Echeveria yalmanantlanensis (Crassulaceae): A new species from Cerro Grande, Sierra de Manantlán, western Mexico

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Abstract. **Echeveria yalmanantlanensis**, a new species from eastern Sierra de Manantlán, Biosphere Reserve, on the Jalisco-Colima border in western Mexico, is described and illustrated, and a table for comparison of morphologically related taxa is provided. This species belongs to series *Valvatae*, differing from the other members of the series by its acaulescent habit, shape and color of leaves and bracts, size of scape, bract pattern on scape, size and color of the corolla, habitat, and geographic distribution. There is support for the hypotheses that this species is endemic to the calcareous massif Cerro Grande and is already in danger of extinction.

Key Words: Allopatric, Endangered, Endemic, *Echeveria* series *Valvatae*.

Resumen. Se describe e ilustra **Echeveria yalmanantlanensis**, una especie nueva de la Sierra de Manantlán oriental, en los límites de los estados de Colima y Jalisco, occidente de México; se provee un cuadro comparativo para la identificación de taxones relacionados morfológicamente. Esta especie pertenece a la serie *Valvatae*, difiere de los otros dos miembros de la serie por su hábito acaulescente, forma y color de sus hojas y brácteas, tamaño del escapo, patrón de brácteas en el escapo, tamaño de la corola, color de sépalos y de corola, distribución geográfica y hábitat. Se apoyan las hipótesis de que esta especie es endémica del macizo calcáreo Cerro Grande y de que se encuentra en peligro de extinción.

Echeveria DC. comprises some 140 known species, and 95 % of these are found in Mexico, the richest center of diversity and endemism for the genus (Uhl, 1992; Thiede, 1995; Meyrán & López-Chávez, 2003). There are about ten species of *Echeveria* in the state of Jalisco (Pilbeam, 2008), mostly distributed in temperate mountainous rocky areas, with only two of these occurring in tropical dry forest: *E. pringlei* (Watson) Rose and *E. elegans* var. *tuxpanensis* Walther. Even though the Sierra de Manantlán Biosphere Reserve in Western Mexico has been extensively explored for decades, no *Echeveria* species has ever been recorded from this geographical area (Vázquez-García et al., 1995; Vázquez-García & Givnish, 1998; Cuevas & Jardel, 2004). However, during a botanical excursion to Cerro Grande, Sierra de Manantlán, in 2002, led by Miguel Cházaro and including Ignacio Contreras and Antonio Machuca, two undetermined species of this genus were found. One of these species, a short-statured, pink-flowered

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Echeveria morphologically similar to *E. fulgens* Lemaire, was found at higher elevations (2200–2300 m) in oak forest with numerous individuals in each of several populations. This taxon remains to be studied. The other one, an extremely rare and unusual ivory-white flowered tropical *Echeveria*, was found by Mr. Contreras in a small population with few individuals on a single limestone outcrop at 1550 m altitude. Soon after, Mr. Cházaro suggested that the taxon was an undescribed species of series *Valvatae* Moran, a series consisting of two species: *Echeveria valvata* Moran and *E. calycosa* Moran (Moran, 1963, 1967). In this paper, we describe a third known species of series *Valvatae* and argue that it is a narrow endemic in danger of extinction.

Echeveria yalmanantlanensis A.Vázquez & Cházaro, **sp. nov.** Type: Mexico. Colima-Jalisco: Municipio de Comala-Tolimán, camino a Campo Cuatro, Cerro Grande, on a rock of a limestone slope, 1550 m, 26 Sep 2011 (fl, fr), *J. Antonio Vázquez-García, M. Cházaro B. & J. Padilla-Lepe 9175* (holotype: IBUG; isotype: NY). (Figs. 1, 2)

Planta perennis glabra; rosula solitaria, sessilis, 8–22 (–35) cm lata; folia oblonga, oblong-oblanceolata, vix glauca, 6–13(–20) cm longa, 1.3–3.6 cm lata, 4 mm crassa; rami floriferi 1–3, erecti, 5.1–5.8 dm alti, foliis 14–20 instructi; cincinnus solitarius, 8–13(–16) cm longus, 18 florus; pedicelli 1.5–3.2×3 mm, breves; calyx 7–13 mm longus, segmentis erectis, inaequalibus; corolla eburnea, glauca, 10 mm longa, segmentis valvatis, triangulo-lanceolatis, acutis, 0.5-1 mm connatis.

Perennial with a single herbaceous rosette, 5–6×8–22(–35) cm, acaulescent, lax, glabrous; roots fibrous; leaves 9–18, 6–13(–20)× 1.3–3.6 cm, 4 mm thick, the blades oblanceolate to oblong-oblanceolate, acuminate at the apex, slightly keeled at the base, ventrally flattened and dorsally convex, grayish green to green, the surface waxy when young, the margin straight, hyaline and pinkish; scapes 1–3, 38–46(–54) cm from base to first flower, 51–58(–70) cm in total length, lateral and ascendant, pale yellowish green; cincinnus solitary, 8–13(–16)× 1.5–2.5 cm, circinate before anthesis, becoming erect after anthesis, grayish white to grayish green and waxy; scape bracts 14–20, 2.6–5.9×0.5–1.28 cm, spirally arranged, erect, oblong-oblanceolate to narrowly triangular, ventrally flattened and dorsally convex, acute to acute-rounded, usually with two spurs at the base, grayish green; cincinnus bracts 22, 8–22×3–7.5 mm, 2 mm thick, ovate to oblanceolate, acuminate at the apex, slightly curved inward and adaxially concave, tightly imbricate and succulent before anthesis, sparsely arranged in zigzag and dried soon after anthesis, with two spurs at the base, grayish green at the apex, pinkish toward the base; bractlets 22, 3×5–8 mm, triangular, with two spurs at the base, above the right side of each bract before anthesis, below the right side of a bract after anthesis, fleshy before during and after anthesis, ivory to yellowish; pedicels 1.5–3.2×3 mm, grayish green; flowers 18–22(–44), 13–14 mm long, 11 mm wide at the base, 16 mm wide at the apex, in a zigzag pattern; sepals 5, unequal, equal or larger than the corolla, larger ones 15–17×6 mm, smaller ones 6.4–14×2.8–4 mm, triangular, barely imbricate if at all or rarely spaced at the base, erect and appressed before anthesis, ascendant after anthesis, lanceolate, acuminate, spreading after anthesis, inconspicuously bicolored, grayish white before and during anthesis, becoming green after anthesis and pinkish at the base; corolla 12–13×8–10 mm, pentagonal, conical, slightly urceolate, forming a pale yellow tube, ivory-white to pale yellow; petals fully valvate at aestivation, partially valvate in the lower portion (2/3 to 1/2) during anthesis, slightly keeled, triangular-lanceolate, spreading outward at the upper third, connate at the base 0.5–1 mm, inconspicuously bicolored, ivory-white to glaucous pale yellow, pinkish at the apex after anthesis; stamens 10, at two levels, the epipetalous ones 5–5.1 mm long, the insertion point 1 mm above the base, the antipetalous ones 6.3–6.4 mm long, the insertion point at the base, between corolla and carpels, the filaments ivory-white to pale yellowish; anthers 0.9×0.5 mm, the epipetalous ones yellow, the antipetalous ones brownish; nectar glands 0.5–1×1.3–2 m,

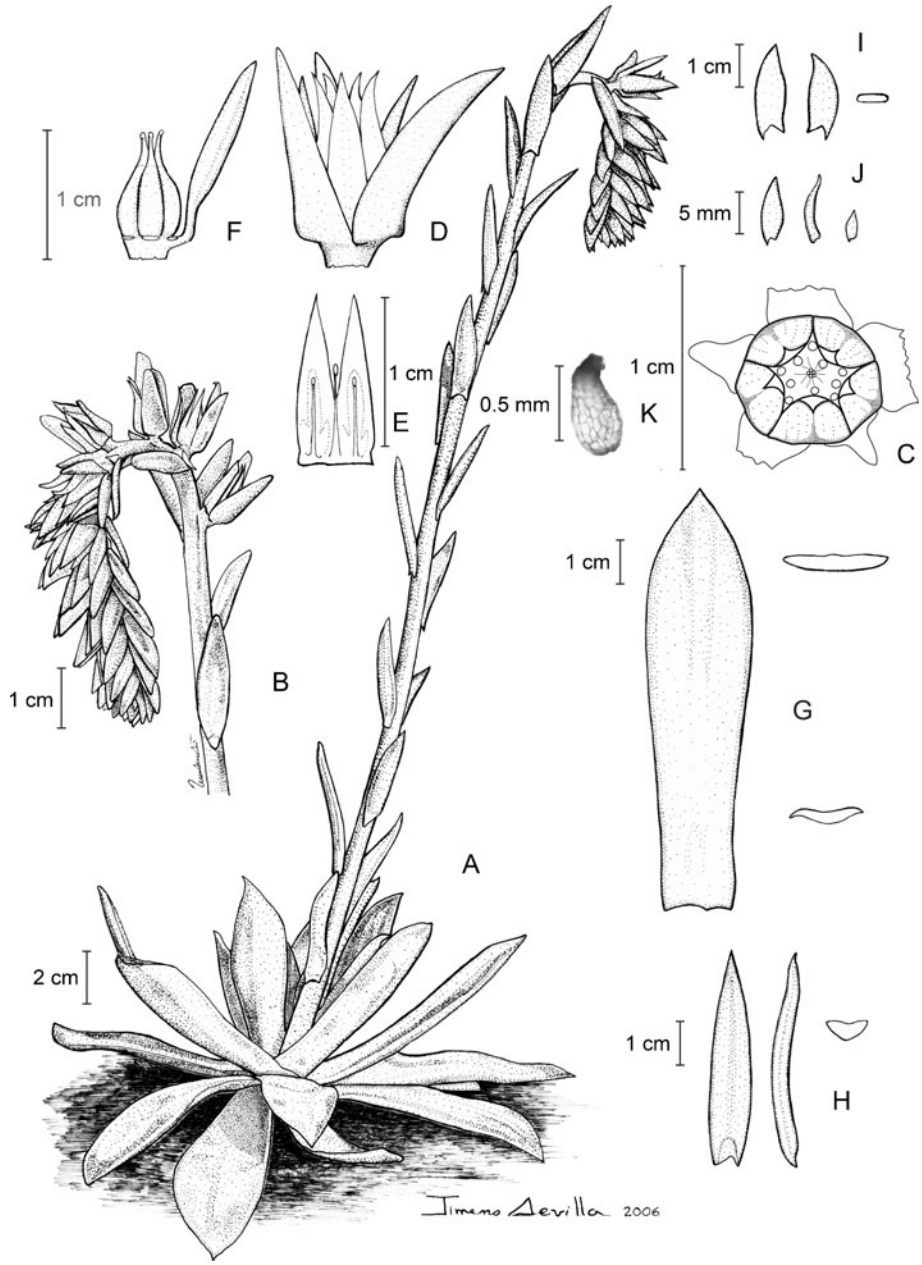

FIG. 1. *Echeveria yalmanantlanensis*. **A.** Habit. **B.** Cincinnus detail. **C.** Flower in cross section, seen from above. **D.** Flower in lateral view. **E.** Flower dissected. **F.** Carpels. **G.** Leaf and outlines of cross section at two levels. **H**. Scape bracts before first flower and outlines of cross section at one level. **I.** Bracts at cincinnus. **J.** Bractlets adjacent to bracts. **K.** Seed (A, B, D–J from *Vázquez-García 7830b*, IBUG; C from photograph by M. Cházaro at Jesús Trujillo´s succulent home garden (August 2004); K scanned from *Vázquez-García 7830b*, IBUG.)

oblong, transversely narrow, hyaline pale amber; carpels 7.5×3 mm; styles 2.6 mm long, the lower half mostly white, green at the apex; follicles erect, 7.5×3 mm, erect, reddish; seeds numerous, 0.39–0.90×0.16–0.31 mm, elliptic, narrow and acute at the apex and base, reticulate and wrinkled, pale brown to hyaline.

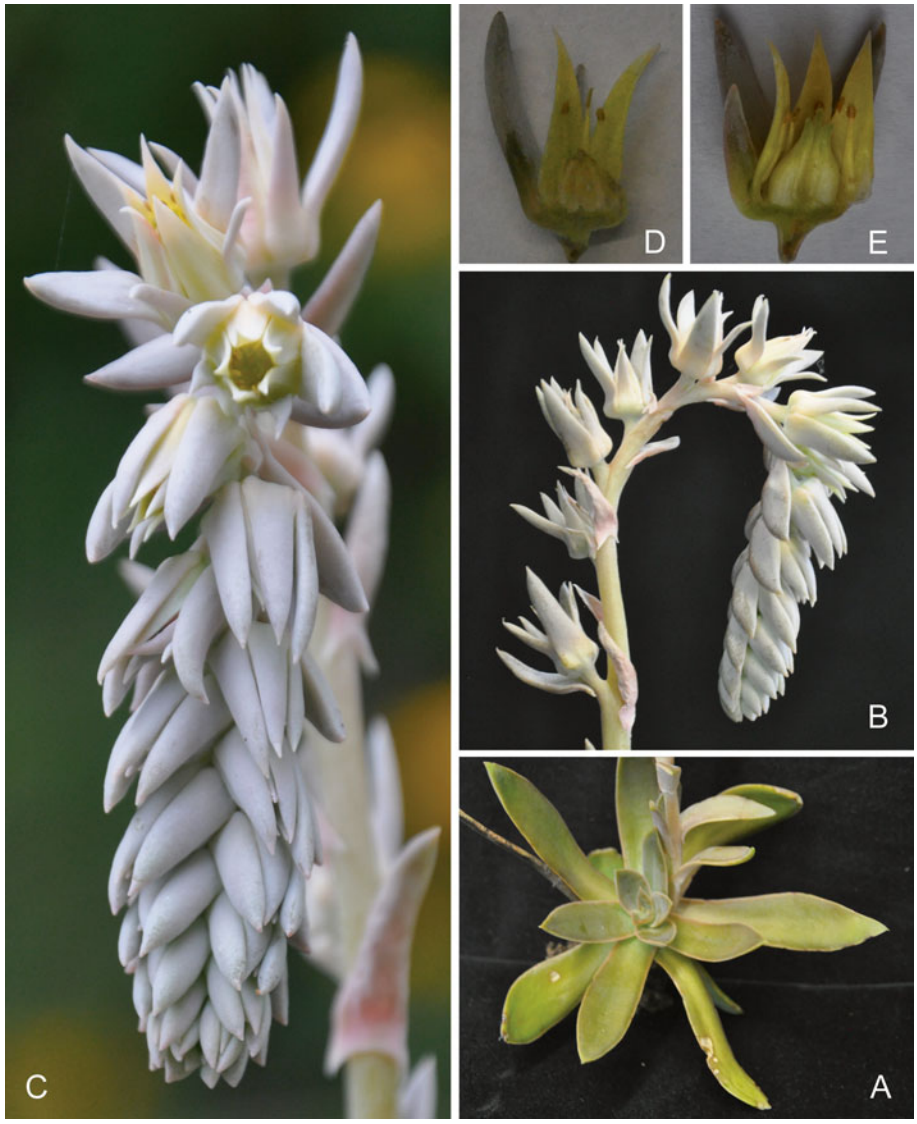

Fig. 2. *Echeveria yalmanantlanensis*. **A.** Rosette. **B.** Cincinnus, lateral view. **C.** Cincinnus, front view, with full valvate petals at aestivation and half valvate petals at anthesis. **D, E.** Flower in longitudinal section, showing sepals, petals, carpels, and stamens.

Distribution and ecology.—*Echeveria yalmanantlanensis* is known only from the type locality, growing on a single rock, at 1550 m on steep karstic topography with a thin (ca. 2 cm) layer of soil, closely sharing the habitat with the rupiculous *Tillandsia capitata* Griseb., under tropical dry forest with *Jatropha bartlettii* Wilbur, *Bursera macvaughiana* Cuevas & Rzed., and *Agave attenuata* Salm-Dyck. The climate of the region is semi-warm sub-humid (A)Ca (w1) (w) of Köppen (García, 1973, Vázquez-García et al., 1995).

Phenology.—Flowering from late July to early October; fruiting from September to December.

Etymology.—The specific epithet honors both plant ecologist Yalma Luisa Vargas-Rodríguez, from the Department of Biological Sciences, Louisiana State University, and

he Sierra de Manantlán, western Mexico, where she has conducted relevant ecological plant community sampling and analysis of both maple forest and tropical dry forest (Vargas-Rodríguez et al., 2005, 2010).

Additional specimens examined: **MEXICO. Colima-Jalisco**: Municipios Comala-Tolimán border, camino de Campo Cuatro a La Añilera, Cerro Grande, tropical dry forest, on a rock of a limestone slope, 1500 m, 18 Jul 2004 (fl), *Vázquez-García & Contreras 7830a, 7830b* (IBUG).

Echeveria yalmanantlanensis, except for its inconspicuously bicolored sepals, shares with *Echeveria calycosa* and *Echeveria valvata* most of the characters of series *Valvatae* (Moran, 1963; Meyrán & López-Chávez, 2003), such as single cincinnus, closely imbricate bracts, erect or ascending sepals equal to or larger than the corolla, reticulate seeds, pentagonal corollas with segments free nearly to the base and valvate petals, the latter an unusual character within the genus and restricted to series *Valvatae*. However, *Echeveria yalmanantlanensis* differs from these other two species in its acaulescent habit, shape and color of leaves and bracts, size of scape, bract pattern on scape, size and color of the corolla, habitat, and geographic distribution (Table I). *Echeveria yalmanantlanensis* is now the third known member of series *Valvatae*, this species is the only member of the series with ivory-white to pale yellow corollas, and the only one in the series inhabiting tropical dry forest at 1500 m in elevation. *Echeveria yalmanantlanensis* also represents the first member of the series for the states Colima-Jalisco and is the first record of *Echeveria* for the Sierra de Manantlán Biosphere Reserve (Vázquez-García et al., 1995; Vázquez-García et al., 1998; Cuevas & Jardel, 2004).

Field studies indicate that *Echeveria yalmanantlanensis* is endemic to the calcareous massif Cerro Grande. Several major efforts

TABLE I
DIFFERENCES BETWEEN *ECHEVERIA YALMANANTLANENSIS* AND OTHER MEMBERS OF SERIES VALVATAE.

	E. calycosa	*E. valvata*	*E. yalmanantlanensis*
Rosette diameter	5–10(–15) cm	8–15(–20) cm	8–22(–35) cm
Rosette habit	Shortly caulescent	Shortly caulescent	Acaulescent
Blade shape	Spatulate, rounded at the apex and weakly mucronate	Cuneate-spatulate to narrowly obovate or somewhat rhombic	Oblanceolate to oblong-oblanceolate, acuminate at the apex
Leaf color	Pale green	Pale green	Grayish green
Leaf size	2.5–5×1.5–2.5 cm	4–10×2–3.5 cm	6–13(–20)×1.3–3.6 cm
Scape length to first flower	5–21 cm	10–35 cm	38–46(–54) cm
Distribution of scape bracts	Absent in the lower 1–8 cm	Absent in the lower 1–10 cm	Present throughout
Corolla length	7.5–10 mm	7–11 mm	12–13 mm
Color of sepals	Conspicuously bicolored, pinkish at the base and pale green at the apex	Conspicuously bicolored, green, pinkish at the base, becoming green	Inconspicuously bicolored, grayish white during anthesis, becoming green with pinkish at the base
Corolla color	Conspicuously bicolored, yellow at the apex, pinkish to reddish at the base, orange in appearance	Conspicuously bicolored, glaucous raspberry red, appearing pinkish, paler at the base	Inconspicuously bicolored, ivory-white to pale glaucous yellow becoming pinkish at the apex after anthesis
Distribution	Southern Uruapan, Michoacán (Tzararacua, Río Cupatitzio, Tributario La Tinaja)	Southwestern and northern State of Mexico (Jilotepec, Nachititla, Piedra Grande, Temascaltepec, Valle de Bravo)	Colima-Jalisco border (Cerro Grande)
Habitat	Pine oak forest	Oak forest	Tropical dry forest
Elevation	1200 m	1450–1800 m	1550 m

have failed to locate additional populations, including moderate exploration through floristic and ecological studies in tropical dry forests of both the calcareous Cerro Grande (Vázquez-García et al., 1995; Vázquez-García & Givnish 1998, 2000) and the adjacent volcanic areas (perhaps substrate barriers); Sierra de Manantlán central (Vázquez-García et al., 1995; Cuevas & Jardel, 2004; Vargas-Rodríguez, et al., 2005; Luquín-Sánchez, 2003) and Nevado de Colima (CONANP-SEMARNAT, 2006). Since its discovery, nearly a decade ago, six guided attempts by at least six experienced botanists were conducted in order to locate additional populations in the vicinity of Campo Cuatro, Cerro Grande, all without success. A recent survey, on the agaves of western Mexico (Vázquez-García et al., 2007) allowed us to conduct further unsuccessful explorations to other potential habitats of *E. yalmanantlanensis*, such as the calcareous habitats with tropical dry forest in the states of Colima (Coquimatlán, Ixtlahuacán, Jalisco; Pihuamo, and Michoacán: Aquila-Coalcomán and Maruata). The other members of series *Valvatae* do not overlap in their narrow geographic range (Fig. 3).

We suggest that its current pattern and morphological divergence from other members of the series (Table I) perhaps resulted from a relatively recent process of allopatric speciation within the series.

Observational data support the hypothesis that *Echeveria yalmanantlanensis* is currently endangered with extinction, probably due to overcollection. As far as we know the species is confined to a single rock and for nearly a decade has declined in number of individuals with no evident natural extrinsic threat. We do not recommend *Echeveria yalmanantlanensis* as an ornamental because it is difficult to cultivate. For reasons unknown, various specimens have died at home gardens in Guadalajara and Talpa de Allende after two and three years of cultivation respectively. Overcollection seems to be a major threat, since the original population size of ca. 14 individuals has drastically declined to two individuals in situ and two individuals ex situ. Thus, this species must be immediately

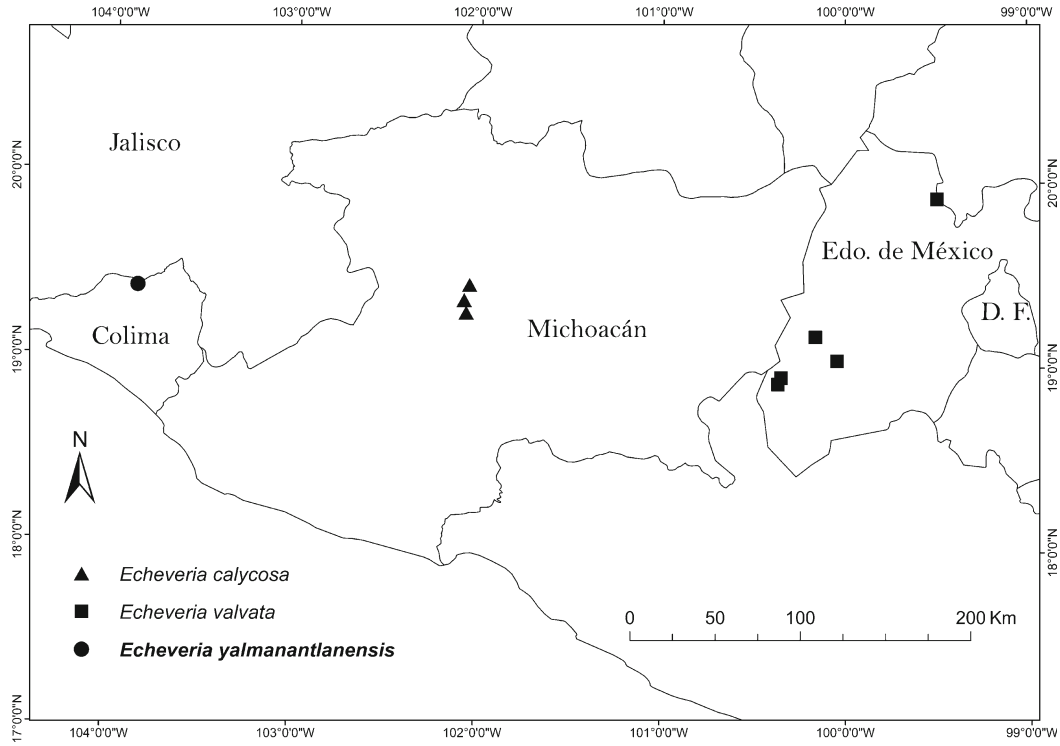

Fig. 3. Known populations of *Echeveria* series *Valvatae* in western and central Mexico.

included in the Mexican Endangered Species Act, NOM-ECOL-059 (2001) as an endangered species.

Further systematic exploration to locate additional populations of *Echeveria yalmanantlanensis* are urgently needed, particularly in the vicinity of Cerro Jumpiche and Piedra de Juluapan, Cerro Grande, a few kilometers southwest of the type locality. Ecological and genetic studies are recommended. We urge current managers at the Sierra de Manantlán Bisosphere Reserve to take legal and physical action to prevent *Echeveria yalmanantlanensis* from vanishing forever and to promote research into the causes that might be driving this species to extinction.

Meanwhile, efforts are being made to propagate the species at the University of Guadalajara-CUCBA, Zapopan, using seed germination and tissue-culture methods on seeds and scape bracts. These efforts include the elaboration of a conservation strategy for the species.

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