Acta Bot. Neerl. 21(4), August 1972, p. 428–435

CHROMOSOME NUMBERS IN THE SERIES RUPESTRIA BERGER OF THE GENUS SEDUM L.

H. 'THART

Instituut voor Systematische Plantkunde, Utrecht

SUMMARY

In the series *Rupestria* Berger the following chromosome numbers were found: *Sedum forsterianum* Sm., 2n = 48 and 96; *Sedum montanum* Song. & Perr., 2n = 34 and 51; *Sedum ochroleucum* Chaix in Vill., 2n = 34 and 68; *Sedum reflexum* L., 2n = 85, 102, and 153; *Sedum sediforme* (Jacq.) Pau, 2n = 32, 64, and 96; *Sedum tenuifolium* (Sibth. & Sm.) Strobl, 2n = 24 and 72. The author is of the opinion that for the present all these taxa should be treated as separate species.

1. INTRODUCTION

The series *Rupestria* within the genus *Sedum* L. was described by BERGER in 1930. The species of this group are very similar in habit. All have approximately terete, linear and acuminate leaves which are rather closely imbricate on the non-flowering shoots. The flowering shoots are 10–60 cm long, with a more or less compact, terminal cyme. The flowers are 5–7(–8)-merous, with erect carpels. PRAEGER (1921) already used for these species the name 'rupestre group', but did not give a formal description. WEBB in Flora Europaea (1964) also placed the species of this group together, although without using the name *Rupestria* Berger. According to WEBB (1964) the European species of this group are the following (only the synonyms used by Praeger and Berger are added): *Sedum forsterianum* Sm. (= *S. rupestre* L.); *Sedum ochroleucum* Chaix in Vill. (= *S. anopetalum* DC.); *Sedum reflexum* L.; *Sedum sediforme* (Jacq.) Pau (= *S. altissimum* Poir.); *Sedum tenuifolium* (Sibth. & Sm.) Strobl (= *S. amplexicaule* DC.), and *Sedum pruinatum* Brot.

The species *Sedum montanum*, described by SONGEON & PERRIER in 1864, also belongs to the *Rupestria* Berger. Praeger and Berger did not recognize it. HUBER, in Hegi's Illustrierte Flora von Mittel-Europa (2nd ed. 1961), treated *S. montanum* Song. & Perr. as a distinct species and regarded it, in accordance with SONGEON & PERRIER (1864), as about equally related to both *S. ochroleucum* Chaix in Vill. and *S. reflexum* L. WEBB (1961, 1964), on the other hand, treated *S. montanum* as a subspecies of *S. ochroleucum* Chaix in Vill.

The specific rank of other taxa of the *Rupestria* has also been doubted. HEGI (1921), e.g., treated *S. reflexum*, *S. ochroleucum*, *S. montanum*, and *S. elegans* Lej. (the latter a synonym of *S. forsterianum* Sm.) all as subspecies of *Sedum rupestre* L.*) Within the *Rupestria* FRÖDERSTRÖM (1931) distinguished next to

*) According to HUBER (1961) the name *Sedum rupestre* is invalid, since it cannot be established whether Linnaeus meant by this name *S. reflexum* or *S. forsterianum*.

S. tenuifolium (Sibth. & Sm.) Strobl and *S. pruinatum* Brot. not more than two species, *S. nicaeense* All. [= *S. sediforme* (Jacq.) Pau] with one variety, var. *ochroleucum* (Chaix) Fröd. (= *S. ochroleucum* Chaix in Vill.), and *S. rupestre* L. (= *S. forsterianum* Sm., *S. reflexum* L.). Within *Sedum rupestre* L. he did not recognize any subspecies or varieties.

Chromosome numbers counted in species of the *Rupestria* are as follows:

Species	2n Author
S. ochroleucum Chaix in Vill.	32 RODRIGUES (1953)
	34 GADELLA & KLIPHUIS (1968)
S. ochroleucum Chaix in Vill. subsp. *ochroleucum*	34 GADELLA & KLIPHUIS (1970b)
– ssp. *montanum* (Song. & Perr.) Webb	34 GADELLA & KLIPHUIS (1970a)
	51 GADELLA & KLIPHUIS (1970b)
S. reflexum L.	34, 68 BALDWIN (1935)
	c. 112 TOYOHUKU (1935), SOEDA (1944)
S. sediforme (Jacq.) Pau	32 GADELLA & KLIPHUIS (1968)
	c. 64 NILSSON & LASSEN (1971)
S. tenuifolium (Sibth. & Sm.) Strobl	24 FERNANDES & QUEIRÓS (1971)

In all cases roottip mitoses were used for counting the chromosomes. In addition to the chromosome numbers quoted above, WEBB (1964) reported the following chromosome numbers, without indicating the original publications: *Sedum reflexum* L., 2n= 108 and *Sedum sediforme* (Jacq.) Pau, 2n=32. Rodrigues (see LÖVE & LÖVE 1961) added *S. sediforme* and *S. anopetalum* to the synonymy of *S. ochroleucum* Chaix. In plants originating from the same source (Liège), TOYOHUKU (1935) and SOEDA (1944) counted in *Sedum reflexum* 2n = about 112 chromosomes. In the second paper Toyohuku (SOEDA 1944) doubted the identity of the species.

The aim of the present study was to try to analyse the complex relations between the species in the group *Rupestria* by using cytological methods.

2. MATERIAL AND METHODS

All plants were collected in nature and cultivated in pots in the experimental garden of the State University of Utrecht. Voucher specimens of the cultivated plants were preserved in alcohol 70%.

The determination of the chromosome numbers was based on the study of roottip mitoses. The roottips were fixed in Karpechenko's fixative, embedded in paraffin, sectioned at 15 micron, and stained according tot Heidenhain's haematoxylin method.

3. RESULTS

A. In *Sedum forsterianum* Sm. the chromosome numbers 2n = 48 and 96 were found (see table). From these data it is not yet possible to decide whether the basic chromosome number of this species is X = 12 or 16.

Both cytotypes may be geographically separated. The only plant with the

chromosome number 2n = 48 originated from Portugal. The cytotype with 2n = 96 chromosomes was found in the northern and central part of the area of this species, viz. in England and France.

B. According to SONGEON & PERRIER (1864), HUBER (1961), and WEBB (1964), the closely related species *Sedum montanum* Song. & Perr., *S. ochroleucum* Chaix in Vill., and *S. reflexum* L. differ in the following characters:

	S. montanum	*S. ochroleucum*	*S. reflexum*
Inflorescence	Not drooping and flat in bud, flat in fruit.	Not drooping and flat in bud, flat in fruit.	Drooping and subglobose in bud, concave in fruit.
Pedicels	With glandular hairs.	With glandular hairs.	Glabrous.
Sepals	Acute to acuminate, with glandular hairs, 4–6(3–7) mm long.	Acute to acuminate, with glandular hairs, 5–7 mm long.	Acute to obtuse, glabrous or with a few glandular hairs, 3–4 mm long.
Petals	Yellow, c. twice as long as the sepals, 7–8 mm long, patent in flower.	Creamy, c. 1,5 times as long as the sepals, 8–10 mm long, erect in flower.	Yellow, 2–3 times as long as the sepals, 6–7 mm long, patent in flower.
Stamens	Smooth.	Smooth.	Mostly papillate at the base.

The descriptions given by Songeon & Perrier, Huber, and Webb do not completely agree, although they are never contradictory. In the plants identified according to the characters mentioned above, the following chromosome numbers were found (see table):

1. *Sedum montanum* Song. & Perr. 2n = 34 and 51;
2. *Sedum ochroleucum* Chaix in Vill. 2n = 34 and 68;
3. *Sedum reflexum* L. 2n = 85, 102, and 153.

The chromosome numbers 2n = 32 in *S. ochroleucum* (RODRIGUES 1953) and 2n = 34, 68 and c. 112 in *S. reflexum* (BALDWIN 1935; TOYOHUKU 1935; SOEDA 1944) were not met with. All three species proved to have the same basic chromosome number X = 17.

As shown in *fig. 1*, both cytotypes of *S. montanum* were only found at higher altitudes in the Alps. The cytotype with the chromosome number 2n = 34 of *S. ochroleucum* was found outside the Alps at lower altitudes, whereas the cytotype with 2n = 68 chromosomes was only found in Yugoslavia. The cytotype with 2n = 102 chromosomes of *S. reflexum* seems to be the most common, occurring throughout the area of the species. Both other cytotypes were only found in northern Spain.

C. In *Sedum sediforme* (Jacq.) Pau the chromosome numbers 2n = 32, 64, and 96 were found (see table).

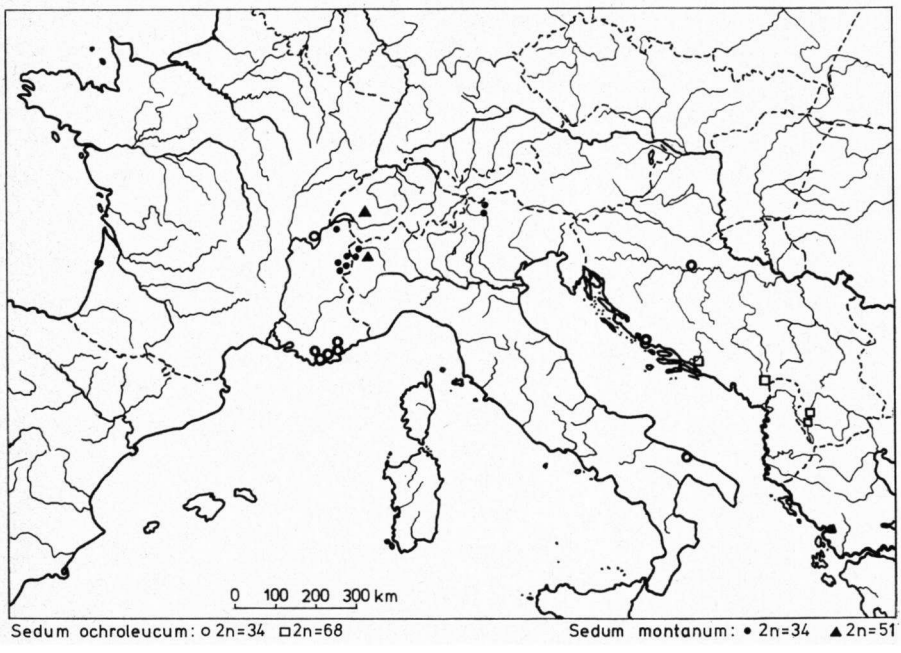

Fig. 1. Distribution of the cytotypes of *Sedum montanum* Song. & Perr. and *Sedum ochroleucum* Chaix in Vill. In this figure are also plotted some plants published by Gadella & Kliphuis (1970a, b).

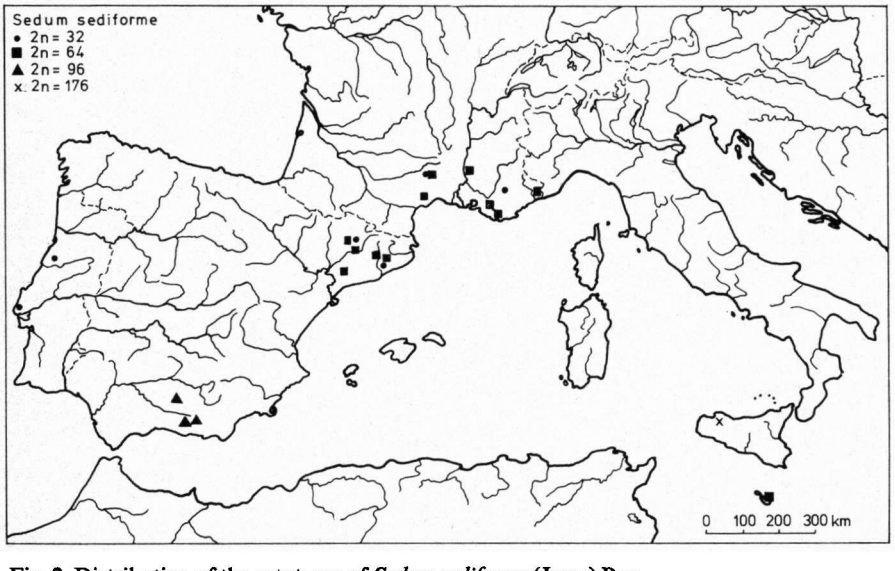

Fig. 2. Distribution of the cytotypes of *Sedum sediforme* (Jacq.) Pau.

Plants send by Mr. G. Ceska originating from Monte Pellegrino near Palermo, Sicily, which did not yet flower in the experimental garden but most probably belong to *S. sediforme*, had 2n = 176 chromosomes. The basic chromosome number of this species is X = 16.

The distribution of the cytotypes of *S. sediforme* does not show a clear pattern (*fig. 2*), nor does the altitude of the places of origin seem to be correlated with the chromosome numbers. It is remarkable that the higher polyploids mainly occur in the southern part of the area.

D. In *Sedum tenuifolium* (Sibth. & Sm.) Strobl the chromosome numbers 2n = 24 and 72 were found (see table). The basic chromosome number of this species is X = 12.

The cytotype with 2n = 24 chromosomes originated from Portugal, the cytotype with 2n = 72 from the Sierra Nevada, southern Spain.

4. Discussion

In the *Rupestria* three basic chromosome numbers were found to occur. It appears that this series within the genus is not so uniform in cytological respect, in spite of the close morphological resemblance of the species. Of the six species studied, all except *S. forsterianum*, which has as basic chromosome number X = 12 or 16, fit in the following scheme:

n	2	3	4	5	6	7	8	9	10	11	Species
X=17	34	51									*S. montanum*
	34	–	68								*S. ochroleucum*
	–	–	–	85	102	–	–	153			*S. reflexum*
X=16	32	–	64	–	96	–	–	–	–	176	*S. sediforme*
X=12	24	–	–	–	72						*S. tenuifolium*

The results do not support the classification of Fröderström (1931), since it seems incorrect to class under one species taxa with different basic chromosome numbers. Thus *S. ochroleucum* with X=17 cannot be regarded as a variety of *S. sediforme* (= *S. nicaeense*) with X=16, nor can *S. forsterianum* with X=12 or 16 be united with *S. reflexum* with X=17 as *S. rupestre*. For the same reason it seems incorrect in Hegi's classification to assign *S. forsterianum* (= *S. elegans*) to *S. rupestre*, together with *S. montanum*, *S. ochroleucum*, and *S. reflexum*.

Sedum montanum, *S. ochroleucum*, and *S. reflexum* all have the same basic chromosome number X = 17 and form a more or less continuous polyploid series. No evidence was found whether these three species are parts of one morphologically variable species complex or three distinct species. Among these three species the closest morphological affinities exist between *S. montanum* and *S. ochroleucum*. The latter, however, are geographically separated and also

differ in their flowering periods (GADELLA & KLIPHUIS 1970b). Thus most probably both species are reproductively isolated from each other in nature. The best solution for the moment seems to be to follow HUBER (1961) and to regard all three taxa as distinct but related species.

Sedum pruinatum Brot. was not studied, as no living material could be obtained. *S. pruinatum* is endemic in a small area of Portugal and closely resembles *S. tenuifolium* (Sibth. & Sm.) Strobl. FRÖDERSTRÖM (1931) was even of the opinion that it might be "a local race of the latter." In view of this morphological resemblance it seems likely that *S. pruinatum* also has as basic chromosome number X = 12.

ACKNOWLEDGMENT

The author wishes to express his gratitude to Dr. Th. W. J. Gadella and Mr. E. Kliphuis who determined an important part of the chromosome numbers. Thanks are also due to Dr. K. U. Kramer for the correction of the English text.

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Table. Chromosome number, collection number and origin of the plants.

A. *Sedum forsterianum* Sm.

2n=48

6852, Portugal (Estremadura), Sintra, on the walls of Castello dos Mouros.

2n=96

4818, Netherlands, cultivated.
8123, 8129, England (Devon), Lynton, on coastal rocks.
8283, France (Vosges), Bocquegney, 15 km E. of Epinal, pasture.
8287, France (Haut-Rhin), Ste. Marie aux Mines, on rocks.
9160, Luxembourg, Larochette, in a pasture, alt. 400 m.
9966, France (Puy-de-Dôme), Mont Dore, Vallée de Chaudefour.
12274, France (Cantal), Puy Mary, Brecce de Roland.
12284, 12281, France (Puy-de-Dôme), Besse, Bois de Besse.

B. 1 *Sedum montanum* Song. & Perr.

2n=34

5461, France (Savoie), le Miroir, Between Val d'Isère and Petit Saint Bernard.
5467, Italy, Valley of Aosta, Ville sur Nus.
7319, 7320, 7321, France (Savoie), Haute Maurienne, Col de la Madeleine, between Lans le Villard and Bessans.
7352, France (Savoie), Plateau d'Andey, S. of Bonneville and Presles.
7356, 7360, 7370, 7374, Italy, Avellengo near Merano, alt. 1200 m.
7380, Italy, Merano.

2n=51

7307, Switzerland, about 3 km E. of Jaun-Pass.

B. 2 *Sedum ochroleucum* Chaix in Vill.

2n=34

5444, France (Ain), Virieu le Grand.
6671, Yugoslavia (Dalmatia), Trogir.
6854, Yugoslavia (Slavonia), by road from Zagreb to Beograd.
6867, France (Var), Massif de la Sainte Baume, Hêtraie.
6898, 6899, Italy (Puglia), Bari, Murge near Monopoli.
8702, 8703, 8704, 8705, France (Var), Massif des Maures, between St. Maxime and le Muy, vic. of Plan-de-la-Tour.
8706, 8707, 8708, 8710, France (Var), Massif de Maures, from 15 to 8 km E. of Collobières.
9547, France (Var), Hyères, on the road to Notre Dame du Fenouillet, alt. 300 m.

2n=68

8425, 8470, Yugoslavia (Makedonija), Mavrovo, near the lake.
8467, Yugoslavia (Makedonija), between Mavrovo and Debar.
8513, 8514, Yugoslavia (Montenegro), between Kolašin and Brogradsko Jeziro.
8574, 8575, 8576, Yugoslavia (Dalmatia), Grodac between Split and Dubrovnik.

B. 3 *Sedum reflexum* L.

2n=85

6878, 6879, Spain (Barcelona), Col de Sta. Elena, near Santa Fe, alt. 1100 m.

2n=102

1395, 4852, Netherlands, Rhenen, Grebbeberg.
4706, Netherlands, Gerendal (cultivated).
6871, Spain (Barcelona), St. Bernat, Montseny, alt. 850 m.
7150, France (Loire-Atlantique), La Censerie, Pouillé N. of Ancenis.
7207, 7243, Andorra, near Soldeu.
7261, Spain (Lérida), Viella, alt. 900 m.

2n=153
6889, Spain (Barcelona), 2 km N. of Empalme, Station Massanet de Selva, in bed of the Tordera River.

C. *Sedum sediforme* (Jacq.) Pau
2n=32
6873, Spain (Barcelona), 2 km E. of Moncada, alt. 100 m.
6875, 6876, Spain (Barcelona), Castellar del Vallés, Puig de la Creu, alt. 550 m.
8339, France (Aveyron), Nant.
7335, Spain (Lérida), Fuente de les Bagasses, Artesa, alt. 350 m.
9957, Portugal, Guincho.
10594, Portugal, Coimbra.
11201, France (Basses Alpes), Grand Canyon du Verdon, Pont d'Aiguines, alt. 1000 m.
2n=64
6653, 6654, 6655, Spain (Lérida), Sierra de Montsech, Vilanuva de Meià, alt. 700 m.
6656, 6658, Spain (Lérida), Fuente de les Bagasses, Artes, alt. 350 m.
6870, France (Var), Massif de la Ste. Baume, Crêtes du St. Pilon, alt. 900 m.
6874, Spain (Barcelona), San Bernat, Montseny, alt. 850 m.
7065, Spain (Tarragona), 7 km W. of Alforja.
7237, France (Hérault), 7 km S.E. of Montpellier.
7249, Spain (Lérida), between Artesa and Balaguer.
7912, 7915, Malta, Mellieha.
8338, France (Aveyron), Nant.
8340, France (Aveyron), Causse du Larsac, between Nant and Brandes.
8725, France (Alpes-Maritimes), Menton, Cap Martin.
9546, France (Var), Hyères.
9559, France (Vaucluse), Orange, Parc de la Colline.
2n=96
7218, 7230, Spain, Sierra Nevada, alt. 1500–2000 m.
7231, Spain, Santa Lucia, about 34 km S. of Jaén.
8728, France (Alpes-Maritimes), Menton, Cap Martin.

E. *Sedum tenuifolium* (Sibth. & Sm.) Strobl
2n=24
8766, Portugal, Coimbra.
2n=72
7226, 7227, 7228, Spain, Sierra Nevada, alt. 2000 m.