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Echeandia cholulensis (Asparagaceae), a new species from central Mexico

Echeandia cholulensis (Asparagaceae), una especie nueva del centro de México

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Abstract:

Background and Aims: The genus *Echeandia* (Asparagaceae) characterizes the Mexican geophyte flora. The group is exclusive of the Americas and includes 85 species. In Mexico, there are 74 species, of which 63 are endemic; however, the species richness is concentrated in the Mexican Transition Zone, including the Transmexican Volcanic Belt (TMVB). Here, we name and describe a new species of *Echeandia* found along the TMVB in the states of Puebla and Tlaxcala.

Methods: Field work and herbarium revision led us to discover a new species of *Echeandia*. The morphological description and illustration were based on eight voucher specimens plus living plants from two populations. Moreover, we compared the morphology of the new taxon with that of *E. michoacensis* and *E. robusta*. Lastly, we assessed its conservation status by calculating its extent of occurrence (EOO) and its area of occupancy (AOO), using the GeoCAT tool and based on the IUCN Red List categories and criteria.

Key results: *Echeandia cholulensis* is a new species from Mexico. The new taxon includes robust plants characterized by root-thickenings distant from the corm; lanceolate, undulate, and glaucous leaves; ascending flowers with white tepals; clavate and muricate filaments, and free anthers with longitudinal dehiscence. Until now, it is known from three populations in central Mexico in the states of Puebla and Tlaxcala.

Conclusions: Along the TMVB, volcanism has created topographic and climatic variation favoring speciation and persistence. The discovery and morphological description of *Echeandia cholulensis* exemplifies this observation. Furthermore, botanical exploration and herbaria revisions might discover new species that would increase the great plant diversity of the TMVB.

Key words: Mexican Transition Zone, Puebla, Tlaxcala, Transmexican Volcanic Belt.

Resumen:

Antecedentes y Objetivos: El género *Echeandia* (Asparagaceae) agrupa geófitas que caracterizan la flora de México. El grupo es endémico de América e incluye 85 especies, 74 de las cuales han sido encontradas en México y 63 son endémicas de este país. Su riqueza se concentra en la Zona de Transición Mexicana, incluido el Eje Volcánico Transmexicano (EVT). En este trabajo, se nombra y se describe a una especie nueva de *Echeandia* recolectada en el EVT en los estados de Puebla y Tlaxcala.

Métodos: Recolectas en campo y revisión de ejemplares de herbario permitieron el descubrimiento de una especie nueva de *Echeandia*. Analizamos la morfología de ocho ejemplares de herbario y plantas vivas de dos poblaciones para describir el nuevo taxón y diferenciarlo de *E. michoacensis* y *E. robusta*. Por último, evaluamos su estado de conservación mediante el cálculo de la extensión de ocurrencia (EOO) y el área de ocupación (AOO) con la herramienta GeoCAT y basándonos en las categorías y criterios de la Lista Roja de la IUCN.

Resultados clave: Describimos *Echeandia cholulensis* como una especie nueva de México. Se caracteriza por desarrollar los engrosamientos de las raíces alejados del cormo. Las hojas son lanceoladas, onduladas y glaucas. Produce flores ascendentes con tépalos blancos, filamentos clavados y muricados y anteras libres con dehiscencia longitudinal. Se conoce de tres poblaciones en el centro de México, en los estados de Puebla y Tlaxcala.

Conclusiones: En el EVT, el volcanismo ha generado variación topográfica y climática que favorece la especiación y persistencia de las plantas. El descubrimiento y descripción morfológica de *Echeandia cholulensis* ejemplifican lo anterior. La exploración botánica y la revisión de los ejemplares de herbario podrían resultar en el descubrimiento de especies nuevas que aumenten la riqueza florística del EVT.

Palabras clave: Eje Volcánico Transmexicano, Puebla, Tlaxcala, Zona de Transición Mexicana.

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Introduction

The main mountain chains of Mexico, including the Transmexican Volcanic Belt (TMVB), form the Mexican Transition Zone (MTZ) (Morrone, 2020). Within the MTZ, orogeny, volcanism and paleoclimatic changes have promoted biological speciation and local survival (Mastretta-Yanes et al., 2015). As a result, angiosperm species richness is concentrated there (Cruz-Cárdenas et al., 2013; Rodríguez et al., 2018; Sosa et al., 2018; Mishler et al., 2020). The Mexican angiosperm flora totals 22,126 species (Villaseñor, 2016), although Joppa et al. (2011) estimated that 15% remains to be discovered and Espejo Serna (2012) calculated that this percentage is around 30.8%.

The genus *Echeandia* Ortega (Asparagaceae) characterizes the Mexican geophyte flora (Rzedowski, 2019). It has 85 species, 74 of which grow in Mexico and 63 are endemic to this country (Espejo Serna, 2012; Ortiz-Brunel et al., 2021). The genus ranges from the southwestern United States of America to southern Peru, but several species have narrow geographic ranges. The number of species is increasing since more areas are being explored and detailed analyses are made based on herbarium specimens (Cruden, 1999; López-Ferrari et al., 2002; Rodríguez and Ortiz-Catedral, 2013; Rodríguez and Ortiz-Brunel, 2019). Both field and herbarium work led us to name and describe a new species, which are the objectives of this study.

Materials and Methods

During a systematic study of *Echeandia*, we collected tall plants of this genus within the boundaries of the Cholula archaeological site, Puebla. Later, we discovered another population in Tlaxcala. Finally, we found two herbarium specimens (Boege 1478) deposited at the National Herbarium of the Universidad Nacional Autónoma de México (MEXU). These were collected at the Xochitécatl archaeological site in the state of Tlaxcala. All populations were from sites in the Transmexican Volcanic Belt. After the analysis of the vegetative and floral characters of these plants, we concluded that they represented an undescribed species. The morphological description and illustration were based on eight voucher specimens plus living plants from two populations. We followed the terminology described by Moreno (1984). Moreover, we assessed its conservation

status by calculating its extent of occurrence (EOO) and its area of occupancy (AOO) using the GeoCAT tool (Bachman et al., 2011) and based on the IUCN Red List Categories and Criteria (IUCN, 2019).

Results

Taxonomy

Echeandia cholulensis Aarón Rodr. & Ortiz-Brunel, sp. nov., Figs. 1, 2.

TYPE: MEXICO. Puebla, municipio San Andrés Cholula, pirámide de Cholula, 2187 m, 19°03'27.8"N, 98°18'5.27"W, 08.VII.2002, A. Rodríguez and L. Ortiz-Catedral 2987 (holotype: IBUG!, isotype: MEXU!).

Plantae robustae; radicum parte incrassata ab cormo 3-4 cm distante; foliis basalibus 6-9, lanceolatis, undulatis, 50-60 cm longis, 4-5 cm latis, marginibus hyalinis; scapo glabro, 1-1.6 m alto, subtento in dimidio inferiore per bracteam longifoliaceam, ramo 0-1; scapi bracteis 6-8, ab basin vaginantes; tepalis albis, reflexis; tepalis externis ellipticis, 15-17 mm longis, 4-5 mm latis; tepalis internis ellipticis, 15-17 mm longis, 5-7 mm latis; filamentis cylindricis vel clavatis, muricatis, 8 mm longis; antheris liberis, sagittatis, dorsifixis, 6 mm longis, lateraliter dehiscentibus; stylo 13 mm longo; ovario cylindrico, 4 mm longo, 1.5 mm lato; capsula elliptica, 9-11 mm longa, 4-5 mm lata.

Perennial herbs, 100-160 cm high, including the inflorescence; root-thickenings 3-4 cm from the corm, 2-4 cm long; basal leaves 6-9, lanceolate, glaucous, margin hyaline, entire, undulate, 50-60 cm long, 4-5 cm wide; inflorescence racemose, rarely 1-branched; peduncle glabrous, ca. 100 cm long, bracts 6-8, the lower half of the peduncle enveloped by long-sheathing leafy bracts; raceme ca. 60 cm long; flowers pedicellate, ascendant, opening in the morning; pedicels green, 10-15 mm long, articulated at the middle; tepals white, reflexed, with 5 green longitudinal nerves; outer tepals elliptic, 15-17 mm long, 4-5 mm wide, acute; inner tepals elliptic, 15-17 mm long, 5-7 mm wide, acute; filaments white, linear, cylindric to clavate, muricate,



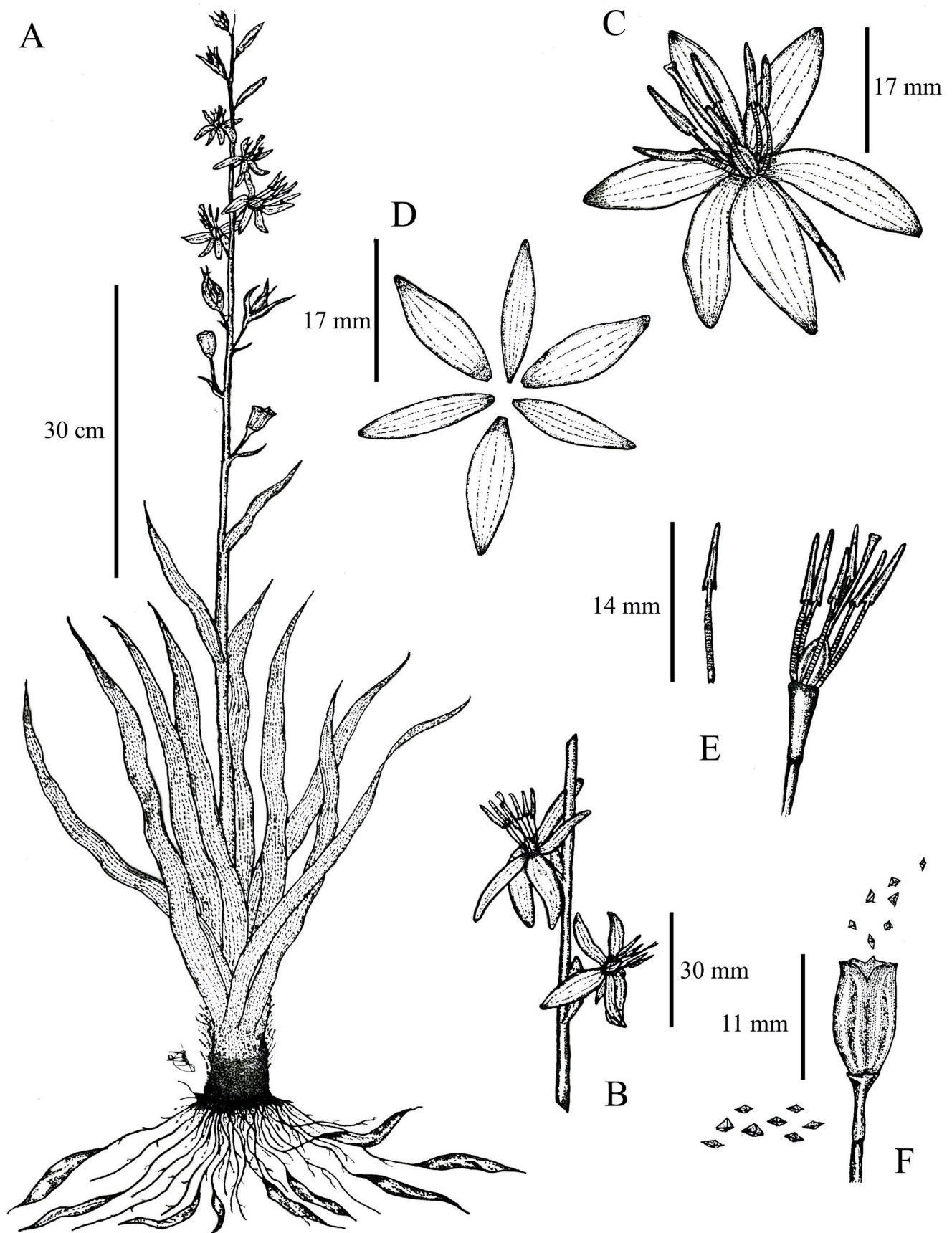


Figure 1: *Echeandia cholulensis* Aarón Rodr. & Ortiz-Brunel. A. habit; B. inflorescence detail; C. flower; D. tepals; E. androecium, gynoecium; F. capsule, seeds. Drawn by Juvenal Aragón Parada from the type (A. Rodríguez and L. Ortiz-Catedral 2987).

ca. 8 mm long; anthers sagittate, dorsifixed, free, ca. 6 mm long, dehiscing through longitudinal slits; style white, ca. 13 mm long, surpassing the anthers by ca. 3 mm; stigma capitate; ovary green, narrowly oblong to narrowly ellipsoid, 3-4 mm long, ca. 1.5 mm diameter; capsule green, ellipsoid, 9-11 mm long, 4-5 mm wide; seeds deltoid, folded, black, opaque, 1-1.5 mm long, 1-1.5 mm wide.

Etymology: the specific epithet refers to the Cholula archeological site.

Distribution and ecology: *Echeandia cholulensis* is known from three collections in the states of Puebla and Tlaxcala (Fig. 3). It has been collected in the valleys around the cities of Puebla and Tlaxcala. It grows in open areas with heavy clay soils and gullies with secondary vegetation derived from the pine-oak forest. It has been found between 2200-2400 m elevation. The populations have numerous individuals. The flowers open during the morning and remain so until early afternoon.

Phenology: the flowering and fruiting period extends from July to October.

Conservation status: EOO and AOO values were estimated at 42.705 km² and 12 km², respectively. Based on the criteria B1a and B2a, established by the IUCN (2019), the new species should be considered as Endangered (EN). Its geographical range lies within the urban areas of Puebla and Tlaxcala. This area is under severe pressure due to the agricultural practices and urban growth. According to the RBG Kew (2016) assessment, both processes represent the first and third causes of plant extinction, respectively. However, *Echeandia cholulensis* was collected within the boundaries of two archaeological sites: Cholula and Xochitécatl. In Cholula, the population has numerous individuals. As a consequence, both populations are safeguarded since Mexican archaeological sites are protected by federal law.

Additional specimens examined: MEXICO. Tlaxcala, municipio Tepetitla de la Solidaridad, Xochitécatl, 2368 m, 19°14'44.61"N, 98°21'0.17"W, 11.X.1970, L. W. Boege 1478 (MEXU); cerca de La Corona, 2.3 km antes de llegar a

la caseta de cobro, 2286 m, 19°19'5.41"N, 98°24'27.56"W, 09.IX.2018, G. Munguía-Lino et al. 567 (IBUG, IEB, MEXU, UAMIZ).

Discussion

Morphologically, *Echeandia cholulensis* resembles *E. michoacensis* (Poelln.) Cruden and *E. robusta* Cruden (Fig. 2). All three species include robust plants with root-thickenings distant from the corm, muricate filaments, and free ascending anthers. *Echeandia cholulensis* and *E. robusta* have white tepals, while those of *E. michoacensis* are yellow (Cruden, 1987; 1993). The inflorescence of *E. cholulensis* is unbranched or produces only one basal branch, in contrast to that of *E. robusta* which branches several times. The flowers of *E. cholulensis* open during the morning and the anthers dehisce by longitudinal slits. Conversely, in *E. robusta* the anthesis occurs in the afternoon with the release of pollen by apical pores. *Echeandia cholulensis* occurs in the pine-oak forest or secondary vegetation derived from it, above 2000 m elevation and along the TMVB in Puebla and Tlaxcala. Collections of *E. robusta* have been made in southern Jalisco, along the Pacific slopes of the Sierra Madre del Sur. It grows in savannah-like vegetation (Rzedowski and McVaugh, 1966; Rzedowski, 1978), between 500 and 1000 m a.s.l. (Fig. 3).

Cruden (1999) divided *Echeandia* into subgenera *Echeandia* and *Mscavea* Cruden. The former includes plants with flowers opening early in the morning, commonly with elliptic white or yellow tepals, and ellipsoidal fruits. Most species grow above 1500 m elevation. In contrast, plants in the subgenus *Mscavea* have flowers which open near noon or later, most of them have narrowly elliptical white tepals and globose fruits. These plants grow below 1500 m elevation. According to this, *E. cholulensis* pertains to *E.* subg. *Echeandia*.

Villaseñor (2016) listed 22,126 species of angiosperms for Mexico with 49.8% of them endemic. This number defines Mexico as a hotspot with a diverse flora, ranking it fifth worldwide (RGB Kew, 2016). Based on Sosa et al. (2018), most Mexican plant lineages diversified around 5-20 million years ago, which coincides with the TMVB formation (Ferrari et al., 2012). Consequently, orogeny, volcanism and paleoclimatic changes facilitated the diversifica-



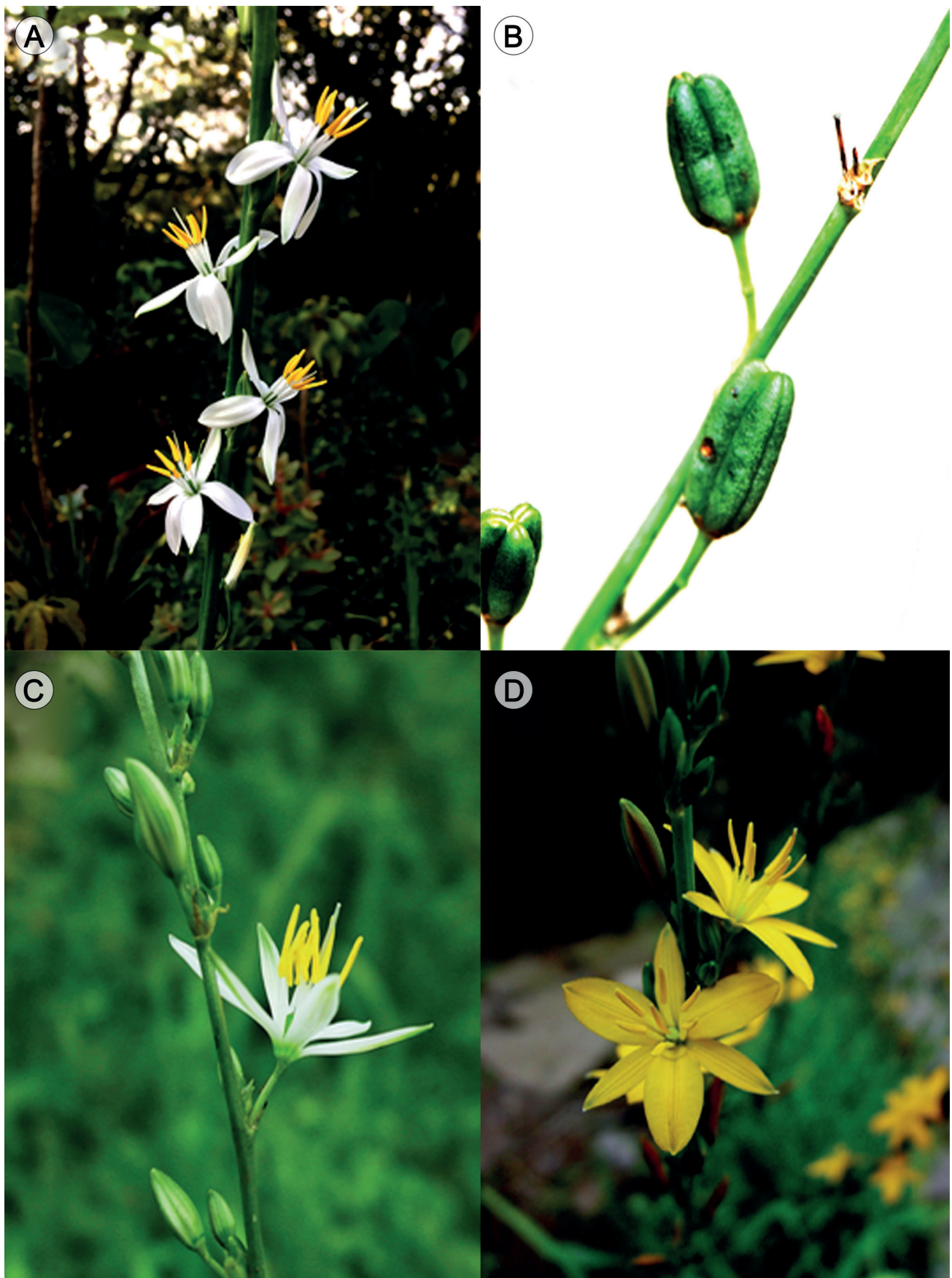


Figure 2: Photos of *Echeandia cholulensis* Aarón Rodr. & Ortiz-Brunel and its morphologically related species. A. inflorescence; B. fruits; C. inflorescence of *E. robusta* Cruden; D. inflorescence of *E. michoacensis* (Poelln.) Cruden. Photos by Aarón Rodríguez.

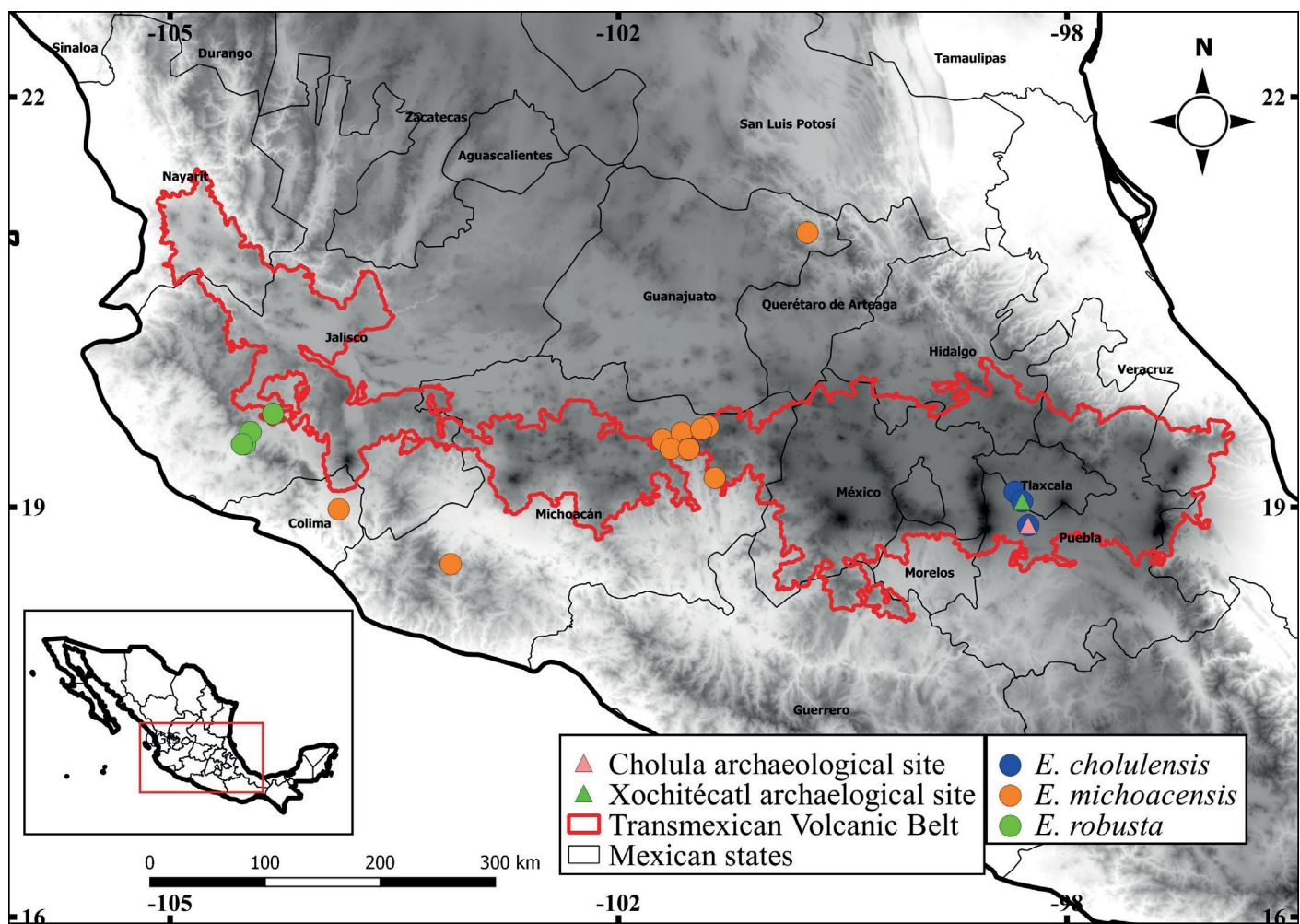


Figure 3: Distribution of *Echeandia cholulensis* Aarón Rodr. & Ortiz-Brunel, *E. michoacensis* (Poelln.) Cruden, and *E. robusta* Cruden in Mexico.

tion and persistence of the Mexican plant species on the mountainous areas of the country (Mastretta-Yanes et al., 2015; Muellner-Riehl et al., 2019). The diversification of *Di-oon* Lindl. and *Quercus* L. fits in this scenario (Gutiérrez-Ortega et al., 2018; Hipp et al., 2018).

Yet, several species of plants remain to be discovered, named, and described. At a global scale, Joppa et al. (2011) estimated that this proportion is about 15%, while Espejo-Serna (2012) calculated that this percentage is around 30.8% for the Mexican flora. Herbaria hold millions of plant specimens, but Goodwin et al. (2015) assessed that more than 50% of the tropical collections could be incorrectly identified. Our work highlights the importance of herbaria revision, since botanical exploration provides specimens, but many of these wait inside herbarium cabinets to be reviewed or identified.

Author contributions

AR led the fieldwork. AR and JPOB reviewed the herbarium specimens, elaborated the species description, and wrote the manuscript. JPOB elaborated the Figures 2 and 3. Both authors reviewed the document and prepared the final version.

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