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*, endémico, 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 zigomórfico rojo escarlata presumiblemente especializado para la polinización por colibríes. Como parte de los estudios taxonómicos en curso sobre la flora del norte de México, 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 Sinaloa, 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 cóncicos 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.
Introduction

Cochemiea (K. Brandegee) Walton (Cactaceae Juss., Cacteae 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 Brandegee (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 (Brandegee, 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 electron 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).
Figure 1: Cochemiea thomasii García-Mor., Rodr. González, J. García-Jim. & Iamonico. 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 deflect-
ed, this last being slightly longer, stiff needle-like, sligh-
ly 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
zygomer-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 lanceo-
late, 6-8, 20-25 × 5-7 mm, apex entire, irregularly rounded,
icurved outwards; the middle segments 4-6, located at
middle of the tube, 4-12 × 4-5 mm, incurved apically out-
wards, 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; ova-
ry 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 seg-
ments sometimes remaining attached; seed pear-shaped,
1.3 × 0.8 mm, 0.65 mm thick, black; hylum micropylar re-
gion 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 bor-
ders on them are barely recognizable, sunken in uneven
honeycomb form.

Etymology: we dedicate this new species to our
friend and colleague Thomas Linzen (Irxeiben, 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 distrib-
buted and they always grow on vertical rock walls. Most
of the plants are inaccessible at a height of 5-10 m abo-
ve ground. Older specimens are particularly noticeable by
their hanging stems. The geographically closest representa-
tives of the genus Cochemiea occur in Baja California,
more than 300 km from this location. From Mammillaria
halei Brandegee, the morphologically closest species, the
geographic distance extends more than 550 km.

Conservation status: only one population (type local-
ity) 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 spe-
cies 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 cat-
egories of threat, the precautionary approach would rec-
ommend 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. Brandegee 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 Mar-
garita Island, 20.III.1911, J. N. Rose 16301 (NY03858753,
US-00171188); Mainland between Cd. Constitución and San Carlos,
Ciudad Constitución, 42

Taxonomic notes: Cochemiea thomasii is mor-
phologically similar to C. halei, based on characters of tuber-
cules and spines (Table 1). Molecular studies are in pro-
cess to verify the relationships between C. thomasii and
the remaining Cochemiea taxa (García-Morales et al., in
prep.).
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 (Brandegee) Walton

2b. Central spines 1 to 4, up to 13 mm long; Cosalá, Sinaloa ........................................ Cochemiea thomasii García-Mor., Rodr. González, J. García-Jim. & Iamonico

3a. Central spine 1; radial spines 7-9; Santa Rosalía to Cabo San Lucas ................................................................. Cochemiea poselgeri (Hildm.) Britton & Rose

3b. Central spines more than 2; radial spines 10-30 ............ 4

4a. Central spines 3, radial spines 20-30; Cedros and Natividad 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 Lucia 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 he draft prepared by LJGM and provided suggestions to improve the manuscript.

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Literature cited


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