SEDUM INCE (*CRASSULACEAE*), A NEW SPECIES FROM SOUTHERN ANATOLIA

H. 'T HART* & K. ALPINAR†

The newly described white-flowered annual *Sedum ince* closely resembles *S. eriocarpum* and the annual forms of *S. hispanicum* (*S. longibracteatum*), but differs from the former by its alternate instead of verticillate leaves, and from the latter by the 5-merous instead of 6 9-merous flowers and the ripe follicles which are divergent instead of patent and lack the distinct lips along the ventral suture. Molecular phylogenetic analyses indicate that *S. ince* is but distantly related to *S. eriocarpum* as well as to *S. hispanicum*. It belongs to a cytological distinct lineage of *Sedum* subgenus *Gormania* sporting a basic chromosome number of x = 7. Within this lineage, however, *S. ince* holds a unique position and consequently it is classified in the monotypic *S.* series *Elegans*.

Keywords. Chloroplast DNA, *Crassulaceae*, flora of Turkey, new species, *Sedum*.

INTRODUCTION

In contrast to the *Crassulaceae* floras of Mexico, South Africa and Asia, the Mediterranean *Crassulaceae* flora comprises a high number (20%) of strictly annual species (Böttcher & Jäger, 1984; 't Hart, 1996). Annual *Crassulaceae* are usually quite variable in habit and gross morphology due to a direct response to variation in edaphic conditions during early development. However, most annual Mediterranean species are quite distinct and can be easily distinguished by different combinations of morphological characters, except for the species of the species-aggregate including the white-flowered *S. hispanicum* L. and *S. rubens* L. More than 20 segregate species and subspecies have been described for this aggregate from the Aegean region and Near East. However, there is little consensus on the validity and taxonomic status of most segregate taxa so far (Boissier, 1872; Rechinger, 1943; Chamberlain, 1972; 't Hart & Alpınar, 1991a; 't Hart, 1996). Cytologically the *S. hispanicum-rubens* aggregate is extremely variable, comprising at least 25 different cytotypes ('t Hart & Alpınar, 1991b; 't Hart & van Ham, 1991; 't Hart, 1996).

As part of a biosystematic study of Turkish *Sedum* ('t Hart & Alpınar, 1991a) we collected a large number of plants of these critical, white-flowered, annual *Sedum* taxa throughout the larger part of Turkey. In addition to the common and widely distributed *S. eriocarpum* Sibth. & Sm., *S. hispanicum*, *S. pallidum* M. Bieb. (although predominantly perennial this species also belongs to this aggregate; 't Hart & Alpınar,

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1991b), *S. steudelii* Boiss., and *S. rubens* we collected a white-flowered, annual *Sedum*, that differed from the aforementioned species by a unique combination of flower, fruit and seed characters. We found it in southern Anatolia only (Table 1) and named it *Sedum ince*. The name of the new species is derived from the Turkish word 'ince' which means elegant (Latin: *gracilis*) and refers to the habit of the plants which have delicate, slender stems, relatively long pedicels, and small flowers.

Sedum ince 't Hart & Alpınar, **sp. nov.**
Sedum annuum gracile, S. *eriocarpo* et *S. hispanico* proximum, a primo foliis alternis, flosculis minoribus, folliculis laevibus, seminibus pallide brunneis, a postremo floribus pentameris, folliculis suberectis ad divergentibus differt.
Type: cultivated at Utrecht Botanic Garden from seeds collected in Turkey [prov. Konya, Aydos Dağı 19km SE of Ereğli, near Sinanlı along the road to the village of Delimahmutlu, rocky limestone slopes near a graveyard, 1350m, 1991, *Alpınar & 't Hart* AH793], 25 v 1992 [holo. ISTE (*72678*), iso. U (HRT-*32001*)].

Erect, usually simple, slender annual to 7 or rarely 10cm high, glandular pubescent, especially in upper part. *Leaves* alternate, sessile with a very short, truncate spur, oblong to linear, to 10mm long, rounded, terete, grey-green or glaucous-white. *Inflorescence* cymose with 11–13(4–18) flowers on 2 or 3, suberect, monochasial branches, rarely with subsidiary branches. *Bracts* 1, leaf-like. *Peduncles* slender, 1–1.5mm long. *Flowers* 5-merous, with 10 stamens. *Sepals* broadly sessile, basally connate, triangular, 0.6–0.8mm long, acute. *Petals* basally free, ovate-oblong to elliptic, 3.5–5mm long, acuminate, white sometimes tinged red. *Filaments* white, glabrous. *Anthers* oblong-globose, red. *Styles* distinct, c.0.8mm long. *Nectary scales* cuneate to quadrate-oblong, denticulate, yellow. *Follicles* suberect or divergent, smooth, pale brown. *Seeds* ovoid, pale brown, costate, apex acute. $2n = 14$.

TAXONOMIC POSITION OF *SEDUM INCE*

Cytological and morphological data

We collected seeds of *Sedum ince* at 5 locations (Table 1) on rocky or gravelly, limestone soils at 1350–1850m altitude. Seeds of Mediterranean, annual *Sedum* species usually germinate within 3–7 days in high numbers when sown in the greenhouse in early spring. Seeds of *S. ince*, however, did not germinate that easily. They need a prolonged cold treatment (vernalization) and so far only seeds of accession HRT-*32001* have germinated after spending a winter in a cold frame. The seedlings were subsequently brought into the greenhouse and cultivated like other annual *Sedum*.

At first sight flowering plants of *Sedum ince* (Fig. 1) are almost indistinguishable from *S. eriocarpum* subsp. *orientale* 't Hart ('t Hart, 1996) or the strictly annual form of *S. hispanicum* from southern Anatolia (Hatay) and the Near East (Israel, Lebanon, Syria and Saudi Arabia), which is also known as *S. longibracteatum* Fröd.

TABLE 1. Origin of the plants (HRT numbers refer to the accession-numbers of plants cultivated at the Utrecht Botanic Gardens and voucher specimens of the cultivated plants in the Utrecht herbarium; the ISTE numbers refer to voucher specimens in the herbarium of the Istanbul Faculty of Pharmacy). Accessions marked with an asterisk (HRT numbers) have been used in the chloroplast DNA analyses

Species	Origin
Phedimus spurius (M. Bieb.) 't Hart	Turkey (Ardahan); Yalnızçam Geçidi, 2300m, HRT-*31393**, ISTE *61127*.
Prometheum aizoon (Fenzl) 't Hart	Turkey (Kahramanmaraş); Berit Dağı, c.2500m, HRT-*31740**, ISTE *62223*.
Prometheum sempervivoides (M. Bieb.) H. Ohba	Turkey (Erzurum); Delibaba gorge, 17km E of Horasan along the road to Ağrı, 1750m, HRT-*31153**, ISTE *60785*.
Rosularia sempervivum (M. Bieb.) A. Berger	Turkey (Hatay); village of Arpalıuşağı, between Kırıkhan and Hassa, 900m, HRT-*31674**, ISTE *62120*.
Sedum acre L.	Turkey (Bolu); 6km W of Mengen along the road to Dirgine, 200m, HRT-*30869**, ISTE *59479*.
Sedum album L.	Spain (Teruel); 9km SE of Albarracin, 1350m, HRT-*29329**.
Sedum eriocarpum Sibth. & Sm. subsp. *orientale* 't Hart, 2n = 14	Turkey (Muğla); 21km N of Kalkan along the road to Gölbent, 150m, HRT-*30294*. Turkey (Manisa); Kırkağaç Dağı, above Kırkağaç, 950m, HRT-*32487**, ISTE *65296*.
Sedum eriocarpum Sibth. & Sm. subsp. *orientale* 't Hart, 2n = 20	Turkey (Denizli); Honaz Dağı, 12km N of Honaz, 1550m, HRT-*32538**, ISTE *65355*.
Sedum hispanicum L.	Turkey (Bolu); Yedigöller Milli Parki, 1150m, HRT-*30865**, ISTE *59475*. Greece (Thrakia); Mesti, 6km W of Avra along the road to Komotini, 150m, HRT-*30220*.
Sedum ince 't Hart & Alpınar	Turkey (Konya); Aydos Dağı, foothills SE of Ereğli, rocky slopes at Eşeçoban near Madde, 3–4km S of Delimahmutlu along the road to Eğerkaya, greyish limestone pebbles, 1550m, HRT-*31987* & *31989*, ISTE *63264* & *63266*. Turkey (Konya); Aydos Dağı, foothills SE of Ereğli, rocky slopes along the road to Eğerkaya, S of Delimahmutlu, limestone, 1650–1850m, HRT-*31993*, ISTE *63270*. Turkey (Konya); Aydos Dağı, 19km SE of Ereğli, rocky slopes near Sinanlı along the road to village Delimahmutlu, near graveyard, limestone, 1350m, HRT-*32001**, ISTE *63278* & *72678*. Turkey (Niğde); Emli gorge, 9km E of Çukurbağı, gravelly places at base of rocky

TABLE 1. (*Continued*).

	limestone slopes, 1700m, HRT-*31825*, ISTE *62379*.
Sedum microcarpum Smith	Israel (Coastal Carmel): Atlit, HRT-*31112**.
Sedum steudelii Boiss.	Turkey (Van): N of Muradiye, valley of the river Bendimahi, 1800m, HRT-*31249**, ISTE *60911*.

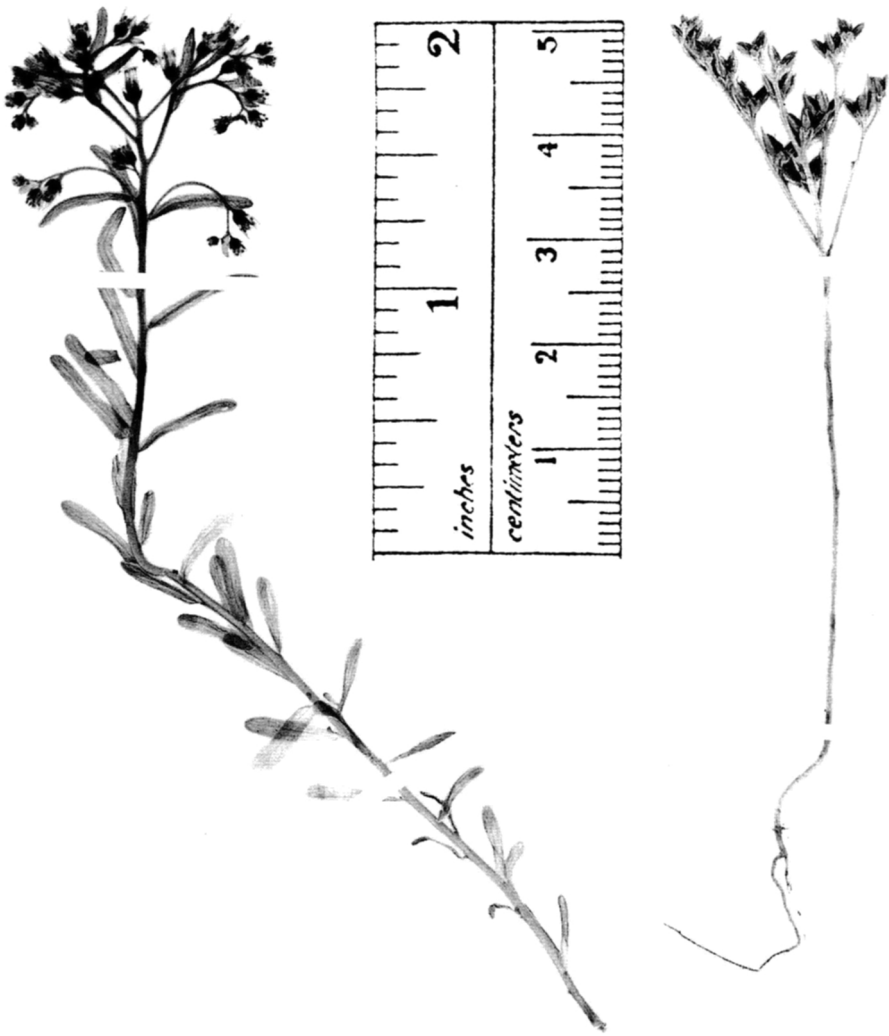

FIG. 1. Flowering and fruiting specimens of *Sedum ince* 't Hart & Alpınar from Aydos Dăgı. On the left a plant cultivated at Utrecht (HRT-*32001*), on the right a wild-collected fruiting specimen (HRT-*31987*).

(Fröderström, 1936, 1960; 't Hart & van Ham, 1991). *Sedum ince* and *S. eriocarpum* subsp. *orientale* both have erect stems with linear-oblong, obtuse or rounded leaves, spatulate to oblong, sparsely dentate nectary scales and divergent or suberect follicles (Fig. 1). However, the latter differs significantly by having leaves in whorls of four (at least at the base of the stem), stouter stems, larger flowers with shorter pedicels (subsessile), often somewhat verrucose or mamillate follicles gradually tapering into the style, and ovoid, dark brown or almost black seeds. *Sedum ince* and *S. longibracteatum* resemble each other in the alternate, oblong leaves, pale brown follicles and oblong-ovoid, brown seeds. The leaves of *S. longibracteatum*, however, tend to be more elliptic and rather subacute than obtuse or rounded, and, most significantly, its has 6–7-(–9-)merous flowers, with much larger, red-striped petals, cuneate, usually coarsely dentate scales and stellate patent follicles with very distinct lips along the ventral suture.

In contrast to the traditional view (Grisebach, 1843; Boissier; 1872; Berger, 1930; Fröderström, 1932; Chamberlain, 1972) *Sedum eriocarpum* and *S. hispanicum* are not closely related. Cytologically and morphologically the two species differ significantly and, moreover, they are separated by a strong reproductive barrier ('t Hart, 1991, 1996). Accordingly they have been classified in different infrageneric taxa, i.e. *Sedum eriocarpum* in *S.* series *Aithales* (Webb & Berth.) 't Hart and *S. hispanicum* in *S.* series *Glauco-rubens* Fröd., respectively. In addition to *S. eriocarpum*, *Sedum* series *Aithales* contains two more species, i.e. *S. pallidum* M. Bieb. and *S. rubens* L., whereas *S.* series *Glauco-rubens* also comprises *S. steudelii* Boiss. Because *S. ince* is quite distinct morphologically and by and large intermediate between *S.* series *Aithales* and *S.* series *Glauco-rubens* we have been unable to assign it unequivocally to either one of the two series. In order to learn more about the systematic position of *S. ince* we used the cultivated material in comparative cytological and molecular studies.

For our cytological studies we used root-tips which were fixed in Karpechenko's fixative and subsequently dehydrated, embedded in paraffin and sectioned at 15μm ('t Hart, 1985). The sections were stained according to Haidenhain's haematoxylin method and made permanent. *Sedum ince* has a chromosome number of $2n = 14$. Its chromosomes are about 1μm long and the karyotype is rather symmetrical (Fig. 2a). The chromosome number $2n = 14$ is quite common in *Sedum* and has been reported for *S. eriocarpum* as well as *S. hispanicum* ('t Hart & Alpınar, 1991a; 't Hart 1996). In *S. hispanicum* there is a polyploid series based on $x = 7$. The diploid cytotype ($2n = 14$) is most common and comprises the perennial as well as the strictly annual forms (including *S. longibracteatum*; 't Hart and van Ham, 1991). The basic chromosome number of *S. eriocarpum* is $x = 5$ or $x = 10$, but dysploid cytotypes with chromosome numbers of $2n = 8$, $2n = 12$, $2n = 14$, and $2n = 16$ have been reported from southern Anatolia and Israel ('t Hart and Alpınar, 1991b; 't Hart and van Ham, 1991; 't Hart, 1996). Although the chromosomes of *S. ince* are somewhat smaller than those of dysploid *S. eriocarpum* with a chromosome number of $2n = 14$ and somewhat larger than those of diploid *S. hispanicum* the karyotypes of these three species do not differ significantly (Fig. 2).

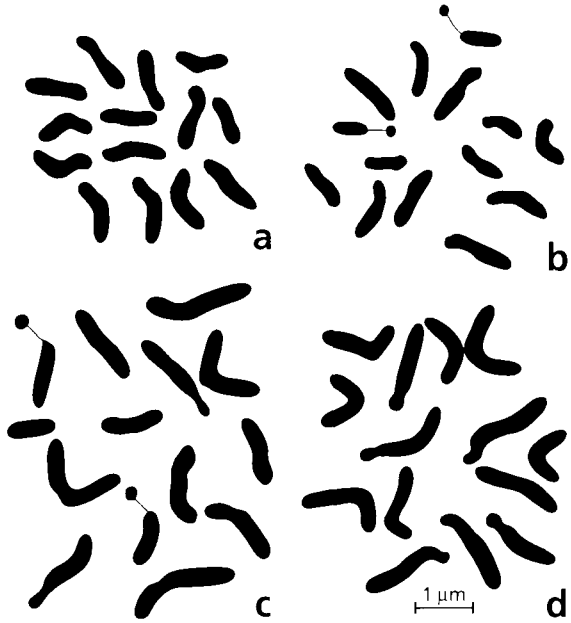

FIG. 2. Chromosome complements of Anatolian species of the *Leucosedum* lineage of *Sedum* with the diploid chomosome number of 2n = 14: a, *Sedum ince* 't Hart & Alpınar, HRT-*32001*; b, *Sedum hispanicum* L., HRT-*30220*; c, *Sedum eriocarpum* Sibth. & Sm. subsp. *orientale* 't Hart, HRT-*30294*; d, *Prometheum aizoon* (Fenzl) 't Hart (after 't Hart & Eggli, 1989).

Molecular data

For a rapid assessment of the systematic position of *Sedum ince* we amplified and sequenced the chloroplast DNA *trnL*(UAA)-*trnF*(GAA) intergenic spacer (IGS; Taberlet *et al.*, 1991; van Ham *et al.*, 1994, Kim *et al.*, 1996) and compared the aligned sequence with our *Crassulaceae* database of this intergenic spacer which presently contains about 200, mainly Eurasian taxa. As we expected from our morphological studies (leaf shape, testa ornamentation and insertion of the sepals) parsimony analysis of a wide taxonomic sample from our molecular data-set (results not shown) included *S. ince* in the *Leucosedum* clade (van Ham & 't Hart, 1998) which is by and large identical to *S.* subgenus *Gormania* Clausen ('t Hart, 1995). Within this *Leucosedum* clade *S. ince* was included in a clade which also contained *S. hispanicum*, *S. microcarpum* (Smith) Schönland (≡*Telmissa microcarpa* (Smith) Boiss.), *S. steudelii*, and *Prometheum* (A. Berger) H. Ohba. The aligned *trnL-trnF* IGS sequences of a relevant subset of 12 taxa (including two outgroup species) is presented in Table 2. The results of a cladistic analysis of these 12 taxa is presented in Fig. 3.

In addition to the 20 phylogenetically informative base substitutions the aligned *trnL-trnF* IGS sequences contain several highly significant, large indels (4 bp or longer; van Ham *et al.*, 1994). A 5 bp insertion (position 7–11) which is unique for species of the *Leucosedum* clade (though secondarily lost in *Sedum microcarpum*),

TABLE 2. Aligned sequences of the chloroplast DNA *trnL*(UAA)-*trnF*(GAA) intergenic spacer of 12 *Sedoideae* (*Crassulaceae*). Spacer length is indicated at the end of the sequence. The length of the alignment is 310 bp. Dashes indicate alignment gaps

Species	Sequence				
	10	20	30	40	50
Phedimus spurius	AATCCC----	-CTAA-----	------TAAA	GGATTATTTG	ATTACCTAAT
Sedum acre	AATCCC----	-CTAA-----	------CAAA	GTAGCATTTG	ATTCCCTAAT
Sedum album	AATCCCCTAA	TCTAA-----	------TAAA	GTATCCTTTT	TTTACCTAAT
Sedum eriocarpum 2n = 14	AATCCCCTAA	TCTAA-----	------TAAA	GTATCATTTG	ATTACCTAAT
Sedum eriocarpum 2n = 20	AATCCCCTAA	TCTAA-----	------TAAA	GTATTATTTG	ATTACCTAAT
Rosularia sempervivum	AATCCCCTAA	TCGAATCCTA	ATCTAATAAA	GTATCATTTG	ATTACCTAAT
Sedum microcarpum	AAT-------	----------	------TAAA	GTATCATTTG	ATTAACTAAT
Sedum hispanicum	AATCCC-TAA	TCTAA-----	------TAAA	GTATCAGTTG	ATTACCT---
Sedum steudelii	AATCCCCTAA	TCTAA-----	------TAAA	GTATCATTTG	ATTACCTAAT
Sedum ince	AATCCCCTAA	TCTAAT----	-TCTAATAAA	GTATCATTTG	A----CTAAT
Prometheum aizoon	AATCCCCTAA	TCTAA-----	------TAAA	GTACCATTTG	ATTACCTAAT
Prometheum sempervivoides	AATCCCCTAA	TCTAA-----	------TAAA	GTATCATTTG	ATTACCTAAT
	60	70	80	90	100
Phedimus spurius	ACTTTTTCTC	CATACTCCCG	TTTCTTTT--	------CATT	AGTGGTTTCA
Sedum acre	TCTTTTTCTC	-ATACTCTCG	TTTCTTGG--	------CAT-	AGTATTTTCA
Sedum album	TCTTTTTCTC	-ATATTCTCG	TTTCTTTT--	------CAT-	AGTAGTTTCA
Sedum eriocarpum 2n = 14	TCTTTTTCTC	-ATATTGTCG	TTTCTTT---	----------	----------
Sedum eriocarpum 2n = 20	TCTTTTTCTC	-ATATTCTCG	TTTCTTT---	----------	----------

TABLE 2. (*Continued*).

Species	Sequence				
	60	70	80	90	100
Rosularia sempervivum	TCTTGTTCTC	-ATATTCTCG	TTTCTTTT--	------CAT-	AGTAGTTTCC
Sedum microcarpum	TCTTTTTTTC	-ATATTCTCG	TTTCTTTT--	------CAG-	AGTAGT--CA
Sedum hispanicum	------TTTC	-CTATTCGCG	TTTCTTTTCT	TCTTTTCAT-	AGTAGTTTCA
Sedum steudelii	TCTTTTTTTC	-ATATTCTCG	TTTCTTTT--	------CAT-	AGTAGTTTCA
Sedum ince	TCTTTTTCTC	-ATATTCTCG	TTTCTTTT--	------CAT-	AGTAGTTTCA
Prometheum aizoon	TCTTTTTCTC	-ATATTCTCG	TTTCTTTT--	------CAT-	AGTAGTTTTA
Prometheum sempervivoides	TCTTTTTCTC	-ATATTCTCG	TTTCTTTT--	------CAT-	AGTAGTTTAA
	110	120	130	140	150
Phedimus spurius	AGCTTGTTAT	CTTTCTTATT	CACCCTATT-	--------AG	TTTACAACG-
Sedum acre	AGCTTGTTAT	GTTTCTCATT	CAACCTATTT	TATCTTACTT	TTTACAAAG-
Sedum album	AGCTTGTTAT	GTTTCGCATT	CGACCAATTT	T-------TT	TTTACAAAA-
Sedum eriocarpum 2n = 14	----------	----------	----------	----------	----------
Sedum eriocarpum 2n = 20	----------	----------	----------	----------	----------
Rosularia sempervivum	AGCTTGTTAT	GTTTCTCATT	CAACCTATT-	--------TT	TTTACAAAA-
Sedum microcarpum	AGCTTGTTAT	GTTTCGCATT	CAATCTTTT-	--------TT	TTTGTAAAAA
Sedum hispanicum	AGCTTGTTAT	GTATCTCATT	CAATCCATT-	--------TT	TTTACAAAG-
Sedum steudelii	AGCTTGTTAT	GTTTCCCATT	CAATCTATT-	--------TT	TTTA??AAA-
Sedum ince	AGCTTCTTAT	GTTTCTTATT	CAATTTCTT-	--------TT	TTTACAAAA-
Prometheum aizoon	AGCTTGTTAT	GTTTCTTATT	CAATCTATT-	--------TT	TTTACAAAA-
Prometheum sempervivoides	AGCTTGTTAT	GTTTCTTATT	CAATCTATT-	--------TT	TTTAGAAAA-

TABLE 2. (*Continued*).

Species	Sequence				
	160	170	180	190	200
Phedimus spurius	-AGATCCTAT	AAAAA-TTGG	ATTCTCTTTT	CACAAACTTA	GAAAGTCTAG
Sedum acre	-AAATCCTAG	AAAAA-TTGG	ATTTCCTTAT	CCCAAACTTA	GAAAGTCTAG
Sedum album	-AAATCCTAA	ATAAA-TTTG	ATTCTATTAT	CACAAACTTA	GAAAGTCTAG
Sedum eriocarpum 2n = 14	----------	----------	----------	---- AGCTTA	GAAAGTCTAG
Sedum eriocarpum 2n = 20	----------	----------	----------	---- AACTTA	GAAAGTCTAG
Rosularia sempervivum	--AATCCTAA	AAAAA-TTGG	ATTCTATTAT	CACAAACTTA	GAAAGTCTAG
Sedum microcarpum	AAAATCCTAA	AAAAA-TTGG	ATTCTATTAT	CACAAACTTA	GAAAGTCTAG
Sedum hispanicum	-GATTCCTAA	AAAAAATGGG	ATTCTATTCT	CACAAACTTC	GAAAGTCCCG
Sedum steudelii	-GAATCCG?A	AAAAAATTGG	ATTCGATTAT	CACAAACTTA	GAAAGTCTTG
Sedum ince	-TAATCCTAA	AAAAAATTGG	ATTCTATTAT	CACAAACTTC	GAAAGTCTAA
Prometheum aizoon	-GAATCCTAA	AAAAATTTGG	ATTCTATTAT	CACAAACTTC	GAAAGTATAG
Prometheum sempervivoides	-GAATCCTAA	AAAAATTTGG	ATTCTATTAT	CACAAACTTC	GAAAGTCTAG
	210	220	230	240	250
Phedimus spurius	GGACTGTATA	AGACTTTAA-	----------	-----TAAAT	ACCCTTTCAT
Sedum acre	GCGCTGTATA	AGACTTTAAT	TGAATAAAGA	TTGAATAAAT	ACCCTTTTAT
Sedum album	GGACTGTATA	CGATTTTAA-	----------	-----TAAAT	ACCCTTTCAT
Sedum eriocarpum 2n = 14	GGACTGCATA	AGACTTTAA-	----------	TTTA?TAAAT	ACCCTTTCAT
Sedum eriocarpum 2n = 20	GGACTGCATA	AGACTTTAA-	----------	TTTAATAAAT	ACCCTTTCAT

TABLE 2. (*Continued*).

Species	Sequence				
	210	220	230	240	250
Rosularia sempervivum	GGACTGTATA	AGA-------	----------	------- AAA	ACCCTTTCGT
Sedum microcarpum	GGGTTGTATA	AGACTTTAA-	----------	----- TAAAA	ACCCTTTCAT
Sedum hispanicum	GGACTGTATA	AGACTGTAA-	----------	----- TAAAA	AGCCTTGCAT
Sedum steudelii	GGGCGGTATA	AGACTTTAA-	----------	----- TAAAA	AGCCTTTCGT
Sedum ince	GGACTGTATA	AGACTTTAC-	----------	----- TAAAA	ACCCTTTGAT
Prometheum aizoon	GGACTGTCTA	AGACTTTAA-	----------	----- GAAAA	ACCCTTTCAT
Prometheum sempervivoides	GGACTGTCTA	AGACTTTAA-	----------	----- TAAAA	ACCCTTTCAT
	260	270	280	290	300
Phedimus spurius	TTTTTT-AAT	TGACATAGCC	TCAAGTCATA	TAGTAAAATT	AGACTGATAC
Sedum acre	TTTTTTTTAT	TGACATAGCC	TCGCGTCATA	TCGTAAAATT	AAAGTGATAC
Sedum album	TTTTTT--AT	TGACATAGCC	TCAAGTCATA	TCGTAAAATT	AGACTGATAC
Sedum eriocarpum 2n = 14	TTTTTTT-AT	TGACATAGCC	TCAAGTCATA	TCGTAAAATT	AGACTTATAC
Sedum eriocarpum 2n = 20	TTTTTTTTAT	TGACATAGCC	TCAAGTCATA	TCGTAAAATT	AGACTTATAC
Rosularia sempervivum	TTTTTTTTAT	TGACATAGCC	TCAAGTCATA	TCGTAAAATT	AGACTGATAC
Sedum microcarpum	TTTTTTTTAT	TGACATAGCC	TCCAGTCATA	TCGTAAAATT	AGACTGATAC
Sedum hispanicum	TTTTTTT-AT	TGACATAGCC	TCAAGTCATA	GCGTAAAATT	AGACTGATAC
Sedum steudelii	TTTTTT--AT	?GACA?AGCC	TCAAA?CATA	GCGTAAAATC	AGAC?GATAC
Sedum ince	TTTTTTTTAT	TGACATAGCC	TCAAGTCATC	TCGTAAAATT	AGACTGATAC
Prometheum aizoon	TTCTTTT-AT	TGACATAGCC	TCAAGTCATA	TCGTAAAATT	AGACTGATAC
Prometheum sempervivoides	TTTTTTT-AT	TGACATAGCC	TCAAGTCATA	TCGTAAAATT	AGACTGATAC

TABLE 2. (*Continued*).

Species	Sequence
	310
Phedimus spurius	GGAGAGGATG [257 bp]
Sedum acre	GGAAAGGATG [281 bp]
Sedum album	GGAAAGGATA [261 bp]
Sedum eriocarpum 2n = 14	GGAAAGGATG [179 bp]
Sedum eriocarpum 2n = 20	GGAAAGGATG [180 bp]
Rosularia sempervivum	GGGAAGGATG [263 bp]
Sedum microcarpum	AGAAAGGGTG [249 bp]
Sedum hispanicum	GGAAAGGATG [259 bp]
Sedum steudelii	GGAAAGGAGG [260 bp]
Sedum ince	GGAAAGGATG [264 bp]
Prometheum aizoon	GGAAAGGATG [261 bp]
Prometheum sempervivoides	GGAAAGGATG [261 bp]

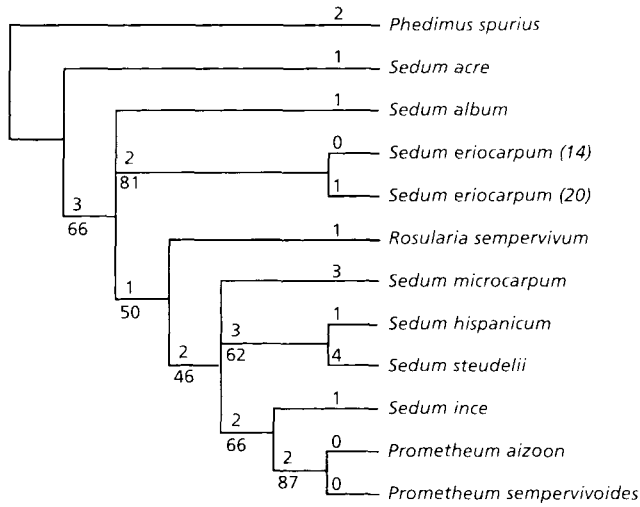

FIG. 3. Strict consensus of the six most parsimonious Wagner trees (PAUP version 3.1.1, Branch and Bound option; Swofford, 1993) of the sequences presented in Table 2, using *Phedimus spurius* as outgroup. The tree has a length of 30 steps and a consistency index of 0.700 (including autapomorphies). Branch lengths (base substitutions) are indicated above the branches and the figures below the branches indicate bootstrap values (100 replicates).

also occurs in *S. ince* and strongly supports its inclusion in *S.* subgenus *Gormania*. The unique position of *S. ince* relative to the species of *S.* series *Aithales* and *S.* series *Glauco-rubens* is supported by four unique indels which separate it from *S. eriocarpum* and *S. hispanicum*, respectively. The two cytotypes of *S. eriocarpum* stand apart from all other taxa in this sample by a shared, large 107 bp deletion (position 78–184), whereas *S. hispanicum* is characterized by two unique indels, a 9 bp deletion (position 48 56) and an 8 bp insertion (position 79 86), respectively. Finally, *S. ince* contains a unique, small 4 bp deletion (position 42 45).

CONCLUSIONS

The chloroplast DNA analysis indicates *Sedum ince* as the sister of a clade comprising *Prometheum aizoon* (Fenzl) A. Berger (≡*Rosularia aizoon* (Fenzl) A. Berger) and *P. sempervivoides* (M. Bieb.) H. Ohba (≡*Sedum sempervivoides* M. Bieb.). This clade represents the monophyletic genus *Prometheum* (A. Berger) H. Ohba which comprises about eight, perennial or hapaxanth (biennial), densely rosulate species with white, pink, red or yellow flowers (Ohba, 1978; 't Hart, 1995). Basal to *S. ince* are *S. microcarpum* and a clade comprising the two species of *S.* series *Glauco-rubens*, *S. hispanicum* and *S. steudelii*. The two cytotypes of *S. eriocarpum*, with 2n = 14 and 2n = 20, respectively, form a monophyletic clade that appears to be only distantly related to *S. ince* and *S.* series *Glauco-rubens*.

Cytologically the clade comprising *Sedum ince*, *S. microcarpum*, *S.* series *Glauco-*

rubens, and *Prometheum* is surprisingly uniform considering the enormous cytological variation (particularly chromosome numbers) which is so characteristic for *Sedum* and related genera (Uhl, 1963; 't Hart, 1991). The basic chromosome number x = 7 occurs in 10 out of the 12 species of this lineage and the other two species, *Prometheum pilosum* (M. Bieb.) H. Ohba (= *Sedum pilosum* M. Bieb.) and *Sedum steudelii*, both have a basic number of x = 6 as a result of two independent, descending dysploid changes (Moran, 1972; 't Hart, 1985; 't Hart & Eggli, 1989; 't Hart & Alpınar, 1991a). On the other hand, this clade is extremely diverse morphologically. The rosulate, slightly sympetalous species of *Prometheum* form a distinct group and so do *S. hispanicum* and *S. steudelii* which form a comparium ('t Hart, 1991), whereas *S. microcarpum* is a highly specialized annual with 4-merous, haplostemonous flowers and 1- to 2-seeded carpels. Because *S. ince* is not clearly affiliated with any of these taxa we classify it in a new, monotypic series, *S.* series *Elegans*.

Sedum series **Elegans** 't Hart & Alpınar, **series nova**
Plantae glanduloso-pubescentes. Folia alterna, oblonga vel linearia, obtusa. Flores 5-meri. Sepala basin receptaculo adnata. Petala alba. Folliculi suberecti vel patentes. Semina apice acuta, testa costata.
Type species: *Sedum ince* 't Hart & Alpınar.

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