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Source: Willdenowia, 48(1) : 51-55

Published By: Botanic Garden and Botanical Museum Berlin (BGBM)

URL: https://doi.org/10.3372/wi.48.48104

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Willdenowia
Annals of the Botanic Garden and Botanical Museum Berlin

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The taxonomy and typification of *Sedum creticum*, and the curious protologue of *S.* ×*donatae* (*Crassulaceae*)

Version of record first published online on 29 March 2018 ahead of inclusion in April 2018 issue.

Abstract: The intricate taxonomy of *Sedum creticum* C. Presl, a name misinterpreted for 159 years up to the study of the original material by Král in 1987, is reviewed and revised. The two "ecotypes" distinguished within *S. creticum* (var. *creticum* and var. *monocarpicum* 't Hart) are shown to represent mere non-heritable modifications not warranting formal taxonomic recognition. *Sedum* ×*donatae* Afferni, a purported natural hybrid between *S. creticum* and *S. cyprium* A. K. Jacks. & Turrill, is based on the same type gathering as *S. hierapetrae* Rech. f., which is a taxonomic synonym of *S. creticum.* A full synonymy of *S. creticum* is given and a lectotype is designated for *S. hierapetrae* Rech. f.

Key words: *Crassulaceae*, Flora of Crete, Flora of Greece, Flora of the Mediterranean region, nomenclature, *Sedum*, *Sedum creticum*, taxonomy, typification

Article history: Received 18 December 2017; peer-review completed 1 March 2018; received in revised form 10 March 2018; accepted for publication 14 March 2018.

Citation: Thiede J. & Stephenson R. 2018: The taxonomy and typification of *Sedum creticum*, and the curious protologue of *S.* ×*donatae* (*Crassulaceae*). – Willdenowia 48: 51–55. doi: https://doi.org/10.3372/wi.48.48104

Introduction

Sedum L. is the largest genus in the *Crassulaceae* and comprises some 420 species distributed mainly in temperate and subtropical regions of the N hemisphere (Thiede & Eggli 2007) including most of Europe (53 species; Hart & Eggli 2003) where it is centred in the Mediterranean region (about 31 species; Hart & Eggli 2003); 14 species occur on the Greek island of Crete (Fielding & Turland 2005; Strid 2016). One of the best-known and most common *Sedum* species on Crete is *S. creticum* C. Presl, a small, rosette-forming, annual to perennial plant (Hart 1989; Jahn & Schönfelder 1995; Hart 2002; Hart & Bleij 2003; Hart & Eggli 2003; Fielding & Turland 2005; Marhold 2011; Strid 2016) that includes two ecotypes (Hart 1989): annual to biennial plants with terminal inflorescences, as well as perennial and tufted plants with axillary inflorescences (Fig. 1A–F). Despite many treatments, the taxonomy and typification of *S. creticum* is not yet satisfactorily settled and is therefore reviewed and reassessed here, also including an assessment of the status of the purported nothospecies *S.* ×*donatae* Afferni (2014), which involves *S. creticum* as one of its putative parental species.

Material and methods

Specimen data were provided by the Botanischer Garten und Botanisches Museum Berlin (B); the Natural History Museum, London (BM); Conservatoire et Jardin botaniques de la Ville de Genève (G); Martin-Luther-Universität, Halle (HAL); Friedrich-Schiller-Universität Jena (JE); Naturalis, Nationaal Herbarium Nederland,

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Leiden (L); V. L. Komarov Botanical Institute, St. Petersburg (LE); Muséum National d'Histoire Naturelle, Paris (P); Charles University in Prague (PRC); and Naturhistorisches Museum Wien (W); via JSTOR Global Plants (https://plants.jstor.org/) or other resources accessed on 10 March 2017 or later.

Results and Discussion

The taxonomic history of *Sedum creticum*

Sedum creticum C. Presl (1828) was based on "*Sedum Cotyledon* Sieb. non Jacq." of Sieber's "Herbarium creticum", collected by Sieber in 1817 at "Lassiti" (Lasithi). The diagnosis is "very brief and not allowing the recognition or the identification of the plant" (Král 1987: 307) and leaves open whether the species is annual to biennial or perennial. The name was placed by several later authors in the synonymy of the annual to biennial *S. cepaea* L. (e.g. by Fröderström 1931: 41), a species not recorded from Crete until Deschatres & Greuter (2001).

Sedum creticum Boiss. & Heldr. (in Boissier 1849: 16), an annual to biennial plant with terminal inflorescences, was published without knowledge of Presl's earlier name, based on a Heldreich gathering from the Kourtaliotiko ("Korduliotiko") Gorge.

Sedum hierapetrae Rech. f. (1943) is based on a Rechinger gathering from the Thripti mountains ("Aphendi Kavusi-Gebirge") and differs from *S. creticum* Boiss. & Heldr. especially in its perennial growth with terminal inflorescences; it was likewise published without knowledge of Presl's *S. creticum*.

Maire (1977: 356), after nearly 150 years, noted that *Sedum creticum* Boiss. & Heldr. represents an illegitimate later homonym of *S. creticum* C. Presl and published the replacement name *S. cretense* Maire for the former.

Greuter (1981) considered *Sedum creticum* C. Presl as the annual to biennial ecotype with axillary inflorescences and thus identical with *S. creticum* Boiss. & Heldr., and he was the first author to treat both names as conspecific.

Following Greuter (1981), Hagemann & Hart (1986: 353) published the new combination *Sedum creticum* var. *hierapetrae* (Rech. f.) 't Hart & I. Hagemann for the perennial mountain ecotype with terminal inflorescences.

The original material of *Sedum creticum* C. Presl, two duplicates at PRC, was not studied until Král (1987), who showed that it has perennial rosettes with axillary inflorescences. Král designated a lectotype and published the new genus *Helladia* M. Král with *H. cretica* (C. Presl) M. Král and two further species, which received no acceptance.

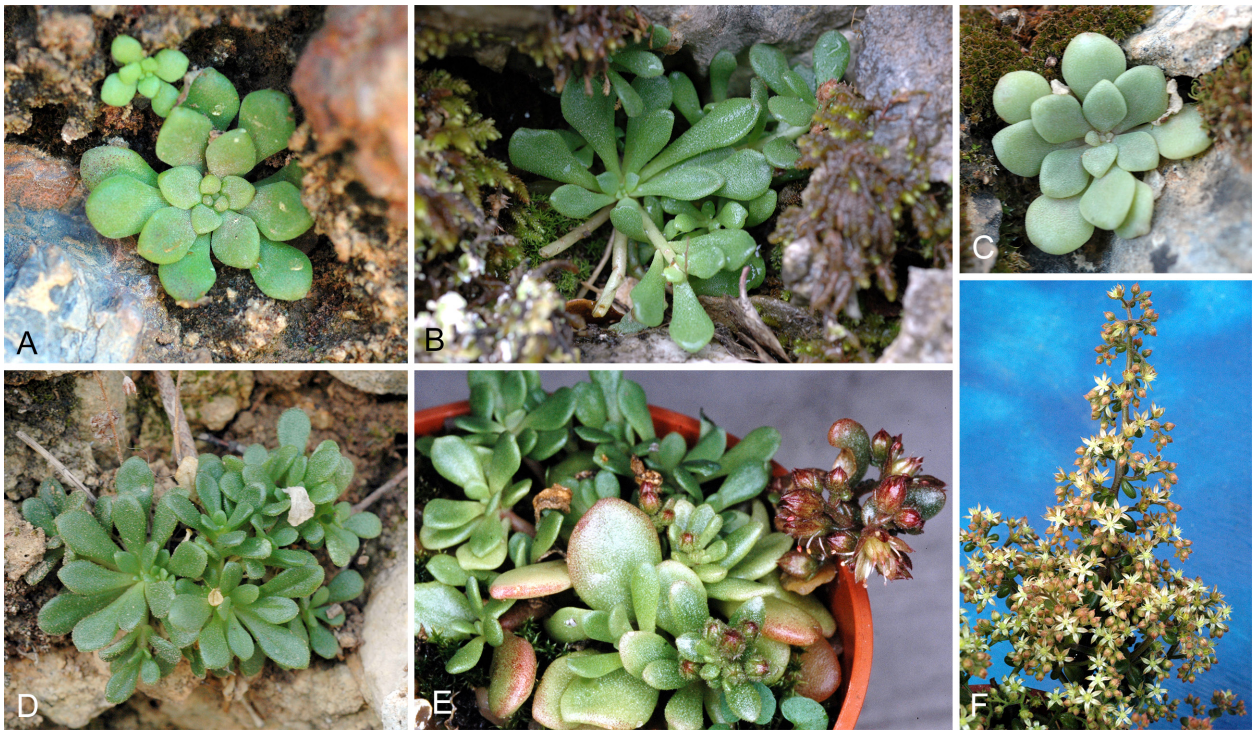


Fig. 1. *Sedum creticum* in habitat (A–D) and in cultivation (E & F). – A: in the lowlands of Crete, the unbranched, monocarpic ecotype ("var. *monocarpicum*") prevails (Gerani W of Rethimno, 20 Oct 2006). – B: in the Cretan mountains, the branched, perennial ecotype ("var. *creticum*") dominates (Lagou on Lasithi plain, 12 Oct 2006). – C & D: in the altitudinal mid-zone, the unbranched, monocarpic ecotype (C) and the branched, perennial ecotype (D) may be found at the same locality less than 1 m apart (near Stavros, Oros Thripti, 21 Oct 2006). – E: the perennial ecotype with axillary inflorescences in cultivation, originally collected near Exo Potami (Oros Dikti, 22 Feb 2007). – F: well-watered plants of the perennial ecotype often become monocarpic with terminal inflorescences and flower themselves to death (from near Exo Potami, Oros Dikti, 4 Jul 2007). – All photographs: Ray Stephenson.

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In summary, *Sedum creticum* C. Presl was misinterpreted for 159 years due to the lack of study of the original material, leading to the publication of several redundant names. This highlights the importance of original (type) material in the application of names of taxa.

The two ecotypes of *Sedum creticum*

Král's (1987) lectotypification of *Sedum creticum* C. Presl prompted Hart (1989) to provide a new concept for the species, recognizing two ecotypes at varietal rank: var. *creticum*, from more mesic and shadier mountain habitats between 500 and 1000(–1600) m, includes perennial, tufted plants with axillary inflorescences (Fig. 1B, D & E); whereas var. *monocarpicum* 't Hart (≡ *S. creticum* Boiss. & Heldr.), from rocky and dry lowland habitats up to 500(–1000) m, includes annual to biennial, monocarpic, simple plants with terminal inflorescences (Fig. 1A & C). Hart (1989) observed that all 23 populations studied by him could unequivocally be attributed to one of both varieties, but, with the more abundant watering prevailing in cultivation, plants of var. *monocarpicum* became indistinguishable from var. *creticum* after a few months.

Hart (2002), Hart & Eggli (2003) and Hart & Bleij (2003) upheld the two varieties, adding that they "most probably merely represent different phenotypic expressions of a similar genotype in different habitats" (Hart & Bleij 2003: 258).

Stephenson (2000, 2007, 2015) carried out studies in habitat (August 1999 and September–October 2006) and in cultivation. In habitat, both varieties are not separable: at their extremes (*Sedum creticum* var. *monocarpicum* in the lowlands [Fig. 1A] and var. *creticum* in the mountains [Fig. 1B]), they can always be separated, but in the altitudinal mid-zone, the plants are annual and monocarpic in dry places (Fig. 1C) or during long periods of drought, and perennial in wet places (Fig. 1D) or in particularly wet seasons. Both varieties may be found at the same locality less than 1 m apart (Fig. 1C & D). In humid seasons, some seedlings within colonies of var. *monocarpicum* may become perennial, and for huge areas of var. *creticum* the plants may act as annuals during drought (Stephenson 2015). Within a population of the annual to biennial lowland ecotype in a gorge east of Anogia at about 550 m, c. 20 % of the rosettes formed side rosettes from the stem after flowering, thus becoming multi-annual and multi-headed (Kimnach [1984] illustrated a similar plant), and Stephenson (2000: 41–43) even found one stoloniferous plant (as "var. *creticum*"). Cultivated plants nearly always develop into the perennial ecotype, as was already noted by Hart (1989), and either variety can be transformed into the other by controlling the amount of irrigation (Stephenson 2015). Well-watered plants often become monocarpic with terminal inflorescences (Fig. 1F).

Sedum creticum consists of two distinct morphotypes described as (genetically distinct) ecotypes, but these actually represent non-heritable modifications induced by the amount of water and are transformable into each other, so that the same individual may belong to two different taxa in different phases of its life-cycle. The formal classification of the two "ecotypes" at varietal rank introduced by Hart (1989) transgresses ICN Principle IV (McNeill & al. 2012). Consequently, *S. creticum* var. *monocarpicum* is referred here to the synonymy of *S. creticum*, and no infraspecific taxa are recognized for the species.

The protologue and status of *Sedum ×donatae*

Sedum ×donatae Afferni (2014) was published for a purported natural hybrid from Crete between *S. creticum* C. Presl and *S. cyprium* A. K. Jacks. & Turrill, which caused critical comments by Stephenson (2015). Here, the rather curious protologue of *S. ×donatae* and its status is reassessed.

Sedum creticum is known from Andikithira, Crete, Gavdos, Kasos, Karpathos and Saria (Strid 2016), whereas *S. cyprium* is endemic to Cyprus (Hart 2002; Hart & Bleij 2003; Hart & Eggli 2003; Hand & al. 2011). Consequently, the purported parental species are allopatric, separated by at least 550 km, and the purported natural hybrid *S. ×donatae* cannot exist in habitat, as was also indirectly admitted by Afferni himself (2014: 157), but both species can be hybridized artificially (Hart 1983). The description and the purported diagnostic differences of *S. ×donatae* from *S. creticum* (Afferni 2014: 157–158) fully conform to, and do not differ at all from, descriptions of *S. creticum* (var. *creticum*) by Kimnach (1984), Král (1987), Hart (2002), Hart & Bleij (2003) and Hart & Eggli (2003). Moreover, Afferni was aware that the "holotype" of *S. ×donatae*, *Rechinger 13188* (W), is the type gathering of *S. hierapetrae* Rech. f. (1943), and he cited the latter name in the synonymy of the former, thus inverting the priority of names with the same rank (ICN Art. 11.4; McNeill & al. 2012) and rendering the name *S. ×donatae* nomenclaturally superfluous when published and therefore illegitimate (ICN Art. 52.1). The photograph of a cultivated flowering plant labelled *S. ×donatae* published as fig. 4 in the protologue (reproduced here as Fig. 1E) was taken by Stephenson and sent by him to Afferni labelled as *S. creticum* var. *creticum*; it shows the perennial ecotype photographed in cultivation, originally collected by Stephenson in E Crete near Exo Potami (Oros Dikti).

The "holotype" of *Sedum ×donatae* designated by Afferni (2014: 157, 158), "*Rechinger 13188* (W)", is actually a gathering consisting of two specimens at W which therefore represent syntypes under ICN Art. 9.5 (McNeill & al. 2012); *Rechinger 13188* (W) is also the type gathering of the earlier *S. hierapetrae*. Because *S. hierapetrae* is placed here in the synonymy of *S. creticum* C. Presl, *S. ×donatae* is necessarily also a synonym of *S. creticum* C. Presl.

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Taxonomy

Sedum creticum C. Presl in Isis (Oken) 21: 273. 1828 ≡ *Helladia cretica* (C. Presl) M. Král in Preslia 59: 309. 1987. – Protologue: [Crete, *Sieber*]. – Lectotype (designated by Král 1987: 310): [Greece], "In insula Creta ad Lassiti", 1817, *Sieber s.n.* (PRC barcode PRC 454476 [right-hand plant]!; isolectotypes: HAL barcode HAL0119831!, JE barcode JE00019750!, L barcode L 0544583!, PRC barcode PRC 454477!, W 0010476 digital image!, W 0010477 digital image!).

Note — The lectotype and all isolectotypes bear the same printed label "*Sedum Cotyledon*. Sieber. Lassiti."

= *Sedum creticum* Boiss. & Heldr. in Boissier, Diagn. Pl. Orient., ser. 1, 10: 16. 1849, nom. illeg. (ICN Art. 53.1) [non *Sedum creticum* C. Presl in Isis (Oken) 21: 273. 1828] ≡ *Sedum cretense* Maire, Fl. Afrique N. 14: 356. 1977 ≡ *Sedum creticum* var. *monocarpicum* 't Hart in Taxon 38: 650. 1989. – Protologue: "Hab. in saxosis faucis *Korduliotiko* Eparchiae *Hagiovasily* Cretae (*Heldreich*). Fl. Jun." – Lectotype (designated by Hart 1989: 650): [Greece], "Creta in saxosis faucis Korduliotico Eparchiae Hagio Vasili", May 1846, *Heldreich s.n.* (G-BOIS barcode G00760985!; isolectotypes: G barcode G00375438!, G barcode G00375443!, KW-TURCZ [not seen, fide Byalt & Fedoronchuk 2008: 321], LE barcode LE 00013198!, LE barcode LE 00013199!, P barcode P03194525 [lower 3 plants only]!).

Note — The protologue did not indicate a collection number and date; "Fl. Jun." is seen as indication of the flowering period. The designation of a "Type" at "G-Boiss." by Hart (1989) is effective designation of the specimen at G-BOIS as the lectotype (ICN Art. 7.10; McNeill & al. 2012). The five duplicates accessible electronically at G (two duplicates), LE (two duplicates) and P all bear the same xerocopied handwritten label of the lectotype and represent isolectotypes. The following specimens represent different gatherings and are not therefore isolectotypes: *Heldreich 1559*, Jun 1846 (B barcode B 10 0272265!; as "isotypus" on label by V. Byalt, in B database, and at JSTOR Global Plants); *Heldreich s.n.*, Jun 1846 (BM barcode BM000750534!; as "type" in BM database and at JSTOR Global Plants).

= *Sedum hierapetrae* Rech. f. in Denkschr. Akad. Wiss. Wien, Math.-Naturwiss. Kl. 105(2, 1): 86. 1943 ≡ *Oreosedum hierapetrae* (Rech. f.) Grulich in Preslia 56: 44. 1984 ≡ *Sedum creticum* var. *hierapetrae* (Rech. f.) 't Hart & I. Hagemann in Strid, Mount. Fl. Greece 1: 353. 1986 ≡ *Sedum* ×*donatae* Afferni in Avonia 32: 158. 2014, nom. illeg. (ICN Art. 52.1). – Protologue: "[Kreta:] Hierapetra: Aphendi Kavusi-Gebirge, in Höhlungen und Ritzen von Kalkkonglomeratfelsen unterhalb Orinon, zirka 650 m, blühend und mit vorjährigen Fruchtständen am 20. Mai 1942 ([*Rechinger*] 13.188)". – **Lectotype (designated here):** *Rechinger 13188* (W 1960-0012946 digital image!; isolectotype: W 1962-0009747 digital image!).

Note — From the two specimens at W, the sheet with more ample material, which was also depicted in the protologue of *Sedum* ×*donatae* (Afferni 2014: 156), is designated here as the lectotype of *S. hierapetrae*.

Distribution — Greece: Andikithira, Crete, Gavdos, Kasos, Karpathos and Saria. Distribution maps: Hart (2002: map 1288); Strid (2016: map 1426).

Chromosome number — $n = 11$ (Uhl in Kimnach 1984, lowland ecotype; Hart & Loon 1982, both ecotypes).

Acknowledgements

The author is indebted to the reviewers Nicholas Turland (B) and Urs Eggli (ZSS) for their comments on the manuscript and nomenclatural advice, and to the Phanerogamic Herbarium (G) of the Conservatoire et Jardin botaniques (CJB) de la Ville de Genève (Laurence Loze and Laurent Gautier) for scanning specimens of its holdings.

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Willdenowia
Open-access online edition www.bioone.org/loi/will
Online ISSN 1868-6397 · Print ISSN 0511-9618 · Impact factor 0.680
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