

**AJO PEAK TO TINAJAS ALTAS: A FLORA OF SOUTHWESTERN ARIZONA
PART 12. EUDICOTS: CAMPANULACEAE TO CUCURBITACEAE**

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ABSTRACT

A floristic and natural history account is provided for nine eudicot families as part of the vascular plant flora of the contiguous protected areas of Organ Pipe Cactus National Monument, Cabeza Prieta National Wildlife Refuge, and the Tinajas Altas Region at the heart of the Sonoran Desert in southwestern Arizona: Campanulaceae, Cannabaceae, Capparaceae, Caprifoliaceae, Caryophyllaceae, Cleomaceae, Crassulaceae, Crossosomataceae, and Cucurbitaceae. This is the twelfth contribution for this flora, published in *Phytoneuron* and also posted open access on the website of the University of Arizona Herbarium (ARIZ).

This contribution to our flora in southwestern Arizona includes 9 eudicot families, 23 genera, and 25 species: Campanulaceae (2 genera, 2 species); Cannabaceae (2 genera, 3 species); Capparaceae (1 species); Caprifoliaceae (1 species); Caryophyllaceae (6 genera, 6 species); Cleomaceae (2 genera, 2 species); Crassulaceae (3 genera, 3 species); Crossosomataceae (1 species); and Cucurbitaceae (5 genera, 6 species). A synopsis of local distributions and growth forms of the nine families is given in Table 1.

The first article in this series includes maps and brief descriptions of the physical, biological, ecological, floristic, and deep history of the flora area (Felger et al. 2013a). This flora includes the modern, present-day taxa as well as fossil records from packrat middens. These contributions are also posted open access on the website of the University of Arizona Herbarium (ARIZ).

Family designations follow APG III (Angiosperm Phylogeny Group 2009; also see Stevens 2001). Three present-day species, *Celtis pallida*, *C. reticulata*, and *Crossosoma bigelovii*, also represented by fossil specimens, are indicated with a dagger symbol (†) and *Symphoricarpos*, no longer present in the flora area, is marked with two dagger symbols (††). The two non-native species are marked with double asterisks (**), indicating they are not established in the flora region. In the following species accounts, the accepted scientific names are in bold and selected synonyms are italicized within brackets [--]. Common names, when known or worthwhile, are in English, Spanish,

and the Hia-Ced O’odham dialect, respectively (Spanish-language names are italicized). The qualifications *about* and *approximately* are generally omitted, with the obvious understanding that such quantitative values are, to varying degrees, seldom exact.

Table 1. Local distributions and growth forms of Campanulaceae, Cannabaceae, Capparaceae, Caprifoliaceae, Caryophyllaceae, Cleomaceae, Crassulaceae, Crossosomataceae, and Cucurbitaceae. † = Modern species also represented by a fossil; †† = fossil taxon no longer present; ** = non-native species not established in the flora area. OP = Organ Pipe Cactus National Monument; CP = Cabeza Prieta National Wildlife Refuge; TA = Tinajas Altas Region. SU = Summer/warm season ephemerals; WI = winter-spring/cool season ephemerals; AP = facultative annuals or perennials; PR = perennials.

Taxa	Region			Growth Form			
	Organ Pipe	Cabeza Prieta	Tinajas Altas	Ephemerals		Facultative annuals or perennials	Perennials
				Summer	Winter		
CAMPANULACEAE							
<i>Nemacladus orientalis</i>	OP	CP	TA		WI		
<i>Triodanis biflora</i>	OP				WI		
CANNABACEAE							
** <i>Cannabis sativa</i>	?	?	?	SU			
† <i>Celtis pallida</i>	OP	CP					PR
† <i>Celtis reticulata</i>	OP						PR
CAPPARACEAE							
<i>Atamisquea emarginata</i>	OP						PR
CAPRIFOLIACEAE							
†† <i>Symphoricarpos</i> sp.	OP						PR
CARYOPHYLLACEAE							
<i>Achyronychia cooperi</i>	OP	CP	TA		WI		
<i>Cerastium texanum</i>	OP				WI		
<i>Drymaria viscosa</i>		CP			WI		
** <i>Herniaria hirsuta</i>	OP				WI		
<i>Loeflingia squarrosa</i>	OP	CP	TA		WI		
<i>Silene antirrhina</i>	OP	CP			WI		
CLEOMACEAE							
<i>Polanisia dodecandra</i>	OP			SU			
<i>Wislizenia refracta</i>	OP	CP				AP	
CRASSULACEAE							
<i>Crassula connata</i>	OP	CP	TA		WI		
<i>Dudleya arizonica</i>	OP	CP	TA				PR
<i>Graptopetalum rusbyi</i>	OP						PR
CROSSOSOMATACEAE							
† <i>Crossosoma bigelovii</i>	OP	CP	TA				PR
CUCURBITACEAE							
<i>Brandegea bigelovii</i>	OP	CP	TA		W		
<i>Cucurbita digitata</i>	OP	CP	TA				PR
<i>Cucurbita palmata</i>			TA				PR
<i>Echinopepon wrightii</i>	OP			SU			
<i>Marah gilensis</i>	OP						PR
<i>Tumamoca macdougalii</i>	OP						PR

Unless otherwise stated, all photos and scans are by Sue Rutman and all botanical illustrations are by Lucretia Breazeale Hamilton (1908–1986) except for *Tumamoca*. All specimens cited are at the University of Arizona Herbarium (ARIZ) unless otherwise indicated by the abbreviations for herbaria at Cabeza Prieta National Wildlife Refuge (CAB), Organ Pipe Cactus National Monument (ORPI), and the standardized abbreviations for herbaria (Index Herbariorum, Thiers 2014). We have seen specimens or images of all specimen cited. When no collection number is provided, the specimen is identified by the date of collection. Generally only the first collector's name is given. Area designations are: OP = Organ Pipe Cactus National Monument; CP = Cabeza Prieta National Wildlife Refuge; TA = Tinajas Altas Region (Figure 1). Additional explanation of the format for this flora series is provided in part 3 (Felger et al. 2013b). Descriptions and keys pertain to taxa and populations as they occur in the flora area.

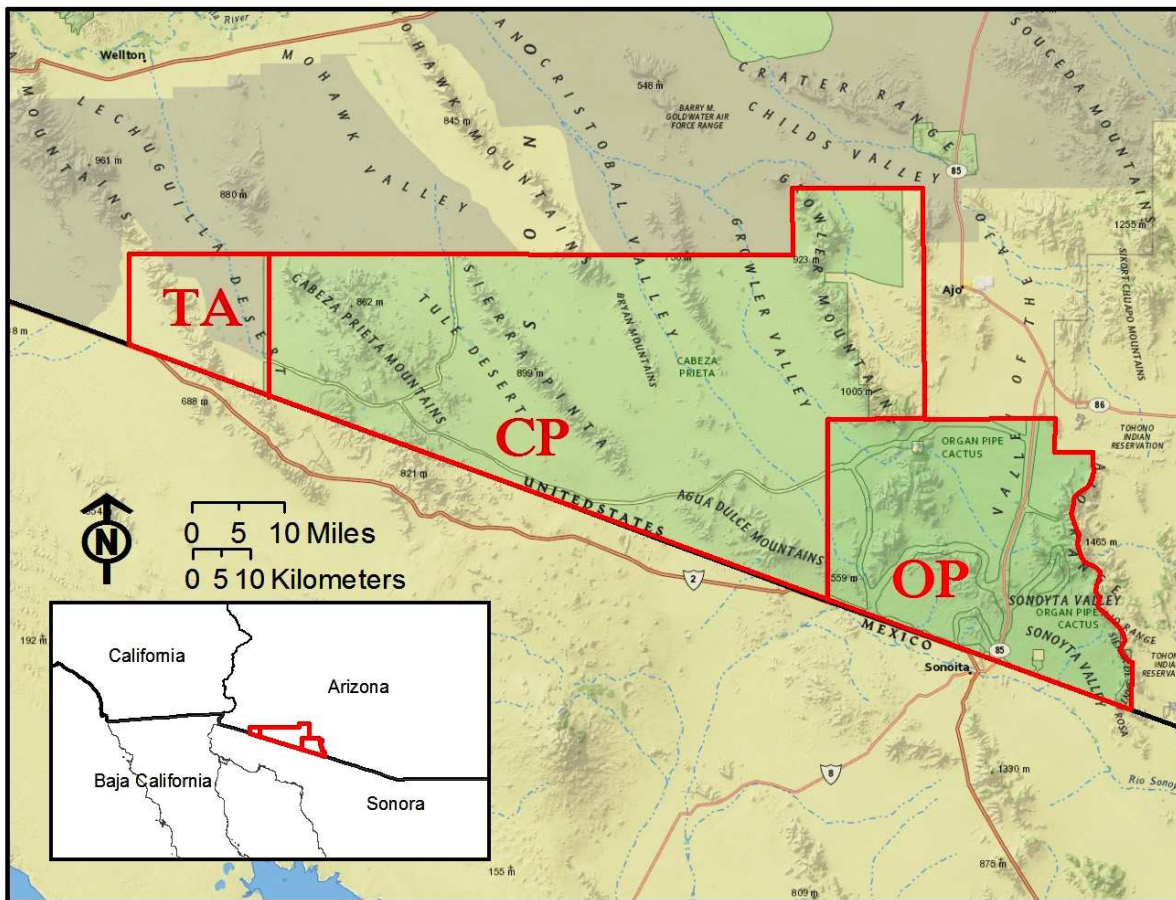


Figure 1. Flora area in southwestern Arizona. TA = Tinajas Altas; CP = Cabeza Prieta NWR; OP = Organ Pipe Cactus National Monument. Green shading indicates approximate boundaries of federally designated wilderness.

CAMPANULACEAE – Bellflower Family

Small cool-season ephemerals (those in the flora area; elsewhere also perennial herbs to trees). Leaves alternate, simple, without stipules. Flowers 5-merous; corollas sympetalous; ovary inferior. Fruit a capsule; seeds numerous and minute. This worldwide family of 84 genera and 2380 species is poorly represented in deserts.

1. Flowering stems branched and zigzag above with minute bracts (not leafy); flowers and fruits stalked; corollas white and red; capsules to 3.5 mm long; widespread in desert habitats.

..... **Nemacladus**

1. Stems straight and unbranched or branching from the base and leafy; flowers and fruits sessile; flowers cleistogamous or the upper (terminal) flowers may have bluish or lavender/purple corollas; capsules 5 mm long; upper edge or above the desert in the Ajo Mts **Triodanis**

Nemacladus

Southwestern USA and northwestern Mexico; 18 species.

Nemacladus orientalis (McVaugh) Morin

[*N. glanduliferus* Jepson var. *orientalis* McVaugh]

Redtip thread plant. Figure 2.

Plants 3.5–18 cm tall, glabrous or sparsely to moderately pubescent at the base. Herbage usually dark olive-green to purple-brown. Stems thread-like, the branches zigzag. Leaves 3–10 mm long in a compact basal rosette, oblanceolate with toothed margins, withering before flowering; stem leaves bract-like or absent. Pedicels slender, longer than the flowers. Corollas bilateral, 1.5–3 mm long, 2-lipped, the upper lip 3-lobed, the lower 2-lobed, the lobes white with reddish-tips.

Widespread; washes, plains, bajadas, canyons, and mountains in Organ Pipe, much of Cabeza Prieta, and locally farther west along Coyote Wash.

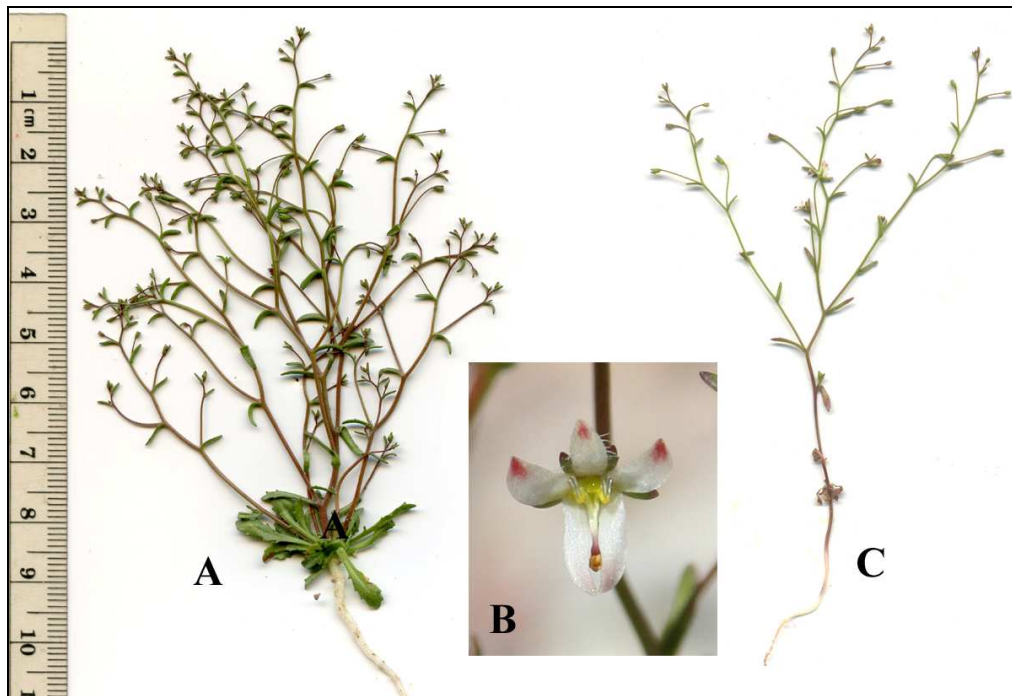


Figure 2. *Nemacladus orientalis*. (A) Hwy 85, sands of small wash N of Crater Range, Maricopa Co., 28 Feb 2015. (B) Growler Canyon, Bates Mts, 20 Mar 2005. (C) Kuakatch Wash near Hwy 85, 28 Feb 2008.

Inland southern California, southern Nevada, southern Utah, Arizona, New Mexico, northern Sonora, and Baja California.

OP: Alamo Canyon, 14 Mar 1941, *Benson 10663*. Quitobaquito, 25 Mar 1944, *Clark 11481*. Bates Well, 17 Mar 1945, *Gould 2978*. Bull Pasture Trail, 5 Apr 1978, *Bowers 1202*.

CP: S end of Sierra Pinta, *Monson 20 Mar 1958*. Tule Well, sandy flat and wash, saline soil, 6 Apr 1979, *Lehto L-23567* (ASU). Charlie Bell Road near E Refuge boundary, 9 Apr 1993, *Felger 93-329*.

TA: Coyote Water, 21 Feb 2005, *Felger 05-147*. Below Raven Tank, deep xeroriparian canyon, 29 Mar 2010, *Felger 10-235*.

Triodanis – Venus looking-glass

North America and Mediterranean Region; 7 species.

Triodanis biflora (Ruiz & Pavón) Greene

[*Triodanis perfoliata* var. *biflora* (Ruiz & Pavón) Bradley]

Small Venus looking-glass. Figure 3.

Delicate ephemerals, the stems 4–40+ cm long, slender and 4-angled, usually straight and unbranched or larger, robust plants sometimes branched from near the base. Leaves or leaf-like bracts alternate. Most or all flowers cleistogamous, especially on smaller and drought-stressed plants, and without petals, and only the uppermost one to several flowers of larger plants may open and bear attractive lavender corollas with a white center. Seeds minute, shiny white, escaping through small pores opening by flaps in the capsule walls.



Figure 3. *Triodanis biflora*. (A) Alamo Canyon, 18 Mar 2005. (B) Nisene-Marks State Park, Santa Cruz Co., CA, 3 Jun 2005, photo © by Aaron Schusteff (CalPhotos).

Ajo Mountains at higher elevations, highly localized. In Bull Pasture it grows at the margins of small ephemeral streams or puddles.

Arizona mostly above the desert. Across much of the USA except the northern portion, and Mexico to South America.

OP: Saddle between Boulder Canyon and Arch Canyon, 3800 ft, 3 May 1978, *Bowers 1285*. Bull Pasture, along ephemeral stream: 3 May 1978, *Bowers 1278* (ORPI); 10 Apr 2005, *Felger 05-200*. Alamo Canyon, S fork, 2650 ft, 25 Apr 2003, *Rutman 2003-511* (ORPI).

CANNABACEAE – Hemp Family

Annuals to trees and some vines. Worldwide, 11 genera, 170 species.

***Cannabis*

One species; annual. Native to Central Asia.

***Cannabis sativa* Linnaeus

Marijuana, dope; *mota*. Figure 4

Marijuana has long been trafficked from Mexico across the flora area, and occasional clandestinely or accidentally seeded plants may be encountered in wet seasons and wetland sites. Human “mules” carry 50-pound backpacks of carefully sealed and weighed bundles of *mota* into the USA and sometimes have small quantities for personal use. Loads have sometimes been abandoned, the packaging degrading over time or being eaten by small mammals, and the marijuana spilling out into the desert. Travelers on Hwy 85 expel their personal use quantities prior to entering Mexico; seedlings might be expected along the southern terminus. Much of the marijuana imported across the USA/Mexico border in Arizona is grown in the Mexican state of Sinaloa. The drug cartels that control the illicit drug trade supply to the USA are responsible for murders and other tragedies as well as political corruption and economic instability in Mexico.



Figure 4. *Cannabis sativa*. Bales of marijuana confiscated in Organ Pipe, ca. 2007.

Celtis – Hackberry

Hardwood trees and shrubs. Leaves alternate, simple, usually with 3 main veins, and scabrous (rough, sandpaper-like when rubbing your finger backwards on the leaf). Flowering with new growth; flowers in small axillary clusters, wind-pollinated, small, and mostly unisexual, the sepals inconspicuous, petals none; male flowers produced first, and sometimes with bisexual flowers between the male and female flowers. Stamens held by the cupped sepals, the filaments expanding

like tension-held springs as they mature, suddenly straightening and flinging a small puff of dry, powdery pollen from the anthers. Fruits of drupes (1-seeded).

Worldwide, mostly tropical and temperate; 60 species.

1. Thorny, spinescent, briar-like shrubs, often with zigzag twigs; fruiting pedicels shorter than the fruits; fruits orange; widespread **Celtis pallida**

1. Unarmed trees or large shrubs usually with a single trunk, the twigs straight (not zigzag); fruiting pedicels as long as or longer than the fruits; fruits reddish; Ajo Mountains **Celtis reticulata**

Celtis pallida Torrey subsp. **pallida**

[*C. tala* Gillies var. *pallida* (Torrey) Planchon]

Desert hackberry; *cúmaro*, *garambullo*; kuavulí. Figure 5.

Spinescent, briar-like shrubs mostly 1.5–3 m tall, the bark smooth; herbage with stiff, appressed white hairs, becoming glabrate with age. Twigs often zigzag, often with single or paired thorns and especially the larger thorns often with 1 (2 or 3) nodes that often produce small leaves and sometimes flowers. Leaves gradually drought deciduous, 2.2–4 (7) cm long, the blades asymmetric at base, more or less ovate to broadly elliptic, scabrous, the margins entire or toothed; petioles short. Flowers in small axillary clusters shorter than the leaves, in March and with summer-fall rains. Fruits 8 mm long, rounded, with a thin, fleshy, orange, and edible pericarp.

Widespread in Arizona Upland areas across Organ Pipe (not in the southwestern portion) and the eastern margin of Cabeza Prieta. Often along larger washes and canyons in mountains on the east side of Organ Pipe. Fossils in Organ Pipe date to 8600 years ago.

Central Arizona to southern Texas and Oaxaca, both Baja California states, southern Florida, Central America, and Paraguay and Argentina. An additional subspecies occurs in South America.

Prominent domatia form in the axils of the major leaf veins near the base of the blade; these are pocket-like flaps of hairs that provide habitat for predatory mites (see Dottori 1976). The domatia of this species are unique and more prominent than on the other *Celtis* from the Sonoran Region, and can be used as a diagnostic feature.

The small, orange, fleshy fruits are slightly sweet and edible when fresh, mostly as a minor resource or snack food on the trail. Castetter and Bell (1951: 207) and Hodgson (2001) interpret Rogers’s report (in Castetter & Bell) of “orange-colored” edible fruits as *C. reticulata*, but orange fruits would be from *C. pallida* and not *C. reticulata*, which has hard, reddish-brown fruits.

Based on examination of the type specimen, Berg and Dahlberg (2001) reported that the desert hackberry should be called *C. ehrenbergiana* (Klotzsch) Liebmann. James Henrickson (pers. comm. to Felger, 2012) also looked at the type specimen of *C. ehrenbergiana* and is of the opinion that it more closely fits *C. iguanaea* (Jacquin) Sargent and does not pertain to *C. pallida*. However, *Celtis iguanaea* and *C. pallida* are closely related (Sherman-Broyles 1997).

OP: Pitahaya Canyon, *Nichol 23 Feb 1939* (ORPI). 7.3 mi W of Hwy 85 on S. Puerto Blanco Drive, 10 Nov 1987, *Felger 87-285*. Alamo Canyon, *Wirt 14 Oct 1989* (ORPI). Canyon NW of Kino Peak, 20 Mar 2005, *Rutman 2005-0320-31* (ORPI). †Alamo Canyon, seeds (endocarps), 1150 to 8590 ybp (3 samples). †Puerto Blanco Mts, on ridge, endocarps, 2160 to 7970 ybp (5 samples; not on slopes today but in washes below).

CP: Cameron Tank, *Simmons 22 Sep 1963* (CAB). Charlie Bell Rd, 1 km W of E boundary of Refuge, 5 Mar 1994, *Felger 94-25*.

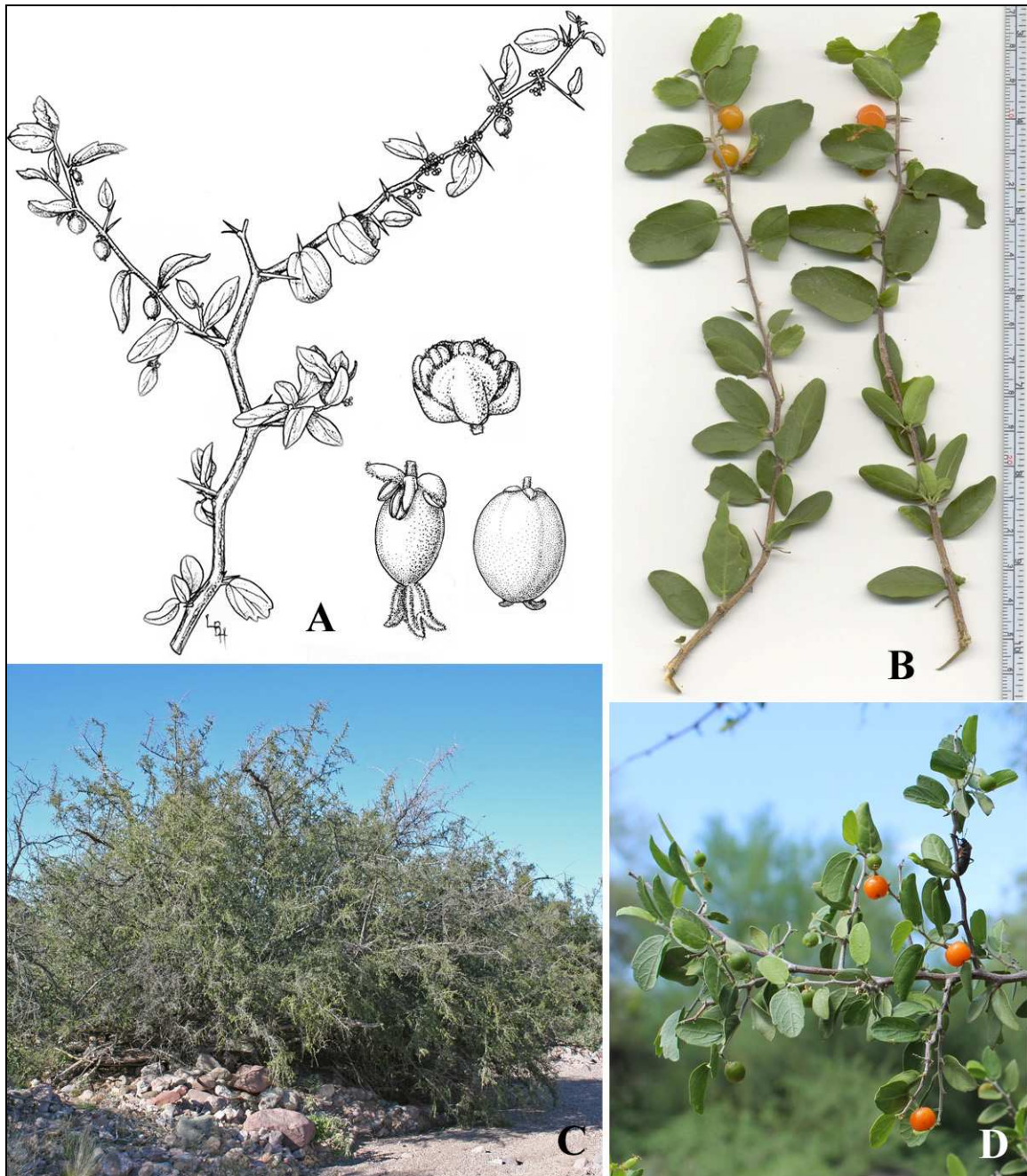


Figure 5. *Celtis pallida* subsp. *pallida*. (A) Spinescent branch, a male flower (above), and a bisexual flower and fruit (below), by Lucretia Breazeale Hamilton. (B) Alamo Canyon, 10 Sep 2008. (C) Kuakatch Wash near Hwy 85, 26 Jan 2009. (D) Gunsight Hills, 10 Sep 2013.

***Celtis reticulata* Torrey**

Netleaf hackberry; *cúmero*. Figure 6

Trees 2.5–7 (12) m tall, with large, well-formed trunks, the trunks and lower limbs studded with rough, woody, knobby ridges. Leaves winter deciduous, highly variable in size, to about 8 cm long, the blades broadly ovate, scabrous, usually rather thick and tough, asymmetric at the base, the margins mostly entire, but at least some leaves often with margins serrated above the middle part of the blade; petioles short. (Rapidly growing long shoots of new growth may have unusually large and

relatively thin leaves, and sometimes with toothed margins extending to the base of the leaf blade; figure 6C). Flowering in spring. Fruits red-brown, hard-walled, ripening in summer.

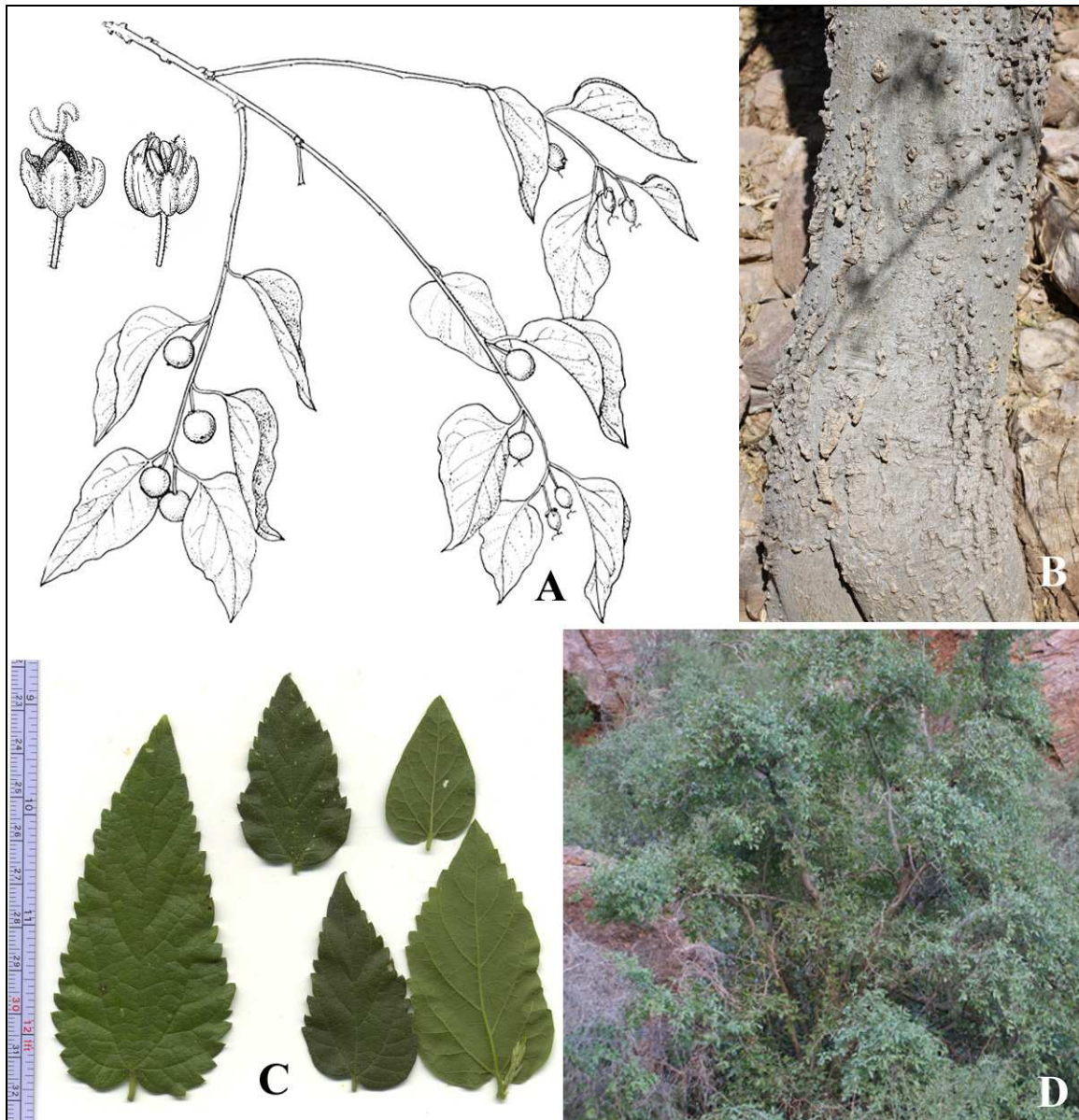


Figure 6. *Celtis reticulata*. (A) Female flower on left, male flower on right, by Lucretia Breazeale Hamilton. South fork of Alamo Canyon: (B) Bark of mature tree, 7 Feb 2013; (C) 9 Sep 2013. (D) Boulder Canyon, 24 Sep 2007.

Riparian canyon bottoms in the Ajo Mountains, including Alamo and Arch Canyons, mostly above 3000 ft; canyons, crevices in bedrock, or against bedrock cliffs on north-facing slopes. In 2003, more than one dozen trees, mostly with well-formed single trunks, were encountered along the bottom of Alamo Canyon, one near the abandoned ranch and the others farther up the canyon growing with oaks (*Quercus turbinella*) and rosewoods (*Vauquelinia californica*). Five of these adult hackberry trees, the largest one about 12 m tall, died in the extreme drought of 2001–2002. By 2010

the remaining trees were either dead or dying. This species has been in Alamo Canyon since at least the early Holocene.

Widespread in southwestern USA to Washington and Kansas, and northern Mexico including Baja California Norte and Sur, Isla Tiburón, and Sonora to Coahuila.

The small fruits are marginally edible, but dried and crushed they impart a pleasant flavor to beverages and food.

OP: Alamo Canyon: 13 Sep 1941, *Goodding 303-41*; 29 Mar 2003, *Felger 03-394*. Arch Canyon, beneath arch, one tree 8 ft tall, *Rutman 26 Sep 2002* (ORPI). †Alamo Canyon, seeds (bony endocarp), 1150 & 9570 ybp.

CAPPARACEAE – Caper Family

Trees, shrubs, vines, and herbs. Worldwide, especially in the tropics; 16 genera, 480 species.

Atamisquea

This genus has a single species. *Atamisquea* and many members of the caper family are strong or foul smelling with watery sap containing mustard-oil glucosides.

Atamisquea emarginata Miers ex Hooker & Arnott

[*Capparis atamisquea* Kuntze]

Palo hediondo. Figure 7.

Much-branched, hardwood shrubs often 2–2.5 m tall, sometimes to 4 m with several trunks, each 12–15 cm in diameter. Sue Rutman (5 May 2005) observed clonal propagation by root sprouts at Quitobaquito. Twigs straight, stout, rigid, and brittle, often branching at right angles, often bluntly thorn-tipped, otherwise unarmed. Young stems, lower leaf surfaces, outer surfaces of sepals, and pistils and fruits densely covered with translucent, winged silvery to yellowish peltate scales. Leaves evergreen or eventually leafless in extreme drought, alternate, simple, thick, and leathery, (0.8) 1–3 cm long on short shoots, or often 2.5–5.5 cm long on long shoots. Petioles stout, 1–2 mm long, the leaf blades linear-oblong to oblong, dark green above, dull silvery to brownish below with a dense cover of scales, the midrib prominent; leaf margins entire or the tip sometimes moderately notched; stipules none.

Flowers solitary to few in leaf axils. Flowers moderately bilateral. Sepals 4, essentially separate, green, the outer pair cupped and much larger and thicker than the inner pair. Petals and stamens cream-white; petals 4 (6) in number, often 6.5 mm long. Fertile stamens 6 (7), the filaments often 5.5 mm long, plus 0–3 staminodes. Ovary green beneath the scales. Body of fruit 8–11.3 × 6–7.7 mm, oval with a small, pointed tip, olive-green below the dense, silvery scales. Ripe exocarp splitting to reveal a bright red, fleshy aril, giving the ripe fruits a spongy texture. Exocarp and aril with a strong, spicy odor like creosotebush and a sharp horseradish taste. Seeds 1 (2 or rarely 3) per fruit, 3.8–5 × 3.2–4.3 mm, nearly orbicular to broadly kidney-shaped, firmly embedded in the aril and blackish when cleaned. Flowering profusely in May and June. Fruits ripening simultaneously in August.

Flowers visited by honeybees, native bees, large tarantula-hawk wasps (*Hemipepsis* sp.), and many other insects. The red arils and seeds are eaten by birds including the house finch and verdin, which are likely seed dispersers. *Atamisquea* is the only larval food for the pierid butterfly *Ganyra* (*Ascia*) *howarthi* (Bailowitz 1988).

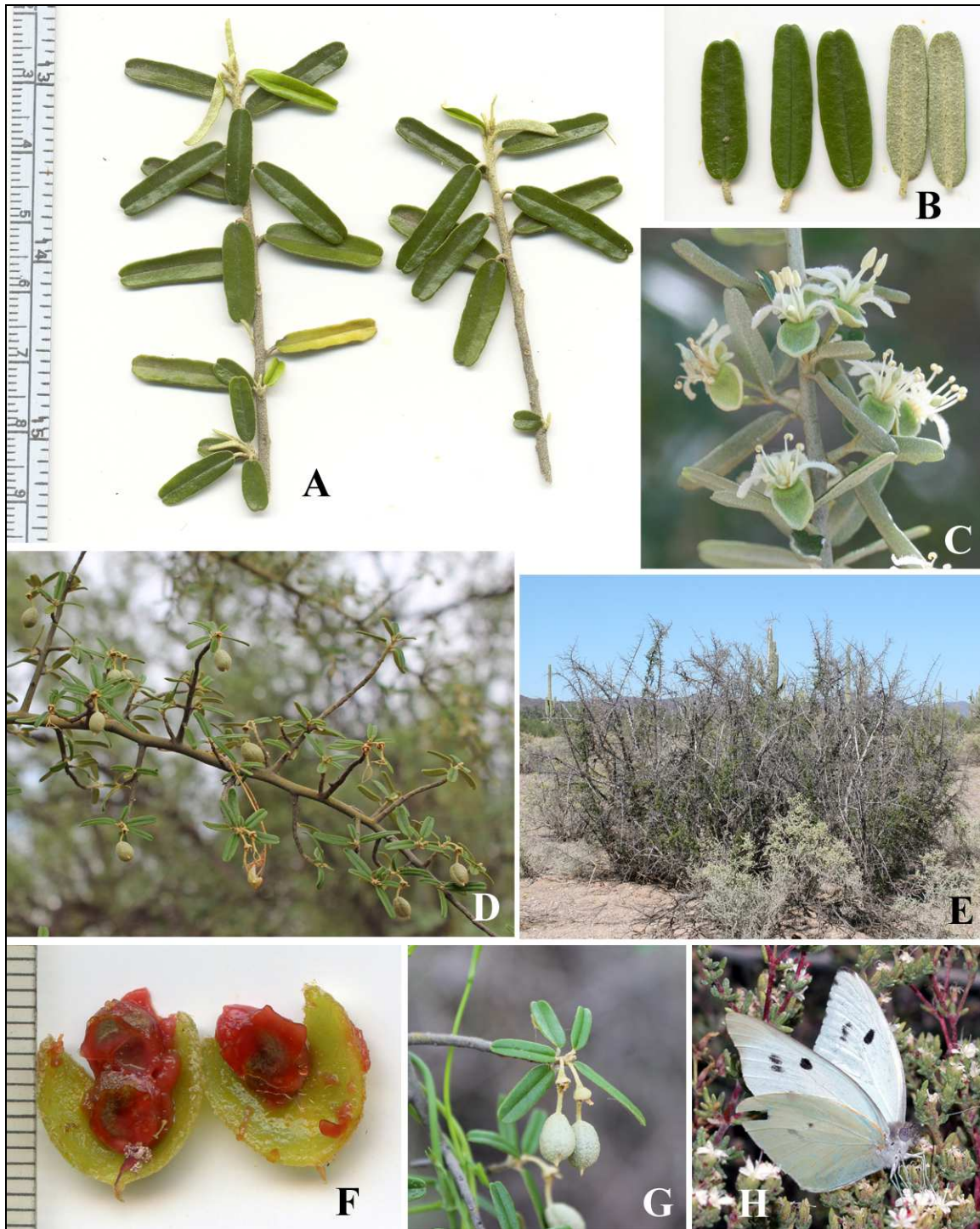


Figure 7. *Atamisquea emarginata*. Quitobaquito: (A & B) 5 Apr 2013; (C) 7 Jun 2005. (D, F & G) Aguajita Wash near USA/Mexico boundary, 2 Aug 2014. (E) Drought-stricken plant, eastern tributary of Aguajita Wash near USA/Mexico boundary, 12 Oct 2006. (H) Female Howarth's white, *Ganrya howarthi*, on *Frankenia palmeri*, near Bahía Kino, Sonora, 30 Mar 2009, photo © by Dave Powell.

Shrubs, mostly to 2 m tall, are common on sandy gravelly flats immediately east of Aguajita Spring, and a few, scattered, shrubs occur northward to 6 km from Aguajita Spring. Also shrubs or

small trees to 4 m tall with several trunks, as well as small plants, were infrequent in the dense mesquite thicket near Aguajita Spring in the immediate vicinity of the international fence. Large *Atamisquea* shrubs also grow in dense brush south and north of the Quitobaquito pond.

No other plants of this species are known from the USA, although it is common along old floodplains of the nearby Río Sonoyta in Sonora and southward in western Sonora to coastal northwest Sinaloa. Also on the Baja California Peninsula and disjunct in South America.

OP: Quitobaquito: 27 Nov 1939, *Harbison 26181* (ARIZ, SD); Old fields, two shrubs, climbing into mesquite, 3.6 & 4 m tall, 6 Apr 1988, *Felger 88-310*. 1 mi NE of Quitobaquito Springs, 23 Aug 1975, *Engard 784* (DES). 4 mi N of Quitobaquito, one shrub, 3+ m wide and 2 m tall, 7 Jun 1975, *Engard 543* (DES). Aguajita Spring, 13 Jun 1978, *Bowers 1335*. 350 m E of Aguajita Wash, *Atriplex* flat, 13 May 1988, *Baker 7612* (ASU). Several plants growing to the S of Quitobaquito Pond, in an old-growth *Prosopis velutina-Ziziphus obtusifolia* bosque, *Atamisquea* is clonal, *Rutman 5 May 2005*. La Abra Plain, 2 mi W of Ten-Mile Hill and ¾ mi E of Aguajita Wash, via South Puerto Blanco Drive, sparse xeroriparian zone through hypersaline area dominated by *Atriplex polycarpa*, N of South Puerto Blanco Drive, several more plants along same riparian system to the S of South Puerto Blanco Drive; single large shrub that died back due to prolonged drought of the early 2000s now seems to be recovering, 12 Oct 2006, *Rutman 20061012-6*. Wetland/bosque N of Quitobaquito Pond, *Tibbitts 13 May 2013*.

CAPRIFOLIACEAE – Honeysuckle Family

Worldwide, especially the Northern Hemisphere; 42 genera, 890 species.

Symphoricarpos

This genus includes about 15 species, mostly in temperate regions of North and Central America, and 1 species in China.

††**Symphoricarpos** sp.

Snowberry

Winter deciduous shrubs. Fruits fleshy, globose, and white.

It was in the Ajo Mountains from 13,500 to 32,000 years ago. The nearest present-day population of this genus is *S. longiflorus* A. Gray in pine-oak woodland on Baboquivari Peak (7 Oct 1944, *Gould & Haskell 2765*; also see Kearney & Peebles 1960).

OP: †Alamo Canyon, seeds, 14,500, 29,110, & 32,000 ybp. Montezuma’s Head, seeds, 13,500 & 20,490 ybp.

CARYOPHYLLACEAE – Pink Family

The five species in the flora area are winter-spring ephemerals (other members of this family are often perennial herbs, vines, or shrubs). Leaves opposite (see *Drymaria*) or sometimes alternate, simple, entire. Flowers usually bisexual and radial; sepals 4 or 5, separate or united; petals 4 or 5, separate, the apex often notched (bilobed) or deeply cut (fringed), or petals sometimes reduced or absent. Fruit a capsule, the seeds few to numerous or sometimes a 1-seeded utricle.

Worldwide; 86 genera, 2200 species.

1. Plants densely and conspicuously glandular hairy.
2. Plants spreading to prostrate, usually more than 6 cm wide and more than 3 cm tall; stems clearly visible, the leaves not rigid..... **Drymaria**

- 2. Plants very compact, dwarf and mat-like, usually less than 6 cm wide and less than 2.5 cm tall; stems at least partially obscured by needle-like rigid leaves..... **Loeflingia**
- 1. Plants not glandular hairy, or sometimes sparsely glandular pubescent or with patches of glands.
 - 3. Plants glabrous; stipules conspicuous, papery and white; petals absent..... **Achyronychia**
 - 3. Plants sparsely hairy; without stipules; petals present.
 - 4. Stems weak and sprawling, without glandular patches; sepals separate; petals white
..... **Cerastium**
 - 4. Stems erect to ascending, with conspicuous glandular patches; sepals united most of their length; petals red-purple..... **Silene**

Achyronychia

This genus has a single species.

Achyronychia cooperi Torrey & A. Gray

Sandmat, frostmat. Figure 8.

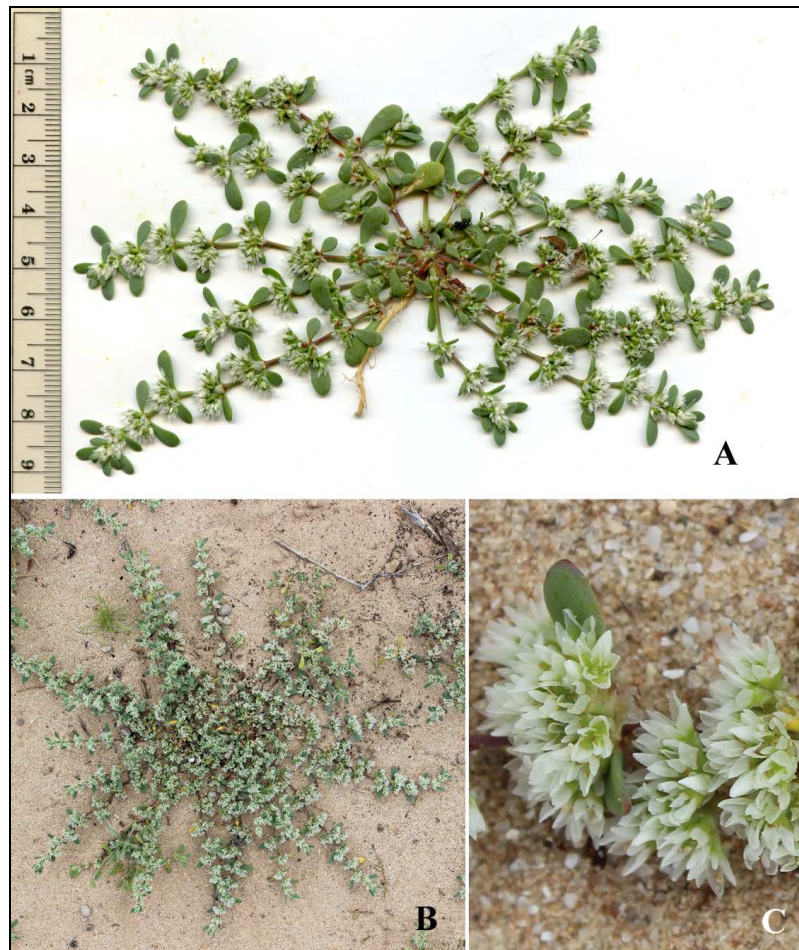


Figure 8. *Achyronychia cooperi*. (A) Dunes S of Sierra Blanca, Pinacate Biosphere Reserve, Sonora, 18 Feb 2015. (B & C) Dunes near airport, N of Mex Hwy 37 about 25 miles E of Puerto Peñasco, Sonora, 20 Feb 2015.

Small winter-spring ephemerals, glabrous, becoming prostrate and mat-like. Leaves opposite, bright green, spatulate (widest at tip), those of each pair unequal in size; stipules thin, papery white, and conspicuous. Flowers small, crowded in axils along the stem, the calyx lobes with conspicuous papery, white wings resembling the stipules; petals none. Fruits 1-seeded, indehiscent.

Widespread, mostly on sandy soils in valley bottoms, washes, and dunes, especially in the western part of Cabeza Prieta and the Tinajas Altas Region, and widely scattered elsewhere in the lowland desert in the flora area.

Deserts in western Arizona, Nevada, California, Sonora, and both Baja California states.

OP: Foothills of the Growler Mts, 16 Apr 1952, *Parker 7984*. Flats W of Bates Mts, 31 Mar 1978, *Bowers 1162 (ORPI)*.

CP: Papago Well, 13 Mar 1983, *Eiber 23*. Salazaria Wash, 12 Apr 1992, *Harlan 209*. Pinta Sands, 11 Jan 2002, *Felger 02-17*.

TA: 1 mi N of Tinajas Altas Pass, W side of mts, *Van Devender 26 Mar 1983*. Coyote Water, 25 Oct 2004, *Felger 04-22*.

Cerastium

Annual and perennial herbs. Worldwide, mostly in north-temperate regions; 100 species.

Cerastium texanum Britton

Mouse-ear chickweed. Figure 9.

Stems delicate, slender, and lax. Leaves often to 3 cm long, thin and broadly spatulate. Inflorescences slender and mostly few-branched with long internodes. Flowers small, the sepals glandular pubescent, the petals white, 5–8 mm long and notched. Capsules cylindrical; seeds many.



Figure 9. *Cerastium texanum*. Alamo Canyon: (A) 12 Mar 2005; (B) 26 Feb 2014; (C) 31 Mar 2008.

Among rocks in shaded places; Ajo and Diablo mountains, especially at higher elevations.

Southern Arizona, New Mexico, and northwestern Mexico at least to southeastern Sonora, southwestern Chihuahua, and in Baja California Sur.

OP: Tres Alamos Canyon, *Nichol 24 Feb 1939* (ORPI). Canyon Diablo, 15 Apr 1951, *Supernaugh 428* (ORPI). Bull Pasture Trail, 11 Apr 1978, *Bowers 1231* (ORPI). Trail from The Cones to Mount Ajo, 4025 ft, 10 Apr 2005, *Felger 05-270*.

Drymaria

Annual and perennial herbs. Widespread in the Americas and introduced elsewhere; 48 species.

Drymaria viscosa S. Watson

Sticky drymary. Figure 10.

Small spring ephemerals, with a well-developed taproot. Plants often partially buried by drifting sand. Stems, leaves, pedicels, and sepals with stalked glandular hairs, with sand grains sticking to the glandular-sticky surfaces. Stems 3–17 cm long, delicate and very slender. Leaves appearing whorled at least from all but the uppermost nodes, semi-succulent, linear-spatulate, tapering basally to the clasping petiole, mostly 5–10 (22) × less than 1–1.5 mm, the first leaves in a basal rosette and larger than the stem leaves; stipules 0.5–1.5 mm long, transparent-membranous, slender, and soon deciduous (or perhaps sometimes absent rather than deciduous). Inflorescences terminal and axillary, short with 4–7 crowded flowers. Flowers minute, white, closing with midday heat; sepals separate, ovate, green in the middle with broad white margins; petals delicate, pure white, Y-shaped with a long, slender claw and an expanded bifid blade. Seeds 0.5–0.7 mm long including the projecting radicle (seen as a strange little projection of the embryo), often 8–12 per capsule. The seeds, resembling grains of sand, are striking compared with seeds of other *Drymaria* species because they are smooth and pale cream or buff instead of sculptured and dark brown.

In the USA known only from the Pinta Sands. Common in similar habitat in adjacent northwestern Sonora southward to the vicinity of Tastiota, 28°20'N, and both Baja California states.



Figure 10. *Drymaria viscosa*. (A) Dunes about 20 mi SW of Sonoyta, near Mex Hwy 8, Sonora, 15 Feb 2014. (B) Dunes S of Sierra Blanca, Pinacate Biosphere Reserve, Sonora, 20 Feb 2005.

CP: Pinacate lava flow, E edge, off Camino del Diablo, dunes, 17 Apr 1983, *Hodgson 2080* (DES). West Pinta Sands, 11 Jan 2002, *Felger 02-24* (ARIZ, ASU).

***Herniaria**

Annual, biennial, or perennial herbs. Native in South America, Eurasia, and Africa; 45 species.

****Herniaria hirsuta** Linnaeus var. **cinerea** (de Candolle) Loret & Barrandon
Burst-wort. Figure 11.

Cool season ephemerals; the plants small and prostrate. Leaves 1–12 mm long, oblanceolate to obovate, opposite below, alternate above. Flowers axillary, minute and inconspicuous.



Figure 11. *Herniaria hirsuta* var. *cinerea*. Midway Wash near Hwy 85 at mile marker 28, 7 Mar 2015.

Occasional in Organ Pipe in disturbed habitats, probably not established.

Naturalized in disturbed habitats in the Sonoran Desert National Monument and the Goldwater Range (Felger et al. 2007). A widespread weed, native to Eurasia and North Africa.

OP: Organ Pipe headquarters, wet ground of water drain, several dozen plants, 11Mar 2003, *Felger 03-246*.

Loeflingia

Annuals. North America, Eurasia, and Africa; 7 species.

Loeflingia squarrosa Nuttall

[*L. squarrosa* subsp. *cactorum* Barneby & Twisselmann]

Spreading pygmy-leaf. Figure 12.

Dwarf spring ephemerals, glandular pubescent, quickly forming a taproot and dense, cushion-like mats usually less than 1.5 cm tall and about 1 (5) cm wide, and sometimes as small as 3 × 3 mm.

Leaves often 3–15 mm long, reduced upwards, narrowly linear, mostly stiff and thickened (subulate), with a short bristle tip; first leaves often in a loose basal rosette, thin, and soon withering; stipules white, bristle-like. Flowers essentially sessile; cleistogamous, minute and hidden among the leaves, sepals resembling the leaves. Seeds numerous, 0.4–0.45 mm long.

Widespread in lowlands across the flora area, often on open, partially barren gravelly-sandy soils, such as decomposed granite pediments or upper bajada flats or washes, or sandy plains and washes, and sometimes among dense spring ephemerals in microhabitats where water temporarily had puddled.

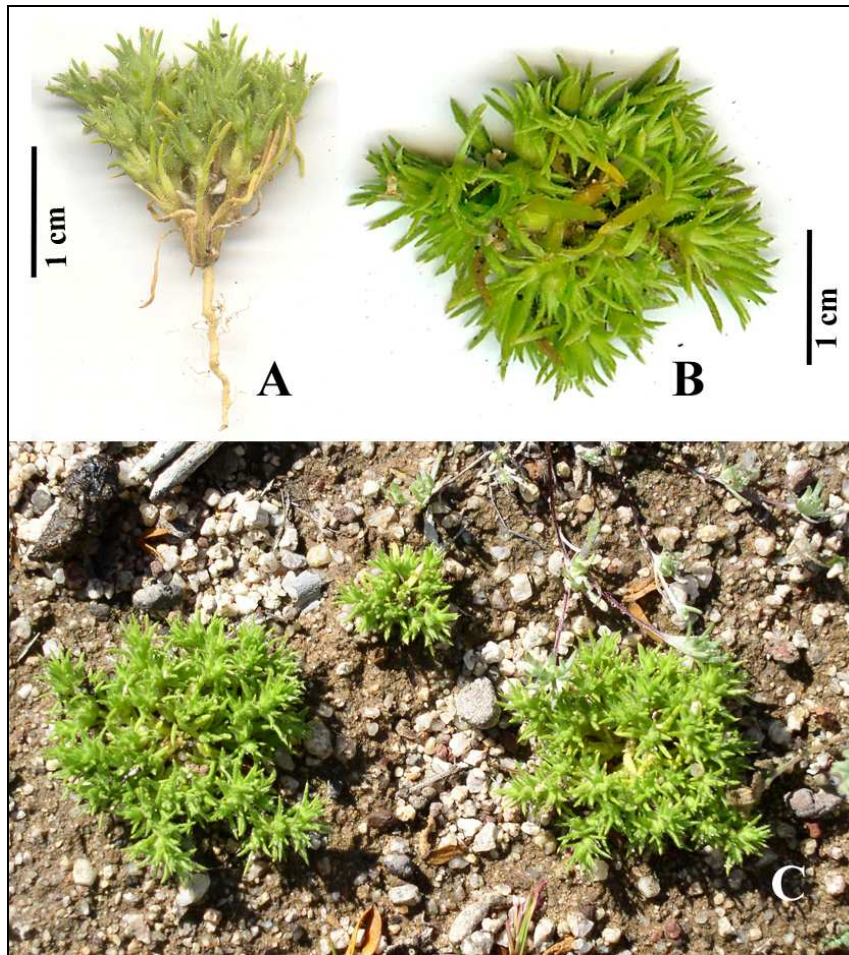


Figure 12. *Loefflingia squarrosa*. W of mile marker 60, Hwy 85: (A) 21 Mar 2003; (B) 19 Dec 2008; (C) 13 Feb 2005.

Western USA and northern Mexico.

OP: Senita Basin, small wash, 24 Mar 1979, *Lehto 23386* (ASU). Armenta Rd, 11 Mar 2003, *Felger 03-184*. W of Bates Well Road near Growler Pass, 7 Mar 2003, *Rutman 2003-227* (ORPI). SW base of Santa Rosa Mts, 12 Mar 2003, *Felger 03-355*.

CP: Cholla Pass, S22, T15S, R9W, 5 Apr 1979, *Lehto 23467* (ASU). Flats near Sheep Mt, N end of Agua Dulce Mts, 18 Feb 1979, *McLaughlin 1951*. Lower bajada of NE Growler Mts, 22 Mar 2003, *Rutman 2003-375*.

TA: Tinajas Altas, 15 Jun 1992, *Felger 92-608*.

Silene – Campion, catchfly

Annual to perennial herbs. Mostly in the Northern Hemisphere; 700 species.

Silene antirrhina Linnaeus

Sleepy catchfly. Figure 13.

Stems to 60 cm with ascending branches, often much smaller, with reddish purple, glandular-sticky bands below the nodes trapping insects and seeds that have fallen from the capsules. Early leaves in a basal rosette, stem leaves narrowly oblanceolate, 2–5 cm × 4–8 mm, the upper leaves reduced; stipules none. Flowers dark red-purple, the petals narrowed basally to a claw. Seeds kidney-shaped, 0.6–0.8 mm in diameter.

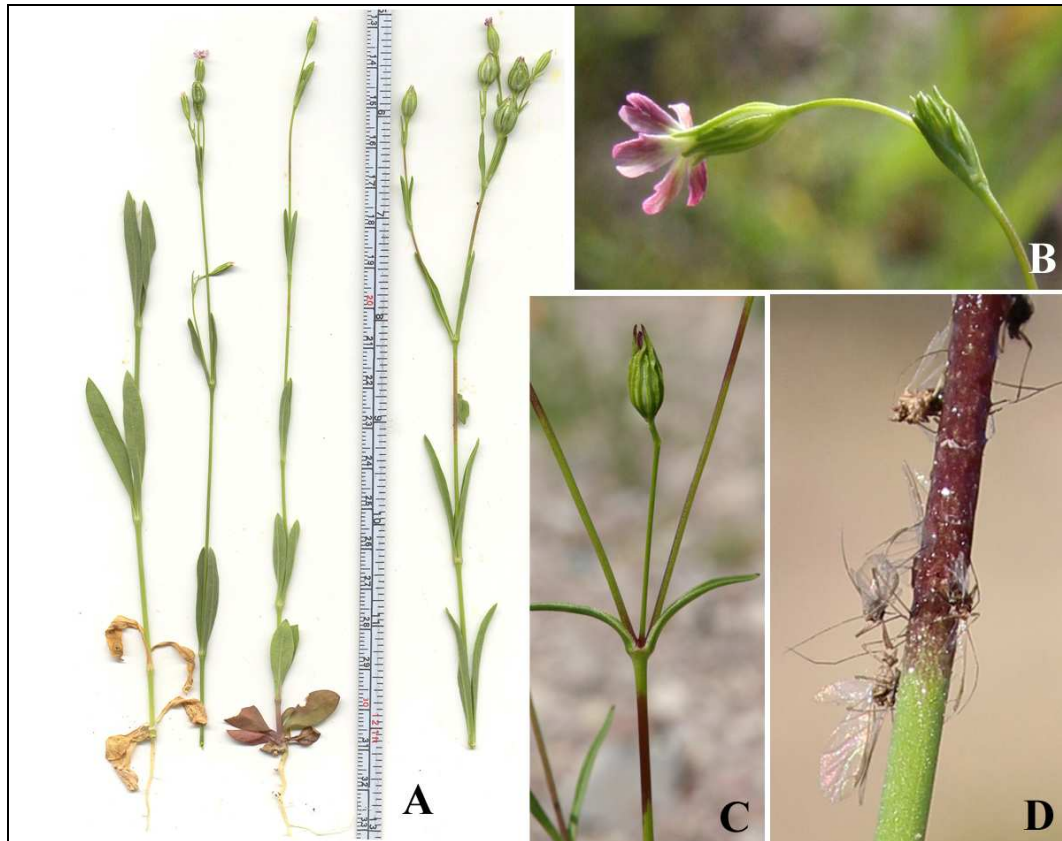


Figure 13. *Silene antirrhina*. (A) Alamo Well, 21 Mar 2008. (B) Estes Canyon, 26 Feb 2005. (C) Coffeepot Mountain, Saucedo Mts, 27 Feb 2005. (D) Aphids trapped on glandular area of stem, Hat Mountain, Saucedo Mts, Maricopa Co., 22 Mar 2014.

Widespread in Organ Pipe and on the east side of Cabeza Prieta; sandy soils, often in washes, canyons, and rocky slopes.

Abundant and often weedy across much of North America to nearly 3000 m elevation.

OP: Sweetwater Pass, *Dakan 12 Feb 1973* (ORPI). Arch Canyon, 5 Apr 1978, *Bowers 1193* (ORPI). Kuakatch Wash near milepost 59 on Hwy 85, *Rutman 2 Apr 1998* (ORPI). Below Cement Tank, foothills of Santa Rosa Mts, 2 Apr 2003, *Rutman 2003-445* (ORPI). 1.2 mi NW of Kino Peak, tributary to Growler Wash, draining NW slopes of Kino Peak, 1509 ft, coarse-sandy wash bed, 20 Mar 2005, *Rutman 20050320-25*.

CP: Near Tule Well, 20 Mar 1992, *Yeatts 3236* (CAB). 0.4 mi on Charlie Bell Rd, W of Refuge boundary, 9 Apr 1993, *Felger 93-330*. Daniels Arroyo at Charlie Bell Rd, 9 Apr 1993, *Felger 93-363*.

CLEOMACEAE – Cleome Family

Ephemerals to sometimes perennials (or shrubs elsewhere). Leaves alternate, palmately compound, sometimes unifoliolate. Flowers in racemes. Sepals and petals separate and 4 each. Stamens exserted. Fruit a capsule or with a pair of nutlets.

Mostly tropical and warm temperate regions worldwide, especially in the Americas; 17 genera, 150 species.

- 1. Plants conspicuously glandular-viscid (sticky); flowers white and reddish; fruits longer than wide. **Polanisia**
- 1. Plants glabrate, not glandular-sticky; flowers yellow; fruits wider than long..... **Wislizenia**

Polanisia

Annuals or perennials. North America; 5 species.

Polanisia dodecandra (Linnaeus) de Candolle subsp. **trachysperma** (Torrey & A. Gray) H.H. Iltis
 [*P. trachysperma* Torrey & A. Gray]

Western clammy-weed. Figure 14.

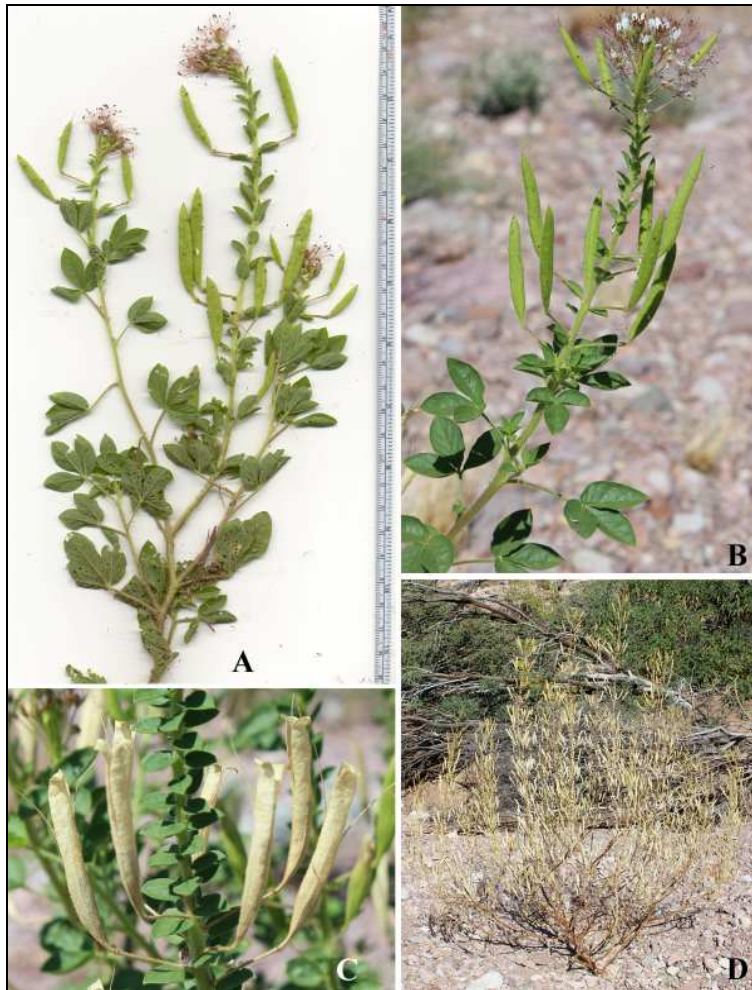


Figure 14. *Polanisia dodecandra* subsp. *trachysperma*. Alamo Canyon: (A) 10 Sep 2008; (B & C) 30 Jul 2013; (D) persistent dead plant, 2 Nov 2013.

Summer ephemerals, glandular and with stalked glandular hairs. Leaves with 3 leaflets. Flowers in long racemes held above the foliage; petals white, to 1 cm long; stamens prominent, reddish purple, 10 or more, to more than twice as long as the petals. Capsules 4+ cm long, many-seeded.

In the flora area, known from a few records in Organ Pipe along drainages from the Ajo and Diablo mountains.

This subspecies is native mainly in the Great Plains and western states and adventive elsewhere. *Polanisia dodecandra*, with 3 subspecies, is widespread in North America from Mexico to Canada, and adventive elsewhere (Tucker & Vanderpool 2010).

OP: Alamo Wash under Hwy 85 bridge, *Rutman 23 Nov 1994* (ORPI). Alamo Canyon, wash bed near springhouse, *Rutman 5 Sep 1999* (ORPI). Drainage W of the Diablo Mts near Hwy 85, 3 Sep 2014, *Rutman*, observation.

Wislizenia

This genus has 3 taxa, variously treated as 3 species (Tucker & Vanderpool 2010) or 3 subspecies.

Wislizenia refracta Engelman subsp. **refracta**

Jackass clover. Figure 15.

Non-seasonal ephemerals and sometimes persisting as short-lived perennials, the plants glabrate and stinky. Leaves with 3 broadly obovate leaflets. Racemes densely flowered, the flowers bright yellow, bilateral; flowering at almost any time of year, often during dry seasons when few other plants are blooming. Ovary with a slender, elongated, pedicel-like stipe longer than the petals. Stamens 6, longer than the petals. Fruits of 2 divergent 1-seeded nutlets, each 1.8–2 mm long.

Most often in moist, alkaline, sandy soils in washes and along roadsides and rocky granitic slopes at Aguajita and Quitobaquito and other alkaline soils of the La Abra plain east of Quitobaquito, and the extreme southeastern corner of Cabeza Prieta. It is an early pioneer on disturbed alkaline soils. After the 3-acre fire at Hocker Well in 1993, *W. refracta* colonized a de-vegetated area and was soon replaced by *Suaeda nigra* (Rutman, observations 1994–2003).

Subspecies *refracta* occurs in Nevada and southeastern California to New Mexico and western Texas, and northern Sonora and northern Chihuahua. Two other subspecies occur from southeastern California to Baja California Sur and western Sonora. Plants of subsp. *palmeri* (A. Gray) S. Keller in northwestern Sonora are often shrubs (Felger 2000).

Kirk (1970) and Whiting (1939) report that the leaves of young plants can be cooked as greens.

OP: Quitobaquito: 5 Mar 1940, *Peebles 14558*; 18 Feb 1978, *Fay 742*. 9.9 mi E of Quitobaquito on Puerto Blanco Drive, *Van Devender 31 Aug 1978*.

CP: Corner Well (Simmons 1966).



Figure 15. *Wislizenia refracta* subsp. *refracta*. Quitobaquito: (A) 11 Sep 2008; (B) 13 Sep 2006; (C) 6 Oct 2013; (D) 7 Nov 2012.

CRASSULACEAE – Stonecrop Family

Succulent ephemeral and perennial herbs, mostly glabrous (elsewhere also shrubs). Leaves alternate or opposite. Flowers radial, 3–5-merous. Sepals and petals often separate, or sometimes united at base or to above middle. Ovary usually superior with 4 or 5 carpels separate or united only at base. Seeds very small.

Nearly worldwide; 34 genera, 1400 species.

- 1. Minute winter-spring ephemerals; leaves opposite, less than 5 mm long..... **Crassula**
- 1. Thick-stemmed perennials; leaves alternate in a rosette, 2 or more cm long.
- 2. Leaves glaucous, often powdery white and more than 5 cm long; flowers tubular, yellow and red, not spotted or cross-banded..... **Dudleya**

2. Leaves glabrous, green or greenish brown, 2–5 cm long; flowers open, cream and reddish spotted and cross-banded..... **Graptopetalum**

Crassula

Annuals and mostly succulent perennials and some shrubs; nearly worldwide, 250 species, especially diverse in southern Africa. The New World species are small annuals.

Crassula connata (Ruiz & Pavón) A. Berger

[*C. connata* var. *eremica* (Jepson) Bywater & Wickens. *Tillaea erecta* Hooker & Arnott]

Pygmy stonecrop; sand pygmyweed. Figure 16.

Diminutive winter-spring ephemerals, (0.5) 1–5.5+ cm tall, succulent throughout; individual plants green, reddish, or yellow-green (different colored plants often intermixed). Leaves opposite, united at base, very fleshy, ovate to oblong and mostly bead-like, the larger ones mostly 2–3.5 mm long. Most or all flowers on a plant sessile or subsessile, some with a minority of flowers on pedicels to 3 mm long (pedicel length seems to be influenced by soil moisture). Flowers (3) 4 (5)-merous, 1 mm wide; sepals (1.2) 1.4–1.6 mm long and longer than the carpels. Corollas white to nearly transparent, shorter than the sepals, the segments lanceolate. Seeds 0.35 mm long, brown, ellipsoid, shiny with faint longitudinal lines (longitudinally ridged when viewed with a scanning electron microscope).

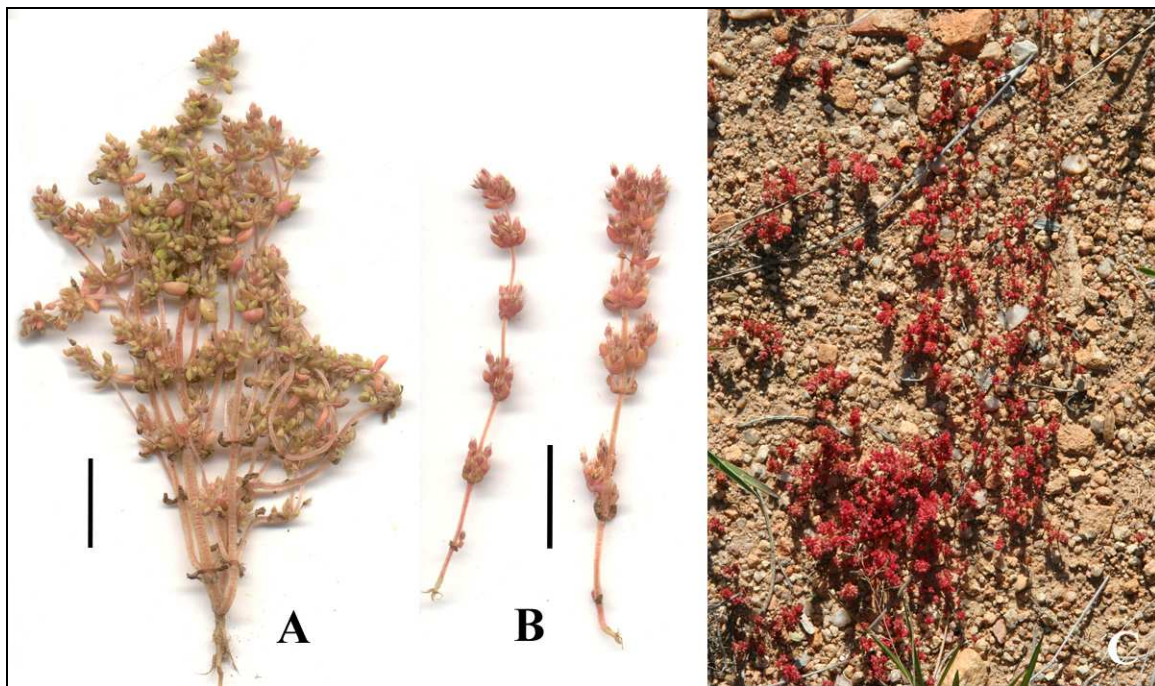


Figure 16. *Crassula connata*. (A & B) Valley of the Ajo, W of Hwy 85 milemarker 60, 22 Mar 2003, scale bar = 1 cm. (C) Javelina Mountain, Sand Tank Mts, 3 Mar 2005.

Seasonally widespread across the flora area, mostly on sandy and gravelly soils, sometimes especially abundant on bajada slopes and broad washes, and also soil pockets on hills and mountains; generally not appearing during drier years.

Western North America to Argentina and Chile in many habitats. Bywater and Wickens (1984) recognized five varieties, although Moran (1992, 1994, 2009) found the varieties to have little geographic meaning and be poorly defined.

OP: Senita Basin, 19 Jan 1973, *Schmitt 3168* (ORPI). 9 mi on 2-way Puerto Blanco Drive E of Hwy 85, 26 Feb 1978, *Bowers 1077* (ORPI). Aguajita Wash, 3 Mar 1992, *Felger 92-105*. Santa Rosa Mts, 12 Mar 2003, *Felger 03-356*. Growler Valley, 11 Apr 2003, *Rutman 2003-460* (ORPI). Bull Pasture, 10 Apr 2005, *Felger* (observation).

CP: Pinacate lava flow, depressions with silt, 7 Apr 1979, *Lehto L23590* (ASU). Charlie Bell Pass, 3 Apr 1992, *Whipple 3946*. Below Heart Tank, 27 Feb 1993, *Felger 93-162*. Papago Well, 26 Feb 1993, *Felger 93-130*.

TA: Camino del Diablo, SSE of Raven Butte, 20 Feb 2005, *Felger 05-26*.

Dudleya

Perennial herbs with succulent leaves. Southwest USA and northwest Mexico. This genus with more than 45 species primarily occurs along the Pacific Coast of California and Baja California, and only two species occur east of California. Members of this genus respond to winter-spring Pacific rains and are summer dormant.

The fresh leaves and young flowering stems of California species, including *D. pulverulenta*, were eaten in spring when the plants are fresh and growing (Bean & Saubel 1972; Meigs 1939; Palmer 1878).

Dudleya arizonica Rose

[*D. pulverulenta* (Nuttall) Britton & Rose subsp. *arizonica* (Rose) Moran. *Echeveria arizonica* (Rose) Kearney & Peebles]

Arizona liveforever. Figure 17.

Perennials growing during the cooler seasons; summer dormant. Leaves in rosettes, the rosettes 1 to several from a short, thick stem and thickened root, the old dry leaves persistent. Leaves several or more per rosette, mostly 4–10.5 cm long, lanceolate to ovate, very thick and succulent, with a white-waxy bloom, whiter during dry periods, greener during winter-spring wet periods, the leaves sometimes reddish. In late spring and early summer the larger leaves dry up and the remaining leaves shrivel and curl in over the center of the rosette. During years of exceptional cool-season rains the Ajo Mountain plants can become unusually large, some leaves reaching 25 cm long and 6 cm wide, and whitish towards base and otherwise rose-colored. Buds and developing inflorescences conspicuously glaucous-whitish; flowering stems and leaves, bracts, and pedicels usually coral pink at anthesis. Flowering stems axillary, usually 1–3+ per rosette, 9–30 (50) cm long, with reduced leaves shriveling as the flowers develop. Flowers 5-merous, 13–16 mm long. Calyx fleshy, greenish glaucous or sometimes coral pink above. Corollas often 13–14 mm long, nearly tubular, reddish orange, or greenish yellow to yellow at base, and yellow-orange to red-orange at the tip. Stamens 10, the anthers red prior to pollen shedding. Capsules 7.5–12 mm long. Seeds many, 0.7 mm long. Flowering March and early April; seeds ripe in May.

Mostly on bedrock slopes and cliffs, often on north-facing slopes, growing wedged between rock crevices. Ajo and Diablo mountains in Organ Pipe and in Cabeza Prieta, Tinajas Altas, and adjacent northwestern Sonora on granitic mountains to peak elevations. Notably prominent on the Mount Ajo trail 2775–4000 feet.

Western Arizona, northwestern Sonora, southern Nevada, southwestern Utah, southeastern California, and northern Baja California.

OP: Canyon Diablo, *Steenbergh & West 25 Apr 1962* (ORPI). Bull Pasture Trail, 3000 ft, 2 May 1978, *Bowers 1268* (ORPI). Plants unusually large, largest leaves 24–25 cm long, thick and succulent, reddish rose and whitish glaucous basally, inflorescence branches and bracts succulent, corollas orange distally, common among rocks, 9 Apr 2005, *Felger 05-173* (ARIZ, ASU, ORPI).

CP: Cabeza Prieta Peak: W slope, *Simmons 27 Oct 1962*; Hanging in crevices of steep, broken cliffs on S face below summit, 2200 ft, common above this elevation to summit, 24 Mar 1995, *Yeatts 3670 (CAB)*.
TA: Tinajas Altas, *Vorhies 16 Apr 1924*. 1 mi N of Tinajas Altas, 17 Apr 1948, *Kurtz 1170*.



Figure 17. *Dudleya arizonica*. Bull Pasture Trail: (A) 10 Apr 2005; (D) 18 Mar 2005. (B) South Fork of Alamo Canyon, 12 Mar 2005. (C) Crest of Little Ajo Mts, 2 Feb 2004.

Graptopetalum

Succulents perennials. This genus, with about 15 species in Mexico and Arizona, is allied to several genera of diverse Mexican montane succulents such as *Echeveria* attuned to summer-monsoon rains. *Graptopetalum* is the only one to enter the margins of the Sonoran Desert. Two species occur in Arizona; *G. bartramii* Rose occurs above the desert in southeastern Arizona, Chihuahua, and Sonora.

Graptopetalum rusbyi (Greene) Rose

Figure 18.

Perennials with a rosette of succulent leaves, actively growing in spring and with summer-fall rains. Leaves mostly 2–5 cm long, green to greenish brown, oblanceolate. Flowering April and May, flowering stems slender and often 5–15 cm long. Flowers probably 15–20 mm wide, petals cream-colored and banded and spotted with dark red-brown; Moran (1993) euphemistically calls the fragrance “musky.” Fruits many-seeded.



Figure 18. *Graptopetalum rusbyi*. (A) Bull Pasture Trail, 18 Mar 2005. (B & C) Lower Jacobson Canyon, Pinalaño Mts, Graham Co., 5 May 2008, photos by Patrick Alexander.

Ajo Mountains, mostly at mid-elevations, often in rock crevices and on shaded or north-facing slopes, canyon walls, and cliffs.

Mountains eastward to central Arizona and Sonora, generally at elevations above the desert; also mountains in Chihuahua and Sinaloa.

OP: Canyon N of Alamo Canyon, 3000–3800 ft, 31 Mar 1948, *Darrow 3863*. Boulder Canyon, *Steenbergh 24 May 1962* (ORPI). Bull Pasture Trail, 3000 ft, 2 May 1979, *Bowers 1269* (ORPI).

CROSSOSOMATACEAE – Crossosoma Family

Shrubs. Southwestern USA and Mexico; 4 genera, 12 species.

Crossosoma

Shrubs. Southwestern USA and Mexico; 2 species.

***Crossosoma bigelovii* S. Watson**

Ragged rock-flower. Figure 19.

Shrubs mostly 1–1.5 m tall, with long and short shoots, the short shoots sometimes becoming long shoots. Leaves alternate on long shoots, clustered on short shoots, evergreen or tardily drought deciduous, mostly 7–15 (21) mm long, elliptic to oblong or obovate, somewhat thick, grayish or glaucous green, subsessile with petioles less than 1 mm long, the margins entire. Flowers fragrant, solitary or in small clusters, bisexual or some of them unisexual, radial, and perigynous, the hypanthium forming a thickened nectary disk. Sepals and petals each 5; sepals persistent; petals white and deciduous, 12.5–13.5 mm long, obovate, rounded at apex, often held vertically and sidewise like propeller blades. Stamens 15+, attached to the nectary disk. Pistils 2–5, separate from each other, and stalked (stipitate), 7–11.5 mm long in fruit, cylindrical, and transversely wrinkled. Flowering mid-winter and spring; fruits mostly ripe in April. Seeds 4–8, with a conspicuous white- or yellow-fringed aril.

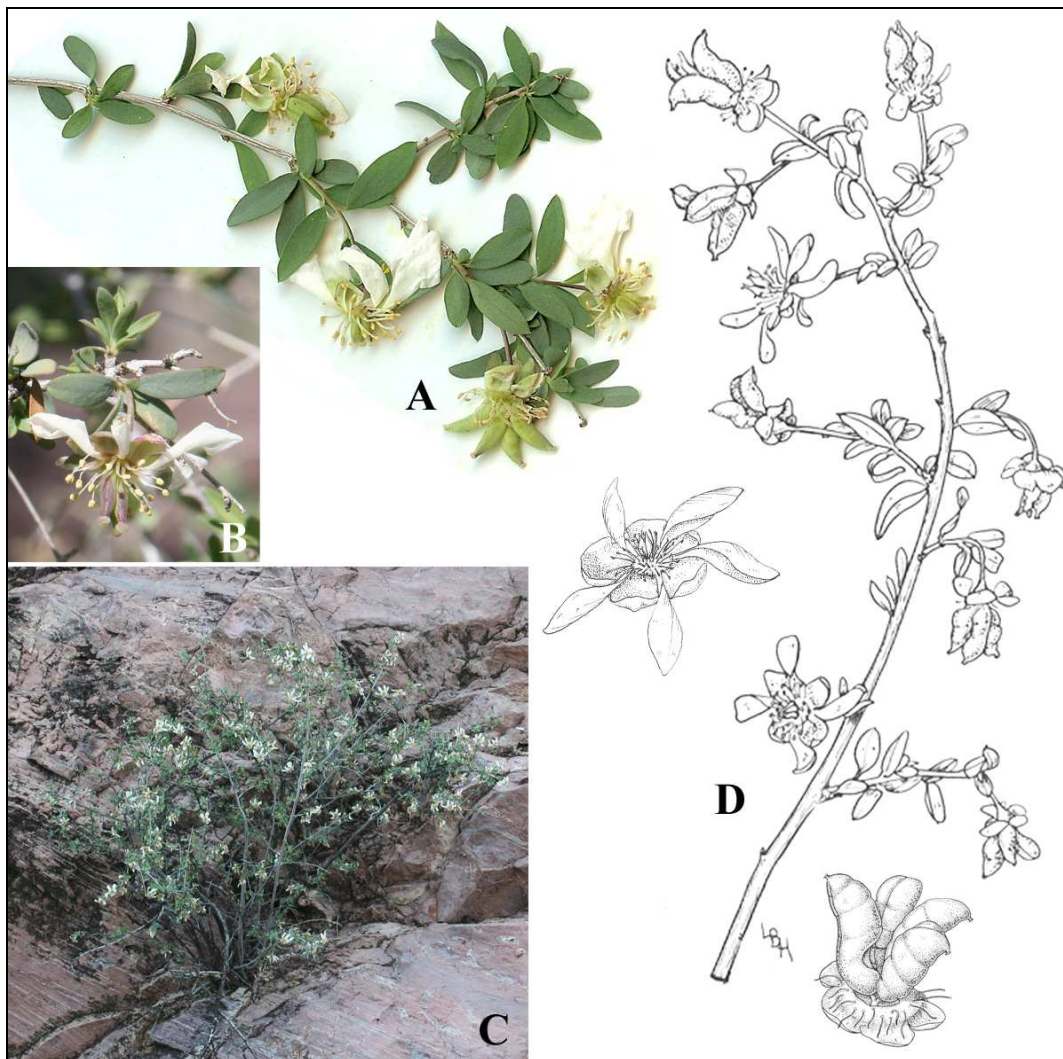


Figure 19. *Crossosoma bigelovii*. Estes Canyon: (A) 16 Mar 2008; (B) 2 Mar 2008. (C) South fork of Alamo Canyon, 28 Feb 2009. (D) By Lucretia Breazeale Hamilton.

Granitic and volcanic mountains, often rooted in bedrock canyon walls or cliff faces. Organ Pipe in the major ranges except the Quitobaquito Hills. Cabeza Prieta in the larger mountains, and in the Tinajas Altas Mountains. Its history across the flora area extends to more than 37,000 years.

Western and southern Arizona, northern Sonora (southward to the Guaymas Region), northwestern Chihuahua, western Nevada, inland southern California, and Baja California.

OP: Pitahaya Canyon, *Nichol 23 Feb 1939*. Alamo Canyon, *Tinkham 18 Apr 1942*. Above Dripping Springs, 16 Apr 1952, *Parker 7961*. Growler Mts, W of Growler Pass, 7 Mar 2003, *Rutman 2003-253 (ORPI)*. Trail from The Cones to Mount Ajo, 4090 ft, 10 Apr 2005, *Felger* (observation). †Alamo Canyon, leaves, 8590 to 14,500 ybp (3 samples).

CP: Eagle Tank, 13 Jun 1992, *Felger* (observation). Canyon at Agua Dulce Tank, 26 Feb 1993, *Felger 93-86*.

TA: Tinajas Altas, 17 Mar 1980, *Webster 24254*. Borrego Canyon, vicinity Borrego Tank, 27 Feb 1993, *Felger 93-194*. †Tinajas Altas, leaves, fruits, 4010 to 15,680 ybp (9 samples), & >37,000 ybp.

CUCURBITACEAE – Gourd Family

Annuals and perennials (elsewhere sometimes shrubs and one succulent tree on Socotra Island in the Indian Ocean). Stems vining or trailing, the nodes with leaves and tendrils. The aerial parts of members of this family are frost-sensitive, although two of the six species in the flora area grow with cool-season rains; perennials in the flora area all have seasonal growth, the aerial parts dying back in unfavorable seasons. Leaves alternate, petioled, usually palmately veined and lobed; stipules none. Flowers unisexual, radial, the calyx and corolla each 5 lobed; corollas yellow or white. Stamens 3 or 5. Ovary inferior. Fruits highly variable; seeds 1 to many.

Worldwide, mostly tropical and subtropical; 120 genera, 835 species (Nesom in press). This family includes cucumbers, gourds, melons, pumpkins, squashes, and zucchinis.

- 1. Fruit a hard-shelled gourd 8 cm or more in diameter; flowers more than 2 cm wide..... **Cucurbita**
- 1. Fruit not a gourd, not hard-shelled, 3 cm or less in diameter; flowers less than 1.5 cm wide.

- 2. Plants growing with (or beginning just before) hot-weather rains.

- 3. Ephemerals; stems with 3-branched tendrils; leaves finely haired; fruits 2–2.5 cm long and spiny..... **Echinopepon**
- 3. Perennials; stems with simple (unbranched) tendrils; leaves glabrate or glabrous and smooth; fruits 1 cm long and smooth..... **Tumamoca**

- 2. Plants growing with cool-weather rains (fall to spring, or sometimes beginning in August).

- 4. Flowers less than 5 mm wide; fruits oblique (asymmetric), 1 cm long; lowlands...**Brandegea**
- 4. Flowers 6–10 mm wide; fruits globose, 2–3 cm in diameter; Ajo Mts..... **Marah**

Brandegea

This genus has a single species. It appears to be closely related to *Vaseyanthus insularis*, which replaces *Brandegea* southward in the Gulf of California region of the Sonoran Desert. Both grow with cool-season rains, although *Brandegea* sometimes grows following hot-weather rains.

Brandegea bigelovii (S. Watson) Cogniaux
Desert star-vine. Figure 20.

Ephemerals, mostly growing with cool season rains. Herbaceous vines from a stout, carrot-shaped, fleshy, white taproot often reaching 2–2.5+ cm in diameter. Stems slender, with simple

(unbranched) tendrils. Leaves highly variable, the blades 2.5–8 (12) cm long and about as wide, thin, prominently short-scabrous, shallowly to deeply 3 or 5 lobed, the lobes broader and shallower on juvenile growth, becoming narrower (to broadly linear) and deeper lobed on upper stems; petioles reaching 2–4 cm long. Flowers white and delicately fragrant; male and female flowers often in the same axil; male flowers 3–4 mm across, with 3 (5) stamens, in several-flowered racemes; female flowers larger, solitary on slender pedicels, 1 (2 or 3) per axil. Fruits 1- (2-) seeded, irregularly dehiscent, the body (6) 7–7.5 mm long, obovoid-oblique, laterally compressed, with soft prickles (warty), and a prominent beak (4) 5–7 mm long. Seeds 5 mm long.



Figure 20. *Brandegea bigelovii*. (A) Hwy 85, 12 miles S of Gila Bend, 31 Mar 2013. (B) Two staminate flowers and immature fruit, Tinajas Altas, 2 Mar 2014, photo by Sue Carnahan (SEINet–MABA). (C) Fruit, Daniels Arroyo at Charlie Bell Road, 5 Sep 2014. (D) Near Red Cone Campground, Pinacate Biosphere Reserve, Sonora, 18 Jan 2009. (E) Road to Red Cone Campground, Pinacate Biosphere Reserve, 7 Mar 2009.

Sandy-gravelly and loamy soils of washes and floodplains, often seasonally festooning trees and shrub in green curtains. Western part of Organ Pipe, widespread in Cabeza Prieta, and in the Tinajas Altas Region; common in adjacent Sonora. These plants are annuals (robust ephemerals) and growing mostly September–April but vigorous young growth sometimes seen in August following sufficient rains. The plants sometimes continue growing well into May, but such late season plants have relatively small leaves with narrow leaf lobes. The plants perish as the weather becomes hotter and drier in late spring and early summer. Is this plant capable of growing any time in summer of year with sufficient water? Is it facultatively perennial? In the California part of the Sonoran Desert it can germinate and grow with summer rains (Andrew Sanders, pers. comm. to Felger, Sep 2014).

Mojave and Sonoran Deserts; southeastern California to Baja California Sur, southwestern Arizona, and northwestern Sonora.

Seris used the roots to make a cleansing shampoo and a bitter infusion was drunk during vision quests to induce an altered state of consciousness (Felger & Moser 1985).

OP: 10 mi S of Bates Well, Growler Mts, 5 Mar 1940, *Benson 9932*. Near Quitobaquito, 5 Mar 1940, *Peebles 14556-a*. Senita Basin Rd, 12 Oct 1988, *Perrill 5875*. North Puerto Blanco Drive, 4.2 mi W of Hwy 85, 3 Dec 1990, *Felger 90-570*.

CP: Papago Well: Arroyo margin with mesquite and *Cercidium*, long climbing vine, 27 Oct 1937, *Gentry 5499* (ASU); *Nichol 13 Nov 1937*. Silt soil in lush overflow area of San Cristobal Wash, Monreal Well, *Simmons 21 Oct 1962*. Huge fragrant clumps, climbing over shrubby vegetation, esp. along dry wash, 1 mile E of Papago Well by the Camino del Diablo, 13 Mar 1983, *Eiber 15*. Lechuguilla Desert, SSW of Cabeza Prieta Peak, 13 Dec 1970, *Carr 106*. Buckhorn Tank, 28 Mar 1970, *Duncan 16*. Cabeza Prieta Mts, 1100 ft, 9 Mar 1986, *Schmidt 9-86*. Jose Juan Tank, 14 Sep 1992, *Felger 92-721*. N side of Tule Mts, 2 Feb 1992, *Felger 92-56*.

TA: Tinajas Altas, 5 Dec 1935, *Gooding 2092*. Tinajas Altas Pass, 17 Mar 1980, *Webster 24256*. Coyote Water, 21 Feb 2005, *Felger 05-139*.

California: Imperial County, Arroyo Seco, 4 km of Rainey’s Well (Chuckwalla Spring), annual vine in wash, under *Parkinsonia florida*, flowers white, 22 Aug 2012, *Sanders 40373* (UCR).

Cucurbita

Perennial vines from a large, tuberous root (those in the flora area; annuals and perennials elsewhere). Male and female flowers on the same plant. Flowers large, yellow, and solitary. Stamens 3. Fruits of smooth, rounded gourds (those in the flora area). Seeds many, ovate, compressed, and smooth.

The large green-striped cushaw squash, *C. argyrosperma* Huber subsp. *argyrosperma* (*C. mixta* Pangalo), has been cultivated in the Sonoran Desert since ancient times. It has been grown along the lower Río Colorado, at Quitovac, and undoubtedly at Quitobaquito and elsewhere in the region. It is distinguished by an enormous corky peduncle and large fruits (squashes). This genus includes wild and domesticated gourds and squashes.

Warm regions of the Americas; 14+ species.

- 1. Leaves (except newest growth, see below) divided nearly to the base with linear, finger-like segments or lobes..... **Cucurbita digitata**
- 1. Leaves with broad, mostly triangular lobes cleft to about the middle of the leaf.
..... **Cucurbita palmata**

***Cucurbita digitata* A. Gray**

Finger-leaf gourd, coyote gourd; *calabacilla*, *chichi coyota*; 'adavī, 'ad. Figure 21.

Perennials from a deep, thickened root. Stems relatively coarse, sprawling across the ground to several meters long, occasionally climbing into shrubs and trees. Herbage scabrous. Tendrils 2–5-branched. Leaf blades digitately and deeply cleft, the lobes (6) 8–13 cm long, slender and finger-like, the upper surfaces whitish near the midrib due to dense concentration of hairs and greenish near the margins, the petioles 4–9 cm long; leaves of juvenile plants and first growth of season with much shorter and broader lobes (like those of *C. palmata*). Corollas bright yellow, 7–10 cm across. Gourds 8–9.5 cm in diameter, rounded, smooth, green with whitish stripes and mottling, yellow at maturity with a thin but hard rind. Seeds 9–11 mm long, smooth, compressed, and whitish. Growing and flowering with warm weather, often beginning in spring even in dry years, dying back in severe drought.

Washes, canyons, and sandy to loamy flats, also roadsides; widely scattered across Organ Pipe including Ajo Mountain canyons and in Cabeza Prieta and Tinajas Altas regions.

Southern Arizona, northern Sonora, northern Baja California, northwestern Chihuahua, southern New Mexico, and rare in southern California.

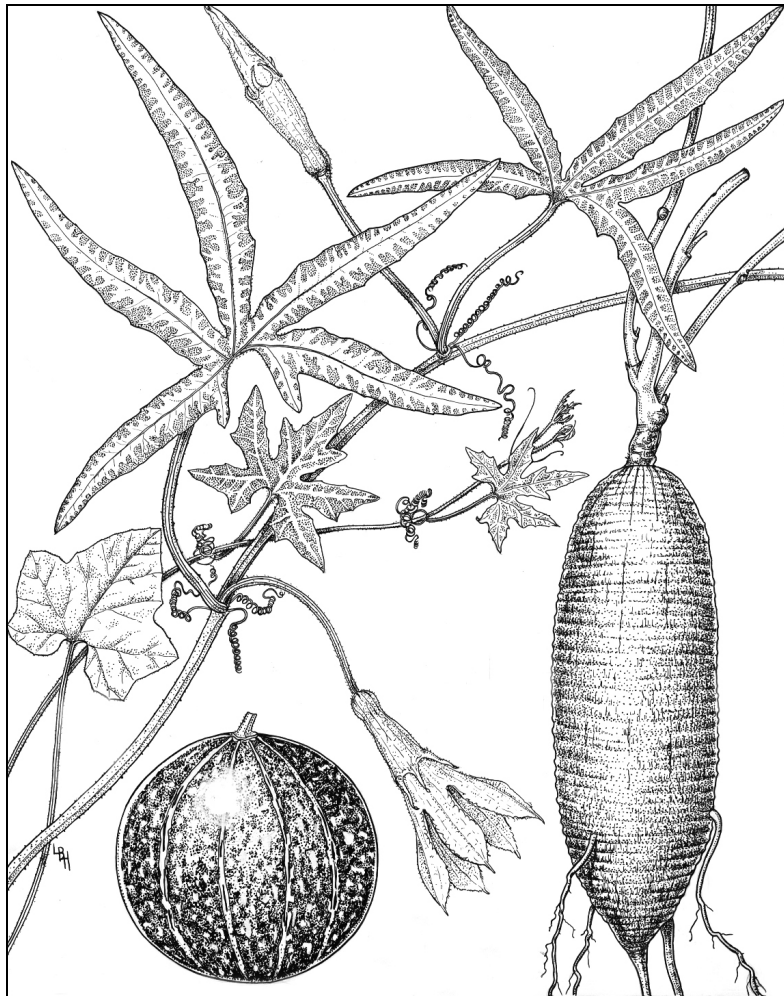


Figure 21. *Cucurbita digitata*. By Lucretia Breazeale Hamilton.

The roots were used as a medicine to treat dandruff and were also mashed in water for use as soap and bleach for fabric (Betty Melvion in Bell et al. 1980). “Wild gourds. . . my grandmother used to slice them up and put them. . . in the water where she was soaking her sheets, the white sheets. . . for bleach in the wash. The wash would come out so white. . . with the roots of the gourds they use it to wash their hair. . . its almost like adding Clorox to the wash. . . they would use the gourd in this way when it was still green, not when it was dry” (Betty Melvin in Zepeda 1985: 49, 54).

The fruits are very bitter and not edible, although the seeds are reported to be edible after being toasted or boiled and ground into flour (Hodgson 2001). River Pimas used juice from the root, extracted by pounding in a mortar and boiling, as ear drops to alleviate earache (Russell 1908).

OP: Cipriano Well, *Nichol 27 Apr 1939*. 1 mi W of Growler Pass, 1000 ft, *Simmons 1 Oct 1963*. Armenta Well, *Warren 16 Nov 1974*. Alamo Canyon, near corral, *Van Devender 31 Aug 1978* (ORPI). Quitobaquito, 24 Oct 1990, *Felger 90-493* (ORPI).

CP: Bluebird Mine (Simmons 1966). Daniels Wash at Charlie Bell Rd, 18 Aug 1992, *Felger 92-671*.

TA: Tinajas Altas, *Goodding 5 Dec 1935*. Tinajas Altas Pass, 1100 ft, washes, *Reeves R5408* (ASU). Frontera Canyon, 18 Mar 1998, *Felger* (observation).

Cucurbita palmata S. Watson

Coyote gourd; *calabacilla*, *chichi coyota*; 'adavī, 'ad. Figure 22.

Similar to *C. digitata* but with much broader and shorter leaf segments or lobes, the leaf lobes more or less triangular, often nearly as broad as long, and usually with entire margins.



Figure 22. *Cucurbita palmata*. (A) About 6 mi S of Ludlow, San Bernardino Co., California, 25 Sep 2011. (B) Vicinity of Hwy 58 & 223, Kern Co., California, 19 Sep 2009. Photos © by Neal Kramer.

Sandy soils of Lechuguilla Valley and arroyo bottoms of the Tinajas Altas Mountains. Often growing over shrubs.

Southwestern Arizona, northwestern Sonora near the Río Colorado, southeastern California, northeastern Baja California, Nevada, and southwestern Utah.

Cucurbita palmata generally replaces *C. digitata* in the western margin of the flora area, where *C. palmata* locally occurs in more xeric, harsher habitats than does *C. digitata*. The leaves of

juvenile plants or the first growth of the season of *C. digitata* are essentially indistinguishable from those of both the juvenile and adult leaves of *C. palmata*. These taxa are part of a complex of several closely related, arid-region cucurbits in southwestern USA and northwestern Mexico that might be considered as subspecies of a single species (Bemis & Whitaker 1965).

TA: Camino del Diablo, E of Raven Butte, valley floor bajada, decomposed gravel sand soil, 29 Nov 2001, *Felger 01-584* (ARIZ, ASU).

Echinopepon

Herbaceous vines. Southwestern USA to Central America and disjunct in Argentina; 19 species.

Echinopepon wrightii (A. Gray) S. Watson
Wild balsam-apple. Figure 23.

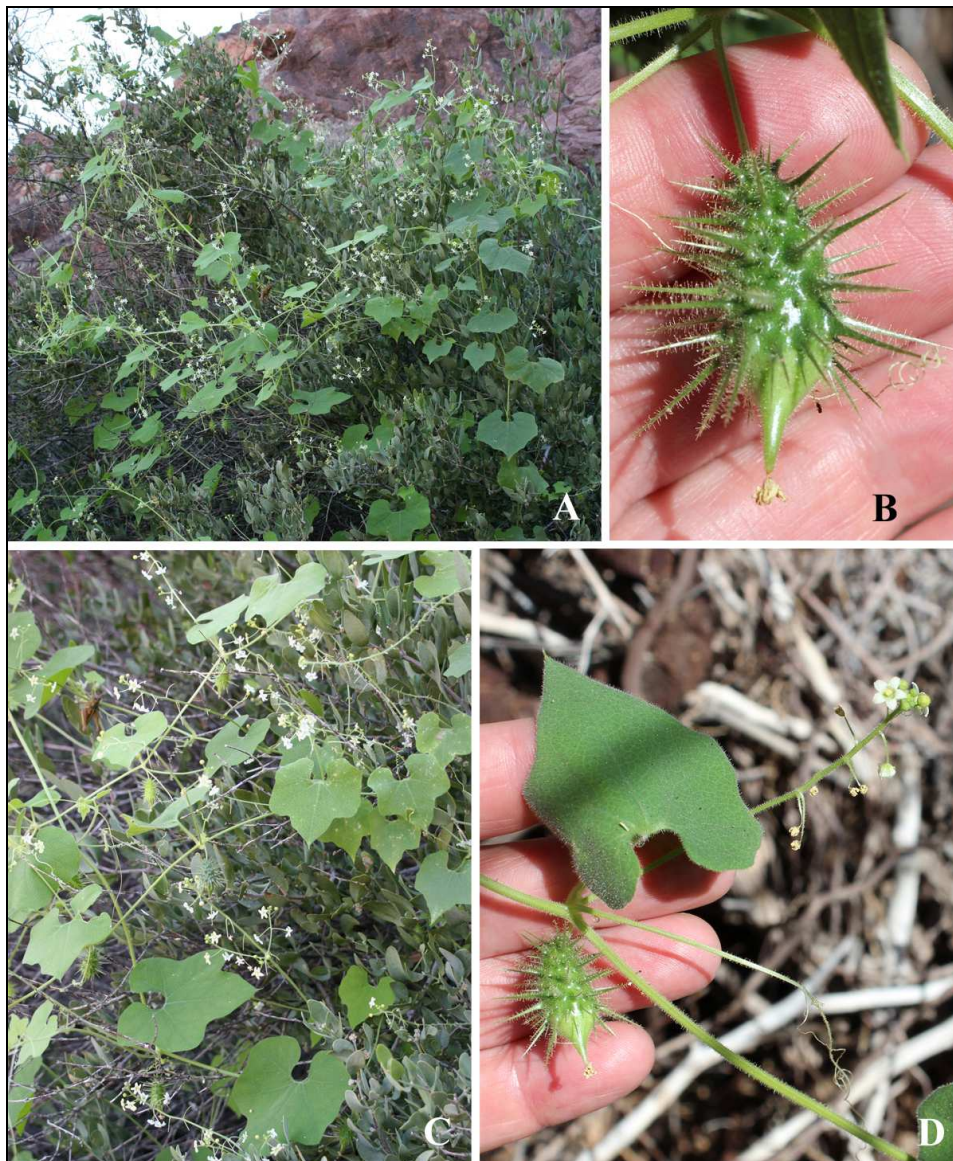


Figure 23. *Echinopepon wrightii*. (A & C) Arch Canyon, 16 Sep 2006. (B & D) Estes Canyon, 22 Sep 2013.

Robust summer-fall ephemeral (annual) vines, growing into or over shrubs and trees. Plants with glandular and non-glandular hairs. Tendrils mostly 3-branched. Leaf blades to 12 cm long, thin, cordate and generally palmately 3–5-lobed. Flowers white. Mature fruits become capsules, the body 2–3.5 cm long and covered with spines 1–2.5 cm long, the fruit body and spines bear stalked glands. Capsules 3-chambered, the seeds shed from apical pores; capsules often hanging in trees on the dry, dead vines for several months.

Canyons and upper slopes in the Ajo Mountains.

Mostly along the upper elevational edge of the Sonoran Desert and adjacent non-desert zones. Southern Arizona, southern New Mexico, and northern Mexico including Baja California Sur, Chihuahua, and Sonora.

OP: Alamo Canyon, 14 Dec 1939, *Harbison 26431* (SD). Arch Canyon, 3000 ft, *Wirt 13 Oct 1990*. Below arch in Arch Canyon, 900 m, 2 Dec 1990, *Felger 90-563*. Estes Canyon, 0.1–0.2 mi upstream from Estes Canyon Picnic area, 738 m, uncommon vine, sprawling among rocks in wash bed, 22 Sep 2013, *Rutman 20130922-30*.

Baja California Sur: Sierra Guadalupe, W of Mulegé, S of Rancho San Sebastian near Ranchos San Fernando, 26°59'20"N, 112°27'33"W, 2952 ft, 27 Oct 1997, *Rebman 4586* (SD, UCR).

Marah – Manroot

Perennial vines from large tuberous roots. Western North America; 8 species.

Marah gilensis (Greene) Greene

Big root, Gila manroot. Figure 24.

Robust perennial vines from a very large tuberous root, the vines climbing on trees and shrubs; growing and flowering during the cooler months and summer dormant. New growth and inflorescences densely pubescent, with age becoming glabrate. Tendrils simple or 2-branched. Leaf blades thin, palmately (3) 5 (7)-lobed, scabrous above, glabrous or sparsely pubescent below, especially along major veins. Flowers pale yellow or greenish yellow, 6–10 mm wide; male and female flowers in the same axil. Fruits sub-globose, 2–3 cm wide, with many herbaceous prickles, succulent when green, becoming dry at maturity; seeds 3 or 2 when 1 does not develop. Flowering December–March.

Ajo Mountains, locally common in canyon bottoms and slopes, mostly at higher elevations.

Eastward and northward in Arizona, few records in southwestern New Mexico, and expected in northern Sonora.

OP: Alamo Canyon: 2500 ft, *Nichol 14 Mar 1939*; 14 Dec 1939, *Harbison 26258*; steep N- facing slopes, 9 Mar 1946, *Gooding 12-46*. S side of Arch Canyon, 3500 ft, 28 Mar 1965, clambering over shrubs of *Lycium parishii* and *Encelia farinosa*, *Niles 555*. Side canyon of Arch Canyon, just W of the Natural Arch, 3000 ft, vine climbing on *Simmondsia chinensis*, 25 Feb 1978, *Bowers 1061*. Arch Canyon trail, 2550–2900 ft, 11 Mar 1983, *Daniel 2620* (UCR).



Figure 24. *Marah gilensis*. South fork of Alamo Canyon: (A) 26 Feb 2014; (B) staminate flowers, 14 Jan 2014; (C) 12 Mar 2005. (D) 50-pound tuber, Boyce Thompson Arboretum, Gila Co., 29 Oct 2011, photographer unknown.

Tumamoca – Globe-berry

In collaboration with Frank Reichenbacher.

This genus is named for Tumamoc Hill, Tucson, site of the Carnegie Institute Desert Laboratory, founded in 1905, which later became part of the University of Arizona. Some of the most important scholars of desert ecology headquartered or began their careers at Tumamoc Hill including Julio Betancourt, Tony L. Burgess, Janice E. Bowers, Kenneth L. Cole, Francis Lloyd, Daniel T. MacDougal, Vera Markgraf, Paul S. Martin, Peter J. Mehringer, Kate Aason Rylander, Geoffrey W. Spaulding, Volney Spaulding, Forrest Shreve, Godfrey Sykes, Robert S. Thompson, Raymond M. Turner, Thomas R. Van Devender, and Robert H. Webb, as well as a number of distinguished archeologists.

Tumamoca is closely related to *Ibervillea* (Nesom in press) and indeed shows some overall resemblance to *I. sonorae* (S. Watson) Greene, *guarequi*, a well-known Sonoran Desert plant in northwestern Mexico. They are, however, clearly distinctive. A second species of *Tumamoca*, *T. mucronata* Kearns, is known only by the type specimen (Kearns 1994) and that specimen has not been located in recent years (Tom Wendt, pers. comm. to Felger, 11 Mar 2015).

Lira et al. (2015) have placed *Ibervillea* (including *Dieterlea*) and *Tumamoca* in the same genus, and the name *Ibervillea* has priority. A cladistic analysis, based on morphological as well as molecular data, indicates that *Tumamoca* is sister to the core *Ibervillea*, thus *Ibervillea* is monophyletic even if *Tumamoca* is not included and the rationale for expanding *Ibervillea* is equivocal. Another genus, the Southern Hemisphere *Ceratosanthes*, is sister to the *Ibervillea/Tumamoca* clade. The strength of the case for combining all three American genera is that they are indeed similar and form an obviously coherent geographical group in “Megamexico” (sensu Rzedowski 1991). While the inclusion of *Tumamoca* is justifiable, so also is a decision to keep it separate — we believe that Lira et al. have provided weak support for their decision and prefer to emphasize the distinction of *Tumamoca*.

***Tumamoca macdougallii* Rose**

[*Ibervillea macdougallii* (Rose) Lira, Dávila & Legaspi]

Tumamoc globe-berry. Figure 25.

Perennials from tuberous roots that vary in shape, size, number, and configuration. Tuberous roots of juvenile plants tend to be carrot-shaped and 10–40 cm long, and those of adult plants are carrot- or potato-shaped, single, or clustered, horizontal or vertical, in soil deep or shallow; the largest ones may weigh 2 kg and are from 40–80 cm long. Plants glabrous or glabrate, the young herbage sometimes very sparsely pubescent. Stems slender and vining, climbing in shrubs, trees, or cacti—potentially climbing as much as 3 m above ground. New growth appears with summer rains, or just prior to monsoon onset in the larger adult plants, in which case minute flower buds may appear and are successively aborted until the rain arrives; the stems and leaves quickly perish when the rains cease. Tendrils simple (unbranched). Leaf blades deeply parted or divided, often about 4 x 4 cm. Male and female flowers variously on the same or different plants (sub-monoecious); apparently self-compatible and moth-pollinated (Reichenbacher 1990). Male flowers on short racemes, the female flowers solitary; flowers pale yellow, the lobes spreading and sometimes recurved. Fruits globose, 1 cm in diameter, glabrous and fleshy, at first green with white mottling, becoming uniformly bright red when ripe in late summer–early fall; seeds several or more per fruit.

Known from several scattered localities in Organ Pipe, where it is at its westernmost limit. The plants are often hidden in shrubs and not easy to find, and generally can be located only during the brief summer rainy season.

Southern Arizona from Organ Pipe to the Tucson Region, western Sonora to northwestern Sinaloa, and Isla Tiburón.

“Tumamoc globeberry is always found in the shade of and among the canopies of...shrubs and trees. These ... ‘nurse plants’ provide habitat for seed germination, shelter for seedlings and juveniles, and support for the display of flowers to potential pollinators and presentation of fruits to potential seed dispersers” (Reichenbacher 2008: 6). Frank Reichenbacher and associates have been monitoring this species in southern Arizona since 1983 and have noted a substantial decrease in the number of plants in certain Tucson populations (Reichenbacher 2008; Frank Reichenbacher, pers. comm. to Felger, 2015). The Tumamoc globe-berry was listed as an endangered species in 1986 but was removed from the endangered species list in 1993 (U.S. Fish & Wildlife Service 1986, 1993).

The small red fruits have been eaten fresh by the Seris (Felger & Moser 1985; Felger & Wilder 2012).

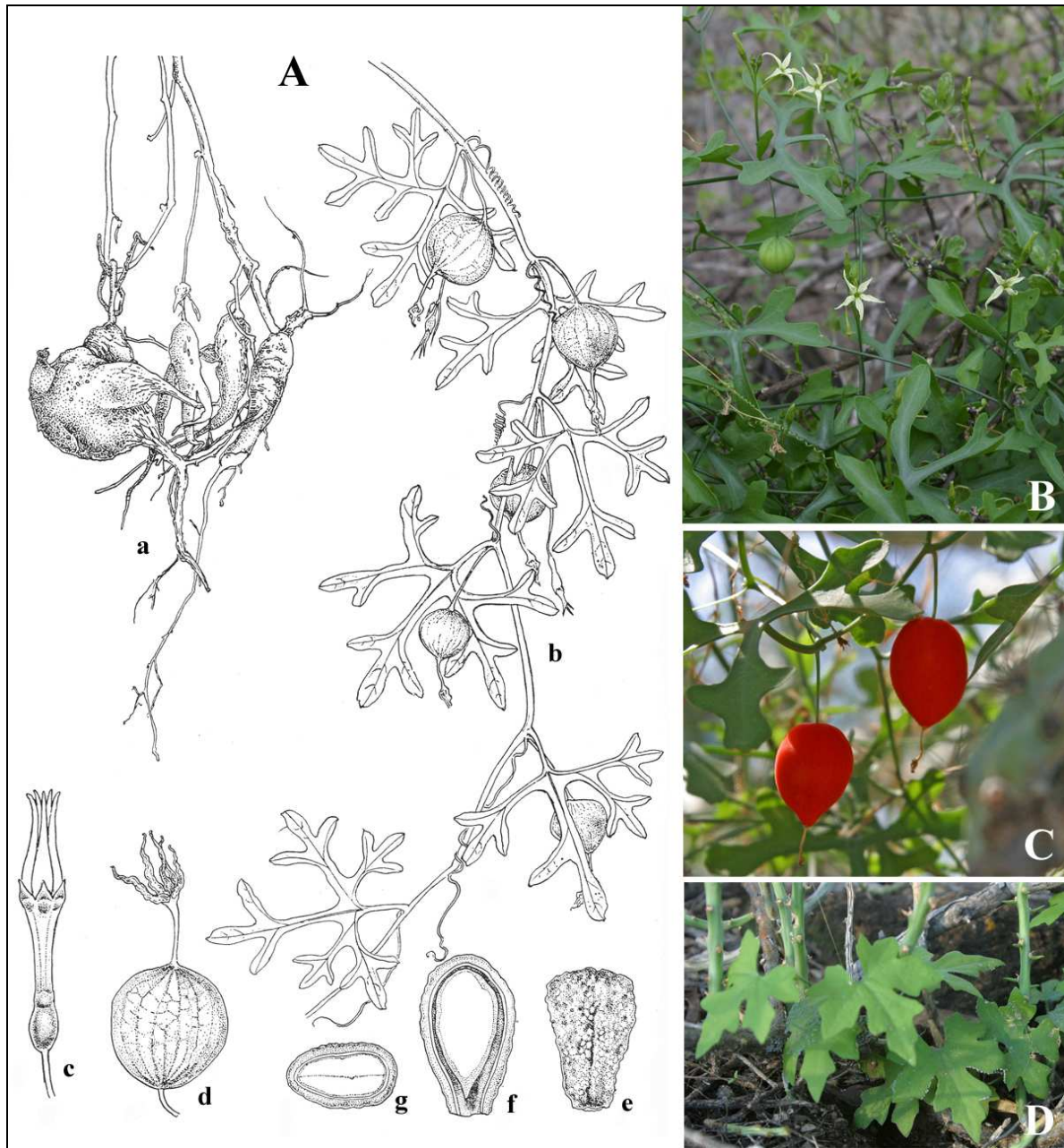


Figure 25. *Tumamoca macdougallii*. (A) Copy of illustration accompanying the original description by Rose (1912: plate 17): “a, Cluster of roots; b, fruiting branch; c, flower; d, fruit with old flower; e, seed; f, longitudinal section of seed; g, cross section of seed.” See text for comments on this illustration. (B) Sabino Canyon, Santa Catalina Mts, Pima Co., 21 Aug 2011. (C) Anklam Road near Tumamoc Hill, Tucson, 25 Aug 2012. (D) Tumamoc Hill, 25 Aug 2012. Photos by Frank Reichenbacher.

Frank Reichenbacher provided the following comments for Figure 25A, which is a copy of the illustration accompanying the original description of *Tumamoca* by Rose (1912):

“This is an excellent illustration but suffers a lack of comparative data available to Rose and the anonymous illustrator. The ‘cluster of roots’ appears to be two separate plants. In the 200+ plants excavated from the Central Arizona Project route (Reichenbacher 1990) none appeared to have roots as fragmented as the one shown in ‘a.’ All of the flowers in this illustration are female. The characteristic male racemes are not shown. The flower bud in the top of the illustration, just above ‘b,’ appears to be shown with subtending bracts, which *T. macdougallii* does not have. The fruit illustrated in ‘d’ was green (not ripe)—when the fruits are ripe, the mottling disappears in favor of a monochromatic red. The illustrator was not given an open flower to draw, so the flower shown in ‘c’ (also a female flower) gives the impression that this is what they look like. In fact the corolla flares widely and the lobes even recurve.”

OP: Dripping Springs, 27 Oct 1951, *Supernaugh 453* (ORPI). E of Dos Lomitas, *Prosopis-Cercidium* wash through *Atriplex* flats, vine growing through *Atriplex polycarpa* along outside of wash, 11 Oct 1988, *Baker 7638* (ASU, ORPI). N of Lukeville, under a mesquite, about one dozen small to large plants, *Rutman 16 Aug 1997* (ORPI). Hwy 85, milepost 71, creosote bush flat, growing up into a creosotebush, 1 mi N of Cherioni Wash, 12 Sep 2004, *Rutman*, photo.

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