

The Crassulaceae of Southern Peru

Abstract. Three taxa of succulent Crassulaceae: Two *Echeveria*, and one *Sedum* were found in the Southern Departments of Perú. (1) *Echeveria peruviana*, a species described 180 years ago, was not found until recently in its type locality, a full description is provided and more localities in the departments of Tacna and Moquegua are given. (2) *Echeveria vulcanicola* is a new species with conspicuous stems. It has only been found growing among black lava rocks in the Valley of the Volcanoes in Arequipa. (3) *Sedum ignescens* is a new species from Arequipa, Apurímac, Moquegua and Tacna, with leaves similar to *Sedum andinum* but with longer branches, its inflorescences and flowers are slightly smaller than those of *Sedum reniforme* but yellow with red spots instead of greenish white. Both *Echeveria* belong to series Racemosae. We consider all three species endemic to Southern Perú.

Keywords: Crassulaceae, *Echeveria*, *Sedum*.

1. *Echeveria peruviana* Meyen, *Reise um die Erde*, I: 448, 1834; Walpers *Repert. Bot. Syst.*, Vol 5: 794, 1845–46; Poellnitz, in *Fedde Repert.*, Vol 38: 192, 1935; J.F. Macbride, *Flora of Peru, Field Mus. Bot. Ser. Vol XIII*, Part II, No. 3: 1009–1014, 1938; Walther E, *Echeveria*. San Francisco: California Academy of Sciences, San Francisco: 367–368, 1972.

Synonym: *Cotyledon peruviana* Baker in *Saunders Refug. Bot.*, Vol 1 (10), 1869; *Gard. Chron.*, Vol 2: 258, 1874.

Holotype: PERU Dept. Tacna, Prov. Tacna, Dist. Palca, near Palca, road from Tacna, 1832?, *Meyen s/n* (B: Lost)

Lectotype: Photo at Rockefeller Foundation Nr. 18248 (F)

This plant was discovered and described by Franz Julius Ferdinand Meyen, a German (Prussian) Botanist and Physician, who visited the coasts of Perú and Bolivia between 1830 and 1832 aboard the German ship “Prinzess Luise”, discovering also during this trip the Humboldt penguin (*Spheniscus humboldti*). The

description on his book “Voyage around the world” (1834) is meagre, “leaves born from root: obovate-cuneate acute, caulinar leaves (bracts) lanceolate acute, terminal spike loose, with bracts, calyx much shorter than corolla, corolla purplish”. He stated that the type locality was: Road from Tacna near Palca, Peru.

Meyen’s compatriot and colleague Wilhelm Gerhard Walpers published a slightly more detailed description of *Echeveria peruviana*, in his *Repertorium Botanices Systematicae*, six years after Meyen’s death. He never visited Peru, but it is likely they shared information about this plant, as both worked together in Berlin. He added to the description that the rosettes are glaucous and that the corolla is “coccinea” (red), being similar to *Echeveria racemosa*, differing in the leaf shape, bracts at the base of scape and persistent sepals and bracts.

For more than one century researchers have explored the vicinities of Palca and nobody has ever been able to find this plant again at exactly the same place. Walther even made a description based on plants from Argentina attributed to be *E. peruviana* and this has led more to confusion (1972). He also claimed a distribution in Central Peru where plants are clearly other species like *E. andicola*, *E. deltoidea* and *E. fruticosa* (see Pino 2005, 2018). He mentioned that its type had been destroyed at the bombings at Berlin during WWII, but as a Lectotype existed at F, there was no need to designate a Neotype, even if collected at the type locality.

According to Kimnach (2003), Paul Hutchison was one of the researchers who unsuccessfully tried to find *E. peruviana* at its type locality in 1964. He did not find

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1a. *Echeveria peruviana* growing in habitat near the hot springs of Putina in Ticaco.



1b. *Echeveria peruviana* growing on the road to Palca near type locality (P.H.)

it there, but he collected 7176.8 (UC 64.1501, HNT 3499), with small oblong, green leaves with red edges and red petals, 62 km NE of Tacna, 17 km NE of Quilla on road to Tarata, at approximately 3100 m, before arriving to Estique Pampa. We have explored this road and found the point 17 km away from Quilla, where the road reaches this height but no plants were found. Hutchison wrote down on his fieldbook that this collection would make a Topotype for *E. peruviana*, but he did not publish this designation anywhere. Uhl studied two cultivated plants of this collection and described them as having narrow racemes with pink flowers and some two-flowered cincinni lower down. He indicated that its 50 ± 2 chromosomes clumped tightly together at meiosis but otherwise appeared normal. He was the first to publish two photos of living plants of this species (fig. 31, 32 in p. 14, Uhl, 2007). Pilbeam also published a photo of these cultivated plants taken by Jack Napton in the 60s (2008).

In year 1998 Asunción Cano and Maria Isabel La Torre, both researchers of the Museo de Historia Natural from Lima found populations of *E. peruviana* also in the province of Tarata, at Cerro Mocara and Ticaco. César Cáceres Musaja, a local Botanist of Tacna also collected this plant at Ticaco in year 2000 (Fig. 1a).

Since 2007 the first author has visited the road to Palca every year, after the expected rainy period (January to March), to try to find *E. peruviana* at its type locality. The first time we arrived at Palca and talked to the villagers, we were amazed to learn that due to the climate change that had already started then, there had been no rain at all for more than three years! Palca (from Aymara and altiplanic Quechua “p’allqa” “forked”, and by extension, river confluence) is a common name in many places of Peru, anywhere a city stands near a river bifurcation. In this case the closest river to Palca is the Uchusuma that runs into the Mauri, then it joins the Desaguadero that drains Titicaca Lake to the Poopo Lake in Bolivia. In 1867 a canal of the Uchusuma was built driving part of its water to Peruvian and Chilean territory westward, thus partially emptying its flow to the Pacific basin. This shift of water disposal may be responsible for the progressive desertification of Palca Valley and perhaps this has almost led to the extinction of *Echeveria peruviana* at its type locality.

In 2009, having heard of some rainfall at the beginning of the year, the first author together with José Guillermo Celso Pizarro Neyra and Luisa Infante Escalante explored the vicinity of Palca, finding



1c. Young plants of *Echeveria peruviana* showing tuberos root system.

very few almost dry plants in a gorge very close to the town of Palca. As Walther stated that the type no longer exists in B but a Lectotype of it is kept in F, there was no need to declare a Neotype, but we collected just one adult plant to make an Epitype for USM, for study purposes, such as the description in this article and future molecular research. José Pizarro is a local expert of the cacti of Tacna region and has written a book about it, where the finding of this *Echeveria* is mentioned (Pizarro, 2014). In 2012, after a very rainy Southern hemisphere summer, independently from our findings, the acknowledged cactus expert Paul Hoxey from England, found healthier, more abundant populations of *E. peruviana* somewhat closer to Tacna city, near the hamlet of Chontacollo (not Chontacollo mountain) along the road before the second ascent to Palca (Fig. 1b). His findings and photographs were published in the International Crassulaceae Network <http://www.crassulaceae.ch/de/artikel?akID=48&aID=2&aID=2756>. In subsequent years (2013, 2014 & 2018), either José Pizarro or the first author have returned to the locality we knew closer to Palca without any luck, only to find the hills around this town each time drier and even the cacti of the surroundings dying from diseases caused by drought.

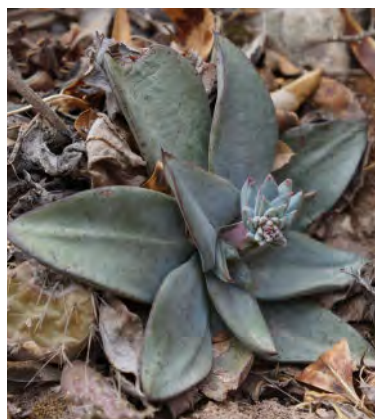


1d. *Echeveria peruviana* ex-situ from Ticaco, Tarata

Description: A succulent glabrous acaulescent herb. **Roots** tuberous, a taproot in young plants, then 3–5 tuberous roots, 2–9 (–15) cm long, 0.5–0.6 (1.2) cm diam. at the base, swollen up to the proximal 2–3 cm, then tapering, cream yellowish, also fibrous from sides of main roots, 1–3 cm long, 0.3–0.5 mm diam. (Fig. 1c). **Stem** none, present very rarely in very old plants, in that case subterranean or hidden among mosses, when present erect, short, 1–3 cm diam., cream-yellowish, very rarely 1–3 branched. **Rosette** generally simple, 5–18 cm diam. (Fig. 1d). **Leaves** 12–16 (–20), widely obovate when young, (Fig. 1e), narrowly obovate in older plants, (Fig. 1f), sessile, almost horizontal, 2–6 (–8) cm long, 0.7–1.7 cm wide at base, 1–1.1 (2.2) cm wide at proximal third, 1.2–2.5 cm wide at middle, 1–2.2 cm wide at distal third, 3–4 mm thick, upper side concave to subcanaliculate, rarely central nerve prominent (Fig. 1g) very light green at proximal half, distal half grayish olive green in the dry season, even gray-glaucous with a purplish hue when very dry, very dark green in the rainy season or when shaded, in some young leaves subfaceted 3–4 mm from border in distal half (Fig. 1h), **margins** red at distal half in light colored plants (Fig. 1i), lower side carinate, somewhat reddish at facets and keel, some reddish stripes beneath, **apex** acute to cuspidate or



1e. Detail of leaves of young *Echeveria peruviana* from Ticaco.



1g. Young plant of *Echeveria peruviana* from Moquegua showing prominent central nerve (D.M.)



1f. Detail of leaves of mature *Echeveria peruviana* from Palca.



1h. Young plant of *Echeveria peruviana* from Moquegua showing faceted leaves and red tips (D.M.)



1i. Young plant of *Echeveria peruviana* on the road to Palca with reddish margins (P.H.)



1j. Plant ex-situ of *Echeveria peruviana* from type locality showing scapes.

mucronate, red above, 2 mm at base, 2 mm long, base hyaline pinkish.

Flowering stem 1 (–5) oblique lateral subterminal raceme, **rachis** 25–38 (–78) cm long, 5–8 mm diam. at base, slowly tapering to 1.5–2 mm diam. at apex, light green at base, turning pinkish at distal end with reddish stripes (Fig. 1j). **Peduncular bracts** 10–20, erect, alone at proximal two thirds of stem, then one at the base of each pedicel, spaced 1.5–2 cm apart at base and 1–1.5 cm apart towards apex, very narrowly obovate or narrowly lanceolate, straight, 1–2.5 (–3.5) cm long, 2.5–5 (–12) mm wide, 1.5–2 mm thick, inner side concave to canaliculated, light green with reddish dots near apex, outer side convex or subcarinate, covered evenly with reddish dots, tips and margins reddish, apex acuminate, base hyaline pinkish (Fig. 1k). **Flowers** 9–21 (–30), appearing from February to May, at distal third of the scape, 1.4–1.6 cm long and 0.8–0.9 cm diam. **Pedicels** 0.4–1.5 cm long, erect or oblique, 1–1.5 mm diam., pink, with



1k. Detail of the bracts of *Echeveria peruviana* from Ticaco.



1l. *Echeveria peruviana* from type locality: From left to right: Bracts (3); Above: Flower bud, sepals (2), petals (2), sectioned flower showing gynoecium, Below: complete flower, fruit, dry fruit (2).



1m. *Echeveria peruviana* from Moquegua: From left to right: Sepals (3), flower buds (2), sepals (2), complete flower, sectioned flower showing gynoecium, carpel, gynoecium, carpel, petals (3), dry fruit.



1n. Detail of germinated plants of *Echeveria peruviana*, (below) and the development of taproot (above).

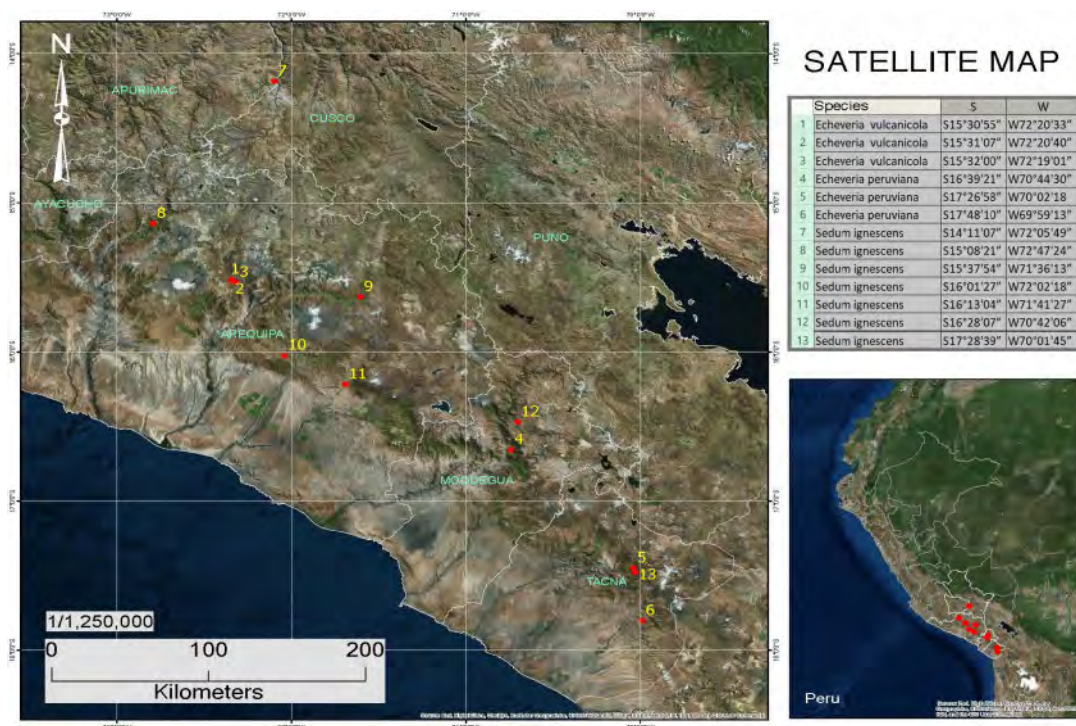


1o. *Echeveria peruviana* at Moquegua (D.M).

one small 3–4 mm long, 1–1.5 mm wide bract at base, sometimes with a similar small bractlet at the middle when long, and a smaller one at the base of calyx (Fig 1l). **Calyx lobes** united at base, sepals unequal, oblong to narrowly ovate or narrowly triangular, acuminate, incurved, light green glaucous, inner side concave, outer side convex, 5–8 mm long, 2–2.5 mm wide, light green, tip reddish. **Flower buds** ovoid, 0.9–1.5 cm long, 0.7–0.8 cm diam., cream at base, reddish at apex and keels. **Corolla** urceolate, subprismatical, 0.8–0.9 cm thick near base, 0.4–0.6 mm thick near apex, 1.4–1.6 cm long, **petals** oblong, acute, 1.3–1.7 cm long, 3–4 mm wide, outer surface keeled, cream yellow at proximal half with reddish stripes, salmon red at distal half and keel (Fig 1l), apex recurving, darker red, inner surface cream or yellow at proximal half, red at distal half. **Stamens** 10, the 5 epipetalous 7–8 mm long, the antesealous 8–10 mm long, **filaments** cream to pinkish distally, 0.6 mm thick at base, gradually tapering to 0.2 mm. **Anthers** ovate, yellow, 1.8–2.6 mm long and 0.9–1.1 mm wide. **Gynoecium** ovoid, 7–10 mm long, 4–6 mm thick. **Carpels** 5, easily detachable, cream yellow. **Styles** 2–3 mm long, parallel, almost touching each other, greenish yellow reddish at the tip. **Stigma** dark red. (Fig. 1g). **Nectaries** reniform, greenish yellow 0.8–1 × 1.8–2 mm. **Fruit** a dehiscent capsule 1–1.4 cm long, 1.2–1.7 cm diam. (spreading dry

sepals), brown (Fig. 1m).

Other localities: PERU: Dept. Tacna, Prov. Tacna, Dist. Palca. Dist. Palca, dry loamy and rocky gorge just before Palca Town aprox. 45° open, on moss, rocky sandy soil on slope exposed North, with subshrubs, *Baccharis* sp. *Maytenus* sp. *Solanum* sp. and *Tagetes* sp., 2692 m, S 17° 48' 10", W 69° 59' 13", Apr 10, 2009, G. Pino & J. Pizarro 2426. (USM 304304, **Epitype**) Below Palca, growing in a steep, partially rocky slope just below the road together with *Haageocereus chilensis*, *Oreocereus hempelianus*, *Browningia candelaris*, *Corryocactus brevistylus* and *Neoraimondia arequipensis*, 2470 m, S 17° 48' 38" W 070° 00' 00", Mar 9, 2012, P. Hoxey 971.06. Prov. Tarata, Dist. Estique. Road from Tacna to Tarata, 62 km NE of Tacna, 17 km NE of Quilla, before Estique Pampa, growing with *Corryocactus brevistylus*, *Corryocactus aureus*, *Oreocereus hempelianus* and *Sedum ignescens*, 3100 m. S 17° 36' 32" W 070° 03' 38" (approximate), Nov 28, 1964. Paul Hutchison 7176 (HNT 3499). Dist. Tarata. Cerro Mocara, rocky sandy soil on rocky slope, thicket with cacti, 3800 m, Apr 1, 1998, M.I.La Torre, A. Cano, S. Córdova & C. Baldeviano 2370. (US 3370384). Dist. Ticaco. Ticaco, rocky sandy soil on rocky slope, with columnar cacti and *Polylepis* forests, 3600 m, Mar 30, 1998, A. Cano 8347. (USM 159915). Road from Ticaco to Putina Hotsprings, on rocky slope, with grassland, 3287 m, S 17° 26' 58", W 70° 02' 18", Mar 17, 2018, G. Pino 2820.



Map 1. Locations of *Echeveria vulcanicola* (1–3), *Echeveria peruviana* (4–6) and *Sedum ignescens* (7–13).

(HUSA 14568, USM 304302). Dept. Moquegua, Prov. General Sanchez Cerro, Dist. Yunga. Spiny scrubland. Rocky slopes by the road from Yunga to Pampilla, 3511 m, S 16° 12' 22", W 70° 41' 41", Feb 17, 2006, *D. Montesinos* 788 (HCSM). Prov. Mariscal Nieto, Dist. San Cristóbal de Calacoa. Xerophytic scrub. Cliff by the road to Sijuaya, 1 km N of Sijuaya town, 2696 m, S 16° 39' 21", W 70° 44' 30", Apr 20, 2018, *D. Montesinos & K. Chicalla* 6107. (HUSA 14567).

Etymology and ethnobotany: The vernacular name for this *Echeveria* in the Aymara language is: Qamaq Jinchu: "Fox ear": a composite of qamaq (fox) and jinchu (pronounced heen-choo). This information was provided by Yemilé Sandoval, the girl who helped the first author find the populations near Putina Hot Springs, Ticaco. Her aunt uses this plant as medicine for earache and conjunctivitis, as it is done with many other *Echeveria* species elsewhere in Perú.

Ontogeny: After germinating, this *Echeveria* looks like any other species of this genus but it soon develops a taproot, that later will become the main tuberous root (Fig. 1n). These roots form an additional succulent reservoir for dry years. Sometimes no leaves are seen, but the surviving plants produce new leaves from tuberous roots as soon as it starts raining.

Distribution: To date, *E. peruviana* is endemic of

the Peruvian departments of Tacna (at the extreme south of the Peruvian Andes) and Moquegua (where it was found by our second author in two of its provinces) (Fig. 1o, Map 1), being its type and most southern locality less than 20 km away from the border of Peru with Chile and less than 100 km far from Bolivia. However, plants seem to be currently more abundant in the Province of Tarata. Dr. Karl von Poellnitz stated in his writings (1935), that this plant occurs in northern Chile — according to a personal communication of Dr. Rose to Dr. White — a fact that has never been confirmed with a Herbarium sheet or written report. The latest bibliography consulted shows no evidence of its occurrence in the First Region of Arica - Parinacota in Chile (Pinto R. 2009, Hernández J et al. 2014). Further research is needed to determine the presence of this *Echeveria* in the Northern Chilean Andean valleys, which is possible.

Some authors have insisted that *E. peruviana* grows in Argentina. Walther's description of an Argentinian plant clearly depicts a very different species he observed. Moreover, according to the photographs of plants from Salta and Jujuy published in the web, it is clear that there are two different species in Argentina, none of them *E. peruviana*.

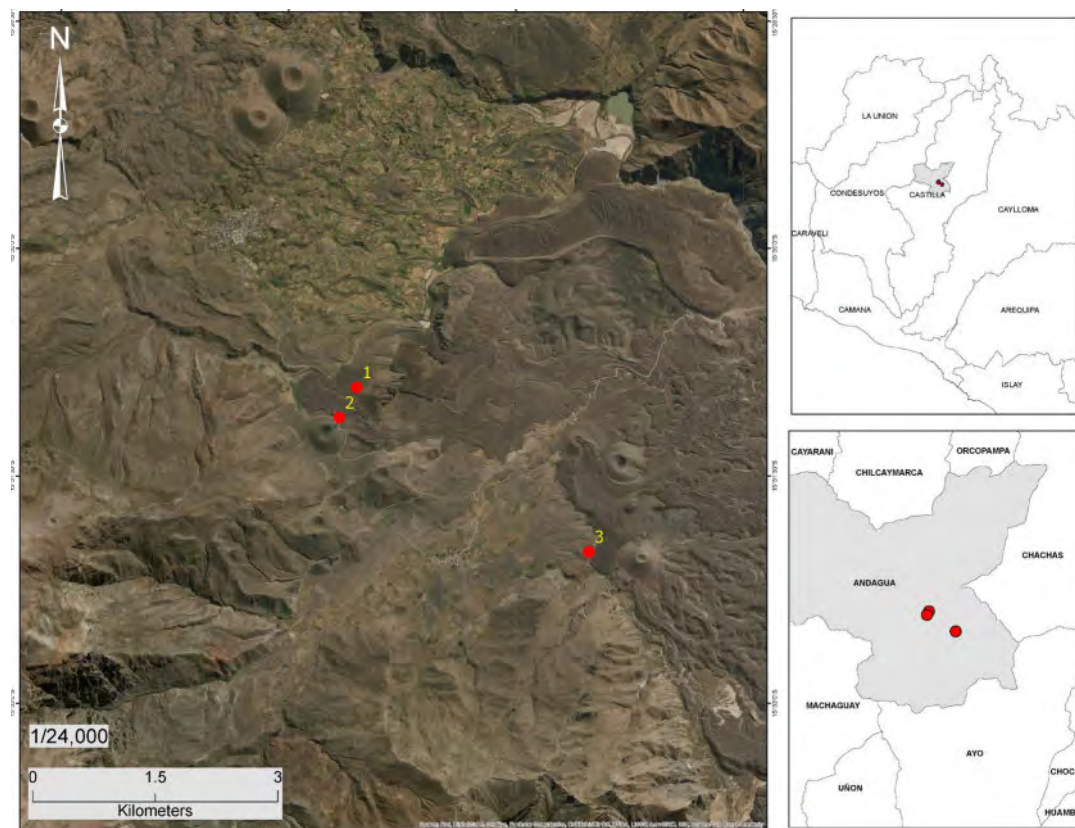


2a. *Echeveria vulcanicola* at type locality in Andagua.

2. *Echeveria vulcanicola* Pino, Montesi- nos & Matuszewski, sp. nova

Holotype: PERU: Dept. Arequipa, Prov. Castilla, Dist. Andagua. Footpath to the Mirador of Antaymarca, plains on both sides of the path, among rocky crevices of black volcanic rocks, 3556 m, S 15° 30' 55", W 72° 20' 33", Feb 19, 2018, *D. Montesinos 6014*. (HUSA 14566, Type) (Fig. 2a).

In year 2011 the third author, the Polish cactus explorer Grzegorz Matuszewski discovered this *Echeveria* among volcanic rocks along the route from Ayo towards Andagua in the Valley of the Volcanoes, Arequipa during his trip to Perú. He has been searching for new Cacti species since 1996, mainly in Mexico and Chile, having discovered and described 2 new species: *Turbincarpus graminispinus* and *T. saueri* subsp. *septentrionalis*, and he has published a book about *The locactus* together with Stanisław Hinz (Matuszewski et al. 2011), as well as more than 100 articles. After his trip to Peru he posted several photos of the new *Echeveria* he found in his web page: www.kaktusymeksyku.pl as *Echeveria* aff. *chilensis*. In 2017, he published



Map 2. Localities of *Echeveria vulcanicola* ●.



2b. Footpath to the Antaymarca volcano, type locality of *Echeveria vulcanicola*.

articles in *Avonia* and in the *Polish Cactus Journal*, where he shows photos of this new *Echeveria*, and he lists other Peruvian species, concluding this may be new to science. That year he also contacted Joël Lodé, the renowned cactus publisher who forwarded us the information about this new *Echeveria* (Pers. comm.).

In February/March 2018 we explored the Valley of the volcanoes, starting our trip from the Majes River Valley on the road from Lima to Arequipa, driving north and reaching the towns of Aplao, Acoy and Andamayo after which the road slowly becomes narrower and full of curves as we approach the town of Viraco, to turn afterwards into a breathtaking drive passing through deep river valleys of more than a thousand meters high. Afterwards the road continues with life-threatening hairpin loops ascending to a freezing 4800 m pass, then it progresses to a high plain where Vicuñas run across the road with the Qurupuna (Coropuna) volcano (the largest and highest volcano in

Peru) in the background, until we finally reach the town of Andagua (Antawa in quechua language, probably after “anta”, copper or “antawara”, reddish sky in the sunset). After Andagua, our second author headed to the Mirador (viewpoint) of Antaymarca. This is an inactive volcano and from its summit the city of Andagua and the twin extinct volcanoes Shippee and Johnson can be seen to the North, (these named after U.S. Navy Lt. George R. Johnson, a pioneer in aerial photography and Robert Shippee, a Harvard-educated geologist and pilot who explored archaeological sites and geographical features of Peru using aerial photography in the 1930’s, see Map 2). The footpath towards the viewpoint is carpeted with bright red lava dust and it struggles between the fallen ruins of Antaymarca city, whose remains are only its broken rock streets and walls made of black lava stone (Fig. 2b).

It is among these rocks and debris where this new species is luckily well hidden. There are also some cacti like *Corryocactus brevistylus* (Sankhi), *Austrocylindropuntia exaltata* (P’ata kiska), *Cumulopuntia sphaerica* and bromeliads like *Tillandsia* and *Puya* sp. that shelter the plants (Fig. 2c). It is likely that there are other populations of this *Echeveria* among the black lava rocks that can be found all around the valley, as our third author found previously in his other two localities. The flowers from these other places seem to be slightly longer and narrower, perhaps because the photos were taken at the end of the blooming season, in June (Fig. 2d). To date, among Peruvian plants only *Echeveria fruticosa* from Lima exhibits a pattern of enlarged aerial stems, but his species has quite different leaves and flowers (Pino, 2018).



2c. *Echeveria vulcanicola* sheltered by *Corryocactus brevistylus*. (G.M.)



2d. *Echeveria vulcanicola* with a single stem on the road to Soporo (G.M.)



2e. Young *Echeveria vulcanicola* already showing branched stems. (G.M.)



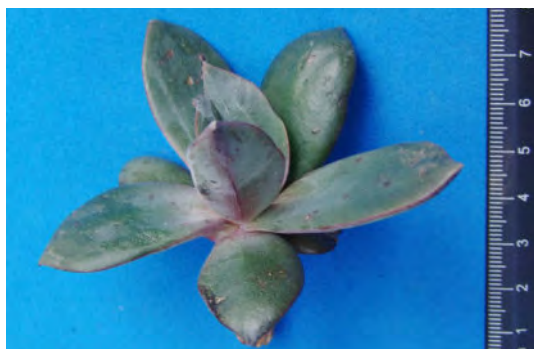
2f. Ex situ young plant of *Echeveria vulcanicola* with a single erect stem and tuberous roots.

Description: A succulent glabrous herb with conspicuous stems (Fig. 2e). **Roots** primary (1–7) narrowly tuberous, 3–20 cm long, 4–10 (–15) mm diam., light grayish brown, branching, gradually tapering, born from the base of main stem, secondary roots fibrous from sides of tuberous roots, 1–5 cm long, 0.2–0.6 cm diam. (Fig. 2f). **Stem** conspicuous, simple or branched, aerial, erect, 2–2.5 cm diam., swollen at base up to 4 cm diam., up to 30 cm long or more in very old plants, light gray, with annular scars of fallen leaves, sometimes constricted, with 1.5–2 mm diam. circular scars of fallen scapes every 2–5 cm. **Stems** sometimes covered with small growing *Tillandsia*. **Branches** 0–5, alternate, shortly after the base or up to every 5 cm, same color as stems. **Branches** tapering slowly down to 1 cm diam. at apex (Fig. 2g). **Rosettes** one at the end of stem or branch, 7–12 cm diam. (Fig. 2h). **Leaves** (8–) 12–16, oblong to narrowly obovate, sessile, strongly attached, slightly incurved, 3–8 (–10) cm long, 0.6–1.2 cm wide at base, 0.8–1.7 cm wide at proximal third, 1.2–1.7 cm wide at middle, 0.9–1.2 cm wide at distal third, 6–9 mm thick, (Fig. 2i) upper side flat, light green, tinged reddish near margins, reddish at tips, lower side convex, reddish green to dark red, rarely subcarinate, then keel red, margins red, apex acute with an acute slightly recurved reddish mucro 0.5–1 mm long at apex, base hyaline pinkish (Fig. 2j).

Flowering stem 1–2 oblique lateral subterminal racemes, (Fig. 2k) up to 5 persistent dry scapes, **rachis**



2g. Multistemmed *Echeveria vulcanicola* with *Tillandsia* sp. growing on the stem. (D.M.)



2h. Detail of the rosette of *Echeveria vulcanicola*.

16–43 cm long, 7–8 mm diam. at base, 2–3 mm diam. at apex, pink to salmon red. **Peduncular bracts** 12–18, at proximal half of stem, spaced 1.5–2 cm apart at base and 0.75–1.5 cm apart at apex, narrowly ovoid-obovoid to lanceolate, erect, 1.3–2.7 cm long, 0.5–1 cm wide, 3–5 mm thick, inner side flat, outer side subcarinate, rarely keeled, same color as leaves, base hyaline, tips margins and keel reddish, apex acute to mucronate, slightly incurved (Fig. 2l). **Flowers** 8–14 (–20), appearing from late February to June, present at distal half of the scape, 1.6–1.8 cm long and 0.9–1.1 cm diam. **Pedicels** short (1–2 mm long) or in lower flowers, oblique, 2–2.5 mm diam., same color as flowering stem, with 1–2 small oblong bracteoles at base, 4–6 mm long, 1–1.4 mm wide. **Calyx lobes** united at base, sepals unequal, narrowly ovate or oblong acute, erect, inner side concave, outer side convex, 7–10 mm long, 3.5–4.5 mm wide, olive green, minutely striped lighter in color, distal half and tip acute. **Flower buds** ovoid, 1.2 diam × 1.3 long, cream at base, reddish at apex and keels. **Corolla** urceolate, subprismatical, 1.1–1.2 cm thick near base, 0.9–1.1 cm thick near apex, 1.5–1.8 cm long, **petals** oblong, acute, 1.3–1.5 cm long, 3.5–4.5 mm wide, outer surface keeled, salmon red, slightly paler at base and sides, apex slightly



2i. Detail of the leaves of *Echeveria vulcanicola*.



2j. Underside view of the rosette of *Echeveria vulcanicola* showing abaxial side of leaves.

recurving, inner surface cream or yellow at proximal half, red at distal half. **Stamens** 10, the 5 epipetalous 7–8 mm long, the antesealous 8–12 mm long, **filaments** cream, 1 mm thick at base, gradually tapering to 0.2 mm. **Anthers** ovate, yellow, 2.5–3 mm long and 1–1.2 mm wide. **Gynoecium** ovoid, 10–12 mm long, 5–6 mm thick. **Carpels** 5, yellow. Styles 3–3.4 mm long, parallel, almost touching each other, dark



2k. Developing scape of *Echeveria vulcanicola* with flower buds.



2l. Detail of the bracts of *Echeveria vulcanicola*.



2m. From left to right: Sepals (3), flower, sectioned flower showing gynoecium, gynoecium, detail of anthers, petals (3) of *Echeveria vulcanicola*.



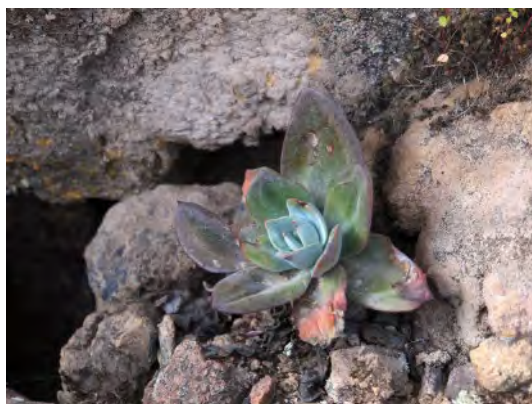
2n. Detail of the dry fruits of *Echeveria vulcanicola*.

red almost brown at the tip. **Stigma** dark red to purple. **Nectaries** reniform, yellow 1–1.2 × 1.8–2 mm (Fig. 2m). **Fruit** a dehiscent capsule 1.2–1.3 cm long, 1–1.5 cm diam. (spreading dry sepals), dark brown (Fig. 2n).

Other localities: PERU: Dept. Arequipa, Prov. Castilla, Dist. Andagua. Near type locality, 3577 m, S 15° 30' 57", W 72° 20' 33", Mar 14, 2018, *G. Pino 2817*. Road from Andagua to Soporo, plain close to the road at the left side, near Volcán Jenchana. 3600 m, S 15° 31' 07", W 72° 20' 40", June 7, 2011, *G. Matuszewski 1400.5*. (This place no longer exists, it has been covered by debris of the new road). Close to this place, 3583 m, S 15° 31' 7", W 72° 20' 41", Mar 14, 2018, *G. Pino 2818*. (HUSA 14569) Same road on the way to Ayo, near Volcán Jechapita. 3240 m, S 15° 32' 00", W 72° 19' 01", June 7, 2011, *G. Matuszewski 1400*.

Ontogeny: After germinating, this *Echeveria* looks like any other species, but under adverse conditions, it develops a bulb-like structure similar to a recently germinated cactus that later becomes the swollen base of the stem. After the first drought the plantlet can eventually lose its leaves, regenerating them from the caudex. With time, it also develops tuberous roots. Very few young plants were seen in habitat. These form a rosette with no evident stem, because it has not yet developed or is well hidden among rocks (Fig. 2o).

Etymology and distribution: The epithet “vulcanicola” refers to its habitat, dwelling at the base of dormant volcanoes, always on the cracks of black lava stones, to date, only near the type locality in the district of Andagua in Arequipa (Maps 1 and 2).



2o. Young plant of *Echeveria vulcanicola* with stem hidden among rocks (G.M.)

3. *Sedum ignescens* Pino & Montesinos, sp. nov.

Holotype: PERU: Dept. Arequipa, Prov. Arequipa, Dist. Yura. Road to the right after crossing railroad before town to Estate Ccapua and to the waterfall of Corontorio, km 6, on a rocky slope, at the base of stones facing west, dry cactus forest of *Cumulopuntia sphaerica*, *Weberbauerocereus weberbaueri*, *Oreocereus hempelianus* and *Corryocactus brevistylus*, 2580 m, S 16° 13' 04", W 71° 41' 27", Apr 10, 2006, *D. Montesinos 1064* (HUSA 11900, HSP) (Fig. 3a).

The earliest collection of this plant was made in 1937 by Dora Stafford, a British explorer who wrote a review about the Flora of Southern Peru (Stafford, 1939). She collected it at the foothills of the “Misti”, one of the three volcanoes that surround the city of Arequipa, the second city in importance in Perú. The Misti is the middle volcano of the trio, and it is said to have the most perfect cone shape of a mountain in the country. It is also the eastern landmark and symbol of the “white city” Arequipa, named so because of the abundance of buildings made with white lava bricks “sillar”. The plate she deposited at Kew is determined as the closest species to that date: *Altamiranoa imbricata* = *Villadia imbricata* = *Villadia reniformis* = *Sedum reniforme*, (Pino, 2009:15–16). This new *Sedum* was not collected for a Herbarium again in this locality until year 2000, but it was not until 2006 when our second author, Daniel Montesinos-Tubée recognized it as a possible new species. He found it in a not-so-steep rocky slope full of cacti, at one bend of the winding and dusty road that leads to the Estate Qapuwa (Ccapua) and to the waterfall of river Qapuwa at Corontorio in Yura, this time near the Chachani Volcano. Here this *Sedum* is more or less abundant,



3a. *Sedum ignescens* in blossom at type locality. (D.M.)

and it grows at the bases and in the crevices of huge rocks facing west. Yura is a place with hot springs, all heated by the intense volcanic activity of the zone, and a main tourist attraction.

Photos of this new species taken some 150 km to the North, at the Cotahuasi Canyon also in Arequipa, one of the deepest of the world, have been published on the web at the Field Museum Guide N° 160 by Maritza Rodríguez Díaz: Valle del Cotahuasi Common plants, <http://fieldguides.fieldmuseum.org/guides/guide/160> page 4, N° 73 as *Villadia reniformis* and also at <http://www.enjoyperu.com/multimedia-gallery/photos/htm-eng/flora/flora13.htm>. Our third author also published his discovery in *Lluta*: <http://www.kaktusymeksyku.pl/2.html> as *Sedum andinum*.

Description: A succulent glabrous herb, subcaespitose, forming mats to 3–15 cm diam., 6–11 (–25) cm tall. **Roots** primary 2–5, 2–5 (–9) cm long, 1.5–2 mm diam., **secondary roots** many, fibrous, 1–2 cm long, 0.2–0.3 mm diam., densely growing inside moss (Fig. 3b). **Stem** in young plants 1–2.5 mm diam., 3–5 cm long, erect for 3–5 cm then branching, first from sides then from base, greenish gray, in old plants procumbent at base, 4–6 mm diam., 5–7 (–20) cm long, light gray-brownish (Fig. 3c). **Branches** alternate every 1–2.5 cm, 10–30 or more, erect to slightly decumbent, 2–9 cm long, stem 1–1.6 (–4) mm diam., light greenish gray, sometimes pinkish when devoid of leaves and very exposed. **Vegetative branches**, altogether covered



3b. Plant of *Sedum ignescens* ex situ. (D.M.)



3c. Young plants of *Sedum ignescens* showing development of stems.

with leaves 2.6–6.5 mm diam., (Fig. 3d). **Reproductive branches** altogether with leaves tapering to 2.5–4 mm diam. (Fig. 3e). **Leaves** succulent, sessile, spirally attached to stem one after another, in vegetative branches crowded; in reproductive branches spaced every 1–4 mm, subrhomboid when young, later broadly ovate, sometimes elliptical to rotundate, 2–3.5 mm long, 1.5–2.5 mm wide, 1.5–2 mm thick, subacute to obtuse obscurely incurved, inner side flat to slightly concave, convex sometimes near flowering apex and then slightly recurved, yellowish green with some reddish dots near margin in distal half; outer side convex yellowish green intensely covered with minute red dots, more dense in distal half, **margins** entire, **base** hyaline light green (Fig. 3f).

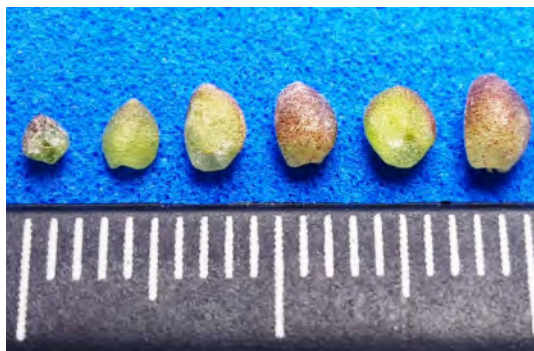
Inflorescence a terminal cyme (dichasium) with two cincinnoid branches 0.8–0.9 mm diam. at base, 1–2.5 (–5) cm long, light green or reddish when very exposed. **Flowers** 7–14 per cincinnus, mainly sessile, rarely with a 0.6–0.8 mm diam. pedicel only in basal flowers when many flowered, appearing in habitat from February to April (Fig. 3g). **Flower buds** ovoid 3–3.5 mm long, 2.5–2.8 mm diam, yellow reddish at the tips. **Bracteoles** oblong to narrowly ovate, 2.5–4.2 mm long, 1.4–1.8 mm wide, subacute, upper side flat, reddish at margins, lower side convex, yellowish green with dense reddish dots at two distal thirds. **Sepals** ovate, 1.8–3.5 mm long, 0.6–1.2 mm wide, similar to bracteoles or slightly narrower, incurved. **Petals** oblong, acute-deltoid at tip, bending outward at the middle, 4.5–5 mm long, 1–1.5 mm wide, greenish yellow to intense yellow, with reddish dots at keel and distal half of outer side when very exposed. **Stamens** 10, the 5 epipetalous 3.5–4 mm long, the antepetalous 4–5 mm long, **filaments** greenish yellow. **Anthers** globose, yellow, 0.3 mm diam. **Gynoecium** narrowly ovoid, 2–2.5 mm long, 1.5–2 mm diam. **Carpels** 5,



3d. Detail of the vegetative branches of *Sedum ignescens*.



3e. Apex of reproductive branch of *Sedum ignescens* showing modified leaves.



3f. Detail of leaves of *Sedum ignescens*.



3g. Flowering dichasium of *Sedum ignescens*.

greenish yellow. **Style** 1–1.4 mm long, greenish yellow, stigma white. **Nectaries** wide reniform, intense yellow (Fig. 3h). **Fruit** 3–4 mm long, 4–5 mm diam., star-shaped from above (Fig. 3i).

Other localities: **PERU:** Dept. Arequipa, Prov. Arequipa, Dist. Yura. Near type locality, 2652 m, S 16° 13' 05", W 71° 41' 28", Mar 21, 2018, *G. Pino 2825*. Road from Yura to Huanca. Rocky slope. 3200 m, Jun 9, 1999, *J. Roque & J. Betancourt 1049*. (USM 171073) Dist. San Juan de Sigüas. Road to Ojuli. Rocky slope. 2500 m, Jun 8, 1999, *J. Roque & J. Betancourt 993*. (USM 171074) Dist. Alto Selva Alegre, Foothills of Misti Volcano, in crevices in face of rock in full sun, 2600 m, Apr 4, 1937, *Dora Stafford 631* (K) North of the Ecological Park of Alto Selva Alegre, rocky slope, 2863 m, S 16° 19' 45", W 71° 31' 17", Apr 11, 2008, *V. Quipuscoa, K. Durand & D. Durand V. 3717*. (HUSA 10283). Lithic formation, rocky gully in watercourse, 2600 m, Mar 26, 2000, *V. Quipuscoa, R. Tesci Ll. &*



3i. *Sedum ignescens* at the type locality showing star-shaped dry fruits.

S. Torres Ch. 1817. (HUSA 004590) Prov. Caylloma, Dist. Lluta. Road from Majes to Lluta, before the town. 3140 m, S 16° 01' 27", W 72° 02' 18", June 4, 2011, *G. Matuszewski 1381*. (Fig. 3j) Dist Chivay. Hill above observatory of the Colca Valley, facing Colca River to the south, 3651 m, S 15° 37' 54", W 71° 36' 13", Mar 27, 2017, *D. Montesinos 5172b*. Prov. La Unión, Dist. Huaynacotas. Rocky slopes with scrubland vegetation near Luicho hot springs, 2972 m, S 15° 08' 21", W 72° 47' 24", Mar 19, 2011, *D. Montesinos 2972* (USM 246429, HUSA 012054). (Fig. 3k) Dept. Moquegua, Prov. General Sanchez Cerro, Dist. Coalaque. Between Puquina and Omate, dry scrub forest with *Kageneckia*, *Balbisia* and cacti, 3003 m, S 16° 37' 42.2", W 71° 04' 17.6", Apr 20, 2006, *M. Weigend, F. Cáceres H & C. Schwarzer 8327* (*M W 6_68*). (USM 218485). Dist Chojata. Xerophytic scrubland by the road to the west before the town of Chojata,



3h. From left to right: Sepals (6), flower with bud, single flower, sectioned flower showing gynoecium, petals, dry fruit of *Sedum ignescens*.



3j. *Sedum ignescens* in habitat at Lluta. (G.M.)

3710 m, S 16° 28' 07", W 70° 42' 06", Apr 20, 2018. *D. Montesinos* 6106. (HUSA 14570) (Fig. 3l) Dist Yunga. Stone walls S of Pampilla town, 3515 m, S 16° 12' 39", W 70° 42' 01", Feb 16, 2006, *D. Montesinos*. Tacna, Prov. Tarata, Dist. Estique. Road from Tacna to Tarata, 62 km NE of Tacna, 17 km NE of Quilla, before Estique Pampa, growing with *Corryocactus brevistylus*, *Corryocactus aureus*, *Oreocereus hempelianus* and *Echeveria peruviana*, 3100 m. S 17° 36' 32" W 070° 03' 38" (approximate), Nov 28, 1964. *Paul Hutchison* 7183 (as *Villadia andina*). Dist. Tarata. Cerro Mocara, rocky sandy soil on rocky slope, thicket with cacti, 3800 m, Apr 1, 1998, *M.I. La Torre* 2334. (USM 159226). Dept. Apurimac. Prov. Cotabambas, Dist. Haquira. Loose white stones with fossils near Quishuarara, (Border with Dept. Cusco, Prov. Chumbivilcas, Dist Colquemarca) 3396 m, S 14° 11' 07", W 72° 05' 49", Mar 29, 2017, *D. Montesinos* 5219b.

Distribution: Our second author and other explorers have found this *Sedum* at Arequipa and in several localities in the surrounding Departments of Southern Perú (Apurimac, Moquegua and Tacna) (Map 1). When examined, they prove to be *Sedum reniforme* or *Sedum andinum* in the Herbaria. To date, no record or mention of this plant in the neighboring Chile or Bolivia has been made.

Differential diagnosis: The closest species to *Sedum ignescens* in Peru are *Sedum reniforme* from Cajamarca, La Libertad and Ancash; *Sedum renzopalmae* and *Sedum andinum* from Lima. All four share the same size and shape of leaves (Table 1). *Sedum renzopalmae* has also yellow flowers, yet they are almost twice as long and of a pure yellow color, and its stems are of a deep purple color not seen in the others. *Sedum reniforme* has similar inflorescences but slightly smaller with shorter branches in the cincinni and less number of flowers, greenish-white to pure white, plants are generally more compact and they



3k. *Sedum ignescens* at the Cotahuasi Canyon (D.M.)

thrive at higher altitudes with heavier moisture and moss surrounding. Leaves are sometimes wider than longer. *Sedum andinum* has very similar leaves but these are dull reddish when dry; plants are generally smaller, inflorescences are very different, branches of their cincinni being almost absent, with very few red and white flowers with widely spreading petals (Pino 2006, 2009).

Etymology: The name "ignescens" (burning) recalls the strong bright reddish hue of plants in drought or strong light, moreover when they start to bloom with scattered red/yellow flowers, giving them the aspect of a small bonfire. No local name in local languages has been reported. Fátima Cáceres has recorded the local Spanish name "vidrio" to the plants she found at Alto Selva Alegre (determined as *Villadia glabra*, Cáceres F et al. 2003), probably named so by the locals after broken glass reflecting intensely the sunlight.

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3l. *Sedum ignescens* at Chojata, Moquegua (D.M.)

Notes: HCSM is the acronym of the Herbarium of the Universidad Católica Santa María (Saint Mary’s Catholic University) in Arequipa, which is in the process of indexation.

All photos by Guillermo Pino, except where stated : D.M. = Daniel Montesinos-Tubée, G.M. = Grzegorz Matuszewski, P.H. = Paul Hoxey.

Literature cited

Cáceres F, Poma I Salas A. 2003. La flora natural del Parque Ecológico Regional de Arequipa (Perú), especialmente las cactáceas. *Quad. Bot. Ambientale Appl.*, 14: 117–124.

Kimnach M. 2003. *Echeveria*, in *Illustrated Handbook of Succulent Plants*, Tome VI, *Crassulaceae*. Edited by Eggli U, Springer-Verlag Berlin Heidelberg GmbH :119.

Hernández J et al. 2014. *Biodiversidad terrestre de la región de Arica y Parinacota*. Universidad de Chile. Maval Impresores.

Macbride JF. 1938. *Flora of Peru, Field Museum Botanical Series*, Vol XIII, Part II, No. 3: 1009–1014. Chicago.

Matuszewski,G. 2017. Eine neue *Echeveria* in den Anden. *Avonia* 35:4 (Heft 98):208–215.

Matuszewski,G. 2017. Nowa andyjska *Echeveria*. *Świat Kaktusów* 51 (1): 33–39.

Matuszewski,G., Hinz S. 2011. *Thelocactus. Systematik, Vorkommen und Kultur*.

Meyen F. 1834. *Reise um die Erde*, Vol I: 448.

Poellnitz K von, 1935. *Fedde Repert* Vol 38: 192.

Pilbeam J. 2008. *The Genus Echeveria*. The British Cactus and Succulent Society, Essex, UK: 206.

Pino G. 2002. The varieties of *Echeveria chilensis* (Crassulaceae), an endemic Peruvian species. *Haseltonia* 9: 51–61.

Pino G. 2005. *Echeveria andicola*, a new species from central Peru *Haseltonia* 11: 98–102.

Pino G. 2006. Little known Crassulaceae of Central Peru. *Haseltonia* 12: 55–66.

Pino G. 2009. The Crassulaceae of Cajamarca, Peru. *Haseltonia* 15: 3–26.

Pino G. 2018. The *Echeverias* from the Chillón River Valley, Lima, Perú, including three new taxa. *Cact.& Succ. Journal US*, 90(3): 168–185.

Pinto R. Kirberg. A. 2009. Cactus del Extremo Norte de Chile. AMF. Santiago, Chile.

Pizarro J. 2014. Cactáceas de Tacna. 86 p. Tacna Perú.

Stafford, Dora. 1939. On the Flora of Southern Peru. In *Proceedings of the Linnean Society of London*, 151 (3), 172–181. Blackwell Publishing Ltd.

Uhl C. 2007. Chromosomes and hybrids of *Echeveria*, XI, South American species of Series Racemosae. *Haseltonia* 13: 3–22.

Walther E. 1972. *Echeveria*. San Francisco: California Academy of Sciences, San Francisco: 367–369.

Walpers WG. 1845/46 *Repert.Bot.Syst.V*: 794.

Table 1: Comparison of plants of *Sedum ignescens*, *Sedum reniforme*, *Sedum andinum* and *Sedum renzopalmae*.

	<i>Sedum ignescens</i>	<i>S. reniforme</i>	<i>S. andinum</i>	<i>S. renzopalmae</i>
Height	6–11 cm	7–10 cm	3–7 cm	6–10 cm
Stem diameter	4–6 mm	1.8–2.5 mm	1.5–2 mm	1.8–2.2 mm
Length of branches	2–9 cm	3–6 cm	2–5 cm	2.5–6.5 cm
Diameter of vegetative branches	2.6–6.5 mm	7–9 mm	5–6 mm	5–6 mm
Diameter of reproductive branches	2.5–4 mm	4–5 mm	4–5 mm	4–5 mm
Shape of leaves	Broadly ovate	Broadly ovate	Broadly ovate to sphaerical	Broadly ovate to subtriangular
Size of leaves	2–3.5 mm long 15–2.5 mm wide 1.5–2 mm thick	3–6 mm long 3.5–5 mm wide 2–3 mm thick	2–3.5 mm long 15–2.5 mm wide 1.5–2.5 mm thick	3–4 mm long 2.2–2.5 mm wide 1.3–1.5 mm thick
Inflorescence (per branch)	2–9 cm long 7–14 flowers	0.6–2 cm long 5–9 flowers	Very short 1–2 flowers	0.8–1 cm long 3–4 flowers
Petals	4.5–5 mm long 1–1.5 mm wide Yellow with red-dish dots.	3.5–4.5 mm long 2–3.5 mm wide Greenish white to white.	3.5–4.5 mm long 2–3.5 mm wide Spreading, crimson red at sides, pink or white at keels and tip.	8–9 mm long 2.5–3 mm wide Intense pure yellow.