A biosystematic study of *Pelargonium* section *Ligularia*: 3. Reappraisal of section *Jenkinsonia*

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The presumed relationship between *P. antidysentericum* (Eckl. & Zeyh.) Kostel., *P. divisifolium* Vorster, *P. dolomiticum* Knuth, *P. griseum* Knuth, *P. plurisectum* Salter, *P. praemorsum* (Andr.) Dietr., *P. redactum* Vorster, *P. seneciodes* L'Hérit., *P. tenuicaule* Knuth, *P. tragacanthoides* Burch. and *P. trifidum* Jacq., based on karyological characters, is confirmed by palynological and *rbc*L gene sequence studies as well as phenolic compounds. These 11 species are placed in the section *Jenkinsonia* (Sweet) DC. ampl. J.J.A. van der Walt. The big variation in floral structure in the section is ascribed to convergent evolution and different pollination strategies. Taxonomic treatments of the section and species are presented.

Keywords: Biosystematics, Geraniaceae, *Pelargonium*, section *Jenkinsonia*.

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Introduction

The taxonomic history of the section *Jenkinsonia* DC. was reviewed by Scheltema and van der Walt (1990). They recognized *Pelargonium antidysentericum* (Eckl. & Zeyh.) Kostel., *P. praemorsum* (Andr.) Dietr. and *P. tetragonum* (L.f.) L'Hérit. as species constituting the section in South Africa. Albers *et al.* (1992) suggested on karyological grounds that *P. antidysentericum* and *P. praemorsum* are related to *P. divisifolium* Vorster, *P. dolomiticum* Knuth, *P. griseum* Knuth, *P. plurisectum* Salter, *P. tenuicaule* Knuth, *P. tragacanthoides* Burch. and *P. trifidum* Jacq. The recently described *P. redactum* Vorster (1996), and *P. dolomiticum* have many macromorphological characters in common. *P. redactum* also resembles *P. senecioides* L'Hérit. (1789) vegetatively, both are annuals and their leaves are very similar. Albers *et al.* (1995) transferred *P. tetragonum* to the section *Chorisma* DC.

The aim of this multidisciplinary study was to establish whether *P. antidysentericum, P. divisifolium, P. dolomiticum, P. griseum, P. plurisectum, P. praemorsum, P redactum, P. senecioides, P. tenuicaule, P. tragacanthoides* and *P. trifidum* are related and whether they should be classified in a single section.

Material and Methods

The same methods as described by van der Walt *et al.* (1995) were applied for the macromorphology, palynological, karyological and chemical studies.

Results and Discussion

Macromorphology

All 11 species have recently been described and illustrated: *P. trifidum* [as P. *fragile* (Andr.) Willd.] by van der Walt (1977), *P. dolomiticum, P. griseum* and *P. plurisectum* by van der Walt and Vorster (1981a), *P. divisifolium, P. senecioides, P. tenuicaule* and *P. tragacanthoides* by van der Walt and Vorster (1988), *P. antidysentericum* and *P. praemorsum* by Scheltema and van der Walt (1990) and *P. redactum* by Vorster (1996). The reader is referred to these references for detailed descriptions and illustrations of the species.

Nine of the species are sparsely to much-branched perennial shrubs or subshrubs with rather woody stems. *P. redactum* and *P. senecioides* are annual herbs with herbaceous stems and strongly or normally developed tap roots. *P. antidysentericum* is a much-branched shrub growing from a relatively large, partly subterranean tuber (Figure 7). On the basis of leaf morphology the species can be divided into two groups: *P. divisifolium* (Figure 16), *P. dolomiticum, P. griseum, P. redactum, P. senecioides, P. tragacanthoides* (Figure 9) and *P. plurisectum* all have pinnately divided or pinnately compound leaves. The leaves of *P. antidysentericum* (Figure 7), *P. praemorsum* (Figure 3), *P. tenuicaule* and *P. trifidum* are palmately divided and those of *P. trifidum* may even be trifoliolate. Pyriform-headed glandular hairs occur on the leaves of both groups with the exception of *P. dolomiticum* and *P. plurisectum*, which have spherical-headed glandular hairs. No hairs have been observed on the leaves of *P. divisifolium* and *P. praemorsum*. The flowers are borne in reduced pseudo-umbels of 1–6 flowers each. The floral structure of *P. dolomiticum, P. griseum, P. redactum* and *P. tragacanthoides* (Figure 9) is very similar. Their flowers are extremely zygomorphic, the number of petals is reduced to four and the claws of the posterior petals are inrolled to form false tubes. The number of petals of *P. praemorsum* (Figure 3) may sometimes also be reduced to four, whereas the flowers of all the other species have five much less zygomorphic (Figure 7) or more or less equally sized petals. The number of fertile stamens is normally seven (Figures 3, 7, 9), but *P. divisifolium* (Figure 16) has five, and *P. redactum* 2–3.

Palynology

The pollen grains of most species can be described as almost spherical, but those of *P. redactum* and *P. seneciodes* are oblate The pollen grains are tricolporate, zonotreme monads. (Figure 1). The polar diameter usually slightly exceeds the equatorial diameter (Table 1). The polar diameter of the pollen grains varies from *ca.* 45 μm in *P. senecioides* to *ca.* 105 μm in *P. praemorsum* subsp. *speciosum*. The exine is usually *ca.* 5 μm thick but may reach 7 μm in *P. praemorsum* subsp. *praemorsum* and *P. griseum* (Table 1). The tectum is reticulate-striate (Figure 1A–C) in all

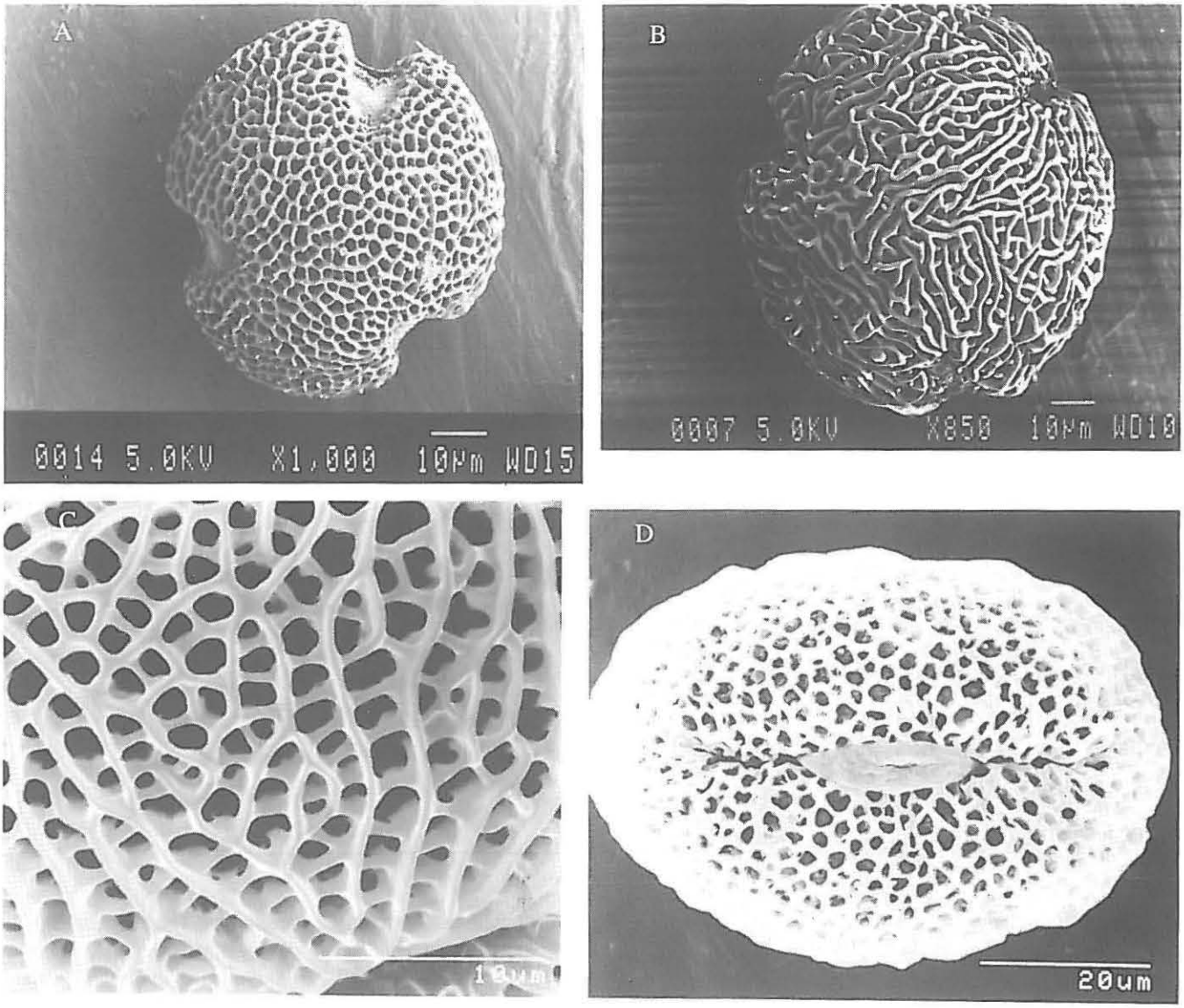

Figure 1 Pollen grains of A, *P. plurisectum* (polar view); B, *P. praemorsum* subsp. *praemorsum* (polar view); C, *P. seneciodes*; (tectum); D, *P. redactum* (equatorial view).

species except in *P. redactum* (striate-reticulate, Figure 1D). Intraluminal baculae are lacking.

The pollen grains of the species are structurally very similar. The differences in sizes are specific to the species. It is striking that the smallest pollen grains belong to those species which are self fertile (*P. senecioides* and *P. redactum*).

Karyology

The chromosome numbers of most species have already been published (Yu & Horn 1988; Gibby *et al.* 1990, Albers *et al.* 1992). Additional countings confirmed these chromosome numbers (Table 2). The chromosome numbers of *P. senecioides* and *P. redactum* are published here for the first time. The basic chromosome number of all the species is $x = 9$. and all are diploid, except *P. divisifolium*, *P. plurisectum* and *P. tenuicaule* which are tetraploids. In *P. antidysentericum* and *P. praemorsum* intraspecific polyploidy occurs ($2n = 18$ and 36), but this is not correlated to the circumscribed subspecies (Scheltema & van der Walt 1990). No correlation between geographic distribution or edaphic conditions and the different polyploid levels can be inferred.

The karyotype size of the 11 species is very similar, and the chromosome sizes vary between 1.7 and 2.5 µm. *P. redactum* is the exception with relatively small chromosomes (0.7–1.8 µm). In the past, *P. redactum* has often erroneously been identified as *P. senecioides* (Merxmüller & Schreiber 1966). The chromosome sizes of these two species, however, clearly differ. The smaller size of the chromosomes of *P. redactum* could be explained in terms of the rapid evolutionary changes of annuals.

Phenolic compounds

All the species have a basic flavonoid pattern (Table 3). The flavonol quercitin is present in all species, the pattern of kaempherol is slightly different (lacking in two subspecies of *P. antidysentericum* and *P. tenuicaule*, questionable in *P. griseum* and *P. trifidum*). Two-thirds of the species contain the flavone luteolin. The two hydrobenzoic acids are present in all the species. Hydrolysable tannins are lacking only in *P. plurisectum* and are questionable in *P. redactum* and *P. tragacanthoides*. The latter is interesting as it contains two additional compounds unknown in the other species (isorhamnetin, delphinidin). C-glycosyl-flavones seem to be absent in *P. divisifolium*, *P. praemorsum* and *P. antidysentericum* subsp. *zonale*. Compounds like myricitin and pro-anthocyanidins, which are considered primitive, do not occur in any species.

Table 1 Pollen grain dimensions of section *Jenkinsonia* (in μm)

Species	Project number	Polar diameter			Equatorial diameter			Exine thickness
		Min	Max	X	Min	Max	X	
P. antidysentericum subsp. *antidysentericum*	STEU 2972	71	83	76	64	75	73	5
subsp. *inerme*	STEU 3298	73	90	89	75	90	82	5
subsp. *zonale*	STEU 2870	68	75	73	53	75	68	5
P. divisifolium	STEU 3379	62	81	65	60	79	64	5
P. dolomiticum	STEU 4305	66	82	74	64	77	71	5
P. griseum	STEU 2838	66	84	74	64	84	79	7
P. plurisectum	STEU 2968	59	82	74	62	82	74	5
P. praemorsum subsp. *praemorsum*	STEU 625	77	112	97	74	115	97	5
	STEU 2976	87	107	102	74	107	99	5
subsp. *speciosum*	STEU 2348	82	97	92	77	97	89	5
	STEU 2975	79	112	105	79	115	105	5
P. redactum	MSUN Al 2738	46	50	48	68	71	70	?
P. senecioides	MSUNAI 2095	30	48	45	48	60	59	?
P. tenuicaule	STEU 3061	71	89	79	71	84	79	5
P. tragacanthoides	STEU 1728	69	84	77	66	82	77	5
	STEU 1849	56	87	84	61	84	82	5
P. trifidum	STEU 3047	54	66	59	56	59	58	5
	STEU 4020	51	66	61	59	69	64	5

*Rbc*L gene sequences

Up to now only four species of the newly circumscribed section *Jenkinsonia* have been sequenced for the chloroplast *rbc*L gene (Price *et al.*, unpubl.). *P. praemorsum* appears to form a robust monophyletic group with *P. trifidum* and *P. griseum*. This grouping of species is supported as monophyletic by two shared derived base substitutions, while the latter two species are placed in a monophyletic subgroup nested within the section and supported by an additional two shared derived base substitutions. Both of these sets of relationships are supported by bootstrap values of over 80%. *P. antidysentericum* appears to be relatively closely related to these three species on the basis of the *rbc*L sequence comparisons, differing from *P. praemorsum* by only five base substitutions, but lacks the shared derived base substitutions that groups these other species together. Therefore, in phylogenetic analysis of the sequence data, *P. antidysentericum* is placed in an unresolved polychotomy with these taxa.

Conclusion

The macromorphological variation in this proposed section is rather high. The different life forms are probably the result of adaptations to environmental conditions. *P. antidysentericum* can reach a height up to 1.5 m, but an annual like *P. senecioides* is sometimes less than 100 mm high. Some species have similar leaves and others share the same floral structure, but it is very difficult to demarcate the 11 species on macromorphological grounds.

Micromorphological and chemical characters, however, support the circumscription of the group into a single section. The pollen grains of all the species are similar. The differences in the patterns between *P. redactum* and the other species should, however, not be overestimated. The karyological evidence illustrates a close relationship between the species. Their relationship is further supported by a very similar flavonoid pattern in all the species and *rbc*L gene sequences in those species investigated. Studies of the phenolic compound pattern in other sections of *Pelargonium* proved to be valuable in the delimitation of sections (Dreyer *et al.* 1992).

It is concluded that the 11 species are closely related and should be included in the same section, namely *Jenkinsonia*. The section *Jenkinsonia* appears to be closely related to the sections *Chorisma* and *Myrrhidium*. The relationship between the last two sections is demonstrated and discussed by Albers *et al.* (1995). Based on the analysis of the *rbc*L sequence data of *P. candicans* (section Myrrhidium) this species is very close to *P. antidysentericum* although the two species do not share the same basic chromosome number.

Taxonomy

Taxonomic treatment of section

Pelargonium* section *Jenkinsonia *(Sweet) DC.*, Prodromus systematic naturalis regni vegetabilis 1: 658 (1824) ampl. J.J.A. van der Walt; Harv.: 291 (1860); Knuth: 390 (1912); Scheltema & van der Walt: 285 (1990). Type species: *Jenkinsonia quinata* Sweet (= *Pelargonium praemorsum* (Andr.) Dietr.).

Genus *Jenkinsonia* Sweet: 99 (1820); Eckl. & Zeyh.: 70 (1835).

Table 2 Chromosome numbers in *Pelargonium* section *Jenkinsonia*

Species	Chromosome number 2*n*	Specimen studied	Collection number	Locality
P. antidysentericum subsp. *antidysentericum*	36	*Albers & Meve 66*	MSUN 051086/66	Namibia, Witzputz
	36	*Albers & Meve 68*	MSUN 051086/68	Namibia, Witzputz
	18	*Drijfhout 2762*	STEU 2972	RSA, N. Cape, Sannagas
subsp. *inerme*	36	*Scheltema 1*	STEU 3298	RSA, W. Cape, Botterkloof Pass
subsp. *zonale*	18	*Van Jaarsveld 4057*	STEU 2350	RSA, N. Cape, Steinkopf
	18	*Drijfhout*	STEU 2870	RSA, N. Cape, Steinkopf
P. divisifolium	36	*Van der Walt 798*	STEU 1589	RSA, Riviersonderend, Tygerhoek
	36	*Drijfhout 2692*	STEU 2978	RSA, W. Cape, Riviersonderend Mts.
	36	*Vorster 2939*	STEU 3379	RSA, W. Cape, Greyton
P. dolomiticum	18	*Van der Walt 1579*	STEU 3948	RSA, Gauteng, Centurion
	18	*Van der Walt 1340*	STEU 3082	RSA, Mpumalanga, Pilgrims Rest
P. griseum	18	*Fischer 370*	STEU 2932	RSA, E. Cape, Oudeberg
	18	*Fisher 376*	STEU 2838	RSA, E. Cape, Andriesberg
P. plurisectum	36	*Drijfhout s.n.*	STEU 2906	RSA, W. Cape, Stellenbosch
	36	*Gibby MG20*		RSA, W. Cape, Stellenbosch
P. praemorsum subsp. *praemorsum*	36	*Fischer27*	STEU 1571	RSA, N. Cape, Calvinia
	36	*Fischer 31*	STEU 1575	RSA, N. Cape, Nieuwouldtville
	36	*Van der Walt s.n.*	STEU 810	RSA, N. Cape, Pakhuis Pass
	18	*Van der Walt 773*	STEU 1503	RSA W. Cape, Landplaas
	36	*Drijfhout 1396*	STEU 625	RSA, N. Cape, Steinkopf
	36	*Drijfhout 2765*	STEU 2977	RSA, N. Cape, Sannagas
subsp. *speciosum*	36	*Van Jaarsveld 4138*	STEU 2352	RSA, N. Cape, Helskloof
	18	*Marschewski 105*	MSUN Ma 105	RSA, Mpumalanga
P. redactum	18	*Albers 2738*	MSUN 2738	Namibla, Aus
P. senecioides	18	*Albers 2095*	MSUN 2095	RSA, W. Cape, Leipoldtville
P. tenuicaule	36	*Lavranos 19942*	STEU 3061	Namibia, Namuskluft
	36	*Albers, Kusch & Meve*	MSUN	RSA, N. Cape, Helskloof
P. tragacanthoides	18	*Van der Walt 891*	STEU 1728	RSA, E. Cape, Cradock
	18	*Fischer 51*	STEU 1843	RSA, E. Cape, Cradock
	18	*Fischer 57*	STEU 1849	RSA, E. Cape, Middelburg
P. trifidum	18	*Van der Walt 531*	STEU 742	RSA, W. Cape, Worcester
	18	*Van der Walt 1054*	STEU 2435	RSA, W. Cape, Worcester
	18	*Denyssen s.n.*	STEU 2107	RSA, W. Cape, Safraanpoort
	18	*Denyssen s.n.*	STEU 2111	RSA, W. Cape, George
	18	*Van der Walt 812*	STEU 1611	RSA, W. Cape, Matjiesfontein
	18	*Van der Walt 1143*	STEU 2730	RSA, W. Cape, Meiringspoort

Diagnostic features

Perennial subshrubs or annual herbs, sometimes aromatic and sometimes with tubers. Stems rather woody or herbaceous, sometimes relatively thin and trailing. Leaves palmately or pinnately divided or trifoliolate, often covered with non-glandular hairs with glandular hairs interspersed, glandular hairs spherical or pyriform-headed; petiole longer or shorter than lamina. Pseudo-umbels 1–6-flowered. Pedicels shorter or longer than

Table 3 Phenolic and further chemical compounds of *Pelargonium* section *Jenkinsonia*

Species	Collection no.	Compounds															
		M	Q	K	L	A	I	Qm	Km	Ch	De	Cy	Pe	Ga	Pr	HT	CG
P. antidysentericum subsp. *antidysentericum*	STEU 3337	-	3	2	?	-	-	-	-	-	-	-	-	3	3	2	2
subsp. *inerme*	STEU 3298	-	2	-	?	-	-	-	-	-	-	-	-	3	3	1	2
subsp. *zonale*	STEU 2350	-	3	-	-	-	-	-	-	-	-	-	-	3	3	2	-
P. divisifolium	STEU 1589	-	3	2	-	-	-	-	-	-	-	-	-	3	3	2	-
P. dolomiticum	STEU 3948	-	3	2	1	-	-	-	-	-	-	-	-	3	3	2	2
	MSUN Mar 105	-	3	2	-	?	-	-	-	-	-	-	-	3	3	2	2
P. griseum	STEU 2838	-	3	?	2	-	-	-	-	-	-	-	-	3	3	2	2
P. plurisectum	STEU 2906	-	3	2	2	?	-	-	-	-	-	-	-	3	3	-	2
P. praemorsum subsp. *praemorsum*	STEU 1575	-	3	2	?	-	-	-	-	-	-	-	-	3	3	1	-
subsp. *speciosum*	STEU 2348	-	3	2	?	-	-	-	-	-	-	-	-	3	3	2	-
	STEU 2352	-	2	3	-	-	-	-	-	-	-	-	-	2	2	?	?
P. redactum	MSUN Al 2738	-	3	2	1	-	?	-	-	-	-	-	-	3	2	?	1
P. senecioides	MSUN Mar 101	-	3	1	2	?	-	-	-	-	-	-	-	3	3	2	2
P. tenuicaule	STEU 3061	-	3	-	1	-	-	-	-	-	-	-	-	3	3	2	2
P. tragacanthoides	STEU 1849	-	3	2	2	-	2	-	-	-	1	-	-	2	2	?	2
P. trifidum	STEU 2730	-	3	?	2	-	-	-	-	-	-	-	-	3	3	2	2

M = myrecitin, Q = quercitin, K = kaempferol, L = luteolin, A = apigenin, I = isorhamnetin, Qm = quercitin-3-methylether, Km = kaempferol-4-methylether, Ch = chrysoeriol, De = delphinidin, Cy = cyanidin, Pe = pelargonidin, Ga = gallic acid, Pr = protocatechuicacid (the two latter are hydroxybenzoic acids), HT = hydrolysable tannins, CG = C-glycosyl-flavone
1= Low content, 2 = medium content, 3 = main compound, ? = questionable

hypanthia. Petals 4 or 5, posterior two the same size or larger than the anterior ones, claws of posterior petals sometimes inrolled to form false tubes. Fertile stamens 2, 3, 5 or 7.

Geographical distribution (Figure 2)

The section *Jenkinsonia* has a very wide distribution in Southern Africa. It is represented in Namibia, Botswana and the whole of South Africa with the exception of the eastern part. The wide distribution in the summer-rainfall areas can largely be ascribed to the distribution of *P. dolomiticum* and to a lesser extent to that of *P. tragacanthoides*. The centre of distribution of the section is in the Northern Cape along the west coast where up to six species occur in one degree square.

Key to the species

1a. Leaves palmately divided or trifoliolate 2
2a. Posterior petals more than 2 × size of anterior petals, petals usually 4, proximal part of petiole usually persistent . . . . . ***P. praemorsum***
2b. Posterior petals less than 2 × size of anterior petals, petals usually 5, proximal part of petiole not persistent 3
3a. Leaves borne in clusters of 2–4, older stems woody, partly subterranean tuber present . . ***P. antidysentericum***
3b. Leaves borne singly, older stems herbaceous, partly subterranean tuber lacking 4
4a. Leaves 5-palmatilobate to 5-palmatifid, pseudo-umbels 2-flowered, posterior and anterior petals of more or less the same size . . . . . ***P. tenuicaule***
4b. Leaves 3-palmatilobate to 3-foliolate, pseudo-umbels 2–6-flowered, posterior petals much larger than anterior ones . . . . . ***P. trifidum***
1b. Leaves pinnately divided 5
5a. Petals 4, claws of posterior petals inrolled to form false tubes 6
6a. Annual herbs, fertile stamens 2 or 3. . . . . ***P. redactum***
6b. Perennial subshrubs, fertile stamens 4 or 5 7
7a. Petioles shorter than laminae . . . . ***P. tragacanthoides***
7b. Petioles longer than laminae 8
8a. Posterior petals 2 x length of anterior petals, glandular hairs on leaves spherical-headed. . . . . ***P. dolomiticum***
8b. Posterior petals slightly larger than anterior petals, glandular hairs on leaves pyriform-headed . . . . . ***P. griseum***
5b. Petals 5, claws of posterior petals not inrolled 9
9a. Annual herbs, stems herbaceous . . . . . ***P. senecioides***
9b. Perennial subshrubs, stems woody. 10
10a. Posterior petals and anterior petals more or less of equal size and shape, fertile stamens 7 . . . . . ***P. plurisectum***
10b. Posterior petals much wider than anterior ones, fertile stamens 5. . . . . ***P. divisifolium***

Taxonomic treatment of species

1. ***Pelargonium praemorsum*** (Andr.) Dietr. in Vollstandiges Lexicon der Gartnerei und Botanik 7: 48 (1807); Scheltema & van der Walt: 296 (1990). Type: Andr.: t. 150 (1801).

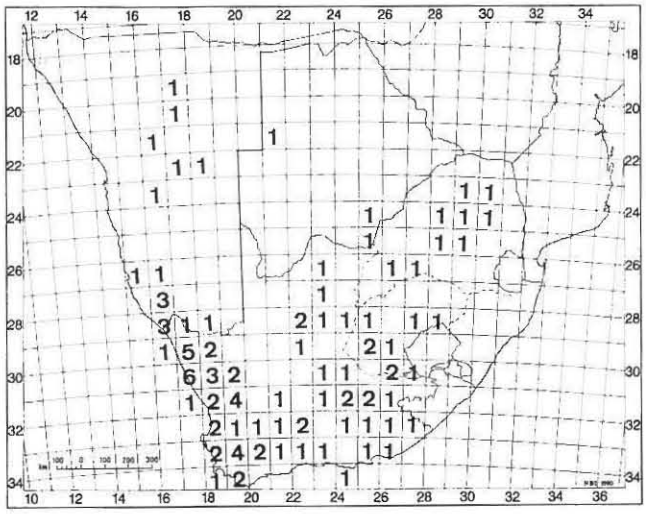

Figure 2 Distribution and concentration of species of the section *Jenkinsonia*.

Diagnostic features (Figure 3)

Much-branched subshrub. Stems flexuose, cylindrical, herbaceous, brittle. Leaves borne singly or in clusters of 2–4; lamina 5-palmatipartite or deeply incised, sparsely hirtellous to densely pubescent; proximal part of petiole usually persistent; stipules membranous; persistent. Pseudo-umbels 1–2-flowered. Pedicel (2–15 mm) shorter than hypanthium (9–40 mm). Petals 4(5), posterior two 27–38 mm × 18–31 mm, cream with wine-red or dark purple streaks; anterior two or three 12–18 mm × 6–9 mm, cream or light purple to pink with streaks.

Scheltema and van der Walt (1990) distinguished the following two subspecies: subsp. *praemorsum* and subsp. *speciosum* Scheltema (Figure 3).

Key to the subspecies

1a. Anterior two petals cream coloured, leaves light green and sparsely hirtellous ..... **(a) subsp. *praemorsum***

1b. Anterior two petals light purple to pink, leaves dark green, densely pubescent ..... **(b.) subsp. *speciosum***

(a) subsp. *praemorsum*

Scheltema & van der Walt in South African Journal of Botany 56, 3: 296 (1990).

Pelargonium praemorsum (Andr.) Dietr.: 48 (1807); Moore: 18 (1955); van der Walt: 35 (1977); Bond & Goldblatt: 308 (1984); Webb: 65 (1984). Type: as for *P. praemorsum* (Andr.) Dietr.

Geranium praemorsum Andr.: t. 150 (1801).

Pelargonium quinatum Sims: t. 547 (1802); Pers.: 229 (1807); Ait.f.: 175 (1812); Don: 732 (1831); Endl.: 1168 (1840); Steud.: 289 (1841); Harv.: 285 (1860); Knuth: 323 (1912); Eliovson: 49 (1972). Type: as for *P. praemorsum* (Andr.) Dietr.

Jenkinsonia quinata (Sims) Sweet: 79 (1820); Eckl. & Zeyh.: 70 (1835).

Geranium quinatum (Sims) Poiret: 758 (1812).

Geographical distribution (Figure 4)

Subsp. *praemorsum* is well represented in Namaqualand and has been collected from the vicinity of Springbok in the north to near Clanwilliam in the south, and eastwards towards Calvinia. The entire area is characterized by dry, hot summers with scanty rain during the winter months. This subspecies often grows in the shelter of rocks or other plants.

Selected specimens studied

RSA

—2917 (Springbok): Klipfontein (–BA), *Van der Walt 1400* (STEU).

—3017 (Hondeklipbaai): Bowesdorp (–BB), *Van der Walt 558* (STEU).

—3018 (Kamiesberg): 16 km NE of Garies on road to Leliefontein (–AC), *Scheltema 6* (STEU).

—3117 (Lepelfontein): Koelfontein (-AA), *Van der Walt 776* (STEU).

—3118 (Vanrhynsdorp): 6 km NE of Koekenaap (-CB), *Van der Walt 770* (STEU).

—3119 (Calvinia): Botterkloof Pass (–CD), *Scheltema 2* (STEU).

—3218 (Clanwilliam): Clanwilliam (–BB), *Ecklon & Zeyher s.n.* (MEL).

(b) subsp. *speciosum* Scheltema

Scheltema & van der Walt in South African Journal of Botany 56, 3: 297 (1990). Type: Northern Cape: 'Helskloof, Die Koei', *Van Jaarsveld 4138* (PRE, holo.!, K!, STEU!).

Geographical distribution (Figure 4)

Subsp. *speciosum* has a very limited and localized distribution. It occurs mainly in the northern part of the Richtersveld in succulent veld. It grows in rock crevices and among rocks in direct sunlight on the eastern and lower north-western slopes of hills and ridges.

Specimens studied

RSA

—2816 (Oranjemund): Khubus (–BD), *Marloth 12342* (PRE); Khubus Mountains above Helskloof (–BD), *Verdoorn 1837* (PRE); Helskloof (–BD), *Van Jaarsveld 4138* (K, PRE, STEW); Helsberge (–BD), *Van Breda 1201* (PRE); Numees Mine (–BD), *Hall 699/53* (BOL).

—2817 (Vioolsdrif): Jenkinskop (–CB), *Van Jaarsveld 4099* (STEU).

2. *Pelargonium trifidum* *Jacq.*, Hortus Schoenbrunnensis 2: 5, t. 134 (1797); Vorster: 268 (1986). Type: Jacq.: t. 134 (1797).

Pelargonium fragile (Andr.) Willd.: 686 (1800); van der Walt: 15 (1977). Type: as for *Geranium fragile*.

Pelargonium tripartitum Willd.: 683 (1800). Type: as for *P. trifidum*.

Geranium fragile Andr.: t. 37 (1798). Type: Andr.: t. 37 (1798).

Diagnostic features

Much-branched subshrub. Stems spreading and trailing, cylindrical, herbaceous, brittle. Leaves 3-partite to 3-foliolate; lamina cordiform, 10–40 mm × 12–50 mm, pubescent to hispid with pyriform-headed glandular hairs in between; stipules membranous. Pseudo-umbels 2–6-flowered. Pedicel (1–2 mm) much shorter than hypanthium (15–25 mm). Petals 5, cream; posterior two *ca.* 25 × 8 mm, with reddish streaks; anterior three *ca.* 15 × 4 mm.

Geographical distribution (Figure 5)

P. trifidum shows a disjunct distribution pattern, one distribution area is in the Northern Cape and the other in a strip parallel to the

Figure 3 *P. praemorsum* subsp. *speciosum*: A, vegetative branches × 1; B, flowering branch × 1; C, petals × 1; D, androecium × 1.5; E, gynoecium × 1.5.

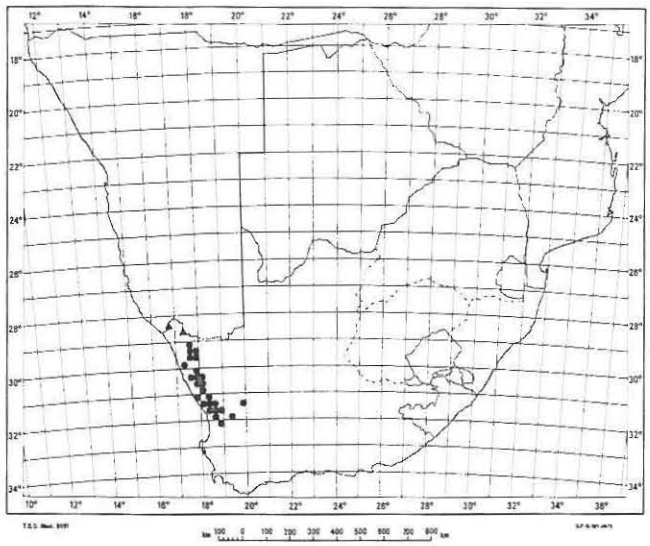

Figure 4 Geographical distribution of *P. praemorsum* subsp. *praemorsum* ● and subsp. *speciosum* ▲.

Cape south coast. The distribution area in the Northern Cape stretches from the Orange River southwards to the vicinity of Hondeklip Bay. This is an area with very high temperatures during the summer months and an annual rainfall of less than 150 mm. The second distribution area stretches from Worcester in the Western Cape to the vicinity of Uitenhage in the Eastern Cape. This area has a much milder climate and higher rainfall figures than the other distribution area. *P. trifidum* is often found on rocky slopes on sandy soil.

Specimens studied

RSA

—**2816** (Oranjemund): Kubus (–BD), *Marloth 12341* (PRE); Waterkloof at Doornpoort (–DB), *Pillans 5476* (BOL).

—**2916** (Port Nolloth): 3 km N. of Port Nolloth (–BD), *Hardy 157* (PRE).

—**2917** (Springbok): Eenriet near Steinkopf (–BD), *Esterhuysen 2904* (BOL).

—**3017** (Hondeklipbaai): 3 km SE of Hondeklipbaai (–AD), *Pillans 17963* (BOL).

—**3221** (Merweville): Prince Albert (–DC), *Bolus 11454* (BOL), *Krige s.n.* (BOL).

—**3319** (Worcester): Osplaas station NE of De Doorns (–BC), *Mauve & Olivier 228* (PRE), *Pillans 14186* (BOL, Z); Karoo Botanical Garden (–CB), *Van der Walt 531* (STEU), *Van der Walt & Vorster 1054* (STEU); Rabiesberg (–DA), *Compton 5738* (BOL).

—**3320** (Montagu): Soutkloof mountains (–BA), *Moffett 797* (STEU); Matjiesfontein (–BA), *Van der Walt 812* (STEU); 32 km W. of Ladismith (–BB), *Leighton 818/52* (BOL); Dobbelaarskloof (–CB), *M.R.L. 6709* (BOL); Bonnievale (–CC), *Pillans 10833* (MO); Between Montagu and Barrydale (–DC), *M.R.L. 517* (BOL).

—**3321** (Ladismith): Seweweekspoort (–AD), *Esterhuysen 24814* (BOL), *M.R.L. 2423* (BOL); 5.5 km W. of Ladismith (–BA), *Marsh 1422* (PRE); Bosluiskloof Pass (–BC), *Acocks 18432* (PRE), *Leistner 244a* (PRE).

—**3322** (Oudtshoorn): Blesberg (–AA), *Esterhuysen 24897* (PRE); Swartberg Pass (–AC), *Bolus 11453* (BOL); N. of Swartberg Pass (–AC), *Van der Walt 1590* (STEU); Farm Frisgewaagd (–AD), *Vlok 1602* (STEU); Meiringspoort (–BC), *Van der Walt 1143* (STEU); Farm Buffelsklip (–BD), *Lavranos & Pehlemann 19821* (STEU); Farm Draaihoek (–CB), *Denyssen s.n.* (STEU); Saffraanpoort (–CC), *Denyssen s.n.* (STEU); Near Moeras River (–CC), *Esterhuysen 19290* (BOL); Farm Doornkraal near De Rust (–DA), *Dahlstrand 2083, 2144, 2175, 3601* (PRE).

—**3323** (Willowmore): Kouga Mountain (–CA), *Esterhuysen 4668* (BOL); Uniondale (–CA), *Paterson 3070* (GRA).

—**3325** (Port Elizabeth): Van der Merwe River, Suurberge (–AD), *Drége s.n.* (MEL); Bloukrans (–CD), *Bolus 443* (BOL).

—**3326** (Grahamstown): Alicedale (–AC), *Cruden 102* (GRA).

—**3424** (Humansdorp): Droogekloof (–BB), *Fourcade 3532* (BOL).

3. *Pelargonium tenuicaule* *Knuth* in Repertorium novarum specierum regni vegetabilis 45: 63 (1938); Van der Walt & Vorster: 139 (1981b). Type: Namibia: 'Ebene östlich vom Kahanstal', *Dinter 8202* (B+, holo.; M; lecto.!, BM!; BOL!; G!; PRE!).

Diagnostic features

Sparsely branched subshrub with small subterranean tubers. Stems spreading and trailing, cylindrical, herbaceous, brittle. Leaves 5-palmatilobate to 5-palmatifid; lamina circular, 30–50 mm in diameter, sparsely hispid with pyriform-headed glandular hairs in between; stipules membranous. Pseudo-umbels 2-

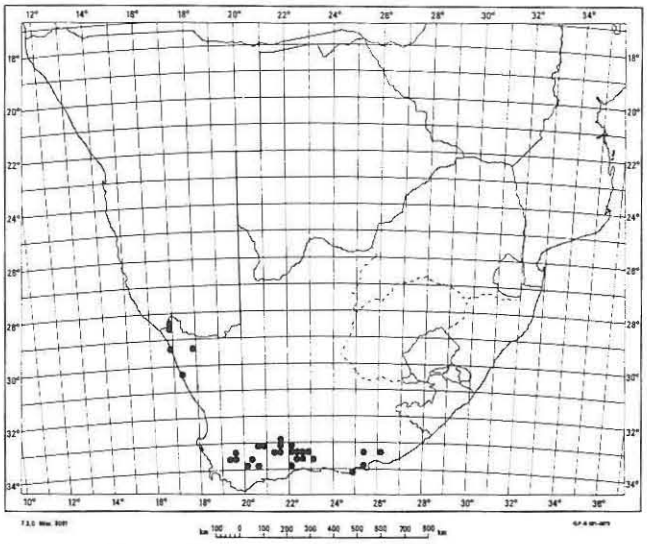

Figure 5 Geographical distribution of *P. trifidum*.

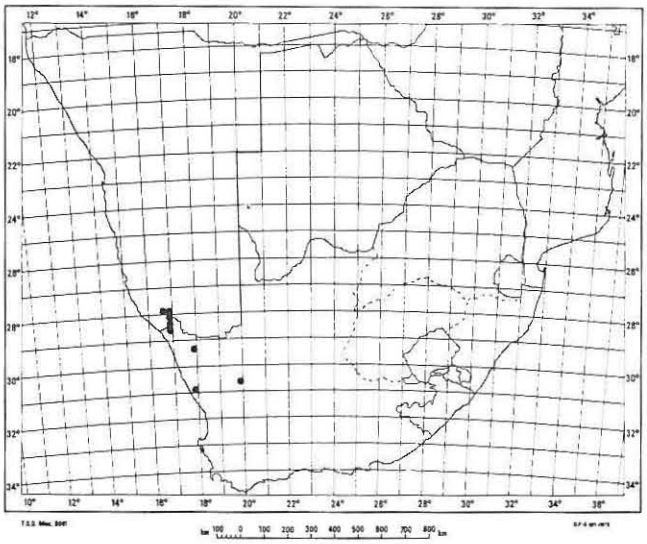

Figure 6 Geographical distribution of *P. tenuicaule*.

flowered. Pedicel (2–4 mm) much shorter than hypanthium (18–20 mm). Petals 5, cream but becoming white; posterior two 17–25 mm × 6–12 mm, with wine-red blotches and feather-like markings; anterior three 19–28 mm × 7–16 mm.

Geographical distribution (Figure 6)

P. tenuicaule occurs in the southern part of Namibia and the Richtersveld but it is also known from three more southern localities in Namaqualand. The distribution area has a low annual rainfall of less than 150 mm during the winter and very high temperatures are experienced during the summer months. *P. tenuicaule* grows on rocky slopes, cliff faces and also on flats among rocks.

Specimens studied

NAMIBIA

—2716 (Witputz): Farm Spitskop (–DC), *Merxmüller & Giess 32289* (WIND), *Van der Walt 1469* (STEU); Farm Namuskluft (–DD), *Lavranos & Pehlemann 19942* (STEU), *Lavranos, Pehlemann & Barad 19222* (STEU); Zebrafontein (–DD), *Müller & Horn 1563* (STEU), *Venter 8910* (BFLU).

—2816 (Oranjemund): Kahanstal (–BB), *Dinter 8202* (BOL, PRE, Z).

RSA

—2816 (Oranjemund): Kodaspieks (–BB), *Van der Westhuizen 131/80* (STE), *Van Jaarsveld & Kritzinger 6223* (NBG), *Venter 8188* (BLFU), Swartpoort (–BB), *Van Jaarsveld 4309a* (NBG); Helskloof (–BD), *Thompson & Le Roux 87* (STE); Farm Olienhout (–DB), *Thompson & Le Roux 376* (STE), Doringpoort (–DB), *Van Zyl 10* (STEU).

—2917 (Springbok): Near Katberg (–BD), *Hall s.n.* (BOL).

—3017 (Hondeklipbaai): E. of Nuwefontein and Kubus (–DD), *Drijfhout 2906* (STEU).

—3019 (Loeriesfontein): Augrabiespoort (–DB), *Bolus 6658* (BOL).

4. *Pelargonium antidysentericum* *(Eckl. & Zeyh.) Kostel.*, Allgemeine Medizinischpharmazeutische Flora 5: 1896 (1836); Scheltema & van der Walt: 291 (1990). Type: Northern Cape: 'ad montem Kamiesberg (Namaqualand)', *Ecklon & Zeyher 542* (S; lecto.!; L!; M!; MO!)

Diagnostic features (Figure 7)

Much-branched shrub with a partly subterranean tuber. Stems vimineous, angular, sulcate or cylindrical, herbaceous but becoming woody with age. Leaves borne in clusters of 3–4 on short branchlets; lamina reniform , 5(– 7)-palmatilobate to 5(–7)-palmatipartite, sparsely hirtellous with many pyriform-headed glandular hairs in between; stipules membranous or recurved persistent spines. Pseudo-umbels 2–5-flowered. Pedicel (5–10 mm) shorter than hypanthium (10–30 mm). Petals 5, light purple to purple or white with dark purple streaks; posterior two 10–20 mm × 5–8 mm; anterior three 10–13 mm × 2–4 mm.

Scheltema and van der Walt (1990) distinguished the following three subspecies: subsp. *antidysentericum* (Figure 7), subsp. *inerme* Scheltema and subsp. *zonale* Scheltema.

Key to the subspecies

1a. Leaves zoned, petals white with streaks, stems decumbent .... **(c) subsp. *zonale***

1b. Leaves not zoned, petals light purple to purple with streaks, stems erect 2

2a. Stipules recurved persistent spines, stems dark brown, angular, style white ..... **(a) subsp. *antidysentericum***

2b. Stipules membranous and not persistent, stems light brown, cylindrical to sulcate, style wine-red ..... **(b) subsp. *inerme***

(a) subsp. *antidysentericum*

Scheltema & van der Walt in South African Journal of Botany 56,3: 291 (1990).

Pelargonium antidysentericum (Eckl. & Zeyh.) Kostel.: 1896 (1836); Harv. 1: 286 (1860); Pappe: 4 (1868); Knuth: 391 (1912); van der Walt & Vorster: 7, t (1981a); Bond & Goldblatt: 304 (1984). Type: as for *P. antidysentericum* (Eckl. & Zeyh.) Kostel: *Jenkinsonia antidysenterica* Eckl. & Zeyh.: 70 (1835).

Geographical distribution (Figure 8)

Subsp. *antidysentericum* has been collected in the southern part of Namibia but its main centre of distribution is in the district of Springbok, Namaqualand. It occurs as far south as the Kamiesberg near Kamieskroon. The entire area is characterized by dry, hot summers and scanty rain during the winter months. Subsp. *antidysentericum* grows in mountainous habitats.

Selected specimens studied

NAMIBIA

—2716 (Witputz): Spitskop *ca.* 10 km N. of Rosh Pinah (–DC), *Van der Walt & Vorster 1269* (STEU).

RSA

—2917 (Springbok): Sannagas (–DC), *Scheltema 10* (STEU).

—2918 (Gamoep): Silwerfontein (–CC), *Scheltema 9* (STEU).

—3017 (Hondeklipbaai): Kamiesberg Pass (–BB), *Van der Walt 559* (STEU).

—3018 (Kamiesberg): Kamiesberg Pass (–AC), *Van der Walt 791* (STEU).

(b) subsp. *inerme* Scheltema

Scheltema & van der Walt in South African Journal of Botany 56, 3: 293 (1990). Type: Northern Cape: 'Botterkloof Pass between Ceres and Calvinia', *Scheltema 1* (PRE, holo.!, K!, STEU!).

Geographical distribution (Figure 8)

Subsp. *inerme* has a more southerly distribution in Namaqualand than subsp. *antidysentericum*. Its habitats are even hotter and drier than those of subsp. *antidysentericum*. It grows on the southern and south-western slopes of mountains and hills.

Specimens studied RSA

—3019 (Loeriesfontein): Loeriesfontein (–CD), *Lavranos 5910* (PRE).

—3119 (Calvinia): 2 km NE of Nieuwoudtville (–AC), *Van Wyk 164* (STEU); Nieuwoudtville Nature Reserve (–AC), *Scheltema 4* (STEU); Rietfontein (–AC), *Scheltema 5* (STEU); Calvinia (–BD), *Schmidt 515* (PRE); Stinkfonteinberg (–CA), *Scheltema 1* (K, PRE, STEW), *Van der Walt 943* (STEU); Bloukrans Pass between Calvinia and Ceres (–DB), *Van der Walt 422* (STEU).

(c) subsp. *zonale* Scheltema

Scheltema & van der Walt in South African Journal of Botany 56, 3: 293 (1990). Type: Northern Cape: 'Besondermeid' near Steinkopf, *Scheltema 11* (PRE, holo.!, K!, STEU!).

Geographical distribution (Figure 8)

Subsp. *zonale* has a very localized distribution and is only known from the area near Steinkopf in the northern part of Namaqualand. It grows on the western and south-western slopes of low hills, amongst ferruginous quartzite in full sunlight.

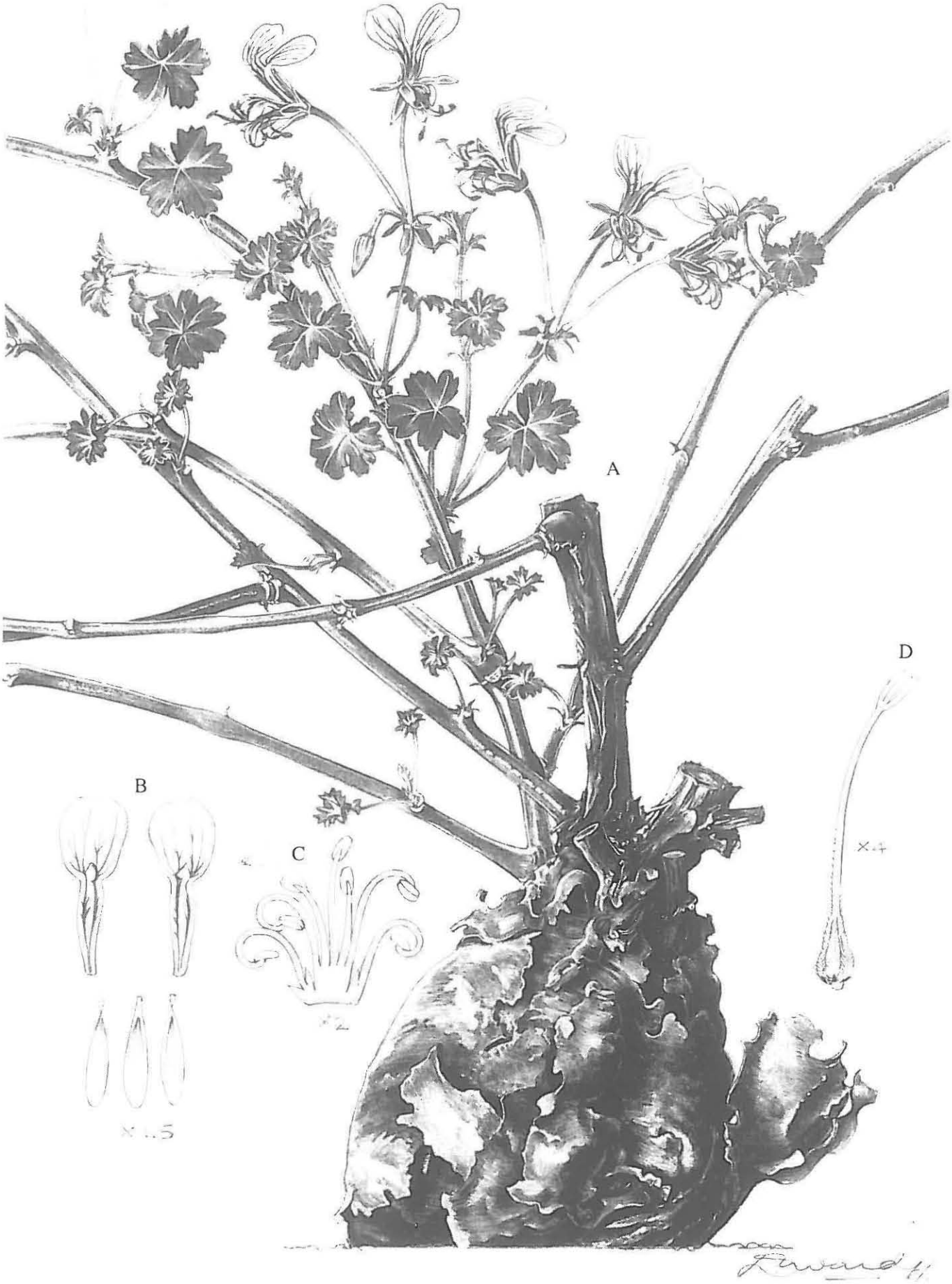

Figure 7 *P. antidysentericum* subsp. *antidysentericum*: A, young plant × 1; B, petals × 1.5; C, androecium × 2; D, gynoecium × 4.

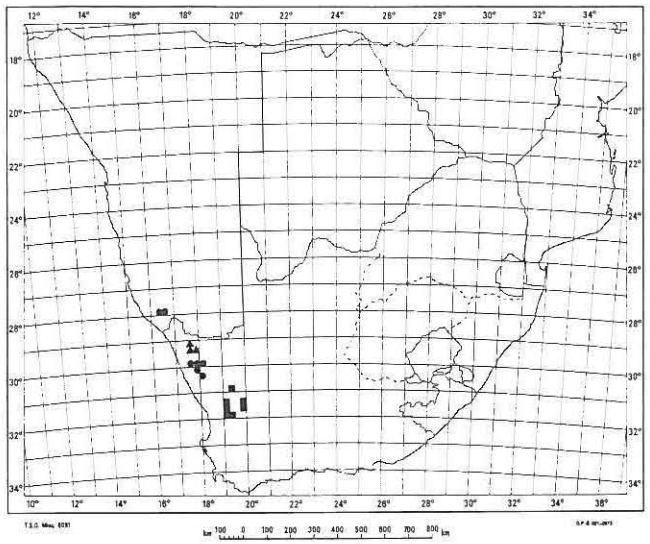

Figure 8 Geographical distribution of *P. antidysentericum* subsp. *antidysentericum* ●, subsp. *inerme* ■ and subsp. *zonale* ▲.

Specimens studied

RSA

—2917 (Springbok): Steinkopf (–BA), *Meyer 12573* (PRE), *Kling s.n.* (GRA); 7 km from Steinkopf to Port Nolloth next to Kosies's turn-off (–BA), *Scheltema 15* (STEU), *Van Jaarsveld 4057* (STEU); Besondermeid, 2 km S. of Steinkopf (–BC), *Drijfhout & Van Jaarsveld 2978* (STEU), *Scheltema 11* (K, PRE, STEU).

5. *Pelargonium tragacanthoides* *Burch.*, Travels in the interior of Southern Africa 2: 98 (1824); Vorster: 65 (1987a); van der Walt & Vorster: 145 (1988). Type: Northern Cape: 'on the Table-mountain in the vicinity of a place dominated by Horse's Grave', *Burchell 2693* (G-DC, lecto.!; K!; LE).

P. ramosissimum auct. mult.; non (Cav.) Willd.: 688 (1800) – based on *Geranium ramosissimum* Cav.: 260 (1787).

Diagnostic features (Figure 9)

Branched, erect, aromatic subshrub. Stems woody and smooth. Leaves pinnate to bipinnate with the pinnae repeatedly divided into linear segments; sparsely sericeous and with pyriform-headed glandular hairs interspersed; lamina narrowly ovate in outline; petiole shorter than lamina. Pseudo-umbels 2–4-flowered. Pedicel shorter than hypanthium. Petals 4, white, pronouncedly unguiculate; posterior two auriculate, claws inrolled to form false tubes, with wine-red markings at base, twice as long as anterior petals. Fertile stamens 7.

Geographical distribution (Figure 10)

P. tragacanthoides has a wide distribution in the Western, Northern and Eastern Cape and it is also known from the south-western part of the Free State. It grows under low rainfall conditions of 200–400 mm per annum. *P. tragacanthoides* usually occurs on hillsides, often on dolorite where it is wedged into crevices, although it has also been reported to grow on sand in the Northern Cape.

Selected specimens studied

RSA

—2822 (Glen Lyon): Langeberg near Hay (–DD), *Acocks 8530* (PRE).

—2917 (Springbok): Near Springbok (–DB), *Hardy & Bayliss 1117* (PRE).

—2925 (Jagersfontein): Fauresmith (–CB), *Henrici 2667* (PRE).

—3024 (De Aar): De Aar (–CA), *Acocks 626* (PRE).

—3026 (Aliwal North): Near Burgersdorp (–CD), *Flanagan 1542* (BOL).

—3119 (Calvinia): Farm Plaatberg (–BD), *Acocks 18607* (PRE).

—3121 (Fraserburg): Walkraal (–AC), *Foley 164* (PRE).

—3123 (Victoria West): Murraysburg (–DD), *Bolus 1784* (BOL).

—3124 (Hanover): Nieu Bethesda (–DC), *Van der Walt 995* (STEU).

—3125 (Steynsburg): Grootfontein (–AC), *Moffett 1018* (STEU).

—3220 (Sutherland): 8 km E. of Sutherland (–BC), *Acocks 14132* (PRE).

—3222 (Beaufort West): Sunnyside near Beaufort West (–BC), *Esterhuysen 2719* (BOL).

—3225 (Somerset East): Mountain Zebra Park (–AB), *Van der Walt 891* (STEU).

—3226 (Fort Beaufort): Schoombie near Tarkastad (–AB), *Mansergh 17529* (BOL).

—3227 (Stutterheim): Hanover (–CD), *Sim 2870* (PRE).

6. *Pelargonium griseum* *Knuth* in Engler, Das Pflanzenreich 4, 129, Vol. 53: 386 (1912); van der Walt & Vorster: 67, t (1981a). Type: Northern Cape: 'Oudeberg bei Graaff Reinet', *Bolus 703* (BOL, lecto!; K!; MEL!; S!); 'Albert Distrikt', *Cooper 682* (BM!; E!; K!; W!; Z!).

Diagnostic features

Much-branched, erect, aromatic subshrub. Stems rather woody and smooth, older stems covered with remains of leaf bases. Leaves pinnate with pinnae irregularly divided into narrow segments, pilose and with pyriform-headed glandular hairs interspersed; lamina cordiform to narrowly cordiform in outline; petiole longer than lamina, persistent for some time. Pseudo-umbels 2–3-flowered. Pedicel shorter than hypanthium. Petals 4, pinkish-purple with darker veins, unguiculate; posterior two auriculate, claws inrolled to form false tubes, slightly longer than anterior petals. Fertile stamens 7.

Geographical distribution (Figure 11)

P. griseum occurs in the Great Karoo in the Eastern Cape. Its distribution range stretches from Beaufort West in a north-easterly direction to Lady Grey. It grows in mountainous habitats receiving an annual rainfall of 200–300 mm, mainly during the summer months.

Specimens studied

RSA

—3026 (Aliwal North): Burgersdorp (–CD), *Thode A475* (PRE).

—3027 (Lady Grey): Lady Grey (–CA), *Gerstner 127* (PRE); Joubert's Pass (–CA),*Werger 1049, 1800* (PRE).

—3124 (Hanover): Compass Berg, Middelburg (–DC), *Esterhuysen 19712* (BOL).

—3125 (Steynsburg): Sneeuberg, Gordonville (–AC), *Acocks 16548* (PRE).

—3126 (Queenstown): Andriesberg (–DA), *Fischer 376* (STEU), *Galpin 6277* (GRA).

—3222 (Beaufort West): S. of Kruiwaskloof, Beaufort West (–BC), *Van Zyl s.n.* (STEU).

—3224 (Graaff Reinet): Sneeuberge, Graaff Reinet (–AA), *Bolus 703* (BOL, K, MEL, S).

7. *Pelargonium dolomiticum* *Knuth ex Engl.* in Sitzungsberichte der Königlich Preussischen Akadademie der Wissenschaften II: 877 (1906), nom. nud.; Knuth in Botanische Jahrbucher 40: 71 (1908); Knuth: 386 (1912); Burtt Davy: 189 (1926); Müller: 143 (1963); Merxmüller & Schreiber: 11 (1966);

van der Walt & Vorster: 55 (1981a); van der Walt & Vorster: 432 (1981b). Type: North-West Province: Ottoshoop, auf der Dolomitsteppe, *Engler 2889* (B, holo+). Free State: Bloemfontein, *Mostert 1661* (PRE, neo.!).

P. juffae Dinter ex Knuth: 401 (1912), nom. nud. in syn.

P. bechuanicum Burtt Davy: 48, 189 (1926). *P. bechuanicum* Burtt Davy var. *latisectum* Burtt Davy: 48,189 (1926); Dyer: t. 780 (1940); Letty: 177, t. 88.3 (1962).

Figure 9 *P. tragacanthoides*: A, flowering branch × 1; B, petals × 2; C, androecium × 2; D, gynoecium × 4.

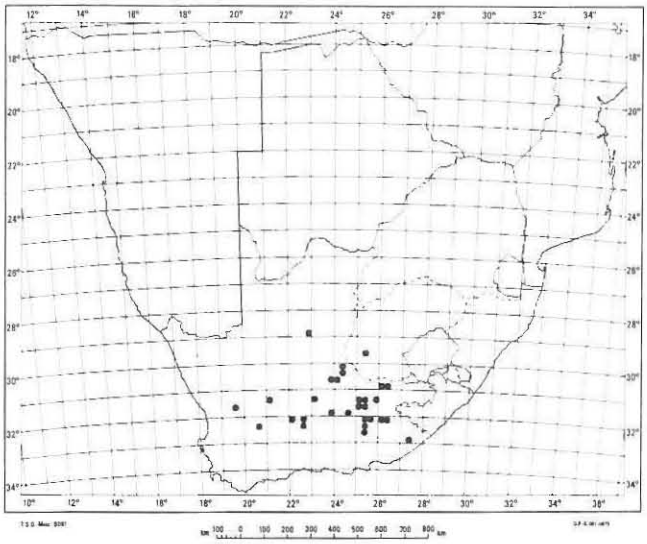

Figure 10 Geographical distribution of *P. tragacanthoides*.

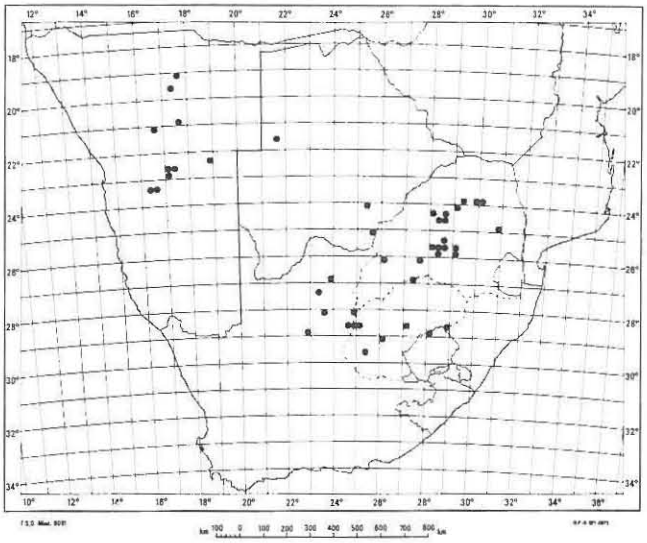

Figure 12 Geographical distribution of *P. dolomiticum*.

Diagnostic features

Much-branched, erect, aromatic subshrub. Stems herbaceous except woody base of main stem, smooth. Leaves pinnate to bipinnate, pinnae irregularly incised into linear or narrowly oblong segments, densely hirtellous with spherical-headed glandular hairs interspersed; lamina ovate to narrowly ovate in outline; petiole much longer than lamina. Pseudo-umbels 3–6-flowered. Pedicel shorter than hypanthium. Petals 4, white or cream-coloured to pink or light purple with red to dark red markings, pronouncedly unguiculate; posterior two auriculate, claws inrolled to form false tubes, twice as long as anterior petals. Fertile stamens 7.

Geographical distribution (Figure 12)

P. dolomiticum is one of the most widely distributed *Pelargonium* species in southern Africa. It occurs in Namibia, the Northern Cape, Free State, Gauteng, North-West Province and Botswana. The greater part of its distribution area receives between 400 and 600 mm of rain during the summer months. *P. dolomiticum* grows on deep, well-drained sandy soil and is often associated with dolomite.

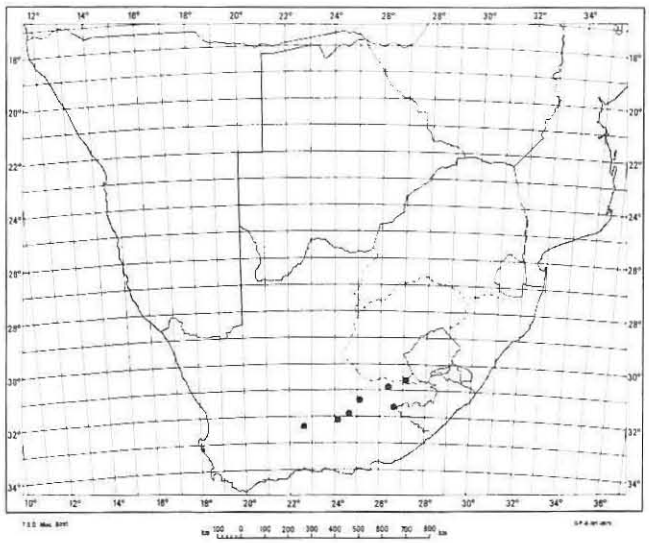

Figure 11 Geographical distribution of *P. griseum*.

Selected specimens studied

BOTSWANA

—**2121** (Ghanzi): Ghanzi (–DA), *Story 5063* (PRE).

—**2425** (Gabarone): Near Ngware (–AB), *Hansen 3192* (SRGH).

NAMIBIA

—**1917** (Tsumeb): Farm Auros (–BA), *Giess 12549* (PRE).

—**2017** (Waterberg): 33 km E. of Vaalwater (–DC), *Codd 965* (PRE).

—**2116** (Okahandja): Farm Omatakoview (–BA), *Meyer 10796* (WIND).

—**2217** (Windhoek): Farm Regenstein (–CA), *Giess 15347* (WIND).

—**2218** (Gobabis): Farm Stormfried (–BD), *Schlieben 10362* (PRE).

—**2316** (Nauchas): Gamsberg (–AD), *Kers 159* (WIND).

RSA

—**2329** (Pietersburg): 9.5 km S. of Pietersburg (–CD), *Codd 10456* (PRE).

—**2330** (Tzaneen): Wolkeberg Pass (–CC), *Moffett 1986* (STEU).

—**2428** (Nylstroom): Sterkrivier Dam (–BC), *Jacobsen 2574* (PRE).

—**2429** (Zebediela): Near Potgietersrus (–AA), *Galpin 8932* (PRE).

—**2430** (Pilgrim's Rest): Between Pilgrim's Rest and Bourke's Luck (–DD), *Van der Walt & Vorster 1340* (STEU).

—**2528** (Pretoria): Roodeplaat (–BC), *Clarke 560* (PRE).

—**2529** (Witbank): Waterfall area near Witbank (–CA), *Repton 1206* (BOL).

—**2623** (Morokweng): Vaalboschfontein (–DD), *Schlechter 4786* (Z).

—**2626** (Klerksdorp): Bakerville (–AA), *Morris & Engelbrecht 1164* (PRE).

—**2627** (Potchefstoom): Koedoesfontein (–CD), *Louw 1673* (PRE).

—**2723** (Kuruman): Kuruman (–AD), *Jordaan CBK5* (PRE).

—**2822** (Glen Lyon): Langberg near Hay (–DD), *Hunter 2* (PRE).

—**2823** (Griekwastad): Danielskuil (–BA), *Esterhuysen 765* (BOL).

—**2824** (Kimberley): Kimberley (–DA), *Moran 13341* (BOL).

—*2825* (Boshof): 48 km SW of Christiana (–CA), *Leistner 1181* (PRE).

—**2827** (Senekal): Willem Pretorius Nature Reserve (–CA), *Leistner 3000* (PRE).

—**2828** (Bethlehem): Witsieshoek (–DB), *Junod 17501* (PRE).

—*2925* (Jagersfontein): Townlands (–CB), *Henrici 2869* (PRE).

—**2926** (Bloemfontein): National Botanical Garden (–AA), *Van der Walt 1170* (STEU).

8. *Pelargonium redactum* *Vorster* in South African Journal of Botany 62, 1: 54 (1996). Type: Namibia: 'Farm Zebrafontein LUS 87', 30 km NE of Rosh Pinah, *Merxmüller & Giess 28793* (WIND, holo.!; PRE, iso.!).

Diagnostic features

Erect to procumbent annual herb with strongly developed tap root. Stems herbaceous. Leaves 2–3-pinnatifid with almost linear segments, green with a silvery sheen, covered with short hairs and glandular hairs interspersed, lamina cordiform in outline; petiole much longer than lamina, persistent. Pseudo-umbels 2–3(–4)-flowered. Pedicel usually longer than hypanthium. Petals 4, dark wine-red; posterior two auriculate, claws inrolled to form false tubes, longer than anterior petals. Fertile stamens 2–3.

Geographical distribution (Figure 13)

This species has a wide distribution in a strip along the west coast of the Northern Cape and southern Namibia, from Vanrhynsdorp in the south to the neighbourhood of Aus in the north. It occurs in desert areas with low, scattered shrublets and grass tufts, usually but not invariably on deep loose sand, with a predilection for open places such as sand washes in dry watercourses. The annual rainfall does not exceed 200 mm on average.

Selected specimens studied

NAMIBIA

—2615 (Luderitz): Tschaukaib, near Haalenberg (–DA), *Wendt s.n.* (WIND).

—2616 (Aus): Aus, 8 km NE of (–CA), *Dinter 8065* (Z); Farm 'Klein Aus' (–CA), *Kinges 2238* (PRE); Farm 'Kubub' near Aus (–CB), *Giess 14676* (PRE, WIND); Aus (–CB), *Giess & Van Vuuren 615* (WIND); Namib flats between Neisip (–BC) and Eureka (–CB), *Merxmüller & Giess 2893* (PRE, WIND); Farm 'Paddaputz', 8 km W. of Aus (–CC), *Van Vuuren s.n. sub STEU 3814* (PRE).

—2716 (Witputz): Udidap Mountain (–BB), *Müller 811* (WIND); N. of Rosh Pinah (–DD), *Giess 14663* (PRE, WIND); Farm 'Zebrafontein, LUS 87' (–DD), *Merxmüller & Giess 28748* (PRE, WIND); *28793* (PRE, WIND).

—2818 (Warmbad): Farm 'Bankwasser, WAR 139' (–CB), *Kotze s.n. sub Giess 10491* (WIND).

RSA

—2917 (Springbok): Steinkopf (–BC), *Schlechter 11499* (BOL); Tkouberg, Springbok (–DC), *Van derSchijff 8116* (PRE).

—2918 (Gamoep): Areb, 43.2 km NE of Springbok (–AC), *Van der Westhuizen 279* (PRE); Farm 'Silwerfontein', Springbok (–CC), *Drége 7481* (P); *Van der Walt 1394* (STEU).

—3017 (Hondeklipbaai): Arakup (–BB); *Schlechter 11252* (PRE).

—3018 (Kamiesberg): Grootklip, Vanrhynsdorp (–DD), *Acocks 19047* (PRE).

9. *Pelargonium senecioides* *L'Hérit.* in Ait., Hortus Kewensis ed. 1, 2: 420 (1789); t. 11 (1792); Willd.: 661 (1800); DC.: 660, n. 125 (1824); Sweet: t. 327 (1826–1828); Harvey: 188 (1860); Knuth: 401 (1912) (p.p.); van der Walt & Vorster 3: 127, t. (1988). Type: 'Cape of Good Hope', *Masson* (not seen). Lectotype: L'Hérit., Geran. t. 11 (1792).

Geranium senecioides (L'Hérit.) Poir.: 749 (1812).

Myrrhidium senecioides (L'Hérit.) Eckl. & Zeyh.: 72, n. 559 (1835). Type: 'Sabulbsis planitiei apud montes Tigerberge inque Zwartland', Ecklon & Zeyher 559 (MO!, SAM!).

Geraniospermum senecioides (L'Hérit.) O.Kuntze.: 95 (1891).

Pelargonium phellandrium E. Mey.: 209 (1843), nom. nud. Type: 'Groenekloof', *Drége 1297* (P!).

Diagnostic features

Erect, annual herb with a normally developed tap root. Stems herbaceous. Leaves 2–3-pinnatifid with almost linear segments, green, covered with short hairs and shorter glandular hairs interspersed, lamina cordiform in outline. Pseudo-umbels 2–4-flowered. Pedicel much shorter than hypanthium. Petals 5, white to creamy-white to pinkish with dark pink-purple reticulation abaxially; all petals more or less equally sized. Fertile stamens 7.

Geographical distribution (Figure 14)

P. senecioides occurs from Wallekraal in the Northern Cape southwards along the coast to the Cape Peninsula in the Western Cape. It grows in a variety of vegetation types, from coastal Fynbos in the extreme south, through Strandveld, to Namaqualand Broken Veld. The rainfall, which varies between 100 and 600 mm, is restricted to the winter months. Throughout this area it occurs on deep sandy soil and it favours open, sunny situations. This species flowers mainly from September to November, seeming to take advantage of the cool and moist winter conditions to complete its life cycle.

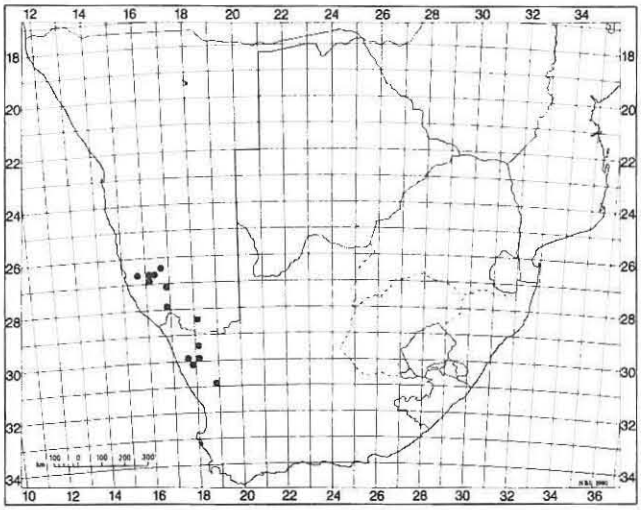

Figure 13 Geographical distribution of *P. redactum*.

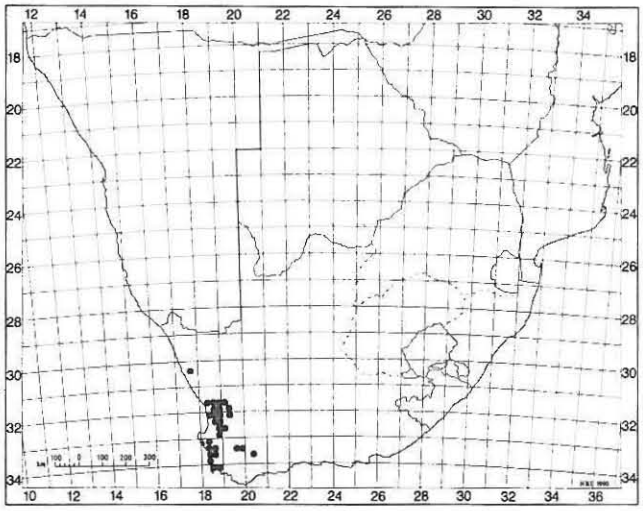

Figure 14 Geographical distribution of *P. senecioides*.

Selected specimens studied

—**3017** (Hondeklipbaai): Wallekraal near Hondeklipbaai (–BC), *Boucher 76* (STEU). 19

—**3118** (Vanrhynsdorp): Farm Liebendal, Vredendal (–CB), *Hall 3851* (NBG); 15 km on Vredendal road to Papendorp (–CB), *Arnold 909* (PRE); Vredendal road (–DA), *Steyn 449* (NBG); W. of Vredendal (–DA) *Wilman 693* (GRA); Farm Widouw, 15 km S. of Vanrhynsdorp (–DB), *Hugo 450* (MO, PRE); Tigerberge in Zwartland (–DB), *Ecklon & Zeyher 559* (MO, BOL); Klawer (–DC), *Andreae 519* (PRE); Nardouw, Clanwilliam (–DC), *Compton 19995* (NBG); Oudshoek Dam, Clanwilliam (–DD), *Hall 846* (NBG).

—**3119** (Calvinia): Lokenburg, Calvinia (–CA), *Acocks 17488* (PRE); Top of Botterkloof (–CD), *Compton 20904* (NBG).

—**3218** (Clanwilliam): Nortier experimental farm (–AB), *Boucher 2608* (PRE); Between Leipoldtville and Elands Bay (–AB/AD), *Zinn s.n.* (SAM); 15 km E. of Lamberts Bay (–BA), *Compton 24145* (NBG); Graaf Water on road to Lamberts Bay (–BA), *Van Breda 1266* (PRE); Clanwilliam campsite (–BB), *Goldblatt 4213* (PRE); Boschkloof (–BB), *Barker 2654* (NBG); 8 km on Clanwilliam road to Kransvlei (–BB), *Gillett 4026* (BOL); NE of Verlorenvlei, at Matjiesgoeddrift (–BC), *Pillans 7996* (BOL); Paleisheuwel (–BC), *Van der Walt 1051* (STEU); Farm Onder-Berg-vlei, Paleisheuwel (–BC), *Van der Walt 1415* (STEU); Foot of Nieuwoudts Pass on road to Algeria (–BD), *Hugo 655* (PRE); Bergvallei, Clanwilliam (–DA), *Zeyher 183* (PRE).

—**3219** (Wuppertal): Bidouw Valley (–AB); *Marais 10* (STEU); Between Citrusdal and Alpha (–CA), *Esterhuysen 22161* (PRE).

—**3318** (Cape Town): Road to Saldanha Bay (–AB), *Bachmann 1541* (Z); Hopefield (–AB), *Bachmann 295* (BOL); Between Langebaan and Yzerfontein (–AC), *Marais 23/Fischer 319* (STEU); Darling Flower Reserve (–AD), *Winkler 170* (NBG); Mamre road, Malmesbury (–BC), *Barker 1146* (NBG); W. base of Kanonberg (–BC), *Pillans 6634* (BOL); Buffelsriver (–CB), *Taylor 4161* (STE); Between Mamre and Darling (–AD/CB), *Salter 1754* (BOL); Farm Groote Poort, Mamre (–CB), *Middlemost 1834* (NBG); Paarden Island (–CD), *Fairall 211* (NBG); Milnerton dunes (–CD), *Compton 163* (NBG); Farm Goeie Hoop, on Darling road to Kalbaskraal (–DA), *Marais 17/Fischer 315* (STEU).

—**3319** (Worcester): Hex River Valley (–BC), *Tyson 727* (BOL); Hex River Valley (–BD), *Boucher 93* (STEU).

—**3320** (Montagu): Nougaspoort (–CA), *Drége s.n.* (P).

—**3418** (Simonstown): Cape Peninsula (–AB/AD), *Salter 8267* (BOL); Fish Hoek (–AB), *Bolus 4876* (BOL); Faure (–BA), *Vorster 2938* (STEU).

10. *Pelargonium plurisectum* *Salter* in Journal of South African Botany 8: 279 (1942); Adamson & Salter: 516 (1950); van der Walt & Vorster: 115 (1981a). Type: Western Cape: 'Appelskraal, between the Zwarteberg and River Zonderende', *Zeyher 2054* (alternative number: *Drége 9460*) (S, lecto.!; G!; P!; TCD!; W!).

P. multifidum Harv.: 282 (1860); Knuth: 384 (1912); non Salisb.: 313 (1796). Type: as for *P. plurisectum*.

Diagnostic features

Much-branched, erect, subshrub. Stems rather woody, older stems covered with remains of leaf bases. Leaves pinnatisect with linear segments, sericeous with sperical-headed glandular hairs interspersed; lamina ovate in outline; petiole longer than lamina, persistent for some time. Pseudo-umbels 1–2-flowered. Pedicel (up to 3 mm) much shorter than hypanthium. Petals 5, light yellowish to flesh-coloured, strongly reflexed, posterior and anterior petals more or less of equal shape and size. Fertile stamens 7.

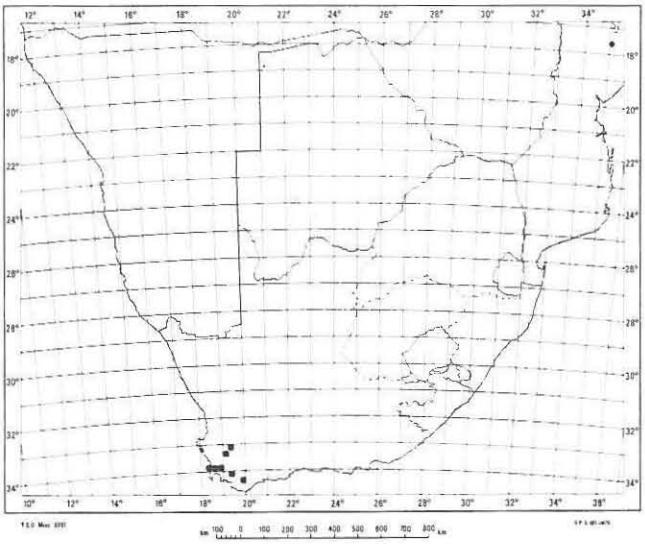

Figure 15 Geographical distribution of *P. plurisectum*.

Geographical distribution (Figure 15)

P. plurisectum is confined to a relatively small distribution area in the Western Cape. It has been collected on the Cape Peninsula and in the districts of Stellenbosch, Tulbagh, Ceres and Caledon. The entire distribution range is in the winter-rainfall area with an annual rainfall of more than 700 mm. The summers are hot and dry. *P. plurisectum* is usually found on clayish soil.

Specimens studied RSA

—**3318** (Cape Town): Lion's Head, Table Mountain (–CD), *Guthrie s.n.* (BOL); Tygerberg Nature Reserve (–DC), *Loubser 3449* (MO); Stellenbosch (–DD), *Duthie s.n.* (BOL), *Vorster 2926* (STEU).

—**3319** (Worcester): Gydo Pass, Ceres (–AB), *Fischer 345* (STEU); Tulbagh Valley (–AC), *Pillans s.n.* (BOL).

—**3419** (Caledon): Caledon (–AB), *Guthrie s.n.* (BOL); 45 km SE of Caledon (–BD), *Fischer 266* (STEU); Between Swartberg and Riviersonderend (–BD), *Zeyher 2054* (P, S).

11. *Pelargonium divisifolium* *Vorster* in South African Journal of Botany 53: 71 (1987b); van der Walt & Vorster: 49 (1988). Type: Western Cape: 'Farm Happy Valley, E. of Greyton', *Vorster 2939* (PRE, holo.!; K!; MO!; NBG!).

P. artemisiaefolium sensu auct.; non DC.: 661 (1824).

Diagnostic features (Figure 16)

Sparsely branched, scandent subshrub. Stems rather woody, smooth. Leaves bipinnate with the pinnae repeatedly divided into linear, semi-terete segments, sparsely hirtellous to glabrous and eglandular; lamina ovate in outline; petiole usually more or less the same length as the lamina. Pseudo-umbels 2–5-flowered. Pedicel more or less the same length as the hypanthium. Petals 5, pink or occasionally white; posterior two with wine-red markings, slightly longer but much wider than anterior petals. Fertile stamens 5.

Geographical distribution (Figure 17)

P. divisifolium has a limited distribution range in the Western Cape. It is only known from mountains near the village of Worcester and the Riviersonderend mountains. This is a winter-rainfall area and the precipitation is in excess of 800 mm per year. *P. divisifolium* occurs on the lower slopes of the mountains as a component of Fynbos on sandstone-derived soil.

Specimens studied

RSA

—3319 (Worcester): Near Worcester (–CB), *Cooper 1720* (MEL); Kanonberg near Greyton (DC), *Rycroff 3179* (PRE); McGregor (–DD), *Drijfhout 2692* (STEU), *Van der Walt 1570* (STEU).

—3419 (Caledon): Appelskraal near Riviersonderend (–AB), *Zeyher 2066* (MEL, PRE, SAM, Z); Genadendal (–BA), *Bolus 617* (BOL), *6926* (BOL, NH, PRE), *Pappe s.n.* (MEL), *Schlechter 9862* (BOL,

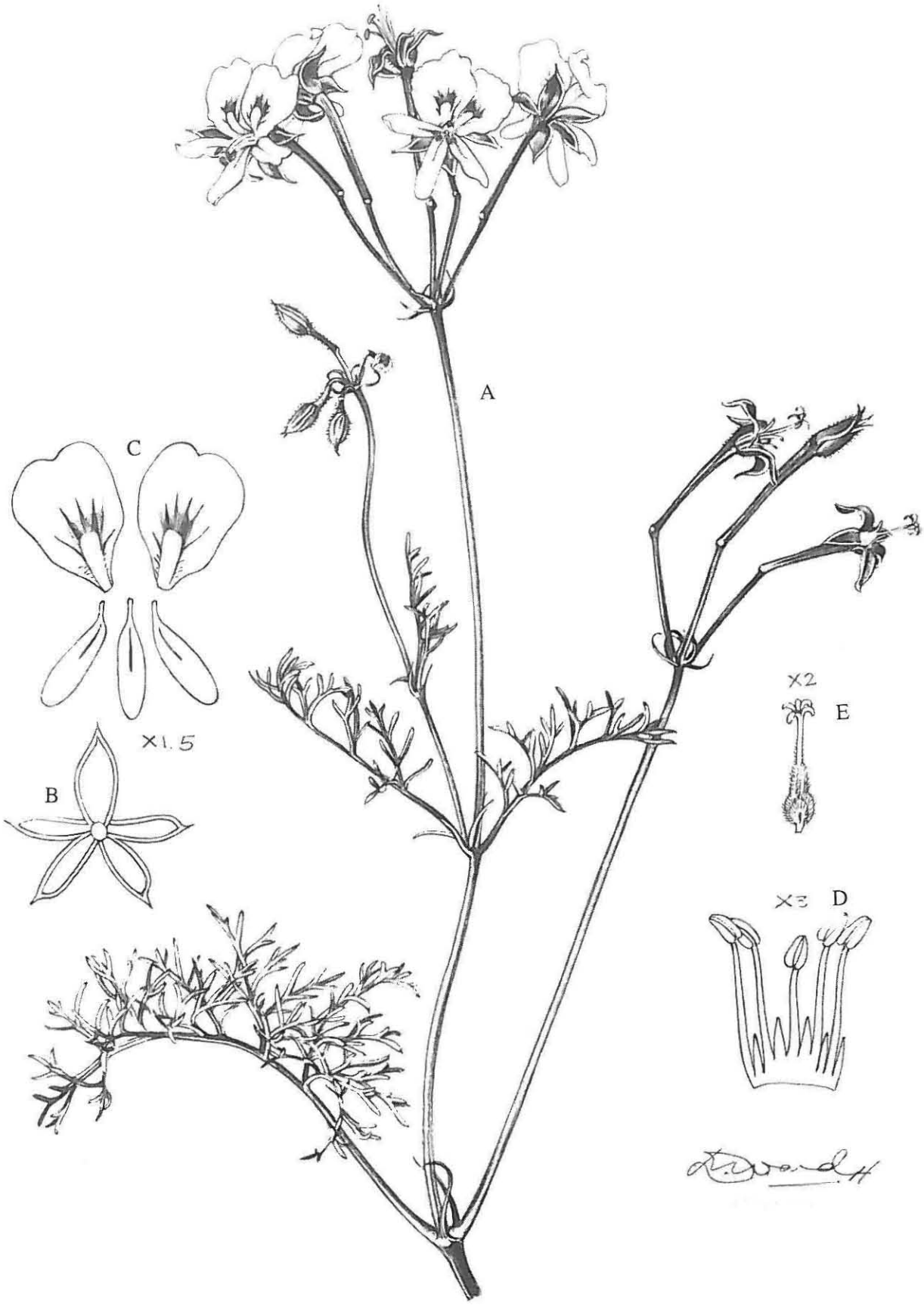

Figure 16 *P. divisifolium*: A, flowering branch × 1; B, sepals × 1.5; C, petals × 1.5; D, androecium × 3; E, gynoecium × 3.

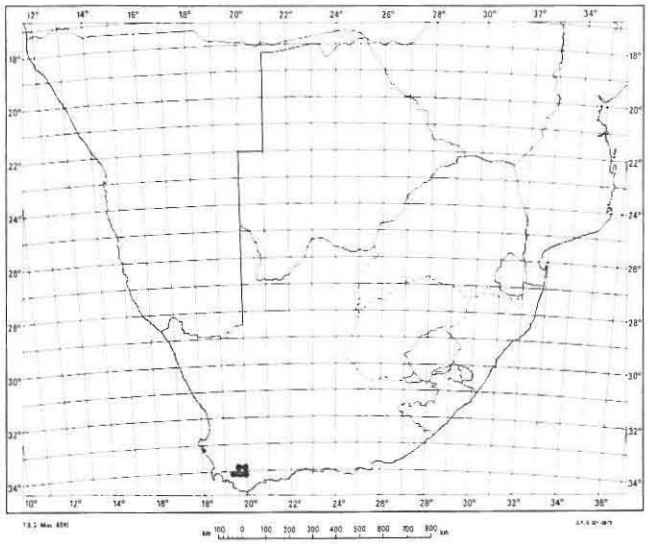

Figure 17 Geographical distribution of *P. divisifolium*.

E, MO, PRE, Z); Farm Happy Valley near Greyton (–BA), *Esterhuysen 20760* (BOL, MO), *Vorster 2939* (STEU); Riviersonderend (–BB), *Esterhuysen 25076* (BOL, PRE), *Stokoe 7399* (BOL), *Van der Walt 1107* (STEU).

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