

## SEDUM MESOAMERICANUM (CRASSULACEAE), A NEW SPECIES FROM MEXICO AND GUATEMALA

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**Abstract:** *Sedum mesoamericanum* is described as a new species, and illustrated based on collections from the Mexican states of Oaxaca and Chiapas, as well as Guatemala. It is distinguished by the possession of subclasping leaves with denticulate margins. Previous phylogenetic analyses placed this species in a clade of *Villadia* species from the Sierra Madre del Sur, with which it is compared. Additionally, the morphological similarities of *Sedum mesoamericanum* to *S. goldmanii* and *S. porphyranthes* are discussed.

**Keywords:** *Acre* clade, *Altamiranoa*, Mesoamerica, Sedeae, Sempervivoideae, *Sedum*, *Villadia*.

With approximately 420 species and a distribution that includes many regions of both the Old and New World, *Sedum* L. (Tribe Sedeae, subfamily Sempervivoideae) is the largest and most widespread genus of Crassulaceae (Thiede and Eggli 2007). Generic delimitation and relationships within the taxon have been largely problematic, and at present it is widely acknowledged that *Sedum*, as traditionally recognized, is highly paraphyletic, and nested within it are many genera such as *Altamiranoa*, *Echeveria*, *Graptopetalum*, *Villadia*, etc. (van Ham and 't Hart 1998; Mort et al. 2001; Carrillo-Reyes et al. 2008, 2009; Mort et al. 2010). The lack of phylogenetic understanding for most of the species, and poor resolution of hypothetical clades, has led to the acceptance — inherently pro tem — of 't Hart's (1995) proposal to maintain *Sedum* as a paraphyletic assemblage instead of proposing drastic changes in its classification, as discussed by Thiede & Eggli (2007). However, it is obvious that numerous taxonomic modifications are needed in order to obtain a classification that is based on the recognition of monophyletic groups. There are two basic problems associated with the failure to get a better classification of the Crassulaceae: (1) The general lack of resolution of DNA-based phylogenies and (2) the lack of morphological diagnostic characters for many of those groups identified as monophyletic (Thiede & Eggli 2008; Carrillo-Reyes et al. 2009; Mort et al. 2010).

During the course of a floristic inventory in El Triunfo Biosphere Reserve (Martínez-Meléndez et al. 2008), and the examination of herbarium material for phylogenetic analyses (Carrillo-Reyes et al., 2009), we encountered a taxon of the Crassulaceae with white tubular flowers and cymose inflo-

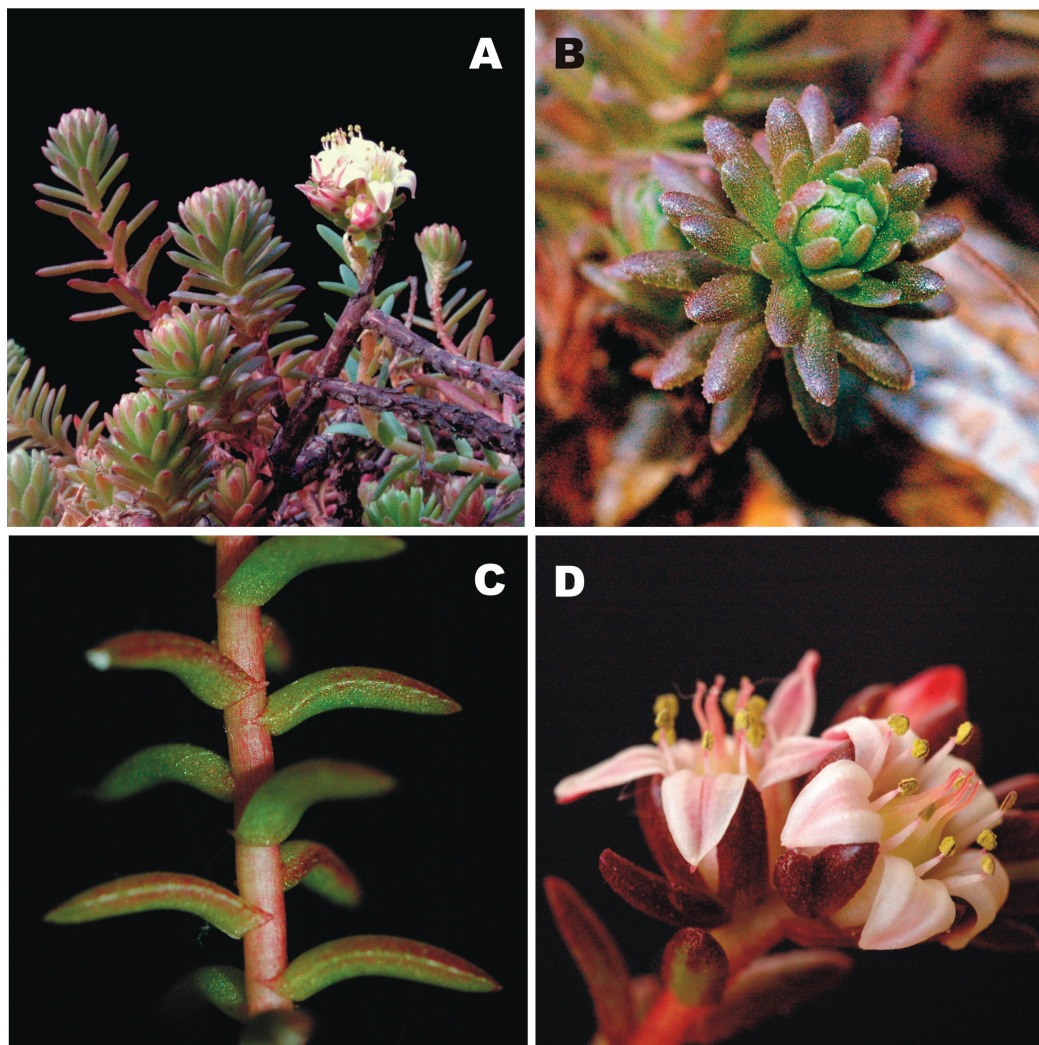
rescences that has been collected in many localities from southern Mexico and adjacent Guatemala. It is morphologically similar to *Sedum goldmanii* (Rose) Moran, with which it is often confused. After comparing the morphological characteristics with those of other species of *Sedum* with tubular corollas (formerly placed in *Altamiranoa* Rose), and with those of the closely related *Villadia* Rose, we conclude that the material concerned is an undescribed species, as follows:

***Sedum mesoamericanum* P. Carrillo & Pérez-Farrera SP. NOV.**

*Planta succulenta glabra. Caulibus erectis vel prostratis ad 25–30 cm longi rubelli. Foliis sessilia, cocleatim dispositis. Foliorum margines papilatae, primum visum denticulatae. Flores in cymis dispositi, corolla 7–8 mm longa, alba, tubum basalem 2.5–3.0 mm longum ferens.*

**Type:** MEXICO. Oaxaca, Mun. San Mateo Río Hondo, ca. 0.5 km al NO de San José del Pacífico, 16° 10' 23"N, 96° 30' 10" W, 2520 m, 20 Jul 2009 (pressed on 2 Dec 2009). *P. Carrillo-Reyes & D. Cabrera-Toledo 5562* (holotype IEB, isotypes HEM, MEXU, MO) (Figs. 1, 2).

**Paratypes:** MEXICO. **Oaxaca:** Cerro de San Felipe, 2400 m, 6 Dec 1962, *R. Moran 10135* (SD); Mun. Oaxaca, Cerro Microondas Corral de Piedra, al N de la ciudad de Oaxaca, 3200 m, 3 Nov 1994, *M. Cházaro & B.L. Mostul 7485* (IBUG); *Ibid.* *M. Cházaro & B.L. Mostul 7495* (IBUG); Mun. Villa Díaz Ordaz, 2 km al E de Benito Juárez, 2960 m, 16 Nov 1984, *R. López et al., 253* (IEB, ENCB, MEXU,

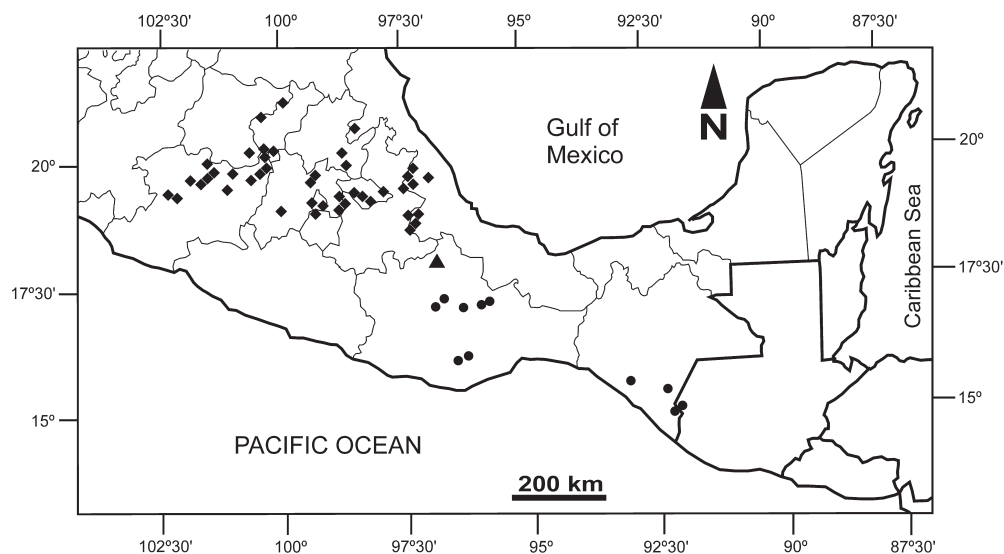


**Figure 1.** *Sedum mesoamericanum* from the type collection (Carrillo-Reyes & Cabrera-Toledo 5562) near San José Pacífico, Oaxaca. A. Habit; B. Detail of the rosette showing the papillose margin of the leaves; C. Detail of the stem showing the clasping base of the leaves; D. Flower. Photos: P. Carrillo-Reyes.

OAX); Mun. Mixistlán de la Reforma, Mixistlán, 2200 m, 27 Jan 1986, *J. Rivera Reyes & G.J. Martin 71* (MEXU); Mixistlán, 15 Sep 1992, *J. Martínez-Nicolasa 15* (MEXU); Mun. Santiago Zacatepec, 2.6 km al SE de la desviación a Totontepec sobre la carretera Mitla-Zacatepec, 17° 08' 23" N, 96° 01' 58" W, 2576 m, 13 Jun 2008, *E. Ruiz-Sánchez & V. Sosa 215* (IEB); Mun. Totontepec Villa de Morelos, Totontepec, 1900 m, 2 Nov 1986, *J. Rivera Reyes 489* (MEXU, MO); Mun. San Andrés Paxtlán, 2 miles south of Portillo San Andrés, 2500 m, 23 Nov 1959, *R. Moran & M. Kimmach 7757* (SD); Mun. San Juan Mixtepec, Ladera del Cerro Quieshovee, 3500 m, 4 Feb 1992, *S. Salas 285* (OAX). **Chiapas:** Mun. La Concordia, Cima del Cerro Cebú, 2236 m, 16 Dec 2004, *J. Martínez-Meléndez 705* (HEM, IEB, MEXU); Mun. Mototzintla de Mendoza, Cerro Mo-

zotal, 3000 m, 30 Dec 1972, *D.E. Breedlove & R.F. Thorne 31167* (ENCB, MEXU, MO); Mun. Mototzintla de Mendoza, Cerro Mozotal, 3000 m, 22 Nov 1976, *D.E. Breedlove 41728* (MEXU, MO); Mun. Unión Juárez, Volcán Tacaná, above Talquián, 3500 m, 11 Nov 1972, *D.E. Breedlove 29393* (ENCB, MEXU, MO); GUATEMALA. **San Marcos,** Volcán Tacaná, 3500 m, 5 Feb 1987, *E. Martínez et al. 19525* (MEXU); Entre aldea Toniná y Plan de Ardillas, 2700-3200 m, 8 May 1987, *E. Martínez et al. 20827* (MEXU).

Succulent glabrous perennial herb, branching from the base and less often from the old stems. Stems erect or prostrate, to 25 (-30) cm long, 0.5 cm diameter at the base, reddish, glossy, with pale yellow leaf scars to ca. 0.4 mm wide. Leaves densely arranged, the sterile shoots (0.5-) 1-3 (-3.5) cm



**Figure 2.** Geographic distribution of *Sedum mesoamericanum* (●), *S. porphyranthes* (▲), and *S. goldmanii* (◆).

long, to 1 cm wide, with (25–) 40–90 leaves each. Leaves succulent, ascending, imbricate, the upper one slightly incurved, oblong, 5.5–8.0 mm long, 1.5–2.5 mm wide, green or becoming reddish at age, obtuse at the apex, margins with prominent papillae, giving it a denticulate appearance, the base with two lateral clasping projections ca. 0.4 mm long. Inflorescence cymose to 20 cm high, including the peduncle, the cymes 2.0–3.5 cm high, 2.0–4.0 cm wide, with 5–10 (–15) flowers. Bracts similar in shape and size to the leaves. Pedicels to 2.5 mm long or usually absent. Sepals ascending, unequal, free, oblong-lanceolate 4.5–6.0 mm long, 0.7–3.0 mm wide, acute or obtuse and sometimes purple-reddish throughout or just at the apex, the base with a small spur to 0.5 mm long. Corolla 7–8 mm long, white, the petals 5, united at the base into a tube 2.5–3.0 mm long, lobes spreading, triangular 4.0–5.5 mm long, (2.2–) 2.5–3.5 mm wide, acute at the apex, canaliculate above, keeled below. Stamens 10; the episealous 4.5–5.0 mm long, the epipetalous 5.0–6.5 mm long. Anthers orbicular to obovate, 0.8–1.4 mm long, ca. 0.7–1.0 mm wide. Nectar scale slightly cuneate, ca. 1 mm long and wide. Gynoecium with 5 carpels, 5.5–6.0 mm long. Follicles erect at anthesis, stellate spreading and widely opened along the suture at maturity, 6–7 mm long, ca. 1.3 mm wide, color brown. Seeds ca. 1 mm long, reddish-brown, with reticulate surface.

**Phenology:** Flowering from October to January. *Fruiting* from December to May.

**Common name:** The only common name recorded by collectors is Kix Tzooy (Mixe language, *Martínez-Nicolasa 15*).

**Chromosome number:**  $n = 20$  (Uhl & Moran, 1999, cited as *Sedum* sp.)

**Distribution.** *Sedum mesoamericanum* is endemic to the Sierra Madre del Sur and Sierra Madre de Chiapas (known as the Cordillera Central in Guatemala) (Fig. 2). Following the characterization of vegetation presented by Breedlove (1981), it occurs on igneous or metamorphic outcrops in pine-oak and evergreen cloud forests, as well as in evergreen cloud scrubs (Fig. 3), at elevations from 2200 to 3500 m. The presence of this species in El Triunfo Biosphere Reserve (Martínez-Meléndez et al. 2008, cited as *Villadia* sp.) promotes its conservation.

## Discussion

Phylogenetic analyses in the *Acre* clade of Crassulaceae placed the new species in a clade with some species of *Villadia* from the Sierra Madre del Sur (Carrillo-Reyes et al. 2009; *Sedum mesoamericanum* was included as *Sedum* sp.). However, in their analysis the genus *Villadia* was also demonstrated to be paraphyletic, and relationships are not yet satisfactorily resolved. *Villadia*, together with *Altamiranoa*, were segregated from *Sedum* on the basis of having flowers with united petals; *Villadia* was further characterized by possessing racemose or spiciform thyrses, these in contrast to the broad cymose inflorescences that occur in *Altamiranoa* and many species of *Sedum* (Britton and Rose 1903). Both the fusion of the corolla and the type of inflorescence have been used as diagnostic features in many groups of the Crassulaceae; however, in light of phylogenetic studies these characters have proven to be unreliable. Indeed, the status and relationships between *Sedum*,



**Figure 3.** Habitat in evergreen cloud scrub with *Weraubia gladioliflora* (H. Wendl.) J.R. Grant, granitic stoncrop at El Triunfo Biosphere Reserve. Photo: J. Martínez-Meléndez.

*Altamiranoa* and *Villadia*, have long been controversial (Fröderström 1935; Baehni 1937; Walther 1938; Thiede; 2003). Moran (1996), however, maintained *Villadia*, but included *Altamiranoa* in *Sedum*, arguing that *Altamiranoa* and *Sedum* intergrade morphologically and that the phylogeny of 't Hart (1995) suggests a close relationship of the only *Altamiranoa* species included in this analysis and some Mexican *Sedum* species. However it should be noted that 't Hart's sampling was very limited and no species of *Villadia* (sensu stricto) was included.

Until an analysis aimed to clarify the delimitation of *Villadia* is published, we have decided to follow provisionally Moran's (1996) proposal and assign the present novelty to *Sedum* for the following reasons: (1) *S. mesoamericanum* possesses cymose inflorescences, a feature that is otherwise unknown in *Villadia* but is common in *Sedum*. (2) The group of *Villadia* species with which *S. mesoamericanum* is associated is in itself not closely related to the group of *Villadia* that contains *V. misera* (Lindl.) R.T. Clausen, the type of the genus (see Carrillo-Reyes et al. 2009).

*Sedum mesoamericanum* is distinguished by a unique combination of characters including cymose inflorescences, reddish stems, white flowers, and leaves with papillose margins. Closely related species suggested by the only phylogenetic analysis in which this taxon has been included (Carrillo-Reyes

et al. 2009), are *Villadia diffusa* Rose, *V. imbricata* Rose, *V. nelsonii* Rose, and *V. recurva* Moran, Kimmach & Uhl. (combinations in *Sedum* unavailable). All of these species occur in southern Mexico, mostly in the Sierra Madre del Sur, and share vegetative characters, as well as white flowers with petals fused into a tube at the base. However, they are easily distinguished from *S. mesoamericanum* by their spicate or thyrsoid inflorescences. Although phylogenetic analysis did not suggest a close relationship with *Sedum goldmanii* (Rose) Moran (= *Altamiranoa mexicana* (Schltdl.) Rose), these two are morphologically alike and share a similar habit, reddish stems, cymose inflorescences and white flowers with the petals united at the base. In fact, some collections of the new species have been found in herbaria determined as *S. goldmanii* (or as one of its many synonyms). The new taxon can be distinguished from *S. goldmanii* by having leaves with papillose margins, and clasping lateral projections at the base (Figs. 1B, 1C) (vs. leaves with entire margins and decurrent projections at the base). In addition, the follicles of the new species are very often stellate spreading and widely opened along the suture at fruiting time (vs. divergent and slightly opened), and the foliage is never glaucous (vs. foliage glaucous in young *S. goldmanii*). So far as is known, *Sedum goldmanii* has a haploid chromosome number of 25, while that of *S. mesoamericanum* has

been reported as 20 (Uhl & Moran, 1999). Furthermore, both taxa are geographically separated: *S. goldmanii* is distributed along the Trans-Mexican Volcanic Belt (Clausen 1959; Pérez-Calix 2008), whereas *S. mesoamericanum* occurs in the Sierra Madre del Sur and Sierra Madre de Chiapas (Fig. 2). The nearest collection points between them are separated by approximately 200 km. The citation of *Altamiranoa mexicana* (Schltdl.) Rose for the state of Oaxaca by Pérez-Calix (2008), is very likely based on *S. mesoamericanum*. *Sedum porphyranthes* J. Reyes, Brachet & O. González, from the Sierra Norte de Oaxaca, vegetatively resembles both *S. mesoamericanum* and *S. goldmanii*; however, it is clearly separated by its purple flowers (Reyes et al. 2008).

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