

**CACTACEAE CACTUS FAMILY**  
**Part Three**  
**Cylindropuntia (Engelm.) Knuth Chollas**

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Trees or shrubs, erect, rarely creeping, much-branched. STEM segments firmly attached to easily dislodged, of varied lengths, cylindrical to slightly clavate, straight, glabrous. SPINES with whole epidermis sheath deciduous; major spines not or only basally angularly flattened. FLOWER: inner tepals yellow-green, yellow to bronze, red to magenta, spatulate, emarginate-apiculate; outer tepals green with margins tinged color of inner tepals. FRUIT fleshy and green to yellow to scarlet, sometimes tinged red to purple, or dry and tan to brown, cylindrical to subspherical, sometimes clavate, spineless or spiny. SEEDS pale yellow to tan to gray, flattened, angular to squarish or circular, often warped, each commonly bearing 1-4 large depressions due to pressures from adjacent developing seeds, the girdle smooth or as a low marginal ridge. --32 spp; Chihuahuan, Mohave, Sonoran Deserts, U.S. and Mexico; Caribbean. [*Opuntia* subgenus *Cylindropuntia* Engelm.]. (Latin: *cylindrus*=cylinder + *Opuntia*).

Many interspecific cholla hybrids are known; only two are fully treated here (recently treated as species or varieties): *C. ×kelvinensis* because it is so widespread and *C. ×tetracantha* because it has been confused with other hybrids; additional hybrids are described under the parent with specific epithet first in alphabet.

1. Fruit fleshy at maturity, tuberculate to smooth, green to yellow (sometimes tinged red or purple), bearing glochids but no spines (occasionally 1-few spines, particularly in interspecific hybrids between fleshy and dry-fruited species).
2. Terminal stem segments mostly alternate, 0.8-1.2 cm in diam.; large stem spines 0-4(-6) per areole.
  3. Stem tubercles inconspicuous, usually appearing as longitudinal wrinkles when dried; large spines on stems usually 0 or 1 per areole; fruit smooth and spineless.
  4. Flowers yellow to greenish yellow, 10-15 mm in diam.; fruits yellow to scarlet, mostly 9-15 mm long; stems bearing numerous short, laterally arranged, terminal branches ..... *C. leptocaulis*
  - 4' Flowers green- to orange-bronze, 20-35 mm in diam.; fruits pale green sometimes tinged red to purple, 20-40 mm long; stems bearing 0-few short, laterally arranged terminal branches ..... *C. arbuscula*
  - 3' Stem tubercles conspicuous; spines on stems usually 2-4 per areole; fruits tuberculate at least apically, usually bearing a few short spines ..... *C. ×tetracantha*
- 2' Terminal stem segments commonly whorled or subwhorled, usually 1.5-8.5 cm in diam.; large stem spines usually 6-30 or more per areole.
  5. Fruits smooth to shallowly tuberculate, green to yellow-green, sometimes tinged red to purple, commonly proliferating.
  6. Flowers pink to magenta; tubercles very prominent, broadly oval; stems usually 2-5 cm in diam., green.
  7. Fruits forming long pendant chains; anthers white; inner tepals pink, 12-16 mm long ..... *C. fulgida*

- 7' Fruits solitary or commonly forming short erect to pendant chains of 2-4 fruits; anthers yellow; inner tepals rose to magenta, to 25(-30) mm long . . . . . *C. ×kelvinensis*
- 6' Flowers yellow-green, yellow to gold and bronze or red to rose or magenta; tubercles prominent, narrowly elongate; stems 1-2 cm in diam., green often tinged purplish . . . . . *C. versicolor*
- 5' Fruits strongly tuberculate, yellow or yellow-green sometimes tinged red to purple, solitary, not proliferating.
8. Stem segments easily detached, the spines obscuring the stem; flowers pale green to yellow, sometimes edged reddish purple or aging bronze to reddish brown . . . . . *C. bigelovii*
- 8' Stem segments firmly attached, the spines not or but little obscuring the stem except in some forms of *C. whipplei*; flowers pale yellow to yellow to salmon to rose to magenta.
9. Trees dense, small, grading into low, compact shrubs; flowers pale yellow to yellow; spines dimorphic, the smaller radial spines surrounding (1-)4 larger central spines, these spreading into a cross . . . . . *C. whipplei*
- 9' Trees wide-branching, medium to large; flowers usually rose to magenta (sometimes white in *C. imbricata* or whitish, yellow to salmon in *C. spinosior*); spines subequal or, if some longer, not dimorphic or arranged in a cross.
10. Stems with crowded, less prominent tubercles, these usually 0.5-1.5 cm long; fruit tubercles 28-50 or more, the distal ones longest . . . . . *C. spinosior*
- 10' Stems with widely-spaced, swollen tubercles, these usually 2-4 cm long; fruit tubercles 18-30, subequal in length or basal ones longer . . . . . *C. imbricata*
- 1' Fruit dry at maturity, tuberculate, green to yellow or tan to gray, bearing glochids and spines (spineless to nearly so and usually slow-drying in *C. abyssi* and *C. acanthocarpa* var. *thorneri*).
11. Fruit (spineless) spiny to bur-like with **stout** spines; areoles elliptic to subcircular; tubercles oblong to linear.
12. Filaments green or yellow; tepals yellow to pale yellow or green to yellowish green to reddish maroon; fruit tubercles subequal; terminal stem segments 3-14 cm long; stem tubercles mostly 0.4-1.5 cm long.
13. Fruits yellowish, spineless or with 1-2 short spines; filaments yellow; tepals pale yellow to greenish yellow; terminal stem segments mostly 8-14 cm long, detachable . . . . . *C. abyssi*
- 13' Fruits tan, spiny; filaments green; tepals yellow or green to yellowish green to reddish maroon; terminal stem segments mostly 3-7.5 cm long, firmly attached . . . . . *C. echinocarpa*
- 12' Filaments red; tepals yellow, bronze, magenta, to brick-red; fruit tubercles subequal or usually the basal ones longest; terminal stem segments mostly 10--30 or more cm long; stem tubercles (1.5-)2-4.5 cm long . . . . . *C. acanthocarpa*
- 11' Fruit bur-like with **bristly** spines; areoles mostly deltoid-linear, the apical spine-/glochid-bearing portion wedged distally between bases of 2 adjacent tubercles, the tubercles rhombic to squarish . . . . . *C. ramosissima*

***Cylindropuntia abyssi*** (Hester) Backeb. (for habitat, an abyss or deep canyon). Peach Springs Canyon Cholla. --Shrubby trees, openly branched, to 1 m tall. STEM segments detachable, but not as easily as in *C. bigelovii*, cylindrical, 8-14 cm long, 1.8-2.5 cm in diam.; tubercles prominent, moderately broad, 6-15 mm long. AREOLES white to gray, aging gray-white, elliptic, 5-7 mm long, 2.5-3.5 mm

wide. SPINES whitish to yellowish tan, aging gray, flexible, in brush-like clusters of 10-15 per areole; upper ones erect, divergent, terete to angularly flattened at base, the longest 18-32 mm long, erect, ascending; lower ones recurved, angularly flattened to flat, sometimes twisted, erect to descending, the longest 23-38 mm long; sheaths silvery white. GLOCHIDS pale yellow, in inconspicuous small apical tuft, 0.5-1.5 mm long, a few much longer and scattered along periphery of areole. FLOWER: inner tepals pale to greenish yellow spatulate, apiculate, 1.5-2 cm long; filaments yellow, the anthers yellow; style whitish; stigmas yellowish. FRUIT green becoming yellow, dry, tuberculate with deep umbilicus, 14-17 mm long, 15-18 mm in diam., spineless or with 1-2 short spines; areoles 16-24. SEEDS 3-4 mm long, 3.2-3.5 mm wide, tan, slightly angular and warped, the sides and girdle smooth. [*Opuntia abyssii* Hester]  $2n = 22$ . --Desertscrub, on limestone ledges and crests, Peach Springs Canyon: Mohave Co.; 500-750 m (1600-2300 ft); Mar-May. Tentatively viewed as a narrow endemic relict but may well be a persistent hybrid derivative, most likely involving *C. bigelovii*.

Hybridizes with *C. acanthocarpa*; this hybrid having flowers with pink filaments, and spiny fruits,  $2n = 22$ , Mohave Co.

***Cylindropuntia acanthocarpa*** (Engelm. & J. M. Bigelow) Knuth (spiny-fruited). Buckhorn Cholla. --Trees or shrubs, sparsely to much-branched, 1-2(-4) m tall. STEM segments firmly attached, cylindric, 10-30 (-50) cm long, 2-2.5(-3) cm in diam.; tubercles prominent, narrow to broad, 1.5-4.5 cm long. AREOLES white-, yellowish- to tan-felty, aging gray-black, elliptic to subcircular, 4-5.5 mm long, 4-5 mm wide. SPINES mostly in distal areoles, 6-20(-30) per areole, often with 0-5 short bristle-spines at areole margins; sheaths white to grayish with yellow to golden tips, baggy to more tight-fitting; major apical spines terete, ascending-divergent, yellow or tan to deep red-brown, aging gray, the central one longest, 12-30(-38) mm long; major basal spines subterete to flattened, deflexed to divergent, the central one longest, 12-30(-35) mm long. GLOCHIDS yellow to brown, in inconspicuous small apical tuft, 0.5-2 mm long. FLOWER: inner tepals bright yellow to bronze to brick-red, spatulate, apiculate-emarginate, 2-3 cm long; filaments dark red, the anthers yellow; style and stigmas white to light green. FRUIT at maturity tan, obconic to ellipsoid, the basal tubercles longest, dry, with apical flange above shallow umbilicus, 1.5-3.5 cm long, 1.5-2 cm in diam., densely to sparsely spiny, rarely spineless; areoles 12-30. SEEDS 3.5-5 mm long, 3-4.5 mm wide, pale yellow to tan, angular or squarish in outline, warped, the sides smooth but each with 2-4 large depressions, the girdle smooth. [*Opuntia acanthocarpa* Engelm. & J. M. Bigelow]. --4 vars., all in AZ; CA, adjacent Mex. Intermediates among varieties are common.

1. Tubercles 25-45 mm long, very prominent, broad; stem segments gray-green; spines of adjacent areoles not or barely interlaced, 6-11(-14) per areole; fruit bearing few spines or sometimes spineless ..... var. *thornberi*
- 1' Tubercles (10-)15-25 mm long, smaller but obvious, broad to narrow; stem segments green to yellow-green; spines of adjacent areoles interlaced, (14-)15-30+; fruit densely spiny, sometimes bur-like.
2. Spines 15-25 per areole, the 5-7 basal ones deflexed and mostly sub-parallel, whitish to light brown; tubercles broad, oval; shrubs of strict habit ..... var. *acanthocarpa*
- 2' Spines (14-)18-30 per areole, the basal ones all deflexed to divergent and spreading, pale yellow to red-brown; tubercles narrowly elliptic; shrubs of spreading habit.
3. Branches mostly at acute angles; stem segments yellowish green, (10-)15-30 cm long; spines 18-30+ per areole, yellow to tan, baggy-sheathed; inner tepals yellow ..... var. *coloradensis*
- 3' Branches mostly at obtuse angles; stem segments green to dark-green, 8-20 cm long; spines 14-18(-23) per areole, yellow to red-brown, not baggy-sheathed; inner tepals yellow to bronze to brick red ..... var. *major*

Var. **acanthocarpa**. --Shrubs or small trees with few branches, mostly at acute angles. STEM segments green, 6-17.5 cm long; tubercles broad, rounded, oval, 15-22 mm long. SPINES brown, aging gray, not baggy-sheathed, (14-)18-30 per areole; major 5-7 basal spines deflexed, sub-parallel. FLOWER: inner tepals yellow-green, sometimes reddish orange-tinged. FRUIT densely spiny; areoles 16-26,  $2n = 22$ . --Desert, adjacent juniper woodlands, rocky slopes; Mohave, Yavapai cos.; 1150-1200 m (3700-3900 ft); May; UT ?.

Var. **coloradensis** (L. D. Benson) Pinkava (for habitat, Lower Colorado River). --Trees or sometimes shrubs with few branches, mostly at acute angles. STEM segments yellowish green, 10-30 cm long; tubercles salient, elongate, (15-)20-30 mm long. SPINES yellow to light brown, aging dark gray, baggy-sheathed, 18-30 per areole, greatly increasing in number with time; major basal spines deflexed to divergent. FLOWER: inner tepals bright yellow. FRUIT densely spiny; areoles 18-30 or more,  $2n = 22$ . [*Opuntia acanthocarpa* Engelm. & J. M. Bigelow var. *coloradensis* L. D. Benson]. --Deserts to edges of juniper woodlands, sandy flats to rocky slopes; La Paz, Maricopa, Mohave, Pima, Yavapai, Yuma cos.; 400-1200 m (1300-3900 ft); Mar-Jun; CA, NV, UT; Son. in Mex.

Hybridizes with *C. echinocarpa* in La Paz and Maricopa cos. and se CA, this hybrid, *C. ×deserta* (Griffiths) Pinkava, having reddish filaments, short tubercles, variable-length spines per areole, and dry spiny fruits.

Var. **major** (Engelm.) Pinkava (greater). --Shrubs sprawling, with numerous branches, mostly at obtuse angles. STEM segments green to dark-green, 8-20(-31) cm long; tubercles salient, moderately broad, 15-25 mm long. SPINES yellow to deep red-brown, aging gray, not baggy-sheathed, 14-18(-23) per areole; major basal spines mostly deflexed, spreading. FLOWER: inner tepals yellow to bronze to brick-red. FRUIT spiny; areoles 14-22(-26).  $2n = 22$ . [*Opuntia acanthocarpa* Engelm. & J. M. Bigelow var. *major* (Engelm.) L. D. Benson, *Opuntia echinocarpa* Engelm. & J. M. Bigelow var. *major* Engelm., *O. echinocarpa* Engelm. & J. M. Bigelow var. *ramosa* Peebles, *O. echinocarpa* Engelm. & J. M. Bigelow var. *robustior* J. M. Coult. --Sandy desert flats and washes to rocky slopes; Maricopa, Pima, Pinal cos.; 300-900 m (1000-2900 ft); Mar-Jun; n Son. in Mex.

Hybridizes with: *C. bigelovii* var. *bigelovii* near Phoenix, AZ, this hybrid appearing similar but as a slightly more open tree than *C. bigelovii* var. *bigelovii*, with yellow green inner tepals and magenta filaments,  $2n = 44$ .; *C. leptocaulis* (see *C. ×tetracantha*); *C. spinosior*, this hybrid as a sprawling shrub with irregular branching pattern, the spines clusters with 1 or more spines longer than others, the fruits fleshy, some with 1-few spines per fruit,  $2n = 22$ , Pinal Co.; *C. versicolor* in Pima and Pinal cos, this hybrid with fleshy tuberculate fruits but often with 1-2 short permanent spines at apex and longer and more numerous spines per stem areole.

Var. **thornberi** (Thornber & Bonker) Backeb. (for J. J. Thornber). Thornber Cholla. --Trees and shrubs with few to many branches, at acute and obtuse angles. STEM segments gray-green, 10-25(-50) cm long; tubercles very prominent and broad, 25-45 mm long. SPINES yellow to deep red-brown, aging gray, 6-11(-14) per areole, rarely interlacing with spines of adjacent areoles, not baggy-sheathed; major basal spines mostly deflexed and spreading. FLOWER: inner tepals yellow to bronze. FRUIT bearing few spines, sometimes spineless; areoles 12-20.  $2n = 22$ . [*Opuntia acanthocarpa* Engelm. & J. M. Bigelow var. *thornberi* Thornber & Bonker]. --Desertscrub, desert grasslands, chaparral transition areas, rocky hills and ridges; Gila, Maricopa, Pinal, Yavapai cos.; 600-1450 m (1900-4700 ft); Apr-Jun.

Hybridizes with *C. whipplei* in Yavapai Co., as *C. ×congesta* (Griffiths) Pinkava, this hybrid as a compact shrub with long-tubercled stem segments, 8-12 mm thick, bearing 0-4 erect to deflexed spines per areole, and tuberculate, green to yellowish fruits occasionally bearing 1-few spines,  $2n = 22$ .

**Cylindropuntia arbuscula** (Engelm.) Knuth (small tree-like). Pencil Cholla. --Trees or shrubs, much branched, 0.5-3 m tall. STEM segments green, sometimes purple-tinged, 6-10.5 cm long, 0.5-1.3

cm in diam.; tubercles obscure, narrowly elongate appearing as wrinkles when dry, 1-2 cm long. AREOLES tan- to brown-felty, aging gray to black, circular, 2-3 mm in diam. SPINES 0-2(-3), sparsely distributed along stem, pale yellow to red-brown aging black, stout, usually deflexed, the longest 0.8-3.5(-5) cm long; sheaths loose-fitting, yellowish brown. GLOCHIDS pale yellow, in an apical tuft with a few marginal ones, encircling areole. FLOWER: inner tepals dark bronze to orange bronze, spatulate, apiculate, 1.7-2 cm long; filaments dark green-bronze, the anthers yellow; style whitish basally to light orange apically; stigmas very pale green. FRUIT green becoming yellowish apically, sometimes purplish at areoles, obconic-stipitate, commonly sterile, narrow and tuberculate to 2.5 cm long, the fertile ones obconic-stipitate, becoming smooth, spineless, fleshy, 2.5-5 cm long, 1.5-3.5 cm in diam., the umbilicus 3-4 mm deep; areoles 15-17(-34). SEEDS 3-5 mm in diam., pale yellow, angularly circular to oblong, thick, lumpy, the girdle smooth, not protruding.  $2n=66$ . [*Opuntia arbuscula* Engelm.]. --Sonoran Desert flats and bajadas, desert scrub; Maricopa, Pima, Pinal cos.; 350-1000 m (1000-3300 ft); Apr-Jun; Son. in Mex.

Hybridizes with: *C. leptocaulis* in Pima Co., this hybrid with narrow obscurely tubercled stems and reddish fruits nearly size of those of *C. arbuscula*,  $2n=55$ ; *C. spinosior* in Pima, Pinal cos., this hybrid *C. × neoarbuscula* (Griffiths) Knuth, with large green fruits (often splitting open) and distal stem segment areoles usually bearing 3-4 spines to 2.5 cm long; *C. versicolor* in Pima Co., this hybrid, *C. × vivipara* (Rose) Knuth, with large green fruits (often splitting open) and distal stem segment areoles usually bearing 1-2 spines to 1.5 cm long,  $2n=55$ .

***Cylindropuntia bigelovii* (Engelm.) Knuth (for J. M. Bigelow).** Teddy-bear Cholla. --Trees or shrubs, small, much-branched, the older branches at base of crown dark-brown, clinging to solitary or multiple trunks, 0.3-1.5(-3) m tall. STEM segments green to light green, the ultimate ones usually very easily detached, 4-13(-18) cm long, (2-)4-5.5 cm in diam.; tubercles salient, obdeltoid, 6-12 mm long. AREOLES white-, yellow- to brownish-felty, aging gray, elliptic-deltoid, 3-7 cm long, 2-4 mm wide. SPINES at most areoles, pale yellow to yellow to tan, aging dark brown, interlaced, and nearly completely obscuring stem, 3-11(-15) per areole; sheaths uniformly whitish or pale yellow, baggy; distal spines terete, erect-spreading, largest (10-)20-30 mm long; basal spines subterete to flattened, spreading to deflexed, the largest (10-)15-25 mm long. GLOCHIDS yellow, in a broad apical crescent, sometimes extending basally along areole margins, 3-4 mm long. FLOWER: inner tepals pale green, sometimes red-tipped, spatulate, emarginate-apiculate, often erose, (15-)20-35 mm long; filaments pale green to green, the anthers yellow-orange; style light green; stigmas cream to green. FRUIT yellow, strongly tuberculate, cylindric to broadly obconic, with umbilicus to 10 mm deep, fleshy-leathery, becoming spineless, losing bristle-spines of young fruit, (15-)22-40 mm long, (8-)16-20(-28) mm in diam.; areoles 36-76, equally spaced. SEEDS, 2.5-4 mm long, 2.2-3.5 mm wide, pale yellow, in gelatinous mass, angular to squarish in outline, warped, the sides smooth, each with 1-2 large depressions, the girdle smooth or as a very narrow marginal ridge. [*Opuntia bigelovii* Engelm.]. --2 vars., 1 in AZ; sw U.S. and nw Mex. *Opuntia bigelovii* var. *ciribe* (Engelm.) W. T. Marshall, erroneously reported for AZ, occurs only in Baja C. Sur in Mex.

Var. ***bigelovii***. --Shrubby trees, usually with solitary trunk. STEM segments very spiny, obscuring the tubercles. SPINES usually 7-11 per areole.  $2n=22$ , usually 33. --Sandy desert flats to gravelly to rocky washes, bajadas and hillsides; Gila, La Paz, Maricopa, Mohave, Pima, Pinal, Yavapai, Yuma cos.; 300-900 m (1000-2900 ft); Mar-Jun, Sep; CA, NV; Baja C., Baja C. Sur, Son. in Mex.

Hybridizes with *C. acanthocarpa* var. *major*.

***Cylindropuntia echinocarpa* (Engelm. & J. M. Bigelow) Knuth (spiny-fruited).** Silver Cholla, Golden Cholla. --Trees or shrubs, much-branched, 0.5-2 m tall. STEM segments usually firmly attached, cylindric, green to light gray-green, 3-7.5(-12) cm long, 1-2.5 cm in diam.; tubercles salient, short-oval, 4-13(-15) mm long, moderately broad. AREOLES whitish-, yellow- to tan-felty, aging

gray, broadly elliptic, 4-4.5 mm long, 2-3.5 mm wide. SPINES at most areoles, most prominent in distal ones, interlaced obscuring stem, sometimes forming brushlike clusters, (6-)10-17(-22) per areole, with 0-5 short bristly spines at areole margins; sheaths whitish with yellow to golden tips, baggy; major distal spines white, pale yellow, tan to brown, rarely deep red-brown, terete, erect-spreading, the largest 22-35(-50) mm long; major basal spines whitish, yellow to tan, mostly subterete to flattened, spreading to deflexed, the largest 20-30(-45) mm long. GLOCHIDS yellow, conspicuous in a broad apical crescent, 3-4(-5) mm long. FLOWER: inner tepals light-green to yellow-green, sometimes suffused with maroon or rose, spatulate, emarginate-apiculate, 20-23 mm long; filaments greenish white to yellow, sometimes suffused with bronze or rose, but not red; anthers yellow; style and stigmas whitish, cream to light green. FRUIT at maturity tan, obconic to subspherical, the basal tubercles not markedly longer than distal ones, dry with apical flange around the deep umbilicus, densely spiny, sometimes bur-like, 13-23 mm long, 11-20 mm in diam.; areoles 16-24(-36). SEEDS 4-6 mm long, 3.5-5 mm wide, pale yellow, angular to squarish in outline, warped, the sides smooth, each with 2-4 large depressions, the girdle smooth, rarely as a very narrow ridge.  $2n = 22$ . [*Cactus echinocarpus* (Engelm. & J. M. Bigelow) Lemaire, *Cylindropuntia wigginsii* (L. D. Benson) H. Rob., *Opuntia echinocarpa* Engelm. & J. M. Bigelow; *O. wigginsii* L. D. Benson]. --Desert grasslands and juniper and oak-juniper woodlands; sandy, loam, alluvial to gravelly substrates; flats, bajadas to canyons; La Paz, Maricopa, Mohave, Yavapai cos.; 20-1700 m (66-5500 ft); Mar-Jun; CA, NV; Baja C., Son. in Mex.

Hybridizes with: *C. acanthocarpa* var. *coloradensis*; *C. whipplei* in AZ-NV-UT borders area, particularly with the low, compact form of *C. echinocarpa* in Mohave Co., this hybrid, *C. ×multigeniculata* (Clokey) Backb., bearing spineless to nearly spineless fruits and numerous intergrading spines per stem areole,  $2n = 22$ .

***Cylindropuntia fulgida*** (Engelm.) Knuth (shining). Chain-fruit Cholla. --Trees, 1-3 m tall, the trunks divaricately branching, the crown much-branched, spreading. STEM segments gray-green, often drying blackish, the terminal ones easily dislodged, 6-16(-23) cm long, 2-3.5 cm in diam.; tubercles salient, broadly oval, 8-13(-19) mm long. AREOLES gold- to tan-felty, aging gray to black, obdeltoid, 5-7(-10) mm long, 2.5-4 mm wide. SPINES 0-12(-18) per areole, yellowish, sometimes also pale pinkish, aging brown, interlaced or not; sheaths uniformly whitish, yellowish to golden, baggy; distal spines erect-spreading, terete to subterete, largest spine to 3 cm long; basal spines erect to deflexed, spreading, flattened basally, the largest to 3.5 cm long. GLOCHIDS yellow, in an apical tuft, sometimes also scattered along areole margins, 1-3 mm long. FLOWER opening in late afternoon or evening; inner tepals pink to magenta, obovate to ligulate, apiculate emarginate, 12-16 mm long; filaments pale pink to magenta, the anthers white to cream; style pinkish; stigmas whitish to pale yellow. FRUIT gray-green, obconic, often stipitate, proliferating, forming long, branching, pendulous chains, fleshy, spineless, the tubercles becoming obscure, with umbilicus to 8 mm deep; basal fruits 32-55 long, 23-45 mm in diam.; terminal fruits 20-33 mm long, 13-23 mm in diam.; areoles 18-35. SEEDS 1.8-5.5 mm long, 1.5-.5 mm wide, pale yellow to brownish, in a gelatinous mass, angular to very irregular in outline, warped, the sides smooth, each with 1-2 large depressions, girdle smooth, the hilum region pointed. [*Opuntia fulgida* Engelm.]. --2 vars., both in AZ. Intermediates are known between the varieties.

The species hybridizes with: *C. spinosior* (see *C. ×kelvinensis*); *C. leptocaulis* in Pima Co., this hybrid with stems of intermediate diam., spines (0-)1-5 per areole, 1 spine very long; fruits in chains to 6+, spineless, yellowing, often reddish.

1. Spines of stems interlaced, the largest spines usually 2.5-3.5 cm long, the sheaths baggy; stem segments appearing spiny from afar, obscuring the strongly mammillate tubercles beneath . . . .  
 ..... var. *fulgida*

- 1' Spines of stems not or but little interlaced, largest spines 1-2 cm long, the sheaths tight-fitting; stem segments appearing spineless from afar, exposing the strongly mammillate tubercles beneath  
 ..... var. *mamillata*

Var. *fulgida*. --SPINES of stems interlaced, the largest spines usually 2.5-3 cm long, their sheaths baggy. STEM appearing spiny from afar, obscuring the strongly mammillate tubercles beneath.  $2n = 22, 33$ . --Sandy desert flats to rocky slopes of rolling hillsides; Cochise, Gila, Maricopa, Pima, Pinal, Yavapai, Yuma cos.; 300-1100 m (1000-3600 ft); Apr-Sep; Son. in Mex.

Var. *mamillata* (A. Schott) Backeb. (mammillate referring to tubercles). --SPINES of stems not or but little interlaced, the largest spines usually 1-2 cm, their sheaths tight-fitting. STEM segments appearing spineless or nearly so from afar, obviously exposing the strongly mammillate tubercles.  $2n = 22$ . [*Opuntia mamillata* A. Schott; *O. fulgida* Engelm. var. *mamillata* (A. Schott) J. M. Coult.]. --Sandy desert flats to rocky slopes, rolling hills; Gila, Maricopa, Pima, Pinal cos.; 200-1100 m (600-3600 ft); Apr-Aug, Oct; Sin., Son., ne Gulf of CA islands in Mex.

A crested morph from Pinal Co. is commonly cultivated as the Boxing-glove Cholla.

*Cylindropuntia imbricata* (Haw.) Knuth (overlapping). Tree Cholla. --Trees or shrubs with short trunks or large shrubs, (1-)1.5-2.5(-3) m tall. STEM segments gray-green, cylindrical to weakly clavate, 8-25 cm long, 1.5-4 cm in diam.; tubercles very prominent, widely spaced, (1.5-)2-5 cm long. AREOLES yellow-tan-felty, aging gray to black, elliptic, 5-8 mm long, 3-4 mm wide. SPINES usually at most areoles, silver to yellow to usually reddish to tan to brown, not obscuring the stem, stout, terete or sometimes flattened basally, spreading, straight or slightly curved, (0-)8-15(-30) per areole, 8-30(-40) mm long; sheaths silver to yellow to usually tan to dirty-white, yellow-tipped. GLOCHIDS pale yellow, in dense apical tuft, 0.5-3 mm long. FLOWER: inner tepals dark pink to magenta to red-magenta, obovate, apiculate, 1.5-3.5 cm long; filaments green basally to pink to magenta apically, the anthers yellow; style light green basally to pink to red-magenta apically; stigmas green to cream. FRUIT yellow, fleshy, obovoid, spineless, 2.4-4.5 cm long, 2-4 cm in diam., the tubercles subequal, prominent but occasionally smooth at maturity, the umbilicus 7-14 mm deep; areoles 18-30. SEEDS 2.5-4 mm diam., yellow-tan, subcircular to angled, warped, sides smooth to slightly lumpy, the girdle usually narrow, not protruding [*Cactus imbricatus* Haw.; *Opuntia imbricata* (Haw.) DC.]. --2 vars., 1 in AZ; sc U.S. and n Mex.

Var. *imbricata*. --Trees to 3 m tall, openly branched. STEM segments and tubercles large. SPINES and sheaths yellowish to usually tan to dirty-white.  $2n = 22$ . [*Opuntia arborescens* Engelm.]. --Hills to plains of deserts and grasslands, at times in pinyon-juniper woodlands; ?Gila, Pima, cos.; 800-2200 m (2700-7300 ft); May-Aug; CO, KS, NM, OK, TX; n Mex.

*Cylindropuntia imbricata* var. *imbricata* is the wide-ranging aspect-dominant cholla of the Chihuahuan Desert; AZ specimens poorly represent the species (probably introgressed).

Hybridizes with *C. whipplei* and occurs in scattered localities (perhaps transported by Native Americans) in n NM, sw CO and Navajo Co., AZ, this hybrid, *C. ×viridiflora* (Britton & Rose) Knuth, having a low, bushy habit, ripe cantaloupe-colored inner tepals, and an irregular non-dimorphic spine pattern,  $2n = 22$ .

*Cylindropuntia ×kelvinensis* (V. Grant & K. A. Grant) P. V. Heath (of Kelvin, AZ). --Trees, 1.5-2 m tall, the trunks commonly branched, the open to compact crown usually bearing whorled branches. STEM segments green to purple, the terminal ones often easily dislodged, 5-13 cm long, 1.8-3 cm in diam.; tubercles prominent, broad-oval, 7-12(-15) mm long. AREOLES yellow-felty, aging gray to black, obdeltoid to rhombic, 4.5-6 mm long, 3-5 mm wide. SPINES at most areoles, yellowish to tan, sometimes with pinkish hue, to red-brown and partially gray-coated, aging brown-gray to gray, usually slightly interlacing, 0-8(-13) per areole, sometimes with 1-3 bristle-spines along areole margins;

sheaths uniformly whitish or yellow- to gold-tipped, slightly baggy; major distal spines subterete, erect-divergent, the largest to 18 mm long; major basal spines angular-flattened, mostly reflexed, the largest to 30 mm long. GLOCHIDS yellow, in an inconspicuous apical crescent, to 1 mm long. FLOWER: inner tepals, rose to magenta, spatulate, emarginate-apiculate, 18-25(-30) mm long; filaments deep rose, the anthers yellow; style rose apically, whitish basally; stigmas cream to white. FRUIT yellow-green to yellow, sometimes purplish, the prominent tubercles progressively longer toward apex, sometimes forming short chains, fleshy, spineless, usually sterile, 25-45 mm long, 15-22 mm in diam., the umbilicus 4-7 mm deep; areoles 32-44. SEEDS 3.5-4 mm long, 3-4 mm wide, pale yellow, orbicular to angular or squarish in outline, flat to warped, the side smooth, each with 0-2 large depressions, 3.5-4 mm long, 3-4 mm wide, the girdle smooth, the hilum sometimes pointed.  $2n = 22$ , mostly 33. [*Cylindropuntia fulgida* (Engelm.) Knuth  $\times$  *C. spinosior* (Engelm.) Knuth; *Opuntia kelvinensis* V. Grant & K. A. Grant]. --Desertscrub, edges of desert grasslands, rocky flats and slopes, rolling hills; Gila, Pima, Pinal cos.; 550-950 m (1800-3100 ft); Apr-Jun.

***Cylindropuntia leptocaulis* (DC.) Knuth** (narrow-stemmed). Desert Christmas Cholla. --Shrubs or small trees, sparingly to densely branched, usually bearing many short, commonly spineless branchlets arranged along major axes, 0.5-1.8 m tall. STEM segments gray-green to purplish, very narrow, 20-80 mm long, 3-5 mm in diam.; tubercles not prominent, linear, drying as elongate, rib-like wrinkles, 11-20(-30) mm long. AREOLES white- to yellow-felty, aging gray, broadly elliptic, (1-)1.5-3.5 mm long, 0.7-2 mm wide. SPINES essentially absent or mostly in apical areoles to well distributed, red-brown with a gray to whitish coat, the tips yellow, aging red-brown, terete, angular-flattened basally, erect, flexible, straight or arching upward or downward, 0-1(-3) per areole, the largest (4-)14-45 mm; sheaths gray to purple-gray with yellow to red-brown tips or yellow throughout. GLOCHIDS yellow to reddish brown, in an apical tuft or crescent to encircling the areole, 1-3(-5) mm long. FLOWER: inner tepals pale yellow to greenish yellow, sometimes red-tipped, narrowly obovate, acute, apiculate, 6-12 mm long; filaments greenish yellow, the anthers yellow; style yellow; stigmas greenish yellow. FRUIT green, sometimes tinged purple, becoming yellow (rarely), orange-red to scarlet at maturity, obovoid to stipitate obovoid, smooth, spineless, fleshy, with umbilicus 2-4 mm deep, occasionally proliferating, 9-15(-27) mm long, 6-7(-12) mm in diam.; areoles 16-20. SEEDS 3-4.5 mm in diam., pale yellow, suborbicular to squarish and crenate in outline, warped, the sides smooth, each with 1-3 large depressions, the girdle smooth or as a very narrow ridge, 3-4.5 mm in diam.  $2n = 22, 33$ , also 44 in Chihuahuan Desert. [*Opuntia leptocaulis* DC., *O. fragilis* Nutt. var. *frutescens* Engelm., *O. frutescens* (Engelm.) Engelm., *O. leptocaulis* var. *brevispinus* (Engelm.) S. Wats., *O. leptocaulis* var. *longispina* Engelm. ex Berger, *O. vaginata* Engelm.]. --Widespread in N. Amer. deserts (commonly with nurse plant), sandy, loamy to gravelly substrates, flats, bajadas and slopes to desert and plains grasslands to chaparrals and oak-juniper woodlands; Cochise, Coconino, Gila, Graham, La Paz, Maricopa, Mohave, Pima, Pinal, Santa Cruz, Yavapai, Yuma cos.; 50-1500 m (200-5000 ft); Mar-Aug, Oct; NM, OK, TX; Chih., Coah., Dgo., N. L., Son., S.L.P., Tam., Zac. in Mex.

Hybridizes with: *C. arbuscula*; *C. fulgida*; *C. spinosior*; and *C. versicolor* (see discussion under *C.  $\times$  tetracantha*); *C. whipplei* in Yavapai Co., this hybrid with narrow tuberculate stems bearing 0-1(-2) major spines per areole, and tuberculate, spineless, orange to red fruits, these and the flowers intermediate in size to the parents,  $2n = 22$ .

***Cylindropuntia ramosissima* (Engelm.) Knuth** (very much branched). Diamond Cholla. --Trees or shrubs, intricately branched, 0.5-2 m tall. STEM segments firmly attached, cylindrical, green drying gray and rope-like, 2-8(-10) cm long, 0.4-1 cm in diam.; tubercles rhombic, convex (flat upon drying), 4-8 mm long. AREOLES tan- to white-felty, subcircular in basal areoles becoming mostly deltoid-linear in distal areoles, (3-)4-7 mm long, 1-1.5 mm wide, the apical glochid-bearing portion protruding distally and wedged between the bases of 2 adjacent tubercles. SPINES mostly in distal areoles or sometimes absent or nearly so, tan to red-brown to deep purple, aging gray, 0-5 per areole, baggy-



sheathed; major apical spines 0-1(-2), the largest one spreading, (1.5-)2.5-6 cm long; basal spines mostly reflexed, short to ca. 1 cm. GLOCHIDS in a subcircular to linear apical tuft, yellow to tan to brown, to 2 mm in diameter. FLOWER: inner tepals bronze-red commonly suffused with rose with midstripes darker, ovate, acute-apiculate to attenuate, 6-13 mm long; filaments greenish, the anthers yellow; style whitish or blushed with rose-pink or light green; stigmas whitish. FRUIT maturing tan, dry, developing increasingly bur-like, with evenly spaced woolly areoles producing many bristle-spines, ellipsoid to stipitate-ellipsoid, 1.5-3 cm long, 1-1.5 cm in diam.; areoles (32-)40-66. SEEDS 4-4.5 mm long, 3-5.4 mm wide, pale yellow to tan-gray, angular to squarish in outline, warped, the sides irregularly concave-convex, the girdle smooth.  $2n = 22, 44$ . [*Opuntia ramosissima* Engelm., *O. tessellata* Engelm.]. --Sandy loam, desert pavement to stony volcanic substrates, on washes, flats and bajadas; La Paz, Maricopa, Mohave, Pima, Yuma cos.; 50-1050 m (200-3400 ft); Apr-Aug; CA, NV; Baja C., Son. in Mex.

**Cylindropuntia spinosior** (Engelm.) Knuth (spiny). Cane Cholla. --Trees compact, 0.4-2 m tall, with whorled branches. STEM segments green to purple, 5-23 cm long, 1.3-3.5 cm in diam.; tubercles pronounced, oval to narrowly oval, 4.5-12(-15) mm long. AREOLES yellow- to tan-felty, aging gray to black, broadly obdeltoid to elliptic, 4.5-7 mm long, 2-4 mm wide. SPINES at most areoles, pale tan (rarely yellowish), pinkish to red brown, interlacing with spines of adjacent areoles, (4-)6-18(-24) spines per areole, 0-few bristly spines at areole basal margins; sheaths uniformly whitish, long-persisting, not baggy; distal spines erect-spreading, subterete; basal spines erect to mostly deflexed, terete, often flattened basally, 8-19 mm long. GLOCHIDS yellow to tan, aging gray, in inconspicuous apical tuft(s), 1-2 mm long. FLOWER: inner tepals rose to red-purple, or bronze-purple, or yellow, sometimes pale greenish yellow to whitish, spatulate, emarginate-apiculate, 18-35 mm long; filaments deep purple to pink-purple, sometimes green, the anthers pale yellow; style white or pink to purple apically; stigmas white to cream. FRUIT yellow, sometimes tinged reddish to purplish, broadly cylindrical, pulpy-fleshy, rarely proliferating, 2.5 cm long, 1.7-3 cm in diam., strongly tuberculate, the tubercles increasing in length apically with umbilicus to 10 mm deep; areoles 28-50(-62). SEEDS 4-5 mm long, 3-4 mm wide, pale yellow, suborbicular to oval in outline, nearly flat to warped, the sides smooth with 0-3 large depressions, the girdle smooth, 4-5 mm long, 3-4 mm wide.  $2n = 22$ . [*Opuntia spinosior* (Engelm.) Toumey; *O. whipplei* Engelm. & J. M. Bigelow var. *spinosior* Engelm.; *O. spinosior* var. *neomexicana* Toumey]. --Desert and plains grasslands, extending on to Sonoran Desert flats, sandy to loamy soils; Cochise, Gila, Graham, Greenlee, Maricopa, Pima, Pinal, Santa Cruz, Yavapai cos.; 300-2000 m (1000-6600 ft); Apr-Aug; NM; Son., Chih. in Mex.

Hybridizes with: *C. acanthocarpa* vars. *coloradensis* and *major*; *C. arbuscula*; *C. fulgida* (see *C. ×kelvinensis*); *C. leptocaulis* (see discussion under *C. ×tetracantha*); *C. versicolor* in sc AZ, this hybrid with intermediate values for the number of spines per stem areole, stem segment diameter and color, fruit tubercles,  $2n = 22$ . Grant, V. and K. A. Grant. 1971. *Proc. Nat. Acad. Sci.* 68:1993-1995.

**Cylindropuntia ×tetracantha** (Toumey) Knuth (four-spined). Toumey Cholla. --Shrubs, openly branched, 0.5-1.3 m tall. STEM segments green to gray-green (or reddish), 5-28 cm long, 0.7-1.4 cm in diam.; tubercles moderately prominent, narrowly elongate, 1.5-3 cm long. AREOLES tan-felty, aging gray, subcircular, 1.5-3 mm in diam. SPINES in all but segment's basal areoles, yellow with whitish to pinkish basal coating, usually all deflexed, moderately stout to acicular, (0-)1-4 per areole, the longest 1.5-2.8 cm; sheaths whitish at bases to golden at tips. GLOCHIDS yellow, in apical tuft with a few encircling the areole, 1-3 mm. FLOWER: inner tepals greenish bronze or red to magenta, spatulate- to obovate-apiculate, filaments reddish, the anthers light yellow; style and stigma colors unknown. FRUIT commonly sterile, green becoming yellow with red blush to red, moderately tuberculate, a few areoles producing 1(-2) short spines, obconic to obovate-stipitate, fleshy, often proliferating, 1.5-2.3 cm long, 1--2 cm in diam.; umbilicus 3-4.5 mm deep; areoles 10-18. SEEDS 3-4 mm long, 3-3.5 mm wide, tan, angularly subcircular to broadly oval, warped with uneven sides, the

girdle broad, lumpy, slightly protruding, 3-4 cm long, 3-3.5 mm wide.  $2n = 22$ . [*C. acanthocarpa* (Engelm. & J. M. Bigelow) Knuth var. *major* (Engelm.) Pinkava  $\times$  *C. leptocaulis* DC., *C. tetracantha* (Toumey) Knuth, *Opuntia tetracantha* Toumey; *O. kleiniae* DC. var. *tetracantha* (Toumey) W. T. Marshall]. --Desert flats and hills, desertscrub; Maricopa, Pinal, Pima cos.; 550-1000 m (1800-3200 ft); Apr-May.

Uncommon hybrid; other sympatric and allopatric hybrids long confused with and usually included in *C. \times tetracantha*: *C. leptocaulis*  $\times$  *C. spinosior*, this hybrid with spineless, reddish, and strongly tuberculate fruits, and with long spreading subwhorled branches,  $2n = 22$ , Cochise, Gila, Graham, Pima, Pinal cos.; *C. leptocaulis*  $\times$  *C. versicolor*, this hybrid with spineless, reddish, smooth and enlarged fruits, and with a less spreading habit, Pima Co.; and *C. leptocaulis*  $\times$  *C. whipplei* in Yavapai Co.

**Cylindropuntia versicolor** (Engelm. ex J. M. Coult.) Knuth (variously colored, referring to flowers). Staghorn Cholla. --Trees or shrubs, openly branching at acute angles, to 2 m tall. STEM segments purple to green-purple, 4-18 cm long, 1-2 cm in diam.; tubercles prominent, elongate-oval, 1-2(-2.5) cm long. AREOLES tan- to brown-felty, aging gray, subcircular, 3.5-4 mm in diam. SPINES well distributed along stem, slightly interlacing, 6-8 per areole (more numerous in older areoles), with 0-2 bristle-spines, the sheaths grayish tipped brown, yellow to golden; distal spines rich red-brown, gray-coated below, erect-spreading, subterete, 6-11 mm long; basal spines whitish, pinkish to red brown, mostly reflexed, lightly flattened, longest 10-18 mm long. GLOCHIDS dark yellow, in a small apical tuft or crescent, to 1 mm long. FLOWER: inner tepals yellow-green, yellow to gold and bronze or red to rose or magenta, spatulate, apiculate, 20-25 mm long; filaments yellowish green, the anthers yellow; style whitish to pale bronze; stigmas whitish. FRUIT yellowish green or tinged red to purple, leathery-fleshy, obovate and often stipitate, essentially spineless, often proliferating, 2.5-4 cm long, 1-2 cm in diam., at first the tubercles prominent, subequal in length or lower ones longer, but swelling and becoming smooth if fertile, the umbilicus to 9 mm deep; areoles 20-30. SEEDS 3.5-5.5 mm long, 2.5-5 mm wide, yellowish, polygonal in outline, warped, the sides nearly flat with depressions and protrusions to angular subspheric, the girdle smooth or in groove.  $2n = 22$ . [*Opuntia versicolor* Engelm. ex J. M. Coult., *O. arborescens* Engelm. var. *versicolor* (Engelm. ex J. M. Coult.) E. Dams, *O. thurberi* Engelm. subsp. *versicolor* (Engelm. ex J. M. Coult.) Felger & Lowe]. --Desert flats, washes to rocky hillsides and canyons, desertscrub; Pima, Pinal, Santa Cruz cos.; 600-1300 m (1900-4300 ft); Apr-Jun; Son. in Mex.

Hybridizes with: *C. acanthocarpa* var. *major*, *C. leptocaulis* (see discussion under *C. \times tetracantha*), and *C. spinosior*.

**Cylindropuntia whipplei** (Engelm. & J. M. Bigelow) Knuth (for A. W. Whipple). Whipple Cholla. --Trees or shrubs, low to upright, sparingly to very densely branched with whorled to subwhorled branchlets, 0.5-1.3 m tall. STEM segments green, 3-9(-15) cm long, 0.5-1.5(-2.2) cm in diam.; tubercles very prominent and short, 5-10 mm long. AREOLES pale yellow- to white-felty, aging gray, oval to obdeltoid, 2-6 mm long, 1.5-4 mm wide. SPINES in all but basal-most areoles, best developed toward apex, whitish or pale yellow, pink pale red-brown, sometimes yellow-tipped, (1-)3-8(-10) per areole, interlacing, dimorphic per areole, the sheaths whitish to pale yellow (rarely golden) throughout or yellow to golden tipped; central spines stout, subterete, usually 4(-6) spreading into a cross, 2-3.4(-4.5) cm long; lateral spines slender, flattened basally, deflexed, 5-8 mm long; also 0-2 bristly spines. GLOCHIDS yellow, in apical tuft, 1-3 mm long. FLOWER: inner tepals pale yellow, yellow to green-yellow, spatulate, apiculate 1.5-2.5(-3) cm long; filaments yellowish to yellow-green, the anthers yellow; styles white to yellowish; stigmas whitish, yellowish to pale green, rarely pink-tinged. FRUIT yellow to greenish-yellow, pulpy-fleshy, broadly cylindrical to subspheric, spineless, 18-30(-35) mm long, 15-22(-32) mm in diam., the tubercles sub-equal or uppermost longest, usually prominent, the umbilicus 7-8 mm deep; areoles 36-62. SEEDS 3-3.5 mm long, 2.5-3.5 mm wide, pale

yellow, subcircular to slightly angular in outline, nearly flat to warped, the sides smooth or with 1-3 depressions, the girdle smooth.  $2n = 22, 44$ . [*Cylindropuntia whipplei* (Engelm. & J. M. Bigelow) Knuth var. *enodis* (Peebles) Backeb., *C. hualpaensis* Backeb., *Opuntia whipplei* Engelm. & J. M. Bigelow, *O. whipplei* var. *enodis* Peebles, *O. whipplei* var. *laevior* Engelm.]. --Deserts, desert and plains grasslands, juniper woodlands with oaks, pinyons or sagebrush to pine forests, various substrates; Apache, Coconino, Mohave, Navajo, Yavapai cos.; 900-2300 m (2900-7600 ft); May-Jul; ?CO, NM, UT.

Hybridizes with: *C. acanthocarpa* var. *thornberi*, *C. echinocarpa*, *C. imbricata* var. *imbricata*, and *C. leptocaulis*.

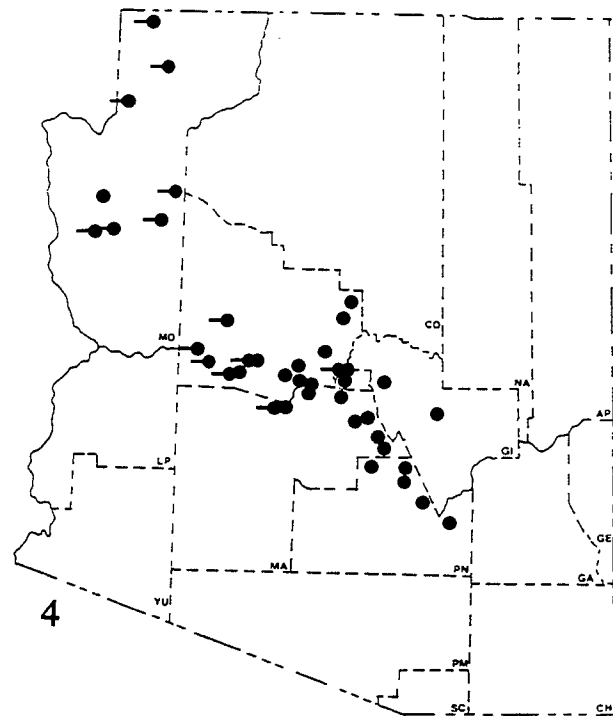
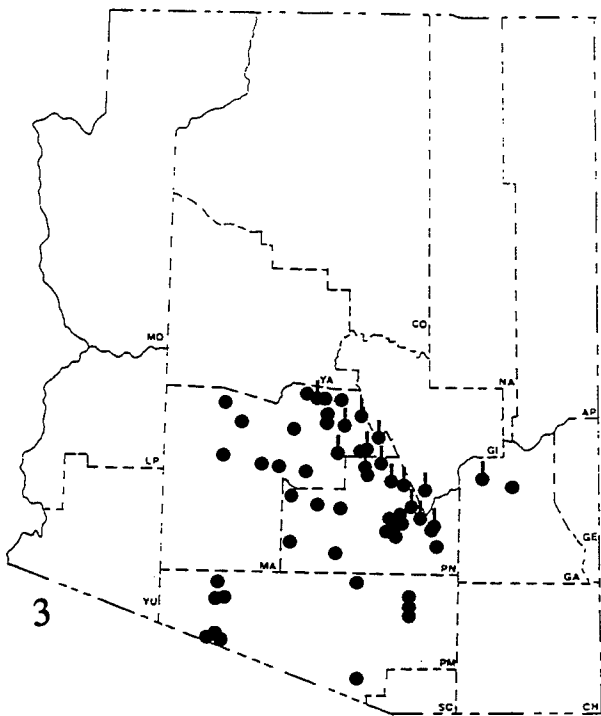
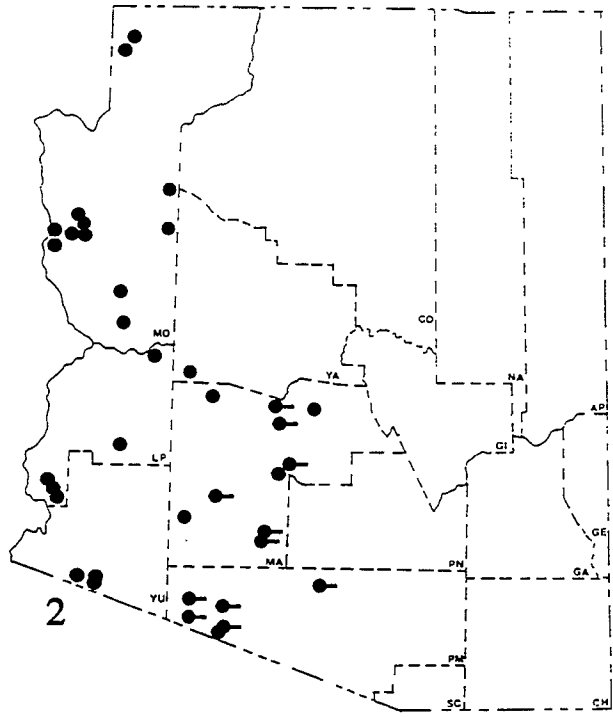
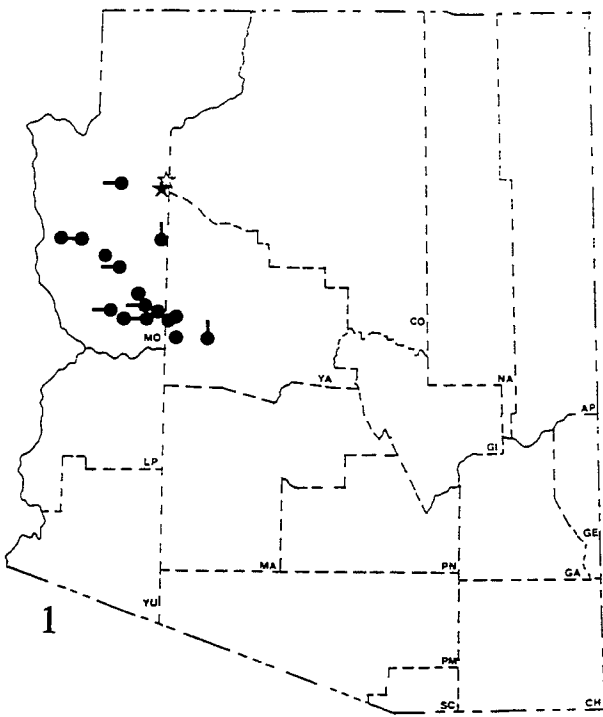
#### ACKNOWLEDGMENTS

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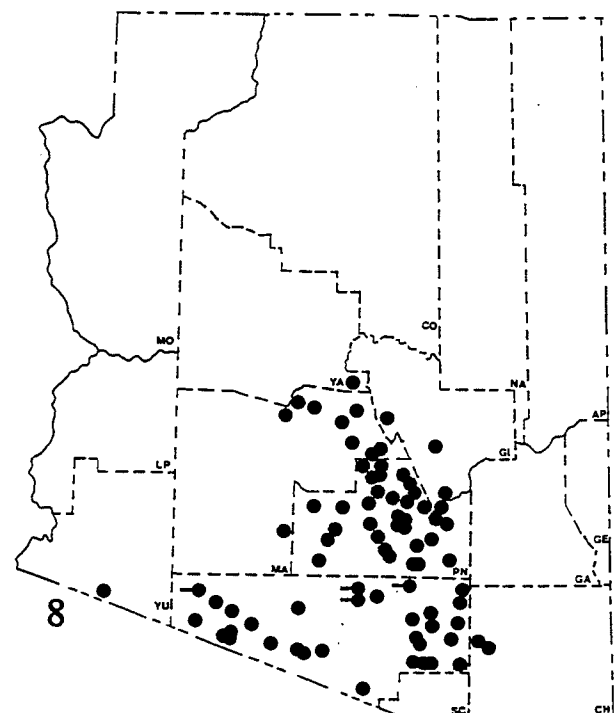
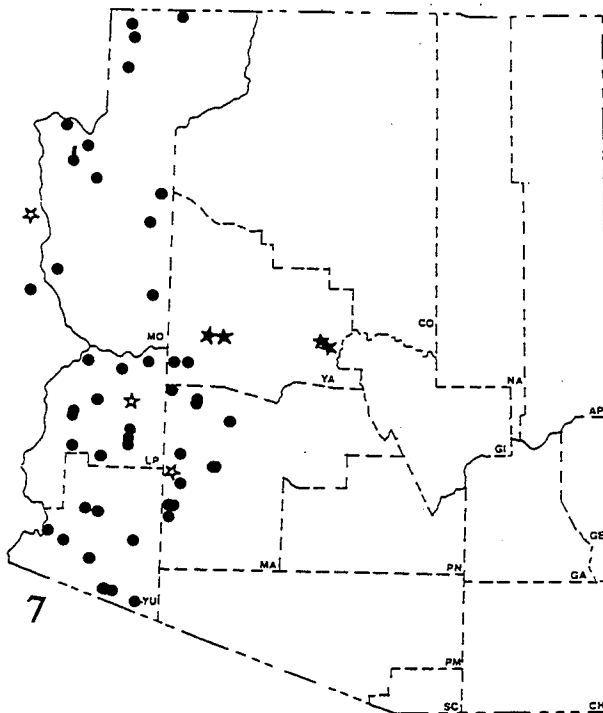
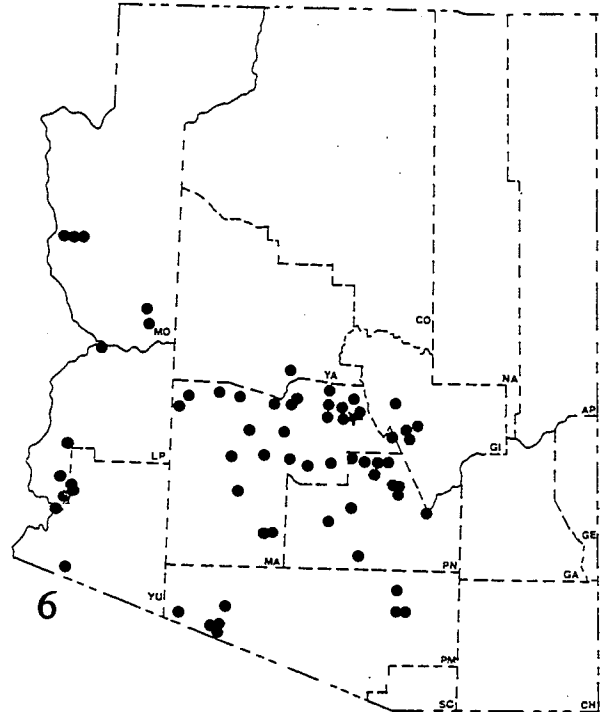
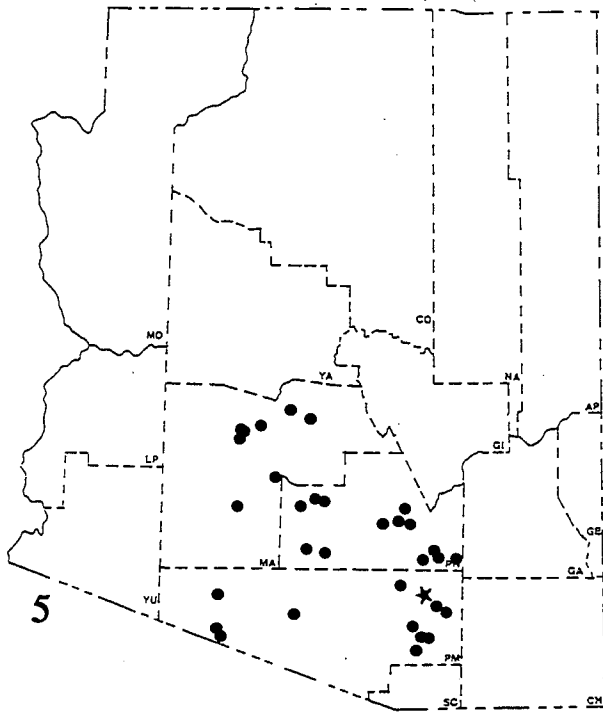
#### NOMENCLATURAL NOTES

The following nomenclatural changes are necessary in support of this treatment:

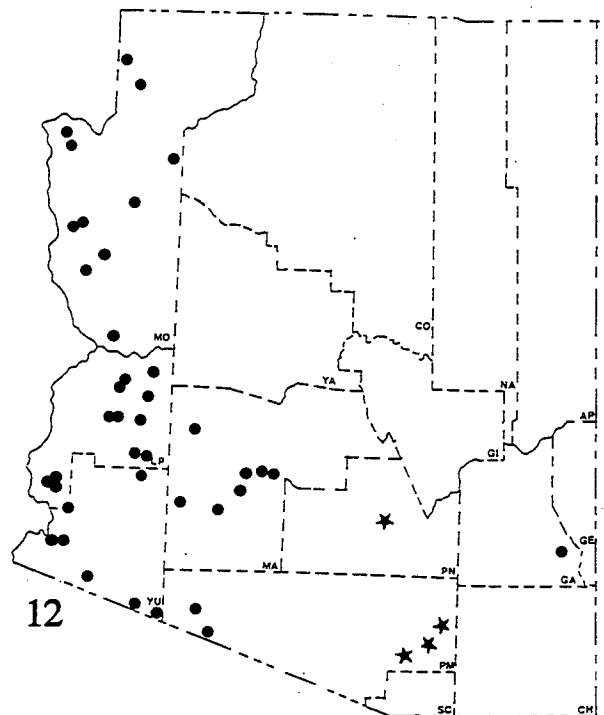
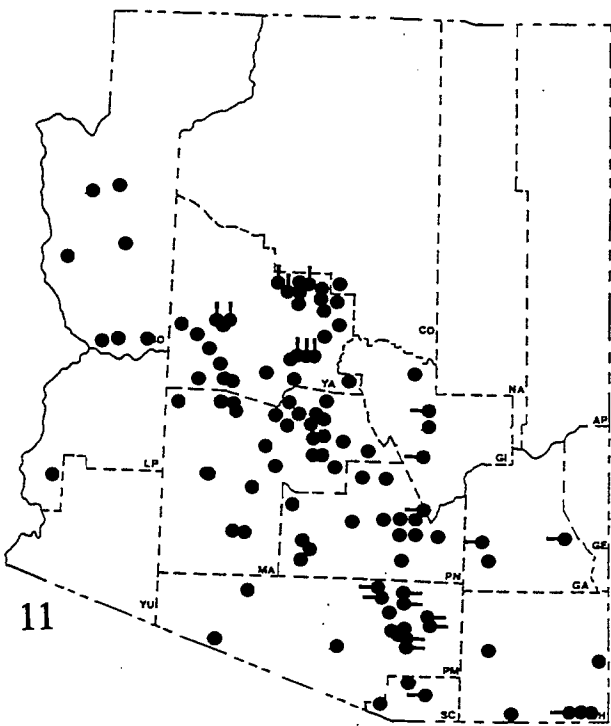
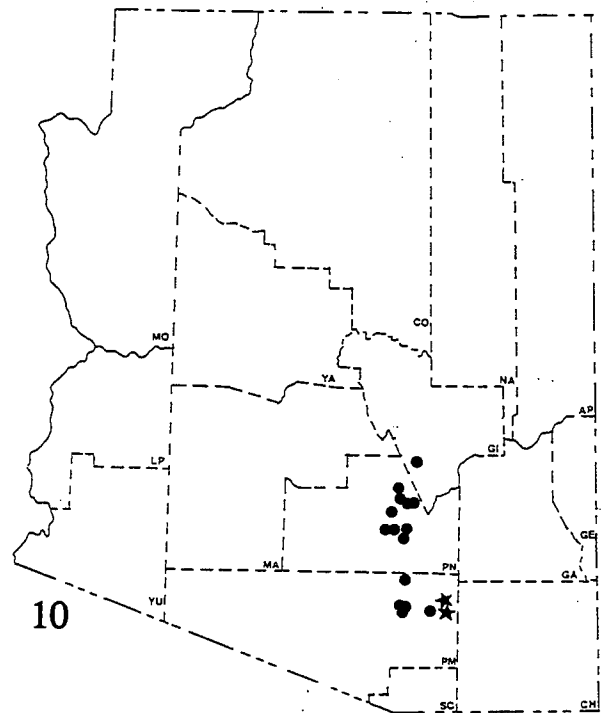
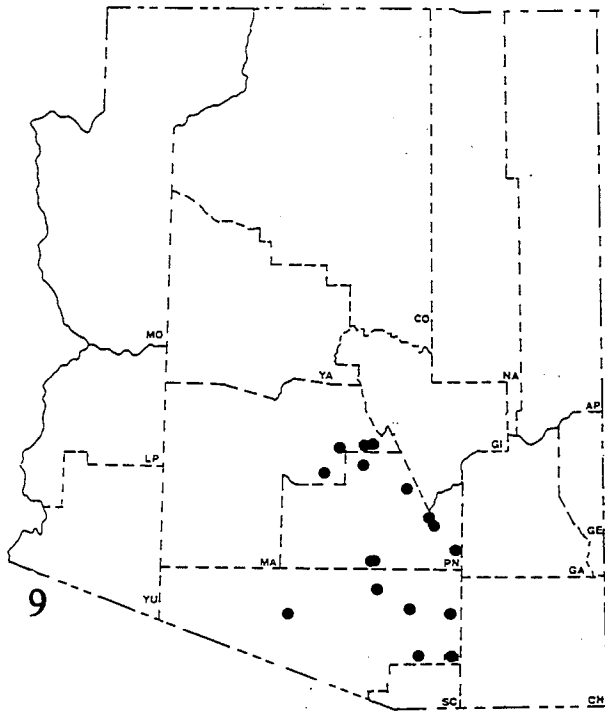
- Cylindropuntia acanthocarpa* (Engelm. & J. M. Bigelow) Knuth var. *coloradensis* (L. D. Benson) Pinkava, comb. nov. Basionym: *Opuntia acanthocarpa* Engelm. & J. M. Bigelow var. *coloradensis* L. D. Benson, Cacti Ariz. ed. 3, p. 20. 1969.
- Cylindropuntia acanthocarpa* (Engelm. & J. M. Bigelow) Knuth var. *major* (Engelm.) Pinkava, comb. nov. Basionym: *Opuntia echinocarpa* Engelm. & J. M. Bigelow var. *major* Engelm., Proc. Amer. Acad. 3: 305, 1856.
- Cylindropuntia* × *congesta* (Griffiths) Pinkava, comb. nov. et pro sp. Basionym: *Opuntia congesta* Griffiths, Rep. Mo. Bot. Gard. 20:88, Plate 2, figs. 4, 7; Plate 8; Plate 13, fig 5. 1909. [= *C. acanthocarpa* (Engelm. & J. M. Bigelow) Knuth × *C. whipplei* (Engelm. & J. M. Bigelow) Knuth].
- Cylindropuntia* × *deserta* (Griffiths) Pinkava, comb. nov. et pro sp. Basionym: *Opuntia deserta* Griffiths, Monatss. Kakteenk. 23: 132, photo, 1913. [= *C. acanthocarpa* (Engelm. & J. M. Bigelow) Knuth × *C. echinocarpa* (Engelm. & J. M. Bigelow) Knuth].
- Cylindropuntia* × *multigeniculata* (Clokey) Backeb., pro sp. Basionym: *Opuntia multigeniculata* Clokey, Madroño 7: 69, Plate 4, fig. A. 1943 [= *C. echinocarpa* (Engelm. & J. M. Bigelow) Knuth × *C. whipplei* (Engelm. & J. M. Bigelow) Knuth].
- Cylindropuntia* × *neoarbuscula* (Griffiths) Knuth pro sp. Basionym: *Opuntia neoarbuscula* Griffiths, Rep. Mo. Bot Gard. 1: 260, Plate 23 (upper). 1908. [= *C. arbuscula* (Engelm.) Knuth × *C. spinosior* (Engelm.) Knuth].
- Cylindropuntia* × *tetracantha* (Toumey) Knuth, pro sp. Basionym: *Opuntia tetracantha* Toumey, Garden and Forest 9: 432. 1896. [= *C. acanthocarpa* (Engelm. & J. M. Bigelow) Knuth × *C. leptocaulis* (DC.) Knuth].
- Cylindropuntia* × *viridiflora* (Britton & Rose) Knuth, pro sp. Basionym: *Opuntia viridiflora* Britton & Rose, Cactaceae I: 55. 1919. [= *C. imbricata* (Haw.) Knuth × *C. whipplei* (Engelm. & J. M. Bigelow) Knuth].
- Cylindropuntia* × *vivipara* (Rose) Knuth, pro sp. Basionym: *Opuntia vivipara* Rose, Smithsonian Misc. Coll. 52: 153, Plate 12. 1908. [*C. arbuscula* (Engelm.) Knuth × *C. versicolor* (Engelm. ex J. M. Coult.) Knuth].



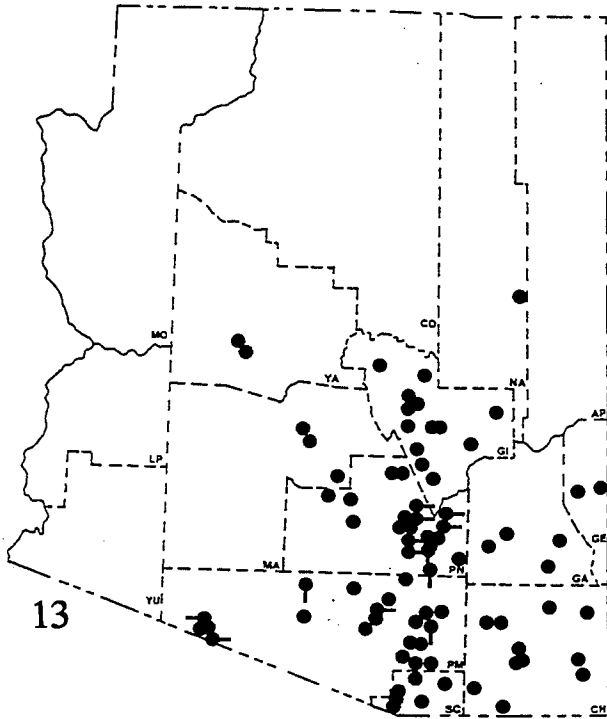
**Cactaceae** Figs. 1-4. Distribution of: 1. *Cylindropuntia abyssii* (closed star); *C. abyssii* × *C. acanthocarpa* var. *thornberi* (open star); *C. acanthocarpa* var. *acanthocarpa* (circles) and intermediates to var. *coloradensis* (circles, glyph left) and var. *thornberi* (circles, glyph up) [for interspecific hybrids of vars. of *C. acanthocarpa*, see map of other parent]; 2. *C. acanthocarpa* var. *coloradensis* (circles) and intermediates to var. *major* (circles, glyph right); 3. *C. acanthocarpa* var. *major* (circles) and intermediates to var. *thornberi* (circles, glyph up); 4. *C. acanthocarpa* var. *thornberi* (circles) and intermediates to var. *coloradensis* (circles, glyph left).



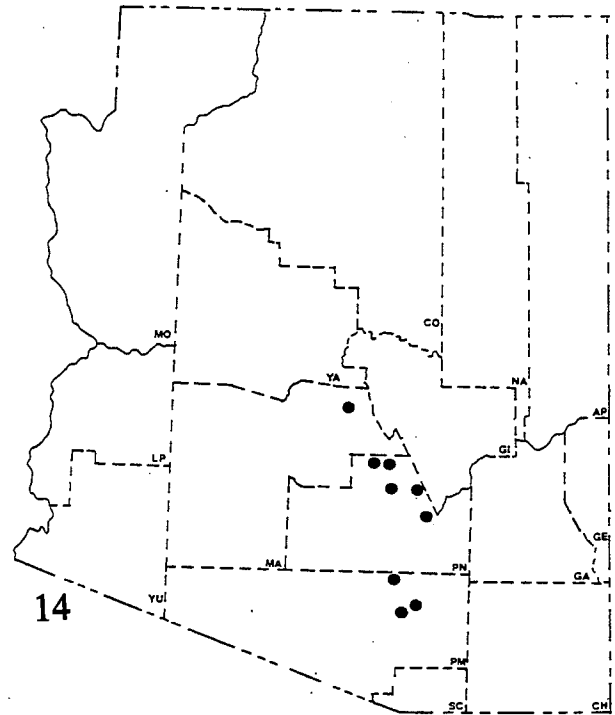
**Cactaceae Figs. 5-8.** Distribution of: 5. *Cylindropuntia arbuscula* (circles); *C. arbuscula* × *C. leptocaulis* (star); 6. *C. bigelovii* var. *bigelovii* (circles); *C. bigelovii* var. *bigelovii* × *C. acanthocarpa* var. *major* (star); 7. *C. xcongesta* (closed stars); *C. xdeserta* (open stars); *C. echinocarpa* (circles; compact growth form = circle, glyph up); 8. *C. fulgida* var. *fulgida* (circles); *C. fulgida* × *C. leptocaulis* (circles, glyph left).



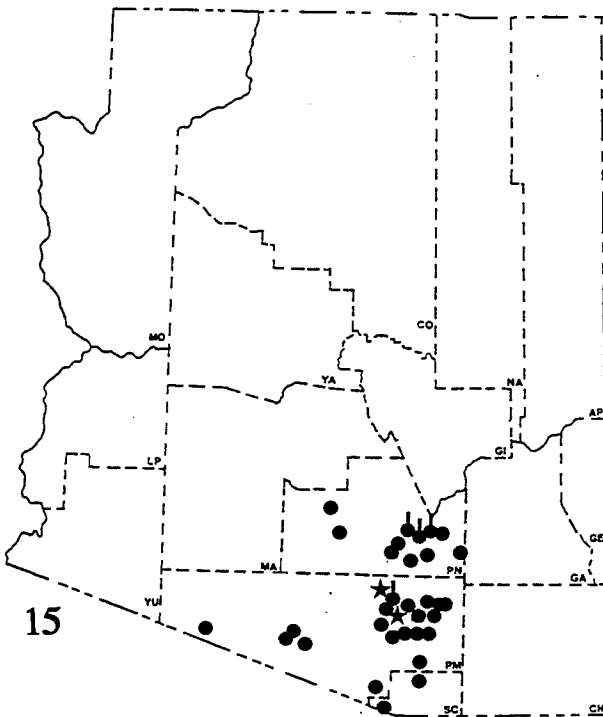
**Cactaceae** Figs. 9-12. Distribution of: 9. *Cylindropuntia fulgida* var. *mamillata*; 10. *C. imbricata* var. *imbricata* (stars); *C. xkelvinensis* (circles); 11. *C. leptocaulis* (circles); *C. leptocaulis* x *C. spinosior* (circles, glyph left); *C. leptocaulis* x *C. versicolor* (circles, glyph right); *C. leptocaulis* x *C. whipplei* (circles, glyph up); *C. xmultigeniculata* [see map 16]; 12. *C. xneoarbuscula* (stars); *C. ramosissima* (circles).



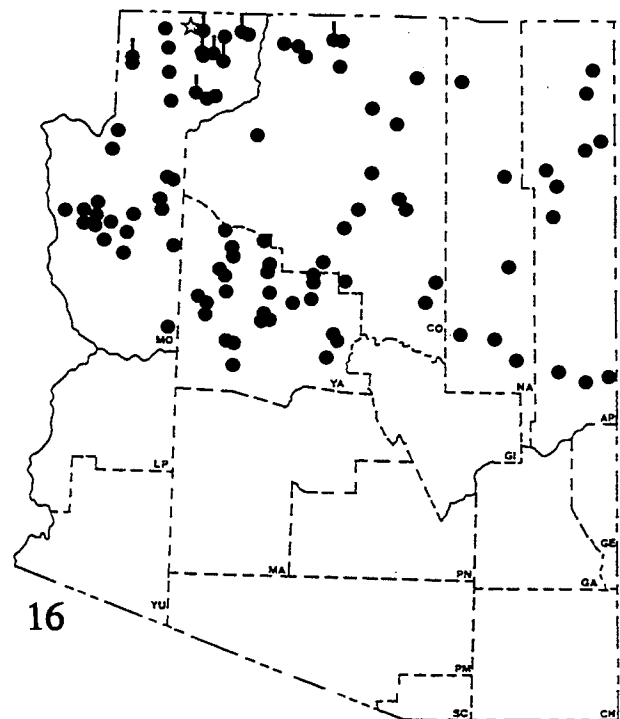
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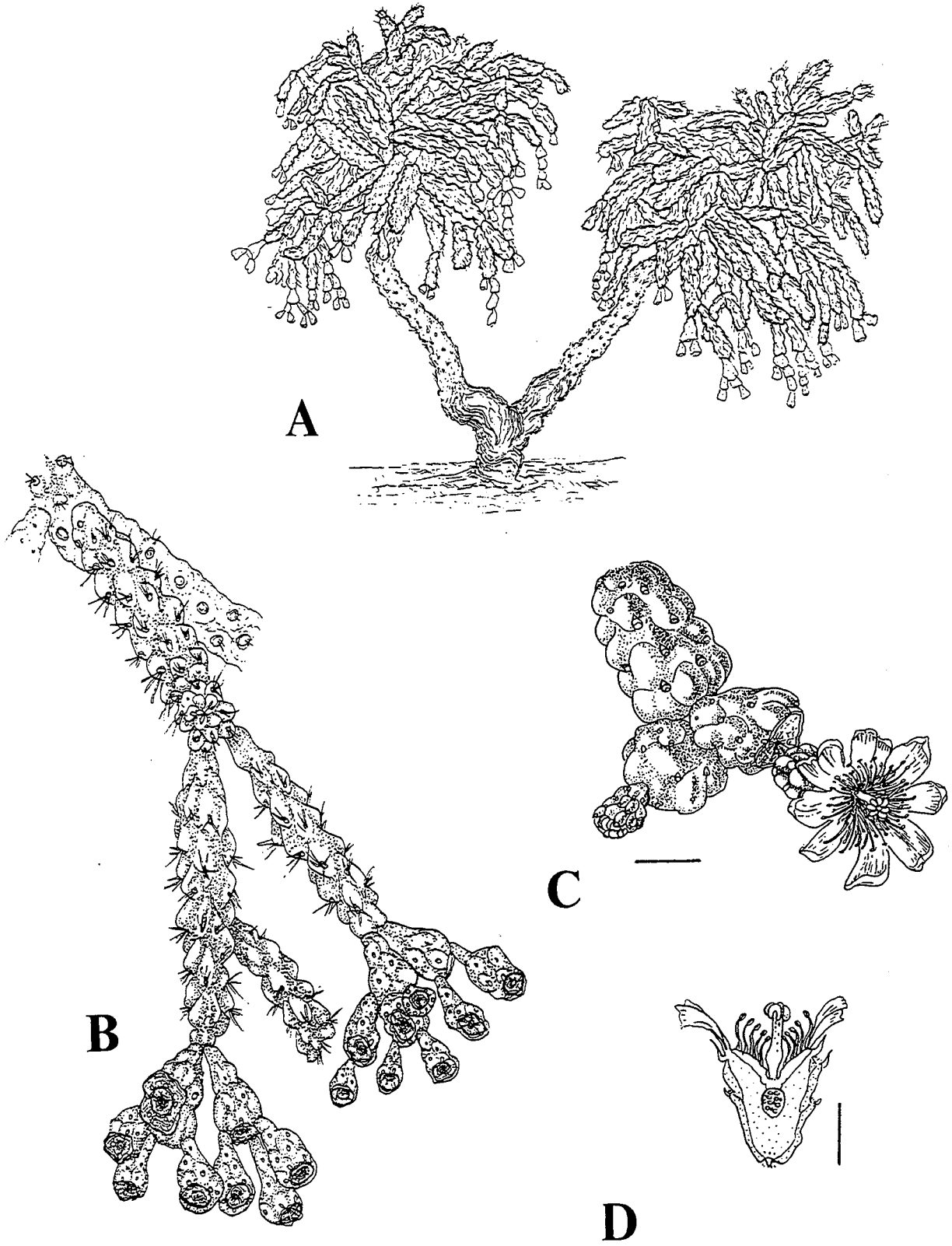


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**Cactaceae** Figs. 13-16. Distribution of: 13. *Cylindropuntia spinosior* (circles); *C. spinosior* × *C. acanthocarpa* var. *coloradensis* (circles, glyph left); *C. spinosior* × *C. acanthocarpa* var. *major* (circles, glyph right); *C. spinosior* × *C. versicolor* (circles, glyph down); 14. *C. x tetracantha*; 15. *C. versicolor* (circles); *C. versicolor* × *C. acanthocarpa* var. *major* (circles, glyph right); *C. x viridiflora* (open star); *C. x vivipara* (closed stars); 16. *C. x multigeniculata* [= *C. echinocarpa* compact growth form × *C. whipplei*] (star); *C. echinocarpa* open growth form × *C. whipplei* (circles, glyph up); *C. whipplei* (circles).



Cactaceae Fig. 17. *Cylindropuntia fulgida* var. *mamillata*. A, habit of plant 2.2 m tall, 3 m broad. B, fruiting branches. C, flower. D, flower (l.s.). Scale bars = 1 cm. Illustrations by M. A. Oakason.