



A new and unusual endemic species from the Chihuahuan Desert, Mexico: *Antiphytum geoffreyi* (Boraginaceae, Echiochiloideae)

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Abstract

A new and unusual species of *Antiphytum*, here named *A. geoffreyi*, is described and illustrated. This new species is assigned to the genus *Antiphytum* because it possesses eremocarps directly attached to a pyramidal gynobase, which forms a ventral cicatrix on the eremocarp. However, it is unique within *Antiphytum* in having multiple inflorescence branches arising nearly at the base of the plant, a triangular-pyramidal gynobase, and the proportionally longest eremocarp cicatrix of the genus. Some of these characteristics are reminiscent of *Ogastemma*, the sister genus of *Antiphytum*, making *A. geoffreyi* of potential great significance in the systematics of Boraginaceae subfam. Echiochiloideae. Among species of *Antiphytum*, *A. geoffreyi* is most similar to *A. peninsulare*, with which it shares a triangular-shaped eremocarp, but it differs from this species in possessing an infra-medial cicatrix and a smaller corolla limb diameter. The new species is known from only two collections in Coahuila, Mexico, both made by the Hinton family, who have discovered many new species in their extensive explorations of the country and provided important specimens to the country's flora.

Keywords: endangered species, fruit, gynobase, North America

Introduction

Antiphytum DC. ex Meisner (1840: 280) (Boraginaceae, Echiochiloideae Weigend; see Chacon *et al.* 2016) is an American genus with nine recognised species, following Johnston (1923, 1927) who last revised the genus. *Antiphytum* is characterised by having eremocarps (terminology sensu Hilger 2014; also termed mericarps or nutlets) directly attached to a flat or depressed-pyramidal gynobase, forming a ventral or basal attachment scar on the eremocarp, the scar termed cicatrix by Hilger (2014). Most species are North American, with seven species ranging from the southwestern USA to southern Mexico, but two species are endemic to South America, in Brazil and Uruguay (Johnston 1927).

The most recent species described in the genus is *Antiphytum hintoniorum* Higgins & Turner (1983: 457), which is endemic to gypsum soils in Nuevo Leon, Mexico. This species was discovered by James Hinton and named in honor of the Hinton family, who for three generations have explored the botanical richness of Mexico, leading to the discovery and description of several hundred new species (Hinton & Rzedowski 1972). George B. Hinton, who was the first botanist of the family, concentrated his fieldwork in the states of Guerrero, Michoacan, and Mexico (Rico *et al.* 2008). His son James Hinton collected in the mountains of Nuevo Leon, Coahuila, Michoacan, Guerrero, and Oaxaca (Hinton 2008), and his grandson George S. Hinton has continued the family tradition through his extensive exploration of northern Mexico. Their collections are available at the G. B. Hinton herbarium (GBH).

In this manuscript we describe yet another important taxonomic novelty, *Antiphytum geoffreyi*, collected by George S. Hinton in Coahuila, Mexico. This species represents an important new addition to the flora of the Chihuahuan Desert and, due to its unusual characters, is important for understanding the systematics of the genus and the subfamily. This new species is assigned to the genus *Antiphytum* by having eremocarps directly attached to a pyramidal gynobase, forming a ventral cicatrix on the eremocarp.

Material and Methods

Herbarium specimens (acronyms according to Thiers continuously updated):—The revision of Boraginaceae at GBH revealed two collections of an undescribed species of *Antiphytum* of the state of Coahuila, Mexico. These specimens were collected by George S. Hinton, who provided duplicates as donation to MEXU. Images provided by Hinton from GBH specimens were also studied. To properly describe the characteristic inflorescence of the species, we follow Weberling (1989) and Weigend *et al.* (2016). This terminology is defined as part of the description when necessary.

Fruit observations:—Mature eremocarps and gynobases from specimens of the new species, as well as from the morphologically similar *Antiphytum peninsulare* (Rose) Johnston (1923: 51), and *Ogastemma pusillum* (Coss. & Durieu ex Bonnet & Barrate) Brummit (1982: 680), were observed with a confocal stereo microscope (Leica Z16 APO A, Leica Microsystems GmbH, Wetzlar, Germany), and photographed with a camera (Leica DFC490, Leica Microsystems GmbH) at Laboratorio de Microscopía y Fotografía de la Biodiversidad (II) of Instituto de Biología, Universidad Nacional Autónoma de México (UNAM). Also, SEM photographs were taken (Hitachi SU1510, Hitachi Ltd., Tokyo, Japan) at Laboratorio de Microscopía Electrónica y Fotografía de la Biodiversidad (I). The image files were cleaned in Adobe Photoshop CS5 12.0 (Adobe Systems Incorporated, San Jose, California).

Distribution map:—A distribution map was produced using QGIS Brighton (2.6.1) employing layers from Instituto Nacional de Estadística y Geografía (2017).

Taxonomy

Antiphytum geoffreyi N. Mend. & Flores Oliv., *sp. nov.* (Figs. 1–2).

Type:—MEXICO. Coahuila: Municipality Francisco I. Madero, West side of Sierra de Tlahualilo, 1275 m, 26° 36' 46.8" N, 103° 21' 13" W, 21 April 2015. *Hinton et al.* 29613 (Holotype: GBH!, Isotypes: ANSM, CIIDIR, GBH, MEXU!, TEX).

Diagnosis:—Differs from all other species of the genus by possessing a terminal inflorescence arising at the bottom of each branch rather than from the distal part, by possessing a triangular-pyramidal rather than a deltate-pyramidal or flat gynobase, and by possessing the proportionally longest eremocarp cicatrix in the genus.

Suffruticose perennial, erect (or decumbent?), up to 20 cm tall, covered by strigose and hispid indumenta with a multicellular lithocystic structure, and hyaline glandular-capitate trichomes on branches, leaves, and other leafy organs. **Stems** of numerous branches arising from almost the base of a short main stem, branches alternate or opposite, non-fistulose, slender, with white exfoliating bark on the older parts. **Leaves** cauline and pseudobasal, without a basal rosette, sessile, blades linear-oblong to linear-oblong, margins flat, entire, apices acute, bases truncate connate, surfaces concolorous, veins not visible; cauline leaves opposite, alternate (?) when subtending inflorescences, 8.0–10.0 × 1.0 mm, gradually smaller upward along the stem; pseudobasal leaves at the base of some branches, the newest ones 3.0 × 0.5 mm. **Inflorescence** arising at the bottom of each branch, ending in a flower (monotelic) with alternate paraclades, forming a terminal homocladic determinate thyrse (thyrroid) with dichasial branching, one side a scorpioid cyme and the other side branching many times; first internode of a lateral axis (hypopodium) 4.3–8.2 mm in length; mature scorpioid cymes up to 133 mm in length, many-flowered, bracteate; floral bracts oblanceolate to linear-oblong, sessile, strigose, with glandular capitate-trichomes at margins, veins not visible, blades 6.0–6.5 × 1.7 mm, gradually smaller upward along the cyme. **Flowers** perfect, sessile or subsessile (pedicel ca. 0.7 mm in length); calyx strigose on both surfaces, glandular-capitate and hispid trichomes at margins, accrescent in fruit, divided almost to the base, lobes asymmetric, acute, scarious at the base, three linear-oblong and two oblanceolate, ca. 2.2–3.3 × 0.4–1.2 mm; corolla hypocrateriform (rotate), white, with five papillose faucal appendages of color unknown on the throat opposite to corolla lobes, tube not surpassing the calyx, 1.4–1.5 mm in length, 0.8 mm in diameter at the base, limb 4.7(–5.0) mm in diameter, lobes oriented nearly perpendicular to the tube, imbricate, rounded, sinuate at apex, ca. (2.0–) 2.1–2.4 × (1.9–) 2.0–2.2 mm, abaxially strigose at the middle; stamens inserted, alternate to corolla lobes, adnate at ca. 0.6 mm from the base of the corolla tube; filaments up to 0.4 mm in length, slender; anthers oblong, slightly lanceolate, dorsifixed, ca. 0.6–0.7 × 0.3–0.4(–0.5) mm; ovary with four ovules, style gynobasic, 0.7–0.8 mm in length at anthesis, stigma bilobed to near the apex of the style (subterminal). **Fruit** dry, covered by a persistent calyx, usually with 3–4 developed eremocarps; eremocarps lustrous, triangular and apically acute in ventral view, 1.6–1.7 × 1.3–1.4 mm, dorsally convex, tuberculate and papillate except to the tubercles apex, cicatrix at infra-medial position on the ventral face, triangular, ca. 0.9 mm in length, three keels straight, a ventral (apical) not forming a stipe, and two lateral (basal)



FIGURE 1. Holotype of *Antiphytum geoffreyi* sp. nov. Photo provided by George S. Hinton from the GBH specimen.

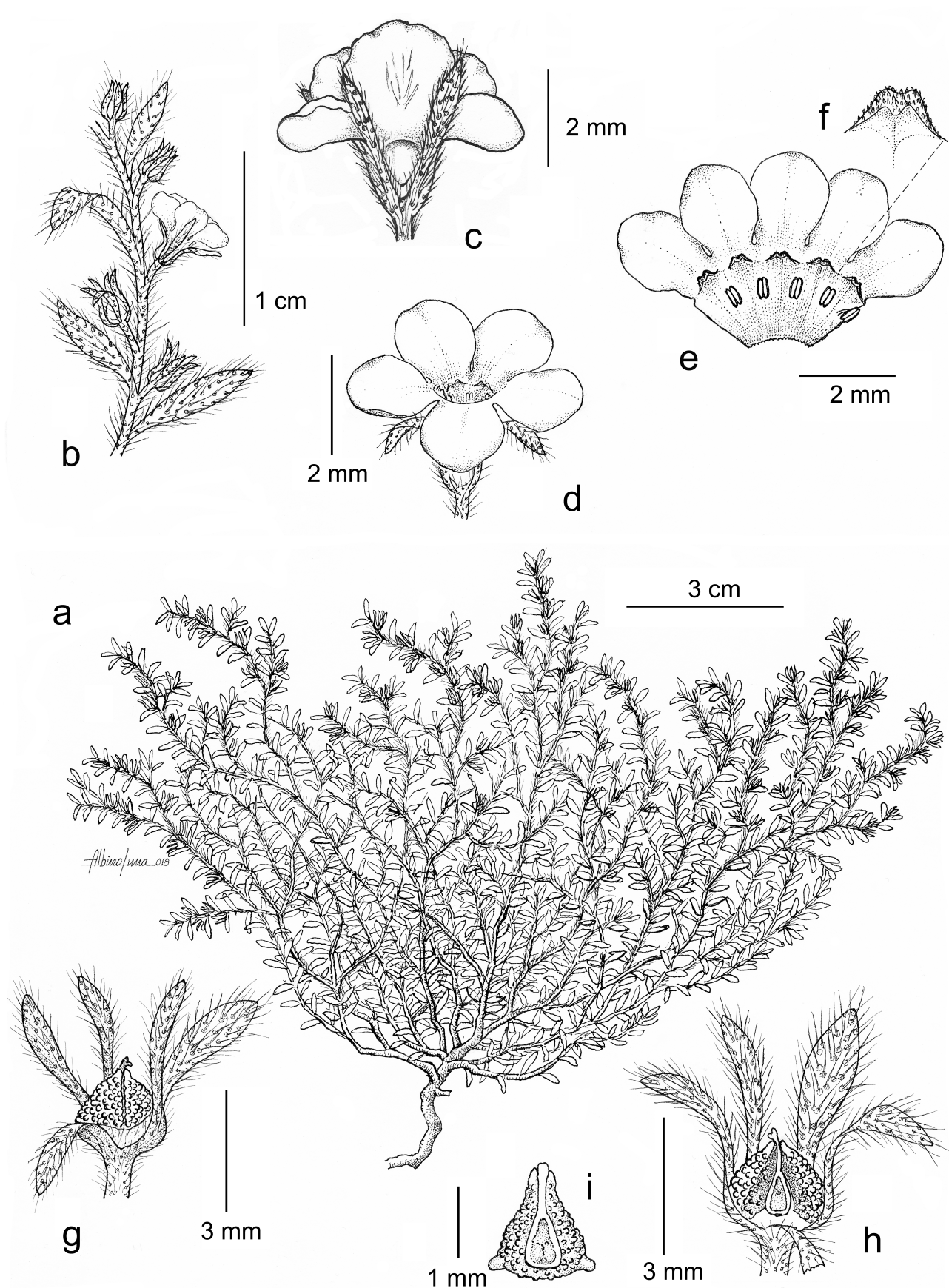


FIGURE 2. *Antiphytum geoffreyi*: a, general appearance, b, fragment of the scorpioid cyme, c, flower in lateral view, d, flower showing the corolla limb, e, open flower, f, detailed of faucal appendage, g, fruit, h, fruit showing the gynobase and eremocarp insertion, i, eremocarp. (Illustration by Albino Luna from *Hinton et al.* 29613 & 29132 in MEXU and GBH).

from the vertices of the eremocarp to the corresponding cicatrix vertices; gynobase triangular-pyramidal, with four areoles corresponding to the cicatrix of each eremocarp, style plus stigmas 1.8 (–1.9) mm, surpassing the eremocarps.

Additional specimens examined (paratypes):—MEXICO. Coahuila: Municipality Parras, South of Parras, 1326 m, 25° 18'15.4" N, 102° 13' 42.5" W, 30 April 2010. *Hinton et al. 29132* (ANSM, CIIDIR, GBH!, MEXU!, TEX).

Additional specimens examined (other species):—*Antiphytum cruciatum* (Chamisso) DC. in Candolle & Candolle (1846: 121). BRASIL. Rio Grande do Sul, Porto Alegre: Belem novo (Hindenburghöhe) near Porto Alegre, November 1926. *Jünger 254* (B!, GH!). Itapoan, Granja Neugebauer p. Itapoan, 11 October 1950. *Rambo 48956* (B!, US!). Sao Sepe, 02 October 1988. *Wasum et al. 4538* (MO!, NY!). URUGUAY. Cerro Largo: Río Negro y Palleros, December 1937. *Rosengurt 2346* (GH!). *Antiphytum floribundum* (Torrey) Gray (1874:55). MEXICO. Coahuila: Municipality Ocampo, Sierra de Hechiceros, vicinity of Rancho El Tule, near Chihuahuan boundary, 17–19 September 1940. *Johnston & Muller 1330* (GH!). *Antiphytum heliotropioides* A. DC. in Candolle & Candolle (1846: 122). MEXICO. Coahuila: Municipality Muzquiz, ca. 130 road km NW of Muzquiz on Coa Hwy 2A (Muzquiz-Boquillas), then SW of 2A on tunnel road to La Encantada basin, Sa. Buenavista of Sa. La Encantada, 1650 m, 28° 34' N, 102° 30' W, 03 June 1992. *Nesom & Mayfield 7421* (MEXU!). Municipality General Cepeda, in upper reaches of Canada el Aguirreno, from 0–1 km W of old Barita mine, ca. 4–5 air km from mouth of canyon, ca. 11 air km SE of Las Coloradas, on NW side of Sierra La Paila; Las Coloradas 1:50 000, 26° 06'15" N, 101° 35' 30" W, 05 April 1990. *Bridges et al. 13074* (MEXU!). Municipality Arteaga, El Chorro, 1800 m, July–August 1942. *Lyonnet 3681* (MEXU!). *Antiphytum peninsulare*. MEXICO. Baja California Sur: Gulf of California, volcanic hillside near north west end of Isla San Marcos, 27° 15' N, 112° 07' W, 28 March 1962. *Wiggins 17328* (MEXU!). Municipality Mulege, N side of river, bottom of sandy/gravelly arroyo, 5 m, 26.8998 N, 111.9762 W, 18 January 2005. *Valov 2005017* (MEXU!). Municipality Mulege, N side of river; bottom of sandy/gravelly arroyo, 5 m, 26° 59.990' N, 111° 58.570' W, 04 February 2004. *Valov 2004046* (HCIB!). Municipality Santa Rosalia, along the wash emptying at Punta El Aterrizaje, just N of airstrip, ca. 5.6 km N of Santa Rosalia, along gravel road turning N from Mex Hwy 1, 5 m, 27° 23.6' N, 112° 18.2' W, 28 February 1995. *Porter & Machen 11056* (HCIB!). Municipality Santa Rosalia, Isla San Marcos, 15 m, 27° 14' N, 112° 06' W, 27 October 1995. *León de la Luz 7736* (HCIB!). *Ogastemma pusillum*. KUWAIT. Wadi Al-Batin, 12 km N Al-Salmi border station with Saudi Arabia, 280 m, 17 April 1990. *Boulos & Cope 17614* (K!). Shu'aib Al-Batin, 25 km E Al-Shagayah, 280 m, 17 April 1990. *Boulos & Cope 17685* (BM!, K!). Medairah halophytes project north of city in National Park, 05 March 1990. *Hepper 8000* (K!). 35 km north-east of Jahra along Jahra-Al Subbiyah road, 29° 36' N, 47° 56' E, 30 March 1995. *Mathew 2633* (K!). SAUDI ARABIA. 27-48 N 47-18 E, 27 February 1970. *Mandaville Jr. 2720* (BM!).

Additional specimens examined (type specimens):—*Antiphytum*. Type: *Anchusa cruciata* Chamisso (1829:438) (designated by Johnston 1923):—BRASIL. Brasilia Meridionalis, *Sellow s/n* (UC <https://plants.jstor.org/stable/10.5555/al.ap.specimen.uc493522>). *Antiphytum peninsulare*. Type:—MEXICO. Baja California Sur, Santa Rosalia, 23 February to 3 March 1889. *Palmer 203* (GH!). *Ogastemma pusillum*. Type:—ALGERIA. Biskra, sur les collines incultes, 10 May 1853, *Balansa 1035* (E <https://plants.jstor.org/stable/10.5555/al.ap.specimen.e00115613>).

Etymology:—The epithet honours Geoffrey Hinton, who accompanied his father George S. Hinton in the discovery of the new species in Sierra Tlahualilo, Coahuila.

Phenology:—Flowers appear at the beginning of April, perhaps earlier, with fruits appearing at the end of April. Whether the species can also flower in the late summer during the rainy season is unknown.

Distribution and habitat:—*Antiphytum geoffreyi* is known from only two collections by George S. Hinton, in disjunct localities in the municipalities of Francisco I. Madero in the Sierra Tlahualilo, and Parras, Coahuila (Fig. 3). It occurs at elevations of 1,275 m and 1,326 m, in a steep rockslide and a rocky outcrop on a gypsum hill. This new species is a gypsovag (signifying that it grows on and off gypsum), as are many other North American species of the genus, such as *A. caespitosum* Johnston (1923: 52), *A. heliotropioides*, *A. parryi* Watson (1883: 122), and *A. peninsulare*. So far as is known, *A. geoffreyi* is endemic to Coahuila and hence represents the third known *Antiphytum* in the state, along with *A. heliotropioides* and *A. floribundum*, the latter only known in Coahuila from one collection (*Johnston & Muller 1330*, GH!) close to the border with Chihuahua.

Conservation status—The new species is known only from two disjunct subpopulations in the state of Coahuila, Mexico (Fig. 3) and the estimated area of occupancy is geographically limited to less than 500 km². According to the IUCN (2012), it meets the criteria under B2ab(iii) for the category of Endangered (EN).

Discussion:—A number of unusual traits characterize *Antiphytum geoffreyi*, most prominently involving the fruit. Fruit characters are useful for the classification and taxonomy of Boraginaceae (Weigend *et al.* 2016). When the eremocarps are released, the part of the fruit that remains on the plant is termed a gynobase (Hilger 2014), which in *Antiphytum* is either flat or depressed-pyramidal (Johnston 1927). Within the genus, the length/width ratio of the

gynobase can be classified as deltate (1:1) to shallowly triangular (1:2) to totally flat (*pers. obs.*). The shape of the gynobase is linked with the eremocarp orientation (Weigend *et al.* 2016), and is therefore also associated with the position and shape of the eremocarp cicatrix. *Antiphytum geoffreyi* possesses a triangular-pyramidal gynobase (2:1; see Table 1), which represents a new gynobase shape for the genus (Fig. 4). The new species also possesses the longest cicatrix, relative to the eremocarp (cicatrix length/ventral eremocarp face length) in the genus (Table 1). The unusual gynobase shape in *A. geoffreyi* is closer to the almost narrowly triangular shape present in the sister taxon of *Antiphytum*, the monotypic *Ogastemma pusillum* (Långstrom & Oxelman 2003, Cohen 2014), which has a relatively long triangular cicatrix (Fig. 4) that extends from the middle to the infrabasal part of the eremocarp (Table 1).

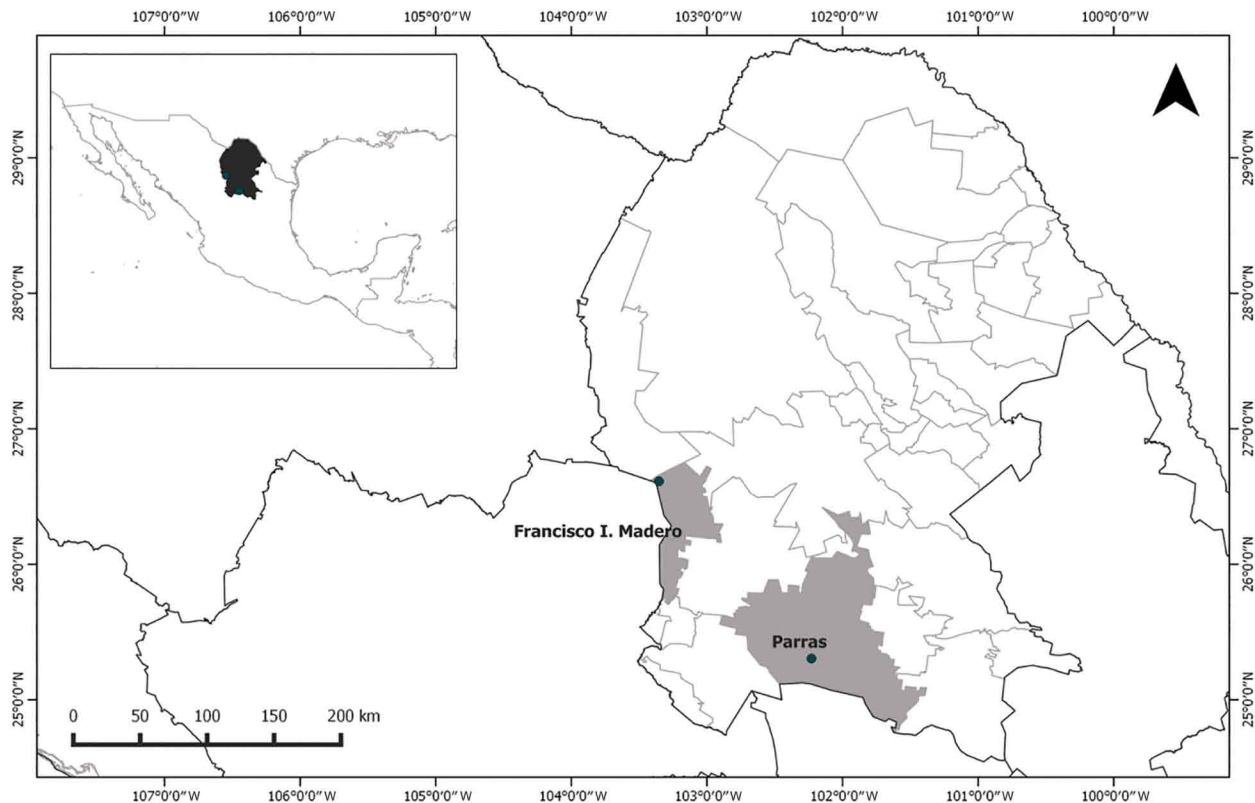


FIGURE 3. Map of the known distribution of *Antiphytum geoffreyi*. The areas shaded in grey indicate the municipalities where specimens have been collected, dots the location of the two individual collections.

The inflorescences of *Antiphytum geoffreyi* are also similar to those of *Ogastemma*. Specifically, *A. geoffreyi* is the only species in the genus with multiple branches bearing inflorescences that arise nearly at the base of the plant, similar to *Ogastemma pusillum*. Despite the similarities of *A. geoffreyi* with *Ogastemma pusillum*, we consider the new species to be part of *Antiphytum* due to shared floral characters, such as the calyx exceeding the corolla in *Ogastemma* compared to the reverse in *Antiphytum*. Other species of *Antiphytum*, such as *A. heliotropioides*, *A. hintoniorum*, and *A. peninsulare*, have principal stems branching multiple times with inflorescences distal from the base. As with *A. geoffreyi*, all of these species lack leaves arranged in basal rosettes. Those species with basal rosettes, such as *A. caespitosum*, have distal inflorescences bearing well-defined unbranching flowering stems.

Within *Antiphytum*, *A. geoffreyi* is most similar to *A. peninsulare*. Both species share white colouration on old branches, the presence of capitate glandular trichomes, a triangular-shaped eremocarp and similar pericarp ornamentation (Fig. 5). Nevertheless, *Antiphytum geoffreyi* differs in several key characters from *A. peninsulare*, including the basal (vs. distal) position of inflorescences, a corolla limb diameter of 4.7–5.0 mm (vs. 10.0–12.0 mm), and an infra-medial (vs. medial) and relatively long eremocarp cicatrix.

The unusual characters of *Antiphytum geoffreyi* and the similarity of some of its characters to *Ogastemma* make it a potentially important species for the systematics of *Antiphytum* and the subfamily Echiochiloideae as a whole. Future molecular phylogenetic studies may elucidate its position in the complex. This distinctive new species is also an important addition to the Chihuahuan Desert flora, a region still in need of exploration as shown by the collections of the Hinton family.

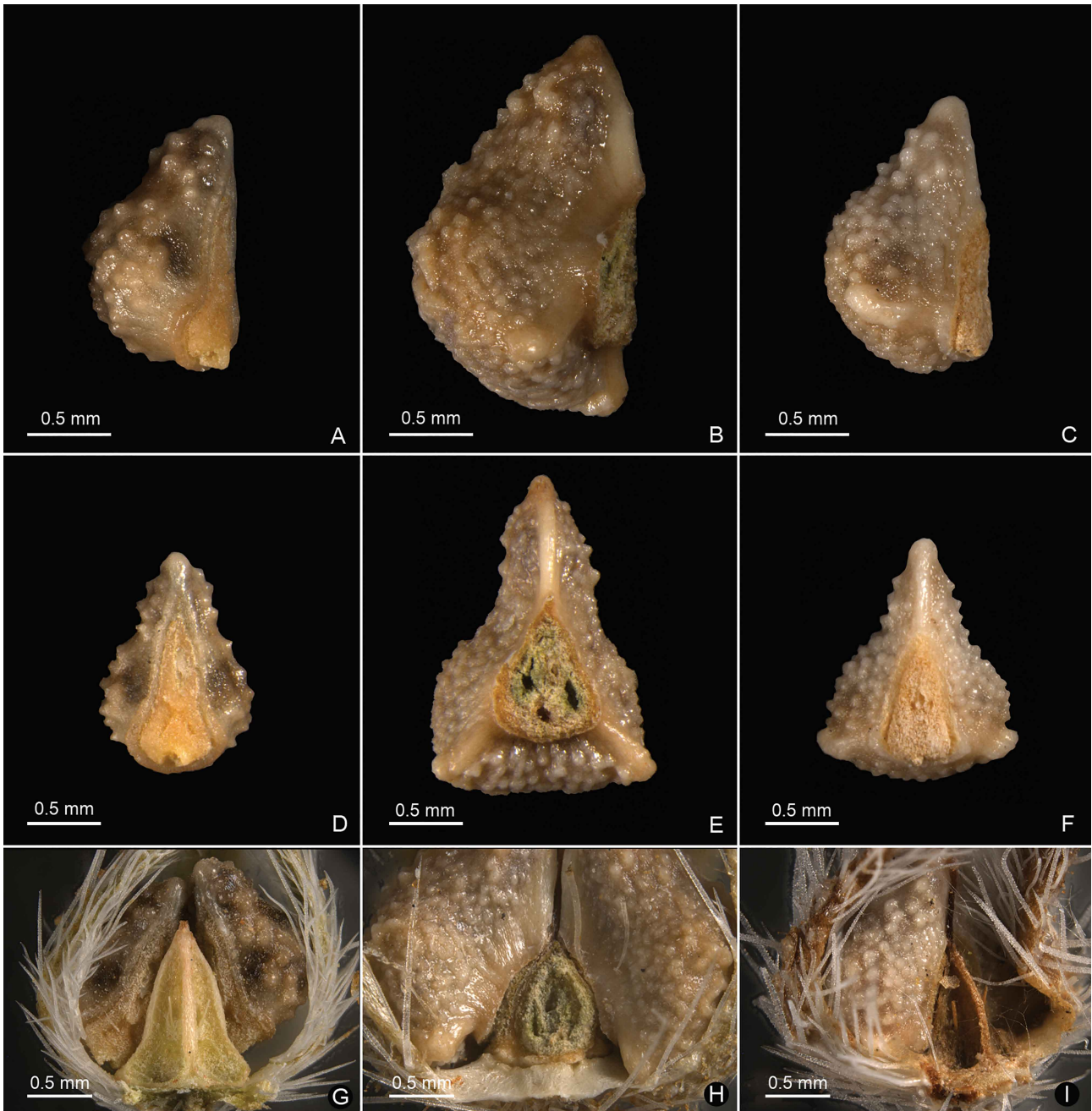


FIGURE 4. Comparison of eremocarps in oblique (A–C) and ventral views (D–F), with their respective gynobases (G–I). A, D & G, *Ogastemma pusillum* (Boulos & Cope 17614, K), B, E & H, *Antiphytum peninsulare* (Wiggins 17328, MEXU), C, F & I, *A. geoffreyi* (Hinton et al. 29613, MEXU).

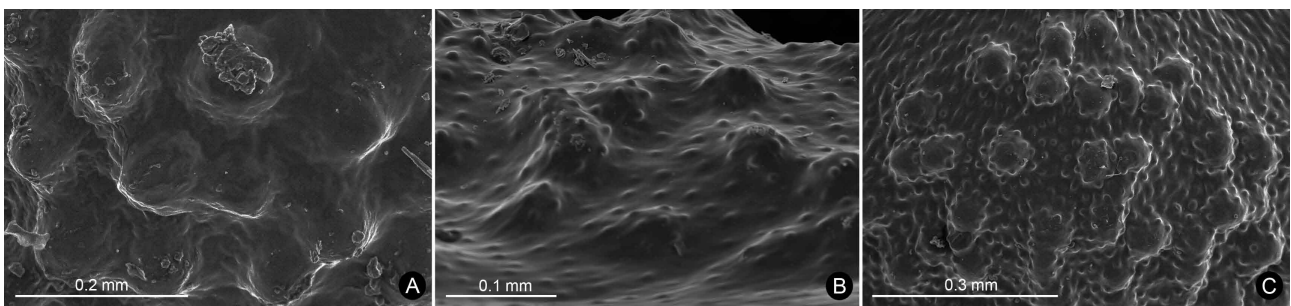


FIGURE 5. Pericarp ornamentation. A, *Ogastemma pusillum* (Boulos & Cope 17614, K), B, *Antiphytum peninsulare* (Wiggins 17328, MEXU), C, *A. geoffreyi* (Hinton et al. 29613, MEXU). Note larger tubercles and smaller papillae in B and C.

TABLE 1. Differences among *Antiphytum geoffreyi* and morphologically similar taxa.

	<i>Antiphytum geoffreyi</i>	<i>A. peninsulare</i>	<i>Ogastemma pusillum</i>
Corolla diameter (mm)	4.7–5.0	10.0–12.0	2.0
Eremocarp cicatrix position	infra-medial	medial	extending from the middle to the infrabasal part
Gynobase (length: width)	triangular (2:1)	deltate (1:1)	almost narrowly triangular (5:2)
Ratio of cicatrix length/eremocarp ventral face length	50%	30–40%	70%

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