

ECHEVERIA ZOQUITLANENSIS (CRASSULACEAE), A NEW MICROENDEMIC SPECIES FROM OAXACA, MEXICO

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Abstract

Background: *Echeveria* (Crassulaceae) is an American genus distributed from Mexico to South America. The genus has 164 species recorded in Mexico, where the state of Oaxaca with 56 species has the greatest richness of the genus. The exploration of the high mountains of Santa María Zoquitlán led us to discover a population of *Echeveria* that differed from previously known species.

Questions: Does the *Echeveria* population from the high areas of the municipality of Santa María Zoquitlán, Oaxaca represent a new species?

Taxon: *Echeveria* species.

Study site: Oaxaca Mountains, Mexico.

Methods: Morphological comparison with the closely related taxa *E. islasiae*, *E. longissima*, *E. longissima* subsp. *brachyantha*, and *E. longissima* var. *azatlensis*. Evaluation of conservation status based on the IUCN Red List categories and criteria.

Results: We described and illustrated *Echeveria zoquitlanensis* from Santa María Zoquitlán, Oaxaca, Mexico as a new species. Due their long corollas and styles, the new species were placed in the series *Longistylae*, mapped its distribution, and determined its conservation status category as critically endangered (CR B1; B2). It differs from the other members of the series by its very long (up to 3.7 cm) crimson red homochromatic flowers, and pale pink to red pistils.

Conclusions: *Echeveria zoquitlanensis* is the species with the largest flowers within the genus. Exploration carried out in isolated areas in Oaxaca favor the discovery of additional new species that would increase the large diversity of the state.

Keywords: Endemism, new species, Saxifragales, Sierra Madre del Sur, Zoquitlán.

Resumen

Antecedentes: *Echeveria* (Crassulaceae) es un género americano que se distribuye desde México hasta Sudamérica. En México se registran 164 especies. Oaxaca con 56 especies es el estado con mayor riqueza del género. Exploraciones de campo en las montañas altas del municipio de Santa María Zoquitlán derivaron en el descubrimiento de una población de *Echeveria* con características que no se ajustan a las especies previamente conocidas.

Pregunta: ¿Representa la población de *Echeveria* de las zonas altas del municipio de Santa María Zoquitlán una especie nueva?

Taxón: Especies de *Echeveria*.

Sitio de estudio: Montañas de Oaxaca, México.

Métodos: Se realizaron comparaciones con especies cercanas morfológicamente como son *E. islasiae*, *E. longissima*, *E. longissima* subsp. *brachyantha* y *E. longissima* var. *azatlensis*. Se evaluó el estado de conservación con base en las categorías y criterios de la Lista Roja de la UICN.

Resultados: Se describe e ilustra *Echeveria zoquitlanensis*, una nueva especie de Santa María Zoquitlán, Oaxaca, México. Por la longitud de sus flores y estilos fue ubicada en la serie *Longistylae*. Se diferencia de los demás miembros de la serie por presentar flores muy largas (de hasta 3.6 cm) homocromáticas, de color rojo carmesí. Se presentan imágenes y un mapa de distribución.

Conclusiones: *Echeveria zoquitlanensis* es una especie nueva para Oaxaca. Las exploraciones realizadas en áreas aisladas en Oaxaca favorecen el descubrimiento de otras posibles nuevas especies que aumentarían la gran diversidad del estado.

Palabras clave: Endemismo, nueva especie, Saxifragales, Sierra Madre del Sur, Zoquitlán.

Echeveria DC (De Candolle 1828: 401) is an American genus of the Crassulaceae family with 17 infra-specific groups and around 204 taxa distributed from the southern United States (Texas) to Central and South America (Pilbeam 2008, de la Cruz-López *et al.* 2019, Pérez-Calix & Guadián-Marín 2025). In Mexico, around 164 species of the genus are found, concentrating their richness and endemism mainly in the mountainous areas of the southern part of the country. At least 60 are distributed in the Sierra Madre del Sur biogeographic province, where 29 species are endemic (Villaseñor 2016, Aragón-Parada *et al.* 2021, Pérez-Calix & Guadián-Marín 2025). The state of Oaxaca, with around 65 species, is the state with the greatest diversity of the genus in Mexico (Villaseñor 2016, Pérez-Calix & Franco-García 2004, Pérez-Calix 2011, Reyes-Santiago *et al.* 2025). The great orographic and geological diversity of the state of Oaxaca has favored a great biological diversity, which is manifested in the high richness values for many biological groups, including vascular plants (Centeno-García 2004, Villaseñor 2016, Aragón-Parada *et al.* 2021).

During our explorations and collections made in the municipality of Santa María Zoquitlán –forming part of the upper basin of the Tehuantepec River- with the objective of gathering records of vascular plants, we collected plants of the genus *Echeveria* growing at the top of the Guilache hill located in the northeastern part of the municipality. Our attempts to determine the identity of these plants following specialized literature (*i.e.*, Walther 1972, Meyrán & López 2003, Pilbeam 2008) only allowed us to place it within *Echeveria* series *Longistylae*, which only includes *Echeveria longissima* Walther (1938: 147) and their subspecific taxa *E. longissima* var. *aztatlensis* Meyrán (1982: 33). Furthermore, the collected specimen was also contrasted with recently described taxa that was also placed in this series: *E. longissima* subsp. *brachyantha* Reyes-Santiago *et al.* (2015: 81), and *E. islasiae* Reyes-Santiago & de la Cruz-López (2021: 363). The noticeable long flowers (longer than any other species in the genus), with homochromatic red corollas, and elongated styles, as well as the geographic distribution, makes the population in the Guilache hill different from those of all other subspecies and varieties of *Echeveria longissima* and *E. islasiae*. Because of this we here describe it as a new species and present its geographical distribution map, illustrations and photographs, and a morphological comparison with the most similar taxa.

Material and methods

Some of the collected specimens were herborized according to Sánchez (1986) and other was cultivated at Zapopan, Jalisco, Mexico. All the specimens were subsequently reviewed and measured at the IBUG herbarium (Thiers 2019). Descriptions were made by measuring fresh and dry material and morphological analysis of leaves and flowers using a standard stereo microscope. To ensure the status of the proposed new species, we reviewed high-definition images of type specimens, protologues, and other descriptions of all the members in the series *Longistylae* –*Echeveria longissima*, *E. longissima* subsp. *brachyantha*, and *E. longissima* var. *aztatlensis*, taxa with the most morphological similarities (Pilbeam 2008, Reyes-Santiago *et al.* 2015, Reyes-Santiago & de la Cruz-López 2021). The type of material was deposited at the herbarium Luz María Villarreal de Puga (IBUG), and duplicate specimens were sent to the herbaria MEXU and OAX (acronyms according to Thiers 2019). Finally, we assessed the conservation status of the new species by calculating its extent of occurrence (EOO) and 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

Echeveria zoquitlanensis J. Aragón-Parada & P. Carrillo, sp. nov. ([Figures 1, 2](#); [Table 1](#))

Type. México, Oaxaca, municipality of Santa María Zoquitlán, Cerro Guilache, 2.8 km al NO de La Trampa. Alt. 1952 m; 16° 35' 30" N; 96° 17' 58.7" W. Oak forest. 2 August 2021. J. Aragón-Parada & M. Sosa-Sosa 1632 (Holotype: IBUG!, isotypes: MEXU!, OAX!).

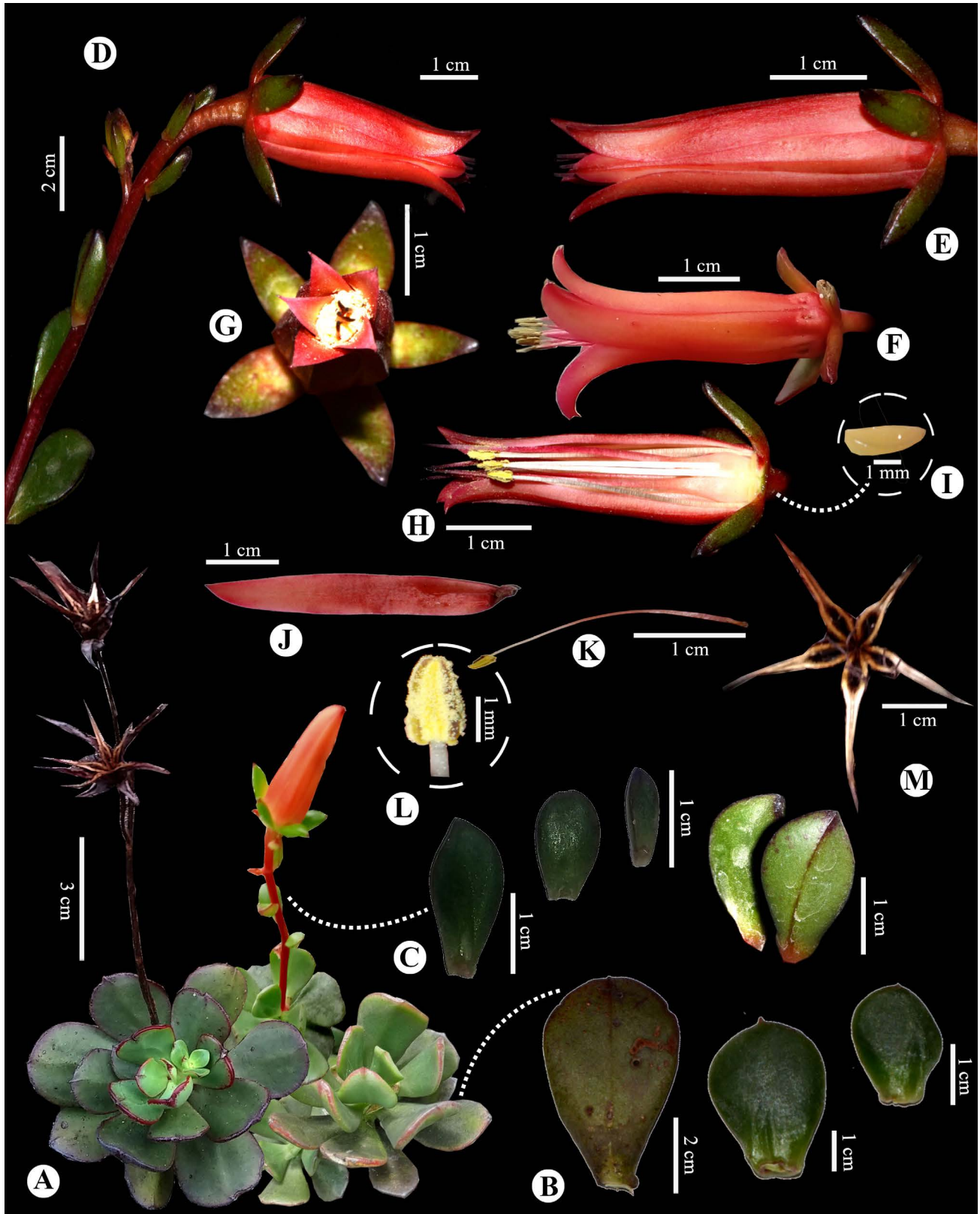


Figure 1. *Echeveria zoquitlanensis* Aragón-Parada J. & P. Carrillo. A) Habit. B) Leaves. C) Bracts. D) Inflorescence side view. E, F) Flower side view. G) Flower face view. H) Flower longitudinal section. I) Nectary. J) Petal. K) Stamen. L) Anther. M) Fruit.

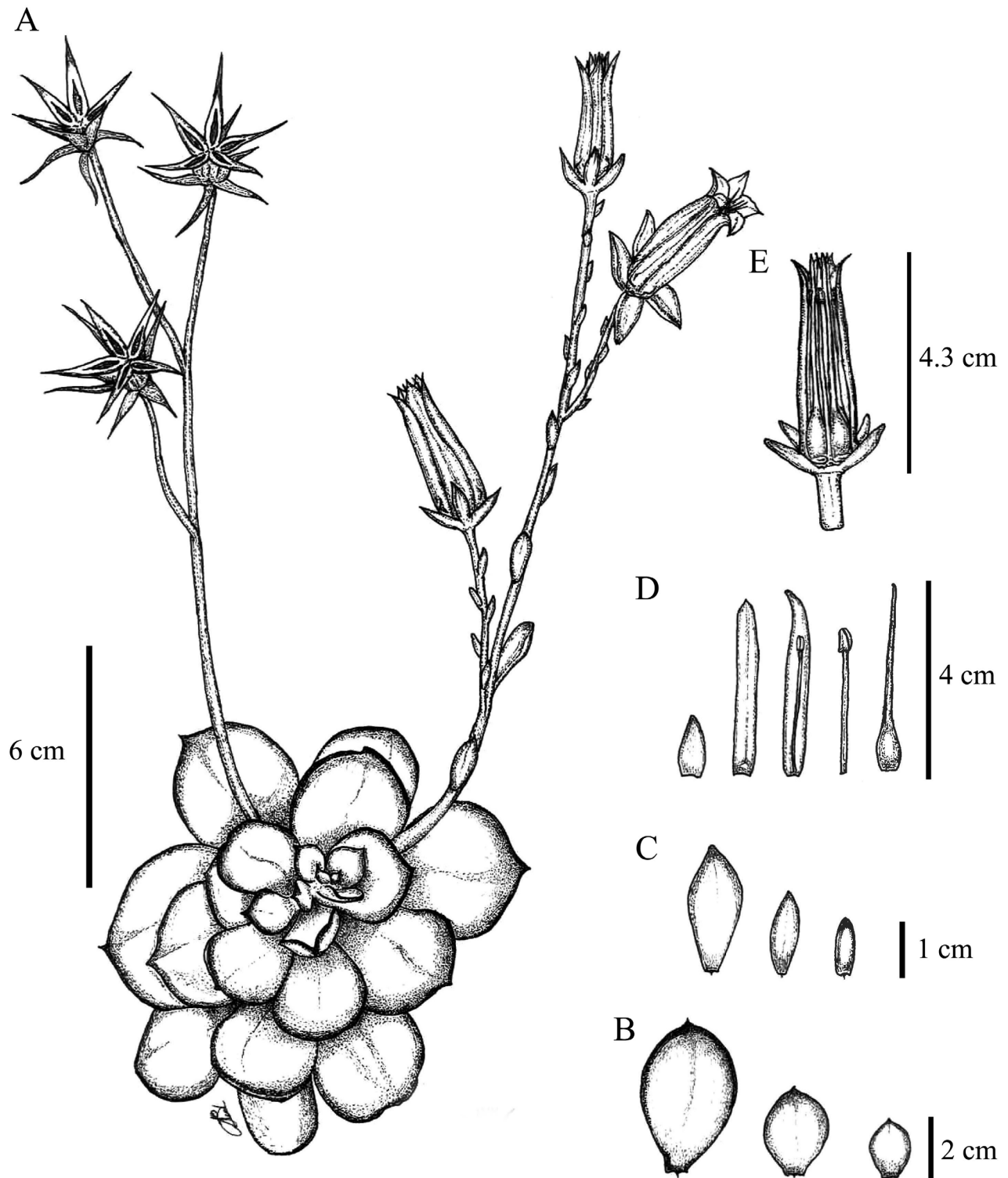


Figure 2. *Echeveria zoquitlanensis* Aragón-Parada J. & P. Carrillo-Reyes. A) Habit. B) Leaves. C) Bracts of the inflorescence. D) Sepal, petal in abaxial view, petal in adaxial view, with an epipetalous stamen, stamen and carpel. E) flower with one petal removed. Illustration by Juvenal Aragón-Parada.

Table 1. Comparative characters of *Echeveria zoquitlanensis* and related species. Modified from Reyes-Santiago *et al.* (2015) and Reyes-Santiago & De la Cruz López (2021).

Characters	<i>E. islasiae</i>	<i>E. longissima</i> var. <i>longissima</i>	<i>E. longissima</i> subsp. <i>brachyantha</i>	<i>E. longissima</i> var. <i>aztatensis</i>	<i>E. zoquitlanensis</i>
Stem (cm)	2-4	2	5	1.5	2-22
Rosette diameter (cm)	4.5-7	7-12	8-11	3-8	6-8
Leaf shape	oblanceolate-spathulate to cymbiform	broadly ovate-cuneate	obovate	obovate	broadly elliptic to obovate
Leaf length (cm)	2.5-3	3.5-6	4-7	2.3-3	2-6
Flower pedicel length (mm)	13-15	13-19	10-11	3-10	20-40
Corolla color	pink at the base, green at the apex	orange at the base, yellow at the middle and green at the apex	orange at the base, green at the apex	yellow at the base, pink at the middle part, green at the apex	red crimson to red-coral
Corolla length (mm)	13-16	30	13-16	26-30	34-36
Corolla width (mm)	6-7	7-10	8-11	10-12	10
Corolla shape in anthesis	conical to globose	cylindrical	cylindrical	cylindrical	cylindrical
Gynoecium	white	white	white	white	pale pink to dark crimson red at the styles
Flowering period	December	April-May	May-July	August-October	July-August
Type locality	Guerrero: Oliná, Cualac	Puebla: Caltepec, San Luis Atlotitlán	Oaxaca: San Miguel El Grande, Cerro Yucunino.	Oaxaca: Concepción Buenavista, San Miguel Azatlá	Oaxaca: Santa María Zoquitlán, Cerro Guilache
Vegetation	<i>Quercus</i> forest	xerophytic enclave with <i>Quercus</i>	<i>Pinus-Quercus</i> forest	xerophytic enclave with <i>Quercus</i>	<i>Quercus</i> forest
Elevation (m a.s.l.)	1,830	2,000-2,500	2,500-2,880	2,400-2,600	1,940-2,100

Diagnosis. *Echeveria zoquitlanensis* is similar to other members of *Echeveria* series *Longistylae* in having long tubular corollas but differs in the 20-40 mm flower pedicels (3-19 mm in other members), 3.4-3.6 cm homochromatic corollas (1.3-3 cm heterochromatic corollas in other members), and pale pink to dark crimson red gynoecium (white to pinkish white in other members).

Description. Perennial herb, glabrous, succulent, caulescent, 10-40 cm tall (including the inflorescences); stem erect up to 22 cm long and 1 cm in diameter near at the base, unbranched; leaves, 8-18 (-20), 2-6 cm long, 2-4 cm wide and 2.5-3 mm thick near the base, arranged in a spiral, forming a semi dense 6-8 cm diameter rosette, slightly ascending, fleshy lamellae, dark green, broadly elliptic to obovate, rounded apex, mucronate, margin entire, generally red colored; inflorescence 1 per rosette, 12-19 cm tall including the red peduncle, racemose, 3-5 mm in diameter near at the base, with 1-4 flowers, bracts arranged in a spiral, oblong-obovate appressed, 1-2.5 cm long, 1-1.5 cm wide and 1-2 mm thick in the middle part, slightly lighter green than the leaves, red outline and mucronate, slightly spurred, deciduous; pedicels 2-4 cm long and about 3 mm in diameter; flower up to 3.7 cm long, about 2.5 cm in diameter across the sepals; calyx extended in pre-anthesis to somewhat appressed in anthesis, sepals fused at the base, oblong-elliptical to lanceolate, equal, up to 10 mm long and 2-3.5 mm wide, 0.9-1.2 mm thick, calyx tube 1.5 mm long;

corolla conoid in button, quincuncial, cylindrical, segments lanceolate, 3.4-3.6 cm long and 1 cm wide at the base, with a small rib in the middle dorsal part, red-crimson to red-coral, apex acute-mucronate; stamens 10, 5 opposite to the petals, 25 mm long, 5 alternate, 27 mm long, exerted in anthesis, filaments 21-24 mm long, white, anthers 4 mm long; gynoecium pale pink at the base to dark crimson red at the styles, carpels 5, free, up to 40 mm long, 5 mm wide at the base, styles slightly exerted; follicles erect, 10 mm long; nectaries 5, 3 mm long, 1.2 mm wide, pale yellow; seeds numerous, brown.

Distribution and habitat. The population of *Echeveria zoquitlanensis* grows on sedimentary sandstone rocks on shallow soil in protected or open areas of the oak forest in the municipality of Santa María Zoquitlán, Oaxaca, Mexico, at elevations between 1,952 and 2,078 m (Figures 3,4). The species is distributed over an oak forest with the presence of *Bletia lilacina* A. Rich. & Galeotti, *Echeveria macdougallii* E. Walther, *Echeveria moranii* E. Walther, *Nolina longifolia* Hemsl., *Pinguicula moranensis* Kunth, *Pinus devoniana* Lindley, *Prosthechea michuacana* (La Llave & Lex.) W.E. Higgins, *Viridantha atroviridipetala* (Matuda) Espejo, and *Quercus* sp.

Etymology. The specific epithet refers to the municipality of Santa María Zoquitlán, Oaxaca, Mexico, where it was collected.

Phenology. The flowering and fruiting period extends from July to August.

Conservation status. *Echeveria zoquitlanensis* is represented by an average nucleus of 0.8 km². Its Extension of Occurrence (EOO) was 0.8 km² and its Occupation Area (AOO) was 4 km². Following the IUCN (2019) criteria, the EOO and AOO values of *E. zoquitlanensis* lower than 100 and 10 km², respectively, place it within the critically endangered category (CR B1; B2).

Additional examined specimens. MEXICO. Oaxaca: Santa María Zoquitlán, Cerro Guilache a 1.7 km al NO de La Trampa, Alt. 1,942 m, 16° 35' 31.9" N; 96° 16' 55.1" W, 2 August 2021. J. Aragón-Parada & M. Sosa-Sosa 1628 (IBUG, MEXU). Cerro Guilache a 2.3 km de La Trampa, Alt. 2,054 m, 16° 35' 18.30" N; 96° 17' 13.20" W, 5 January 2021. J. Aragón-Parada & M. Lucero-Parada 1621 (IBUG, SERO).

Discussion

The discovery of this new taxon was the result of our exploration of the upper basin of the Tehuantepec River made with the objective of expanding the locations of the endemic plants reported for this geographical area. *Echeveria longissima*, its subspecies, and its varieties are distributed in the Mixteca region, a geographical area recognized for its high endemism (García-Mendoza *et al.* 1994), while *E. islasiae* is only known in the state of Guerrero (Reyes-Santiago & de la Cruz-López 2021). The morphological differences between *E. longissima*, *E. islasiae*, and *E. zoquitlanensis* are noticeable. *Echeveria zoquitlanensis* has the longest flowers known for the genus, additionally, it is the only species with homochromatic corollas in the series *Longistylae* (Figure 1; Table 1).

The long tubular red flowers with exerted anthers strongly suggest an ornithophily syndrome, which was previously reported in the genus by Vargas & Parra-Tabla (2002) and Jimeno-Sevilla *et al.* (2013). Due to the limited geographic distribution of *E. longissima*, *E. islasiae*, and *E. zoquitlanensis*, these taxa could be placed under conservation status by Mexican law. Extensive grazing, changes in land use, agriculture, and other human activities are among the most evident factors that put populations of these taxa at risk. Finally, it is important to mention the presence of species endemic to the upper basin of the Tehuantepec River -like *Hechtia marnier-lapostollei* Smith (1961: 58), *Echeveria moranii*, *Dioon oaxacensis* Gutiérrez-Ortega *et al.* (2020: 1), *Ortegocactus macdougallii* Alexander (1961: 17), and *Bursera heliae* Rzedowski & Calderón de Rzedowski (2002: 83)- and of species with distributions restricted to the state of Oaxaca (Acosta *et al.* 2003, Aragón-Parada *et al.* 2021) nearby the distribution area of *E. zoquitlanensis*, because of which this area is considered of high value for conservation.



Figure 3. *Echeveria zoquitlanensis* Aragón-Parada J. & P. Carrillo. A-C) Habit. D) Habitat.

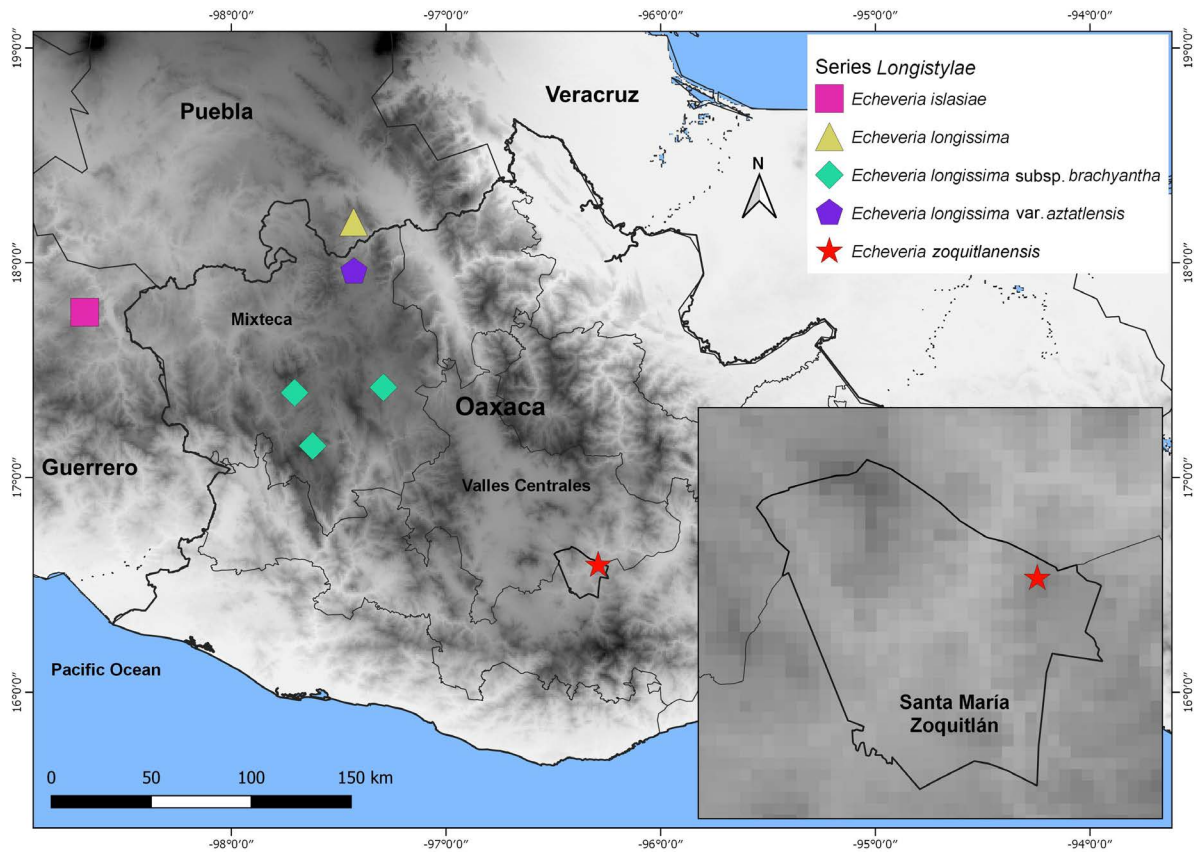


Figure 4. Distribution of *Echeveria* series *Longistylae*.

Acknowledgments

We acknowledge Eduardo Ruiz-Sánchez, Sergio Zárate-Pedroche, and two anonymous reviewers for their valuable comments to improve the manuscript, Jesús G. González-Gallegos for his observations on the specific epithet of the species. Thanks are given to M. Lucero-Parada and M. Sosa-Sosa for their help with the fieldwork.

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Associate editor: Martha Juana Martínez Gordillo

Author contributions: JAP led the fieldwork. JAP and PCR reviewed the herbarium specimens, elaborated the species description, and wrote the manuscript. JAP elaborated the figures and [Table 1](#). Both authors reviewed the document and prepared the final version.

Supporting Agencies: Secretaría de Ciencia, Humanidades, Tecnología e Innovación (SECITHI) granted a doctoral scholarship for JAP (CVU: 778553).

Conflict of interests: The authors declare that there is no conflict of interest, financial or personal, in the information, presentation of data, and results of this article.