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A distinctive new species of *Thelocactus* (Cactaceae) from Oaxaca, Mexico

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Abstract

Thelocactus tepelmemensis, a distinctive new species of Cactaceae from northern Oaxaca, Mexico, is described and illustrated. The new species is closest to *T. leucacanthus* but differs significantly from this and other species in the genus by a combination of morphological characters: smaller, red-purple flowers; stems with ribs consistently vertical; lower number of spines per areole, these being usually shorter; ovoid fruit; and seeds with conjunct micropyle. The new species is found in a narrow canyon growing on steep limestone rock faces protected from direct afternoon sun. The only known population appears to be locally common but geographically restricted.

Keywords: endemic, Oaxaca, Tehuacán-Cuicatlán Biosphere Reserve

Resumen

Se describe e ilustra *Thelocactus tepelmemensis*, una nueva especie de Cactaceae del norte de Oaxaca, México. La nueva especie está cercanamente relacionada a *T. leucacanthus*, pero difiere de ésta y otras especies del género por una combinación de caracteres morfológicos, en particular por tener flores más pequeñas, de color rojo-púrpura; los tallos con costillas consistentemente verticales; el número más bajo de espinas por areola, siendo éstas usualmente más cortas; el fruto ovoideo; y las semillas con el micrópilo conjunto. La nueva especie se localiza en un cañón estrecho creciendo sobre paredes verticales de calizas protegidas del sol vespertino. La única población conocida parece ser relativamente densa, pero restringida geográficamente.

Palabras Clave: endémica, Oaxaca, Reserva de la Biosfera Tehuacán-Cuicatlán

Introduction

In February 2017, during a research trip in northern Oaxaca, Mexico, a distinctive blooming cactus was discovered growing in a very narrow, steep-walled canyon. The plant had a number of characters that in combination resembled members of the genus *Thelocactus* found well to the north of Oaxaca but did not match any of the known species. In January 2018, after securing the appropriate permits, an expedition was organized to further study the population and collect herbarium material. The additional research and herbarium samples confirmed our original suspicion that the cactus is a distinctive new species.

The new taxon, though more than 300 km south of the southernmost known population of the genus, clearly belongs within *Thelocactus*. *Thelocactus* (K. Schumann 1898: 429) Britton & Rose (1922: 251) is a genus of Cactaceae comprising 11–12 species (Anderson 1987, 2001; Mosco & Zanovello 2000; Hunt 2006, 2016). The genus is characterized by having tuberculate stems sometimes with strongly developed ribs, areoles usually developing a short groove, occasionally with extrafloral nectaries, ovary covered with scales, and fruits dehiscing basally with a persistent perianth. Geographically, the genus has been considered almost entirely restricted to the Chihuahuan Desert Region, with *T. hastifer* (Werdermann & Boedeker 1931: 274) Knuth (1935: 360) and *T. leucacanthus* (Zuccarini

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1837: 66) Britton & Rose (1923: 8) having the southernmost distributional limits in the genus (Hernández *et al.* 2004, Hernández & Gómez-Hinostrosa 2011).

Here we describe and illustrate this distinctive new member of *Thelocactus*, detail natural history and population information, and briefly discuss its taxonomic relationships.

Materials and Methods

Morphological data were gathered at the type locality from 20 individuals and complemented with observations of herbarium specimens deposited at MEXU (Thiers 2017) under a stereomicroscope. Seeds were cleaned with an ultrasonic cleaner (Branson 200), gold-coated, observed with a scanning electron microscope (Hitachi, model SU1510) at the Instituto de Biología, UNAM, and measured with the ImageJ image-processing program (https://imagej.nih.gov/ij). The conservation status of the species was assessed under the Red List criteria of the International Union for Conservation of Nature (IUCN 2017).

Description

Thelocactus tepelmemensis T.J. Davis, H.M. Hern., G.D. Starr, and Gómez-Hin., *sp. nov*.

Diagnosis:—Similar to *Thelocactus leucacanthus*, but differing in having a lower number of spines per areole, these being poorly differentiated into radials and centrals (vs. more and readily differentiated spines); by the much smaller, red-purple flowers (vs. larger yellow or magenta flowers); and, the conjunct seed micropyle lying inside the hilum border (vs. disjunct micropyle lying outside border).

Type:—MEXICO. Oaxaca, municipality Tepelmeme, 17 January 2018 (fl., fr.), *H.M. Hernández et al. 4128* (holotype: MEXU 1471315!; isotypes: DES!, MEXU 1471316!). (Figures 1–3)

Stems solitary or caespitose with up to 11 (rarely more) lateral stems, usually erect, depressed-globose, globose to cylindrical, glabrous, to 14(–30.5) cm tall, 10.5 cm diam., green, not obscured by the spines. **Ribs** (11–)13, tuberculate, vertical, rounded apically. **Areoles** circular to elliptic, usually developing a rectangular or triangular groove at the proximal side, 3–4 mm diam. in the widest portion, 5–8(–10) mm long including the groove, 15–20(–25) mm apart, with white or tan wool; 2–3 small glands rarely present proximally in flowering areoles. **Spines** acicular, (6–)8–9 per areole, poorly differentiated, radiating but usually with one spine centrally located, diffuse to erect, straight, rounded in cross section, rigid, moderately piercing at touch, reddish or tan with reddish tips when young, becoming grey with age, of unequal length, 1–2.6(–4.2) cm long, 0.47–0.84(–1.1) mm diam. at base. **Flowers** arising from the stem apex at the proximal portion of the areoles of young tubercles, infundibuliform, diurnal, 1.3–2.3 cm long at anthesis; pericarp covered with scales, greenish or reddish; scales deltoid or widely ovate, truncate or sub-auriculate at base, fimbriate at margin, apiculate, 0.5–1 mm long, white with reddish or pinkish centers. **Perianth segments** membranous, red-purple with pink or white margins; external segments ovate-lanceolate becoming lanceolate towards the flower apex, fimbriate at margin, acute or apiculate apically, 4–9 mm long × 2–3 mm wide; internal segments lanceolate, entire at margin, acute or apiculate apically, 10–11 mm long × 2–3 mm wide. **Stamens** numerous, erect; filaments white, of unequal length, 3–5 mm long, variably inserted near to well-above the nectary, with the lower filaments arising ca. 3 mm above the base of the tube; anthers yellow; ovary obovate, truncate apically, ca. 2 mm long × 1.8 mm wide; style greenish-white, cylindric, 7–9 mm long × 0.7 mm wide; stigma lobate, with 6 radiating 0.5–0.6 mm long lobes. **Fruits** ovoid, scaly, red-purple at maturity, with the perianth persistent, non-fleshy, to 1 × 0.5 cm. **Seeds** broadly oval, medium-sized, 1.06–1.21 mm long × 0.78–1 mm wide, semi-matt, black-brown, periphery keeled; border expanded around hilum; cells polygonal, gradually smaller towards hilum, isodiametric, anticlinal boundaries raised, straight; microrelief finely verrucose; hilum large, basal, impressed, micropyle conjunct lying inside the hilum border, hilum-micropyle region oval.

Etymology:—The specific name refers to the community of Tepelmeme Villa de Morelos in whose territory the new species is currently known. The suggested English (Tepelmeme cliff cactus) and Spanish (Biznaga de acantilado de Tepelmeme) names refer to the species' cliff habitat and the community of Tepelmeme Villa de Morelos.

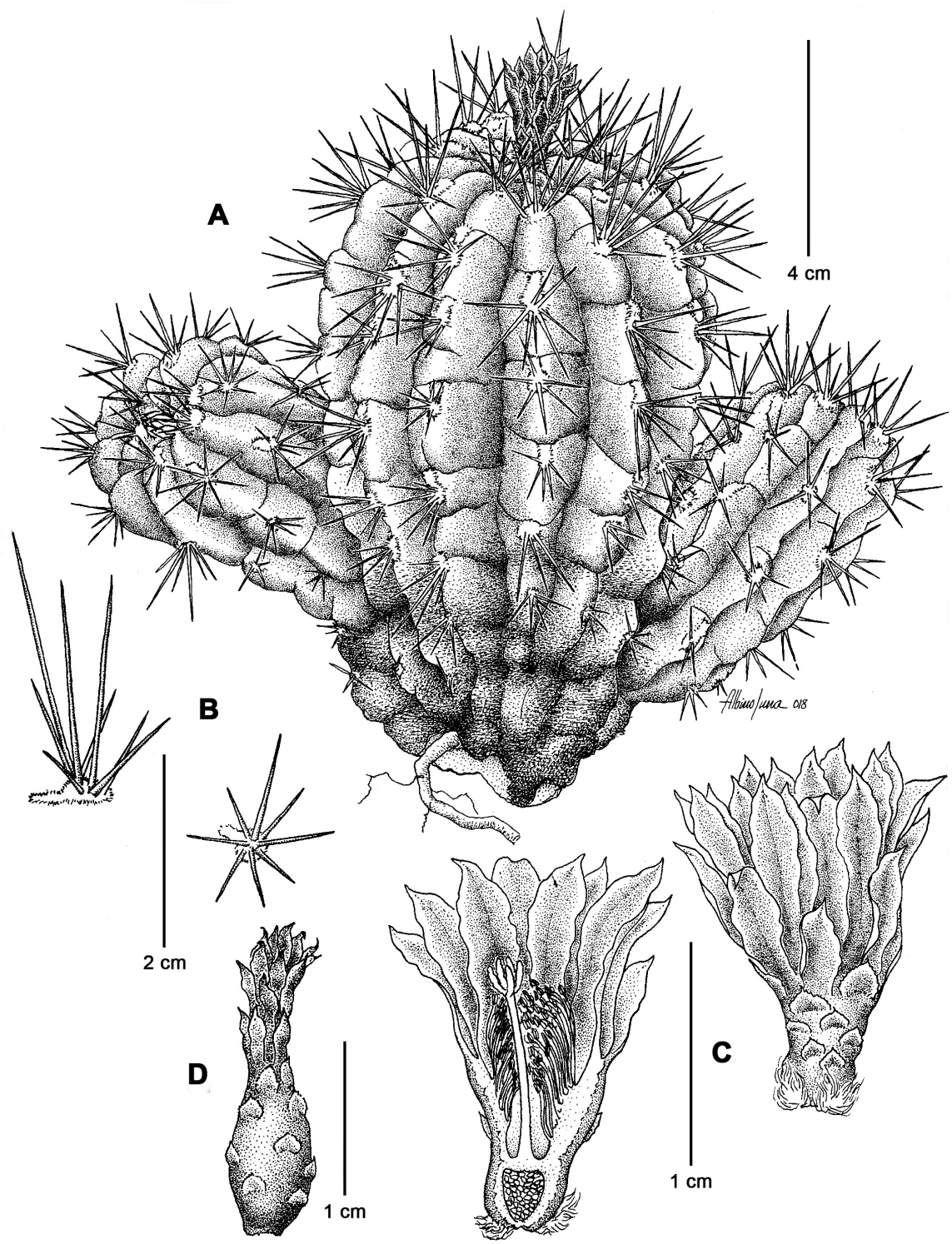

FIGURE 1. *Thelocactus tepelmemensis.* **A**. Stem with flower. **B**. Areoles. **C**. Flower (lateral view and dissected). **D**. Fruit. Voucher: *H.M. Hernández et al. 4128* (MEXU). Drawn by Albino Luna.

Distribution:—Currently, *T. tepelmemensis* is known to occur only within a single narrow river canyon in northern Oaxaca, Mexico. Details of the precise location are being withheld to protect the population from illegal activities. The species should be looked for in similar nearby canyons where the specific habitat and exposure are present.

Habitat and Plant Associations:—*Thelocactus tepelmemensis* was found exclusively on exposed vertical limestone rock in a narrow river gorge in open xerophytic scrub; the limestone had many cracks and small ledges from which the cactus could grow (Figure 2B). Smoother, presumably younger portions of the limestone cliffs in the area did not appear to support populations of the cactus.

FIGURE 2. *Thelocactus tepelmemensis* (body, flower, and fruit) and its habitat. **A**. Caespitose individual with several lateral stems (Type). **B**. Vertical limestone wall with several individuals. **C**. External aspect of a flower (above); dissected flower showing the internal perianth segments, the stamens, and the gynoecium (middle); and, semi-mature fruit with persistent perianth (below). Voucher: *H.M. Hernández et al. 4128* (MEXU).

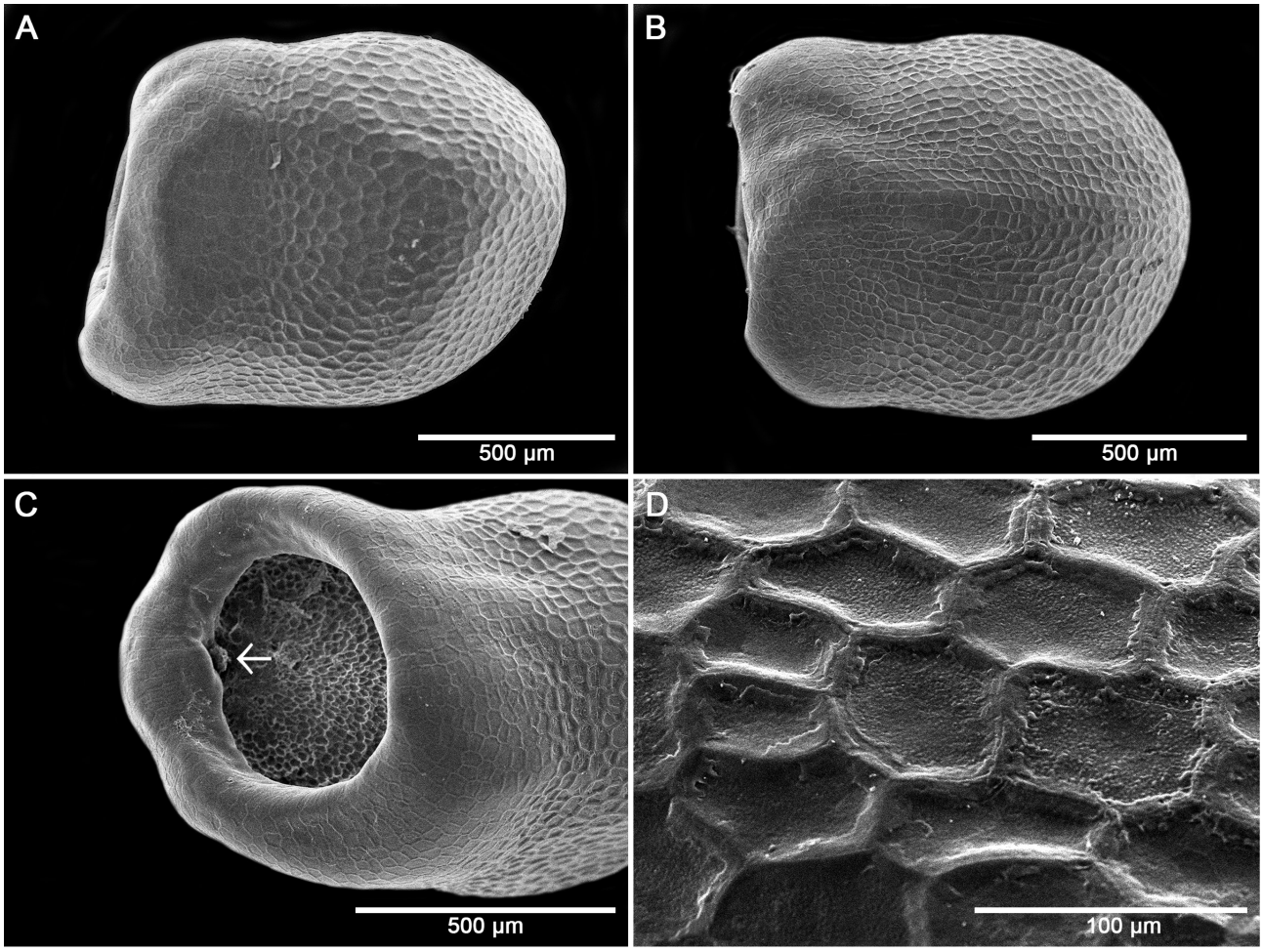

FIGURE 3. Scanning Electron Microscope (SEM) micrographs of *Thelocactus tepelmemensis* seeds. **A**. Lateral view. **B**. Dorsal view showing the keel. **C**. View of the hilum-micropyle region (the arrow indicates the position of the micropyle). **D**. Detail showing cell shape and microrelief. Voucher: *H.M. Hernández et al. 4128* (MEXU).

Additionally, *T. tepelmemensis* was located almost entirely on east-facing slopes with fewer on northeast and southeast exposed slopes. Seemingly perfect habitat oriented in other directions showed no signs of the new species; this habitat restriction implies that the species cannot tolerate strong sun exposures and only thrives in places where morning sun with some significant shading during the hottest part of each day is available.

Because they were typically located in cracks and on/near small ledges in the cliff face (Figure 2B), plants often had accumulated leaf and other vegetative matter in spines and along bases, especially in clumping specimens. In several instances, multiple separate plants were concentrated on ledges or significant gaps where seeds could accumulate.

The plant was recorded from 1420 m to 1460 m elevation in dry xerophytic scrub. Associated plants on the slopes included: *Agave titanota* Gentry (1982: 176) (Asparagaceae); *Hechtia* spp*., Tillandsia* spp. (Bromeliaceae); *Bursera* spp. (Burseraceae); *Cephalocereus columna-trajani* (Karwinsky in Pfeiffer 1837: 76) K. Schumann (1897: 198), *Opuntia pubescens* H.L. Wendland in Pfeiffer (1837: 149), *Opuntia decumbens* Salm-Dyck (1834: 361)*, Escontria chiotilla* (F.A.C. Weber in Schumann 1897: 83) Rose (1906: 126), *Mammillaria carnea* Zuccarini in Pfeiffer (1837: 19), *Mammillaria albilanata* Backeberg (1939: 47), *Mammillaria viperina* J.A. Purpus (1912: 148), *Pilosocereus chrysacanthus* (F.A.C. Weber in Schumann 1897: 178) Byles & G.D. Rowley (1957: 66), *Stenocereus* sp. (Cactaceae); *Sedum* sp. (Crassulaceae); *Cnidoscolus multilobus* (Pax in Engler 1910: 107) I.M. Johnston (1923: 86) (Euphorbiaceae); *Acacia* spp. (Fabaceae); *Fouquieria purpusii* Brandegee (1909: 386) (Fouquieriaceae); and, *Selaginella lepidophylla* (Hooker & Greville 1830: 162) Spring (1840: 126) (Selaginellaceae).

Phenology:—Primary flowering seems to occur from December through February, which is the dry season in the area. Flowering was recorded January 17, 2018 with most plants with at least one flower open and all but a few with at least developing flower buds. At that time, few plants had spent flowers from the current season. The species was also

recorded blooming February 6–8, 2017; however, most flowering seemed done at that time with most plants showing spent flower remains, few developing flower buds, and limited evidence of mature fruits. Plants as small as 4 cm diam. showed developing buds or spent flowers. A small iridescent hymenopteran was seen emerging from a mature flower in February 2017. Several immature fruits and one mature fruit were preserved in January 2018; only one mature fruit was noted in February 2017 but not preserved. Seed set probably occurs most commonly in March through May, which is the start of the rainy season in the area. Local inhabitants indicate flowering and fruiting occurred throughout the year.

Discussion

The genus *Thelocactus* has been considered essentially endemic to the Chihuahuan Desert Region (Hernández & Gómez-Hinostrosa 2011). Most of the species occur between the Sierra Madre Occidental and the Sierra Madre Oriental and extend from the Big Bend area of Texas (30º12'14" N lat.) to Guanajuato, Querétaro, and Hidalgo, Mexico (20º26' N lat.). The only exceptions to this pattern are *T. setispinus* (Engelmann 1845: 246) E.F. Anderson (1987: 59) and some populations of *T. bicolor* (Galeotti in Pfeiffer 1848: t. 25) Britton & Rose (1922: 251), which are found in the Tamaulipan thorn scrub of Nuevo León, Tamaulipas, and Texas, east of the Sierra Madre Oriental.

The discovery of *T. tepelmemensis* in the Oaxacan portion of the Tehuacán-Cuicatlán Valley extends the distribution limit of the genus to the south by more than 300 km. This distribution pattern is not entirely surprising because some cactus genera with their centers of distribution in the Chihuahuan Desert, or with a high species representation in the dry regions of northern Mexico (for example, *Coryphantha*, *Echinocactus*, *Echinocereus*, *Ferocactus,* and *Stenocactus*), have their southern distribution limit in Oaxaca, especially in the northwestern portion of the state. Hernández *et al.* (2004) have suggested that Oaxaca's rich cactus diversity is partly the result of genera that originated in the Chihuahuan Desert and expanded to the south. This hypothesis is supported by the fact that there is a relatively high similarity in cactus species composition between northwestern Oaxaca and the disjunct Meridional sub-region of the Chihuahuan Desert, which corresponds to the semi-arid areas of Guanajuato, Querétaro, and Hidalgo (Hernández *et al.* 2004).

Comparison with other Taxa:—Within *Thelocactus*, *T. tepelmemensis* appears to be morphologically closest to *T. leucacanthus* (Table 1). The two species have clustering stems with vertical tuberculate ribs (often spiral in *T. leucacanthus*), areoles with extrafloral nectaries (these apparently only in areoles producing contemporary flowers in *T. tepelmemensis*), and flowers with fimbriate external perianth segments. In addition, the seeds of both species are extremely similar (Figure 3), although those of *T. leucacanthus* are larger and have an external micropyle (Mosco 2004). However, the two species are easily distinguished by geographical distribution, flower length and color, fruit shape, number of spines per areole, and length and differentiation of spines (Table 1).

Conservation and Population Status:—The new species seems to be restricted to very steep limestone slopes in a relatively inaccessible canyon. Additionally, the locality is within the Tehuacán-Cuicatlán Biosphere Reserve that requires special permission to access from local communities; these communities are extremely vigilant to trespassers so help enforce the protection of the known population of the new cactus.

We attempted to determine general population density of the species; however, because of the species' predilection for mostly inaccessible cliff slopes, only visual estimates of population density were possible.

To assess a general size of the population, we counted all plants visible from a trail that traversed the bottom part of the canyon from 1420 m to 1460 m; above 1460 m along the trail, appropriate habitat was not visible, though potentially suitable habitat could be seen across the canyon. Because of obstructed views (rocks, vegetation, etc.), plants were typically only visible vertically within about 15–20 m of the trail. Along the trail, there were only two main sections that had viewable plants: one section was ca. 50 m long, the other ca. 30 m long. Within the first section, *T. tepelmemensis* was common and concentrated in the proper habitat (bare, crumbling, steep limestone); a total of 35 plants were counted within this stretch of the trail. Within the second section, *T. tepelmemensis* was less common, perhaps because of less vegetation cover and farther distance from the trail (thus inhibiting closer inspection); a total of 15 plants were counted within that stretch of the trail. Counts along the first section included plants of many sizes including small (< 4 cm diam.) seedlings and imply active population recruitment.

An analysis of satellite images of the area suggests there are few other small canyons in the general area that may also meet the specific habitat and orientation components that *T. tepelmemensis* apparently requires. Extrapolating from these images, the potential population of this species may be three or four times the size we encountered at the type locality.

Based upon this rough assessment, *T. tepelmemensis* seems to occur at a relatively high density within its preferred habitat, and we suspect that additional pockets of suitable habitat exist both in other areas within the same canyon as well as in adjacent unexplored canyons. Nonetheless, *T. tepelmemensis* has an extremely limited known distribution, a potentially geographically-restricted range, and small known population size; these data, combined with the difficulty of collecting population size and stability data within its habitat, suggest that the species should be tentatively considered Vulnerable (IUCN 2017). The need to conduct a formal assessment of this taxon is urgent despite its occurrence within a protected area.

TABLE 1. Comparative morphological characters of *Thelocatus tepelmemensis* and *T. leucacanthus*.

	T. tepelmemensis	*T. leucacanthus**
Geographic distribution	Oaxaca	Guanajuato, Querétaro, Hidalgo
Stem	Single or clustering	Usually clustering
Rib number	(11–)13	7–14
Rib orientation	Vertical	Vertical to spiral
Areoles with extrafloral nectaries	Flowering areoles only	Yes
Spines per areole	8–9	6–21
Spine length (mm)	10–26(–42)	5–50
Spine differentiation (radials and centrals)	Poorly differentiated	Readily differentiated
Flower length at anthesis (mm)	13–23	25–52
Flower external perianth segments	Fimbriate	Fimbriate
Flower dominant color	Red-purple	Yellow (subsp. *leucacanthus*) Magenta (subsp. *schmollii*)
Fruit size (mm)	10 × 5	6–9 × 6–8
Seed size and shape	Broadly oval, 1.06–1.21 mm × 0.78–1 mm, keeled	Broadly oval, 1.6–2 mm × 1.3–1.4 mm, keeled
Seed border	Expanded around hilum	Expanded around hilum
Seed cells	Polygonal, isodiametric, anticlinal boundaries raised, microrelief finely verrucose	Polygonal, isodiametric, anticlinal boundaries raised, microrelief verrucose
Seed hilum-micropyle configuration	Hilum basal, micropyle conjunct lying inside the hilum border, hilum-micropyle region oval	Hilum basal, micropyle lying outside the hilum border (disjunct), hilum-micropyle region oval

* Data taken from Anderson (1987) and from Mosco (2004)

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