Phytotaxa 170 (1): 035–040
www.mapress.com/phytotaxa/

Article

ISSN 1179-3155 (print edition)
PHYTOTAXA
ISSN 1179-3163 (online edition)

http://dx.doi.org/10.11646/phytotaxa.170.1.4

Echeveria marianae (Crassulaceae), a new species from Jalisco, México

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Abstract

A new species, *Echeveria marianae* (Crassulaceae) is described from Sierra del Tigre, Valle de Juárez, State of Jalisco, Mexico. The species belongs to ser. *Gibbiflorae* due to of its acaulescent or short caulescent rosette habit, paniculiform inflorescence, conical-urceolate corolla, and tricolpate pollen grains. Within ser. *Gibbiflorae* it shares morphological affinities with *E. novogaliciana* and *E. dactylifera* from which it differs in the shape, color and margin of leaves, corolla size and color, stamen length, nectaries morphology, and its geographical distribution.

Resumen

Se describe *Echeveria marianae* (Crassulaceae) como una especie nueva para la ciencia de la Sierra del Tigre, Valle de Juárez, Estado de Jalisco, México. Esta especie pertenece a la ser. *Gibbiflorae* por poseer un breve tallo o acaule, arrosetada, inflorescencia paniculiforme, corola cilíndrico-urceolada y granos de polen tricolpado. Dentro de las especies de esta ser. *Gibbiflorae*, comparte afinidades morfológicas con *E. novogaliciana* y *E. dactylifera,* de las cuales difiere en la forma, color y margen de las hojas, color y tamaño de la corola, longitud de los estambres, morfología de los nectarios y su distribución geográfica.

Key words: corolla appendages, conservation, morphology, scanning electron microscopy, taxonomy, ser. *Gibbiflorae*

Introduction

Echeveria includes ca. 140 species of which over 90% have diversified in Mexico where the genus is characterized by a high degree of endemism (Uhl 1992; Thiede 1995; Meyrán & López-Chavez 2003). A revision of herbarium specimens collected in 1997 from Sierra del Tigre in Western Jalisco revealed a new species and further field work was conducted in 2012–2013 to collect more plant material for additional examination. The species, which we name *E. marianae*, belongs to ser. *Gibbiflorae* (Baker) A. Berger (Berger 1930: 474), which is characterized by large leaves, paniculiform inflorescences, pedicellate flowers, dark-colored stigmas (Walther 1972), and tricolpate pollen grains (Pérez-Calix 2004). Phylogenetic relationships within this group are largely unknown because only a few species were included in a recent molecular study (Carrillo-Reyes *et al*. 2009). Historically, the series was separated into two unranked subgroups useful for identification (Walther 1972; García & Pérez-Calix 2007): one group of species with acaulescent rosettes or having a short caudex, and one group characterized by a long caudex. The new species belongs to the former subgroup, which includes, among others, *E. dactylifera* (Walter 1972: 179) and the recently described *E. novogaliciana* (Reyes *et al.* 2011: 89).

Material and methods

Field work was conducted in Sierra del Tigre, Jalisco in 1996–1997 and 2012–2013. In addition to herbarium specimens, flowers and leaves were fixed in FAA (Ruzin 1999) for morphological studies. Several living plants were collected with soil and cultivated in Jiquilpan, Jalisco for further study. We examined the basic morphology of both fresh and fixed flowers under a Nikon SMZ1500 stereomicroscope equipped with a PaxCam Arc digital camera and Pax-it 7.6

Accepted by Alex Monro: 12 Apr. 2014; published: 19 May 2014

software (MIS Inc., Villa Park, Illinois). For scanning electron microscopy (SEM), we used hexamethydisilazane (HMDS) as an alternative for critical dry point (Wright *et al.* 2011). Fresh or fixed flowers were dehydrated using a series of ethanol steps (70%, 80%, 95% and 100%; each step 10 minutes), immersed for 10 minutes in 1:1 ethanol: HMDS, and passed through three changes, each of 30 minutes in 100% HMDS. Samples were air dried and coated with 20 nm gold using an Emitech K 550 sputter coater. Micromorphological examination, measurements and pictures were taken at 5–10 kV using a Hitachi SU1510 variable pressure scanning electron microscope.

Taxonomy

Echeveria marianae I. García & Costea, *sp. nov*., Figs. 1–2.

Type:—MÉXICO. Jalisco: Municipio de Valle de Juárez, Barranca del Ojo de Agua al este de Mazamitla, 2460 m, bosque de encino-pino con elementos de bosque mesófilo de montaña; 29 Augusto 2013, *I. García & M. Costea 8732* (holotype CIMI! isotypes; DAO!, ENCB!, IEB!, MEXU!, MICH!).

Similar morphologically to *E. novogaliciana* and *E. dactylifera* in the absent or short caudex, calyx with unequal sepals, and presence of corolla appendages at the base of epipetalous stamens but differing from both species in the general leaf shape, carinate petals, external orange colour, toward the tips darker-orange to reddish, and convergent, ascending or erect corolla appendages. In addition, it differs from *E. novogaliciana* in the smaller leaf rosettes, inflorescences with fewer cincinni, and shorter stamens, and from *E. dactylifera* in the shorter pedicels, smaller flowers, and reniform, pink nectaries.

Perennial herb, not cespitose, glabrous, light green to yellow-green, not glaucous, acaulescent or short caulescent, caudex (when present) 4–6 cm long and 3–4 cm in diameter; rosette lax, 30–40 cm in diameter with 16–18 (22) leaves; leaves light-green to yellow-green, obovate to oblanceolate, 5–22 (24) × 3–7.5 cm, thickness of lamina at the base 6–9 mm; entire or sometimes 2–4-lobed distally, base amplexicaulous, apex acute to apiculate, margins with a thin, red line, somewhat crenulate in young leaves; inflorescence paniculiform thyrse, solitary or double, 80–90 (100) cm long and 6–13 cm wide, with (7) 8–10 secondary axes (cincinni), each with 1–6 flowers; bracts of the main inflorescence axis (7) 8–10, oblong to ovate-lanceolate, 2–6.2 × 0.5–1.5 cm, base auriculate, upper ones caducous; bracts of cincinni similar to those on the main axis but 18–22 × 4–6 mm; pedicels 5–9 mm long and 2–3 mm thick; calyx gamosepalous, the tube 2.3–2.5 mm long, lobes unequal, spreading to slightly recurved, triangular-lanceolate, green, 9–15 × 3–6 mm; corolla pentagonal-conical in bud, urceolate to campanulate at anthesis, 15–20 mm long, 10–12 mm in diameter at the base, opening distally for 4–8 mm; petals imbricate, oblong-lanceolate with a concavity at the base corresponding to the nectaries, 15–20 × 6–7 mm, slightly recurved, tips mucronate, external color pale yellow-whitish at the base, orange in the rest with dark-orange to reddish tips, internal color pale, yellow at the base, yellow-orange in the rest, tips reddish; nectaries reniform, 3 × 1 mm, pink with darker margins; epipetalous filaments (including the anthers) 7–9 mm long, with 1 or 2 multicellular corolla appendages at the base (sometimes one is basally bifid giving the impression of 3 appendages present at the base of the stamen), linear, oblanceolate or conical, convergent, ascending or erect, 1–5 × 0.5–1 mm, sometimes with a red line on the margin toward the apex, surface with epicuticular wax organised as parallel rodlets; episepalous filaments (including anthers) 10–12 mm long; anthers 2–2.5 × 1 mm, yellow to red; pollen agglutinated into large masses, tricolpate, oblate in equatorial view, triangular in polar view, 30–32 × 14–16 μm, tectum imperforate, scabrate; ovary with 5 carpels, 10–13 × 4 mm, white-yellowish; styles (including the stigmas) 4–5 mm long, reddish at the base and dark brown-reddish apically; stigma globose; fruit suberect follicles, 8.5 × 2.8 mm; seeds numerous, oblong to obovate, light to dark-brown, reticulate, 0.6–0.8 × 0.25–0.3 mm; reticulum size 40–50 μm.

Discussion:—As indicated in the diagnosis *E. marianae* shares close morphological affinities with *E. novogaliciana* and *E. dactylifera* but differs from both in the morphology of the leaves, carinate corolla lobes which are orange-colored with darker red tips, and a different morphology of the corolla appendages. For a detailed comparison see Table 1. The lobed leaves character can be seen especially in mature plants with larger rosettes; young plants may have all the leaves entire. The plants cultivated in Jiquilpan, Michoacán at a lower elevation (1560 m), under full sun and higher temperature conditions were similar to those in the wild but had smaller flower (14–16 mm long), narrower leaves, the corolla had a more uniform and stronger shade of orange (Fig. 1L), sometimes with pink-red areas, and the nectaries were also red. Also in cultivated plants, the calyx was yellow-greenish to orange (not light-green as in the wild plants).

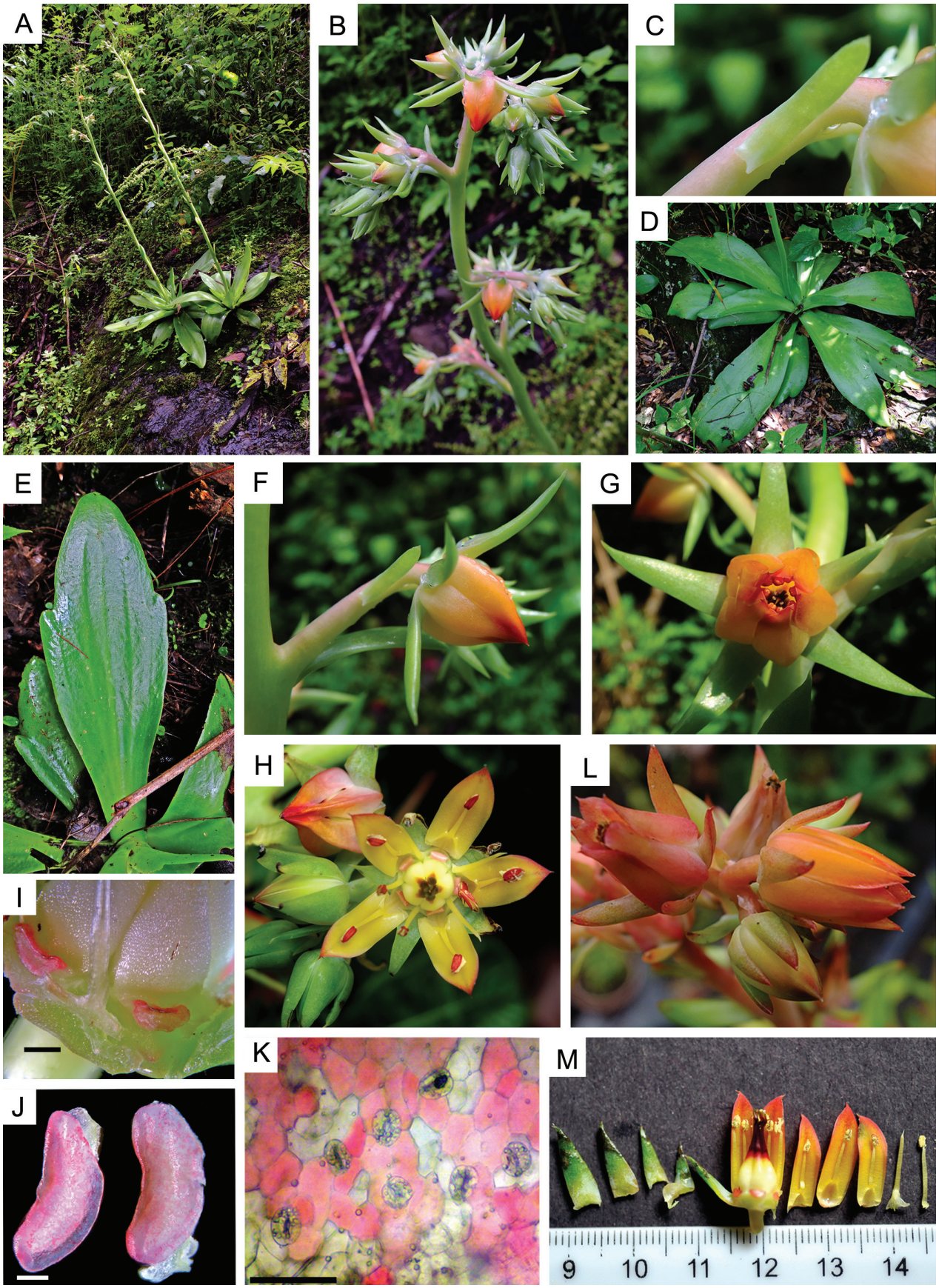

FIGURE 1. *Echeveria marianae*. A–K. Type specimen(s) prior to conservation. L–M. Flower(s) from transplanted plant. A. Habit and habitat. B. Inflorescence. C. Bract of secondary inflorescence axis (cincinnus). D. Leaf rosette. E. Lobed leaf. F. Flower (lateral view). G. Flower (distal view). H. Opened flower. I. Base of ovary with nectaries (scale bar = 1 mm). J. Dissected nectaries (scale bar = 0.5 mm). K. Stomata on epidermis of nectaries (scale bar = 100 μm). L. Flowers. M. Dissected flower.

The epidermis of the nectaries in *E. marianae* has numerous stomata surrounded by epidermal cells filled with anthocyanin pigments, which give the overall pink or red color to the nectaries of this species (Fig. 1I–K). The nectar released through the stomata accumulates in the cavities found at the base of the petals, which are covered in part by the coralline appendages found at the base of the epipetalous filaments (Figs. 1H; 2A). Based on the absence of secretory structures (Fig. 2B–C), the role of the corolla appendages is likely to shield the nectar from the pollinators lacking a specialized feeding apparatus. Corolla appendages at the base of stamens have also evolved in *Pachyphytum* (Walther 1972; Thiede & Eggli 2007), a genus that forms a sister clade to the remaining "*Echeveria* group" (Carrillo-Reyes *et al*. 2009).

Distribution and ecology:—*Echeveria marianae* is currently known only from Sierra del Tigre, Jalisco at elevations between 2450–2550 m. The species is saxicole or sometimes epiphytic (e.g., on *Quercus* sp.) and it grows in shaded habitats that maintain sufficient humidity even during the dry season, for example, in wet ravines or margins of streams. The general type of vegetation consists of mesophyllous oak and pine forest. The flowers are pollinated by hummingbirds.

Phenology:—Flowers from August to October.

Conservation status:— Based on the area of occupancy and the very small population size we assess *E. marianae* as Vulnerable (VU) (IUCN 2001) based on criteria D. Although an exhaustive survey has not been undertaken the species is known from a single locality of less than 10 km^2 (criterion B.2 and condition B(a)) with less than 100 plants among which less than 50 are mature and the Sierra del Tigre is not a protected area and the nearby touristic resort of Mazamitla continues to expand through new constructions in the region.

Etymology:—The specific epithet is dedicated to Mariana the youngest daughter of the first author in recognition of her dedication and care for cultivated material of this species.

Additional specimens examined:—MÉXICO. Jalisco: Municipio de Valle de Juárez, Peñas del lado sureste de El Tigre, 2550 m, 22 September 1997, *I. García 4975* (CIMI!)*;* Municipio de Valle de Juárez, Peñas del lado sureste de El Tigre, 2550 m, 10 October 1998, *I. García 5520* (CIMI!). Both specimens resulted from plants cultivated in Jiquilpan, Michoacán after transplantation from the type locality.

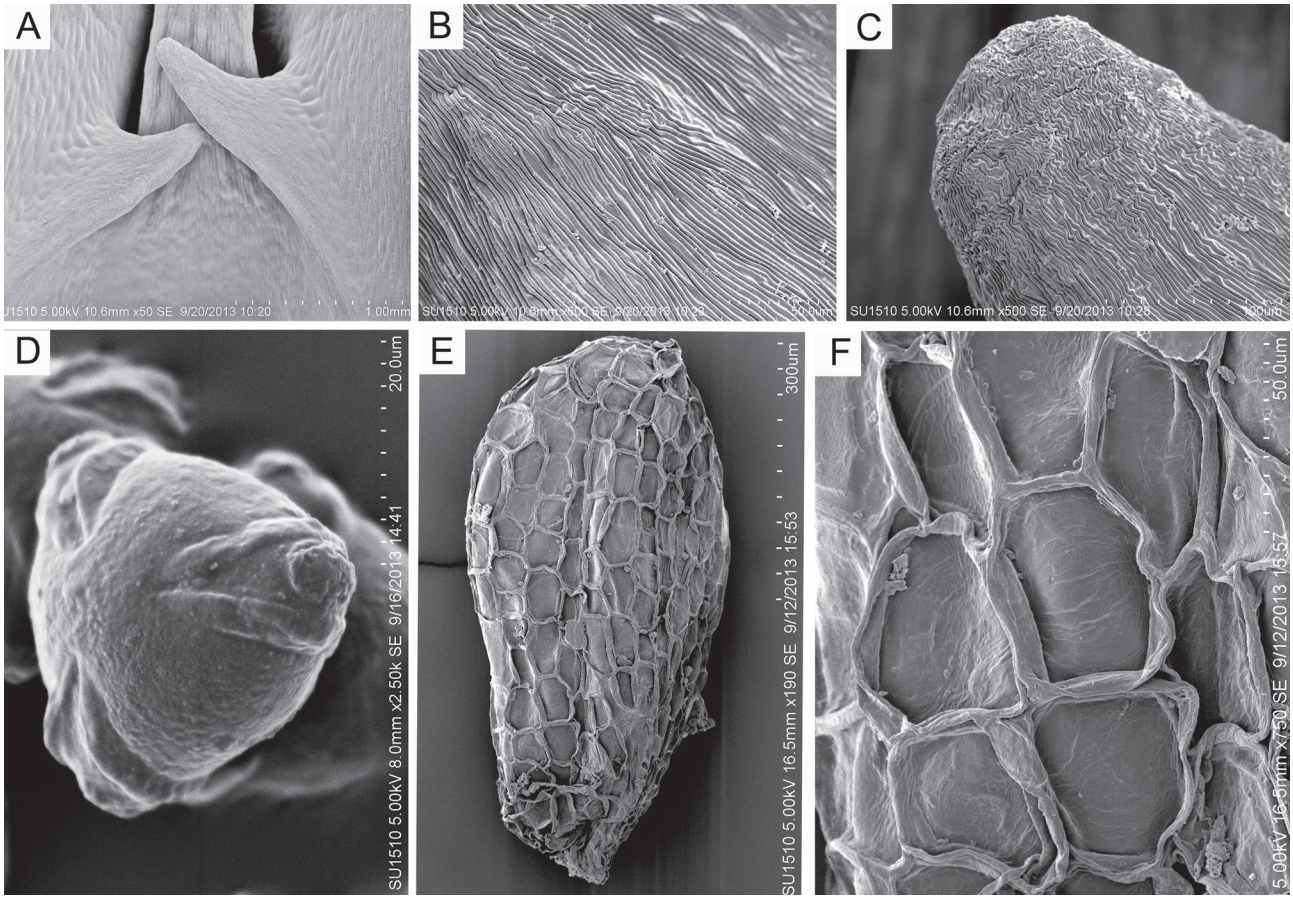

FIGURE 2. Micromorphological features of *Echeveria marianae* (from holotype material fixed in FAA prior to pressing/drying). A–C. Corolla appendages at the base of the epipetalous stamens. A. General morphology. B. Surface of corolla appendage (note the lack of stomata and presence of epicuticular waxes). C. Distal part of appendage without secretory structures. D. Pollen grain. E–F. Seed morphology. E. General view of seed. F. Surface of seed coat reticulum. Scale bars and SEM data are embedded in the images.

TABLE 1. Comparison of *Echeveria marianae*, *E. novogaliciana* (Reyes *et al.* 2011) and *E. dactylifera* (Walther 1972); "—" indicates data not available for comparison.

Character	*Echeveria marianae*	*E. novogaliciana*	*E. dactylifera*
Caudex	Acaulescent or caudex inconspicuous,	Inconspicuous;	Evident;
Length × diameter (cm)	4–6 × 3–4	4 × 2	10 × 3.5
Rosette diameter (cm)	30–40	44–60	20–40
Leaves			
Color	Not glaucous; light green to yellow-green	Glaucous, green to pink	Green-reddish to brownish
Shape	Obovate-oblanceolate; base amplexicaulous; apex acute to mucronate	Lanceolate, ensiform	Elliptic-oblong; base amplexicaulous, cuneate; apex acute
Length (cm)	5–22 (24)	22–27	>25
Width (cm)	3–7.5	3–5	9
Margin/Border	Margin entire or lobed in the distal 1/2; border with a thin, red line; young leaves ± crenulate	Denticulate; border hyaline	Entire; border red adaxially, greenish with pink stripes abaxially
Inflorescence			
Number of main axes	1–2	1–2	1
Length (cm)	80–90 (100)	66–80	100
Diameter at the base (cm)	6–13	10–18	30
Number of cincinni	6–8	10–14	—
Bracts on main inflorescence axis (number)	8–15	—	—
Shape	Oblong to ovate-lanceolate	Oblanceolate	Narrow oblong-elliptic
Length (cm)	2–6.2	6.5–10	≤ 7
Width (cm)	0.5–1.5	1.5–2	2
Pedicel			
Length × diameter (mm)	5–9 × 2–3	5–7 × 2–3	25–30 × 2.5–3
Flower (corolla) shape	Pentagonal-conical in bud; broadly urceolate at anthesis	—	broadly urceolate at anthesis, pentagonal
Length (mm)	15–20	18–24	≤ 30
Width (mm)	10–11	12–13.5	17
Sepals (calyx)	Spreading to slightly recurved; unequal	Spreading to slightly ascendant; unequal	Ascendant; unequal
Shape	Triangular-lanceolate	Triangular-lanceolate	Triangular to oblong-ovate
Length × width (mm)	9–15 × 3–6	6–8 (11–15)–2.5–15	20 (the longest)
Color	Light green	—	—
Petals			
Shape	Oblong-lanceolate, carinate	Lanceolate; not carinate	Not carinate
Length × width (mm)	15–20 × 6–7	18–24	—
External color	Whitish-yellow at the base, orange in the rest, with the tips reddish; not pruinose	Light pink; pruinose	Yellow-reddish
Internal color	Pale white-yellow at the base, yellow-orange in the rest, tips reddish	Yellow	Yellow
Appendages	(1) 2; lanceolate, oblanceolate or conical, ascendant or convergent	Bent downwards	2; finger-like, recurved
Nectaries			
Shape	Reniform	Reniform	Narrow semilunar
Length (mm)	2.5–3.3	2.4	4
Width (mm)	1	1.2	—
Color	Pink with reddish margins	Red to yellow	Yellowish
Stamens			
Episepalous filaments + anther length (mm)	10–12	13–16	22–24
Epipetalous filaments + anther length (mm)	7–9	10–13	20–25
Anthers length (mm)	2–2.5 × 1	—	—
Anther color	Pink-reddish to yellow	Reddish (in bud)	Reddish (in bud)

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TABLE 1. (Continued)

Character	*Echeveria marianae*	*E. novogaliciana*	*E. dactylifera*
Gynoecium/carpels			
Length × width (mm)	10–13 × 4	10–11 × 8	26.5 × 9.7
Fruit	follicles semierect, 8.5 × 2.8 mm	—	—
Seeds	oblong to obovate, reticulate, 0.6–0.8 × 0.25–0.3 mm	—	—
Flowering	August–October	August–October	October
Geographical distribution	SE of Jalisco	Aguascalientes, Jalisco	Jalisco, Durango Sinaloa y Aguascalientes
Habit	Saxicole or occasionally epiphytic; wet and shaded habitats	—	—
Vegetation type	Oak-pine with mesophyllous mountain forest elements	Tropical deciduous forest; gallery forest; oak forest with elements of xerophilous matorral	Oak forests (?)

Acknowledgements

We would like to thank to Emmanuel Pérez-Calix for his comments on a first draft of the manuscript, Alexandre Monro for helping us choose the appropriate conservation rank, and to two anonymous reviewers for their suggestions. The first author also thanks to Hector Arandas, for his help in the field, and to COFAA of the Instituto Politécnico Nacional, Mexico for supporting this type of research.

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