





First record of *Sclerocactus papyracanthus* (Cactaceae) in Mexico

Primer registro de *Sclerocactus papyracanthus* (Cactaceae) en México

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Abstract:

Background and Aims: *Sclerocactus* (Cactaceae) is a genus that comprises 27 taxa mainly distributed in the southern United States of America and northern Mexico. *Sclerocactus papyracanthus* is a very distinctive species due to its flattened papyraceous central spines and its growth form, which is similar to that of some grasses. Its currently known distribution is in the states of Arizona, New Mexico, and Texas in the southern USA close to the border with Mexico. However, we detected an observation of a putative individual of this species in Chihuahua on the Naturalista platform. Therefore, we set out to find individuals of *S. papyracanthus* in Mexico, describe their morphology, its ecological preferences, and document their occurrence in this country with herbarium specimens, photographs, and illustrations.

Methods: Using the location indicated in the Naturalista observation, we carried out two explorations in early 2023 to the state of Chihuahua in search of the species. A cactus population that resembled *S. papyracanthus* was found. We took photographs, measured and described the morphological characters of the found individuals, and prepared herbarium specimens. The obtained morphological and ecological data were compared with those reported in the scientific literature and with other available herbarium vouchers.

Key results: The morphological comparisons corroborated that the *Sclerocactus* population found corresponded to *S. papyracanthus* and the presence of the species in Mexico was confirmed. A total of 38 plants of different sizes were found. Also, two young individuals flowering were documented.

Conclusions: In Mexico, *S. papyracanthus* is now known from a single grassland locality in the municipality of Ascensión, Chihuahua. Further exploration and investigation are needed to understand its ecological preferences and its distribution in Mexico.

Key words: cacti, Chihuahua, grama grass cactus, neoteny.

Resumen:

Antecedentes y Objetivos: *Sclerocactus* (Cactaceae) es un género que comprende 27 taxones principalmente distribuidos en el sur de los Estados Unidos de América y el norte de México. *Sclerocactus papyracanthus* es una especie muy distintiva debido a sus espinas centrales papyraceas y aplanadas, y a su forma de crecimiento similar a la de algunos pastos. Su distribución actual conocida es en los estados de Arizona, Nuevo México y Texas en el sur de los Estados Unidos de América, cerca de la frontera con México. Sin embargo, detectamos una posible observación de esta especie en Chihuahua en la plataforma Naturalista. Derivado de esto, nuestros objetivos fueron encontrar individuos de *S. papyracanthus* en México, describir su morfología, sus preferencias ecológicas y documentar la ocurrencia de la especie en México con ejemplares de herbario, fotografías e ilustraciones.

Métodos: Usando la ubicación reportada en la observación de Naturalista, se realizaron dos exploraciones en el estado de Chihuahua a principios de 2023 para buscar la especie. Se encontró una población de cactus similares a *S. papyracanthus*. Se tomaron fotografías, mediciones morfológicas y datos del hábitat y se prepararon ejemplares de herbario. Los datos ecológicos y morfológicos obtenidos fueron comparados con aquellos reportados en literatura científica y en otros ejemplares de herbario disponibles.

Resultados clave: Las comparaciones morfológicas corroboraron que la población de *Sclerocactus* encontrada corresponde a *S. papyracanthus* y la presencia de la especie en México fue confirmada. Se encontraron un total de 38 plantas de varios tamaños. Además, se documentaron dos individuos juveniles floreciendo.

Conclusiones: Actualmente en México, *S. papyracanthus* se conoce solo de una localidad de pastizales en el municipio de Ascensión, Chihuahua. Se necesitan más exploración e investigación para complementar el conocimiento de las preferencias ecológicas y la distribución de la especie en México.

Palabras clave: cactáceas, cactus del pasto grama, Chihuahua, neotenia.

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Introduction

The genus *Sclerocactus* Britton & Rose (Cactaceae) comprises small globose to subcylindrical-stemmed plants with naked or slightly scaled fruits and tuberculate seeds (Porter et al., 2000). The name of the genus derives from the Greek *scleros* (“hard” or “cruel”) and refers to “the formidable hooked spines” that most of the species develop (Anderson, 2001). The plants have a low growth rate, are mostly solitary and reach sizes of 1.8-15 cm width and 1-40 cm height. The epidermis is pale green to dark green and occasionally glaucous (Heil and Porter, 1994).

Following the new circumscription proposals for Cactaceae (Korotkova et al., 2021), *Sclerocactus* includes 27 taxa, mainly distributed in the western and southwestern United States of America (USA) and northern Mexico (Porter et al., 2000; Hernández and Gómez-Hinostrosa, 2011). These cacti occur in dry regions in the states of Arizona, California, Colorado, Nevada, New Mexico, and Utah in the USA, and in northern Mexico in the states of Coahuila, Chihuahua, Durango, Nuevo León, San Luis Potosí, Sonora, and Zacatecas, at altitudes that range from 500 (California) to 2500 m (Utah) of elevation (Hochstätter and Holland, 1995; Hernández and Gómez-Hinostrosa, 2011). *Sclerocactus* species tend to grow in small, scattered populations in dry highland deserts (Heil and Porter, 1994). The dominant vegetation in these habitats consists of xerophilous scrubland and grassland, as well as sparse pine woods (Hochstätter and Holland, 1995; Porter et al., 2000). Most of the species have very restricted populations that have been adversely affected by illegal collecting and destruction of their habitats (Anderson, 2001).

Some *Sclerocactus* species endemic to the USA have populations situated near the border with Mexico, as for example *Sclerocactus polyancistrus* Britton & Rose and *S. papyracanthus* (Engelm.) N.P. Taylor (Benson, 1982). None of the aforementioned species had been found in Mexico; nevertheless, *S. papyracanthus* was recorded approximately 100-150 km away from the border with Mexico (Powell and Weedon, 2004).

Sclerocactus papyracanthus is a solitary plant with globose-elongated or cylindrical stems that can grow up to 7.5 cm long and 2 cm in diameter. The species can be easily distinguished by its long (2-3.5 cm) papyraceous and flattened (several times broader than thick) central spines (Benson, 1982). It presents “dead grass mimicry” because the central spines resemble in shape and coloration the dry, dead leaves of grasses (Wiens, 1978).

Sclerocactus papyracanthus grows in or near rings of the grama grass *Bouteloua gracilis* (Kunth) Lag. ex Griffiths (Poaceae) and the plants are usually unnoticed because “the spines seem like the dried leaves of grass” (Vincent and Lutonsky, 1995). Therefore, this species is known as grama grass cactus, paper-spined cactus, and paper-spine pincushion cactus (Anderson, 2001). The grama grass and some shrubs protect *S. papyracanthus* from grazing (Vincent and Lutonsky, 1995), and this cactus tends to grow shorter than the surrounding protective vegetation, so a nursing plant effect occurs (Flores and Jurado, 2003).

Sclerocactus papyracanthus is found in small groups that are unevenly dispersed (Klein, 1995). It inhabits grasslands in pinyon-juniper woodlands at 1500-2200 m a.s.l., but is usually also located in sandy and saline soils in open flats in grasslands (Heil and Porter, 2001). The species occurs in Arizona, New Mexico, and Texas, very close to the border with Mexico (Benson, 1982). Because northern Mexico has some similar habitats close to the border with the USA, Hernández and Gómez-Hinostrosa (2011) suggested that *S. papyracanthus* could be located in the country, particularly in the state of Chihuahua, but the species had not been reported in the scientific literature for this state (Lebgue-Keleng and Quintana-Martínez, 2013).

Citizen science platforms have been demonstrated to play a very important role in terms of biodiversity documentation (Spear et al., 2017; Soteropoulos et al., 2021; Alvarado-Cárdenas et al., 2023), and the case of *S. papyracanthus* is not an exception. In 2020, the first record of a putative individual of the species was uploaded to the Naturalista

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platform (Naturalista, 2020a; 2020b). Due to the mimicry of the species and the difficult access to the place where the plant was found, until now it had not been possible to obtain additional information about the ecology of the species in the country. Following an exploration in early 2023 in the municipalities of Ascensión and Juárez in Chihuahua, Mexico, that resulted in the discovery of a well established population of *S. papyracanthus*, here we confirm the presence of the species for the country. We aim to describe the species morphology, its ecological characteristics, and to document it with herbarium specimens, photographs, and illustrations.

Materials and Methods

We undertook two explorations to Chihuahua in 2023 to the surroundings of the putative first sighting of *S. papyracanthus* in the municipalities of Juárez and Ascensión, in the state of Chihuahua, Mexico (Naturalista, 2020a). However, the cactus population was only located in Ascensión. The first expedition occurred in early March and aimed to find at least one plant. This took two hours of searching in an area of about 24 km². Once a population was located, the second expedition occurred in early April and had as objectives to find the plants in flower and to approximate the size of the population. This second visit took about six hours of exploration in the same area of 24 km². Because the ecological preferences of the species in Mexico were unknown, the plants were searched in the area by a broad search.

During the expeditions, we photographed with a metric scale all the individuals that were morphologically related to *S. papyracanthus*. Also, based on their size, the individuals were catalogued into seedling (<1 cm), young (1-3 cm), or adult plants (>3 cm). All the main morphological traits, such as stem length and width, radial and central spines length and width, and perianth segments size were measured *in situ* using an electronic vernier (Absolute AOS Digimatic, Mitutoyo, Japan).

The description of the species was complemented with measures of the tubercles, areoles, and the reproductive whorls of the flower using scaled photographs taken with a digital camera (Rebel T7, Canon Inc, Tokyo, Japan)

and the ImageJ program (Schneider et al., 2012; ImageJ, 2023). Because the number of plants found was low, we collected only two individuals to prepare herbarium specimens which were deposited in the Universidad de Guadalajara, Luz María Villarreal de Puga herbarium (IBUG) and in the Universidad Nacional Autónoma de México, Herbario Nacional de México (MEXU) (acronyms according to Thiers, 2023).

We used morphological descriptions of *S. papyracanthus* (Benson, 1981, 1982; Heil and Porter, 2001) to corroborate the determination of our sightings and collections. Once the plants were determined, we searched digital herbarium collections from MEXU and the Arizona State University Vascular Plant Herbarium (ASU) to ensure that it still was the first record of the species in the country. Also, for this purpose, we consulted floristic literature for the study area (CONANP, 2013; Lebgue-Keleng and Quintana-Martínez, 2013; Barajas et al., 2014). Finally, we followed the descriptive format of *S. papyracanthus* of Benson (1982) to present the morphological characters of this species in Mexico.

A distribution map was prepared in QGIS v. 2.14.3 (QGIS Development Team, 2018). The precise point of the location was omitted and the entire municipality of Ascensión, Chihuahua, was highlighted to represent the possible range of distribution of the species. To avoid poaching, we also omitted the complete details of the locality and presented only general information about the habitat and the location of the species.

Results

Our morphological comparison and literature revision supported that this is the first record for *Sclerocactus papyracanthus* in Mexico (Fig. 1). This record is located in the municipality of Ascensión, Chihuahua. In the first visit, four adult plants were sighted in two hours. In a second visit to the area, we found 38 plants in a single but extensive locality. According to our size classification, twenty-three individuals were catalogued as seedlings, two as juveniles, and 13 were adults. Most adult plants were flowering, and we also documented this phenomenon in two juvenile individuals (Fig. 1H).



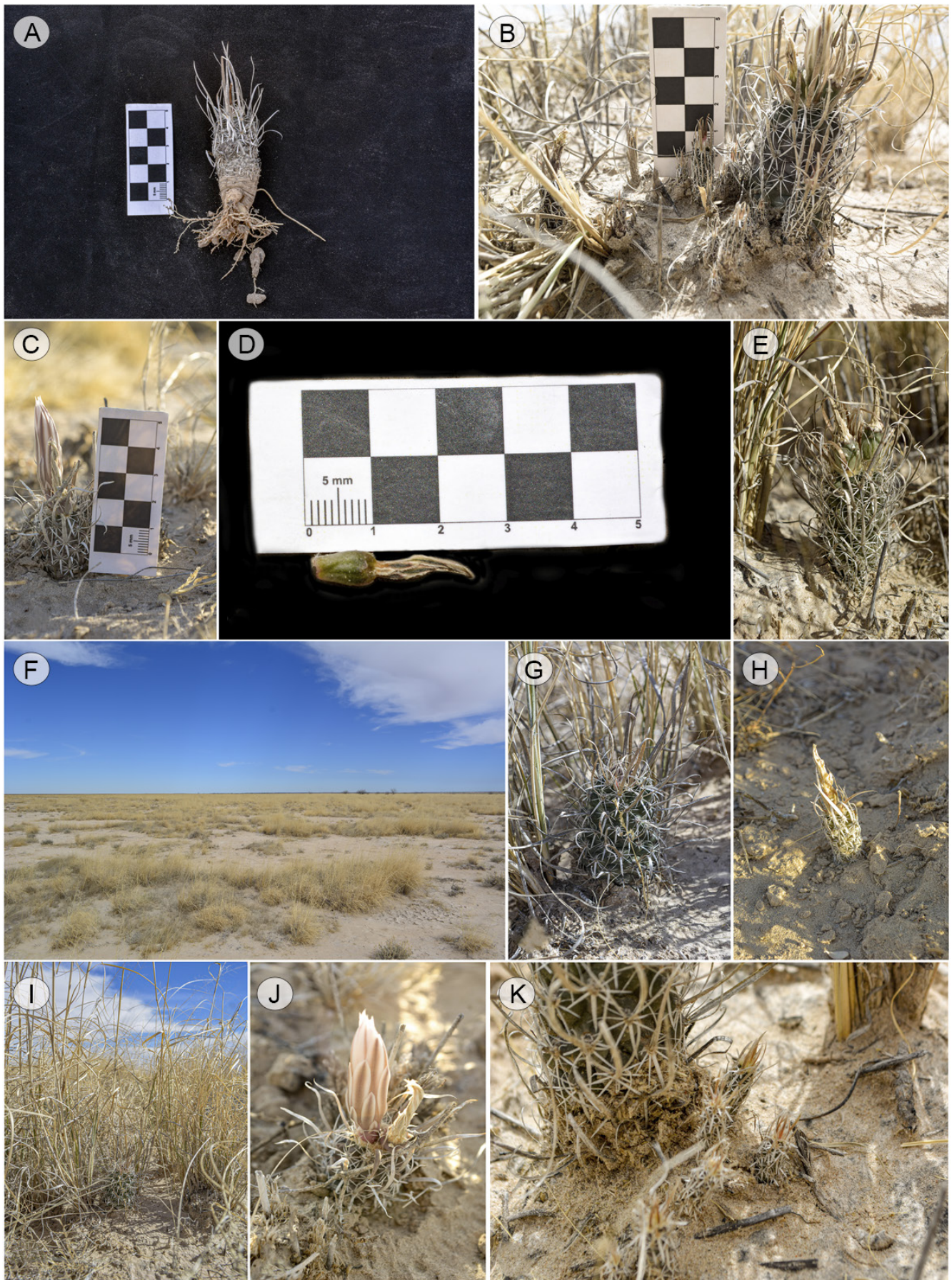


Figure 1: *Sclerocactus papyracanthus* (Engelm.) N.P. Taylor in Mexico. A-C. plant size; D. fruit size; E-K. plants in habitat.

Derived from this, we present the description of the individuals of *S. papyracanthus* in its first recorded population for Mexico.

Taxonomy

Sclerocactus papyracanthus (Engelm.) N.P. Taylor, *Bradleya* 5: 94. 1987. Figs. 1, 2.

≡ *Mammillaria papyracantha* Engelm., Mem. Amer. Acad. Arts ser. 2, 4: 49-(-50). 1849. TYPE: UNITED STATES OF AMERICA. New Mexico, in a valley between the lower hills near Santa Fe in loose sandy red soil, 15.V.1847, A. Fendler 12 (holotype: MO-313109!; isotype: GH-00267757!).

≡ *Echinocactus papyracanthus* (Engelm.) Engelm., Trans. Acad. Sci. St. Louis 2: 198. 1863.

≡ *Toumeyia papyracantha* (Engelm.) Britton, Rose & M.P. Berg, Cact. Succ. J. (Los Angeles) 12: 101, descr. emend. 1940.

≡ *Pediocactus papyracanthus* (Engelm.) L.D. Benson, Cact. Succ. J. (Los Angeles) 34: 61. 1962.

Roots fleshy; stems solitary, elongate, obconical-cylindroid, 2.5-5.5 cm long, 1.5-2 cm wide; tubercles elongate-mamillated or conical, 3-5 mm long, 4-6 mm wide; areoles 1-1.5 mm wide; central spines 1(-3), 21-42 mm long, whitish or pale brown, changing to gray, flexible, most of them curving upward, 1.4-2.5 mm wide at the base, subulate, markedly flattened, midrib evident on ventral side, margins slightly puberulent; radial spines ashy white or gray, never pale brown, flexible, 6-8 per areole, 3-6 mm long, 0.5-1 mm wide, straight, flat, the lower one 5-8 mm long, 1-1.5 mm wide, conspicuously flat; flower 2-2.5 cm wide, 2-3.2 cm long; external perianth segments with purplish-to reddish-brown midribs and nearly white margins, the larger spatulate, to 25 mm long, 3-4 mm wide, apically obtuse, scarious; internal perianth segments white with brownish midribs, oblanceolate, 20-30 mm long, 4-5 mm wide, acuminate, entire; filaments whitish, 6-9 mm long; anthers whitish, 1 mm long, style greenish, 18-20 mm long; stigmas 5, 1-1.5 mm long; ovary 3-4 mm long; fruit green when young, becoming green-purplish when mature, with

a few scales in the upper portion, subglobose, 6-10 mm long, to 4-6 mm wide; seeds black, obovoid, flattened, 2.5-3 mm long, 3 mm wide, 1-1.5 mm thick.

Examined specimen: MEXICO. Chihuahua, municipio Ascensión, 1200 m, 8.IV.2023, J. P. Ortiz-Brunel et al. 1785 (IBUG, MEXU).

Habitat: in Mexico, *Sclerocactus papyracanthus* is known from a single but wide locality in the state of Chihuahua at an elevation of approximately 1200 m (Fig. 3). It inhabits salt flats covered by grasslands mainly composed of *Bouteloua gracilis* and *B. hirsuta* Lag. (Fig. 1F). The plants are always located very close to or inside the grass colonies. Also, it shares its habitat with other cacti such as *Coryphantha macromeris* (Engelm.) Lem., *C. robustispina* (A. Schott ex Engelm.) Britton & Rose, *Echinocereus fendleri* (Engelm.) Sencke ex Haage, and *Opuntia arenaria* Engelm.

Phenology: during the early March visit, we detected small buds on all the plants, but no flower was fully developed. In early April, immature fruits, fresh and dried flowers, and small buds were found. Hence, it is possible that *S. papyracanthus* in Mexico flowers in March and April (and perhaps May) and fruits from April to July. This observation must be considered carefully since we are estimating this based only on the size and number of developing buds and the time that occurred between the visits.

Discussion

Hernández and Gómez-Hinostrosa (2011) stated that it was very feasible that *S. papyracanthus* occurred in the state of Chihuahua in Mexico (Fig. 3). This species has a clear affinity to grasslands in pinyon-juniper woodlands (Heil and Porter, 2001). However, it is known that it also occurs in sandy, saline, or gypsum flats within grasslands, particularly in the Texas populations most closely situated to the border with Mexico (Powell and Weedin, 2004). This new record from Mexico is also located in salt flats within a grassland, just as is the case in the nearest USA populations (Benson, 1981; Powell and Weedin, 2004). It is quite possible that other populations of the species occur in Mexico, particularly



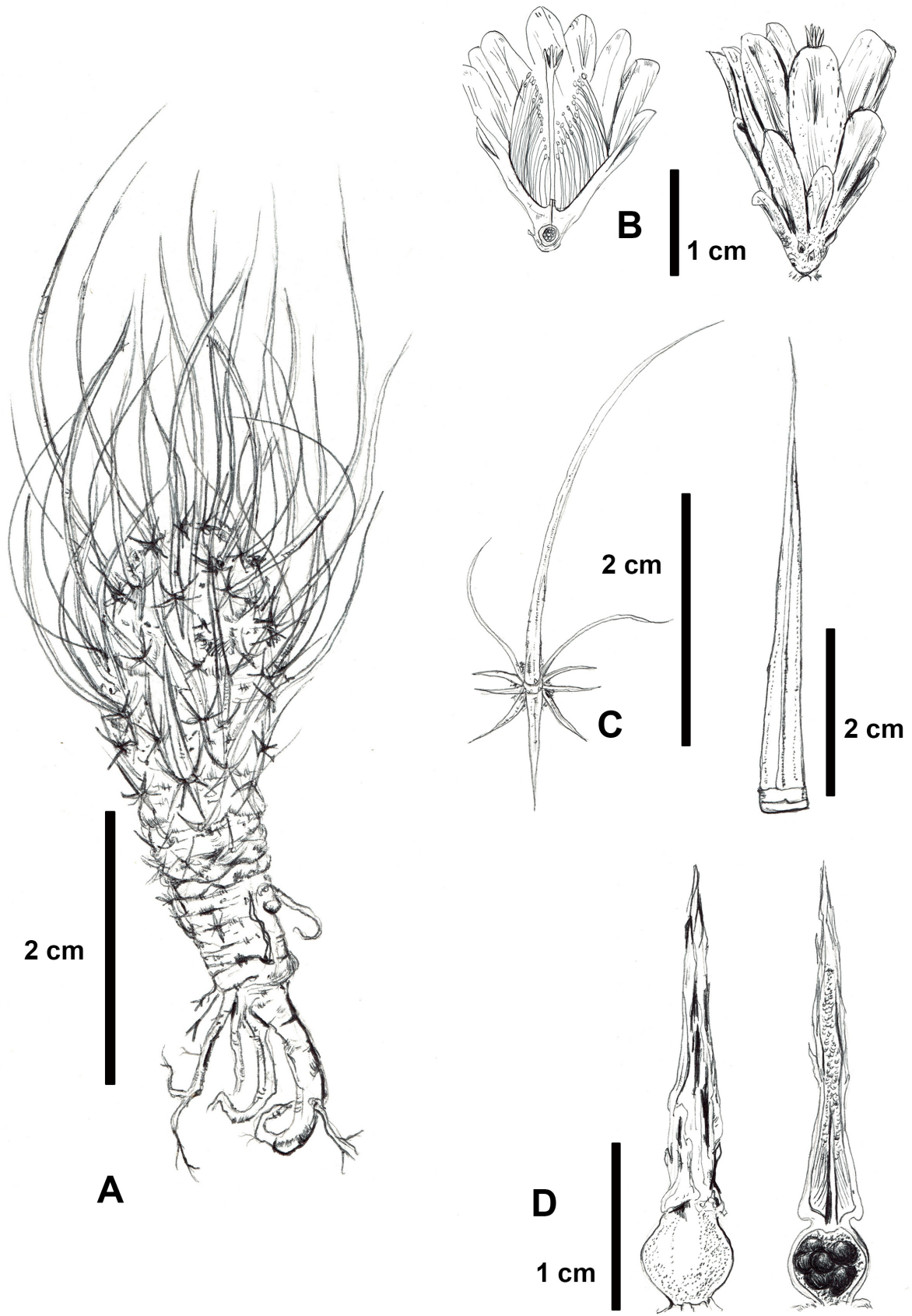


Figure 2: *Sclerocactus papyracanthus* (Engelm.) N.P. Taylor. A. habit; B. flower; C. areole with spines and longer central spine; D. dry flower, fruit, and seeds. Illustrator: Cristian Pérez Badillo.

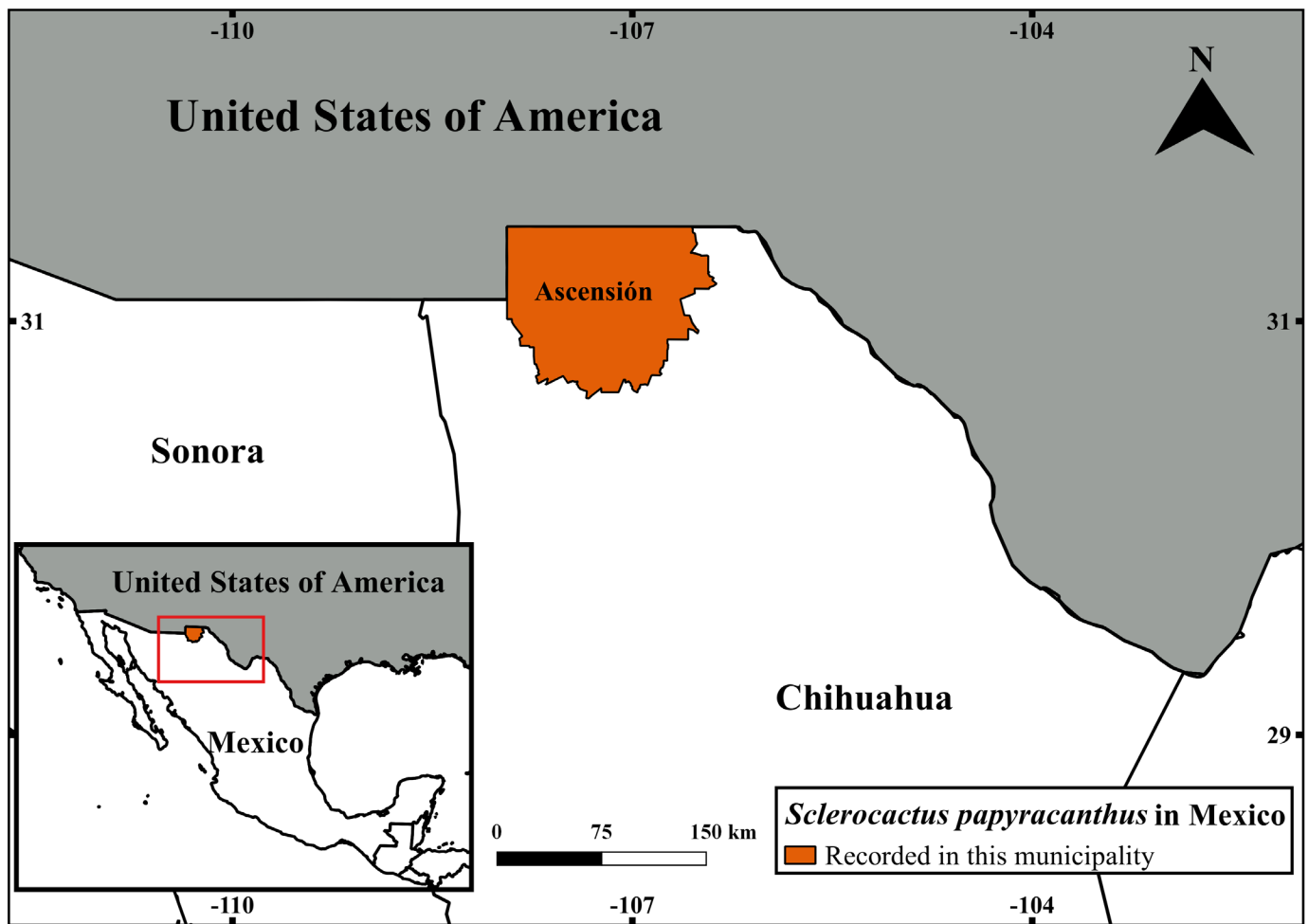


Figure 3: Municipality where the only known population of *Sclerocactus papyracanthus* (Engelm.) N.P. Taylor in Mexico is located.

in Chihuahua. The northern portion of this state includes many areas with the optimal characteristics for the species, but extensive exploration may be required to locate additional populations, especially given how difficult it can be to find these plants (Vincent and Lutonsky, 1995).

We found two juvenile individuals (1.2-1.5 cm tall) of *S. papyracanthus* flowering (Fig. 1H). This interesting phenomenon in which individuals are capable of sexual reproduction while they present juvenile morphology is called neoteny (Kordyum and Kravets, 2021). This has previously been documented in cacti from the genera *Escobaria* Britton & Rose (Breslin, 2012), *Pediocactus* Britton & Rose (Baker and Cloud-Hughes, 2022), and *Turbinicarpus* (Backeb.) Buxb. & Backeb. (Anderson, 2001; Mosco, 2009). In addition, Porter et al. (2000) considered neoteny as the

retention of juvenile traits throughout the life of the plant. They mentioned neotenic stems in *Sclerocactus* (small, depressed-globose, bearing tubercles but no ribs; the spines are short and have few or no hooked central spines), but did not explain if these plants developed flowers and fruits. As far as we know, this is the first record of neoteny for *S. papyracanthus*, but more research is needed to better understand the reproductive ecology of this species.

With the addition of *S. papyracanthus* to the flora of Mexico, there are now eight species of the genus recorded in the country, of which five are known for the state of Chihuahua (Korotkova et al., 2021). *Sclerocactus papyracanthus* is easily distinguished from any other species of the genus by the presence of long papyraceous and flattened central spines that resemble the dry leaves of the

grasses. There is no other species of this genus that develops such long spines (Benson, 1981; Heil and Porter, 2001).

Even though we found only 38 plants, we believe that the population has more individuals but, as stated by Benson (1981), the ecological preferences of the species make it very difficult to find them. However, we only sampled a small portion of the first locality, and it is quite possible that the species is widespread in the region. More exploration in northern Mexico is needed to complement the information about the occurrence and ecological preferences of *S. papyracanthus* in the country and perhaps for documenting other species of Cactaceae reported in the southwest USA but not in Mexico.

Author contributions

IZS discovered the species in Mexico. Explorations and fieldwork were supported by AD and carried out by AD, CPB, IZS, JPOB, and RDRS. JPOB and JF prepared the collections, the species description and the first version of the manuscript. JPOB and RDRS prepared the figures. The illustration was made by CPB. All authors revised and contributed to the final version of the manuscript.

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