



Acta Botanica
Mexicana

A new species of *Cochemiea* (Cactaceae, Cacteae) from Sinaloa, Mexico

Una nueva especie de *Cochemiea* (Cactaceae, Cacteae) de Sinaloa, México

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Abstract:

Background and Aims: *Cochemiea* is a genus which currently comprises five species occurring in Mexico. It is morphologically characterized by cylindrical decumbent to prostrate stems and by a long red-scarlet zygomorphic perianth, presumably specialized for hummingbird pollination. As part of the ongoing taxonomic studies on the North Mexican flora, a population discovered by Thomas Linzen in 2012 in central Sinaloa (Mexico), previously identified as *Mammillaria* sp., actually refers to a *Cochemiea* species and cannot be ascribed to any of the known species of that genus. As a consequence, we here propose to describe this population as a new species for science.

Methods: The work is based on field surveys (autumn 2018 and spring 2019) in central Sinaloa, examination of herbarium specimens, and analysis of relevant literature. Its conservation status was assessed following the guidelines of the IUCN; AOO and EOO were calculated with the program GeoCAT.

Key results: *Cochemiea thomasii* is described and illustrated from Sinaloa. The new species is morphologically similar to *C. halei* from which it differs by the hanging stems, the larger conical tubercles, less numerous and shorter central spines, and the ovoid fruits. A diagnostic key of the known *Cochemiea* species is included.

Conclusions: *Cochemiea thomasii* is endemic to the state of Sinaloa where it occupies a small area. On the basis of the criteria B2a (geographic range) and C (small population) of IUCN, the new species can be assessed as Critically Endangered (CR) or Vulnerable (VU). Adopting the precautionary approach, *Cochemiea thomasii* is considered as Critically Endangered (CR).

Key words: *Cochemiea halei*, *Cochemiea thomasii*, endemic, Sierra Madre Occidental.

Resumen:

Antecedentes y Objetivos: *Cochemiea* es un género que actualmente comprende cinco especies que se encuentran en México, y se caracteriza morfológicamente por sus tallos decumbentes cilíndricos o postrados y por su largo perianto zigomorfo rojo escarlata presumiblemente especializado para la polinización por colibríes. Como parte de los estudios taxonómicos en curso sobre la flora del norte de México proponemos como nueva especie una población descubierta por Thomas Linzen en 2012 en el centro de Sinaloa (México), previamente identificada como *Mammillaria* sp., se trata de una especie de *Cochemiea* que no concuerda con ninguna especie conocida del género, la cual proponemos como nueva especie para la ciencia.

Métodos: Este trabajo se basa en estudios de campo (otoño 2018 y primavera 2019) en el centro de Sinaloa, la revisión de ejemplares de herbario y de literatura relevante. Se evaluó su estatus de conservación siguiendo los lineamientos propuestos por la IUCN; AOO y EOO fueron calculados usando el programa GeoCAT.

Resultados clave: *Cochemiea thomasii* es descrita e ilustrada de Sinaloa. Esta nueva especie es morfológicamente similar a *C. halei*, de la cual difiere por sus tallos colgantes, los tubérculos cónicos más grandes, las espinas radiales menos numerosas y más cortas, y los frutos ovoides. Se incluye una clave diagnóstica de las especies conocidas de *Cochemiea*.

Conclusiones: *Cochemiea thomasii* es endémica del estado de Sinaloa donde vive en un área reducida. Con base en los criterios B2a (distribución geográfica) y C (población pequeña) de la IUCN, esta especie se evalúa como En Peligro Crítico (CR) o Vulnerable (VU). Adoptando el principio de precaución, *Cochemiea thomasii* es considerada en Peligro Crítico (CR).

Palabras clave: *Cochemiea halei*, *Cochemiea thomasii*, endémico, Sierra Madre Occidental.

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Received: October 17, 2019.

Reviewed: November 14, 2019.

Accepted by Marie-Stéphanie Samain: January 31, 2020.

Published Online first: February 18, 2020.

Published: Acta Botanica Mexicana 127 (2020).



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To cite as: García Morales, L. J., R. González González, J. García Jiménez and D. Iamónico. 2020. A new species of *Cochemiea* (Cactaceae, Cacteae) from Sinaloa, Mexico. Acta Botanica Mexicana 127: e1626. DOI: 10.21829/abm127.2020.1626.

e-ISSN: 2448-7589

Introduction

Cochemiea (K. Brandegees) Walton (Cactaceae Juss., Cactaceae Rchb.) is a small genus of five currently accepted species that occur in Mexico (e.g., Vázquez-Sánchez et al., 2013; Hind, 2018). This genus is morphologically characterized by cylindrical decumbent to prostrate stems and by a long red-scarlet zygomorphic perianth, presumably specialized for hummingbird pollination (Anderson, 2001).

Although *Cochemiea* was originally proposed at subgenus level of *Mammillaria* Haw. by Brandegees (1897), recent molecular data (Butterworth and Wallace, 2004; Hernández-Hernández et al., 2011; Vázquez-Sánchez et al., 2013) supported the proposal by Walton (1899) to consider this taxon at generic level. Many authors subsequently accepted this treatment (e.g., Britton and Rose, 1923; Backeberg and Knuth, 1935; Backeberg, 1966; Bravo-Hollis and Sánchez-Mejorada, 1991; Barthlott and Hunt, 1993; Guzmán et al., 1993), whereas other botanists (e.g., Schumann, 1899; Hunt, 1971, 1987, 2006; Lüthy, 1995; Hernández and Gómez-Hinostroza, 2015) still recognized *Cochemiea* within *Mammillaria*.

As part of the ongoing taxonomic studies in Mexican territory (e.g., García-Morales et al., 2014a, 2014b, 2019a, 2019b), we realized that a population discovered by Thomas Linzen in 2012 in central Sinaloa, which was identified as *Mammillaria* sp., actually refers to a *Cochemiea* species. The plants cannot be morphologically ascribed to any of the known species of the genus, and we here propose to describe this population as a new species for science, including a diagnostic key of the known species of *Cochemiea*.

Material and Methods

The work is based on both field surveys carried out in autumn 2018 and spring 2019 at the locality previously visited by Thomas Linzen in Sinaloa, Mexico, examination of specimens deposited at GBH, HFLA, ITCV, MEXU, NY, and UC (acronyms according to Thiers, 2020+), and analysis of relevant literature (Brandegees, 1897; Walton, 1899; Bravo-Hollis and Sánchez-Mejorada, 1991; Anderson, 2001). Plants (both live and exsiccata) were examined using a stereomicroscope (Carl Zeiss Stemi DV4, Göttingen, Germany), whereas seeds were studied using a scanning elec-

tron microscope (SEM Phillips XL30 ESEM at 20 kV, Eindhoven, Netherlands). Spines and seeds were coated with gold before SEM observation. Its conservation status was assessed following the guidelines of IUCN (2014). The Area of Occupancy (AOO) and Extent of Occurrence (EOO) were calculated based on the known collections of the new species by using the program GeoCAT (Bachman and Moat, 2012). Coordinates are not included because of conservation risks.

Results

Cochemiea thomasii García-Mor., Rodr. González, J. García-Jim. & Iamónico, sp. nov. Fig. 1.

TYPE: MEXICO. Sinaloa, municipality Cosalá, North Cosalá, 300 m, low deciduous Tropical Forest, 15.III.2019, L. García-Morales and T. Linzen 6226 (holotype: ITCV!, isotypes: CIDIIR!, GBH!, HFLA!, IEB!).

Diagnosis: *Cochemiea thomasii* differs from *C. halei* (Brandegees) Walton by the hanging stems, the larger conical tubercles, less numerous and shorter radial spines, less numerous and shorter central spines, the ovoid fruits and the isolated continental distribution.

Body slender cylindrical, stems pendulous, sprouting from the base and later also from the body sides, rarely sprouting from the apices or nearly so when damaged, shoots erect at first, later on the soil or hanging, 3.5-5 cm diameter, up to 60 cm long or longer, older body parts with corky texture partly without spines, with watery juice; roots fibrous, spreading, tubercles conical, rounded at the apex, areolar groove absent, slightly tapered at the base, the sides somewhat less rounded, the areole tip slightly upwards, 11-13 mm wide and high, 9-10 mm long, green colored; areoles rounded, in young plants 2-3 mm diameter, with white wool, later naked; axils between the young tubercles, from which the flowers develop, with white wool dots, later naked; radial spines 10-15, relatively uniform, radially and horizontally radiating, stiffly acicular, white, partly with a short brown tip, 7-9 mm long; central spines 1(-2)-(3-)4, if 4 then nearly cross-shaped, or

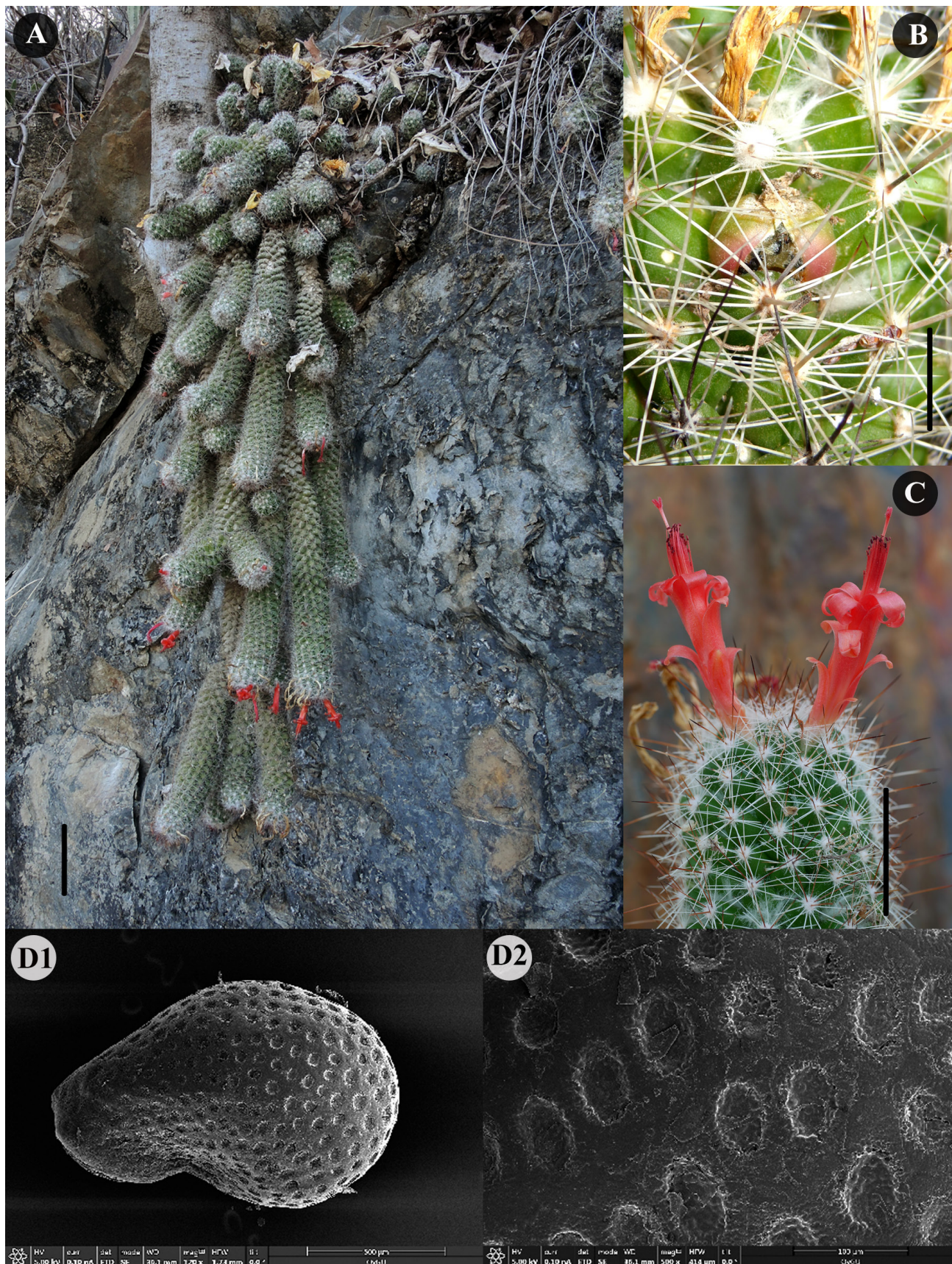


Figure 1: *Cochemiea thomasii* García-Mor., Rodr. González, J. García-Jim. & Iamónico. A. Plant (scale bar=10 cm); B. spines (scale bar=1 cm); C. flowers (scale bar=1 cm); D1. seed; D2. seed surface magnified (photos A-C by T. Linzen).

when 3, two pointing toward the apex and one deflected, this last being slightly longer, stiff needle-like, slightly thicker than the radial spines, 7-13 mm long, whitish, brown to black, darkening to apex, later gray, all straight; radial spines 10-15, acicular, slender, white with reddish tips, radiate around the areole, 5-10 mm long; flowers zygomorph-tubular, close to the apex, 30-42 × 12-15 mm at the apex, more or less apically campanulate, all flower parts scarlet red; sepals in three series, the upper lanceolate, 6-8, 20-25 × 5-7 mm, apex entire, irregularly rounded, incurved outwards; the middle segments 4-6, located at middle of the tube, 4-12 × 4-5 mm, incurved apically outwards, the lower segments squamiform, 2-5 mm long and wide, appressed to the tube; filaments 40-60, 25-32 mm long, scarlet red, protruding over the upper sepals and these in turn clearly surpassed by the pistil, anthers 1 mm long, 0.4 mm wide, dark red; stigma pale pink, pistil 28-38 long, 0.5 mm wide, stigma lobes lanceolate-oblong, 5-6, 1.0 mm × 0.4 mm, fimbriate, glutinose, scarlet red; ovary ovoid, 2.5-3 mm diameter, ovary walls 0.8-1 mm thick; fruit ovoid, dehiscent by a lateral slit, initially green, later reddish-brownish, juicy, 7-9 × 6-8 mm, dried perianth segments sometimes remaining attached; seed pear-shaped, 1.3 × 0.8 mm, 0.65 mm thick, black; hylum micropylar region subbasal, oval-shaped; testa with tabular-concave roundish to isodiametric cells whose sunken central area is roundish, the non-sunken peripheral wall portions are structured in a weakly wart-like manner, the anticline borders on them are barely recognizable, sunken in uneven honeycomb form.

Etymology: we dedicate this new species to our friend and colleague Thomas Linzen (Irxleben, Germany), discoverer of this interesting new species and great scholar of the genus *Mammillaria* and relatives.

Phenology: flowering in February-March; fruiting in July-August.

Distribution and habitat: *Cochemiea thomasii* is known from a single narrow location north of the town of Cosalá, Sinaloa, at elevations between 300 to 325 m, in gentle slopes near the transition of the Pacific Coastland

into the Sierra Madre Occidental. According to González-Elizondo et al. (2012), the habitat corresponds to deciduous tropical forest. The observed plants are sporadically distributed and they always grow on vertical rock walls. Most of the plants are inaccessible at a height of 5-10 m above ground. Older specimens are particularly noticeable by their hanging stems. The geographically closest representatives of the genus *Cochemiea* occur in Baja California, more than 300 km from this location. From *Mammillaria halei* Brandegees, the morphologically closest species, the geographic distance extends more than 550 km.

Conservation status: only one population (type locality) was found and a total of 150 individuals was counted. On the basis of the criteria B2a (geographic range) and C (small population) of the IUCN (2014), we assessed this species within the categories CR (Critically Endangered, AOO is 4 km², whereas EOO is about 1 km²) and VU (Vulnerable, by counting less than 500 mature individuals). According to the IUCN (2014) guidelines, "In situations where the spread of plausible values ... qualifies a taxon for two or more categories of threat, the precautionary approach would recommend that the taxon be listed under the higher (more threatened) category", and thus we here assess *Cochemiea thomasii* as Critically Endangered (CR).

Revised specimens of *Cochemiea halei* (Brandegee) Walton: MEXICO. Baja California Sur, Magdalena Island, I.1889, T. S. Brandegees s.n. (UC108174); loc. cit., III.1917, C. R. Orcutt 054 (NY00385890, NY00385891, NY1188383); loc. cit., 01.V.1924, C. R. Orcutt 054 (K000062947); Santa Margarita Island, 20.III.1911, J. N. Rose 16301 (NY03858753, US-00171189); Santa María bay, 18.III.1911, J. N. Rose 16275 (NY03858752, US-00171188); Mainland between Cd. Constitución and San Carlos, Ciudad Constitución, 42 km SW, IV.1983, N. P. Taylor 65 (K29047.722).

Taxonomic notes: *Cochemiea thomasii* is morphologically similar to *C. halei*, based on characters of tubercles and spines (Table 1). Molecular studies are in process to verify the relationships between *C. thomasii* and the remaining *Cochemiea* taxa (García-Morales et al., in prep.).

Table 1: Morphological comparison between *Cochemiea thomasi* García-Mor., Rodr. González, J. García-Jim. & Iamónico and *C. halei* (Brandege) Walton. Morphological data of *C. halei* were taken from Bravo-Hollis and Sanchez-Mejorada (1991) and examination of exsiccata (collected from 1889 to 1893; see the paragraph “Additional examined material”) and living plants.

	<i>Cochemiea thomasi</i> García-Mor., Rodr. González, J. García-Jim. & Iamónico	<i>Cochemiea halei</i> (Brandege) Walton
Stems	Pendulous, hanging	Caespitose, procumbent
Tubercles	Conical	Conical
Size	11-13 × 9-10 mm	6-8 × 7-9 mm
Areoles	rounded, 2-3 mm diameter	oval, 3.5-5 mm diameter
Central spines	1-4, 7-13 mm long	6-9, 20-25 mm long
Radial spines	10-15	15-22
Length	7-13 mm	9-15 mm
Flowers	30-42 mm long	35-50 mm long
Fruit	ovoid, initially green, later reddish-brownish	clavate, red
Size	7-9 mm long	12 mm long
Distribution	Municipality of Cosalá, Sinaloa	Magdalena and Margarita Islands, and mainland near Ciudad Constitución in Baja California Sur
Elevation	300-325 m	0-25 m

By the addition of our new species, *Cochemiea* now includes six species. A diagnostic key is proposed below.

Diagnostic key of *Cochemiea* species

- 1a. Central spines all straight 2
- 1b. Several central spines hooked 3
- 2a. Central spines 6 to 9, up to 25 mm long; Islands Margarita and Magdalena, and mainland of Baja California Sur *Cochemiea halei* (Brandege) Walton
- 2b. Central spines 1 to 4, up to 13 mm long; Cosalá, Sinaloa *Cochemiea thomasi* García-Mor., Rodr. González, J. García-Jim. & Iamónico
- 3a. Central spine 1; radial spines 7-9; Santa Rosalía to Cabo San Lucas *Cochemiea posegeri* (Hildm.) Britton & Rose
- 3b. Central spines more than 2; radial spines 10-30 4
- 4a. Central spines 3, radial spines 20-30; Cedros and Navidad Islands *Cochemiea pondii* (Greene) Walton
- 4b. Central spines 4-5; radial spines 10-15 5
- 5a. Spines dark brown; around Punta Blanca (Baja California) *Cochemiea maritima* Lindsay
- 5b. Spines white with dark tips; Angel de la Guarda Island, Sierra San Borja, Sierra San Francisco, Sierra Santa Lucía and near Bahía de los Ángeles *Cochemiea setispina* (Coulter) Walton

Author contributions

LJGM carried out field surveys, searched the necessary material and prepared the first draft of the paper. DI, RGG, JGJ checked the draft prepared by LJGM and provided suggestions to improve the manuscript.

Funding

Programa para el Desarrollo Profesional Docente, para el Tipo Superior (PRODEP) of the Secretaría de Educación Pública (SEP) and Consejo Nacional de Ciencia and Tecnología (CONACyT) for support of part of this research. The Arbeitskreis für Mammillarienfreunde (AfM) financed the SEM images.

Acknowledgements

Thanks are due to directors and curators of all cited herbaria for the support during our visits or loan of specimens/photographs. M. Wilke from the Otto von Guericke University Magdeburg, Institute of Materials and Joining Technology (IMF) for the SEM recordings. Special thanks to T. Linzen for the photos used in the Figure 1.

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