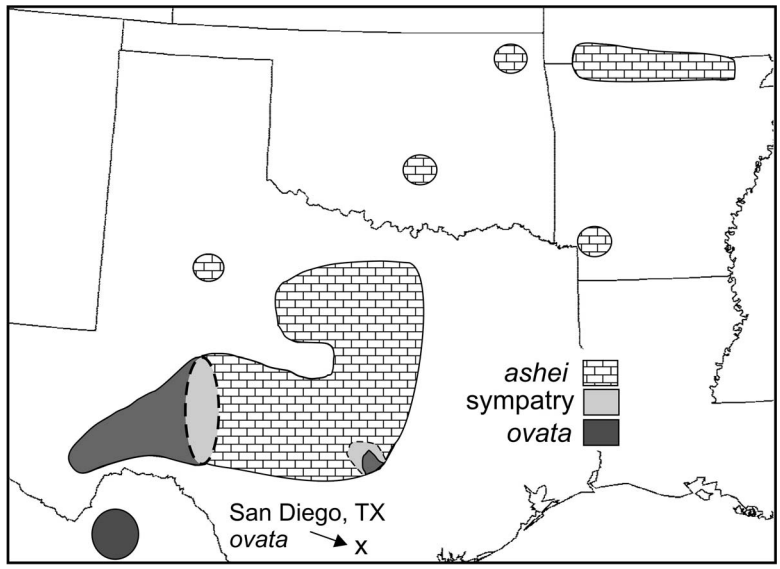

FIG. 4. Distribution of *Juniperus ashei* and *Juniperus ovata*. Areas of sympatry are shown in dash-line, gray areas in south-central Texas (New Braunfels) and the trans-Pecos area.

Juniperus cerrosianus Kellogg, Proc. Calif. Acad. Sci. 2: 37. 1863.

Juniperus californica Carrière fo. *lutheyana* J. T. Howell & Twisselm., Four Seasons 2(4): 16. 1968.

Juniperus. occidentalis sensu Parl. *non* Hooker

DIOECIOUS (RARELY MONOECIOUS, 1.9%). SHRUBS multi- (seldom one) stemmed shrub-tree, 2-8 m, with round crown. TRUNK BARK on twigs (5-10 mm diameter) brown or gray, not exfoliating in scales or flakes. BRANCHES, ultimate branchlets approx. as wide as scale-leaf length; scale leaves closely appressed and generally flattened, branchlets terete. LEAVES both whip and scale. Leaf glands conspicuous. Whip- and scale-leaf margins denticulate (20× magnification). SEED CONES bluish brown, white glaucous, reddish brown, beneath glaucous bloom, (7-)9-10(-13) mm, maturing in 1 year. SEEDS 1(2-3) per cone (avg. 1.3), 5-7 mm long. POLLEN SHED Jan-March.

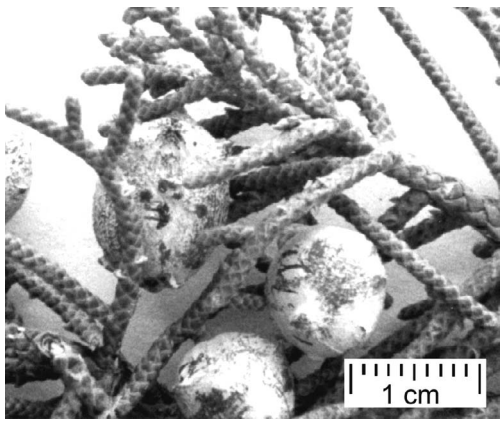

FIG. 5. *Juniperus californica*. Leaves and seed cones (*R. P. Adams 10154*, BAYLU).

COMMON NAME: California juniper.

DISTRIBUTION: United States: Arizona, California, Nevada. Mexico: Baja California (Fig. 6).

HABITAT: dry, rocky slopes and flats; 750-1600 m.

STATUS: common and expanding its range (Miller and Rose, 1995).

USES: none known, possibly fence posts.

Two chemical (volatile leaf oils) races were described by Vasek and Scora (1967) and reconfirmed by Adams et al. (1983). These two chemo-types were not found using the volatile wood oils test (Adams, 1987). To date, no morphological character or any DNA polymorphisms appear to be correlated with the chemical races.

FIG. 6. Distribution of *Juniperus californica*. Xs denote outlying populations.

Juniperus coahuilensis (Martínez) Gaussen ex R. P. Adams, Phytologia 74: 450 (1993). *Juniperus erythrocarpa* var. *coahuilensis* Martínez, Anales Inst. Biol. Univ. Nac. México 17: 115-116. 1946. TYPE: Mexico, Coahuila, Sierra de los Hechiceros, Cañón de la Madera, I.M. Johnson (with C.H. Muller) 1290, (HOLOTYPE: MEXU!; ISOTYPES: GH, NA, TENN, TEX).

Juniperus erythrocarpa Cory, Rhodora 38: 186-187. 1936. *Juniperus pinchotii* var. *erythrocarpa* (Cory) J. Silba, Phytologia Mem. 7: 35. 1984.

DIOECIOUS. TREES large shrub to small tree, 3-8 m, often with a single stem to 1 m, with flattened-globular or irregular crowns. TRUNK BARK brown, thin, exfoliating in long ragged strips. BRANCHES ascending to erect in shrubs, spreading in trees. Branch bark scaly, ashy gray. Stumps sprouting after burning or cutting. LEAVES both whip and scale. Whip- and scale-leaf margins denticulate (20×), white-glaucous on adaxial leaf surface. At least ¼ or more of the whip-leaf glands with a white crystalline exudate. SEED CONES rose to pinkish but yellowish orange, orange or dark red beneath the whitish blue glaucous layer, soft and juicy, globose to ovate, 6-7 mm diameter, 1(-2) seeded. SEEDS 4-5 mm long, the hilum scar pale brown, approx. ½ as long as seed. POLLEN SHED late fall - early winter. Fig. 7.

COMMON NAME: Rose fruited juniper.

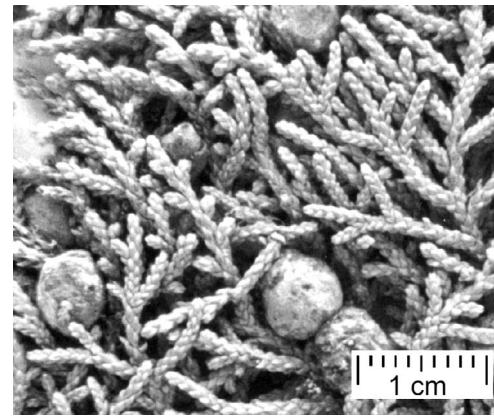

FIG. 7. *Juniperus coahuilensis*. Leaves and seed cones (*R. P. Adams 6829*, BAYLU).

DISTRIBUTION: 980-1600 (-2200) m, United States: trans-Pecos Texas. Mexico: common in northern Mexico around the margins of the Chihuahuan Desert (Fig. 8).

HABITAT: *Bouteloua* grasslands and adjacent rocky slopes.

STATUS: abundant and increasing.

Cory (1936) collected his type specimen from the base of Mt. Emory, in the Basin, Big Bend National Park from a tree with bright red seeds cones. Unfortunately, this a hybrid zone between *J. coahuilensis* and *J. pinchotii* (see Adams and Kistler, 1991) and his specimen is clearly a hybrid. Hybridiza-

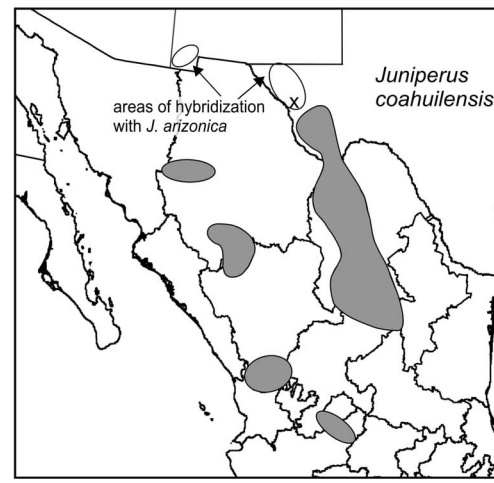

FIG. 8. Distribution of *Juniperus coahuilensis*.

tion between *J. coahuilensis* and *J. monosperma* appears likely in Arizona (see *J. monosperma*). Hybridization between *J. coahuilensis* and *J. pinchotii* occurs in the Big Bend National Park, Brewster Co., Texas (Adams and Kistler, 1991) and possibly near Saltillo, Mexico. *Juniperus arizonica* and *J. coahuilensis* hybridize in the trans-Pecos, Texas area and in southwestern New Mexico (Adams, 2017).

USES: fence posts. It sprouts from cut stumps.

Juniperus communis L. var. ***communis*** Sp. Pl. 2: 1040 (1753). TYPE: (Europe, Alps?), leg. ign., (LECTOTYPE BM-HSC, see Jarvis et al., 1993).

See Adams, 2014 for synonymy.

The taxonomy of *J. communis* in North America has recently been reviewed and revised based on morphology, Random Amplified Polymorphic DNAs and nrDNA SNPs (Adams, 2008b, 2014) and five varieties were recognized for North America.

KEY TO *JUNIPERUS COMMUNIS* VARIETIES IN NORTH AMERICA:

1. Strict (columnar) trees; leaves long (15-20(-30) mm, straight (not curved) ..... var. ***communis***
1. Shrubs; leaves short (<15 mm), curved.
2. Seed cones 10 –13 mm diameter, much larger than leaf length; known only from Southeastern Canada..... var. ***megistocarpa***
2. Seed cones 6 –9 mm diameter, smaller or slightly larger than leaf length; other than Southeastern Canada.
3. Glaucous stomatal band twice or more as wide as each green leaf margin, boat-shaped, curved leaves; mature seed cones length greater than leaf length; spreading, mat-like shrub; grows in sphagnum (muskeg) bogs, Calvert Island to Queen Charlotte Islands, and north to Chichagof Island, Alaska.. ..... var. ***charlottensis***
3. Glaucous stomatal band 1.5, 2, 3, 4 times as wide as each green leaf margin, not in sphagnum bogs, widespread in mountains in Canada and United States, absent in Calvert Island to Queen Charlotte Islands, and north to Chichagof Island, Alaska.
4. Glaucous stomatal band about as wide to 1.5x as wide as each green leaf margin; prostrate or low shrub with ascending branchlet tips (or occasionally a spreading shrub); leaves upturned, rarely spreading, linear to curved..... var. ***depressa***
4. Glaucous stomatal band twice or more as wide as each green leaf margin, spreading, mat-like or upright shrubs; leaves usually spreading, mostly linear.
5. Gland on brown sheath long, narrow, raised; immature seed cones elongated to subglobose; leaves curved, boat-shaped, appressed to stem or leaf above on branchlet; shrubs, usually prostrate or mat-like on serpentine or ultramafic rock (sometimes on volcanic lava, rarely on granite); northwestern California, western Oregon, Olympic Mts., Washington ..... ***J. jackii*** (included in this key as it is often confused with var. *kelleyi*)
5. Gland on brown sheath elongated oval or if a long narrow gland, then with a rounded bottom end; immature seed cones globose; leaves most straight to slightly curved, not usually boat-shaped, free (not appressed to stem or leaf above on branchlet); usually shrubs to 0.5 m tall with upturned to elevated branchlets, not on serpentine, but grows in various habitats from granite, sandstone, alluvial, sand, and lava; northwestern United States, western Canada. .... var. ***kelleyi*** (prev. treated as var. ***saxatilis***)

Juniperus communis L. var. ***communis***,

This variety is common in Europe and naturalized in New England, New York, West Virginia, may also be present in Pennsylvania and Virginia (Adams et al., 2016). Hybridizes with *J. communis* var. *depressa* (Adams et al. 2016). Figures 9.1 - 9.4 show DNA verified *J. communis*. var. *communis* from West Virginia and Maine.

COMMON NAME: Common juniper.

FIG. 9.1. *Juniperus communis* var. *communis* (*R. P. Adams 14503*, BAYLU), Otter Creek, West Virginia.

Juniperus communis var. **charlottensis** R. P. Adams, Phytologia 90(2): 187. 2008b. TYPE: Canada, Queen Charlotte Island, 9 km south of Masset, on hwy 16, in muskeg bog, 53° 55.511′N, 132° 06.471′W, 61 m, 2004, *R. P. Adams 10306* (HOLOTYPE: BAYLU!).

DIOECIOUS. LOW SHRUBS with upturned branchlets. TRUNK BARK brown, exfoliating in wide strips or plates. BRANCHES spreading and upturned. LEAVES acicular, imbricate to open, curved, boat-shaped, tips apiculate to mucronate, 5-7 mm x 1.6 mm. Glaucous stomatal band twice as wide as each green leaf margin. SEED CONES 8-9 mm, larger than leaf length, dark blue when mature (2-3yrs).

FIG. 9.2. Habitat *Juniperus communis* var. *communis*, Otter Creek, West Virginia.

FIG. 9.3. *Juniperus communis* var. *communis* (*Gilman 07229*), Bingham, Maine.

SEEDS 1(2) per cone. POLLEN SHED spring. Fig. 10.

COMMON NAME: Queen Charlotte Island juniper.

DISTRIBUTION: Calvert Island to Queen Charlotte Islands, Canada and north to Chichagof Island, Alaska, (Fig. 11).

HABITAT: sphagnum bogs.

STATUS: at present, the habitat (sphagnum bogs) seems conserved, so this variety does not appear to be threatened nor endangered.

USES: none known.

FIG. 9.4. Google Earth 'street view' of power-line near Bingham, Maine. Arrow points possible, pyramidal *Juniperus commnunis* var. *communis* tree.

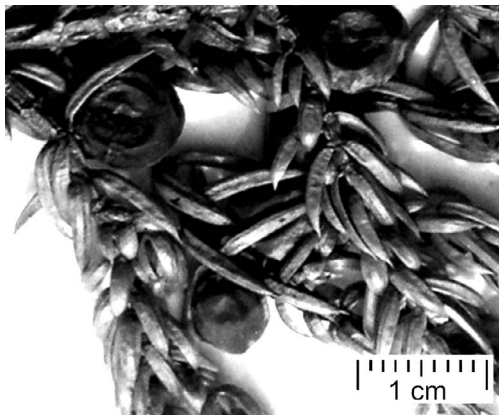

FIG. 10. *Juniperus communis* var. *charlottensis*. Leaves and seed cones (*R. P. Adams 10304*, BAYLU).

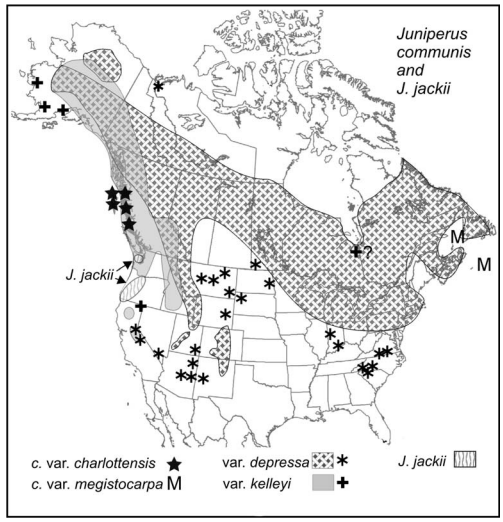

FIG. 11. Distribution of *Juniperus communis* in North America.

Juniperus communis var. **depressa** Pursh, Fl. Amer. Sept. 2: 646. 1814. TYPE: unknown, (Coll. F. T. Pursh? see Farjon, 2005, p. 270), said to be from New York, and particularly in the province of Maine. *Juniperus depressa* (Pursh) Raf., Med. Fl. 2: 13. 1830. *Juniperus communis* L. subsp. *depressa* (Pursh) Franco, Bol. Soc. Brot. ser. 2, 36: 117. 1962. *Juniperus. communis* L. subsp. *depressa* (Pursh) A. E. Murray, Kalmia 12:21 (1982).

Juniperus canadensis Lodd. ex Burgsd., Anleit. Sich. Erfzieh. Holzart. 2: 124. 1787. *Juniperus communis* L. var. *canadensis* (Lodd. ex Burgsd.) Loudon, Arbor. Frutic. Brit. 4: 249. 1838.

Juniperus depressa Raf. ex M'Murtrie, Florula Louisvill., 219. 1819.

Juniperus intermedia Schur, Verh. Mitth. Siebenburg. Vereins Naturwiss. Hermannstadt 2: 169.1851.

Sabina multiova Goodwyn, Amer. Bot. (Binghamton) 37(4): 152. 1931.

DIOECIOUS. PROSTRATE OR LOW SHRUBS with ascending branchlet tips (or occasionally a spreading shrub to 3 m). TRUNK BARK brown, exfoliating in wide strips or plates. BRANCHES erect to ascending. LEAVES acicular, upturned, rarely spreading, linear, acuminate, tips acute to mucronate, to 15.0 × 1.6 mm. Glaucous stomatal band approx. as wide as or to 1.5x each green leaf margin. SEED CONES 6-9 mm, smaller than leaf length, dark blue when mature (2-3 years). CHROMOSOME NUMBER $2\underline{n} = 22$ (Hall, Mukherjee and Crowley, 1979). SEEDS 3 per cone. POLLEN SHED spring. Fig. 12.

COMMON NAME: Depressed juniper.

DISTRIBUTION: common in mountains in United States and Canada (Fig. 11).

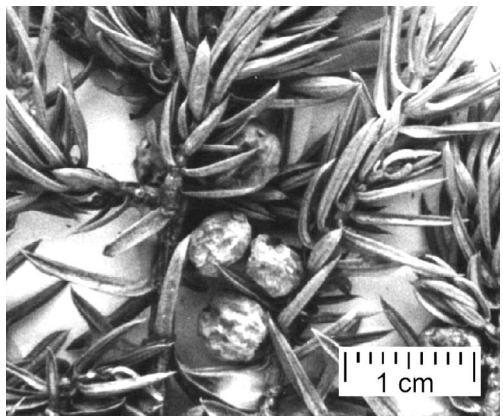

FIG. 12. *Juniperus communis* var. *depressa*. Leaves and seed cones (*R. P. Adams 7802*, BAYLU).

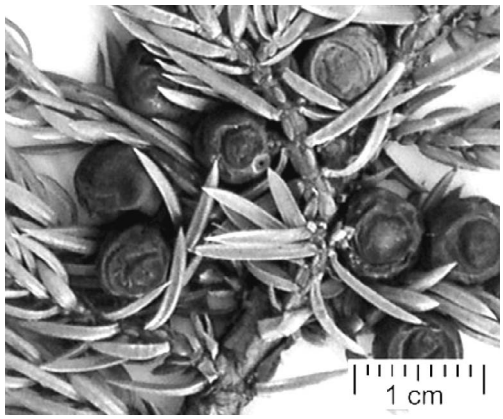

FIG. 13. *Juniperus communis* var. *kelleyi*. Leaves and seed cones from Redfish Lake, Idaho, United States, cf *R. P. Adams 10890* BAYLU.

HABITAT: rocky soil, rocky slopes and summits, sea level to 2800 m due to latitudinal range.

STATUS: common and expanding into disturbed areas. Not threatened.

USES: none known.

Juniperus communis var. **kelleyi** R. P. Adams, Phytologia 95(3): 215. 2013. TYPE: USA, Idaho, Blaine Co., on shore of Little Redfish Lake, 44° 09.588′ N, 114° 54.372′ W, 1997 m, 2005, R. P. *Adams 10892* (HOLOTYPE: BAYLU!).

SHRUBS, similar to *J. communis* var. *depressa*, but differing in having curved to slightly curved leaves, with cross section concave and stomatal band 1.5-2 x width of green leaf margins, leaf blades free, 30° to 80° to the stem; seed cones about as long as leaves, ovoid, purple-blue when mature.

Gland on brown sheath elongated oval or if a long narrow gland, then with a rounded bottom end, immature seed cones globose, leaves most straight to slightly curved, not usually boat-shaped, free (not appressed to stem or leaf above on branchlet), usu. shrubs to 0.5 m tall with upturned to elevated branchlets, not on serpentine, but grows various habitats including granite, sandstone, alluvial, sand, and lava. Other specimens studied: *Adams 10890, 10891, 10893, 10894* (BAYLU!). Fig. 13.

Juniperus communis var. *kelleyi* is common in the NW United States and BC, Canada. In British Columbia and Alaska, var. *kelleyi* and var. *depressa* appear to intergrade. Variety *kelleyi* has been treated as *J. communis* var. *saxatilis* Pall., but recent DNA sequencing found that var. *saxatilis* is restricted to the Eastern Hemisphere (Adams, 2013c).

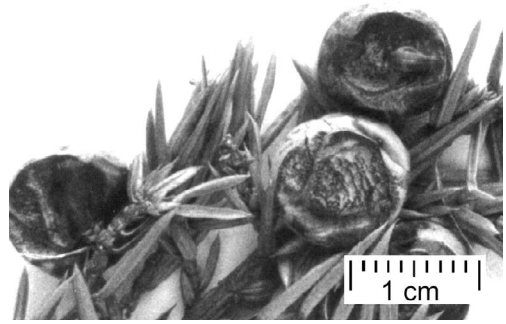

FIG. 14. *Juniperus communis* var. *megistocarpa*. Leaves and seed cones (*R. P. Adams 8575*, BAYLU).

Juniperus communis var. **megistocarpa** Fernald & H. St. John, Proc. Bos. Soc. Nat. Hist. 36: 58. 1921. TYPE: Canada. Quebec: Madeleine Islands, Alright Island, Narrows, 1912, *M. L. Fernald with B. H. Long 6729* (HOLOTYPE: GH!).

DIOECIOUS. PROSTRATE SHRUBS. TRUNK BARK cinnamon, exfoliating in wide strips or plates. BRANCHES mostly prostrate on the ground. LEAVES acicular, boat-shaped, curved, 7-10 mm, stomatal band 1.5 x as wide as green leaf margins. SEED CONES very glaucous, purplish blue, mature in 2-3 yrs, 9-13 mm, larger than leaf length. SEEDS 1–3 per cone. POLLEN SHED spring? Fig. 14.

COMMON NAME: Large fruited common juniper.

DISTRIBUTION: Newfoundland, Nova Scotia: Sable Island, Quebec: Magdalene Island, Canada. (Fig. 11).

HABITAT: sand dunes, serpentine and limestone barrens; 0-500 m.

STATUS: this is a very restricted taxon and can easily become threatened.

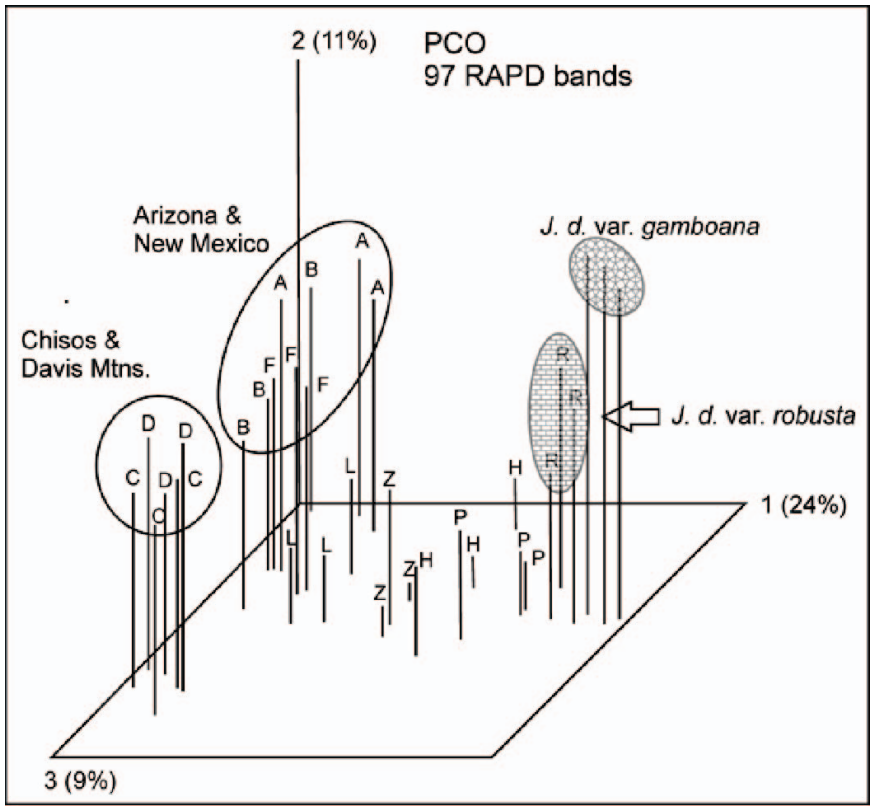

FIG. 15. Principal Coordinate Analysis of *Juniperus deppeana* varieties, from Adams et al. (2007). The first principal coordinate separates var. *gamboana* and var. *robusta* from the other *Juniperus deppeana* varieties. Notice some separation between the Arizona - New Mexico and the Texas Chisos - Davis Mountains populations of *Juniperus deppeana* var. *deppeana*.

This is the most distinct variety of *J. communis,* especially in its seed cone size, it habitat on sand dunes, and DNA data, yet it appears to be of only recent (Pleistocene) origin (Adams et al., 2003).

Juniperus deppeana Steud., Nomencl. Bot. ed. 2, 1: 835. 1840. TYPE: (apparently destroyed) Mexico, Veracruz: Llanos de Perote, *Schiede in 1828*, (LECTOTYPE: MO, designated by Zanoni and Adams, Bol. Soc. Bot. México 38: 83, 1979).

Juniperus thurifera Spach, Ann. Sci. Nat. Bot., ser. 2, 16: 298. 1841, *non* L. 1753.

Juniperus mexicana Schiede ex Schltdl. & Cham., Linnaea 5: 77. 1830, *non* Spreng., 1826.

Juniperus foetida Spach, Hist. Nat. Veg. Phan. 11: 314. 1841.

Juniperus gigantea Roezl, in part, Cat. Graines Conif. Mexic. 8. 1857. *Sabina gigantea* (Roezl) Antoine, Cupress. Gatt.: 38 1857.

Juniperus deppeana Steud**.** var. *pachyphlaea* (Torr.) Martínez, Anales Inst. Biol. Univ. Nac. México 17(1): 53. 1946, (HOLOTYPE: United States: New Mexico, Zuni Mountains, Bigelow in 1853, NY!)

Juniperus pachyphlaea Torr., Pacific Railr. Rep.4(5): 142. 1857. *Sabina pachyphlaea* (Torr.) Antoine, Cupress. Gatt.: 39. 1857.

Sabina plochyderma Antoine, Cupress. Gatt.: 40. 1857. *nom nud.*

Adams, Zanoni and Hogge (1984), using leaf terpenoids examined the varieties of *J. deppeana*. They found that samples from Arizona (BA, SA) to be rather distinct from the other *J. deppeana* varieties (Fig. 15). However, additional research using DNA sequencing and fingerprinting (Adams et al., 2007), confirmed that there is only one variety in the southwestern United States (*J. deppeana* var. *deppeana*).

KEY TO FORMS OF ***JUNIPERUS DEPPEANA***:

1. Stem bark longitudinally furrowed into long, interconnected strips; terminal whip branches often flaccid and somewhat pendulous ..... fo. ***sperryi***
1. Stem bark in quadrangular plates; terminal whip branches ascending to erect.
2. Terminal whips long (15-30 cm) and pendulous, all (or nearly all); leaves on adult plants juvenile (decurrent, whip-type)..... fo. ***elongata***
2. Terminal whips short (5-10 cm) and not pendulous; all leaves on adult plants scale-like (except on new growth where whip-leaves occur) ..... var. ***deppeana***

Juniperus deppeana Steud. var. ***deppeana,***

DIOECIOUS. TREES 10-15(-30) m, with rounded crown. TRUNK BARK in rectangular plates, (Fig. 16). BRANCHES erect, often gray green or light green, branchlets (1 cm) exfoliating to reveal copper color. LEAVES both decurrent (whip) and scale. Decurrent and scale leaf margins denticulate (20× magnification), whip and scale leaves usually with ruptured glands (clear, yellow or white exudate). SEED CONES globose, 8-15 mm across, fibrous to obscurely woody, maturing in the second year, reddish tan to dark reddish brown with glaucous bloom, (Fig. 17). SEEDS 2-4 per cone, 6-9 mm long. POLLEN SHED late winter - early spring.

FIG. 16. United States National Big Tree for *Juniperus deppeana* var. *deppeana* in the Prescott National Forest, Arizona. Craig Walton is on the left and David Emerson is on the right. Photo courtesy of Craig Walton, 2008.

COMMON NAMES: Alligator bark juniper, Cedro, Cedro chins (Puebla), Sabino, Tascate (Chihuahua and Durango), Tlascal or Tlaxcal (Hidalgo), Huata, Agoziza (Sonora).

HABITAT: rocky soils, slopes and mountains; 2000-2900 m.

DISTRIBUTION: United States: Arizona, New Mexico, Texas. Northern Mexico (Fig. 18).

STATUS: common, not threatened.

USES: fence posts. Sprouts from cut stumps and is difficult to eradicate.

Adams et al. (2007) show (Fig. 15) that there is some differentiation between populations of var. *deppeana* from Arizona and New Mexico and those from the Chisos and Davis Mountains of Trans-Pecos Texas, but not sufficient to warrant formal recognition.

Juniperus deppeana fo. ***sperryi*** (Correll) R. P. Adams. Brittonia 25:289 (1973). *Juniperus deppeana* var. *sperryi* Correll, Wrightia 3: 188 (1966). *Juniperus deppeana* subsp. *sperryi* (Correll) A. E. Murray, Kalmia 13: 8 (1983). TYPE: United States. Texas: Jeff Davis Co., Dry Canyon of Davis Mountains, about 8 miles from Sproul Ranch Headquarters, 30 December 1940, *Sperry T870* (HOLOTYPE: GH; ISOTYPE: US!). Fig. 19.

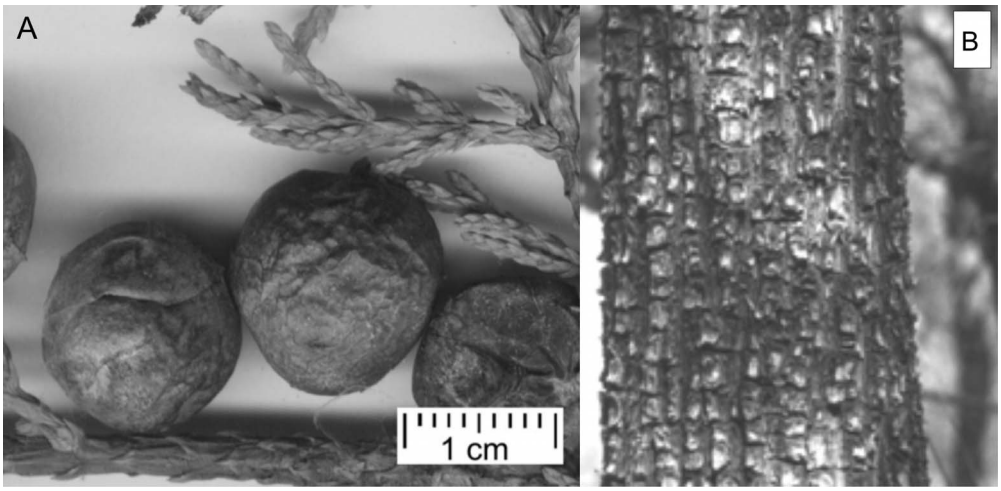

FIG. 17. *Juniperus deppeana* var. *deppeana*. A. Leaves and seed cones (*R. P. Adams 7633*, BAYLU). B. Bark.

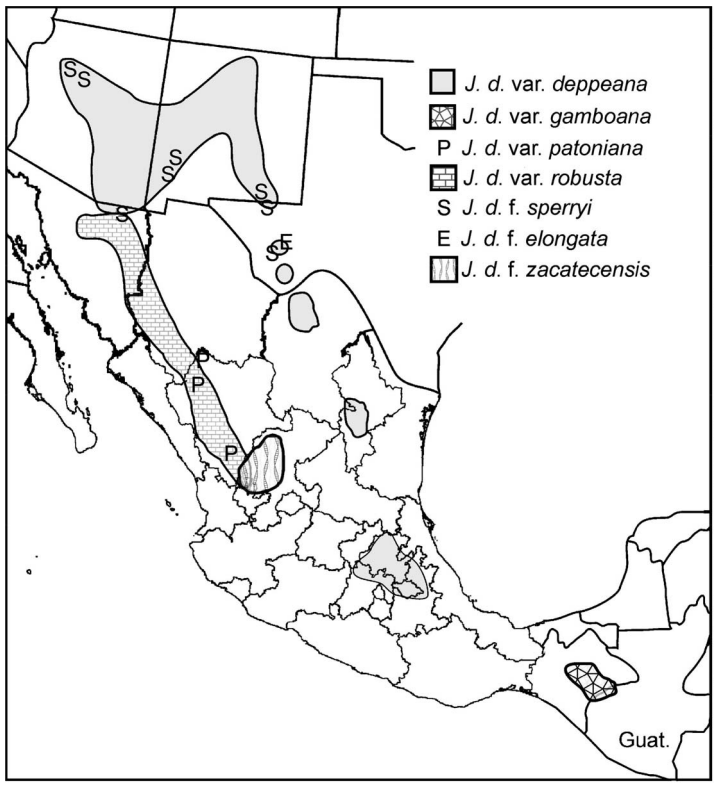

FIG. 18. Distribution map of *Juniperus deppeana*. The population of *J. deppeana* var. *patoniana* (P) in northern Sonora, Mexico has previously been identified as *Juniperus deppeana* fo. *sperryi*. (adapted from Adams and Schwarzbach, 2013)

FIG. 19. *Juniperus deppeana* fo. *sperryi*. Author at the putative tree source of the type specimen on the H. E. Sproul Ranch, near Ft. Davis, Texas, 1968, (*R. P. Adams 352*, BAYLU).

DIOECIOUS. TREES 10-15 m, with rounded crown. TRUNK BARK stem bark longitudinally furrowed into interconnected strips (Figs. 19, 20B). BRANCHES terminal whip branches and larger branches somewhat flaccid. LEAVES both decurrent (whip) and scale. Decurrent and scale-leaf margins denticulate (20× magnification). SEED CONES globose, 8-15 mm, fibrous to obscurely woody, maturing in the second year, reddish-tan when immature, then reddish- blue with very light bloom (glaucous) when mature. SEEDS 5-6 per cone or 1(2) in Sonora (see discussion below), 6-9 mm long. POLLEN SHED spring? Fig. 20.

COMMON NAME: Sperry's juniper.

DISTRIBUTION: United States: Arizona Prescott National Forest, southwestern New Mexico at the Gila National Forest NM (Fig. 21), Texas, Davis Mountains, (Figs. 18, 22).

HABITAT: rocky soils, slopes and mountains.

USES: none known.

STATUS: very rare, subject to burning.

Trees with furrowed bark and pendulous foliage are in northern Sonora and have only 1(2) seeds per cone. These are best referred to *J. deppeana* var. *patoniana*, but additional research is needed in this area. David Thornburg (pers. comm.) has recently found *J. deppeana* trees in northern Arizona that have furrowed bark. They do not seem to form a natural population, but occur as scattered individual trees among otherwise normal (quadrangular) barked trees. This suggests that only a few genes may be expressed to give the furrowed bark.

Juniperus deppeana fo. ***elongata*** R. P. Adams. Phytologia 87(2): 101. 2005. TYPE: United States. Texas: Jeff Davis Co., on Tex 118, 4.2 km west of western entrance to Lawrence E. Wood Madera

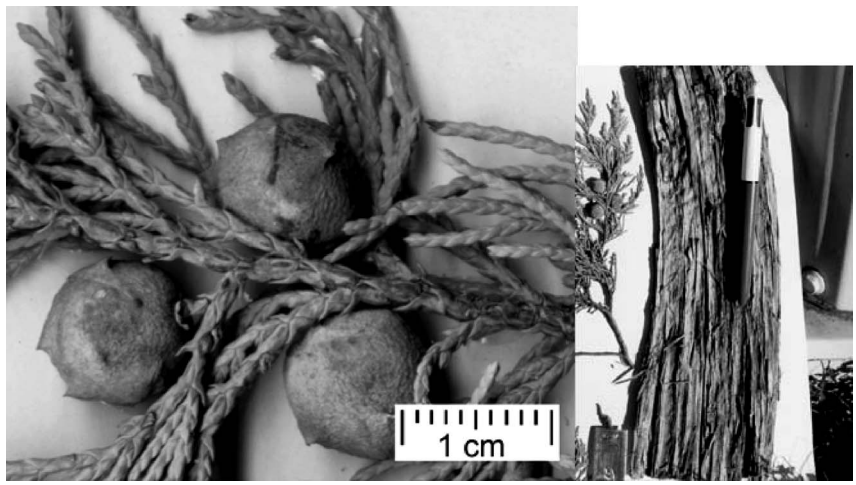

FIG. 20. A. *Juniperus deppeana* fo. *sperryi*. Leaves and seed cones (*R. P. Adams 352*, BAYLU). B. Bark.

FIG. 21. *Juniperus deppeana* fo. *sperryi*. tree with furrowed bark (insert photo) in Gila National Forest, NM, Photo by Lew Stockman, 2013.

Creek park, 1845 m, 30° 43.437′ N, 104° 08.255′ W, 11 March 2005, *R. P. Adams 10627* (HOLOTYPE: BAYLU!; ISOTYPE: BAYLU!).

ADDITIONAL SPECIMEN EXAMINED: United States. Texas: Jeff Davis Co. summit of Brown Mountain, 2190 m, 11 March 2005, *R. P. Adams 10629* (BAYLU).

DIOECIOUS. TREES 4-5 m, with rounded crown. TRUNK BARK stem bark in rectangular plates. BRANCHES terminal whip branches elongated and very flaccid (Fig. 23). LEAVES both decurrent (whip) and scale. Decurrent and scale-leaf margins denticulate (20× magnification). SEED CONES globose, 8-15 mm across, fibrous to obscurely woody, maturing in the second year, reddish tan when immature, then reddish blue with very light bloom (glaucous) when mature. SEEDS 5-6 per cone or 1(2) in Sonora (see discussion below), 6-9 mm long. POLLEN SHED spring? Fig. 23.

DISTRIBUTION: United States. Texas: Davis Mountains, (Fig. 18).

HABITAT: rocky soils, slopes and mountains.

Status: only two trees known.

USES: none known.

Juniperus flaccida Schltdl. Linnaea 12: 495. 1838. *Sabina flaccida* (Schltdl.) Antoine, Cupress. Gatt. 37: 49, 1857. *Sabina flaccida* (Schltdl.) A. A. Heller, Muhlenbergia 5(8): 120, 1909. TYPE: Mexico, Hidalgo, Mineral del Monte, Regla, *C.*

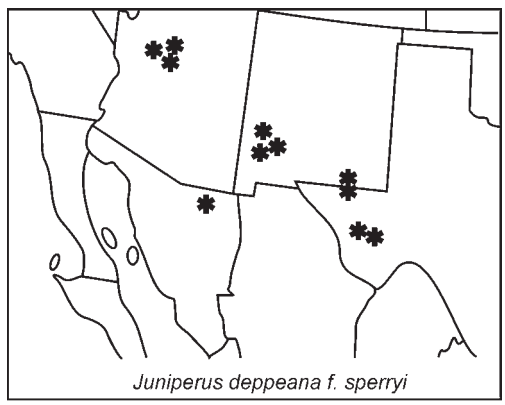

FIG. 22. Distribution of *Juniperus deppeana* fo. *sperryi*.

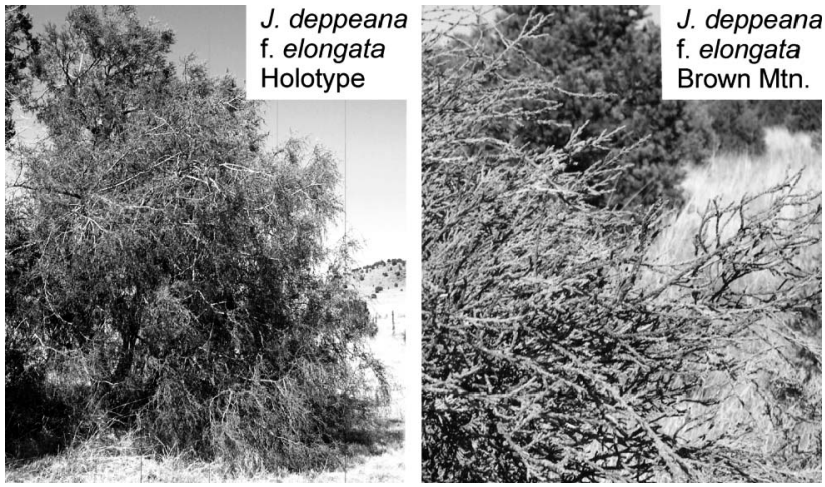

FIG. 23. Habit of *Juniperus deppeana* fo. *elongata*. A. Tree with the long terminal whips and pendulous foliage (*R. P. Adams 10627*, BAYLU). B. Detail of branches of another f. elongata tree at Brown Mountain, Texas (*R. P. Adams 10629*, BAYLU).

A. Ehrenberg s. n. (LECTOTYPE: MO, 2085919; designated by Zanoni and Adams, Bol. Soc. Bot. México 38: 100. 1979).

*Juniperus foetida v*ar. *flaccida* (Schltdl.) Spach, Ann. Sci. Nat. Bot., sér. 2, 16: 300. 1841.

Juniperus gracilis Endl., Syn. Conif.: 31. 1847.

Juniperus gigantea Roezl Cat. Graines Conif. Mexic. 8. 1857. in part. *Sabina gigantea* (Roezl) Antoine, Cupress. Gatt.: 38, 1857.

Juniperus flaccida var. *gigantea* (Schltdl.) Gaussen, Trav. Lb. Forest. Toulouse 1(2/10): 117, 1968.

DIOECIOUS. TREES to 12 m, trunk branching at 1-2 m. TRUNK BARK cinnamon reddish brown or gray reddish brown, exfoliating in broad interlaced fibrous strips. BRANCHES spreading and forming a globose crown. Ultimate branchlets drooping, flaccid. LEAVES both decurrent (whip) and scale. Scale-leaves often appearing somewhat decurrent, 1.5-2 mm, opposite, narrowly ovate, acuminate. Whip- and scale-leaf margins appearing entire at 20× but with irregular teeth at 40×. SEED CONES spherical (4-)6-10(-13) seeded, tan-brown to brownish-purple with white glaucous, 9-20 mm in diameter maturing in 2 years? SEEDS 5-6 mm long. POLLEN SHED late winter-early spring. Fig. 24.

COMMON NAME: Weeping juniper.

DISTRIBUTION: Mexico, Big Bend National Park, Texas, United States (Fig. 25).

HABITAT: rocky soils and slopes.

STATUS: widespread in Mexico. The only population in the United States is in the Chisos Mountains, Big Bend National Park, Texas. Reproducing as evidenced by young and seedling plants in the area.

USES: none known.

Juniperus grandis R. P. Adams. Phytologia 88(3): 306. 2006. *Juniperus occidentalis* W. J. Hooker subsp. *australis* Vasek, Brittonia 18: 352. 1966. *Juniperus occidentalis* var. *australis* (Vasek) A. Holmgren & N. Holmgren, Intermountain Fl. 1: 239. 1972. TYPE: United States, California, San Bernardino Mountains, 0.2 miles N of state highway 18 on Polique Canyon Road to Holcomb Valley, 29 Sep 1961, *Vasek 610929-38* (HOLOTYPE: RSA!).

DIOECIOUS, approx. 5% trees MONOECIOUS (Vasek, 1966). TREES to 30 m. TRUNK BARK brown. BRANCHES erect to pendulous.

FIG. 24. *Juniperus flaccida*. Leaves and seed cones (*R. P. Adams 6892*, BAYLU).

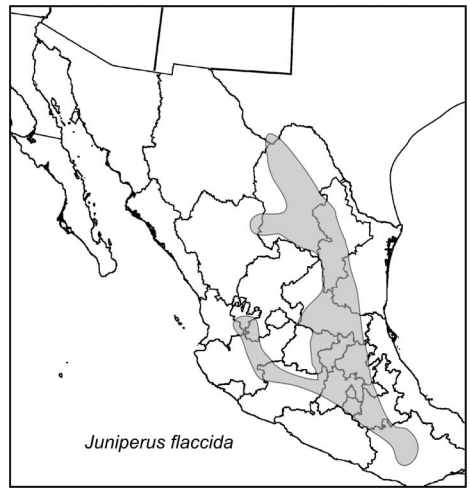

FIG. 25. Distribution of *Juniperus flaccida*.

LEAVES decurrent (whip) and scale-like, scale and whip-leaves with visible glands (Fig. 26). SEED CONES blue to blue black, with resinous pulp, maturing in 2 yrs, 5–9 mm long (avg. 7.6). SEEDS 1-2(3) per cone (avg. 1.5). POLLEN SHED spring. Fig. 26.

COMMON NAME: Big western juniper, grand juniper.

DISTRIBUTION: Sierra Nevada of California, western Nevada (Fig. 27).

HABITAT: on dry rocky slopes in the Sierra Nevada of California; 1000-3000 m.

STATUS: occurs in areas protected from fires. i.e. rocky with minimal combustible fuel, it is not threatened.

USES: fence posts.

Adams et al. (2006), using both DNA sequence and fingerprinting data, showed that *J. occidentalis* var. *australis* is more closely related to *J. osteosperma* than to *J. occidentalis*. Based on these data, *J. occidentalis* var. *australis* was recognized as a distinct species, *Juniperus grandis* (Adams et al., 2006, Adams and Kauffmann, 2010). *Juniperus grandis* hybridizes with *J. occidentalis* and *J. osteosperma* (Adams, 2013a, 2013b) in northwestern Nevada and likely in populations north of Lake Tahoe, California.

Juniperus horizontalis Moench, Methodus 699 (1794). *Sabina horizontalis* (Moench) Rydb., Bull. Torrey Bot. Club 39: 100 (1912), TYPE: no longer extant (Stafleu, 1967), Canada, Nova Scotia, Halifax, *M. Hultgren s.n.*, (NEOTYPE: BM, designated by Farjon (p. 308, 2005). *Sabina vulgaris* Antoine in part, Cupress. Gatt. 58, 1857.

Juniperus sabina Michx., Fl. Bor. Amer. 2: 246 (1803), *non Juniperus sabina* L. (1753)

Juniperus prostrata Pers., Syn. Pl. 2(2): 632 (1807), TYPE: "Hab. in Amer. austr." probably Canada, *A. Michaux s.n.* (ex. herb. *A. N. Desvaux*). *Juniperus sabina*

FIG. 26. *Juniperus grandis*. Leaves and seed cones (*R. P. Adams 11963*, BAYLU).

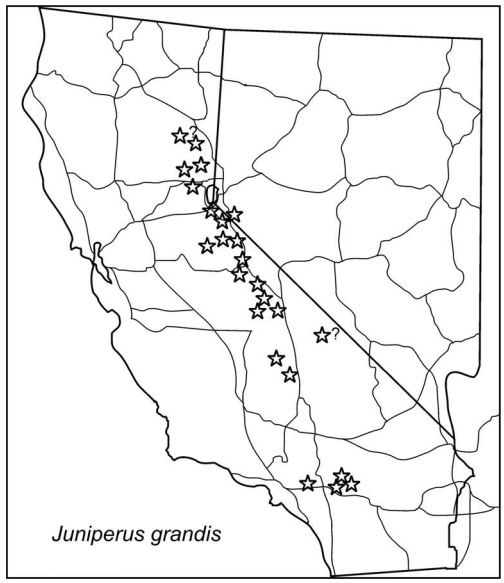

FIG. 27. Distribution of *Juniperus grandis*. Note: '?' in the northern-most distribution denotes a potential hybrid/introgressed zone with *Juniperus occidentalis*. The '?" in central eastern California is a putative location. In 2012, the author was unable to find *Juniperus grandis* at that location. (Adams, 2014).

var. *prostrata* (Pers.) Loudon, Arbor. Frutic. Brit. 4: 2499, 1838. *Juniperus virginiana* L. var. *prostrata* (Pers.) Torr., Fl. New York 2: 235 (1843). *Sabina prostrata* (Pers.) Antoine, Cupress. Gatt.: 57 (1857)

Juniperus sabina Michx. var. *procumbens* Pursh, Fl. Amer. Sept. 2: 647 (1814)

Juniperus repens Nutt., Gen. N. Amer. Pl. 2: 245 (1818)

Juniperus sabina Michx. var. *humilis* Hook., in part, Fl. Bor. Amer. 2(10): 166 (1838)

Juniperus hudsonica Forbes, Pinet. Woburn.: 208 (1839)

Juniperus foetida Spach *multicaulis* Spach in part, Ann. Sci. Nat. Bot. sér. 2, 16: 295 (1841)

Juniperus horizontalis Moench fo. *lobata* O.W. Knight, Rhodora 9: 2010 (1907)

Juniperus horizontalis Moench fo. *alpina* (Loudon) Rehder, J. Arnold Arb. 6: 203 (1925)

Juniperus horizontalis Moench var. *douglasii* Rehder in L.H. Bailey, Stand. Cycl. Hort. 3: 1729 (1915)

DIOECIOUS. PROSTRATE TO DECUMBENT SHRUBS. TRUNK BARK brown, exfoliating in plates. BRANCHES procumbent, forming large mats often several meters across. LEAVES decurrent (whip) and scale-like. Foliage green but turning reddish purple in winter. Leaf margins entire (20× and 40× magnifications). scale-leaf tips apiculate, mostly overlapping, both whip and scale leaves growing along the branchlets. SEED CONES 1-2(3) seeded, bluish black to bluish brown when ripe, borne on generally curved peduncles, mostly maturing in 2 years, 5-7 mm. (Fig. 28). SEEDS 4-5 mm. CHROMOSOME NUMBER 2n = 22 (Hall, Mukherjee and Crowley, 1979). POLLEN SHED spring. Fig. 28.

COMMON NAMES: Creeping juniper, prostrate juniper.

DISTRIBUTION: Canada: all provinces. United States: Alaska, Montana, Wyoming, North Dakota, South Dakota, Nebraska, Minnesota, Iowa, Wisconsin, Illinois, Michigan, New York, Vermont, Massachusetts, Maine (Fig. 29).

HABITAT: sand dunes, sandy and gravelly soils, prairies, slopes and along stream banks; sea level to 1000 m.

STATUS: this taxon is common and reproducing. Not threatened.

USES: none known.

Juniperus horizontalis hybridizes with both *J. virginiana and J. scopulorum* (Adams, 1983; Fassett, 1945a, b, c; Palma-Otal, et al., 1983). The *J. horizontalis* x *J. scopulorum* hybrid was named *J. scopulorum* var. *patens* Fassett (= X *J. fassettii* B. Boivin).

Juniperus jackii (Rehder) R. P. Adams, Phytologia 94(2): 292. 2012. *Juniperus communis* var. *jackii* Rehder, Mitt. Deutsch. Dendrol. Ges. 1907 (16): 70 (1907). TYPE: United States. California: Siskiyou Mountains, on the road from Waldo, Oregon to Crescent City, 3000

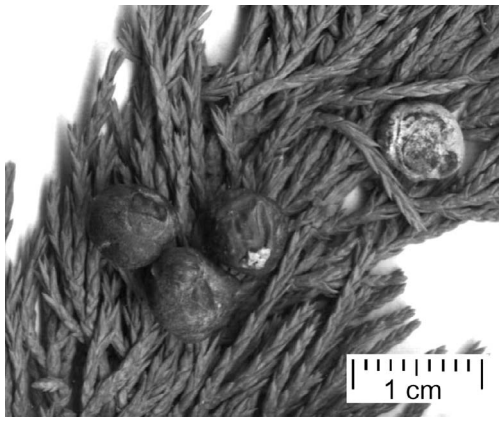

FIG. 28. *Juniperus horizontalis*. Leaves and seed cones (*R. P. Adams 7096*, BAYLU).

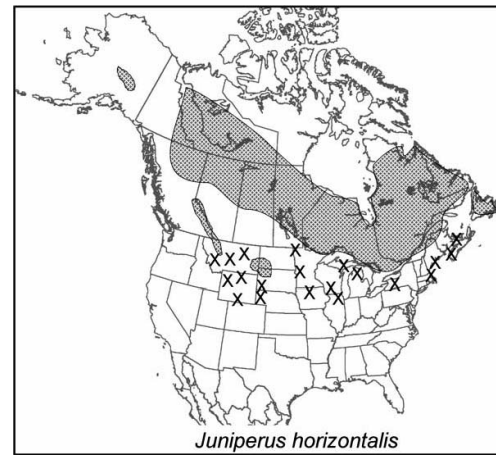

FIG. 29. Distribution of *Juniperus horizontalis*. Xs denote outlying populations.

ft., 25 Aug, 1904, *J. G. Jack and Alfred Rehder s.n.* (LECTOTYPE: A!, designated by Farjon, 2005). Named after J. G. Jack.

DIOECIOUS. PROSTRATE SHRUBS to small shrubs. TRUNK BARK brown, exfoliating in wide strips or plates. BRANCHES spreading. LEAVES acicular, curved, tips apiculate to mucronate, 5-7 mm x 1.6 mm.

Glaucous stomatal band 3-4 times as wide as each green leaf margin (Table 1). SEED CONES 6-7 mm, elongated-subglobose or ellipsoid, dark blue when mature (2-3 years). SEEDS 1(2) per cone, (Fig. 30). POLLEN SHED spring. Fig. 30.

DISTRIBUTION: United States. Serpentine rock in northwestern California, on granite (Trinity Alps, California), lava talus slopes in Cascade Mountains in Oregon, and lava talus slopes, Olympic Mountains, Washington (Fig. 31).

HABITAT: serpentine rock and lava talus slopes.

STATUS: At present, the habitat (serpentine and lava talus slopes) seems conserved, so this species does not appear to be threatened nor endangered.

USES: none known.

The type locality is on serpentine, but *J. jackii* also grows on high elevation lava at Mt. Hood, Oregon. *Juniperus communis* with short, curved leaves with a stomatal band about twice as wide as the green leaf margin, is found from northern California to Alaska. Recent analysis of nrDNA SNPs (Adams, 2008b) shows that the Siskiyou Mountains and Mt. Hood populations are somewhat

TABLE 1. Comparison of the leaf morphology of *Juniperus communis* var. *kelleyi*, *Juniperus communis* var. *depressa,* and *Juniperus jackii* (Adams, 2013c).

	J. c. var. *kelleyi*	*J. c.* var. *depressa.*	*J. jackii*
Stomatal band width vs. green leaf margin (GM)	1.5-2x GM	1-1.5x GM	3-4x GM
Leaf cross-section	concave	very concave	concave,
Leaf shape	curved	straight	curved, boat-shaped
Leaf blades	free, 30° to 80°	free, 45° to 20°	mostly appressed to stem
Mature seed cones vs. leaf length	cones about as long as leaves	cones much shorter than leaves	cones as long as or longer than leaves
Seed cone shape	ovoid	ovoid	elongated ovoid(ellipsoid)

FIG. 30. *Juniperus jackii*. Leaves and oblong seed cone (*R. P. Adams 10287*, BAYLU).

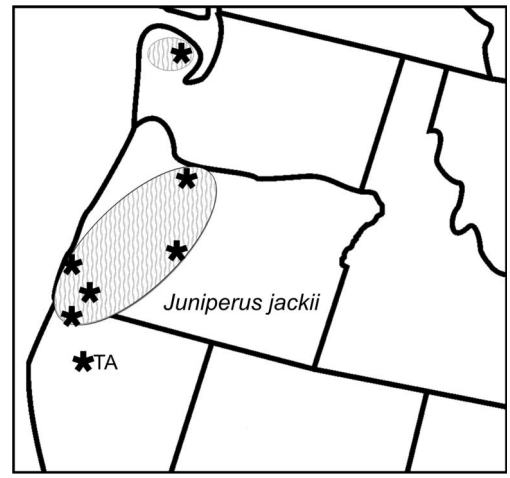

FIG. 31. Distribution of *Juniperus jackii*. TA = Trinity Alps.

different from the other populations. Those populations differ from *J. communis* also in having appressed, boat-shaped leaves and oblong cones. *Juniperus jackii* was recognized by Adams and Schwarzbach (2012) at the species level as it was found in a well supported clade using nrDNA and cpDNA.

Juniperus maritima R. P. Adams. Phytologia 89(3): 278. 2007. TYPE: Canada, British Columbia, Vancouver Island, Brentwood Bay, 48° 34.794′ N; 123° 20.211′ W, elev. 5 m, 29 May 2006, *R. P. Adams 11056* (HOLOTYPE: BAYLU!; ISOTYPE: V!).

DIOECIOUS. TREES single stemmed to 15 m or more, pyramidal to round crown. TRUNK BARK brown, exfoliating in thin strips. BRANCHES foliage erect or occasionally lax, green but turning reddish-brown in the winter, twigs (3-5 mm diameter) with persistent dead scale leaves, bark on twigs (6-15 mm diameter) smooth, reddish brown. LEAVES both decurrent (whip) and scale. Whip leaves growing only at branchlet tips (on mature trees), with an elliptical or elongated gland. Scale leaves overlapping by less than 1/5 length), tips obtuse. Scale-leaf margins entire (20× and 40× magnifications). SEED CONES globose to reniform, bluish black to bluish brown, maturing in 14 to 16 months, borne terminally, 6-8 mm in diameter, (1) 2 seeded. SEEDS tan to brown, 2-4 mm long, commonly abnormally exserted due to insect damage. POLLEN SHED March-April. Fig. 32.

COMMON NAME: Seaside juniper.

DISTRIBUTION: United States: Puget Sound and Strait of Georgia, Washington. Canada. British Columbia: Strait of Georgia. (Fig. 33). (See Adams et al., 2010 for notes on distribution on the Olympic Peninsula).

HABITAT: near the seashore on southern and western exposed rock, on sand; on rock in the rain shadow of Mt. Olympia.

STATUS: this taxon has very limited distribution and grows in areas of prime development, so it may become threatened.

USES: none known.

Recent DNA sequencing shows *J. maritima* is in a well supported clade distinct from *J. virginiana* and *J. scopulorum* (Adams, 2014). This species is similar to *J. scopulorum* but differs in that the seed cones mature in 1 year (14-16 months), seeds are usually exserted from the cone, and the scale leaf tips are obtuse (Table 2).

Juniperus maritima is usually found in rocky areas, often within meters of the water. However, a population exists on

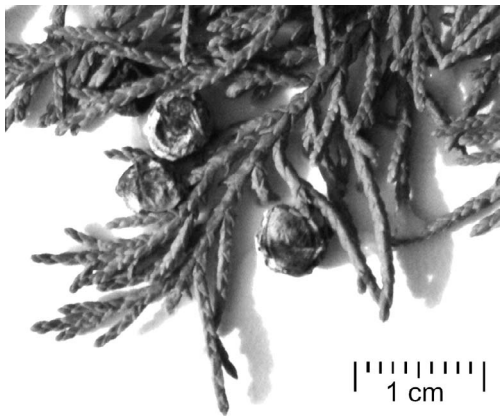

FIG. 32. *Juniperus maritima*. Leaves and seed cones (*R. P. Adams 11056*, BAYLU).

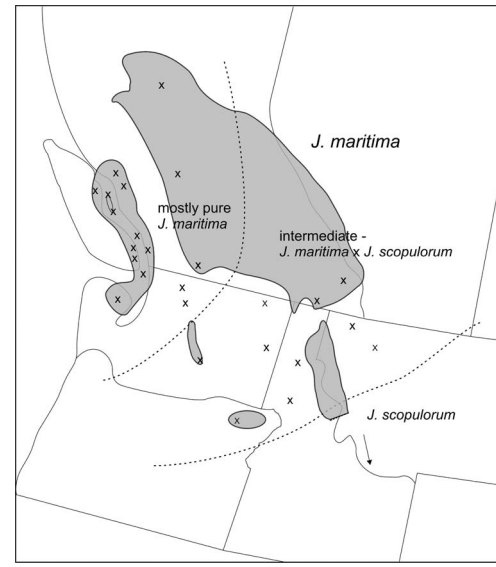

FIG. 33. Distribution of *Juniperus maritima* and zones of hybridization and introgression with *Juniperus scopulorum*. adapted from Adams, 2015. X indicates for individual tree records.

coastal sand dunes near Cranberry Lake, Whidbey Island, WA. No other population has been found on sand, so that site may be atypical, and it has now been found on rocky areas in BC (Adams, 2015). Adams (2015) found evidence of hybridization and introgression between *J. maritima* and *J. scopulorum*.

Juniperus monosperma (Engelm.) Sarg., Silva 10: 89. 1896. TYPE: USA, Colorado, Fremont Co., Canon City, limestone hills, 1874, *G. Engelmann s. n.* (LECTOTYPE: MO 3377643, selected by T. Zanoni, Feb. 1992, designated by Farjon (p. 318, 2005). *Juniperus occidentalis* Hook. var. *monosperma* Engelm., Trans. Acad. Sci. St. Louis 3: 590. 1878. *Juniperus californica* Carrière var. *monosperma* (Engelm.) Lemmon, Cone-bear. Trees Pacif. Slope ed. 2: 17. 1892. *Sabina monosperma* (Engelm.) Rydb., Bull. Torrey Bot. Club 32: 598. 1905. *Junniperus mexicana* Schiede ex Schltdl. & Cham. var. *monosperma* (Engelm.) Cory, Rhodora 38: 183. 1936.

J. occidentalis Hook. var. *gymnocarpa* Lemmon, Handb. W. Amer. Cone-bearers, ed. 3: 80. 1895.

TABLE 2. Comparison of the morphology of *Juniperus maritima*, *J. scopulorum* and *J. virginiana*.

Character	*J. maritima*	*J. scopulorum*	*J. virginiana*
seed cones mature	1 yr (14-16 mos)	2 years	1 year
seed cone diam.	6-8 mm	6-9 mm	3-6(7) mm
seed cone shape	globose to reniform	globose to reniform	ovoid
seeds per cone	(1) 2	(1) 2 (3)	1-2 (3)
exserted seeds	ubiquitous	rare	rare
scale-leaf overlap	< 1/5 length	< 1/5 length	> 1/4 length
scale-leaf tips	obtuse	acute to obtuse	acute
branchlets (6-15mm diam)	smooth, reddish-brown	smooth, bright reddish-brown	with persistent old leaves, brown

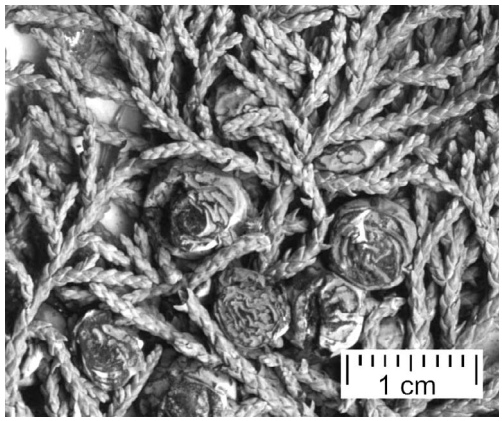

FIG. 34. *Juniperus monosperma*. Leaves and seed cones (*R. P. Adams 10931*, BAYLU).

FIG. 35. Gymnocarpy in *Juniperus* is found in nearly all species junipers world-wide. Photo of *Juniperus saltillensis* (*R. P Adams 6887*, BAYLU).

Juniperus occidentalis Hook. fo. *gymnocarpa* (Lemmon) Rehder, J. Arnold Arbor. 7: 239. 1926.

Juniperus gymnocarpa (Lemmon) Cory, Rhodora 38: 184. 1936.

DIOECIOUS. SHRUB or small tree, 2-7(-12) m, usually with stems branching near the ground. TRUNK BARK thin, gray to brown, exfoliating in thin strips revealing cinnamon color. BRANCHES ascending to erect, with an ashy-white peeling bark. LEAVES both decurrent (whip) and scale-like. Ultimate branchlets approx. 2/3 as wide as scale leaf length, square or six-sided but not terete. Whip- and scale-leaf margins denticulate (20× magnification). Scale leaves acute to acuminate. Whip-leaf gland ¾ as long as the leaf, adaxial (inner) leaf surface glaucous. Scale-leaves 1-3 mm, ovate, acute to acuminate, green. Scale-leaf tips free with the abaxial surface raised. Few (less than 1/5) whip-leaf glands ruptured and with a white crystalline exudate (visible without a lens). SEED CONES 6-8 mm diameter, soft and juicy pulp, globose to ovoid, reddish blue to bluish brown, white glaucous, 1(2-3) seeded, the hilum scar approx. 1/3 as long as seed, (Fig. 34). SEEDS 4-5 mm long, sometimes exerted (as in *Juniperus saltillensis* M. T. Hall, Fig. 35). POLLEN SHED late winter—early spring. Fig. 34.

COMMON NAME: One-seeded juniper, cherry-stone juniper.

DISTRIBUTION: United States: Arizona, Colorado, New Mexico, Oklahoma, Texas. (Fig. 36). Often reported from Mexico, but these plants should be referred to *J. angosturana* R. P. Adams or *J. coahuilensis*.

HABITAT: common shrub in dry rocky soils and slopes; 1000-2300 m.

USES: not rot resistant, not commonly used for fence posts.

STATUS: this species is the dominant plant on millions of hectares in the state of New Mexico, United States. It is considered a weed in pastures by ranchers.

Hybridization between *J. monosperma* and *J. pinchotii* (Hall and Carr, 1968) is not supported using numerous chemical and morphological characters (Adams, 1972; 1975). In addition their pollen shedding times do not overlap (*J. monosperma* in March - April, *J. pinchotii* in September - October). Hybridization with *J. coahuilensis*, that sheds its pollen in March-April, does appear possible in southwestern New Mexico. The distribution of *J. monosperma* is shown in Fig. 36.

Juniperus occidentalis W. J. Hooker, Fl. Bor. Amer. 2(10): 166. 1838. *Sabina occidentalis* (Hook.) Antoine, Cupress. Gatt.: 64 (1857). TYPE: Washington, Columbia River, *D. Douglas s.n.*, (HOLOTYPE: K!).

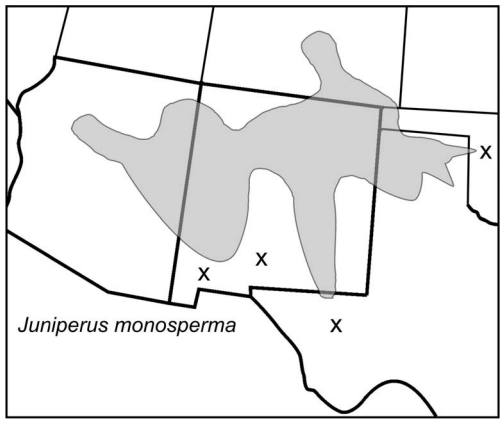

FIG. 36. Distribution of *Juniperus monosperma*. Xs denote outlying populations.

Juniperus andina Nutt., N. Amer. Sylva 3: 95, t.110. 1849.

Chamaecyparis boursieri Decne., Bull. Soc. Bot. France 1: 70. 1854.

Juniperus pseudocupressus Dieck, Neuheit.-Off. Nat.-Arb. Zoschen 1899: 8. 1899.

Juniperus californica Carrière var. *siskiyouensis* L.F. Henderson, Rhodora 33: 203. 1931.

MONOECIOUS/DIOECIOUS approx. 50% of the plants are monoecious (Vasek, 1966). TREES to 20 m. TRUNK BARK red brown. BRANCHES ascending. LEAVES decurrent (whip) and scale-like, both kinds with visible glands. SEED CONES blue to blue-black, with resinous pulp, maturing in 2 years, 7-10 mm long (avg. 8.3). SEEDS 1-2(3) per cone (1.6 avg.). POLLEN SHED late spring. Fig. 37.

COMMON NAME: Western juniper, Sierra juniper.

HABITAT: dry rocky foothill and mountain slopes; (near sea level) to 1500-3000 m Map: Vasek, 1966.

USES: fence posts (but not very rot resistant).

DISTRIBUTION: United States. Sierra Nevada of northern California, Idaho, Nevada, Oregon and Washington (Fig. 38).

STATUS: common and reproducing. Considered a weed on pasture lands in Oregon.

Vasek (1966) reported hybridization with *J. osteosperma* in northwestern Nevada.

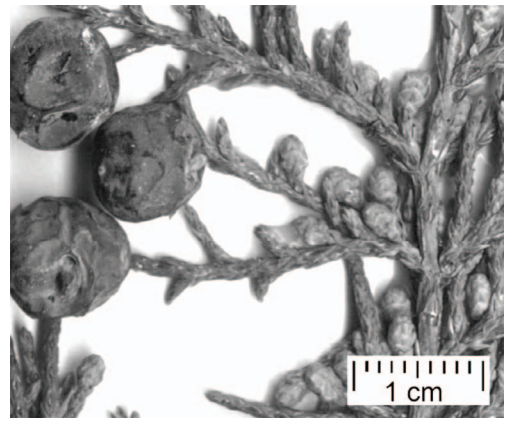

FIG. 37. *Juniperus occidentalis*. Leaves, male cones filled with pollen and seed cones (*R. P. Adams 8592*, BAYLU).

Terry et al. (2000) confirmed hybridization between *J. occidentalis* and *J. osteosperma* using chloroplast and nuclear DNA markers. Adams et al. (2006), using both DNA sequence and fingerprinting data, clearly showed *J. occidentalis* var. *australis* to be more closely related to *J. osteosperma* than *J. occidentalis*. Based on these data, *Juniperus occidentalis* var. *australis* was recognized as the distinct species, *J. grandis* (Adams et al., 2006, Adams and Kauffmann, 2010). *Juniperus occidentalis* hybridizes with *J. osteosperma*, Adams, 2013a, 2013b) in northwestern Nevada and it likely hybridizes with *J. grandis* in populations north of Lake Tahoe, California.

Juniperus occidentalis fo. ***corbetii*** R. P. Adams, Phytologia 94(1): 29. 2012. TYPE: United States. Oregon: Deschutes Co., 32 km E of Bend, on Oregon Hwy. 20, shrubs, 0.5 - 1m tall, 43° 53.922′ N, 120° 59.187′ W, 1274 m, 4 Aug 2009, *Robert P. Adams 11949* (HOLOTYPE: BAYLU!).

Similar to *Juniperus occidentalis* but differing in habit, being a shrub with compact foliage (Fig. 39). The typical variety, with a strong central axis and pyramidal crown, grows on a nearby hillside, whereas fo. *corbetii* grows along a dry wash

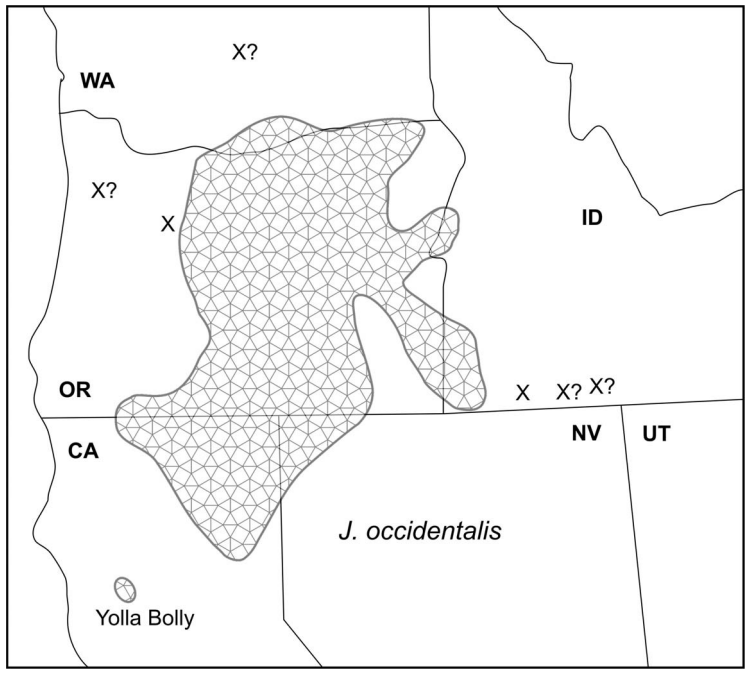

FIG. 38. Distribution of *Juniperus occidentalis*. Xs denote outlying populations.

on a mix of lava and sand. No female cones were found in this population.

Juniperus osteosperma (Torr.) Little, Leafl. Western Bot. 5: 125, 1948. *Juniperus tetragona* Schltdl. var. *osteosperma* Torr., Pacif. Railr. Rep. 4(5): 141, 1857. *Sabina osteosperma* (Torr.) Antoine, Cupress. Gatt. 51. 1857. *Juniperus californica* Carrière subsp. *osteosperma* (Torr.) A. E. Murray, Kalmia 12: 21. 1982. TYPE: Arizona, Coconino Co., Bill Williams Mt., *J. M. Bigelow s.n.* (LECTOTYPE: NY! designated by Little p. 127, 1948).

J. californica var. *utahense* Vasey, Cat. For. Trees U.S. 37. 1876.

Juniperus californica var. *utahensis* Engelm., Trans. Acad. Sci. St. Louis 3: 588. 1878. *Juniperus utahensis* (Engelm.) Lemmon, Bienn. Rep. Calif. State Board Forest. 3: 183. 1890. *Sabina utahensis* (Engelm.) Rydb., Bull. Torrey Bot. Club 32: 598. 1905.

Juniperus occidentalis Hook. var. *utahensis* Kent, Veitch's Man. Conif.: 289. 1881.

Juniperus knightii A. Nelson, Bot. Gaz. 25: 198. 1898. *Juniperus monosperma* (Engelm.) var. *knightii* (A. Nelson) Lemmon, Cone-bear. Trees Pacif. Slope, ed. 4: 114. .1900. *Sabina knightii* (A. Nelson) Rydb., Bull. Torrey Bot. Club 32: 598. 1905.

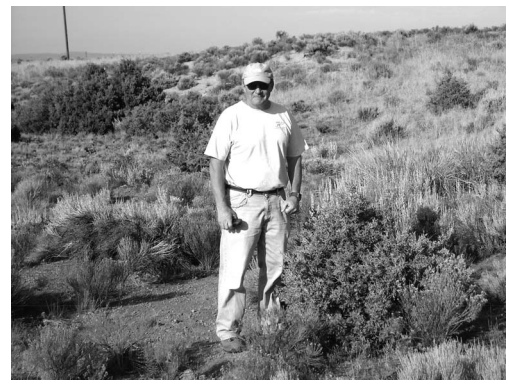

FIG. 39. Mark Corbet with the shrubby form of *Juniperus occidentalis* fo. *corbetii*. 32 km east of Bend, Oregon (cf. *R. P. Adams 11949-11951,* BAYLU).

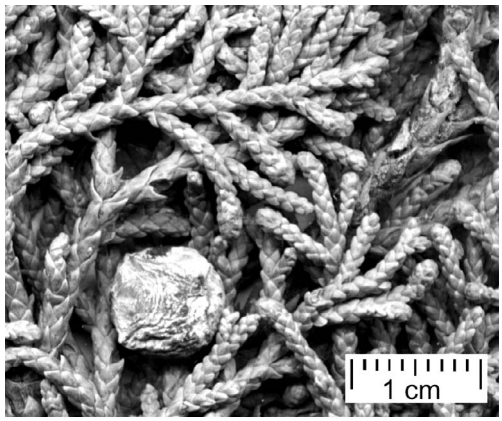

FIG. 40. *Juniperus osteosperma*. Leaves and seed cone (*R. P. Adams 6811*, BAYLU).

Juniperus utahensis (Engelm.) Lemmon var. *cosnino* Lemmon, Sierra Club Bull. 4: 122, pl. 62. 1902.

Juniperus megalocarpa Sudw., Forest & Irrig. 13: 307. 1907. *Sabina megalocarpa* (Sudw.) Cockerell, Muhlenbergia 3: 143. 1908. *Juniperus utahensis* (Engelm.) Lemmon var. *megalocarpa* (Sudw.) Sarg., Bot. Gaz. 67: 208. 1919.

MONOECIOUS OR RARELY DIOECIOUS (10%). SHRUBS multi- (seldom one) stemmed, shrub or tree, 3-6(-12) m with round crown. TRUNK BARK exfoliating in thin gray brown strips. Bark on twigs (5-10 mm diameter) brown or gray, not exfoliating in scales or flakes. BRANCHES erect. LEAVES decurrent (whip) and scale-like, foliage light yellow green. Whip- and scale-leaf margins denticulate (20× magnification). Leaf glands not conspicuous (embedded in the leaf, therefore not visible). SEED CONES fibrous, bluish brown, with white glaucous, often almost tan beneath the glaucous bloom, (6-)8-9(-13) mm diameter, maturing in 1-2 years. SEEDS 1(2), avg.1.07 per cone, 4-5 mm long. POLLEN SHED spring. Fig. 40.

COMMON NAME: Utah juniper.

DISTRIBUTION: United States: Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming (Fig. 41).

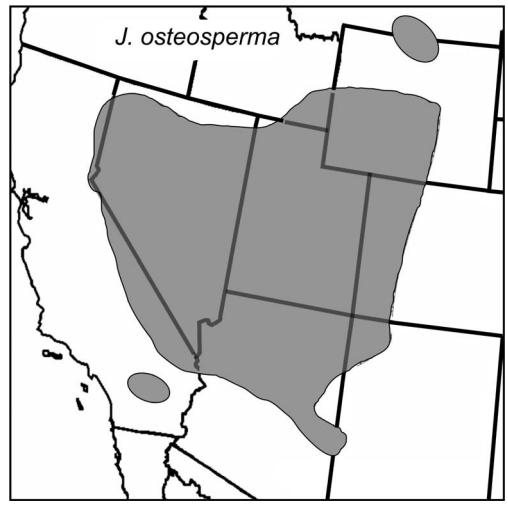

FIG. 41. Distribution of *Juniperus osteosperma*. Hybrids with *Juniperus occidentalis* occur in western Nevada (near Carson City) and in northwestern Nevada and adjacent northeastern California.

HABITAT: dry, rocky soil and slopes; 1300-2600 m.

STATUS: abundant in Utah and adjacent states. Considered a weed in ranch lands.

USES: none known, not rot resistant. Trunks of living trees often with rotted heartwood.

Juniperus osteosperma is the dominant juniper of Utah. Terry et al. (2000) reported hybridization between populations of *J. occidentalis* and *J. osteosperma* in northwestern Nevada using cp and nuclear DNA markers. Adams (2013a, 2013b) using leaf terpenes confirmed that *J. osteosperma* hybridizes with *J. occidentalis* in northwestern Nevada. It appears to hybridize with *J. monosperma* in northwestern New Mexico based on morphological intermediacy between the two species (pers. obs.).

Juniperus ovata (R. P. Adams) R. P. Adams, Phytologia 95(2): 175 (2013). *Juniperus ashei* var. *ovata* R. P. Adams, Phytologia 89(1): 17. 2007. TYPE: United States. Texas: Crockett Co., 5 km west of Ozona, 6 Dec. 1994, *R. P. Adams 7463* (HOLOTYPE: BAYLU!).

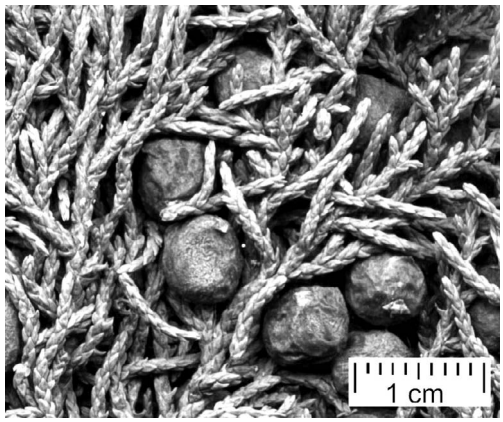

FIG. 42. *Juniperus pinchotii*. Leaves and seed cones (*R. P. Adams 10464*, BAYLU).

DIOECIOUS. TREES with broad, bushy rounded or irregularly open crown, to 15 m, with a single trunk branching at 1-3 m or occasionally branching at the base. TRUNK BARK exfoliating in thin brown strips. BRANCHES brown but usually with a grey-white fungus. LEAVES both whip and scale-like. Whip leaves with a raised, oval or elliptical glands (not obvious on scale leaves, but round on scale leaves). Whip- and scale-leaf margins denticulate (20× magnification). SEED CONES ovoid to subglobose, maturing in one year, dark blue and glaucous, (5)6(-8) mm, seeds (1)2 (avg. 1.7) per cone. SEEDS 4-6 mm long. 2n = 22. POLLEN SHED Dec-Feb. Fig. 3.

ADDITIONAL SPECIMENS EXAMINED: MEXICO. Coahuila, *Adams 1066-1076*. United States. Texas: Crockett Co., 5 km west of Ozona, 6 Dec 1994, *R. P. Adams 7464, 7465, 7466, 7467* (BAYLU); Comal Co. Jct. Tex 46 and Loop 337 in New Braunfels, 16 Mar 2007, *Adams 11314, 11315, 11316* (BAYLU), 40 m southwest of Jct. Cedar Elm St. and Madeline St. on Madeline St., New Braunfels, 16 Mar 2007, *Adams 11309, 11310, 11311* (BAYLU).

DISTRIBUTION: United States: Texas. Northern Mexico (Fig. 4).

HABITAT: Limestone glades and bluffs, 150-600 m.

STATUS: abundant on limestone in central/west Texas. The range is expanding, and it is regarded as a weed in Texas.

USES: fence posts.

Juniperus ovata is morphologically similar to *J. ashei*, but instead of having hemispherical glands, the glands are oval to elliptical on the whip-leaves. *Juniperus ovata* also has smaller cones, and more seeds per cone (∼2) than *J. ashei*. The whip-leaf glands are illustrated in Fig. 42. Notice hemispherical glands on *J. ashei* and the raised, oval to elongated glands on *J. ovata*. It should be noted that a few nearly hemispherical glands are present on whip-leaves of *J. ovata*. Gland morphology is informative, as this character can be used to distinguish *ovata* from *ashei*, yet exclude other nearby juniper species such as *J. monosperma*, *J. pinchotii* and *J. coahuilensis* which do not have raised hemispherical glands.

Results from DNA sequencing (Adams and Schwarzbach, 2013a,b) found *Juniperus ovata* is in a clade with *J. saltillensis* and *J. zanonii* R. P. Adams, and is not as closely related to *J. ashei* as previously thought.

KEY TO *JUNIPERUS ASHEI* AND *JUNIPERUS OVATA*:

1. Glands on whip leaves hemispheric; female cones (8)9(10) mm in diameter; seeds 1 (rarely 2, avg. 1.01) per cone..... ***J. ashei***
1. Glands on whip leaves oval to elliptical; female cones (5)6(8) mm diameter; seeds 2 (avg. 1.7) per cone ..... ***J. ovata***

The distribution of the two taxa shows (Fig. 4) areas of possible sympatry are in west Texas and around New Braunfels in central Texas. Additional field collections are needed to define better their distributions in these areas (Adams 2008a, Adams and Baker, 2007).

Juniperus pinchotii Sudw., Forest & Irrig. 11: 204. 1905 *Juniperus monosperma* (Engelm.) Sarg. var. *pinchotii* (Sudw.)

Melle, Phytologia 4: 29 (1952). TYPE: USA, Texas, Palo Duro Canyon, 'Palodura Canyon', *G.L. Clothier s.n.* (HOLOTYPE: US!)

Juniperus texensis Melle, Phytologia 4: 26 (1952)

DIOECIOUS. SHRUBS to small shrubby tree, 1-6 m, usually multi- stemmed at the base and forming broad shrubs. TRUNK BARK thin, ashy gray, exfoliating in long strips. BRANCHES stiff, erect or spreading, the bark in long, narrow scales. LEAVES both decurrent (whip) and scale-like. Whip- and scale-leaf margins denticulate (20×), leaves yellow green. Adaxial leaf surface not glaucous. Many glands ruptured and with a white, crystalline (mostly camphor) exudate, both whip- and scale-leaf glands elliptical to elongate. SEED CONES copper to copper-red, not glaucous, globose to ovoid, 6-8(-10) mm; soft and juicy, sweet pulp, 1(2) seeded. SEEDS 4-5 mm long, the hilum scar approx. ½ as long as the seed. POLLEN SHED fall. Fig. 42.

COMMON NAMES**:** Copper berry juniper, Pinchot juniper, red-berry juniper.

DISTRIBUTION: United States. New Mexico, Oklahoma, Texas. Northeastern Mexico (Fig. 43). An isolated very small population has recently been discovered in Duval Co., TX (Adams and Schwarzbach, 2011).

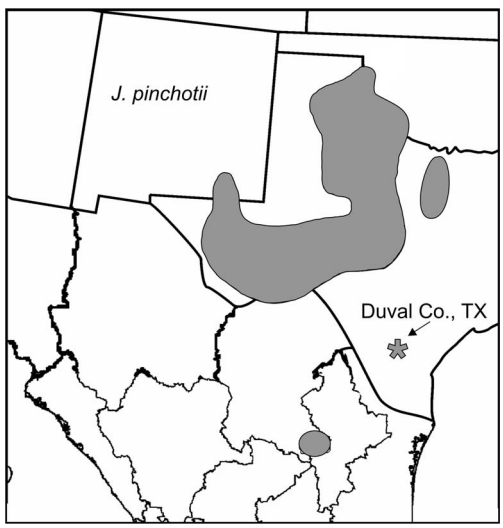

FIG. 43. Distribution of *Juniperus pinchotii*. Note the isolated population in Duval Co., Texas (Adams and Schwarzbach, 2011).

HABITAT: 300-1000(-1700) m; gravelly soils on rolling hills and ravines, limestone, gypsum.

STATUS: this species is abundant in its range and is an invasive weed that invades degraded grasslands. It has greatly increased in areas that are not subjected to periodic burning.

USES: occasionally used as fence posts, but it is not rot resistant.

The species forms hybrids with *J. coahuilensis* (see above). No hybridization with *J. ashei* has been found (see discussion above) nor has hybridization with *J. monosperma* (see above) been documented, at least by terpenoid analyses. Hall et al. 1961 reported hybridization between *J. ashei* and *J. pinchotii*, but this seems unlikely because *J. pinchotii* sheds pollen in Sept-Oct. and *J. ashei* sheds pollen in Dec-Feb.

Juniperus scopulorum Sarg., Gard. & Forest 10: 420, f. 54. 1897. *Juniperus virginiana* L. var. *scopulorum* (Sarg.) Lemmon, Cone-bear. Trees Pacif. Slope ed. 4: 114. 1900. TYPE: Yellowstone National Park, *C.S. Sargent s.n.*, 8 Jul 1896, (LECTOTYPE: A!, designated by Zanoni, Phytologia 38(6): 445, 1978.)

Sabina scopulorum (Sarg.) Rydb., Bull. Torrey Bot. Club 32: 598. 1905.

Juniperus virginiana L. subsp. *scopulorum* (Sarg.) A. E. Murray, Kalmia 13: 8. 1983.

Juniperus excelsa Pursh, Fl. Amer. Sept. 2: 647. 1814, *non* M.-Bieb. (1800)

Juniperus virginiana L. var. *montana* Vasey, Cat. For. Trees U.S. 37. 1876.

Juniperus occidentalis Hook. var. *pleiosperma* Engelm., Trans. Acad. Sci. St. Louis 3: 590. 1878.

Juniperus scopulorum var. *patens* Fassett, Bull. Torrey Bot. Club 72: 46. 1945. [= X *fassettii* Boivin (*horizontalis* x *scopulorum*)]

Juniperus scopulorum Sarg. var. *columnaris* Fassett, Bull. Torrey Bot. Club 72: 482.

FIG. 44. *Juniperus scopulorum*. Leaves and seed cones (*R. P. Adams 10895*, BAYLU).

1945. *Juniperus scopulorum* Sarg. f. *columnaris* (Fassett) Rehder, Biblio. Cult. Trees: 63. 1949. *Juniperus scopulorum* var. *columnaris* Fassett (environmentally induced by gases from burning coal, see Adams, 1982)

Juniperus fassettii B. Boivin, Naturaliste Canad. 93: 372. 1966.

DIOECIOUS. TREES single (rarely multi-) stemmed tree to 20 m, pyramidal to occasionally round crowns. Twigs (3-5 mm diameter) with smooth bark, twigs (6-15 mm diameter) with bark exfoliating in plates, reddish copper beneath. TRUNK BARK brown, exfoliating in thin strips. Foliage light to dark green but often blue and blue gray due to glaucousness. BRANCHES erect to occasionally pendulous at the tips. LEAVES both decurrent (whip) and scale. Whip-leaves growing only at branchlet tips (on mature trees). Scale-leaves not overlapping, or, if so, then not by more than 1/5 the length, obtuse to acute, margins entire at 20× magnification (and 40× magnification). SEED CONES maturing in 2 years, globose to 2-lobed, appearing light blue when with heavy glaucous coating, but dark blue black beneath glaucous (when mature). [Note: cones may appear tan beneath the glaucous cover when immature], 6-9 mm, borne on mostly straight peduncles. SEEDS (1)2(3) per cone, 4-5 mm long. CHROMOSOME NUMBER 2n = 22 (Hall, Mukherjee and Crowley, 1973). POLLEN SHED March-April. Fig. 44.

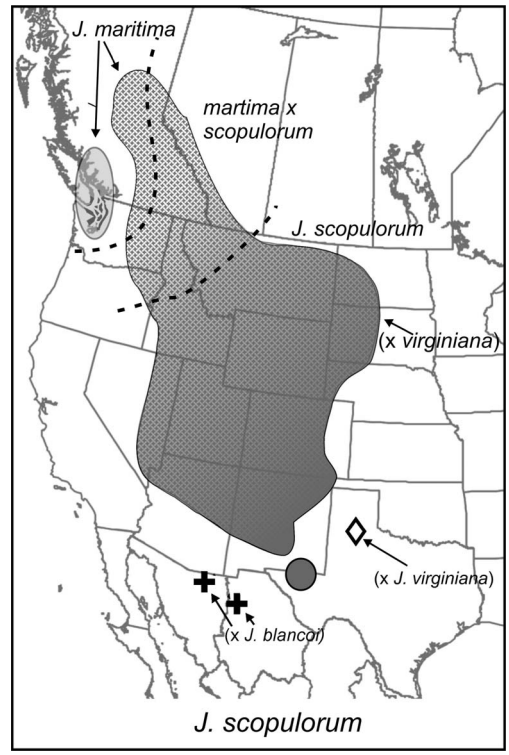

FIG. 45. Distribution of *Juniperus scopulorum*. The diamond symbol in Palo Duro Canyon of the Texas Panhandle denotes that the plants are intermediate between *Juniperus scopulorum* and *Juniperus virginiana* (see Adams, 1983). The + symbol in Mexico denotes *Juniperus blancoi* x *Juniperus scopulorum* hybrids. Note introgression from *Juniperus maritima* in the Pacific Northwest.

COMMON NAME: Rocky mountain juniper.

DISTRIBUTION: Canada: Alberta, British Columbia. USA: Arizona, Colorado, Idaho, Montana, Nebraska, North Dakota, New Mexico, Nevada, Oregon, South Dakota, Texas, Utah, Washington, Wyoming. Northern Mexico (Fig. 45).

HABITAT: rocky soils, and slopes, eroded hillsides, sea level (Vancouver Isl., Puget Sound), otherwise 1200-2700 m.

STATUS: abundant and increasing, considered a weed in rangelands.

USES: fence posts.

Juniperus scopulorum hybridizes with its eastern sibling species, *J. virginiana* in the zones of contact in the Missouri River Basin (Comer, Adams and Van Haverbeke, 1982; Flake, Urbatsch and Turner, 1978; Van Haverbeke, 1968). Relictual hybridization with *J. virginiana* is present in Palo Duro Canyon in the Texas Panhandle (Adams, 1983). The species also hybridizes with *J. horizontalis* (see *J. horizontalis*, above).

Juniperus virginiana L., Sp. Pl. 2: 1039. 1753. *Juniperus foetida* Spach var. *virginiana* (L.) Spach, Ann. Sci. Nat. Bot., ser. 2, 16: 298. 1841. *Sabina virginiana* (L.) Antoine, Cupress.-Gatt.: 61. 1857. TYPE: USA, Location unknown, *leg. ign.* LINN 1198.7, (LECTOTYPE: Linn!, see Jarvis et al. 1993).

Juniperus caroliana Mill., Gard. Dict., ed. 8: *Juniperus* No. 4. 1768.

Juniperus. arborescens Moench, Methodus: 699. 1794.

Juniperus caroliniana Du Roi, Harbk. Baumz., ed 2, 1: 497. 1795.

Juniperus hermannii Spreng., Syst. Veg. 3: 908. 1826.

Juniperus virginiana L. var. *vulgaris* Endl., Syn. Conif.: 28. 1847.

Juniperus virginiana L. var. *crebra* Fernald & Griscom, Rhodora 37: 133, t. 332. 1935. *Juniperus virginiana* L. subsp. *crebra* (Fernald & Griscom) E. Murray, Kalmia 12 :21 (1982)

Juniperus virginiana L. var. *ambigens* Fassett; (=X Ambigens, *virginiana* x *horizontalis*) Bull. Torrey Bot. Club 72: 380. 1945.

In the present treatment, two varieties are recognized. However, var. *virginiana* may be divided into pyramidal (var. *virginiana*) and strict (var. *crebra*) growth habits. Research is currently being conducted to determine if var. *crebra* merits recognition.

KEY TO VARIETIES:

1. Seed cones 6-6(7) mm diameter; crowns strict, pyramidal to round; bark reddish brown; scale-leaves acute; pollen cones 3-4 mm; inland and in old fields ..... var. ***virginiana***
1. Seed cones 4-5 mm diameter; crowns flattened; bark cinnamon reddish; scale-leaves bluntly obtuse to acute; pollen cones 4-5 mm long; on sand on fore-dunes (coastal) ..... var. ***silicicola***

Juniperus virginiana var. ***silicicola*** (Small) A. E. Murray, Kalmia 13: 8. 1983. *Sabina silicicola* Small, N. Y. Bot. Gard. 24: 5 (1923). *Juniperus silicicola* (Small) L.H. Bailey, Cult. Conif. N. Amer. 18 (1933). *Juniperus virginiana* L. subsp. *silicicola* (Small) A. E. Murray, Kalmia 13: 8 (1983). *Juniperus virginiana* L. var. *silicicola* (Small) J. Silba, Phytologia Mem. 7: 37 (1984). TYPE: USA, Florida, Dixie Co., Suwannee River, Hog Island, on shell mound south of the mouth of Suwannee River, *J.K. Small (with G.K. Small & J. B. de Winkeler) 10030*, (HOLOTYPE: NYBG).

Juniperus barbadensis C. Mohr, *non Juniperus barbadensis* L.

DIOECIOUS. TREES small tree to 10 m, with a flattened crown, pyramidal when young and protected or crowded. TRUNK BARK cinnamon-reddish, exfoliating in narrow strips. BRANCHES spreading to pendulous, ultimate twigs terete or 4-angled. LEAVES both decurrent (whip) and scale. Scale-leaves bluntly obtuse to acute. Whip- and scale-leaf margins entire (20× and 40×). Pollen cones 4-5 mm. SEED CONES maturing in 1 year, blue, glaucous, resinous, ovoid 4-5 mm diameter. SEEDS tan to chestnut brown, 1.5-3 mm long. POLLEN SHED late winter - early spring. Fig. 46.

COMMON NAMES: Southern red cedar, coastal red cedar.

DISTRIBUTION: United States: along the coast, North Carolina South Carolina,

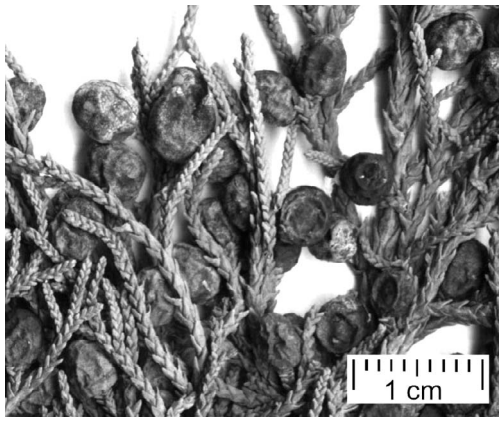

FIG. 46. *Juniperus virginiana* var. *silicicola*. Leaves and seed cones (*R. P. Adams 9186*, BAYLU).

FIG. 47. Distribution of *J. virginiana var. silicicola*.

Georgia, western Florida, and Alabama (Fig. 47).

HABITAT: coastal fore-dunes, coastal river sand banks, sea level to 15 m.

STATUS: this southern variety of *J. virginiana* appears to be restricted to coastal fore-dunes and differs little in morphology or leaf terpenoids from the upland *J. virginiana var virginiana* (Adams, 1986). Both of these taxa are distinct from the Caribbean junipers (*J. barbadensis* var. *lucayana* Britt., Bahamas, Jamaica, Cuba; *J. bermudiana* L., Bermuda, see Adams, Zanoni and Hogge, 1984). There appears to be some intergradation of characters between *J. virginiana* var. *virginiana* and this variety in Georgia (Adams, 1986).

USES: no known uses.

Juniperus virginiana L. var. *virginiana*

DIOECIOUS. TREES single stemmed to 30 m, pyramidal to strict. TRUNK BARK brown, exfoliating in thin strips. BRANCHES foliage erect or occasionally lax, green but turning reddish-brown in the winter, twigs (3-5 mm diameter) with persistent dead scale leaves, bark on twigs (6-15 mm diameter) not exfoliating in plates, if so brownish beneath. LEAVES both decurrent (whip) and scale. Whip-leaves growing only at branchlet tips (on mature trees), with an elliptical or elongated gland. Scale leaves overlapping (more than ¼ length). Scale-leaf margins entire (20× and 40× magnifications). SEED CONES blue-black to brownish blue, maturing in 1 year, borne terminally, 3-6(7) mm in diameter, 1-2(3) seeded. SEEDS tan to brown, 2-4 mm long. CHROMOSOME NUMBER $2\underline{n} = 22$, $3\underline{n} = 33$ (Hall, Mukherjee and Crowley, 1979). POLLEN SHED March-April. Fig. 48.

COMMON NAMES: Red cedar, Virginia cedar, eastern red cedar.

DISTRIBUTION: Canada: Ontario, Quebec. United States: all states except: Alaska, Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, North Dakota, Oregon, Utah, Washington, Wyoming, (Fig. 49).

HABITAT: upland or low woods, old fields, glades, fence rows and river swamps, from near sea level to 1400 m.

STATUS: Perhaps the most aggressive, weedy juniper in the world. It is spread by birds and invades abandoned fields and roadsides in the eastern United States from the Atlantic Ocean to the Edwards Plateau in central Texas and into the central Great Plains.

USES: production of eastern red cedar wood oil, furniture, fence posts, widely cultivated for landscaping.

Juniperus virginiana hybridizes with *J. horizontalis* (see *J. horizontalis*) and *J. scopulorum* (see *J. scopulorum*). Earlier reports of hybridization between *J. ashei* and *J. virginiana* (Hall, 1952) were not

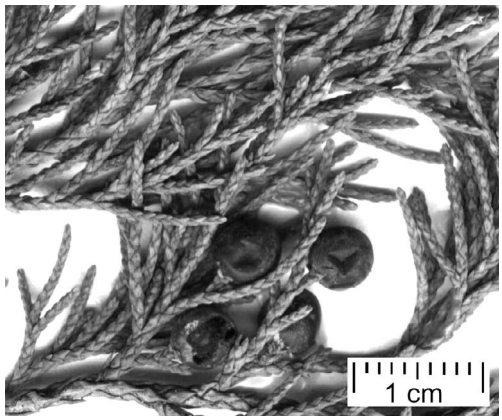

FIG. 48. *Juniperus virginiana* var. *virginiana*. Leaves and seed cones (*R. P. Adams 6754*, BAYLU).

supported in subsequent studies using leaf terpenoids (Adams, 1977; Flake et al., 1969).

Eastern Red Cedar is an aggressive, weedy species. *Juniperus virginiana* var. *virginiana* (and most junipers) are disseminated by birds and a typical pattern in the USA is the 'fence row junipers' where birds have dropped the seeds while sitting on the fence wire. It also invades disturbed sites as well as old fields. *Juniperus virginiana* var. *virginiana* is the most weedy juniper known, in that it can invade tall (0.5 m tall) grass prairie. The control of *Juniperus* is a major problem in the United States. Interestingly, the junipers of the eastern hemisphere are seldom weeds. Of course, the spread of juniper in the eastern hemisphere is often limited by goat grazing. In contrast, goat grazing is a relatively modern phenomenon in the western hemisphere and little practiced in the United States. Goat grazing has been reported to completely remove young junipers in central and west Texas (Taylor and Fhlendorf, 2003; Taylor et al., 2005; Allred et al., 2012).

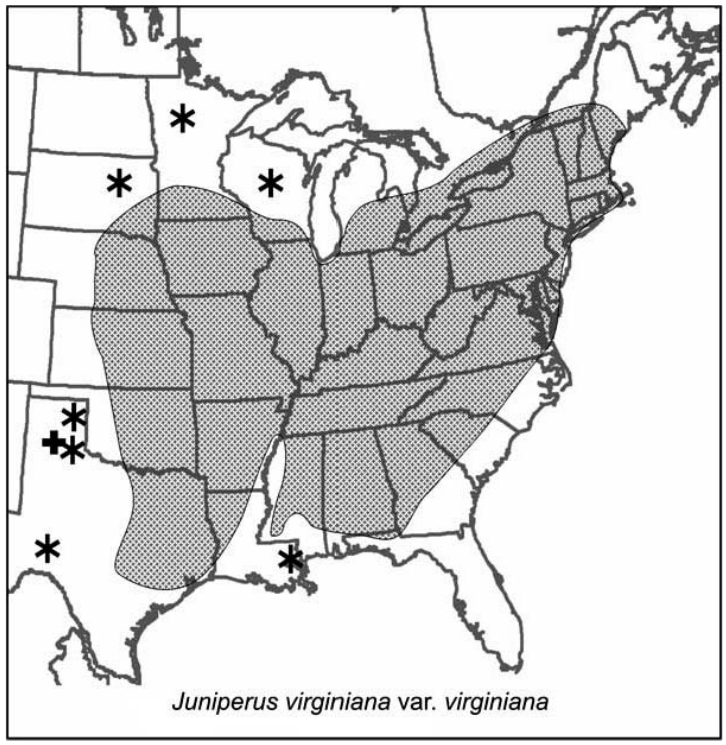

FIG. 49. Distribution of *Juniperus virginiana* var. *virginiana*. The + symbol at Palo Duro Canyon, Texas Panhandle denotes plants that are intermediate to *Juniperus scopulorum* (see Adams, 1983).

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