



Echeveria flammigera (Crassulaceae), a new name and status for *E. pringlei* var. *parva*

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Abstract

A revision of *Echeveria pringlei* var. *parva* was made based on morphological and biogeographical comparisons. The results show that this taxon should be raised to the species level and that it belongs to *E.* ser. *Nudae*. Since the epithet *parva* is unavailable for use due to the existence of *E. parva*, *E. flammigera* is proposed as a new replacement name. An updated description of the taxon is provided, as well as a distribution map.

Keywords: biogeography, Durango, *Echeveria multicaulis*, *E.* ser. *Echeveria*, morphological comparison, Sierra Madre Occidental

Resumen

Se realiza una revisión de *Echeveria pringlei* var. *parva* basada en comparaciones morfológicas y en biogeográficas. Los resultados muestran que este taxón debe elevarse al nivel de especie y que pertenece a *E.* ser. *Nudae*. Dado que el epíteto *parva* no está disponible para su uso debido a la existencia de *E. parva*, se propone *E. flammigera* como un nuevo nombre de reemplazo. Se proporciona una descripción actualizada para el taxón, así como un mapa de distribución.

Palabras clave: biogeografía, comparación morfológica, Durango, *Echeveria multicaulis*, *E.* ser. *Echeveria*, Sierra Madre Occidental

Introduction

Echeveria de Candolle (1828: 401) is a genus of the Crassulaceae family that includes succulent plants with leaves arranged in rosettes and tubular to urceolate pentamerous flowers. Its geographic distribution ranges from the Southern United States to Northern Argentina, being Mexico its center of diversity with 83% of the genus diversity (de la Cruz-López *et al.* 2019). The current infrageneric classification of *Echeveria* is based on morphology and comprises seventeen series (Kimmach 2003). Although most of the series were retrieved as non-monophyletic in recent phylogenetic studies (de la Cruz-López *et al.* 2019), this infrageneric classification can still be useful as a framework for species identification.

The members of *Echeveria* ser. *Echeveria* are characterized by having medium to tall stems; minutely puberulent to hirsute leaves; and spike or raceme inflorescences, which are often pubescent (Kimmach 2003). This series includes eleven species and it can be found from the southwestern part of Durango state in Mexico to Northeastern Guatemala: *E. amphoralis* Walther (1958b: 149), *E. carminea* Alexander (1941: 138), *E. harmsii* Macbride (1931: 22), *E. pulvinata* Rose in Britton & Rose (1903: 5) and *E. zorziana* Reyes-Santiago & Brachet (2009: 93) are endemic to Oaxaca (Kimmach 2003; NaturaLista 2022a; Reyes-Santiago & Brachet 2009); *E. leucotracha* Purpus (1914: 65) and *E. pilosa* Purpus (1917: 146) are endemic to Puebla (Kimmach 2003), the former recently proposed as a variety of *E. pulvinata* by Kimmach (2017) but which is not followed here; *E. pringlei* (Watson 1890: 148) Rose in Britton & Rose (1903: 6)

is found in Durango and Jalisco (Kimmach 2003); *E. setosa* Rose & Purpus (1910: 45) is native to Oaxaca and Puebla (Kimmach 2003); *E. coccinea* (Cavanilles 1793: 54) de Candolle (1828: 401) is distributed in Chiapas, Ciudad de México, Guanajuato, Hidalgo, Oaxaca, Puebla, Querétaro, Tlaxcala and Veracruz (Jimeno-Sevilla *et al.* 2012; Pérez-Calix 2008); and *E. macrantha* Standley & Steyemark (1944: 159) is endemic to Guatemala (Walther 1972).

Echeveria pringlei was first described as *Cotyledon pringlei* from plants collected in the ravine near Guadalajara. Three infraspecific taxa are recognized based on differences from the type in the length of the stems, leaves and sepals [longer in *E. pringlei* var. *longisepala* Kimmach (1998: 51)] and by having smaller, nearly glabrous and reddened leaves [*E. pringlei* var. *parva* Kimmach (1998: 52)]. In October of 2021, as part of our research project with the Crassulaceae in Western Mexico, we collected flowering specimens of *Echeveria pringlei* var. *pringlei* from the Barranca de Matatlán in the municipality of Zapotlanejo, Jalisco. We readily realized that the characteristics of these plants strongly differed from those of the widely cultivated *E. pringlei* var. *parva*, reason enough to conduct a review of the latter variety. As a result, the morphological and biogeographical differences not only allowed us to determine that *E. pringlei* var. *parva* should be treated at the species rank, but also that this taxon can be transferred to *E. ser. Nudae* Walther (1958a: 46), one of the most diverse series of the genus. According to our revision, *E. multicaulis* Rose (1905: 294) is its morphologically closest species. The present work aims to propose these taxonomic changes using the new name *E. flammigera*, since the epithet *parva* has already been used for *Echeveria parva* Berger (1930: 477). An updated description of the taxon and a distribution map are presented.

Material and methods

In this work, *E. pringlei* var. *parva* and morphologically similar taxa, *E. pringlei* var. *pringlei*, *E. pringlei* var. *longisepala* and *E. multicaulis*, were studied to determine the proper status of the former. The generic classification of *Echeveria* by Kimmach (2003) was adopted.

The morphological comparison among taxa was made using descriptive data obtained from protologues (Kimmach 1998; Rose 1905; Watson 1890), relevant literature (Walther 1972; Flores-Macías & Cházaro-Basáñez 1993) and herbarium specimens, focusing on type material as well as specimens available in SEINet (2022) and in the IBUG and MEXU herbaria. For *E. pringlei* var. *pringlei* and *E. pringlei* var. *parva*, variations in morphological traits were recorded during the flowering season (October 2021) for *in situ* and cultivated plants of known origin. The resulting data were also used to complement the previous descriptions of *E. pringlei* var. *parva* (referred to as *E. flammigera* in the following sections).

To obtain a better understanding of the biogeographical aspects of the taxa involved, a distribution map was generated using the SimpleMapp software (Shorthouse 2010). Subsequently, the map was edited with Photoshop to include a template of the Mexican biogeographic provinces *sensu* Morrone *et al.* (2017).

The International Plant Name Index (IPNI 2022) was consulted to corroborate that the epithet *parva* is unavailable for use at specific rank within *Echeveria*. To verify that *Echeveria parva* is validly published, the protologue (Berger 1930) and other sources (Nakai 1988; Kimmach 2003) were checked.

Results

The unique set of morphological features, in combination with biogeographical evidence, shows that the proper status for *Echeveria pringlei* var. *parva* is at the species level. Since the combination *Echeveria parva* is already occupied, a new name for the taxon is proposed: *Echeveria flammigera* (see Taxonomy section).

As shown in Table 1, *E. flammigera* differs consistently from *E. pringlei* var. *pringlei* in the lack of pubescence (glabrous with minutely papillose leaves); in its longer stems; in its leaves half the size or even smaller; and in its less numerous flowers whose sepals are shorter. Compared to the plants of *E. pringlei* var. *longisepala*, those of *E. flammigera* are profusely ramose having much shorter and thinner stems; have profusely reddish leaves; and its leaves, inflorescence and sepals are shorter. In addition, the flowers are almost always less numerous and the pedicels usually shorter. Likewise, the characteristics of *E. flammigera* do not correspond to *E. ser. Echeveria* but rather to *E. ser. Nudae*, which includes plants usually with tall stems, glabrous or papillose leaves and raceme or spike inflorescences (Kimmach 2003). Within this series, *E. multicaulis* is its morphologically closest species, but *Echeveria flammigera* has very minutely papillose leaves; shorter stems and leaves; less numerous flowers; usually shorter pedicels; and a longer corolla.

TABLE 1. Morphological comparison among *Echeveria flammigera*, the now two varieties of *E. pringlei* and *E. multicaulis*.

	<i>E. flammigera</i>	<i>Echeveria pringlei</i> var. <i>pringlei</i>	<i>E. pringlei</i> var. <i>longisepala</i>	<i>E. multicaulis</i>
Habit	Shrubby, with numerous decumbent or ascending branches	Shrubby, with numerous decumbent or ascending branches	Sparsely branching	Subshrubby, with numerous spreading branches
Plant surface	Glabrous but the leaves very minutely papillose	Densely pubescent on all exterior portions	Nearly glabrous but with minute rounded papillae on the leaves	Glabrous and the leaves not papillose
Stem size (cm)	Length up to 40 or more and diameter up to 0.3–0.5	Length up to 10–20 and diameter up to 0.6	Length up to 80 or more and diameter up to 1	Length up to 120
Leaf length (cm)	1–1.5	3–4	3–4	3–4
Leaf colour	Green but nearly always with intense red colourations	Green, sometimes with reddish or orange colourations	Green, rarely slightly reddish at the margin and apex	Shining green with red tips and edges
Inflorescence length (cm)	Up to 20	Up to 20	Up to 50	Up to 25
Number of flowers per inflorescence	2–5 (–7)	12 or more	5–14	6–15
Pediceal length (cm)	0.4–0.8	0.4–0.9	0.6–1	0.6–1
Corolla length (cm)	1.2–1.8	1.1–1.5	1.4–1.8	0.8–1
Sepal length (cm)	0.6–0.9	1–1.4	1.4–1.8	0.4–0.8
Sources of information	Kimmach (1998), herbarium specimens and live plants	Walther (1972), herbarium specimens and live plants	Kimmach (1998) and herbarium specimens	Walther (1972) and herbarium specimens

On the other hand, all four taxa studied are allopatric (Fig. 1) and differ in biogeographical aspects (Table 2). Among these, *E. flammigera* has the northernmost distribution and occurs in Durango where it is endemic and none of the other related taxa is located, being separated from them by a considerable distance: at least 250 km from *E. pringlei* var. *longisepala*, about 440 km from *E. pringlei* var. *pringlei* and about 450 km from the nearest locality of *E. multicaulis*. Both *E. flammigera* and *E. pringlei* var. *longisepala* inhabit pine-oak forests of the Sierra Madre Occidental biogeographic province but within different watersheds, the former in the Río Piaxtla watershed and the latter in the Río Huaynamota watershed. Although *E. flammigera* is found at elevations of 1350 m, it thrives mainly at elevations between 2000 and 2400 m, whereas *E. pringlei* var. *longisepala* is found only at about 1800 m elevation, *E. pringlei* var. *pringlei* under 1400 m elevations and *E. multicaulis* at elevations up to 3200 m.

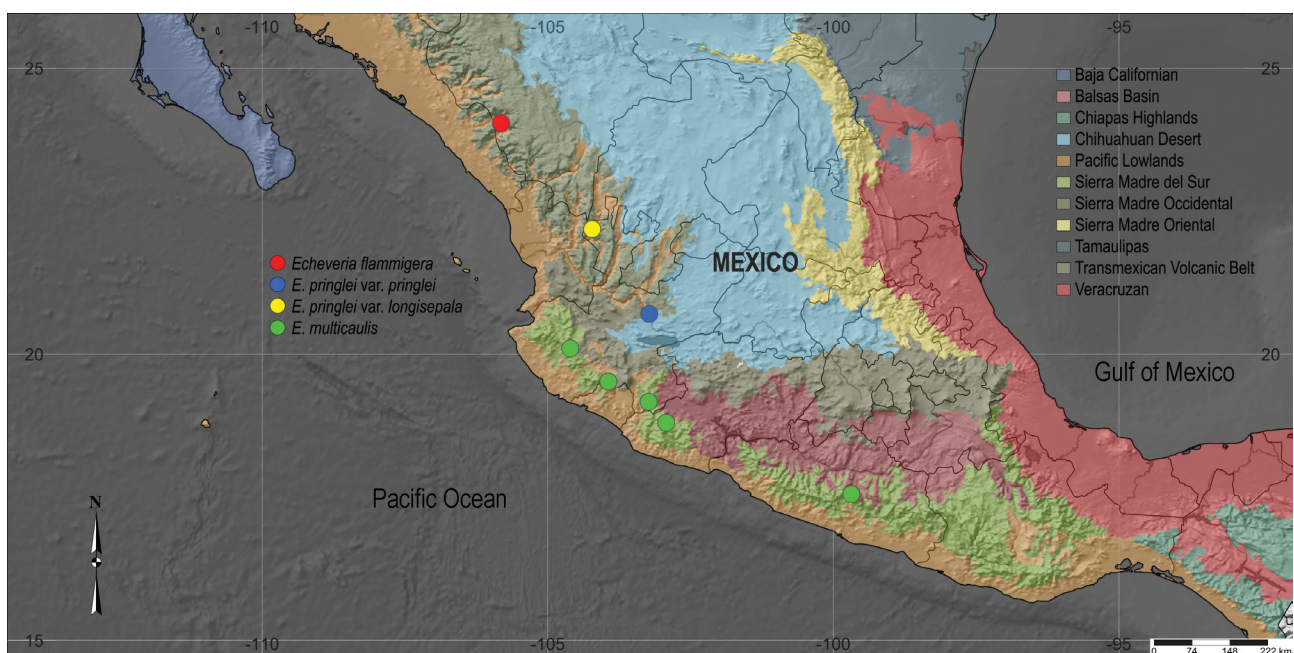


FIGURE 1. Distribution map of *Echeveria flammigera* and morphologically similar taxa.

TABLE 2. Comparison among biogeographical aspects of *Echeveria flammigera*, the now two varieties of *E. pringlei* and *E. multicaulis*.

	<i>E. flammigera</i>	<i>Echeveria pringlei</i> var. <i>pringlei</i>	<i>E. pringlei</i> var. <i>longisepala</i>	<i>E. multicaulis</i>
Geographic distribution	Tayoltita area (Durango)	Gran Barranca de Guadalajara (Jalisco)	Mesa de San Andrés Cohamiata (Jalisco)	Sierra de Manantlán (Jalisco), Sierra de Coalcomán (Michoacán) and Chilpancingo area (Guerrero)
Biogeographic province	Sierra Madre Occidental	Pacific Lowlands	Sierra Madre Occidental	Sierra Madre del Sur
Elevation (m)	(1350–) 2000–2400	1100–1400	About 1800	2000–3200
Watershed	Río Piaxtla	Río Verde	Río Huaynamota	Río Atenguillo, Río Armería, Río Tepalcatepec, Río Aguililla and Río Papagayo
Vegetation	Pine-oak forest	Tropical deciduous forest	Pine-oak forest	Pine-oak forest
Sources of information	Kimnach (1998) and <i>in situ</i> observations	Flores-Macías & Cházaro-Basáñez (1993), Walther (1972) and <i>in situ</i> observations	Kimnach (1998) and Vázquez-García (personal communication, 2022)	Walther (1972) and NaturaLista (2022b)

Discussion

Echeveria flammigera, now a separate entity from *E. pringlei*, is characterized by its numerous branches, its small, glabrous and reddened leaves, as well as by its few-flowered inflorescences (Fig. 2). Its transference to *E. ser. Nudae* increases the number of this series to 24 species, which places it as the third most diverse series of the genus, only behind *E. ser. Gibbiflorae* (Baker 1869: lacking page numbers) Berger (1930: 474) with 39 species and *E. ser. Racemosae* (Baker 1869: lacking page numbers) Berger (1930: 472) with 40 species. On the other hand, *E. pringlei* var. *pringlei* can be recognized with the naked eye by being pubescent on all exterior portions and by having numerous flowers (Fig. 3), while *E. pringlei* var. *longisepala* is characterized by its long stems which sparsely branch and by its long sepals.

E. flammigera has not yet been included in phylogenetic studies. As morphology suggests, *E. multicaulis* is a putative close relative of *E. flammigera*, as well as an undescribed species from western Jalisco. Despite its associated traits with *E. ser. Nudae*, it cannot be ruled out that *E. flammigera* may also have a close relationship with some members of *E. ser. Echeveria*, since the recent phylogenetic analysis by de la Cruz-López *et al.* (2019) shows that both *E. ser. Echeveria* and *E. ser. Nudae* are artificial. Although in the same study *E. pringlei* and those labelled as *E. pringlei* var. *parva* (*E. flammigera*) are nested together with strong support (100/1), the accessions correspond to *E. pringlei* var. *pringlei* as the indicated source of the material is the Barranca de Colimilla area where this variety grows.

Restricted to pine-oak forests of the Tayoltita area, *E. flammigera* is isolated from the presently known members of *E. ser. Nudae* and *E. ser. Echeveria*; among these, it is the only species occurring in the state of Durango and has the northwesternmost distribution. As these data suggest, *E. flammigera* may have arisen as a result of allopatric speciation. The Cretaceous-Cenozoic magmatic and tectonic events that gave rise to the Sierra Madre Occidental (Ferrari *et al.* 2005) generated a heterogeneous relief and a great variety of micro-climates, which may have led the species to evolve in very specific environmental conditions. This is not surprising, because the Sierra Madre Occidental, as the largest mountain range in Mexico, hosts a great diversity of species, many of which are endemic (González-Elizondo *et al.* 2012). From this area, several narrow-endemic species of the Crassulaceae family are being discovered and others have been described in recent years, such as *E. juliana* J.Reyes, O.González & Kristen in Reyes-Santiago *et al.* (2012b), *E. kristenii* L.E.Cruz-López & J.Reyes in de la Cruz-López *et al.* (2021), *Sedum kristenii* J.Reyes, O.González & Etter in Reyes-Santiago *et al.* (2012a), *S. piaxtlaense* J.Reyes, Etter & Kristen in Reyes-Santiago *et al.* (2015), *S. sinforosanum* J.Reyes, Etter & Kristen in Reyes-Santiago *et al.* (2017) and *S. acaxee* Art.Castro, H.Ávila & Gonz.-Bernal in Castro-Castro *et al.* (2022).

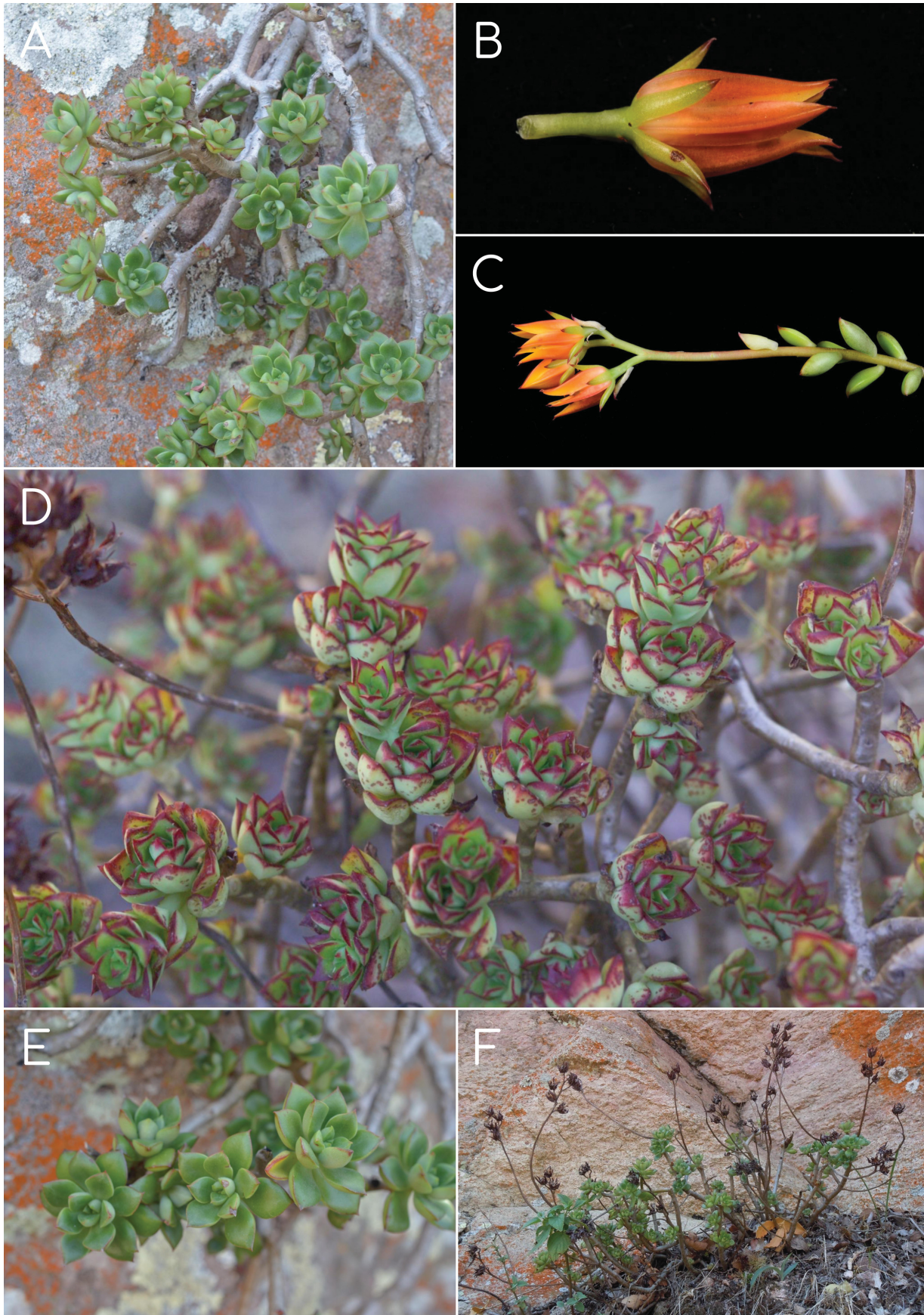


FIGURE 2. *Echeveria flammigera*. A. Decumbent stems. B. Flower. C. Inflorescence. D, E. Rosettes. F. Plants with dry inflorescences and ascending stems. Photographs by J. Etter and M. Kristen.

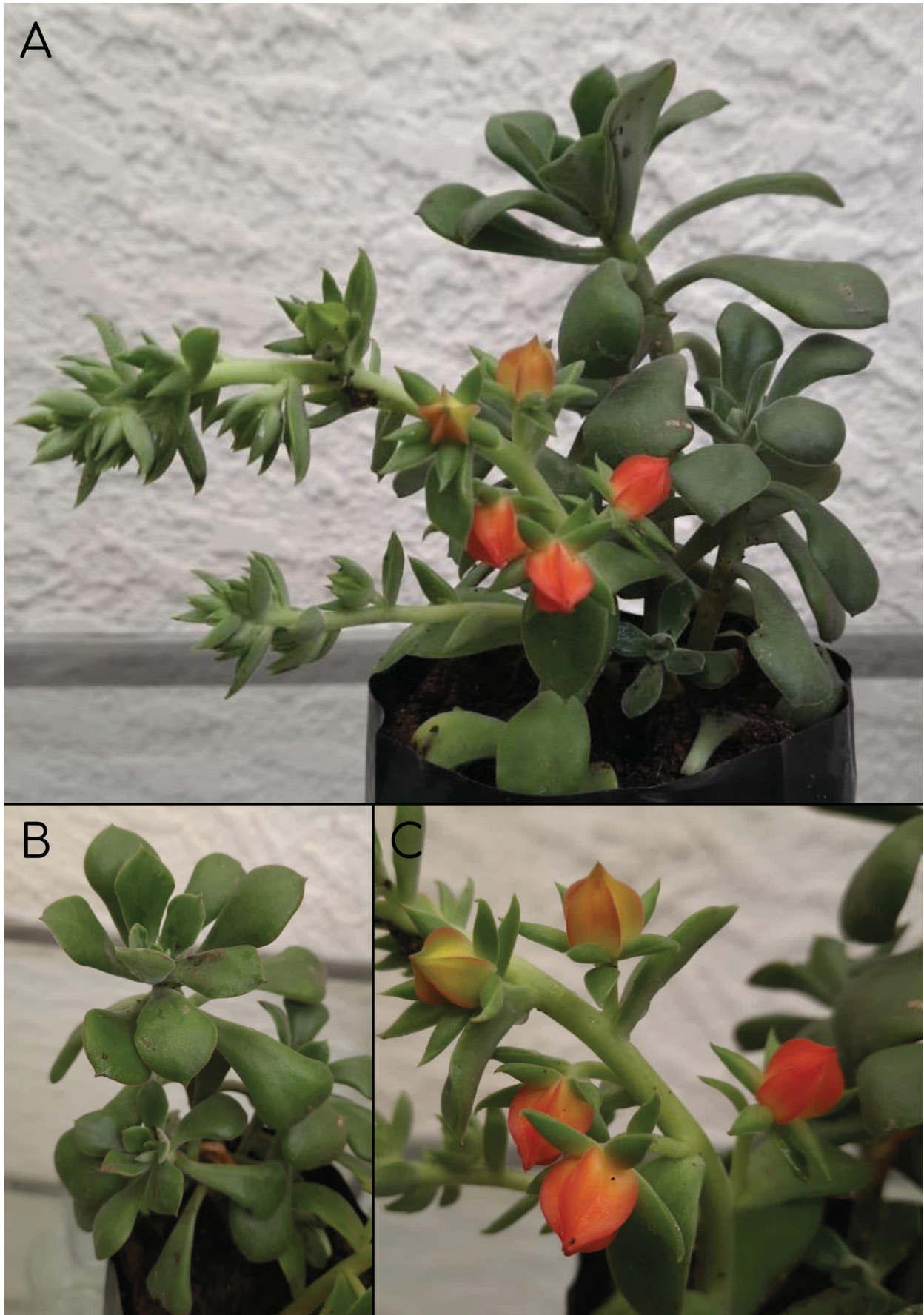


FIGURE 3. *Echeveria pringlei* var. *pringlei*. A. Plant with inflorescence B. Rosette. C. Flower buds. Photographs by Carlos Morales.

Conclusions

1. The morphological comparison, together with biogeographical information, allowed us to unveil that *Echeveria pringlei* var. *parva* is best treated at species rank; the new name *E. flammigera* is proposed since the combination *E. parva* is already occupied. 2. *Echeveria pringlei* now has only two varieties and is endemic to Jalisco. 3. Exploration in Western Mexico is suggested to find undescribed taxa of *E. ser. Nudae* and new populations. 4. Phylogenetic studies are needed to better understand the relationships of *Echeveria flammigera*, as well as to identify useful characters for an accurate delimitation of *E. ser. Nudae* and *E. ser. Echeveria*.

Taxonomy

Echeveria flammigera Rosales, *nom. et stat. nov.* ≡ *Echeveria pringlei* (S. Watson) Rose var. *parva* Kimmach, *Haseltonia* 5: 52 (1997 publ. 1998). Type:—MEXICO. Durango: along the trail from Cinco Señores to Socayon, San Dimas, 1350 m, around 1977, *R. Spencer s.n.* (holotype: HNT!).

Notes:—Raising *Echeveria pringlei* var. *parva* with a new combination to species rank would create an illegitimate younger homonym, since the resulting combination is preoccupied by the earlier *Echeveria parva* Berger (1930: 477), a synonym of *Dudleya cymosa* subsp. *pumila* (Rose in Britton & Rose 1903: 14) Nakai (1988: 336). Consequently, a *nomen novum* (replacement name) is chosen here following ICN Art. 6.11. (Turland *et al.* 2018). The epithet of the new name means ‘bearing flames’, which refers to the flowers that have the appearance of small flames due to their colour and shape.

Updated description:—Plants perennial, caulescent, shrubby, with numerous decumbent or ascending branches, glabrous; stems 40 cm long or more, 0.3–0.5 cm in diameter, tan or grayish, with more or less circular scars of the fallen leaves; rosettes terminal, 2.1–3.9 cm in diameter, lax; leaves 12–22 per rosette, 1–1.5 cm long, 0.5–1 cm wide, 0.5–0.6 cm thick near the apex, obovate, mucronate, nearly straight to somewhat incurved, lower surface convex and keeled from the middle, upper surface somewhat flattish to convex but often with a shallow concavity in the middle, very minutely papillose, green but with intense red colourations; inflorescence a lateral raceme, generally 1 per rosette, up to 20 cm long; peduncle usually up to 15 cm long, tan or grayish in the proximal part, greenish with reddish hues to the apex; peduncle leaves similar in shape and colour to leaves, the basal ones similar in size to leaves, the distal ones more than 0.5 cm long; fertile part usually starting in the upper third of the scape, lax; flowers 2–5 (–7) per inflorescence; pedicels 0.4–0.6 cm long, ca. 0.2 cm thick in the middle, slightly thickened distally; sepals 5, almost equal, 0.6–0.9 cm long, lanceolate, acute to acuminate, slightly recurved in the distal half, both surfaces convex, green with reddish tips; corolla 1.2–1.8 cm long, 0.8–1 cm thick at the widest part in the proximal third of its length, 0.6–0.7 cm thick at the mouth, tubular, light orange to reddish; petals 5, lanceolate, with a prominent mid-keel, the tips finely apiculate and slightly curved outside; carpels 5, 1.0–1.3 cm long; ovary white orangish; styles 0.4–0.5 cm long, narrowed to the apex, orangish, intense red to the apex; stamens 10, 5 antisepalous and 0.8–0.9 cm long, 5 epipetalous and 0.6–0.7 cm long; filaments pale-yellowish to orangish; anthers ca. 0.15 cm long, oblongoid, yellow; nectaries 0.1–0.15 cm wide, reniform, whitish to yellowish; fruits follicles, brownish; seeds reddish, inconspicuous.

Additional specimens examined:

***Echeveria flammigera*:**—MEXICO. **Durango:** near Tayoltita, San Dimas, *R. Spencer s.n.* (HNT!); La Desmontada, 4.5 km al S, por el camino a Mala Noche, San Dimas, 2150 m, 7 March 1990, *M. González 2388* (MEXU!).

***Echeveria multicaulis*:**—MEXICO. **Guerrero:** collected by E. W. Nelson and E. A. Goldman near Omiltemi, May 1903 (flowered in Washington in December 1903), *Rose 628* (F!, GH!, US!); about 10 km west of Camotla, 2500 m, 1 December 1963, *C. Feddema et al. 2798* (MICH!); an 8 km al NE de Puerto del Gallo camino a Filo de Caballo, 3000 m, 15 April 1982, *E. Martínez 910* (MEXU!); Sierra de Campo Morado 5 km SW of Filo de Caballo, at jct. of roads to Chilpancingo and Atoyac, 18 January 1983, *D. Neill 5356* (MEXU!); 15 km SO de Jilguero, 3100 m, 4 June 1983, *T. P. Ramamoorthy et al. 4243* (MEXU!); Cerro Teotepec, 26 km al SO de El Jilguero, 3130 m, 17 August 1985, *J. C. Soto & S. Román 10049* (MEXU!); a 200 m de Carrizalillo, 1 km al SO de Filo de Caballo, 2360 m, 2 December 1988, *A. García et al. 4106* (MEXU!); Parque Omiltemi, 2514 m, 17°33′07.43″N 99°43′09.33″W, 27 August 2010, *J. Reyes 6635* (MEXU!). **Jalisco:** ca. 6 km al S de Canutillo, sobre brecha a Mexiquillo, Tecalitlán, 2000 m, 21 October

1989, *J. Villa et al.* 117 (IBUG!); San Miguel de la Sierra, 35 km al oeste de Ayutla, alrededores de la cascada Salto de Roma, Ayutla, 2050 m, 20°06'30"N 104°36'08"W, 2 April 2011, *A. Castro et al.* 2395 (IBUG!). **Michoacán:** 500 m al NE de Dos Aguas, antena de microondas Chiqueritos, Aguililla, 2400 m, 1 November 2009, *J. González et al.* 404 (IBUG!).

***Echeveria pringlei* var. *pringlei*:**—**MEXICO. Jalisco:** dry shaded ledges of the barranca near Guadalajara, 28 November 1888, *C. G. Pringle* 1853 (F!, GH!, MEXU!, MICH!, NY!, PH!, RSA!, US!); Barranca de Guadalajara, 28/29 September 1903, *J. N. Rose* 870 (GH!, MEXU!); Barranca de Oblatos a ½ km de la entrada por el camino que conduce a los baños, Guadalajara, 1370 m, 14 November 1992, *S. Guerrero et al.* 473 (MEXU!, MICH!); Barranca de Colimilla, en cañada antes de la presa, Tonalá, 1300 m, 27 October 1993, *M. Negrete et al.* 65 (IBUG!, MEXU!); Barranca de Colimilla, en cañada antes de la presa, Tonalá, 1300 m, 6 November 1993, *M. Negrete et al.* 78 (TEX!, WIS!); Cañón de Matatlán, 3.3 km en línea recta al NO de Matatlán, Vereda de Las Cruces hacia El Agua Caliente, Zapotlanejo, 1400 m, 20°44'16"N 103°09'43"W, 11 July 2017, *P. Carrillo et al.* 8603 (IBUG!).

***Echeveria pringlei* var. *longisepala*:**—**MEXICO. Jalisco:** below and E of the mesa of San Andrés Cohamiata, on rocky SE ledge, Mezquitic, ca. 1800 m, 28 October 1987, *J. Bauml & G. Voss* 1932 (HNT!, MICH!).

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