



# A new species of *Pachyphytum* (Crassulaceae) from the Sierra de Puruagua, Guanajuato, Mexico

## Una especie nueva de *Pachyphytum* (Crassulaceae) de la Sierra de Puruagua, Guanajuato, México

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### Abstract

**Background and Aims:** *Pachyphytum* (Crassulaceae) is a genus with 26 species endemic to Mexico. During explorations in the Sierra de Puruagua, Guanajuato, a population of *Pachyphytum* with distinctive characteristics was discovered. The aims of this study were to describe *P. theodactylum* as a new species to science, present a distribution map, assess its conservation status and provide a key to the *Pachyphytum* taxa in Guanajuato.

**Methods:** Flowering specimens were collected for morphological analysis and data were compared with the most similar species. The collections were prepared as herbarium specimens and will be deposited in the IBUG and ZON herbaria. Its conservation status was assessed using GeoCAT and IUCN criteria. The distribution map was generated in QGIS with georeferenced herbarium coordinates projected on a layer of the biogeographic provinces of Mexico. The identification key was elaborated based on specialized literature.

**Key results:** *Pachyphytum theodactylum* is described as a new species morphologically similar to *P. garciae*, distinguished primarily by its longer and wider stems, elliptic-lanceolate peduncle bracts with acute apex, longer pedicels, sepals with pink and olive coloration and acute apex, shorter antesealous stamens, and pink styles. It is assessed as a Critically Endangered (CR) species.

**Conclusions:** The description of *Pachyphytum theodactylum* raises the number of endemic species of the genus in Mexico to 27. Given its vulnerability, conservation measures are recommended.

**Key words:** endemic species, *Pachyphytum garciae*, rupicolous flora, sect. *Pachyphytum*.

### Resumen

**Antecedentes y Objetivos:** *Pachyphytum* (Crassulaceae) es un género con 26 especies endémicas de México. Durante exploraciones en la Sierra de Puruagua, Guanajuato, se descubrió una población de *Pachyphytum* con características distintivas. Los objetivos de este estudio fueron describir *P. theodactylum* como una especie nueva para la ciencia, presentar un mapa de distribución, evaluar su estado de conservación y proporcionar una clave para los taxones de *Pachyphytum* en Guanajuato.

**Métodos:** Se colectaron ejemplares en floración para su análisis morfológico y los datos se compararon entre las especies más similares. Los especímenes colectados se herborizaron y serán depositados en los herbarios IBUG y ZON. Su estado de conservación fue evaluado con GeoCAT y los criterios de la IUCN. El mapa de distribución se generó en QGIS con coordenadas georreferenciadas de ejemplares de herbario, proyectadas sobre una capa de las provincias biogeográficas de México. La clave de identificación se elaboró con base en literatura especializada.

**Resultados clave:** Se describe a *P. theodactylum* como una especie nueva morfológicamente similar a *P. garciae*, que se distingue principalmente por sus tallos más largos y anchos, brácteas del pedúnculo elíptico-lanceoladas con ápice agudo, pedicelos más largos, sépalos de coloración rosa y oliva con ápice agudo, estambres antesépalos más cortos y estilos rosados. Se propone su clasificación como una especie En Peligro Crítico (CR).

**Conclusiones:** La descripción de *Pachyphytum theodactylum* eleva a 27 el número de especies del género endémicas de México. Dada su vulnerabilidad, se recomienda implementar medidas de conservación.

**Palabras clave:** especie endémica, flora rupícola, *Pachyphytum garciae*, sect. *Pachyphytum*.

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## Introduction

*Pachyphytum* Link, Klotzsch & Otto (Link et al., 1841) is a genus in the Crassulaceae family with 26 described species, all of them endemic to Mexico, with the state of Guanajuato hosting the highest number of species (nine), including at least four that are endemic to its territory (Hernández-Campos et al., 2025). This genus comprises plants with a generally suffruticose habit, hanging succulent rosettes, cincinnus-shaped lateral inflorescences, flowers characterized by a calyx of five sepals united at the base and appressed to the corolla, and two finger-like appendages inside each petal (Thiede, 2003). A revision of *Pachyphytum* in Guanajuato state was included in the corresponding Flora del Bajío y de regiones adyacentes treatment (Pérez-Calix, 2008). However, since that publication, new species such as *P. confusum* Pérez-Calix, Guadián-Marín & I. García (Pérez-Calix et al., 2018), *P. viscidum* Reyes & de la Cruz-López (Reyes-Santiago et al., 2019), *P. meyranii* H. Montero, J. Reyes & R. Raya (Montero-Corrales et al., 2025) and *P. angustiflorum* H. Montero, D. Hernández & A. Gasca-Prieto (Hernández-Campos et al., 2025) have been described from this state.

As the area surrounding Guanajuato, including Hidalgo, Querétaro and San Luis Potosí, has been reported as an important center of endemism for Crassulaceae species by Castro-Castro et al. (2023) and Sosa et al. (2020), explorations in the Sierra de Puruagua within Guanajuato state were conducted in order to have a better understanding of the diversity of Crassulaceae family in this region. This led to the discovery of a plant that, due to its characteristics, belongs to the genus *Pachyphytum*, but it did not fit well within the variation and distribution of known species. Flowering plants were photographed, collected and morphologically characterized to compare with similar species, concluding that it represents a species new to science.

The objectives of this work were to 1) describe *Pachyphytum theodactylum* as a new species to science, 2) explore and discuss its morphological affinities with similar taxa, 3) assess its conservation status, 4) provide a distribution map, and 5) present an identification key for the species of *Pachyphytum* in the state of Guanajuato.

## Materials and Methods

During 2023, the authors conducted fieldwork across multiple localities in Guanajuato state aiming to record new places where members of the Crassulaceae family might grow. One of those explorations, near El Chilarillo in the Sierra de Puruagua, led to the discovery of a *Pachyphytum* species that did not match well with any known species. Subsequent surveys in the next months were conducted in nearby ravines to collect flowering specimens, document morphological variation, phenology, habitat and search for additional populations of this species.

Morphological characterization was performed using fresh material, following the criteria of Pérez-Calix et al. (2018), in order to accurately document measurements, shape and color traits, often lost during drying and preservation for herbarium deposition. The collected material was processed and mounted as herbarium specimens, which will be deposited in the herbaria IBUG and ZON (acronyms following Thiers, 2024).

A morphological comparative analysis was performed reviewing specialized literature (Meyrán and López, 2003; Pérez-Calix, 2008) and specimens deposited in the herbaria IBUG and MEXU (Thiers, 2024), as well as those available on the platform Red de Herbarios Mexicanos (RHM, 2024), to determine the morphologically and geographically closest species. The analysis revealed that *P. garciae* Pérez-Calix & Glass and *P. rzedowskii* I. García, E. Pérez-Calix & Meyrán are the most similar taxa. The identification key was elaborated based on specialized literature (Meyrán and López, 2003; Pérez-Calix, 2008). Some measurements and qualitative characters not included in their protologues were obtained from cultivated individuals originating from their respective type localities: El Zapote, Peñamiller, Querétaro for *P. garciae* and Cerro de la Víbora, Tuxpan, Michoacán for *P. rzedowskii*.

The conservation status was assessed using the GeoCAT tool (Bachman et al., 2011) to calculate the Extent of Occurrence (EOO) and Area of Occupancy (AOO), adhering to the IUCN (2022) criteria. The distribution map was generated using QGIS v. 3.34.9 software (QGIS, 2023), incorporating a layer of biogeographic provinces proposed by Morrone et al. (2017) to contextualize the species distribution within a broader ecological framework.



## Results

### Taxonomy

***Pachyphytum theodactylum*** E. Carreño, A. Gasca-Prieto, Quirarte & J. Caltzonzi sp. nov. Figs. 1, 2.

TYPE: MEXICO. Guanajuato, municipio Jerécuaro, a 3.5 km al norte de Puruagua, por el camino hacia El Chilari-llo, 2320 m, bosque de pino-encino, 2.III.2025, E. A. Carreño Plascencia et al. 7 (holotype: IBUG!, isotype: ZON!, to distribute).

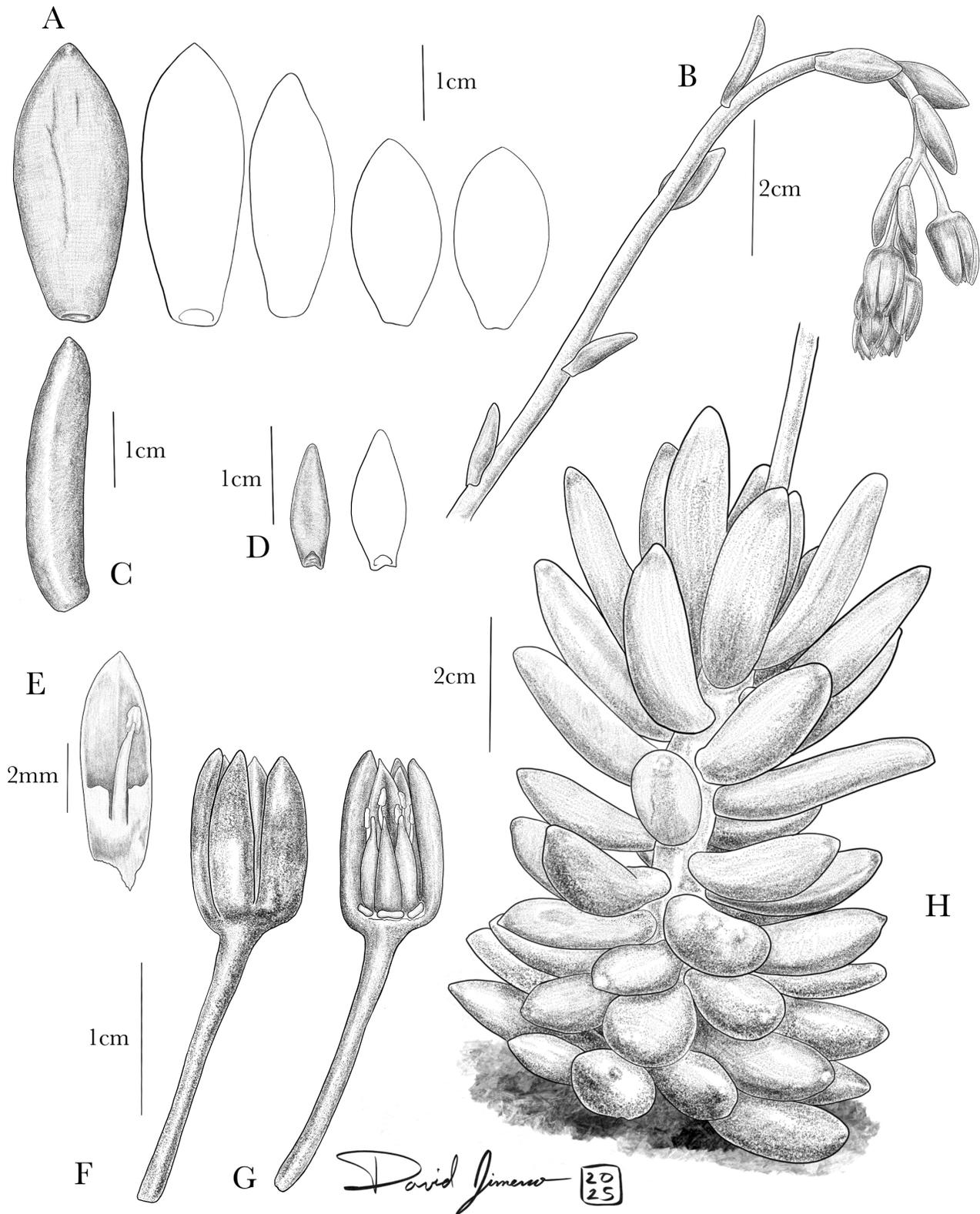
*Pachyphytum theodactylum* is morphologically close to *P. garciae*, but it differs from the latter in its stems dimensions, which reach up to 56 × 1.3 cm (vs. up to 40 × 0.6 cm); peduncle bracts ovate-lanceolate with apex acute (vs. obovate to elliptic with a rounded to obtuse apex); pedicel length of 1.4-2 cm (vs. 0.3-0.8 cm); sepals pink in the basal half and olive-green in the upper half (vs. yellowish in the basal half and greenish in the upper half); sepals with acute apex (vs. rounded to obtuse); antesepalous stamens 0.6 cm long (vs. 1 cm); and styles pink (vs. yellow to reddish near the stigma).

Plants perennial, subshrubby, glabrous, erect to pendant; roots fibrous; stem up to 56 cm long, 1.3 cm in diameter, smooth, with irregular diamond-shaped scars, ochre to grayish in color, branched from the base; rosettes lax, 6-8 cm diameter, with 21-43 leaves, spirally arranged, clustered near the stem apex; leaves 1.5-3.5 cm long, 0.7-1.1 cm wide, 0.6-0.9 cm thick, elliptic-lanceolate to oblong-elliptic in outline, subcylindrical in cross section, the upper ones ascending, the basal ones spreading, bluish-green, pruinose, glaucous, apex acute, rounded or obtuse, sometimes smoothly mucronulate, paler to purplish with age; inflorescence a cincinnus, 1 per rosette, 10-25 cm long; peduncle to 20 cm long, 0.4 cm wide at the base, peach-pink in color; peduncle bracts 6-9, 1.3-1.4 cm long, 0.4-0.6 cm wide, ovate-lanceolate, apex acute, base sagittate, appressed in young peduncle, ascending during anthesis, spirally arranged, pink with violet hues near the apex, persistent, pruinose; cincinnus 5-9 cm long at the

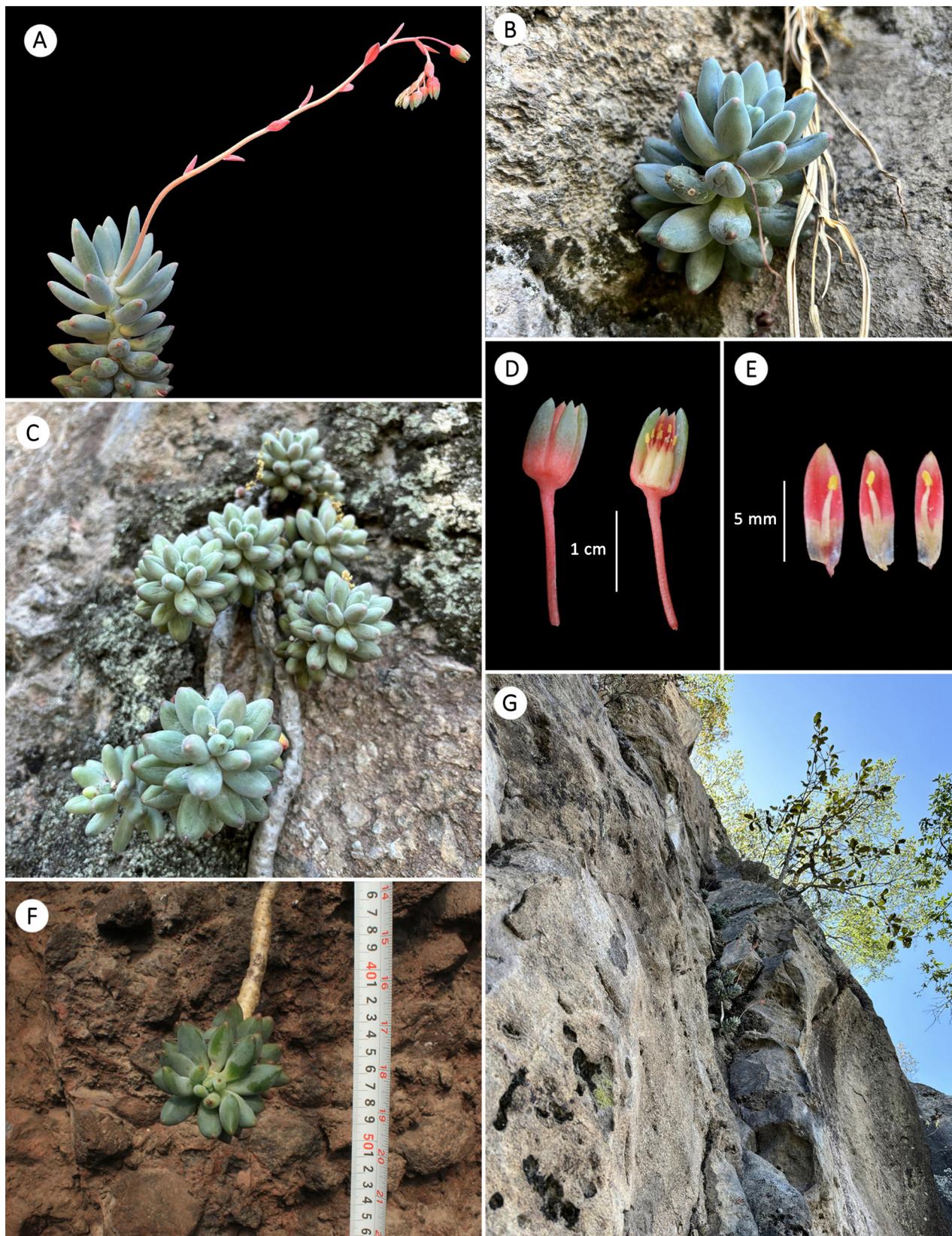
end of flowering, glaucous to pinkish, with 3-12 flowers; pedicels 1.4-2 cm long, 0.1 cm in diameter, cylindrical, turbinate, pink; calyx slightly longer than the corolla, 0.5-0.6 cm wide; sepals 5, unequal, 0.9-1 cm long, 0.3-0.5 cm wide, 0.1 cm thick, oblong-lanceolate to lanceolate, apex acute, bicolored, pink in the basal half, olive-green in the upper half, slightly pruinose, appressed to the corolla, fused at the base; corolla subcampanulate, equal to or 0.1 cm shorter than the calyx; petals 5, 0.8-0.9 cm long, 0.2-0.25 cm wide, oblong-lanceolate, apex acute, shortly mucronate, free at the base, imbricate in the upper second third, ascending, pale yellow in the basal half, pink in the upper half, hyaline, with an irregular reddish-pink spot in the upper half of the inner face, slightly pruinose on both surfaces; appendages 2, parallel on each side of the epipetalous stamens, truncate, 1.0-1.5 mm long, pink, hyaline; stamens 10, antisepalous 5, 0.6 cm long, epipetalous 5, 0.4-0.5 cm long, inserted approximately at the middle of the petal, whitish, pinkish near the apex, hyaline; nectary scales 1.8 mm wide, narrowly elliptic-lunulate; carpels 5, erect, 0.6-0.7 cm long, pale yellow; styles 0.2 cm long, pink; stigmas capitate, green; fruits polyfollicular, dehiscent longitudinally in a star-like pattern, brown; seeds 0.5 mm long, reddish-brown.

Habitat and distribution: *Pachyphytum theodactylum* to date has only been recorded in its type locality, in the Sierra de Puruagua, where it grows exclusively in ravines on vertical slopes of extrusive igneous rocks with a western exposure at an elevation of 2320 m. The vegetation in the area corresponds to a pine-oak forest, with an arboreal stratum composed of *Arbutus tessellata* P.D. Sørensen, *Clethra mexicana* DC., *Pinus teocote* Schied. ex Schltdl. & Cham., *Quercus crassifolia* Bonpl., and *Q. laeta* Liebm. In the shrub layer, species such as *Croton adspersus* Benth., *Lobelia laxiflora* Kunth, *Loeselia mexicana* (Lam.) Brand, *Montanoa grandiflora* Alamán ex DC., *Stevia lucida* Lag., and *Verbesina virgata* Cav. are present. Additionally, some rupicolous species growing on the same slope are *Laelia autumnalis* (Lex.) Lindl., *Phlebodium pseudoaureum* (Cav.) Lellinger, and *Pleopeltis polypodioides* (L.) E.G. Andrews & Windham.





**Figure 1:** *Pachyphytum theodactylum* E. Carreño, A. Gasca-Prieto, Quirarte & J. Caltzonzi. A. variation in leaf shape; B. lateral view of the inflorescence; C. lateral view of a leaf; D. adaxial and abaxial faces of the peduncle bracts; E. inner face of the petal; F. lateral view of the flower; G. inner parts of the flower; H. lateral view of a rosette. Illustration based on E. A. Carreño-Plascencia et al.7 (IBUG), by H. David Jimeno Sevilla.



**Figure 2:** *Pachyphytum theodactylum* E. Carreño, A. Gasca-Prieto, Quirarte & J. Caltzonzi. A. habit; B. upper-lateral view of a solitary rosette; C. pendant rosettes growing on a vertical slope of extrusive igneous rocks; D. lateral view of the flower (left) and the inner parts of it (right); E. inner face of the petals; F. rosette with a long stem; G. habitat. Photos by Emmanuel Carreño Plascencia and Aureliano Gasca Prieto.

Phenology: inflorescences begin to emerge in late December, with the first flowers blooming by the end of February and dehiscent fruits appearing by late March.

Etymology: the species name *theodactylum* is derived from the Greek words *theos* meaning “god” and *dactylos* meaning “finger”, reflecting the common name “deditos de dios” (fingers of God) by which this species is known.

Preliminary conservation status: *Pachyphytum theodactylum* has only been collected from its type locality, occupying a highly specific ecological niche. It is estimated that this population consists of fewer than 20 mature individuals. The low abundance of specimens represents a threat to its short- and medium-term survival due to potential collection pressures or natural disasters. The results of the AOO (4 km<sup>2</sup>) and EOO (0 km<sup>2</sup>), together with the IUCN (2022) criteria B1ab(iii) + B2ab(iii), suggest that *P. theodactylum* should be provisionally treated under the Critically Endangered (CR) category.

## Discussion

*Pachyphytum garciae* is the species most morphologically similar to *P. theodactylum*. However, the latter has longer and more robust stems, reaching up to 56 cm in length and 1.3 cm in diameter. The bracts of the new species are longer, ovate-lanceolate with an acute apex, and its pedicels are also longer. The sepals exhibit a pink coloration in the basal half and olive-green in the upper half, with an acute apex. In other floral structures, the appendages are generally paler, the antisepalous stamens shorter, and the styles pink (Table 1).

*Pachyphytum theodactylum* is also morphologically similar to *P. rzedowskii*, but can be distinguished by the longer stems in the former. Its leaves are elliptic-lanceolate to oblong-elliptic in outline with a bluish-green color, the peduncle bracts are also longer and elliptic-lanceolate in shape, and the pedicels are comparatively longer. The sepals are pink at the base and green at the top, the petals

are pale yellow at the base, turning pink at the top, with a pink spot on the inner side. Finally, the appendages and styles of *P. theodactylum* are pink (Fig. 3).

Current phylogenetic evidence confirms that *Pachyphytum* is a monophyletic genus (de la Cruz-López et al, 2019). However, it also suggests that its traditional division into sections *Pachyphytum* Moran and *Diotostemon* (Salm-Dyck) Walther represents artificial groupings. Studies by García-Ruíz (2003) and Carrillo-Reyes et al. (2009) have recovered mixed assemblages of species from both sections, while the work of de la Cruz-López et al. (2019) identified these groups as a polytomy. Despite the challenges of proposing infrageneric classifications within Crassulaceae based on molecular evidence, morphological-based sections and series remain useful tools for species identification (Rosales-Martínez and Hernández-Campos, 2023). Following Thiede’s (2003) sectional proposal, *P. theodactylum* is assigned to sect. *Pachyphytum* due to its imbricate bracts in the young circinnus, corolla slightly shorter than the calyx and the presence of a pink spot on the inner face of the petals. The new species stands out from other members of sect. *Pachyphytum* by the pink spot on the inner face of the petals, whereas in other species it is typically darker, and by its long pedicels, which can measure up to 2 cm, a feature characteristic of the sect. *Diotostemon*.

As noted by Castro-Castro et al. (2023), most species of *Pachyphytum* have a narrow distribution, often restricted to a single biogeographical province. The Chihuahuan Desert province stands out for its richness in this genus, as 16 species occur here, including the one described in this study. Morphologically similar species to *P. theodactylum* also follow this distribution pattern, with *P. garciae* restricted to the Sierra Madre Oriental and *P. rzedowskii* to the Trans-Mexican Volcanic Belt (Fig. 4). Ecological preferences among this group of species are also evident. *Pachyphytum theodactylum* is found in pine-oak forests at 2360 m above sea level, while *P. garciae* grows in submontane scrub at 1600 m, and *P. rzedowskii* inhabits tropical deciduous forests within an elevational range of 1800 to 2150 m.



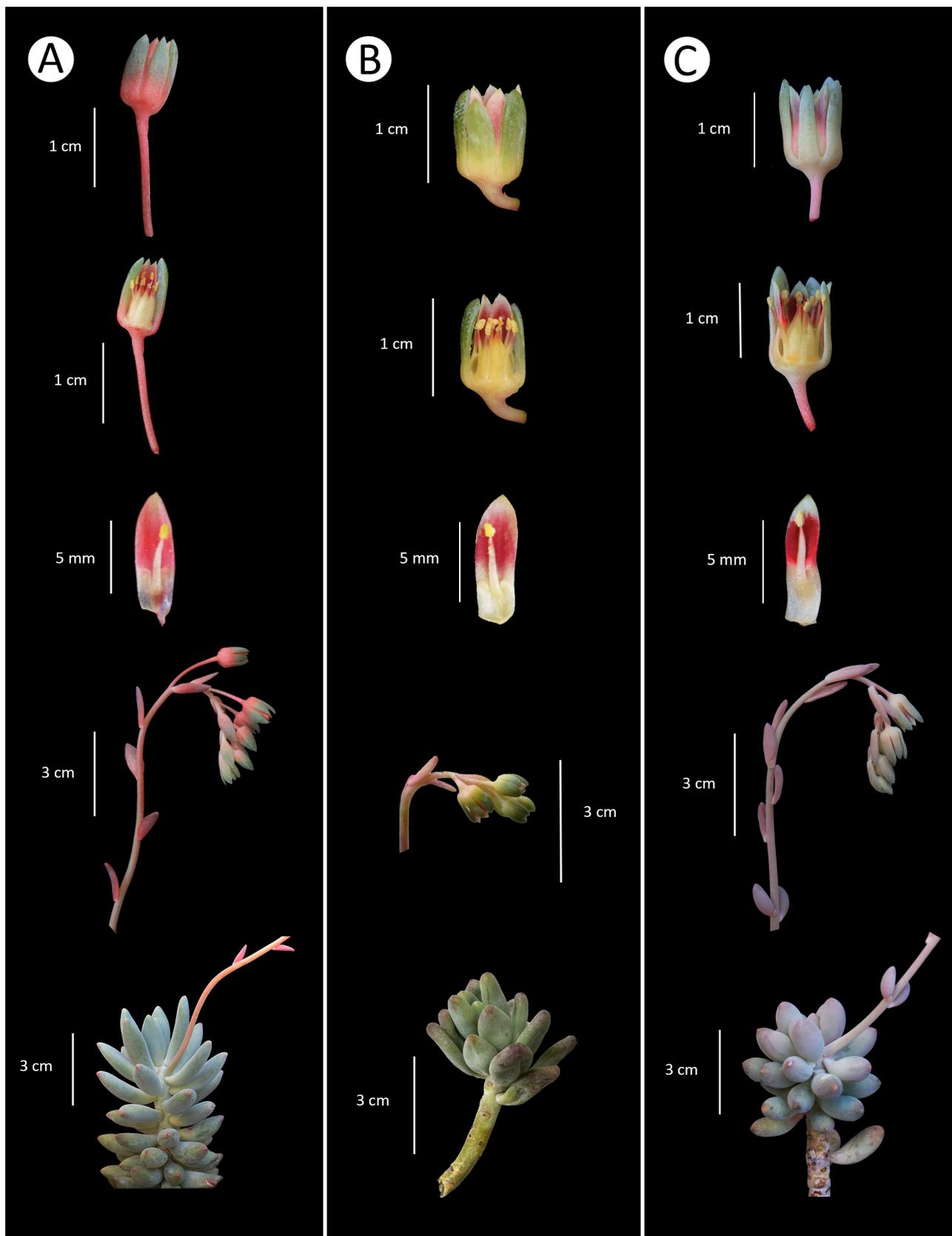
**Table 1:** Comparative table between *Pachyphytum theodactylum* E. Carreño, A. Gasca-Prieto, Quirarte & J. Caltzonzi and related species.

	<i>Pachyphytum theodactylum</i> E. Carreño, A. Gasca-Prieto, Quirarte & J. Caltzonzi	<i>Pachyphytum garciae</i> Pérez-Calix & Glass	<i>Pachyphytum rzedowskii</i> I. García, Pérez-Calix & Meyrán
Stem dimensions (cm)	Up to 56 × 1.3	Up to 40 × 0.6	Up to 30 × 1-1.5
Leaf shape	Elliptic-lanceolate to oblong-elliptic	Elliptic, elliptic-oblongate, obovate or obovate-spatulate	Obovate to oblanceolate
Leaf apex shape	Acute, rounded or obtuse, sometimes smoothly mucronulate	Widely acute	Acute, mucronulate
Leaf color	Bluish green	Bluish green	Pinkish at the base, grayish to bluish in the middle and pale pink at the apex
Leaf apex pigmentation	Pale bluish green to purplish	Purplish	Light green
Peduncle bracts shape	Ovate-lanceolate	Obovate to elliptic	Ovate-lanceolate to ovate-elliptic
Peduncle bracts apex	Acute	Rounded to obtuse	Subacute
Pedicel length (cm)	1.4-2	0.3-0.8	0.3-0.8
Sepal color	Pink in the basal half, olive green in the upper half	Yellowish in the basal half, greenish in the upper half	Green to whitish yellow in the basal half, bluish green close to the apex
Sepal apex	Acute	Rounded to obtuse	Subacute to acute
Petal color	Pale yellow in the basal half, pink in the upper half	Yellowish in the basal half, pink in the upper half	Pale green in the basal half, bluish green in the upper half
Spot in the inner face color	Reddish-pink	Dark pink	Scarlet red
Appendages color	Pink hyaline	Reddish	Scarlet red
Antisepal stamens length (cm)	0.6	1	0.6-0.7
Style color	Pink	Yellow to reddish close to the stigma	Reddish brown
Vegetation type	Pine-oak forest	Submontane scrubland	Tropical deciduous forest
Elevation (m a.s.l.)	2320	1600	1800-2150
Biogeographic province	Chihuahuan desert	Sierra Madre Oriental	Trans-Mexican Volcanic Belt

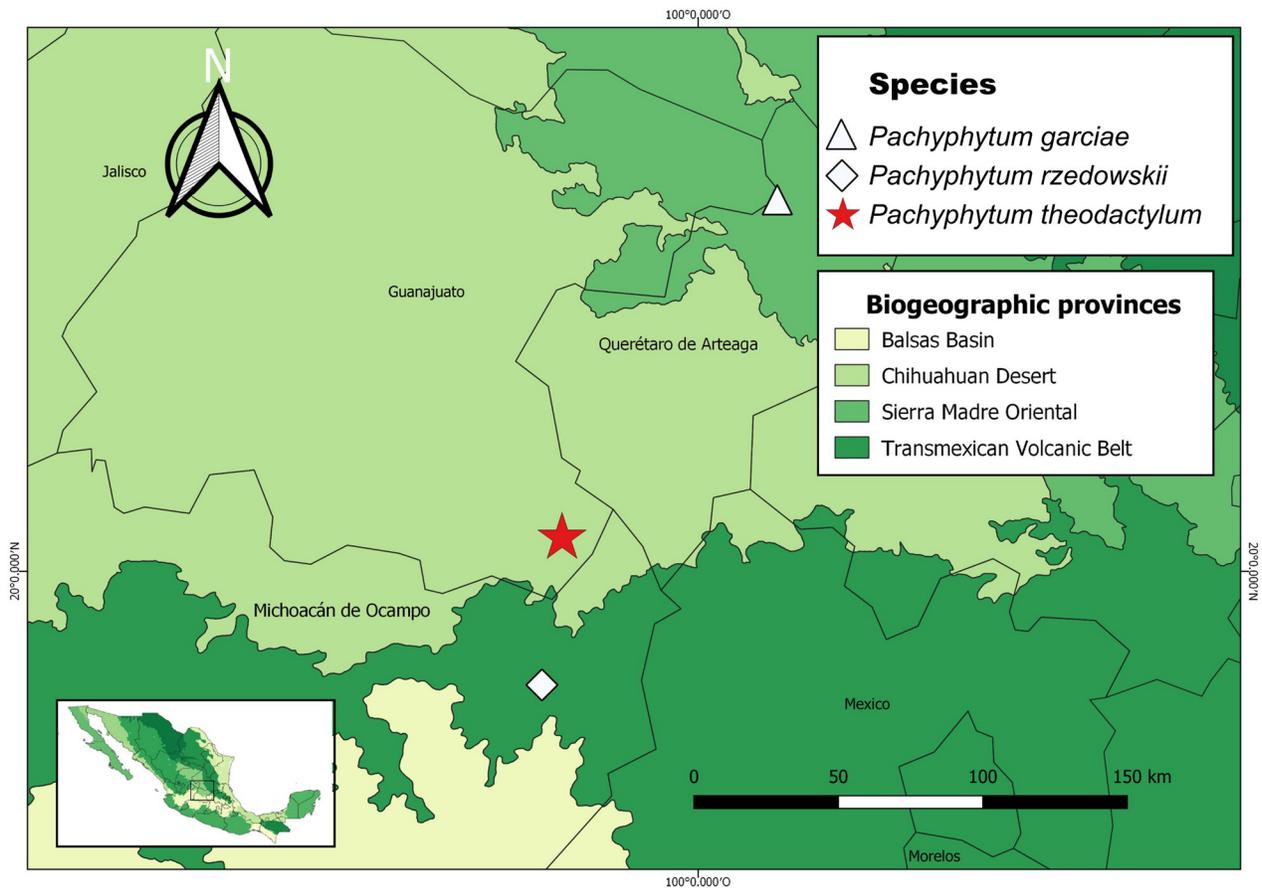
The new species is provisionally assessed to the status of CR (Critically Endangered), as it is currently known from a single population comprising few individuals, restricted to a specialized habitat. Wildfires are recurrent in this area during the annual dry season, posing an ongoing threat to the survival of *P. theodactylum* and the ecosystem

it inhabits. Continued exploration in areas with similar environmental conditions is recommended in search of additional populations, along with the planning and eventual implementation of both *in situ* and *ex situ* conservation measures. Below we present an identification key for the *Pachyphytum* species of the state of Guanajuato.





**Figure 3:** Comparative sheet between the new species and related taxa. A. *Pachyphytum theodactylum* E. Carreño, A. Gasca-Prieto, Quirarte & J. Caltzonzi; B. *Pachyphytum garciae* Pérez-Calix & Glass; C. *Pachyphytum rzedowskii* I.García, E. Pérez-Calix & Meyrán. From top to bottom: lateral view of the flower, gynoecium, inner side of the petal, inflorescence and rosette. Photographs by Aureliano Gasca Prieto, Emmanuel Carreño Plascencia and Jaime Quirarte.



**Figure 4:** Distribution map of *Pachyphytum theodactylum* E. Carreño, A. Gasca-Prieto, Quirarte & J. Caltzonzi and related species on a layer of biogeographic provinces *sensu* Morrone et al. (2017).

### Key to the species of *Pachyphytum* in Guanajuato

- |                                                                                           |   |                                                                                                           |                        |
|-------------------------------------------------------------------------------------------|---|-----------------------------------------------------------------------------------------------------------|------------------------|
| 1a. Corolla longer than the calyx .....                                                   | 2 | 6b. Petals pale yellow at base, greenish yellow close to the apex, with a red spot on inner surface ..... |                        |
| 1b. Corolla equal to or shorter than the calyx .....                                      | 7 | ..... <i>P. angustiflorum</i> H. Montero, D. Hernández & A. Gasca-Prieto                                  |                        |
| 2a. Young stems glutinous near the rosette .....                                          |   | 7a. Leaves glaucous, pruinose .....                                                                       | <i>P. theodactylum</i> |
| ..... <i>P. viscidum</i> Reyes & de la Cruz-López                                         |   | E. Carreño, A. Gasca-Prieto, Quirarte & J. Caltzonzi                                                      |                        |
| 2b. Young stems not glutinous .....                                                       | 3 | 7b. Leaves neither glaucous nor pruinose .....                                                            | 8                      |
| 3a. Leaves with whitish semi-arc patterns .....                                           |   | 8a. Leaves cylindrical or subcylindrical in cross section .....                                           |                        |
| ..... <i>P. compactum</i> Rose                                                            |   | ..... <i>P. viride</i> E. Walther                                                                         |                        |
| 3b. Leaves without whitish semi-arc patterns .....                                        | 4 | 8b. Leaves not cylindrical or subcylindrical in cross section .....                                       | 9                      |
| 4a. Petals uniformly colored .....                                                        | 5 | ..... <i>P. fittkaui</i> Moran                                                                            |                        |
| 4b. Petals bicolored .....                                                                | 6 | 9a. Sepals uniformly colored in glaucous green .....                                                      |                        |
| 5a. Petals bright yellow .....                                                            |   | ..... <i>P. brevifolium</i> Rose                                                                          |                        |
| 5b. Petals dark pink to reddish .....                                                     |   | 9b. Sepals bicolored, pink in the base and olive green in the upper portion .....                         |                        |
| ..... <i>P. meyranii</i> H. Montero, J. Reyes & R. Raya                                   |   | ..... <i>P. confusum</i> Pérez-Calix, Guadián-Marín & I. García                                           |                        |
| ..... <i>P. hookeri</i> (Salm-Dyck) A. Berger                                             |   |                                                                                                           |                        |
| 6a. Petals yellowish at base and reddish at apex, without red spot on inner surface ..... |   |                                                                                                           |                        |



## Autor contributions

Conceptualization: JDHC, JAQT; Funding: EACP, AGP, JAQT, JACC, JDHC; Investigation: JDHC, AGP, JAQT; Methodology: JDHC; Project administration: JDHC; Validation: JDHC, JAQT, AGP, EACP, JACC; Visualization: AGP, EACP, JDHC; Writing - original draft: JDHC, AGP, JAQT; Writing - review & editing: JDHC, JAQT, AGP, EACP, JACC.

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## Literature cited

- Bachman, S., J. Moat, A. Hill, J. de la Torre and B. Scott. 2011. Supporting red list threat assessments with GeoCAT: Geospatial conservation assessment tool. *ZooKeys* 150: 111-126. DOI: <http://doi.org/10.3897/zookeys.150.2109>
- Carrillo-Reyes, P., V. Sosa-Ortega and M. E. Mort. 2009. Molecular phylogeny of the *Acre* clade (Crassulaceae): Dealing with the lack of definitions for *Echeveria* and *Sedum*. *Molecular Phylogenetics and Evolution* 53(1): 267-276. DOI: <https://doi.org/10.1016/j.ympev.2009.05.022>
- Castro-Castro, A., J. P. Ortíz-Brunel, H. Ávila-González, I. H. Lichter-Mark, P. Carrillo-Reyes, I. L. López-Enríquez and M. A. Barvosa-Jiménez. 2023. Spatial richness analysis and an evaluation of extinction risk for the genus *Pachyphytum* (Crassulaceae), with the description of a new species from Sierra Madre Occidental, Mexico. *Phytotaxa* 629 (3): 197-209. DOI: <https://doi.org/10.11646/phytotaxa.629.3.2>
- de la Cruz-López, L. E., F. Vergara-Silva, J. Reyes-Santiago, G. Espino Ortega, P. Carrillo-Reyes and M. Kuzmina. 2019. Phylogenetic relationships of *Echeveria* (Crassulaceae) and related genera from Mexico, based on three DNA barcoding loci. *Phytotaxa* 422(1): 33-57. DOI: <https://doi.org/10.11646/phytotaxa.422.1.3>
- García-Ruiz, I. 2003. Relaciones interespecíficas del género *Pachyphytum* (Crassulaceae), empleando marcadores genéticos AFLP. Tesis de maestría. Facultad de Ciencias Biológicas y Agropecuarias, Universidad de Colima. Tecomán, Colima, México. 108 pp.
- Hernández Campos, J. D., A. Gasca Prieto, J. H. Montero Corrales and R. D. Raya Sánchez. 2025. *Pachyphytum angustiflorum* (Crassulaceae), una especie nueva de Guanajuato, México. *Acta Botanica Mexicana* 132: e2429. DOI: <https://doi.org/10.21829/abm132.2025.2429>
- IUCN. 2022. Guidelines for Using the IUCN Red List Categories and Criteria. Version 15. Prepared by the Standards and Petitions Committee. Gland, Suiza. <http://www.iucnredlist.org/documents/RedListGuidelines.pdf> (consulted December, 2024).
- Link, J. F. H., J. F. Klotzsch and C. F. Otto. 1841. *Pachyphytum bracteosum*. *Allgemeine Gartenzeitung* (Otto & Dietrich) 9(2): 9.
- Meyrán, J. and L. López. 2003. Las crasuláceas de México. *Sociedad Mexicana de Cactología, A.C. México, D.F., México*. 111-122 pp.
- Montero-Corrales, H., R. Raya-Sánchez and J. Reyes-Santiago. 2025. *Pachyphytum meyranii* (Crassulaceae), una nueva especie en el noreste del estado de Guanajuato, México. *Cactáceas y Suculentas Mexicanas* 70(1): 4-11.
- Morrone, J. J., T. Escalante and G. Rodríguez-Tapia. 2017. Mexican biogeographic provinces: Map and shapefiles. *Zootaxa* 4277: 277-279. DOI: <https://doi.org/10.11646/zootaxa.4277.2.8>
- Pérez-Calix, E. 2008. Familia Crassulaceae. Fascículo 156. *Flora del Bajío y de Regiones Adyacentes*. Instituto de Ecología, A.C., Centro del Bajío. 60-75 pp. DOI: <https://doi.org/10.21829/fb.92.2008.156>
- Pérez-Calix, E., J. I. Guadián-Marín and I. García-Ruiz. 2018. *Pachyphytum confusum* (Crassulaceae), una especie nueva del suroeste del estado de Guanajuato, México. *Acta Botanica Mexicana* 125: 231-238. DOI: <https://doi.org/10.21829/abm125.2018.1401>
- QGIS. 2023. QGIS Geographic Information System Version 3.34.9 QGIS Association. <https://qgis.org> (consulted December, 2024).



- Reyes Santiago, J., L. E. de La Cruz-López, M. Kuzmina and F. Vergara-Silva. 2019. Morphological and molecular diagnostic characters reveal a new species of *Pachyphytum* (Crassulaceae). *Haseltonia* 26: 14-22.
- RHM. 2024. Red de Herbarios Mexicanos. <http://herbanwmex.net/portal/index.php> (consulted December, 2024)
- Rosales-Martínez, C. S. and J. D. Hernández-Campos. 2023. *Echeveria flammigera* (Crassulaceae), a new name and status for *E. pringlei* var. *parva*. *Phytotaxa* 592(2): 99-108. DOI: <https://doi.org/10.11646/phytotaxa.592.2.3>
- Sosa, V., M. Vásquez-Cruz and J. A. Villarreal-Quintanilla. 2020. Influence of climate stability on endemism of the vascular plants of the Chihuahuan Desert. *Journal of Arid Environments* 177: 104-139. DOI: <https://doi.org/10.1016/j.jaridenv.2020.104139>
- Thiede, J. 2003. *Pachyphytum*. In: Egli, U. (ed.). *Crassulaceae. Illustrated handbook of succulent plants*. Springer. Berlin, Germany. 190-195 pp.
- Thiers, B. 2024 (continuously updated). *Index Herbariorum: A Global Directory of Public Herbaria and Associated Staff*. New York Botanical Garden's Virtual Herbarium. New York, USA. <http://sweetgum.nybg.org/science/ih/> (consulted December, 2024).

