

FOUR NEW TAXA OF THE GENUS *Echeveria* FROM THE STATE OF OAXACA, MEXICO

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Abstract: Four new taxa of the genus *Echeveria* from the Mixteca Alta region, Oaxaca, are described and illustrated: *Echeveria longissima* subsp. *brachyantha*, *E. nuyooensis*, *E. triquiana*, and *Echeveria uhlii* subsp. *coelestis*. The first is a variant of *Echeveria longissima* var. *longissima* and *E. longissima* var. *aztatlensis* from which it differs mainly in the shorter corolla, short pedicels, longer stems and its habitat above 2500 m to the south of the localities of the two other known taxa in the series *Longistylae* E. Walther. The second taxon belongs to series *Spicatae* (Baker) A. Berger and is related to *E. australis* (Nudae), *E. pittieri* and *E. tencho*. Its distinguishing factors are size of the floral stem, inflorescence in form of a thyrs, and white nectaries. The third taxon is compared to *E. fulgens* and *E. gibbiflora* from which it differs mainly in shorter stems, short floral stem, pink-colored corolla, thick leaves, and white nectaries with reddish margins. The fourth taxon is a subspecies of *E. uhlii* of series *Racemosae* (Baker) Berger, differing in its bigger size.

Resumen: Se describen e ilustran cuatro nuevos taxa del género *Echeveria* para la región de la Mixteca Alta, estado de Oaxaca: *Echeveria longissima* subsp. *brachyantha*, *E. nuyooensis*, *E. triquiana* y *Echeveria uhlii* subsp. *coelestis*. El primero es un variante de *Echeveria longissima* var. *longissima* y *E. longissima* var. *aztatlensis* de las que difiere principalmente en la corola más corta, pedicelos cortos, tallos con mayor longitud y habita a más de 2500 metros de altitud al sur de las localidades de los dos taxa conocidos de la serie *Longistylae* E. Walther. El segundo taxón se relaciona con *E. australis* (serie *Nudae*), *E. pittieri* y *E. tencho*, distinguiéndose de éstas por el tamaño de su tallo floral, su inflorescencia tirseiforme y nectarios blancos, se le ubica en la serie *Spicatae* (Baker) A. Berger. El tercer taxón se compara con *E. fulgens* y *E. gibbiflora* de las que difiere principalmente en tallos más cortos, tallo floral corto, el color rosa de la corola urceolada, hojas gruesas y nectarios blancos con bordes rojizos y el cuarto taxón es una subespecie de *E. uhlii* de la serie *Racemosae* (Baker) Berger que se distingue por su mayor tamaño.

Keywords: Crassulaceae, new species, Oaxaca, *Echeveria*

INTRODUCTION

The genus *Echeveria* DC. (Crassulaceae) is distributed naturally on the American continent from northern Mexico to South America with the highest diversification in the high mountains of Mexico, especially in temperate forests. In a recent compilation of data, approximately 170 species are recorded, of which 143 grow in Mexico, and 85% of these are exclusively restricted to the Mexican territory (Reyes et al., 2011). The genus *Echeveria* features a huge diversity of shapes and sizes, making a rigorous taxonomic treatment difficult. Also, geographic isolation by barriers such as mountain ranges has contributed

to the speciation which makes the task of distinguishing taxa on a purely morphological level more difficult. The genus is comprised of perennial species with fibrous, sometimes thickened roots; single or branched, short or elongated stems; helically or spirally arranged leaves, mostly rosulate and succulent throughout without evident petioles. The pentamerous corollas are united at the base forming a short tube. Fruits are in the form of a dehiscent capsule with seeds measuring less than 0.5 mm in any dimension (Meyrán y López, 2003; Reyes, et al., 2011).

The Mixteca Alta region in Oaxaca has a botanical richness surpassing 3500 species of vascular plants, where the genus *Echeveria* stands out with



Figure 1. Habitat of *Echeveria longissima* subsp. *brachyantha* at La Muralla. All photos by J. Reyes unless otherwise indicated

20 of the 49 species known for the state. 28% are strictly endemic species to the area (Reyes, unpublished data). This makes the Mixteca the region richest in species and endemism, not only of the genus *Echeveria* but also of other groups of vascular plants (García-Mendoza, *et al.*, 1994).

In the last 10 years, botanical explorations in search of species of the *Crassulaceae* family in the state of Oaxaca have intensified, especially in the area of the Mixteca. The results of these quests have led to the description of the following new taxa:

Echeveria longissima* subsp. *brachyantha

Reyes, Brachet & González-Zorzano, subsp. nov. (Figs. 1–5).

Echeveria longissima subsp. *brachyantha* Reyes, Brachet et González-Zorzano *E. longissimae* var. *longissimae* Walther *et E. longissimae* var. *azatlensis* Meyrán *similis sed inflorescentia in cincinnis vel panicula (vs. panicula) corolla brevior* 13–16 mm longa (vs. 26–30 cm) differt.

Plant glabrous. **Stems** erect, up to 5 cm tall, 1.5 cm thick, occasionally branching by stolons, not evident. **Rosette** 8–11 cm in diameter, 16–25 leaves. **Leaves** obovate, upper surface concave, apex mucronate, 4–7 cm long, 2.5–3 cm wide, green with shades of reddish, extended, the leaves in winter slightly papillose, ascending. **Flowering stem** erect, 15–28 cm tall with elliptical-oblongate, acute, as-



Figure 2. Rosette of *Echeveria longissima* subsp. *brachyantha* in habitat.

centing leaves, these 1.5–2 cm long. **Inflorescence** a cincinnus or sometimes a panicle, with 5–7 flowers, leaves of floral stem elliptical-oblongate, 1.3–1.9 cm long, 6–8.5 mm wide, ascending, appressed, green-reddish, acute. **Pedicels** 10–11 mm long, 2–2.5 mm thick. **Calyx** extended, 2–2.3 cm in diameter. **Sepals** very unequal, extended to ascending, triangular-elliptical, the largest ones 8–11 mm long, 2.8–3.8 mm wide, the smallest ones near the base 4.4–5.5 mm long, 1.5–2 mm wide, green-reddish. **Corolla** cylindrical, 13–16 mm long, 8–11.6 mm wide at the base, orange, the inside pale yellow, greenish apex. **Petals** acute, apiculate, 3.4–3.7 mm wide, ventrally concave and keeled at the dorsal part, nectar chamber ca. 2.7 mm wide. **Style** white, stigma green. **Filaments** white, epipetalous stamens 3.7–4.2 mm long, antisepalous stamens 6.6–7.4 mm long. **Nectaries** whitish, 2.7 mm wide, obovate.

Type: Mexico, Oaxaca, district of Tlaxiaco, municipality of San Miguel El Grande: Cerro Yucunino, 12 km south of Tlaxiaco, 2880 m, January 7, 2007, J. Reyes & C. Brachet, 5593 (Holotype: MEXU).

Phenology: Flowers from May to July in habitat and in cultivation.

Distribution and habitat: *Echeveria longissima* subsp. *brachyantha* grows on hillsides on rocky outcroppings in a temperate and cool forest on Cerro Yucunino south of Tlaxiaco. The dominating associated species are *Pinus hartwegii* Lindl., *P. pseudostrobus* Lindl., *P. patula* Schiede ex Schltdl. & Cham., *Quercus crassifolia* Humb. & Bonpl., *Q. laeta* Lieb., *Clethra mexicana* A. DC., *Arbutus xalapensis* Kunth, and succulent species such as *Echeveria chazaroi* Kimnach, *E. procera* Moran, *Sedum confusum* Hems-



Figure 3. Inflorescence of *Echeveria longissima* subsp. *brachyantha*.

ley, *S. liebmannianum* Hemsley, *S. torulosum* R.T. Clausen, and *Agave atrovirens* var. *atrovirens* Karwinsky ex Salm-Dyck.

Etymology: The name of this subspecies makes reference to the short flower in relationship with the type species, *E. longissima* var. *longissima* Moran. It is derived from the Greek words *brachys* = short and *Anthos* = flower.

DISCUSSION

The discovery of this new taxon is the result of a botanical exploration in the district of Tlaxiaco, Oaxaca, undertaken in January 2007 by Christian Brachet and Jerónimo Reyes of the Mexican Cactus Society and the Universidad Nacional Autónoma de México respectively. The team was searching for *Echeveria procera*, a species that had not been seen since it was collected in a locality known as La Muralla, close to the base of Cerro Yucunino south of Tlaxiaco by the explorer and naturalist Thomas MacDougal in January 1947, and was later described in 1967 (Moran, 1967). The type locality of *E. procera* has largely been destroyed, which was the motivation to find other similar sites. No plants of this species were found on nearby rocky outcroppings however, but during the ascent, the team discovered a plant which later produced flowers similar to *E. longissima* but much shorter.

The markedly short and pentagonal flowers of *Echeveria longissima* subsp. *brachyantha* clearly distinguish it from *E. longissima* var. *longissima* and *E. longissima* var. *aztatensis* Meyrán of series *Longistylae*, both of which have almost 30 mm long flowers. Table 1 shows features of the three taxa in compari-



Figure 4. Flower of *Echeveria longissima* subsp. *brachyantha*.

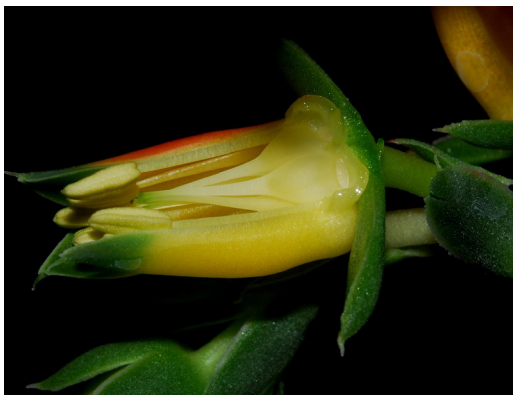


Figure 5. Ovaries and nectaries of *Echeveria longissima* subsp. *brachyantha*.

| | | <i>Echeveria longissima</i> subsp. <i>brachyantha</i> | <i>Echeveria longissima</i> var. <i>longissima</i> | <i>Echeveria longissima</i> var. <i>aztatlensis</i> |
|------------------------|--------|--|---|--|
| Stem | | 5 cm long, rarely with offshoots | 2 cm long, rarely with offshoots | 1.5 cm long, with many offshoots |
| Rosette | | semi-dense, 8–11 cm in diameter | dense, 7–12 cm in diameter | dense, 6–8 cm in diameter |
| Leaves | Shape | obovate | broadly obovate | obovate |
| | Length | 4–7 cm | 3.5–6 cm | 2.3–3 cm |
| Flowering stem | | up to 28 cm tall | up to 32 cm tall | up to 20 cm tall |
| Inflorescence | | cincinnus or panicle | panicle | panicle |
| Pedicels | | 10–11 mm long | 13–19 mm long | 3–10 mm long |
| Sepals | | unequal, 8–12 mm long | unequal, 8–12 mm long | unequal, 6–8 mm long |
| Corolla | | cylindrical, 13–16 mm long, 8–11.6 mm wide | cylindrical, 30 mm long, 7–10 mm wide | cylindrical, 26–30 mm long, 10–v12 mm wide |
| Filaments | | white | whitish | yellowish or whitish-greenish |
| Gynoecium | | white | white | white |
| Flowering time | | May–July | April–May | August–October |
| Type locality | | Oaxaca: Cerro Yucunino, south of Tlaxiaco | Puebla: San Luis Atolotitlán | Oaxaca: San Miguel Aztatla |
| Vegetation type | | <i>Pinus-Quercus</i> forest | xerophytic enclave with <i>Quercus</i> | xerophytic enclave with <i>Quercus</i> |
| Altitude | | 2500–2880 m | 2000–2500 m | 2400–2600 m |

Table 1. Comparative characteristics of *Echeveria longissima* subsp. *brachyantha*, *E. longissima* var. *longissima*, and *E. longissima* var. *aztatlensis*.

son.

The new variety has also been collected on recent explorations in San Pedro Yosoñama, municipality of San Juan Numí, near Nicananduta, municipality of San Sebastian Nicananduta, and in the municipality of Magdalena Peñasco, always growing in dry environments and in populations with few plants.

The limited geographic distribution of *E. longissima* var. *longissima* and *E. longissima* var. *aztatlensis* was the reason for including them into the category “Threatened” (“Amenazada” (A)) in the “Norma Oficial Mexicana” (literally Official Mexican Standard) of species in risk of extinction (NOM-059, 2010). The new variety has a wider range of distribution, although its populations are small and show factors of high risk such as proximity to cattle raising, agriculture, and other human activities. This variety seems to be difficult to cultivate in warm areas.

Finally it is important to mention that this new variety was found only a few 100 meters away from the type locality of *Echeveria procera*, originally collected by the naturalist Thomas MacDougall, as well as the more recently described *Echeveria chazaroi*. The type locality of *E. longissima* subsp. *brachyantha* is relatively well conserved because of the rocks which make threatening human activities such as agriculture difficult, an exception being logging.

Echeveria nuyooensis Reyes & Islas sp. nov. (Figs. 6–10)

Echeveria nuyooensis Reyes *et* Islas, *E. pitieri* Rose, *E. australi* Rose, *E. tencho* Moran & Uhl *similis sed caule usque ad 100 cm longo* (vs. 10–50 cm), *pedunculum longiore* 31–62 cm *longo* (vs. 20–45 cm), *inflorescentia thyrsiformi* (vs. *racemosa vel spicata*), *multis floribus per inflorescentia* 20–68 (vs. 20–45) *pedicellis*, *corolla et nectariis longioribus*.

Plant glabrous. **Stems** erect, branching from the base, up to 1 m tall, 11–14.2 mm thick, pale green, decumbent with age. **Rosettes** lax, 5–9 cm diameter in plants growing in full sun, 12–22 leaves, distributed between 5.5–10 cm of stem length. **Leaves** oblanceolate-spatulate, retuse, slightly pruinose, 4–12 cm long, 3–5 cm wide, base narrowed, concave, purple margins, mucronate. **Flowering stems** 1–2 per branch, 31–62 cm tall including pseudospike, 4.5–8.5 mm in diameter, 15–25 extended leaves, some recurved and sometimes adpressed, oblanceolate, obtuse, mucronate, 2–5 cm long, 1–2.7 cm wide, 1.3–1.6 mm thick, green yellowish, reddish margins. **Inflorescence** thyrsiform, with 20–68 flowers, rarely three almost sessile flowers per branch. Bracts of inflorescence lanceolate, reflexed to ascending, 12.4–19.7 mm long, the lowest ones similar



Figure 6. *Echeveria nuyooensis* in habitat.



Figure 7. Flowering *Echeveria nuyooensis* in habitat. Photo by J. Etter & M. Kristen.



Figure 8. Rosette of *Echeveria nuyooensis*.



Figure 9. Thyrsoid inflorescence of *Echeveria nuyooensis*.



Figure 10. Flower structure of *Echeveria nuyooensis*.

to the leaves of the floral stem. **Pedicels** 2.7–6 mm long, 2–3 very unequal **bracteole bracts**, subulate, reddish, sometimes positioned between the calyx segments, the larger ones appressed to the flower. **Calyx** discoid, 14.5–24 mm in diameter (extended). **Sepals** unequal, the small ones 4.3–6.7 mm long, ca. 1 mm wide, subulate, the largest ones 8.1–11.6 mm long, 1.8–2.2 mm wide, cuspidate, subulate, extended, sometimes ascending, green to reddish-green. **Corolla** cylindrical, pentagonal, 12.1–12.7 mm long, 6.5–7.5 mm wide close to the base, bright pink with yellowish hues, yellow on the inside. **Petals** lanceolate, slightly united at base, imbricate, acute and apiculate, 2.8–4 mm wide, ventrally channeled and keeled dorsally; **nectar chamber** very small, ca. 1.5 mm wide. **Filaments** yellow-greenish, base whitish, epipetalous 4.1–5.6 mm long, antisepalous stamens 4.9–6.3 mm long, opening after anthesis, **anthers** yellow. **Nectaries** white, reniform, ca. 2.4 mm wide. **Gynoeceum** 3.6–4 mm long, 3.5–5 mm wide at base, ovary yellowish, base pink, **styles** green, 1.7–2 mm long, **stigma** green.

Type: Mexico, Oaxaca, district of Tlaxiaco, municipality of Santiago Nuyoo: Mirador de Yucunino, 6.8 km N of Nuyoo, 2715 m, December 27, 2007, J. Reyes, 6069 (Holotype: MEXU).

Phenology: Flowers from November to January in habitat.

Distribution and habitat: *Echeveria nuyooensis* is only known from north of Nuyoo where it grows on rocky hillsides between Mirador de Yucunino and Cueva de la Olla in a very disturbed vegetation of a relict cloud forest. The predominant species are: *Quercus laurina* Bonpl., *Pinus pseudostrobus* Lindl., *Chiranthodendron pentadactylon* Cerv. ex Cav., *Oreopanax peltatus* Linden, *Arbutus xalapensis* Kunth, and succulent plants such as *Echeveria chazaroi*, *E. gibbiflora* DC., *Sedum dendroideum* ssp. *dendroideum* DC., *Agave atrovirens* var. *atrovirens* Karwinsky ex

Salm-Dyck, *A. horrida* ssp. *horrida* Lemaire ex Jacobi, and *Pinguicula konzattii* Zamudio Ruiz & van Marm.

Etymology: The specific epithet makes reference to the village of Nuyoo whose Mixtec meaning is “face of moon”, Nu = face and yoo = moon; or also “where the moon hides”, Nu = descend and yoo = moon.

DISCUSSION

On December 27 of 2007, Jerónimo Reyes went on an exploration with his Mixtec relatives from San Juan Mixtepec visiting various sites of botanical and tourist interest such as Cueva de la Olla and other localities with dense vegetation. He also wanted to see the type locality of *Pinguicula konzattii*, collected by Dr. Alfred Lau in September 1987 along the road to Nuyoo and later described in 2003 (Zamudio, 2003). This species was located and photographed at the Mirador de Yucunino. Looking around, a species of the genus *Echeveria* was found, a plant very similar to *Echeveria procera* but with shorter stems and smaller rosettes, the petals without appendages and a thyrsiform inflorescence. Plants were collected for further study. In 2011 Ángeles Islas Luna, Omar González and Jerónimo Reyes recollected more specimens to complete the above description.

Echeveria nuyooensis is a species endemic to the Mixteca Alta, Oaxaca. It shows morphological resemblance to Central American species such as *Echeveria australis* Rose and *E. pittieri* Rose, and *Echeveria tencho* Moran & Uhl from Veracruz and northern Oaxaca. Table 2 compares the related species.

In the comparison of available morphological data, *Echeveria nuyooensis* is distinguished from its closest relatives by longer floral stems, more flowers per inflorescence, larger pedicels and nectaries, as well as the type of habitat with a clear geographic isolation by the Isthmus of Tehuantepec and the Sierra Madre Occidental.

Echeveria nuyooensis shows similarities with *E. australis* from Costa Rica. The two species, both of series *Nudae*, share characters such as the bracteoles, short pedicels and inflorescence in the form of a thyrs. The new species differs from *E. pittieri* and *E. tencho* in size, form and color of the corolla, but shares similar characters in stems and number of flowers per flowering stem. Although in appearance the new species looks like *E. procera*, the latter was not included in the comparison table because it features scales on the upper side of the petals, has more robust stems and rosettes, and a subspicate inflorescence. The data for this new species comes from live plants collected in habitat on December 29, 2007. It is important to mention that because of their similarity, plants without flowers could be mistaken for *E. procera* which occurs only 6 km away. However the populations encompassing an area from the mountains of Mirador de Yucunino to Cueva de la Olla are homogeneous and do not show any other variation other than in size, depending on the exposure to the sun.

| | | <i>Echeveria nuyooensis</i> | <i>Echeveria pittieri</i> | <i>Echeveria australis</i> | <i>Echeveria tencho</i> |
|------------------|-----------------|---|--------------------------------------|---|--|
| Stem | | glabrous, 100 cm tall or more | glabrous, to 10 cm tall or more | glabrous, more than 20 cm tall | 50 cm tall or more |
| Rosette | | lax, 5–9 cm in diameter | lax | subrosulate | difuse, lax, 7–12 cm in diameter |
| Leaves | Shape | oblanceolate, spatulate | elliptical-oblanceolate | subrosulate, obovate-cuneate | oblanceolate |
| | Length | 4–12 cm | 6–8 cm | 7 cm | 5–6.5 cm |
| | Width | 3–5 cm | 2 cm | 2 cm | 1.5–2.2 cm |
| Flowering stem | | 31–62 cm tall | 20 cm tall | 25 cm tall or more | 50 cm tall |
| Inflorescence | | thyrsiform, 20–68 flowers | dense spike, 4–5 cm long, 20 flowers | racemose-paniculate, more than 25 cm long, 40 or more flowers | racemose, 7–20 cm long, 25–45 flowers |
| Pedicels | | 3–6 mm long | 1 mm long | pseudo-pedicels, 5 mm long | 2–3 mm long |
| Sepals | | unequal, 4–11 mm long, green to reddish-green | shorter than the corolla | unequal, ascending or extended, 8–12 mm long, pinkish-green | unequal, ascending or extended, 6–12 mm long |
| Corolla | Shape | cylindrical | campanulate | cylindrical | cylindrical |
| | Length | 12–12.7 mm | 12–13 mm | 11–14 mm | 13–15 mm |
| | Width | 6.5–7.5 mm | 6 mm | | |
| | Color of petals | bright pink with yellow lines on the inside | pale pink | pink to reddish | yellow with pink apex |
| Filaments | | yellow-greenish | No data available | no data available | pale yellow |
| Gynoecium | | 3.6–4 mm long, 3.5–5 mm wide | No data available | 6 mm long | 7–8 mm long, 4–4.5 mm wide |
| Nectary | | reniform, white, ca. 2–4 mm wide | reniform, 1 mm wide | lunate, 1 mm wide | yellow |
| Chromosome count | | no data available | n= 62 | n= 28 | n= 51 |
| Flowering time | | December–January | January | December–March | December–February |
| Type locality | | Yucunino, Nuyoo, Oaxaca, Mexico | Lake of Ipala Volcano, Guatemala | Volcán de Irazu, San José, Costa Rica | San Andrés Tuxtla, Veracruz, Mexico |
| Vegetation type | | cloud forest | no data available | no data available | subtropical deciduous forest |
| Altitude | | 2725 m | 1000–2400 m | no data available | 300–950 m |

Table 2. Main differences and similarities of *Echeveria nuyooensis* and its relatives *E. pittieri*, *E. australis* and *E. tencho*.

R. Moran (1967) refers to a plant similar to *Echeveria procera* collected by T. MacDougall (B-227) near Chichahuatla coinciding completely with *E. nuyooensis*, observing two aspects: 1) lack of appendages (scales) on the inner surface of the petals; and 2) flowers forming short side branches like cincinni along the inflorescence, characters that would exclude it from series *Nudae*.

This data coincides with the characteristics of *E. nuyooensis*, although the authors have not yet been able to find the abovementioned plants on Cerro Zarzamora. However it is believed that it combines the majority of the morphological characteristics, such as suffruticose stems, a small, glabrous rosette,

and an inflorescence in form of a spike or resembling a lax raceme to include it in series *Nudae*, even if in the case of *E. nuyooensis* the inflorescence is described as thyrsiform. The inflorescence does not correspond to a well-defined pattern; it could also be called “pseudoracemose”.

It is likely that future molecular and biogeographical data will contribute to clarify the level of relationship between these taxa which have been isolated by the complex mountain systems of the Sierra Madre del Sur and the transisthmian mountain range.



Figure 11. *Echeveria triquiana* in habitat. Photo by J. Etter & M. Kristen.

Echeveria triquiana Reyes & Brachet sp. nov. (Figs. 11–14)

Echeveria triquiana Reyes & Brachet, *E. fulgenti* Lemaire *et* *E. gibbiflorae* De Candolle *similis sed caule brevius usque ad 11 cm* (vs. 30–40 cm) *pedunculum brevius 66–80 cm* (vs. 100 cm), *foliis caulibus floralibus oblanceolatis* (vs. *anguste oblongo-ellipticis vel obovatis*), *corolla urceolata* (vs. *cylindrica vel campanulata*), *gynoeceo 10–11 mm* (vs. 18–25 mm) *differt*.

Plant glabrous. **Root** fibrous. **Stem** erect, simple, up to 11 cm tall, 2–2.8 cm in diameter. **Rosettes** compact, 24–30 cm in diameter. **Leaves** narrowly obovate to spatulate, mucronate, bluish-green to reddish-green, margin reddish, entire to frequently crenulate, extended to ascending, 12–15 cm long, 5–7.5 cm wide. **Flowering stems** erect, 1–2 per rosette, pinkish, 30–70 cm tall (including inflorescence), 6.5–7 cm thick close to base, with ca. 11 leaves distributed along the stem, the ones close to the base resembling the leaves of the rosette, 1–5 cm long, 0.5–1.5 cm wide, oblanceolate-lanceolate, reddish. **Inflorescence** paniculate, 4–5 cincinni with 6–8 flowers each; **bracts** lanceolate and appressed each branch, 5–10 mm long, 3–4 mm wide, lanceolate, secondary bracts tiny, lanceolate. **Pedicels** 8–10 mm long, 1.3–1.5 mm thick, pinkish. **Sepals** unequal, ascending, deltoid-triangular, 3.4–6.8 mm long, 1.5–2 mm wide, reddish-green, apex acute. **Corolla** urceolate-pentagonal, 10–11 mm long. **Petal** segments lanceolate, slightly reflexed at apex, orange-pink on the outside, yellow on the inside, pink margin. **Filaments** yellowish, epipetalous ca. 3.5 mm long, anti-



Figure 12. Flowering stem of *Echeveria triquiana*.



Figure 13. Flower of *Echeveria triquiana*.

sepalous stamens ca. 5.5 mm long, **anthers** 1.5 mm long. **Nectaries** oblong, 1.5 mm wide, white, pinkish on the sides. **Gynoecium** yellow, ca. 4.5 mm long, 4.2 mm wide; style purple, ca. 2.3 mm long; **stigma** olive green.

Type: Mexico, Oaxaca, Agua Fría, 7.7 km south of Naranjos, along highway from Juxtlahuaca to Tlaxiaco and Putla, municipality of Santiago Juxtlahuaca. Alt. 1889 m. February 16, 2008. *Jerónimo Reyes & C. Brachet*, 5614 (Holotype: MEXU).

Vegetation type: Secondary vegetation originally pertaining to the cloud forest. The new species



Figure 14. Floral structure of *Echeveria triquiana*.

grows in a xerophytic limestone enclave but the site is disturbed by human activities such as farming. The original species include *Liquidambar styraciflua* L., *Pinus leiophylla* Schiede ex Schltdl. & Cham., *Quercus candicans* Née, *Alnus acuminata* Kunth, among others that were observed nearby.

Etymology: The name of the species makes reference to the Triqui ethnic group who live in the area where the species occurs.

Flowering time: The species has been found flowering from November to January.

| | | <i>Echeveria triquiana</i> | <i>Echeveria fulgens</i> | <i>Echeveria gibbiflora</i> |
|--------------------------|--------|---------------------------------------|----------------------------|---------------------------------------|
| Stem length | | up to 11 cm | up to 30 cm | up to 40 cm |
| Rosette diameter | | 24–30 cm | 8–30 cm | 30–50 cm |
| Leaves | Shape | obovate to spatulate | obovate-spatulate | obovate-orbicular |
| | Length | 22–27 cm | 25 cm or more | 15–25 cm |
| | Width | 3–5 cm | 9 cm | 5–10 cm |
| Flowering stem | Number | 1 or 2 | solitary | 1 or 2 |
| | Length | 66–80 cm | 15–20 | up to 100 cm |
| Leaves of flowering stem | | oblanceolate | narrowly oblong-elliptical | obovate, acuminate |
| Inflorescence | | paniculate, 10–14 cincinni | paniculate | narrowly paniculate, up to 12 racemes |
| Pedicel length | | 5–7 mm | 20 mm | 2–5 mm |
| Corolla | Color | pink to orange | red | pink |
| | Shape | urceolate | campanulate | cylindrical |
| | Length | 18–24 mm | 30 mm | 22 mm |
| Gynoecium (length) | | 10–11 mm | 25 mm | 18 mm |
| Nectaries | | reniform, white, with pinkish margins | narrowly reniform, yellow | truncate, reniform, white |
| Chromosome count | | | 54 | 54 |

Table 3. Main differences and similarities of *Echeveria triquiana*, *E. fulgens* and *E. gibbiflora*.



Figure 15. *Echeveria ublii* subsp. *coelestis* in habitat.

DISCUSSION

On a botanical exploration carried out by Christian Brachet, Roxana Mondragón and Jerónimo Reyes in February of 2008, who were looking for *Echeveria helmutiana* Kimnach for the national *Crassulaceae* collection at the Botanical Garden of the “Instituto de Biología de la Universidad Nacional Autónoma de México”, a species of *Echeveria* similar to *E. fulgens* var. *fulgens* Lemaire but with pink flowers and reddish or white and reddish-rimmed nectaries was found. This prompted the beginning of the plant's study. The team had to return to the site several times, to collect vegetative samples and seeds. After three years of cultivating this taxon at the installations of the Jardín Botánico, UNAM, it was possible to compare it to live specimens of *Echeveria fulgens* from the states of México, Guerrero and Michoacán, which resulted in characters not present in series *Gibbiflorae* (Baker) A. Berger. The morphological variation of the “fulgens” group species and the absence of a neotype for *Echeveria fulgens* have made it very difficult to differentiate it from recently found species such as *Echeveria aurantiaca* Reyes, González-Zorzano & Brachet, *E. purhepecha* I García, *E. perezcalixii* Jimeno-Sevilla & P. Carrillo, among others. Nonetheless, few but valuable distinctive morphological characters have been found to justify the recognition of a new species. *Echeveria triquiana* is distinguished from its closest relatives by its more robust rosettes with very thick leaves which show no pruinosity. The most important character separating the species is its urceolate, pink- or slightly orange-colored flowers (see Table 3). Additional characters that distinguish *E. triquiana* from *E. fulgens* are the short pedicels and nectaries with a pinkish margin.

Echeveria ublii J. Meyrán subsp. *coelestis* Reyes & López subsp. nov. (Figs. 15–19)

Echeveria ublii subsp. *coelestis* Reyes & López, differt a specie typica magnitudo omnibus partibus. Rosula usque ad 13 cm diam (vs. 6 cm) inflorescentia 30 cm (vs. 15 cm).

Plant perennial, glabrous, cespitose. **Roots** fibrous. **Stem** erect up to 3 cm long, not evident. **Rosettes** 10–13 cm in diameter. **Leaves** obovate, margin entire, hyaline, slightly, glaucous, frequently concave, apex mucronate, 4.5–5 cm long, 2.7–4 cm wide, ca. 3 mm thick in the middle. **Flowering stems** 1–2, decumbent to pendant, 18–30 cm long, including panicle, ca. 4.5 mm thick at the base, leaves obovate, 2–3 cm long, 1–1.5 cm wide, margin hyaline, apex mucronate. **Inflorescence** paniculate with 3–5 branches. **Bracts** similar to leaves, 1–1.5 cm long, 5–10 mm wide. **Pedicels** 2.5–4 cm long, ca. 1.6 mm thick, extended to reflexed, 1–2 bracteoles obovate to oblanceolate, 9–10 mm long, 3–6.7 mm wide. **Calyx** discoid, 4–5 mm wide. **Sepals** unequal, extended, sometimes ascending, triangular-lanceolate, the small ones 5–9 mm long, close to 2 mm wide, the bigger ones 7–13 mm long, 2.2–3 mm wide. **Corolla** campanulate-pentagonal, 12–15 mm long, 7–8 mm wide at the base, yellow with reddish hues at the base. **Petals** united close to the base, elliptical-oblong and apiculate. **Filaments** white yellowish. **Nectaries** reddish to yellowish. **Gynoeceum** 6.5–7 mm long, 4.5–5 mm thick, ovary reddish to yellowish, ca. 4 mm long, **style** conical, ca. 3 mm long, yellow.

Type: Mexico, Oaxaca, District of Teposcolula,



Figure 17. Inflorescences of *Echeveria uhlii* subsp. *coelestis*.



Figure 16. *Echeveria uhlii* subsp. *coelestis* with dried leaves at the base of the rosette.

municipality of San Pedro Nopala, Cañada del Cerro Tabacón, 3.5 km northwest of San Pedro Nopala, 2400 m, January 22, 1995, *J. Reyes & Guillermo Moreno*, 3611-A (Holotype: MEXU).

Phenology: Flowers from May to June in a greenhouse.

Distribution and habitat: *Echeveria uhlii* subsp. *coelestis* is only known from the type locality in a steep and rocky ravine. *Quercus laeta* Liebm., *Q. castanea* Née, *Furcraea longaeve* Karwinsky & Zuccarini,

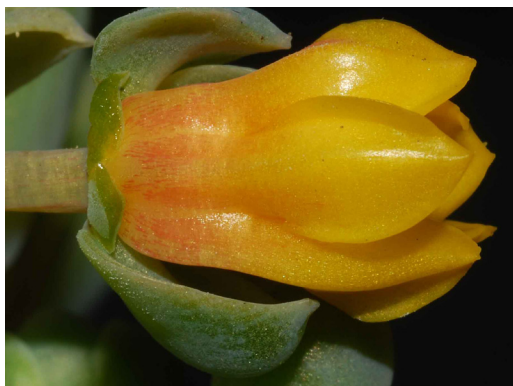


Figure 18. Flower of *Echeveria uhlii* subsp. *coelestis*.



Figure 19. Floral structure of *Echeveria uhlii* subsp. *coelestis*. *Agave* aff. *ghiesbreghtii* Lemaire ex Jacobi, *Sedum torulosum* Rose, and *Dahlia pteropoda* Sherff are the predominant species.

Etymology: The name makes reference to the heavenly beauty of this species.

DISCUSSION

On an exploration trip in the municipality of San Pedro Nopala, District of Teposcolula, Oaxaca, searching for new localities of *Echeveria longissima* a plant similar to *E. uhlii* but bigger in size was found and live specimens were collected for their cultivation at the botanical garden of the National Autonomous University of Mexico (UNAM). This species has been in the collection of live plants for many years without ever being formally described.

Echeveria uhlii subsp. *coelestis* is a taxon with a very limited distribution with less than 100 individuals in the abovementioned ravine close to the village of San Pedro Nopala in the Mixteca Alta. It is distinguished from the type species, *E. uhlii*, by its bigger size (see Table 4), although the distance to the locality of the type species is less than 10 km. This species might be the same that the explorer and cactus enthusiast Charles Glass together with Felipe Otero, another expert in the field, had found back in 1994, a fact mentioned in J. Meyrán's book "Las Crasuláceas de México" (Meyrán & López, 2003).

In the original description of *Echeveria uhlii* subsp. *uhlii*, it is stated that the species belongs to series *Racemosae* (Meyrán, 1992). However after studying many individuals in the field these differ in having paniculate and racemose inflorescences. In fact, the species could belong to a new series due to its growing during the dry season. This is an unusual phenomenon—more than half of the leaves of the rosette dry up, probably to avoid dehydration because they are very thin and exposed to cold and hot weather. In addition, its campanulate flowers with a very short tube are distinctive.

The richness in endemism of the flora of the Mixteca Alta, Oaxaca, is generally explained by the isolation and geological stability of the area for millions of years, the lack of catastrophic events, high physiographic variation, and high intensity of evolution (Rzedowski, 1991).

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