

**TAXONOMIC STUDIES IN *PELARGONIUM*,
SECTION *HOAREA* (GERANIACEAE)**

by

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Declaration

I, the undersigned, hereby declare that the work contained in this dissertation is my own original work and has not previously in its entirety or in part been submitted at any university for a degree

Signature

Date

We must never conceal from ourselves that our concepts are creations of the human mind which we impose on the facts of nature, that they are derived from incomplete knowledge, and therefore will never exactly fit the facts, and will require constant revision as knowledge increases.

A.G. Tansley (1920)

ABSTRACT

Fifty nine species were studied in this taxonomic treatment of section *Hoarea* (Sweet) DC. of the genus *Pelargonium* L'Hérit., which was last revised by Knuth in 1912. The majority of species occur in the winter rainfall area of the south-western Cape, but some species occur in the eastern Cape, a region of winter and summer rainfall. A few species also occur in the summer rainfall area in the central Karoo.

Morphological, leaf anatomical, palynological and geographical data were studied in order to delimit the taxa and to determine their relationships. Eight new species were described and several name changes were made. Diagnostic features of the section are the regularly or turnip-shaped tubers with numerous dark brown peeling tunics or periderms and apically a short flattened stem from which the leaves and scape emerge. The zygomorphic flowers are almost sessile, because the pedicels are very short (0,5--1 mm) and the hypanthia long (6--100 mm). A large variation occurs in leaf form and floral structure, and the section is divided in 14 different floral groups, mainly based on the structure of the androecium and the tectum of the pollen grains, although petal form and size are also considered in clustering the species.

Section *Hoarea* with its deciduous geophytes and sometimes extremely zygomorphic flowers, exhibits advanced morphological characters. Because of the large variation in the structure of the androecium, pollination biology was probably one of the major driving forces in the evolution of the section, and the annual rainfall plays an important role in the distribution patterns of the different species.

UITTREKSEL

Neën en vyftig spesies is bestudeer in hierdie taksonomiese ondersoek van seksie *Hoarea* (Sweet) DC. van die genus *Pelargonium* L'Hérit., wat laas deur Knuth (1912) hersien is. Die meerderheid van die spesies kom in die winterreënstreek van die suidwes Kaap voor, maar sommige spesies word ook in die Oos-Kaap, wat 'n winter- en somerreënstreek is, aangetref. Enkele spesies kom in die somerreënstreek van die sentrale Karoo voor.

Morfologiese, blaaranatomiese, palinologiese en geografiese data is bestudeer om die verskillende taksons af te baken, en terselfdertyd verwantskappe tussen die onderskeie spesies te bepaal. Agt nuwe spesies is beskryf en verskeie naamsveranderinge is gemaak. Diagnostiese kenmerke van die seksie is die reëlmatig gevormde of raapvormige wortelknol met verskeie afskilferende donkerbruin periderms en apikaal 'n verkorte stingel waaruit blare en 'n bloeispil groei. Die sigomorfe blomme is byna sittend, aangesien die blomstele uiters kort is (0,5--1 mm) en die hipantiums relatief lank (6--100 mm). 'n Groot variasie in blaarvorm en blomstruktuur kom voor, en die seksie word in 14 verskillende blomvorms verdeel. Hierdie blomvorms is hoofsaaklik gebaseer op die struktuur van die andresium en tektum van die stuifmeelkorrels, alhoewel kroonblaarvorm en -grootte ook 'n rol gespeel het in die onderverdeling van die seksie.

Seksie *Hoarea* met sy bladwisselende geofiete en soms uiters sigomorfe blomme, vertoon gevorderde morfologiese kenmerke. Die groot variasie in die struktuur van die andresium dui op 'n moontlike prominente rol wat die bestuiwingsbiologie gespeel het in die evolusie van die seksie, en die jaarlikse reënval speel 'n belangrike rol in die verspreidingspatrone van die verskillende spesies.

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CHAPTER 1

INTRODUCTION

Section *Hoarea* (Sweet) DC. is the largest section of the genus *Pelargonium* L'Hérit. comprising more than 70 species. It consists of deciduous geophytes with regularly shaped tubers with dark brown peeling tunics or periderms, and apically a dense crown of petiole remains. The tuber is a root with apically a short flattened stem from which the leaves and scape emerge (Marais 1989a). Although the flowers of the majority of species in this section are rather small and dull-coloured, the large number of flowers per plant causes many of them being a spectacular sight when in flower. A small number of species does have large, bright-coloured and very attractive flowers. Unfortunately, because of the geophytic habit, these plants have a limited horticultural potential. They flower once a year, for a relatively short period, after which the leaves and scapes die away.

Sweet (1820) accommodated all *Pelargonium* species with turnip-shaped tubers, five petals and recurved sepals in the genus *Hoarea*. The name commemorates Sir Richard C. Hoare who probably had the largest collection of Geraniaceae in England at the time of Sweet's publication. Sweet was also obliged to him for many useful observations on the Geraniaceae. Sweet (1820) accommodated a second group of species with turnip-shaped tubers in the genus *Dimacria*, in allusion to the two anterior fertile stamens being twice the length of the rest (Don 1831). This genus was distinguished from *Hoarea* by the erect sepals and the incurved staminodes. Another genus with the same habit but with four perfect stamens only, the monotypic genus *Grenvillea*, was also described by Sweet (1825). Harvey (1860) included both *Dimacria* and *Grenvillea* in the section *Hoarea*. Yet another genus with turnip-shaped tubers and flowers with only two petals was described by Sweet (1824) as *Seymouria*, named in honour of Lady Seymour. This genus was transferred to sectional rank by Harvey (1860).

In the last revision of *Pelargonium*, published in 1912, Knuth divided the genus into 15 sections. In this he followed Harvey's (1860) revision in *Flora Capensis*. Both of them regarded the species with the more or less turnip-shaped tubers as belonging to two different sections, based on the number of petals present. Section *Hoarea* represents species with four- or five-petalled flowers (Sweet's genera *Hoarea*, *Dimacria* and *Grenvillea*), whereas section *Seymouria* consists of species with two-petalled flowers. Because of the similarities in growth form of these two sections as well as the similarities in the floral structure of all the species in section *Seymouria* and that of some species of

section *Hoarea* (*P. auritum* (L.) Willd., *P. bubonifolium* (Andr.) Pers. and *P. parvipetalum* E.M. Marais), these two sections are best regarded as one, namely section *Hoarea* (Marais 1989a).

Two species of the present section *Hoarea*, namely *Geranium pinnatum* L. and *G. auritum* L. were already published in Linnaeus's *Species Plantarum* in 1753. Following this publication, several more species were described by different authors. Sweet (1820), by describing the genus *Hoarea*, was the first to accommodate all the species with turnip-shaped tubers in a taxonomic unit of its own. De Candolle (1824) regarded this genus as a section of *Pelargonium*, a point of view followed by Harvey (1860) and Knuth (1912). Although section *Hoarea* does not represent the only tuberous species in *Pelargonium*, the subterranean flaking tuber with the short flattened stem, from which leaves and a scape emerge is distinctive for *Hoarea* and is unique for *Pelargonium*. As far as the floral structure is concerned, *Hoarea* shows little relationship with the rest of the genus (Marais 1981) and can be regarded as a natural taxon within the genus *Pelargonium*.

In respect to leaf form, Knuth (1912) divided section *Hoarea* into three subsections:

- Integra*: Leaves entire, and leaves entire and laciniate.
- Trilobata*: Leaves trilobate and tripartite.
- Pinnatifida*: Leaves pinnatifid.

Because of the variation in leaf incision within one species and because of the heteroblastic leaf development occurring in many species, this subdivision of the section is unacceptable to me. It is also generally accepted that vegetative characters are often regarded as unreliable evidence, because in many cases superficially similar morphological features are found in quite unrelated plants (Stace 1980). Stuessy (1990) regarded vegetative features to be more plastic and variable because of their numerous functions, and therefore more difficult to be used for taxonomic purposes. On the other hand it is well known that floral characters have been, and still are, those most used in the classification of flowering plants (Stace 1980). Therefore, in this taxonomic treatment of section *Hoarea* the emphasis was shifted to the floral features and especially to that of the androecium and the petals.

Knuth (1912) described a number of new species with outstanding diagnostic characters, but unfortunately he did not mention these characters in his descriptions, for example the very long staminodes of *P. fumariifolium* Knuth. Knuth never visited South Africa and studied only herbarium specimens. Knuth (1912) as well as Harvey (1860) inadvertently described new species which had been previously described by other taxonomists. The

problem in both cases was that herbarium specimens are difficult to relate to illustrations without detailed descriptions. I am convinced that for the taxonomic revision of this section, studying and collecting plants in their natural habitat and cultivating them in the garden is a necessity. Another advantage in my study of these plants, was the availability of the superb drawings of Ellaphie Ward-Hilhorst, without which this study would have been almost impossible.

Problems that complicated this study were the large number of species, the poor herbarium specimens, including poor type specimens, specimens without leaves or without flowers, in some cases the small number of specimens per species available, and also the small populations in which some of the species occur. This resulted in a very complicated nomenclature for this section.

The aim of this study was the taxonomic revision of section *Hoarea*, which, in the first place was the delimitation of the different species. Because of the large number of species in the section, a second aim and one which I regard as very important, was the subdivision of the section into smaller taxonomic units. To achieve this, macromorphological, anatomical and palynological characters were studied. Living plants were studied in their natural environment as well as in the Botanic Garden. This was supplemented by the study of a large number of herbarium specimens. Karyological studies are currently undertaken by Prof. F. Albers and co-workers at the Westfälische Wilhelms-Universität, Münster, and Dr M. Gibby at the Natural History Museum, London, and are not included here.

Because of the large number of species in this section, only taxa of which living material was available, were included. Poorly known species and species of which no living material could be found, were excluded from the study and listed in chapter 8 of this thesis. For some of these species no type specimens could be traced, for others the type specimens are so poor that the species concept is very difficult to define. A number of herbarium specimens, which could not be identified and which might be undescribed species, do exist, but were not included in this study. Of the living plant material which could not be matched with any described species, eight new species were described. Because of the exclusion of several species of this section, and without the results of the karyological studies, this revision should rather be regarded as an attempt to bring about a framework for the subdivision of the section. This will simplify the study of the unidentified specimens and also those species of which the species concept is difficult to define. With karyological and chemotaxonomical data known, the subdivision of the section should be finalized, and subsections should be demarcated with more confidence.

CHAPTER 2

MATERIAL AND METHODS

This revision is based on macromorphological, leaf anatomical and palynological data as well as the distribution patterns of the different species.

An extensive literature study was undertaken. All available literature since 1753 on the Geraniaceae and on the Cape Flora were searched for names and with the help of a computer and the PC-File⁺ database programme these data were sorted. The following fields were used: species name, author, date of publication, publication, basionym, taxon, type, type locality, herbarium (type specimen). This enabled me to extract all the names for a specific taxon. At the same time the oldest basionym could be determined. For four names no type material could be traced, and for several others the type specimens or the iconotypes were so poor that the interpretation of them are almost impossible. A list of these insufficiently known species is included in chapter 8. Fifty nine species, of which one is subdivided into two varieties, are included in this study. Type specimens or iconotypes for all species included and for all synonyms recognized, were studied. Lectotypes were designated where necessary. Living material of all the included taxa were available and were illustrated by Ellaphie Ward-Hilhorst.

Extensive field work was done to study plants in their natural environment. Plants were collected in the field and cultivated in the garden. Most of the species of section *Hoarea* flower in summer after the leaves have been shed, therefore herbarium specimens without leaves or without flowers are quite common. This results in incomplete herbarium specimens and in several cases very poor type specimens. Another factor contributing to the poor herbarium record is the fact that species of this section usually occur in very small populations. For this project proper specimens were prepared from cultivated plants in the garden. Leaves and flowers were collected at different stages.

Herbarium specimens were studied at, or obtained on loan, from the following herbaria (abbreviations are from Holmgren and Keuken 1974):

B	Botanic Garden & Botanic Museum, Berlin Dahlem, Berlin.
BLFU	Geo. Potts herbarium, University of the Orange Free State, Bloemfontein.
BM	The Natural History Museum, London.
BOL	Bolus Herbarium, University of Cape Town, Cape Town.
BOL-FOURCADE	Fourcade Herbarium, University of Cape Town, Cape Town.

CGE	Herbarium, Botany School, University of Cambridge, Cambridge.
E	Herbarium, Royal Botanic Garden, Edinburgh.
G	Conservatoire and Botanic Garden, Genève.
G-BURM	Burman Herbarium, Conservatoire and Botanic Garden, Genève.
G-DC	De Candolle Herbarium, Conservatoire and Botanic Garden, Genève.
GRA	Herbarium, Albany Museum, Grahamstown.
K	Royal Botanic Gardens, Kew.
KMG	Herbarium, Alexander McGregor Museum, Kimberley.
L	Rijksherbarium, Leiden.
LINN	Herbarium, Linnean Society, London.
M	Herbarium, Botanische Staatssammlung, München.
MA	Herbarium, Botanic Garden, Madrid.
MEL	National Herbarium of Victoria, Royal Botanic Garden, Melbourne.
MO	Herbarium of Missouri Botanic Garden, Saint Louis.
NBG	Compton Herbarium, National Botanical Institute, Cape Town.
NH	Natal Herbarium, National Botanical Institute, Durban.
OXF	Fielding-Druce Herbarium, Department of Botany, Oxford University, Oxford.
P	Herbarium, Museum of Natural History, Paris.
P-JU	Jussieu Herbarium, Museum of Natural History, Paris.
P-LA	Lamarck Herbarium, Museum of Natural History, Paris.
PRE	National Herbarium, National Botanical Institute, Pretoria.
S	Herbarium, Swedish Museum of Natural History, Stockholm.
SAM	South African Museum Herbarium, National Botanical Institute, Cape Town.
SRGH	Government Herbarium, Harare, Zimbabwe.
STE	Herbarium, National Botanical Institute, Stellenbosch.
STEU	Herbarium, Department of Botany, University of Stellenbosch, Stellenbosch.
TCD	Herbarium, Trinity College, Dublin.
UPS	Herbarium, Institute of Systematic Botany, University of Uppsala, Uppsala.
W	Natural History Museum, Vienna.
WIND	Government Herbarium, Windhoek.
WU	Botanical Institute and Botanical Garden, University of Vienna, Vienna.
Z	Botanic Garden and Institute for Systematic Botany, University of Zürich, Zürich.

Macromorphology

Living specimens, collected in the field or as in most cases grown in the garden for at least one season, as well as herbarium specimens were studied for macromorphological data. Depending on the availability of the material, between five and ten herbarium

specimens for every taxon were studied in detail and measurements were taken. The descriptive terminology used in this study was based on that given by Radford *et al.* (1974).

Leaf anatomy

Leaf anatomical studies were performed on fresh material from plants growing in the garden for more than one season. This ensured that all the material studied was from plants growing for a considerable time under similar conditions. For the majority of species three or more specimens were studied (Table 4.7). This, however was not possible for all species and for *P. chelidonium* (Houtt.) DC., *P. proliferum* (Burm. f.) Steud., *P. caledonicum* L. Bol., *P. attenuatum* Harv. and *P. campestre* (Eckl. & Zeyh.) Steud. no living specimens were available at the time the anatomical study was undertaken.

Transverse sections of wax-embedded petioles and laminae were cut with a rotary microtome and stained with Alcian Green Safranin (Joel 1983). Sections were made through the middle part of the petiole and the laminae, or in the case of compound leaves the middle part of the pinnae.

Pollen morphology

Pollen grains of all the species were studied. For the majority of the species pollen grains were freshly collected in the garden, but in some cases also taken from herbarium specimens (Table 5.3). All pollen specimens were prepared using the acetolysis method (Radford *et al.* 1974) and studied with the light microscope after mounted in glycerine jelly, and with a JEOL JSM-35 scanning electron microscope, after sputter-coated with palladium. At least twenty-five pollen grains of each specimen were studied and measured.

Geographical distribution and ecology

The data on the geographical distribution of all herbarium specimens cited, were computerized, using the PC-File⁺ database programme. Geographical distribution of every specimen was cited according to the grid reference method proposed by Leistner & Morris (1976). A distribution map for every taxon was compiled from these data. Data on soil type and vegetation preferences as well as the flowering time were also obtained

from the herbarium sheets. Rainfall figures for the different species were compiled by comparing distribution maps the with rainfall maps of Jackson (1961).

Taxonomy

The taxonomic treatment has been arranged according to the guide for contributors to the *South African Journal of Botany*. This includes the format for references to the literature and the specimens cited.

Cytological studies

Cytological studies are currently undertaken by Prof. F. Albers and co-workers at the Westfälische Wilhelms-Universität, Münster, and Dr M. Gibby at the Natural History Museum, London, and are not included here.

CHAPTER 3

MACROMORPHOLOGY

As stated by Stuessy (1990) morphology or the external form of an organism, has been and still is the type of data used most in plant classification. Morphological features have the advantage of being easily seen, and hence their variability has been much more appreciated than for other kinds of features. It is generally accepted that the floral features play an important role in angiosperm taxonomy, but vegetative characters can often be used to good effect. According to Stuessy (1990), vegetative characters are repeating units of structure without fixed numbers of parts, in contrast to floral features which are more definite in number. This he ascribed to the narrow but obvious important role of floral features in reproduction. He regarded the features of the vegetative organs to be more plastic and/or variable because of the numerous functions, and hence more difficult to use for taxonomic purposes. Nevertheless in section *Hoarea* leaves do reveal variation which can be useful in the taxonomic treatment of the section.

Tuber

According to Jones & Luchsinger (1987) growth habit of plants may be of primary usefulness in classification and vegetative underground structures such as rhizomes, corms, and bulbs may sometimes characterize a group. Both these statements are true in the case of section *Hoarea*, since the section is demarcated as deciduous geophytes with more or less regularly shaped tubers. If compared with other sections of *Pelargonium* with tuberous species, plants of this section have turnip-shaped or elongated tubers, with dark brown peeling tunics or periderms. The tuber is a root with apically a short flattened stem from which the leaves and a scape emerge. Sometimes the tap-root or lateral roots form series of underground tubers. The size of the main tuber varies from 10--150 mm in length and from 10--150 mm in diameter. In young plants the tuber usually produces only one scape, whereas older plants are inclined to produce two or even more scapes. In *P. appendiculatum* (L. f.) Willd. numerous stem divisions are very prominent. This extensive branching is probably stimulated by grazing of sheep and antelope, forming clumps up to half a meter in diameter. The annual increments, terminated by leaves, are clearly distinguishable on these branches. To a lesser extent this same type of stem divisions occurs in *P. triphyllum* Jacq. In older plants of *P. fasciculaceum* E.M. Marais extensive branching of the fleshy roots and the formation of numerous stem-growing points, result in large colonies of these plants (Marais 1991). Colony formation, however, is not typical for section *Hoarea*. Although the morphology

of the tuber is a distinctive character by which the section is demarcated from the rest of the genus, the morphology of the tuber is of little or no taxonomic value within the section itself.

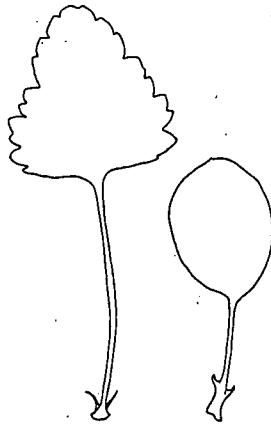
Leaves

In some taxa vegetative features are of little taxonomic value, but in species with similar flower or fruit structures, leaf shape can be an important taxonomic feature (Jones & Luchsinger 1987). In *Hoarea* the leaf shape could be important for identification purposes in species with similar floral structures. It is useful to distinguish between *P. ellaphieae* E.M. Marais and *P. asarifolium* (Sweet) Loudon, *P. heterophyllum* Jacq. and *P. trifoliolatum* (Eckl. & Zeyh.) E.M. Marais, and *P. carneum* Jacq. and *P. radiatum* (Andr.) Pers. (Figure 3.1). The problem however, is that leaves of most *Hoarea* species may wither and die before flowering, and are often lacking on specimens with flowers and fruits. A second problem concerning leaf form is the variation in leaf incision within one species, and a third problem is the heteroblastic leaf development that occurs in many species. According to Gould (1993) different hypotheses have been developed to explain leaf heteroblasty among New Zealand's flora, of which the possibility that juvenile forms are adaptations, evolved in response to browsing by animals, could be applied to species of *Hoarea*, since these plants are heavily grazed. A second hypothesis that heteroblastic species have arisen from interspecific hybridization of ancestral homoblastic species could also be true for section *Hoarea*, because in all groups hybridization remains always a possibility. Nevertheless, heteroblasty causes difficulties in demarcating species as was found in the highly variable species *Begonia dregei* Otto & Dietr. (McLellan 1990). The first taxonomist recognized numerous different species in respect to the degree of leaf incision, while the second taxonomist placed all these names in synonymy (McLellan 1990). In the study of section *Hoarea* a more conservative way regarding heteroblasty was followed; lumping rather than splitting species as in *P. longifolium* (Burm. f.) Jacq., *P. dipetalum* L'Hérit. and *P. proliferum*. Leaf size in section *Hoarea* is also of little taxonomic value since in species with prostrate leaves the older leaves are larger with longer petioles than the younger ones, forming a rosette. This complicates identification of species on leaf characters alone. Despite these problems there is somehow a pattern in leaf form and leaf incision (Figure 3.1) that can be useful to distinguish between species with similar floral structures. Twelve basic patterns for the leaf shape are recognized, and due to differences in texture of the laminae and the orientation or the length of the petioles these groups are subdivided. In Figure 3.1 species with similar leaf structures are grouped together.

Figure 3.1 Species of section *Hoarea* arranged according to leaf form.

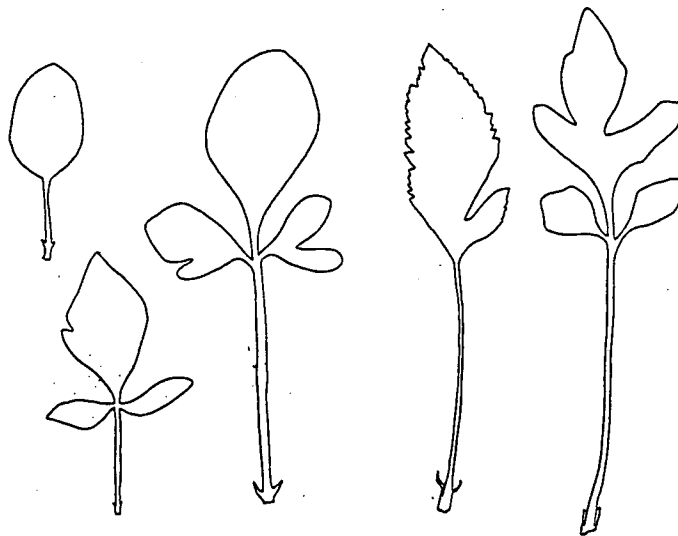
1. Simple, cordiform, prostrate

- P. punctatum*
- P. triandrum*
- P. curviandrum*
- P. oblongatum*
- P. githagineum*
- P. asarifolium*



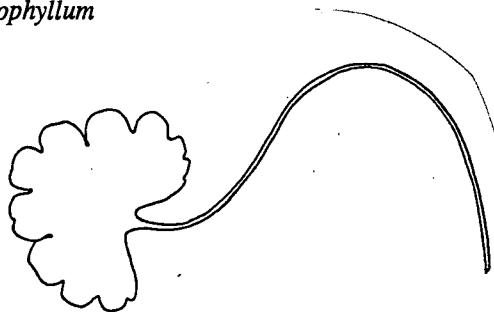
2. Simple (ovate to cordiform) to tripartite or trifoliolate, prostrate

- P. heterophyllum*
- P. tenellum*
- P. chelidonium*
- P. moniliforme*
- P. vinaceum*
- P. nervifolium*
- P. triphyllum*
- P. campestre*
- P. aestivale*
- P. grenvilleae*
- P. radiatum*
- P. nummulifolium*



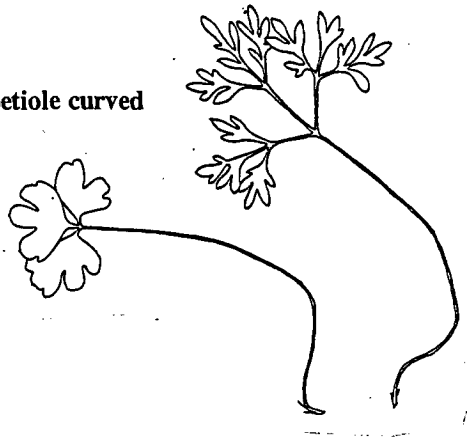
3. Simple (palmately veined), reniform, petiole curved

- P. nephrophyllum*



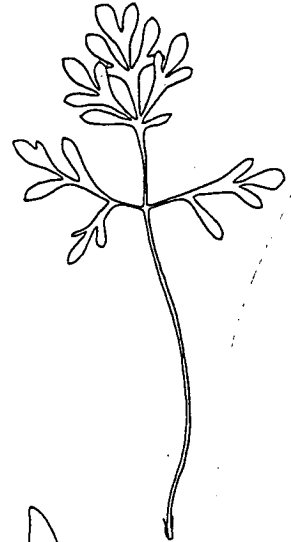
4. **Palmately compound, ternate to tripinnatisect, petiole curved**

P. ternifolium
P. reflexum
P. fergusoniae



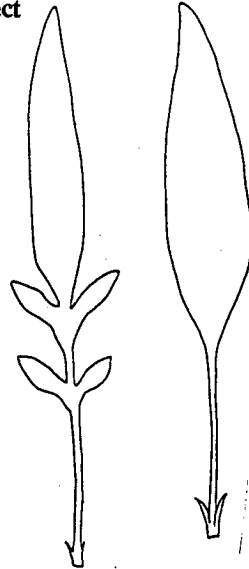
5. **Palmately compound, ternate to tripinnatisect, petiole erect**

P. luteolum
P. gracillimum
P. attenuatum
P. angustipetalum



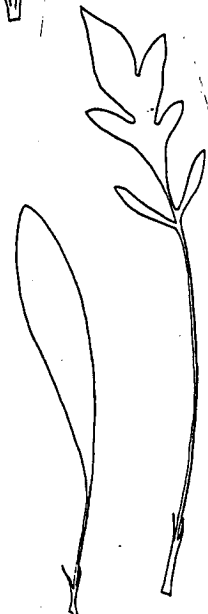
6. **Simple to tripartite or trifoliolate, lanceolate, petiole erect**

P. longiflorum
P. radicans
P. ellaphieae



7. **Simple to pinnatisect or pinnately compound, lanceolate, petiole erect**

P. pilosellifolium



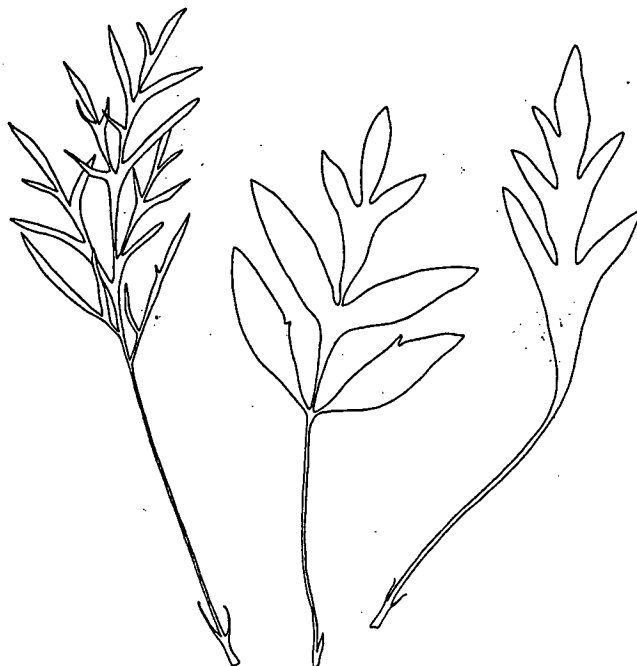
8. **Simple or pinnately compound to irregularly bipinnatisect, lanceolate to ovate, petiole erect**
P. longifolium
P. proliferum
P. dipetalum



9. **Pinnately compound, erect, pinnate**
P. pinnatum
P. viciifolium
P. trifoliolatum



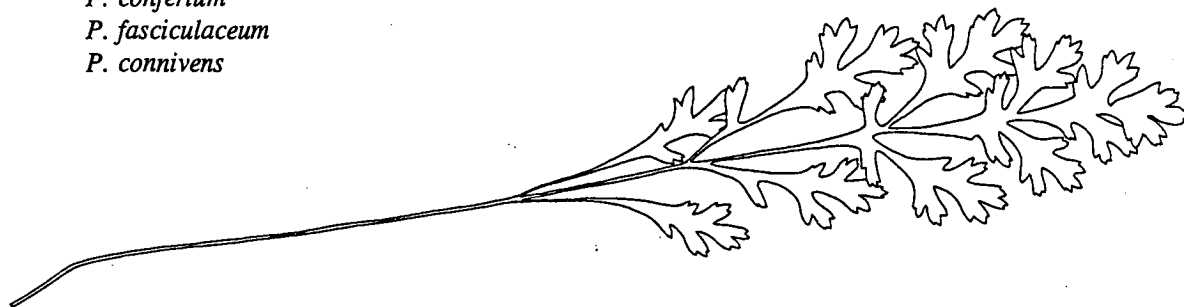
10. **Pinnately compound, erect, pinnatisect to pinnate, trullate or elliptic**
P. violiflorum
P. leptum
P. undulatum
P. fumariifolium
P. leipoldtii



11. Pinnately compound, erect, pinnate to irregularly bi- or tripinnatisect

*P. auritum**P. incrassatum**P. fissifolium**P. petroselinifolium**P. aristatum**P. luteum**P. carneum**P. bubonifolium**P. parvipetalum**P. appendiculatum**P. caroli-henrici**P. rubiginosum**P. caledonicum**P. rapaceum*

12. Pinnately compound, erect, irregularly bi- or tripinnatisect, aciculatum group

*P. aciculatum**P. confertum**P. fasciculaceum**P. connivens*

Different types of trichomes occur on the leaves, and different combinations of glandular hairs (short, medium length and long) and non-glandular hairs (long soft patent hairs, appressed curly hairs, appressed stiff hairs, patent stiff hairs and bristles) occur. Thus the indumentum of the leaf varies, and can be useful as a diagnostic tool rather than using it as an aid to establish interrelationships of taxa. This is based on the statement by Metcalfe & Chalk (1950) that the value for systematic purposes of different types of trichomes, is lessened by the fact that the same kind of trichome occur in unrelated groups, thus making it reasonably certain that the same type of hair must have been evolved along independent lines. Therefore trichomes do not have a significant influence

on phylogenetic thought. An outstanding character of the indumentum of section *Hoarea* is that appressed hairs are always distally orientated.

One of the diagnostic characters of section *Hoarea* is the stipules which are adnate to the petioles. In species with prostrate leaves the stipules are rather short and in most cases triangular in outline, whereas in species with erect or erecto-patent leaves the stipules are long and usually subulate. The length of the stipules often varies conspicuously within one population of a species. This variation can be ascribed to the depth of the tuber below ground level; the deeper the tubers are situated the longer the stipules (Marais 1993). Only in *P. appendiculatum* the form of the stipules is diagnostic within section *Hoarea*.

Inflorescence

The flowers of *Pelargonium* are borne in pseudo-umbels or umbelliform dichasiums (Wyatt 1982) with the older flowers in the centre and the younger ones on the periphery of the inflorescence. In section *Hoarea* flowers are borne on a scape. Some plants bear only a single scape, whereas others, usually older plants, have more than one scape per plant, due to the presence of more than one stem-growing point per tuber. In the majority of species the scape is branched, forming a compound inflorescence with 2--8(-12) pseudo-umbellets, each with 3--60 almost sessile flowers. Only *P. incrassatum* (Andr.) Sims, *P. grenvilleae* (Andr.) Harv., *P. moniliforme* Harv. and *P. vinaceum* E.M. Marais habitually have an unbranched scape. Two thirds of the species studied have less than fifteen flowers per pseudo-umbellet (Table 3.1). The remaining species may have 30 and in some cases even up to 60 flowers per pseudo-umbellet. The large variation in the number of flowers per pseudo-umbellet within the same species lessens the diagnostic value of this character.

The flower buds, flowers and the fruits are erect. The height of the plants when in flower varies from 80--500 mm above ground level. The scape with the flowers usually rise above the leaves.

Table 3.1 Number of flowers per pseudo-umbel or pseudo-umbellet of the different *Hoarea* species.

Species	0	20	40	60	80
<i>P. aestivale</i>		—	—		
<i>P. fissifolium</i>		—	—		
<i>P. petroselinifolium</i>		—	—		
<i>P. aristatum</i>		—			

Table 3.1 Number of flowers per pseudo-umbel or pseudo-umbellet of the different *Hoarea* species (continue).

Species	0	20	40	60	80
<i>P. chelidonium</i>		—			
<i>P. nervifolium</i>		—	—		
<i>P. pinnatum</i>		—			
<i>P. reflexum</i>	—				
<i>P. heterolobum</i>		—			
<i>P. attenuatum</i>		—			
<i>P. angustipetalum</i>		—			
<i>P. leptum</i>		—			
<i>P. viciifolium</i>		—			
<i>P. longifolium</i>		—			
<i>P. fergusoniae</i>		—	—		
<i>P. undulatum</i>		—	—		
<i>P. longiflorum</i>		—			
<i>P. proliferum</i>		—			
<i>P. pilosellifolium</i>		—	—		
<i>P. caledonicum</i>		—			
<i>P. heterophyllum</i>		—	—		
<i>P. tenellum</i>		—			
<i>P. trifoliolatum</i>		—	—		
<i>P. aciculatum</i>		—	—	—	
<i>P. confertum</i>		—	—	—	
<i>P. fasciculaceum</i>		—	—	—	
<i>P. connivens</i>		—	—		
<i>P. luteum</i>		—	—		
<i>P. fumarifolium</i>		—	—		
<i>P. incrassatum</i>		—	—	—	
<i>P. grenvilleae</i>		—	—		
<i>P. moniliforme</i>		—	—	—	
<i>P. vinaceum</i>		—	—		
<i>P. radicatum</i>		—	—		
<i>P. appendiculatum</i>	—	—			
<i>P. campestre</i>		—			
<i>P. nephrophyllum</i>		—			
<i>P. carneum</i>		—			
<i>P. radiatum</i>		—			
<i>P. nummulifolium</i>		—			

Table 3.1 Number of flowers per pseudo-umbel or pseudo-umbellet of the different *Hoarea* species (continue).

Species	0	20	40	60	80
<i>P. luteolum</i>	_____				
<i>P. gracillimum</i>	_____				
<i>P. rapaceum</i>	_____				
<i>P. auritum</i> var. <i>auritum</i>	_____				
<i>P. auritum</i> var. <i>carneum</i>	_____				
<i>P. bubonifolium</i>	_____				
<i>P. parvipetalum</i>	_____				
<i>P. leipoldtii</i>	_____				
<i>P. ellaphieae</i>	_____				
<i>P. asarifolium</i>	_____				
<i>P. dipetalum</i>	_____				
<i>P. ternifolium</i>	_____				
<i>P. triphyllum</i>	_____				
<i>P. githagineum</i>	_____				
<i>P. caroli-henrici</i>	_____				
<i>P. rubiginosum</i>	_____				
<i>P. oblongatum</i>	_____				
<i>P. curviandrums</i>	_____				
<i>P. triandrums</i>	_____				
<i>P. punctatum</i>	_____				

Flower

Floral features are the most important characters in the classification of flowering plants. Being more constant than vegetative features, reproductive characters are generally more numerous and therefore provide more features to differentiate taxa. In addition these features are easily observed, and they are practical for use in keys and descriptions (Jones & Luchsinger 1987), therefore the emphasis in the taxonomic treatment of section *Hoarea* was on the floral structure.

Like most species of the genus *Pelargonium*, all species of section *Hoarea* have zygomorphic flowers. In almost all species the form and size of the posterior two petals

differ obviously from the anterior three. The degree of zygomorphy is emphasized by the differences between the orientation of the posterior petals and those of the anterior ones. The androecium in all species is also zygomorphic.

Hypanthium

The hypanthium, typical for *Pelargonium*, is well developed in all *Hoarea* species. In all the species in section *Hoarea* the hypanthium is long (6--100 mm) in comparison with the very short pedicel (0,5--1 mm long). In the majority of species the hypanthium is straight, but in *P. incrassatum* and *P. grenvilleae* it is typically curved. The length of the hypanthium could be of diagnostic value in species with similar floral structures (Table 3.2; *P. aciculatum* E.M. Marais, *P. confertum* E.M. Marais, *P. fasciculaceum*, and *P. connivens* E.M. Marais; *P. fissifolium* (Andr.) Pers. and *P. petroselinifolium* G. Don; *P. luteolum* N.E. Br. and *P. gracillimum* Fourc., and *P. radicum* Venten. and *P. appendiculatum*). On the other hand the length of the hypanthium does confirm relationships among species with similar floral structures like *P. proliferum*, *P. pilosellifolium* (Eckl. & Zeyh.) Steud. and *P. caledonicum* L; *P. heterophyllum*, *P. tenellum* (Andr.) G. Don and *P. trifoliolatum*; *P. luteum* (Andr.) G. Don and *P. fumariifolium*; and *P. auritum* (L.) Willd. var. *auritum*, *P. auritum* var. *carneum* (Harv.) E.M. Marais, *P. bubonifolium* (Andr.) Pers, *P. parvipetalum* E.M. Marais, *P. leipoldtii* Knuth, *P. ellaphieae* E.M. Marais, *P. asarifolium* (Sweet) Loudon and *P. ternifolium* Vorster (Table 3.2). The diagnostic value of the hypanthium length, however, is lessened by the large variation in the length occurring in *P. aestivale* E.M. Marais (33--66 mm), *P. fissifolium* (28--65 mm), *P. pinnatum* (L.) L'Hérit. (11--35--45 mm), *P. longiflorum* Jacq. (10--15--44 mm), *P. moniliforme* (20--77 mm), *P. appendiculatum* (60--100 mm), *P. rapaceum* (L.) L'Hérit. (12--55 mm), *P. carneum* (29--35--75 mm), *P. radiatum* (30--62 mm), *P. oblongatum* Harv. (30--68 mm), most of them species with long hypanthia. In *P. dipetalum*, with usually short hypanthia (7--18 mm long), three populations with very long hypanthia (35--50 mm long) were found.

The indumentum of the hypanthium is often similar to that of the peduncle and sepals. The colour of the hypanthium varies from green to greenish red (*P. githagineum* E.M. Marais) or conspicuously wine-red (*P. moniliforme*, *P. vinaceum*, *P. caroli-henrici* B. Nord. and *P. rubiginosum* E.M. Marais). Both characters are of diagnostic value.

Table 3.2 The hypanthium length of the different species of section *Hoarea*.

Species	10	20	30	40	50	60	70	80 mm
<i>P. aestivale</i>				—	—	—	—	—
<i>P. fissifolium</i>			—	—	—	—	—	—
<i>P. petroselinifolium</i>		—	—					
<i>P. aristatum</i>		—	—					
<i>P. chelidonium</i>	—							
<i>P. nervifolium</i>			—	—				
<i>P. pinnatum</i>	—	—	—	—	—			
<i>P. reflexum</i>		—	—					
<i>P. violiflorum</i>	—							
<i>P. attenuatum</i>		—	—					
<i>P. angustipetalum</i>		—	—	—				
<i>P. leptum</i>	—	—	—					
<i>P. viciifolium</i>		—	—	—				
<i>P. longifolium</i>	—	—	—					
<i>P. fergusoniae</i>		—	—	—	—			
<i>P. undulatum</i>	—	—	—					
<i>P. longiflorum</i>	—	—	—	—	—			
<i>P. proliferum</i>	—							
<i>P. pilosellifolium</i>	—							
<i>P. caledonicum</i>	—							
<i>P. heterophyllum</i>	—							
<i>P. tenellum</i>	—	—	—					
<i>P. trifoliolatum</i>	—	—	—					
<i>P. aciculatum</i>	—	—						
<i>P. confertum</i>	—	—						
<i>P. fasciculaceum</i>				—	—	—		
<i>P. connivens</i>				—	—	—		
<i>P. luteum</i>		—	—					
<i>P. fumariifolium</i>		—	—					
<i>P. incrassatum</i>			—	—				
<i>P. grenvilleae</i>			—	—				
<i>P. moniliforme</i>		—	—	—	—	—	—	—
<i>P. vinaceum</i>	—	—	—					
<i>P. radicatum</i>				—	—	—		
<i>P. appendiculatum</i>							—	—
<i>P. campestre</i>	—							

Table 3.2 The hypanthium length of the different species of section *Hoarea* (continue).

Species	10	20	30	40	50	60	70	80 mm
<i>P. nephrophyllum</i>		—	—					
<i>P. carneum</i>			—	—	—	—	—	—
<i>P. radiatum</i>			—	—	—	—		
<i>P. nummulifolium</i>			—	—				
<i>P. luteolum</i>	—	—						
<i>P. gracillimum</i>		—	—					
<i>P. rapaceum</i>	—	—	—	—	—	—		
<i>P. auritum</i> var. <i>auritum</i>	—	—						
<i>P. auritum</i> var. <i>carneum</i>	—	—						
<i>P. bubonifolium</i>	—	—						
<i>P. parvipetalum</i>	—	—						
<i>P. leipoldtii</i>	—	—						
<i>P. ellaphieae</i>	—	—						
<i>P. asarifolium</i>	—	—						
<i>P. dipetalum</i>	—	—		—	—			
<i>P. ternifolium</i>	—	—						
<i>P. triphyllum</i>	—	—						
<i>P. githagineum</i>	—	—						
<i>P. caroli-henrici</i>		—	—					
<i>P. rubiginosum</i>		—	—					
<i>P. oblongatum</i>			—	—	—	—	—	
<i>P. curviandrum</i>		—	—					
<i>P. triandrum</i>		—	—					
<i>P. punctatum</i>		—	—					

Sepals

The calyx in section *Hoarea* is of little or no taxonomic value. All species have five sepals of which the posterior one is the widest. During anthesis all the sepals could be patent or all could be recurved, but often the posterior one remains erect, whereas the others are recurved. The relation between the length of the sepals and that of the stamens is an important character used in the delimitation of the different types of floral structures

(Table 3.3). The sepals are persistent and cover the developing fruit after fertilization, thus a character which could be used after the petals are dropped.

Table 3.3 The comparison between sepal length (■) and stamen length (—) of the species of section *Hoarea*.

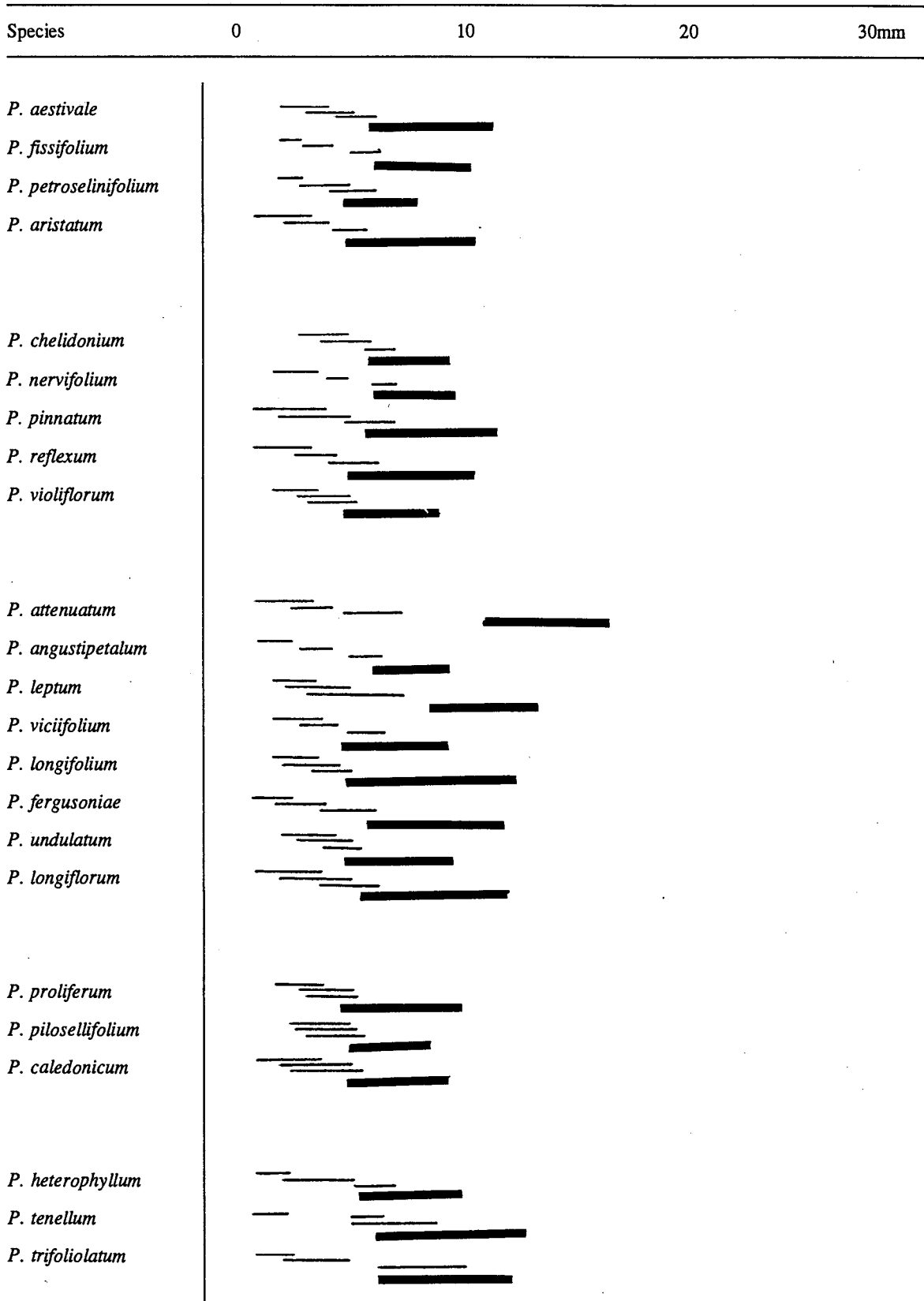


Table 3.3 The comparison between sepal length (▬▬▬) and stamen length (—) of the species of section *Hoarea* (continue).

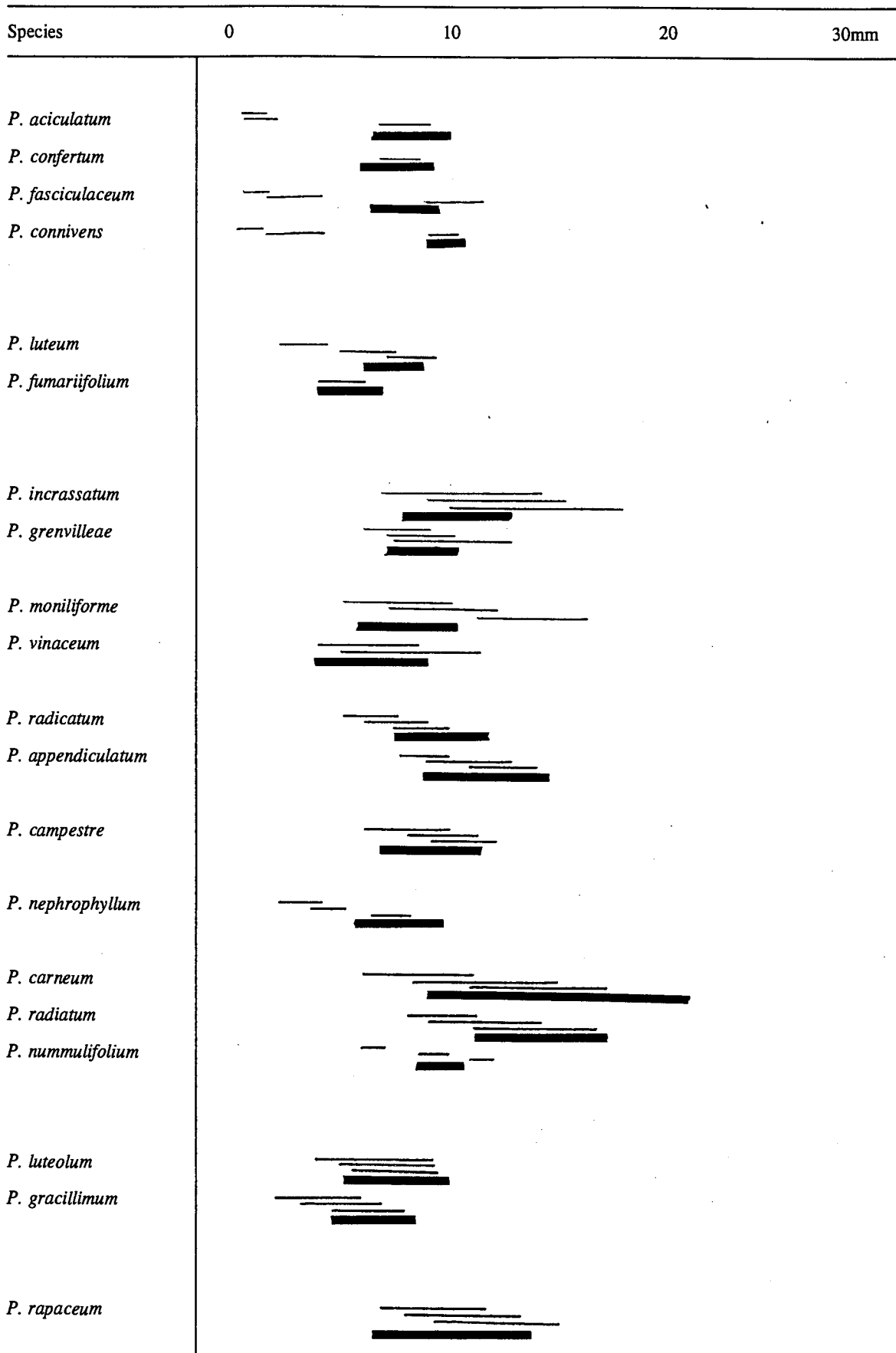


Table 3.3 The comparison between sepal length (■) and stamen length (—) of the species of section *Hoarea* (continue).

Species	0	10	20	30mm
<i>P. auritum</i> var. <i>auritum</i>			—	—
<i>P. auritum</i> var. <i>carneum</i>		■	—	—
<i>P. bubonifolium</i>		—	—	—
<i>P. parvipetalum</i>		■	—	—
<i>P. leipoldtii</i>		■	—	—
<i>P. ellaphieae</i>		■	—	—
<i>P. asarifolium</i>		■	—	—
<i>P. dipetalum</i>		■	—	—
<i>P. ternifolium</i>		■	—	—
<i>P. triphyllum</i>		■	—	—
<i>P. githagineum</i>		■	—	—
<i>P. caroli-henrici</i>		■	—	—
<i>P. rubiginosum</i>	■	—	—	—
<i>P. oblongatum</i>		—	—	—
<i>P. curviandrum</i>		■	—	—
<i>P. triandrum</i>		■	—	—
<i>P. punctatum</i>	■	—	—	—

Petals

Modifications in floral morphology can usually be related to the mode of pollination or specialized reproduction. Insect-pollinated plants, typically have large colourful, bisexual flowers (Jones & Luchsinger 1987). The showiness of the flowers attracts pollinators. Although *Hoarea* species, like most *Pelargonium* species, are probably insect-pollinated plants (Vogel 1954, Van der Walt, McDonald & Van Wyk 1990,

McDonald & Van der Walt 1992, Zietsman 1993), the majority of species have rather small white, cream-coloured, pale yellow or pale pink flowers. Only a few species like *P. incrassatum*, *P. nummulifolium* Salisb., *P. carneum*, *P. radiatum* have large bright pink or purple petals. *P. oblongatum* is another species with large flowers, but with yellow petals. Although smaller than the former, the pink flowers of *P. chelidonium* and those of *P. nephrophyllum* E.M. Marais are also very striking. *P. pilosellifolium*, *P. caledonicum*, *P. auritum* var. *auritum*, *P. ellaphieae* and *P. asarifolium* are all species with small flowers, but they still are striking because of the wine-red or nearly black petals. Flower colour is diagnostic in the case of *P. petroselinifolium*, *P. chelidonium*, *P. incrassatum*, *P. nephrophyllum*, *P. gracillimum*, *P. auritum* var. *auritum*, and *P. auritum* var. *carneum*. Although the majority of species in *Hoarea* have dull-coloured flowers, pollinator guides compensate for the lack of bright colours. In *P. longifolium*, *P. heterophyllum*, *P. trifoliolatum*, *P. moniliforme* and *P. vinaceum* prominent black or wine-red blotches occur on the posterior petals, which are also diagnostic in all these species. These markings also confirm a relationship between *P. heterophyllum* and *P. trifoliolatum*, and a relationship between *P. moniliforme* and *P. vinaceum*. The majority of species have wine-red feather-like markings on the posterior petals, and a few others have only dimly coloured V-shaped markings (*P. fasciculaceum*, *P. connivens*, *P. luteum* and *P. fumariifolium*).

The orientation of the petals varies in the different species. In the majority of species the claws form a floral sheath, in which short stamens are concealed. The apices of the petals are patent or recurved to different degrees, and depending on the length of the stamens, the latter protrudes from the flowers.

The majority of species have five-petalled flowers. Only one species, *P. triandrum* E.M. Marais, has four petals, and *P. leipoldtii*, *P. ellaphieae*, *P. asarifolium*, *P. dipetalum*, and *P. ternifolium* have flowers with only two petals each in the posterior position. The androeciums of the two-petalled flowers are very similar and the reduction in the number of petals confirms the relationships among these species.

The shape and size of the petals are important characters used in the taxonomic treatment of the section. The posterior petals are always longer and wider than the anterior ones, except in *P. pilosellifolium* and *P. fumariifolium*, where the anterior petals are longer than the posterior ones. These two species are not closely related because *P. pilosellifolium* has very short stamens and *P. fumariifolium* has longer stamens which are twisted in an unusual way. In *P. luteum* the posterior petals and anterior ones have more or less the same length. This is also true for *P. luteolum*, although in the latter the

anterior petals are wider than the posterior ones. The anterior petals of *P. luteolum* are also borne in a special way; the median one is covered by the lateral two, enclosing the stamens at the same time. The same orientation of the anterior petals is found in *P. gracillimum*. The papilionaceous flowers of *P. rapaceum* is a unique type of floral structure for *Pelargonium*. The anterior petal is very wide (5--11 mm) and conduplicate like the keel of a papilionaceous type of flower, enclosing the relatively long and straight stamens. The two lateral petals or wings cover the keel. The two posterior petals are unguiculate-spathulate and bend backwards above the claws.

The length (Table 3.4) and the length/width ratio (Table 3.4) of the posterior petals play an important role in the delimitation of the different floral structure groups. Some species with very short stamens have long ligulate petals, with a length/width ratio bigger than five (*P. attenuatum* Harv., *P. angustipetalum* E.M. Marais, *P. leptum* L. Bol., *P. viciifolium* DC., *P. longifolium*, *P. fergusoniae* L. Bol., *P. undulatum* (Andr.) Pers., *P. longiflorum* and *P. aristatum* (Sweet) G. Don), whereas others have shorter, but wider petals with a length/width ratio of less than five (*P. chelidonium*, *P. nervifolium* Jacq., *P. pinnatum*, *P. reflexum* (Andr.) Pers., *P. violiflorum* (Sweet) DC., *P. aestivale*, *P. fissifolium* and *P. petroselinifolium*).

Table 3.4 The length/width ratio and the length of the posterior petals of the species of section *Hoarea*.

Species	Length/width		Length (mm)			
	0	10	20	30	40	
<i>P. aestivale</i>			—————			
<i>P. fissifolium</i>			—————			
<i>P. petroselinifolium</i>			—————			
<i>P. aristatum</i>			—————			
<i>P. chelidonium</i>			—————			
<i>P. nervifolium</i>			—————			
<i>P. pinnatum</i>			—————			
<i>P. reflexum</i>			—————			
<i>P. violiflorum</i>			—————			
<i>P. attenuatum</i>				—————		
<i>P. angustipetalum</i>				—————		
<i>P. leptum</i>				—————		
<i>P. viciifolium</i>			—————			
<i>P. longifolium</i>			—————			
<i>P. fergusoniae</i>				—————		
<i>P. undulatum</i>			—————			
<i>P. longiflorum</i>			—————			
<i>P. proliferum</i>			—————			
<i>P. pilosellifolium</i>			—————			
<i>P. caledonicum</i>			—————			

Table 3.4 The length/width ratio and the length of the posterior petals of the species of section *Hoarea* (continue).

Species	Length/width		Length (mm)			
	0	10	20	30	40	
<i>P. heterophyllum</i>			—	—		
<i>P. tenellum</i>			—	—		
<i>P. trifoliolatum</i>			—	—		
<i>P. aciculatum</i>			—			
<i>P. confertum</i>			—			
<i>P. fasciculaceum</i>			—			
<i>P. connivens</i>				—		
<i>P. luteum</i>			—			
<i>P. fumarifolium</i>			—			
<i>P. incrassatum</i>			—	—		
<i>P. grenvilleae</i>			—			
<i>P. moniliforme</i>			—	—		
<i>P. vinaceum</i>			—			
<i>P. radicum</i>			—	—		
<i>P. appendiculatum</i>			—	—		
<i>P. campestre</i>			—	—		
<i>P. nephrophyllum</i>			—			
<i>P. carneum</i>			—	—	—	
<i>P. radiatum</i>			—	—	—	
<i>P. nummulifolium</i>			—	—		
<i>P. luteolum</i>			—			
<i>P. gracillimum</i>			—			
<i>P. rapaceum</i>			—	—		
<i>P. auritum</i> var. <i>auritum</i>			—	—		
<i>P. auritum</i> var. <i>carneum</i>			—	—		
<i>P. bubonifolium</i>			—	—		
<i>P. parvipetalum</i>			—	—		
<i>P. leipoldtii</i>			—			
<i>P. ellaphieae</i>			—			
<i>P. asarifolium</i>			—	—		
<i>P. dipetalum</i>			—	—		
<i>P. ternifolium</i>			—	—		
<i>P. triphyllum</i>			—	—		

Table 3.4 The length/width ratio and the length of the posterior petals of the species of section *Hoarea* (continue).

Species	Length/width		Length (mm)		
	0	10	20	30	40
<i>P. githagineum</i>	=====	=====			
<i>P. caroli-henrici</i>	=====	=====			
<i>P. rubiginosum</i>	=====	=====			
<i>P. oblongatum</i>	=====			=====	
<i>P. curviandrum</i>		=====	=====		
<i>P. triandrum</i>		=====	=====		
<i>P. punctatum</i>		=====	=====		

Several species have petals with undulate margins. In *P. heterophyllum*, *P. tenellum* (Andr.) G. Don and *P. trifoliolatum* this character confirms relationship. The undulate margins of the petals, together with an identical androecium confirms the relationship between *P. asarifolium* and *P. ellaphieae*.

Androecium

Different modifications of flowers, which include among others stamen number, stamen length, anther position, ovary position, style length, stigma shape, and size and form of perianth parts, contribute to the reproductive success of the species (Jones & Luchsinger 1987). They also stated that the value of characters drawn from reproductive morphology varies from group to group within the angiosperms. This is true for the evolutionary history of *Pelargonium*. In section *Hoarea* the modifications in the floral structure result in a large variation in the structure of the androecium, whereas the variation in the androecium of sections *Pelargonium*, *Otidia* (Sweet) DC. and *Myrrhidium* DC. is less prominent (Marais 1981).

The androecium of *Pelargonium* consists of ten filaments, arranged in two whorls of five each, basally connate, and obdiplostemonous (Figure 3.2). Usually the staminal column is smooth, but in *P. auritum*, *P. bubonifolium*, *P. parvipetalum* and all the two-petalled species it is papillate (Figure 3.3), a characteristic that suggests a relationship among these species. The androecium is zygomorphic; the staminal column is longer on the posterior side than on the anterior side and the anterior stamens are longer than the posterior one. In the genus *Pelargonium* the number of fertile stamens varies from two to seven and the staminodes are usually much shorter than the stamens. However, *P. fumariifolium* has very long staminodes, which are not only unique for *Hoarea*, but also unique for the genus, and therefore a diagnostic feature for this species. In Figure 3.2

the stamens are numbered clockwise with the posterior stamen as no. 1, and in Table 3.5 the positions of the fertile stamens for the genus are given. From this it is clear that in section *Hoarea* the filaments of the outer whorl are always lacking anthers. At the same time the variation in the different filaments of the inner whorl which bear anthers, is also revealed. The number of fertile stamens is rather a diagnostic feature than one to establish interrelationships in the section.

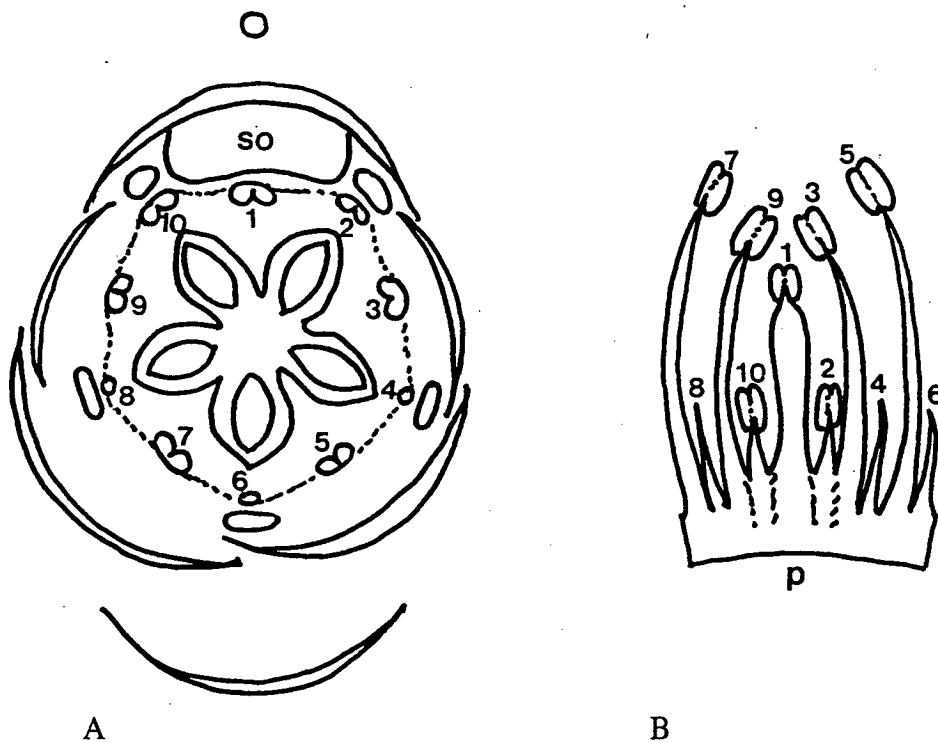


Figure 3.2 A, Floral diagram of *Pelargonium* to illustrate the position of the stamens. B, The androecium of *Pelargonium*. p = posterior, so = spur opening.



Figure 3.3 Scanning electron micrograph of the papillate staminal column of *P. auritum* var. *auritum* (Van der Walt 482). Scale bar: 50 μm .

Table 3.5 The androecium of *Pelargonium*, illustrating the position of the fertile stamens

Number of fertile stamens	Stamens with anthers, numbered according to Figure 3.3.						Outer whorl	Inner whorl
	8	10	2	4	6	7		
7	*	*	*	*	*	*	-	-
6	*	*	-	*	*	*	-	-

Section <i>Hoarea</i>											
5	*	-	*	-	*	-	*	-	*	-	
4	*	-	*	-	-	-	*	-	*	-	<i>P. longiflorum</i>
											<i>P. ternifolium</i>
											<i>P. githagineum</i>
											<i>P. caroli-henrici</i>
											<i>P. curviandrum</i>
2,3,4	*	-	?	-	-	-	?	-	*	-	<i>P. vinaceum</i>
2	*	-	-	-	-	-	-	-	*	-	<i>P. confertum</i>
											<i>P. rubiginosum</i>
2	-	-	*	-	-	-	*	-	-	-	<i>P. fumariifolium</i>
3	Reduction in filament number										<i>P. triandrum</i>
2	Reduction in filament number										<i>P. punctatum</i>

All the species in section *Hoarea* share more or less the same basic structure of the androecium, the posterior stamen is short, the lateral two somewhat longer and the anterior two the longest. The posterior and lateral stamens are twisted in such a way that the dehiscent anthers show backwards. The flowers of all the species in this section are protandrous. When the petals unfold, the stamens are longer than the pistil and the dehiscent anthers are borne in a way to form a flat pollen-covered surface which must be touched by the abdomen of the insect visiting the flowers (Scott Elliot 1891). During anthesis the pistil lengthens and the style bends upwards, while the stigma branches recurve, occupying the original position of the anthers. At the same time the filaments bend downwards and in most cases the anthers are dropped, a mechanism to avoid self-pollination. Exceptions to this are *P. caroli-henrici* where the free filaments are twisted so that pollen surfaces are turned to the front, *P. luteum* where the filaments are twisted in a unique way, forming a pollen-lined tunnel to the nectar tube (Figure 8.28.2), and *P. fumariifolium* with a similar androecium than *P. luteum*, but with only two fertile stamens.

The relative length of the stamens is diagnostic at specific level and varies from much shorter than, the same length as, or longer than the calyx (Table 3.3). The comparison of the stamen length to that of the sepals is a practical one, since the sepals are persistent and the comparison is still possible, even after the petals are dropped. The differences in the length between the posterior stamen, the lateral stamens, and the anterior stamens vary in the different species. In *P. aciculatum*, *P. fasciculaceum* and *P. connivens* the posterior and lateral stamens are very short and concealed within the floral sheath. The anterior stamens are long and protrude from the flower. Although *P. confertum* has only two fertile stamens, the structure of the androecium fits in well with that of the above mentioned three species. Because of the resemblance in the structure of the androecium, leaf morphology (Figure 3.1) and pollen structure, these four species can be regarded as a natural taxon (*Aciculatum* group) within section *Hoarea* (Marais 1991). In *P. heterophyllum*, *P. tenellum* and *P. trifoliolatum* the posterior stamen is much shorter than the lateral and the anterior ones, and in respect to this character, and the similarities in the morphology of the petals and the pollen, these three species are placed together as the *Heterophyllum* group. The stamens of the species with the papillate staminal column are longer than the sepals, and the lateral and anterior stamens are more or less of the same length and the posterior one slightly shorter. All these characters confirm the relationship among these species and they are put together in the *Auratum* group. *P. triphyllum*, a species with five long stamens, all of them more or less of the same length, differs from the *Auratum* group in that the staminal column is smooth and the posterior petals are auriculate, thus forming a floral group of its own (*Triphyllum* group). In several species the stamens are long and straight and an obvious difference occurs in the lengths of the posterior, lateral and anterior stamens (*Incrassatum*, *Luteolum* and *Rapaceum* groups). The *Luteolum* group is distinguished in respect to the wide anterior petals and the way the anterior petals enclose the stamens, and the *Rapaceum* group is distinguished in respect to the papilionaceous type of corolla. The *Luteum* group (*P. luteum* and *P. fumariifolium*) is distinguished in respect to the orientation of the stamens.

The variation in the structure of the androecium is not only of diagnostic value, but it is also the most important character set to delimit smaller taxonomic units within the section. In about one third of the species studied, the stamens are short and concealed within the floral sheath (Table 3.6: *Fissifolium*, *Pinnatum*, *Attenuatum* and *Proliferum* groups). In another third the anterior stamens are more or less the same length as the sepals and depending on the orientation of the petals, the stamens sometimes protrude from the flower (Table 3.6: *Heterophyllum*, *Aciculatum*, *Luteum*, *Incrassatum*, *Luteolum* and *Rapaceum* groups). In the rest of the species the stamens are long and protrude from the flower (Table 3.6: *Auratum*, *Triphyllum*, *Caroli-henrici* and *Punctatum* groups). Both

the *Caroli-henrici* and *Punctatum* groups have long stamens. They differ because in the *Punctatum* group the stamens are very long and curved upwards, whereas those of the *Caroli-henrici* group remain straight during anthesis.

In respect to the length of the different stamens and the ratio between the length of the stamens and that of the sepals or petals, different types of floral structures are recognized (Table 3.6). The size and the form of the petals (*Pinnatum* group with spatulate petals, and *Attenuatum* group with ligulate petals) and the structure of the pollen (*Proliferum* group) also play a major role in constructing the different floral structure groups. In Table 3.6 species are listed according to the different floral groups, and at the same time, the different leaf forms, as defined in Figure 3.1 are included.

Table 3.6 Different floral groups of section *Hoarea* and the different leaf forms occurring in each group.

Floral group / species	Leaf forms as defined in Figure 3.1											
	1	2	3	4	5	6	7	8	9	10	11	12
1.Fissifolium group												
<i>P. aestivale</i>		*										
<i>P. fissifolium</i>												*
<i>P. petroselinifolium</i>												*
<i>P. aristatum</i>												*
2.Pinnatum group												
<i>P. chelidonium</i>		*										
<i>P. nervifolium</i>		*										
<i>P. pinnatum</i>									*			
<i>P. reflexum</i>				*								
<i>P. violiflorum</i>												*
3.Attenuatum group												
<i>P. attenuatum</i>					*							
<i>P. angustipetalum</i>					*							
<i>P. leptum</i>												*
<i>P. viciifolium</i>									*			
<i>P. longifolium</i>								*				
<i>P. fergusoniae</i>				*								
<i>P. undulatum</i>								*				
<i>P. longiflorum</i>						*						
4.Proliferum group												
<i>P. proliferum</i>						*						
<i>P. pilosellifolium</i>							*					
<i>P. caledonicum</i>												*
5.Heterophyllum group												
<i>P. heterophyllum</i>		*										
<i>P. tenellum</i>		*										
<i>P. trifoliolatum</i>									*			

Table 3.6 Different floral groups of section *Hoarea* and the different leaf forms occurring in each group (continue).

Floral group / species	Leaf forms as defined in Figure 3.1											
	1	2	3	4	5	6	7	8	9	10	11	12
14. Punctatum group												
<i>P. oblongatum</i>	*											
<i>P. curviandrum</i>	*											
<i>P. triandrum</i>	*											
<i>P. punctatum</i>	*											

Key to Table 3.6

1. Simple, cordiform, prostrate
2. Simple (ovate to cordiform) to tripartite or trifoliolate, prostrate
3. Simple (palmately veined), reniform, petiole curved
4. Palmately compound, ternate to tripinnatisect, petiole curved
5. Palmately compound, ternate to tripinnatisect, petiole erect
6. Simple to tripartite or trifoliolate, lanceolate, petiole erect
7. Simple to pinnatisect or pinnately compound, lanceolate, petiole erect
8. Simple or pinnately compound to irregularly bipinnatisect, lanceolate to ovate, petiole erect
9. Pinnately compound, erect, pinnate
10. Pinnately compound, erect, pinnatisect to pinnate, trullate or elliptic
11. Pinnately compound, erect, pinnate to irregularly bi- or tripinnatisect
12. Pinnately compound, erect, irregularly bi- or tripinnatisect, aciculatum group

Gynoecium

The gynoecium in section *Hoarea* is typical for *Pelargonium*, consisting of a densely sericeous, four- or five-lobed, oblong-conical ovary, a filiform style and a stigma with four or five recurved branches. In *P. punctatum* (Andr.) Willd., *P. triandrum* and *P. rubiginosum* the stigma branches are very short and incapable of recurving. The ovary consists of a basal part containing the ovules and a rostrum which lengthens greatly after fertilization. The flowers of *Hoarea* are protandrous and when the petals unfold the pistil is much shorter than the stamens, except in *P. githagineum*, where closed stigma branches protrude from the flower bud. During anthesis the rostrum, style and often the stigma branches lengthen, and when the stamens bend down and the anthers are dropped, the recurved stigma branches take the original position of the anthers. This causes a large variation in the measurements of the pistil, as a result the measurements are less useful for diagnostic purposes. Species with long stamens also have long styles.

Fruit

The fruit is typical for the Geraniaceae. It is a schizocarp with five mericarps, with the exception of *P. punctatum* and *P. triandrum* which usually have only four mericarps.

When ripe, the four or five mericarps, each with an enclosed seed, are distributed by the wind. The length of the base varies from (3-)4--6(-8) mm, and that of the rostrum from (13-)18--37(-55) mm. *P. appendiculatum* has the longest fruits (rostrum is 50--55 mm long) and those of *P. nephrophyllum* are the shortest (rostrum is 13--17 mm long). The presence or absence of glandular hairs on the distal side of the base (Figure 3.4) could be of diagnostic value at species level (Table 3.7).

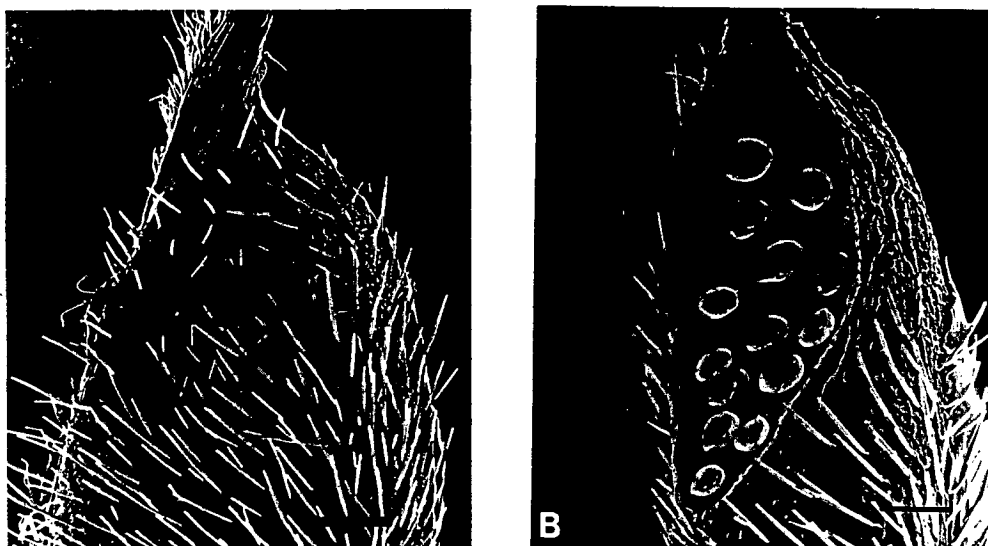


Figure 3.4 The distal side of the fruit base. A, without glandular hairs of *P. trifoliolatum* (Marais 178) and B, with glandular hairs of *P. radiatum* (Van der Walt 970). Scale bar: 0,25 mm.

Table 3.7 The length of the fruit of the different *Hoarea* species and the presence of glandular hairs on the base

Species	Gla	Base length	Rostrum length			
			0	20	40	mm
1. Fissifolium group						
<i>P. aestivale</i>	*	—				
<i>P. fissifolium</i>	*	—			—	
<i>P. petroselinifolium</i>	*	—		—		
<i>P. aristatum</i>	*	—		—		
2. Pinnatum group						
<i>P. chelidonium</i>	*	—			—	
<i>P. nervifolium</i>	*	—		—		
<i>P. pinnatum</i>	-	—		—		
<i>P. reflexum</i>	*	—		—		
<i>P. violiflorum</i>	-	—		—		

Table 3.7 The length of the fruit of the different *Hoarea* species and the presence of glandular hairs on the base (continue).

Species	Gla	Base length	Rostrum length			
			0	20	40	mm
3. Attenuatum group						
<i>P. attenuatum</i>	*	—		—	—	
<i>P. angustipetalum</i>	*	—		—	—	
<i>P. leptum</i>	-	—		—	—	
<i>P. viciifolium</i>	*	—		—	—	
<i>P. longifolium</i>	-	—		—	—	
<i>P. fergusoniae</i>	-	—		—	—	
<i>P. undulatum</i>	*	—		—	—	
<i>P. longiflorum</i>	-	—		—	—	
4. Proliferum group						
<i>P. proliferum</i>	-	—		—	—	
<i>P. pilosellifolium</i>	-	—		—	—	
<i>P. caledonicum</i>	-	—		—	—	
5. Heterophyllum group						
<i>P. heterophyllum</i>	?	—		—	—	
<i>P. tenellum</i>	?	—		—	—	
<i>P. trifoliolatum</i>	-	—		—	—	
6. Aciculatum group						
<i>P. aciculatum</i>	*	—		—	—	
<i>P. confertum</i>	*	—		—	—	
<i>P. fasciculaceum</i>	?	—		—	—	
<i>P. connivens</i>	?	—		—	—	
7. Luteum group						
<i>P. luteum</i>	*	—		—	—	
<i>P. fumariifolium</i>	*	—		—	—	
8. Incrassatum group						
<i>P. incrassatum</i>	-	—		—	—	
<i>P. grenvilleae</i>	?	—		—	—	
<i>P. moniliforme</i>	-	—		—	—	
<i>P. vinaceum</i>	-	—		—	—	
<i>P. radicatum</i>	*	—		—	—	
<i>P. appendiculatum</i>	-	—		—	—	—
<i>P. campestre</i>	*	—		—	—	
<i>P. nephrophyllum</i>	*	—		—	—	
<i>P. carneum</i>	*	—		—	—	
<i>P. radiatum</i>	*	—		—	—	
<i>P. nummulifolium</i>	*	—		—	—	
9. Luteolum group						
<i>P. luteolum</i>	*	—		—	—	
<i>P. gracillimum</i>	*	—		—	—	

Table 3.7 The length of the fruit of the different *Hoarea* species and the presence of glandular hairs on the base (continue)

Species	Gla	Base length	Rostrum length			
			0	20	40	mm
10. Rapaceum group						
<i>P. rapaceum</i>	*	—		—————		
11. Auritum group						
<i>P. auritum</i> var. <i>auritum</i>	*	—		—————		
<i>P. auritum</i> var. <i>carneum</i>	-					
<i>P. bubonifolium</i>	*	—		—————		
<i>P. parvipetalum</i>	*	—		—————		
<i>P. leipoldtii</i>	*	—			—————	
<i>P. ellaphieae</i>	*	—				—————
<i>P. asarifolium</i>	-	—		—————		
<i>P. dipetalum</i>	-	—		—————		
<i>P. ternifolium</i>	-	—		—————		
12. Triphyllum group						
<i>P. triphyllum</i>	*	—		—————		
13. Caroli-henrici group						
<i>P. githagineum</i>	-	—			—————	
<i>P. caroli-henrici</i>	-	—			—————	
<i>P. rubiginosum</i>	-	—		—————		
14. Punctatum group						
<i>P. oblongatum</i>	*	—			—————	
<i>P. curviandrum</i>	*	—		—————		
<i>P. triandrum</i>	-	—		—————		
<i>P. punctatum</i>	-	—		—————		

gla, * = glandular hairs; - = without glandular hairs; ? = not seen

Discussion

Natural selection, associated with successful reproduction, maintains a basic similarity of the reproductive features of flowers within the various species. This general constancy makes these structures ideal for characterizing taxonomic groups. Floral features are often fundamental in defining natural groups (Jones & Luchsinger 1987). In section *Hoarea* the characteristics of the androecium have proved to be most useful in the classification of the section. The relative length of the stamens can be used to distinguish between species, but can also confirm interrelationships among species. This includes the length of the stamens if compared to that of the sepals and the differences in the length of the posterior, lateral and anterior stamens. In about one third of the species the stamens are shorter than the sepals (*Fissifolium*, *Pinnatum*, *Attenuatum* and *Proliferum* groups). The ratios between the length of the posterior and lateral stamens, and that of the lateral

and the anterior ones in these species, are more or less the same (Table 3.3). All these species have less than 20 flowers per pseudo-umbellet (Table 3.1). If the length and the length/width ratio of the posterior petals of these species are considered, they can be divided into smaller groups. The *Pinnatum* group has flowers with spatulate petals, of which the length/width ratio of the posterior petals is smaller than five, and the *Attenuatum* group has long ligulate petals with a length/width ratio of bigger than five. Because of the petal size and the uniformity of the pollen structure, *P. proliferum*, *P. pilosellifolium* and *P. caledonicum* are placed in the *Proliferum* group. The differences in the length of the posterior, lateral and anterior stamens demarcate the *Aciculatum*, *Heterophyllum* and *Incrassatum* groups. In respect to petal size, length/width ratio of the posterior petals, hypanthium length, and flower number per pseudo-umbellet the *Incrassatum* group can be subdivided into smaller groups. The papilionaceous flower of *P. rapaceum* is a unique type of floral structure and demarcates this species as a monotypic group. The delimitation of the *Luteolum* group (*P. luteolum* and *P. gracillimum*) is based on the way the anterior petals are borne during anthesis, and leaf shape supports this demarcation.

In *P. luteum* and *P. fumariifolium* the stamens are twisted in a similar way, with open anthers facing to the front. Both species have the same petal morphology, nectar guides, hypanthium length, inflorescence size and in both species the flowers have the same delicate appearance, forming the *Luteum* floral group.

The outstanding characters of the *Auratum* group are long stamens, all of them of the same length, and the papillate staminal column. *P. triphyllum* has the same long stamens as the *Auratum* group, but the staminal column is smooth, forming a floral group of its own (*Triphyllum* group).

Although the division of section *Hoarea* is mainly based on the variations in the androecium and petals, several other characters also play a role in the demarcation of the different groups. There is no single character that confirms relationship in all the groups. Most of the characters confirm relationships in some groups, but at the same time act as a diagnostic tool in other groups. None of the groups can be demarcated by only one character, in all of them a combination of characters is necessary for the delimitation.

CHAPTER 4

LEAF ANATOMY

Anatomical characters can be taxonomically useful as an aid toward establishing the interrelationships of taxa at and above the species level. Like all other taxonomic characters, a distinction must be made between diagnostic taxonomic characters that can be used to distinguish between different taxa, or characters that assist in our understanding the evolutionary relationships of plants (Dickison 1975). Several taxonomists applied leaf anatomical data for these purposes in the Geraniaceae. In *Sarcocaulon* (DC.) Sweet the anatomy of the lamina confirms the demarcation of two of the sections and with lamina anatomy in combination with trichomes all four sections of the genus can be distinguished (Verhoeven *et al.* 1983a, 1983b). Neubauer (1972) regarded the presence or absence of a medullary bundle in the petiole of *Pelargonium* as of taxonomic value, a point of view which was confirmed for sections *Pelargonium* (Volschenk, 1980), *Myrrhidium* DC. (Van der Walt & Boucher 1986), *Polyactium* DC. (Maggs 1987), *Campylia* (Sweet) DC. (Van der Walt & Van Zyl 1988), *Jenkinsonia* (Sweet) Harv. (Scheltema & Van der Walt 1990), and *Ligularia* (Sweet) Harv. (Marais 1990b). In *Polyactium* (Maggs 1987) and *Hoarea* (Marais 1991) the structure of the medullary bundle varies from a single bundle, consisting of one to three fused bundles, to several bundles. This may probably be ascribed to the way in which the medullary bundles are formed as described by Neubauer (1972), Volschenk (1980), and Dreyer (1990b). According to Dreyer (1990b) and Dreyer *et al.* (1992) petiole anatomy strengthens the evidence for the demarcation of the section *Reniformia* (Knuth) Dreyer and section *Cortusina* (DC.) Harv. *sensu stricto*. The presence of perivascular sclerenchymatous tissue in the petiole varies from sclerenchyma strands, restricted to the vascular bundles (Van der Walt & Van Zyl 1988, Dreyer 1990b, Marais 1990b), to a continuous cylinder as in *Myrrhidium* (Van der Walt & Boucher 1986), *Campylia* (Van der Walt & Van Zyl 1988), *Reniformia* (Dreyer 1990b), and *Hoarea* (Marais 1991). Both dorsiventral and isobilateral leaves occur in sections *Pelargonium* (Volschenk 1980), *Myrrhidium* (Van der Walt & Boucher 1986), *Campylia* (Van der Walt & Van Zyl 1988), *Jenkinsonia* (Scheltema & Van der Walt 1990), *Ligularia* (Marais 1990b), *Cortusina sensu stricto* and *Reniformia* (Dreyer 1990b), and often closely related taxa can be distinguished because of the dorsiventral or isobilateral leaves.

According to Dickison (1975) it is essential that the ranges of variability of anatomical characters within the same individual and different individuals in relation to the environment should be investigated. Carlquist (1961) stressed the need to describe the

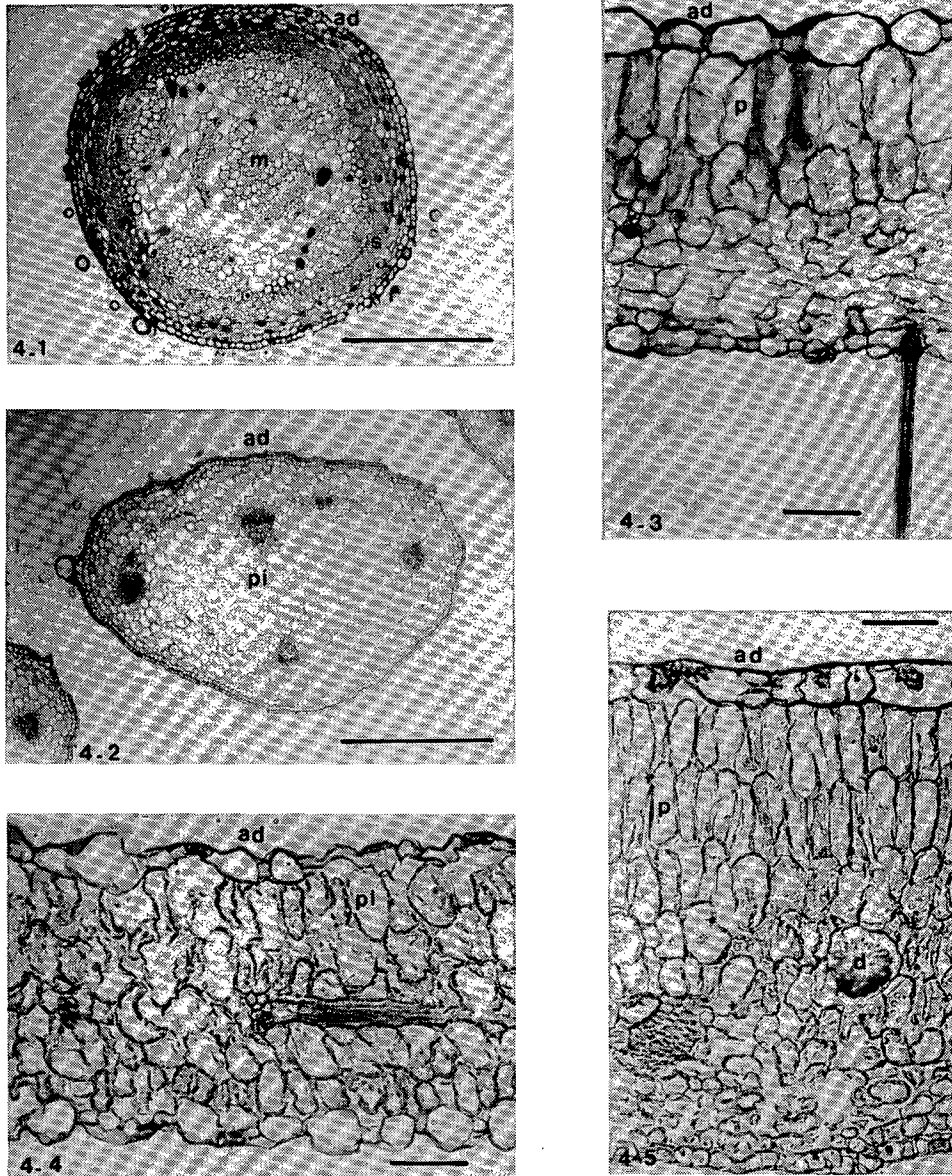


Figure 4.1 Transverse section of the petiole of *P. luteolum* (Lavranos 20266). Scale bar: 0,3 mm.

Figure 4.2 Transverse section of the petiole of *P. tenellum* (Van der Walt 1027). Scale bar: 0,65 mm.

Figure 4.3 Transverse section of the lamina of *P. githagineum* (Lavranos 20785a). Scale bar: 60 μ m.

Figure 4.4 Transverse section of the lamina of *P. rubiginosum* (Van Jaarsveld 4100). Scale bar: 60 μ m.

Figure 4.5 Transverse section of the lamina of *P. asarifolium* (Van der Walt 1062). Scale bar: 60 μ m.

ad = adaxial, d = druse, m = medullary vascular bundle, p = palisade, pi = pith, pl = palisade-like, s = schlerenchyma cylinder.

entire range of character variation of a given tissue or structure. For this reason an average of three specimens per species were studied where material was available (Table 4.7). The material studied was from plants growing for more than one season in the Botanic Garden of the University of Stellenbosch. This ensures that all the material studied was from plants growing for a considerable time under similar environmental conditions, and thus excluding to a large extent variations that could be ascribed to ecological factors.

According to Stuessy (1990) the leaf outline and the internal architecture of the leaf could be of taxonomic importance. Because of the variation in leaf form in section *Hoarea*, the leaf outline could be of taxonomic value in some cases, but because of the heteroblastic leaf development in many species this is not always a reliable taxonomic character in this section. Additional to leaf form the internal architecture was studied for diagnostic characters as well as characters to confirm relationships between species.

The anatomy of the leaves of section *Hoarea* shows little or no adaptations to the xeric habitats in which most of the species occur. All the species are deciduous geophytes, shedding their leaves during the summer and the habitus itself is an adaptation to survive the unfavourable season.

Anatomy of the petiole

The transverse sections of the middle part of the petioles of the different species vary from round, adaxially flattened or slightly grooved. In all species the petioles are covered by a uniseriate epidermis with different combinations of glandular hairs and/or non-glandular hairs. The cortex comprises a uniseriate collenchymatous hypodermis and two to six layers of chlorenchyma cells. The vascular tissue consists of a cylinder of four main bundles alternating with a varying number of medium-sized and smaller bundles. In very thin petioles as in *P. angustipetalum*, *P. fergusoniae*, *P. luteolum* (Figure 4.1) and *P. gracillimum* only four large bundles occur in the cylinder. In all the studied species, except *P. tenellum* (Figure 4.2) a medullary bundle occurs, consisting of one to three fused bundles. This medullary bundle is often in association with the adaxial bundle (Marais 1993). In some species more than one medullary bundle occur (Marais 1991), but the number is not consistent for a species. The presence of perivascular sclerenchymatous tissue varies. In species with prostrate leaves it is usually lacking in the median section, but can be present at the proximal end (Marais 1992). In species with erecto-patent leaves the sclerenchyma is restricted to strands on the outside of the vascular bundles. In these cases there is sometimes a tendency towards a continuous

sclerenchymatous cylinder surrounding the vascular bundles. In rigid erect petioles a perivascular sclerenchyma cylinder, consisting of three to six cell layers occurs (Marais 1991, Marais 1993), and in the very thin petioles of *P. angustipetalum*, *P. fergusoniae*, *P. reflexum*, *P. luteolum* and *P. gracillimum* this cylinder is very prominent (Figure 4.1). In these species the chlorenchyma tissue surrounding the sclerenchyma consists of only two cell layers. In all species the pith consists of rather large parenchyma cells.-

Table 4.1 Leaf anatomical characters in the different leaf forms of section *Hoarea*. (Species arranged according to leaf form.)

Leaf form / species	1	2	3	4	5	6	7	8	9
1. Simple, cordiform, prostrate									
<i>P. punctatum</i>	*		2-3		L			*	
<i>P. triandrum</i>	*		1		L	B		*	
<i>P. curviandrum</i>	*		2-3			B		*	
<i>P. oblongatum</i>	*		2		L			*	
<i>P. githagineum</i>	*		2		L	B		*	
<i>P. asarifolium</i>	*		3-4		L				*
2. Simple (ovate to cordiform) to tripartite or trifoliolate, prostrate									
<i>P. moniliforme</i>	*		2		L	B		*	
<i>P. vinaceum</i>	*		2		L			*	
<i>P. nervifolium</i>	*		3-4		L		*	*	
<i>P. triphyllum</i>	*		2-3		L			*	
<i>P. campestre</i>									
<i>P. aestivale</i>	*		2-3		M	B		*	
<i>P. heterophyllum</i>	*		3		L				*
<i>P. tenellum</i>	*		2-4		L				*
<i>P. chelidonium</i>									
<i>P. grenvilleae</i>	*		2-3		L	B	?		*
<i>P. radiatum</i>	*		2-3		L				*
<i>P. nummulifolium</i>	*		2-3		L				*
3. Simple (palmately veined), reniform, petiole curved									
<i>P. nephrophyllum</i>	*		2		M	B		*	
4. Palmately compound, ternate to tripinnatisect, petiole curved									
<i>P. ternifolium</i>	*		1-2		M	B	*	*	
<i>P. reflexum</i>		*	2	1	M	B			*
<i>P. fergusoniae</i>	*		2		S	B			*
1.	Leaves dorsiventral								
2.	Leaves isobilateral								
3.	Number of palisade layers adaxially								
4.	Number of palisade layers abaxially								
5.	Palisade cells short (S), medium length (M), long (L)								
6.	Palisade cells broad (B)								
7.	Stained layer								
8.	Spongy tissue loosely arranged								
9.	Mesophyll compact								

Table 4.1 Leaf anatomical characters in the different leaf forms of section *Hoarea*. (Continue)

Leaf form / species	1	2	3	4	5	6	7	8	9
5. Palmately compound, ternate to tripinnatisect, petiole erect									
<i>P. luteolum</i>	*		2		S	B	*		*
<i>P. gracillimum</i>		*	2	1	S	B			*
<i>P. attenuatum</i>									
<i>P. angustipetalum</i>	*		2		S	B	*	*	
6. Simple to tripartite or trifoliolate, lanceolate, petiole erect									
<i>P. longiflorum</i>		*	2	1	S/L		*		*
<i>P. radicum</i>	*		2		S	B			*
<i>P. ellaphieae</i>	*		2		S	B			*
7. Simple to pinnatisect or pinnately compound, lanceolate, petiole erect									
<i>P. pilosellifolium</i>		*	2	1	M	B	?		*
8. Simple or pinnately compound to irregularly bipinnatisect, lanceolate to ovate, petiole erect									
<i>P. longifolium</i>		*	1-2	1	S	B	*		*
<i>P. proliferum</i>									
<i>P. dipetalum</i>		*	2	1	L		*		*
9. Pinnately compound, erect, pinnate									
<i>P. pinnatum</i>	*	*	1	1	M	B	*		*
<i>P. viciifolium</i>	*		1		M	B	*		*
<i>P. trifoliolatum</i>		*	1	1	M	B	*		*
10. Pinnately compound, erect, pinnatisect to pinnate, trullate or elliptic									
<i>P. leptum</i>		*	2	1	S		?		*
<i>P. undulatum</i>		*	2	1-2	S/L		?		*
<i>P. leipoldtii</i>	*	*	2	1	S/L	B	?		*
<i>P. fumarifolium</i>	*		2		S		*	*	
<i>P. violiflorum</i>	*		2-3		M	B		*	
11. Pinnately compound, erect, pinnate to irregularly bi- or tripinnatisect									
<i>P. auritum</i>		*	2	1	S				*
<i>P. incrassatum</i>		*	2	1	S/L		*		*
<i>P. fissifolium</i>		*	2	1	S				*
<i>P. petroselinifolium</i>		*	2	1	S				*
<i>P. aristatum</i>	*	*	2	1	S				*
<i>P. carneum</i>		*	2-3	1-2	M		*		*
<i>P. luteum</i>	*		2-3		L			*	
<i>P. bubonifolium</i>		*	2	1	M	B			*
<i>P. parvipetalum</i>		*	2	1	S	B	?		*
<i>P. appendiculatum</i>	*		1		S	B			*
<i>P. caroli-henrici</i>	*		2		S	B			*
<i>P. rubiginosum</i>	*		2		S	B			*
<i>P. caledonicum</i>									
<i>P. rapaceum</i>		*	2	1	M	B			*
12. Pinnately compound, erect, irregularly bi- or tripinnatisect, aciculatum group									
<i>P. aciculatum</i>	*		1		M	B			*
<i>P. confertum</i>	*		1		M	B			*
<i>P. fasciculaceum</i>	*		1		M	B			*
<i>P. connivens</i>	*		1		M	B			*

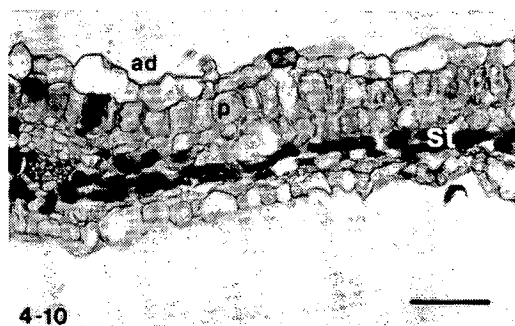
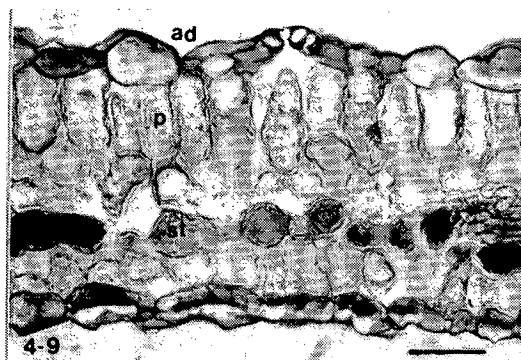
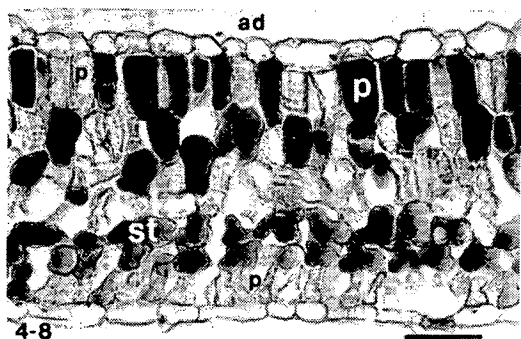
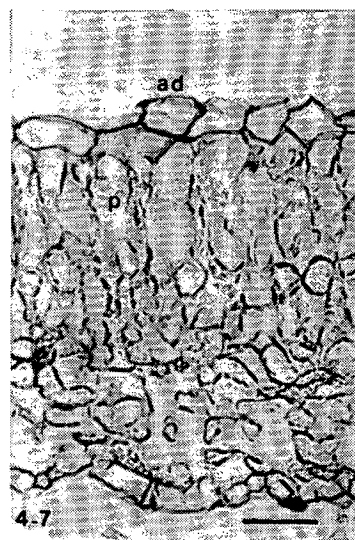
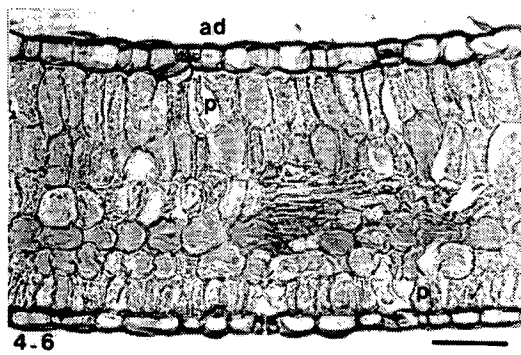


Figure 4.6 Transverse section of the lamina of *P. pilosellifolium* (Fischer 293). Scale bar: 60 μm .

Figure 4.7 Transverse section of the lamina of *P. curviandrum* (Lavranos 20941). Scale bar: 60 μm .

Figure 4.8 Transverse section of the lamina of *P. undulatum* (Marais 331). Scale bar: 60 μm .

Figure 4.9 Transverse section of the lamina of *P. viciifolium* (Marais 13). Scale bar: 60 μm .

Figure 4.10 Transverse section of the lamina of *P. ternifolium* (Marais 319). Scale bar: 60 μm .

ad = adaxial, p = palisade, st = stained layer.

Anatomy of the lamina

The laminae are amphistomatic with a uniserial epidermis and different combinations of glandular and non-glandular hairs, covered by a thin and smooth cuticle. Studies with the scanning electron microscope (SEM) of the leaves show that the cuticular wax patterns are of no taxonomic significance in section *Hoarea*. The cells of the adaxial epidermis are usually slightly larger than those of the abaxial side. However, in species with simple leaves like *P. githagineum* (Figure 4.3), *P. curviandrum* E.M. Marais, *P. nephrophyllum*, *P. vinaceum*, *P. asarifolium*, and *P. radicum* the difference is much more prominent. The abaxial epidermal cells of *P. nephrophyllum* and of *P. nervifolium* contain anthocyanin, hence the reddish purple colour on the lower side of the leaves. In surface view the anticlinal walls of the epidermis cells on both sides are sinuous.

In the majority of species (34) the laminae are dorsiventral, and in 18 species the leaves are isobilateral (Table 4.1). This is of diagnostic value, because environmental variations will not alter arrangements which are rigidly controlled by the genome (Cutler 1978). In *P. pinnatum*, *P. leipoldtii* and *P. aristatum* both leaf types occur (Table 4.1). The palisade cells in most species are rather broad (Figure 4.4, Table 4.1) and in *P. rubiginosum* (Figure 4.4), *P. caroli-henrici*, *P. radicum* and *P. appendiculatum* this tissue should rather be described as palisade-like. The number of palisade cell layers inside the adaxially epidermis varies from one to four, of which the outer layer consists of longer cells than the inner layers. In the case of *P. asarifolium* (Figure 4.5), *P. nervifolium* and *P. tenellum* the palisade tissue extends over half the cross section of the leaf. Although the number of palisade cell layers is a variable character which is easily influenced by environmental conditions (Cutler 1978), it must be kept in mind that the material studied here grew under similar conditions. In isobilateral leaves usually only one layer of palisade cells occurs inside the abaxial epidermis (Figure 4.6). In the majority of species (38) the mesophyll is rather compact with small and few air spaces (Table 4.1, Figure 4.6). This includes all the species with isobilateral leaves. Although it is not true for all species with simple or trifoliolate leaves, the majority of them have spongy tissue with large intercellular spaces (Table 4.1, Figure 4.7). Five species with compound leaves (*P. ternifolium*, *P. angustipetalum*, *P. fumariifolium*, *P. luteum* and *P. violiflorum*) have similar loosely arranged spongy parenchyma cells. In more or less one third of the species studied, a prominently stained layer of cells occurs on the abaxial side of the mesophyll (Marais 1993, Figures 4.8 & 4.9). In the isobilateral leaves this layer occurs on the inside of the abaxial palisade cells (Figure 4.8) and in the dorsiventral leaves this layer represents the second layer inside the abaxial epidermis (Figure 4.9). This layer is associated with the compact type of mesophyll, although it is not restricted

to this type of leaf (Table 4.1). Exceptions to this are *P. nervifolium*, *P. ternifolium* (Figure 4.10), *P. angustipetalum* and *P. fumariifolium*, all of them with a loosely arranged mesophyll. This stained layer does not always have the same intensity in the different specimens of the same species and is like-wise indicated (?) in Table 4.1.

The presence of idioblasts with tannin or druse crystals in the petioles and the laminae varies not only between species but also in different specimens of the same the species. Therefore I do not regard them as of any taxonomic value in section *Hoarea*. Druses in the petioles occur scattered through the pith, usually in the vicinity of the vascular bundles and in the laminae they occur on the border between the palisade and the spongy tissue or throughout the spongy tissue.

Table 4.2 Anatomical characters of the laminae compared to different leaf forms occurring in section *Hoarea*. (Species arranged according to leaf form)

Leaf form / species	1	2	3	4
1. Simple, cordiform, prostrate				
<i>P. punctatum</i>	■			
<i>P. triandrum</i>	■			
<i>P. curviandrum</i>	■			
<i>P. oblongatum</i>	■			
<i>P. githagineum</i>	■			
<i>P. asarifolium</i>		■		
2. Simple (ovate to cordiform) to tripartite or trifoliolate, prostrate				
<i>P. moniliforme</i>	■			
<i>P. vinaceum</i>	■			
<i>P. nervifolium</i>	■			■
<i>P. triphyllum</i>	■			
<i>P. campestre</i>				
<i>P. aestivale</i>	■			
<i>P. heterophyllum</i>		■		
<i>P. tenellum</i>		■		
<i>P. chelidonium</i>				
<i>P. grenvilleae</i>		■		■
<i>P. radiatum</i>		■		
<i>P. nummulifolium</i>		■		
3. Simple (palmately veined), reniform, petiole curved				
<i>P. nephrophyllum</i>	■			

1. Dorsiventral, spongy tissue loosely arranged
2. Dorsiventral, spongy tissue compact
3. Isobilateral, spongy tissue compact
4. Stained layer

Table 4.2 Anatomical characters of the laminae compared to different leaf forms occurring in section *Hoarea*. (Continue)

Leaf form / species	1	2	3	4
4. Palmately compound, ternate to tripinnatisect, petiole curved				
<i>P. ternifolium</i>	■			■
<i>P. reflexum</i>			■	
<i>P. fergusoniae</i>		■		
5. Palmately compound, ternate to tripinnatisect, petiole erect				
<i>P. luteolum</i>		■		■
<i>P. gracillimum</i>			■	
<i>P. attenuatum</i>				
<i>P. angustipetalum</i>	■			■
6. Simple to tripartite or trifoliolate, lanceolate, petiole erect				
<i>P. longiflorum</i>			■	■
<i>P. radicatum</i>		■		
<i>P. ellaphieae</i>		■		
7. Simple to pinnatisect or pinnately compound, lanceolate, petiole erect				
<i>P. pilosellifolium</i>			■	■
8. Simple or pinnately compound to irregularly bipinnatisect, lanceolate to ovate, petiole erect				
<i>P. longifolium</i>			■	■
<i>P. proliferum</i>				
<i>P. dipetalum</i>			■	■
9. Pinnately compound, erect, pinnate				
<i>P. pinnatum</i>		■	■	■
<i>P. viciifolium</i>		■		■
<i>P. trifoliolatum</i>			■	■
10. Pinnately compound, erect, pinnatisect to pinnate, trullate or elliptic				
<i>P. leptum</i>			■	■
<i>P. undulatum</i>			■	■
<i>P. leipoldtii</i>		■	■	■
<i>P. fumariifolium</i>	■			■
<i>P. violiflorum</i>	■			
11. Pinnately compound, erect, pinnate to irregularly bi- or tripinnatisect				
<i>P. auritum</i>			■	
<i>P. incrassatum</i>			■	■
<i>P. fissifolium</i>			■	
<i>P. petroselinifolium</i>			■	
<i>P. aristatum</i>		■	■	
<i>P. luteum</i>	■			
<i>P. carneum</i>			■	■
<i>P. bubonifolium</i>			■	
<i>P. parvipetalum</i>			■	■
<i>P. appendiculatum</i>		■		
<i>P. caroli-henrici</i>		■		
<i>P. rubiginosum</i>		■		
<i>P. caledonicum</i>				
<i>P. rapaceum</i>			■	

Table 4.2 Anatomical characters of the laminae compared to different leaf forms occurring in section *Hoarea*. (Continue)

Leaf form / species	1	2	3	4
12. Pinnately compound, erect, irregularly bi- or tripinnatisect, aciculatum group				
<i>P. aciculatum</i>		■		
<i>P. confertum</i>		■		
<i>P. fasciculaceum</i>		■		
<i>P. connivens</i>		■		
1. Dorsiventral, spongy tissue loosely arranged				
2. Dorsiventral, spongy tissue compact				
3. Isobilateral, spongy tissue compact				
4. Stained layer				

Table 4.3 Anatomical characters of the laminae compared to different floral groups occurring in section *Hoarea*. (Species arranged according to floral groups)

Floral group / species	1	2	3	4
1. Fissifolium group				
<i>P. aestivale</i>	■			
<i>P. fissifolium</i>			■	
<i>P. petroselinifolium</i>			■	
<i>P. aristatum</i>		■	■	
2. Pinnatum group				
<i>P. chelidonium</i>				
<i>P. nervifolium</i>	■			■
<i>P. pinnatum</i>		■	■	■
<i>P. reflexum</i>			■	
<i>P. violiflorum</i>	■			
3. Attenuatum group				
<i>P. attenuatum</i>				
<i>P. angustipetalum</i>	■			■
<i>P. leptum</i>			■	■
<i>P. vicifolium</i>		■		■
<i>P. longifolium</i>			■	■
<i>P. fergusoniae</i>		■		
<i>P. undulatum</i>			■	■
<i>P. longiflorum</i>			■	■
4. Proliferum group				
<i>P. proliferum</i>				
<i>P. pilosellifolium</i>			■	■
<i>P. caledonicum</i>				
5. Heterophyllum group				
<i>P. heterophyllum</i>		■		
<i>P. tenellum</i>		■		
<i>P. trifoliolatum</i>			■	■
1. Dorsiventral, spongy tissue loosely arranged				
2. Dorsiventral, spongy tissue compact				
3. Isobilateral, spongy tissue compact				
4. Stained layer				

Table 4.3 Anatomical characters of the laminae compared to different floral groups occurring in section *Hoarea*. (Continue)

Floral group / species	1	2	3	4
6. Aciculatum group				
<i>P. aciculatum</i>		■		
<i>P. confertum</i>		■		
<i>P. fasciculaceum</i>		■		
<i>P. connivens</i>		■		
7. Luteum group				
<i>P. luteum</i>	■			
<i>P. fumarifolium</i>	■			■
8. Incrassatum group				
<i>P. incrassatum</i>			■	■
<i>P. grenvilleae</i>		■		■
<i>P. moniliforme</i>	■			
<i>P. vinaceum</i>	■			
<i>P. radicum</i>		■		
<i>P. appendiculatum</i>		■		
<i>P. campestre</i>				
<i>P. nephrophyllum</i>	■			
<i>P. carneum</i>			■	■
<i>P. radiatum</i>		■		
<i>P. nummulifolium</i>		■		
9. Luteolum group				
<i>P. luteolum</i>		■		■
<i>P. gracillimum</i>			■	
10. Rapaceum group				
<i>P. rapaceum</i>			■	
11. Auritum group				
<i>P. auritum</i> var. <i>auritum</i>			■	
<i>P. auritum</i> var. <i>carneum</i>			■	
<i>P. bubonifolium</i>			■	
<i>P. parvipetalum</i>			■	■
<i>P. leipoldtii</i>		■	■	
<i>P. ellaphieae</i>		■		
<i>P. asarifolium</i>		■		
<i>P. dipetalum</i>			■	■
<i>P. ternifolium</i>	■			■
12. Triphyllum group				
<i>P. triphyllum</i>	■			
13. Caroli-henrici group				
<i>P. githagineum</i>	■			
<i>P. caroli-henrici</i>		■		
<i>P. rubiginosum</i>		■		

Table 4.3 Anatomical characters of the laminae occurring with different floral groups occurring in section *Hoarea*. (Continue)

Floral group / species	1	2	3	4
14. Punctatum group				
<i>P. oblongatum</i>	■			
<i>P. curviandrum</i>	■			
<i>P. triandrum</i>	■			
<i>P. punctatum</i>	■			

1. Dorsiventral, spongy tissue loosely arranged
2. Dorsiventral, spongy tissue compact
3. Isobilateral, spongy tissue compact
4. Stained layer

Discussion

Comparing vegetative morphological characters to floral morphology, it confirms Dickison's (1975) statement that evolutionary modifications of vegetative characteristics are not necessarily closely synchronized with floral evolution (Table 3.6). Only the *Aciculatum* and the *Punctatum* floral groups are delimited by both the floral structure and the leaf form. When anatomical characters of the laminae are compared to leaf form (Table 4.2) or to floral structure (Table 4.3), these two groups again are delimited as taxonomic units. Relationships between smaller groups with similar floral structures and similar leaf forms are also confirmed by this comparison (Tables 4.4a).

Table 4.4a *Hoarea* species with similar floral structures, leaf form and lamina anatomy.

1.	<i>Aciculatum</i> group
2.	<i>Punctatum</i> group
3.	<i>P. moniliforme</i> and <i>P. vinaceum</i>
4.	<i>P. radiatum</i> and <i>P. nummulifolium</i>
5.	<i>P. heterophyllum</i> and <i>P. tenellum</i>
6.	<i>P. leptum</i> and <i>P. undulatum</i>
7.	<i>P. bubonifolium</i> and <i>P. parvipetalum</i>

This list of species with similar features is extended when the anatomy of the lamina is compared to floral structure only (Table 4.4b).

Table 4.4b *Hoarea* species with similar floral structures and lamina anatomy.

8.	<i>P. luteum</i> and <i>P. fumariifolium</i>
9.	<i>P. radicum</i> and <i>P. appendiculatum</i>
10.	<i>P. caroli-henrici</i> and <i>P. rubiginosum</i>

This comparison also reveals the diagnostic value of the anatomy of the lamina. Dorsiventral or isobilateral leaf architecture could be used to distinguish between species with similar leaf outlines (Table 4.5).

Table 4.5 Anatomy of the lamina of *Hoarea* species with similar leaf outlines.

Dorsiventral	Isobilateral	Floral structure
1. <i>P. luteolum</i>	<i>P. gracillimum</i>	similar
2. <i>P. reflexum</i>	<i>P. fergusoniae</i>	different
3. <i>P. longiflorum</i>	<i>P. radicum</i>	different
4. <i>P. longiflorum</i>	<i>P. ellaphieae</i>	different

At the same time the anatomy of the lamina could also be of diagnostic value if floral structures are compared (Table,4.6).

Table 4.6 Anatomy of the lamina of *Hoarea* species with similar floral structures.

Dorsiventral	Isobilateral	Leaf outline
1. <i>P. grenvillea</i>	<i>P. incrassatum</i>	different
2. <i>P. luteolum</i>	<i>P. gracillimum</i>	similar
3. <i>P. radiatum</i>	<i>P. carneum</i>	different
4. <i>P. nummulifolium</i>	<i>P. carneum</i>	different
5. <i>P. aestivale</i>	<i>P. fissifolium</i>	different
6. <i>P. aestivale</i>	<i>P. petroselinifolium</i>	different

The anatomy of the petiole does not contribute much to the delimitation of species or give any indication of trends of evolution in section *Hoarea*. The only useful character of the petiole anatomy is the absence of a medullary bundle in the petiole of *P. tenellum*. In *P. longifolium* a medullary bundle was lacking in some specimens, but not in all of them.

The presence or absence of sclerenchymatous tissue should rather be interpreted ecologically than giving it a taxonomic interpretation.

Anatomical characters of the lamina in section *Hoarea* are useful in the delimitation of some of the species. In other species similarities in the anatomy confirm relationships between species and do lend support to ideas formulated on macromorphology and pollen structure. Since similar anatomical structures have arisen many times in widely divergent taxa, similarities in structural specialization do not necessarily imply close relationship (Dickison 1975). For that reason I regard the support from the anatomy to the delimitation of smaller groups (Table 4.3) of more importance than the lack of it in the larger floral type groups.

Table 4.7 Specimens of the different *Hoarea* species studied for leaf anatomy.

Taxon Specimen	Herbarium number	Taxon Specimen	Herbarium number
1. FISSIFOLIUM GROUP		<i>P. leptum</i>	
<i>P. aestivale</i>		<i>Oliver s.n.</i>	STEU 442
<i>Lavranos 20952</i>	STEU 3209	<i>Marais s.n.</i>	STEU 1740
<i>Van der Walt 1454</i>	STEU 3270	<i>Marais 209</i>	STEU 3642
<i>Marais 146</i>	STEU 3485		
<i>P. fissifolium</i>		<i>P. viciifolium</i>	
<i>Van der Walt s.n.</i>	STEU 1625	<i>Van der Walt 479</i>	STEU 554
<i>Fischer 133</i>	STEU 1928	<i>Marais 13</i>	STEU 2523
<i>Marais 232</i>	STEU 3667	<i>Marais 321</i>	STEU 3875
<i>Marais 249</i>	STEU 3684	<i>Marais 165</i>	STEU 3518
<i>P. petroselinifolium</i>		<i>P. longifolium</i>	
<i>Fischer 356</i>	STEU 2688	<i>Van der Walt s.n.</i>	STEU 1252
		<i>Van der Walt 1060</i>	STEU 2440
<i>P. aristatum</i>		<i>Marais 57</i>	STEU 2920
<i>Fischer 27a</i>	STEU 1571	<i>Marais 342</i>	STEU 3936
<i>Fischer 28</i>	STEU 1572		
<i>Van der Walt 1442</i>	STEU 3256	<i>P. fergusoniae</i>	
		<i>Fischer 231</i>	STEU 2564
2. PINNATUM GROUP		<i>Bayer 2513</i>	STEU 3153
<i>P. nervifolium</i>		<i>Meve 261186/396</i>	STEU 3750
<i>Van der Walt s.n.</i>	STEU 1624	<i>P. undulatum</i>	
<i>Lavranos 18999</i>	STEU 2822	<i>Van der Walt s.n.</i>	STEU 1069
<i>Marais 145</i>	STEU 3484	<i>Lavranos 17470</i>	STEU 2310
<i>Marais 274</i>	STEU 3711	<i>Van der Walt 1111</i>	STEU 2698
<i>Marais 276</i>	STEU 3713	<i>Lavranos 18803</i>	STEU 2820
<i>Marais 334</i>	STEU 3897	<i>Muller 4141a</i>	STEU 3462
<i>P. pinnatum</i> (* Large-flowered species)		<i>Marais 331</i>	STEU 3894
<i>Fischer 271</i>	STEU 2604*	<i>P. longiflorum</i>	
<i>Marais 169</i>	STEU 3544*	<i>Marais 35</i>	STEU 2665
<i>Van der Walt 510</i>	STEU 584	<i>Walters 3</i>	STEU 2987
<i>Drijfhout 662</i>	STEU 856	<i>Van der Walt 1412</i>	STEU 3181
<i>Hugo s.n.</i>	STEU 1748	<i>Van der Walt 1421</i>	STEU 3190
<i>Lavranos 20905</i>	STEU 3206a	<i>Marais 182</i>	STEU 3555
<i>Muller s.n.</i>	STEU 3436	<i>Marais 267</i>	STEU 3704
<i>Marais 289</i>	STEU 3739	<i>Marais 268</i>	STEU 3705
<i>Van der Walt 1558</i>	STEU 3861	<i>Marais 308</i>	STEU 3820
<i>P. reflexum</i>		<i>Le Maitre s.n.</i>	STEU 3839
<i>Van Wyk 161</i>	STEU 2129	4. PROLIFERUM GROUP	
<i>Marais 278</i>	STEU 3715	<i>P. pilosellifolium</i>	
<i>P. violiflorum</i>		<i>Schonken 201</i>	STEU 2174
<i>Fischer 216</i>	STEU 2548	<i>Fischer 293</i>	STEU 2626
3. ATTENUATUM GROUP		<i>Lavranos 20911</i>	STEU 3213
<i>P. angustipetalum</i>		5. HETEROPHYLLUM GROUP	
<i>Drijfhout 1371</i>	STEU 674	<i>P. heterophyllum</i>	
		<i>Van der Walt 1041</i>	STEU 2408
		<i>Marais 33</i>	STEU 2663

Table 4.7 (Continue)

Taxon Specimen	Herbarium number	Taxon Specimen	Herbarium number
<i>P. tenellum</i>		8. INCRASSATUM GROUP	
<i>Van der Walt 1027</i>	STEU 2395	<i>P. incrassatum</i>	
<i>Van Zyl s.n.</i>	STEU 3253	<i>Boucher 63</i>	STEU 989
<i>Marais 136</i>	STEU 3453	<i>Van der Walt 789</i>	STEU 1525
<i>Van Zyl s.n.</i>	STEU 3884	<i>Fischer 1</i>	STEU 1545
<i>P. trifoliolatum</i>		<i>Marais 74</i>	STEU 3320
<i>Cillié s.n.</i>	STEU 589	<i>P. grenvilleae</i>	
<i>Marais 40</i>	STEU 2673	<i>Van der Walt 1406</i>	STEU 3170
<i>Marais 45</i>	STEU 2680	<i>Marais 131</i>	STEU 3428
<i>Marais 178</i>	STEU 3551	<i>Williamson 3951</i>	STEU 3911
<i>Marais 300</i>	STEU 3779	<i>Williamson 3950</i>	STEU 3913
<i>Marais 345</i>	STEU 3941	<i>P. moniliforme</i>	
6. ACICULATUM GROUP		<i>Boucher 77</i>	STEU 996
<i>P. aciculatum</i>		<i>Lavranos 17478</i>	STEU 2324
<i>Ward s.n.</i>	STEU 1098	<i>Marais 73</i>	STEU 3318
<i>Van der Walt 1024</i>	STEU 2282	<i>Marais 217</i>	STEU 3652
<i>Van der Walt 1039</i>	STEU 2405	<i>Marais 355</i>	STEU 3996
<i>Marais 265</i>	STEU 3702	<i>P. vinaceum</i>	
<i>P. confertum</i>		<i>Lavranos 20785</i>	STEU 3220
<i>Van der Walt 956</i>	STEU 2069	<i>Marais 77</i>	STEU 3339
<i>Van Jaarsveld 4283</i>	STEU 2375	<i>Williamson 3527</i>	STEU 3626
<i>Marais 72</i>	STEU 3317	<i>Visser s.n.</i>	STEU 3859
<i>P. fasciculaceum</i>		<i>Williamson 4010</i>	STEU 3915
<i>Van der Walt 1046</i>	STEU 2420	<i>P. radicum</i>	
<i>Marais 184</i>	STEU 3557	<i>Van der Walt 1417</i>	STEU 3186
<i>Marais 199</i>	STEU 3632	<i>P. appendiculatum</i>	
<i>Marais 266</i>	STEU 3703	<i>Van der Walt 1429</i>	STEU 3233
<i>P. connivens</i>		<i>P. nephrophyllum</i>	
<i>Lavranos 19001</i>	STEU 2817	<i>Snijman 593</i>	STEU 3229
<i>Lavranos 19000</i>	STEU 2824	<i>P. carneum</i>	
7. LUTEUM GROUP		<i>Fischer 363</i>	STEU 2826
<i>P. luteum</i>		<i>Marais 147</i>	STEU 3486
<i>Marais 120</i>	STEU 3417	<i>Marais 153</i>	STEU 3491
<i>Marais 121</i>	STEU 3418	<i>Marais 154</i>	STEU 3492
<i>Perry 3243</i>	STEU 3449	<i>P. radiatum</i>	
<i>Marais 270</i>	STEU 3707	<i>Van der Walt 970</i>	STEU 2114
<i>Marais 271</i>	STEU 3708	<i>Van der Walt 1063</i>	STEU 2443
<i>P. fumarifolium</i>		<i>Van der Walt 1494</i>	STEU 3476
<i>Marais 240</i>	STEU 3675	<i>Albers s.n.</i>	STEU 3728
<i>Marais 391</i>	STEU 4100		

Table 4.7 (Continue)

Taxon Specimen	Herbarium number	Taxon Specimen	Herbarium number
<i>P. nummulifolium</i> Watson 71	STEU 3954	Van Wyk 752	STEU 3063
9. LUTEOLUM GROUP		<i>P. dipetalum</i> Marais 173	STEU 3548
<i>P. luteolum</i> Lavranos 20266	STEU 3105	<i>P. ternifolium</i> Drijfhout 1627	STEU 855
<i>P. gracillimum</i> Marais 161	STEU 3499	Marais s.n.	STEU 1741
Marais 162	STEU 3500	Marais 319	STEU 3873
		Marais 320	STEU 3874
10. RAPACEUM GROUP		12. TRIPHYLLUM GROUP	
<i>P. rapaceum</i> Marais 122	STEU 3419	<i>P. triphyllum</i> Von Willert s.n.	STEU 4096
Marais 200	STEU 3633	13. CAROLI-HENRICI GROUP	
Van Zyl s.n.	STEU 3886	<i>P. githagineum</i> Lavranos 20785a	STEU 3220a
11. AURITUM GROUP		Marais 143	STEU 3482
<i>P. auritum</i> v <i>auritum</i> Marais 96	STEU 3393	Marais 243	STEU 3678
Marais 314	STEU 3868	<i>P. caroli-henrici</i> Drijfhout 2708	STEU 2889
<i>P. auritum</i> v <i>carneum</i> Lavranos 20926	STEU 3216	Marais 281	STEU 3718
Marais 156	STEU 3494	<i>P. rubiginosum</i> Van Jaarsveld 4100	STEU 2371
Marais 160	STEU 3498	Drijfhout 2811	STEU 2888
<i>P. bubonifolium</i> Van Jaarsveld 4230	STEU 2370	14. PUNCTATUM GROUP	
Drijfhout 2971	STEU 2886	<i>P. oblongatum</i> Van der Walt s.n.	STEU 819
Drijfhout 2970	STEU 2895	Van Jaarsveld 5368	STEU 2887
<i>P. parvipetalum</i> Bruyns 1519	STEU 1455	<i>P. curviandrum</i> Lavranos 20941	STEU 3214
Stirton 9242	STEU 3066	<i>P. triandrum</i> Van der Walt s.n.	STEU 1464
<i>P. leipoldtii</i> Walters 2	STEU 2986	Van der Walt s.n.	STEU 1477
Muller 4036	STEU 3465	Friedrich 452	STEU 2184
Marais 207	STEU 3640	Van der Walt 1276	STEU 2947
Marais 220	STEU 3655	Van Niekerk s.n.	STEU 3627
Van Zyl s.n.	STEU 3973	<i>P. punctatum</i> Fischer 34	STEU 1578
<i>P. ellaphieae</i> Marais 305	STEU 3817	Van der Walt 944	STEU 2057
Marais 306	STEU 3818	Lavranos 18876	STEU 2821
Marais 383	STEU 4085	Marais 67	STEU 3302
<i>P. asarifolium</i> Van der Walt 1062	STEU 2442	Meve 273	STEU 3744
Fischer 343	STEU 2475		

CHAPTER 5

PALYNOLOGY

Data from pollen grains are known to be useful at all levels of the taxonomic hierarchy and data obtained with the help of the scanning electron microscope are often most valuable at the lower levels of the taxonomic hierarchy (Stuessy 1990). It is also known that in some genera no significant differences are found among the different species, whereas in others remarkable variations of great and obvious taxonomic value occur. Several studies investigated the taxonomic value of the pollen morphology of the Geraniaceae. According to Bortenschlager (1967) the pollen morphology of the different genera of the Geraniaceae is heterogeneous. *Pelargonium* was shown to have some affinities with the related genera *Erodium* L'Hérit., *Monsonia* L. and *Sarcocaulon*. All five genera of the Geraniaceae have representatives with a reticulate exine, but in *Erodium* and *Geranium* a reticulate to striate pattern occurs. In their study of the pollen of *Sarcocaulon*, Verhoeven & Venter (1988) failed to produce any diagnostic characters of the exine within the genus, but pollen size might be useful in some cases to distinguish between species. Pollen data support the close relationship between *Sarcocaulon* and *Monsonia* L. (Verhoeven & Venter 1986). Except for *M. speciosa* L. and *M. deserticola* Dinter ex Knuth, pollen morphology of *Monsonia* cannot be used to distinguish between different species, but is useful in grouping species into four different pollen types, and according to Verhoeven & Venter (1986) pollen morphology supports the present taxonomic division of the genus. In respect to pollen size and density of suprategal processes in the European representatives of *Geranium* L., Stafford and Blackmore (1991) identified four different groups. They observed a certain degree of overlap between the four groups. Although the southern African *Geranium* species cannot be grouped in a similar way, pollen size plays an important role in grouping these species (Verhoeven & Venter 1992). In *Erodium* different pollen types are identified (El-Oqlah 1983, Verhoeven & Venter 1987) but because of the variation in the sculpture within the same species, the pollen morphology is of little taxonomic value in this genus.

In *Pelargonium* pollen morphology is useful in the delimitation of the different sections. In the case of section *Polyactium* pollen morphology confirms the delimitation of the subsections (Marais 1981, Verhoeven & Marais 1990). In most cases pollen morphology cannot be used to distinguish between closely related species in *Pelargonium*, but there are cases in which the presence or absence of intraluminal baculae (Bortenschlager 1967, Dreyer 1990a) and the size of the pollen grains exhibit differences at species level. In *Pelargonium* several examples are known where pollen

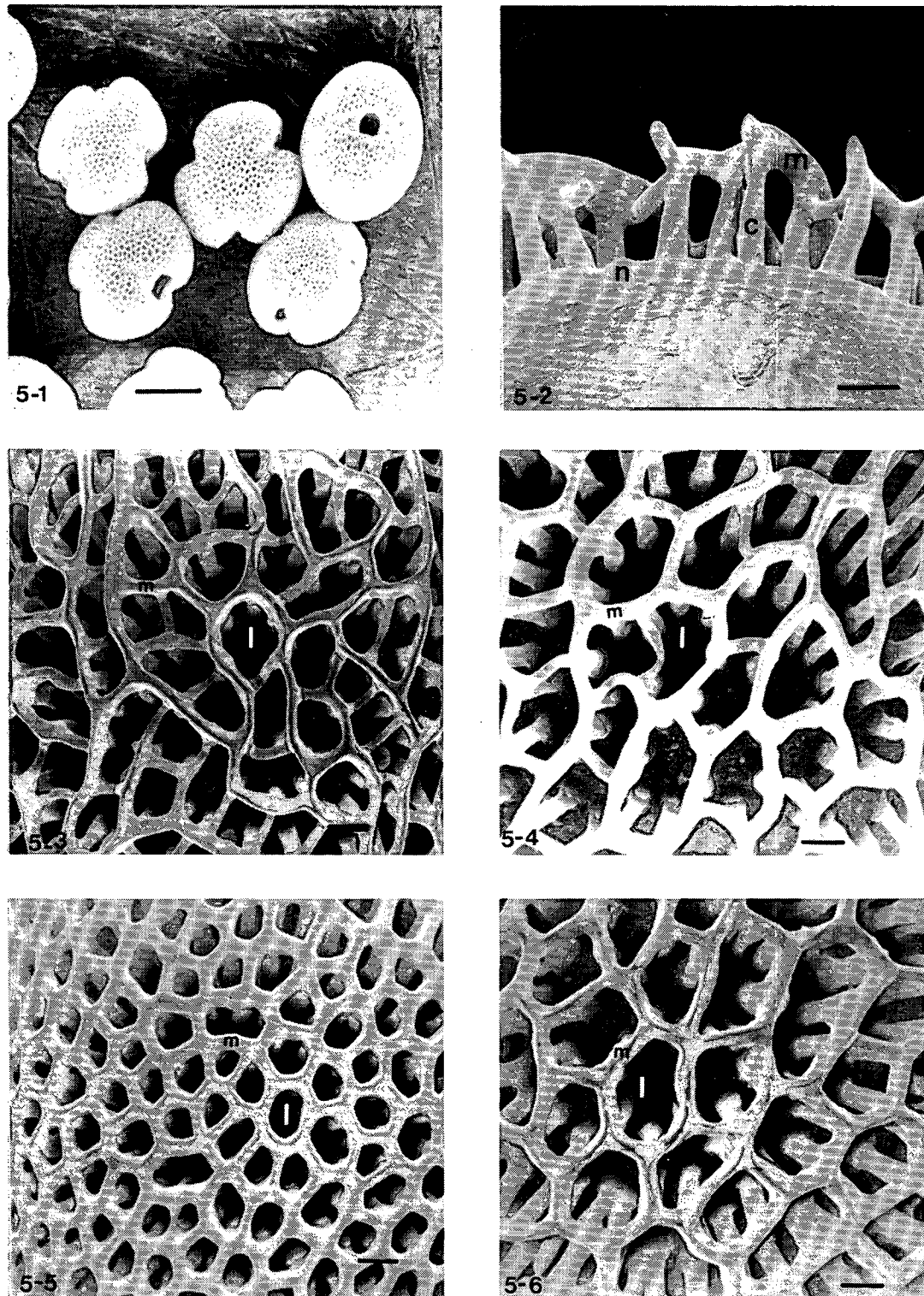


Figure 5.1 Pollen grains of *P. undulatum* (Van der Walt s.n., STEU 1069). Scale bar: 30 μm .

Figure 5.2 Pollen wall of *P. carneum* (Van der Walt s.n., STEU 1654). Scale bar: 2 μm .

Figure 5.3 Mesocolpium of the pollen of *P. luteum* (Marais 270). Scale bar: 2 μm .

Figure 5.4 Mesocolpium of the pollen of *P. fissifolium* (Drijfhout 2657). Scale bar: 2 μm .

Figure 5.5 Mesocolpium of the pollen of *P. proliferum* (Van der Walt 931). Scale bar: 2 μm .

Figure 5.6 Mesocolpium of the pollen of *P. longifolium* (Van der Walt 1060), Scale bar: 2 μm .

c = columella, l = lumen, m = muri, n = nexine.

morphology confirms the misplacement of species by Knuth (1912) in sections with non-related species (Verhoeven & Marais 1990).

Table 5.1 Type of tectum structures in the different sections of *Pelargonium*. (From Verhoeven & Marais 1990)

	1	2	3	4	5	6	7
<i>Eumorpha</i>				+	+		
<i>Pelargonium</i>				+ -	+		
<i>Glaucophyllum</i>			+		+		
<i>Dibrachya</i>					+		
<i>Ciconium</i>					+		
<i>Isopetalum</i>					+		
<i>Campylia</i>					+		
<i>Peristera</i>	+		+		+		
<i>Cortusina</i>	+	+	+		+		
<i>Reniformia</i>			+		+		
<i>Polyactium</i>	+				+		+
<i>Ligularia s.l.</i>	+	+	+	+	+		
<i>Myrrhidium</i>					+		
<i>Jenkinsonia</i>					+		
<i>Otidia</i>					+		
<i>Hoarea</i>	+		+	+	+	+	

1 = reticulate		
2 = reticulate + intraluminary baculae		! = prominent
3 = reticulate/striate		
4 = reticulate/striate + intraluminary baculae		- = seldom present
5 = striate/reticulate		
6 = striate		
7 = double structure:	Pole:	striate
	Mesocolpium:	striate/reticulate

Taxonomic characters provided by pollen grains include aggregation, shape and size of the grains, number, shape and position of apertures and the ornamentation of the wall, that is primarily the exine (Jones & Luchsinger 1987, Stuessy 1990), thus resulted in the description of *Pelargonium* pollen grains as spherical, radiosymmetric, isopolar, tricolporate monades (Figure 5.1, Bortenschlager 1967, Verhoeven & Marais 1990). According to Walker & Doyle's (1975) criteria, the pollen grains are large (50 to 100 μm in diameter). The exine consists of a nexine and sexine. The latter is semitectate and consists of columellae and a tectum (Figure 5.2). Bortenschlager (1967) distinguished different patterns in the arrangement of the muri in the tectum and described these as reticulate, reticulate-striate, striate-reticulate and striate. In the majority of species of *Pelargonium* the structure of the tectum is striate-reticulate because some muri are on a higher level and appear more or less parallel to each other and more prominent than others (Figure 5.3). This pattern is represented in all the sections in *Pelargonium* (Table 5.1, Verhoeven & Marais 1990). Sometimes the minor muri are more or less on the same level as the parallel ones and the tectum appears to be reticulate-striate (Figure 5.4).

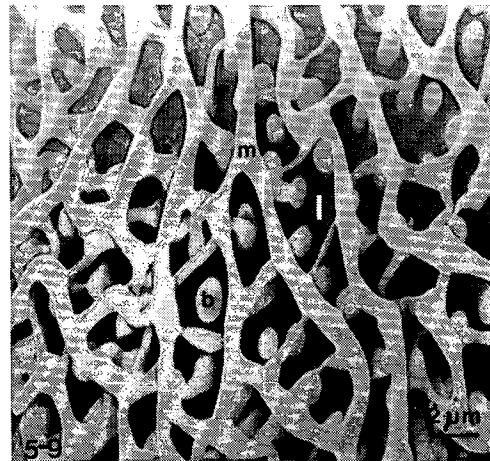
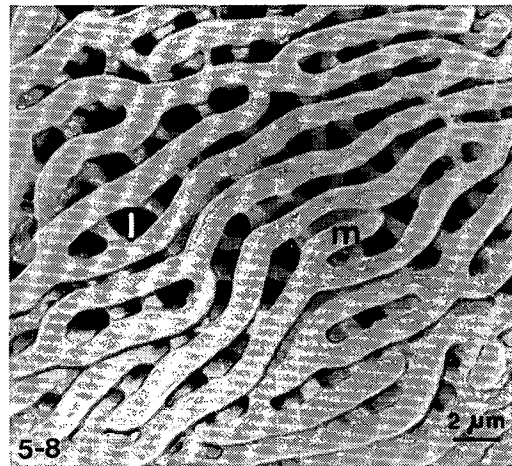
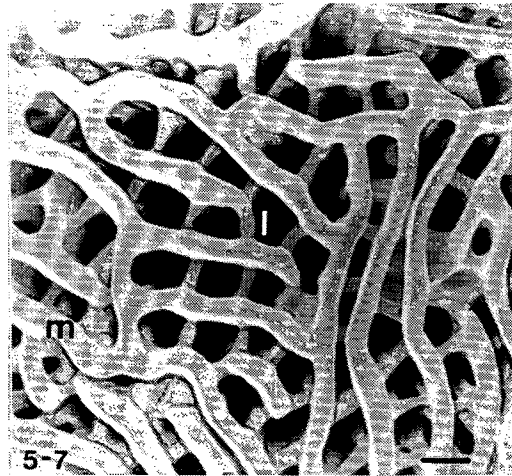


Figure 5.7 Mesocolpium of the pollen of *P. radicum* (Niven s.n. (S)). Scale bar: 2 μm .

Figure 5.8 Mesocolpium of the pollen of *P. punctatum* (Van der Walt 944). Scale bar: 2 μm .

Figure 5.9 Mesocolpium of the pollen of *P. nummulifolium* (Watson 71). Scale bar: 2 μm .

b = intraluminary bacula l = lumen, m = muri.

When all the muri are on the same level the tectum can be described as reticulate. (Figures 5.5 & 5.6) In section *Ligularia* (species *P. otaviense* Knuth and *P. grandicalcaratum* Knuth) a reticulate ornamentation with minute luminae occurs (Verhoeven & Marais 1990, Van der Walt, Albers & Gibby 1990), and could be described as tectate perforate (Walker & Doyle 1975). Another feature of the tectum is the presence of intraluminary baculae (Bortenschlager 1967). In section *Cortusina sensu stricto* these baculae are very prominent in some species, but are lacking in others (Dreyer 1990a). Intraluminary baculae are present in other sections also, but never as prominent as in section *Cortusina*.

Results

The pollen morphology of section *Hoarea* fits in well with the rest of the genus. The variation in the tectum includes all patterns present in the genus except that of *P. otaviense* and *P. grandicalcaratum*, and the double structure occurring in section *Polyactium* (Verhoeven & Marais 1990). In section *Hoarea* the reticulate pattern is represented by one with small luminae like in *P. proliferum* (Figure 5.5), and another one where the luminae are larger like in *P. longifolium*. (Figure 5.6). The tectum of some species in section *Hoarea* can be described as striate because the main, parallel muri are much thicker and more prominent than the lower connecting ones (Figure 5.7), and in some cases an extremely striate pattern of the tectum occurs that does not occur in the any other section of *Pelargonium* (Figure 5.8). In most cases the reticulate pattern on one side and the extreme form of striate pattern on the other side can easily be recognized, but the reticulate-striate and striate-reticulate ornamentations are difficult to distinguish and transitional forms occur throughout the whole spectrum. Because of these transitional forms and the difficulty with which border lines are established between the three main tectum patterns (reticulate, striate-reticulate and striate), these patterns were subdivided, each receiving a qualitative value of one to six (see key to Table 5.2). No measurements of lumina sizes were taken. The shape of the pollen grains and the details of the apertures are more or less the same in all *Pelargonium* species and do not get any attention here. Specimens studied as well as the equatorial diameters of the pollen grains are listed in Table 5.3.

Table 5.2 Pollen grains of section *Hoarea*: (a) structure of the tectum; (b) equatorial diameter.

Species	(a) Tectum structure							(a) Equatorial diameter (μm)				
	1	2	3	4	5	6	7	40	50	60	70	80 μm
Fissifolium group												
<i>P. aestivale</i>			*							—		
<i>P. fissifolium</i>			*						—	—		
<i>P. petroselinifolium</i>			*						—	—		
<i>P. aristatum</i>			*						—			
Pinnatum group												
<i>P. chelidonium</i>			*						—	—		
<i>P. nervifolium</i>			*						—	—		
<i>P. pinnatum</i>		*								—	—	
<i>P. reflexum</i>		*							—	—		
<i>P. violiflorum</i>		*							—	—		
Attenuatum group												
<i>P. attenuatum</i>				*				—	—			
<i>P. angustipetalum</i>				*					—	—		
<i>P. leptum</i>		*					+		—	—		
<i>P. viciifolium</i>		*					+		—	—		
<i>P. longifolium</i>		*							—	—		
<i>P. fergusoniae</i>		*							—	—		
<i>P. undulatum</i>		*							—	—		
<i>P. longiflorum</i>		*							—	—		
Proliferum group												
<i>P. proliferum</i>	*								—	—		
<i>P. pilosellifolium</i>	*								—	—		
<i>P. caledonicum</i>	*								—	—		
Heterophyllum group												
<i>P. heterophyllum</i>				*					—	—		
<i>P. tenellum</i>				*					—	—		
<i>P. trifoliolatum</i>				*						—	—	
Aciculatum group												
<i>P. aciculatum</i>				*						—	—	
<i>P. confertum</i>				*						—	—	
<i>P. fasciculaceum</i>				*						—	—	
<i>P. connivens</i>				*						—	—	
Luteum group												
<i>P. luteum</i>			*							—	—	
<i>P. fumariifolium</i>			*						—	—		

1 = reticulate, small luminae	5 = striate
2 = reticulate, large luminae	6 = extremely striate
3 = reticulate-striate	7 = intraluminary baculae
4 = striate-reticulate	

Table 5.2 Continue

Species	(a) Tectum structure							(a) Equatorial diameter (μm)				
	1	2	3	4	5	6	7	40	50	60	70	80 μm
Incrassatum group												
<i>P. incrassatum</i>					*						—	
<i>P. grenvilleae</i>					*						—	
<i>P. moniliforme</i>					*					—		
<i>P. vinaceum</i>					*					—		
<i>P. radiculatum</i>					*					—		
<i>P. appendiculatum</i>					*							—
<i>P. campestre</i>					*					—		
<i>P. nephrophyllum</i>					*					—		
<i>P. carneum</i>					*							—
<i>P. radiatum</i>					*							—
<i>P. nummulifolium</i>					*		+					—
Luteolum group												
<i>P. luteolum</i>					*					—		
<i>P. gracillimum</i>					*			—				
Rapaceum group												
<i>P. rapaceum</i>					*					—		
Auratum group												
<i>P. auratum v auratum</i>					*					—		
<i>P. auratum v carneum</i>					*					—		
<i>P. bubonifolium</i>					*					—		
<i>P. parvipetalum</i>					*					—		
<i>P. leipoldtii</i>					*					—		
<i>P. ellaphieae</i>					*					—		
<i>P. asarifolium</i>					*					—		
<i>P. dipetalum</i>					*		+			—		
<i>P. ternifolium</i>					*		+				—	
Triphyllum group												
<i>P. triphyllum</i>					*					—		
Caroli-henrici group												
<i>P. githagineum</i>					*		+				—	
<i>P. caroli-henrici</i>					*					—		
<i>P. rubiginosum</i>										—		
Punctatum group												
<i>P. oblongatum</i>					*							—
<i>P. curviandrum</i>					*							—
<i>P. triandrum</i>												—
<i>P. punctatum</i>					*					—		

Discussion

Hemsley and Ferguson (1985) pointed out that in palynological contributions to taxonomy the emphasis so far, was on the comparative studies of structure and ornamentation among pollen. Only recently the attention has been shifted to the functional aspects of the structural details. According to them it seems reasonable to expect that pollen, subject to natural selection just as much as the whole plant, has evolved to meet the demands imposed upon them. Therefore I regard that the evolution in the floral structure of *Hoarea*, was accompanied by a co-evolution of the pollen grains. With this in mind section *Hoarea* was divided into different groups on the basis of floral morphology with the accent on the structure of the androecium, and the pollen morphology also playing a role in this planning (Table 5.2).

According to Stafford & Gibby (1992) pollen size may be significant in delimiting some sections within the genus. This does not apply for the section *Hoarea*, because the equatorial diameter for the different species studied varies from 43 to 95 μm (Tables 5.2 & 5.3). That is almost representative of the whole spectrum for the genus (Stafford & Gibby 1992). However, in some floral type groups in *Hoarea*, pollen size could be one of the contributing factors in delimiting the groups (Table 5.2), but this does not apply to all the groups. On the other hand, polyploid species can have larger pollen grains than closely related diploid ones (Dreyer *et al.* 1992), but polyploidy versus pollen grain size can only be verified when the chromosome numbers become available.

The average diameters of the pollen grains of species with short stamens (*Fissifolium*, *Pinnatum*, *Attenuatum* and *Proliferum* groups) vary between 48 and 66 μm , which delimit these species as a group with medium size pollen grains. Although there is a variation in the form and size of the petals of these species, the stamens are always shorter than the sepals and concealed within the floral sheath. There is a slight variation in the ornamentation of the tectum in this group and it varies from reticulate (with small luminae and with large luminae) to reticulate-striate. However, in *P. attenuatum* and *P. angustipetalum*, two very closely related species, the tectum could rather be described as striate-reticulate. Within this larger group the *Proliferum* group can be delimited as a taxonomic unit because of the small petals and the uniformity of the tectum ornamentation (Table 5.2).

Although there is a noticeable variation in the size of the pollen grains of the *Heterophyllum* group, the delimitation of this group on the basis of the androecium structure, is confirmed by the homogeneous pattern of the tectum. The *Aciculatum* group

as well as the *Auratum* group are delimited on the basis of floral structure, tectum ornamentation as well as pollen size (Table 5.2).

The *Incrassatum* group seems to be heterogeneous with regard to tectum ornamentation as well as pollen size. This group is delimited on the basis of long, straight, protruding stamens, with an obvious difference in the length of the posterior, the lateral and anterior stamens. It is also characterized by the differences in the form and size of the petals of the different species. The *Caroli-henrici* and the *Punctatum* groups seem both to be heterogeneous with respect to pollen size and pollen structure.

In several cases in section *Hoarea* the size of the pollen grains can be used to distinguish between species with similar floral structures and similar ornamentations of the tectum. The pollen grains of *P. trifoliolatum* (62--67 μm) are larger than those of the related *P. heterophyllum* (49--50 μm) and *P. tenellum* (51--56 μm). The same accounts for the two related species *P. luteolum* (53--62 μm) and *P. gracillimum* (43--58 μm) and for another two species: *P. luteum* (58--67 μm) and *P. fumariifolium* (49--55 μm). The pollen grains of *P. punctatum* (57--60 μm in diameter) and *P. triandrum* (70--85 μm in diameter), species with similar floral structures and in both cases an extremely striate ornamentation of the tectum, reveal a remarkable difference in size (Table 5.2).

The flowers of *P. appendiculatum* and *P. radicum* are seemingly very similar. However, the ornamentation of the tectum shows a slight difference between the two species and the pollen size a remarkable one. Pollen grains of *P. appendiculatum* vary between 77 to 85 μm in diameter and those of *P. radicum* between 60 to 68 μm .

In *P. pinnatum* pollen size of small-flowered individuals varies between 57 and 65 μm and those of large-flowered individuals between 69 and 71 μm (Marais 1993). The occurrence of polyploidy in large-flowered individuals in this case should be investigated.

Although the presence of intraluminary baculae is never so prominent in section *Hoarea* as in section *Cortusina* (Dreyer 1990a), and although I do not regard the occasional presence of intraluminary baculae in most species as of any significance, there are cases where these baculae are noticeable, like in *P. nummulifolium* (Figure 5.9), where their presence delimits this species from the closely related *P. radicum*. Intraluminary baculae are lacking in the latter.

The most important contribution of the pollen morphology to the taxonomy of section *Hoarea* is the delimitation of smaller groups within the section and the structure of the

tectum supports to a large extent the proposed grouping of species in respect to the structure of the androecium. Although this is mainly based on the ornamentation of the tectum, the size of the pollen grains also plays a role in this demarcation. However, this is not the case for all the floral groups in section *Hoarea*. In some cases pollen size plays a significant role in the delimitation of species and a character to be used to distinguish between species. Pollen morphology suggests the heterogeneity of the composition of the *Caroli-henrici* as well as the *Punctatum* groups (Table 5.2).

Phylogeny

Although it is generally accepted that a reticulate ornamentation represents the primitive type of tectum, a view also held by Stafford & Gibby (1992), I regard the striate-reticulate tectum to be the primitive type in the case of *Pelargonium*. This I base on a statement made by Walker & Doyle (1975) on the evolution of pollen wall architecture, that sculpturing itself undoubtedly represents a more or less reversible character which must be interpreted in terms of individual correlations observed within any given taxa. The striate-reticulate pattern is present in all the sections of *Pelargonium* (Table 5.1). It is also the only type of tectum present in section *Pelargonium*, a section with many other primitive characters also (Van der Walt 1985, Van der Walt & Roux 1991). Reticulate and striate patterns of the tectum can be regarded as derived conditions. The extremely striate pattern, occurring in *P. punctatum*, *P. triandrum* and *P. rubiginosum*, is associated with the reduction in the number of fertile stamens and in some cases also with the reduction in the number of filaments and carpels. The reduction in the number of floral parts is regarded as a derived character (Radford *et al.* 1974). Therefore the extremely striate pattern of the tectum of *P. punctatum*, *P. triandrum* and *P. rubiginosum* can be regarded as the most advanced type of pollen structure in *Pelargonium*.

Table 5.3 Specimens of *Hoarea* species studied for pollen grain morphology and the equatorial measurements.

Taxon Specimen	Herbarium number	Pollen measurements		
		Min	Max	x (μm)
1. FISSIFOLIUM GROUP				
<i>P. aestivale</i>				
<i>Lavranos 20952</i>	STEU 3209	54	66	59
<i>Van der Walt 1454</i>	STEU 3270	49	62	57
<i>Marais 146</i>	STEU 3485	52	69	60
<i>P. fissifolium</i>				
<i>Fischer 133</i>	STEU 1928	52	66	59
<i>Van der Walt 1057</i>	STEU 2438	49	57	53
<i>Drijfhout 2657</i>	STEU 2757	47	59	54
<i>Marais 249</i>	STEU 3684	49	59	52
<i>Marais 348</i>	STEU 3989	49	74	61
<i>Marais 354</i>	STEU 3995	54	66	61
<i>P. petroselinifolium</i>				
<i>Lavranos 17471</i>	STEU 2315	47	62	56
<i>Fischer 356</i>	STEU 2688	47	57	53
<i>Marais 65</i>	STEU 3340	49	64	55
<i>P. aristatum</i>				
<i>Fischer 27a</i>	STEU 1571	46	55	51
<i>Fischer 28</i>	STEU 1572	48	58	52
<i>Schonken 215</i>	STEU 2308	46	60	53
<i>Van der Walt 1442</i>	STEU 3256	46	58	51
2. PINNATUM GROUP				
<i>P. chelidonium</i>				
<i>Marais 261</i>	STEU 3696	48	62	56
<i>P. nervifolium</i>				
<i>Van der Walt s.n.</i>	STEU 1624	55	60	59
<i>Lavranos 18999</i>	STEU 2822	55	65	60
<i>Marais 141</i>	STEU 3480	55	62	59
<i>Marais 145</i>	STEU 3484	50	58	54
<i>Marais 253</i>	STEU 3688	55	65	60
<i>P. pinnatum</i> (* Large-flowered specimens) *				
<i>Vorster 2905</i>	STEU 2478 *	64	76	71
<i>Vorster 2917</i>	STEU 2491 *	56	74	69
<i>Marais 169</i>	STEU 3544 *	61	76	70
<i>Van der Walt 510</i>	STEU 584	56	69	61
<i>Drijfhout 662</i>	STEU 856	56	69	62
<i>Hugo s.n.</i>	STEU 1748	54	74	65
<i>Marais 32</i>	STEU 2662	49	61	57
<i>Lavranos 20905</i>	STEU 3206a	61	69	64
<i>P. reflexum</i>				
<i>Van Wyk 161</i>	STEU 2129	50	65	57
<i>P. violiflorum</i>				
<i>Fischer 216</i>	STEU 2548	50	60	55

Table 5.3 (Continue)

Taxon Specimen	Herbarium number	<u>Pollen measurements</u>		
		Min	Max	x (μm)
3. ATTENUATUM GROUP				
<i>P. attenuatum</i>				
<i>Smit s.n.</i>	STEU 3221	43	58	51
<i>P. angustipetalum</i>				
<i>Drijfhout 1371</i>	STEU 674	43	55	51
<i>Roux 265</i>	STEU 3252	43	50	48
<i>Meve 236</i>	STEU 3745	46	53	49
<i>P. leptum</i>				
<i>Oliver s.n.</i>	STEU 442	48	58	53
<i>Marais s.n.</i>	STEU 1740	53	58	55
<i>P. viciifolium</i>				
<i>Van der Walt 479</i>	STEU 554	49	61	59
<i>Marais 13</i>	STEU 2523	54	66	61
<i>Marais 134</i>	STEU 3451	44	59	52
<i>Marais 321</i>	STEU 3875	44	61	51
<i>P. longifolium</i>				
<i>Van der Walt s.n.</i>	STEU 1252	46	55	51
<i>Van der Walt 1060</i>	STEU 2440	50	65	57
<i>Marais 57</i>	STEU 2920	50	58	54
<i>P. fergusoniae</i>				
<i>Fischer 231</i>	STEU 2564	48	60	55
<i>Fischer 304</i>	STEU 2636	48	55	52
<i>Bayer 2513</i>	STEU 3153	46	55	52
<i>P. undulatum</i>				
<i>Van der Walt s.n.</i>	STEU 1069	55	62	58
<i>Lavranos 18803</i>	STEU 2820	53	62	58
<i>Van der Walt 1593</i>	STEU 4062	50	65	57
<i>P. longiflorum</i>				
<i>Schonken 37</i>	STEU 1533	47	71	50
<i>Marais 35</i>	STEU 2665	47	71	51
<i>Van der Walt 1421</i>	STEU 3190	47	71	50
<i>Marais 182</i>	STEU 3555	59	71	66
<i>Marais 267</i>	STEU 3704	43	50	47
<i>Marais 308</i>	STEU 3820	43	55	49
<i>Le Maitre s.n.</i>	STEU 3839	50	62	57
4. PROLIFERUM GROUP				
<i>P. proliferum</i>				
<i>Van der Walt 931</i>	STEU 1940	46	55	50
<i>Van der Walt 1083</i>	STEU 2469	41	53	47
<i>Fischer 302</i>	STEU 2634	46	55	50
<i>Van der Walt 1428</i>	STEU 3222	43	55	48
<i>Marais 85</i>	STEU 3360	48	60	50
<i>Cillie s.n.</i>	STEU 3368	41	53	47

Table 5.3 (Continue)

Taxon Specimen	Herbarium number	Pollen measurements		
		Min	Max	x (μm)
<i>P. pilosellifolium</i>				
<i>Schonken 201</i>	STEU 2174	48	53	50
<i>Fischer 293</i>	STEU 2626	46	53	48
<i>Fischer 365</i>	STEU 2828	41	53	48
<i>Lavrano 20911</i>	STEU 3213	46	53	50
<i>P. caledonicum</i>				
<i>Van der Walt s.n.</i>	STEU 1596a	46	60	54
<i>Van der Walt 1093</i>	STEU 2506	46	60	54
<i>Fischer 268</i>	STEU 2601	48	60	55
5. HETEROPHYLLUM GROUP				
<i>P. heterophyllum</i>				
<i>Van der Walt 1041</i>	STEU 2408	48	53	50
<i>Marais 33</i>	STEU 2663	43	58	49
<i>P. tenellum</i>				
<i>Van der Walt 1027</i>	STEU 2395	50	60	56
<i>Marais 15</i>	STEU 2531	43	60	54
<i>Van Zyl s.n.</i>	STEU 3253	50	60	55
<i>Marais 136</i>	STEU 3453	41	55	51
<i>P. trifoliolatum</i>				
<i>Cillié s.n.</i>	STEU 589	56	74	62
<i>Marais 40</i>	STEU 2673	56	76	66
<i>Marais 45</i>	STEU 2680	61	76	67
6. ACICULATUM GROUP				
<i>P. aciculatum</i>				
<i>Ward s.n.</i>	STEU 1098	57	69	61
<i>Van der Walt 1024</i>	STEU 2282	59	79	70
<i>Van der Walt 1039</i>	STEU 2405	56	71	65
<i>Marais 265</i>	STEU 3702	68	76	72
<i>P. confertum</i>				
<i>Van der Walt 956</i>	STEU 2069	66	81	74
<i>Van Jaarsveld 4283</i>	STEU 2375	64	79	73
<i>Marais 72</i>	STEU 3317	67	86	79
<i>P. fasciculaceum</i>				
<i>Van der Walt 1046</i>	STEU 2420	62	86	74
<i>Marais 184</i>	STEU 3557	66	74	70
<i>Marais 199</i>	STEU 3632	74	86	82
<i>Marais 266</i>	STEU 3703	66	81	74
<i>Von Willert s.n.</i>	STEU 3756	64	79	72
<i>Marais 325</i>	STEU 3880	66	86	75
<i>P. connivens</i>				
<i>Lavrano 19001</i>	STEU 2817	59	76	70
<i>Lavrano 19000</i>	STEU 2824	71	86	79

Table 5.3 (Continue)

Taxon Specimen	Herbarium number	Pollen measurements		
		Min	Max	x (μm)
7. LUTEUM GROUP				
<i>P. luteum</i>				
<i>Fischer 33</i>	STEU 1577a	53	62	58
<i>Perry 3243</i>	STEU 3449	60	74	67
<i>Marais 270</i>	STEU 3707	53	72	62
<i>Marais 271</i>	STEU 3708	58	67	63
<i>P. fumariifolium</i>				
<i>Marais 240</i>	STEU 3675	50	60	55
<i>Marais 391</i>	STEU 4100	46	55	48
8. INCRASSATUM GROUP				
<i>P. incrassatum</i>				
<i>Van der Walt 789</i>	STEU 1525	65	72	68
<i>Fischer 1</i>	STEU 1545	62	70	67
<i>Drijfhout 2942</i>	STEU 2890	60	67	64
<i>P. grenvilleae</i>				
<i>Van der Walt 1406</i>	STEU 3170	62	70	66
<i>Marais 131</i>	STEU 3428	60	67	64
<i>Williamson 3951</i>	STEU 3911	53	72	65
<i>Williamson 3950</i>	STEU 3913	60	67	64
<i>P. moniliforme</i>				
<i>Boucher 77</i>	STEU 996	50	62	59
<i>Marais 68</i>	STEU 3303	58	62	59
<i>Marais 75</i>	STEU 3321	53	60	57
<i>Marais 355</i>	STEU 3996	58	65	61
<i>P. vinaceum</i>				
<i>Lavranos 20785</i>	STEU 3220	55	72	62
<i>Marais 77</i>	STEU 3339	55	65	59
<i>Van Jaarsveld 9695</i>	STEU 3858	53	72	65
<i>Williamson 4010</i>	STEU 3915	53	70	61
<i>P. radicatum</i>				
<i>Bachman 1533</i>	Z	53	65	60
<i>Niven s.n.</i>	S	58	70	63
<i>Van Berkel 455</i>	NBG	55	65	60
<i>Van der Walt 1417</i>	STEU 3186	60	74	68
<i>P. appendiculatum</i>				
<i>Leipoldt 4395</i>	BOL	72	82	79
<i>Adamson 1484</i>	BOL	72	82	77
<i>Engelbrecht s.n.</i>	STEU 3238	72	89	85
<i>P. campestre</i>				
<i>Jacot-Guillarmod 8300</i>	STEU 2694	62	74	69
<i>P. nephrophyllum</i>				
<i>Acocks 14178</i>	PRE	59	66	62
<i>Walters 123</i>	STE	56	71	63

Table 5.3 (Continue)

Taxon Specimen	Herbarium number	Pollen measurements		
		Min	Max	x (μm)
<i>P. nephrophyllum</i> (Continue)				
<i>Schonken 35</i>	STEU 1531	61	69	64
<i>Snijman 593</i>	STEU 3229	59	71	65
<i>P. carneum</i>				
<i>Van der Walt s.n.</i>	STEU 1653	72	96	82
<i>Van der Walt s.n.</i>	STEU 1654	70	84	77
<i>Coutnik s.n.</i>	STEU 3201	79	89	84
<i>Marais 154</i>	STEU 3492	70	84	78
<i>P. radiatum</i>				
<i>Van der Walt 970</i>	STEU 2114	72	89	81
<i>Van der Walt 1058</i>	STEU 2439	72	84	79
<i>Van der Walt 1063</i>	STEU 2443	72	86	79
<i>Van der Walt 1494</i>	STEU 3476	72	82	78
<i>P. nummulifolium</i>				
<i>Watson 71</i>	STEU 3954	60	91	73
9. LUTEOLUM GROUP				
<i>P. luteolum</i>				
<i>Van der Walt s.n.</i>	STEU 1641	53	60	57
<i>Lavranos 19837</i>	STEU 3054	53	62	58
<i>P. gracillimum</i>				
<i>Marais 161</i>	STEU 3499	43	58	52
<i>Marais 162</i>	STEU 3500	46	53	50
10. RAPACEUM GROUP				
<i>P. rapaceum</i>				
<i>Marais 97</i>	STEU 3394	53	65	58
<i>Marais 322</i>	STEU 3877	55	65	59
<i>Marais 378</i>	STEU 4072	55	70	63
<i>Weber 1</i>	STEU 4078	58	72	65
11. AURITUM GROUP				
<i>P. auritum</i> v <i>auritum</i>				
<i>Van der Walt 482</i>	STEU 556	55	65	61
<i>Marais 96</i>	STEU 3393	48	65	57
<i>Marais 138</i>	STEU 3477	58	65	61
<i>P. auritum</i> v <i>carneum</i>				
<i>Van der Walt s.n.</i>	STEU 1688	50	65	60
<i>Van der Walt s.n.</i>	STEU 1695	55	70	62
<i>P. bubonifolium</i>				
<i>Van Jaarsveld 4230</i>	STEU 2370	55	60	58
<i>Drijfhout 2971</i>	STEU 2886	55	67	58
<i>Drijfhout 2970</i>	STEU 2895	58	62	60

Table 5.3 (Continue)

Taxon Specimen	Herbarium number	Pollen measurements		
		Min	Max	x (μm)
<i>P. parvipetalum</i>				
<i>Bruyns 1519</i>	STEU 1455	58	67	61
<i>Stirton 9242</i>	STEU 3066	55	65	59
<i>Le Roux s.n.</i>	STEU 3240	55	65	60
<i>Marais 327</i>	STEU 3882	46	65	56
<i>P. leipoldtii</i>				
<i>Walters 2</i>	STEU 2986	53	65	59
<i>Muller 4038</i>	STEU 3464	58	67	63
<i>Marais 207</i>	STEU 3640	53	62	58
<i>Marais 317</i>	STEU 3871	58	67	62
<i>P. ellaphieae</i>				
<i>Marais 193</i>	STEU 3618	55	65	60
<i>Marais 197</i>	STEU 3630	55	62	59
<i>Marais 204a</i>	STEU 3637a	53	65	58
<i>Van der Walt 1520</i>	STEU 3734	53	70	61
<i>P. asarifolium</i>				
<i>Hugo s.n.</i>	STEU 862	55	67	61
<i>Van der Walt 573</i>	STEU 864	58	67	62
<i>Ward-Hilhorst 113a</i>	STEU 1350	55	65	59
<i>P. dipetalum</i>				
<i>Marais 170</i>	STEU 3545	58	72	66
<i>Marais 173</i>	STEU 3548	55	65	60
<i>Van der Walt 1525</i>	STEU 3749	62	84	76
<i>Beyers s.n.</i>	STEU 4037	65	77	70
<i>P. ternifolium</i>				
<i>Drijfhout 1627</i>	STEU 855	60	70	64
<i>Van der Walt s.n.</i>	STEU 2200	58	70	64
<i>Marais 164</i>	STEU 3517	58	72	65
<i>Marais 337</i>	STEU 3914	58	67	64
12. TRIPHYLLUM GROUP				
<i>P. triphyllum</i>				
<i>Esterhuysen 18020</i>	BOL	52	66	60
<i>Cillié s.n.</i>	STEU 3838	62	76	68
<i>Von Willert s.n.</i>	STEU 4096	59	74	65
13. CAROLI-HENRICI GROUP				
<i>P. githagineum</i>				
<i>Lavranos 20785a</i>	STEU 3220a	67	77	72
<i>Marais 143</i>	STEU 3482	60	79	68
<i>Marais 243</i>	STEU 3678	58	77	69
<i>P. caroli-henrici</i>				
<i>Bayer 2209</i>	NBG	48	65	55
<i>Drijfhout 2708</i>	STEU 2889	53	65	59
<i>Marais 130</i>	STEU 3427	53	67	62
<i>Marais 281</i>	STEU 3718	58	70	64

Table 5.3 (Continue)

Taxon Specimen	Herbarium number	Pollen measurements		
		Min	Max	x (μm)
<i>P. rubiginosum</i>				
<i>Van Jaarsveld 4100</i>	STEU 2371	48	58	53
<i>Drijfhout 2811</i>	STEU 2888	53	67	62
14. PUNCTATUM GROUP				
<i>P. oblongatum</i>				
<i>Herre s.n.</i>	BOL	72	84	79
<i>Dregè s.n.</i>	OXF	67	82	73
<i>Van der Walt s.n.</i>	STEU 819	72	84	78
<i>P. curviandrum</i>				
<i>Hall 2117</i>	NBG	67	84	76
<i>Barker 65</i>	BOL	67	79	74
<i>Lavranos 20941</i>	STEU 3214	65	79	73
<i>Marais 168</i>	STEU 3543	67	84	75
<i>P. triandrum</i>				
<i>Van der Walt s.n.</i>	STEU 1464	67	91	80
<i>Van der Walt s.n.</i>	STEU 1477	67	74	72
<i>Van der Walt 1276</i>	STEU 2947	62	79	70
<i>Van Niekerk s.n.</i>	STEU 3627	72	91	85
<i>P. punctatum</i>				
<i>Fischer 34</i>	STEU 1578	55	60	57
<i>Van der Walt 944</i>	STEU 2057	58	62	60
<i>Marais 67</i>	STEU 3302	55	60	58

CHAPTER 6

GEOGRAPHICAL DISTRIBUTION, ECOLOGY AND POLLINATION

Information on the ecology of flowering plants is basic to systematics in providing an understanding of the distribution of taxa, the variation within taxa and the adaptations of plants (Jones & Luchsinger 1987). For this study no experimental work in this connection was done, but conclusions were drawn from observations made on collecting trips and in the garden as well as information given on the labels of herbarium specimens.

Although section *Hoarea* is the largest section of *Pelargonium*, it has a rather limited distribution area when compared with some other sections in the genus (Van der Walt & Vorster 1983). It is quite common in the south-western Cape. Goldblatt (1978) regarded the Geraniaceae as one of the characteristic families of the Cape Floristic Region, a statement which is based on the overall presence of *Pelargonium* species in this area. This is not only true for the genus as a whole, but can also be applied for section *Hoarea*. The section also occurs in the other parts of the winter rainfall area along the west coast, that is from the extreme southern part of Namibia, through the Richtersveld and Namaqualand to the Vanrhynsdorp-Calvinia area. It is also found in the southern Cape and as far east as Grahamstown, a region of winter and summer rainfall. A few species occur in the summer rainfall area around Murraysburg and Middelburg in the central Karoo (Figures 6.1 & 6.2).

As previously stated, section *Hoarea* has a relatively small distribution area. Within this limited area at least one species, *P. rapaceum*, has a large distribution area occupying more or less the same area as the section (Figure 8.43.2). On the other hand about twenty percent of the species included in this study have very small distribution areas. This includes species occurring around Nieuwoudtville, Vanrhynsdorp and Clanwilliam, areas with a scant rainfall and at the same time very hot summers. Although Snijman & Perry (1987), in their floristic analysis of the Nieuwoudtville Reserve, did not list any *Pelargonium*, they found this area to be rich in geophytic species, and concluded that geophytes provide the highest proportion of endemic species in the area. As contrasted with the above mentioned species, *P. nummulifolium* occurring at a high altitude and a high annual rainfall, also has a small distribution area. In the eastern Cape there are also species with small distribution areas. In some cases these distributions are based on small numbers of herbarium specimens and could be misleading. In a large number of *Hoarea*

species populations are small with a wide-spread spatial distribution of plants. These plants are usually very difficult to find.

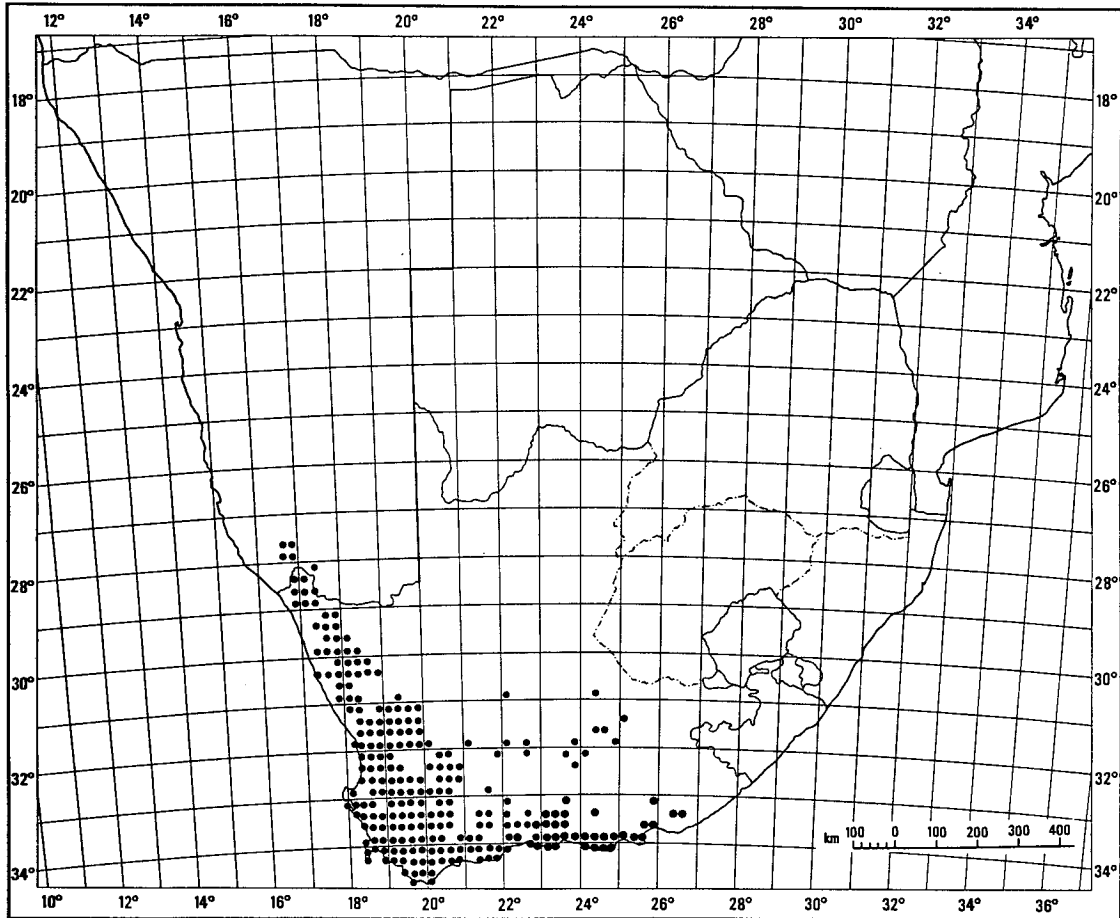


Figure 6.1 Geographical distribution of section *Hoarea*.

The centre of diversity for this section occurs in the one degree square including the town of Worcester (Figure 6.2). This coincides with the centre of diversity of most of the sections of *Pelargonium* and of the genus as a whole (Van der Walt & Vorster 1983). A secondary centre of diversity occurs in the Springbok area, south of the Gariep element as nominated by Nordenstam (1966). From Vanrhynsdorp to the north there is a decline in the number of species, but this number increases again in the Springbok area. This reduction in the number of species occurring in the Kamiesberg area, could possibly be due to a poor herbarium record of this area, which I doubt it to be, because the Kamiesberge is a very popular collecting area for most botanists, and secondly other taxa like the genera and subgenera of the Mesembryanthemaceae and the species of *Crassula* L. show a similar pattern (Jürgens 1991).

The Springbok area is a region with a very low annual rainfall, dry and hot summers and could be regarded as a semi-desert, and thus regarded as a centre of diversity in

accordance with Raven and Axelrod's (1974) idea that severe deserts and semi-arid transitional areas are important as centres of plant evolution. Secondly, the variable topography of this area creates a variety of microniches where active speciation could take place and as stated by Diamond (1988) that more complex or variegated structured habitats contain more species than simpler habitats.

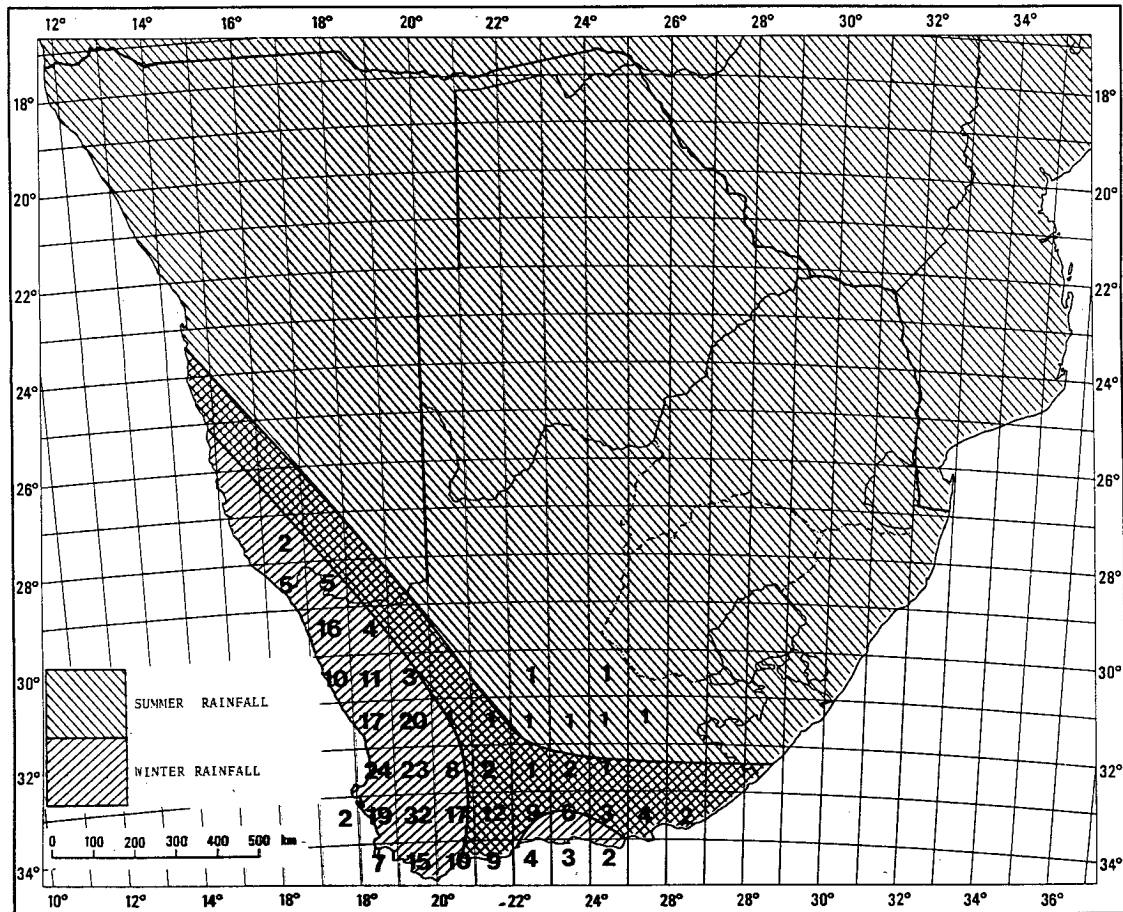


Figure 6.2 Distribution and species diversity of section *Hoarea*.

Like several other sections of the genus *Pelargonium* (*Pelargonium*, *Eumorpha*, *Polyactium* and *Myrrhidium*), with their centre of diversity in the south-western Cape, and with one or more species extending through the summer rainfall region (Van der Walt & Vorster 1983), *Hoarea* has also an extension in the summer rainfall area (Figures 6.1 & 6.2).

Habitat

The majority of species in this section grow in sandstone derived soils, but are seldom restricted to this type of substrate. Several species occur on a wide variety of soils like sand, clay, loam, lime, quartz and weathered granite. Most species of section *Hoarea*

seem not to give preference to specific types of soil, so that I do not regard the substrate alone being an important factor determining the distribution patterns of the species. The annual rainfall plays a more important role in this connection and a combination of substrate and rainfall should be considered as a determining factor in the distribution patterns.

The large variety of soil types concerned is coupled to a large variety of vegetation types in which species of this section occur. Although most species occur in fynbos, they usually are not restricted to it and renosterveld and different types of succulent or karroid vegetations create also suitable habitats for them. Succulent or karroid vegetations are usually low and open ones in which most plants are exposed to direct sunlight. In section *Hoarea*, however, the majority of species occur in rock crevices and under bushes, probably because these are the only niches in which they survive heavy grazing. Some species occur on plains or flat areas, but mountainous habitats or steep hillsides are not uncommon. Populations are usually small with a wide-spread spatial distribution of plants.

No where in the distribution area of this section, are the plants subjected to extremes of temperatures during the growing season. In areas with very hot summers the plants are dormant during the unfavourable season. Additional to this the tubers are covered by numerous flaking tunics or periderms, which serve as insulators. The altitude at which the plants occur, varies from low elevations near sea level to mountainous areas. Of the studied taxa only two species are restricted to high mountains. They are *P. nummulifolium* occurring in the Du Toitskloof Mountains and *P. triphyllum*, a species with a larger distribution area along the western and south-western escarpment.

No studies of the reaction of these plants to fire were undertaken, but field observations revealed an expected pattern for tuberous plants. Older plants with fire scars sprout again during the next winter. At the same time numerous seedlings occur in the first but also in the second winter after the fire. With further development of the vegetation after the fire the number of individuals declines.

Reproduction by seed is the most important mode for increasing in numbers and keep up capacity levels of the different populations, although in cultivation the division of the tuber could be successful in some cases. However, in *P. fasciculaceum* older plants in the field are found to form colonies in sandy soil (Marais 1991). This is similar to what is found *P. triste* (L.) L'Hérit. of section *Polyactium* and also in different members of section *Campylia* (Van der Walt & Van Zyl 1988). Because of the branching of the

fleshy roots, *P. fasciculaceum* develops an extensive root system with several stem-growing points. In the same area older plants are often found in colonies, whereas younger and smaller plants grow singly. This indicates that in nature plants of *P. fasciculaceum* easily develop from seeds. Although numerous stem divisions were also observed in *P. appendiculatum* and to a lesser extent in *P. triphyllum*, the formation of colonies does not occur in the majority of species in this section.

Rainfall

The majority of species studied occur in the winter rainfall region along the western coastal plain and the western escarpment (Figure 6.2). Six of the 60 taxa studied, occur in the western Cape, where winter rain prevails, but also in the eastern Cape where the precipitation could occur throughout the year. Another three taxa are restricted to the eastern Cape where the precipitation occurs throughout the year. Only one species, *P. aestivale*, occurs in the central Karoo, which is a summer rainfall area. A small number of unidentified specimens, collected in the Karoo, was found. Thus the number of species occurring in the Karoo could be more.

The annual rainfall figures for the different species were compiled by comparing the distribution maps with that of rainfall maps (Jackson 1961, Table 6.1). Annual rainfall, combined with soil type, may play an important role in determining distribution patterns. *P. pinnatum* occurs in the southern Cape on mainly shale derived soils. Comparing the distribution map of *P. pinnatum* with the rainfall map it is significant that the distribution of *P. pinnatum* coincides with the 400 mm rainfall border (Figure 6.3). *P. pinnatum* also occurs on sandstone derived soils on the south-western escarpment where the annual rainfall is much higher (600--1000 mm). The same could account for the distribution patterns of *P. auritum*, *P. rapaceum*, *P. carneum* and *P. dipetalum*, all of them species with large distribution areas, occurring on a variety of substrates in areas with wide ranges in the rainfall figures. The occurrence of *P. chelidonium*, *P. violiflorum* and *P. proliferum* in smaller distribution areas than the above mentioned species, but also with a similar wide range in the rainfall figures, could probably be explained because of the different types of soil in which they occur.

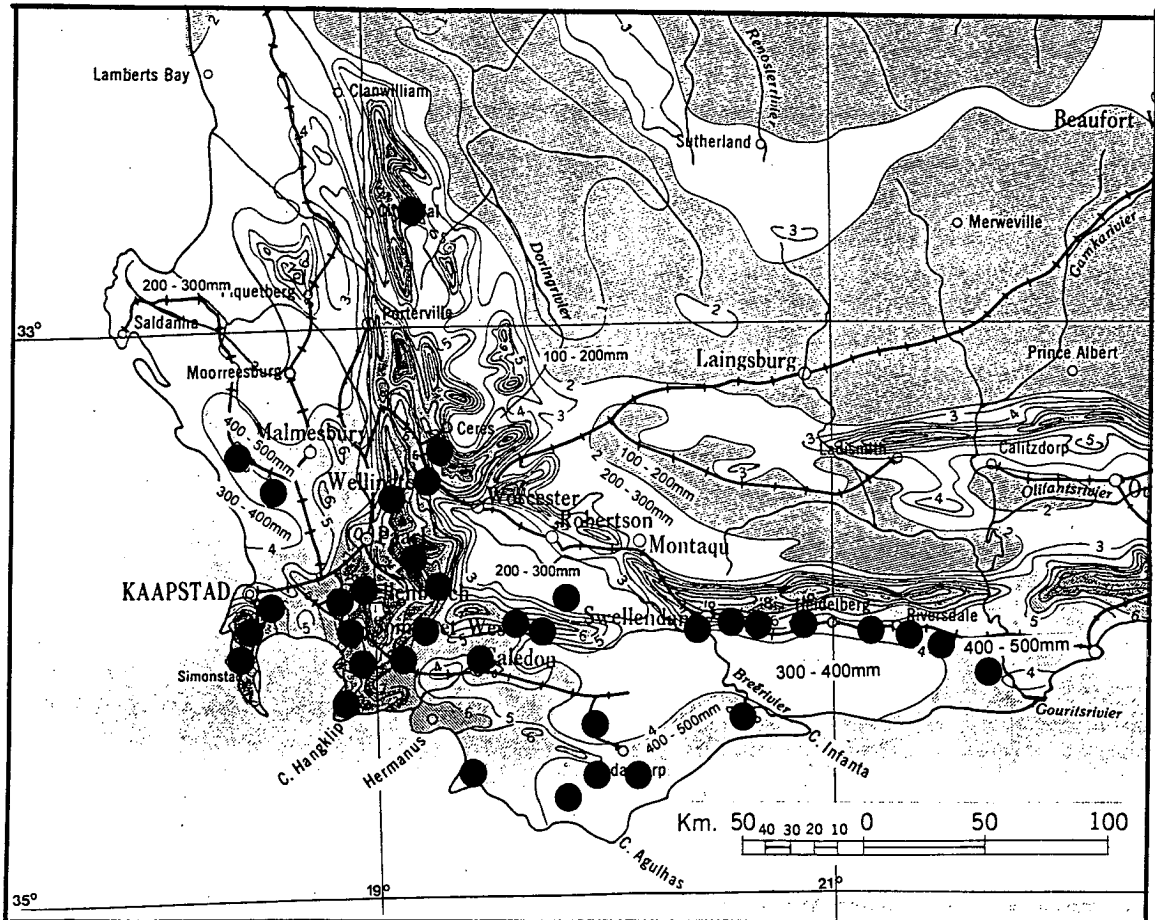


Figure 6.3 A comparison between the distribution of *P. pinnatum* and the annual rainfall figures.

- | | |
|---|---|
| 1 = borderline of the 100 mm rainfall area. | 4 = borderline of the 400 mm rainfall area. |
| 2 = borderline of the 200 mm rainfall area. | 5 = borderline of the 500 mm rainfall area. |
| 3 = borderline of the 300 mm rainfall area. | 6 = borderline of the 600 mm rainfall area. |

In a few cases it seems that presumably related species occupy adjacent distribution areas due to the differences in the rainfall figures. *P. heterophyllum* occurs in an area with an annual rainfall of 300--400 mm, whereas *P. tenellum* occupies an adjacent area with an annual rainfall figure of 400--600 mm. *P. petroselinifolium* occupies an area with an annual rainfall of up to 1000 mm, whereas the presumably related *P. fissifolium* occurs in an adjacent area with an annual rainfall of 200--300 mm. A similar case is that of *P. radiatum*, which occurs in an area with a higher (1000 mm) rainfall figure than that of *P. carneum* (200--800 mm).

The annual rainfall figure may also play an important role in the discontinuous distribution pattern of *P. leptum* (Figure 6.4) and *P. ellaphieae* (Figure 6.5). Both species occur in the Cape Peninsula or the vicinity thereof as well as in the Olifantsrivier Valley and the Cederberge, 150 to 200 km to the north. This distribution pattern

coincides with the annual rainfall of 400--600 mm. I must admit that these conclusions were made on a small number of herbarium specimens and that the extensive cultivation of the Swartland has possibly reduce the chances of founding them there. On the other hand other *Hoarea* species still occur in the small undisturbed patches in this area and that the disjunct distribution patterns of *P. leptum* and *P. ellaphieae* can be ascribed to the annual rainfall of the area.

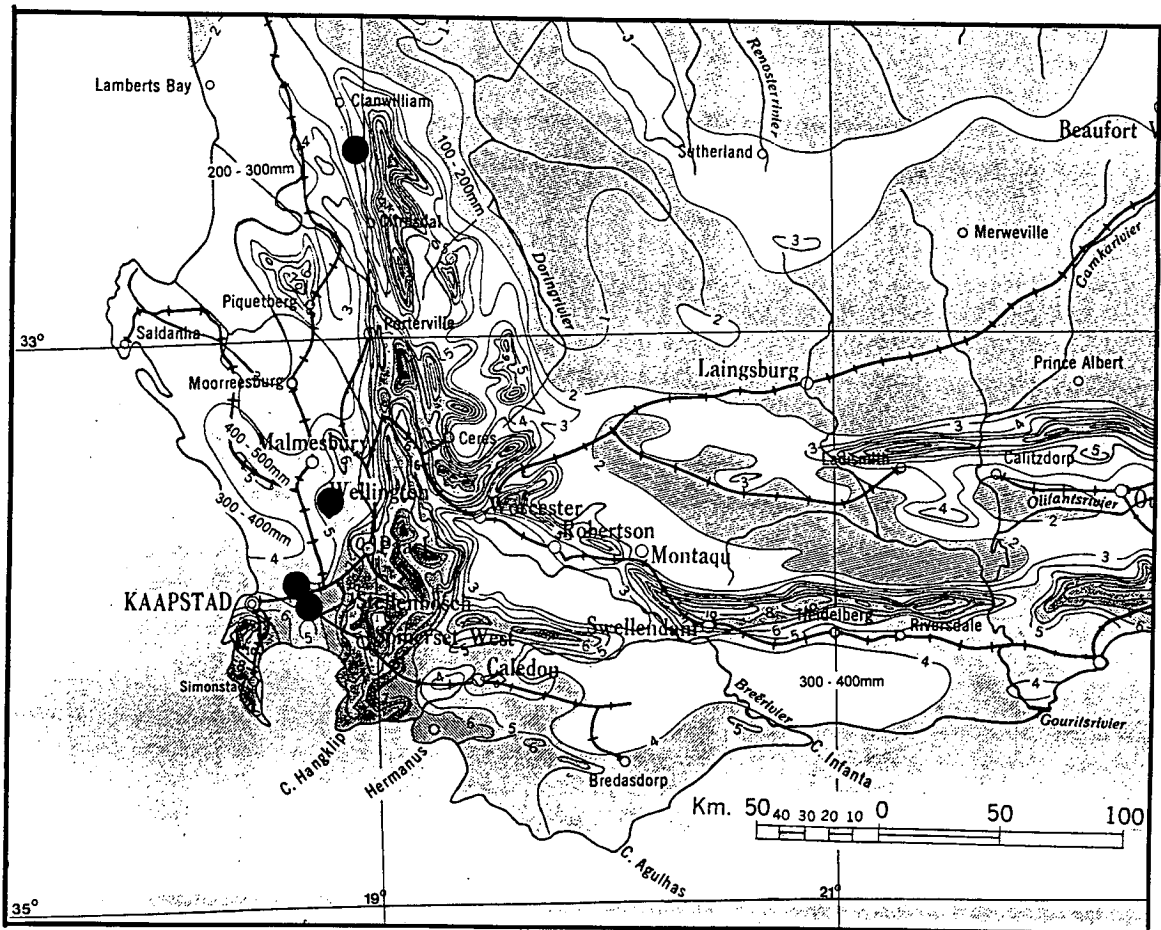


Figure 6.4 A comparison between the distribution of *P. leptum* and the annual rainfall figures.

- | | |
|---|---|
| 1 = borderline of the 100 mm rainfall area. | 4 = borderline of the 400 mm rainfall area. |
| 2 = borderline of the 200 mm rainfall area. | 5 = borderline of the 500 mm rainfall area. |
| 3 = borderline of the 300 mm rainfall area. | 6 = borderline of the 600 mm rainfall area. |

Six of the 59 species studied occur in areas with a high annual rainfall (600--1000 mm). Two of them, *P. nummulifolium* and *P. triphyllum*, are restricted to high altitudes. The other four, *P. radiatum*, *P. ternifolium*, *P. longifolium* and *P. trifoliolatum*, occur on high mountains, but also on low land flats with a relatively high annual rainfall (Table 6.1). Sixteen species occur in areas with an annual rainfall of less than 200 mm and

another 14 species occur in areas where the rainfall varies between 100–300 mm per annum. Thus fifty percent of the species studied occurs in areas with an annual rainfall of less than 300 mm (Table 6.1). From this I conclude that rainfall plays an important role in the distribution patterns of *Hoarea* species, and might be one of the major driving forces of speciation in this section.

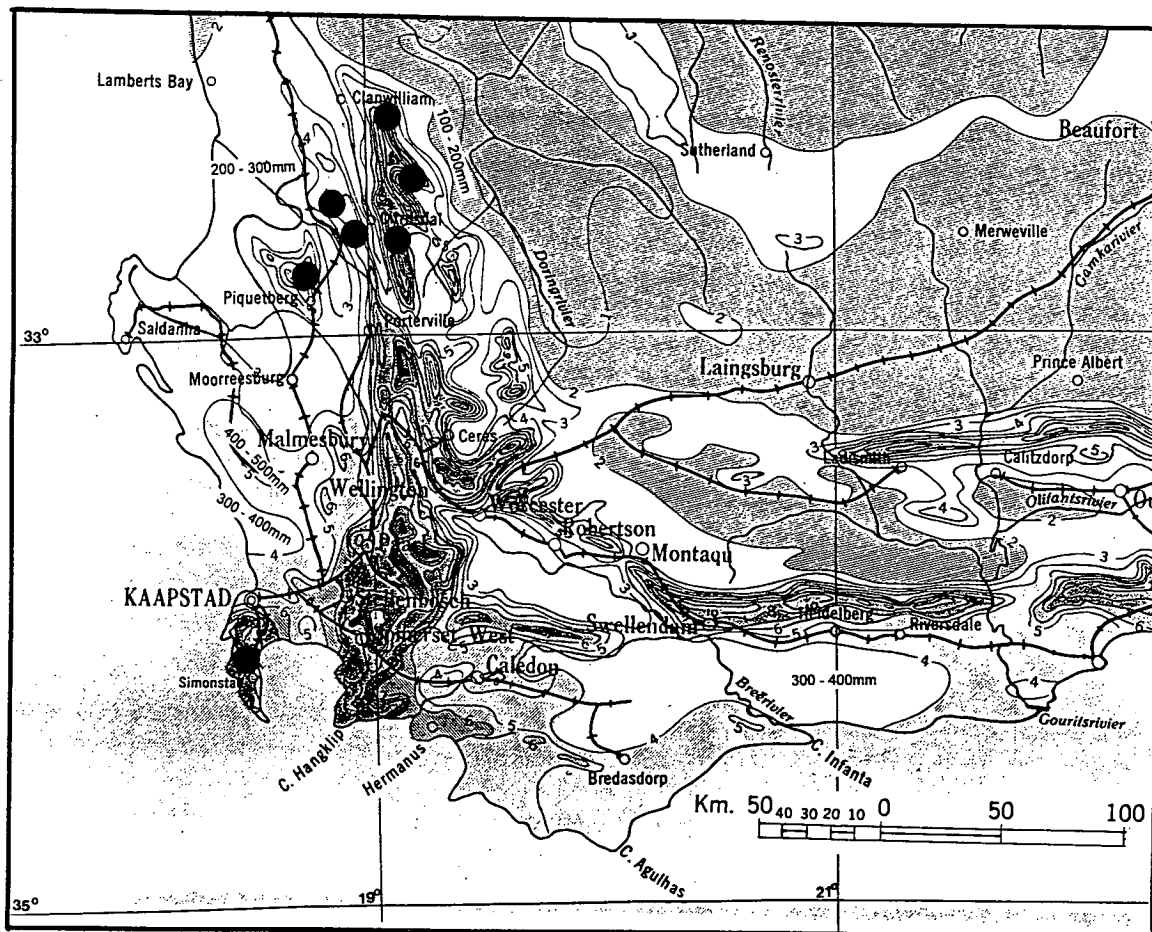


Figure 6.5 A comparison between the distribution of *P. ellaphieae* and the annual rainfall figures.

- | | |
|---|---|
| 1 = borderline of the 100 mm rainfall area. | 4 = borderline of the 400 mm rainfall area. |
| 2 = borderline of the 200 mm rainfall area. | 5 = borderline of the 500 mm rainfall area. |
| 3 = borderline of the 300 mm rainfall area. | 6 = borderline of the 600 mm rainfall area. |

Flowering time

The section *Hoarea* is represented by deciduous geophytes most of which flower in summer after the leaves have been shed. The plants remain dormant during the unfavourable season and sprout after the first rains of the next growing season. In the majority of species the apical meristems of the stems are protected during dormancy by a dense crown of petiole remains. In the winter rainfall area the leaves appear from April

to June, after the first winter rains, and in the summer rainfall area, after early spring showers or any rain following a drought.

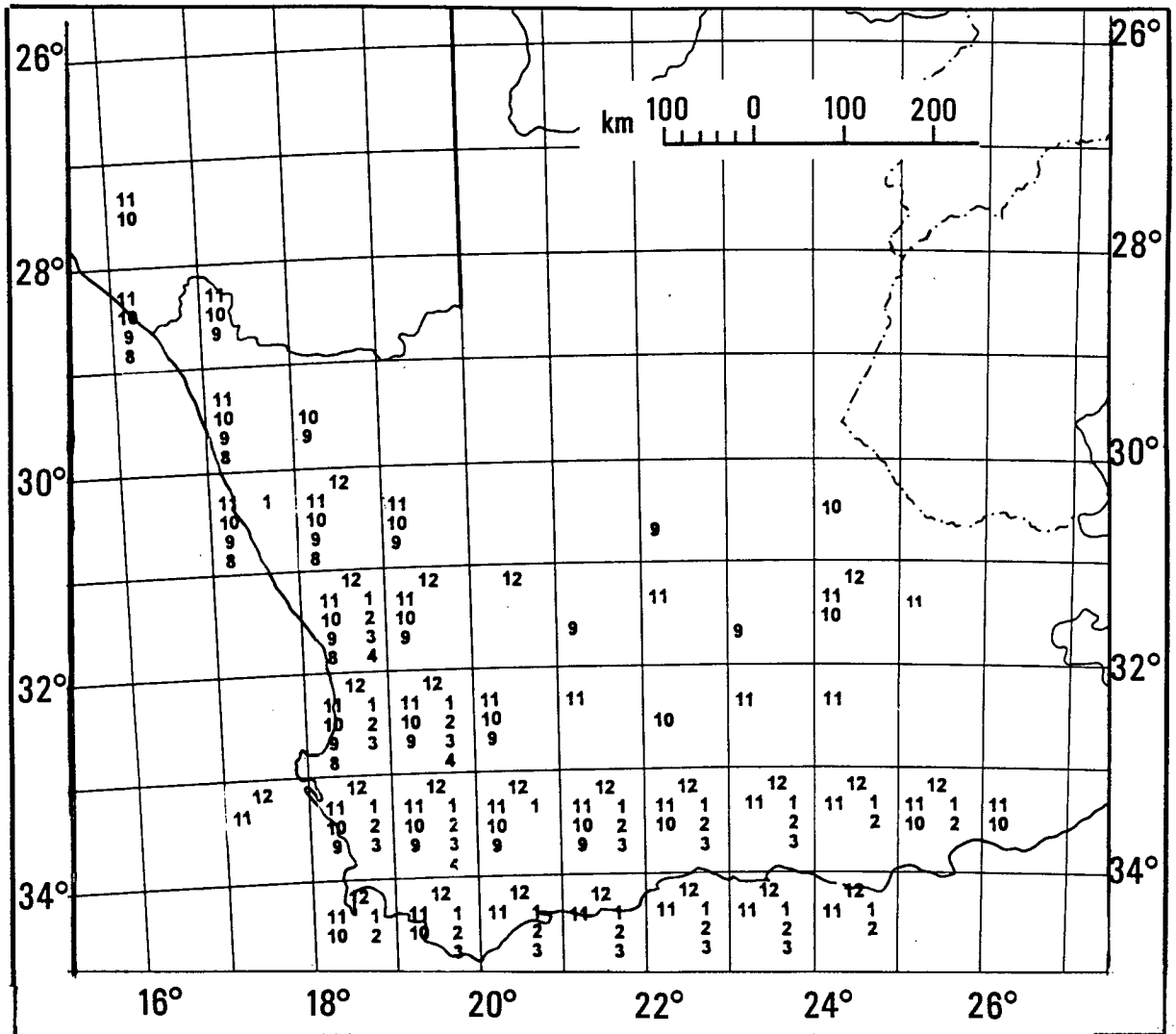


Figure 6.6 An illustration of the flowering time of all *Hoarea* species occurring in a given latitude/longitude square. 1 = January, 2 = February, 3 = March, 4 = April, 8 = August, 9 = September, 10 = October, 11 = November, 12 = December.

The flowering time for this section starts during August and keeps on till March and April, with the peak during October and November. From herbarium specimens the flowering time of all species occurring in a latitude/longitude square was determined (Figure 6.6). According to Figure 6.6 the flowering time starts in August along the coast of Namaqualand and inland species flower at a later stage. Moving south, flowering time starts later and moving east, this is still later. This is in accordance with the peak of the flowering time for the different regions. In Namaqualand the peak of the flowering time is the end of August or beginning of September, in the south-west Cape it is late September and in the southern Cape it is October. However, if the flowering times for

the different species are considered, the peak of the flowering time for the majority of species of *Hoarea* for every latitude/longitude square, is later than that of the rest of the vegetation. This pattern also shows that the flowering time for *Hoarea* species in Namaqualand is from August to November, whereas the flowering time of the species in the south-western and southern Cape keeps on till March. Exceptions to this are *P. luteolum*, with a flowering time in January and occurring around Garies and *P. nephrophyllum*, flowering in March and April and occurring near Vanrhynsdorp.

There is no pattern in the flowering time of the species occurring in the summer rainfall area. This is due to the unpredictability of the rainfall. Early spring showers result in early sprouting of plants and accordingly an early flowering time, but if rains are delayed, flowering time will also be delayed.

Some species have several scapes per plant and others several pseudo-umbellets per scape which mature in succession, thus lengthening the flowering season of that species. Only species which flower early in spring, that is from August to September, and species growing at high altitudes have leaves and flowers at the same time. The majority of species flower after the leaves are shed. Only *P. nephrophyllum*, from the vicinity of Vanrhynsdorp, flowers in March and April, just before new leaves appear.

Pollination

I regard pollination as a prerequisite for fruit formation in *Pelargonium*. This is based on observations made in the garden and also keeping in mind the ease with which hybrids are produced in the *Pelargonium* flower industry. If apomixis does play a role in the fruitset of *Pelargonium* it will be of little concern. The conclusions made on the pollination biology of section *Hoarea* are based on the success of fruit formation in the different species.

The majority of species of *Pelargonium* are probably entomophilous. Bees and other insects are often found visiting the flowers of *Pelargonium* and several authors referred to insects visiting *Pelargonium* flowers (Scott Elliot 1891, Burkhill 1899, Vogel 1954, Van der Walt, McDonald & Van Wyk 1990, McDonald & Van der Walt 1992, Zietsman 1993). This can also be extrapolated to section *Hoarea*.

Regarding the different factors influencing pollination vectors, only two species, *P. ellaphieae* and *P. grenvilleae*, of section *Hoarea* have strongly scented flowers. *P. appendiculatum* is an aromatic geophyte, but this is probably due to volatile oils excreted

by the leaves or by the whole plant, and not an attractant or odour which is observed only during anthesis. Like all *Pelargonium* species, the flowers of all *Hoarea* species produce nectar, but in this study no analyses were performed on it.

An important attraction to insects is the markings or nectar guides on the petals (Van der Walt, McDonald & Van Wyk 1990, McDonald & Van der Walt 1992) and in most cases they are restricted to the posterior petals. In section *Hoarea* a variety of nectar guides is observed. The majority of species have wine-red feather-like markings on the posterior petals, a few species have dimly coloured V-shaped markings on the posterior petals (*P. fasciculaceum*, *P. connivens*, *P. luteum* and *P. fumariifolium*) and several species have prominent dark red or black blotches on the posterior petals (*P. longifolium*, *P. heterophyllum*, *P. trifoliolatum*, *P. moniliforme* and *P. vinaceum*). Another type of nectar guide is found in *P. caroli-henrici* where the dark red claws of the posterior petals and the dark red blotches on the anterior petals together with the wine-red filaments form a prominent point of attraction in the centre of the cup-shaped flowers. A fourth type of nectar guide is found in *P. githagineum* where the petals are very small and the markings are completely lacking. The point of attraction is initially formed by the prominent dark red anthers, but are later replaced by the long wine-red recurved stigma branches. This can also be applied to *P. leipoldtii* and *P. parvipetalum*, both species with very small petals, but with wine-red feather-like markings on the posterior petals.

All the species in section *Hoarea* have more or less a similar androecium structure, the posterior stamen is short, the lateral two somewhat longer and the anterior two the longest. The posterior and lateral stamens are twisted in such a way that the dehisced anthers show backwards. The flowers of all the species in this section are protandrous. When the petals unfold, the stamens are longer than the pistil and the dehisced anthers are borne in a way to form a flat pollen-covered surface which must be touched by the abdomen of the insect visiting the flowers (Scott Elliot 1891). During anthesis the pistil lengthens and the style bends upwards, while the stigma branches recurve, occupying the original position of the anthers. At the same time the filaments bend downwards and in most cases the anthers are dropped, a mechanism to avoid self-pollination. Exceptions to this are *P. caroli-henrici* where the free filaments are twisted so that pollen surfaces are turned to the front, *P. luteum* where the filaments are twisted in an unique way, forming a pollen-lined tunnel to the nectar tube (Figure 8.28.2), and *P. fumariifolium* with a similar androecium than *P. luteum*, but with only two fertile stamens.

For the majority of species fruitset under cultivated conditions is rare. Hemsley and Ferguson (1985) stated that it is not necessary for plants to be optimally adapted with

respect to all of its morphological features, because an inefficient pollination system may be compensated for by great longevity. This could be true for section *Hoarea*, but field collections and herbarium specimens reveal that fruit formation under field conditions is usually very successful. The poor fruitset in the garden could probably be ascribed to the variation in the structure of the androecium of the different species and in most cases a special adapted structure which is dependent on a special pollinator, and this pollinator is not present in the garden.

In species with very long curved stamens, like *P. punctatum* and *P. oblongatum*, fruitset in cultivation is poor, but in field collections, every flower was found to produce a mericarp. This implies that in nature there is no imperfection in the reproductive biology of these species. Hand-pollination applied in the garden to the flowers of *P. oblongatum* results in complete fruitset in the case of cross-pollination, but was less successful in self-pollination.

Fruitset in cultivation of *P. auritum*, *P. bubonifolium* and *P. parvipetalum* is very successful. In all three species the five fertile stamens are more or less of the same length and protrude from the flower. All three species flower in spring, that is from August to October. In *P. asarifolium* and *P. ellaphieae*, species with a similar androecium than the above mentioned three, fruitset in the garden is poor. These two species flower in summer, that is from November to March. Two possibilities for this behaviour could be considered. As self-compatibility is not uncommon in *Pelargonium* (*P. candicans* Spreng, Marais 1981; *P. dolomiticum* Knuth, Zietsman 1993; *P. oblongatum*, own observations), this could be the case for *P. auritum*, *P. bubonifolium* and *P. parvipetalum*. Although the flowers are protandrous, the differences in the time of ripening of the anthers and that of the stigmas could be very short, and self-pollination in these cases could be very successful, which is not the case of the second group. A second possibility is that a suitable pollinator is present in the garden during spring, but not during summer.

A similar observation was made in *P. appendiculatum*, an early flowering species, and that of *P. radicum*, which flowers during summer. The floral structures of the two species are very similar. Fruitset in the garden in *P. appendiculatum* is very successful, but not so in *P. radicum*.

Although it seems that flowers with very short stamens together with very short pistils, concealed in the floral sheath, could create an ideal situation for self-pollination, this is

not true for *P. pinnatum* and *P. nervifolium*. Fruitset in the garden of these species is not very successful; only one or two mericarps per pseudo-umbellet are formed.

Although the basic structure of the androecium is very similar in all the species of *Hoarea*, the relative length of the stamens is diagnostic at specific level. The length of the stamens varies from much shorter than, the same length as or longer than the calyx. This results in different types of floral structures, which could be regarded as a co-evolution for the pollination strategy. For that reason the pollination biology of section *Hoarea* could be one of the more important driving forces in the evolution of this section, resulting in the large diversity in the length of the stamens and the way the stamens are borne during anthesis.

CHAPTER 7

DISCUSSION AND CONCLUSION

Section *Hoarea* is a very large section, demarcated by characteristic turnip-shaped, elongated and often moniliform tubers with smooth flaking periderms. The growth form delimits the section as a natural taxonomic unit (Marais 1989a), and within this unit there exists a large variation in the floral structure.

Hoarea as a section of *Pelargonium*

Previous studies in *Pelargonium* indicated little relationship between the floral structure of section *Hoarea* and that of the rest of the genus (Marais 1981). Secondly, no natural hybrids between any of the *Hoarea* species and species of any other section of *Pelargonium* exist, whereas natural hybridization between species of different sections in *Pelargonium* does occur (Van der Walt 1985, Gibby & Westfold 1986, Albers & Van der Walt 1992). The question arises whether *Hoarea* ought to be included in *Pelargonium*, or whether it should be a genus on its own as was proposed by Sweet (1820). Therefore the basic structure of the flowers of all sections in *Pelargonium* was compared to that of *Hoarea*.

In *Pelargonium* flowers are borne in pseudo-umbels, with several flowers per inflorescence (Marais 1981). In section *Hoarea* the flowers are borne on a scape, which is usually branched, bearing several pseudo-umbellets per scape. In both cases the older flowers are in the centre and the buds on the periphery, and can be described as an umbelliform dichasium (Wyatt 1982).

The presence of a hypanthium in all *Hoarea* species is also typical for the genus. In *Hoarea* the hypanthium is long (6--100 mm) in comparison with the very short pedicel (0,5--1 mm), and the hypanthium length/pedicel length ratio equals the length of the hypanthium. This ratio remains constant for *Hoarea*. In the rest of the genus, the hypanthium length/pedicel length ratio does not vary only among the different sections of *Pelargonium*, but also within the different sections (Marais 1981) and can be used as a diagnostic tool to differentiate between species.

The morphology of the sepals of all *Hoarea* species is very similar to that of the rest of the genus. In all *Pelargonium* species the sepals are persistent, covering the basis of the

developing fruit, and in all species of the genus the sepals are of little or no taxonomic value (Marais 1981).

Like all the species in the rest of the genus, *Hoarea* species also have zygomorphic flowers. In all species a difference occurs in the form and the size of the posterior two petals and that of the anterior three. The degree of zygomorphy is emphasized by the differences between the orientation of the posterior petals and those of the anterior three.

The basic structure of the androecium in all *Pelargonium* species is the same. It consists of ten filaments, arranged in two whorls of five each, basally connate, and obdiplostemonous (Figure 3.2). The androecium is zygomorphic; the staminal column is longer on the posterior side than on the anterior one, and the anterior stamens are longer than the posterior one. The staminodes are usually very short. In most species the posterior and lateral stamens are twisted in such a way that the dehisced anthers show backwards, forming a flat pollen-covered surface which must be touched by the abdomen of the insect visiting the flowers (Scott Elliot 1891). The length of the stamens in section *Hoarea* varies from shorter than, the same length as or much longer than the sepals. This represents the same spectrum of variation that occurs in the different sections of *Pelargonium* (Marais 1981). The number of fertile stamens in *Pelargonium* varies from two to seven (Table 3.5). This variation could be used as a diagnostic tool, or in some sections it confirms relationship between species.

The structures of the gynoecium and the fruit in *Hoarea* species, are typical for the genus, and the variation in the length of the style and the rostrum represents the same variation that exists in the genus.

The leaf anatomy of section *Hoarea* corresponds well with the rest of the genus (Volschenk 1980, Van der Walt & Boucher 1986, Maggs 1987, Van der Walt & Van Zyl 1988, Dreyer 1990b, Marais 1990b, Scheltema & Van der Walt 1990). The leaves are amphistomatic and the stomata anomocytic. Both dorsiventral and isobilateral leaves occur in sections *Pelargonium* (Volschenk 1980), *Myrrhidium* (Van der Walt & Boucher 1986), *Campylia* (Van der Walt & Van Zyl 1988), *Jenkinsonia* (Scheltema & Van der Walt 1990), *Ligularia* (Marais 1990b), *Cortusina sensu stricto* and *Reniformia* (Dreyer 1990b), and often closely related taxa can be distinguished because of the dorsiventral or isobilateral leaves. The same accounts for the presence or absence of a medullary bundle in closely related species.

The pollen morphology of *Hoarea* fits in well with that of the genus. The pollen grains are spherical, radiosymmetric, isopolar, tricolporate monades. The pattern of the tectum varies from reticulate, reticulate-striate, striate-reticulate, to striate. In *Hoarea* an extremely striate pattern of the tectum occurs that does not occur in any other section of *Pelargonium*. On the other hand a double structure of the tectum occurs in section *Polyactium* (Marais 1981, Verhoeven & Marais 1990), and a reticulate tectum with minute luminae occurs in *Ligularia* (Verhoeven & Marais 1990, Van der Walt, Albers & Gibby 1990), which does not occur in *Hoarea* or the other sections of *Pelargonium*. The size of the pollen grains of *Hoarea* (equatorial diameter 43--95 μm) coincides with that of the whole spectrum of *Pelargonium*.

The presence of a hypanthium, the morphology of the sepals, the difference in the form and size of the posterior and the anterior petals, the basic structure of the androecium, and the similarities in the structure of the gynoecium, are characteristics present in all *Pelargonium* species and also present in all *Hoarea* species. The variations of these features in *Hoarea*, represent the same spectrum of variations occurring in the genus. The variations in the leaf anatomy and the pollen morphology also fit in well with the rest of the genus. Although no natural hybrids between *Hoarea* species and species of any other section of *Pelargonium* exist, crossings under cultivated conditions could be enforced (De Marie, personal communication) and although the floral structure of *Hoarea* shows apparently little relationship with the rest of the genus, the basic structures of the flowers that demarcate other sections as part of *Pelargonium*, are also present in *Hoarea*. Therefore I regard *Hoarea* as a well defined section within *Pelargonium*.

The position of section *Hoarea* in the genus

Section *Hoarea* does not represent the only tuberous species in *Pelargonium*, but the subterranean flaking tuber with the short flattened stem, from which leaves and a scape emerge is distinctive for the section and is unique for *Pelargonium*. The tuber in *Hoarea* is a root and the peeling tunics or periderms are smooth, giving the tuber a smooth surface. This is in contrast with other tuberous species in *Pelargonium*. Although the tubers in sections *Polyactium* and *Reniformia* (Dreyer 1990b) are also fleshy roots they do not produce smooth, flaking periderms, instead, the tubers develop more persistent periderms with scurfy surfaces. Several members of sections *Campylia* (Van der Walt & Van Zyl 1988) and *Polyactium* are soboliferous, and in *Polyactium* the underground stems are also fleshy, and in appearance very similar to the fleshy roots. The short flattened stem of section *Hoarea* produces leaves, arranged in a rosette, and a scape without leaves. Tuberous species of section *Polyactium* produce short epigeal stems

with leaves and flowering stems. Although the tubers in the different sections of *Pelargonium* are fleshy roots they are not identical in all sections and have probably originated at different times in different groups.

The long curved stamens of the *Punctatum* group are very similar to those of section *Jenkinsonia* (Marais 1981), and likewise is the androecium of the *Auratum* group similar to that of section *Otidia* (Marais 1981). However, in *Otidia* the staminal column is not papillate. Both these cases I regard as convergent evolution in reaction to the pollination strategies of the different groups. Another example of convergent evolution is the large stipules of *P. appendiculatum*, which are similar to those of *P. stipulaceum* (L. f.) Willd. of section *Ligularia*.

Section *Hoarea* seems to be well defined in respect to growth form. At the same time the floral morphology reveals a large variety in structure. This is similar to section *Campylia*, which is demarcated by a caespitose type of growth form, but at the same time represents a considerable variation in floral structure (Van der Walt & Van Zyl 1988). In respect to morphological characters no close relationships between section *Hoarea* and any other section of the genus could be traced.

The subdivision of section *Hoarea*

Although the morphology of the tuber of *Hoarea* is a distinctive character by which the section is demarcated from the rest of the genus, the morphology of the tuber is of little or no taxonomic value within the section itself. A large variation in leaf shape occurs within the section. If only leaf form is considered, twelve different forms are recognized (Figure 3.1). If the leaf texture, indumentum and incisions are also considered, some of the major groups are subdivided into smaller groups (Figure 3.1). Comparing floral morphology to leaf form, it confirms Dickison's (1975) statement that evolutionary modifications of vegetative characteristics are not necessarily closely synchronized with floral evolution (Table 3.6). Leaf form suggests relationship in the *Aciculatum* group and also in the *Punctatum* group, but in the majority of floral groups leaf form can be used to distinguish between species.

One of the diagnostic characters of the section is the stipules which adnate to the petioles. In the majority of species the stipules are long and subulate. In species with prostrate leaves the stipules are usually short and triangular. Only in *P. appendiculatum* the shape of the stipules is a diagnostic character within section *Hoarea*.

In the majority of species in *Hoarea* flowers are borne on a branched scape, forming a compound inflorescence. Two thirds of the species have less than fifteen flowers per pseudo-umbellet. This includes all the species with very short stamens (Table 3.1, *Fissifolium*, *Pinnatum*, *Attenuatum* and *Proliferum* groups), and the *Heterophyllum* and *Auratum* groups. Some species in the other groups also have small numbers of flowers per pseudo-umbellet, where this character acts as a diagnostic feature. However, its diagnostic value is lessened by the large variation that could occur in several species (Table 3.1).

The very long hypanthium, together with the very short pedicel is diagnostic for the section. Within the section a short hypanthium demarcated the *Auratum*, *Luteum*, *Proliferum* and the *Heterophyllum* groups. On the other hand this feature can be a diagnostic character to differentiate between closely related species (Table 3.2).

The majority of species have five-petalled flowers. *P. triandrum* is the only species with only four petals, in which case it is a diagnostic character. Five species, *P. leipoldtii*, *P. ellaphieae*, *P. asarifolium*, *P. dipetalum* and *P. ternifolium* have two-petalled flowers. The androecium of these five species is very similar and the reduction in the number of petals confirms relationship amongst these species.

Although the majority of species in *Hoarea* have dull-coloured flowers, there are species with bright colours and in these cases flower colour could be a diagnostic feature (*P. incrassatum* versus *P. grenvilleae*, *P. auratum* var. *auratum* versus *P. auratum* var. *carneum*, and *P. petroselinifolium* versus *P. fissifolium*). The presence of pollinator guides is common in *Pelargonium*. The form and size of the guides could be a diagnostic feature (*P. heterophyllum* versus *P. tenellum*), or it can confirm a relationship between species (*P. heterophyllum* and *P. trifoliolatum*).

The form and the size of the petals, and the length/width ratio of the posterior petals play an important role in the delimitation of smaller groups within *Hoarea*. In flowers with very short stamens this ratio is important for demarcating smaller groups.

The relative length of the stamens in section *Hoarea* is diagnostic at specific level and varies from much shorter than, the same length as or longer than the sepals. Different modifications of the flowers contribute to the reproductive success of a species (Jones & Luchsinger 1987). In the case of *Hoarea* the structure of the androecium plays a major role in this process. Variation in the structure and especially the length of the stamens and the way in which they are borne determine the success for pollination. The poor

fruit formation under cultivated conditions indicates that pollinators are absent in the garden. Thus, special pollinators are needed for special structures of the androecium. For that reason the subdivision of the section was based on the length of the stamens in relation to that of the sepals, and secondly the length of the anterior stamens in relation to those of the lateral and the posterior ones. Additionally to this the structure of the pollen tectum (Table 5.2) and the size of the petals, as well as the length/width ratio of the posterior petals (Table 3.4) were considered in constructing the subdivision. Other external morphological structures were also considered. Chromosome numbers only influenced my decision on demarcating *P. aestivale*, *P. fissifolium*, *P. petroselinifolium* and *P. aristatum* as a separate group. According to Albers (personal communication), these four species have a basic chromosome number of $x = 9$, which is an unusual basic number for section *Hoarea*. This can be considered as a derived chromosome number since the primitive basic number for *Pelargonium* is $x = 11$ (Albers & Van der Walt 1984). The external morphology of these four species was studied for characters to confirm close relationships among them. All four species have very short stamens, less than 20 flowers per pseudo-umbellet, and a similar structure of the pollen, thus morphological evidence to justify their clustering in the *Fissifolium* group. On the other hand, if petal morphology is considered, three of the species (*P. aestivale*, *P. fissifolium*, *P. petroselinifolium*) could be included in the *Pinnatum* group, and *P. aristatum* fits in well with the *Attenuatum* group.

When all the characters studied are considered, there is no single character that can be used to divide the section in smaller units. Because of the importance of the androecium in the reproductive success of *Hoarea* species, the basis for the subdivision of the section was the variation in the androecium. Secondly, because of the co-evolution between the floral structure and that of the pollen grains in the angiosperms (Hemsley & Ferguson 1985), the structure of the tectum played a major role in constructing this subdivision (Table 5.2). Although the combination androecium-tectum structure seems to give the best results in clustering the species, the composition of several floral groups should be reconsidered (Table 5.2, *Attenuatum*, *Caroli-henrici* and *Punctatum* groups). All other characters studied, support the delimitation of some of the floral groups, but at the same time they can be used as a diagnostic tool in the other groups. The section was subdivided as follows:

1. Stamens shorter than the sepals
 - 1.1 Petals spatulate or ligulate; basic chromosome number $x = 9$ *Fissifolium* group
 - 1.2 Petals spatulate; length/width ratio of posterior petals smaller than five *Pinnatum* group

- 1.3 Petals ligulate; length/width ratio of posterior petals greater than five *Attenuatum* group
- 1.4 Petals small (7--16 x 1--4 mm), wine-red or wine-red blotches, hypanthium short (6--16 mm); tectum of pollen reticulate, with small luminae *Proliferum* group
- 2. Anterior stamens more or less the same length than the sepals
 - 2.1 Petals ligulate, slightly curved, margins undulate; posterior stamen very short, lateral and anterior stamens long *Heterophyllum* group
 - 2.2 Posterior and lateral stamens very short, anterior stamens long *Aciculatum* group
 - 2.3 Stamens twisted, pollen covered surfaces to the front *Luteum* group
- 3. Stamens long, straight, protrude from the flower
 - 3.1 Differences in the form and size of petals; posterior, lateral and anterior stamens of different lengths *Incrassatum* group
 - 3.2 Lateral and anterior petals enclose the stamens *Luteolum* group
 - 3.3 Papilionaceous type of flower *Rapaceum* group
 - 3.4 Fertile stamens more or less the same length, staminal column papillate *Auratum* group
- 4. Stamens much longer than the sepals
 - 4.1 Fertile stamens more or less the same length, remain straight, staminal column smooth, posterior petals auriculate *Triphyllum* group
 - 4.2 Stamens remain straight; scape thick, greenish red, wine-red or reddish brown *Caroli-henrici* group
 - 4.3 Stamens curved upwards *Punctatum* group

This classification should be regarded as an attempt to bring about a framework for the subdivision of the section which will simplify the study of the unidentified specimens and those species of which the species concept is difficult to define. It should also be considered as a preliminary classification, because some groups seem to be of a heterogeneous constitution (*Caroli-henrici*, *Punctatum* and *Incrassatum* groups). *P. oblongatum* and *P. curviandrum* of the *Punctatum* group have long curved stamens. The androecium of these two species consists of ten filaments of which five are fertile in *P. oblongatum* and four fertile in *P. curviandrum*. The tectum of the pollen of these species is striate-reticulate. *P. triandrum* and *P. punctatum* also have long curved stamens, but with a reduction in the number of filaments and fertile stamens (Tables 7.1 & 7.2). The tectum of both species is extremely striate, and the similarities in the *Punctatum* group

should rather be ascribed to convergent evolution than a phylogenetic relationship. The same kind of differences occur in the *Caroli-henrici* group and to a lesser extent in the *Attenuatum* group, and the similarities could probably be ascribed to convergent development. According to morphological features alone, species with very short stamens should be placed in three different groups: firstly in respect to petal size and pollen structure (*Proliferum* group), and secondly in respect to the length/width ratio of the petals. This second group can be divided in species with ligulate petals (length/width ratio of petals bigger than five) and species with spathulate petals (length/width ratio of petals smaller than five). If chromosome numbers are considered four of these species have the unusual basic chromosome number $x = 9$. If the chromosome numbers and the chromosome sizes of all the other species with short stamens were known, one might come to the conclusion that other characters than petal size and length/width ratio of petals should be used for the subdivision of the section. Chromosome number and chromosome size, as well as DNA studies and chemotaxonomical data could reveal other relationships, additionally to what were revealed by morphological data alone. Cladistic analysis on morphological characters alone proved to be very misleading in *Pelargonium*, as was found in section *Ligularia s.l.* (Van der Walt, personal communication), since convergent evolution seems quite often to be the cause for the development of similar structures in *Ligularia s.l.* As Albers and co-workers are studying the chromosomes at present, and karyological data will be available in the near future, I do not want to regard the floral type groups, mainly based on morphological data, as subsections. With karyological and chemotaxonomical data known, cladistic analysis could be done and subsections should be demarcated with more confidence. Keys for the identification of the species within each subdivision, should then be constructed.

Phylogeny

The evolutionary development of section *Hoarea* follows a radiating pattern and it is very difficult to determine the direction of the evolutionary trends in the section.

The section has a rather limited distribution area when compared with some other sections in the genus. Within this limited distribution area there are several species with a very small distribution, species which are specifically adapted to that special habitat in which annual rainfall probably plays an important isolating role. The majority of species occur in the winter rainfall area. Leaves appear after the first winter rains, and die in summer before or after flowering time. These deciduous-leaved geophytes are dormant during the hot dry summer, an advanced mechanism to survive the unfavourable season (Radford *et al.* 1974).

The stem divisions in *P. appendiculatum* could probably be a transition to the shrub-like *Pelargoniums* or vice versa. *P. appendiculatum* is a tuberous species with a regularly shaped tuber, typical for *Hoarea*, but extensive branching, probably stimulated by grazing of sheep and antelope, resulted in annual stem increments similar to those of *P. stipulaceum* and to a lesser degree to *P. torulosum* E.M. Marais. The latter is a much-branched decumbent shrublet with a succulent, moniliform stem. The older sagging prostrate stems are partly covered by sand, and during winter small globular increments terminated by leaves, appear above ground level. It flowers in November, after which the leaves die and the plants remain dormant until the following winter. During dormancy the stems are covered by sand, probably a way to survive during the hot dry summer (Marais 1990a). This mechanism for survival suggests an evolutionary trend towards geophytism. *P. stipulaceum*, a species closely related to *P. torulosum*, usually occurs between rocks, where the stems are supported by the rocks. *P. stipulaceum* also has sometimes moniliform stems (Marais 1990a), and a very characteristic feature of this species is the large membranous, persistent stipules (Van der Walt & Vorster 1981a), very similar to that of *P. appendiculatum*. Although the survival mechanism of *P. torulosum* indicates an evolutionary trend towards the development of geophytism, which is probably similar to the origin of the geophytes in section *Hoarea*, I regard the stem divisions in *P. appendiculatum* as a secondary development from a geophyte towards a shrublet, because these stem divisions probably develop in reaction to grazing. Plants of *P. appendiculatum*, growing in the protected environment of the garden, develop several stem-growing points typical for section *Hoarea*, and not stem increments as developing in plants exposed to grazing.

Pelargonium flowers are borne in pseudo-umbels with several flowers per inflorescence. The older flowers are borne in the centre and the buds on the periphery. In some sections like *Jenkinsonia* and *Myrrhidium*, there are species with only one or two flowers per inflorescence. In these cases the flowers are borne in the axils of a limited number of bracts (Marais 1981). I regard this as a reduction in the number of flowers in the inflorescence and regard it as a secondary specialization and thus an advanced character. The flowers in these cases are also extremely zygomorphic (Marais 1981). Section *Hoarea* does not show the same evolutionary trend, instead the evolutionary trend point at an increase in the number of flowers. This, according to Radford *et al.* (1974), is generally accepted as the evolutionary trend in flowering plants. According to Rodriguez-Robles *et al.* (1992) the inflorescence size, that is the total number of flowers per inflorescence contributes to the attraction of pollinators, but Wyatt (1982) stressed that the opinion of several experts on this subject is that the aggregation of flowers into a

head is biologically equivalent to a single flower. Burt (1961) pointed out that the latter is true in terms of pollinator attraction, but the advantage of many-flowered inflorescences lies in the much higher outcrossing rates and by that enhancing new gene combinations. By having large numbers of flowers per inflorescences, is probably the mechanism by which *Hoarea* species, which usually occur in small populations, enhance new gene combinations. The majority of species in section *Hoarea* usually have less than fifteen flowers per pseudo-umbellet (Table 3.1). Although not true in the case of *P. ternifolium* and *P. longiflorum*, species with a reduction in the number of fertile stamens tend to have large numbers of flowers per pseudo-umbellet (Table 7.1). The increase in the number of flowers is probably to enhance the male phase in the pollination mechanism (Wyatt 1982). Some species with five fertile stamens (*P. incrassatum*, *P. moniliforme* and *P. rapaceum*) also have large numbers of flowers per pseudo-umbellet.

Table 7.1 Comparison between the reduction in number of fertile stamens and the number of flowers per pseudo-umbellet of some *Hoarea* species.

Species	number of fertile stamens	number of flowers per pseudo-umbellet
<i>P. incrassatum</i>	5	(15-)20--55
<i>P. moniliforme</i>	5	12--40(-50)
<i>P. rapaceum</i>	5	6--30(-47)
<i>P. longiflorum</i>	4, 5	4--15
<i>P. ternifolium</i>	4	3--7
<i>P. githagineum</i>	4	6--27
<i>P. caroli-henrici</i>	4	(10-)15--25(-50)
<i>P. curviandrum</i>	4	7--23(-29)
<i>P. vinaceum</i>	2, 3, 4	(7-)10--27
<i>P. triandrum</i>	3	7--26(-30)
<i>P. confertum</i>	2	13--24(-40)
<i>P. rubiginosum</i>	2	10--30
<i>P. punctatum</i>	2	(10-)17--45(-60)

A similar reduction in the number of fertile stamens occurs in different floral types (Table 7.2) and does not necessarily reveal evolutionary relationships in *Hoarea*. The reduction in the number of fertile stamens can be associated with striate and extremely striate patterns of the tectum (Table 7.2). In plants, both the reduction in floral parts (Radford *et al.* 1974) and the striate pattern of the tectum (Chapter 5) can be regarded as derived characters.

Table 7.2 Floral groups of section *Hoarea* where the reduction of fertile stamens occur with the accompanying tectum structure.

Floral group Species	Number of fertile stamens	Tectum structure
<i>Attenuatum</i> group		
<i>P. longiflorum</i>	4 or 5	reticulate large lumen
<i>Auratum</i> group		
<i>P. ternifolium</i>	4	striate-reticulate
<i>Caroli-henrici</i> group		
<i>P. githagineum</i>	4	striate-reticulate
<i>P. caroli-henrici</i>	4	striate-reticulate
<i>P. rubiginosum</i>	2	extremely striate
<i>Incrassatum</i> group		
<i>P. vinaceum</i>	2, 3, or 4	striate
<i>Punctatum</i> group		
<i>P. curviandrum</i>	4	striate-reticulate
<i>P. triandrum</i>	3	extremely striate
<i>P. punctatum</i>	2	extremely striate
<i>Aciculatum</i> group		
<i>P. confertum</i>	2	striate

Section *Hoarea* with its deciduous geophytes and sometimes extremely zygomorphic flowers, and with its large variation in the floral structure, especially that of the androecium, exhibits advanced morphologic characteristics. These include the striate pattern of the tectum of the pollen grains and the reduction in the number of floral parts (Table 7.3). In comparing section *Hoarea* to the rest of the genus, advanced characters seem to be more numerous in *Hoarea* than in the rest of the genus.

Table 7.3 Reduction in the number of floral parts of section *Hoarea* in comparison with the rest of the genus.

	Section <i>Hoarea</i>	Rest of genus <i>Pelargonium</i>
Petals	5, 4, 2	5, 4, (0)
Stamens	10, 8, 7	10
Fertile stamens	5, 4, 3, 2	7, 6, 5, 4
Carpels	5, 4	5

Previous studies in *Pelargonium* indicated little relationship between the floral structure of section *Hoarea* and the rest of the genus (Marais 1981). From this I deduce that section *Hoarea* parted already at an early stage of the evolutionary history of *Pelargonium* from the rest of the genus. In this process it developed advanced floral structures in which the pollination biology was probably one of the major driving forces in the evolution of the section. At the same time plants developed an advanced growth form as an adaptation to the environment, and rainfall seems to play an important role in the distribution of the different species.

Because of this variation in the androecium a preliminary classification of the section is made. The relative length of the stamens is diagnostic at specific level and varies from much shorter than, the same length as or longer than the calyx. On account of the length of the different stamens and the ratio between the length of the stamens and that of the sepals or the petals, different types of floral structures can be recognized. Other characters in the inflorescence and floral structure were also used in this classification.

The preliminary subdivision is mainly based on external morphology of the plants. Although all morphological characters were considered, the emphasis was on the structure of the androecium. This is because reproduction in any living organism is very important and the development of the androecium and that of the gynoecium are an important safeguard for the survival of any organism. In the species of *Hoarea* like all the species of *Pelargonium*, the gynoecium shows no or little variation. Only the length of the ovary (special that of the rostrum) and the length of the style may differ. Species with long stamens also have long ovaries and styles.

CHAPTER 8

TAXONOMIC TREATMENT

Section *Hoarea* (Sweet) DC., Prodrumus 1: 649 (1824); Loudon: 569 (1829); G. Don: 725 (1831); Harv.: 261 (1860); Benth. & Hook. f.: 273 (1862); Knuth: 320 (1912); Van der Walt: xiii (1977); Marais: 240, 241 (1989a).

LECTOTYPE: *Hoarea corydaliflora* Sweet, Geraniaceae. 1: t. 18 (1820), at present included in the synonymy of *P. rapaceum* (L.) L'Hérit. (Marais 1989a).

Genus *Hoarea* Sweet: viii (1820); Eckl. & Zeyh.: 60 (1835).

Genus *Dimacria* Sweet: viii (1820).

Section *Dimacria* (Sweet) DC.: 653 (1824); Loudon: 571 (1829); Don: 728 (1831).

Genus *Seymouria* Sweet: t. 206 (1824).

Section *Seymouria* (Sweet) Loudon: 573 (1829); Don: 731 (1831); Harv.: 271 (1860); Benth. & Hook. f.: 273 (1862); Knuth: 349 (1912); Van der Walt: xiii (1977).

Genus *Grenvillea* Sweet: t. 262 (1825).

Section *Grenvillea* (Sweet) G. Don: 731 (1831).

Deciduous geophytes with regularly shaped subterranean tubers with apically a dense crown of petiole remains, 80--500 mm tall when in flower. **Tuber:** a turnip-shaped or elongated, sometimes moniliform root with a short flattened stem, covered with flaking dark brown periderms, main tuber 10--150 mm long and 10--150 mm in diameter. **Leaves** radical, hysteranthous, rosulate, heteroblastic, petiolate; lamina simple, trifoliate, pinnate, irregularly bipinnatisect, or palmate-pinnate, 15--300 mm long, adaxially and abaxially with different types of glandular and non-glandular hairs (long soft patent hairs, appressed curly hairs, appressed stiff hairs, patent stiff hairs and bristles) and different combinations thereof, in all cases appressed non-glandular hairs are distally orientated; petiole 15--200 mm long, prostrate, erect or erecto-patent; stipules subulate, triangular or obtrullate, adnate to petioles with apices free, usually ciliate. **Inflorescence:** scape 10--300 mm long, 1--5 mm in diameter, unbranched with 1 pseudo-umbel or branched, bearing 2--9 pseudo-umbellets with 3--60 flowers each; peduncles 30--300 mm long, 1--3 mm in diameter, with different types of glandular and non-glandular hairs and different combinations thereof; bracts triangular or lanceolate;

flower buds, flowers and fruits erect. **Pedicel** 0,5--1 mm long. **Hypanthium** 6--100 mm long, green, reddish brown or greenish red, indumentum usually as on peduncle. **Sepals** 5, lanceolate, apices acute or attenuate, 5--15 mm long, 1--5 mm wide, all patent or all recurved or posterior one erect, others reflexed, green to pale reddish brown. **Petals** 2, 4 or 5, white, cream-coloured, pale yellow, yellow, pale pink, bright pink, or bright purple, claws forming a sheath; posterior two ligulate (14--42 mm long), spathulate (6--25--36 mm long), obovate or obcordate (17--34 mm long), with V-shaped or feather-like markings or prominent dark blotches, bases cuneate or narrowly cuneate, apices rounded, truncate or emarginate; anterior three spathulate or ligulate, bases attenuate, apices rounded, truncate or emarginate. **Stamens**: filaments 7, 8 or 10, basally connate, staminal column 1--5 mm long, white, pink or wine-red, smooth or papillate; perfect stamens 2, 3, 4 or 5, of different lengths, concealed within the floral sheath or protruding from the flower, white, pink or wine-red; staminodes 1--6 mm long; anthers pink, red or wine-red, 1--3 mm long, pollen white, pale pink, yellow or orange. **Gynoecium**: ovary superior, oblong-conical, 4--5-lobed, densely sericeous; style filiform, pale green, pink or wine-red; stigma with 5 branches. **Fruit**: a schizocarp consisting of 4--5 mericarps, bases of mericarps 4--8 mm long, with or without glandular hairs, tails 13--55 mm long.

Key to the floral groups

- | | | |
|----|--|--------------------------|
| 1a | All stamens shorter than the sepals | 2 |
| 1b | Anterior stamens or all stamens the same length or longer than the sepals | 3 |
| 2a | Posterior petals spathulate, length/width ratio of posterior petals smaller than five | |
| | | <i>Fissifolium</i> group |
| | | <i>Pinnatum</i> group |
| | | <i>Proliferum</i> group |
| 2b | Posterior petals ligulate, length/width ratio of posterior petals bigger than five | |
| | | <i>Fissifolium</i> group |
| | | <i>Attenuatum</i> group |
| 3a | Anterior stamens or all stamens the same length as the sepals | 4 |
| 3b | All stamens much longer than the sepals | 7 |
| 4a | Anterior petal conduplicate | <i>Rapaceum</i> group |
| 4b | Anterior petal not conduplicate | 5 |
| 5a | Anterior petals wider than the posterior ones, lateral and anterior petals enclose stamens | |
| | | <i>Luteolum</i> group |
| 5b | Anterior petals narrower than the posterior ones | 6 |

6a	All stamens more or less the same length, staminal column papillate	<i>Auratum</i> group
6b	Obvious differences between the lengths of the posterior, lateral and anterior stamens	
		<i>Aciculatum</i> group
		<i>Heterophyllum</i> group
		<i>Incrassatum</i> group
		<i>Luteum</i> group
7a	Anterior petal conduplicate	<i>Rapaceum</i> group
7b	Anterior petal not conduplicate	8
8a	Anterior petals wider than the posterior ones, lateral and anterior petals enclose stamens	
		<i>Luteolum</i> group
8b	Anterior petals narrower than the posterior ones	9
9a	All stamens more or less the same length	10
9b	Obvious differences between the lengths of the posterior, lateral and anterior stamens	11
10a	Staminal column papillate	<i>Auratum</i> group
10b	Staminal column smooth	<i>Triphyllum</i> group
11a	Stamens straight	<i>Incrassatum</i> group
		<i>Caroli-henrici</i> group
11b	Stamens very long and curved upwards	<i>Punctatum</i> group

FISSIFOLIUM GROUP

Geophytes with simple ovate leaves or pinnately compound to irregularly bipinnatifid leaves. Scape branched, bearing 2--5 pseudo-umbellets with 3--14 flowers each. Flowers with cream-coloured, pale yellow or pink, spatulate or ligulate petals. Stamens 5 fertile, much shorter than the sepals, concealed within the floral sheath. Tectum of pollen reticulate-striate. Basic chromosome number $x = 9$.

8.1 *Pelargonium aestivale* E.M. Marais, sp. nov. in sectione *Hoarea*, *P. fissifolio* affine.

Herba perennis acaulescens tuberosa. Tuber subterraneum, napiforme vel elongatum, interdum moniliforme, 30--80 mm longum, 12--30 mm in diam. Folia hysterantha, rosulata, viridia, petiolata; lamina ovata vel ternata, integra vel serrata, 25--95 mm longa, 14--48 mm lata, utrinque hirsuta et glandulosa; petiolus 25--90 mm longus, prostratus, densim hirsutus et glandulosus, pilis adpressis; stipulae petiolo adnatae. Inflorescentia: scapus pseudoumbellus 2--4, utraque 3--8(-11) floribus. Pedicellum ca. 0,5 mm longum. Hypanthium 33--66 mm longum, hirsutum et glandulosum. Sepala 5, lanceolata, 6,5--11 mm longa, 1,5--3 mm lata, unum posterium erectum, cetera recurvata. Petala 5, cremea vel flava, dua

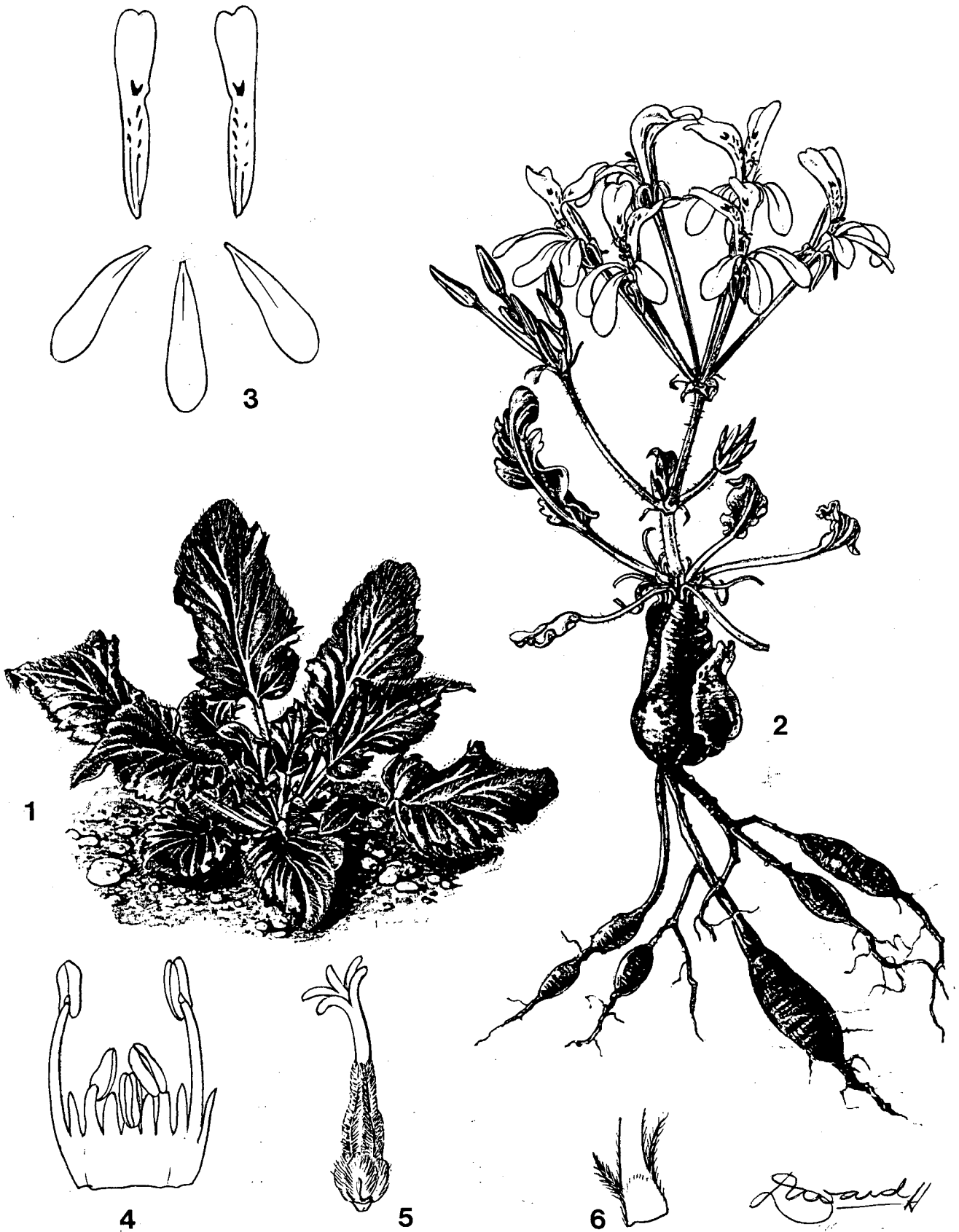


Figure 8.1.1 *Pelargonium aestivale*. 1, plant with leaves x1; 2, flowering plant x1; 3, petals x1,5; 4, androecium x5; 5, gynoecium x5; 6, leaf base x3.

postica unguiculata spathulata, subtiliter carmineo rubra 14--25 mm longa, 3,5--6 mm lata, tria antica spathulata, 12--20 mm longa, 3,5--5 mm lata. **Stamina fertilia** 5, staminodia 5.

TYPE - Cape Province: " In clivis montosis prope Murraysburg." *Tyson 328* (BOL, holotype; BM, K, SAM, Z).

A deciduous geophyte with a regularly shaped subterranean tuber, 120--200 mm tall when in flower. **Tuber**: a turnip-shaped or elongated, sometimes moniliform root with a short flattened stem, covered with flaking dark brown periderms, 30--80 mm long and 12--30 mm in diameter. **Leaves** radical, hysteranthous, rosulate, simple or ternate, green, petiolate; lamina ovate, apex acute, margin entire to serrate, revolute, 25--95 x 14--48 mm, adaxially and abaxially hirsute or sparsely hirsute with stiff hairs interspersed with short glandular hairs and long soft non-glandular hairs; petiole 25--90 mm long and 1--3 mm in diameter, prostrate, densely hirsute with short appressed hairs and sparsely interspersed with short glandular hairs; stipules subulate, adnate to petioles with apices free, 5 mm long and *ca.* 1 mm wide, ciliate. **Inflorescence**: scape 10--70 mm long, 1--3 mm in diameter, branched, bearing 2--4 pseudo-umbellets with 3--8(-11) flowers each; peduncles 35--85 mm long, 1--2,5 mm in diameter, densely hirsute with distally appressed curly hairs interspersed with long glandular hairs; bracts lanceolate, 4--8 mm long, 1,5--2 mm wide, abaxially hirsute with distally appressed hairs interspersed with glandular hairs; flower buds, flowers and fruits erect. **Pedice** *ca.* 0,5 mm long. **Hypanthium** 33--66 mm long, pale green, indumentum as on peduncle. **Sepals** 5, lanceolate, apices acute, 6,5--11 mm long, 1,5--3 mm wide, posterior one erect, others reflexed, green to pale reddish brown with margins white, indumentum abaxially as on peduncle. **Petals** 5, cream-coloured to yellow, claws forming a sheath; posterior two with wine-red feather-like markings, unguiculate-spathulate, bases cuneate, apices emarginate, 14--25 x 3,5--6 mm; anterior three spathulate, bases attenuate, apices rounded, 12--20 x 3--5 mm. **Stamens** 10, basally connate, staminal column 1,5--2 mm long, white; perfect stamens 5, concealed within the floral sheath, posterior one 2--3,5 mm long, lateral two 3--4,5 mm long, anterior two 4--7 mm long, white; staminodes 2,5--3 mm long; anthers pink, 1,5--2 mm long, pollen orange. **Gynoecium**: ovary superior, oblong-conical, 5-lobed, 2,5--4 mm long, densely sericeous; style filiform, 0,5--2 mm long, pale green; stigma with 5 recurved branches, 1-2 mm long, adaxially wine-red. **Fruit**: a schizocarp consisting of 5 mericarps, bases of mericarps *ca.* 7 mm long, with glandular hairs, tails *ca.* 36 mm long. (Figure 8.1.1).

Diagnostic features and affinities

P. aestivale is a geophyte with simple or ternate, prostrate leaves. The laminae are revolute and the margins entire to serrate. Furthermore, *P. aestivale* is characterized by the cream-coloured or yellow flowers with short stamens and very long hypanthia. The colour and structure of the flowers resemble those of *P. fissifolium*. However, leaves of *P. fissifolium* are usually irregularly bipinnatifid, although juvenile leaves could be simple or tripartite.

Leighton (1933) referred to the specimen *Tyson 328*, collected at Murraysburg, as the type of *P. tysonii* Szyszyl., and that a substitute name for *Geranium ciliatum* Cav. was necessary, because *P. ciliatum* L'Hérit. (1792), a synonym for *P. heterophyllum* Jacq. already existed. When renaming *G. ciliatum* Cav., Szyszylowics (1888) did cite *Tyson 328*, but did not designate it as the type. Referring to this specimen was in any case a misidentification, because it neither corresponds to the illustration accompanying Cavanilles's original description, nor agrees with the Thunberg specimen in Madrid herbarium on which *G. ciliatum* was based and which is the same as *P. proliferum*.

Geographical distribution and ecology

P. aestivale is one of the few species of section *Hoarea* occurring in the Great Karoo, and also one of the few species restricted to the summer rainfall area, hence the specific epithet *aestivale*. Its distribution area extends from Carnarvon and De Aar in the north to Klaarstroom, north of Meiring's Poort in the south and to Middelburg (C.P.) in the east (Figure 8.1.2), an area receiving an annual rainfall of 100--300 mm. Plants grow in karroid vegetation on rocky hillsides, but also on flat areas where they are locally common. According to herbarium records, flowering time is from September to December. This apparent long flowering season reflects the irregular start of the raining season. New leaves appear after early spring showers or any rain following a drought. Growing time is short and the flowering stage is reached soon. Thus early spring showers will bring an early flowering season or with later showers the flowering season will be delayed accordingly. Sometimes leaves are still present at this stage, but often flowers appear after the leaves have died.

Material studied

--3022 (Carnarvon): Carnarvon (-CC), *Hafström & Acocks 743* (S).

--3024 (De Aar): Poortjiesfontein, Hanover (-CD), *Du Toit 310* (PRE).

- 3123 (Victoria West): Murraysburg (-DD), *Tyson 328* (BM, BOL, K, SAM, Z).
- 3124 (Hanover): Vlakplaats, Richmond (-CB), *Bolus 13774* (BOL, BOL-FOURCADE); Leopard's Vlei, Richmond (-CB), *Watermeyer 20058* (BOL, K); Gordonville, Sneeuberge (-DA), *Acocks 16533* (PRE); Near Zuurpoort Hotel (-DD), *Bolus 1800* (BOL); Blaauwater, Sneeuberge (-DD), *Gill 65* (BOL); Sneeuberge (-DD), *Watermeyer s.n.* (BOL).
- 3125 (Steynsburg): Middelburg, N of College (-AC), *Van der Walt 1454* (STEU).
- 3223 (Rietbron): Rietfontein, between Murraysburg & Aberdeen (-BA), *Marais 146* (STEU).
- 3224 (Graaff Reinet): Doornbosch, in Koudeveldberge (-AA), *Oliver 5471* (STE).
- 3322 (Oudtshoorn): Klaarstroom (-BC), *Lavranos 20952* (STEU).

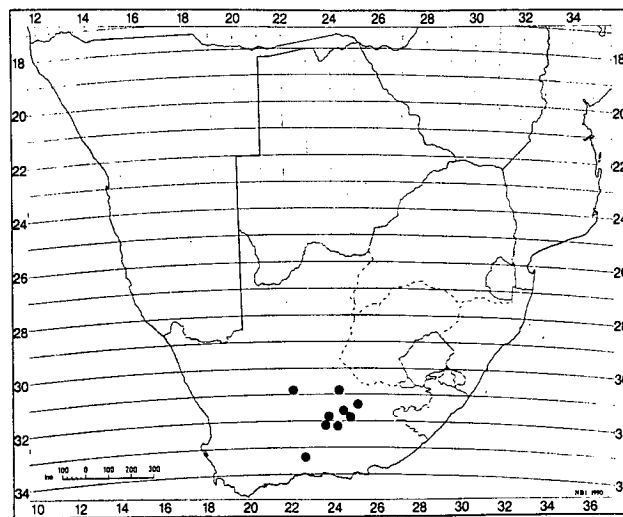


Figure 8.1.2 Geographical distribution of *P. aestivale*.

8.2 *Pelargonium fissifolium* (Andr.) Pers., Synopsis plantarum 2: 227 (1806); Ait. f.: 163 (1812); DC.: 652 (1824); Spreng.: 53 (1826); Loudon: 570 (1829); G. Don: 728 (1831); Loudon: 271 (1832); Steud.: 678 (1840); Steud.: 286 (1841); Harv.: 270 (1860); Knuth: 342 (1912). ICONOTYPE: Andrews, The Botanist's Repository 6: t. 378 (1804b).

Geranium fissifolium Andr.: t. 378 (1804b); Poir.: 757 (1812). ICONOTYPE: Andrews, The Botanist's Repository 6: t. 378 (1804b).

Dimacria fissifolia (Andr.) Sweet: 77 (1826c).

Geranospermum fissifolium (Andr.) Kuntze: 94 (1891).

Geranium floribundum Andr.: t. 420 (1805a); ICONOTYPE: Andrews, The Botanist's Repository 6: t. 420 (1805a).

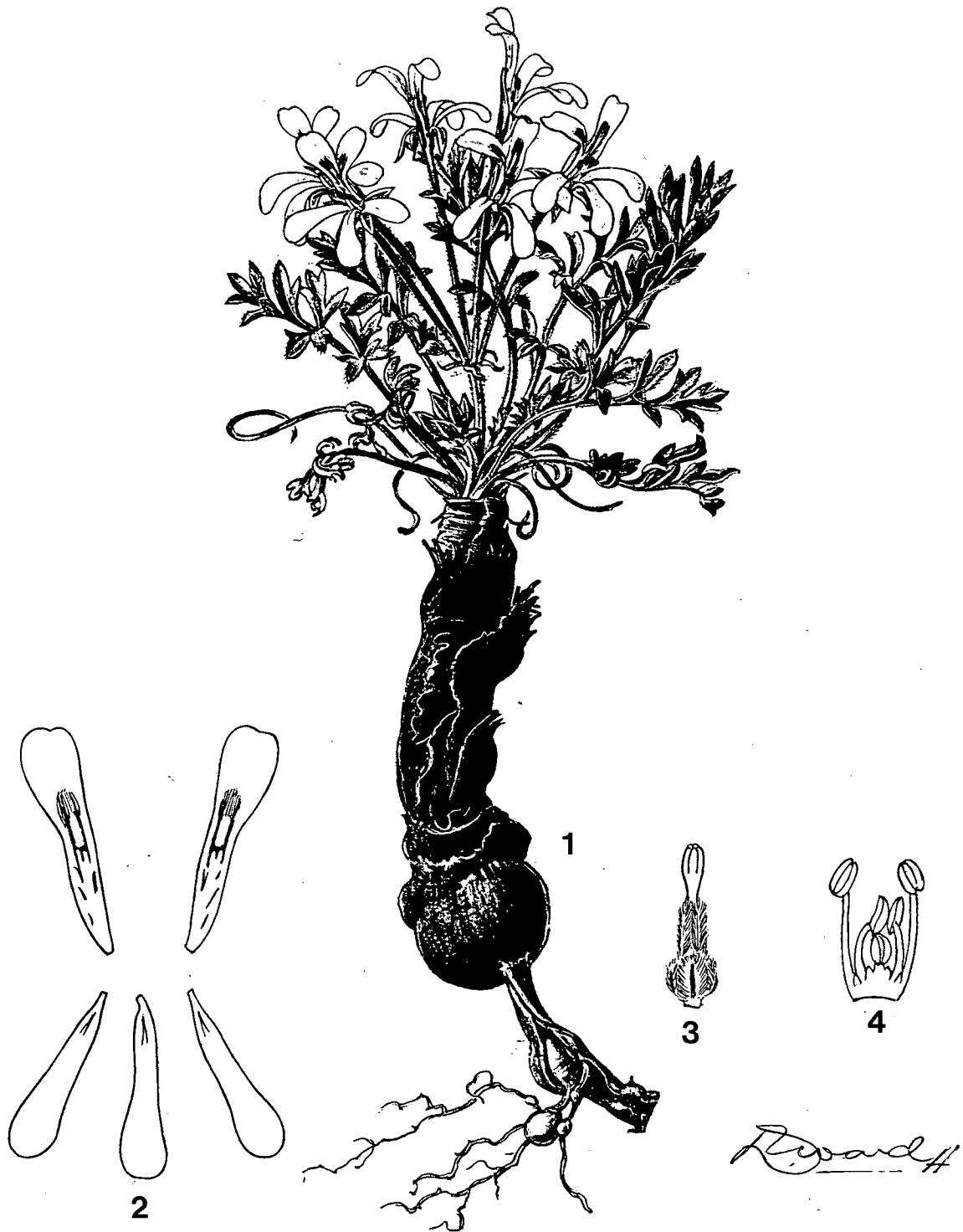


Figure 8.2.1 *Pelargonium fissifolium*. 1, flowering plant x1; 2, petals x2; gynoecium x 5; androecium x5.

Pelargonium floribundum (Andr.) Ait. f.: 163 (1812); DC.: 652 (1824); Spreng.: 53 (1826); Loudon: 570 (1829); G. Don: 728 (1831); Loudon: 271, 272 (1832); Steud.: 678 (1840); Steud.: 286 (1841); Harv.: 270 (1860); Knuth: 346 (1912).

Dimacria floribunda (Andr.) Sweet: 77 (1826c).

Geranospermum floribundum (Andr.) Kuntze: 94 (1891).

A geophyte 70--140 mm tall when in flower. **Tuber:** a turnip-shaped or elongated, often moniliform root 15--45 mm long and 8--25 mm in diameter. **Leaves** green, petiolate; lamina varies from simple, trifoliolate, pinnately divided to irregularly bipinnatifid, cordate to elliptic in outline, 25--70 mm long, pinnae 8--25 mm long, sometimes deeply incised so that segments are lacinate, 1--3 mm wide, apices obtuse, sometimes ending in a single hair, hirsute or sparsely hirsute with long appressed hairs, sometimes glabrous; petiole 25--70 mm long and 1--2 mm in diameter, rigid, erecto-patent, hirsute with short appressed hairs sparsely interspersed with short glandular hairs and stiff non-glandular hairs; stipules subulate, adnate to the petioles for almost their full length, with apices free, 5--15 mm long and 1--2 mm wide, ciliate. **Inflorescence:** scape 15--30 mm long, 1,5--2 mm in diameter, branched, bearing 2--5 pseudo-umbellets with 4--9(-14) flowers each; peduncles 20--60 mm long, 1--1,5 mm in diameter, hirsute with appressed curly hairs interspersed with long glandular hairs; bracts lanceolate, 4--5 mm long, 1--1,5 mm wide, abaxially hirsute, interspersed with glandular hairs. **Pedicel** ca. 0,5 mm long. **Hypanthium** 28--65 mm long, indumentum as on peduncle. **Sepals** 5, lanceolate, apices acute, 6--8,5 mm long, 1--2,5 mm wide, posterior one erect, others reflexed, green or pale reddish brown with margins white, indumentum abaxially as on peduncle. **Petals** 5, cream-coloured or pale yellow; posterior two with wine-red feather-like markings, spathulate, bases cuneate, apices obtuse to rounded or emarginate, 14--22 x 3,2--5,5 mm, length/width ratio smaller than 5; anterior three narrowly spathulate, bases attenuate, apices rounded, 11--18 x 2--4,5 mm. **Stamens:** staminal column 1--1,5 mm long, white; perfect stamens 5, concealed in the floral sheath, posterior one 2--3 mm long, lateral two 3--4 mm long, anterior two 5--6 mm long, white; staminodes 1--2 mm long; anthers pink, 1,5--2 mm long, pollen orange. **Gynoecium:** ovary 2--4 mm long; style 0,2--2 mm long, pink; stigma branches 1--1,5 mm long, wine-red. **Fruit:** bases of mericarps 4--6 mm long, with glandular hairs, tails 25--26 mm long. (Figure 8.2.1).

Diagnostic features and affinities

Although *P. fissifolium* can be described as a geophyte with pinnate to irregularly bipinnatifid leaves, the plants may exhibit a variation in leaf form. This may be due to

the heteroblastic leaf development. Young plants usually have simple to trifoliolate leaves, whereas those of the older plants are bipinnatifid. This leaf development is an annual phenomenon, as the first leaves of the season are simple to pinnatilobed and the younger ones pinnate to bipinnatifid. The pinnae are usually deeply incised and the segments laciniate, hence the specific epithet *fissifolium* or the common name of cleft-leaved geranium (Don 1831). The segments sometimes end in a single hair. The floral structure of *P. fissifolium* resembles that of *P. aestivale*, *P. aristatum* and *P. petroselinifolium*. The stamens of all four species are very short and concealed in the floral sheath. The former three species have pale yellow flowers with wine-red feather-like markings on the posterior petals. In the case of *P. aristatum* the petals are ligulate with the length/width ratio of greater than five, and those of *P. fissifolium* are spatulate with the length/width ratio of smaller than five. The flowers of *P. petroselinifolium* are pink, the petals are smaller and the hypanthia shorter than those of the other three species.

Geographical distribution and ecology

P. fissifolium is well established on the Roggeveld plateau and its distribution area extends to the Witteberge and the vicinity of Nougaspoot. It also occurs on the Koue Bokkeveld plateau and as far south as Worcester (Figure 8.2.2). This is mainly a winter rainfall area, receiving an annual precipitation of 200--300 mm. *P. fissifolium* grows in succulent karoo or transitional vegetation between succulent karoo and fynbos, and also in renosterveld, occurring on sandstone or shale in direct or partial sunlight. Plants usually occur in large populations, and flower from October to November.

Material studied

--3220 (Sutherland): Farm Geelhoek on Calvinia-Sutherland road (-AB), *Marais 238, 239* (STEU); Sutherland, 19 km on Ouberg road (-AD), *Marais 248, 249* (STEU); Kanolfontein on Ouberg road (-AD), *Marais 250* (STEU); Sutherland plateau, near Ouberg Pass (-AD), *Marais 251* (STEU); 6 km from Sutherland-Calvinia road, on Kariega turnoff (-BA), *Marais 235* (STEU); 20 km from Sutherland-Calvinia road, on Kariega turnoff (-BA), *Marais 236* (STEU); 2 km from Sutherland on Calvinia road (-BC), *Marais 227* (STEU); 4 km from Sutherland on Calvinia road (-BC), *Marais 228* (STEU); Klipplaat, at Kariega turnoff (-BC), *Marais 231, 232, 233, 234* (STEU); Sutherland, 3 km on the Ouberg turnoff (-BC), *Marais 244* (STEU); Sutherland, 7 km on the Ouberg turnoff (-BC), *Marais 247* (STEU); Matjiesfontein on the Sutherland-Merweville road (BD), *Forrester 236* (NBG); Kookfonteinberg, Tankwa Karoo (-CC), *Lavranos & Pehlemann 18831* (STEU); Thyshoogte (-CC), *Marais 219* (STEU); Komsberg

Pass (-DB), *Lavranos s.n.* (STEU); *Marais 142* (STEU); *Van der Walt s.n.* (STEU); Oranjefontein, Komsberg (-DB); *Van der Walt s.n.* (STEU).

--3319 (Worcester): Loch Lynne (AB), *Oliver 5182* (PRE, STE); Buffelskraal-Wes, De Doorns (-BC), *Forrester 130* (NBG); Between Moordhoogte & Kleinstraat, on N1 (-BD), *Marais 348* (STEU); Karoo Garden, Worcester (-CB), *Barker 4271* (NBG); *Bayer s.n.* (NBG); *Dobay 79, 86* (NBG); *Fairall & Whitlock s.n.* (NBG); *Fischer 133* (STEU); *Perry 791, s.n.* (NBG); *Van der Walt 1057* (STEU); Nature Reserve, Worcester (CB); *Olivier 196* (PRE); Lemoenpoort (-CD), *Perry 1230* (NBG).

--3320 (Montagu): Jagerskraal (-AB), *Bayer 3605* (NBG); Memorial, Laingsburg (-AB), *Van der Walt s.n.* (STEU); 15 km E of Lettaskraal (-AD), *Bayer 2625* (NBG); Bantams Karoo, Witteberge (-BC), *Compton 12153* (NBG); Foothills of Bantamskop, Witteberge (-BC), *Marais 354* (STEU); Nougaspoort, 34 km SE of Touwsrivier (-CA), *Drijfhout 2657* (STEU); Vandeventerskloof, between Touwsrivier & Montagu (-CA), *Marais 108* (STEU).

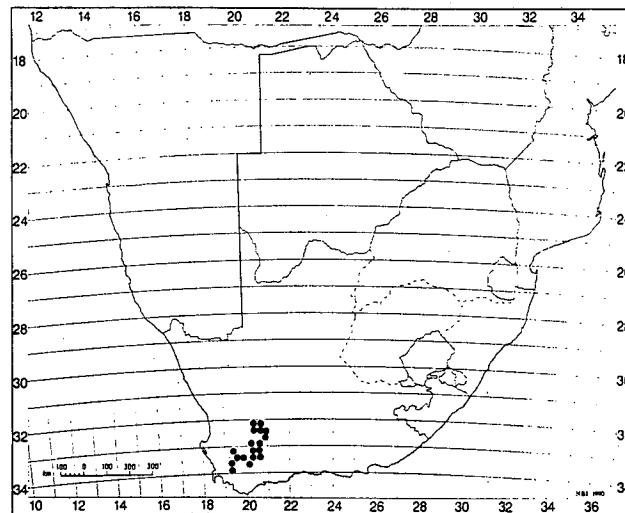


Figure 8.2.2 Geographical distribution of *P. fissifolium*.

8.3 ***Pelargonium petroselinifolium* G. Don**, A general system of gardening and botany 1: 728 (1831): substitute name for *Geranium apiifolium* Andr.: C, ic (1805b). ICONOTYPE: Andrews, Geraniums: C, ic (1805b).

Geranium apiifolium Andr.: C, ic (1805b). ICONOTYPE: Andrews, Geraniums: C, ic (1805b).

Dimacria apiifolia (Andr.) Sweet: 77 (1826c).

Pelargonium apiifolium (Andr.) Loudon: 272 (1832); non J. Jacq.: t. 27 (1812).

Geranium pilosum Andr.: t. 259 (1802b); Andr.: C, ic (1805b); Poir.: 758 (1812); non Cav.: 273 (1788a). ICONOTYPE: Andrews, The Botanist's Repository 4: t. 259 (1802b).



Figure 8.3.1 *Pelargonium petroselinifolium*. 1, flowering plant x1; 2, petals x2; 3, androecium x4; 4, gynoecium x8.

Pelargonium pilosum Pers.: 227 (15-11-1806); Ait. f.: 164 (1812); Link: 186 (1822) (excl. Willd.); DC.: 652 (1824); Spreng.: 53 (1826); Loudon: 570 (1829); G. Don: 727 (1831); Loudon: 271 (1832); Steud.: 288 (1841); Harv.: 268 (1860); Knuth: 341 (1912); non F.G. Dietr.: 69 (May 1806).
ICONOTYPE: Andrews, The Botanist's Repository 4: t. 259 (1802b).

Hoarea pilosa (Pers.) Sweet: 76 (1826c).

Geranospermum pilosum (Pers.) Kuntze: 95 (1891).

A geophyte 80--180 mm tall when in flower. **Tuber:** a turnip-shaped or elongated, sometimes moniliform root 15--40 mm long and 10--30 mm in diameter. **Leaves** green, petiolate; lamina elliptic in outline, 30--60 mm long, pinnately compound, irregularly bipinnatifid, pinnae obtriangular, 12--18 x 6--10 mm, bases cuneate, apices deeply incised; segments 2--3 mm wide, apices obtuse, with or without a single hair, adaxially and abaxially hirsute with appressed hairs interspersed with short glandular hairs; petiole 30--50 mm long and 1--2 mm in diameter, rigid, erecto-patent, densely covered with very short curly hairs interspersed with short glandular hairs; stipules subulate, adnate to the petiole for half to almost its full length, 7--20 mm long and 1--2 mm wide, ciliate. **Inflorescence:** scape 5--50 mm long, 1,5--3 mm in diameter, branched, bearing 2--5 pseudo-umbellets with (3-)5--8(-10) flowers each; peduncles 35--120 mm long, 1--2 mm in diameter, densely covered with short appressed curly hairs interspersed with long and short glandular hairs; bracts lanceolate, 2--4 mm long, 1,5--2 mm wide, abaxially hirsute with appressed hairs interspersed with short glandular hairs. **Pedicel** ca. 0,5 mm long. **Hypanthium** 13--25 mm long, green to pale reddish brown, indumentum as on peduncle. **Sepals** 5, lanceolate, apices acute, 5,5--7 mm long, 1,5--2,5 mm wide, posterior one erect, others reflexed, green or pale reddish brown with margins white, indumentum abaxially as on peduncle. **Petals** 5, pink; posterior two with wine-red feather-like markings, ligulate to narrowly spathulate, bases cuneate, apices emarginate, 11--16,5 x 2,2--3,5 mm, length/width ratio 4--5; anterior three narrowly spathulate, bases attenuate, apices rounded, 10,5--14 x 2--3 mm. **Stamens:** staminal column 1--2 mm long, white; perfect stamens 5, concealed in the floral sheath, posterior one 2--3 mm long, lateral two 3--5 mm long, anterior two 4--6 mm long, white; staminodes 1,5--3 mm long; anthers pink, 1,3--1,8 mm long, pollen orange. **Gynoecium:** ovary 2,5--3 mm long; style 0,5--1,5 mm long, wine-red; stigma branches 1--1,5 mm long, wine-red. **Fruit:** bases of mericarps 5--6 mm long, with glandular hairs, tails 27--28 mm long. (Figure 8.3.1).

Diagnostic features and affinities

P. petroselinifolium is a geophyte with pinnate to irregularly bipinnatifid leaves. The pinnae are usually deeply incised, hence the specific name of parsley-leaved geranium. The morphology and the indumentum of the leaves resemble those of *P. aristatum* and *P. fissifolium*, but segments do not necessarily end in a single hair. The floral structures of these three species are also very similar. All of them have very short stamens which are concealed in the floral sheath. *P. petroselinifolium* has small pink flowers, whereas the other two have larger flowers with cream-coloured or pale yellow petals. All three species have wine-red feather-like markings on the posterior petals.

Geographical distribution and ecology

P. petroselinifolium has a small distribution area around Ceres and on the Koue Bokkeveld plateau, from Gydo in the west to Karoo Poort in the east (Figure 8.3.2). This is a winter rainfall area, receiving up to 1000 mm rain per annum. Plants grow in mountain fynbos or in karroid vegetation and flower during October and November.

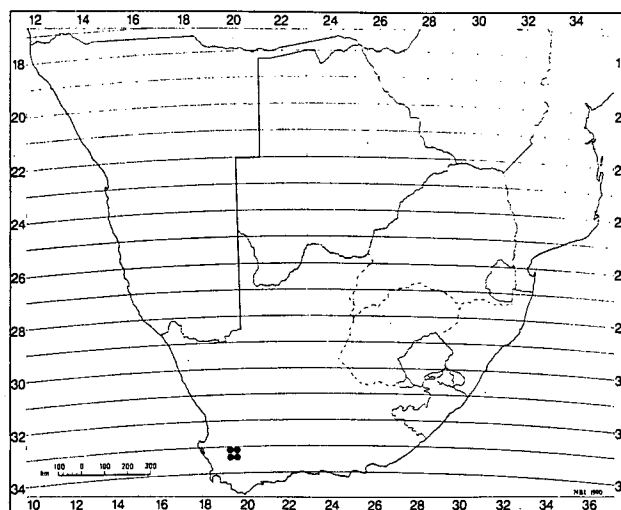


Figure 8.3.2 Geographical distribution of *P. petroselinifolium*.

Material studied

–3319 (Worcester): Die Erf, between Gydo & Baviaanshoek (-AB), *Marais 51* (STEU); Gydo (-AB), *Leipoldt 4003* (BOL); *Marais 65* (STEU); Ceres (-AD), *Bayliss 4033* (Z); 4 km N of Karoo Poort (-BA), *Lavranos & Pehlemann 17471* (STEU); On R46, at turnoff to Op-Die-Berg (-BC), *Forrester 499* (NBG); Karoo Poort side of Theronberg Pass (-BC), *Perry 3059* (NBG).



Figure 8.4.1 *Pelargonium aristatum*. 1, flowering plant x1; 2, androecium x3; 3, gynoecium x4; 4, petals x1,5; 5, leaf base x1,5; 6, plant with leaves.

8.4 Pelargonium aristatum (Sweet) G. Don, *A general system of gardening and botany* 1: 728 (1831): substitute name for *Geranium barbatum* var. *undulatum* Andr.: t. 366 (1804b); Loudon: 272 (1832); Steud.: 283 (1841). **ICONOTYPE:** Andrews, *The Botanist's Repository* 6: t. 366 (1804b).

Geranium barbatum var. *undulatum* Andr.: t. 366 (1804b). **ICONOTYPE:** Andrews, *The Botanist's Repository* 6: t. 366 (1804b).

Dimacria aristata Sweet: 77 (1826c): substitute name for *Geranium barbatum* var. *undulatum* Andr.: t. 366 (1804b).

Geranium barbatum Andr.: t. 303 (1803b). **ICONOTYPE:** Andrews, *The Botanist's Repository* 5: t. 303 (1803b).

Dimacria barbata (Andr.) Sweet: 77 (1826c).

Pelargonium aristatum Steud.: 677 (1840): substitute name for *Geranium barbatum* Andr.: t. 303 (1803b).

Geranium barbatum var. *minor* Andr.: t. 323 (1803b). **ICONOTYPE:** Andrews, *The Botanist's Repository* 5: t. 323 (1803b).

Dimacria recurvata Sweet: 77 (1826c): substitute name for *Geranium barbatum* var. *minor* Andr.: t. 323 (1803b).

Pelargonium recurvatum (Sweet) G. Don: 728 (1831); Steud.: 289 (1841); non Sweet: t. 223 (1824).

(*Pelargonium barbatum* Jacq. (1791b): see *P. proliferum* (Burm. f.) Steud.)

A geophyte 90--300 mm tall when in flower. **Tuber:** a turnip-shaped, sometimes moniliform root 20--40 mm long and 15--30 mm in diameter. **Leaves** green, petiolate; lamina elliptic in outline, 30--80 mm long, pinnately compound, irregularly bipinnatifid, pinnae 20--30 mm long, deeply incised, segments lacinate, 2--3 mm wide, apices obtuse, with a single hair or a tuft of hairs at the apices, sparsely hirsute with long appressed hairs; petiole 30--120 mm long and 1,5--2,5 mm in diameter, rigid, erecto-patent, hirsute with short appressed hairs interspersed with short glandular hairs; stipules subulate, adnate to petioles with apices free, 7--8 mm long and 1--2 mm wide, ciliate. **Inflorescence:** scape 5--120 mm long, 1,5--3 mm in diameter, branched, bearing 2--5(-8) pseudo-umbellets with 4--11 flowers each; peduncles 40--160 mm long, 1--2 mm in diameter, hirsute with appressed curly hairs interspersed with long glandular hairs with large heads; bracts lanceolate, 3--4 mm long, 1 mm wide, abaxially hirsute, interspersed with glandular hairs. **Pedicel** ca. 0,5 mm long. **Hypanthium** 19--35 mm long,

indumentum as on peduncle. **Sepals** 5, lanceolate, apices acute, 5--10 mm long, 1--3 mm wide, posterior one erect, others reflexed, green or pale reddish brown with margins white, indumentum abaxially as on peduncle. **Petals** 5, cream-coloured or pale yellow; posterior two with wine-red feather-like markings, ligulate, bases cuneate, apices rounded or emarginate, 14--26 x 2--4 mm, length/width ratio greater than 5; anterior three narrowly spatulate, bases attenuate, apices rounded, 11,5--24 x 1,5--3 mm. **Stamens**: staminal column 1--1,5 mm long, white; perfect stamens 5, concealed in the floral sheath, posterior one 1,5--3 mm long, lateral two 3--4 mm long, anterior two 4,5--6 mm long, white; staminodes 1,5--2 mm long; anthers pale pink, 1,5--2 mm long, pollen orange. **Gynoecium**: ovary 2--4 mm long; style 0,5--1,5 mm long, pale pink; stigma branches 1--2,5 mm long, pale pink. **Fruit**: bases of mericarps 4 mm long, with glandular hairs, tails 20--24 mm long. (Figure 8.4.1).

Diagnostic features and affinities

P. aristatum is a geophyte with pinnate to irregularly bipinnatifid leaves. The pinnae are usually deeply incised and the segments lacinate, ending in a single hair or a tuft or hairs, resembling an awn, thus the names bearded-leaved geranium (Andrews 1803b), awn-leaved Stork's bill (Don 1831) or the epithet *aristatum*. The floral structure of *P. aristatum* resembles that of *P. fissifolium*. The stamens of both species are very short and concealed in the floral sheath. Both species have pale yellow flowers with wine-red feather-like markings on the posterior petals, but the petals of *P. aristatum* are ligulate with the length/width ratio of greater than five, and those of *P. fissifolium* are spatulate with the length/width ratio of smaller than five. The leaves of these two species are also very similar.

Geographical distribution and ecology

P. aristatum occurs around Vanrhynsdorp, Nieuwoudtville and Calvinia (Figure 8.4.2), an area with an annual rainfall of 200--300 mm mainly in winter. It grows in full sun or partial shade in dry rocky areas in clay or loam, and on flats in Dwyka tillite. Flowering time is in October and November when leaves are fading or after they have dried.

Material studied

–3118 (Vanrhynsdorp): Near Vanrhynsdorp (-DA), *Marloth 7801* (PRE).

–3119 (Calvinia): 11 miles E of Nieuwoudtville (-AC), *Barker 9762* (NBG); 4 miles N of Nieuwoudtville (-AC), *Barker 10547* (NBG); 7 km from Nieuwoudtville to Brandkop (-AC), *Fischer 27a, 28* (STEU);

Nieuwoudtville, near turnoff on road to Rondekop (-AC), *Marais 126, 127* (STEU); Nieuwoudtville Nature Reserve (-AC), *Perry & Snijman 2382* (NBG); Saaikloof, Nieuwoudtville (AC), *Schonken 215* (STEU); 10 km N of Nieuwoudtville (-AC), *Van der Walt 1442* (STEU); Calvinia (-BD), *Thode A1885* (PRE); Near farm Rooiwal, 23 km S of Bo-Downes (-DB), *Snijman 770* (NBG); 14,2 miles along road from Middelpoos (-DD), *Snijman 24* (NBG).

--3120 (Williston): 68 km from Calvinia on Blomfontein road to Middelpoos (CC), *Goldblatt 4618* (MO).

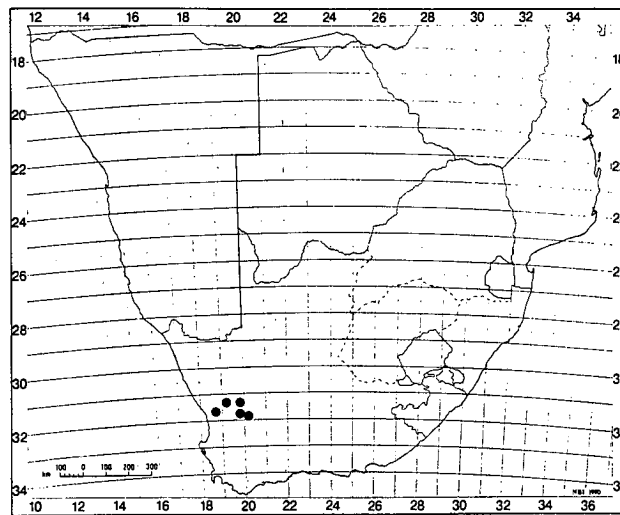


Figure 8.4.2 Geographical distribution of *P. aristatum*.

PINNATUM GROUP

Geophytes with simple, trifoliate, pinnate, bipinnate or palmately compound leaves. Scape branched, bearing 2--8 pseudo-umbellets with 2--9(-17) flowers each. Flowers with white, cream-coloured, pale yellow pink or bright pink, spatulate petals; posterior petals 7--24 mm long, and length/width ratio smaller than five. Stamens 5 fertile, much shorter than the sepals, concealed within the floral sheath.

8.5 *Pelargonium chelidonium* (Houtt.) DC., Prodrumus 1: 650 (1824); G. Don: 726 (1831); Harv.: 265 (1860); Knuth: 334 (1912); Merrill: 349 (1938); Marais: t. 2018 (1990a). TYPE - "Planta Capensis", specimen in Collection Burman (G, holo! specimen with Houttuyn's handwriting).

Geranium chelidonium Houtt.: 8, t. 61, f. 1 (1779). TYPE - "Planta Capensis", specimen in Collection Burman (G, holo! specimen with Houttuyn's handwriting).

Geranospermum chelidonium (Houtt.) Kuntze: 94 (1891).

Pelargonium ficaria Willd.: 643 (1800): substitute name for *Geranium chelidonium* Houtt.: 8, t. 61, f. 1 (1779); Pers.: 226 (1806); Spreng.: 51 (1826); Steud.: 677 (1840); Steud.: 286 (1841).

Geranium ficaria (Willd.) Poir.: 745 (1812).

Geranium trilobum Thunb.: 114 (1800); Thunb.: 519 (1823). TYPE - "e. Cap. b. Spei", specimen in Thunberg herbarium, no. 15669 (UPS, holo!).

Pelargonium trilobum (Thunb.) DC.: 680 (1824); G. Don: 742 (1831); Steud.: 290 (1841).

Geranium revolutum Andr.: t. 354 (1804a); Poir.: 757 (1812). ICONOTYPE: Andrews, The Botanist's Repository 5: t. 354 (1804a).

Pelargonium revolutum (Andr.) Pers.: 226 (1806); Ait. f.: 162 (1811); DC.: 651 (1824); Spreng.: 51 (1826); Loudon: 568 (1829); G. Don: 729 (1831); Loudon: 271, 272 (1832); Steud.: 679 (1840); Steud.: 289 (1841); Harv.: 265 (1860); Knuth : 335 (1912); Adamson & Salter: 514 (1950).

Dimacria revoluta (Andr.) Sweet: 77 (1826c).

Geranospermum revolutum (Andr.) Kuntze: 95 (1891).

Hoarea bijuga Eckl. & Zeyh.: 65 (1835). TYPE - Cape Province: "campestrium vallis 'Tulbagh' prope 'Kloof'", *Ecklon & Zeyher* 499 (S, lecto.!, here designated, MEL!, S!, SAM!).

Pelargonium bijugum (Eckl. & Zeyh.) Steud.: 290 (1841).

Pelargonium meyeri Harv.: 262 (1860) p.p. (*teste* Drège s.n. sub *P. ficaria* Willd.). TYPE - Cape Province: "Zwischen Eikenboom und Riebekkasteel", *Drège s.n.* (TCD, lecto.!, here designated, CGE!, E!, Gx2!, K!, MEL!, MO!, Px2!, S!).

Geranospermum meyeri (Harv.) Kuntze: 95 (1891) p.p.

Misidentifications:

Geranium auritum auct. non L.: Thunb.: 113 (1800); Thunb.: 515 (1823).

A geophyte 70--180 mm tall when in flower. **Tuber:** a turnip-shaped root 15--40 mm long and 8--20 mm in diameter. **Leaves** simple to trilobed or trifoliate to 5-lobed or 5-parted, bright green; lamina widely ovate, base cuneate, apex obtuse, margin entire, 18--30 mm long and 12--25 mm wide, adaxially glabrous, abaxially with bristles along main veins, margins usually with short adpressed bristles; small lateral pinnae widely ovate, 9 mm long and 5--6 mm wide; petiole 10--60 mm long, densely covered with adpressed bristles; stipules lanceolate, adnate to petioles for half their length, *ca.* 10 mm long and 1,5 mm wide, ciliated. **Inflorescence:** scape 20--90 mm long, branched, bearing 3--6 pseudo-umbellets with 4--9 flowers each; peduncles 30--

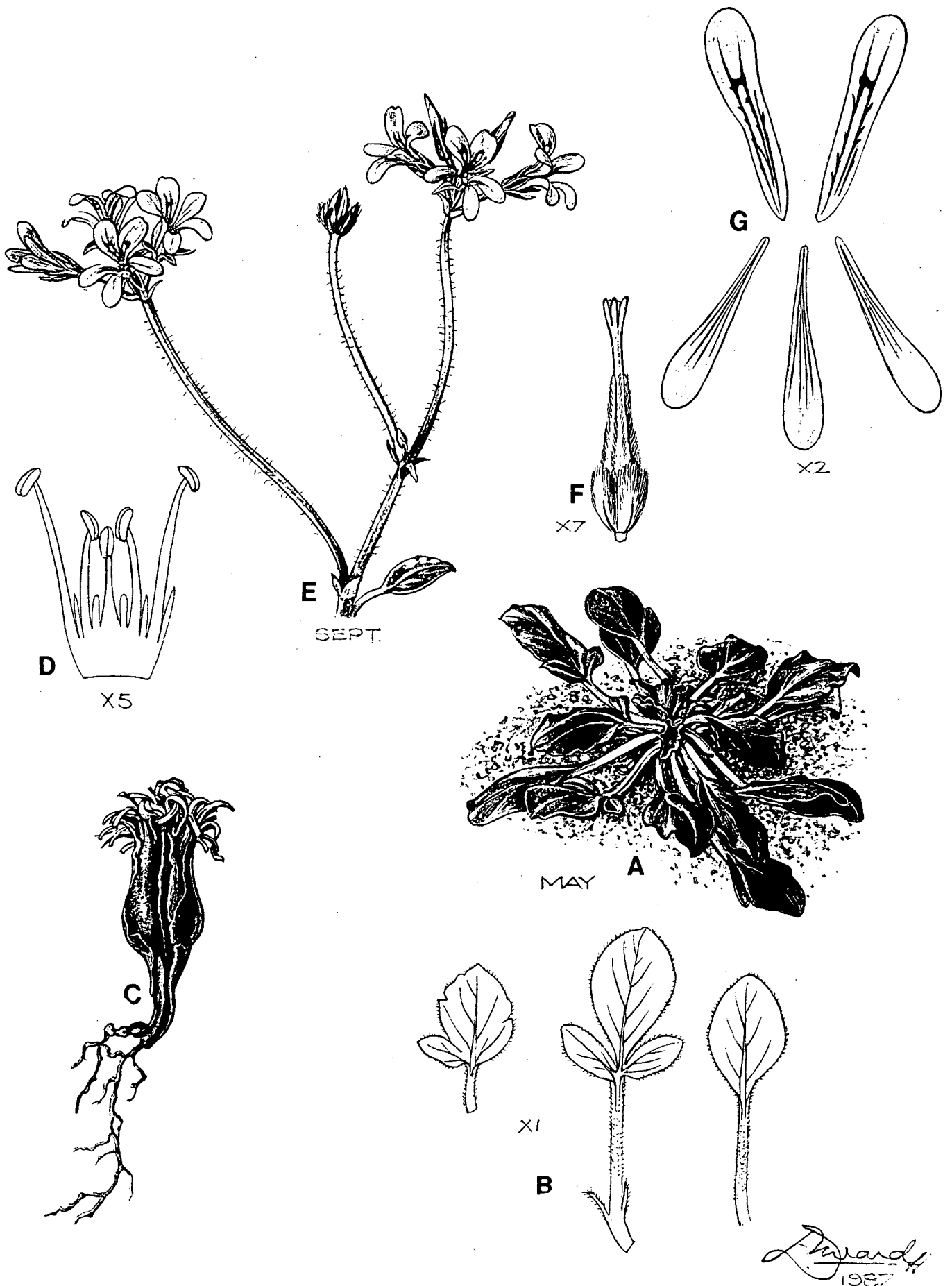


Figure 8.5.1 *Pelargonium chelidonium*. A, plant with leaves x1; B, leaves x1; C, tuber x1; D, androecium x5; E, inflorescence x1; F, gynoecium x7; G, petal x2.

-120 mm long, densely covered with glandular hairs interspersed with coarse hairs; bracts lanceolate, 5--8 mm long, 2--3 mm wide, adaxially and abaxially hirsute. **Pedicel** *ca.* 0,5 mm long. **Hypanthium** 9--16 mm long, densely covered with glandular hairs interspersed with soft hairs. **Sepals** 5, lanceolate, apices acute, 6--9 mm long, 1,5--3 mm wide, reddish brown to green, abaxially densely covered with glandular hairs and adpressed coarse hairs. **Petals** 5, bright pink, oblanceolate, bases cuneate, apices rounded, reflexed at 90°; posterior two with dark pink markings, 13--20 mm long and 3--5,5 mm wide; anterior three 12--19 mm long and 2,5--5 mm wide. **Stamens**: staminal column *ca.* 2 mm long, white; perfect stamens 5, concealed in the floral sheath, posterior one 4 mm long, lateral two 5 mm long, anterior two 7 mm long, pale pink; staminodes *ca.* 3 mm long; anthers pale pink, 1,5 mm long, pollen white. **Gynoecium**: ovary 4--5 mm long, densely sericeous and with glandular hairs; style 1--3 mm long, pink; stigma branches 1--1,5 mm long, pink. **Fruit**: bases of mericarps 5--8 mm long, with prominent glandular hairs, tails 25--30 mm long. (Figure 8.5.1).

Diagnostic features and affinities

P. chelidonium is a small geophyte with bright pink flowers and bright green leaves. The flowers with the oblanceolate petals and short stamens, concealed in the floral sheath, resemble those of *P. pinnatum*. The leaves of *P. chelidonium* vary from entire to trilobed or trifoliate to five-lobed or five-parted. A noteworthy feature of this species is the appressed bristles on the petioles and along the margins of the laminae. The leaf form resembles that of *P. tenellum* and *P. heterophyllum*. Although there is a great similarity in leaf form among these three species, the flowers are quite different. *P. chelidonium* has bright pink petals of more or less the same form and size, whereas in *P. tenellum* and *P. heterophyllum* the posterior petals differ in form and size from the anterior ones. *P. tenellum* has flesh-coloured flowers, whereas those of *P. heterophyllum* are white or cream-coloured with prominent wine-red blotches on the posterior petals.

In the original description Houttuyn (1779) mentioned that the leaves of *Geranium chelidonium* resemble "*speenkruid*", the Dutch name for pilewort (*Ranunculus ficaria* L.), a herb with kidney-shaped leaves and small tubers. According to Wittstein (1856), *Chelidonium* is an early name for *Ranunculus ficaria*. This may explain Houttuyn's choice of the epithet and also the name change by Willdenow (1800).

Geographical distribution and ecology

P. chelidonium grows in clay soil in renosterveld, on foothills or in open areas on dry flats. It occurs in the south-western Cape, from Clanwilliam in the north to Riebeeek-Kasteel in the south, and from Vredenburg in the west to Tulbagh in the east (Figure 8.5.2). This is mainly a winter rainfall area with an annual precipitation of 200 mm in the west to 600 mm in the east. Adamson and Salter (1950) regarded *P. revolutum*, i.e. *P. chelidonium*, as very rare and probably exterminated in the Cape Peninsula, but no herbarium record of a collection in the Cape Peninsula could be found except one, namely *Schlechter 512* in Bolus Herbarium, supposedly collected on the Kenilworth Flats. This record, as Adamson and Salter (1950) stated, is almost certainly false, an observation with which I agree.

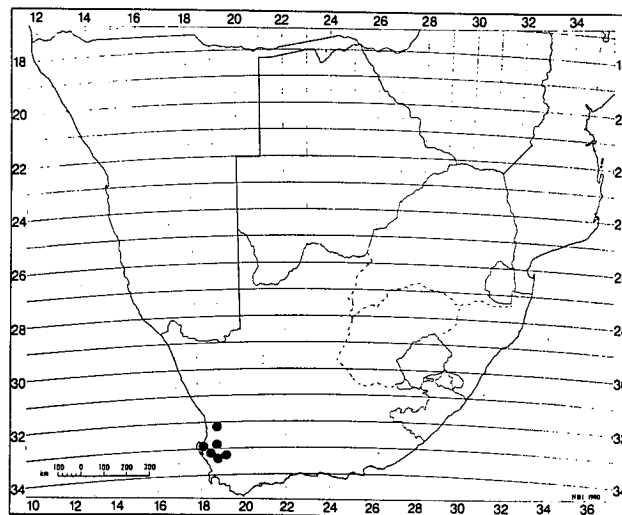


Figure 8.5.2 Geographical distribution of *P. chelidonium*.

Pelargonium chelidonium flowers in spring, from September to October and can be regarded as an early flowering species of the section *Hoarea*. In contrast with the majority of species in this section, the leaves are still present when the bright pink flowers appear. After fruit formation, the leaves and scapes die away and the plant reappears above ground level only after the first winter rains of the next season.

Material studied

–3218 (Clanwilliam): Near Clanwilliam (-BB), *Bolus 8949* (BOL); Driehoeksfontein, near Langebaanweg (-CC), *Boucher 3218* (STE); Near Piketberg (-DD), *Bolus 13526* (BM, BOL, PRE); *Edwards 212* (Z); *Guthrie 18* (NBG); *Visser s.n.* (STE).

--3318 (Cape Town): Near Hopefield (-AB), *Bachmann 1536* (Zx2); *Marloth 8263* (PRE); Lucasfontein near Moorreesburg (-BA), *Acocks 24389* (K, PRE); *Marais 261* (STEU); Near Moorreesburg (-BA), *Bolus 9953* (BOL, NH, Z); Eikenboom (-BD), *Drège 1248* (P); Between Eikenboom and Riebeek Kasteel (-BD), *Drège s.n.* (CGE, E, G, K, MEL, MO, P, S, TCD).

--3319 (Worcester): Saron (-AA), *Lewis 22059* (BOL); Tulbagh (-AC), *Esterhuysen 17490* (BOL); *Marloth 7480* (PRE); *Marloth 9568* (PRE, STE); *Meyer s.n.* (STE); *Pappe s.n.* (K, MEL, TCDx2); *Ross Frames s.n.* (BOL); Near Tulbagh and Tulbaghkloof (-AC), *Bolus 5375* (BOLx2); *Bolus 7539* (K); *Bolus s.n.* (STE); Tulbagh, near Kloof (-AC), *Ecklon & Zeyher 499* (MEL, Sx2, SAM); Artois, Tulbagh (-AC), *Compton 11679* (NBG); Kleinberg, Tulbagh (-AC), *Duthie s.n.* (BOLx3); Steintal, Tulbagh (-AC), *Ecklon & Zeyher 10* (PRE); *Ecklon & Zeyher s.n.* (PRE, STE); *MacOwan 512* (BOL, G, K, P, PRE, SAM, UPS, W); *MacOwan 2592* (SAM); *Pappe 10* (K, TCD); Tulbagh Road (-AC), *Guthrie 19* (NBG); Tulbagh Road, to Waterfall (-AC), *Oliver 4003* (K, PRE, STE); Bergrivier near Tulbagh (-AC), *Rubidge 6252* (BOL); Gouda (-AC), *Forrester 860* (NBG); *Leipoldt s.n.* (BOL); Wolsely (-AC), *Van Breda 556* (K, PRE); Elandsberg Private Nature Reserve (-AC), *Burgers 2920* (STE).

Specimens without localities:

Masson s.n. (BM); *Thunberg s.n.* (Gx2, Sx2, UPSx3); *Van Royen s.n.* (L).

8.6 *Pelargonium nervifolium* Jacq., *Collectanea* 4: 198 (1791b); Jacq.: 9, t. 517 (1792); Willd.: 647 (1800); Pers.: 227 (1806); DC.: 651 (1824); Spreng.: 52 (1826); Loudon: 568 (1829); G. Don: 726 (1831); Loudon: 271 (1832); Steud.: 288 (1841); Harv.: 266 (1860); Knuth: 336 (1912). TYPE - "Ex Promontorio bonae Spei" (W, holo!).

Geranium nervifolium (Jacq.) Poir.: 746 (1812).

Hoarea nervifolia (Jacq.) Sweet: 76 (1826c).

Geranospermum nervifolium (Jacq.) Kuntze: 95 (1891).

A small geophyte 80--130 mm tall when in flower. **Tuber:** a turnip-shaped or elongated root 20--70 mm long and 15--25 mm in diameter. **Leaves** simple, trilobate or trifoliate, petiolate; lamina (or main pinna) ovate, base cuneate or truncate, apex rounded or obtuse, margin entire to irregularly crenate, 20--35 x 15--25 mm, small lateral pinnae ovate, 8--12 x 3--4 mm, adaxially dark green, hirsute with appressed hairs interspersed with very short glandular hairs, abaxially reddish purple, veins usually very prominent, hirsute with appressed hairs interspersed with very short glandular hairs, with non-glandular hairs usually prominent along the veins, margins sometimes ciliate; petiole 30--130 mm long and 1--2 mm in diameter, prostrate to

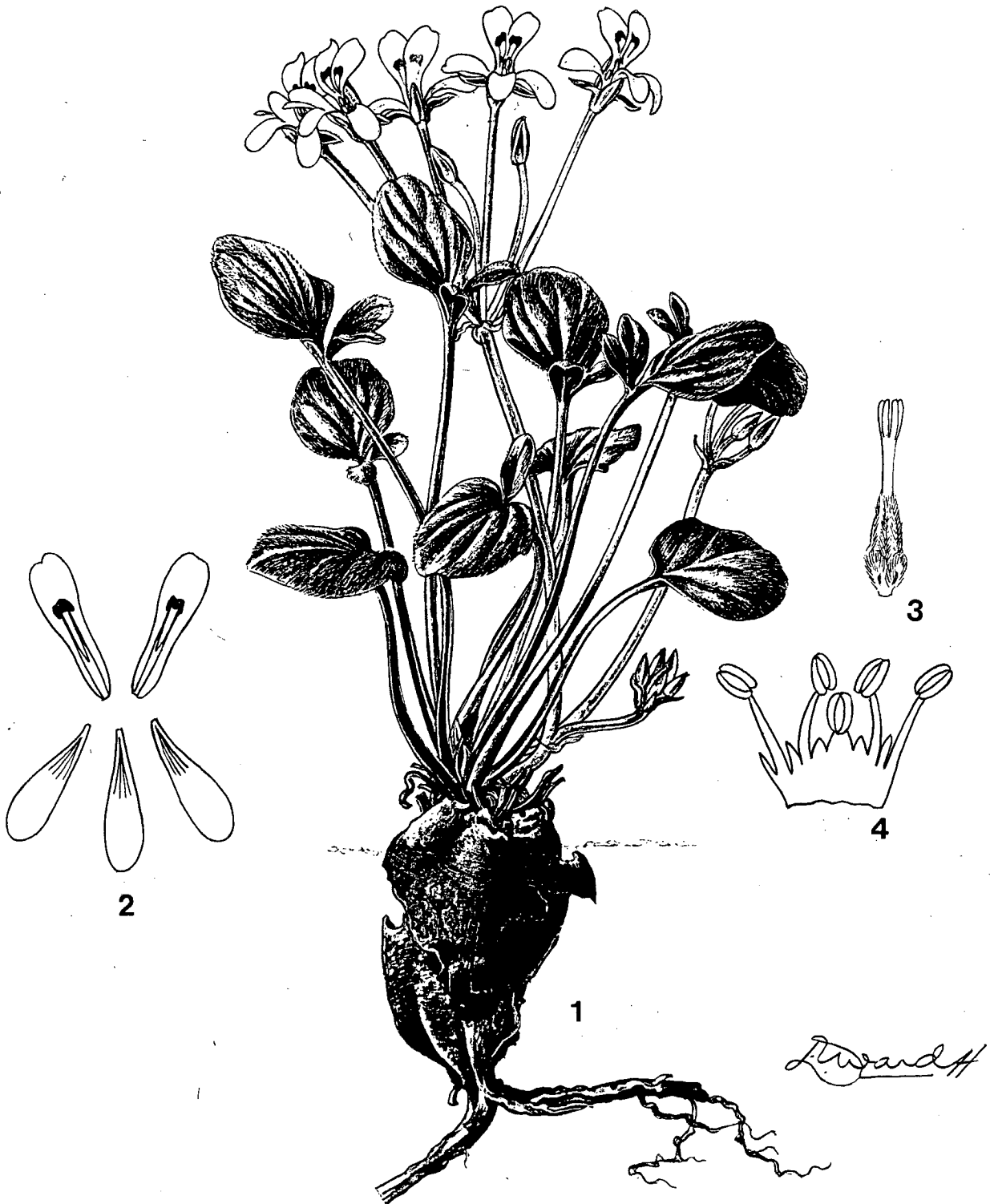


Figure 8.6.1 *Pelargonium nervifolium*. 1, flowering plant x1; 2, petals x1,5; 3, gynoecium x5; 4, androecium x4.

erecto-patent, hirsute with appressed curly hairs interspersed with glandular hairs; stipules subulate, adnate to petioles for two thirds of their length, 3--12 mm long and 1--2 mm wide, ciliate. **Inflorescence:** scape 15--70 mm long and 2--3 mm in diameter, branched, bearing 3--6(-9) pseudo-umbellets with 4--13(-17) flowers each; peduncles 10--30 mm long, 1--2 mm in diameter, covered with glandular hairs interspersed with appressed curly hairs; bracts lanceolate, 4--6 mm long, 1--3 mm wide, abaxially covered with glandular hairs. **Pedicel** ca. 0,5 mm long. **Hypanthium** 30--45 mm long, green, sparsely hirsute with appressed curly hairs interspersed with glandular hairs. **Sepals** 5, lanceolate, apices acute, 6--9 mm long, 1,5--3,2 mm wide, patent, green, indumentum abaxially as on peduncle. **Petals** 5, white, cream-coloured or pale yellow, claws forming a sheath and apices patent during anthesis; posterior two with pink or wine-red blotches in the centre, spathulate, bases cuneate, apices rounded or emarginate, 16--19 x 3,2--5 mm; anterior three spathulate, bases attenuate, apices rounded or emarginate, 13--17 x 3--5 mm. **Stamens:** staminal column 1--2 mm long, white; perfect stamens 5, concealed in the floral sheath, posterior one 2--3,5 mm long, lateral two 4--5 mm long, anterior two 6--6,5 mm long, white; staminodes 2--3 mm long; anthers pink, 1,5--2 mm long, pollen yellow. **Gynoecium:** ovary 2,5--5 mm long; style 0,8--2 mm long, pink; stigma branches 0,8--2 mm long, pink. **Fruit:** bases of mericarps 5 mm long, with prominent glandular hairs, tails 22--25 mm long (Figure 8.6.1).

Diagnostic features and affinities

P. nervifolium is a small geophyte with prostrate to erecto-patent leaves. The abaxial side of the simple, trilobate or trifoliate laminae are usually reddish purple and the veins are usually very prominent, hence the specific epithet. The white, cream-coloured or pale yellow petals are spathulate and the five fertile stamens are shorter than the sepals. This floral structure is similar to that of *P. pinnatum* and *P. chelidonium*. In all three species the claws of the petals form a sheath in which the stamens are concealed, and the apices of the petals are patent during anthesis. There are also similarities in the leaf structure of *P. chelidonium* and *P. nervifolium*. The petioles of *P. nervifolium* are usually long and often erecto-patent, whereas those of *P. chelidonium* are short and always prostrate.

Geographical distribution and ecology

P. nervifolium occurs on the south-western escarpment, from Calvinia in the north to Karoo Poort in the south, and to Sutherland and Matjiesfontein in the east (Figure

8.6.2). This area receives an annual rainfall of 100–300 mm, which occurs mainly during the winter months. *P. nervifolium* grows in stony clay soil, quartzite areas or dolorite hillsides in low and open karroid vegetation. Plants usually occur in direct sunlight. The leaves of plants collected under these field conditions are usually reddish purple on the abaxial side and the tubers are covered with exceptionally many layers of flaking periderms. This serves probably as an insulation layer against the high summer temperatures of this area. *P. nervifolium* is one of the early flowering species of section *Hoarea*, and flowers in September and October before the leaves wither.

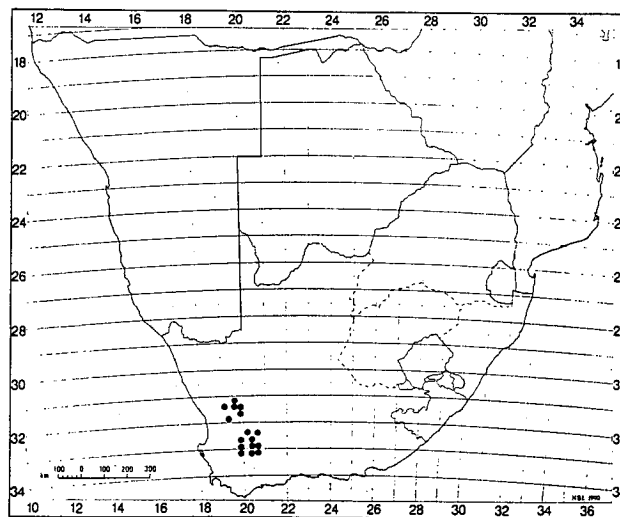


Figure 8.6.2 Geographical distribution of *P. nervifolium*.

Material studied

–3119 (Calvinia): Oorlogskloof & Papkuilsfontein (-AC), *Leipoldt 3078* (BOL); Witkleigat (-BA), *Marais 276* (STEU); 7 miles W of Calvinia (-BC), *Leighton 3196* (BOL); 20 km from Calvinia on the road to Loeriesfontein (-BC), *Marais 274* (STEU); Akkerendam, Calvinia (-BD), *Barker 9504* (NBG); *Bayer 1856* (NBG); Calvinia (-BD), *Thode A1885* (PRE, STE); 17 miles N of Botterkloof (-CD), *Johnson 565* (NBG); Menzieskraal, between Botterkloof & Calvinia (-DB); *Lewis 4066* (SAM).

–3219 (Wuppertal): Ceres Karoo (-DB), *Compton 3811* (BOL, NBG); Beukesfontein (-DD), *Wisura 3507* (NBG).

–3220 (Sutherland): Tankwa-Karoo, Sutherland to Onder-Karoo road (-AC), *Marais 253* (STEU); Sutherland (-BC), *Leipoldt s.n.* (BOL); 47 miles S of Sutherland (-CB), *Leighton 3184* (BOL); Sutherland-Ceres road, farm Windheuwel (-CD), *Marais 334* (STEU); Oranjefontein, Komsberg (-DC), *Van der Walt s.n.* (STEU).

--3319 (Worcester): Inverdoorn farm (-BB), *Forrester 494* (NBG); *Marais 141* (STEU); 15 km N of Karoopoort (-BB), *Hall s.n.* (BOL).

--3320 (Montagu): Patatsrivier (-AB), *Esterhuysen 23526* (BOL, K); *Lavranos & Pehlemann 18999* (STEU); 7 km from Matjiesfontein, on Sutherland road (-BA), *Marais 145* (STEU); Matjiesfontein (-BA), *Marloth 9581, 10753* (PRE); Dwars in die Weg, near Matjiesfontein (-BA), *Marloth 10789* (PRE).

8.7 *Pelargonium pinnatum* (L.) L'Hérit. in Aiton, Hortus Kewensis edn 1, 2: 417 (1789); L'Hérit.: t. 8 (1792); Willd.: 647 (1800); Sims: t. 579 (1802); Pers.: 227 (1806); Dietr.: 48 (1807) (excl. ref. Andr.); Ait. f.: 163 (1812) (excl. ref. Andr.); Steud.: 679 (1840); Steud.: 288 (1841); Harv.: 269 (1860) p.p.; Knuth: 346 (1912) p.p.; Adamson & Salter: 513 (1950); Van der Walt: 34 (1977) p.p.; Wijnands: 108 (1983); Marais: 126 (1993). LECTOTYPE: Commelijn, *Praeludia botanica*: 53, t. 3 (1703); original plate in Moninckx collection in Amsterdam (Wijnands 1983).

Geranium pinnatum L.: 677 (1753); L.: 1141 (1759); non Cav.: 257, t. 115, f. 2 (1787); nec Andr.: t. 311 (1803b). LECTOTYPE: Commelijn, *Praeludia botanica*: 53, t. 3 (1703); original plate in Moninckx collection in Amsterdam (Wijnands 1983).

Dimacria pinnata (L.) Sweet: t. 46 (1820); Sweet: 76 (1826c).

Hoarea pinnata (L.) Eckl. & Zeyh.: 64 (1835).

Geranospermum pinnatum (L.) Kuntze: 95 (1891).

Geranium prolificum var. *pinnatum* (L.) L.: 950 (1763).

Geranium astragalifolium Cav.: 257, t. 104, f. 2 (1787); Jacq.: t. 511 (1789); Jacq.: 184 (1791b); J.F. Gmelin: 1025 (1792); Thunb.: 116 (1800); Andr.: C. ic (1822); Thunb.: 527 (1823); non Andr.: t. 190 (1801b). LECTOTYPE: Commelijn, *Praeludia botanica*: 53, t. 3 (1703), here designated.

Pelargonium astragalifolium (Cav.) Jacq.: 8 (1795); Pers.: 227 (1806) (excl. ref. Andr.); DC.: 653 (1824) (excl. ref. Sweet & Andr.); Spreng.: 52 (1826); G. Don: 782 (1831) (excl. ref. Sweet & Andr.); Steud.: 677 (1840); Steud.: 283 (1841) (excl. ref. Sweet); Harv.: 268, 269 (1860) p.p.; Szyszyl.: 9 (1888); Knuth: 345 (1912) p.p.

Hoarea astragalifolia (Cav.) Eckl. & Zeyh.: 64 (1835).

Geranospermum astragalifolium (Cav.) Kuntze: 94 (1891).

Hoarea lessertiaefolia Eckl. & Zeyh.: 64 (1835). TYPE - Cape Province, ' .lateris orientalis montis "Tafelberg" prope "Constantiam". . ' *Ecklon & Zeyher 495* (S!, lecto, designated here; SAM!).

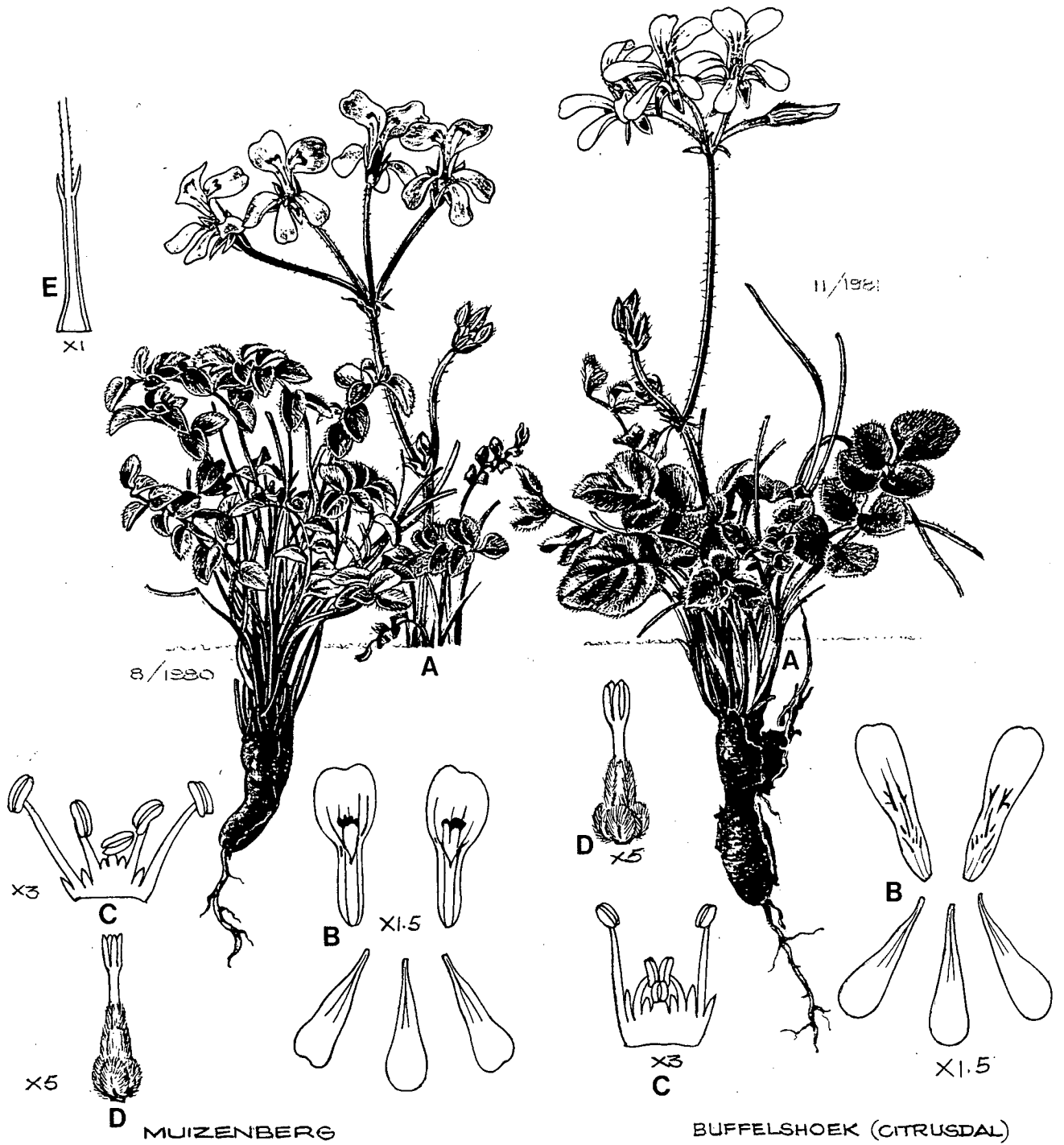


Figure 8.7.1 *Pelargonium pinnatum*. A, flowering plant x1; B, petals x1,5; C, androecium x3; D, gynoecium x5; E, stipules x1.

Pelargonium lessertiaefolium (Eckl. & Zeyh.) Steud.: 287 (1841).

Hoarea ornithopifolia Eckl. & Zeyh.: 64 (1835). TYPE - Cape Province, .'. . in latere orientali montis "Tafelberg" non procul a "Constantia". .' *Ecklon & Zeyher 496* (S!, lecto, designated here; L!; MO!; OXF!; S!; SAM!). (Specimens in L 9920 143, B & W are *P. trifoliolatum* (Eckl. & Zeyh) E.M. Marais.)

Pelargonium ornithopifolium (Eckl. & Zeyh.) Steud.: 288 (1841).

Misidentifications

Geranium pinnatum sensu Burm. f.: 49 (1759) = *P. trifoliolatum*; *G. pinnatum sensu* Cav.: 257, t. 115, f. 2 (1787) = *P. viciifolium* DC.; *G. pinnatum sensu* Andr.: t. 311 (1803b) = *P. viciifolium*.

A geophyte 110--300 mm tall when in flower. **Tuber:** a turnip-shaped or elongated root 12--40 mm long and 10--30 mm in diameter. **Leaves:** lamina pinnate, 25--70 mm long, pinnae ovate, acute, 5--12 x 3--6 mm, the terminal pinna more or less the same size as the other pinnae, adaxially and abaxially hirsute with appressed hairs interspersed with glandular hairs; petiole 25--80 mm long and *ca.* 1 mm in diameter, indumentum as on pinnae; stipules 15--30 mm long and 1,5--2 mm wide, hirsute. **Inflorescence:** scape (25-)40--180 mm long, 1--2 mm in diameter, branched, bearing 2--4 pseudo-umbellets with (2-)4--8 flowers each; peduncles 25--140 mm long, 1,5--2 mm in diameter, densely hirsute with distally appressed curly hairs interspersed with long soft patent hairs and glandular hairs; bracts narrowly triangular, 2--6(-9) mm long, 1 mm wide, abaxially hirsute with distally appressed hairs. **Pedicel** *ca.* 0,5 mm long. **Hypanthium** 11--35(-45) mm long, covered with distally appressed curly hairs, interspersed with glandular hairs. **Sepals** 5, lanceolate, apices acute, 6--11 mm long, 1,2--3,5 mm wide, posterior one erect, others recurved, indumentum abaxially as on peduncle. **Petals** 5, white, cream-coloured, yellow, pale pink to salmon-pink or bright pink or deep purple, claws orientated close together forming a floral sheath, apices patent during anthesis; posterior two with feather-like wine-red markings, spatulate, bases cuneate, apices rounded to emarginate, 11--24 x 3--10 mm, claws 9--14 mm long; anterior three spatulate, bases attenuate, apices rounded, 10--23 x 2--5,5 mm. **Stamens:** staminal column 0,5--2,5 mm long, white; perfect stamens 5, concealed in floral sheath, posterior one 1,5--4 mm long, lateral two 2,5--5,5 mm long, anterior two 4,5--7 mm long, white; staminodes 1,5--3,5 mm long; anthers pink, 1--2,5 mm long, pollen orange. **Gynoecium:** ovary 2,5--4 mm long; style 0,3--1,5 mm long, red; stigma branches 1--2,5 mm long, dark pink. **Fruit:** bases of mericarps 5--6 mm long, without glandular hairs, tails 23--28 mm long (Figure 8.7.1).

Diagnostic features and affinities

P. pinnatum is a geophyte with pinnate leaves, hence the specific epithet. The flowers have spatulate petals with wine-red feather-like markings on the posterior two and the length/width ratio of the posterior petals is usually smaller than five. The stigma branches are always longer than the style and the anterior stamens are shorter than the calyx and hidden in the floral sheath. The scape is branched, bearing two to five pseudo-umbellets with four to eight flowers each. *P. pinnatum* shows variation in the length of the hypanthia and the width of the petals; as a result some plants have very large flowers. Specimens with very long hypanthia (33–45 mm) were collected in the southern Cape, especially in the Riversdale area, but also in the Cape Peninsula. Plants with very long hypanthia do not necessarily have large petals.

P. pinnatum has similar pinnate leaves to *P. viciifolium* and *P. trifoliolatum*. However, the floral structures of the three species differ. Both *P. pinnatum* and *P. viciifolium* have short stamens and feather-like markings on the posterior petals, whereas *P. trifoliolatum* has longer stamens and very prominent blotches on the posterior petals (Marais 1993). *P. pinnatum* has spatulate petals, whereas the petals of *P. viciifolium* are ligulate.

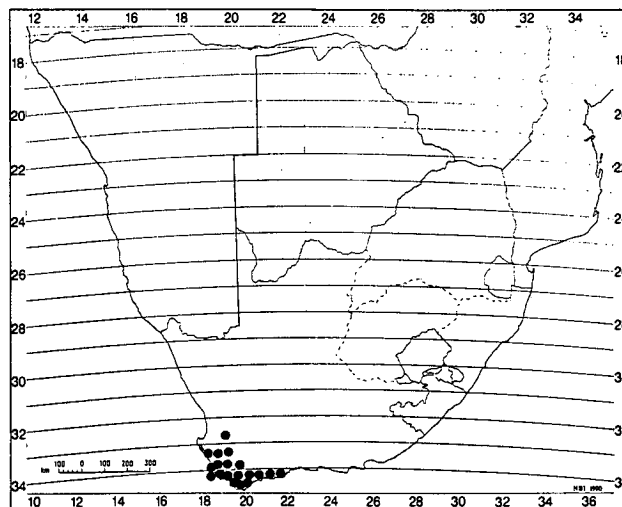


Figure 8.7.2 Geographical distribution of *P. pinnatum*.

Geographical distribution and ecology

P. pinnatum occurs in the south-western Cape Province, from the Cederberg in the north to Albertinia in the east (Figure 8.7.2), an area with an annual rainfall of 400--

600 mm occurring mainly in winter. Populations of *P. pinnatum* are formed by plants occasionally scattered amongst shrubs in different types of soil. It occurs in coastal fynbos, coastal renosterveld or in grassveld in sandy soil, rocky outcrops, well-drained humus-rich loam or shale and clay soils. The peak of the flowering time throughout the distribution area is from November to January, but in the southern Cape flowers are quite common until March.

Material studied

--3219 (Wuppertal): Apollo Peak, Cederberg (-CA), *Esterhuysen 25492* (BOL); Middelberg, 7 km E of Citrusdal (-CA), *Muller s.n.* (STEU).

--3318 (Cape Town): Contreberg farm, Darling (-AD), *Marais 32* (STEU); Modderasvlei, Riebeeck-Kasteel (-BD), *Drijfhout 1625* (STEU); Devil's Peak, Cape Peninsula (-CD), *Baker s.n.* (BOL); *Esterhuysen 20836* (BOL); *Szyszyłowics 1126* (BM, Z); *Szyszyłowics 1127* (Z); Table Mountain (-CD), *Ecklon 604* (PRE, W); *Ecklon & Zeyher 492* (P, Sx2, SAM); *Ecklon & Zeyher 498* (L, OXF, Sx2, SAM); *Marloth 386* (PRE); *Prior s.n.* (K, PRE); Lion's Head (-CD), *Dummer 849* (E); *Ecklon 603* (E, MO, PRE, Wx2); *Ecklon & Zeyher 497* (Sx2, SAM); Little Lion's Head (-CD), *Hall 2231* (NBG); Lion's Rump (-CD), *Salter 6535* (BOL); Signal Hill (-CD), *Van der Walt 662* (STEU); Table Mountain above Kirstenbosch (-CD), *Esterhuysen 22394* (BOL); *Gillett 3328* (STE); *Wisura 941* (NBG); Oranjezicht (-CD), *Marloth 5615* (PRE); Rocks above Camps Bay (-CD), *Marloth 8400* (PRE); Pipe Track, Cairn Ravine, Table Mountain (-CD), *McKinnon s.n.* (STE); Klaasenskop, Table Mountain (-CD), *McKinnon s.n.* (STE); Kanonkop, Dassenberg (-DA), *Boucher 4392* (STE); Tygerberg Nature Reserve (-DC), *Loubser 3459* (MO); Tygerberg (-DC), *Salter 1819* (BOL); Between Bottelary & Stellenbosch (-DD), *Bolus s.n.* (BOL); Joubert's Peak, Simonsberg (-DD), *Buys 88* (STEU); Simonsberg (-DD), *Salter 241/17* (BM); Lower slopes of Stellenbosch Mountain (-DD), *Garside 1192* (K); Jakkalsvlei, Jonkershoek (-DD), *Taylor 4588* (PRE, STEx2); Langrivier, Jonkershoek (-DD), *Van der Walt 510* (STEU).

--3319 (Worcester): Michell's Pass (-AD), *Fischer 338* (STEU); Dutoiskloof (-CA), *Drège 7500* (BOL, E, MO, PRE, S, W); *Esterhuysen 20994* (BOL, PRE); *Van der Walt s.n.* (STEU); Vondeling, W slope of Groenberg (-CA), *Marais 381* (STEU); SW slopes of Seven Sisters Mountain (-CC), *Esterhuysen 18310* (BOL, PRE); Top of Franschoek Pass (-CC), *Hafström & Acocks 1974* (BOL, PRE); Franschoek Pass (-CC), *Schonken 209* (STEU); Amandelrivier between Franschoek and Villiersdorp (-CC), *Hugo s.n.* (STEU); Haelhoeksneekop (-CC), *Stokoe s.n.* (SAM 56879); Rooihoogte N of Villiersdorp (-CD), *Marais 407* (STEU); McGregor, end of unfinished pass (-DD), *Van der Walt 1562* (STEU).

--3418 (Simonstown): Muizenberg (-AB), *Bolus 3068* (BOL, SAM, Z); Constantia Mountain (-AB), *Compton 8237* (NBG); Table Mountain near Constantia (-AB), *Ecklon & Zeyher 495* (Sx2, SAM); Constantia Corner (-AB), *Pillans 10818* (MO, UPS); *Salter 9542* (BM); Constantia Nek (-AB), *Salter*

6394 (BOL); *Wolley Dod* 343 (K); Kommetjie (-AB), *Compton* 12597 (NBG); Silvermine (-AB), *Compton* 14281, 16619 (NBG); Chapman's Peak (-AB), *Compton* 15429 (NBG); Kalk Bay Mountains (-AB), *Fuller s.n.* (E); *Grosvenor* 69 (SRGH); *Moss* 2997 (K); *Wall* 627/55 (MO); *Wolley Dod* 2160 (K); Hout Bay (-AB), *Harvey* 666 (BM, E, K); Simon's Bay (-AB), *MacGillivray* 467 (K); Simonstown (-AB), *Salter* 242/01 (BM); Vlakkenberg (-AB), *Pillans s.n.* (PRE); *Salter* 1908 (BOL); *Salter* 2909 (BM, BOL, K); Peck's Valley (-AB), *Salter* 1887 (BM, K); *Salter* 2940, 3595 (BOL); Foot of Steenberg (-AB), *Salter* 5721 (BOL); 1 mile W of Brakkloof, Vishoek (-AB), *Salter* 7903 (BOL); Orange Kloof (-AB), *Wolley Dod* 2168 (K); Steenbras (-BB), *Bolus s.n.* (BOL); Helderberg (-BB), *Galpin* 12313 (K, PRE); *Marais* 289, 349 (STEU); *Salter* 4233 (BOL); Sir Lowry's Pass (-BB), *Goldblatt* 6731 (NBG); *Lewis* 1085 (SAM); Koeëlbaai Valley (-BD), *Boucher* 961 (STE); N slopes of Klein Hangklip (-BD), *Boucher* 1438 (STE); Rooi Els (-BD), *Compton* 23240 (NBG).

--3419 (Caledon): Grabouw, near Palmiet River (-AA), *Bolus s.n.* (BOL); Elgin (-AA), *Compton* 16522 (NBG); Between Villiersdorp & Viljoen's Pass (-AA), *Esterhuysen* 4312 (BOL); T-junction, Theewaterkloof Dam (-AA), *Marais* 385, 405 (STEU); Viljoen's Pass (-AA), *Rogers* 28836 (SAM); *Strey* 2960 (PRE); *Van der Walt* 1558, 1578 (STEU); Arieskraal, Elgin (-AA), *Van Jaarsveld & Sardien* 7687 (NBG); Houwhoek Pass (-AA), *Vorster* 2905 (STEU); Caledon (-AB), *Bolus s.n.* (BOL); *Purcell* 28, 30, 38, SAM45918 (SAM); Zwartberg near Caledon Bath (-AB), *Bolus* 19181 (BOL, K); Caledon Bath (-AB), *Bolus* 20526 (BOL); Hermanus (-AC), *Compton* 14262 (NBG); Kleinmond (-AC), *De Vos* 304 (STE); Palmiet River Valley (-AC), *Stokoe s.n.* (SAM63197); Highlands State Forest (-AC), *Van der Walt* 1572 (STEU); Sandbaai, Hermanus (-AC), *Walters* 1794 (NBG); Happy valley, S foot of Riviersonderend Mountains (-BA), *Esterhuysen* 20766 (BOL, PRE); *Esterhuysen* 21073 (BOL); Genadendal (-BA), *Van der Walt* 1101 (STEU); Boesmanskloof E of Greyton (-BA), *Vorster* 2917 (STEU); Arieskraal, Caledon district (-BD), *Compton* 16466 (NBG); Napier (-BD), *Fischer* 271 (STEU); *Lavranos* 20905 (STEU); S slopes of Danger Point Mountain (-CB), *Leighton* 1571 (BOL); Near Elim (-DB), *Leighton* 2560 (BOL).

--3420 (Bredasdorp): Bontebok Park (-AB), *Grobler* 588 (STE); Zuurbraak, Swellendam (-BA), *Thode* A2299 (K, PRE, STE); Rietkuil, Buffeljachtrivier (-BA), *Zeyher* 2044 (S); *Zeyher* 2045 (G, P, W); Grootvadersbos, Swellendam (-BB), *Ecklon s.n.* (SAM); Ruggens near Heidelberg (-BB), *Galpin* 3815 (PRE); Potteberg, Cape Infanta (-BC), *Blum* 287 (E); Potberg, De Hoop Nature Reserve (-BC), *Marais* 82 (STEU); *Oliver* 3233 (STE); S slopes of Bredasdorp Mountain (-CA), *Hafström & Acocks* 1976 (BOL).

--3421 (Riversdale): Korinterivierdam (-AA), *Bohnen* 5363 (STE); *Boucher* 3671 (PRE, STE); Reiesiesbaan (-AB), *Bohnen* 7838 (PRE, STE); *Hugo* 97 (PRE, STE); 4,5 miles from Riversdale (-AB), *Bolus* 20513 (BOL); Riversdale Beacon (-AB), *Leighton s.n.* (BOL); Riversdale (-AB), *Muir* 3169 (PRE); *Schlechter* 2211 (Z); 3 km from Albertinia on road to Ystervarkfontein (-BA), *Marais* 169 (STEU); Hills behind Albertinia (-BA), *Muir* 1268 (BOL, PRE).

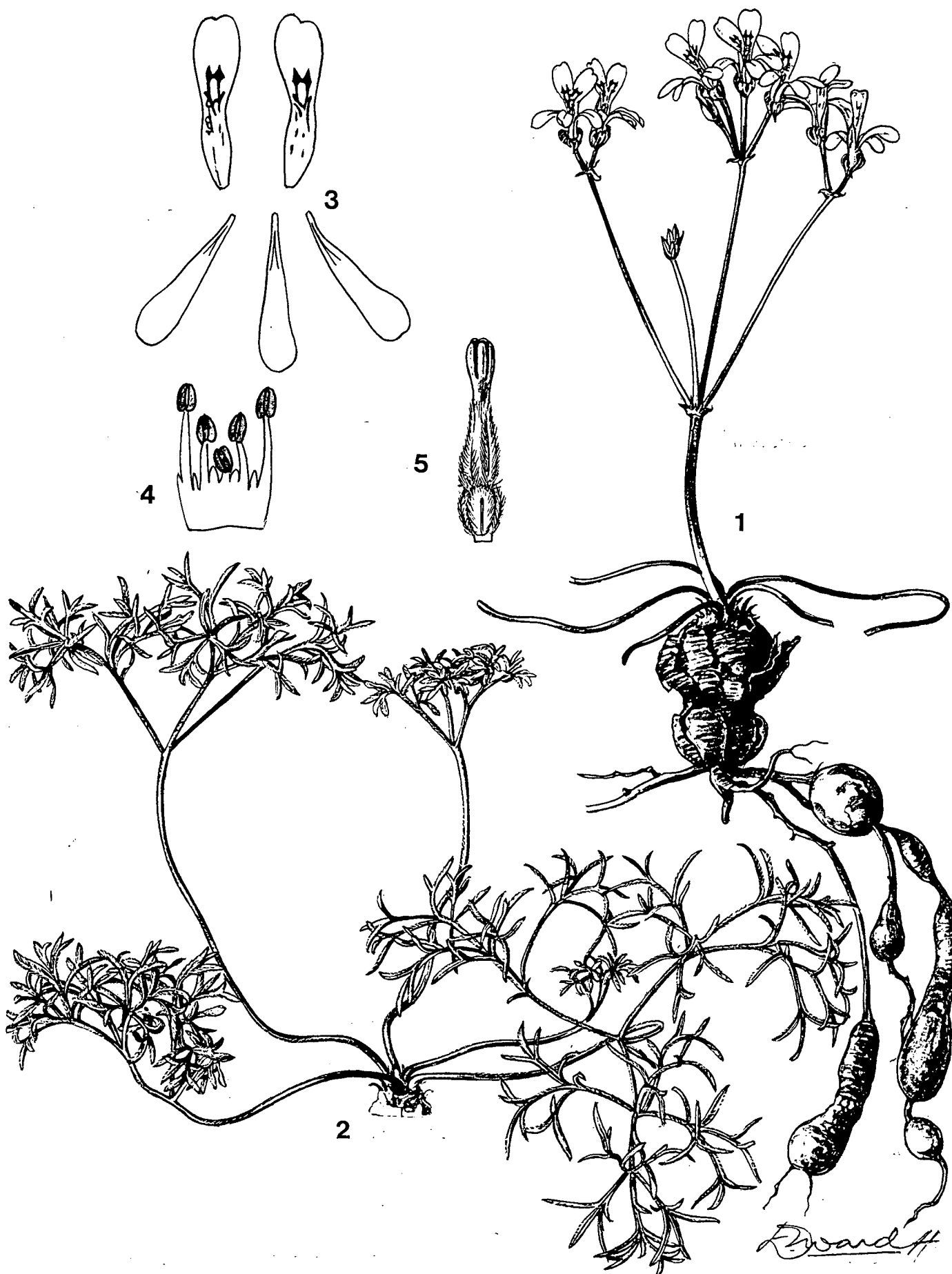


Figure 8.8.1 *Pelargonium reflexum*. 1, flowering plant x1; 2, plant with leaves x1; 3, petals x2; 4, androecium x4; 5, gynoecium x8.

8.8 Pelargonium reflexum (Andr.) Pers., Synopsis plantarum 2: 227 (1806); Ait. f.: 162 (1812); DC.: 651 (1824); Spreng.: 52 (1826); Loudon: 658 (1829); G. Don: 729 (1831); Loudon: 271 (1832); Steud.: 679 (1840); Steud.: 289 (1841); Harv.: 266 (1860); Knuth: 337 (1912). **ICONOTYPE**: Andrews, The Botanist's Repository 4: t. 224 (1802b).

Geranium reflexum Andr.: t. 224 (1802b); Poir.: 758 (1812). **ICONOTYPE**: Andrews, The Botanist's Repository 4: t. 224 (1802b).

Dimacria reflexa (Andr.) Sweet: 77 (1826c).

Geranospermum reflexum (Andr.) Kuntze: 95 (1891).

A geophyte 80--150 mm tall when in flower. **Tuber**: a turnip-shaped, sometimes moniliform root 15--30 mm long and 10--25 mm in diameter. **Leaves** green, petiolate; lamina palmately compound with three main pinnae; pinnae 20--70 mm long, deeply incised, segments lacinate with apices acute, hirsute with long appressed hairs interspersed with very short glandular hairs; petiole 20--150 mm long and 1--2 mm in diameter, rigid, spreading horizontally from the growing point and bending vertically in the middle, hirsute with long and short appressed or patent non-glandular hairs; stipules narrowly triangular, adnate to petioles for one third of their length, 3--5 mm long and *ca.* 1,5 mm wide, ciliate. **Inflorescence**: scape 15--40 mm long, 1--2 mm in diameter, branched, bearing 2--4 pseudo-umbellets with 2--4(-5) flowers each; peduncles 30--100 mm long, 0,5--1 mm in diameter, hirsute with appressed curly hairs interspersed with short glandular hairs; bracts lanceolate, 2--3 mm long, 1 mm wide, abaxially densely hirsute with appressed hairs. **Pedicel** *ca.* 0,5 mm long. **Hypanthium** 13--22 mm long, indumentum as on peduncle. **Sepals** 5, lanceolate, apices acute, 5--10 mm long, 1--3 mm wide, posterior one erect, others reflexed, pale reddish brown with margins white, indumentum abaxially as on peduncle. **Petals** 5, white, spatulate, patent during anthesis; posterior two with wine-red feather-like markings, bases cuneate, apices rounded or emarginate, 10--18 x 2,2--4 mm, length/width ratio smaller than 5,5; anterior three usually without markings, bases attenuate, apices rounded, 9--16 x 1,5--3 mm. **Stamens**: staminal column 1,5--2 mm long, white; perfect stamens 5, concealed in the floral sheath, posterior one 1--3 mm long, lateral two 2,5--4 mm long, anterior two 3,5--6 mm long, white; staminodes 1,5--2,5 mm long; anthers pale pink, 1,2--1,5 mm long, pollen yellow. **Gynoecium**: ovary 2--4 mm long; style 0,2--0,5 mm long, pale pink; stigma branches 1--1,5 mm long, pink. **Fruit**: bases of mericarps 4 mm long, with glandular hairs, tails 20--24 mm long (Figure 8.8.1).

Diagnostic features and affinities

P. reflexum is a geophyte with palmately compound leaves with very long and thin petioles which spread horizontally from the growing point and bend vertically in the middle. This orientation of the petioles resembles that of *P. ternifolium* and *P. fergusoniae*. The former has tripartite leaves, whereas the leaves of *P. fergusoniae* are identical to those of *P. reflexum*. The structure of the flower of *P. reflexum* resembles that of *P. pinnatum*. These species have medium size flowers with spatulate petals and very short stamens which are concealed in the floral sheath. Although the leaves of *P. fergusoniae* and *P. reflexum* are identical, the floral structures of the two species differ. The former has long ligulate petals (posterior two 20--33 mm long) with the length/width ratio greater than 6,5 and those of *P. reflexum* are spatulate and of medium length (posterior two 10--18 mm long) with the length/width ratio smaller than 5,5.

The specific epithet *reflexum* refers to the reflexed character which pervades the whole plant (Andrews 1802b), which includes the rolled-back leaflets, the reflexed petals, the recurved stigma branches and reflexed posterior stamen. None of these characters are unique for this species.

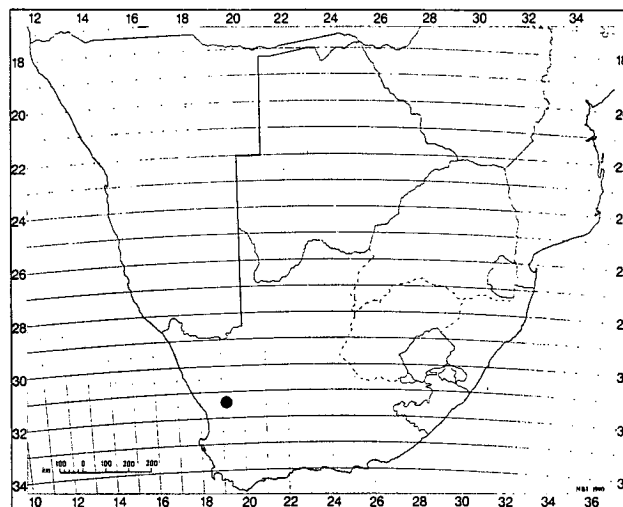


Figure 8.8.2 Geographical distribution of *P. reflexum*.

Geographical distribution and ecology

P. reflexum is known from a small distribution area on the Bokkeveld escarpment around Nieuwoudtville (Figure 8.8.2). It occurs in fynbos on rocky areas or sandy

flats. The area receives an annual rainfall of 200 mm occurring mainly in winter. The plants are locally common. *P. reflexum* flowers in summer, from December to January, after the leaves have died.

Material studied

–3119 (Calvinia): Glenridge, Nieuwoudtville (-AC), *Barker 9188* (NBG); Near Nieuwoudtville (-AC), *Lavis s.n.* (BOL); *Leipoldt 4218* (BOL); Top of Vanrhyn's Pass (-AC), *Marais 278* (STEU); Arendskraal (-AC), *Stirton 11031* (NBG); *Van Wyk 161* (STEU).

8.9 *Pelargonium violiflorum* (Sweet) DC., *Prodromus* 1: 652 (1824) (as "*violaefflorum*"); Loudon: 570 (1829); G. Don: 727 (1831); Loudon: 271 (1832); Steud.: 291 (1841); Harv.: 270 (1860). ICONOTYPE: Sweet, Geraniaceae 2: t. 123 (1822).

Hoarea violaefflora Sweet: t. 123 (1822); Sweet: 75 (1826c); Eckl. & Zeyh.: 63 (1835). ICONOTYPE: Sweet, Geraniaceae 2: t. 123 (1822).

Geranospermum violaefflorum (Sweet) Kuntze: 95 (1891).

Geranium heterophyllum Thunb.: 113 (1800); Thunb.: 515 (1823); non (Jacq.) Poir.: 746 (1812). TYPE: "Cap. bon Spei", *Thunberg s.n.* (UPS, holo!).

Hoarea heterophylla (Thunb.) Eckl. & Zeyh.: 63 (1835).

Pelargonium heterolobum DC.: 680 (1824): substitute name for *Geranium heterophyllum* Thunb.: 113 (1800); G. Don: 742 (1831); Steud.: 286 (1841).

Pelargonium variifolium Steud.: 678 (1840); Steud.: 291 (1841): substitute name for *Geranium heterophyllum* Thunb.: 113 (1800).

Hoarea nivea Sweet: t. 182 (1823); Sweet: 75 (1826c); Eckl. & Zeyh.: 63 (1835). ICONOTYPE: Sweet, Geraniaceae 2: t. 182 (1823).

Pelargonium niveum (Sweet) Loudon: 568 (1829); G. Don: 727 (1831); Loudon: 271 (1832); Steud.: 288 (1841).

Pelargonium longifolium (Burm. f.) Jacq. var *nivea* (Sweet) Knuth: 324 (1912).

(*Pelargonium heterophyllum* Jacq. (1791b): see *Pelargonium heterophyllum* Jacq.)

A geophyte 160--260 mm tall when in flower. **Tuber:** a turnip-shaped or elongated root 20--40 mm long and 10--30 mm in diameter. **Leaves:** juvenile leaves simple,



Figure 8.9.1 *Pelargonium violiflorum*. 1, flowering plant x1; 2, gynoecium x7, 3, androecium x5; 4, petals x3.

others trifoliolate, pinnate to irregularly bipinnatisect, dark green, petiolate; laminae of simple leaves spatulate, 20--70 x 8--20 mm; laminae of compound leaves elliptic or trullate in outline, 25--120 x 40--100 mm, pinnae spatulate or linear to laciniate, 20--60 mm long, 3--12 mm wide, apices acuminate, margins entire, adaxially glabrous, ciliate, abaxially hirsute with long stiff appressed hairs; petiole 10--110 mm long and 1,3--3 mm in diameter, rigid, erect, densely hirsute with appressed hairs interspersed with short glandular hairs; stipules subulate, adnate to petioles for one to two thirds of their length, 12--27 mm long and *ca.* 2 mm wide, ciliate. **Inflorescence:** scape 70--200 mm long, 1,5--3 mm in diameter, branched, bearing 3--6 pseudo-umbellets with 7--14 flowers each; peduncles 30--80 mm long, 1--2 mm in diameter, covered with very long soft hairs interspersed with short glandular hairs; bracts subulate, 4--7 mm long, 1--2 mm wide, adaxially and abaxially hirsute. **Pedicel** *ca.* 0,5 mm long. **Hypanthium** 8--11 mm long, densely covered with glandular hairs. **Sepals** 5, lanceolate, apices acute, 5--7,5 mm long, 1--2,5 mm wide, patent, green, indumentum abaxially as on hypanthium. **Petals** 5, white, apices recurved during anthesis; posterior two spatulate, bases cuneate, apices rounded or emarginate, 7--12 x 2,5--4 mm; anterior three spatulate, bases attenuate, apices rounded, 6--9,5 x 1,2--2 mm. **Stamens:** staminal column 1,5--2 mm long, white; perfect stamens 5, concealed in floral sheath, posterior one 2--3 mm long, lateral two 2,5--4 mm long, anterior two 3--5 mm long, white; staminodes 2--3 mm long; anthers pink, 1,5 mm long, pollen orange. **Gynoecium:** ovary 2--3,5 mm long; style 0,2--1 mm long, dark pink; stigma branches 0,8--2 mm long, dark pink. **Fruit:** bases of mericarps 4--6 mm long, without glandular hairs, tails 21--28 mm long. (Figure 8.9.1).

Diagnostic features and affinities

P. violiflorum is a geophyte with various degrees of pinnate to bipinnatisect leaves and rigid upright petioles. The leaf structure is very similar to that of *P. leptum*, and *P. undulatum*. In *P. violiflorum* the lamina outline varies from elliptic (like *P. undulatum*) to trullate (like *P. leptum*). The indumentum of the leaves of the three different species are the same. *P. violiflorum* is characterized by the pompon-like pseudo-umbellets formed by a rather large number (7--14) of small white flowers with short hypanthia (8--11 mm long), and according to Sweet (1822) the specific epithet *violiflorum*, refers to the white violet type of flower of this species. The structure of the flower resembles that of *P. pinnatum*, both have spatulate petals and short stamens which are concealed in the floral sheath.

Geographical distribution and ecology

P. violiflorum is known from a very small distribution area around Ashton, Robertson and Bonnievale (Figure 8.9.2), where it grows in mountain renosterveld or karroid shrubland on shale or sandstone. This is mainly a winter rainfall area with an annual precipitation of 200–500 mm. *P. violiflorum* is one of the spring flowering species of section *Hoarea* and flowers during September and October before the leaves wither.

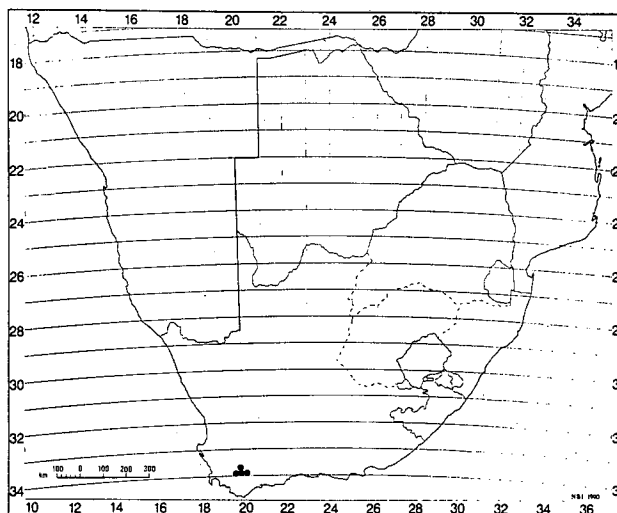


Figure 8.9.2 Geographical distribution of *P. violiflorum*.

Material studied

--3319 (Worcester): 1 km from Langvlei to Noree (-DB), *Fischer 217* (STEU); Langvlei, 16 km from Robertson (-DC), *Fischer 216* (STEU); Nuy, road from Vink to Eilandia (-DC), *Walters 2712* (NBG); 2 miles from Robertson (-DD), *McMurtry NBG407/67* (NBG).

--3320 (Montagu): Ashton (-CC), *Barker 1301* (BOL, NBG); Between Stormsvlei and Bonnievale (-CC), *Leighton 21158* (BOL); Bonnievale Hills (-CC), *Marloth 11824* (PRE, STE).

ATTENUATUM GROUP

Geophytes with simple lanceolate or pinnate, irregularly bipinnatisect or palmately compound leaves. Scape branched, bearing 2–7 pseudo-umbellets with 3–19 flowers each. Hypanthium 6–44 mm long. Flowers with white, cream-coloured, pale yellow or pink, ligulate petals, posterior petals 14–42 mm long, and length/width ratio bigger than

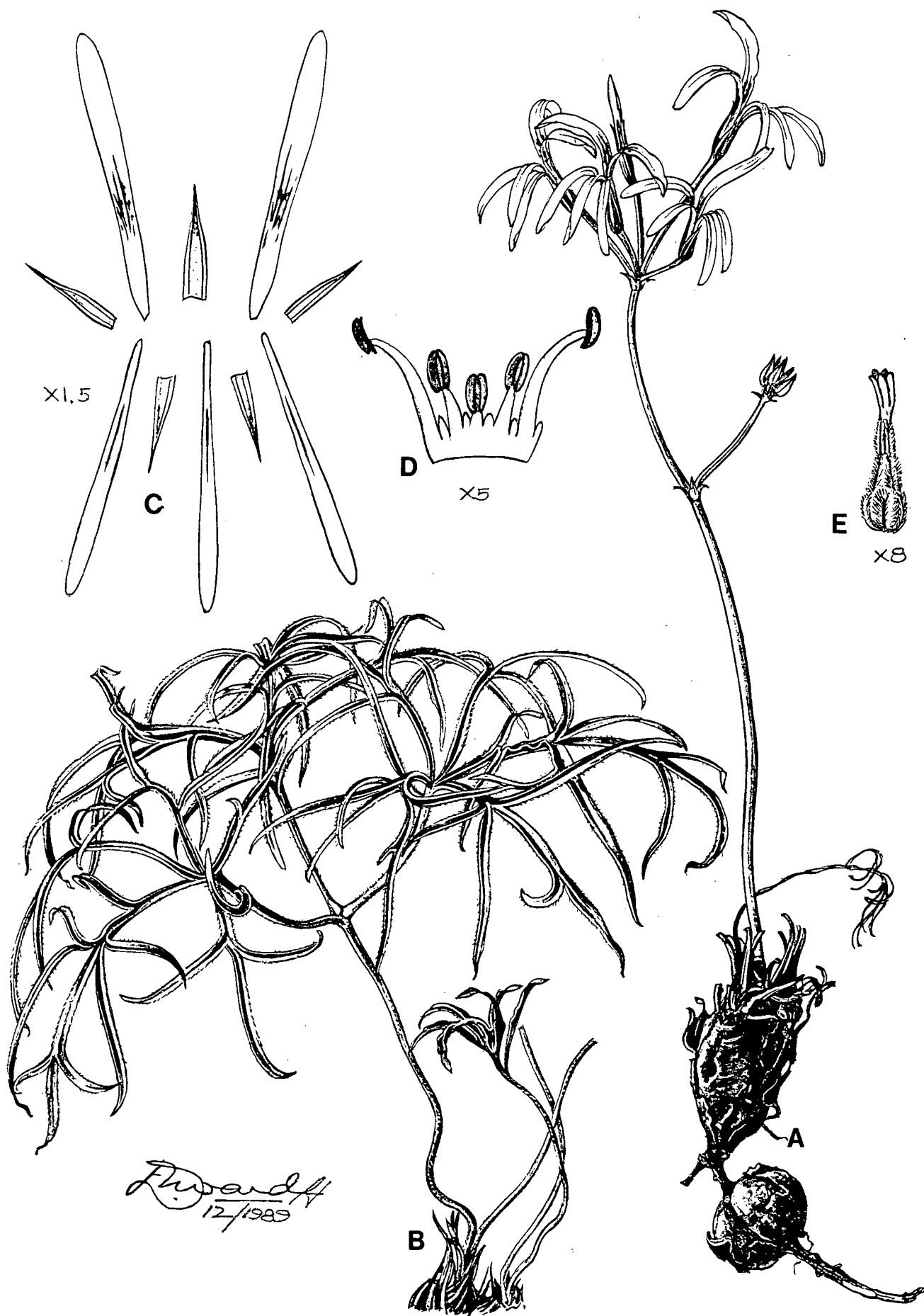


Figure 8.10.1 *Pelargonium attenuatum*. A, flowering plant $\times 1$; B, plant with leaves $\times 1$; C, petals and sepals $\times 1.5$; D, androecium $\times 5$; E, gynoecium $\times 8$.

five. Stamens 4--5 fertile, much shorter than the sepals, concealed within the floral sheath.

8.10 *Pelargonium attenuatum* Harv. in Flora Capensis 1: 266 (1860): Knuth: 337 (1912). TYPE - Cape Province: Uitkomst, Brandenburg, Zeyher 169 (S, holo!, BOL!, K!).

Geranospermum attenuatum (Harv.) Kuntze: 94 (1891).

A geophyte 200--300 mm tall when in flower. **Tuber:** a turnip-shaped or elongated, sometimes moniliform root 15--40 mm long and 10--20 mm in diameter. **Leaves** green, petiolate; lamina palmately compound with three main pinnae; pinnae 65--130 mm long, sometimes deeply incised, segments 35--50 mm long, 2--8 mm wide, sometimes lacinate with apices acute, sparsely hirsute with long appressed hairs; petiole 95--180 mm long and 1--3 mm in diameter, rigid, erect, hirsute or sparsely hirsute with appressed hairs interspersed with short glandular hairs; stipules narrowly triangular, adnate to petioles for half their length, 5--22 mm long and 2--3 mm wide, hirsute. **Inflorescence:** scape 80--170 mm long, 1,5--2 mm in diameter, branched, bearing 2--3 pseudo-umbellets with 4--7 flowers each; peduncles 60--90 mm long, 1--1,5 mm in diameter, densely covered with appressed curly hairs interspersed with long glandular hairs; bracts lanceolate, 3--4 mm long, 1--1,5 mm wide, abaxially hirsute with appressed hairs interspersed with glandular hairs. **Pedicel** ca. 0,5 mm long. **Hypanthium** (16-)22--31 mm long, green, indumentum as on peduncle. **Sepals** 5, lanceolate, apices attenuate, 11--14 mm long, 1,5--2,5 mm wide, patent during anthesis, green with membranous margins, indumentum abaxially as on peduncle. **Petals** 5, cream-coloured, almost white or pale yellow, ligulate, claws forming a sheath, apices patent or recurved; posterior two with wine-red feather-like markings in the centre, bases cuneate, apices rounded or obtuse, 31--42 x 2--4 mm, length/width ratio 10--11,5; anterior three with a wine-red stripe in the centre, bases attenuate, apices rounded or obtuse, 28--38 x 1,5--2,5 mm. **Stamens:** staminal column 1 mm long, white; perfect stamens 5, concealed in the floral sheath, posterior one 2--2,5 mm long, lateral two 3--4 mm long, anterior two 5--6,5 mm long, white; staminodes 1,5--2 mm long; anthers 1,5 mm long, pollen yellow. **Gynoecium:** ovary 2--4 mm long; style 0,3--1,5 mm long, pale green; stigma branches 0,5--1,5 mm long, adaxially red. **Fruit:** bases of mericarps 5--7 mm long, with glandular hairs, tails 25--35 mm long. (Figure 8.10.1).

Diagnostic features and affinities

P. attenuatum is a geophyte with palmately compound leaves with long, thin, upright petioles. It is characterized by the taper-pointed, almost awned sepals, and the very long, narrow petals, hence the epithet *attenuatum* (Harvey 1860). The floral structure of *P. attenuatum* resembles that of *P. angustipetalum* and *P. fergusoniae*. All three species have flowers with long ligulate petals and very short stamens, concealed in the floral sheath, and all of them have palmately compound leaves with long, thin petioles. The petioles of *P. fergusoniae* are spreading horizontally, whereas those of *P. attenuatum* and *P. angustipetalum* are erect. The petals of *P. fergusoniae* (posterior two 20--33 mm long) and those of *P. angustipetalum* (posterior two 21--26 mm long) are also shorter than those of *P. attenuatum* (posterior two 31--42 mm long).

Geographical distribution and ecology

Only a few collections of *P. attenuatum* are known and according to them this species has a small distribution area along the Olifantsrivier valley and the sandy plain to the west, in the vicinity of Graafwater (Figure 8.10.2). This area receives an annual rainfall of 200--300 mm mainly during the winter months. *P. attenuatum* grows in dry mountain fynbos in loose sandy soil and flowers in summer, from late November to January.

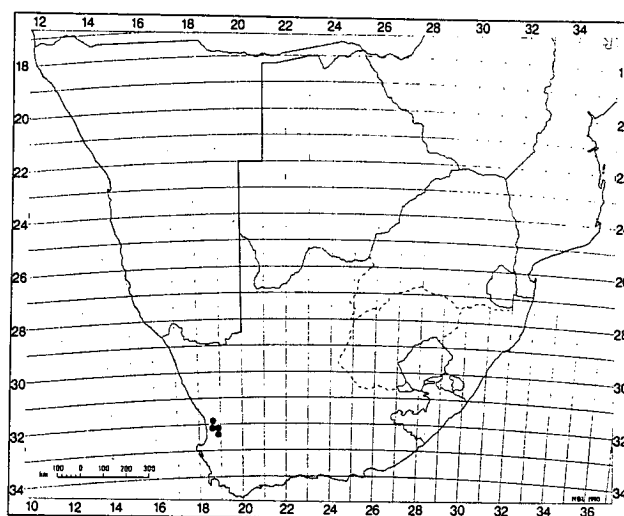


Figure 8.10.2 Geographical distribution of *P. attenuatum*.

Material studied

--3118 (Vanrhynsdorp): Sandkraal, along the Olifantsrivier, Clanwilliam (-DC), *Leipoldt 4324* (BOLx3).

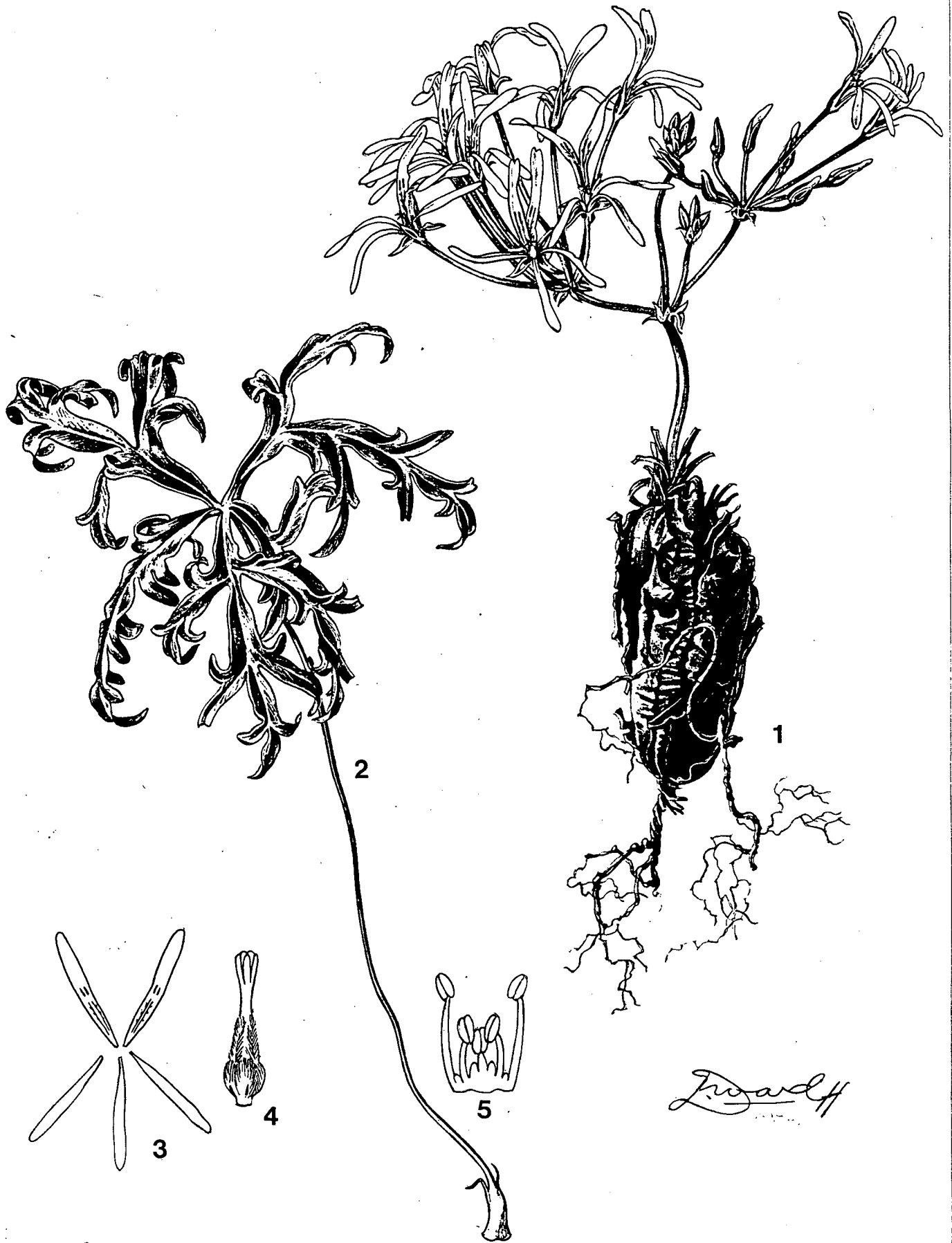


Figure 8.11.1 *Pelargonium angustipetalum*. 1, flowering plant x1; 2, leaf x1; 3, petals x1; 4, gynoecium x6; 5, androecium x3.

--3218 (Clanwilliam): Uitkomst, Brandenburg (-BA), *Zeyher 169* (BOL, K, S); Clanwilliam, village-ground (BB), *Marais 328* (STEU); Melkboomfontein, between Citrusdal & Clanwilliam (-BD), *Smit s.n.* (STEU).

8.11 *Pelargonium angustipetalum* E.M. Marais, sp. nov. in sectione *Hoarea*, affine *P. attenuatum*.

Herba perennis acaulescens tuberosa. **Tuber:** subterraneum, napiforme vel oblongum, 30--35 mm longum, 15--20 mm in diam. **Folia** hysterantha, rosulata, viridia, petiolata; lamina palmatisecta, pinnae 50--90 mm longae, adaxiale et abaxiale hirsuta et breviter glandulosa; petiolus 80--260 mm longus, rigidus, erectus, setosus et breviter glandulosus; stipulae petiolo adnatae. **Inflorescentia:** scapus pseudoumbellus 2--7, utraque 4--12 floribus. **Pedicellum** ca. 0,5 mm longum. **Hypanthium** 21--35 mm longum, hirsutum et glandulosum. **Sepala** 5, lanceolata, 6--8 mm longa, 1,5--3 mm lata, patentia. **Petala** 5, cremea vel pallide flava, dua postica ligulata, subtiliter carmineo rubra, 21--26 mm longa, 2--3 mm lata, tria antica ligulata, 19--23 mm longa, 1--2 mm lata. **Stamina** fertilia 5, staminodia 5.

TYPE - Cape Province: "Between Wildepaardehoek and Komaggas, 3 km from Sannagas" *Drijfhout 1371* (STE, holo; K, PRE).

A deciduous geophyte with a regularly shaped subterranean tuber, 80--240 mm tall when in flower. **Tuber:** a turnip-shaped or elongated root with a short flattened stem, covered with flaking dark brown periderms, 30--35 mm long and 15--20 mm in diameter. **Leaves** radical, hysteranthous, rosulate, green, petiolate; lamina palmately compound with 3--5 pinnae; pinnae 50--90 mm long, sometimes deeply incised, segments 20--40 mm long and 2--7 mm wide, apices acute, hirsute with appressed stiff hairs interspersed with very short glandular hairs; petiole 80--260 mm long and 1--1,5 mm in diameter, rigid, erect, setose with short appressed hairs interspersed with very short glandular hairs; stipules subulate, adnate to petioles for half their length, 10--15 mm long and 2--3 mm wide, hirsute. **Inflorescence:** scape 15--150 mm long and 1,5--2 mm in diameter, branched, bearing 2--7 pseudo-umbellets with 4--12 flowers each; peduncles 20--100 mm long, 1--1,5 mm in diameter, hirsute with short appressed stiff hairs interspersed with short glandular hairs; bracts lanceolate, apices acute, 2 mm long, 1 mm wide, abaxially densely hirsute with appressed hairs interspersed with short glandular hairs; flower buds, flowers and fruits erect. **Pedicel** ca. 0,5 mm long. **Hypanthium** 21--35 mm long, pale green to reddish brown, indumentum as on peduncle. **Sepals** 5, lanceolate, apices acuminate, 6--8 mm long, 1,5--3 mm wide, posterior one erect, others patent, green with margins white, indumentum abaxially as on peduncle. **Petals** 5,

cream-coloured or pale yellow, claws forming a sheath, apices patent or recurved; posterior two ligulate with pink feather-like markings on the claws, bases cuneate, apices rounded, 21--26 x 2--3 mm, length/width ratio 7,5--9; anterior three ligulate, bases attenuate, apices rounded, 19--23 x 1--2 mm. **Stamens** 10, basally connate, staminal column 0,5--1 mm long, white; perfect stamens 5, concealed in the floral sheath, posterior one 1,5--2 mm long, lateral two 2,5--4 mm long, anterior two 5--6 mm long, white; staminodes 1--2 mm long; anthers red, 1,5--2 mm long, pollen orange. **Gynoecium:** ovary superior, oblong-conical, 5-lobed, 2--3 mm long, densely sericeous; style filiform, 0,2--1,5 mm long, pale green; stigma with 5 recurved branches, 1--2 mm long, adaxially pink. **Fruit:** a schizocarp consisting of 5 mericarps, bases of mericarps 5 mm long, with glandular hairs, tails 21--26 mm long. (Figure 8.11.1).

Diagnostic features and affinities

P. angustipetalum is a geophyte with palmately compound leaves with long, thin, upright petioles. It is characterized by the cream-coloured or pale yellow flowers with long, narrow petals, hence the specific epithet *angustipetalum*. The very short stamens are concealed in the floral sheath. This floral structure is similar to that of *P. attenuatum* and *P. fergusoniae*. Comparing these three species, they all have pale yellow flowers with long ligulate petals and short stamens, and they all have palmately compound leaves with long, thin petioles. The petioles of *P. fergusoniae* are spreading horizontally, whereas those of *P. angustipetalum* and *P. attenuatum* are erect. The petals of *P. attenuatum* (posterior two 31--42 mm long) are much longer than those of *P. fergusoniae* (posterior two 20--33 mm long) and *P. angustipetalum* (posterior two 21--26 mm long). The indumentum on the peduncles and hypanthia of *P. angustipetalum* differs from the other two species. The peduncles of *P. angustipetalum* are covered with short appressed stiff hairs, whereas those of the other two species are covered with curly hairs.

Geographical distribution and ecology

P. angustipetalum has a small distribution area in Namaqualand, occurring from Kosies in the Richtersveld in the north to Kamieskroon in the south (Figure 8.11.2). This area has a very scant rainfall of 100--200 mm per annum, occurring during the winter. The summers are very hot and dry. Plants grow in deep sand in karroid vegetation and usually occur in partial sunlight under bushes. Flowering time is in summer, from November to December.

Material studied

--2917 (Springbok): Kosies, Richtersveld (-BA), Roux 265 (STEU); O'Kiep (-DB), Scully s.n. (K); Between Wildepaardehoek & Komaggas (-DC), Drijfhout 1371 (K, PRE, STE).

--3017 (Hondeklipbaai): 4,5 miles N of Kamieskroon on Springbok road (-BB), Hardy & Bayliss 1125 (PRE); 3 km E of Kamieskroon (-BB), Mève 236 (STEU).

Without exact locality: Namaland Minor, Scully 231 (BOL).

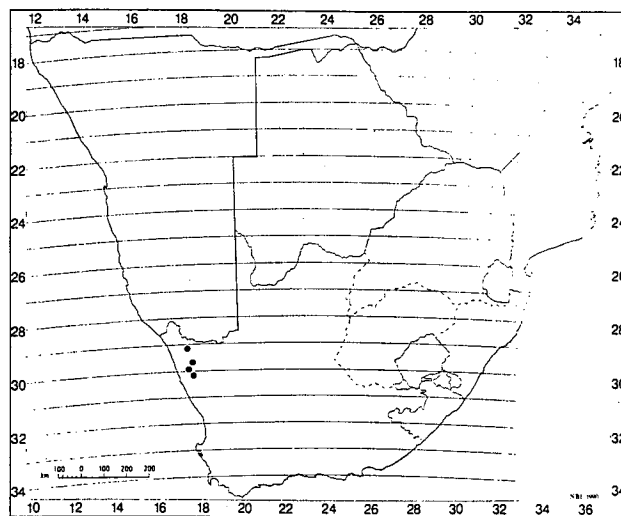


Figure 8.11.2 Geographical distribution of *P. angustipetalum*.

8.12 Pelargonium leptum L. Bol. in South African gardening and country life 22: 229, 232 (1932). TYPE - Cape Province: Near Durbanville, *Leipoldt s.n. sub BOL19185* (BOL, holol, BOL!, Kx2!).

A geophyte 100--300 mm tall when in flower. **Tuber:** a turnip-shaped or elongated root 50--90 mm long and 10--35 mm in diameter. **Leaves:** juvenile leaves simple, others irregularly pinnate to bipinnatisect, green, petiolate; laminae of simple leaves ovate, 20--40 x 8--20 mm; laminae of compound leaves trullate or triangular in outline, 70--210 x 70--190 mm, pinnae linear, 10--110 mm long, 1--4(-10) mm wide, apices acuminate, margins entire, adaxially and abaxially hirsute or sparsely hirsute with long stiff appressed hairs; petiole 25--210 mm long and 0,5--2 mm in diameter, rigid, erect, glabrous or sparsely hirsute with appressed hairs; stipules subulate, adnate to petioles for half their length, 10--50 mm long and 1--2 mm wide, hirsute or ciliate. **Inflorescence:** scape 50--150 mm long, 1,5--2,5 mm in diameter, branched, bearing 3--7 pseudo-umbellets with 6--12 flowers each; peduncles 55--110 mm long, 1--2 mm in diameter,

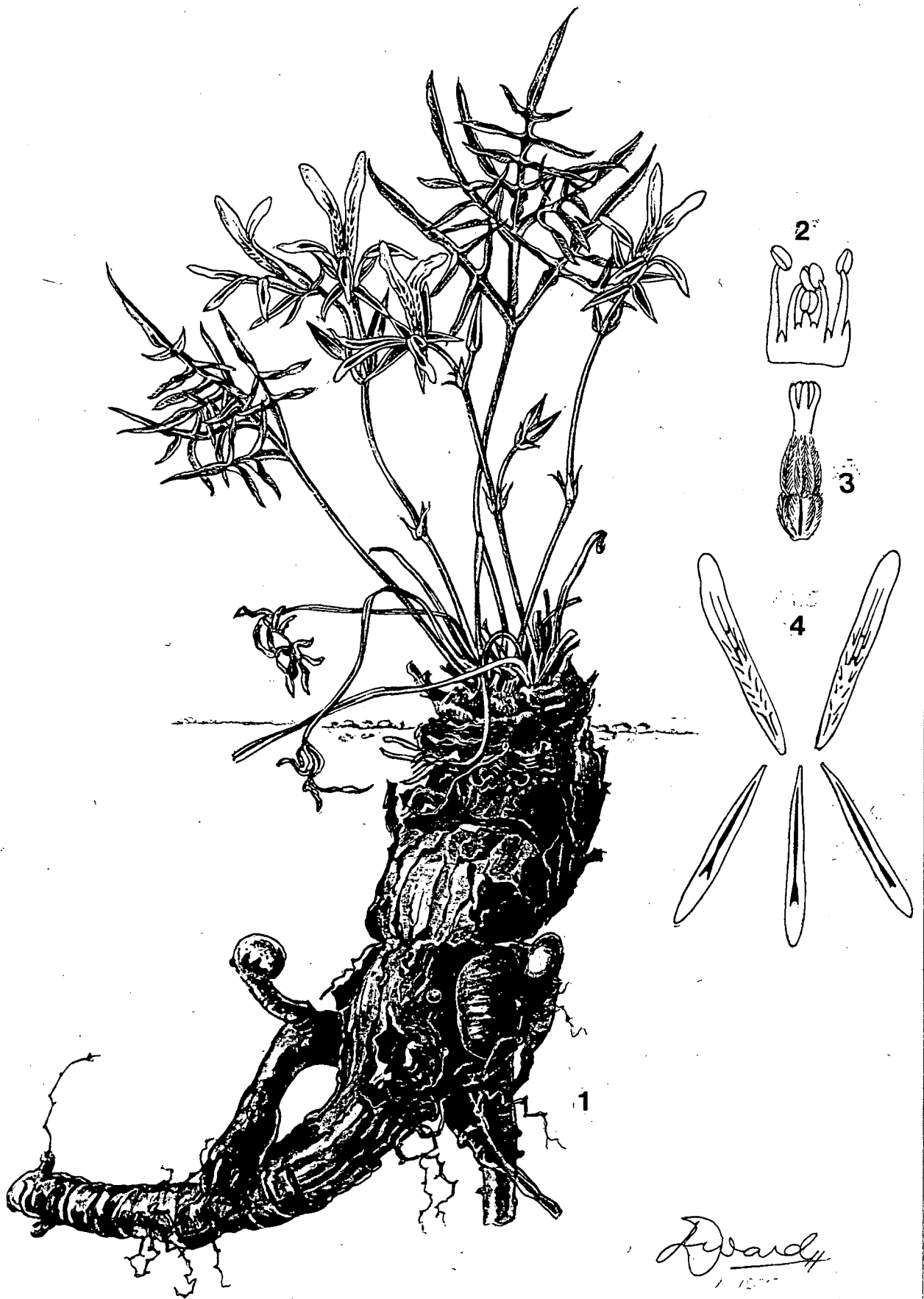


Figure 8.12.1 *Pelargonium leptum*. 1, flowering plant x1; 2, androecium x3; 3, gynoecium x5; 4, petals x1,5.

densely hirsute with appressed curly hairs interspersed with glandular hairs; bracts subulate, 3--5 mm long, 1--2 mm wide, adaxially and abaxially densely hirsute with long appressed hairs interspersed with glandular hairs. **Pedicel** *ca.* 0,5 mm long. **Hypanthium** 12--30 mm long, green, indumentum as on peduncle. **Sepals** 5, lanceolate, apices attenuate, 9--13 mm long, 1--3 mm wide, recurved, green with margins white, indumentum abaxially as on peduncle. **Petals** 5, white, cream-coloured, pale yellow or pale pink, claws forming a sheath, apices patent or recurved; posterior two with wine-red feather-like markings, ligulate, bases cuneate, apices rounded or obtuse, 21--28 x 2--3 mm, length/width ratio 7--11; anterior three with a wine-red stripe in the centre, ligulate, bases attenuate, apices rounded or obtuse, 18--26 x 1,5--2 mm. **Stamens**: staminal column 0,8--2,5 mm long, white; perfect stamens 5, concealed in the floral sheath, posterior one 2--4 mm long, lateral two 2,5--5 mm long, anterior two 3,5--6,5 mm long, white; staminodes 1,5--3 mm long; anthers red, *ca.* 1,5 mm long, pollen orange. **Gynoecium**: ovary 2,2--3 mm long; style 0,2--1 mm long, white; stigma branches 0.5--1 mm long, adaxially pink. **Fruit**: bases of mericarps 4 mm long, without glandular hairs, tails 20--25 mm long. (Figure 8.12.1).

Diagnostic features and affinities

P. leptum is a geophyte with irregularly pinnate leaves with rigid upright petioles and laminae with a trullate or triangular outline. It is characterized by the long and narrow petals, hence the epithet *leptum*, meaning slender (Bolus 1932). The stamens are short and concealed in the floral sheath. This floral structure is similar to that of *P. attenuatum*, *P. fergusoniae* and *P. angustipetalum*. The leaves of the latter three species are palmately compound, whereas those of *P. leptum* are pinnately compound.

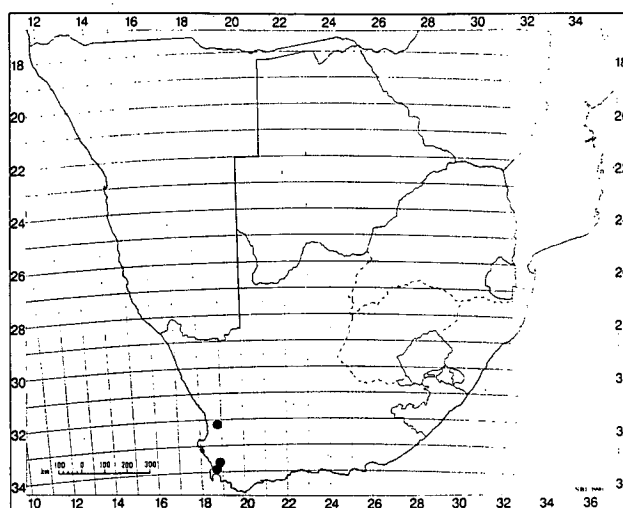


Figure 8.12.2 Geographical distribution of *P. leptum*.

Geographical distribution and ecology

P. leptum occurs in the vicinity of Kuilsrivier and Durbanville in the south and on Paardeberg between Paarl and Malmesbury to the north. Recently it was also collected along the Olifantsrivier near Clanwilliam, leaving an interruption of nearly 200 kilometers (Figure 8.12.2). The number of specimens used to compile this map is small, and one would like to ascribe this scattered pattern to the poor herbarium record available. On the other hand the annual rainfall may play a role in this distribution pattern because specimens were collected only in areas with an annual rainfall of 400--600 mm. The precipitation occurs mainly in winter. *P. ellaphieae* reveals a similar disjunct distribution pattern, from the Cape Peninsula in the south to the Olifantsrivier mountains and Cederberge in the north. *P. leptum* grows in sandy soil in mountain fynbos and flowers in summer from December to February, but in the garden flowers could be found as late as April.

Material studied

--3218 (Clanwilliam): Melkboomfontein, between Clanwilliam & Citrusdal (-BB), *Marais 209* (STEU).

--3318 (Cape Town): Lemoenkloof, Paardeberg (-DB), *Marais s.n.* (STEU); SW corner of Paardeberg (-DB), *Salter & Leighton s.n.* (BOL); Near Durbanville (-DC), *Leipoldt s.n.* sub. *BOL19185* (BOLx2, Kx2); Langverwacht, above Kuilsrivier (-DC), *Oliver 4981* (STE, STEU); *Oliver 5797* (STE).

8.13 *Pelargonium viciifolium* DC., Prodrumus 1: 653 (1824) (as "*viciaefolium*"): substitute name for *G. pinnatum sensu* Cav.: 257, t. 115, f. 2 (1787); Spreng.: 52 (1826); Loudon: 570 (1829); G. Don: 728 (1831); Loudon: 272 (1832); Steud.: 291 (1841) (excl. ref. Sweet); Marais: 129 (1993). ICONOTYPE: Cavanilles, *Dissertationes* 4: t. 115, f. 2 (1787).

Geranium pinnatum sensu Cav.: 257, t. 115, f. 2 (1787); *sensu* Andr.: t. 311 (1803b). non L.: 677 (1753); L.: 1141 (1759).

Pelargonium foliolosum DC.: 653 (1824), substitute name for *G. pinnatum sensu* Andr.: t. 311 (1803b); G. Don: 728 (1831); Steud.: 286 (1841) (excl. ref. Eckl. & Zeyh.); Loudon: 272 (1832) (as "*foliosum*"). ICONOTYPE: Andrews, *The Botanist's Repository* 5: t. 311 (1803b).

Hoarea foliolosa (DC.) Eckl. & Zeyh.: 64 (1835).

Pelargonium astragalifolium var. *foliolosum* (DC.) Harv.: 268 (1860); Knuth: 345 (1912).

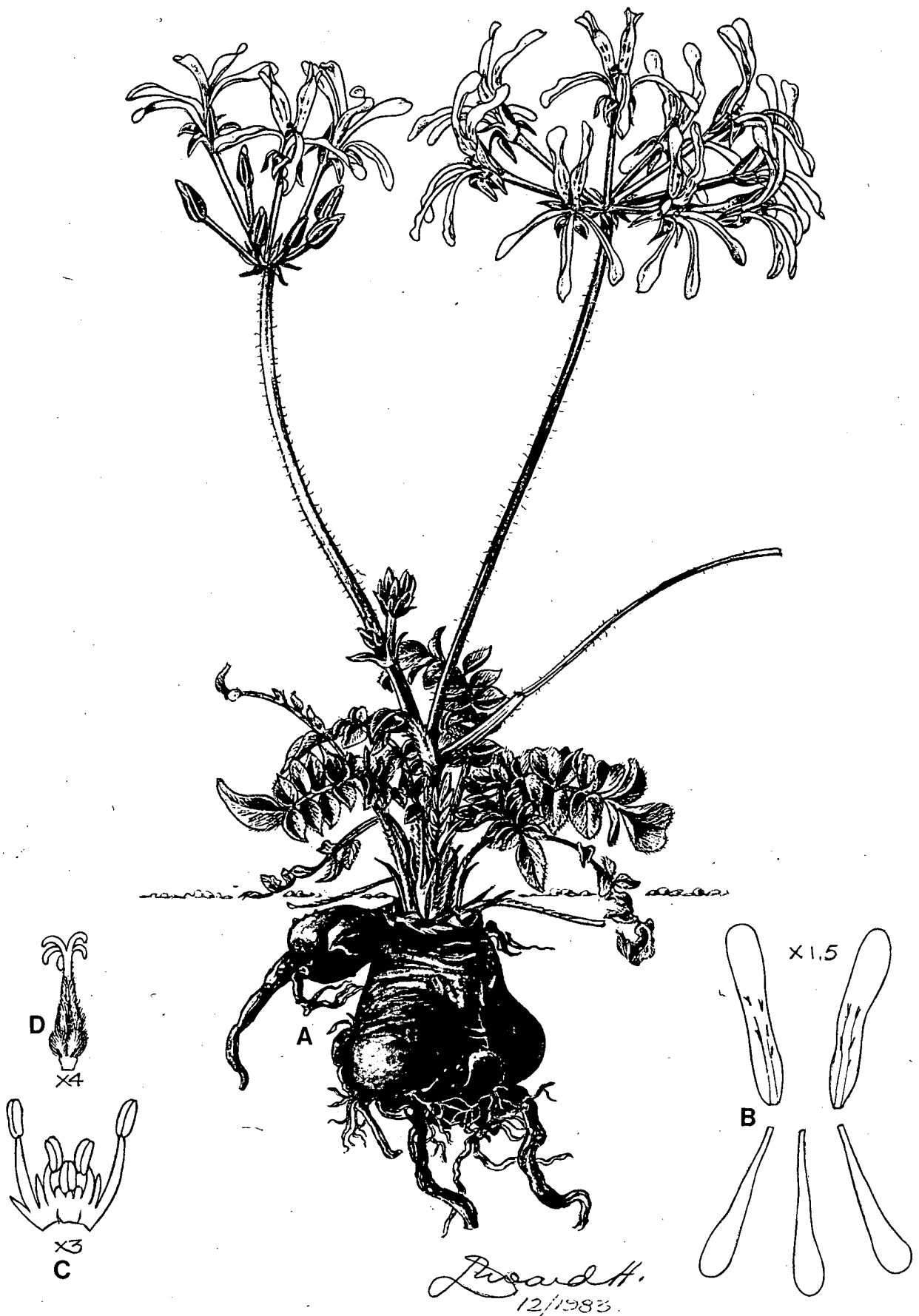


Figure 8.13.1 *Pelargonium viciifolium*. A, flowering plant x1; B, petals x1,5; C, androecium x3; D, gynoecium x4.

Dimacria astragalifolium sensu Sweet: t. 103 (1822); sensu Sweet: 76 (1826c).

Pelargonium astragalifolium var. *minor* Harv.: 268 (1860) (excl. ref. Eckl. & Zeyh.); Knuth: 345 (1912) (as "*minus*"). ICONOTYPE: Sweet, Geraniaceae 2: t. 103 (1822).

Misidentification

Pelargonium pinnatum sensu Harv.: 269 (1860) p.p.; *P. pinnatum* sensu Knuth: 346 (1912) p.p.

A geophyte 120--300 mm tall when in flower. **Tuber:** a turnip-shaped root, 25--40 mm long and 18--40 mm in diameter. **Leaves:** green, petiolate; lamina pinnate, (20-)50--120 mm long; pinnae ovate, acute, 4--12(-16) x 3--6(-10) mm, the terminal pinna usually larger than the other pinnae, adaxially and abaxially hirsute with appressed hairs interspersed with glandular hairs; petiole 23--100(-140) mm long and 1--2 mm in diameter, indumentum as on pinnae; stipules (9-)15--30(-40) mm long and *ca.* 1 mm wide, hirsute. **Inflorescence:** scape 40--200 mm long, 1,5--2 mm in diameter, branched, bearing 2--5 pseudo-umbellets with 7--19 flowers each; peduncles 50--180 mm long, 1--2 mm in diameter, densely hirsute with distally appressed curly hairs interspersed with long soft patent hairs as well as short and long glandular hairs; bracts narrowly triangular, 3--5 mm long, adaxially sparsely hirsute and abaxially densely hirsute with distally appressed hairs interspersed with glandular hairs. **Pedice**l *ca.* 0,5 mm long. **Hypanthium** (15-)20--35(-38) mm long, indumentum as on peduncle. **Sepals** 5, lanceolate, apices acute, 5--9 mm long, 1--3 mm wide, posterior one erect, others patent to recurved, indumentum abaxially hirsute with appressed hairs interspersed with glandular hairs. **Petals** 5, yellow to creamy yellow, claws forming a floral sheath of 10--12 mm long, apices patent during anthesis; posterior two with feather-like wine-red markings, ligulate, bases cuneate, apices rounded to emarginate, 14--22 x 2--4 mm; anterior three narrowly spatulate, bases attenuate, apices rounded, 11--19 x 2--3 mm. **Stamens:** staminal column 0,5--1,5 mm long, white; perfect stamens 5, concealed in floral sheath, posterior one 2--3 mm long, lateral two 3--4 mm long, anterior two 4,5--6 mm long, white; staminodes 2--3,5 mm long; anthers pink, *ca.* 1,5 mm long, pollen orange. **Gynoecium:** ovary 2,5--4,5 mm long; style 0,3--2 mm long, reddish pink; stigma branches 1,5--2,5 mm long, reddish pink. **Fruit:** bases of mericarps 5 mm long, with glandular hairs, tails 20--25 mm long (Figure 8.13.1).

Diagnostic features and affinities

P. viciifolium has yellow flowers with ligulate petals and wine-red feather-like markings on the two posterior petals. The length/width ratio of the posterior petals is usually

greater than five. The stigma branches are always longer than the style (*ca.* 1,5 times the length of the style), and the latter does not lengthen during anthesis or after fertilization. The stamens are short and hidden within the floral sheath. This, together with ligulate petals point to affinities with *P. longiflorum* and *P. leptum* (Marais 1993). The scape is branched, bearing two to five pseudo-umbellets with a relatively large number of flowers (7--19) each. The hypanthium is usually long, two to four times the length of the calyx.

P. viciifolium has similarly pinnate leaves than *P. pinnatum* and *P. trifoliolatum*. However, the floral structures of the three species differ. Both *P. pinnatum* and *P. viciifolium* have short stamens and feather-like markings on the posterior petals, whereas *P. trifoliolatum* has longer stamens and very prominent blotches on the posterior petals (Marais 1993). *P. pinnatum* has spatulate petals, whereas the petals of *P. viciifolium* are ligulate.

Geographical distribution and ecology

P. viciifolium occurs on the south-western Cape coastal plain, including the northern part of the Cape Peninsula, between the 33° and 34° latitudes and between the 18° and 19° longitudes (Figure 8.13.2). The area receives an annual rainfall of 200--400 mm mainly during winter. It occurs on hill sides in grassveld or renosterveld on shale and flowers from October to January with the peak during November and December. Flowers appear after the leaves have died, but dried leaf remnants are usually still present.

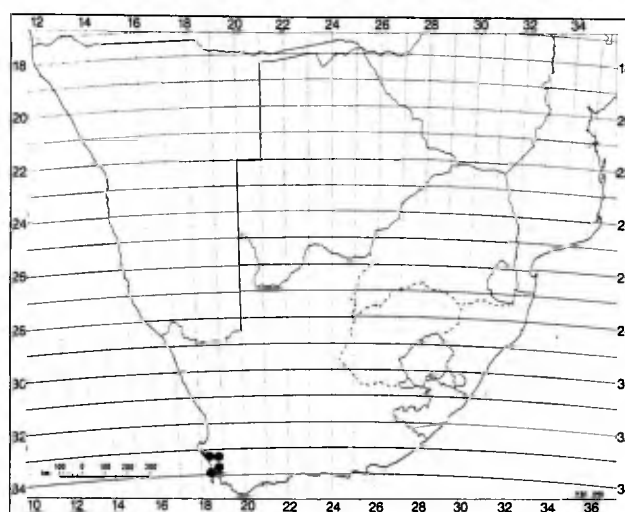


Figure 8.13.2 Geographical distribution of *P. viciifolium*.

Material studied

--3318 (Cape Town): Near Hopefield (-AB), *Leipoldt s.n.*, 20931 (BOL); 2,5 miles NW of Darling (-AD), *Acocks 20690* (K, PRE); Farm Goudmyn, Moorreesburg (-BA), *Marais 165* (STEU); Farm Neulfontein, Moorreesburg (-BA), *Marais 321* (STEU); Between Malmesbury & Hopefield (-BC), *Pillans 6281* (BOL, K); Mamre Hills (-CB), *Hall 166* (NBG); Lion's Head (-CD), *Marloth 386* (PRE); *Schonberg s.n.* (PRE, sub. Galpinn 4855); Lion's Back (-CD), *Worsdell s.n.* (K); Signal Hill (-CD), *Schlechter 45* (G, P, PRE, Z); *Van der Walt 479* (STEU); Van Schoorsdrif, Philadelphia, at Kalbaskraal turnoff (-DA), *Marais 21* (STEU); Swellengift, near Philadelphia (-DA), *Marais 134* (STEU); Wellington (-DB), *Thompson 32* (PRE); Kanonberg, overlooking Bottelary road (-DC), *Acocks 1118* (S); Durbanville (-DC), *Lindeberg s.n.* (S); Koelenhof, Stellenbosch (-DD), *Baker s.n.* (BOL); Between Bottelary and Stellenbosch (-DD), *Bolus s.n.* (BOL); Fisantekraal (-DD), *Marais 13* (STEU); Helshoogte Pass, near Ida's Valley Dam (-DD), *Oliver 5508* (PRE, STE).

8.14 *Pelargonium longifolium* (Burm. f.) Jacq., *Collectanea* 4: 192 (1791b); *Jacq.*: 9 (1795); *Willd.*: 641 (1800); *Pers.*: 226 (1806); *DC.*: 649 (1824); *Spreng.*: 50 (1826); *Loudon*: 568 (1829); *G. Don*: 725 (1831); *Loudon*: 271 (1832); *Steud.*: 678 (1840); *Steud.*: 287 (1841); *Harv.*: 261 (1860) p.p.; *Szysyl.*: 8 (1888); *Knuth*: 322 (1912) p.p.; *Adamson & Salter*: 514 (1950); *Van der Walt*: 25, fig. (1977) p.p.
 TYPE: Cape - "Cap. Bon. Spei" (G!, lecto, designated here).

Geranium longifolium *Burm. f.*: 50, n. 67 (1759); *Burm. f.*: 19 (1768); *Cav.*: 235, t. 102, f. 1 (1787).
 TYPE: Cape - "Cap. Bon. Spei" (G!, lecto., designated here).

Hoarea longifolia (*Burm. f.*) *Sweet*: 76 (1826c); *Eckl. & Zeyh.*: 60 (1835).

Geranospermum longifolium (*Burm. f.*) *Kuntze*: 95 (1891).

Geranium prolificum *L.* var. *longifolium* (*Burm. f.*) *L.*: 949 (1763).

Pelargonium ciliatum *Jacq.*: 195 (1791b); *Jacq.*: 9, t. 519 (1792); *Steud.*: 284 (1841); non *L'Hérit.*: t. 7 (1792); nec *Pers.*: 226 (1806). TYPE - "Ex Promontorio bonae Spei" (W!, holo.).

Pelargonium auriculatum *Willd.*: 643 (1800); substitute name for *P. ciliatum* *Jacq.*: 195 (1791b); *Pers.*: 226 (1806); *DC.*: 651 (1824); *Spreng.*: 51 (1826); *Loudon*: 568 (1829); *G. Don*: 726 (1831); *Loudon*: 271 (1832); *Steud.*: 283 (1841).

Geranium auriculatum (*Willd.*) *Poir.*: 745 (1812).

Hoarea auriculata (*Willd.*) *Sweet*: 76 (1826c).

Dimacria auriculata (*Willd.*) *Sweet*: t. 395 (1828).



LevardH

Figure 8.14.1 *Pelargonium longifolium*. 1, flowering plant x1; 2, tuber x1; 3, petals x1; 4, gynoecium x4; 5, androecium x4; 6, leaf base x1.

Geranium heterophyllum Andr.: C. ic (1805b); non Thunb.: 113 (1800). ICONOTYPE: Andrews, Geraniums: C. ic (1805b).

Pelargonium heterophyllum (Andr.) Loudon: 272 (1832); non Jacq.: 197 (1791b).

Dimacria andrewsii Sweet: 77 (1826c): substitute name for *G. heterophyllum* Andr.: C. ic (1805b).

Pelargonium andrewsii (Sweet) G. Don: 729 (1831); Steud.: 678 (1840); Schweickerdt: t. 9455 (1936).

Dimacria lanceaefolia Sweet: t. 387 (1828). ICONOTYPE: Sweet, Geraniaceae 4: t. 387 (1828).

Pelargonium lanceofolium (Sweet) G. Don: 729 (1831); *P. lanceolatum* (by mistake) Steud.: 287 (1841).

Hoarea lancifolia Eckl. & Zeyh.: 61 (1835). TYPE: Cape Province, "...Inter frutices in latere montis 'Tafelberg' orientem spectante, prope 'Clasenbosch'..." *Ecklon & Zeyher* 463 (S!, lecto, designated here, P!).

Pelargonium lancifolium (Eckl. & Zeyh.) Steud.: 287 (1841).

Hoarea bipinnatifida Eckl. & Zeyh.: 62 (1835). TYPE: Cape Province, "...Lapidosis ad montium latera in 'Hottentotsholland', Stellenbosch." *Ecklon & Zeyher* 476 (S!, lecto, designated here, Lx3!, MO!, S!, SAM!).

Pelargonium bipinnatifidum (Eckl. & Zeyh.) Steud.: 284 (1841).

Misidentification

Pelargonium longifolium sensu Jacq.: t. 518 (1792) = *P. proliferum* (Burm. f.) Steud.

A geophyte 80--240 mm tall when in flower. **Tuber:** a small turnip-shaped, elongated or sometimes moniliform root 10--25(-40) mm long and 10--25 mm in diameter. **Leaves** vary from simple to irregularly pinnately or bipinnately incised, green, petiolate; lamina of simple leaves lanceolate or elliptic, base attenuate, apex acute, margin entire, 40--120 x 8--18 mm, lamina of compound leaves 40--120 mm long, pinnae 8--30 mm long, lacinate, segments 1--2 mm wide, glabrous to sparsely hirsute with appressed hairs; petiole 30--90 mm long and 1--1,5 mm in diameter, rigid, erect, glabrous or hirsute with appressed hairs; stipules subulate, adnate to petioles for two thirds of their length, 12--33 mm long and 1--2 mm wide, ciliate. **Inflorescence:** scape (10-)35--170 mm long, branched, bearing 2--4 pseudo-umbellets with 3--9 flowers each; peduncles 10--70 mm long, 1 mm in diameter, hirsute with appressed curly hairs interspersed with long glandular hairs; bracts subulate, 4--10 mm long, 1--1,5 mm wide, abaxially densely hirsute with appressed hairs. **Pedicel** ca. 0,5 mm long. **Hypanthium** 8--22 mm long, green, indumentum as on peduncle. **Sepals** 5, lanceolate, apices acute, 5--12 mm long, 1--3,5 mm wide, posterior one erect, others recurved, green to pale reddish brown, indumentum abaxially as on peduncle. **Petals** 5, white, cream-coloured, yellow, pink or

salmon-pink, claws forming a sheath with the apices patent during anthesis; posterior two with conspicuous wine-red blotches in the centre, seldom with only feather-like markings, linear-spathulate, bases narrowly cuneate, apices rounded, margins undulate, 15--23 x 2--4 mm; anterior three with a crimson line on the claw, linear-spathulate, bases attenuate, apices rounded, margins undulate, 14--21 x 1,8--3,5 mm. **Stamens:** staminal column 1--2 mm long, white; perfect stamens 5, concealed in the floral sheath, posterior one 2--3 mm long, lateral two 2,5--4 mm long, anterior two 3,5--4,5 mm long, white; staminodes 1,5--2 mm long; anthers dark pink, 1--1,5 mm long, pollen orange. **Gynoecium:** ovary 1,8--3,5 mm long; style 0,1--0,5 mm long, dark pink; stigma branches 0,5--1 mm long, dark pink. **Fruit:** bases of mericarps 4,5--7 mm long, without glandular hairs, tails 27--33 mm long. (Figure 8.14.1).

Diagnostic features and affinities

P. longifolium is characterized by the white, cream-coloured, yellow or pink flowers with conspicuous wine-red blotches on the posterior petals and its very short stamens. The claws of the linear-spathulate petals with undulate margins form a floral sheath in which the stamens are concealed. Another striking feature of *P. longifolium* is the great diversity in the shape of the leaves, not only in one population, but also on one plant. It varies from simple lanceolate leaves to pinnately compound or bipinnatisect leaves with linear segments. The specific epithet *longifolium* refers to the long lanceolate leaves of some individuals of this species. The kind of leaf variation in *P. longifolium* is common within section *Hoarea* and *P. proliferum* exhibits similar leaf incisions. Although this is a cause for misinterpretation, the two species can be distinguished by the size and form of the petals and the markings on the posterior petals. *P. proliferum* has smaller petals with feather-like markings, whereas *P. longifolium* has long, narrowly spathulate petals with prominent honey-guides. In the latter the margins of the petals are undulate, which is not the case with *P. proliferum*. The narrowly spathulate petals with undulate margins and prominent dark blotches on the posterior petals resemble those of *P. trifoliolatum* and *P. heterophyllum*, but the structure of the androecium of *P. longifolium* differs from that of the above mentioned species. *P. longifolium* shows rather resemblance to *P. undulatum*, a species with long and narrow petals with undulate margins and with a similar structure of the androecium.

Harvey (1860) recognized four different varieties within *P. longifolium* and Knuth (1912) added another two to the list. The literature as well as the herbarium specimens cited by both authors represent a mixture of illustrations and specimens of different taxa, most of which I regard as well defined species on their own.

Geographical distribution and ecology

P. longifolium occurs in the south-western Cape, from Citrusdal in the north to the Cape Peninsula in the south and Bredasdorp in the east (Figure 8.14.2), an area receiving an annual rainfall of 400--1000 mm mainly in winter. Populations are usually very localized and occur in sandy places in fynbos. Most of them consist of relatively large numbers of plants. *P. longifolium* flowers from October to December, while the leaves are still present.

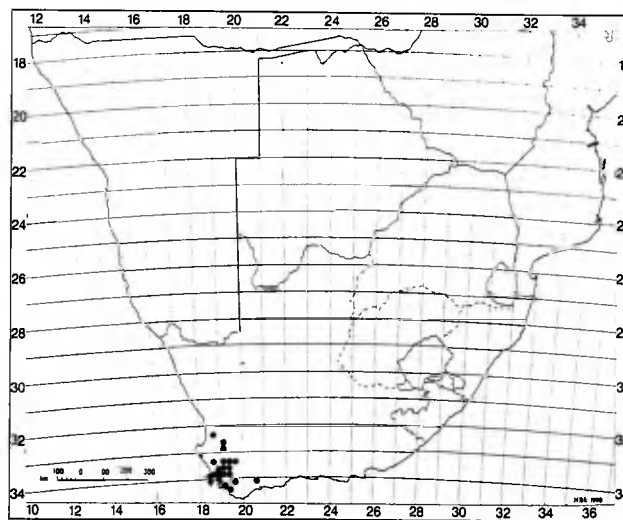


Figure 8.14.2 Geographical distribution of *P. longifolium*.

Material studied

--3218 (Clanwilliam): Piketberg Mountain (-DC), Zinn *s.n.* (SAM).

--3219 (Wuppertal): Elandskloof (-CA), Compton 16776 (NBG); Lewis 1171 (SAM); Citrusdal, 20 miles along the Ceres road (-CA), Hardy 1928 (PRE); Waterval, Porterville (-CC), Edwards 31 (BOL).

--3318 (Cape Town): Groot Post, Near Malmesbury (-BC), Salter 6462 (BM, K); Cape Town (-CD), De Casteluan *s.n.* (P); Lion's Head (-CD), Ecklon *s.n.* (P); Table Mountain (-CD), Ecklon & Zeyher 462 (Sx2, SAM); Ecklon & Zeyher 474 (S); Esterhuysen 22411 (BOL); Claasensbosch (-CD), Ecklon & Zeyher 463 (P, S); Mowbray (-CD), Marloth 478 (PRE); Marloth 1614 (PRE, Z); Slopes near Platteklip (-CD), Marloth 8778a (PRE); Paarl (-DB), Alexander *s.n.* (BM); Esterhuysen 9696 (BOL); Paarlberg (-DB), Drège 7494a (CGE, E, Gx2, Kx2, L, MO, Px2, Sx2, Wx2); Tygerberg (-DC), Ecklon & Zeyher 459 (SAM); Canonberg, district Stellenbosch (-DC), Krauss 38 (G); Kraaifontein (-DC), Salter 1768 (BM); Salter 6490 (BOL); Beecroft farm, Kraaifontein (-DC), Wilman 962 (BOL, PRE); Red Hill (-DC), Wolley Dod 1911 (BOL); Between Bottelary & Stellenbosch (-DD), Bolus *s.n.* (BOL); Stellenbosch (-DD),

Duthie s.n. (BOL); *Garside 101* (K); Jan Marais Nature Reserve, Stellenbosch (-DD), *Marais 57* (STEU); *Soerns s.n.* (STE); Waterfalls, Jonkershoek (-DD), *Oliver 5473* (PRE, STE); Groot Drakenstein (-DD), *Rogers 17988* (Z); *Salter 5009* (BOL); *Salter 6495* (BOL, K); Dennegeur, Stellenbosch (-DD), *Smith 4873* (PRE); Stellenbosch Mountain (-DD), *Van der Walt 669, s.n.* (STEU 1252) (STEU).

--3319 (Worcester): *Liefde* (-AC), *Drège 9519* (P, S); Tulbagh, Waterfall & Winterhoek (-AC), *Ecklon & Zeyher 464* (MO, P, Sx2, SAM); *Ecklon & Zeyher 475* (S); Tulbagh (-AC), *Esterhuysen 17488* (BOL); *Pappe 15* (PRE, TCD); *Stanford s.n.* (BOL); Ceres road (-AC), *Schlechter 9090* (BM, BOL, Gx2, GRA, K, Z); Witzenberg (-AC), *Zeyher 175* (G, P); Tulbaghkkloof (-AC), *Zeyher 173a* (PRE); 3 km N of Ceres (-AD), *Cillie s.n.* (STEU); Schurfteberg (-AD), *Esterhuysen 21871* (BOL); Flats NW of Prince Alfred Hamlet (-AD), *Oliver 5511a* (STE); Matroosberg (-BC), *Phillips 1954* (SAM); Du Toitskloof (-CA), *Drège 7494c* (P); Ruigtevlei, Slanghoek (-CA), *Walters 1555, 2041* (NBG); Shooting Range, Worcester (-CB), *Bayer 2628* (NBG); Worcester Airfield (-CB), *Bayer 2632* (NBG); *Marais 342* (STEU); Between Worcester & Brandvlei (-CB), *Bolus 5130* (BOL, K); Botha (-CB), *Compton 18687* (NBG); Worcester (-CB), *Fine 943* (PRE); *Hall 169* (NBG); Near Edelweiss Garage, Worcester (-CB), *Forrester 251* (NBG); Brandvlei Prison (-CB), *Forrester 515* (NBG); Near Rawsonville (-CB), *Forrester 2088* (NBG); Brandvleidam (-CB), *Hugo 748* (STE); Eikeboom, Slanghoek road (-CB), *Van der Walt 1060* (STEU); Top of Franschoek Pass (-CC), *Albers s.n.* (STEU 4108 & 4109) (STEU); *Drijfhout 2637* (STEU); *Marais 404* (STEU); *Taylor 1490* (PRE); *Van der Walt 1598* (STEU); *Van Wyk 2042* (PRE); Franschoek (-CC), *Bolus 3029* (NBG); *Drège 7494b* (P); *Phillips 1062* (SAM); *Wall s.n.* (S); Groot Drakenstein (-CC), *Compton 4831* (NBG); Wemmershoek (-CC), *Esterhuysen 17717, 31372* (BOL); *Salter 6499* (BOL, K); *Salter 6500* (BOL, K); Moordkuil, along Doornrivier (-CD), *Drège 1285* (P); Between Worcester & Villiersdorp (-CD), *Leipoldt s.n.* (BOL).

--3418 (Simonstown): Bergfliet farm (-AB), *Purcell 241* (SAM); Simon's Bay (-AB), *Wright s.n.* (PRE); Sandy flat near Gordon's Bay (-BB), *Albers s.n.* (STEU); Mountain slopes above Gordon's Bay (-BB), *Bayliss 4087A* (NBG); Gordon's Bay (-BB), *Davis s.n.* (SAM); Hottentotsholland (-BB), *Ecklon & Zeyher 476* (Lx3, MO, Sx2, SAM); *Ecklon & Zeyher 478* (MO, S, SAM); Sir Lowry's Pass (-BB), *Guthrie 2784* (NBG); Between Gordon's Bay & Strand (-BB), *Snijman 577* (NBG).

--3419 (Caledon): Lower slopes of Hermanus Mountain (-AC), *Leighton 330* (BOL); Vogelgat (-AD), *Williams 3368, 3743* (NBG); Genadendal (-BA), *Verreaux s.n.* (G).

--3420 (Bredasdorp): Poort, Bredasdorp (-BA), *Compton 23208* (NBG).

Specimens without exact localities: Worcester district, *Cooper 1609* (TCD); *Cooper 1631* (BM, TCD, W); *Cooper 1639* (BM, K, W); *Cooper 1651* (K, TCD, W); *Cooper 1707* (BM, K, TCD, W, Z); *Cooper 1711* (K, TCD, W, Z); *Cooper 1715* (K, W); *Cooper 1724* (BM, G, K, PRE, TCD, W, Z).

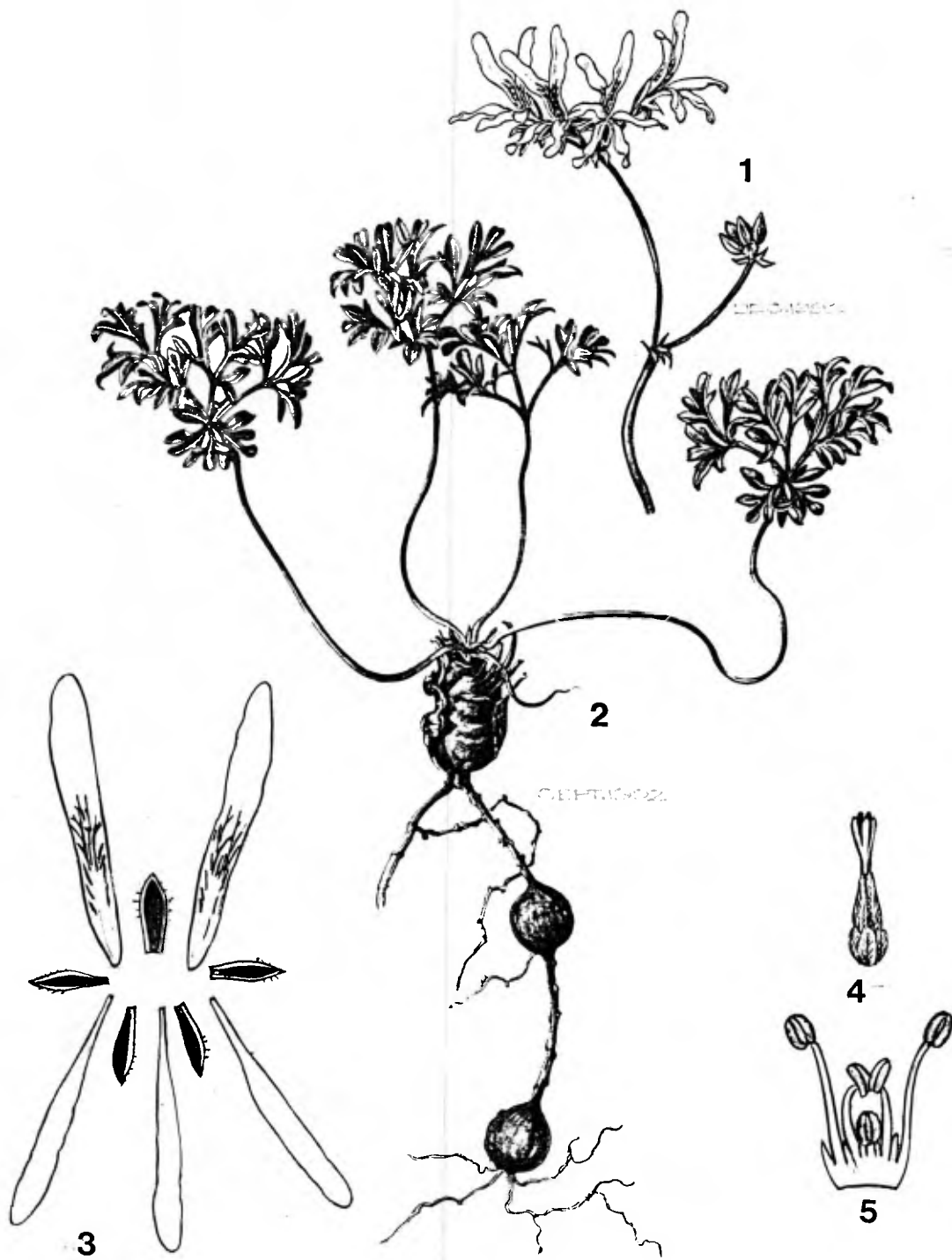


Figure 8.15.1 *Pelargonium fergusoniae*. 1, inflorescence x1; 2, plant with leaves x1; 3, petals x2; 4, gynoecium x5; 5, androecium x5.

8.15 *Pelargonium fergusoniae* L. Bol. in Kew Bulletin 1934: 258 (1934). TYPE - Cape Province: Near Riversdale, *Bolus & Ferguson BOL20512* (BOL, holo.!, K!).

A geophyte 120--220 mm tall when in flower. **Tuber:** a turnip-shaped, sometimes moniliform root 8--30 mm long and 8--15 mm in diameter. **Leaves** green, petiolate; lamina palmately compound with three main pinnae; pinnae 10--50 mm long, deeply incised, segments laciniate with apices acute, sparsely hirsute with long appressed hairs interspersed with very short glandular hairs; petiole 20--100 mm long and 0,5--1 mm in diameter, rigid, spreading horizontally from the growing point and bending vertically in the middle, glabrous or sparsely hirsute with appressed hairs interspersed with glandular hairs; stipules narrowly triangular, adnate to petioles for one third of their length, 3--6 mm long and *ca.* 1,5 mm wide, ciliate. **Inflorescence:** scape 20--100 mm long, 1--2 mm in diameter, branched, bearing 2--4 pseudo-umbellets with 3--8 flowers each; peduncles 40--120 mm long, 0,5--1 mm in diameter, sparsely hirsute with appressed curly hairs interspersed with glandular hairs; bracts lanceolate, 3--4 mm long, 1 mm wide, abaxially hirsute with appressed hairs. **Pedicel** *ca.* 0,5 mm long. **Hypanthium** (15-)20--42 mm long, indumentum as on peduncle. **Sepals** 5, lanceolate, apices acute, 6,5--11 mm long, 1--3 mm wide, posterior one erect, others reflexed, green or pale reddish brown with margins white, indumentum abaxially as on peduncle. **Petals** 5, white, pale pink or cream-coloured, ligulate, claws forming a sheath, apices patent or recurved; posterior two with wine-red feather-like markings, bases cuneate, apices rounded or obtuse, 20--33 x 2,5--3,5 mm, length/width ratio 6,5--8,5; anterior three usually without markings, bases attenuate, apices rounded or obtuse, 15--29 x 2--2,2 mm. **Stamens:** staminal column 1--2 mm long, white; perfect stamens 5, concealed in the floral sheath, posterior one 1,5--2 mm long, lateral two 2,5--3,5 mm long, anterior two 4,5--5 mm long, white; staminodes 1--3 mm long; anthers pink, 1,5 mm long, pollen yellow. **Gynoecium:** ovary 2--3 mm long; style 0,2--1 mm long, pink; stigma branches 1--1,5 mm long, dark pink. **Fruit:** bases of mericarps 5--6 mm long, without glandular hairs, tails 22--32 mm long. (Figure 8.15.1).

Diagnostic features and affinities

P. fergusoniae is a geophyte with palmately compound leaves with very long and thin petioles which spread horizontally from the growing point and bend vertically in the middle. This orientation of the petioles resembles that of *P. ternifolium* and *P. reflexum*. The former has ternate leaves, whereas the leaves of *P. reflexum* are identical to those of *P. fergusoniae*. The floral structure of *P. fergusoniae* resembles that of *P. attenuatum*. Both species have flowers with long ligulate petals and very short stamens, concealed in

the floral sheath. Although the leaves of *P. fergusoniae* and *P. reflexum* are identical, the two species differ in respect to the floral structure. The former has long ligulate petals (posterior two 20--33 mm long) with the length/width ratio greater than 6,5 and those of *P. reflexum* are spatulate and of medium length (posterior two 10--18 mm long) with the length/width ratio smaller than 5,5.

P. fergusoniae is named after E. Ferguson, who accompanied L. Bolus on a trip when they collected this species.

Geographical distribution and ecology

P. fergusoniae is common in the southern Cape Province. It occurs from Hex River Valley in the north to Bredasdorp in the south and from Worcester and Caledon in the west to Riversdale in the east (Figure 8.15.2). This area receives an annual rainfall of 200--400 mm mainly during the winter months. *P. fergusoniae* grows in fynbos in loose sandy soil and flowers in summer, from late November to January.

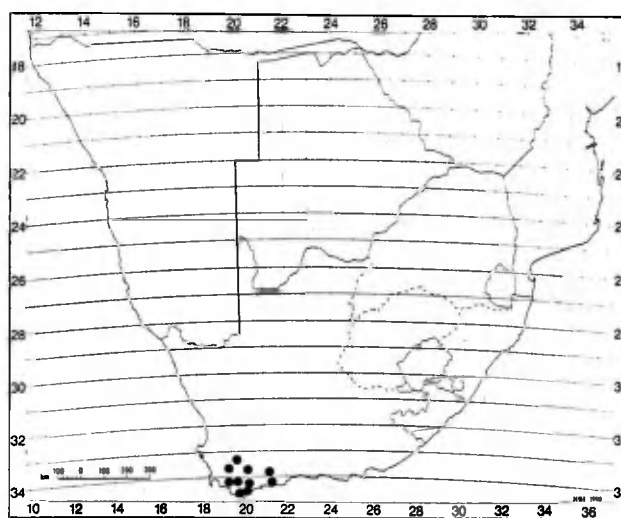


Figure 8.15.2 Geographical distribution of *P. fergusoniae*.

Material studied

--3319 (Worcester): Orchard, Hex River Valley (-BC), *Esterhuysen 10933* (BOLx2); Worcester West township (-CB), *Bayer 5647* (STE); Near Worcester (-CB), *Leipoldt s.n.* (BOL).

--3320 (Montagu): 16 km from Nougaspoort (-CA); *Fischer 231* (STEU); 13 km E of Bonnievale (-CC), *Bayer 1711* (NBGx2).

--3321 (Ladismith): Springfontein, Little Karoo (-CC), *Bolus s.n.* (BOL); Garcia's Pass (-CC), *Ryder 19986* (BOL, K).

--3419 (Caledon): 7 miles NE of Boontjieskraal (-AB), *Salter 6180* (BOL); *Salter NBG1743/36* (NBG); Near Greyton (-BA), *Bayer 2339* (NBG, STEU); 15 km from Bredasdorp to Heuningrug (-DB), *Fischer 287* (STEU); Heuningrug, SW of Bredasdorp (-DB), *Meve 261186/396* (STEU).

--3420 (Bredasdorp): 10 km E of Brakfontein (-AA), *Fischer 304* (STEU); 2 km SW of Swellendam (-AB), *Bayer 2513* (NBG, STEU); Between Bredasdorp & Malgas (-AD), *Lewis 2792* (SAM); Die Poort, Bredasdorp (-CA), *Acocks 23113* (PRE); 6 miles from Bredasdorp to Elim (-CA), *Esterhuysen 19171* (BOLx2, K); Bredasdorp-Poort (-CA), *Esterhuysen 19562* (BOL).

--3421 (Riversdale): Near Riversdale (-AB), *Bolus & Ferguson BOL20512* (K, BOL).

8.16 *Pelargonium undulatum* (Andr.) Pers., *Synopsis plantarum* 2: 226 (1806); *Ait. f.*: 160 (1812); *DC.*: 650 (1824); *Spreng.*: 50 (1826); *Loudon*: 568 (1829); *G. Don*: 729 (1831); *Loudon*: 271, 272 (1832); *Steud.*: 290 (1841). **ICONOTYPE:** Andrews, *The Botanist's Repository* 5: t. 292 (1803b).

Geranium undulatum Andr.: t. 292 (1803b); *Poir.*: 757 (1812). **ICONOTYPE:** Andrews, *The Botanist's Repository* 5: t. 292 (1803b).

Dimacria undulata (Andr.) Sweet: 77 (1826c).

Pelargonium ovatifolium Steud.: 680 (1840): substitute name for *G. undulatum* Andr.: t. 292 (1803b).

Geranium undulatum var. *minor* Andr.: t. 317 (1803b). **ICONOTYPE:** Andrews, *The Botanist's Repository* 5: t. 317 (1803b).

Pelargonium virgineum Pers.: 226 (1806): substitute name for *Geranium undulatum* var. *minor* Andr.: t. 317 (1803b); *DC.*: 650 (1824); *Spreng.*: 50 (1826); *Loudon*: 568 (1829); *G. Don*: 729 (1831); *Loudon*: 271, 272 (1832); *Steud.*: 680 (1840); *Steud.*: 291 (1841).

Geranium virgineum (Pers.) Poir.: 757 (1812).

Dimacria virginea (Pers.) Sweet: 77 (1826c).

Pelargonium longifolium (Burm. f.) Jacq. var. *virgineum* (Pers.) Harv.: 262 (1860); *Knuth*: 322 (1912).

Pelargonium hirsutum Loudon: 570 (1829); substitute name for *Geranium undulatum* var. *minor* Andr.: t. 317 (1803b); *Loudon*: 272 (1832); non (Burm. f.) *Ait.*: 417 (1789).

A geophyte 90--240 mm tall when in flower. **Tuber:** a turnip-shaped or elongated root 20--110 mm long and 15--30 mm in diameter, older plants forming fleshy root branches as well as stem branches. **Leaves:** juvenile leaves simple, others trifoliolate, pinnate or irregularly pinnate or bipinnatisect, green, petiolate; laminae of simple leaves ovate, 20--50 x 8--20 mm; laminae of compound leaves elliptic in outline, 50--120 x 40--100 mm,

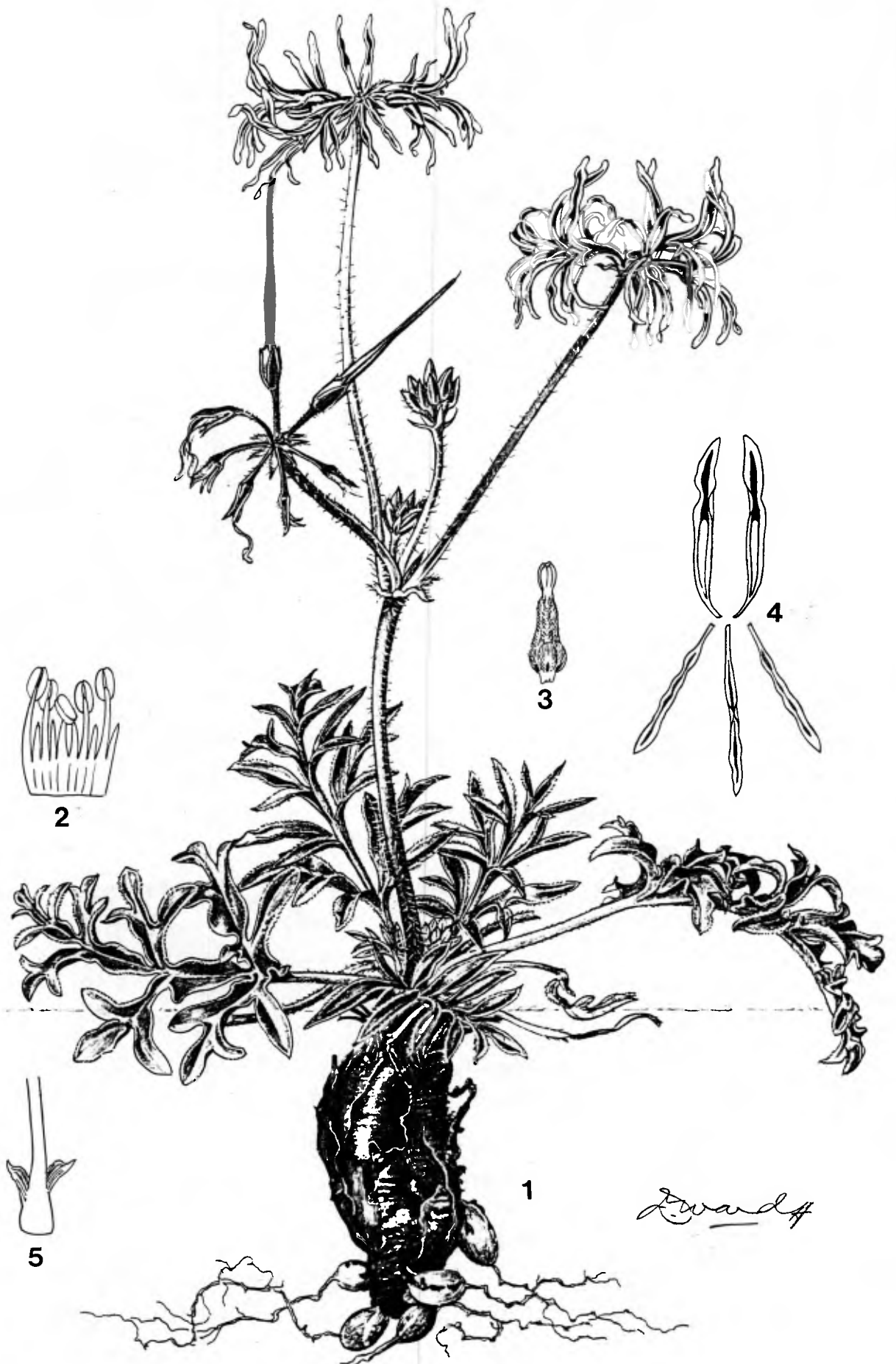


Figure 8.16.1 *Pelargonium undulatum*. 1, flowering plant x1; 2, androecium x3; 3, gynoecium x4; 4, petals x1,5; 5, leaf base x1.

pinnae ovate or linear to lacinate, 20--60 mm long, (1-)3--7 mm wide, apices acuminate, margins entire, adaxially glabrous, ciliate, abaxially hirsute with long stiff appressed hairs; petiole 25--50 mm long and 1--2,5 mm in diameter, rigid, erect, setose with appressed bristle-like hairs interspersed with short glandular hairs; stipules triangular or narrowly triangular, adnate to petioles for half their length, 7--15 mm long and 2--3 mm wide, hirsute or ciliate, apices sometimes laterally curved. **Inflorescence:** scape 30--170 mm long, 1--3 mm in diameter, branched, bearing 2--5 pseudo-umbellets with 3--8(-13) flowers each; peduncles 20--80 mm long, 1--2 mm in diameter, covered with glandular hairs interspersed with very long soft patent hairs; bracts lanceolate, 3--5 mm long, 1--2 mm wide, adaxially and abaxially hirsute with appressed hairs interspersed with glandular hairs. **Pedicel** ca. 0,5 mm long. **Hypanthium** 6--12(-25) mm long, green to reddish brown, densely covered with glandular hairs. **Sepals** 5, lanceolate to triangular, apices acute, 5--8 mm long, 1--4 mm wide, patent during anthesis, green to reddish brown with margins white, abaxially densely covered with glandular hairs and sometimes also with appressed hairs at the apices. **Petals** 5, white, cream-coloured, yellow or pale pink, ligulate, margins undulate, claws forming a sheath, apices patent or recurved; posterior two with a wine-red stripe or blotch in the centre, bases cuneate, apices rounded or obtuse, 16--25 x 1,2--3 mm, length/width ratio 6--16; anterior three with a wine-red stripe in the centre, bases attenuate, apices rounded or obtuse, 13--19 x 1--1,5 mm. **Stamens:** staminal column 1--2,5 mm long, white; perfect stamens 5, concealed in the floral sheath, posterior one 2,5--4 mm long, lateral two 3,5--4,5 mm long, anterior two 4--5 mm long, white; staminodes 2--3,5 mm long; anthers green or red, 1--1,5 mm long, pollen orange. **Gynoecium:** ovary 2,5--3,5 mm long; style 0,2--0,5 mm long, green or red; stigma branches 1--1,5 mm long, adaxially pink. **Fruit:** bases of mericarps 5--7 mm long, with glandular hairs, tails 27--35 mm long. (Figure 8.16.1).

Diagnostic features and affinities

P. undulatum is a geophyte with pinnately compound leaves and rigid upright petioles. This leaf structure is very similar to that of *P. leptum*, but the laminae of *P. undulatum* are elliptic in outline, whereas those of *P. leptum* are trullate or triangular. *P. undulatum* is characterized by the long and narrow petals with undulate margins, hence the specific epithet. The stamens are short and concealed in the floral sheath. This floral structure is similar to that of *P. leptum*, *P. attenuatum*, *P. fergusoniae* and *P. angustipetalum*. However, none of them have undulate petals. Both *P. undulatum* and *P. leptum* have pinnatisect leaves, whereas the leaves of the other three species are palmatisect.

Geographical distribution and ecology

P. undulatum occurs in the vicinity of Worcester, Karoo Poort, the Hex River Valley and as far east as Seweweekspoort (Figure 8.16.2). The annual rainfall of this area varies between 200–400 mm, and occurs mainly during the winter months. *P. undulatum* grows in sandy soil or on shale in low karroid vegetation. Populations are usually small. It is one of the early flowering species of section *Hoarea* and flowers can be found as early as August, although the peak of the flowering time is from September to October.

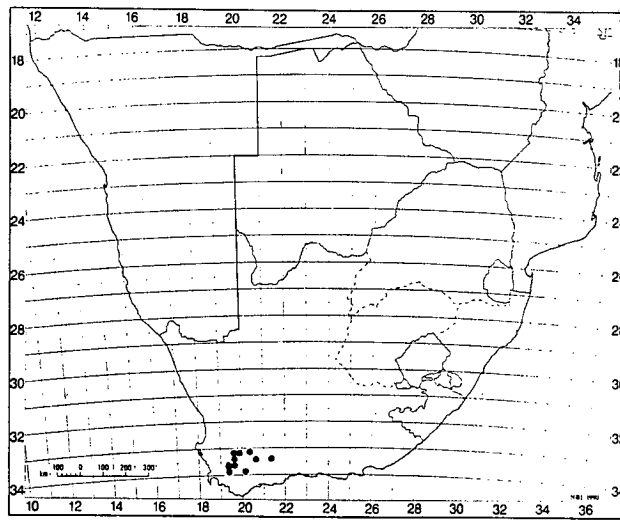


Figure 8.16.2 Geographical distribution of *P. undulatum*.

Material studied

--3319 (Worcester): Karoo Poort (-BA), *Bayer 3597* (NBGx2); *Dymond NBG1923/33* (BOL); *Hall NBG752/50* (BOL); 4 km N of Karoo Poort (-BA), *Lavranos & Pehlemann 17470* (STEU); Karoo Poort, at turnoff to Touwsrivier (-BA), *Muller 4041a* (STEU); Between Hottentotskloof & Sutherland (-BB), *Leipoldt s.n.* (BOL); Hottentotskloof, Ceres (-BC), *Compton 12061* (NBG); Verlorenvlei, Ceres (-BC), *Levyns 1002* (BOL); Orchard (-BC), *Rogers 16523* (K, P, Z); Hex River Valley (-BC), *Wolley Dod 4045* (BOL); W of Langerug, Worcester (-CB), *Bayer 2610* (NBG); Reiersrus, Aan de Doorns (-CB), *Walters 2555* (NBG); Lemoenpoort (-CD), *Perry 1231* (NBG); Draaivlei, Doornrivier (-CD), *Walters 329* (NBG); Sandberg hills, on road from Worcester to Scherpenheuvel (-DA), *Forrester 248* (NBG).

--3320 (Montagu): Tweedside (-AB), *Barker 7478* (NBGx2); *Barker & Lewis 20601* (BOL); *Lewis NBG2789/32* (BOL); Patatsrivier, Ceres Karoo (-AB), *Lavranos & Pehlemann 18803* (STEU); Witteberge (-BC), *Oliver s.n.* (STEU); Corena, between Bonnievale & Drew (-CC), *Forrester & Vosa 183* (NBG).

--3321 (Ladismith): S entrance to Seweweekspoort (-AD), *Levyns 2436* (BOL); N end of Seweweekspoort, 4 km to the E, near Besemfontein (-AD), *Marais 331* (STEU); *Van der Walt 1111*

(STEU); Near N entrance to Seweweekspoort (-AD), *Mauve, Reid, Wikner 126* (STE); Waterkloof, Ladismith (-AD), *Van der Walt 1593* (STEU).

8.17 *Pelargonium longiflorum* Jacq., *Collectanea* 4: 194 (1791b); Jacq.: 9, t. 521 (1792); Willd.: 642 (1800); Pers.: 226 (1806); DC.: 649 (1824); Spreng.: 50 (1826); Loudon: 568 (1829); G. Don: 725 (1831); Loudon: 271 (1832); Steud.: 287 (1841). TYPE - "Ex Promontorio bonae Spei" (W, holo!).

Geranium longiflorum (Jacq.) Poir.: 745 (1812).

Hoarea longiflora (Jacq.) Sweet: 76 (1826c).

Pelargonium longifolium (Burm. f.) Jacq. var. *longiflorum* (Jacq.) Harv.: 262 (1860); Knuth: 323 (1912); Pole-Evans: t. 335 (1929).

Pelargonium depressum Jacq.: 193 (1791b); Jacq.: 9, t. 520 (1792); Loudon: 271 (1832). TYPE - "Ex Promontorio bonae Spei" (W, holo!).

Dimacria depressa (Jacq.) Sweet: t. 290 (1826a).

Hoarea depressa (Jacq.) Sweet: 76 (1826c).

Geranium longiflorum (Jacq.) Poir. var. *depressum* (Jacq.) Poir.: 745 (1812).

Pelargonium longiflorum Jacq. var. *depressum* (Jacq.) Loudon: 271 (1832).

Geranium angustifolium Thunb.: 113 (1800); Thunb.: 514 (1823). TYPE: "Cap. bon Spei" *Thunberg s.n.* (UPS, holo!).

Pelargonium angustifolium (Thunb.) DC.: 680 (1824); G. Don: 742 (1831); Steud.: 677 (1840); Steud.: 283 (1841); Harv.: 262 (1860); Knuth: 326 (1912).

Hoarea angustifolia (Thunb.) Eckl. & Zeyh.: 61 (1835).

Geranospermum angustifolium (Thunb.) Kuntze: 94 (1891).

Geranium spathulatum Andr.: t. 152 (1801b); Poir.: 757 (1812). ICONOTYPE: Andrews, *The Botanist's Repository* 3: t. 152 (1801b).

Pelargonium spathulatum (Andr.) Pers.: 226 (1806); Ait. f.: 160 (1812); DC.: 650 (1824); Spreng.: 51 (1826); Loudon: 568 (1829); G. Don: 729 (1831); Loudon: 271, 272 (1832); Steud.: 679 (1840); Steud.: 290 (1841); Harv.: 264 (1860); Knuth: 325 (1912).

Dimacria spathulata (Andr.) Sweet: 77 (1826c).

Geranospermum spathulatum (Andr.) Kuntze: 95 (1891).

Geranium spathulatum var. *curvifolium* Andr.: t. 282 (1803a). ICONOTYPE: Andrews, *The Botanist's Repository* 4: t. 282 (1803a).

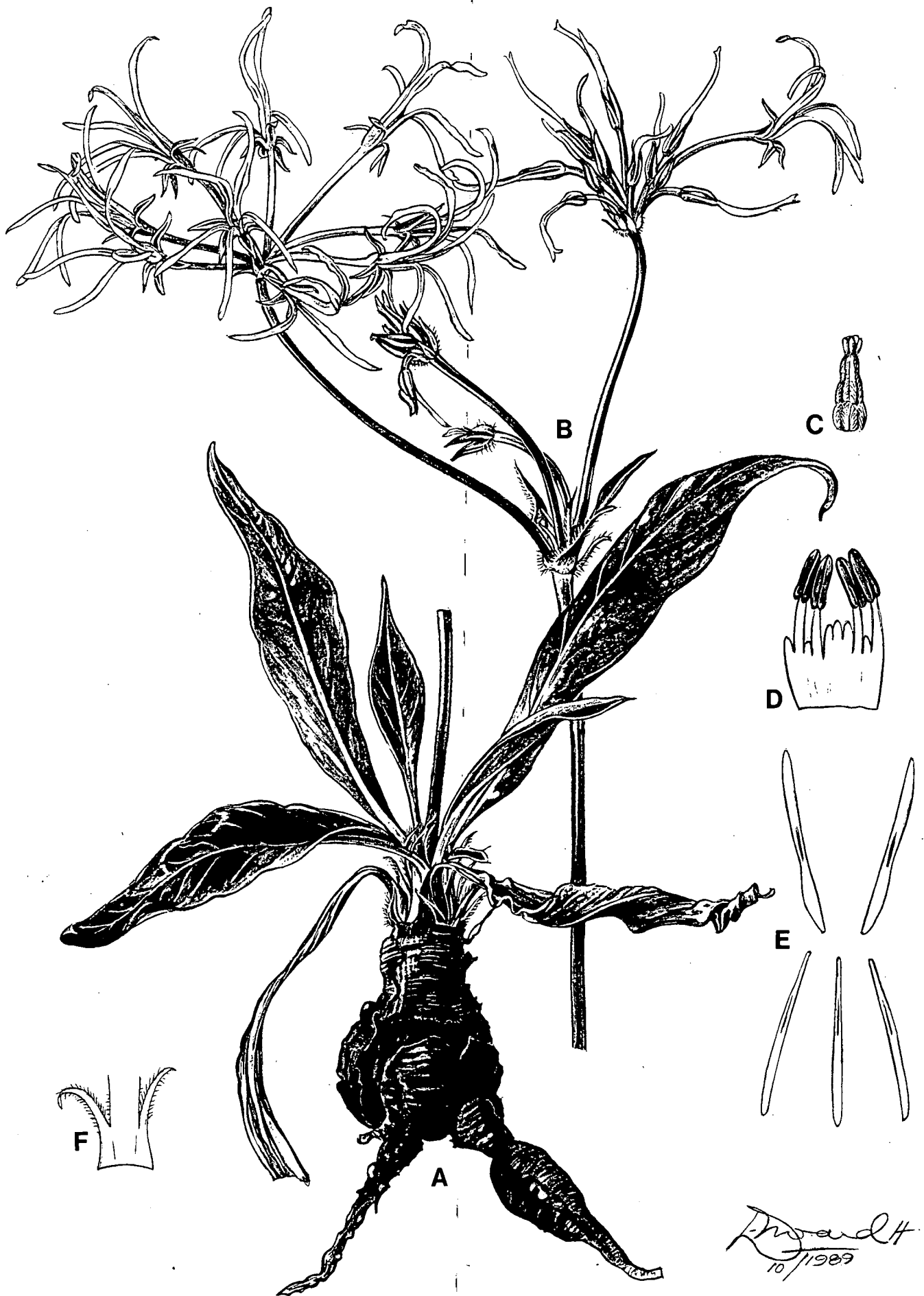


Figure 8.17.1 *Pelargonium longiflorum*. A, plant with leaves x1; B, inflorescence x1; C, gynoecium x5; D, androecium x5; E, petals x1; F, leaf base x2.

Pelargonium spathulatum (Andr.) Pers. var. *curvifolium* (Andr.) Knuth: 325 (1912).

Geranium spathulatum Andr. var. *affine* Poir.: 757 (1812). (Type as for *Geranium spathulatum* var. *curvifolium* Andr.)

Pelargonium spathulatum (Andr.) Pers. var. *affine* (Poir.) Loudon: 568 (1829); Loudon: 272 (1832).

Hoarea affine (Poir.) Sweet: 77 (1826c).

Pelargonium affine (Poir.) G. Don: 729 (1831); Steud.: 283 (1841).

Geranium lineare Andr.: t. 193 (1801b); Poir.: 758 (1812). ICONOTYPE: Andrews, The Botanist's Repository 3: t. 193 (1801b).

Pelargonium lineare (Andr.) Pers.: 228 (1806); Ait. f.: 160 (1812); DC.: 650 (1824); Spreng.: 50 (1826); Loudon: 568 (1829); G. Don: 729 (1831); Loudon: 271, 272 (1832); Steud.: 678 (1840); Steud.: 287 (1841).

Dimacria linearis (Andr.) Sweet: 77 (1826c).

Hoarea linearis (Andr.) Eckl. & Zeyh.: 62 (1835).

Dimacria rumicifolia Sweet: t. 318 (1826b). ICONOTYPE: Sweet, Geraniaceae 4: t. 318 (1826b).

Pelargonium rumicifolium (Sweet) Loudon: 272 (1832); Steud.: 289 (1841).

A geophyte 130–300 mm tall when in flower. **Tuber:** a turnip-shaped, elongated or sometimes moniliform root, older plants sometimes with more than one stem-growing point, 15–50 mm long and 10–30 mm in diameter. **Leaves** green, simple, rarely auriculate, petiolate; lamina lanceolate, base attenuate, apex acuminate, margin entire, 40–160 x 5–25 mm, indumentum adaxially varies from glabrous or sparsely hirsute to densely hirsute with long appressed hairs, and abaxially from glabrous or sparsely hirsute to densely hirsute with long appressed hairs and with very short glandular hairs, margins sometimes ciliate with short or long hairs; petiole 20–110 mm long and 1–2 mm in diameter, rigid, erect, covered with long patent hairs; stipules subulate, adnate to petioles for half or two thirds of their length, 8–40 mm long and *ca.* 2 mm wide, hirsute. **Inflorescence:** scape 20–190 mm long, branched, bearing 2–6(–10) pseudo-umbellets with 4–15 flowers each; peduncles 20–130 mm long, 1–2 mm in diameter, green, hirsute with distally appressed curly hairs interspersed with glandular hairs and sometimes long patent hairs; bracts subulate, 4–11 mm long, 1–2 mm wide, adaxially and abaxially densely hirsute with distally appressed hairs. **Pedicel** *ca.* 0,5 mm long. **Hypanthium** (10–)15–44 mm long, covered with long glandular hairs and sometimes interspersed with appressed curly hairs or patent hairs. **Sepals** 5, lanceolate, apices attenuate, 6–12 mm long, 1–3 mm wide, green, posterior one erect, others reflexed, indumentum abaxially as on peduncle. **Petals** 5, cream-coloured, yellow, orange-pink or pale pink, claws forming a floral sheath, apices recurved during anthesis; posterior two

with wine-red feather-like markings, ligulate or narrowly spathulate, bases attenuate or narrowly cuneate, apices obtuse or rounded, 20--36 x 2--4 mm; anterior three with a wine-red stripe on the claws, ligulate or narrowly spathulate, bases attenuate, apices obtuse or rounded, 17,5--33 x 1--3 mm. **Stamens:** staminal column 1--2 mm long, white, smooth; perfect stamens 4--5, concealed within the floral sheath, posterior one 1,5--4 mm long, lateral two 2,5--5 mm long, anterior two 4--6 mm long, white; staminodes 1,5--2,5 mm long; anthers pink, posterior one sometimes lacking, when present usually smaller than the rest, (1-)1,5--2,5 mm long, pollen orange. **Gynoecium:** ovary 2--4 mm long; style 0,1--1 mm long, pale green; stigma branches 0,2--2 mm long, adaxially pale pink, abaxially pale green. **Fruit:** bases of mericarps 6--7 mm long, without glandular hairs, tails 31--33 mm long (Figure 8.17.1).

Diagnostic features and affinities

P. longiflorum, is as indicated by the specific epithet a species with very long flowers because of the very long and narrow petals. The four or five fertile stamens are very short and concealed in the floral sheath. This floral structure is similar to that of *P. attenuatum*, *P. angustipetalum*, *P. leptum*, *P. fergusoniae*, *P. undulatum* and *P. viciifolium*. All of these species have compound leaves whereas *P. longiflorum* has simple, lanceolate leaves.

The number of the fertile stamens in *P. longiflorum* varies between four and five. The posterior filament often lacks an anther and if the anther is present, it is usually smaller than the rest. A similar variation occurs in *P. echinatum* Curtis and *P. crassicaule* L'Hérit., both species of section *Cortusina* (DC.) Harv. (Marais 1981).

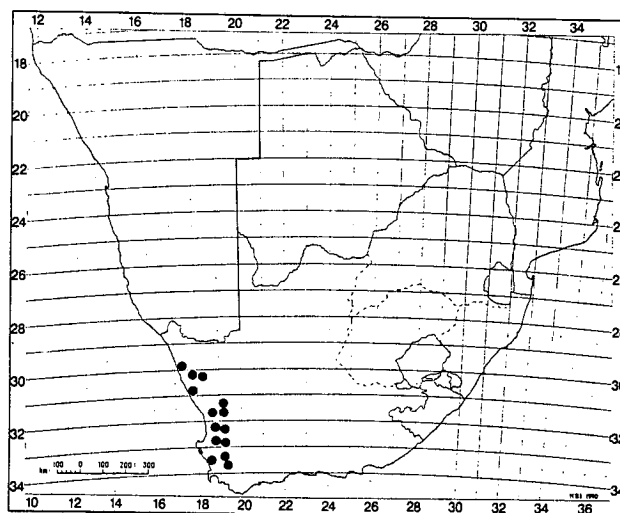


Figure 8.17.2 Geographical distribution of *P. longiflorum*.

Geographical distribution and ecology

P. longiflorum occurs along the west coast of the Cape Province, from Komaggas and Kamieskroon in the north to the vicinity of Darling in the south and Worcester in the east (Figure 8.17.2). This area is mainly a winter rainfall region, receiving an annual precipitation of 100–200 mm. Plants grow in mountain or arid fynbos, but are also found in strandveld vegetation, occurring in light shade under bushes or in direct sunlight. The occurrence of plants varies from single plants to large populations in sandy places, but also on stony clay hillsides. The peak of the flowering time is in October and November, but in some cases flowers were found as early as August or as late as March. At flowering time the leaves are usually still present.

Material studied

- 2917 (Springbok): Komaggas, farm Platvlei (-CD), *Le Roux* 2828 (STE).
- 3017 (Hondekliptbaai): 4,5 miles N of Kamieskroon (-BB), *Hardy & Bayliss* 1125 (PREx3); Kotzesrust, Namaqualand (-DD), *Acocks* 23399 (PREx2).
- 3018 (Kamiesberg): Krakkeelkraal (-AA), *Drège* 3240 (MO, P); Between Pedroskloof & Leliefontein (-AA), *Drège s.n.* (K, P, W); Leliefontein (-AC), *Adamson* 1565 (BOL, PRE); Kamiesberg (-AC), *Ecklon & Zeyher* 472 (G, K, MELx2, MO, Px2, PRE, Sx2, TCD, Wx2); *Zeyher* 73 (MEL); *Zeyher* 1244 (S).
- 3118 (Vanrhynsdorp): Windhoekberg near Klawer (-DA), *Leipoldt* 4093 (BOLx3, PRE); Vleikraal (-DA), *Schonken* 37 (STEU); *Walters* 3 (STEU); *Walters* 88 (PRE, STE).
- 3119 (Calvinia): Groenrivier & Onderbokkeveld (-AC), *Drège* 3238 (P); Groenrivier & Waterval (-AC), *Drège s.n.* (E, G, K, L, MO, P, S, W); Between Grasberg & Waterval (-AC), *Drège s.n.* (G, P); Nieuwoudtville (-AC), *Galpin* 11151 (K, PRE); Between Oorlogskloof & Papkuilsfontein (-AC), *Leipoldt* 3079 (BOL); Lokenburg (-CA), *Acocks* 18581 (K, PRE).
- 3218 (Clanwilliam): Ramskop (-BB), *Leipoldt* 517 (SAM); Melkboomfontein, on the banks of the Olifantsrivier (-BD), *Marais* 267 (STEU); Between Citrusdal & Clanwilliam (-BD), *Van der Walt* 1412 (STEU); Somergroen, S of Paleisheuwel (-DA), *Marais* 308 (STEU); Klipfontein, Driefontein & Bergvallei (-DA), *Zeyher* 173 (BM, G, Kx2, Px2, S, SAM, WU); Versveld Pass (-DC), *Drijfhout* 1813 (STEU); Rhinosterbosch, Piketberg (-DD), *Drège* 7495 (G, MEL, P).
- 3219 (Wuppertal): Pakhuis Pass (-AA), *Leipoldt* 519 (SAM); *Marais* 204b, 268 (STEU); 1 mile SW of Klein Pakhuis (-AA), *Nordenstam* 3431 (S); Algeria (-AC), *Le Maitre s.n.* (STEU); Dasklip road, 2 km on Grootfontein road (-CC), *Marais* 179, 182 (STEU).
- 3318 (Cape Town): Near Groot Post, Malmesbury (-BC), *Salter* 6462 (BOLx2); Groenkloof (-CB), *Zeyher s.n.* (P).

–3319 (Worcester): Tulbagh (-AC), *Esterhuysen 17487* (BOL); Farm De Heuvel, between Tulbagh & Ceres (-AC), *Jordaan 122* (STE); Nuwekloof Pass (-AC), *Marais 35* (STEU); Tulbaghkloof, Winterhoekberge, Vogelvlei (-AC), *Zeyher 173a* (G, W, Z); Worcester West (-CB), *Forrester s.n.* (NBG).

PROLIFERUM GROUP

Geophytes with heteroblastic leaf development. Lanceolate laminae vary from simple to pinnate or irregularly bipinnatisect. Scape branched, bearing 2--4 pseudo-umbellets with 2--7(-10) flowers each. Hypanthium short, 6--16 mm long. Flowers with white, yellow or pink, spatulate petals, with very large wine-red, nearly black markings; posterior petals 7--16 mm long. Stamens 5 fertile, much shorter than the sepals, concealed within the floral sheath. Tectum of pollen reticulate, luminae small.

8.18 *Pelargonium proliferum* (Burm. f.) Steud., *Nomenclator botanicus*, 2nd edn, 2: 289 (1841). TYPE - Cape: "Cap. Bon. Spei" (G, lecto.!, designated here).

Geranium proliferum Burm. f.: 51, n. 70 (1759); Burm. f.: 19 (1768); Cav.: 259, t. 120, f. 3 (1787); Thunb.: 116 (1800); Thunb.: 528 (1823). TYPE - Cape: "Cap. Bon. Spei" (G, lecto.!, designated here).

Geranium prolificum L. *proliferum* (Burm. f.) L.: 949 (1763).

Hoarea prolifera (Burm. f.) Eckl. & Zeyh.: 62 (1835).

Geranospermum proliferum (Burm. f.) Kuntze: 94 (1891).

Geranium ciliatum Cav.: 234, t. 118, f. 2 (1787); Thunb.: 113 (1800); Thunb.: 514 (1823); non Andr.: t. 247 (1802b). TYPE: *Thunberg s.n.* (MA, lecto.!, designated here).

Pelargonium ciliatum (Cav.) Pers.: 226 (1806); Spreng.: 50 (1826); non Jacq.: 195 (1791b); nec L'Hérit.: t. 7 (1792).

Pelargonium parnassioides DC.: 650 (1824); substitute name for *G. ciliatum* Cav.: 234, t. 118, f. 2 (1787); G. Don: 726 (1831); Steud.: 677 (1840); Steud.: 288 (1841).

Hoarea parnassioides (DC.) Eckl. & Zeyh.: 60 (1835).

Pelargonium longifolium (Burm. f.) Jacq. var. *parnassioides* (DC.) Knuth: 324 (1912).

Pelargonium tysonii Szyszyl.: 8 (1888); substitute name for *G. ciliatum* Cav.: 234, t. 118, f. 2 (1787); Knuth: 329 (1912); Leighton: t. 512 (1933).

Pelargonium barbatum Jacq.: 196 (1791b); Jacq.: 8, t. 513 (1792); Willd.: 648 (1800); Pers.: 227 (1806); Ait. f.: 164 (1812); DC.: 652 (1824); Spreng.: 53 (1826); Loudon: 570 (1829); G. Don: 728 (1831); Loudon: 271 (1832); Steud.: 283 (1841); Harv.: 267 (1860); Knuth: 338 (1912).
TYPE - "Ex Promontorio bonei Spei" (W, holo!).

Geranium laciniatum Andr.: t. 131 (1801a); Poir.: 750 (1812). ICONOTYPE: Andrews, The Botanist's Repository 2: t. 131 (1801a).

Pelargonium laciniatum (Andr.) Pers.: 228 (1806); Link: 182 (1822); DC.: 651 (1824); Spreng.: 52 (1826); Loudon: 568 (1829); G. Don: 726 (1831); Loudon: 271 (1832); Steud.: 287 (1841).

Hoarea laciniata (Andr.) Sweet: 75 (1826c).

Pelargonium longifolium (Burm. f.) Jacq. var. *laciniatum* (Andr.) Harv.: 262 (1860) p.p.; Knuth: 324 (1912).

Geranium laciniatum var. *flore purpureo* Andr.: t. 204 (1802a). ICONOTYPE: Andrews, The Botanist's Repository 3: t. 204 (1802a).

Pelargonium purpurascens Pers.: 227 (1806); substitute name for *G. laciniatum* var. *flore purpureo* Andr.: t. 204 (1802a); DC.: 652 (1824); Loudon: 570 (1829); G. Don: 727 (1831); Loudon: 272 (1832); Steud.: 228 (1841).

Geranium purpurascens (Pers.) Poir.: 757 (1812).

Hoarea purpurascens (Pers.) Sweet: 75 (1826c); Eckl. & Zeyh.: 62 (1835).

Geranium laciniatum var. *bicolor* Andr.: t. 269 (1802b). ICONOTYPE: Andrews, The Botanist's Repository 4: t. 269 (1802b).

Pelargonium penniforme Pers.: 227 (1806); substitute name for *G. laciniatum* var. *bicolor* Andr.: t. 269 (1802b); DC.: 652 (1824); Spreng.: 53 (1826); Loudon: 570 (1829); G. Don: 727 (1831); Loudon: 271 (1832); Steud.: 678 (1840); Steud.: 288 (1841); Harv.: 271 (1860).

Geranium penniforme (Pers.) Poir.: 757 (1812).

Hoarea penniformis (Pers.) Sweet: 75 (1826c); Eckl. & Zeyh.: 62 (1835).

Geranospermum penniforme (Pers.) Kuntze: 95 (1891).

Hoarea leana Sweet: t. 323 (1826b); Sweet: 75 (1826c). ICONOTYPE: Sweet, Geraniaceae 4: t. 323 (1826b).

Pelargonium leeanum (Sweet) G. Don: 727 (1831); Loudon: 271 (1832); Steud.: 287 (1841).

A geophyte 130--320 mm tall when in flower. **Tuber:** a turnip-shaped, elongated or sometimes moniliform root 10--30 mm long and 8--25 mm in diameter. **Leaves** vary from simple to irregularly pinnately or bipinnately incised, green, petiolate; lamina of simple leaves lanceolate to ovate, base attenuate to cuneate, apex acute, margin

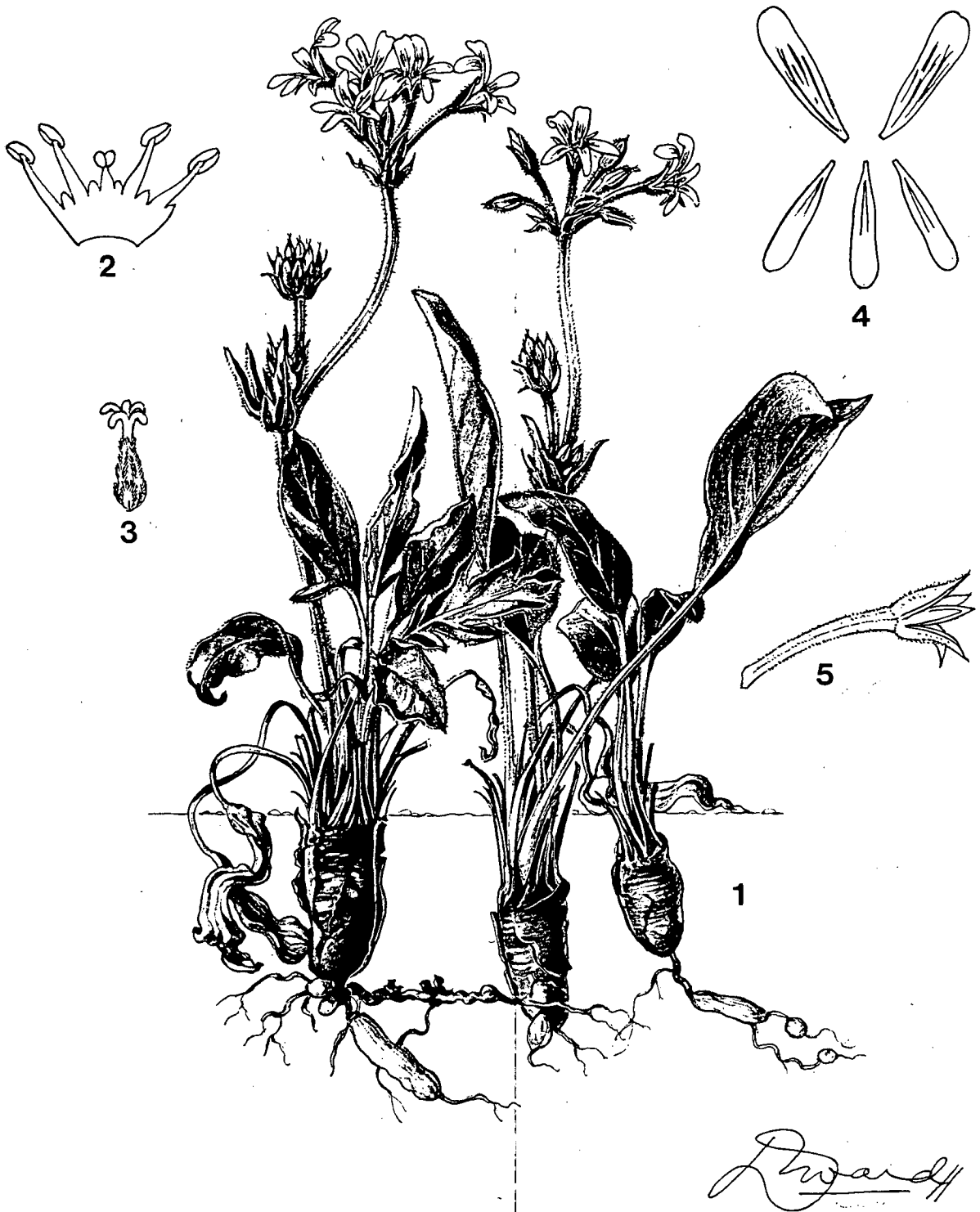


Figure 8.18.1 *Pelargonium proliferum*. 1, flowering plants x1; 2, androecium x4; 3, gynoecium x4; 4, petals x2; 5, hypanthium with sepals x2.

entire, 15--80 x 6--20 mm, lamina of compound leaves 15--80 mm long, pinnae 8--30 mm long, lacinate, segments 1--2 mm wide, glabrous to sparsely hirsute with appressed hairs, margins ciliate; petiole 15--45 mm long and 0,5--2 mm in diameter, rigid, erect, glabrous or hirsute with appressed hairs; stipules subulate, adnate to petioles for half their length, 10--25 mm long and 1--2 mm wide, membranous, ciliate. **Inflorescence:** scape 70--230 mm long, branched, bearing 2--4 pseudo-umbellets with 2--7(-9) flowers each; peduncles 20--80 mm long, 0,5--1 mm in diameter, indumentum varies from densely hirsute with appressed curly hairs interspersed with long glandular hairs to only glandular; bracts subulate, 3--9 mm long, 1--2 mm wide, abaxially hirsute interspersed with glandular hairs. **Pedicel** ca. 0,5 mm long. **Hypanthium** 6--12 mm long, green to reddish brown, densely covered with glandular hairs, sometimes also with appressed curly hairs. **Sepals** 5, posterior one usually triangular, others lanceolate, apices acute, 5--8,5 mm long, 1--4 mm wide, posterior one erect, others recurved, green to reddish brown with margins white, indumentum abaxially as on hypanthium,. **Petals** 5, white, cream-coloured, pale pink or pink, patent during anthesis, with apices recurved; posterior two usually with feather-like wine-red markings, sometimes with wine-red blotches in the centre, ligulate to spatulate, bases cuneate, apices rounded, truncate or emarginate, 8,5--15 x 2--4,2 mm; anterior three spatulate, bases attenuate, apices rounded, 8,5--14 x 1--3 mm. **Stamens:** staminal column 1--2 mm long, white; perfect stamens 5, concealed within the floral sheath, posterior one 2--4 mm long, lateral two 2,5--5 mm long, anterior two 2,5--5 mm long, white; staminodes 1--3 mm long; anthers dark pink, 1,2--2 mm long, pollen orange. **Gynoecium:** ovary 1,5--3 mm long; style 0,1--1 mm long, pink; stigma branches 0,3--1,3 mm long, pink. **Fruit:** bases of mericarps 4,5--6 mm long, without glandular hairs, tails 24--28 mm long. (Figure 8.18.1).

Diagnostic features and affinities

P. proliferum is a geophyte with very small white, cream-coloured, pale pink or pink flowers and short stamens. This floral structure is similar to that of *P. caledonicum* and *P. pilosellifolium*. All three species have small flowers with short stamens which are concealed in the flower sheath. *P. proliferum* usually has feather-like markings on the petals, or sometimes a wine-red blotch in the centre of the petals, whereas the other two species are known for the conspicuous dark markings on all the petals, giving them a wine-red appearance. The leaves of *P. proliferum* show a great diversity in form and incisions and vary from simple to deeply incised, a similar variation as in *P. longifolium*, hence the confusion that exists between the two

species. *P. longifolium* has also short stamens, but the linear-spathulate petals are long (posterior ones 15--23 mm) with prominent blotches in the centre.

The specific epithet *proliferum*, that is producing offsets, refers to the branching scape, producing several peduncles, each with a many-flowered pseudo-umbellet (Burman 1759).

Geographical distribution and ecology

P. proliferum occurs in the south-western Cape. The majority of specimens were collected on the south-western escarpment, but collections from the western and southern coastal plains are also known. It occurs from Nieuwoudtville and the Matsikamma Mountains in the north to Bredasdorp in the south and Garcia's Pass in the east (Figure 8.18.2). This is mainly a winter rainfall area receiving an annual precipitation of 200--600 mm. The plants are common in fynbos on sandstone, but they also occur in renosterveld on shale. Flowers occur throughout the year but the peak of the flowering time is from October to December.

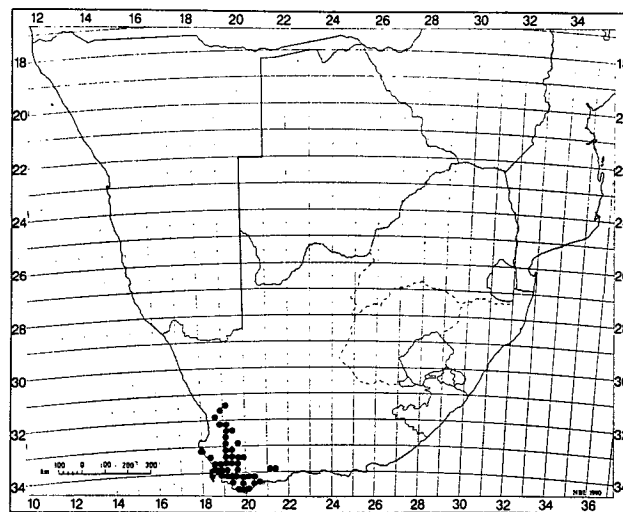


Figure 8.18.2 Geographical distribution of *P. proliferum*.

Material studied

- 3118 (Vanrhynsdorp): Matsikammaberg, N of Die Vlei (-DB), *Snijman 960* (NBG); Giftberg (-DC), *Esterhuysen 21961* (BOL, K, PRE).
- 3119 (Calvinia): Grasberg near Nieuwoudtville (-AC), *Lavranos & Bleck 20884* (STEU).
- 3218 (Clanwilliam): Clanwilliam (-BB), *Edwards s.n.* (BOL).

--3219 (Wuppertal): Heuningvlei (-AA), *Esterhuysen 15015* (BOL); Pakhuis Pass (-AA), *Nordenstam 3446* (S, STE); Middelberg, Cederberge (-AC), *Compton 12735* (NBG); *Esterhuysen 7266* (BOL); *Kerfoot 6154* (NBG); Tafelberg, Cederberge (-AC), *Esterhuysen 18166* (BOL, PRE); Top of Uitkyk Pass, Cederberge (-AC); *Esterhuysen 18172* (BOL, K, NBG); Cederberge (-AC), *Thode A2147* (PRE); Between Ezelsbank & Dwarsrivier (-AD), *Drège s.n.* (K); Olifantsrivier, Matjiesfontein (-AD), *Sonder s.n.* (MEL); Kromrivierkloof, Cederberge (-CA), *Esterhuysen 18016* (BOL, PRE); Top of Dasklippas (-CC), *Marais 86* (STEU); *Van der Walt 1427, 1507* (STEU); Thee river, Olifantsrivier Mountains (-DC), *Esterhuysen 15310* (BOL, K).

--3317 (Saldanha): Dunes at Saldanha Bay (-BB), *Ecklon & Zehyer 477* (P, Sx2, SAM).

--3318 (Cape Town): Darling Flora Reserve (-AD), *Rycroft 1917* (NBG); Lion's Head (-CD), *Alexander s.n.* (TCD); *Compton 12556* (NBG); *Ecklon s.n.* (MEL, SAM); *Ecklon & Zehyer 466* (S, SAM); *Garside 1755* (K); *Lavranos 3781* (PRE); *Leighton 720* (BOL); *MacOwan 1811* (BM, G, K, P, UPS, Z); *Marloth 387* (PRE); Lion's Rump (-CD), *Pappe s.n.* (K); *Salter 6537* (BOL); Lion's Back (-CD), *Salter 6450* (BOL); Table Mountain (-CD), *Brain 5993* (SRGH); *Ecklon 599* (K, MO, W, Z); *Ecklon 601* (BM, E, G, K, MO, P, PRE, Wx3); *Ecklon s.n.* (P); *Ecklon & Zeyher 479* (Sx4, SAM); *Kitching s.n.* (K); *Tyson 2365* (NBG); Blinkwater, Camps Bay (-CD), *Cassidy 89* (NBG); Camps Bay (-CD), *Marloth 7705a* (PRE); Signal Hill (-CD), *Dümmer 848* (E); *Van der Walt 483, 659* (STEU); Kloofnek (-CD), *Marloth s.n.* (PRE); Slopes near Platteklip (-CD), *Marloth 8778b* (PRE); Green Point (-CD), *Pappe s.n.* (S); *Prior s.n.* (K, PRE, Z); Sea Point (-CD), *Wolley-Dod 3677* (BOL, K); Devil's Peak (-CD), *Szyszyłowics 1128* (Z); Kalabaskraal (-DA), *Bolus s.n.* (STE); Paarl (-DB), *Compton 17985* (BOL, NBG); *Drège s.n.* (P); *Prior s.n.* (K); Paarlberg (-DB), *Drège 7494a* (TCD); *Prior s.n.* (K, PRE, Z); Modderkloof, Paardeberg (-DB), *Fellingham 16* (PRE, STE); Kraaifontein (-DC), *Acocks 4345* (S); Annandale (-DC), *Rantanen s.n.* (Z); Between Paarl road and Muldersvlei (-DD), *Acocks 4398* (S); Bottelary road, 8 km from Stellenbosch (-DD), *Acocks 4359* (S); Stellenbosch flats (-DD), *Bos 46* (STE); *Duthie 442, s.n.* (BOL); *Eyles 6553* (SRGH); *Marais 369* (STEU); *Smith 4200A* (PRE); Jan Marais Nature Reserve, Stellenbosch (-DD), *Van der Walt 546* (STEU); Stellenboschberg (-DD), *Van der Walt s.n.* (STEU); Banhoek, Stellenbosch (-DD), *Martley s.n.* (BOL); *Vorster 2767* (STEU); Simonsberg, N slope (-DD), *Buys s.n.* (STEU); Jonkershoek (-DD), *Compton 15351* (NBG); *Garside 1172* (K); *Kruger 87* (STE); *Levyns 7350* (BOL); *Taylor 4381* (PRE, STE); *Taylor 5581* (K, PRE); *Van der Merwe 4231* (PRE, STE); *Walgate 1001* (BOL); Between Franschhoek & Paarl (-DD), *Drège s.n.* (BOL, E, G, K, MEL, MO, OXF, P, S, W); Bergrivier near Paarl (-DD), *Drège s.n.* (L, P, W); Devil's Tooth, Groot Drakenstein (-DD), *Esterhuysen 24015* (BOL, K, PRE); Klein Welmoed, Eersterivier valley (-DD), *Pillans 9972* (BOL).

--3319 (Worcester): Between Driebos & Langvlei (-AA), *Van der Walt 1085, 1086* (STEU); Zuurvlakte (-AA), *Van der Walt 1425* (STEU); Groot Winterhoek Forest Reserve (-AA), *Van der Walt s.n.* (STEU); Hansiesberg (-AB), *Henderson 2201* (NBG); Gydo (-AB), *Leipoldt s.n.* (BOL); *Muller 4037* (STEU); Agter-Witzenberg (-AB), *Marais 44* (STEU); Op Die Berg (-AB), *Marais 190* (STEU); Waterfall, Tulbagh (-AC), *Ecklon & Zeyher 458* (S); *Ecklon & Zeyher 464* (Lx2, Wx2);

Kruger 905 (STE); *Tulbagh* (-AC), *Ecklon & Zeyher 475* (SAM); *Esterhuysen 16899* (BOL); Near Romansrivier (-AC), *Leighton 2195* (BOL); *Steinthal* (-AC), *Pappe 7* (TCD); Ceres road (-AC), *Schlechter 2118* (PRE); 10 km W of Kluitjieskraal (-AC), *Van der Walt 651* (STEU); Bergplaas (-AC), *Van der Walt 931* (STEU); Ceres (-AD); *Cillié s.n.* (STEU); 2 km N of Ceres (-AD), *Cillié s.n. sub. STEU 3368, 3461* (STEU); Prince Alfred Hamlet (-AD), *Oliver 5905* (PRE, STE); Orchard (-BC), *Esterhuysen 10934* (BOL); Sandfontein (-BD), *Esterhuysen 27202* (PRE); Stangenheuwel, Franschoek, Donkerhoek (-CA), *Drège s.n.* (CGE, E, G, K, P, PRE, S, TCD, W); Bainskloof (-CA), *Schlechter 9143* (BM, BOL, E, K, MO, P, PREx2, S, W, Z); *Schlechter 9193* (Gx3); Lategan Farm (-CA); *Walters 894* (NBG); Rawsonville (-CB), *Louw 3600* (PU); Worcester shooting Range (-CB), *Marais 341* (STEU); SE of Brandvleidam (-CB), *Van Zyl s.n.* (STEU); Chavonnes Station veld (-CB), *Walters 1710* (NBG); Wysersdrift, Goudini (-CB), *Walters 1887* (NBG); Groenvlei (-CB), *Walters 2557* (NBG); Drakenstein (-CC), *Leipoldt s.n.* (BOL); Franschoek (-CC), *Phillips 1062* (SAM); Wemmershoek (-CC), *Salter 6501* (BOL); 20 km from Villiersdorp to Franschoek (-CC), *Van Wyk 1958* (PRE); Naudesberg (-DA); *Barker 9128* (NBG); Sand Hills (-DA), *Van der Walt s.n.* (STEU); Between Franschoek & Zonder-einde River bridge (-DC), *Salter 4977* (BOL); Jonaskop (-DC), *Thompson 1433* (STE).

--3321 (Ladismith): *Garcia's Pass* (-CC), *Marais 166* (STEU); Langkloof, near Garcia's Pass (-CD), *McDonald 1096, 1097* (STEU).

--3418 (Simonstown): *Victoria Drive, near Oudekraal* (-AB), *Acocks 1082* (S); Wynberg Hill (-AB), *Bolus 17191* (BOL); *Faure* (-BA), *Bolus 22912* (BOL); *Oliver 5902* (STE, STEU); Gordon's Bay (-BB), *Bolus s.n.* (BOL); Hottentotsholland Mountains (-BB), *Ecklon & Zeyher 470* (G, K, Lx2, MEL, P, Sx2, SAM, W); Sir Lowry's Pass (-BB), *Hafström s.n.* (S); Helderberg (-BB), *Marais 290, 291* (STEU); Between Somerset-West, Sneekop & Landroskop (-BB), *Stokoe SAM53963* (SAM); Hottentotsholland (-BB), *Verreaux s.n.* (G); *Zeyher 83* (MEL).

--3419 (Caledon): *Elgin* (-AA), *Leighton 813* (BOL); *Lewis 1766* (SAM); Houw Hoek Pass (-AA), *Werdermann & Oberdieck 685* (PRE); Theewaterkloof Dam (-AB), *Perry 1218, 1219* (NBG); Stanford (-AD), *Schlechter 10428* (BM, G, Kx2, PRE, Z); Greyton (-BA), *Gillett 869* (BOL); Genadendal (-BA), *Van der Walt 1093* (STEU); Riviersonderend (-BB), *Esterhuysen 4313* (BOL, PRE); Dasberg, near Stormsvlei (-BB), *Stokoe SAM63202* (SAM); Skurfkop, Napier (-BD), *Jordaan 893* (STE); Ratelrivier flats (-DA), *Lewis 5246* (NBG); Groot Hagelkraal (-DA), *Oliver 6124* (PRE, STE); Elim (-DA), *Schlechter 7688* (PRE); 15 km from Bredasdorp to Heuningrug (-DB), *Fischer 285* (STEU).

--3420 (Bredasdorp): 5 km E of Brakfontein, Riviersonderend (-AA), *Fischer 302* (STEU); Knoblauch farm (-AA), *Fischer 311* (STEU); Bosheuwel (-AA), *Van Breda 519* (PRE); Swellendam (-AB), *Marloth 8461* (PRE); Halfway between Bredasdorp & Malgas (-AD); *Esterhuysen 4338* (BOL); De Hoop-Potberg Nature Reserve (-BC), *Burgers 1796* (PRE, STE); S of Hammerkop, Potberg Estates (-BC), *Thompson 1106* (STE); Potberg (-BC), *Van der Walt 1428* (STEU); Bredasdorp (-CA), *Bolus 20524* (BOL).



Figure 8.19.1 *Pelargonium pilosellifolium*. 1, flowering plant x1; 2, petals x2; 3, gynoecium x5; 4, androecium x4.

8.19 Pelargonium pilosellifolium (Eckl. & Zeyh.) Steud., Nomenclator botanicus, 2nd edn, 2: 288 (1841), (as "*pilosellaefolium*"). TYPE - Cape Province: ". . . In collibus apud villam 'Puspasvalley' prope 'Zwellendam', Ecklon & Zeyher 469 (S, lecto!, designated here, G!, K!, Lx3!, MEL!, MO!, OXF!, P!, S!, SAM!, Wx2!).

Hoarea pilosellaefolia Eckl. & Zeyh.: 61 (1835). TYPE - Cape Province: ". . . In collibus apud villam 'Puspasvalley' prope 'Zwellendam', Ecklon & Zeyher 469 (S, lecto!, designated here, G!, K!, Lx3!, MEL!, MO!, OXF!, P!, S!, SAM!, Wx2!).

A geophyte 150--320 mm tall when in flower. **Tuber:** a turnip-shaped, elongated or sometimes moniliform root 15--55 mm long and 10--30 mm in diameter. **Leaves** green or glaucous, petiolate; lamina usually simple, lanceolate, adaxially concave, base narrowly cuneate, apex acute, 30--100 x 13--23 mm, sometimes pinnatisect to pinnate, pinnae 8--25 mm long, 1--1,5 mm wide, usually glabrous, margins ciliate with long stiff appressed hairs; petiole 10--60 mm long and 2 mm in diameter, rigid, erect, hirsute with appressed hairs; stipules subulate, adnate to petioles for one third to half of their length, 15--25 mm long and 1--2 mm wide, membranous, ciliate. **Inflorescence:** scape 90--250 mm long, branched, bearing 2--3(-5) pseudo-umbellets with 5--7(-10) flowers each; peduncles 30--70 mm long, 1--1,5 mm in diameter, indumentum varies from densely hirsute with appressed curly hairs interspersed with long glandular hairs and long soft patent hairs to only glandular interspersed with long soft hairs; bracts subulate, 3--13 mm long, 1--2 mm wide, abaxially densely hirsute with long appressed hairs. **Pedicel** ca. 0,5 mm long. **Hypanthium** 8--13 mm long, reddish brown to wine-red, densely covered with long glandular hairs, sometimes also with appressed curly hairs. **Sepals** 5, posterior one usually triangular, others lanceolate, apices mucronate, 5,5--7,5 mm long, 1--4 mm wide, posterior one erect, others recurved, reddish brown or wine-red with margins white to pink, indumentum abaxially as on hypanthium,. **Petals** 5, white, pale pink or pink with conspicuous and extensive wine-red markings in the centre, leaving only a narrow pink margin, patent during anthesis; posterior two ligulate or narrowly spatulate, bases white, cuneate, apices rounded, truncate or emarginate, 8,5--12 x 2--3 mm; anterior three narrowly spatulate, bases attenuate, apices rounded, 9--13,5 x 1,2--2 mm. **Stamens:** staminal column 1--2,5 mm long, white; perfect stamens 5, concealed within the floral sheath, posterior one 3--4 mm long, lateral two 3,5--5 mm long, anterior two 3,5--5 mm long, white; staminodes 1,5--3 mm long; anthers dark pink, 1,5--1,8 mm long, pollen orange. **Gynoecium:** ovary 2--3,5 mm long; style 0,2--0,5 mm long,

dark pink; stigma branches 0,5--1 mm long, dark pink. **Fruit:** bases of mericarps 6 mm long, without glandular hairs, tails 28--32 mm long. (Figure 8.19.1).

Diagnostic features and affinities

P. pilosellifolium is a geophyte with small wine-red flowers and lanceolate, glaucous leaves. The leaves are usually glabrous but ciliate with long distally appressed hairs. The epithet *pilosellifolium*, derived from *pilosus*, that is hairy with distinct long ascending hairs, refers to the hairs on the margins of the leaves. The flowers are small with ligulate to narrowly spatulate petals with conspicuous wine-red markings, and the stamens are short and concealed in the floral sheath. This floral structure is similar to that of *P. proliferum* and *P. caledonicum*. The flower colour of *P. pilosellifolium* is similar to that of *P. caledonicum*, a species with deeply incised leaves, but differs from that of *P. proliferum* which has white to pink flowers with usually feather-like markings on the petals.

Geographical distribution and ecology

P. pilosellifolium occurs in the southern Cape, from Keeromsberg and Genadendal in the west to Avontuur in the east (Figure 8.19.2). To the west it is mainly a winter rainfall region, but to the east rain occurs throughout the year. The annual precipitation varies between 200 and 400 mm. *P. pilosellifolium* occurs in fynbos on sandstone or the shale-sandstone boundaries. It is also recorded from seasonally moist sandy flats. The peak of the flowering time is in October to December, but flowers may be found as late as February and March.

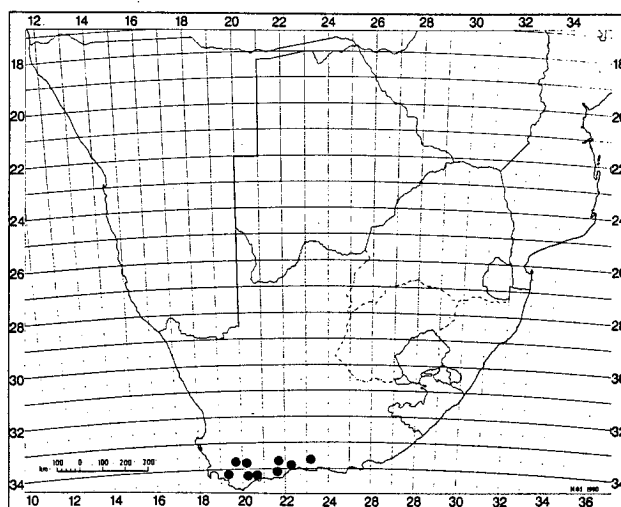


Figure 8.19.2 Geographical distribution of *P. pilosellifolium*.



Figure 8.20.1 *Pelargonium caledonicum*. 1, flowering plant x1; 2, petals x2; 3, androecium x4; 4, gynoecium x4; 5, leaf base x2.

Material studied

- 3319 (Worcester): Keeromsberg (-DA), *Marais 344* (STEU).
- 3320 (Montagu): NW of Brakleegte, Oubergpas (-CA), *Bayer 2661* (NBG); 13,5 km from Bonnievale to Drew (-CC), *Bayer 3269* (NBG).
- 3321 (Ladismith): Rooiberg, E of Boschrivier (-DA), *Thompson 3556* (STE).
- 3322 (Oudtshoorn): Robertson Pass (-CC), *Hops 4* (BOL); 20 km NW of George to Outeniqua Pass (-CD), *Schonken 201* (STEU).
- 3323 (Willowmore): Sondagsberg, Avontuur (-CA), *Fischer 354, 365* (STEU).
- 3419 (Caledon): Near Uitkyk, Genadendal (-AB), *Van der Walt 1105* (STEU).
- 3420 (Bredasdorp): Stormsvlei (-AA), *Fischer 293* (STEU); Voorhuis, W of Swellendam (-AB), *Bayer 2954* (NBG); Puspas Valley, Swellendam (-AB), *Ecklon & Zehyer 469* (G, K, Lx3, MEL, MO, OXF, P, Sx2, SAM, Wx2); National Bontebok Park (-AB), *Grobler 559* (STE); *Liebenberg 7210* (PRE); 30 km SW of Swellendam, on road to Bredasdorp (-AC), *Lavrano 20911* (STEU); Zuurbraak (-BA), *Thode A2300* (PRE); S tip of Potberg, farm Elandspad (-BC), *Burrows 1051* (NBG).
- 3421 (Riversdale): 4 miles W of Albertinia (-BA), *Acocks 23091* (K).

8.20 *Pelargonium caledonicum* L. Bol. in South African gardening and country life 22: 229, 232 (1932); Van der Walt & Vorster: 21, fig. (1981a). TYPE - Cape Province: ". . . on hillslopes between Caledon and the Hot Bath", *L. Bolus s.n. sub BOL19176* (BOL, lecto!, BOLx2!, Kx2!, PRE!)

A geophyte 130--210 mm tall when in flower. **Tuber:** a turnip-shaped, elongated or sometimes moniliform root 10--50 mm long and 8--25 mm in diameter. **Leaves** greyish green, petiolate; lamina varies from simple to pinnate or bipinnatisect, ovate to narrowly ovate in outline, 40--80 x 15--30 mm, pinnae 8--25 mm long, sometimes lacinate, segments adaxially concave, apices mucronate, 1--1,5 mm wide, densely hirsute with long stiff appressed hairs; petiole 40--85 mm long and 1--1,5 mm in diameter, rigid, erect, hirsute with appressed hairs; stipules subulate, adnate to petioles for half or two thirds of their length, 15--40 mm long and 1--1,5 mm wide, membranous, ciliate. **Inflorescence:** scape 25--120 mm long, branched, bearing 2--3 pseudo-umbellets with 2--7 flowers each; peduncles 25--70 mm long, 0,5--1 mm in diameter, densely hirsute with appressed curly hairs interspersed with long glandular hairs and long soft patent hairs; bracts subulate, 4--5 mm long, 1 mm wide, abaxially densely hirsute with appressed hairs. **Pedicel** ca. 0,5 mm long. **Hypanthium** 6--16 mm long, reddish brown to wine-red, hirsute with appressed hairs interspersed with

long glandular hairs. **Sepals** 5, posterior one usually triangular, others lanceolate, apices mucronate, 5--8 mm long, 1--3,2 mm wide, posterior one erect, others recurved, reddish brown or wine-red with margins white to pink, indumentum abaxially as on hypanthium,. **Petals** 5, pink or pale pink with conspicuous and extensive wine-red markings in the centre, sometimes leaving only a narrow pink margin, patent during anthesis; posterior two ligulate or narrowly spathulate, bases cuneate, apices rounded, truncate or emarginate, 7--16 x 2,2--4 mm; anterior three narrowly spathulate, bases attenuate, apices rounded, 7--15 x 1,5--2 mm. **Stamens:** staminal column 1--2 mm long, white; perfect stamens 5, concealed within the floral sheath, posterior one 1,5--4 mm long, lateral two 2--4,5 mm long, anterior two 2--5 mm long, white; staminodes 1,5--3 mm long; anthers dark pink, 1,2--2 mm long, pollen orange. **Gynoecium:** ovary 2--2,8 mm long; style 0,5 mm long, dark pink; stigma branches 0,8--1,5 mm long, dark pink. **Fruit:** bases of mericarps 5--7 mm long, without glandular hairs, tails 22--26 mm long. (Figure 8.20.1).

Diagnostic features and affinities

P. caledonicum is a small geophyte with pinnate to bipinnatisect leaves. Juvenile leaves are usually simple, but the older ones are deeply incised and both types are densely covered with appressed hairs, hence the greyish green colour. The flowers are small with ligulate to narrowly spathulate petals with conspicuous wine-red markings, and the stamens are short and concealed in the floral sheath. This floral structure is similar to that of *P. proliferum* and *P. pilosellifolium*.

Geographical distribution and ecology

So far *P. caledonicum* is only known from a small area around Caledon in the southwestern Cape (Figure 8.20.2), hence the specific epithet. It was first collected in 1930 and since then only a few collections were made, all within a radius of 50 km around Caledon. This is a winter rainfall area with an annual precipitation of 400--600 mm. *P. caledonicum* grows in fynbos, but it was also collected in renosterveld on shale. Occasional plants occur in direct sunlight and flower in summer from December to January when the leaves are dying back.

Material studied

--3419 (Caledon): Zwartberg near Caledon Baths (-AB), *Bolus s.n.* (BOL19176) (BOLx3, Kx2, PRE); *Bolus s.n.* (BOL19176, BOL19179) (BOL); Caledon Botanic Garden (-AB), *Fischer 254* (STEU); *Van*

der Walt s.n. (STEU); Shaw's Mountain Pass (-AD), *Grobbelaar 2230* (PRE); Drayton Siding (-BA), *Strauss 96* (NBG); Boesmanskloof E of Greyton (-BA), *Vorster s.n.* (STEU); 45 km from Caledon to Bredasdorp (-BC), *Fischer 268* (STEU).

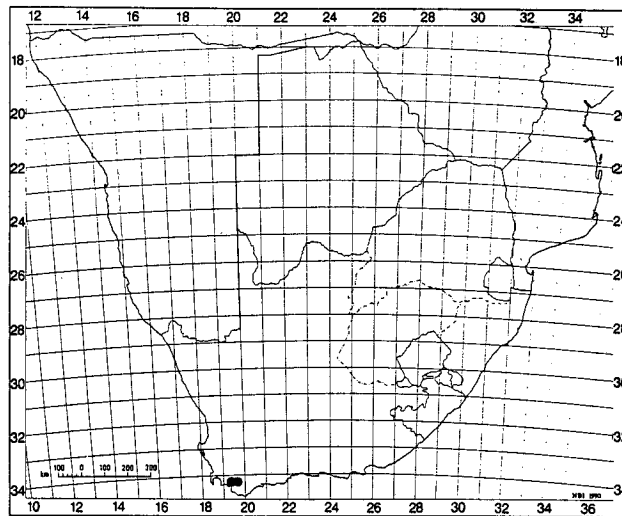


Figure 8.20.2 Geographical distribution of *P. caledonicum*.

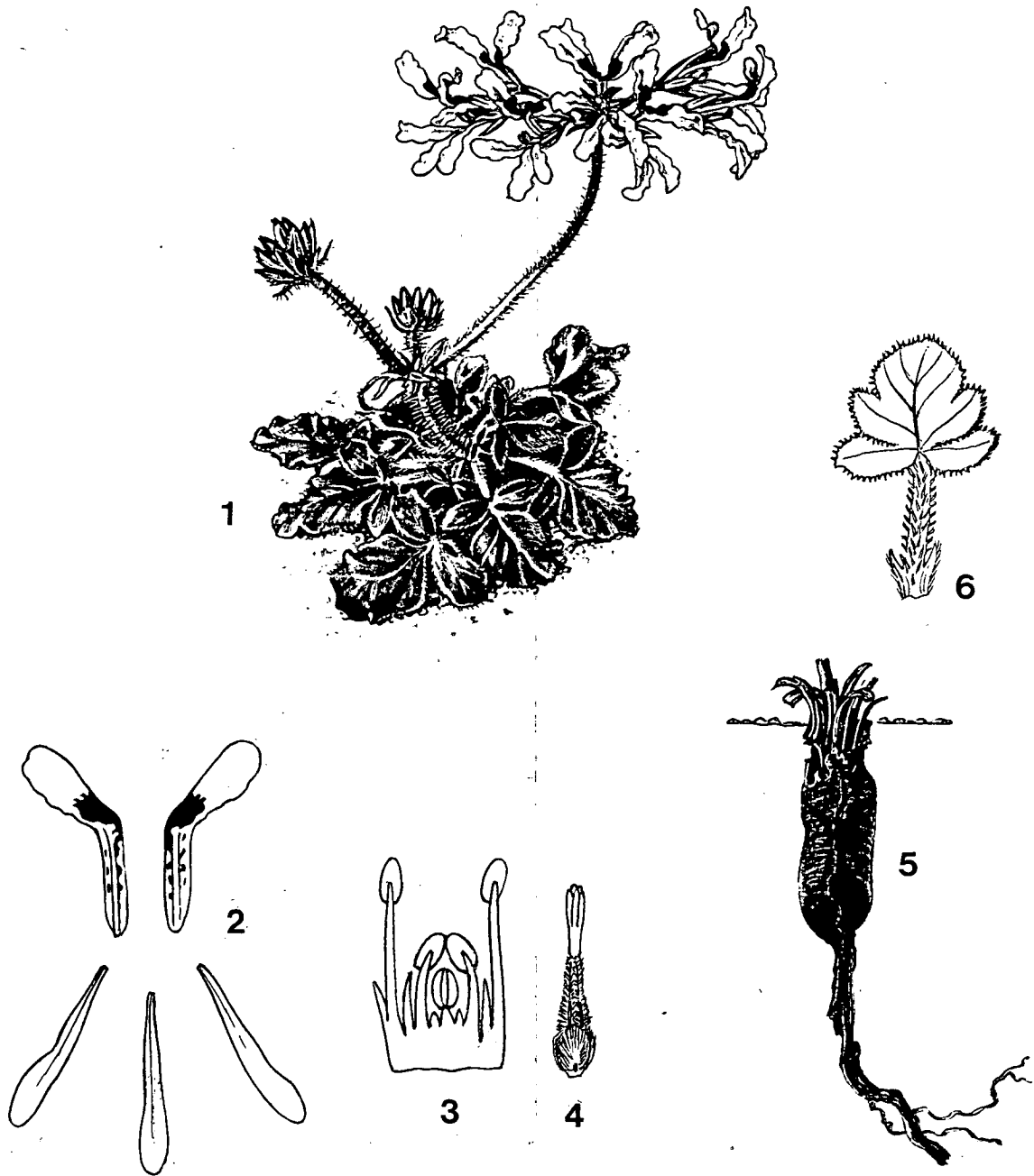
HETEROPHYLLUM GROUP

Geophytes with simple, trilobate or trifoliolate or pinnate, ovate or trullate, leaves, with prostrate or erect petioles. Scape branched, bearing 2--6 pseudo-umbellets with 3--14(-20) flowers each. Hypanthium short, 9--19(-32) mm long. Flowers with white, cream-coloured, pale yellow or pink, ligulate petals with red lines or prominent dark blotches on the posterior two, posterior two petals slightly curved, margins undulate. Stamens 5 fertile, posterior one very short, lateral and anterior stamens more or less the same length as the sepals. Tectum of pollen striate.

8.21 *Pelargonium heterophyllum* Jacq., *Collectanea* 4: 197 (1791b); Jacq.: 9, t. 516 (1792); Willd.: 646 (1800); Pers.: 227 (1806); DC.: 651 (1824); Spreng.: 52 (1826); G. Don: 729 (1831); Steud.: 286 (1841); Harv.: 265 (1860); Knuth: 336 (1912). TYPE - "Ex Promontorio bonae Spei" (W, holo!).

Geranium heterophyllum (Jacq.) Poir.: 746 (1812); non Thunb.: 113 (1800); nec Andr.: C. ic (1805b).

Geranospermum heterophyllum (Jacq.) Kuntze: 95 (1891).



R. S. H.
1875

273 PELARGONIUM

Figure 8.21.1 *Pelargonium heterophyllum*. 1, flowering plant x1; 2, petals x1,5; 3, androecium x4; 4, gynoecium x5; 5, tuber x1; 6, leaf x2.

Geranium pilosum Cav.: 273 (1788a); Poir.: 745 (1812); non Andr.: t. 259 (1802b). ICONOTYPE: Cavanilles, Monadelphiae classis dissertationes decem 6: t. 199 (1788b).

Pelargonium pilosum (Cav.) Steud.: 679 (1840); non F.G. Dietr.: 69 (1806), nec Pers.: 227 (1806).

Pelargonium hirtum Willd.: 644 (1800): substitute name for *Geranium pilosum* Cav.: 273 (1788a); Pers. 226 (1806); Steud.: 286 (1841); non (Burm. f.) Jacq.: t. 536 (1792).

Pelargonium cavanillesii Knuth: 332 (1912): substitute name for *Geranium pilosum* Cav.: 273 (1788a).

Pelargonium ciliatum L'Hérit.: t. 7 (1792); Willd.: 643 (1800); Ait. f.: 159 (1812); Link: 186 (1822); DC.: 650 (1824); Loudon: 568 (1829); G. Don: 726 (1831); Loudon: 271 (1832); Steud.: 284 (1841); non Jacq.: 195 (1791b). ICONOTYPE: L'Héritier, Geranologia: t. 7 (1792).

Hoarea ciliata (L'Hérit.) Sweet: 76 (1826c).

Pelargonium longifolium (Burm. f.) Jacq. var. *ciliatum* (L'Hérit.) Harv.: 262 (1860); Knuth: 324 (1912).

Geranium oxalidifolium Andr.: t. 300 (1803b); Poir.: 757 (1812). ICONOTYPE: Andrews, The Botanist's Repository 5: t. 300 (1803b).

Pelargonium oxalidifolium (Andr.) Pers.: 227 (1806); Ait. f.: 162 (1812); DC.: 651 (1824); Spreng.: 52 (1826); Loudon: 568 (1829); G. Don: 729 (1831); Loudon: 271 (1832) Steud.: 679 (1840); Steud.: 288 (1841); Harv.: 266 (1860).

Dimacria oxalidifolia (Andr.) Sweet: 77 (1826c).

Geranospermum oxalidifolium (Andr.) Kuntze: 95 (1891).

A geophyte 70--170 mm tall when in flower. **Tuber:** a turnip-shaped root 10--25 mm long and 12--25 mm in diameter. **Leaves** simple, trilobate or trifoliolate, bright green, petiolate; lamina (or main pinna) ovate or trullate, base cuneate, apex obtuse, margin entire, 8--25 x 6--25 mm; small lateral pinnae ovate, 8--10 x 5--7 mm, adaxially glabrous or covered with short glandular hairs, abaxially glabrous or setose along the veins, margins with short appressed clavate bristle-like hairs; petiole 4--30 mm long and 1--3 mm in diameter, prostrate, covered with short glandular hairs interspersed with bristles or clavate hairs; stipules subulate or lanceolate, adnate to petioles for less than one third of their length, 4--10 mm long and 2--3 mm wide, ciliate. **Inflorescence:** scape 10--50 mm long and 1,5--2 mm in diameter, branched, bearing 2--6(-8) pseudo-umbellets with 4--9(-11) flowers each; peduncles 40--150 mm long, 1--1,5 mm in diameter, covered with short glandular hairs interspersed with patent bristles; bracts narrowly triangular, 2--5 mm long, 1--2 mm wide, adaxially hirsute, abaxially setose with distally appressed bristles. **Pedicel** ca. 0,5 mm long.

Hypanthium 9--15 mm long, pale reddish-brown, indumentum as on peduncle and sometimes with appressed curly hairs. **Sepals** 5, lanceolate, apices acute, 6--8 mm long, 1--2,5 mm wide, patent, green, abaxially covered with short glandular hairs interspersed with short patent bristles. **Petals** 5, white or cream-coloured with undulate margins, claws patent during anthesis forming a floral sheath; posterior two with a prominent black blotch in the centre, ligulate, laterally curved, bases cuneate, apices rounded or emarginate, laterally recurved, 17--22 x 2,5--4,5 mm; anterior three narrowly spatulate, bases attenuate, apices rounded, 15--20,5 x 2--3,5 mm. **Stamens**: staminal column 1--2 mm long, white; perfect stamens 5, concealed in floral sheath, posterior one 1,5--3 mm long, lateral two 2,5--5,5 mm long, curved upwards, anterior two 4,5--7 mm long, curved upwards, white; staminodes 1,5--2,5 mm long; anthers pale pink, 1,5--2 mm long, pollen almost white. **Gynoecium**: ovary 2--4 mm long; style 0,5--1,5 mm long, pink; stigma branches 0,5--1,5 mm long, pink. **Fruit**: not seen (Figure 8.21.1).

Diagnostic features and affinities

P. heterophyllum is a small attractive species with white or cream-coloured flowers with large prominent black blotches in the centre of the posterior petals. The claws of the petals form a sheath in which the stamens are concealed, and the apices of the posterior petals are laterally recurved. The posterior stamen is usually much shorter than the lateral and anterior ones. This structure of the androecium is similar to that of *P. tenellum* and *P. trifoliolatum*. The small simple or trifoliolate prostrate leaves with appressed bristles along the margins, are similar to that of *P. tenellum* and *P. chelidonium*. However, the floral structure of *P. chelidonium* differs from that of *P. heterophyllum* and *P. tenellum*. The specific epithet *heterophyllum* refers to the variation that occurs in the leaf form.

Geographical distribution and ecology

P. heterophyllum is known from a small distribution area in the vicinity of Darling about 60 km north of Cape Town (Figure 8.21.2). This area receives an annual rainfall of 300--400 mm, which occurs mainly during the winter months. *P. heterophyllum* occurs in renosterveld in stony sand, on flats or lower hillsides or in marginal coastal fynbos in gravel. It flowers in October and November, after the leaves have died.

Material studied

–3318 (Cape Town): Near Darling (-AD), *Johns s.n.* (NBG); Contreberg farm, near Darling (-AD), *Marais 33* (STEU); Oude Post, near Darling (-AD), *Van der Walt 1041* (STEU); Near Oude Post Hotel, Malmesbury (-BC), *Acocks 15234* (PRE); Groenekloof (-CB), *Pappe s.n.* (SAM); *Zeyher 171* (E, Gx2, K, MEL, Px2, PRE, S, SAM, W, WU, Z).

Without exact locality: *Sonder s.n.* (TCD); *Anon* (W, type); *Ryder 19992* (BOL, K).

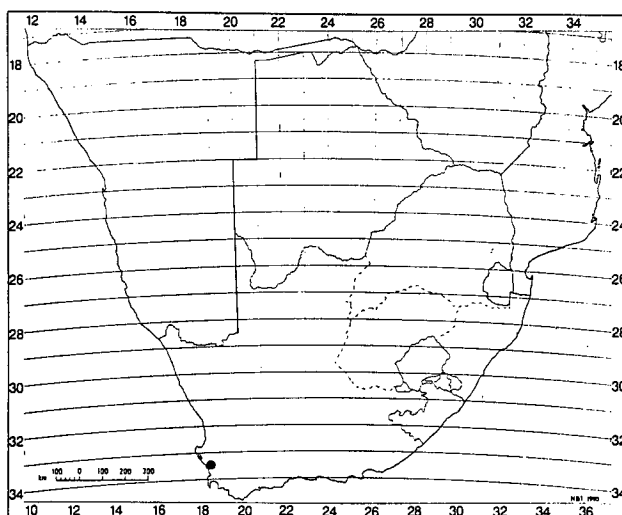


Figure 8.21.2 Geographical distribution of *P. heterophyllum*

8.22 *Pelargonium tenellum* (Andr.) G. Don, A general system of gardening and botany 1: 729 (1831); Loudon: 272 (1832); Steud.: 679 (1840). ICONOTYPE: Andrews, *Geraniums*: C, ic (1820).

Geranium tenellum Andr.: C, ic (1820). ICONOTYPE: Andrews, *Geraniums*: C, ic (1820).

Dimacria tenella (Andr.) Sweet: 77 (1826c).

A geophyte 70--200 mm tall when in flower. **Tuber:** a turnip-shaped root 25--40 mm long and 15--35 mm in diameter. **Leaves** simple, trilobate or trifoliolate, bright green, petiolate; lamina (or main pinna) ovate, broadly ovate or trullate, base cuneate or truncate, apex acute to obtuse, margin entire, 15--35 x 8--25 mm; small lateral pinnae ovate, 8--10 x 5--7 mm, adaxially glabrous or covered with short glandular hairs, abaxially glabrous or sparsely setose mainly along the veins, margins with short appressed bristles; petiole 10--50 mm long and 1--3 mm in diameter, prostrate, sparsely to densely setose with appressed bristles interspersed with short glandular

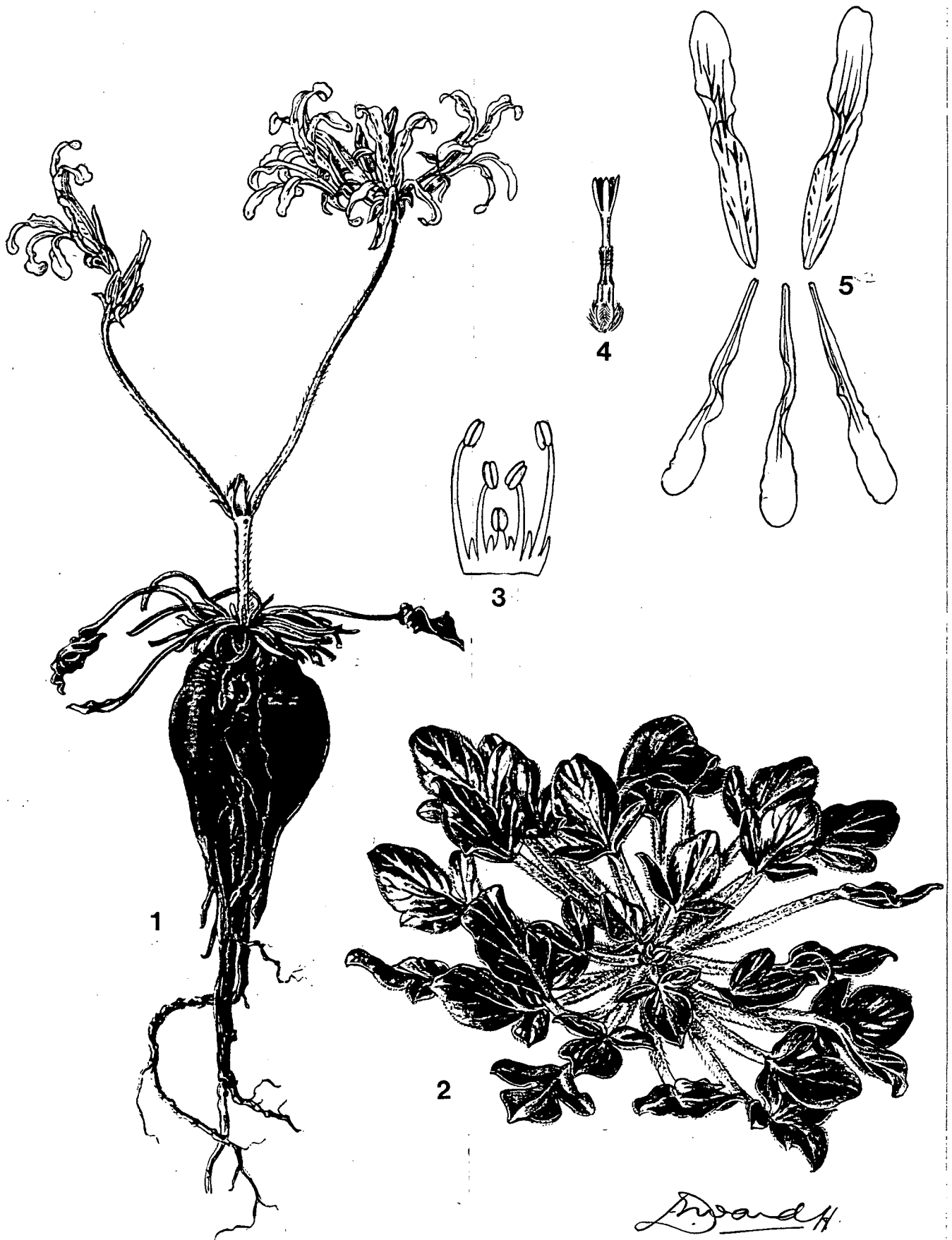


Figure 8.22.1 *Pelargonium tenellum*. 1, flowering plant x1; plant with leaves x1; 3, androecium x4; 4, gynoecium x6; petals x2;

hairs; stipules subulate, adnate to petioles for less than one third of their length, 8--12 mm long and 2--3 mm wide, ciliate. **Inflorescence:** scape 15--50 mm long and 1--3 mm in diameter, branched, bearing 2--4 pseudo-umbellets with 3--10 flowers each; peduncles 20--200 mm long, 1--1,5 mm in diameter, hirsute with appressed curly hairs interspersed with glandular hairs and appressed bristles; bracts subulate, 4--8 mm long, 1--2 mm wide, abaxially hirsute with distally appressed hairs. **Pedicel** *ca.* 0,5 mm long. **Hypanthium** 10--19(-32) mm long, pale green, densely covered with glandular hairs interspersed with appressed curly hairs and appressed stiff hairs. **Sepals** 5, lanceolate, apex acute, 6--11,5 mm long, 1--2,5 mm wide, posterior one erect, others reflexed, green, abaxially setose with appressed bristles interspersed with glandular hairs. **Petals** 5, white, cream-coloured or pale pink with undulate margins, claws patent during anthesis forming a floral sheath; posterior two with red line markings giving it a flesh-coloured appearance, ligulate, claws *ca.* 13 mm long, usually wider than the apices, bases cuneate, apices rounded or emarginate, recurved, 19--25 x 2--3,5(-5) mm; anterior three narrowly spatulate, bases attenuate, apices rounded, 17--23 x 1,5--2,5(-4) mm. **Stamens:** staminal column 1--1,5 mm long, white; perfect stamens 5, concealed in floral sheath, posterior one 1,5--3,5 mm long, lateral two 4,5--6,5 mm long, curved upwards, anterior two 5,5--9 mm long, curved upwards, white; staminodes 1,3--2,5 mm long; anthers pink, 1--2 mm long, pollen white to yellow. **Gynoecium:** ovary 2,5--4,5 mm long; style 0,5--2,5 mm long, pale green; stigma branches 1--2,5 mm long, adaxially red. **Fruit:** not seen. (Figure 8.22.1)

Diagnostic features and affinities

P. tenellum is a geophyte with small simple or trifoliolate prostrate leaves with appressed bristles along the margins, characteristics which are shared with *P. heterophyllum* and *P. chelidonium*. The flowers of *P. tenellum* are also very similar to those of *P. heterophyllum*. Both species have long ligulate petals with undulate margins, and in both cases the claws of the petals form a floral sheath in which the stamens are concealed. In both species the posterior stamen is usually much shorter than the other four stamens, and the lateral and anterior ones are curved upwards. However, they differ in respect to the shape and the markings of the posterior petals. These petals in *P. heterophyllum* are laterally curved with large black blotches in the centre, whereas those of *P. tenellum* are straight with rather pale red lines along the veins. The specific epithet *tenellum* refers to the extremely delicate and tender habit of the plant (Andrews 1820).

Geographical distribution and ecology

P. tenellum occurs on the south-western Cape coastal plain from Philadelphia in the west and the foot of the Du Toitskloof Mountains in the east, and as far south as Kuilsrivier and Stellenbosch. It was also collected on the eastern side of the south-western mountain range along the Doornrivier, a tributary of the Breërivier (Figure 8.22.2). This area receives an annual rainfall of 400--600 mm mainly in winter. *P. tenellum* grows on grassy slopes or in renosterveld on weathered granite or in sandy lime where it usually occurs in full sunlight. Its occurrence varies from occasional to locally frequent, and it flowers in summer, from November to January after the leaves have died.

P. tenellum and *P. heterophyllum* are very similar species and apparently they also give preference to the same habitat, but on closer investigation it seems that *P. tenellum* grows in areas with a higher annual rainfall than *P. heterophyllum*.

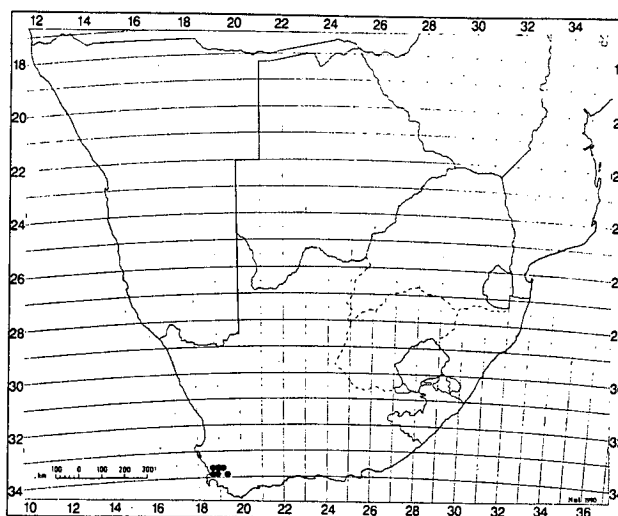


Figure 8.22.2 Geographical distribution of *P. tenellum*.

Material studied

--3318 (Cape Town): Between Kalbaskraal and Darling (-DA), *Marais 15* (STEU); Swellengift, Philadelphia (-DA), *Marais 136, 137* (STEU); Klipheuwel (-DA), *Van der Walt 1027* (STEU); Klein Drakenstein & Dal Josefata (-DB), *Drège 7490a* (G, K, MO, Px2, W); Farm Bulelwa, Agter Paarl (-DB), *Van Zyl s.n.* (STEU); Langverwacht, above Kuilsrivier (-DC), *Oliver 4818* (STE); Bloem Erf, Koelenhof (-DD), *Baker s.n.* (BOL); Agter-Paarl, Protea F.U.C. road (-DD), *Boucher 158* (STE);

Voëltjiesdorp, Stellenbosch (-DD), *Boucher 3383* (STE); Simondium, Paarl (-DD), *Davis s.n.* (BOL); Between Muldersvlei & Klapmuts (-DD), *Salter 6494* (BOLx2).

--3319 (Worcester): Leliefontein farm, foot of Dutoitskloof (-CA), *Lawder s.n.* (NBG); Doornrivier, farm De Hoop (-CD), *Van Zyl s.n.* (STEU).

8.23 *Pelargonium trifoliolatum* (Eckl. & Zeyh.) E.M. Marais in South African Journal of Botany 59: 131 (1993). TYPE: Cape Province, ' . . . vallis "Tulbagh" prope "Waterfall" (Worcester).' *Ecklon & Zeyher 493* (S! lecto, designated here; S!; SAM!).

Hoarea trifoliolata Eckl. & Zeyh.: 64 (1835). TYPE: Cape Province, ' . . . vallis "Tulbagh" prope "Waterfall" (Worcester).' *Ecklon & Zeyher 493* (S! lecto, designated here; S!; SAM!).

Pelargonium astragalifolium var *trifoliolatum* (Eckl. & Zeyh.) Harv.: 268 (1860); Knuth: 346 (1912).

Geranium astragalifolium sensu Andr.: t. 190 (1801); non Cav.: 257, t. 104, f. 2 (1787).

Pelargonium astragalifolium (*sensu* Andr.) Loudon: 570 (1829); Loudon: 272 (1832); non (Cav.) Jacq.: 8 (1795).

Pelargonium trifoliatum Steud.: 290 (1841); non Sweet: t. 294 (1826a); 82, 267 (1826c); nec Harv.: 271 (1860). Probably there is a spelling mistake in Steudel's publication and *P. trifoliatum* (Eckl. & Zeyh.) Steud. should have been *P. trifoliolatum*, because Ecklon & Zeyher did not describe a species *Hoarea trifoliata*.

Misidentifications

Pelargonium pinnatum sensu Harv.: 269 (1860) p.p.; *P. pinnatum sensu* Knuth: 346 (1912) p.p.; *P. pinnatum sensu* J.J.A. v.d. Walt: 34 fig. (1977) p.p.; *P. astragalifolium sensu* Harv.: 268, 269 (1860) p.p.; *P. astragalifolium sensu* Knuth: 345 (1912) p.p.

A geophyte 170--250 mm tall when in flower. **Tuber:** a turnip-shaped root, 12--35 mm long and 10--35 mm in diameter. **Leaves:** lamina pinnate, 50--170 mm long, pinnae ovate, acute, 6--15 x 3,5--6,5 mm, terminal pinna more or less the same size as the other pinnae, adaxially and abaxially hirsute with appressed hairs interspersed with short glandular hairs; petiole 50--150 mm long and 1--2 mm in diameter, indumentum as on pinnae; stipules 13--33 mm long and 1--2 mm wide, abaxially hirsute. **Inflorescence:** scape 20--150 mm long, 1--2 mm in diameter, branched, bearing 2--5 pseudo-umbellets with (3-)5--14(-20) flowers each; peduncles 50--160



Figure 8.23.1 *Pelargonium trifoliolatum*. A, flowering plant x1; B, petals x2; C, androecium x3; D, gynoecium x5; E, stipules x1; F, mericarp x1,5.

interspersed with long soft patent hairs and glandular hairs; bracts narrowly triangular, 3,5--6 mm long, 2 mm wide, abaxially densely hirsute with distally appressed hairs. **Pedicel** ca. 0,5 mm long. **Hypanthium** 10--15(-25) mm long, densely covered with appressed curly hairs and glandular hairs. **Sepals** 5, lanceolate, apices acute, 6--9,5 mm long, 1,2--3 mm wide, patent during anthesis, abaxially densely covered with appressed hairs and glandular hairs. **Petals** 5, cream-coloured, yellow or pink, claws orientated close together forming a floral sheath of 8--12 mm long; posterior two ligulate to narrowly obovate, curved laterally, with a prominent wine-red blotch on the curve, bases cuneate, apices rounded, margins undulate, laterally recurved during anthesis, 14--21 x 2,5--6,5 mm, claws 8--12 mm long; anterior three spatulate, bases attenuate, apices rounded, 13--20 x 2--6 mm. **Stamens**: staminal column 1--2,5 mm long, white; perfect stamens 5, concealed in floral sheath, posterior one 1,5--3 mm long, lateral two 2,2--5 mm long, curved upwards, anterior two 6--9,5 mm long, curved upwards, white; staminodes 2--3,5 mm long; anthers pale pink, 1--2 mm long, pollen yellow. **Gynoecium**: ovary 2,2--5,5 mm long; style 1--3 mm long, pink; stigma branches 0,5--1,5 mm long, pink. **Fruit**: bases of mericarps 3,5--4 mm long, without glandular hairs, tails 17--24 mm long (Figure 8.23.1).

Diagnostic features and affinities

P. trifoliolatum has flowers with prominent dark blotches on the posterior petals. These petals are ligulate to narrowly obovate and laterally recurved during anthesis and the margins are undulate. The stigma branches are usually shorter than the style. The anterior two stamens are more or less the same length as or slightly longer than the calyx. The scape is branched, bearing two to five pseudo-umbellets with about 5--14 cream-coloured, yellow or pink flowers each. The hypanthium is 1,5--3 times the length of the calyx. With respect to the structure of the petals and the androecium *P. trifoliolatum* shows affinities with *P. heterophyllum*. With respect to the morphology of the leaves *P. trifoliolatum* shows similarities with *P. pinnatum* and *P. viciifolium*, both species with different floral structures (Marais 1993).

The specific epithet *trifoliolatum*, although not very typical, refers to the incision of the leaves.

Geographical distribution and ecology

P. trifoliolatum occurs on the lower slopes of the western escarpment of the southwestern Cape, from Piketberg and the Koue Bokkeveld Mountains in the north to the Groot Drakenstein in the south (Figure 8.23.2). During the previous century it was also collected by C.F. Ecklon and C. Zeyher, and R. Marloth in the Cape Peninsula. The distribution area receives an annual rainfall of 400–1000 mm occurring mainly in winter. The plants are locally common. It grows in clay soils in renosterveld as well as in sandy soil in fynbos. Flowering time is from October to January with the peak in November. Flowers appear after the leaves have died, but dried leaf remains are usually still present.

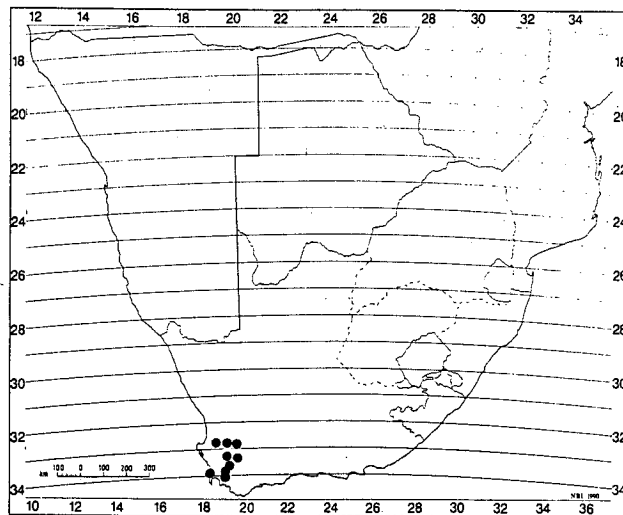


Figure 8.23.2 Geographical distribution of *P. trifoliolatum*.

Material studied

–3218 (Clanwilliam): Blaauwberg (-DB), *Drège 7501a* (P); Levant Hill, Piketberg (-DC), *Nordenstam 3396* (S, STE).

–3219 (Wuppertal): Dasklip road, 2 km on Grootfontein turnoff (-CC), *Marais 178, 181* (STEU); Tweefontein, Koue Bokkeveld (-CD), *Marais 186* (STEU); Ceres Karoo (-DC), *Dymond s.n.* (BOL).

–3318 (Cape Town): Table Mountain (-CD), *Ecklon & Zeyher 498* (B, L, W); The Kloof, Cape Town (-CD), *Marloth 386* (PRE).

–3319 (Worcester): Roodesand (-AA), *Drège 1291* (P); Tulbaghsberg, near Winterhoek (-AA), *Ecklon & Zeyher 496* (Gx2, K, MEL, MO, P, Sx2, SAM, TCD, UPS, Wx2, Z); Rozendalfontein, Agter-Witzenberg (-AA), *Pillans 9576* (BOL, PRE); Between Rozendalfontein & Visgat (-AA), *Pillans 9570* (BOL); At turnoff to Agter-Witzenberg (-AB), *Marais 45* (STEU); Agter-Witzenberg (-AB), *Cillie*

s.n. (STEU); *Marais 49* (STEU); Agter-Witzenberg near Slagboom (-AB), *Marais 347* (STEU); Gydo Pass (-AB), *Marais 66, 394* (STEU); Rocklands, on Gydo-Citrusdal road (-AB), *Marais 370* (STEU); Op-die-Berg, Koue Bokkeveld (-AB), *Marais 189, 300* (STEU); Nieuwekloof, Tulbaghstal (-AC), *Drège s.n.* (G, Kx2, MEL, S, W); *Drège 7501* (MEL); Waterfall, near Tulbagh (-AC), *Ecklon & Zeyher 493* (Sx2, SAM); *Leighton 3041* (BOL); *Pappe 16* (K, MEL, PRE, TCD); *Theron s.n.* (STE); Romansrivier, Wolseley (-AC), *Leighton 2182* (BOL); *Van der Walt 572* (STEU); Witels Kloof, Michell's Pass (-AD), *Esterhuysen 14140* (BOL); S slopes of Castle Rocks (-AD), *Esterhuysen 20712* (BOL); Prince Alfred Hamlet (-AD), *Walgate 386* (NBG); Between Prince Alfred Hamlet & Gydo (-AD), *Marais 40* (STEU); Flats NW of Prince Alfred Hamlet (-AD), *Oliver 5132* (STE); Theronsberg Pass (-AD), *Marais 139* (STEU); W slopes of Roodeberg, Hex River Mountain (-BC), *Esterhuysen 20* (PRE); *Esterhuysen 20921* (BOL); Hexrivier (-BC), *Fischer 208* (STEU); Sanddrifkloof (-BC), *Marais 345* (STEU); Laakenvlei, Matroosberg (-BC), *Phillips 11755* (SAM); Theronsberg Pass (-BC), *Marais 55* (STEU); Kleinberg, Hex River Mountain (-BD), *Esterhuysen 9949* (BOL); Dutoitskloof (-CA), *Drège 7499* (G, P, S, W); Worcester Shooting Range (-CB), *Bayer 2627* (NBGx3); Between Rooihogte & Worcester (-CB), *Bolus s.n.* (BOL); Rainbow Chicken Farm (-CB), *Forrester 258* (NBG); *Walters 1545* (NBG); Near Rawsonville (-CB), *Forrester 208A* (NBG); Drakensteinberge (-CC), *Drège 7501b* (G, P, PRE); La Motte Forest Station, Zachariashoek (-CC), *Viviers 1125* (STE).
 --3419 (Caledon): Grabouw (-AA), *Taylor 4406* (STE).

ACICULATUM GROUP

Geophytes with elongated, branched roots and irregularly pinnate or bipinnatisect leaves with rigid erect petioles. Scape branched, bearing 2--8 pseudo-umbellets with 15--40 flowers each. Flowers with cream-coloured or pale yellow, ligulate or oblanceolate petals with V-shaped or feather-like markings on the posterior two. Stamens 2 or 5 fertile, posterior one and lateral two very short and concealed within the floral sheath, the anterior stamens long and protrude from the flower. Tectum of pollen striate.

8.24 *Pelargonium aciculatum* *E.M. Marais* in South African Journal of Botany 57: 55 (1991). TYPE - Cape Province: Bothmas Kloof, near Riebeeck Kasteel, *Marais 318* (STE, holo!, K!, PRE!).

A geophyte 100--300 mm tall when in flower. **Tuber:** elongated, branched roots, sometimes with more than one stem-growing point, 80--100 mm long and *ca.* 20 mm in diameter. **Leaves:** green, petiolate; lamina elliptic, 100--140 x 35--60(--80) mm, irregularly deeply pinnatilobed to bipinnatisect, densely hirsute with distally appressed

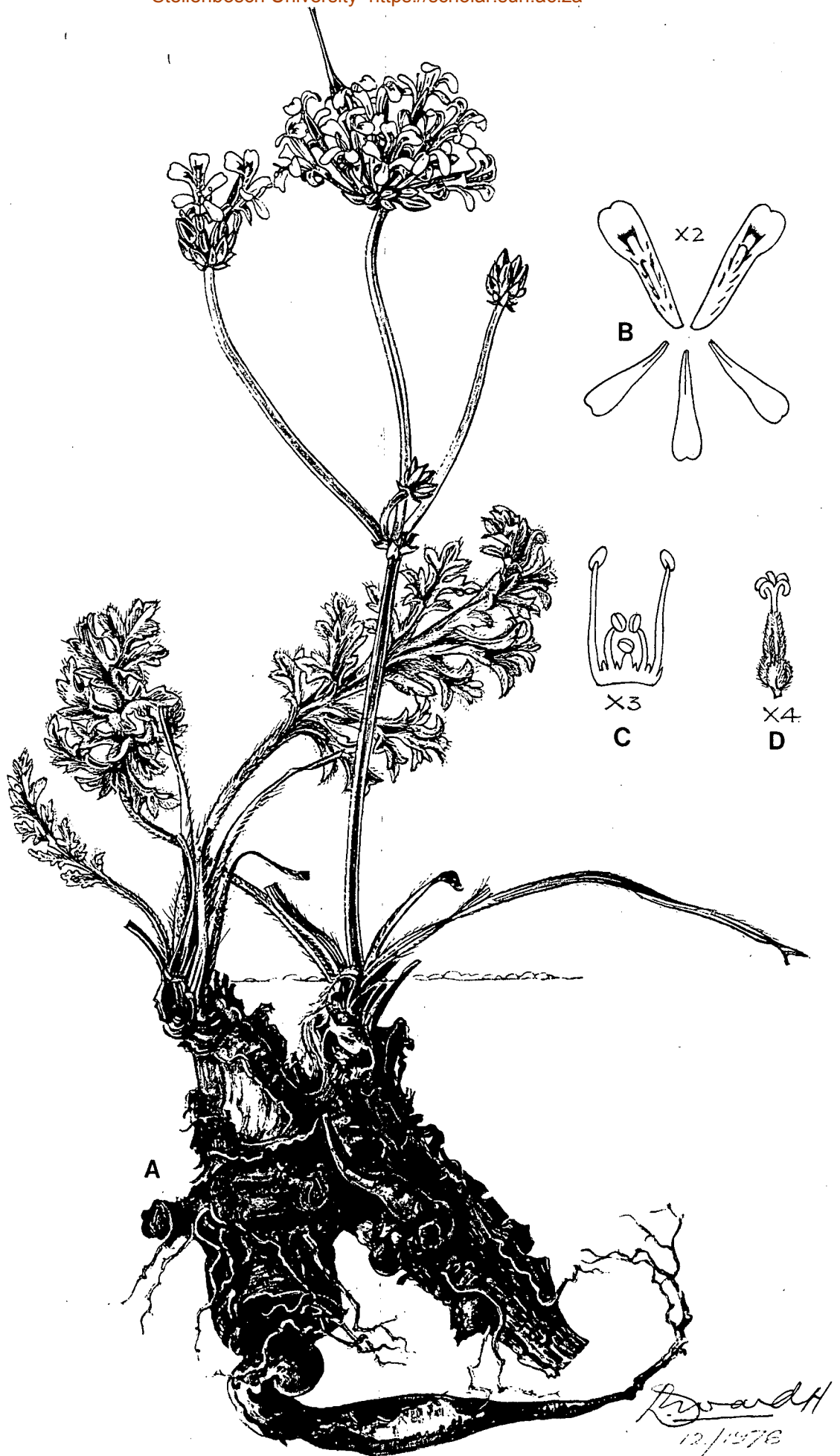


Figure 8.24.1 *Pelargonium aciculatum*. A, flowering plant x1; B, petals x2; C, androecium x3; D, gynoecium x4.

hairs and glandular hairs interspersed; segments linear, 6--12 mm wide, apices acute, margins serrate; petiole 50--130 mm long, rigid, erect, hirsute with coarse hairs and glandular hairs interspersed; stipules subulate, 18--25 mm long and 2 mm wide, ciliate, adnate to the petiole with apices free, free apices *ca.* 8 mm long. **Inflorescence:** scape 60--130 mm long and 2--3,5 mm in diameter, pale green, densely pilose with curly hairs interspersed with long glandular hairs, branched, bearing 2--4 pseudo-umbellets; peduncles 50--130 mm long and 1--1,5 mm in diameter, indumentum as on scape; bracts irregular in form and size, densely hirsute with appressed hairs; pseudo-umbellet 13--32(--40) flowered, subtended by a whorl of spatulate bracts; bracts 3--5 mm long, acuminate, adaxially hirsute with appressed hairs, abaxially hirsute with appressed hairs and interspersed with glandular hairs, initially erect, recurved during senescence. **Pedicel** *ca.* 1 mm long. **Hypanthium** 12--16 mm long (about twice as long as the calyx), pale green, indumentum as on scape. **Sepals** 5, lanceolate, apices acuminate, 7--9 x 1,5--3 mm, posterior one erect, others recurved, pale green, indumentum abaxially as on scape, only less dense. **Petals** 5, pale yellow or cream-coloured, claws orientated close together forming a sheath-like structure; posterior two with feather-like red markings, ligulate, curved laterally, bases cuneate, apices rounded to emarginate, laterally recurved during anthesis, 11--13,5 x 2--3,5 mm; anterior three dimly marked pink at the very base, spatulate, bases narrowly cuneate, apices rounded to emarginate, patent during anthesis, 9--10 x 2--2,5 mm. **Stamens:** staminal column 1--2 mm long, white; perfect stamens 5, posterior one *ca.* 1 mm long, lateral two 2 mm long, recurved so that anthers are borne on the same level as posterior one, anterior two 6,5--8 mm long, protruding from the flower, free filaments dark pink; staminodes *ca.* 2,5 mm long; anthers 1 mm long, dark pink, pollen orange. **Gynoecium:** ovary 4,5 mm long; style 3--4 mm long, dark pink; stigma branches 1 mm long, dark pink. **Fruit:** bases of mericarps *ca.* 4 mm long, with glandular hairs, tails *ca.* 23 mm long. (Figure 8.24.1).

Diagnostic features and affinities

P. aciculatum is a geophyte with erect leaves and rigid petioles. The laminae are irregularly deeply pinnatilobed to bipinnatisect and densely hirsute with appressed hairs. The hypanthia of the small yellow flowers are about twice the length of the calyx. There are five fertile stamens, of which the posterior one and the lateral two are very short and concealed within the floral sheath. The lateral two are recurved so that the anthers are borne on the same level as that of the posterior one. The anterior two stamens are about the same length as the calyx, and protrude from the flower. The petals are about 1,5 times the length of the calyx, with wine-red feather-like markings on the posterior two. The specific epithet refers to the irregular fine streaks on the petals.

P. aciculatum resembles *P. confertum*, *P. fasciculaceum* and *P. connivens* in respect to the morphology of the leaves as well as the floral structure. All four species have ligulate petals, very short lateral and posterior stamens and long anterior stamens. *P. aciculatum* shows a closer relation with *P. confertum* because both of them have rather short petals and short hypanthia. They differ in respect to the number of fertile stamens: *P. aciculatum* has five fertile stamens, whereas *P. confertum* has only two.

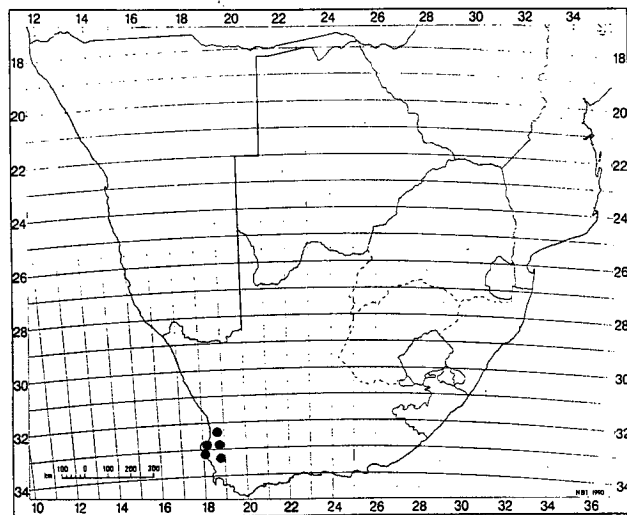


Figure 8.24.2 Geographical distribution of *P. aciculatum*.

Geographical distribution and ecology

P. aciculatum occurs on foothills in renosterveld and is restricted to the west coast (Figure 8.24.2) from Paleisheuvel in the north to Riebeeck-Kasteel in the south, an area receiving an annual rainfall of 200–400 mm, mainly during winter. It flowers in summer, from November to December.

Material studied

--3218 (Clanwilliam): Paleisheuvel (-BC), *Van der Walt 1024* (STEU); Nooitgedacht farm near Vredenburg (-CC), *Barker 10230* (NBG); De Hoek, on Die Kasteel road (-DC), *Marais 265* (STEU); De Hoek, Cement Factory (-DD), *Esterhuysen 20167* (BOL).

--3317 (Saldanha): Saldanha (-BB), *Van der Walt s.n.* (STEU).

--3318 (Cape Town): Langebaan (-AA), *Lewis s.n.* (BOL); *Ward-Hilhorst s.n.* (STEU); Bothmas Kloof, near Riebeeck Kasteel (-BD), *Marais 318* (K, PRE, STE); Voorspoed, Malmesbury (-BD), *Van der Walt 1039* (STEU).

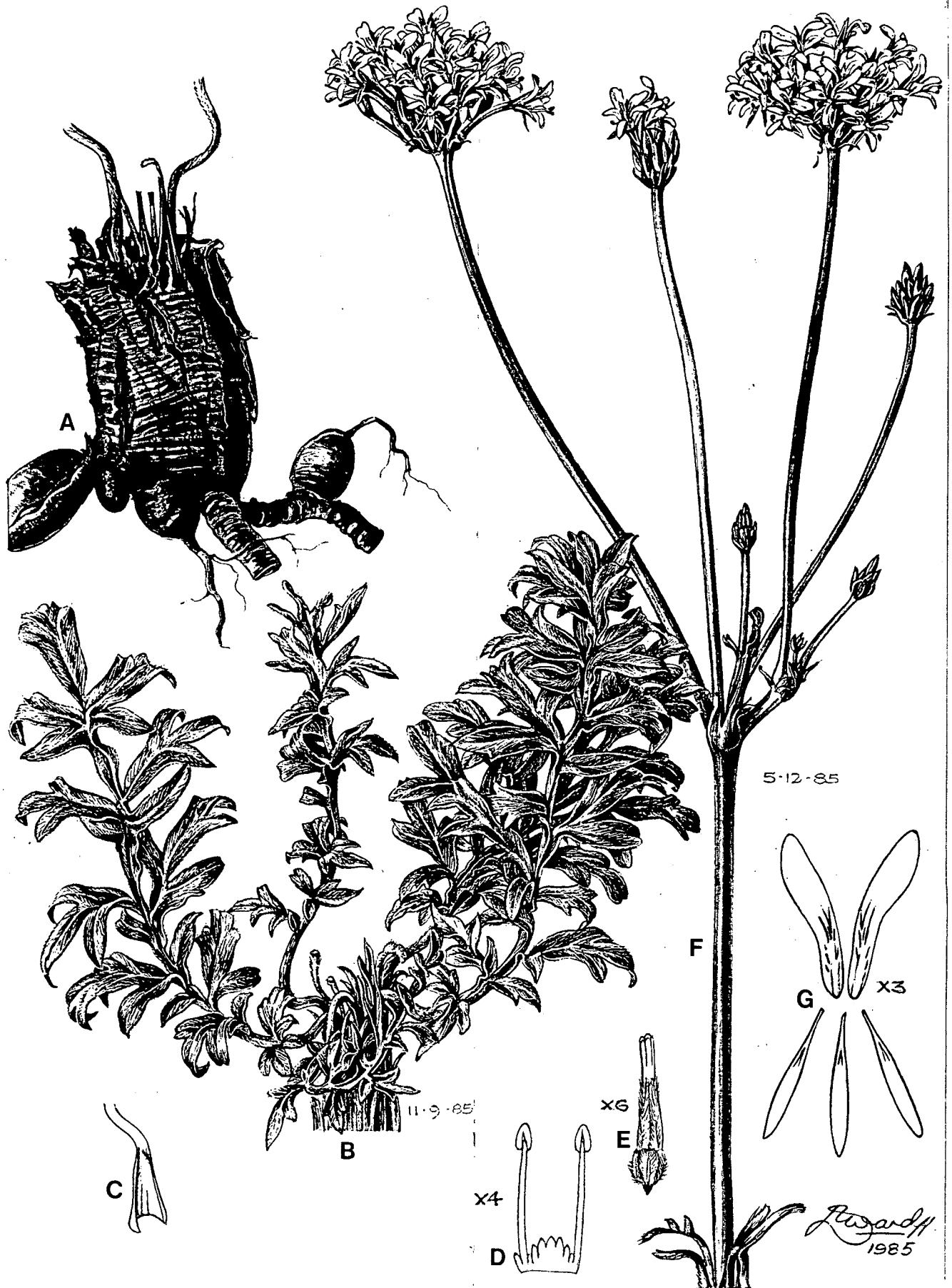


Figure 8.25.1 *Pelargonium confertum*. A, tuber x1; B, leaves x1; C, leaf base x1; D, androecium x4; E, gynoecium x6; F, inflorescence x1; G, petals x3.

8.25 *Pelargonium confertum* E.M. Marais in South African Journal of Botany 57: 57 (1991). TYPE - Cape Province: Darter's Grave, 13 km. S of Kamieskroon, *Van Jaarsveld* 4283 (STE, holo!, K!, PRE!).

A geophyte 140--300 mm tall when in flower. **Tuber:** elongated, branched roots, sometimes with more than one stem-growing point, 70 mm long and 15--30 mm in diameter. **Leaves:** green, petiolate; lamina elliptic to ovate, 90--180 x 40--80(-110) mm, irregularly bipinnate, densely hirsute with distally appressed hairs and with glandular hairs interspersed; segments linear, 5--12 mm wide, apices acute, margins serrate; petiole 35--60 mm long, rigid, erect, conspicuously curved, hirsute with appressed coarse hairs and short glandular hairs interspersed; stipules subulate, 13--20 mm long and 2 mm wide, hirsute to densely hirsute at the apex, adnate to the petiole with apices free, free apices *ca.* 5 mm long. **Inflorescence:** scape 40--200 mm long and 3--5 mm in diameter, pale green, densely pilose with curly hairs interspersed with long glandular hairs, branched, bearing 2--8 pseudo-umbellets; peduncles 70--150 mm long and 1--2 mm in diameter, indumentum as on scape; bracts irregular in form and size, densely hirsute; pseudo-umbellet 13--24(--40) flowered, subtended by a whorl of ovate bracts; bracts 4--5 mm long and *ca.* 1,5 mm wide, acute, abaxially hirsute with appressed hairs and interspersed with glandular hairs. **Pedicel** *ca.* 1 mm long. **Hypanthium** 11--17 mm long (twice as long as the calyx), curved, pale green, indumentum as on scape. **Sepals** 5, lanceolate, apices acuminate, 6--8 x 1--2 mm, posterior one erect, others recurved, pale green, indumentum abaxially as on scape, only less dense. **Petals** 5, pale yellow or cream-coloured, claws orientated close together forming a sheath-like structure; posterior two with feather-like red markings, ligulate, bases cuneate, apices rounded, laterally recurved during anthesis, 9--11 x 2--3 mm; anterior three with red markings at the very base, spatulate, bases attenuate, apices rounded, patent during anthesis, 7--9,5 x 1--2 mm. **Stamens:** staminal column *ca.* 1 mm long, white; perfect stamens 2, in anterior position, 8 mm long, protruding from the flower, free filaments white; staminodes 1--2 mm long, apices pink; anthers 1,5 mm long, pink, pollen orange. **Gynoecium:** ovary 5,5 mm long; style 2--4 mm long, pink; stigma branches 1 mm long, dark red. **Fruit:** bases of mericarps *ca.* 5 mm long, with glandular hairs, tails *ca.* 22 mm long. (Figure 8.25.1).

Diagnostic features and affinities

P. confertum is a geophyte with erect leaves and rigid, curved petioles. The laminae are irregularly bipinnate and densely hirsute with appressed hairs. The hypanthia of the small yellow flowers are about twice the length of the calyx. The large number of

flowers with short hypanthia gives the inflorescence a crowded appearance, hence the specific epithet. Only the anterior two stamens are fertile and they are the same length as the calyx and protrude from the flower. The petals are about 1,5 times the length of the calyx, with wine-red feather-like markings on the posterior two. The floral structure and especially the length of the hypanthia and the size, form and markings of the petals resemble those of *P. aciculatum*. The latter has five fertile stamens, whereas *P. confertum* has only two.

Geographical distribution and ecology

P. confertum occurs in small populations in rock crevices or under bushes in Namaqualand, from Rietkloof Mountains near Steinkopf in the north to Nuwerus in the south (Figure 8.25.2), an area receiving an annual rainfall of 100--200 mm mainly during winter. It flowers from November to December.

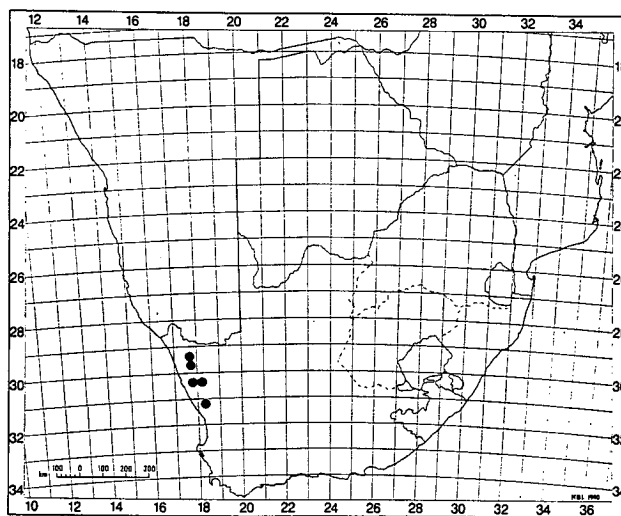


Figure 8.25.2 Geographical distribution of *P. confertum*.

Material studied

- 2917 (Springbok): Northern slopes of Rietkloof Mountains (-BC), *Pearson 5703* (BOL, K); Spektakel Pass (-DA), *Van der Walt 956* (STEU); 2 km ESE of Nababeb (-DB), *Lavrinos 28338* (STEU).
- 3017 (Hondeklipbaai): Darter's Grave, 13 km S of Kamieskroon (-BD). *Van Jaarsveld 4283* (K, PRE, STE).
- 3018 (Kamiesberg): 16 km from Garies to Leliefontein (-AC), *Marais 72* (STEU).
- 3118 (Vanhynsdorp): Between Nuwerus and Bitterfontein (-AB), *Pearson 5541* (BOL, K); Karee Mountains S of Nuwerus (-AB), *Van Zyl s.n.* (STEU).

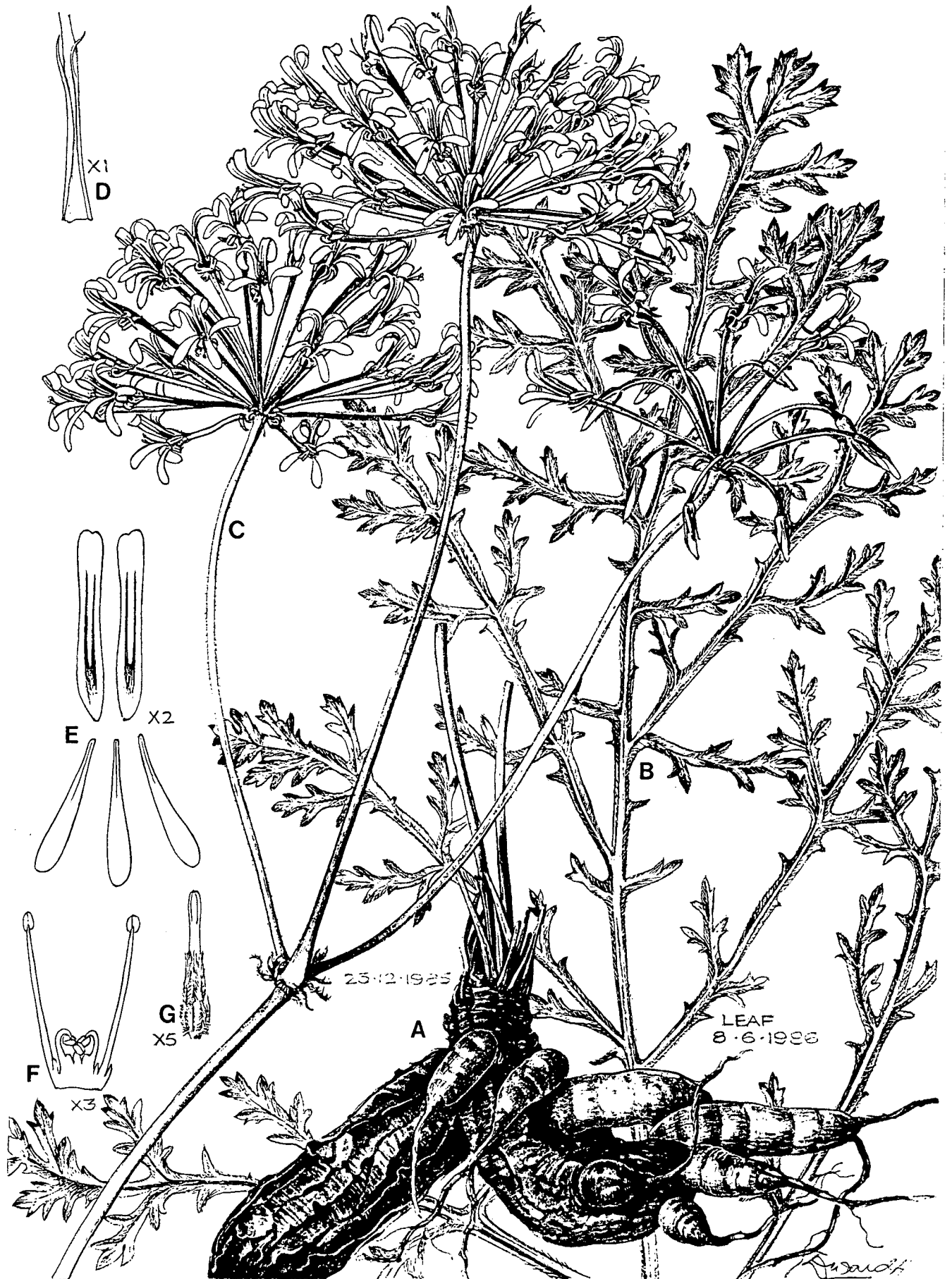


Figure 8.26.1 *Pelargonium fasciculaceum*. A, tuber x1; B, leaf x1; C, inflorescence x1; D, leaf base x1; E, petals x2; F, androecium x3; G, gynoecium x5.

8.26 *Pelargonium fasciculaceum* E.M. Marais in South African Journal of Botany 57: 59 (1991). TYPE - Cape Province: Arbeidsgenot, on gravelled road between Citrusdal and Clanwilliam, Marais 184 (STE, holo!, BOL!, K!, PRE!).

A geophyte 300--500 mm tall when in flower. **Tuber:** elongated, branched roots, sometimes with several stem-growing points, 70--110 mm long and 15--25 mm in diameter. **Leaves:** green, petiolate; lamina ovate, 140--270 x 60--120 mm, irregularly bipinnate, densely hirsute with distally appressed hairs and with glandular hairs interspersed; segments linear, 4--8 mm wide, apices acute, margins serrate; petiole 80--200 mm long, rigid, erect, hirsute with coarse hairs and interspersed with glandular hairs; stipules subulate, 15--25 mm long and 2 mm wide, hirsute to densely hirsute at the apex, adnate to the petiole with apices free; free apices *ca.* 5 mm long. **Inflorescence:** scape 70--170 mm long and 2--5 mm in diameter, pale green, densely pilose with curly hairs interspersed with long glandular hairs, branched, bearing 4--8 pseudo-umbellets; peduncles 90--240 mm long and 1,5--3 mm in diameter, indumentum as on scape; bracts irregular in form and size, densely hirsute; pseudo-umbellet 15--26(-40) flowered, subtended by a whorl of narrowly triangular bracts; bracts 4--5 mm long, acuminate, abaxially hirsute with appressed hairs and interspersed with glandular hairs, initially erect, recurved during senescence. **Pedicel** *ca.* 1 mm long. **Hypanthium** 40--60 mm long, (6--8 times the length of the calyx), pale green, indumentum as on scape. **Sepals** 5, posterior one triangular, remaining four lanceolate, apices acuminate, 7--9 x 1,5--3 mm, posterior one erect, others recurved, pale green, indumentum abaxially as on scape, only less dense. **Petals** 5, pale yellow or cream-coloured, oblanceolate or ligulate, bases cuneate, apices rounded to emarginate, claws orientated close together forming a sheath-like structure; posterior two with V-shaped red markings, apices laterally recurved during anthesis, 16--19 x 3--4 mm; anterior three dimly marked pink at the very base, apices patent during anthesis, 13--16 x 2--3 mm. **Stamens:** staminal column 1,5--2 mm long, white; perfect stamens 5, posterior one *ca.* 2 mm long, lateral two 4 mm long, recurved so that anthers are borne on the same level as posterior one, anterior two 9--11 mm long, protruding from the flower, free filaments dark pink; staminodes *ca.* 2,5 mm long; anthers 1 mm long, dark pink, pollen orange. **Gynoecium:** ovary 3 mm long; style 2 mm long, dark red; stigma branches 1 mm long, dark red. **Fruit:** bases of mericarps *ca.* 5 mm long and tails *ca.* 23 mm long. (Figure 8.26.1).

Diagnostic features and affinities

P. fasciculaceum is a geophyte with very large erect leaves and rigid petioles. The laminae are irregularly bipinnate and densely hirsute with appressed hairs. With the long scapes and peduncles this species is up to 0,5 m high when in flower, and it is thus one of the tallest species in section *Hoarea*. The hypanthia of the pale yellow flowers are about six to eight times the length of the calyx. There are five fertile stamens, of which the posterior one and the lateral two are very short and concealed within the floral sheath. The lateral two are recurved so that the anthers are borne on the same level as that of the posterior one. The anterior two stamens are longer than the calyx and protrude from the flower. The petals are about twice the length of the calyx, with red V-shaped markings on the posterior two. The specific epithet refers to the large number of flowers with long hypanthia diverging from a common centre.

In respect to the leaf form and the structure of the androecium *P. fasciculaceum* resembles *P. aciculatum*, *P. confertum* and *P. connivens*. However, it reveals a closer relation with *P. connivens* because both species have long hypanthia and long ligulate petals with V-shaped markings on the posterior two. These two species differ in respect to the orientation and the colour of the petals (Marais 1991).

Geographical distribution and ecology

P. fasciculaceum grows in sandy places along the banks of the Olifants River and its tributaries, and in mountain fynbos on the Nardous and Bokkeveld plateaux (Figure 8.26.2), an area receiving an annual rainfall of 200–400 mm, occurring mainly during winter. The fleshy roots are branched, forming an extensive root system on which several stem-growing points develop. Thus older plants often grow in colonies while younger and smaller plants usually grow singly, an indication that in nature plants easily develop from seeds. It flowers in summer, from December to January after the leaves have been shed. Each of the numerous scapes per plant bears four to eight pseudo-umbellets which mature in succession, thus lengthening the flowering season. Fruit setting in cultivation is rare. This, as well as the special structure of the androecium suggests a dependance on a special pollinator.

Plants from the Nardous and Bokkeveld plateaux, areas with a lower annual rainfall than along the Olifants River, flower only late in January and usually have fewer pseudo-umbellets per scape and fewer flowers per pseudo-umbellet than those from the Olifants River valley. Plants from the Olifants River valley flower from December to January.

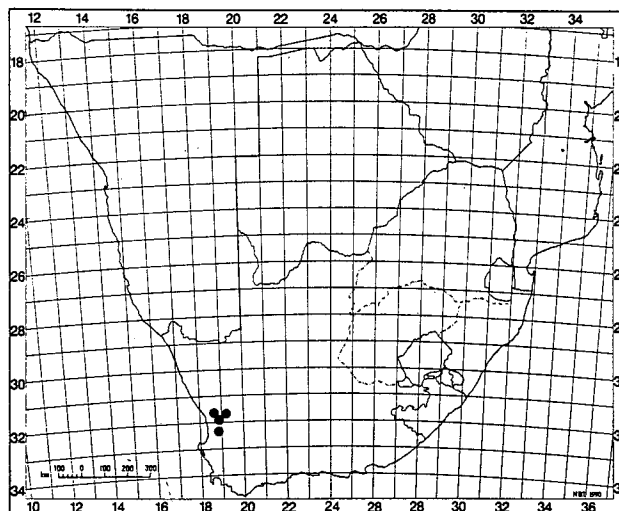


Figure 8.26.2 Geographical distribution of *P. fasciculaceum*.

Material studied

–3118 (Vanrhynsdorp): Vleikraal, 8 km E of Klawer (-DA), *Walters 1* (STEU); Muggiedraai turnoff, on Nardous Pass road (-DD), *Marais 325* (STEU); On top of Giftberg (-DD), *Van Jaarsveld 4363* (STEU).

–3119 (Calvinia): Papkuilsfontein, S of Nieuwoudtville (-CA), *Von Willert s.n.* (STEU).

–3218 (Clanwilliam): Arbeidsgenot on gravelled road between Citrusdal and Clanwilliam (-BD), *Marais 184, 384* (BOL, K, PRE, STE); Haarwegskloof (-BD), *Marais 199* (STEU); Melkboomfontein on the banks of the Olifants River (-BD), *Marais 266* (STEU); 6 km from Paleisheuvel turnoff (-BD), *Van der Walt 1046* (STEU).

8.27 *Pelargonium connivens* *E.M. Marais* in South African Journal of Botany 57: 61 (1991). TYPE - Cape Province: Rondekop, Nieuwoudtville, *Lavranos & Pehlemann 19000* (STE, holo!, K!, PRE!).

A geophyte 180 mm tall when in flower. **Tuber:** elongated, branched roots, *ca.* 40 mm long and *ca.* 20 mm in diameter. **Leaves:** green, petiolate; lamina elliptic to ovate, 100--130 x 40--60 mm, irregularly pinnate to bipinnatisect, densely hirsute with distally appressed hairs and with glandular hairs interspersed; segments linear, 6--12 mm wide, apices acute, margins serrate; petiole 45--70 mm long, rigid, erect, hirsute with appressed coarse hairs and short glandular hairs interspersed; stipules subulate, 7--14 mm long and 1,5 mm wide, hirsute to densely hirsute at the apex, adnate to the petiole with apices free, free apices *ca.* 3 mm long. **Inflorescence:** scape 30--40 mm long and



Figure 8.27.1 *Pelargonium connivens*. A, flowering plant x1; B, leaves x1; C, petals x1; D, gynoecium x6; E, androecium x3.

2--3 mm in diameter, pale green, densely pilose with curly hairs interspersed with long glandular hairs, branched, bearing 2--3 pseudo-umbellets; peduncles 35--70 mm long and 1,5--2 mm in diameter, indumentum as on scape; bracts irregular in form and size, densely hirsute; pseudo-umbellet 10--30 flowered, subtended by a whorl of subulate bracts; bracts 3--4 mm long, abaxially hirsute with appressed hairs and interspersed with glandular hairs, initially erect, recurved during senescence. **Pedicel** *ca.* 1 mm long. **Hypanthium** 40--55 mm long (4--5 times the length of the calyx), pale green, indumentum as on scape. **Sepals** 5, posterior one narrowly triangular, remaining four lanceolate, apices acuminate, 10 x 1,5--3 mm, recurved, pale green, indumentum abaxially as on scape, only less dense. **Petals** 5, cream-coloured to salmon-pink, connivent, forming a sheath-like structure; posterior two with V-shaped pink markings, ligulate, slightly curved, bases cuneate, apices rounded, slightly recurved during anthesis, 24--28 x 4 mm; anterior three dimly marked pink at the very base, ligulate to spatulate, bases cuneate, apices rounded, patent during anthesis, 20--24 x 2--2,5 mm. **Stamens**: staminal column 1,5--2 mm long, white; perfect stamens 5, concealed in the floral sheath, posterior one *ca.* 2,5 mm long, lateral two 4 mm long, erect, anterior two 10 mm long, free filaments white; staminodes *ca.* 2,5 mm long; anthers *ca.* 1 mm long, dark pink, pollen orange. **Gynoecium**: ovary 3 mm long; style 4,5 mm long, pink; stigma branches 1 mm long, pink. **Fruit**: bases of mericarps *ca.* 5 mm long and tails *ca.* 23 mm long. (Figure 8.27.1).

Diagnostic features and affinities

P. connivens is a geophyte with erect leaves and rigid petioles. The laminae are irregularly pinnate to bipinnatisect and densely hirsute with appressed hairs. The hypanthia of the cream-coloured to salmon-pink flowers are about four to five times the length of the calyx. There are five fertile stamens, of which the posterior one and the lateral two are very short and the lateral two are erect. The anterior two stamens are more or less the same length as the calyx. The petals are 2,5 to three times the length of the calyx, connivent, forming a sheath-like structure in which all the stamens are concealed, hence the specific epithet. The pink V-shaped markings on the posterior two petals give the flower a salmon-pink appearance.

In respect to the leaf form and the structure of the androecium *P. connivens* resembles *P. aciculatum*, *P. confertum* and *P. fasciculaceum*. However, it reveals a closer relation with *P. fasciculaceum* because both species have long hypanthia and long ligulate petals with V-shaped markings on the posterior two. These two species differ in respect to the orientation and the colour of the petals (Marais 1991).

Geographical distribution and ecology

Only two collections of *P. connivens* are known, both from Rondekop near Nieuwoudtville (Figure 8.27.2). This area receives an annual rainfall of 200–300 mm, mainly during winter. It flowers from December to January.

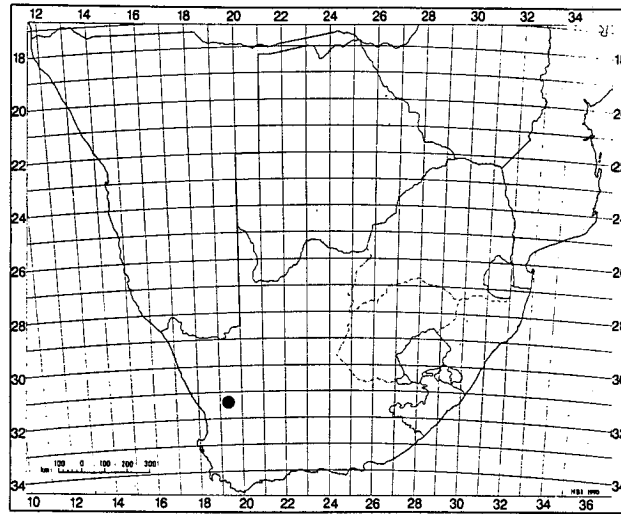


Figure 8.27.2 Geographical distribution of *P. connivens*.

Material studied

–3119 (Calvinia): Rondekop near Nieuwoudtville (-AD), *Lavranos & Pehlemann 19000* (K, PRE, STE); *Lavranos & Pehlemann 19001* (STEU).

LUTEUM GROUP

Geophytes with irregularly pinnate or bipinnatisect leaves. Scape branched, bearing 2–9(-12) pseudo-umbellets with 6–23 flowers each. Hypanthium 20–35 mm long. Flowers with yellow or pale yellow, ligulate to spatulate petals and V-shaped markings on the posterior petals. Stamens 2 or 5 fertile, twisted so that pollen surfaces are facing to the front. Tectum of pollen striate-reticulate.

8.28 *Pelargonium luteum* (*Andr.*) *G. Don*, *A general system of gardening and botany* 1: 726 (1832); *Loudon*: 271 (1832); *Knuth*: 346 (1912). **ICONOTYPE**: *Andrews*, *The Botanist's Repository* 6: t. 423 (1805a).



Figure 8.28.1 *Pelargonium luteum*. A, flowering plant x1; B, plant with leaves x1; C, petals x2; D, gynoecium x4; E, androecium x4; F, leaf base x1.5.

Geranium luteum Andr.: t. 423 (1805a). ICONOTYPE: Andrews, The Botanist's Repository 6: t. 423 (1805a).

Hoarea lutea (Andr.) Sweet: 76 (1826c).

A geophyte 110--200 mm tall when in flower. **Tuber:** a turnip-shaped or elongated root 20--60 mm long and 25--40 mm in diameter. **Leaves** green, petiolate; lamina elliptic, irregularly pinnate to bipinnatisect, 50--120 mm long; pinnae 10--40 mm long, incised, segments lacinate, adaxially and abaxially sparsely hirsute with appressed hairs and sparsely interspersed with glandular hairs; petiole 20--80 mm long and 1,5--2 mm in diameter, rigid, erecto-patent, covered with glandular hairs interspersed with appressed stiff hairs; stipules subulate or narrowly triangular, adnate to petioles for half to almost their total length, 5--10 mm long and 1--2 mm wide, ciliate. **Inflorescence:** scape 10--25 mm long, 1,5--3 mm in diameter, branched, bearing 4--9(-12) pseudo-umbellets with 6--16(-20) flowers each; peduncles 50--150 mm long, 1--2 mm in diameter, hirsute with appressed curly hairs interspersed with long glandular hairs; bracts lanceolate, 2--5 mm long, 1--2 mm wide, abaxially hirsute with appressed hairs, interspersed with glandular hairs. **Pedice**l *ca.* 0,5 mm long. **Hypanthium** 20--33 mm long, reddish green, indumentum as on peduncle. **Sepals** 5, lanceolate, apices acute, 6--8 mm long, 1--3 mm wide, posterior one erect, others recurved, reddish green with white margins, indumentum abaxially as on peduncle. **Petals** 5, yellow, patent during anthesis; posterior two with pale pink or red V-shaped markings, ligulate to spatulate, bases cuneate, apices rounded or emarginate, recurved, 11--15 x 2,5--4 mm; anterior three ligulate, bases attenuate, apices rounded or obtuse, 11--15,5 x 2--2,5 mm. **Stamens:** staminal column 1--3 mm long, white; perfect stamens 5, posterior one 3--4 mm long, lateral two 5,5--7,5 mm long, anterior two 7--9 mm long, white, free filaments of lateral and anterior ones twisted so that pollen surfaces of anthers are turned to the front; staminodes 2--3,5 mm long; anthers dark pink, 1--2 mm long, the posterior one smaller than the others, pollen orange. **Gynoecium:** ovary 1,5--5,5 mm long; style 1,5--5,5 mm long, white; stigma branches 1--2 mm long, adaxially wine-red. **Fruit:** bases of mericarps 4--6 mm long, with glandular hairs, tails 21--25 mm long. (Figure 8.28.1).

Diagnostic features and affinities

P. luteum is a geophyte with irregularly pinnate to bipinnatisect leaves and yellow flowers, hence the specific epithet. The androecium of *P. luteum* is typical for the genus *Pelargonium* and for the section *Hoarea* in having ten filaments and five fertile stamens. However, the way in which the fertile stamens are borne during anthesis, is unique. The

posterior stamen is bent, pushing aside the pistil. At the same time the filaments of the lateral and anterior stamens are twisted so that the open anthers form a pollen-lined tunnel to the nectar tube (Figure 8.28.2). A remarkable elongation of the pistil occurs after the anthers are dropped. This is aimed at cross-pollination, and the special structure of the androecium is an indication of a special pollinator for this species, explaining the poor fruit formation in the Botanic Garden.

The delicate appearance of the pseudo-umbellets, the colour and the form of the petals and the way in which the fertile stamens are borne in *P. luteum*, indicate a relationship with *P. fumariifolium*.

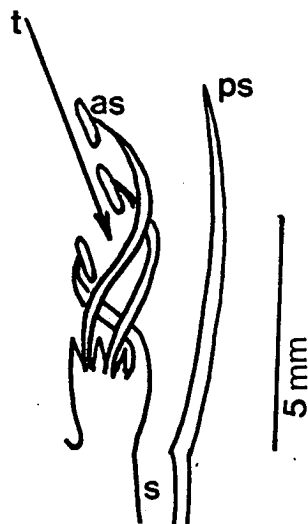


Figure 8.28.2 Androecium of *P. luteum*, as = anterior stamen, ps = posterior sepal, s = spur, t = tunnel

Geographical distribution and ecology

The known distribution area of *P. luteum* is very small. It has only been recorded from the area around Nieuwoudtville and Calvinia (Figure 8.28.3) in rocky places in sand in karroid vegetation. This area has very hot summers and an annual rainfall of 200–300 mm, which occurs mainly in winter. *P. luteum* flowers from October to November. Each plant has a large number of pseudo-umbellets which flower in succession, thus lengthening the flowering period of the plant. In spite of the long flowering time and the large number of flowers per plant, fruit formation in the Botanic Garden is very poor. This may be ascribed to the absence of a special pollinator for this species in the garden. At the end of the flowering time all the leaves have died.

Material studied

--3119 (Calvinia): 11 km from Nieuwoudtville to Brandkop (-AC), *Fischer 33* (STEU); Ambraalshoek, Calvinia (-BD), *Marais 120, 121* (STEU); Foot hills of Teefontein se punt (-BD), *Marais 270, 271* (STEU); 8 km N of Die Bos on Ceres - Calvinia road (-DC), *Perry 3243* (NBG, STEU).

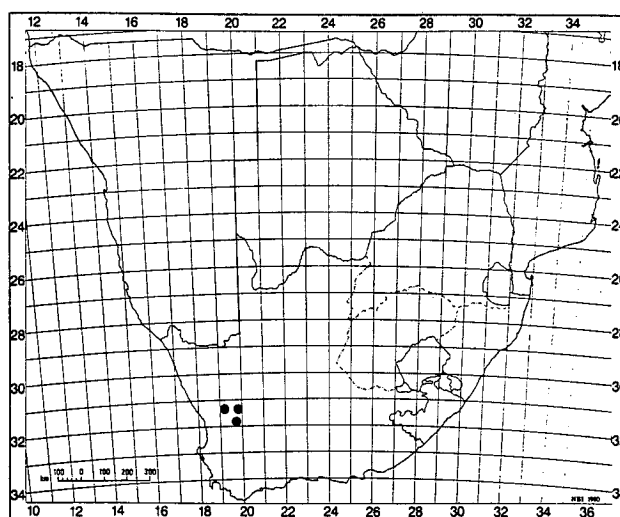


Figure 8.28.3 Geographical distribution of *P. luteum*.

8.29 *Pelargonium fumariifolium* Knuth in *Planzenreich* 4, 129: 347 (1912); Compton: 294 (1931). TYPE - Cape Province: "Nama'land minor", *Scully 210* (BOL, holo!).

A geophyte 80--230 mm tall when in flower. **Tuber:** a turnip-shaped or elongated, sometimes moniliform root 15--60 mm long and 15--30 mm in diameter. **Leaves** green, petiolate; lamina trullate in outline, pinnate to bipinnatisect with 3 or 5 pinnae, 70--130 x 70--140 mm; pinnae 40--90 mm long, lobed to lacinate, adaxially and abaxially hirsute with appressed hairs interspersed with very short glandular hairs; petiole 60--80 mm long and 1--2 mm in diameter, rigid, erecto-patent, densely hirsute with short appressed hairs; stipules subulate, adnate to petioles for half their length, 8--9 mm long and 1--2 mm wide, hirsute. **Inflorescence:** scape 20--150 mm long, 1--3 mm in diameter, branched, bearing 2--6 pseudo-umbellets with (8-)14--23 flowers each; peduncles 20--90 mm long, 1--2 mm in diameter, dark reddish brown, sparsely hirsute with appressed hairs interspersed with short glandular hairs; bracts lanceolate, 2--3 mm long, 1 mm wide, reclinate, abaxially densely hirsute with appressed hairs. **Pedicel** ca. 0,5 mm long. **Hypanthium** 24--35 mm long, pale green, indumentum as on peduncle. **Sepals** 5,

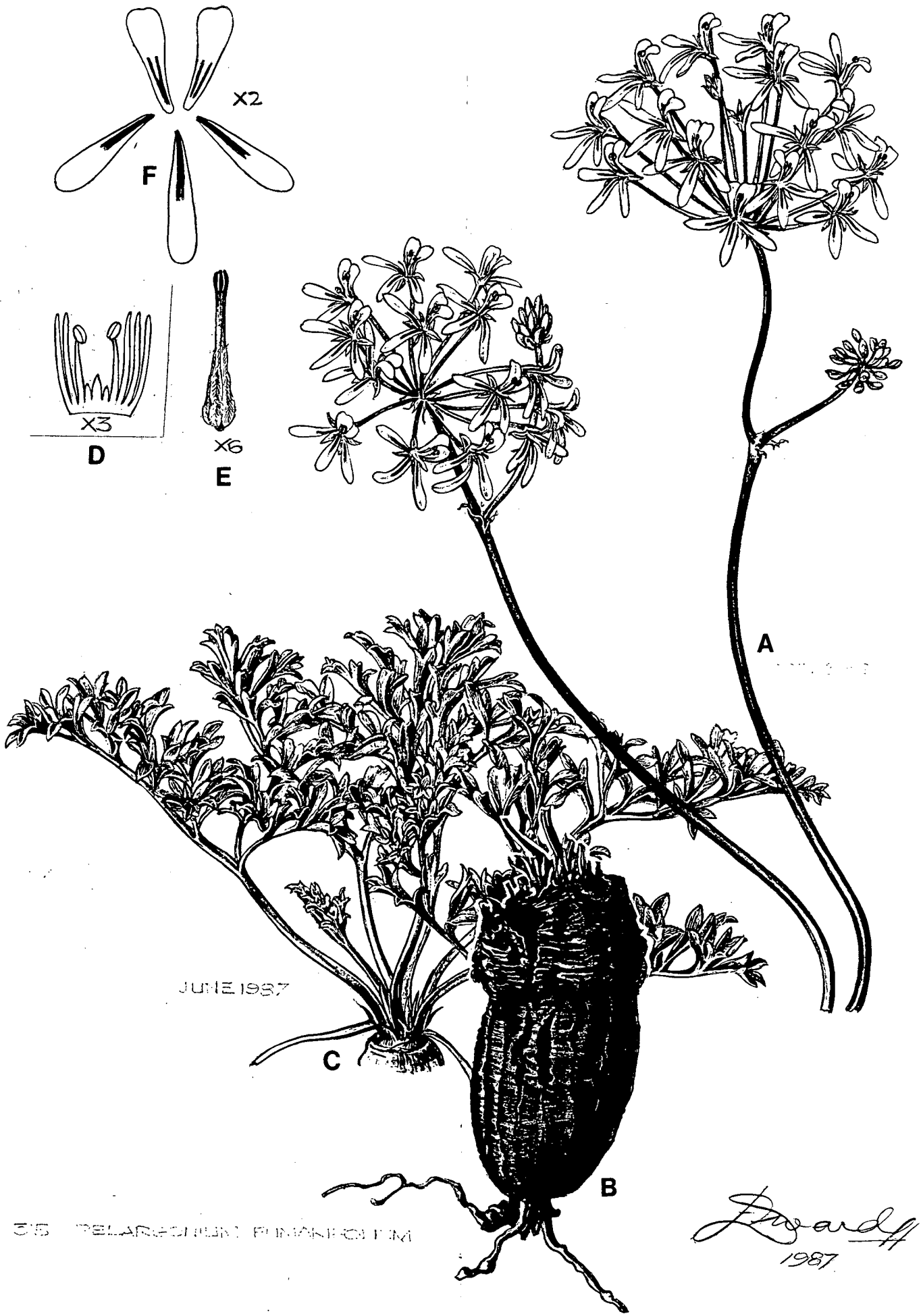


Figure 8.29.1 *Pelargonium fumariifolium*. A, inflorescence x1; B, tuber x1; C, plant with leaves x1; D, androecium x3; E, gynoecium x6; F, petals x2.

lanceolate, apices acute, 4--6 mm long, 1--2 mm wide, patent during anthesis, pale green with membranous margins, abaxially densely hirsute with appressed hairs, interspersed with glandular hairs. **Petals** 5, pale yellow, patent during anthesis; posterior two with pale pink V-shaped markings, ligulate to spatulate, bases cuneate, apices rounded or emarginate, recurved, 8--10 x 2--3 mm; anterior three with a single dark pink stripe on each, spatulate, bases attenuate, apices rounded, recurved, 9,5--13 x 2--3 mm. **Stamens:** staminal column 1--1,5 mm long, white; perfect stamens 2, in lateral position, 4--6 mm long, protruding from the flower, free filaments white, twisted so that pollen surfaces of the anthers are turned to the front; posterior staminodes 1,5--2 mm long, anterior five staminodes 4--6 mm long, protruding from the flower; anthers dark pink, 1--1,5 mm long, pollen yellow. **Gynoecium:** ovary 2--4 mm long; style 1--3 mm long, pink; stigma branches 1 mm long, adaxially dark pink. **Fruit:** bases of mericarps 4 mm long, with glandular hairs, tails *ca.* 24 mm long. (Figure 8.29.1).

Diagnostic features and affinities

The androecium of *P. fumariifolium* is unique for the genus. The flower has only two fertile stamens which are in the lateral position. The filaments of these two stamens are twisted so that the pollen surfaces are facing to the front as in *P. luteum* and *P. carolihenrici*. The posterior staminodes are short (1,5--2 mm), but the five anterior ones are long (4--6 mm) and protrude from the flower. These long staminodes are unique for *Pelargonium*, because staminodes usually are short and concealed within the floral sheath.

P. fumariifolium is closely related to *P. luteum* because of the similarities in the form of the petals and the way the anthers are borne during anthesis. The pseudo-umbellets of both species have a very delicate appearance. The two species differ in leaf form, the indumentum of the scape, the hypanthium and the sepals as well as the number of fertile stamens. *P. fumariifolium* usually has more flowers per pseudo-umbellet than *P. luteum*.

The epithet *fumariifolium* refers to the leaves of *Fumaria* of the Fumariaceae, plants with much-divided leaves.

Geographical distribution and ecology

Although *P. fumariifolium* has a wide distribution area, only a few collections are known. This may possibly be because plants usually occur in small populations and are difficult to find. It occurs from Kaus Mountains in Namaqualand in the north to Ceres-

Karoo in the south and Whitehill in the east (Figure 8.29.2), an area with an annual rainfall of 100–300 mm, occurring mainly in winter. Plants grow in rocky areas in sandy soil or in compacted clayey sand, in renosterveld or karroid vegetation. *P. fumariifolium* flowers from late October to November after the leaves have died.

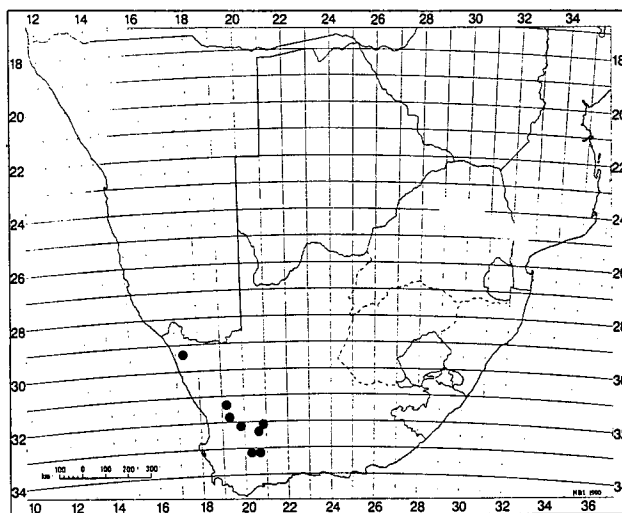


Figure 8.29.2 Geographical distribution of *P. fumariifolium*.

Material studied

- 2917 (Springbok): Kaus Mountains (-AD), *Drège s.n.* (P).
- 3119 (Calvinia): 2 miles E of Nieuwoudtville (-AC), *Barker 9646* (NBG); Top of Botterkloof Pass (-CD), *Taylor 11998* (STE).
- 3220 (Sutherland): S of Sutherland, 3 km on the Ouberg turnoff (-BC), *Marais 240* (STEU).
- 3319 (Worcester): Spes Bona, Ceres-Karoo (-BB), *Marloth 13135* (PRE).
- 3320 (Montagu): 74 km on Karoo Poort - Matjiesfontein road (-AB), *Marais 391* (STEU); Whitehill, Karoo Garden (-BA), *Compton s.n.*, *3617* (BOL); *Compton 13930*, *16386* (NBG).

INCRASSATUM GROUP

Geophytes with various leaf forms. Scape unbranched or branched, bearing 2--4(-7) pseudo-umbellets with 2--55 flowers each. Flowers white, cream-coloured, yellow, pink, bright pink or bright purple, with an obvious difference in form and size between the posterior two and the anterior three. Stamens 5 fertile, of different lengths, protrude from the flower, remain straight during anthesis.

8.30 *Pelargonium incrassatum* (Andr.) Sims in Curtis's botanical magazine 20: t. 761 (1804); Pers.: 228 (1806); Ait. f.: 165 (1812); DC.: 654 (1824); Spreng.: 53 (1826); Loudon: 570 (1829); G. Don: 727 (1831); Loudon: 271 (1832); Steud.: 678 (1840); Steud.: 287 (1841); Harv.: 271 (1860); Knuth: 344 (1912); Van Druten: t. 1134 (1952); Van der Walt & Vorster: 79, fig. (1981). **ICONOTYPE:** Andrews, The Botanist's Repository 4: t. 246 (1802b).

Geranium incrassatum Andr.: t. 246 (1802b); Poir.: 758 (1812). **ICONOTYPE:** Andrews, The Botanist's Repository 4: t. 246 (1802b).

Hoarea incrassata (Andr.) Sweet: 75 (1826c).

Geranospermum incrassatum (Andr.) Kuntze: 95 (1891).

Geranium roseum Andr.: t. 173 (1801b). **ICONOTYPE:** Andrews, The Botanist's Repository 3: t. 173 (1801b).

Pelargonium roseum (Andr.) Ait. f.: 161 (1812); DC.: 651 (1824); Spreng.: 52 (1826); Loudon: 568 (1829); G. Don: 726 (1831); Loudon: 271 (1832); Steud.: 289 (1841); Harv.: 268 (1860); non Ehrh. (1792).

Hoarea rosea (Andr.) Sweet: t. 262 (1825); Sweet: 76 (1826c).

Geranospermum roseum (Andr.) Kuntze: 95 (1891).

Pelargonium condensatum Pers.: 227 (1806): substitute name for *G. roseum* Andr.: t. 173 (1801b); Steud.: 679 (1840); Steud.: 285 (1841).

Geranium condensatum (Pers.) Poir.: 757 (1812).

Pelargonium centauroides DC.: 652 (1824); Spreng.: 53 (1826); G. Don: 727 (1831); Harv.: 271 (1860). **TYPE - Africa:** De Candolle herbarium 44 (G-DC, lecto!, designated here.)

Geranospermum centaurodes (DC.) Kuntze: 94 (1891), (by mistake).

A geophyte 120--300(-370) mm tall when in flower. **Tuber:** a turnip-shaped or moniliform root, often with more than one stem-growing point, 12--40 mm long and 12--40(-55) mm in diameter. **Leaves** green, petiolate; lamina pinnatilobed to irregularly pinnate, ovate or narrowly ovate in outline, base cuneate or truncate, 20--110 x 20--70 mm; pinnae vary from obovate to obtriangular with apices obtuse to irregularly incised, 10--25(-45) mm long, adaxially and abaxially densely hirsute, interspersed with short glandular hairs; petiole 20--60(-130) mm long and 1--4 mm in diameter, prostrate to erecto-patent, hirsute with curly hairs, interspersed with glandular hairs and long soft patent non-glandular hairs; stipules subulate, adnate to the petioles for half their length, apices free, 8--18 mm long and 1--1,5 mm wide, ciliate. **Inflorescence:** 1--4 scapes per

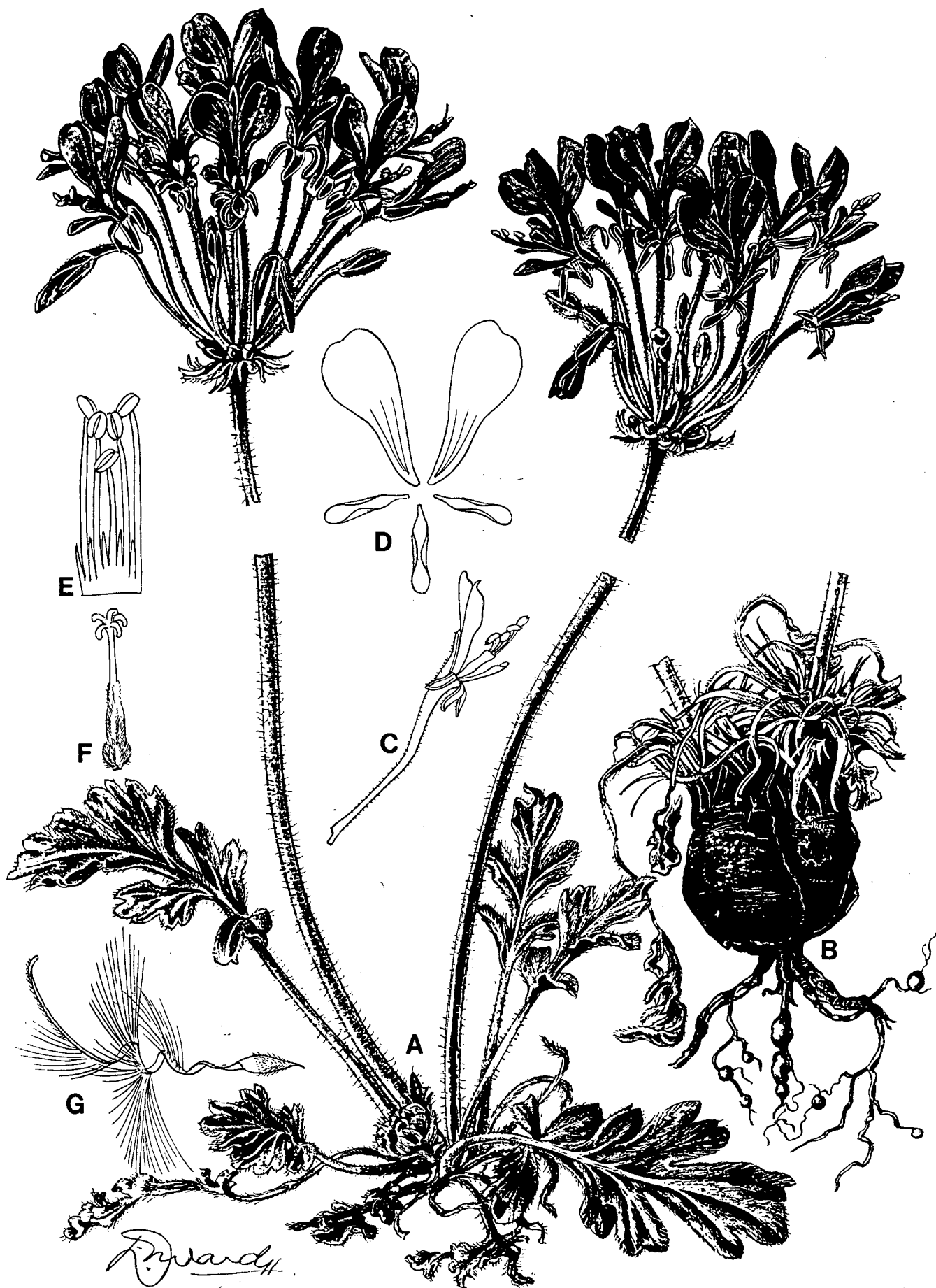


Figure 8.30.1 *Pelargonium incrassatum*. A, flowering plant x1; B, tuber x1; C, flower x1; D, petals x1,5; E, androecium x2; F, gynoecium x3; G, mericarp x2.

plant, scape 80-270 mm long, 2--5 mm in diameter, hirsute with curly hairs, interspersed with glandular hairs and long soft patent non-glandular hairs, usually unbranched; pseudo-umbel with (15-)20--55 flowers; bracts subulate, 6--8 mm long, *ca.* 1 mm wide, reflexed, abaxially densely hirsute. **Pedicel** 1--4 mm long. **Hypanthium** 27--42 mm long, slightly curved, green, densely covered with glandular hairs. **Sepals** 5, lanceolate, apices acute, 8--12 mm long, 1--4,5 mm wide, posterior one erect, others reflexed, green with membranous margins, abaxially densely hirsute, interspersed with glandular hairs. **Petals** 5, bright purple or bright pink, with claws white; claws patent during anthesis, forming a floral sheath, apices recurved; posterior two unguiculate-obovate, claws curved, apices rounded or emarginate, 17--25 x 4--10 mm; anterior three spatulate, bases narrowly cuneate, apices rounded, 8--12,5 x 2--4 mm. **Stamens**: staminal column 2--6 mm long, white, smooth; perfect stamens 5, protruding from the flower, remaining straight during anthesis, posterior one 7,5--14 mm long, lateral two 8,5--15,5 mm long, anterior two 10--17,5 mm long, free filaments purple-pink; staminodes 3,5--7 mm long; anthers dark pink, 2--2,5 mm long, pollen yellow. **Gynoecium**: ovary 4--10 mm long; style 3--12 mm long, pale pink; stigma branches 0,8--2 mm long, adaxially wine-red. **Fruit**: bases of mericarps 5--6 mm long, without glandular hairs, tails 32--35 mm long. (Figure 8.30.1).

Diagnostic features and affinities

P. incrassatum is a very attractive species with a large number of brilliant pinkish purple flowers, borne in a pseudo-umbel on an unbranched scape. The tuber often develops more than one stem-growing point, each producing a scape with a many-flowered pseudo-umbel. The floral structure of this species is very similar to that of *P. grenvilleae*. In both species the hypanthia are slightly curved and the posterior two petals are larger than the anterior ones. Both species have five fertile stamens which remain straight during anthesis and at the same time an excessive lengthening of the style takes place. The two species differ in respect to the colour of the flower and the leaf form. *P. incrassatum* has bright purple flowers and irregularly pinnate leaves, whereas *P. grenvilleae* has cream-coloured flowers and simple leaves.

According to the original publication (Andrews 1802b), the specific epithet *incrassatum* refers to the thickened, succulent leaves of this species. This is, however erroneous, as the leaves are neither succulent nor thickened.

Geographical distribution and ecology

P. incrassatum is restricted to Namaqualand and occurs from the Richtersveld in the north to the Heerenlogementsberg and Nardouw flats in the south (Figure 8.30.2). This is a very hot and arid area with a scant annual rainfall of 150–300 mm occurring mainly in winter. *P. incrassatum* grows in mountain karroid vegetation, short karroid or succulent shrub or broken Namaqualandveld. Sometimes single plants, but more often large populations occur in rocky outcrops, quartzite areas, weathered granite soils, deep or shallow sand or in shale, causing a splendid sight at springtime in Namaqualand. Plants grow in direct sunlight, but also occur under bushes. It is one of the early flowering species of section *Hoarea*, and one of the few species of this section of which the flowering time coincides with the peak of the flowering time in Namaqualand. It flowers from August to October when the leaves are withering.

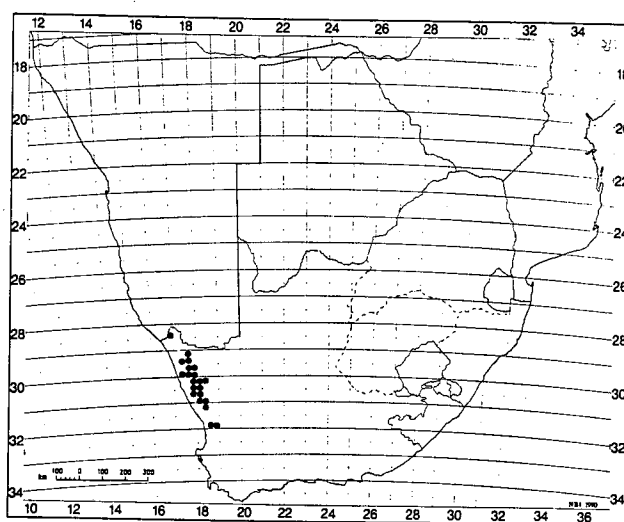


Figure 8.30.2 Geographical distribution of *P. incrassatum*.

Material studied

--2816 (Oranjemund): Die Koei, Helskloof, Richtersveld (-BD), *Drijfhout 2942a* (STEU).

--2917 (Springbok): Karakuis (-AD), *Drège s.n.* (P); Klipfontein (-BA), *Bolus 1112* (BM, BOL, G, P, SAM, UPS); *Herre s.n.* (STE); *Van der Walt 1398* (STEU); 8 km W of Steinkopf (-BA), *Drijfhout 2971a* (STEU); Steinkopf (-BC), *Lewis 5497* (NBG); *Schlechter s.n.* (MO, P); Between Brakwater & Komaggas (-CD), *Hall 150* (NBG); Spektakel Pass (-DA), *Barker 1298* (NBG); *Boucher 73* (STEU); Spektakelberg (-DA), *Thompson 1038* (STE); Nigramoep (-DA), *Wikner s.n.* (SAM); Between Zilverfontein & Kooperenberge (-DB), *Drège s.n.* (G); Nababeeb Golf-course (-DB), *Marais 132* (STEU); Wildepaardehoek Pass (-DC), *Botha 2949* (PRE); Grootvlei (-DC), *Compton 17294* (NBG); *Middlemost*

1640 (NBG); *Swart s.n.* (STE); Sannagas (-DC), *Drijfhout 2783* (STEU); Mesklip (-DD), *Compton 5500* (BOL, P).

-3017 (Hondekliptbaai): 6,5 miles W of Kamieskroon (-BB), *Acocks 14872* (PRE); Grootvlei W of Kamieskroon (-BB), *Acocks 16450* (P, PRE); *Lewis 4363* (SAM); *Martin 1033* (NBG); *Van Jaarsveld 1408* (NBG); Grootvlei Pass W of Kamieskroon (-BB), *Van der Walt 789* (STEU); 4 km E of Grootvlei (-BB), *Van Jaarsveld 4276* (STEU); Kamieskroon (-BB), *Esterhuysen 5699* (BOL); *Hall s.n.* (NBG); *Henrici 2155, 2180* (PRE); *Marloth 13270* (PRE); *Thorne s.n.* (SAM); 2 km from Kamieskroon to Leliefontein (-BB), *Archer s.n.* (STE); 8,4 km from Kamieskroon to Bovlei (-BB), *Fischer 1* (STEU); 1 km S of Kamieskroon (-BB), *Hugo 2888* (STE); 1 mile N of Kamieskroon (-BB), *Theron 1337* (PRE); E of Kamiesberg Pass (-BB), *Marais 284* (STEU); Between Garies & Okiep (-BB), *Marloth 6726* (PRE); Bowesdorp (-BB), *Stokoe SAM57285* (SAM); 20 km from Garies to Kamieskroon (-BD), *Boucher 63* (STEU); Between Garies & Kamieskroon (-BD), *De Vos 1721* (STE); S of Darter's Grave (-BD), *Hall 126* (NBG); Near Garies (-DB), *Van der Walt 167* (STE); 5 miles N of Garies (-DB), *Lewis 1177* (SAM); 4 miles N of Garies (-DB), *Salter 1399* (BM).

-3018 (Kamiesberg): Pedroskloof, N of Leliefontein (-AA), *Archer s.n.* (STE); 9 km from Kamiesberg Pass to Leliefontein (-AA), *Marais 285* (STEU); Leliefontein (-AB), *Drège 7492* (P); 10 km from Kamieskroon to Kamiesberg (-AB), *Schonken 165* (STEU); Gorap (-AB), *Watermeyer s.n.* (PRE); Kasparskloof (-AC), *Drège s.n.* (P); Eselsfontein (-AC), *Hall 142* (NBG); *Markötter s.n.* (PRE); Kamiesberg (-AC), *Marais 60* (STEU); *Marloth 12494* (PRE); *Salter s.n.* (BOL); 3 km from Leliefontein to Kamieskroon (-AC), *Marais 74* (STEU); 28 km from Garies to Leliefontein (-AC), *Thompson 433* (STE); N of Garies (-CA), *Taylor 1061* (BOL); Between Bitterfontein & Stinkfontein (-CC), *Pearson 6523* (BM); Farm Kamagap, 10 km NE of Bitterfontein (-CD), *Nordenstam & Lundgren 1457* (STE); 6 miles from Bitterfontein to Pofadder (-CD), *Thompson 304* (PRE).

-3118 (Vanrhynsdorp): Nieuwe Rust (-AB), *Bolus 19345* (BOL); *Schlechter 11005* (BM, BOL, E, Gx2, GRA, Lx2, MO, P, PRE, S, Z); Near Nieuwe Rust (-AB), *Bolus s.n.* (BOL); Quaggaskop farm, 1 km W of Nuwerus (-AB), *Le Roux 2270* (STE); 5 km N of Nuwerus (-AB), *Nordenstam & Lundgren 1488* (STE); Spitsberg, SE of Nuwerus (-AB), *Oliver 5940* (STE); Heerenlogementsberg (-DC), *Boucher s.n.* (STE); Nardouwvlakte, Clanwilliam (-DD), *Stokoe 8456* (BOL).

8.31 *Pelargonium grenvilleae* (Andr.) Harv. in *Flora Capensis* 1: 265 (1860); Knuth: 331 (1912). ICONOTYPE: Andrews, *Geraniums*: C, ic (1811).

Geranium grenvilleae Andr.: C, ic (1811). ICONOTYPE: Andrews, *Geraniums*: C, ic (1811).

Geranospermum grenvilleae (Andr.) Kuntze: 95 (1891).

Grenvillea conspicua Sweet: t. 262, f. 2 (1825): substitute name for *G. grenvilleae* Andr.: C, ic (1811).

Pelargonium conspicuum (Sweet) G. Don: 731 (1831); Steud.: 678 (1840); Steud.: 285 (1841).



Figure 8.31.1 *Pelargonium grenvilleae*. 1, flowering plant x1; 2, tuber x1; 3, petals x2; 4, androecium x3; 5, flower without petals x1; 6, gynoecium x4.

A small geophyte 70--150 mm tall when in flower. **Tuber:** a turnip-shaped root, sometimes with more than one stem-growing point, 17--35 mm long and 10--25 mm in diameter. **Leaves** greyish green, petiolate; lamina simple, ovate or widely ovate, base cuneate or truncate, apex obtuse or rounded, margin crenulate, 18--40(-60) x 15--35(-45) mm, adaxially and abaxially covered with long and short glandular hairs, sometimes interspersed with patent non-glandular hairs; petiole 13--50 mm long and 1--3 mm in diameter, prostrate, covered with glandular hairs; stipules subulate, almost completely adnate to the petioles with only the extreme apices free, 5--12 mm long and *ca.* 1 mm wide, covered with glandular hairs, margins ciliate. **Inflorescence:** scape 30--120 mm long, 2--3 mm in diameter, covered with glandular hairs, usually unbranched; pseudo-umbel with 10--28 flowers; bracts lanceolate, 4--10 mm long, 2--3 mm wide, sometimes reflexed, adaxially hirsute, abaxially covered with glandular hairs and near the margins with non-glandular hairs. **Pedicel** 1--4(-10) mm long (younger flowers with long pedicels). **Hypanthium** 25--40 mm long, slightly curved, green, densely covered with glandular hairs. **Sepals** 5, lanceolate, apices acute, 7,5--10 mm long, 1--3 mm wide, posterior one erect, others reflexed, green with membranous margins, abaxially covered with glandular hairs and with non-glandular hairs near the margins. **Petals** 5, cream-coloured, with dark pink markings on the claws; claws patent during anthesis, forming a floral sheath, apices recurved; posterior two unguiculate-obcordate, claws curved, apices emarginate, 14--19 x 5--9 mm; anterior three obovate, bases narrowly cuneate, apices rounded, 12--15 x 3,5--6 mm. **Stamens:** staminal column 2--5 mm long, white or pale pink, smooth; perfect stamens 5, protruding from the flower, remaining straight during anthesis, posterior one 6--9 mm long, lateral two 7--10 mm long, anterior two 7--12 mm long, free filaments dark pink; staminodes 3--6 mm long; anthers dark pink, 1,2--2,2 mm long, pollen orange. **Gynoecium:** ovary 3,5--7 mm long; style 2--6 mm long, pale pink; stigma branches 0,5--1 mm long, adaxially dark pink. **Fruit:** not seen. (Figure 8.31.1).

Diagnostic features and affinities

P. grenvilleae is a small geophyte with simple prostrate leaves and cream-coloured flowers. The scape is usually unbranched, but the tuber often develops more than one stem-growing point, each producing a scape with a pseudo-umbel. The floral structure of this species is very similar to that of *P. incrassatum*. In both species the hypanthia are slightly curved and the posterior two petals are larger than the anterior ones. Both species have five fertile stamens which remain straight during anthesis and at the same time an excessive lengthening of the style takes place. The two species differ in respect to the colour of the flower and the leaf form. *P. incrassatum* has bright purple or bright

pink flowers and irregularly pinnate leaves, whereas *P. grenvilleae* has cream-coloured flowers and simple leaves.

According to the original description, *P. grenvilleae* is a very large plant with pale flesh-coloured flowers and four fertile stamens, and according to the illustration the flowers have pale pink petals. All the specimens examined for this project, are small plants (70--150 mm tall) and none of them have pinkish or flesh-coloured flowers or only four fertile stamens. In spite of this, I have no doubt that the specimens examined, are those of *P. grenvilleae*, because no other plants known, match the original illustration better than these ones. *P. grenvilleae* is named in honour of Lord W.W. Grenville by whom it was introduced to England in the summer of 1810 (Andrews 1811).

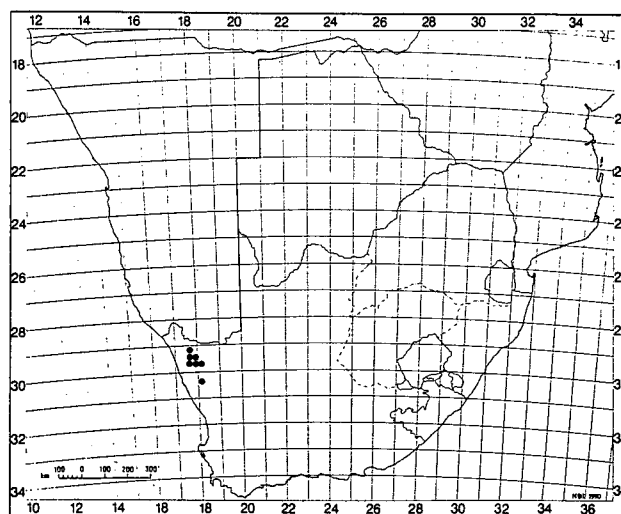


Figure 8.31.2 Geographical distribution of *P. grenvilleae*.

Geographical distribution and ecology

P. grenvilleae is restricted to Namaqualand and occurs from Steinkopf in the north to Kamiesberg in the south (Figure 8.31.2). This is a very hot and arid area with a scant annual rainfall of 150--300 mm occurring mainly in winter. *P. grenvilleae* grows in sand or loam, and plants often occur under bushes. It flowers in spring, from September to October when the leaves are withering. The smaller geographical distribution of *P. grenvilleae* coincides with the much larger area occupied by *P. incrassatum*.



Figure 8.32.1 *Pelargonium moniliforme*. A, flowering plant x1; B, androecium x2; C, gynoecium x2; D, petals x1; E, tuber x1.

Material studied

--2917 (Springbok): 3 km W of Steinkopf (-BA), *Williamson 3950* (STEU); 4,5 km W of Steinkopf (-BA), *Williamson 3951* (STEU); Steinkopf (-BC), *Meyer sub. Marloth 6560* (PRE); Anenous Mountains (-BC), *Taylor 1128* (BOL); Tierkloof near Steinkopf (-BD), *Van Breda 1362* (PRE); 23 km from Springbok to Kleinsee (-DA), *Marais 131* (STEU); 15 miles E of Springbok (-DB), *Hall NBG1088/50* (NBG); Springbok (-DB), *Le Roux s.n.* (STEU); Concordia (-DB), *Schlechter 11365* (BOL); Hester Malan Wild Flower Reserve (-DB), *Van der Walt 1406* (STEU).

--2918 (Gamoep): Hester Malan Wild Flower Reserve, plot 72 (-CA), *Rosch & Le Roux 1031* (PRE).

--3018 (Kamiesberg): E slope of Rooiberg (-AC), *Oliver s.n.* (STEU).

8.32 *Pelargonium moniliforme* Harv. in *Flora Capensis* 1: 264 (1860); Knuth: 333 (1912); Glover: 199 (1917); Marloth: 87 (1925); Compton: 295 (1931); Dyer: t. 9342 (1934). TYPE - Cape Province: Zilverfontein, *Drège s.n. sub. P. moniliforme* (TCD! lecto, here designated; CGE!, E!, Gx4!, K!, MEL!, MO!, OXF!, Px2!, PRE!, S!, SAM!, Wx2!); *Zeyher 2067* (S!).

Geranospermum moniliforme (Harv.) Kuntze: 95 (1891).

A deciduous geophyte 140--400 mm tall when in flower. **Tuber:** a turnip-shaped or elongated root, 15--40 mm long and 7--25 mm in diameter, main root and lateral roots sometimes with a series of small tubers at short intervals. **Leaves** simple to tripartite, green, petiolate; lamina broadly ovate to trullate, apex rounded to obtuse, base widely cuneate, truncate or cordate, margin entire to crenate-lobulate, 15--65 x 15--60 mm, covered with long glandular hairs, abaxially also hirsute along main veins, margins ciliate with appressed or patent stiff hairs; petiole 20--80 mm long and 2--3 mm in diameter, prostrate, densely covered with long glandular hairs interspersed with soft patent hairs; stipules subulate, adnate to petioles with apices free, 6--10 mm long and *ca.* 1 mm wide, ciliate. **Inflorescence:** scape usually unbranched, 75--310 mm long, 2--5 mm in diameter, wine-red, covered with very long (3--4 mm) patent hairs interspersed with glandular hairs; pseudo-umbel with 12--40(-50) flowers; bracts narrowly triangular, 5--10 x 1--2 mm, recurved, adaxially hirsute with distally appressed hairs and abaxially hirsute, interspersed with glandular hairs. **Pedicel** 0,5--2 mm long. **Hypanthium** 20--77 mm long, wine-red, indumentum as on scape. **Sepals** 5, lanceolate, apices acute, 6--10 mm long, 1,5--3 mm wide, recurved, wine-red with green apex, indumentum abaxially as on scape. **Petals** 5, cream-coloured to yellow with a wine-red blotch in the centre, spatulate, bases narrowly cuneate, apices emarginate, patent during anthesis; posterior

two 13--22 x 3--8 mm; anterior three 10,5--17,5 x 3--6,5 mm, sometimes without blotches. **Stamens:** staminal column 2--4 mm long, white, smooth, perfect stamens 5, protruding from the flower, remaining straight, posterior one 5--10 mm long, lateral two 7--12 mm long, anterior two 11--16 mm long, white, apices dark red; staminodes 4--6 mm long; anthers 1,2--2 mm long, wine red, pollen orange. **Gynoecium:** ovary 3,5--6 mm long; style 2--9 mm long, dark pink; stigma branches 0,5--2 mm long, dark pink. **Fruit:** bases of mericarps 5 mm long, without glandular hairs, tails 24--28 mm long. (Figure 8.32.1).

Diagnostic features and affinities

P. moniliforme is a geophyte with entire to tripartite prostrate leaves, the older ones larger with long petioles (*ca.* 60 mm) and the younger ones gradually reducing in size. The thick, usually unbranched scape is wine-red, bearing a pseudo-umbel with 12--40 flowers. The wine-red hypanthia are three to eight times the length of the sepals. The flowers are cream-coloured to yellow with dark red blotches. The blotches are sometimes restricted to the posterior petals. The two posterior petals are borne in such a way that the blotches appear as a single nectar guide. The five fertile stamens are long (5--16 mm) and protrude from the flower with the anterior ones 1,5--2 times the length of the sepals. The structure of the flowers and the morphology of the leaves reveal a close relation with *P. vinaceum*. The two species differ in that the plants of *P. vinaceum* are smaller than those of *P. moniliforme*, and that the flowers of the former have 2--4(-5) fertile stamens, whereas those of *P. moniliforme* always have five. During anthesis a noteworthy lengthening of the style and stigma branches takes place. This characteristic, together with the long straight stamens resemble that of several other species of section *Hoarea*, like *P. incrassatum* and *P. radicum*.

The specific epithet refers to the series of small tubers formed by the main or lateral roots. This, however, occurs in several other species in section *Hoarea* and is not unique to *P. moniliforme*.

Geographical distribution and ecology

P. moniliforme occurs from Holgat River valley in the southwest of the Richtersveld to Karoo Poort in the south and Matjiesfontein in the east (Figure 8.32.2). This area receives an annual rainfall of 100--200 mm, mainly in winter. It grows in sand or in clay, on quartzite outcrops and stony areas, on foothills or on flats, in direct sunlight, or in partial shade in rock shelters or under bushes. Sometimes it occurs in large

populations, but more often plants occur singly. It occurs in short karroid vegetation, in marginal Namaqualand broken veld (Veldtype 33, Acocks 1988), and also in tall dense shrub vegetation as in the Kamiesberge. *P. moniliforme* is grazed by animals. This may be the reason why plants more often occur under bushes than in direct sunlight, they are the only ones to survive heavy grazing. Plants growing under bushes usually have very long scapes. Flowering time is during September, at a stage when the leaves are fading.

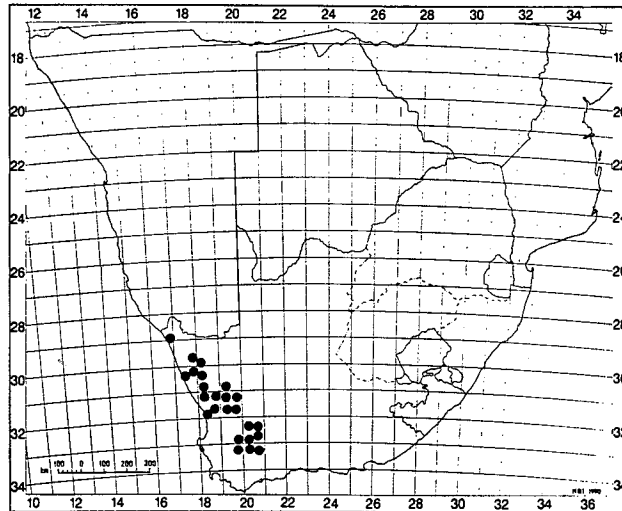


Figure 8.32.2 Geographical distribution of *P. moniliforme*.

Material studied

–2816 (Oranjemund): Holgat River valley (-DD), *Hardy 604* (K, PRE).

–2917 (Springbok): Near Springbok (-DB), *Lewis 1174* (SAM).

–2918 (Gamoep): Zilverfontein (-CC), *Drège s.n.* (CGE, E, Gx4, K, L, MEL, MO OXF, Px2, PRE, S, SAM, TCD, Wx2); *Drège 3236* (P); *Zeyher 2067* (S).

–3017 (Hondeklipbaai): Hondeklipbaai (-AD), *Bruyns 1516* (STEU); Bowsdorp (-BB), *Thorne s.n.* (SAM); Wallekraal (-BC), *Boucher 77* (STEU); Between Garies and Kamieskroon (-BD), *Hutchinson 827* (BOL, K).

–3018 (Kamiesberg): 8 km from Garies to Leliefontein (-AC), *Marais 73* (STEU); 3 km from Leliefontein to Kamieskroon (-AC) *Marais 75, 76* (STEU); Kamiesberg (-AC), *Marais 133* (STEU); Between Garies and Nuwerus (-CC) *Marloth 12489* (BOL, PRE, STEx3); Eenkoker, Kamiesberg (-CC), *Pearson 6751* (K); 10 km N of Bitterfontein (-CD), *Hugo 2900* (PRE, STE); 5 km on Kliprand road, N of Bitterfontein (-CD), *Marais 282* (STEU).

–3019 (Loeriesfontein): Loeriesfontein, village ground (-CD), *Marais 123* (STEU).

–3118 (Vanrhynsdorp): Mierhofkasteel (-AA), *Barker NBG856/50* (NBG); 6 km W of Bitterfontein (-AA) *Marais 70,71* (STEU); 19 km NW of Bitterfontein (-AA), *Nordenstam & Lundgren 1788* (S);

Komkans (-AA), *Nordenstam & Lundgren 1719* (STE); Near Nuwerus (-AB), *Acocks 16435* (K); 13 m SW of Nuwerus (-AB), *Acocks 19592* (K, PRE); Nuwerus (-AB), *Barker 3730* (NBG); *Leighton 1124* (BOL); *Martin 842* (NBG); *Nordenstam 1355* (S, STE); Spitsberg, SE of Nuwerus (-AB), *Oliver 5939* (STE); Between Bitterfontein and Nuwerus (-AB), *Salter 1593* (BM, K); Bitterfontein (-AB), *Alice & Godman 745* (BM); *Schlechter 11030* (Z); Karee Mountains, S of Nuwerus (-AB), *Van Zyl s.n.* (STEU); Bokkeveldsberg (-BB), *Marloth 7798* (PRE); Strandfontein (-CC), *Acocks 15024* (PRE); Vanrhynsdorp (-DA), *Kolbe 14293* (BOL); Vleikraal, E of Klawer (-DA), *Walters 5* (STEU); *Walters 184* (PRE).

--3119 (Calvinia): Brandkop, N of Nieuwoudtville (-AA), *Stokoe s.n.* (SAM); Hantamrivierdrif (-AB), *Barker 9494* (NBG); Hantamrivier, 30 m NW of Calvinia (-AB), *Lewis 4068* (SAM); 30 m from Calvinia to Loeriesfontein (-AB), *Maguire 2001* (NBG); Perdeberg, between Loeriesfontein and Calvinia (-AB), *Marais 125* (STEU); Vanrhyns Pass, Loeriesfontein junction (-AC), *Hardy 80* (K, PRE); Near Brandkop (-AC), *Leipoldt 4394* (BOL); Nieuwoudtville (-AC), *Leipoldt s.n.* (BOL); Witkleigat (-BA), *Marais 275* (STEU); Grootrivier (-BB), *Marais 272* (STEU); Toren road (-BC), *Bayer 1905* (NBG); 20 km from Calvinia to Loeriesfontein (-BC), *Marais 273* (STEU); Akkerendam (-BD), *Acocks 17749* (PRE); *Taylor 2654, 2816* (NBG); Ambraalshoek, Calvinia (-BD), *Marais 119* (STEU); Hills N of Calvinia (-BD), *Marloth 12782* (PRE); Calvinia (-BD), *Schmidt 279* (PRE); Reunie Mountains (CB), *Marloth 10303* (PRE); Blauwkranz Pass (-DA), *Hall 3866* (NBG); *Marais 68* (STEU).

--3219 (Wuppertal): 6 km from Bizansgat to Sutherland (-DD), *Marais 217* (STEU).

--3220 (Sutherland): Ouberg Pass (-AD), *Marais 252* (STEU); Tankwa, Klein Roggeveld (-BC), *Marloth 10388* (PRE); Between Hottentotskloof and Sutherland (-BC), *Leipoldt s.n.* (BOL); Thyshoogte (-CC), *Marais 218, 224* (STEU); Between Windheuwel and Bloemfontein (-CD), *Marais 335* (STEU); Verlatenkloof, Sutherland (-DA), *Leighton 3186* (BOL, K); *Marais 225* (STEU).

--3319 (Worcester): 4 km N of Karoo Poort (-BA), *Lavranos & Pehlemann 17478* (STEU).

--3320 (Montagu): Jagerskraal (-AB), *Bayer 3608* (NBG); Matjiesfontein (-BA), *Compton 3306* (BOL, K); *Marloth 9580* (PRE); *Van der Walt s.n.* (STEU); Whitehill, Karoo Garden (-BA), *Compton 11809, 15228* (NBG); Whitehill ridge (-BA), *Compton 13387* (NBG); Whitehill (-BA), *Pillans 14143* (BOL); 4 km from Matjiesfontein to Sutherland (-BA), *Marais 210* (STEU); Gnaapkop, Matjiesfontein (-BA), *Marais 355* (STEU); Bantams, Witteberge (-BC), *Compton 12167* (NBG).

8.33 *Pelargonium vinaceum* E.M. Marais, sp. nov. in sectione *Hoarea*, *P. moniliforme* affine.

Herba perennis acaulescens tuberosa. Tuber subterraneum, napiforme, 22--35 mm longum, 15--22 mm in diam. Folia hysterantha, rosulata, simplicia raro trilobata vel tripartita, viridia, petiolata; lamina ovato vel trulliformis, margo integro, setis brevibus appressis marginalibus, 22--40 mm longa, 18--30 mm lata, adaxiale sparsim glandulosa, abaxiale sparsim glandulosa et hirsuta; petiolus 10--40 mm longus, prostratus, glandulosus et setosus; stipulae petiolo adnatae. Inflorescentia: scapus vinaceus,



Figure 8.33.1 *Pelargonium vinaceum*. A, flowering plant x1; B, plant with leaves x1; C, petals x2; D, androecium x3; E, gynoecium x5.

pseudoumbellis utraque (7-)10--27 floribus. **Pedicellum** ca. 0,5 mm longum. **Hypanthium** 11--26 mm longum, vinaceum, glandulosum et hirsutum. **Sepala** 5, lanceolata, 4--8 mm longa, 1--3 mm lata, posterius erectum, cetera recurvata. **Petala** 5, crenea vel pallida flava, spatulata, dua postica 10--15,5 mm longa, 3,5--6 mm lata, maculis carmino-rubra, tria antica 7,5--12 mm longa, 3--4,5 mm lata. **Stamina** fertilia 2--4(-5).

TYPE - Namibia: 40 km north of Rosh Pinah, on road to Aus, *Marais 77* (STE, holotypus; BOL, K, MO, PRE).

A deciduous geophyte with a small regularly shaped subterranean tuber, 75--100(-180) mm tall when in flower. **Tuber**: a turnip-shaped or elongated root with a short flattened stem, covered with flaking dark brown periderms, 22--35 mm long and 15--22 mm in diameter. **Leaves** radical, hysteranthous, rosulate, simple, seldom trilobate or tripartite, green, petiolate: lamina broadly ovate to trullate, apex rounded to obtuse, base widely cuneate, margin entire, 22--40 x 18--30 mm, sparsely covered with short glandular hairs, abaxially also hirsute along main veins, margins with short appressed bristles; petiole 10--40 mm long and 2--3 mm in diameter, prostrate, covered with short glandular hairs interspersed with stiff patent hairs; stipules subulate, adnate to petioles with apices free, 5--7 mm long and ca. 1 mm wide, ciliate. **Inflorescence**: scape usually unbranched, 30--80(-140) mm long, 1--2 mm in diameter, wine-red, glandular interspersed with stiff patent hairs, pseudo-umbel with (7-)10--27 flowers; bracts narrowly triangular, recurved, 2,5--4 x 1 mm, hirsute; flower buds, flowers and fruits erect. **Pedicel** ca. 0,5 mm long. **Hypanthium** 11--26 mm long, wine-red, indumentum as on scape. **Sepals** 5, lanceolate, apices acute, 4--8 mm long, 1--3 mm wide, posterior one erect, others recurved, green, indumentum abaxially as on scape. **Petals** 5, cream-coloured to pale yellow, spatulate, bases narrowly cuneate, apices emarginate, patent during anthesis; posterior two with wine-red blotches in the centre, 10--15,5 x 3,5--6 mm; anterior three 7,5--12 x 3--4,5 mm. **Stamens** 10, basally connate, staminal column 1--2,5 mm long, white, smooth; perfect stamens 2--4(-5), protruding from the flower, remaining straight, apices red, lateral two 4--8,5 mm long, anterior two 5,5--11 mm long; staminodes 3--4 mm long; anthers 1--1,5 mm long, dark red, pollen orange. **Gynoecium**: ovary superior, oblong-conical, 5-lobed, 3--5 mm long, densely sericeous; style filiform, 2--7 mm long, pink; stigma with 5 branches, 0,5--1 mm long, pink. **Fruit**: a schizocarp consisting of 5 mericarps, bases of mericarps 4 mm long, without glandular hairs, tails ca. 18 mm long. (Figure 8.33.1).

Diagnostic features and affinities

P. vinaceum is a geophyte with entire, seldom trifoliolate prostrate leaves; the older ones larger with long petioles (ca. 40 mm) and the younger ones gradually reducing in size. The wine-red, usually unbranched scape is bearing a pseudo-umbel with 10--27 flowers. The wine-red hypanthia are 2,5--3,5 times the length of the sepals. The specific epithet *vinaceum* refers to the wine-red scape and hypanthia of this species. The flowers are cream-coloured to pale yellow with wine-red blotches on the posterior two. The two posterior petals are borne in such a way that the blotches appear as a single nectar guide. The number of fertile stamens varies from two to four. They are long (5--11,5 mm) and protrude from the flower with the anterior ones 1,2--2 times the length of the sepals. During anthesis a noteworthy lengthening of the style and stigma branches takes place.

P. vinaceum resembles *P. moniliforme* with respect to the leaf structure as well as the floral structure. Both have simple to trifoliolate leaves, wine-red, unbranched scapes, long hypanthia and cream-coloured to yellow, spatulate petals. The markings on the posterior petals of the two species are identical. Their leaf anatomy and pollen morphology are also similar. *P. vinaceum* differs from *P. moniliforme* in respect to the size of the plants. The plants of *P. vinaceum* are up to 180 mm tall when in flower and those of *P. moniliforme* 400 mm. The latter usually has a larger number of flowers per pseudo-umbel than the former. *P. vinaceum* can also be distinguished from *P. moniliforme* by the short glandular hairs on the laminae, the appressed bristles on the margins of the laminae and the stiff hairs on the scape instead of the long glandular hairs on the laminae, the long appressed or patent stiff hairs on the margins of the laminae and the long soft patent hairs on the scape. The number of fertile stamens of *P. vinaceum* varies from two to four, whereas *P. moniliforme* always has five.

The wine-red scapes and hypanthia of *P. vinaceum* and *P. moniliforme* are similar to those of *P. caroli-henrici* and *P. rubiginosum*.

Geographical distribution and ecology

P. vinaceum occurs from Rosh Pinah in southern Namibia, in the Richtersveld and as far south as the Nigramoep plateau south of Steinkopf (Figure 8.33.2), an area receiving an annual rainfall of about 100 mm, mainly during winter. It grows in karroid vegetation in rock crevices in granites; shale or sand and flowers from October to November after the leaves have died.

The distribution area of *P. vinaceum* is north of that of *P. moniliforme*, although in the Springbok area they are sympatric. Both species occur in the Richtersveld, but *P. moniliforme* occurs nearer to the coast, whereas *P. vinaceum* occurs inland. *P. moniliforme* is one of the early flowering species of section *Hoarea* and flowers in September, while leaves are still present. *P. vinaceum* flowers in October and November, after the leaves have died.

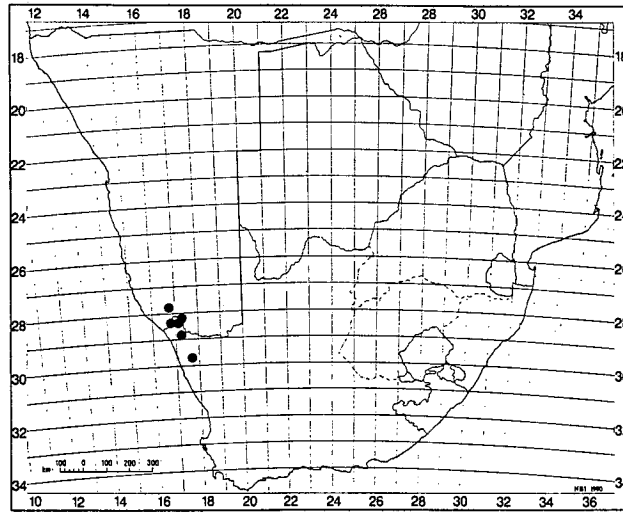


Figure 8.33.2 Geographical distribution of *P. vinaceum*.

Material studied

--2716 (Witputz): Witputz Süd (-DA), *Lavranos 20785* (STEU); 40 km N of Rosh Pinah, on road to Aus (-DB), *Marais 77* (BOL, K, MO, PRE, STE); Spitskop 9 km N of Rosh Pinah (-DC), *Van der Walt & Vorster 1275* (STEU); Zebrafontein (-DD), *Beukes 10108* (BLFN); 35 km N of Rosh Pinah (-DD), *Leuenberger 3227* (WIND); *Venter 8630* (STEU).

--2816 (Oranjemund): Die Koei, Helskloof (-BD), *Drijfhout 2942* (STEU); Numees (-BD), *Visser s.n.* (STEU); *Von Willert s.n.* (STEU); W slope of Numees Mountain (-BD), *Williamson 4010* (STEU).

--2817 (Vioolsdrif): Verberg, Gamkap (-AB), *Van Jaarsveld 9695* (STEU); 15 km E of Helskloof, road to Grasdrif (-AC), *Graham 3527* (STEU); *Beukes 10102* (BLFN); 3 miles SW of Brakfontein (-CC), *Nordenstam 1799* (S); Tierpoortberge, Kliphooft (-CD), *Drijfhout 1431* (STEU).

--2917 (Springbok): Nigramoep Plateau, 35 km S of Steinkopf (-DA), *Williamson 4341* (STEU).

8.34 *Pelargonium radicatum* Venten., *Jardin de la Malmaison 2*: t. 65 (1804): substitute name for *Geranium ciliatum* Andr.: t. 247 (1802b); Ait. f.: 160 (1812); Sims: t. 1718 (1815); DC.: 650 (1824); Spreng.: 50 (1826); Loudon: 568 (1829); G.

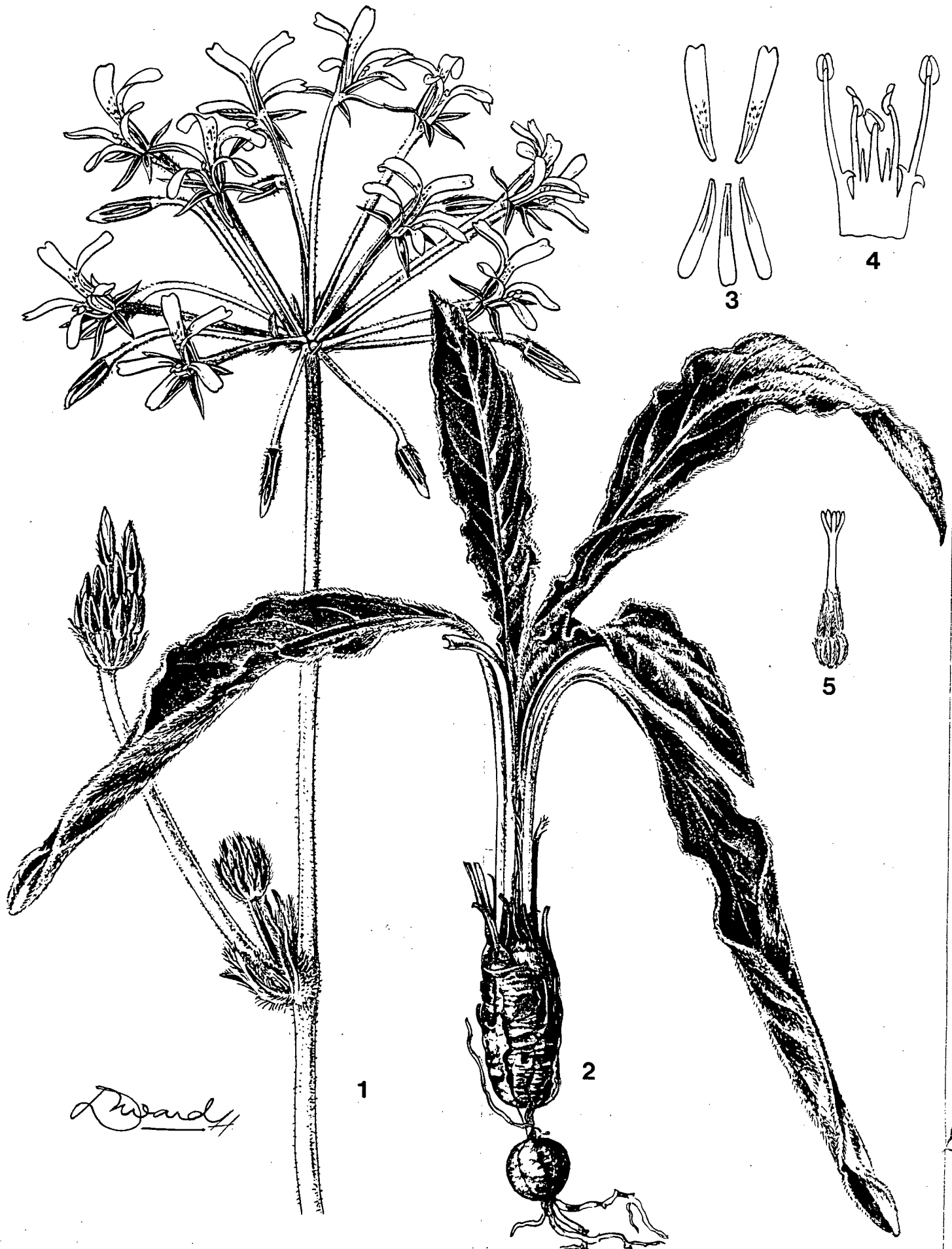


Figure 8.34.1 *Pelargonium radicans*. 1, inflorescence x1; 2, plant with leaves x1; 3, petals x1; 4, androecium x3; 5, gynoecium x4.

Don: 726 (1831); Loudon: 271 (1832); Harv.: 264 (1860); Knuth: 326 (1912); *P. radiatum* (by mistake) Steud.: 289 (1841). ICONOTYPE: Andrews, The Botanist's Repository 4: t. 247 (1802b).

Hoarea radicata (Venten.) Sweet: t. 174 (1823); Sweet: 76 (1826c).

Geranospermum radicum (Venten.) Kuntze: 95 (1891).

Geranium ciliatum Andr.: t. 247 (1802b). ICONOTYPE: Andrews, The Botanist's Repository 4: t. 247 (1802b).

Pelargonium concavifolium Pers.: 226 (1806): substitute name for *Geranium ciliatum* Andr.: t. 247 (1802b); Steud.: 677 (1840); Steud.: 284 (1841).

Geranium concavifolium (Pers.) Poir.: 752 (1812).

Pelargonium squamulosum Knuth: 327 (1912). TYPE: - Cape Province: "Namaland minor" Scully 216 (BOL, lecto!, designated here, BM); "Umgegend von Hopefield" Bachmann 1533 (Z!).

A geophyte 120--300 mm tall when in flower. **Tuber:** a turnip-shaped or elongated, sometimes moniliform root 30--50 mm long and 12--30 mm in diameter. **Leaves** simple, green, petiolate; lamina lanceolate, base attenuate, apex acuminate, margin entire, 70--135 x 20--40 mm, young leaves adaxially pilose and abaxially pilose interspersed with stiff hairs or sometimes bristles, margins with appressed bristles; petiole 20--80 mm long and 2--3 mm in diameter, rigid, erect, pilose with short hairs interspersed with bristles; stipules subulate, adnate to petioles for one third to one half their length, 27--35 mm long and 1--3 mm wide, ciliate. **Inflorescence:** scape 30--110 mm long, 3--5 mm in diameter, branched, bearing (2-)3--7 pseudo-umbellets with 14--31(-35) flowers each; peduncles 30--100 mm long, 1,5--3 mm in diameter, densely hirsute interspersed with long glandular hairs and very long non-glandular hairs; bracts subulate, 7--14 mm long, 1--1,5 mm wide, adaxially velutinous, abaxially densely hirsute interspersed with long glandular hairs. **Pedicel** ca. 0,5 mm long. **Hypanthium** 40--60 mm long, green, densely hirsute interspersed with long glandular hairs. **Sepals** 5, narrowly triangular, apices acuminate, 7--11 mm long, 1--2,5 mm wide, patent, green with membranous margins, indumentum abaxially as on hypanthium. **Petals** 5, pale yellow, patent during anthesis; posterior two minutely dotted with wine-red spots in the central part, ligulate to narrowly spatulate, bases narrowly cuneate, apices truncate to emarginate, 13--20 x 3--3,5 mm; anterior three ligulate, bases attenuate, apices truncate to emarginate, 11--18 x 2--3 mm. **Stamens:** staminal column 1,5--3 mm long, white papillate; perfect stamens 5, initially straight, bending downwards during senescence, posterior one 5--7 mm long, lateral two 6--8 mm long, anterior two 7--9 mm long, white; staminodes 2--4 mm long; anthers pale pink, 1--1,5 mm long, pollen pale yellow. **Gynoecium:** ovary 3--5,5 mm

long; style 1,5--5 mm long, dark pink; stigma branches 1--2 mm long, pink. **Fruit:** bases of mericarps 6--7 mm long, with glandular hairs, tails 32--35 mm long. (Figure 8.34.1).

Diagnostic features and affinities

P. radicum has simple lanceolate leaves, covered on both sides with short soft patent hairs and bristles along the margins. Sometimes bristle-like hairs also occur abaxially. The soft hairs are usually lost during senescence and at the time of flowering the shrivelled leaves are glabrous with white appressed bristles on the margins. Depending on the number of bristles abaxially, the shrivelled leaves can adaxially be glabrous and abaxially squamose.

The large number of pale yellow flowers per pseudo-umbellet and the ligulate or narrowly spatulate petals and long hypanthia of *P. radicum*, resemble those of *P. appendiculatum* and *P. fasciculaceum*. All three species have several pseudo-umbellets per scape which flowers in succession, thus lengthening the flowering period of the plant. The floral structures of *P. appendiculatum* and *P. radicum* are very similar with small differences in the lengths of the fertile stamens. In this respect they differ from *P. fasciculaceum* where the two anterior stamens are long and protrude from the flower, whereas the lateral and posterior ones are very short and concealed in the floral sheath.

The epithet *radicum*, meaning with roots, refers to the large root or tuber. This is not a distinctive character for this species only, but for the section as a whole.

Geographical distribution and ecology

P. radicum occurs along the west coast of the Cape Province, from Springbok in the north to Hopefield in the south (Figure 8.34.2), an area receiving an annual rainfall of 100--300 mm mainly during the winter months. Although it seems to be a rather large distribution area, only a few collections are known, probably because plants usually occur in small populations or because the natural habit is destroyed. Plants grow in sandy soil and flower from late October to December.

Material studied

--2917 (Springbok): Near Bloustasie, Springbok (-DB), *Van Berkel* 455 (NBG).

--3218 (Clanwilliam): Clanwilliam (-BB), *Bolus s.n.* (BOL); Onder-Bergvlei, Paleisheuwel (-BC), *Van der Walt 1417* (STEU); Olifantsrivier (-BD), *Niven 21, s.n.* (S).

--3318 (Cape Town): Near Hopefield (-AB), *Bachmann 1533* (Z).

Without exact locality: Namaland Minor, *Scully 216* (BM, BOL); Herb. de Ventenat, *Anon* (G); Bergrivier, *Zeyher 172* (K, P, SAMx2)

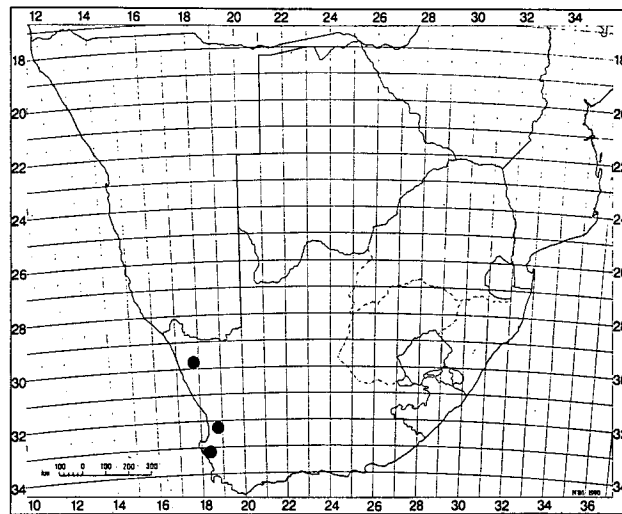


Figure 8.34.2 Geographical distribution of *P. radicum*.

8.35 *Pelargonium appendiculatum* (L. f.) Willd., Species Plantarum 3: 651 (1800); Pers.: 228 (1806); DC.: 662 (1824); Spreng.: 53 (1826); G. Don: 736 (1831); Steud.: 677 (1840); Steud.: 283 (1841); Harv.: 270 (1860); Knuth: 349 (1912); Van der Walt & Vorster: 7, fig. (1988). TYPE - Cape Province: "Habitat in Africa" *sub* LINN 858.92 (LINN, lecto!, designated here).

Geranium appendiculatum L. f.: 304 (1781); Murray: 618 (1784); Cav.: 262, t. 121, f. 2 (1787); Thunb.: 116 (1800); Thunb.: 529 (1823). TYPE - Cape Province: "Habitat in Africa" *sub* LINN 858.92 (LINN, lecto!, designated here).

Hoarea appendiculata (L. f.) Eckl. & Zeyh.: 65 (1835).

Geranospermum appendiculatum (L. f.) Kuntze: 94 (1891).

An aromatic geophyte 150--300 mm tall when in flower. **Tuber:** a turnip-shaped root, branched, forming numerous stem-growing points in older plants; branches covered with flaking periderms, 10--25 mm in diameter; tuberous system forming clumps up to 500 mm in diameter. **Leaves** greyish green, petiolate; lamina elliptic to ovate in outline, irregularly bipinnatisect or tripinnatisect, 30--110 mm long; pinnae 12--35 mm long,

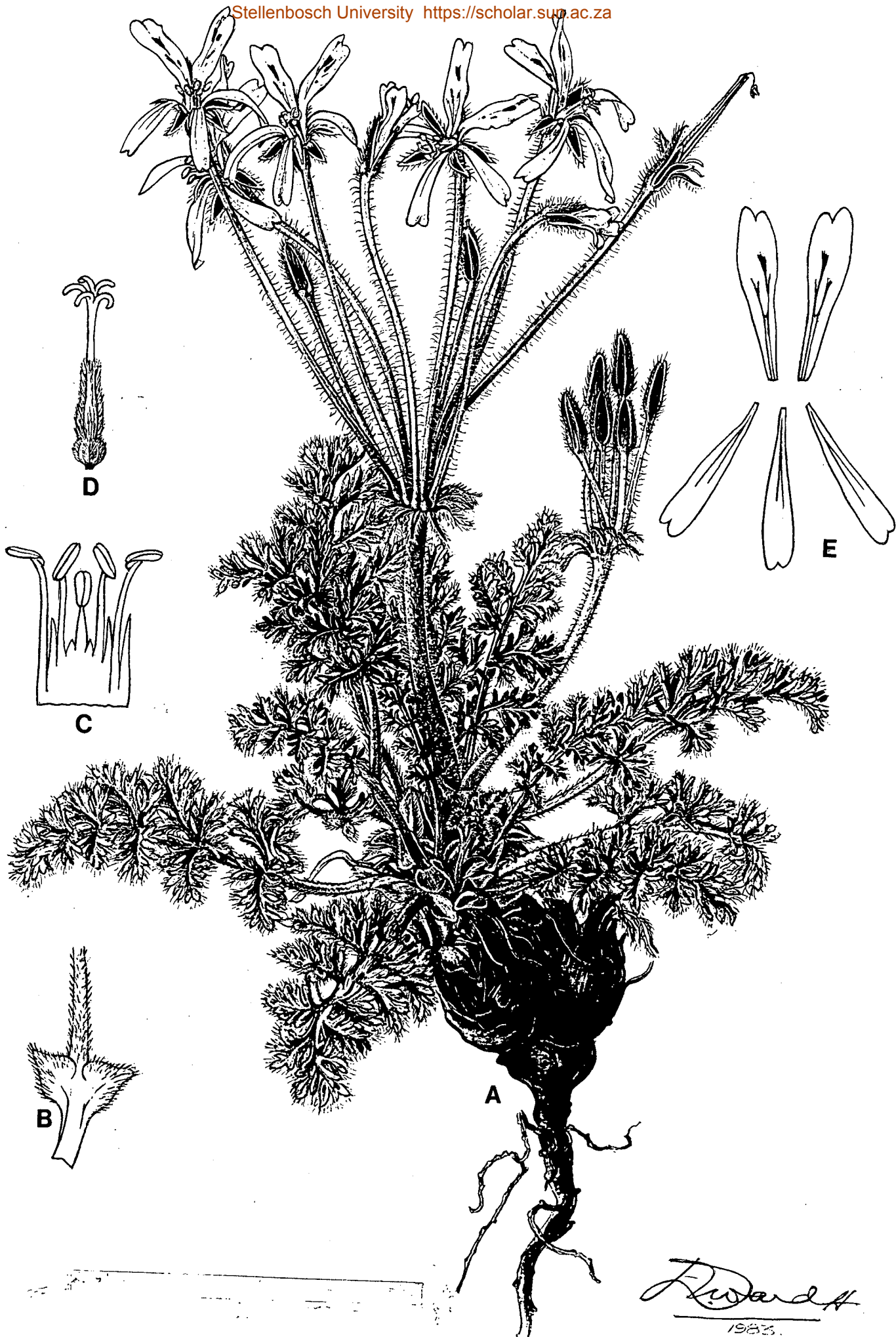


Figure 8.35.1 *Pelargonium appendiculatum*. A, flowering plant x1; B, leaf base x1; C, androecium x3; D, gynoecium x3; E, petals x1,5.

deeply incised, segments 0,5--1 mm wide, apices rounded, densely villous interspersed with glandular hairs; petiole 10--130 mm long and 2--5 mm in diameter, rigid, erecto-patent, villous with glandular hairs interspersed; stipules very conspicuous, obtrullate or ear-shaped, rigid, patent, adnate to petioles for two thirds of their length, 15--30 mm long and 8--12 mm wide, densely hirsute with appressed hairs. **Inflorescence:** scape 10--30 mm long, 2--7 mm in diameter, branched, bearing 2-3 pseudo-umbellets with (4-)6--15 flowers each; peduncles 40--140 mm long, 2--5 mm in diameter, green, densely covered with short glandular hairs interspersed with long soft patent non-glandular hairs; bracts lanceolate to ligulate, 7--9 mm long, 1--1,5 mm wide, adaxially hirsute with appressed hairs and abaxially hirsute with long patent hairs interspersed with short glandular hairs. **Pedicel** *ca.* 0,5 mm long. **Hypanthium** 60--100 mm long, green, indumentum as on peduncle. **Sepals** 5, lanceolate, apices acute, 9--13 mm long, 1--3 mm wide, posterior one erect, others recurved, green with margins white, indumentum abaxially as on peduncle. **Petals** 5, pale yellow, patent during anthesis; posterior two spatulate with small pale pink or dark red blotches in the centre, bases cuneate, apices emarginate, 17--23 x 4--7 mm; anterior three ligulate, bases attenuate, apices emarginate, 15--20 x 2--4 mm. **Stamens:** staminal column 1--3 mm long, white; perfect stamens 5, initially straight, bending downwards during senescence, posterior one 8--10 mm long, lateral two 9--11,5 mm long, anterior two 11--13 mm long, white; staminodes 4--5 mm long; anthers yellow, *ca.* 2 mm long, pollen orange. **Gynoecium:** ovary 4,5--6 mm long; style 3,5--4 mm long, pale green; stigma branches 2,5--3 mm long, pale green. **Fruit:** bases of mericarps *ca.* 7 mm long, without glandular hairs, tails 50--55 mm long. (Figure 8.35.1).

Diagnostic features and affinities

P. appendiculatum is characterized by the exceptionally large, ear-shaped stipules, hence the specific epithet. This form of stipules is unique for section *Hoarea*. Secondly the branching tuber, forming numerous stem-growing points, is also a distinctive character within section *Hoarea*. This extensive branching is probably stimulated by the grazing of sheep and antelope, forming clumps up to half a meter in diameter. The annual increments, terminated by leaves, are clearly distinguishable on these branches. The colour and the form of the petals, as well as the structure of the androecium are very similar to those of *P. radicum*. Both species have pale yellow, spatulate to ligulate petals and stamens with more or less the same length as the sepals. Initially the stamens are straight, but during senescence they bend downwards, probably a mechanism to avoid self-pollination. The hypanthia of *P. appendiculatum* (60--100 mm) are usually longer than those of *P. radicum* (40--60 mm) and the petals of the former are also slightly

larger than those of *P. radicum*. On the other hand, *P. appendiculatum* has a smaller number of pseudo-umbellets per scape (2--3) and less flowers per pseudo-umbellet (6--15) than *P. radicum*. The latter has 3--7 pseudo-umbellets per scape and 14--31 flowers per pseudo-umbellet.

Geographical distribution and ecology

P. appendiculatum is known from a small distribution area along the Langvlei river near Leipoldtville (Figure 8.35.2). During the previous century J.F. Drège collected it at Brakfontein along the Olifantsrivier and during the first half of this century a few collections were made near Clanwilliam. However, since the start of this research project, no collection of this species was made in this area. It is one of the most robust species of section *Hoarea* and should be obvious in the veld, but it is also known that these plants are heavily grazed by sheep and as this area is extensively cultivated, it is possible that its distribution has shrunk and is now confined to the Langvlei area.

P. appendiculatum grows in deep coastal calcareous sands in west coast strandveld in an area with an annual rainfall of 200--300 mm. It flowers from September to October.

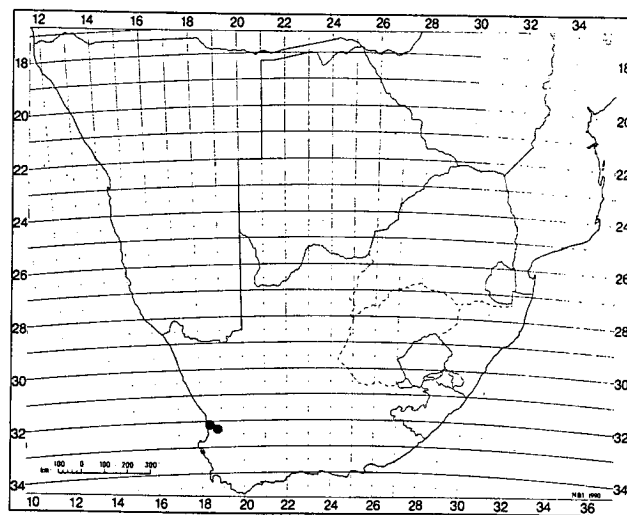


Figure 8.35.2 Geographical distribution of *P. appendiculatum*.

Material studied

--3218 (Clanwilliam): Farm Langdam, Graafwater (-AB), *Engelbrecht s.n.* (STEU); Langevalley (-AB), *Thunberg s.n.* (Sx2, UPS); *Ecklon & Zeyher 503* (G, K, L, MEL, MO, P, S, SAM, TCD, Wx2, WU, Z); Along Langvlei near Leipoldtville (-AB), *Van der Walt 1429, 1430* (STEU); De Brug, Clanwilliam (-BB),

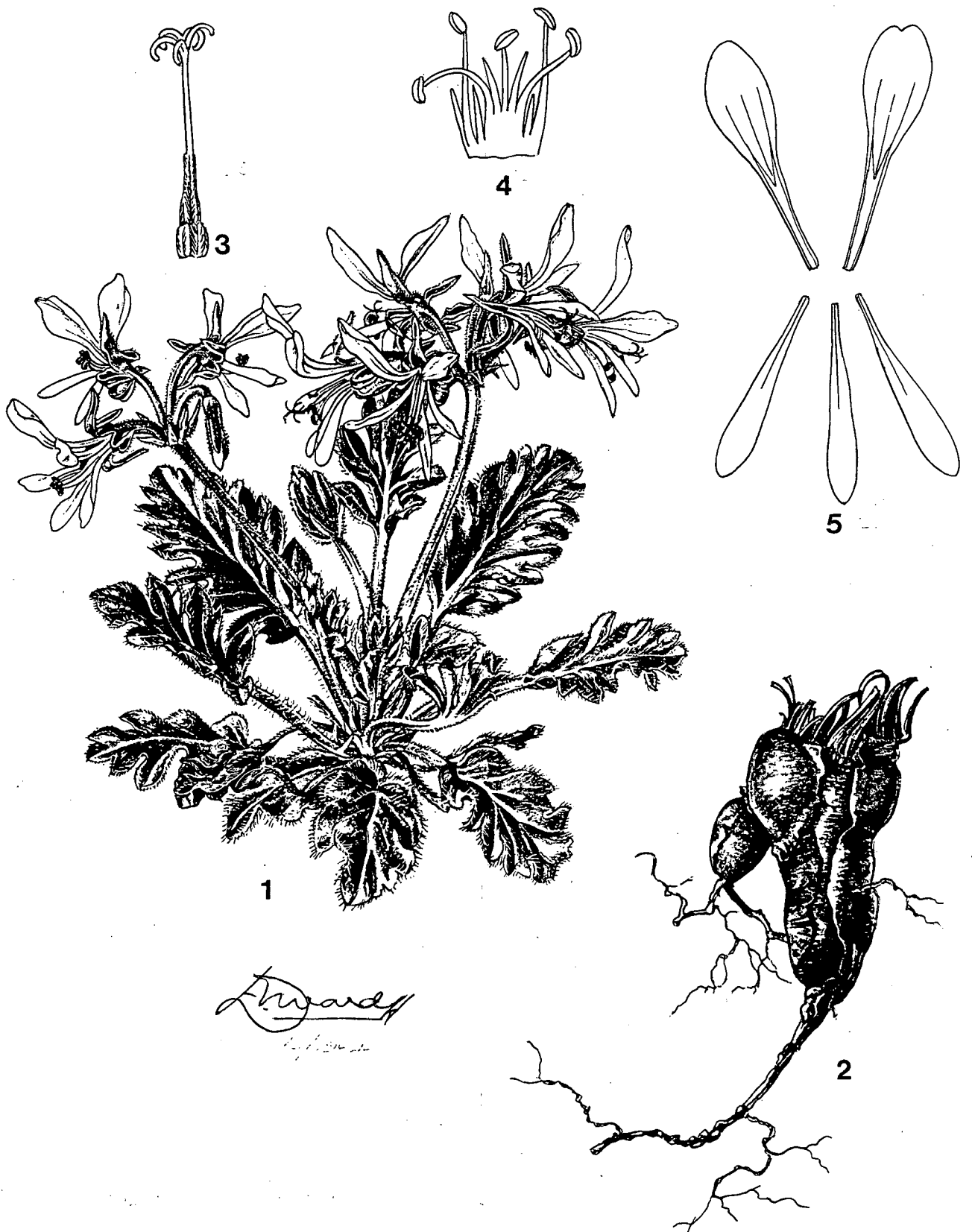


Figure 8.36.1 *Pelargonium campestre*. 1, flowering plant x1; 2, tuber x1; 3, gynoecium x2,5; 4, androecium x2; 5, petals x2.

Adamson s.n. (BOL); Bergvalley (-BC), *Zeyher 80.10* (PRE); Olifantsrivier, near Brakfontein (-BD), *Drège s.n.* (MELx2).

8.36 *Pelargonium campestre* (Eckl. & Zeyh.) Steud., *Nomenclator botanicus*, 2nd edn, 2: 284 (1841); Harv.: 267 (1860); Knuth: 341 (1912). TYPE - Cape Province: '. . In campestris graminosis ad flumen "Zwartkopsrivier" (Uitenhage) . .' *Ecklon & Zeyher 480* (S, lecto!, designated here; K!; LX3!; MELX3!; MO!; OXF!; P!; SAM!; W!).

Hoarea campestris Eckl. & Zeyh.: 63 (1835). TYPE - Cape Province: '. . In campestris graminosis ad flumen "Zwartkopsrivier" (Uitenhage) . .' *Ecklon & Zeyher 480* (S, lecto!, designated here; K!; LX3!; MELX3!; MO!; OXF!; P!; SAM!; W!).

Geranospermum campestre (Eckl. & Zeyh.) Kuntze: 94 (1891).

A geophyte 60--90(-140) mm tall when in flower. **Tuber:** a turnip-shaped or elongated root 25--50 mm long and 10--35 mm in diameter. **Leaves** green, petiolate; lamina simple or irregularly pinnatisect, ovate, base cuneate, apex acute to obtuse, margin entire, irregularly serrate to deeply incised, 15--50 x 7--35 mm; pinnae ovate, 15--20 x 5--10 mm, adaxially glabrous or sparsely hirsute, abaxially sparsely hirsute and with long glandular hairs along the veins, margins ciliate with long appressed stiff hairs; petiole 10--52 mm long and 1--2,5 mm in diameter, prostrate to erecto-patent, sparsely hirsute with patent hairs interspersed with short glandular hairs; stipules subulate, adnate to petioles for half their length, (4-)8--15 mm long and *ca.* 2 mm wide, hirsute. **Inflorescence:** scape 10--50 mm long, 2--2,5 mm in diameter, branched, bearing 2--4 pseudo-umbellets with 5--9 flowers each; peduncles 25--70 mm long, 1--2 mm in diameter, densely covered with long glandular hairs and sparsely interspersed with long soft patent hairs; bracts subulate, 4--8 mm long, 1--2 mm wide, adaxially and abaxially hirsute. **Pedicel** *ca.* 0,5 mm long. **Hypanthium** 12--22 mm long, densely covered with long glandular hairs. **Sepals** 5, lanceolate, apices acute, 7--12 mm long, 1,5--3,5 mm wide, posterior one erect, others recurved, green, indumentum abaxially as on hypanthium. **Petals** 5, white, claws connivent, forming a trumpet-shaped floral sheath, apices patent; posterior two spatulate, claws linear, apices rounded or emarginate, 14--23 x 4--5,5 mm; anterior three spatulate, bases attenuate, apices rounded or obtuse, 11--18 x 2,5--3 mm. **Stamens:** staminal column 2--3 mm long, white, smooth; perfect stamens 5, protruding from the flower, posterior one 6--10 mm long, lateral two 8--11,5 mm long, anterior two 9--13 mm long, white; staminodes 5--8 mm long; anthers wine-red, 2--2,5 mm long, pollen orange. **Gynoecium:** ovary 4,5--8 mm long; style 2--5

mm long, wine-red; stigma branches 2--3 mm long, wine-red. **Fruit:** bases of mericarps ca. 6 mm long, with glandular hairs, tails 26--28 mm long. (Figure 8.36.1).

Diagnostic features and affinities

P. campestre is a small geophyte with simple to irregularly pinnatisect leaves and medium-size white flowers. The petals are without any markings or nectar guides. Probably, to compensate for the lack of these guides, the long protruding stamens have prominent wine-red anthers, forming the centre of attraction of the flower. At a later stage during anthesis the anthers are dropped and the centre of attraction is replaced by the long recurved wine-red stigma branches. The stamens remain straight during anthesis, a characteristic which *P. campestre* has in common with species like *P. moniliforme*, *P. carneum* Jacq. and *P. nephrophyllum*.

Although I do not regard this species as closely related to *P. auritum* var. *carneum*, they often cause confusion. Both species occur in the eastern Cape, and both have white flowers with long protruding stamens. *P. auritum* var. *carneum* has narrow ligulate petals (posterior two 1,5--3 mm wide) and a papillate staminal column, whereas *P. campestre* has wider spatulate petals (posterior two 4--5,5 mm wide) and a smooth staminal column.

The specific epithet *campestre*, meaning pertaining to plains or flat areas, thus referring to the habitat of the species.

Geographical distribution and ecology

So far only four collections of *P. campestre* are known, two from the vicinity of Grahamstown, and two from Redhouse and Zwartkopsrivier near Port Elizabeth (Figure 8.36.2). *P. campestre* occurs in grassveld or karroid vegetation on shale, in an area with an annual rainfall of 400--600 mm. Although the rainy season for this area is unpredictable to some extent, rain can occur throughout the year. Flowering time for this species is from October to December. This apparent long flowering season is probably due to the unpredictability of the rainy season, a phenomenon which is also observed in *P. aestivalis*. The latter is one of the few species of section *Hoarea* occurring exclusively in the summer rainfall area and according to the dates on herbarium specimens, this species also has a very long flowering season.

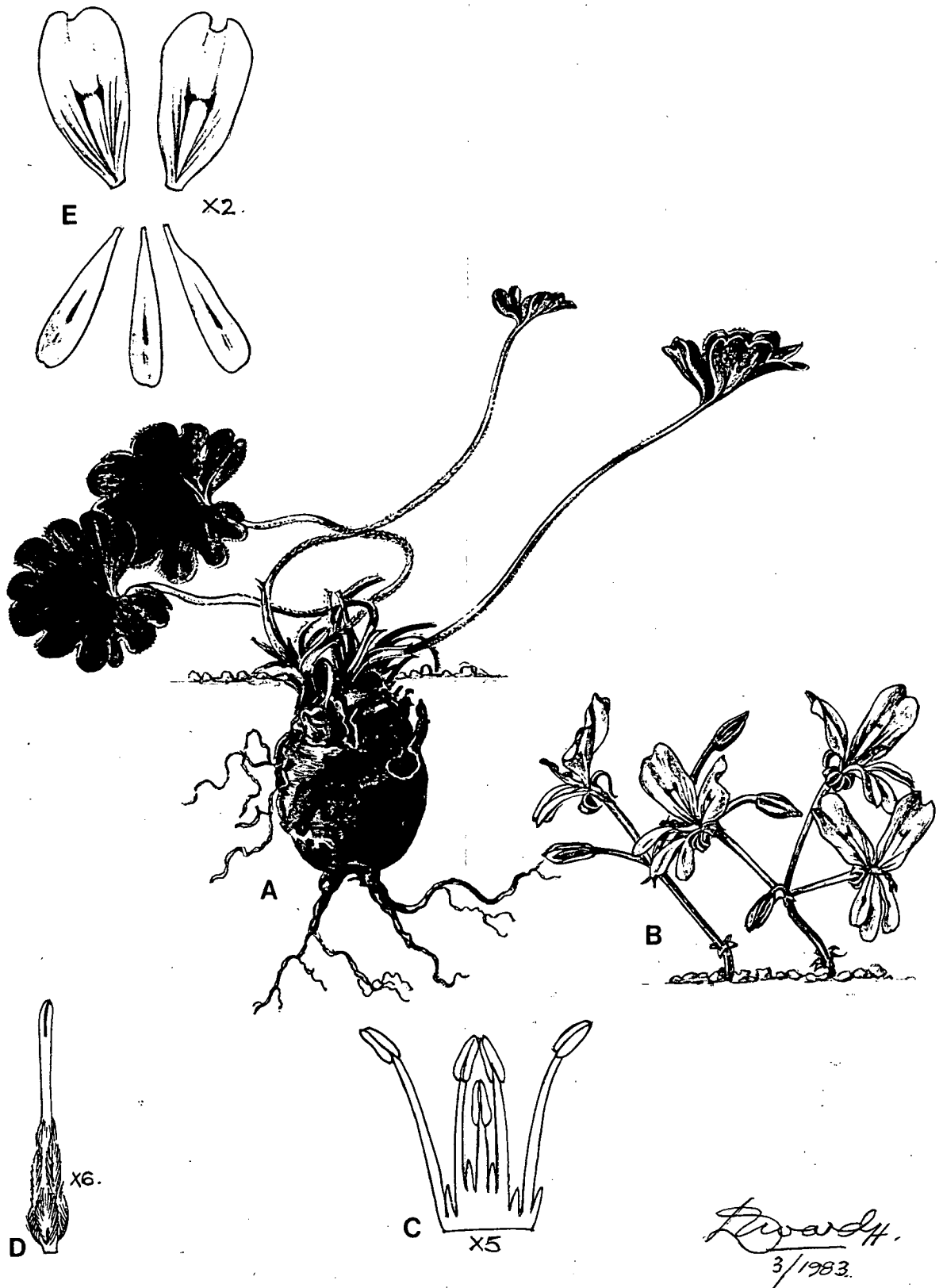


Figure 8.37.1 *Pelargonium nephrophyllum*. A, plant with leaves x1; B, inflorescences x1; C, androecium x5; D, gynoecium x6; E, petals x2.

Material studied

--3325 (Port Elizabeth): Zwartkopsrivier (-DC), *Ecklon & Zeyher 480* (K, LX3, MELX2, MO, OXF, P, S, SAM, W); Redhouse (-DC), *Paterson 292* (GRA, SAM).

--3326 (Grahamstown): 6--7 miles from Grahamstown on Cradock road (-AD), *Dyer 1673* (PRE); 9 km from Grahamstown on Cradock road (-AD), *Jacot-Guillarmod 8300* (STEU).

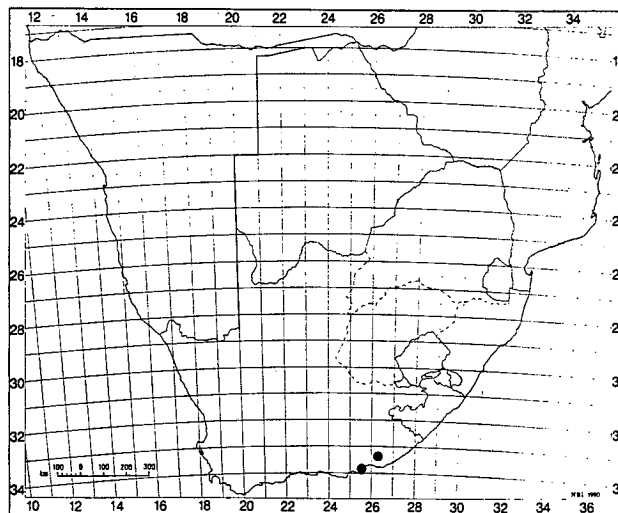


Figure 8.36.2 Geographical distribution of *P. campestre*.

8.37 *Pelargonium nephrophyllum* *E.M. Marais* in South African Journal of Botany 58: 220 (1992). TYPE - Cape Province: Vanrhynsdorp, farm Sandkraal, *Snijman 593* (STE, holo!, BOL!, K!, MO!, NBG!, PRE!).

A geophyte 50--120 mm tall when in flower. **Tuber:** a turnip-shaped root 25--30 mm long and 18--25 mm in diameter. **Leaves** simple, petiolate; lamina reniform, palmately veined, apex rounded, margin deeply crenate, (10-)15--25 x (13-)18--27 mm, adaxially green, sparsely hirsute, abaxially reddish purple, with a few very short glandular hairs, margins with short appressed bristles; petiole 40--80 mm long and 1 mm in diameter, rigid, spreading horizontally from the growing point and bending vertically in the middle, covered with short glandular hairs interspersed with bristles; stipules narrowly triangular, adnate to petioles for one third of their length, 2--3 mm long and *ca.* 1 mm wide, ciliate. **Inflorescence:** scape 10--40 mm long, branched, bearing 2 pseudo-umbellets with 3--7 flowers each; peduncles 25--75 mm long, 1 mm in diameter, hirsute with distally appressed curly hairs interspersed with short glandular hairs; bracts lanceolate, 5--8 mm long, 2--3 mm wide, adaxially and abaxially densely hirsute with

distally appressed hairs. **Pedice**l *ca.* 0,5 mm long. **Hypanthium** 20--30 mm long, indumentum as on peduncle. **Sepals** 5, lanceolate, apices acute, 6--9 mm long, 1--3 mm wide, recurved, pale reddish brown with margins white to pink, indumentum abaxially as on peduncle. **Petals** 5, pink to salmon-pink with an orange blotch in the centre, patent during anthesis; posterior two obcordate, bases cuneate, apices emarginate, 12--14 x 6,5--8 mm; anterior three spatulate, bases narrowly cuneate, apices rounded, 11--14 x 2,5--3,5 mm. **Stamens**: staminal column 1,5--2 mm long, pale pink; perfect stamens 5, protruding from the flower, remaining straight during anthesis, posterior one 3--4 mm long, lateral two 5 mm long, anterior two 7--8 mm long, pink; staminodes 2--3,5 mm long; anthers dark pink, *ca.* 2 mm long, pollen orange. **Gynoecium**: ovary 2,5--3 mm long; style 1--2 mm long, dark pink; stigma branches 1--1,5 mm long, dark pink. **Fruit**: bases of mericarps 4 mm long, with glandular hairs, tails 13--17 mm long. (Figure 8.37.1).

Diagnostic features and affinities

P. nephrophyllum has palmately veined, kidney-shaped leaves with scalloped margins, a leaf shape which is unique for section *Hoarea*, hence the specific epithet. The petioles are long and thin, and spread horizontally from the growing point and bend vertically in the middle. This orientation of the petioles resembles that of *P. ternifolium*, *P. fergusoniae* and *P. reflexum*. *P. ternifolium* has tripartite leaves and the latter two species palmatipartite. The long thin petioles together with the pinkish scape, peduncles and hypanthia give the plant a delicate appearance. The orange blotches on the pink petals are accentuated by the orange coloured pollen. The long straight stamens resemble that of several other species of *Hoarea*, like *P. moniliforme* and *P. incrassatum*, but can easily be distinguished because of the pink, obcordate petals.

Geographical distribution and ecology

So far *P. nephrophyllum* is known from a small distribution area. It occurs in succulent karoo on the stony lower slopes or sandy flats west of the Matsikamma Mountains (Figure 8.37.2), an area with an annual rainfall of 100--200 mm occurring mainly in winter. The plants are locally common. The poor herbarium record may be due to the flowering time of the species from late February to April, a time when few botanists visit the area. This is much later than most of the species in section *Hoarea*. The species flowers before new leaves appear.

Material studied

--3118 (Vanrhynsdorp): Vleikraal, E of Klawer (-DA), *Schonken 35* (STEU); *Walters 123* (PRE, STE); Sandkraal, S of Vanrhynsdorp (-DA), *Perry 1550* (NBG); *Snijman 593* (BOL, K, MO, NBG, PRE, STE); Sandkraal, SW slopes of Matsikamma Mountains (-DB), *Acocks 14178* (PRE).

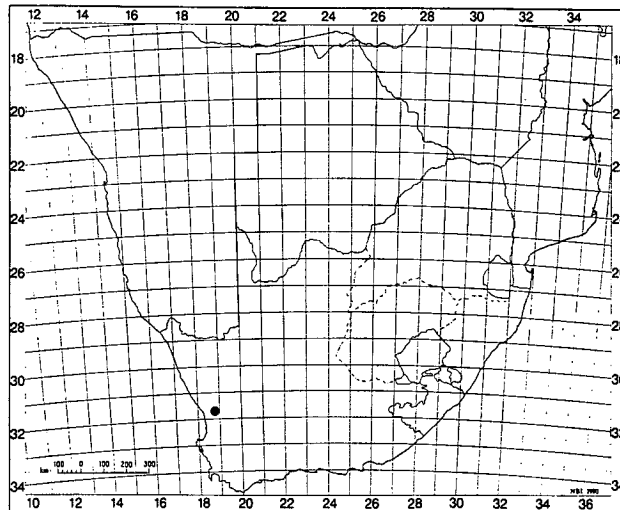


Figure 8.37.2 Geographical distribution of *P. nephrophyllum*.

8.38 *Pelargonium carneum* Jacq., *Collectanea* 4: 189 (1791b); Jacq.: 8, t. 512 (1792); Willd.: 649 (1800), (Excl. *Burm. f.*); Pers.: 228 (1806), (Excl. *Cav.*); DC.: 654 (1824), (Excl. *Cav.*); Spreng.: 53 (1826), (Excl. *Cav.*); Loudon: 570 (1829); G. Don: 728 (1831); Loudon: 272 (1832); Steud.: 284 (1841); Harv.: 269 (1860); Knuth: 340 (1912). TYPE - "Ex Promontorio bonae Spei" (W, *holo!*).

Dimacria carnea (Jacq.) Sweet: 77 (1826c).

Pelargonium maximiliani Schltr.: 151 (1899). TYPE - Cape Province: "In collibus lapidosis montium prope Houw-Hoek, in ditone Caledon" *Schlechter 9421* (K, *lecto!*, designated here, BM!, BOL!, E!, Gx3!, L!, MO!, P!, PREx3!, S!, W!, Z!).

A geophyte 120--380 mm tall when in flower. **Tuber:** a turnip-shaped or elongated root 20--60 mm long and 10--30 mm in diameter. **Leaves** green, petiolate; lamina simple, trifoliolate, pinnate to irregularly bipinnatisect; simple leaves ovate with apices acute and margins entire to serrate, 30--50 x 15--20 mm; compound leaves elliptic in outline, 50--70 mm long, pinnae 15--30 mm long, deeply incised, segments lacinate, 1--3 mm wide,

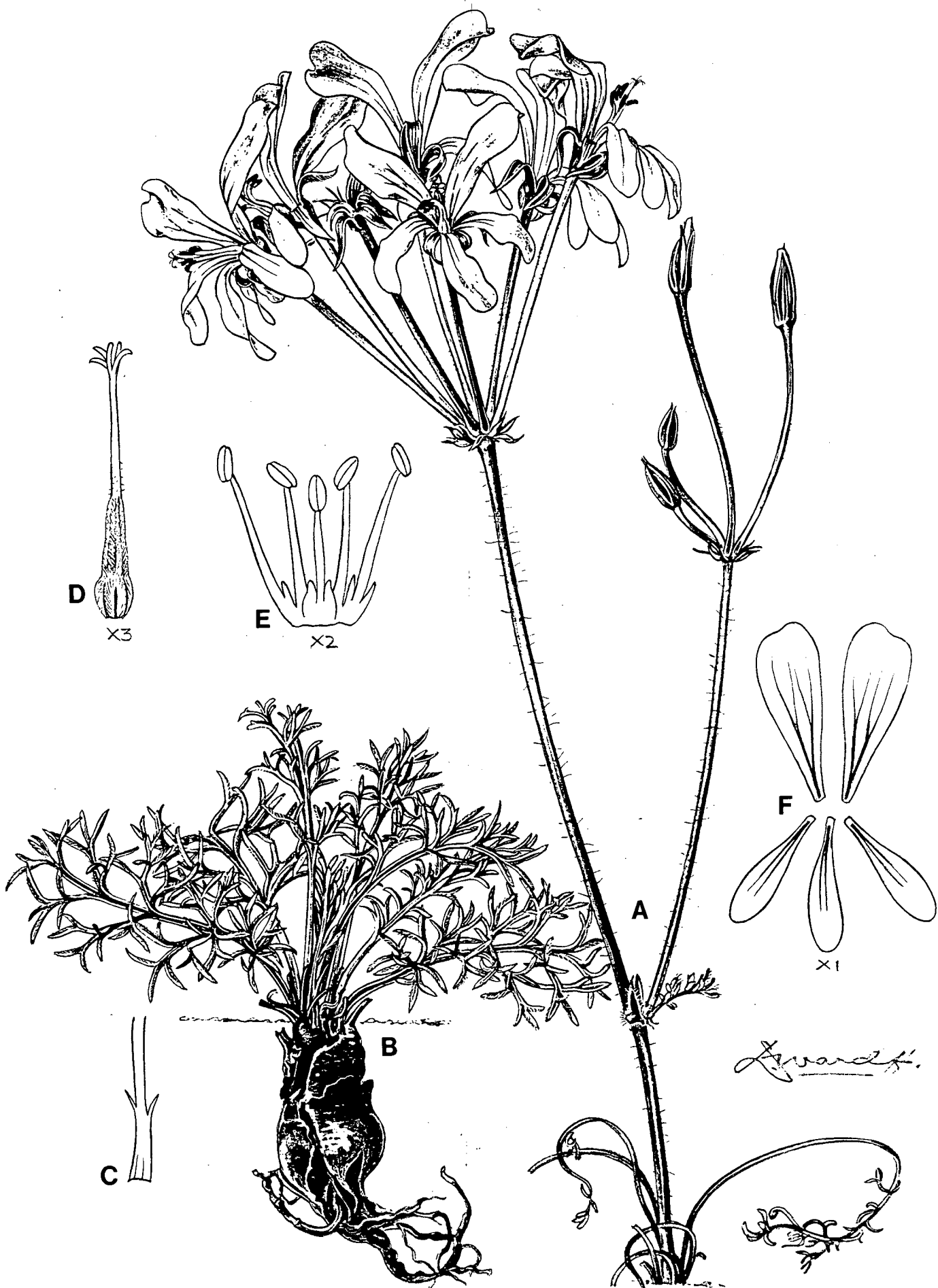


Figure 8.38.1 *Pelargonium carneum*. A, inflorescence x1; B, plant with leaves x1; C, leaf base x1; D, gynoecium x3; E, androecium x2; F, petals x1.

wide, adaxially glabrous, ciliate, abaxially hirsute with long appressed stiff hairs; petiole 25--30 mm long and 1,5--2 mm in diameter, rigid, erecto-patent, hirsute with appressed hairs interspersed with very short glandular hairs; stipules subulate, adnate to the petioles for half their length, 16--30 mm long and 1--2 mm wide, ciliate. **Inflorescence:** scape 20--120 mm long, 2--4 mm in diameter, branched, bearing 2--3 pseudo-umbellets with 4--13 flowers each; peduncles 30--170 mm long, 1,5--3 mm in diameter, covered with short glandular hairs interspersed with long and short patent hairs; bracts narrowly triangular, 5--10 mm long, 2--3 mm wide, abaxially hirsute with appressed hairs. **Pedicel** ca. 0,5 mm long. **Hypanthium** (29-)35--75 mm long, green, covered with short glandular hairs interspersed with sometimes clavate bristle-like hairs. **Sepals** 5, narrowly triangular, apices attenuate, 9--20 mm long, 1,5--4 mm wide, recurved, green to reddish brown with margins white, sparsely setose interspersed with short glandular hairs. **Petals** 5, white, pink, yellow, cream-coloured or flesh-coloured, patent during anthesis; posterior two with wine-red feather-like markings, obovate to widely obovate or obcordate, bases cuneate, apices rounded, truncate or emarginate, 17--34 x 8--15,5 mm; anterior three widely spathulate, bases narrowly cuneate, apices rounded, truncate or emarginate, 15--25 x 4--7,5 mm. **Stamens:** staminal column 1,5--4 mm long, white; perfect stamens 5, remain straight during anthesis, posterior one 6--11 mm long, lateral two 8--14,5 mm long, anterior two 11--17 mm long, white; staminodes 2--6 mm long; anthers dark red, 2--3 mm long, pollen orange. **Gynoecium:** ovary 3,5--7,5 mm long; style 2--8,5 mm long, pale green; stigma branches 1,5--3(-4) mm long, adaxially dark red. **Fruit:** bases of mericarps 6 mm long, with glandular hairs, tails 25--31 mm long. (Figure 8.38.1).

Diagnostic features and affinities

P. carneum is a geophyte normally with irregularly bipinnatisect leaves, although specimens with simple or trifoliolate leaves are also known. The rather large bell-shaped flowers have very long hypanthia ((29-)35--75 mm) and wide patent petals (posterior ones 8--15,5 mm wide). The colour of the petals varies from white, pink, yellow to cream-coloured or flesh-coloured, hence the specific epithet *carneum*. The stamens, of which the anterior ones are of the same length or slightly longer than the sepals, remain straight inside the bell-shaped flower. This flower structure is similar to that of *P. radiatum* and *P. nummulifolium*. However, the three taxa differ in respect to the leaf form and the indumentum of the peduncle, hypanthia and the sepals.

Geographical distribution and ecology

P. carneum occurs along the southern Cape Province, from Worcester and Villiersdorp in the west to the Gamtoos river in the east (Figure 8.38.2). The annual rainfall of this distribution area varies from 200–800 mm. In the west the precipitation occurs mainly in winter, but to the east it occurs throughout the year. Plants occur on limestone hills, in rock crevices, on stony sandy hillsides or on flats in stony sand, or clay or loamy soil. The occurrence varies from rare or occasionally to locally abundant in renosterveld, marginal coastal renosterveld and also in fynbos. *P. carneum* flowers from November to March, after the leaves have died.

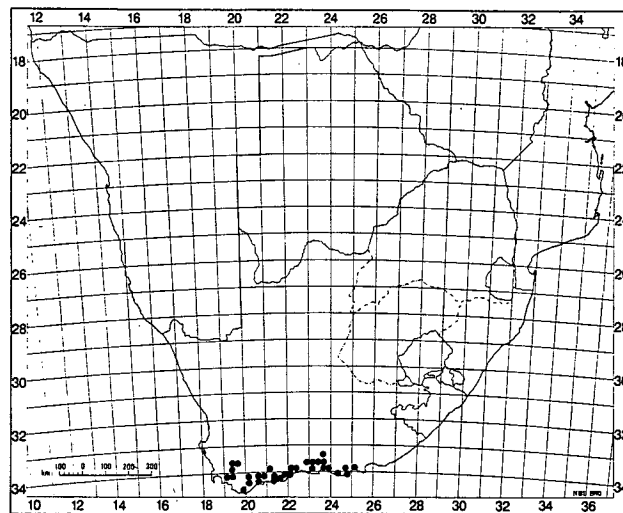


Figure 8.38.2 Geographical distribution of *P. carneum*.

Material studied

--3319 (Worcester): SE of Brandvlei dam (-CB), *Van Zyl s.n.* (STEU 3855, 3959); Rooihoogte, Villiersdorp (-CD), *Bayer 3173* (NBG); Terras, near Worcester (-DA), *Lavranos & Pehlemann 17448* (STEU).

--3321 (Ladismith): Springfontein, between Muiskraal & Barrydale (-CC), *Lavranos 20887* (STEU); Paardeberg, Riverdale (-CC), *Muir 35* (PRE); Garcia's Pass (-CC), *Ryder 19985* (BOL, K); Near Muiskraal (-CC), *Van der Walt s.n.* (STEU 1653, 1654).

--3322 (Oudtshoorn): Moerasrivier, S slopes of Witberg (-CC), *Hugo 133* (PRE, STE); Camfer (-CD), *Esterhuysen 16831* (BOLx3, K); Klipdrift (-CD), *Schlechter 2277* (Z); Mannetjiesberg, Kammanassie, Uniondale (-DB), *Esterhuysen 4707* (BOL).

--3323 (Willowmore): Baviaanskloof road, 31 km S of Willowmore (-BC), *Marais 147* (STEU); Uniondale (-CA), *Burchell 5013* (K); *Esterhuysen 12543* (PRE); *Esterhuysen 19970* (BOL, PRE);

Sondagsberg, Avontuur (-CA), *Fischer 363* (STEU); Hills near Avontuur (-CA), *Fourcade 2072* (BOL, BOL-FOURCADE); Avontuur (-CA), *Van Zyl s.n.* (STEU); 41 km from Joubertina to Avontuur (-CB), *Marais 157* (STEU); N of Joubertina (-CC), *Fourcade 2933* (K); Dwaasrivier, Kouga, Joubertina (-DA), *Manson 251* (STE); 32 km from Joubertina to Avontuur (-DC), *Marais 153, 154* (STEU); Joubertina (-DD), *Esterhuysen 19949, 21259* (BOL).

--3324 (Steytlerville): Uitvlugt, near Groothoek, Humansdorp (-DC), *Fourcade 3513, 5124* (BOL-FOURCADE).

--3325 (Port Elizabeth): Gamtoos River (-CC), *Hall NBG66/59* (BOL).

--3419 (Caledon): Houhoek (-AA), *Schlechter 9421* (BM, BOL, E, Gx3, K, L, MO, P, PREx3, S, W, Z); Caledon (-AB), *Drijfhout s.n.* (STEU); Zeekoeikraal, Riviersonderend (-AB), *Oliver 5476* (STE); Near Caledon (-AB), *Van der Walt s.n.* (STEU); Near Elim (-DB), *Bolus 12958* (BOL).

--3420 (Bredasdorp): Stormsvlei (-AA), *Zeyher 2046* (G, K, MEL, Px2, S, W, Z); Goerreesoe, Swellendam (-AC), *Acocks 23097* (PRE); Between Swellendam & Heidelberg (-BA), *Barker 8887* (NBGx2); Suurbraak, E of Heidelberg (-BA), *Burt-Davy 12552* (PRE); Middelplaas, Suurbraak (-BA), *Viviers 1145* (STE); W of Heidelberg (-BB), *Hall 860* (NBG); Frans Rietfontein near Cape Infanta (-BD), *Esterhuysen 29384* (BOL, K, PRE).

--3421 (Riversdale): Riversdale (-AB), *Muir 2941* (BOL); *Schlechter 1998* (Z); Stilbaai (-AD), *Bohnen 4841* (PRE, STE); *Compton 23176* (NBGx2); *Esterhuysen 19531* (BOLx2, K); *Van Schalkwyk 45* (PU); Meeufontein, Stilbaai (-AD), *Bohnen 7780* (STE); Between Mossel Bay & Riversdale (-BB), *Gillett s.n.* (STE).

--3422 (Mossel Bay): Groot-Brakrivier, station (-AA), *Forrester s.n.* (NBG).

--3424 (Humansdorp): Lower Tsitsikamma, flats near Kromrivier (-AB), *Fourcade 2964* (PRE); Humansdorp (-BB), *Burchell 4854, 4926* (K); *Burt-Davy 12001* (BOL, PRE); *Thode A712* (PRE); Cape St. Francis (-BB), *Coutnik s.n.* (STEU); Between Jeffreys Bay & Kabeljou (-BB), *Fourcade 6350* (STE).

8.39 *Pelargonium radiatum* (Andr.) Pers., Synopsis plantarum 2: 226 (1806); Ait. f.: 160 (1812); Link: 186 (1822); DC.: 650 (1824); Spreng.: 50 (1826); Loudon: 568 (1829); G. Don: 729 (1831); Loudon: 272 (1832); Steud.: 679 (1840); Steud.: 289 (1841). ICONOTYPE: Andrews, The Botanist's Repository 4: t. 222 (1802b).

Geranium radiatum Andr.: t. 222 (1802b); Poir.: 757 (1812). ICONOTYPE: Andrews, The Botanist's Repository 4: t. 222 (1802b).

Dimacria radiata (Andr.) Sweet: 77 (1826c).

Hoarea radiata (Andr.) Eckl. & Zeyh.: 62 (1835).

Geranium oxalioides Andr.: C, ic (1805b). ICONOTYPE: Andrews, Geraniums: C, ic (1805b).



Figure 8.39.1 *Pelargonium radiatum*. A, flowering plant x1; B, androecium x2; C, gynoecium x4; D, petals x1.

Pelargonium crinitum Harv.: 263 (1860); Knuth: 327 (1912); non Nees: 163 (1845). TYPE - Cape Province: "Dutoitskloof", *Drège 1290* (K, lecto!, designated here, E!, G!, L!, MEL!, MO!, OXF!, Px2!, S!, W!).

Geranospermum crinitum (Harv.) Kuntze: 94 (1891).

Pelargonium pulcherrimum Leighton: 229, 232 (1932); non Sweet: t. 134 (1822). TYPE - Cape Province: "Near Worcester", *Leipoldt s.n. sub. BOL19969* (BOL, holo!, K!).

A geophyte 130--230 mm tall when in flower. **Tuber:** a turnip-shaped or elongated, sometimes moniliform root 10--60 mm long and 5--20 mm in diameter. **Leaves** mostly simple, sometimes compound with 2 or more lateral pinnae at base of laminae, green, petiolate; lamina (or median pinna) ovate, base cuneate or truncate, apex obtuse, margin entire, 15--45 x 10--36 mm; small lateral pinnae ovate, 12--22 x 6--9 mm, adaxially sparsely to densely hirsute with long appressed stiff hairs interspersed with glandular hairs, abaxially the indumentum varies from densely hirsute with appressed hairs to setose with appressed hairs only along the larger veins; petiole 10--70 mm long and 1--3 mm in diameter, prostrate, setose, interspersed with appressed curly hairs and long and short glandular hairs; stipules subulate, adnate to the petioles for half their length, 5--10 mm long and 1--2 mm wide, ciliate. **Inflorescence:** scape 30--90 mm long, 1,5--3 mm in diameter, branched, bearing 2--3 pseudo-umbellets with 2--6(-8) flowers each; peduncles 50--120 mm long, 1--2 mm in diameter, covered with short glandular hairs interspersed with long and short soft patent hairs; bracts narrowly triangular, 5--8 mm long, 2--3 mm wide, abaxially hirsute with appressed hairs interspersed with glandular hairs. **Pedicel** ca. 0,5 mm long. **Hypanthium** 30--62 mm long, green, densely covered with glandular hairs sparsely interspersed with stiff patent hairs. **Sepals** 5, lanceolate, apices attenuate, 11--14 mm long, 1,5--3,5 mm wide, patent or sometimes recurved, green, covered with glandular hairs interspersed with appressed stiff hairs. **Petals** 5, pink or bright pink, pale yellow or cream-coloured, patent during anthesis; posterior two with wine-red feather-like markings, obovate to widely obovate or obcordate, bases cuneate, apices rounded, truncate or emarginate, 19--32 x 7,5--16,5 mm; anterior three widely spatulate, bases narrowly cuneate, apices rounded, truncate or emarginate, 16,5--30 x 5--12 mm. **Stamens:** staminal column 1,5--4 mm long, white; perfect stamens 5, remain straight during anthesis, posterior one 8--11 mm long, lateral two 9--14 mm long, anterior two 11--17 mm long, white; staminodes 2--5,5 mm long; anthers wine-red, 2,5--3,8 mm long, pollen orange. **Gynoecium:** ovary 3,5--6 mm long; style 2--6 mm long, white or pale green; stigma branches 1,2--3 mm long, adaxially wine-red. **Fruit:** bases of mericarps 6--8 mm long, with glandular hairs, tails 25--32 mm long. (Figure 8.39.1).

Diagnostic features and affinities

P. radiatum is a geophyte with simple or trifoliolate prostrate leaves, arranged in a radiating manner, hence the specific epithet. Like *P. carneum*, it has rather large bell-shaped flowers with very long hypanthia (30--62 mm) and wide patent petals (posterior ones 7,5--16,5 mm wide). The two species exhibit more or less the same variation in flower colour and in both species the stamens remain straight inside the bell-shaped flower. However, the two taxa differ in respect to the leaf form. *P. radiatum* has simple or trifoliolate leaves, whereas *P. carneum* usually has irregularly bipinnatisect ones. The non-glandular hairs on the peduncle, hypanthia and the sepals of *P. carneum* are more bristle-like and those of *P. radiatum* are a softer type of hair.

Geographical distribution and ecology

P. radiatum has a small distribution in the mountainous region of the south-western Cape. It occurs on the Dutoitskloof and Slanghoek Mountains, and on Jonaskop in the Riviersonderend Mountain range (Figure 8.39.2). This area receives an annual rainfall of over 1000 mm. *P. radiatum* also occurs in lowland areas in the vicinity of Worcester and Villiersdorp. Plants grow in shallow stony sand between rocks in fynbos. It flowers in summer from October to January at a time when the leaves are dying.

P. radiatum seems to be restricted to sandstone areas with a rather high annual rainfall, whereas *P. carneum* occurs on a variety of substrates in areas where the annual rainfall varies from as low as 200 mm to about 800 mm.

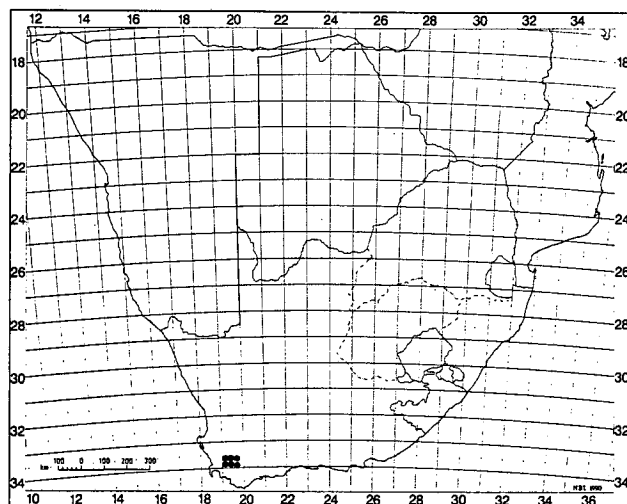


Figure 8.39.2 Geographical distribution of *P. radiatum*.

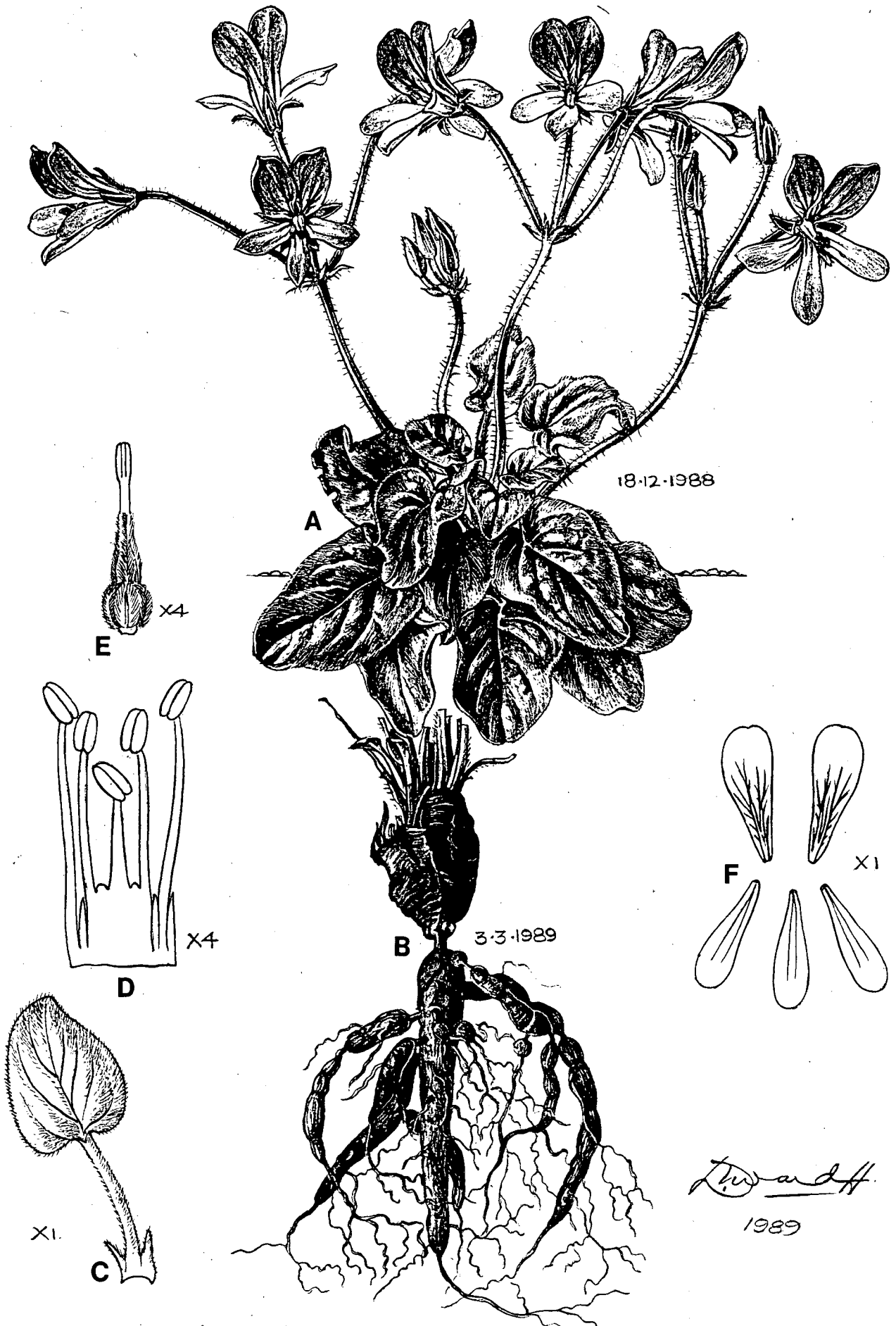


Figure 8.40.1 *Pelargonium nummulifolium*. A, flowering plant x1; B, tuber x1; C, leaf x1; D, androecium x4; E, gynoecium x4; F, petals x1.

Material studied

--3319 (Worcester): Dutoitskloof (-CA), *Drège 1290* (E, G, K, L, MEL, MO, OXF, Px2, S, W); Observation Peak, Slanghoek Mountains (-CA), *Esterhuysen 1706* (BOLx2, K); Molenaarsberg, Slanghoek Mountains (-CA), *Esterhuysen 14350* (BOL); Suurvlaakte, above Dutoitskloof (-CA), *Esterhuysen 21111* (BOL); Eikeboom on Slanghoek road (-CA), *Van der Walt 1063* (STEU); Near Brandvleidam, Worcester (-CB), *Albers s.n.* (STEU); Worcester, Airfield (-CB), *Bayer 2631* (NBGx2); Worcester West, building plots (-CB), *Forrester s.n.* (NBG); Worcester (-CB), *Leipoldt BOL19969* (BOL, K); Die Nekkie, Brandvleidam (-CB), *Perry 760* (NBG); Worcester, Karoo Garden (-CB), *Van der Walt 1058* (STEU); Dutoit's Peak (-CC), *Esterhuysen 8603* (BOL); *Esterhuysen 16630* (BOL, K); *Esterhuysen 18923* (BOL); Seven Sisters Mountain (-CC), *Esterhuysen 18309* (BOLx2, K, PREx2); Villiersdorp (-CD), *Middlemost s.n.* (BOL); Farm Moddergat, Ou Plaas (-CD), *Rossouw 445* (NBG); Effata farm, De Wet (-DA), *Bayer 963* (NBG); Jonaskop (-DC), *Marais 386* (STEU); *Van der Walt 970, 1494* (STEU).

8.40 *Pelargonium nummulifolium* Salisb., *The paradisus londinensis* 1: t. 23 (1806); Loudon: 271 (1832) (*sub. P. nummularifolium*). ICONOTYPE: Salisbury, *The paradisus londinensis* 1: t. 23 (1806).

Hoarea nummularifolia (Salisb.) Sweet: 76 (1826c).

A geophyte 110--150 mm tall when in flower. **Tuber:** a turnip-shaped or elongated, sometimes moniliform root 25--40 mm long and 18--30 mm in diameter, densely crowned with numerous prostrate leaves. **Leaves** simple, greyish green, petiolate; lamina ovate or cordiform, base truncate or cordate, apex obtuse, margin entire, 18--28 x 13--22 mm, adaxially densely hirsute with long appressed stiff hairs interspersed with short glandular hairs, abaxially sparsely hirsute with appressed hairs interspersed with short glandular hairs mainly along the large veins; petiole 12--55 mm long and 1,5--3 mm in diameter, prostrate, hirsute or densely hirsute interspersed with short glandular hairs; stipules subulate, adnate to the petioles for half their length, 3--10 mm long and 1--3 mm wide, ciliate. **Inflorescence:** scape 10 mm long, 2--3 mm in diameter, branched, bearing 2 pseudo-umbellets with 3--5 flowers each; peduncles 50--60 mm long, 1,5--2 mm in diameter, covered with short glandular hairs interspersed with long soft patent hairs and appressed curly hairs; bracts lanceolate, 5 mm long, 2--3 mm wide, abaxially hirsute with appressed stiff hairs interspersed with glandular hairs. **Pedicel** ca. 0,5 mm long. **Hypanthium** 25--40 mm long, pale reddish green, densely covered with glandular hairs sparsely interspersed with coarse patent hairs. **Sepals** 5, lanceolate, apices

attenuate, 9--10 mm long, 2--3 mm wide, patent, reddish brown to green, hirsute with appressed curly hairs interspersed with glandular hairs. **Petals** 5, bright pink or flesh-coloured, patent during anthesis; posterior two with wine-red feather-like markings, obovate to widely obovate or obcordate, bases cuneate, apices rounded or truncate, 20--23 x 7,5--10 mm; anterior three widely spatulate, bases narrowly cuneate, apices rounded or truncate, 18--21 x 5--6 mm. **Stamens**: staminal column 2 long, white; perfect stamens 5, remain straight during anthesis, posterior one 7 mm long, lateral two 9--10 mm long, anterior two 11,5--12 mm long, white; staminodes 2,5--3 mm long; anthers dark red, 2 mm long, pollen orange. **Gynoecium**: ovary 4 mm long; style 1--1,5 mm long, dark red; stigma branches 2 mm long, dark red. **Fruit**: bases of mericarps with glandular hairs. (Figure 8.40.1).

Diagnostic features and affinities

P. nummulifolium is a geophyte with numerous densely arranged leaves growing from a short flattened stem, giving it a cushion or alpine growth form. This species is very similar to *P. radiatum* in respect to the leaf form and the floral structure. They differ, however, in respect to the indumentum and the pollen structure.

The specific epithet *nummulifolium* refers to the leaves of *Nummularia* Hill, a genus of the Primulaceae. These plants usually have basally arranged leaves like *P. nummulifolium*.

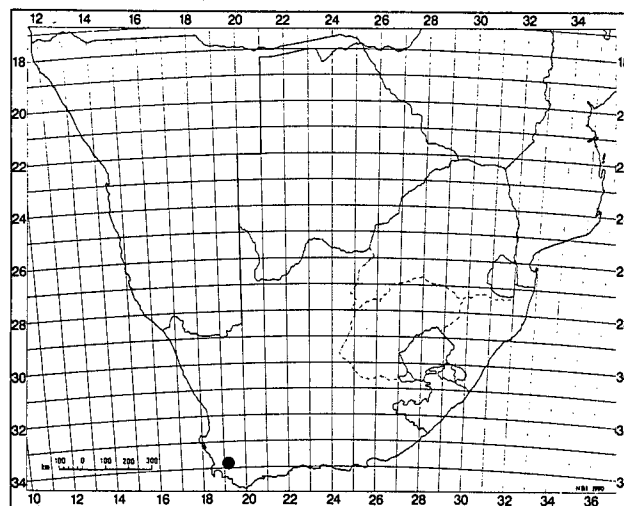


Figure 8.40.2 Geographical distribution of *P. nummulifolium*.

Geographical distribution and ecology

So far *P. nummulifolium* is known from a small distribution area in the mountainous region of the south-western Cape (Figure 8.40.2), an area receiving a rather high rainfall of over 1000 mm per annum. It occurs in sand in mountain fynbos and large populations grow in full sun. This species, like other *Hoarea* species which grow on high mountains, flowers in summer from December to March.

Material studied

--3319 (Worcester): Agter-Tafelberg, Du Toitskloof (-CC), *Watson 71* (NBG, STEU).

LUTEOLUM GROUP

Geophytes with palmately compound leaves and very thin, erect petioles. Scape branched, bearing 2--3 pseudo-umbellets with 3--16 flowers each. Flowers white, cream-coloured, yellow or pink; posterior petals ligulate or unguiculate-spathulate and the anterior petals unguiculate-obovate, wider than the posterior ones. Stamens 5 fertile, remain straight during anthesis, and are enclosed by the anterior petals. Tectum of pollen striate-reticulate.

8.41 *Pelargonium luteolum* *N.E. Br.* in *Kew Bulletin* 1913: 299 (1913); Van der Walt & Vorster: 93, fig. (1981a). TYPE - Cape Province: "near Prince Albert", *Pearson s.n.* (K, holo!).

A geophyte 80--300 mm tall when in flower. **Tuber:** a turnip-shaped or elongated, sometimes moniliform root, or sometimes branched with several stem-growing points, 20--60 mm long and 15--45(-60) mm in diameter. **Leaves** green, petiolate; lamina palmately compound with three main pinnae; pinnae 18--120 mm long, sometimes deeply incised, segments 20--50 mm long, sometimes lacinate, 0,5--5 mm wide, with apices acute, hirsute with long appressed hairs; petiole (10-)60--90(-140) mm long and 0,5--1 mm in diameter, rigid, erect, hirsute with appressed hairs interspersed with short glandular hairs; stipules subulate, adnate to petioles for half their length, 5--12 mm long and 1--2 mm wide, ciliate. **Inflorescence:** scape 10--70 mm long, 1--2 mm in diameter, branched, bearing 2--3 pseudo-umbellets with 3--16 flowers each; peduncles 30--170(-280) mm long, 1--1,5 mm in diameter, densely covered with appressed stiff hairs

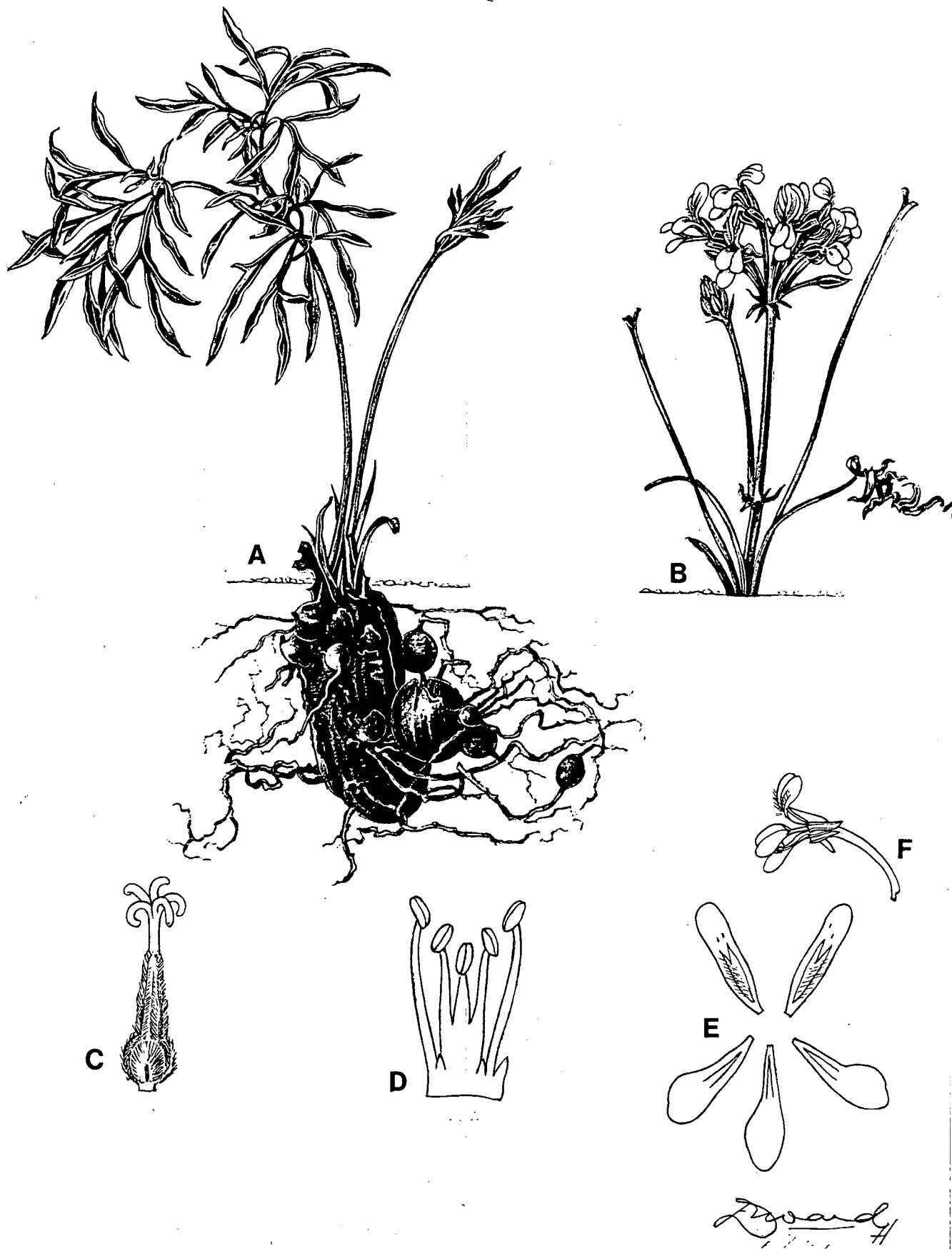


Figure 8.41.1 *Pelargonium luteolum*. A, plant with leaves x1; B, flowering plant x1; C, gynoecium x6; D, androecium x4; E, petals x2; F, flower x1,5.

interspersed with short glandular hairs; bracts lanceolate, 2--4 mm long, 1--1,5 mm wide, abaxially hirsute with appressed hairs. **Pedicel** *ca.* 0,5 mm long. **Hypanthium** 13--20(-24) mm long, green, indumentum as on peduncle. **Sepals** 5, lanceolate, apices acute to attenuate, 5--9,5 mm long, 1--3 mm wide, posterior one erect, others reflexed, green with reddish brown apices and membranous margins, indumentum abaxially as on peduncle. **Petals** 5, cream-coloured, almost white or yellow, claws forming a sheath; posterior two ligulate or unguiculate-spathulate, with wine-red markings along the main veins, 7--14,5 x 2--4 mm, claws 4,5--7 mm long and 1,5--2 mm wide, cuneate, adaxially usually with long soft hairs along the main vein, apices rounded, truncate or emarginate, laterally recurved during anthesis; anterior three unguiculate-obovate, 7--14 x 2,5--5 mm, claws obtriangular, with V-shaped wine-red stripes, 3,5--5 mm long, apices rounded, connivent, the lateral two covering the median one. **Stamens**: staminal column 1,5--3,5 mm long, white; perfect stamens 5, remaining straight during anthesis, covered by the anterior petals, posterior one 4--8,5 mm long, lateral two 4,5--9 mm long, anterior two 5--9,5 mm long, white; staminodes 2--4 mm long; anthers 1--1,8 mm long, pollen orange. **Gynoecium**: ovary 2--5 mm long; style 0,5--2,5 mm long, pale green; stigma branches 0,5--1,5 mm long, adaxially pink. **Fruit**: bases of mericarps *ca.* 4 mm long, with glandular hairs, tails *ca.* 25 mm long. (Figure 8.41.1).

Diagnostic features and affinities

P. luteolum has a peculiar flower with two ligulate or unguiculate-spathulate posterior petals with adaxially long soft hairs along the main veins and laterally recurved during anthesis. The three unguiculate-obovate anterior petals are wider than the posterior ones and connivent, the lateral two covering the median one. At the same time the stamens are concealed by the anterior petals. This floral structure is similar to that of *P. gracillimum*. The latter has pink flowers with long hypanthia (22--35 mm long), whereas *P. luteolum* has yellow flowers and short hypanthia (13--20 mm long). The specific epithet *luteolum* refers to the pale yellow colour of the flowers.

The leaves of *P. luteolum* are vary variable. Leaves of young plants or the first leaves of the season are often trilobate, whereas the leaves of older plants or the later leaves of the season are deeply incised with segments sometimes laciniate. The erect palmately compound leaves with three main pinnae are similar to those of *P. attenuatum* and *P. angustipetalum*, both species with a different floral structure than that of *P. luteolum*. Although the petioles of *P. luteolum* are very thin, they remain erect because of the large amount of sclerenchymatous tissue surrounding the vascular cylinder.

Geographical distribution and ecology

P. luteolum has a large distribution area. It occurs from Garies in Namaqualand, along the west coast to Worcester in the south and along the southern coast as far as Steytlerville and Kleinpoort in the eastern Cape (Figure 8.41.2). The western part of the distribution area is mainly a winter rainfall region, whereas the southern and eastern Cape receive rain throughout the year. The annual rainfall for this distribution area varies between 100 and 300 mm. *P. luteolum* occurs on a variety of substrates, like sandstone, shale or quartzite, and also in a variety of vegetation types. It occurs in karroid vegetation or in different types of fynbos under bushes or in direct sunlight. In drier areas single plants or large populations usually occur on rocky southern slopes of steep hillsides. Flowering time is from November to March, with the peak in January and February.

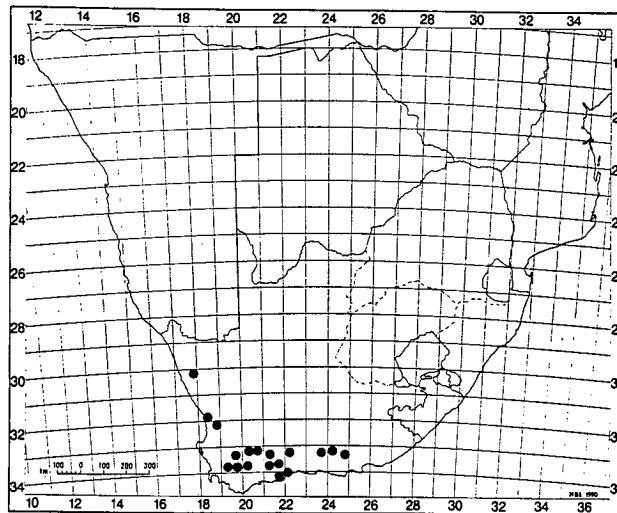


Figure 8.41.2 Geographical distribution of *P. luteolum*.

Material studied

- 3017 (Hondeklipbaai): 8 km from Garies to Hondeklipbaai (-DB), *Drijfhout 1345* (STEU).
- 3118 (Vanrhynsdorp): Knakarberge, Vanrhynsdorp (-CD), *Drège s.n.* (P, S).
- 3218 (Clanwilliam): Clanwilliam (-BB), *Leipoldt 4234*, (BOL).
- 3319 (Worcester): Karoo Poort (-BA), *Marloth 9011, 9013* (PRE); Airfield, Worcester (-CB), *Dobay 110/75* (STEU); Worcester (-CB), *Esterhuysen 10128* (BOL); *Leighton 1035* (BOL); *Leipoldt 20514* (BOL); Karoo Garden, Worcester (-CB), *Leighton 1999* (BOL); *Van der Walt 1056, s.n.* (STEU 740) (STEU); Brandvleidam, Matjieskloof (-CB), *Marais 410* (STEU); Worcester, Veld Reserve (-CB), *Olivier 13* (PRE); Hammansberg (-CD), *Forrester 94, 95* (NBG); Cement Factory, Nuy (-DA), *Barker 10703*

(NBG); Sandhills (-DA), *Dobay 1/75* (STEU); Keeromsberge (-DA), *Esterhuysen 22880, 27639* (BOL); 1 km S of Langvlei Station (-DC), *Van der Walt & Vorster 1389* (STEU); Robertson (-DD), *Van der Walt s.n.* (STEU); Robertson, road to McGregor (-DD), *Van Zyl s.n.* (STEU).

--3320 (Montagu): Tweedside, Matjiesfontein (-AB), *Marloth 12089* (BOL); 4 km from Matjiesfontein on Sutherland road (-BA), *Marais 212* (STEU); 6 km SE of Nougaspoot (-CA), *Fischer 227* (STEU); Nougaspoot (-CA), *Marais 105, 106, 107* (STEU); 8 km S of Lettaskraal (-CB), *Muller 4034* (STEU); Keurkloof (-CC), *Barker 8270* (NBG); Montagu Baths (-CC), *Bolus s.n.* (NBG); Kogmanskloof (-CC), *Marais 111, 112, 113* (STEU); *Van Zyl s.n.* (STEU); Boesmansdrif, 5 km E of Bonnievale (-CC), *Van der Walt 1390* (STEU).

--3321 (Ladismith): Seweweekspoot (-AD), *Marais 330, 389* (STEU); Vanwyksdorp (-CB), *Marais 167* (STEU); Springfontein, Riversdale district (-CC), *Bayer 3756* (NBG); Top of Rooiberg (-DA), *Acocks 20370* (PRE); Rooiberg Pass (-DA), *Lavranos 20266* (STEU); *Van der Walt 1305* (STEU).

--3322 (Oudtshoorn): Prince Albert (-AA), *Pearson s.n.* (K); Prince Albert, entrance to Swartbergpas (-AC), *Marais 368* (STEU).

--3323 (Willowmore): Trompetterskloof, Willowmore (-BA), *Scheltema 21* (STEU); 5 km E of Willowmore (-BC), *Lavranos & Pehlemann 19837* (STEU).

--3324 (Steytlerville): Noorspoort farm (-AD), *Craven s.n.* (STEU); Kleinpoort (-BD), *Craib s.n.* (STEU).

--3421 (Riversdale): Naphymond, Riversdal (-BA), *Bayer 2671* (NBG).

--3422 (Mosselbaai): Mosselbaai (-AA), *Ryder 21* (BOL).

8.42 *Pelargonium gracillimum* Fourc. in Transactions of the Royal Society of South Africa 21: 91 (1932). TYPE - Cape Province: "Hills north of Avontuur", *Fourcade 3570* (BOL-FOURCADE, lecto!, designated here; K!; STE!).

A geophyte 80--270 mm tall when in flower. **Tuber:** a turnip-shaped or narrowly elongated, sometimes moniliform root, 15--50(-80) mm long and 6--20 mm in diameter. **Leaves** green, petiolate; lamina palmately compound with three main pinnae; pinnae (15-)25--120 mm long, sometimes deeply incised, segments 17--60 mm long, sometimes lacinate, 2--4 mm wide, with apices acute, hirsute with long appressed hairs; petiole 25--150 mm long and 0,5--1 mm in diameter, rigid, erect, hirsute with appressed hairs interspersed with short glandular hairs; stipules subulate, adnate to petioles for half their length, 5--12 mm long and 1--2 mm wide, ciliate. **Inflorescence:** scape 15--95 mm long, 1--2 mm in diameter, branched, bearing 2--3 pseudo-umbellets with 3--12(-16) flowers each; peduncles 50--185 mm long, 0,5--1 mm in diameter, densely covered with appressed stiff hairs interspersed with short glandular hairs; bracts lanceolate, 1,5--4 mm long, 1--1,5 mm wide, abaxially hirsute with appressed hairs. **Pedice**l ca. 0,5 mm long.

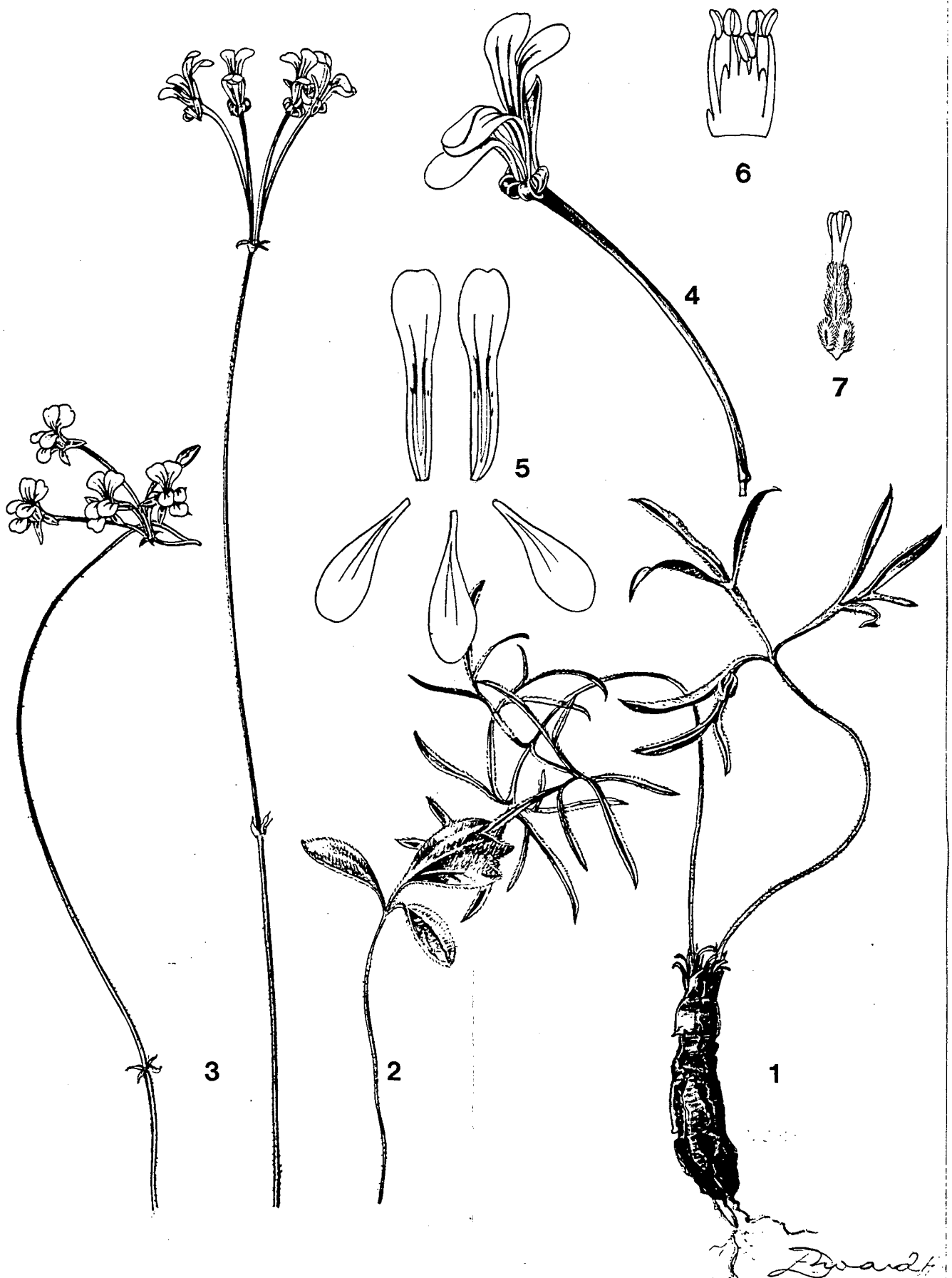


Figure 8.42.1 *Pelargonium gracillimum*. 1, plant with leaves x1; 2, leaf x1; 3, inflorescence x1; 4, flower x3; 5, petals x5; 6, androecium x4; 7, gynoecium x6.

Hypanthium (15-)22--35 mm long, green, indumentum as on peduncle. **Sepals** 5, lanceolate, apices acute to attenuate, 4,5--7,5 mm long, 1--2,5 mm wide, posterior one erect, others reflexed, green with reddish brown apices and membranous margins, indumentum abaxially as on peduncle. **Petals** 5, white to pale pink or pink, claws forming a sheath; posterior two unguiculate-spathulate, with wine-red markings along the main veins, 9--14 x 2,5--3,5 mm, claws 4--7 mm long and 1,5 mm wide, cuneate, apices rounded, truncate or emarginate, laterally recurved during anthesis; anterior three unguiculate-obovate, 8--11,5 x 2,2--4,2 mm, claws obtriangular, with V-shaped wine-red stripes, 2--4 mm long, apices rounded, connivent, the lateral two covering the median one. **Stamens**: staminal column 1--2,5 mm long, white; perfect stamens 5, remaining straight during anthesis, covered by the anterior petals, posterior one 3,5--6 mm long, lateral two 4--7 mm long, anterior two 4,5--7,5 mm long, white; staminodes 2--3,5 mm long; anthers 1,5--1,8 mm long, pollen orange. **Gynoecium**: ovary 2--5 mm long; style 0,5--2 mm long, pale green; stigma branches 0,5--1,5 mm long, adaxially pink. **Fruit**: bases of mericarps 4--5,5 mm long, with glandular hairs, tails 20--26 mm long. (Figure 8.42.1).

Diagnostic features and affinities

P. gracillimum has the same peculiar flower as *P. luteolum*. The unguiculate-spathulate posterior petals are also laterally recurved during anthesis, but are without the trichomes. The three unguiculate-obovate anterior petals are also wider than the posterior ones and connivent, the lateral two covering the median one. In *P. gracillimum* these petals are markedly shorter (8--11,5 mm long) than the posterior ones (9--14 mm long). The stamens are concealed by the anterior petals. Other differences between the two species are the pink flowers and long hypanthia (22--35 mm long) of *P. gracillimum*, whereas *P. luteolum* has yellow flowers and short hypanthia (13--20 mm long).

The leaves of *P. gracillimum* show the same variability as those of *P. luteolum*. Leaves of young plants or the first leaves of the season are often trilobate, whereas the leaves of older plants or the later leaves of the season are deeply incised with segments sometimes lacinate. The specific epithet *gracillimum*, meaning thin or slender, refers to the long thin petioles and the thin and slender appearance of the deeply incised laminae. The erect palmately compound leaves with three main pinnae are similar to those of *P. attenuatum* and *P. angustipetalum*, both species with different floral structures from those of *P. gracillimum* and *P. luteolum*.

Geographical distribution and ecology

P. gracillimum has a relatively small distribution area in the southern Cape, occurring from Seweweekspoort in the west to Baviaanskloof in the east (Figure 8.42.2). This area receives rain throughout the year and the annual precipitation varies from 100--300 mm. *P. gracillimum* occurs on sandstone in fynbos, usually on the southern slopes of very steep hillsides. However, records of plants growing in stony clay or well-drained loam are also known. Populations usually consist of small numbers of plants and flower from January to March.

Although both *P. gracillimum* and *P. luteolum* occur in the southern Cape, the small distribution area of *P. gracillimum* is adjacent to the much larger one of *P. luteolum*, overlapping only in the Seweweekspoort.

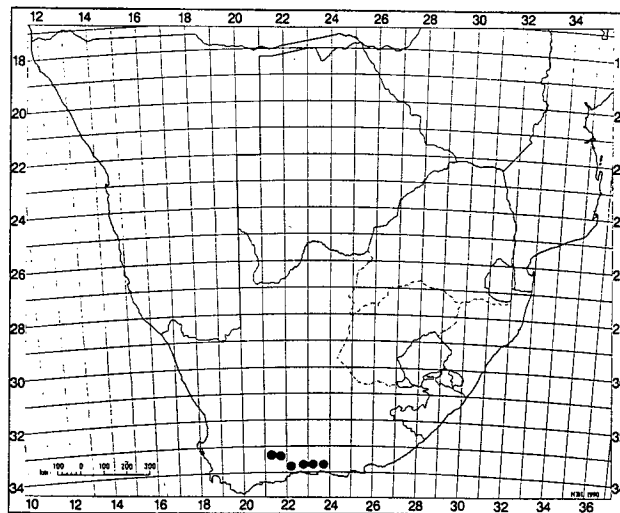


Figure 8.42.2 Geographical distribution of *P. gracillimum*.

Material studied

--3321 (Ladismith): Seweweekspoort (-AD), *Bayliss 1975* (NBG); *Hugo 2567* (PRE, STE); *Wurtz 1656* (NBG); Gamka Mountain Nature Reserve (-BC), *Cattell & Cattell 328* (STE).

--3322 (Oudtshoorn): 7 km from Uniondale to Baviaanskloof road (-CA), *Perry 1441* (NBG); Moerasrivier, district Oudtshoorn (-CC), *Taylor 320* (BOL); Laudina, Uniondale (-DB), *Esterhuysen 18400* (BOL).

--3323 (Willowmore): Uniondale (-CA), *Esterhuysen 16872* (BOL); Avontuur (-CA), *Fourcade 3570* (BOL-FOURCADE, K, STE); 5 km N of Avontuur (-CA), *Marais 161* (STEU); 7 km N of Uniondale (-CA), *Marais 162* (STEU); Uniondale Poort, southern entrance (-CA), *Marais 367* (STEU); Nuwekloof

Pass, Baviaanskloof (-DA), *Bruyns* 2197 (STEU); *Marais* 148, 149 (STEU); *Van Jaarsveld* 7665a (STEU).

RAPACEUM GROUP

Geophytes with erect irregularly bipinnatisect leaves. Scape branched, bearing 2--4 pseudo-umbellets with 6--30(-47) flowers each. Hypanthium of variable length, 12--55 mm long. The papilionaceous type of flower is extremely zygomorphic, the anterior petal is usually wide and conduplicate, enclosing the stamens and forming a keel, the lateral petals or wings cover the keel. Stamens 5 fertile, long and straight during anthesis. Tectum of pollen striate-reticulate.

8.43 *Pelargonium rapaceum* (L.) L'Hérit. in Aiton, Hortus Kewensis edn 1, 2: 418 (1789); Jacq.: 190 (1791b); Jacq.: 8, t. 510 (1792); Willd.: 649 (1800); Pers.: 228 (1806); Ait. f.: 164 (1812); Link: 186 (1822); DC.: 651 (1824); Spreng.: 54 (1826); Loudon: 570 (1829); G. Don: 727 (1831); Loudon: 271 (1832); Steud.: 679 (1840); Steud.: 289 (1841); Harv.: 269 (1860); Szyszyl.: 8 (1888); Knuth: 348 (1912); Adamson & Salter: 513 (1950); Van der Walt: 39 fig. (1977); Wijnands: 108 (1983). LECTOTYPE: Commelijn, Horti Medici Amstelaedamensis 2: 125, t. 63; original plate in Moninckx collection in Amsterdam (Commelijn 1706, Wijnands 1983).

Pelargonium rapaceum (L.) L'Hérit. var *luteum* Sims: t. 1877 (1817); Harv.: 269 (1860); Knuth: 348 (1912).

Geranium rapaceum L.: 1141 (May-June 1759); Poir.: 746 (1812). LECTOTYPE: Commelijn, Horti Medici Amstelaedamensis 2: 125, t. 63; original plate in Moninckx collection in Amsterdam (Commelijn 1706, Wijnands 1983).

Hoarea rapacea (L.) Sweet: 75 (1826c); Eckl. & Zeyh.: 65 (1835).

Geranospermum rapaceum (L.) Kuntze: 95 (1891).

Geranium myrrhifolium L. β : 677 (1753).

Geranium myrrhifolium L. β *rapaceum* (L.) Burm. f.: 45 (17 Aug. 1759).

Geranium prolificum L. α : 949 (1763): Substitute name for *G. rapaceum* L.: 1141 (1759); Burm. f.: 19 (1768).

Geranium selinum Andr.: t. 239 (1802b). ICONOTYPE: Andrews, The Botanist's Repository 4: t. 239 (1802b).

Pelargonium selinum (Andr.) Pers.: 228 (1806); Steud.: 290 (1841).

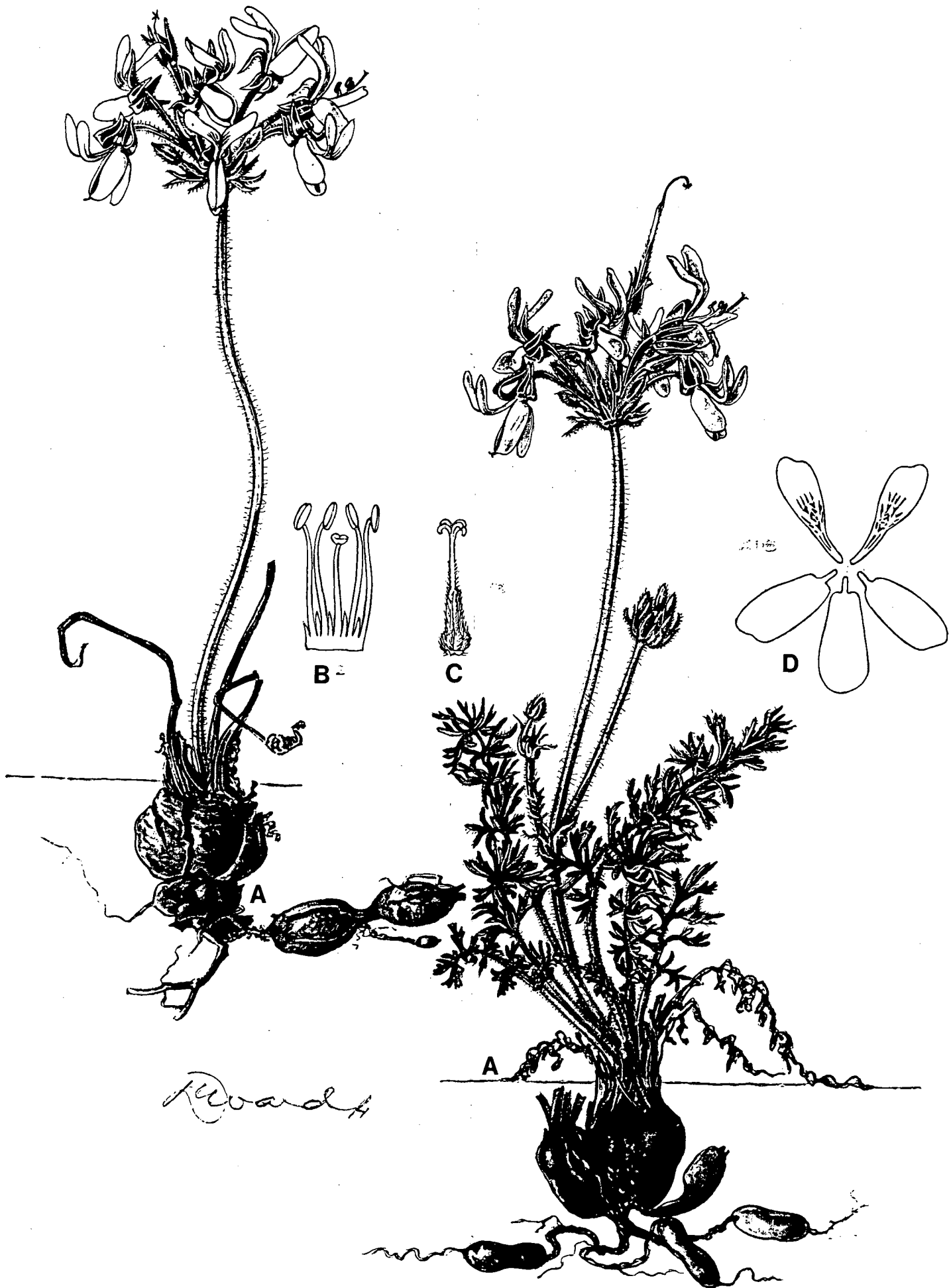


Figure 8.43.1 *Pelargonium rapaceum*. A, flowering plant x1; B, androecium x2; C, gynoecium x2; D, petals x1,5.

Pelargonium rapaceum (L.) L'Hérit. var. *selinum* (Andr.) Harv.: 269 (1860); Knuth: 348 (1912).

Pelargonium carinatum J.C. Wendl.: 79, t. 71 (1810); Loudon: 271 (1832). ICONOTYPE: Wendland, *Collectio plantarum* 2: t. 71 (1810).

Hoarea carinata (J.C. Wendl.) Sweet: t. 135 (1822); Sweet: 75 (1826c); Ecklon. & Zeyh.: 65 (1835).

Geranospermum carinatum (J.C. Wendl.) Kuntze: 94 (1891).

Hoarea corydaliflora Sweet: t. 18 (1820); Sweet: 75 (1826c); Eckl. & Zeyh.: 65 (1835). ICONOTYPE: Sweet, *Geraniaceae* 1: t. 18 (1820).

Pelargonium corydaliflorum (Sweet) DC.: 652 (1824); Loudon: 570 (1829); G. Don: 727 (1831); Loudon: 271 (1832); Steud.: 285 (1841).

Pelargonium rapaceum (L.) L'Hérit. var. *corydalifolium* (Sweet) Harv.: 269 (1860), (by mistake in place of *corydaliflorum*); Kunth: 348 (1912).

Geranium selinum var. *flavum* Andr.: C, ic (1822). ICONOTYPE: Andrews, *Geraniums*: C, ic (1822).

Pelargonium nutans DC.: 651 (1824): Substitute name for *G. selinum* var. *flavum* Andr.: C, ic (1822); Loudon: 570 (1829); G. Don: 727 (1831); Loudon: 271 (1832); Steud.: 288 (1841).

Pelargonium rutaefolium Bak.: t. 27 (1868). ICONOTYPE: Baker in Saunders's *Refugium Botanicum* 1: t. 27 (1868).

A geophyte (100-)170--300(-400) mm tall when in flower. **Tuber:** a turnip-shaped, elongated or sometimes moniliform root, older plants often with more than one stem-growing point, 18--40(-80) mm long and 10--50 mm in diameter. **Leaves** green, petiolate; lamina irregularly bipinnatisect, elliptic in outline, 50--250 mm long; pinnae irregularly and deeply incised, 8--40(-60) mm long, segments 1--3 mm wide, adaxially and abaxially hirsute to densely hirsute; petiole 25--120 mm long and 2--4 mm in diameter, erect, hirsute with long hairs and shorter appressed curly hairs, interspersed with glandular hairs; stipules subulate, attenuate, adnate to the petioles for two thirds of their length, 18--35 mm long and 1--2 mm wide, ciliate. **Inflorescence:** scape 10--80(-110) mm long, 2--4 mm in diameter, branched, bearing 2--4 pseudo-umbellets with 6--30(-47) flowers each; peduncles 70--290 mm long, 1--3 mm in diameter, densely covered with glandular hairs and sparsely interspersed with long soft patent non-glandular hairs; bracts subulate, 6--10 mm long, 1--2 mm wide, abaxially densely hirsute interspersed with glandular hairs. **Pedicel** 1(-10) mm long. **Hypanthium** varies extremely in length, 12--55 mm long, long ones slightly curved, reddish-brown, densely covered with glandular hairs, sometimes interspersed with soft patent non-glandular hairs. **Sepals** 5, lanceolate, apices acute, 7--14 mm long, 2--5 mm wide, reflexed,

reddish-brown with green margins, abaxially densely hirsute with appressed hairs, interspersed with glandular hairs. **Petals** 5, white, cream-coloured, pale yellow, primrose yellow, pink or salmon pink; posterior two unguiculate-spathulate, reflexed above the claws, 10--20 x 2--6 mm, claws straight with wine-red feather-like markings, 5--9 mm long, apices rounded; lateral two unguiculate-elliptic, connivent with the anterior one, 11--18 x 3,5--6 mm, claws narrowly linear, 2 mm long, apices rounded; anterior one unguiculate-elliptic, conduplicate, 11--17 x 5--11 mm, claws narrowly linear, 2 mm long, apices rounded. **Stamens**: staminal column 2,5--5 mm long, white, smooth; perfect stamens 5, enclosed by the anterior petal, remaining straight during anthesis, posterior one 7--12 mm long, lateral two 8--14,5 mm long, anterior two 9--15 mm long, free filaments white; staminodes 3,5--8 mm long; anthers dark red, 1,5--2,5 mm long, pollen orange. **Gynoecium**: ovary 3--9 mm long; style 2,5--8,5 mm long, pale green; stigma branches 0,5--2 mm long, adaxially wine-red. **Fruit**: bases of mericarps 6--8 mm long, with glandular hairs, tails 20--37 mm long. (Figure 8.43.1).

Diagnostic features and affinities

P. rapaceum is characterized by its extremely zygomorphic and papilionaceous type of flower and its typical bipinnatisect leaves. The two posterior petals are unguiculate-spathulate and bend backwards above the claws. The anterior petal is usually very wide and conduplicate like the keel of a papilionaceous type of flower, enclosing the relatively long and straight stamens. At the same time the two lateral petals or wings cover the keel. This flower type is not only unique for section *Hoarea*, but also for the genus *Pelargonium*. The long and straight stamens are similar to those of *P. moniliforme*, *P. incrassatum* and *P. radicum*, but in none of these species the stamens are covered by the anterior petals.

Several synonyms are known for this species. In each case, when a new species was described, the author explained the differences between the so called related species. Harvey (1860) and Knuth (1912) distinguished three different subspecies on the basis of flower colour, but in this study no differences in floral structure could be found to support such a division. Neither did the distribution patterns of the different flower colours contribute any support for such a subdivision. The same variation in flower colour occurs in other species of this section also, like *P. pinnatum*. Instead, the large variation in hypanthium length was examined. Specimens were divided in plants with long hypanthia (44--55 mm long), plants with medium length hypanthia (24--36 mm long), and plants with short hypanthia (12--23 mm long). The majority of specimens have yellow flowers, and the majority of specimens have short hypanthia, but there exists

no correlation between flower colour and the length of the hypanthium. Nothing could be found either in the distribution patterns, flowering time, floral structure, leaf morphology or the indumentum on the leaves or flowers to support a subdivision of this species on the basis of hypanthium length. Like the variation in flower colour, the large variation in hypanthium length is not unique for this section. The same variation occurs in *P. dipetalum* and *P. pinnatum*.

The specific epithet *rapaceum*, meaning turnip-shaped, refers to the thickened tuber.

Geographical distribution and ecology

P. rapaceum has the largest distribution area of all the species in section *Hoarea*. It occupies more or less the same area as the whole section and occurs from the Richtersveld in the north, along the west coast on the coastal plain, as well as on the escarpment, and along the southern coastal plain. One herbarium record is from as far east as Grahamstown (Figure 8.43.2). This area is mainly a winter rainfall region, although the southern and eastern Cape can receive rain in summer as well. A large variation in the annual precipitation occurs. It varies between 100--500 mm per annum and it seems that the amount of rain is not so crucial in the case of this species than in some others species of this section.

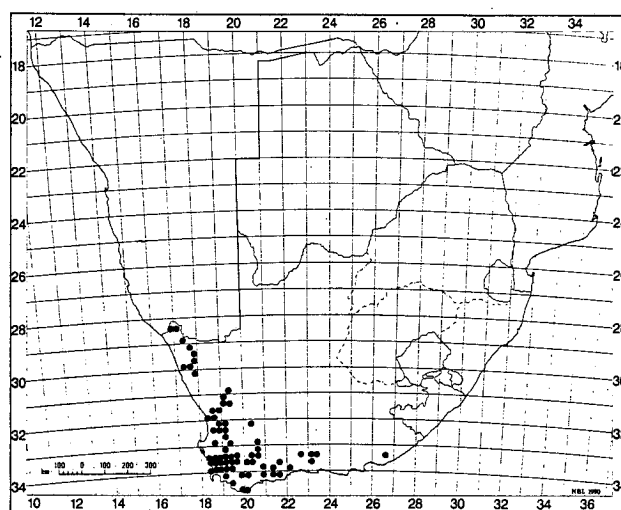


Figure 8.43.2 Geographical distribution of *P. rapaceum*.

P. rapaceum is very common in the south-western Cape and occurs in different vegetation types like fynbos, renosterveld and marginal strandveld. The vegetation varies from a low and open one and plants grow in direct sunlight or in gentle shade when the

vegetation is higher. *P. rapaceum* usually grows in sandy soil, but plants also occur in stony places, rocky clefts, clay or calcareous soils, quartzite or weathered granite. Flowering time for this species is from October to February with the peak in November and December. Sometimes the leaves are still present at flowering time, but often the plants flower after the leaves have died.

Material studied

--2816 (Oranjemund): Die Koei, Helskloof, Richtersveld (-BD), *Drijfhout* 2943 (STEU).

--2817 (Vioolsdrif): 15 km E of Helskloof, on road to Grasdrif (-AC), *Williamson* 3528 (STEU); NE of Paradysberg, Richtersveld (-AC), *Wisura* 1490 (NBG); Tierpoortberge (-CD), *Drijfhout* 1432 (STEU).

--2917 (Springbok): Klipfontein (-BA), *Le Roux s.n.* (STEU); Steinkopf (-BD), *Meyer sub. Marloth* 6317 (PRE); Komaggas (-CD), *Drijfhout* 2810 (STEU); 4 km from Okiep to Concordia (-DB), *Fischer* 14 (STEU); 12 km from Springbok on Kleinsee road (-DB), *Marais* 283 (STEU); Between Wildepaardehoek & Komaggas (-DC), *Drijfhout* 1370 (STEU); Wildepaardehoek Pass (-DC), *Weber* 1 (STEU).

--3017 (Hondeklipbaai): 8,4 km from Kamieskroon to Bovlei (-BB), *Fischer* 3 (STEU); 4 km E of Grootvlei (-BB), *Van Jaarsveld* 4271 (STEU).

--3019 (Loeriesfontein): Loeriesfontein, Village ground (-CD), *Marais* 122 (STEU).

--3118 (Vanrhynsdorp): Between Knakkiesberg & Doringbaai (-CD), *Drijfhout* 1300 (STEU); Sandkraal (-DA), *Acocks* 15164 (PRE); Vleikraal (-DA), *Schonken* 36 (STEU); *Walters* 84 (STE); *Walters* 91 (PRE, STE); Gifbergpas (-DB), *Marais s.n.* (STEU); Heerenloggement (-DC), *Boucher s.n.* (STEU); *Marais* 200 (STEU); Klawer (-DC), *Leipoldt* 4104 (BOL); Gifberg (-DC), *Van der Walt s.n.* (STEU).

--3119 (Calvinia): Bokkeveld near Nieuwoudtville (-AA), *Marloth* 7799 (PRE); Glenridge, Nieuwoudtville (-AC), *Barker* 9186 (NBG); Arendskraal, Calvinia (-AC), *Barker* 9768 (NBG); Bottom of Vanrhyns Pass (-AC), *Barker* 10538 (NBG); Between Grasbergrivier & Waterval (-AC), *Drège s.n.* (Gx3, Px2, S, TCD, Wx3); 14 km from Nieuwoudtville to Leeuriet (-AC), *Fischer* 35 (STEU); Nieuwoudtville Nature Reserve (-AC), *Perry & Snijman* 2331 (NBGx2); 77 km from Clanwilliam on Botterkloof road (-AD), *Fischer* 39 (STEU).

--3218 (Clanwilliam): Between Clanwilliam and Boschkloof (-BB), *Drège s.n.* (G, K, Px2, W); *Drège* 1286 (P); Ramskop Nature Reserve, Clanwilliam (-BB), *Leipoldt* 516 (BOL, SAM); *Van der Walt* 1043 (STEU); Nardouwskloof (-BB), *Marais* 322 (STEU); Amon track, Cedarberg (-BB), *Taylor* 11208 (STE); 2 km from Graafwater to Paleisheuvel (-BC), *Schonken* 87 (STE); Paleisheuvel (-BC), *Van der Walt* 1047 (STEU); Olifantsriviervallei, Clanwilliam (-BD), *Bolus s.n.* (BOL); Clanwilliam, 6 km on Paleisheuvel road (-BD), *Van der Walt* 1048 (STEU); Versveld Pass, Piketberg (-DC), *Nordenstam* 3357 (STE); Kapteinskloof (-DC), *Stirton* 10050 (STE).

--3219 (Wuppertal): Pakhuis Pass (-AA), *Marais* 196 (STEU); *Middelmost* NBG1698/37 (NBG); *Stirton* 10185 (PRE, STE); *Stokoe* SAM57305 (SAM); Hoeksberg on Wuppertal turnoff (-AA), *Marais* 402 (STEU); 30 km from Clanwilliam to Wuppertal (-AA), *Van der Walt* 750 (STEU); Between Wuppertal &

Bidouwvallei (-AA), *Van der Walt 755* (STEU), Algeria (-AC), *Compton 6253* (NBG); *Van der Walt s.n.* (STEU); Ezelsbank (-AC), *Leipoldt 513* (BOL); Katstertdrif, farm Geelkrans (-CA), *Van der Walt 1022* (STEU); 0,8 km from Gydo-Clanwilliam road to Ceres-Karoo (-CD), *Marais 378* (STEU).

--3220 (Sutherland): Bo-Visrivier (-AB), *Lavranos & Pehlemann 18846* (STEU); Fransplaas, Sutherland (-AB), *Marloth 9830* (PREx2); Farm De Hoop, Komsberg (-DC), *Van der Walt 816* (STEU); Oranjefontein, Komsberg (-DC), *Van der Walt s.n.* (STEU).

--3318 (Cape Town): Contreberg farm, Darling (-AD), *Fischer 329* (STEU); Bontberg, between Darling & Yzerfontein (-AD), *Marais 25* (STEU); Near Groot Post (-AD), *Salter 6460* (BOL); *Salter NBG2346/36* (NBG); Mamre Road (-BC), *Barker NBG616/41* (NBG); Riebeek-Kasteel (-BD), *Boucher 49* (STEU); Voorspoed, Malmesbury (-BD), *Van der Walt 1035* (STEU); Groenekloof (-CB), *Zeyher 166* (BM, E, Gx3, MELx2, Px2, PREx3, S, SAM, W, WU, Z); Rosebank, near Cape Town (-CD), *Bolus 2990* (BOL); Camp Ground (-CD), *Bolus 2996* (BOL); Lion's Head (-CD), *Dümmer 846* (E); *Ecklon & Zeyher 502* (MO, Px2, Sx2); *Marloth 388* (PRE); *Van der Walt 467* (STEU); Lion's Back (-CD), *Salter 6533, 6534* (BOL); Table Mountain (-CD), *Ecklon 605* (K, MO); *Ecklon s.n.* (P); Table Mountain & Devil's Peak (-CD), *Ecklon & Zeyher 501* (Sx2, SAM); Camps Bay (-CD), *Marloth 5613* (PRE); *Prior s.n.* (PRE, Z); Signal Hill (-CD), *Van der Walt 480, 661* (STEU); Cape Town (-CD), *Young s.n.* (PRE); Kalbaskraal (-DA), *Marais s.n.* (NBG, STEU); S of Klipheuwel (-DA), *Van der Walt 1026* (STEU); Paarl & Paarlberg (-DB), *Drège s.n.* (G, Px2, TCD); *Drège 7502* (P); Klein Drakenstein & Dal Josefata (-DB), *Drège s.n.* (BOL, E, G, K, MO, Px2, PRE, W); Wellington (-DB), *Thompson 27* (PRE); Tygerberg Nature Reserve (-DC), *Loubser 3472* (MO, NBG); Langverwacht (-DC), *Oliver 4807* (STE); N'dabeni (-DC), *Salter 8713* (BOL); Stellenbosch (-DD), *Duthie s.n.* (BOL); Jonkershoek (-DD), *Marloth 1838* (PREx2); Jonkershoek, Eerste Waterval (-DD), *De Kock 59* (STE); *Van der Walt 503* (STEU); Banhoek (-DD), *Marloth 10023* (PREx2); Lynedoch (-DD), *Pillans 10892* (MO, STE).

--3319 (Worcester): De Hoekvallei, Saron (-AA), *Compton 10049* (NBG); Visgat, Ceres (-AA), *Esterhuysen 13426* (BOL); Nuwekloof Pass (-AC), *Compton 12051* (BOL, NBG); Waterfall, Tulbagh (-AC), *Compton 12415* (NBG); Winterhoek, Tulbagh (-AC), *Ecklon & Zeyher 39* (PRE); Tulbagh (-AC), *Pappe 39* (TCD); Romansrivier, Wolseley (-AC), *Van der Walt 575* (STEU); Near Ceres (-AD), *Bolus 493* (BOL, E, G, P, PREx3, SAM, UPS, W, Z); *Bolus s.n.* (Z); 2 km N of Ceres on road to Prince Alfred Hamlet (-AD), *Cillie s.n.* (STEU); Michell's Pass (-AD), *Compton 10060* (NBG); *Fischer 337* (STEU); *Szyszyłowicz 2345, 2346* (Z); Mostertshoek Twins (-AD), *Esterhuysen s.n.* (PRE); Koekoedouwskloof, E end of Neethlingsberg (-AD), *Esterhuysen 22551* (BOL); Ceres (-AD), *Thode 3966* (STE); *Thode A2226* (PRE); W slope of Matroosberg (-BC), *Esterhuysen 14196* (BOL); W foot of Roodeberg, Hex River Mountains (-BC), *Esterhuysen 20919* (BOL); Hex River (-BC), *Fischer 207* (STEU); De Doorns (-BC), *Wisura 121* (NBG); Dutoitskloof (-CA), *Adamson 3577* (STE); W foot of Bailey's Peak (-CA), *Esterhuysen 22348* (BOL); Bainskloof (-CA), *Schlechter 9109* (Gx2, Z); *Stokoe SAM63205* (SAM); Gevonden (-CA), *Walters 907, 2386* (NBG); Veld of Karoo Garden, Worcester (-CB), *Bayer 261* (NBG); Worcester (-CB), *Fine 34* (PRE); Franschoek (-CC), *Bolus 4550* (NBG); La Motte, Franschoek (-CC), *Drijfhout s.n.* (STEU); Wemmershoek (-CC), *Esterhuysen 4086* (BOL, NBG);

Lewis 1178 (SAM); Purgatory outspan, next to Du Toits River (-CC), *Hugo 2144* (STE); Haalsneeukop (-CC), *Stokoe SAM57287* (SAM); 9 km on Koppies turnoff, Villiersdorp (-CD), *Marais 408* (STEU); Sandhills (-DA), *Van der Walt s.n.* (STEU).

--3320 (Montagu): 15 km SE of Constable Station (-AD), *Fischer 238* (STEU); Karoo Garden, Whitehill (-BA), *Compton 16382* (NBG); Matjiesfontein (-BA), *Lavranos 20889* (STEU); *Ward 44a* (STEU); 3 km N of Matjiesfontein (-BA), *Lavranos & Pehlemann 19742* (STEU); Whitehill (-BA), *Marais 97* (STEU); 88 km from Karoo Poort to Matjiesfontein (-BA), *Marais 393* (STEU); Hillandale, Matjiesfontein (-BA), *Marloth 11010* (PRE); Witteberge, 32 km SE of Konstabel (-BC), *Drijfhout 2663* (STEU); FM-tower Bantamskop, Matjiesfontein (-BC), *Van der Walt 819* (STEU); Pypsteelfontein, Waboomberge (-CA), *Maggs 44* (STEU); Waboomberge (-CB), *Compton 10291* (BOL, NBG); Witbooisloof, Langeberge (-DD), *Marais 388* (STEU).

--3321 (Ladismith): Cannaland, Gauritzrivier, Swellendam (-CD), *Ecklon & Zeyher 500* (Sx2); Dwars in die Weg, Ladismith (-DA), *Marloth 9845* (PRE).

--3322 (Oudtshoorn): 10 km E of De Rust (-BC), *Lavranos 20915, 20916* (STEU); Meiring's Poort (-BC), *Leipoldt s.n.* (BOL); 8 miles N of Robinson Pass (-CC), *Barker 7626* (NBG).

--3323 (Willowmore): Warm Baths, Olifantsrivier, Uniondale (-AC), *Fourcade 5047* (BOL-FOURCADE); Vaalkrans, SW of Willowmore (-AD), *Lavranos & Pehlemann 19832* (STEU); Uniondale (-CA), *Esterhuysen 19977* (BOLx2).

--3326 (Grahamstown): Grahamstown (-BC), *Rogers 27542* (Z).

--3419 (Caledon): Viljoen's Pass (-AA), *Rogers 28894* (SAM); Hermanus (-AD), *De Villiers NBG3305/32* (NBG); Between McGregor & Stormsvlei (-BB), *Esterhuysen 4295* (BOL); Riviersonderend (-BB), *Neethling s.n.* (BOL); *Schlechter 3289* (PRE); *Schlechter 9885* (BM, BOL, E, Gx3, K, L, MO, P, PRE, S, Z); 15 km from Bredasdorp to Heuningrug (-DB), *Fischer 282* (STEU).

--3420 (Bredasdorp): Stormsvleikloof (-AA), *Esterhuysen 4296* (BOL); 10 km E of Brakfontein (-AA), *Fischer 303* (STEU); Knoblauch farm (-AA), *Fischer 310* (STEU); Grootvadersbos, Swellendam (-BB), *Ecklon s.n.* (SAM); Cape Agulhas (-CC), *Leipoldt 4002* (BOL).

--3421 (Riversdale): Soetmelksrivier (-AB), *Bohnen 7374* (STE); Welgevonden, Herbertsdale (-BA), *Brits s.n.* (STEU).

AURITUM GROUP

Geophytes with various leaf forms. Scape branched, bearing 2--7(-10) pseudo-umbellets with 3--15(-26) flowers each. Hypanthium short, 7--20 mm long. Petals 2 or 5, ligulate or sometimes spatulate, white, pink, wine-red or nearly black.

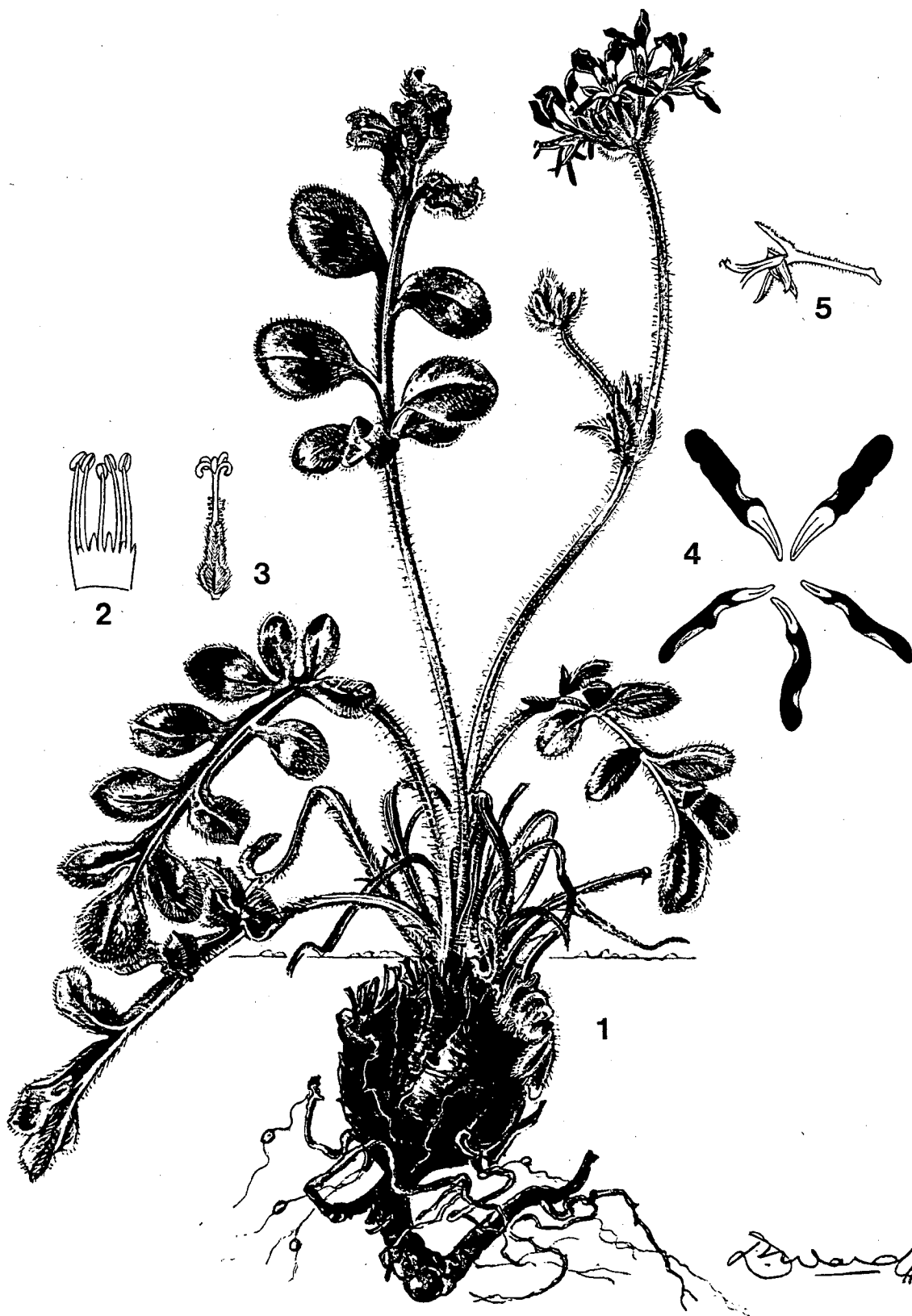


Figure 8.44.1 *Pelargonium auritum* var. *auritum*. 1, flowering plant x1; 2, androecium x2; 3, gynoecium x3; 4, petals x3; 5, flower without petals x1.

Stamens 4 or 5, more or less of the same length, protrude from the flower; staminal column papillate. Tectum of pollen striate-reticulate.

8.44 *Pelargonium auritum* (L.) Willd., Species Plantarum 3: 644 (1800).
LECTOTYPE: Commelijn, Horti Medici Amstelaedamensis 2: 121, t. 61; original plate in Moninckx collection in Amsterdam (Commelijn 1706, Wijnands 1983).

A geophyte 60-260 mm tall when in flower. **Tuber:** a turnip-shaped or elongated, sometimes moniliform root 12--40(-70) mm long and 8--35 mm in diameter. **Leaves** green, petiolate; lamina elliptic to lanceolate, 20--130 x 10--50 mm, simple, auriculate or irregularly deeply pinnatifid to bipinnatisect, segments 12--20 x 4--8 mm, adaxially and abaxially hirsute with long appressed hairs; petiole 10--90 mm long and 1--3 mm in diameter, rigid, prostrate to patent-erect, hirsute with stiff and curly appressed hairs interspersed with short glandular hairs; stipules subulate, adnate to petioles with apices free, 8--30(-45) mm long and 1--2 mm wide, ciliate. **Inflorescence:** scape 15--180 mm long, 1,5--3 mm in diameter, branched, bearing 2--4(-6) pseudo-umbellets with 5--14(-26) flowers each; peduncles 20--110 mm long, 1--2 mm in diameter, green, densely covered with appressed curly hairs interspersed with patent soft hairs and long glandular hairs; bracts subulate, 4--10 x 1--2 mm, abaxially hirsute with distally appressed hairs. **Pedicel** ca. 0,5 mm long. **Hypanthium** 8--20 mm long, reddish brown, densely hirsute with appressed curly hairs interspersed with long glandular hairs. **Sepals** 5, lanceolate, apices acute, 6--10 mm long, 1,2--3 mm wide, posterior one erect, others recurved, reddish brown to green with margins white, indumentum abaxially as on hypanthium. **Petals** 5, ligulate, dark purple black or white to pale pink, patent during anthesis; posterior two 8--17 x 1,5--3,5 mm, bases cuneate, apices rounded; anterior three 7--15 x 1--3 mm, bases attenuate, apices rounded. **Stamens:** staminal column 1,5--5 mm long, white, papillate; perfect stamens 5, protruding from the flower, posterior one 5--13 mm long, lateral two 6--13,5 mm long, anterior two 6--14 mm long, free filaments pink; staminodes 2--7 mm long; anthers red, 1,5--2 mm long, pollen orange. **Gynoecium:** ovary 3--5,5 mm long; style 1,5--4 mm long, red; stigma branches 1--2,5 mm long, wine-red. **Fruit:** bases of mericarps 5--8 mm long, with or without glandular hairs, tails 20--32 mm long (Figures 8.44.1 & 8.45.1).

Diagnostic features and affinities

P. auritum is characterized by the five ligulate petals and the long protruding stamens. The five fertile stamens are almost of the same length and the staminal column is

papillate. In this respect *P. auritum* resembles *P. parvipetalum*, *P. bubonifolium* and all the two-petalled species of section *Hoarea*.

The leaves, which are densely hirsute with appressed hairs, exhibit a considerable variation in the shape of the laminae. Simple, auriculate or deeply pinnatifid to bipinnatisect leaves occur in the same population, and even a single plant may exhibit several of these variations. The epithet *auritum* refers to the sometimes tripartite or auriculate leaves.

Harvey (1860) enumerated two varieties of this species because of the difference in the flower colour. Van der Walt & Vorster (1980) agreed with a subspecific division of the species, but they changed it to subspecies. This they did because of the correlation between the morphological differences and the geographical distribution. They query the validity of the localities of plants with purple-black flowers collected as far east as Addo in the eastern Cape (*Drège s.n., sub. P. melananthum* (P, G, S, SAM) and *Ecklon & Zeyher 489* (S, SAM)). According to them plants with purple-black flowers are restricted to the western Cape and plants with white flowers to the eastern Cape. Recently Professor B-E van Wyk collected a plant with purple-black flowers at Reed Valley near Port Elizabeth. This convinced me to re-evaluate Van der Walt & Vorster's decision to change the subspecific division to subspecies. Because the distribution areas of the two taxa overlap in the eastern Cape I reinstate the varieties as subspecific division of the species.

Key to the varieties

- 1a. Petals dark purple black var. *auritum*.
 1b. Petals white to pale pink var. *carneum*.

var. *auritum*

Geranium auritum L.: 679 (1753); Burm. f.: 47, n. 61 (1759); L.: 1141 (1759); Burm. f.: 19 (1768); Murray: 615 (1784); Cav.: 236 (1787); Murray: 652 (1798). ICONOTYPE: Commelijn, Horti Medici Amstelaedamensis 2: 121, t. 61; original plate in Moninckx collection in Amsterdam. (Commelijn 1706, Wijnands 1983).

Pelargonium auritum (L.) Willd.: 644 (1800); Pers.: 226 (1806); DC.: 651 (1824); Spreng.: 51 (1826); G. Don: 726 (1831); Steud.: 677 (1840); Steud.: 283 (1841); Wijnands: 106 (1983).

Pelargonium auritum (L.) Willd. subsp. *auritum* Van der Walt & Vorster: 285 (1980).

Geranium prolificum L. var. *auritum* (L.) L.: 949 (1763); L.: 433 (1767); L.: 512 (1774).

Geranium hirsutum Burm. f.: 50, n. 68 (1759); Burm. f.: 19 (1768); Cav.: 247, t. 101, f. 2 (1787); Thunb.: 114 (1800); Thunb.: 519 (1823). TYPE - Cape: "Cap. Bon. Spei" (G, lecto!).

Pelargonium hirsutum (Burm. f.) Ait.: 417 (1789); Willd.: 645 (1800); Pers.: 226 (1806); Ait. f.: 161 (1812); DC.: 652 (1824); Spreng.: 52 (1826); G. Don: 727 (1831); Steud.: 678 (1840); Steud.: 286 (1841); Adamson & Salter: 513 (1950); non Loudon: 570 (1829).

Hoarea hirsuta (Burm. f.) Sweet: 76 (1826c).

Geranospermum hirsutum (Burm. f.) Kuntze: 95 (1891).

Geranium lobatum Burm. f. var *hirsutum* (Burm. f.) L.: 950 (1763).

Geranium prolificum L.: 454 (1770); Murray: 615 (1784); Murray: 653 (1798); non L.: 949 (1763). TYPE: LINN 858.33 (lecto!, designated here).

Pelargonium melananthum Jacq.: 188 (1791b); Jacq.: 8, t. 514 (1792); Willd.: 648 (1800); Pers.: 227 (1806); Ait. f.: 164 (1812); Link: 186 (1822); DC.: 653 (1824); Spreng.: 53 (1826); Loudon: 570 (1829); G. Don: 727 (1831); Loudon: 272 (1832); Steud.: 287 (1841). TYPE - "Ex Promontorio bonae Spei" (W, holo!).

Geranium melananthum (Jacq.) Andr.: t. 209 (1802a); Poir.: 747 (1812).

Hoarea melanantha (Jacq.) Sweet: t. 73 (1821); Sweet: 76 (1826c); Eckl. & Zeyh.: 63 (1835).

Pelargonium hirsutum (Burm. f.) Ait. var *melananthum* (Jacq.) Harv.: 267 (1860); Knuth: 339 (1912); Van der Walt: 21, fig. (1977).

Pelargonium atrum L'Hérit.: t. 44 (1792); Willd.: 646 (1800); Pers.: 227 (1806); Ait. f.: 161 (1812); DC.: 653 (1824); Spreng.: 52 (1826); Loudon: 570 (1829); G. Don: 727 (1831); Loudon: 272 (1832); Steud.: 283 (1841). ICONOTYPE: L'Héritier, *Geranologia*: t. 44 (1792).

Geranium atrum (L'Hérit.) Poir.: 746 (1812).

Hoarea atra (L'Hérit.) Sweet: t. 72 (1821); Sweet: 76 (1826c); Eckl. & Zeyh.: 63 (1835).

Pelargonium dioicum Ait. f.: 162 (1812); Sims: t. 2234 (1821); DC.: 653 (1824); Spreng.: 51 (1826); Loudon: 570 (1829); G. Don: 727 (1831); Loudon: 272 (1832); Steud.: 678 (1840); Steud.: 285 (1841). ICONOTYPE: Andrews, *The Botanist's Repository* 3: t. 209 (1802a).

Hoarea dioica (Ait. f.) Sweet: 76 (1826c); Eckl. & Zeyh.: 63 (1835).

Hoarea undulaeflora Sweet: t. 263 (1825). ICONOTYPE: Sweet, *Geraniaceae* 3: t. 263 (1825).

Pelargonium undulaeflorum (Sweet) G. Don: 727 (1831); Loudon: 271 (1832); Steud.: 290 (1841).

Diagnostic features

P. auritum var. *auritum* can be easily identified by the dark purple-black flowers. The margins of the five ligulate petals are conspicuously undulate. Prominent glandular hairs are present on the bases of the mericarps. (Figure 8.44.1).

Geographical distribution and ecology

P. auritum var. *auritum* occurs in the south-western and southern Cape, from Clanwilliam in the north to Addo and Port Elizabeth in the east (Figure 8.44.2), an area receiving an annual rainfall of 200--600 mm, mainly in winter. It grows on hillsides or flat areas in grassveld, renosterveld or fynbos, on stony dry areas, in sand, sandy-loam or clay soils. Plants grow in partial shade or in direct sunlight, resulting in a large variation of plant sizes. Its occurrence varies from rare to fairly frequent and it flowers from September to January with the peak during October and November.

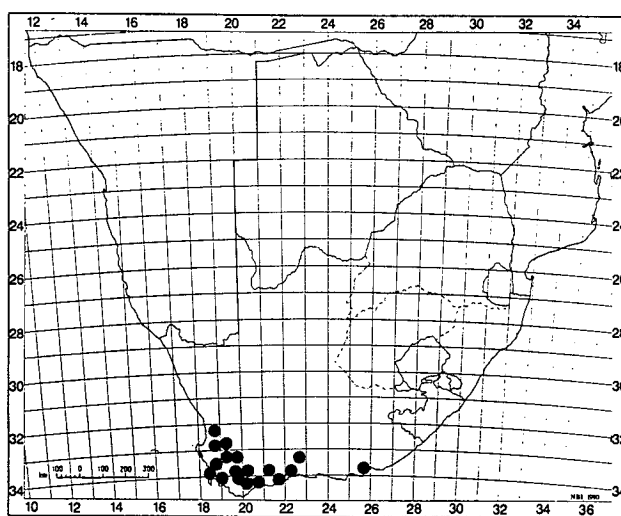


Figure 8.44.2 Geographical distribution of *P. auritum* var. *auritum*.

Material studied

--3218 (Clanwilliam): Modderfontein (-BA), *Leipoldt* 520 (SAM); Arbeidsgenot, between Citrusdal and Clanwilliam (-BD), *Marais* 314 (STEU); Piketberg (-DD), *Drège* 7489 (P, S).

--3219 (Wuppertal): Near Citrusdal (-CA), *Taylor* 1220 (BOL); Excelsior, Koue Bokkeveld (-CD), *Marais* 188 (STEU);

--3318 (Cape Town): Malmesbury, Diepkloof turnoff on N7 (-BC), *Marais 255, 257* (STEU); Malmesbury, E of town (-BC), *Van der Walt 1029* (STEU); Zwartland (-BD), *Ecklon & Zeyher 488* (Sx2, SAM); Lion's Head (-CD), *Bolus 9348* (BOL); *Dummer 854* (E); *Ecklon 602* (E, G, PRE, W, WU); *Ecklon 609* (P); *Ecklon s.n.* (P); *Ecklon & Zeyher 487* (Sx2, SAM); *Pappe 34* (TCD); Table Mountain (-CD), *Ecklon & Zeyher 486* (S); *Moss 4195* (Z); *Pappe & Schwartz s.n.* (W); Near Cape Town (-CD), *Harvey s.n.* (TCD); Signal Hill (-CD), *Marloth 333* (PRE); *Van der Walt 482, 660* (STEU); Green Point Common (-CD), *Marloth 1800* (PRE); Kloofnek (-CD), *Moss 5737* (BM); Camps Bay (-CD), *Prior s.n.* (PRE); Camp Ground, Rondebosch (-CD), *Salter 5671* (BOL); *Salter NBG48/36* (NBG); Sea Point (-CD), *Wolley Dod 3678* (BOL); Wellington (-DB), *Cummings s.n.* (SAM); Vissershok (-DC), *Leighton 48* (BOL); Tygerberg Nature Reserve (-DC), *Loubser 3460* (NBG); Langverwacht, Kuilsrivier (-DC), *Oliver 4798* (STE); Stellenbosch flats (-DD), *Duthie 152* (BOL, STE); *Duthie s.n.* (BOL).

--3319 (Worcester): Baviaanshoek turnoff (-AB), *Marais 53* (STEU); Nuwe Kloof (-AC), *Drège s.n.* (E, G, MO, P, PRE, W); Kleinberg, Tulbagh (-AC), *Duthie s.n.* (BOL); Waterfall, Tulbagh (-AC), *Ecklon & Zeyher 481* (S); Tulbagh (-AC), *Esterhuysen 17489* (BOL); *Marloth 9932* (PRE); *Pappe 14* (TCD); Between Tulbagh & Malmesbury (-AC), *Mostert s.n.* (STEU); Ceres (-AD), *Cillié s.n.* (STEU); Between Prince Alfred Hamlet & Gydo (-AD), *Marais 41* (STEU); Theronsberg Pass (-AD), *Marais 138* (STEU); Buffelskraal (-BC), *Forrester 120* (NBG); East of De Doorns (-BC), *Forrester 231* (NBG); 3 km from N1 on Matroosberg - Montagu road (-BD), *Marais 95, 96* (STEU); Wansbeck, S of Le Chasseur (-DC); Worcester district, *Cooper 1632, 1723* (TCD, W).

--3320 (Montagu): Eleven O'Clock Mountain (-CD), *Wurtz 462* (NBG).

--3321 (Ladismith): Garcia's Pass, Riversdale (-CC), *Ryder 19988* (BOL).

--3322 (Oudtshoorn): Spitzkop, Meiring's Poort (-BC), *Thorne s.n.* (SAM); 3 km SW of Herold at Camferskloof (-CD), *Vlok 1724* (STE).

--3325 (Port Elizabeth): Addo (-DA), *Drège 1292* (P); *Drège s.n.* (G, S, SAM, TCD); *Ecklon & Zeyher 489* (Sx2, SAM); Reed Valley to Sand flats road (-DB), *Van Wyk 3305* (JRAU); Hugel, Port Elizabeth (-DC), *Brunnthaler 675* (WU).

--3419 (Caledon): Onrusrivier (-AC), *Van Niekerk 307* (PRE); Appelskraal, Riviersonderend Mountains (-BB), *Stokoe SAM63198* (SAM); Riviersonderend (-BB), *Zeyher 2047* (S).

--3420 (Bredasdorp): Lemmetjiesdorp, Swellendam (-AB), *Wurtz 462* (NBG); Appelskraal, Bredasdorp (-AC), *Stokoe 9389* (BOL); Near Buffelsjacht (-BA), *Hurling & Niel s.n.* (BOL); Zuurbraak (-BA), *Penther 2193* (W).

--3421 (Riversdale): Hills behind Albertinia (-BA), *Muir 1269* (PRE).

--3422 (Mossel Bay): Pinedew farm, E of Wilderness (-BA), *Hugo 1927* (STE).

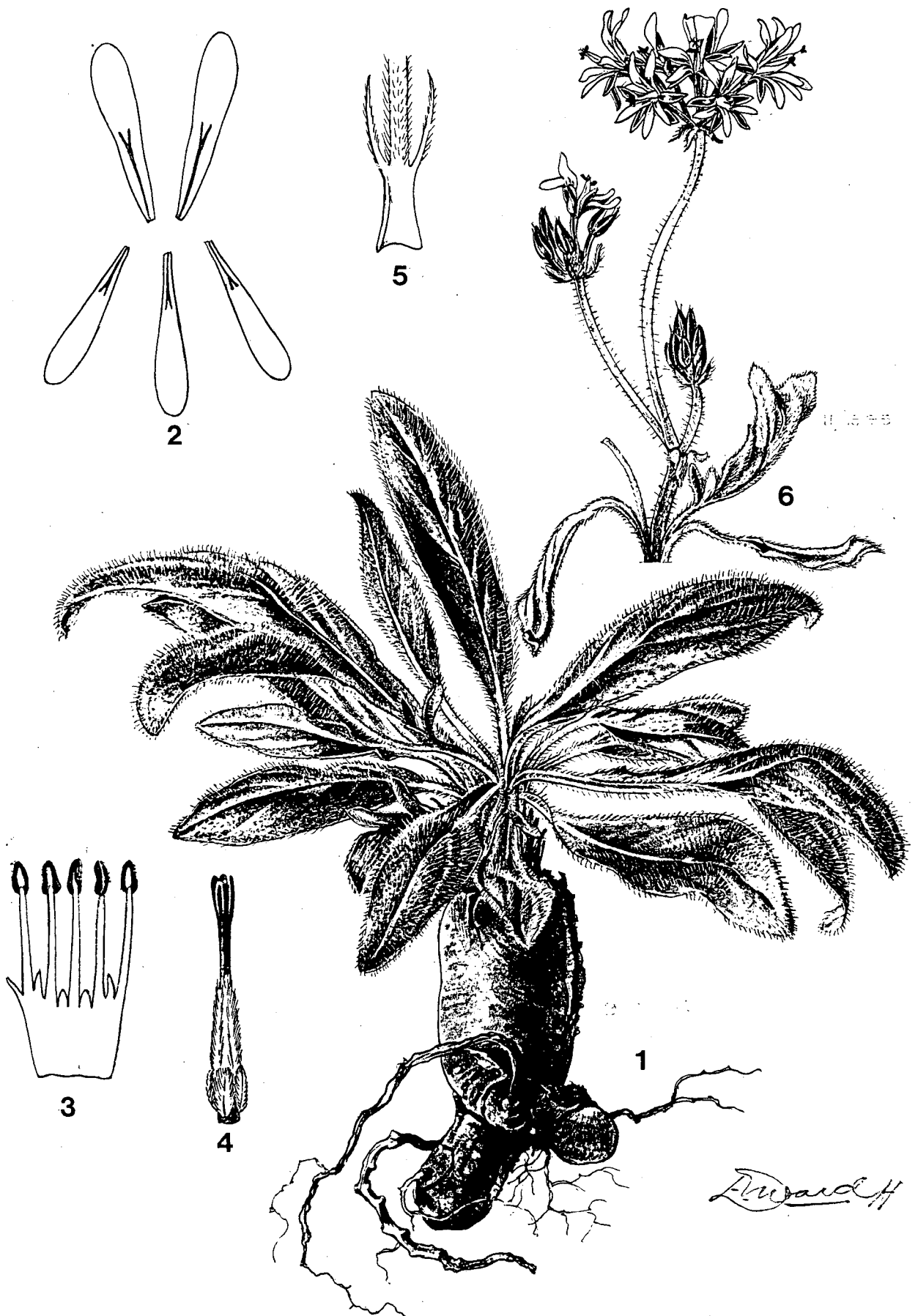


Figure 8.45.1 *Pelargonium auritum* var. *carneum*. 1, plant with leaves x1; 2, petals x6; 3, androecium x4; 4, gynoecium x6; 5, leaf base x2; 6, inflorescence x1.

var. carneum (Harv.) E.M. Marais, *comb. nov.*

TYPE - Cape Province: "Petrosis ad montes in 'Langekloof' (George). " *Ecklon & Zeyher* 482 (S, lecto!, designated here, S!, SAM!).

Pelargonium hirsutum var. *carneum* Harv.: 267 (1860); Knuth: 340 (1912). TYPE - Cape Province: "Petrosis ad montes in 'Langekloof' (George). " *Ecklon & Zeyher* 482 (S, lecto!, designated here, S!, SAM!)

Pelargonium auritum subsp. *carneum* (Harv.) J.J.A. van der Walt: 268 (1980).

Geranium ensatum Thunb.: 113 (1800); Thunb.: 515 (1823). TYPE - " Cap. bon Spei" *Thunberg s.n.* (UPS, holo!).

Pelargonium ensatum (Thunb.) DC.: 680 (1824); G. Don: 742 (1831); Steud.: 285 (1841); Harv.: 263 (1860); Knuth: 327 (1912).

Hoarea ensata (Thunb.) Eckl. & Zeyh.: 61 (1835).

Geranospermum ensatum (Thunb.) Kuntze: 94 (1891).

Hoarea reticulata Sweet: t. 91 (1821); Sweet: 76 (1826c). ICONOTYPE: Sweet, Geraniaceae 1: t. 91 (1821).

Pelargonium reticulatum (Sweet) DC.: 649 (1824); Spreng.: 50 (1826); Loudon: 568 (1829); G. Don: 726 (1831); Loudon: 271 (1832); Steud.: 289 (1841); Knuth: 325 (1912).

Hoarea ovalifolia Sweet: t. 106 (1822); Sweet: 76 (1826c). ICONOTYPE: Sweet, Geraniaceae 2: t. 106 (1822).

Pelargonium ovalifolium (Sweet) DC.: 649 (1824) (excl. Andr.); Spreng.: 50 (1826) (excl. Andr.); Loudon: 568 (1829); G. Don: 726 (1831); Loudon: 271 (1832); Steud.: 288 (1841) (excl. Andr.).

Hoarea strigosa Eckl. & Zeyh.: 61 (1835). TYPE - Cape Province: ' . . Clivis in "Kraakamma" (Uitenhage)'. *Ecklon & Zeyher* 468 (S, holo!, S!).

Pelargonium strigosum (Eckl. & Zeyh.) Steud.: 290 (1841).

Diagnostic features

P. auritum var. *carneum* has white petals with red to purplish veins. The margins of the petals are only slightly undulate to plane. The mericarps are without any glandular hairs. (Figure 8.45.1).

Geographical distribution and ecology

P. auritum var. *carneum* occurs along the south-eastern coast, from Ruigte Vlei, west of Knysna to Uitenhage in the east. It is also quite common in the Langkloof (Figure 8.45.2). The distribution area receives an annual rainfall of 200--600 mm throughout the year. This variety occurs in short grass vegetation, open scrubveld or fynbos, on sand-dunes or dry stony ground in sand. The plants are locally abundant and flowering time is from October to February, with the peak in November and December.

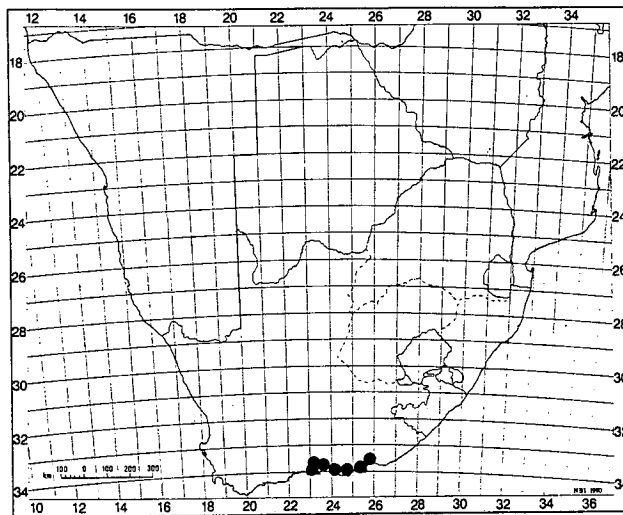


Figure 8.45.2 Geographical distribution of *P. auritum* var. *carneum*.

Material studied

–3322 (Oudtshoorn): Ruigte vlei, near Zwartrivier (-DD), *Fourcade 1541* (BOL, BOL-FOURCADE, PRE, STE).

–3323 (Willowmore): Lang kloof, E of Avontuur (-CA), *Bolus 2271* (BOL); Langkloof (-CA), *Ecklon & Zeyher 467* (S, SAM); *Ecklon & Zeyher 482* (Sx2, SAM); Haarlem (-CB), *Esterhuysen 6937* (BOL, PRE); 50 km from Joubertina to Avontuur (-CB), *Marais 159, 160* (STEU); Prince Alfred Pass (-CC), *Fischer 362* (STEU); Louterwater (-DC), *Compton 4517* (BOL); *Compton 4518* (BOL, NBG); Hills near Joubertina (-DD); *Fourcade 2380* (BOL-FOURCADE); 15 km from Joubertina (-DD); *Van der Walt s.n.* (STEU).

–3324 (Steytlerville): 9,3 miles NW of Kareedouw (-CC), *Acocks 20041* (PRE); 27 km from Kareedouw to Joubertina (-CC), *Marais 152* (STEU); 34 km from Kareedouw to Joubertina (-CC), *Marais 155, 156* (STEU); Assegaibosch (-CD), *Esterhuysen 6729* (BOL); Krommerivier, E of Assegaibosch (-CD), *Fourcade 2348* (BOL-FOURCADE, K); Essenbosch (-CD), *Fourcade 4899*

(BOL-FOURCADE, STE); 20 km from Kareedouw to Humansdorp (-CD), *Marais 151* (STEU); Zuurkransberg, Kareedouw (-CD), *Rycroft 3017* (NBG); Uitvlugt, from Humansdorp to Groot Hoek (-DC), *Fourcade 3513a* (STE); Near Gamtoos River, Humansdorp (-DD), *Barker 6906* (NBG).

--3325 (Port Elizabeth): 29 km from Humansdorp to Port Elizabeth (-CC), *Marais 562* (GRA, PRE); Between Vanstadensberg & Bethelsdorp (-CD), *Drège 7490b* (P, S); *Drège 7491a* (G, K, MO, P, S, TCD, W); Krakakamma (-CD), *Ecklon & Zeyher 468* (Sx2); 10 miles from Port Elizabeth (-CD), *Holland 4081* (BOL); Parsons Vlei (-CD), *Long 877* (PRE); Kragga Kamma (-CD), *Long 892* (K, PRE); Willklip. Uitenhage (-CD), *MacOwan 2087* (MEL); E of Lady Slipper (-CD), *Van der Walt 868* (STEU); Uitenhage (-CD), *Zeyher 436* (K); Villa Paul Mare, Uitenhage (-DB), *Zeyher 2041* (G, P, PRE, S, W); Port Elizabeth (-DC), *Cook s.n.* (BOL); *Drège s.n.* (SAM); *Drège s.n.* (CGE, E, G, P, S, W); *Ecklon & Zeyher 483* (S, SAM); *Gruiden 374* (GRA); *Holland 57* (TCD); *West 212* (BOL, GRA); Zwartkops (-DC), *Hall s.n.* (BOL, NBG); Linkside Golf-links (-DC), *Laubscher s.n.* (STEU); Walmer Golf-links (-DC), *Olivier 1928* (STEU); Redhouse (-DC), *Paterson 292* (BOL); Newton Park (-DC), *Sidey 3084* (PRE).

--3422 (Mossel Bay): Belvedere (-BB), *Duthie 816* (BOL, STE); *Gillett 2180* (BOL); *Hutchinson 1317* (BOL); *Szyszyłowicz 478* (Z); Goukamma Pass (-BB), *Fourcade 6513* (BOL-FOURCADE); Buffelsvermaak (-BB), *Hugo 2023* (PRE, STE).

--3423 (Knysna): Nekkies (-AA), *Fourcade 4152* (BOL-FOURCADE, STE); E of Robberg, Knysna (-AA), *Fourcade 6305* (BOL-FOURCADE); Knysna (-AA), *Penther 2199* (W); *Schlechter 5909* (BOL, Z); Knysna Heads (-AA), *Schonland 3548* (GRA); Leerdamsdriftrivier, W of Plettenberg Bay (-AB), *Hugo 2094* (PRE); Plettenberg Bay (-AB), *Lavranos 20926* (STEU); *Rogers 26825* (PRE); *Rogers 27944* (Z); *Taylor 4324* (MO, NBG); Keurbooms (-AB), *Steyn 700* (NBG).

--3424 (Humansdorp): Witelsbosch (-AA), *Fourcade 1541* (Z); 20 km from Humansdorp to Joubertina (-BA), *Van der Walt s.n.* (STEU); Seekoeirivier (-BB), *Dixon 161* (STE).

8.46 *Pelargonium bubonifolium* (Andr.) Pers., *Synopsis plantarum* 2: 227 (1806); Ait. f.: 163 (1812); DC.: 652 (1824); Spreng.: 53 (1826); Loudon: 570 (1829); G. Don: 727 (1831); Loudon: 271 (1832); Steud.: 677 (1840); Steud.: 284 (1841); Harv.: 270 (1860); Knuth: 347 (1912). ICONOTYPE: Andrews, *The Botanist's Repository* 5: t. 328 (1803b).

Geranium bubonifolium Andr.: t. 328 (1803b); Poir.: 758 (1812). ICONOTYPE: Andrews, *The Botanist's Repository* 5: t. 328 (1803b).

Hoarea bubonifolia (Andr.) Sweet: 75 (1826c).

Geranospermum bubonifolium (Andr.) Kuntze: 94 (1891).

Hoarea congesta Sweet: t. 302 (1826b). ICONOTYPE: Sweet, *Geraniaceae* 4: t. 302 (1826b).

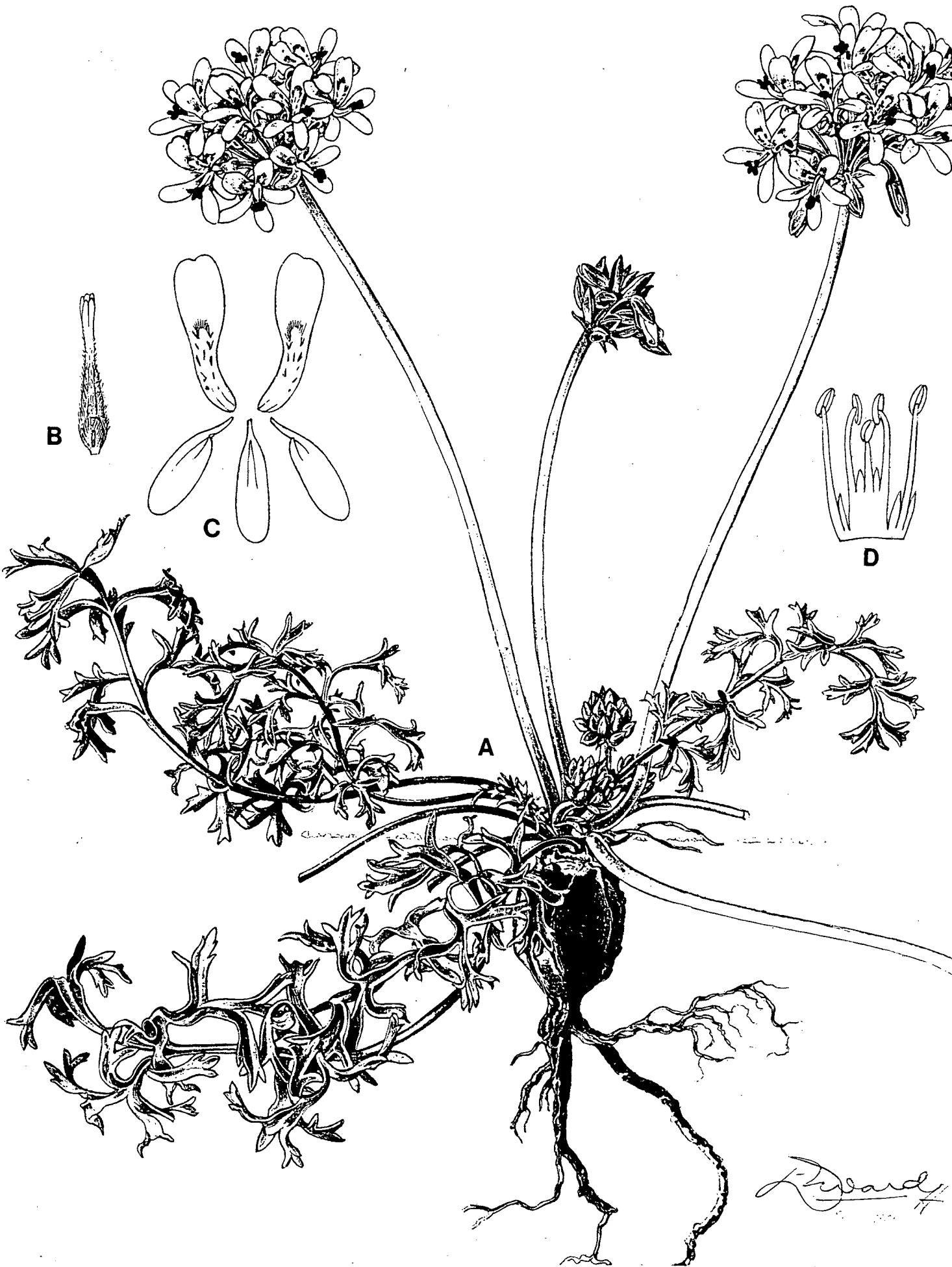


Figure 8.46.1 *Pelargonium bubonifolium*. A, flowering plant x1; B, gynoecium x4; C, petals x2; D, androecium x3.

Pelargonium congestum (Sweet) G. Don: 727 (1831); Loudon: 271 (1832).

Pelargonium namaquense Knuth: 342 (1912); Van der Walt & Vorster: 103, fig. (1988). TYPE - Cape Province: Near Klipfontein, Namaqualand. *Bolus* 448 (B+, holo, Z, lecto!, designated here, BM!, BOL!, E!, Gx2!, K!, NH!, P!, PRE!, SAM!, UPS!, W!, Z!).

A geophyte 100--230 mm tall when in flower. **Tuber:** a turnip-shaped or elongated, sometimes moniliform root, 15--40(-60) mm long and 10--25(-40) mm in diameter. **Leaves** green, petiolate; lamina elliptic, 30--140 mm long and 10--40 mm wide, pinnately compound, irregularly pinnatisect to bipinnatisect; pinnae lobate to lacinate, 20--32 x 10--15 mm, adaxially and abaxially hirsute with long appressed stiff hairs; petiole (20-)30--90 mm long and 1--2 mm in diameter, rigid, erect, hirsute with appressed curly hairs interspersed with appressed stiff hairs and short glandular hairs; stipules subulate, adnate to petioles with apices free, 5--10 mm long and 1--2 mm wide, ciliate. **Inflorescence:** scape 10--20 mm long, 2 mm in diameter, branched, bearing 2--5 pseudo-umbellets with (5-)8--13(-17) flowers each; peduncles 50--150(-230) mm long, 1,5--2 mm in diameter, green, densely covered with appressed curly hairs interspersed with long glandular hairs; bracts subulate, 3--4 x 1 mm, abaxially hirsute with distally appressed hairs. **Pedicel** ca. 0,5 mm long. **Hypanthium** 10--17(-20) mm long, reddish brown, indumentum as on peduncle. **Sepals** 5, lanceolate, apices acute, 6--8,5 mm long, 1--4,5 mm wide, recurved, green, indumentum abaxially as on peduncle. **Petals** 5, white, lilac or pale pink, patent during anthesis; posterior two with dark red feather-like markings, spatulate, bases cuneate, apices rounded or retuse, reflexed at less than 90° during anthesis, 10--16 x 2--4,5 mm; anterior three ligulate to spatulate, bases attenuate, apices rounded, 8--13 x 1,5--3 mm. **Stamens:** staminal column 1--3,5 mm long, white, papillate; perfect stamens 5, protruding from the flower, posterior one 6--8 mm long, lateral two 6,5--10,5 mm long, anterior two 7--10,5 mm long, white; staminodes 2--4,5 mm long; anthers pink, 1,5--2 mm long, pollen orange. **Gynoecium:** ovary 2,5--5 mm long; style 1--3 mm long, pale green; stigma branches 1,5--2,5 mm long, adaxially wine-red. **Fruit:** bases of mericarps 5--6 mm long, with glandular hairs, tails 24--30 mm long. (Figure 8.46.1).

Diagnostic features and affinities

P. bubonifolium is a geophyte with small tubers and irregularly pinnate to bipinnatisect erect leaves. The white or pink petals are larger than the sepals. The five fertile stamens are almost of the same length and are longer than the sepals and

protrude from the flower. The staminal column is papillate, in which respect *P. bubonifolium* resembles *P. auritum*, *P. parvipetalum* and all the two-petalled species of section *Hoarea*. The indumentum of the leaves, peduncles, hypanthia and sepals of *P. bubonifolium* is very similar to that of *P. parvipetalum*. There is also a resemblance in the morphology of the leaves of these two species. Both species have similar pinnate to bipinnatisect leaves and both of them occur in Namaqualand. The petals of *P. bubonifolium* are longer than the sepals and those of *P. parvipetalum* are shorter than the sepals.

The epithet *bubonifolium* refers to the resemblance between the leaves of this species and those of the genus *Bubon* L., a synonym for *Athamanta* L., which are carrot-like plants of the Apiaceae.

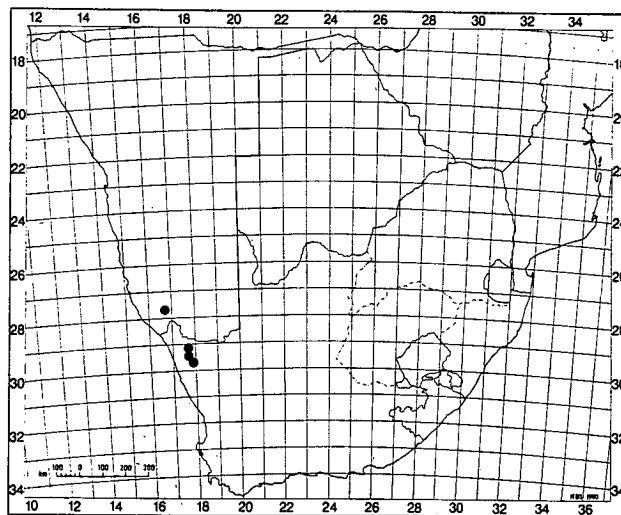


Figure 8.46.2 Geographical distribution of *P. bubonifolium*.

Geographical distribution and ecology

P. bubonifolium is known from Witputs in the extreme southern part of Namibia, and from Steinkopf and Okiep in Namaqualand (Figure 8.46.2). This is a semi-desert area with an annual rainfall of less than 100 mm. It grows in stony places in clay in low succulent vegetation, where it appears to be locally abundant. Flowering time is from August to October with the peak in September. This is also an early-flowering species of section *Hoarea* and leaves are still alive when flowers appear.

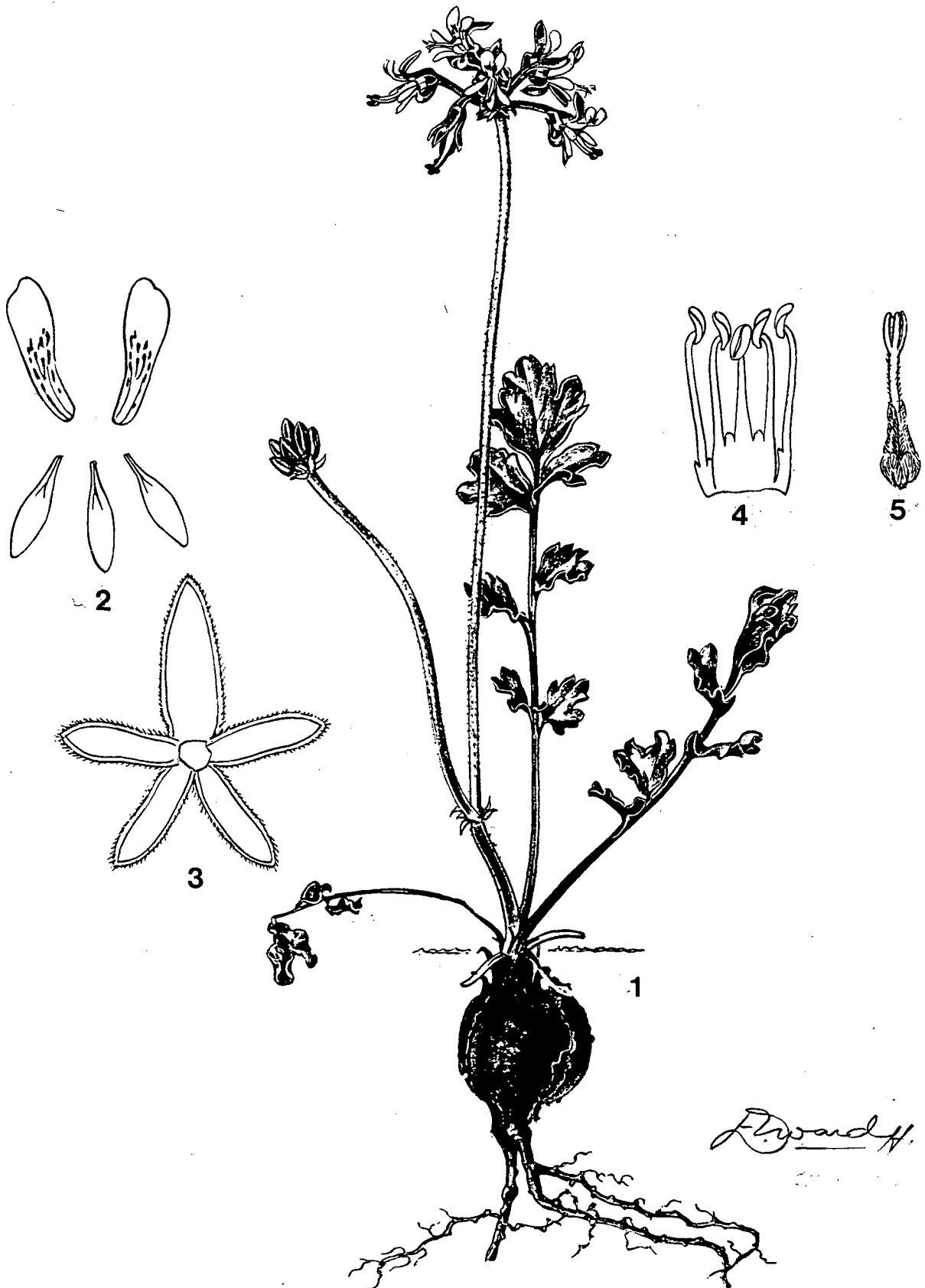


Figure 8.47.1 *Pelargonium parvipetalum*. 1, flowering plant x1; 2, petals x3; 3, sepals x3; 4, androecium x3; 5, gynoecium x4.

Material studied

--2716 (Witputs): S of Witputs (-DA), *Lavranos & Pehlemann 21693* (STEU).

--2917 (Springbok): Near Klipfontein, Namaqualand (-BA), *Bolus 448* (BM, BOL, E, Gx2, K, NH, P, PRE, SAM, UPS, W, Zx2); *Hall 840* (NBG); *Herre 12177* (STE); Between Klipfontein and Kookfontein (-BA), *Bolus 6530* (BOL, K); Gunhill, Steinkopf (-BA), *Drijfhout 2970* (STEU); *Ward-Hilhorst 264a* (NBG); 8 km W of Steinkopf (-BA), *Drijfhout 2971* (STEU); 4,8 km W of Steinkopf (-BA), *Goldblatt 2774* (MO); 2 km NE of Rabas (-BA), *Van Berkel* (NBG); 7 km from Steinkopf to Port Nolloth (-BA), *Perry 3180* (NBG); *Van Jaarsveld 4230* (STEU); Steinkopf (-BC), *Acocks 19534* (K); *Lewis 5500* (NBG); *Williamson 3731* (NBG); Near Okiep (-DB), *Morris s.n.* (BOL).

8.47 *Pelargonium parvipetalum* *E.M. Marais*, sp. nov. in sectione *Hoarea* distincta propter petala minima, *P. leipoldtii* Knuth affine sed petala semper 5 non 2 ad 5.

Herba perennis acaulescens tuberosa. **Tuber** subterraneum, napiforme, interdum moniliforme, 15--40 mm longum, 10--25 mm in diam. **Folia** hysterantha, rosulata, viridia, petiolata; lamina elliptica, 25--95(-140) mm longa, irregulariter pinnatisecta vel bipinnata, pinnae lobatae vel laciniatae, adaxiale et abaxiale hirsuta; petiolus 15--60(-90) mm longus, rigidus, erectus, dense hirsutus, sparsim glandulosus; stipulae petiolo adnatae. **Inflorescentia**: scapus pseudoumbellis (2-)3--5(-6), utraque 7--14(-18) floribus. **Pedicellum** ca. 0,5 mm longum. **Hypanthium** 8--16 mm longum, dense hirsutum et glandulosum. **Sepala** 5, lanceolata, 6--10 mm longa, 2--4,5 mm lata, recurvata. **Petala** 5, alba, sepalis breviora, spatulata, dua postica leviter curvata, 5--8,5 mm longa, 1,5--3 mm lata, subtiliter carmineo-rubra picta, tria antica 4,5--8 mm longa, 1,5--2 mm lata. **Stamina** fertilia 5, staminodia 5.

TYPE - Cape Province: Gamoep, Farm Vaalkoei, 3 km south of Gamoep, *Bruyns 1519* (STE, holo, BOL, K, MO, PRE).

A geophyte 80--250(-280) mm tall when in flower. **Tuber**: a turnip-shaped or elongated, sometimes moniliform root, 15--40 mm long and 10--25 mm in diameter. **Leaves** green, petiolate; lamina elliptic, 25--95(-140) mm long, pinnately compound, irregularly pinnatisect to bipinnatisect; pinnae lobate to lacinate, 10--30 x 6--20 mm, adaxially and abaxially hirsute with long appressed stiff hairs; petiole 15--60(-90) mm long and 1--2 mm in diameter, rigid, erect, hirsute with appressed stiff hairs interspersed with bristle-like hairs and very short glandular hairs; stipules subulate, adnate to petioles with apices free, 10--22 mm long and ca. 1 mm wide, ciliate. **Inflorescence**: scape 20--160(-200) mm long, branched, bearing (2-)3--5(-6) pseudo-

umbellets with 7--14(-18) flowers each; peduncles 40--120 mm long, 1--3 mm in diameter, green, densely covered with appressed curly hairs interspersed with long glandular hairs; bracts subulate, 2--5 x 1 mm, abaxially hirsute with distally appressed hairs. **Pedicel** *ca.* 0,5 mm long. **Hypanthium** 8--16 mm long, reddish brown, densely hirsute with appressed hairs interspersed with long glandular hairs. **Sepals** 5, lanceolate, apices acute, 6--10 mm long, 2--4,5 mm wide, recurved, green, indumentum abaxially as on hypanthium. **Petals** 5, white, patent during anthesis; posterior two with dark red feather-like markings, ligulate to spatulate, bases cuneate, apices obtuse, rounded or emarginate, recurved during anthesis, 5--8,5 x 1,5--3 mm; anterior three spatulate, bases attenuate, apices rounded, 4,5--8 x 1,5--2 mm. **Stamens:** staminal column 2--4 mm long, white, papillate; perfect stamens 5, protruding from the flower, posterior one 7--9 mm long, lateral two 8--10 mm long, anterior two 8--10 mm long, white; staminodes 3--5 mm long; anthers dark red, *ca.* 2 mm long, pollen orange. **Gynoecium:** ovary 3,5--6 mm long; style 1,5--5 mm long, pale green; stigma branches 1--3 mm long, adaxially wine-red. **Fruit:** bases of mericarps *ca.* 5 mm long, with glandular hairs, tails 18--32 mm long. (Figure 8.47.1).

Diagnostic features and affinities

P. parvipetalum is a geophyte with small tubers and irregularly pinnate to bipinnatisect erect leaves. The flowers are inconspicuous because of the very small, white petals, and this motivated the choice for the specific epithet. The sepals are larger than the petals, but recurved so that the protruding stamens with their rather large, dark red anthers (*ca.* 2 mm long) and the long wine-red recurved stigma branches become the prominent features of the flower. The five fertile stamens are almost of the same length and the staminal column is papillate. In this respect *P. parvipetalum* resembles *P. auritum*, *P. bubonifolium* and all the two-petalled species of section *Hoarea*. Because of the very small petals, *P. parvipetalum* resembles closely to *P. leipoldtii*. Both have very small, white petals; *P. parvipetalum* always have five petals, whereas in *P. leipoldtii* the number of petals varies from two to five (Marais 1989a). The leaves of the two species also differ. *P. parvipetalum* has elliptic, pinnate to bipinnatisect leaves, whereas those of *P. leipoldtii* are trifoliolate with a trullate outline.

The indumentum of the leaves, peduncles, hypanthia and sepals of *P. parvipetalum* is very similar to that of *P. bubonifolium*. There is also a resemblance between the morphology of the leaves of these two species. Both species have similar pinnate to

bipinnatisect leaves and both of them occur in Namaqualand. The petals of *P. bubonifolium* are longer than the sepals, whereas those of *P. parvipetalum* are shorter than the sepals.

Geographical distribution and ecology

P. parvipetalum occurs from Gamoep in the north, the Platbakkies area east of Kamiesberge and as far south as Pakhuis Pass (Figure 8.47.2). This area receives an annual rainfall 100--200 mm, mainly in winter. It grows in sandy soil and quartzite patches in short succulent Karoo, in mountain renosterveld (veld type 43, Acocks 1988), marginal western mountain Karoo (veld type 28, Acocks 1988) or in arid fynbos. The occurrence of this species varies from rare to fairly frequent and it is heavily grazed by sheep. *P. parvipetalum* is one of the early-flowering species of section *Hoarea* and the peak of the flowering time is in September when leaves are still present.

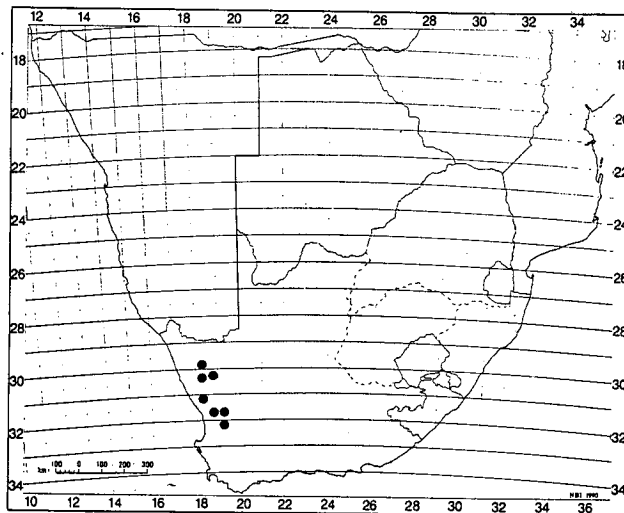


Figure 8.47.2 Geographical distribution of *P. parvipetalum*.

Material studied

- 2918 (Gamoep): Vaalkoei, 3 km S of Gamoep (-CD), *Bruyns 1519* (BOL, K, MO, PRE, STE).
- 3018 (Kamiesberg): Between Bloudraai and Witwater (-AC), *Le Roux & Ramsey 681* (STE); Between Bloudraai and Paulshoek (-AD), *Stirton 9242* (PRE, STE); Garing (-BA), *Lloyd 325* (STE); Vaalputs, near Platbakkies (-BC), *Le Roux s.n.* (STEU); Banke, near Platbakkies (-BD), *Oliver 9855* (STEU).

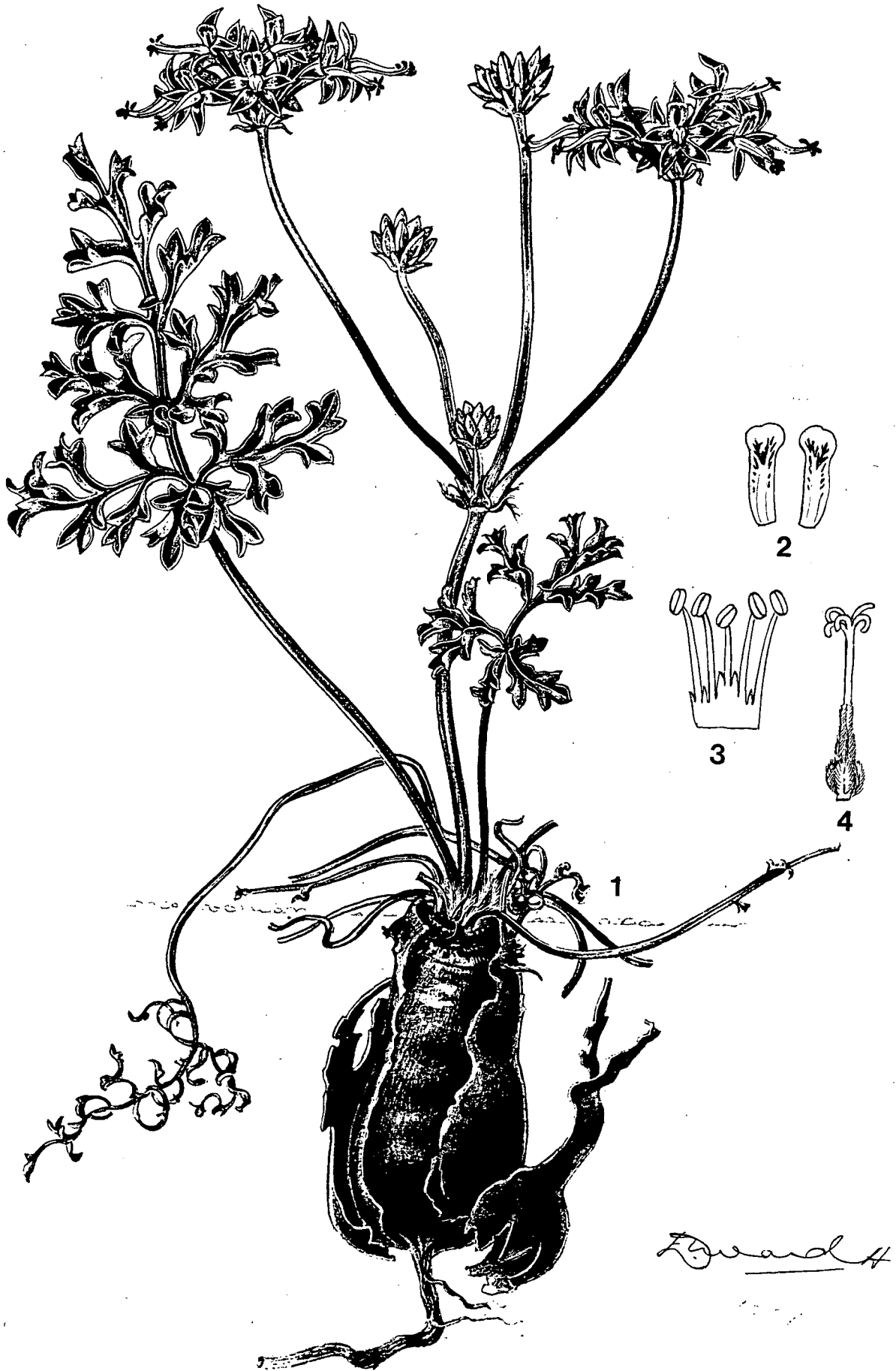


Figure 8.48.1 *Pelargonium leipoldtii*. 1, flowering plant x1; 2, petals x3; 3, androecium x2; 4, gynoecium x3.

--3118 (Vanrhynsdorp): 7 km E of Nuwerus on the Kliprand road (-AB), *Thompson 2839* (STE); Sandkraal, Vanrhynsdorp (-DA), *Acocks 14822* (PRE); *Barker 5651* (NBG); Flats west of Matsikamma (-DB), *Oliver 4991* (PRE, STE).

--3119 (Calvinia): Lokenburg (-CA), *Acocks 17722* (K, PRE, Z); *Leistner 315* (PRE); *Leistner 454* (K); Mensieskraal, Nieuwoudtville (-CB), *Markötter s.n.* (STE).

--3219 (Wuppertal): Near Pakhuis (-AA), *Leipoldt 20760* (BOL); Perdefontein on Nardouw Pass road to Calvinia (-AA), *Marais 327* (STEU).

8.48 *Pelargonium leipoldtii* *Knuth* in *Pflanzenreich* 4, 129: 342 (1912); Van der Walt & Vorster: 91, fig. (1981). TYPE - Cape Province: . . "Nieuwoudtville", *Leipoldt s.n. sub BOL 9396* (BOL holo!; K!).

A geophyte (60-)120--320 mm tall when in flower. **Tuber:** a turnip-shaped, sometimes moniliform root, 15--50 mm long and 12--25 mm in diameter. **Leaves** grey-green, petiolate; lamina trullate in outline, trifoliolate with the terminal leaflet larger than the other two, (30-)60--110(-180) x (20-)40--120(-200) mm; pinnae irregularly pinnately lobed to incised, adaxially and abaxially hirsute with short appressed stiff hairs; petiole 45--140 mm long and 1--3 mm in diameter, rigid, erect, hirsute with appressed stiff hairs interspersed with bristle-like hairs and very short glandular hairs; stipules subulate, adnate to petioles with apices free, (4-)10--15 mm long and *ca.* 1 mm wide, ciliate. **Inflorescence:** scape 35--250 mm long, branched, bearing 2--7(-10) pseudo-umbellets with (3-)6--12(-14) flowers each; peduncles 35--160 mm long, 1--3 mm in diameter, green, densely hirsute with short appressed stiff hairs interspersed with short glandular hairs; bracts subulate, 2--5 x 1--1,5 mm, abaxially densely hirsute with distally appressed hairs. **Pedicel** *ca.* 0,5 mm long. **Hypanthium** 7--12(-14) mm long, green to reddish brown, densely hirsute with appressed stiff hairs interspersed with long glandular hairs. **Sepals** 5, lanceolate, apices acute, recurved during anthesis, 5,5--9 mm long, 2--4 mm wide, green, indumentum abaxially as on hypanthium. **Petals** 2 in posterior position (seldom more), white with wine-red feather-like markings, ligulate to spatulate, 4,5--6 x 1,2--1,8 mm, bases cuneate, apices rounded or emarginate, recurved during anthesis, margins undulate. **Stamens:** staminal column 2--4,5 mm long, white, papillate; perfect stamens 5, protruding from the flower, posterior one 4,5--8 mm long, lateral two 5,5--9 mm long, anterior two 6--9,2 mm long, white; staminodes 2,5--5,5 mm long; anthers dark red, *ca.* 2 mm long, pollen orange. **Gynoecium:** ovary 3--6 mm long; style 0,5--3 mm long, pale green; stigma branches 1--2 mm long, adaxially

wine-red. **Fruit:** bases of mericarps 4--6 mm long, with glandular hairs, tails 29--31 mm long. (Figure 8.48.1).

Diagnostic features and affinities

P. leipoldtii is a geophyte with small tubers and large trifoliolate erect leaves. The leaf segments are irregularly pinnatilobed to incised. The flowers are inconspicuous with only two (rarely more) small, white petals with wine-red markings. The sepals are larger than the petals, but recurved so that the protruding stamens with its rather large, dark red anthers (*ca.* 2 mm long) and the long wine-red recurved stigma branches become the prominent features of the flower. The five fertile stamens are almost of the same length and the staminal column is papillate. In this respect *P. leipoldtii* resembles *P. auritum*, *P. bubonifolium*, *P. parvipetalum* and all the other two-petalled species of section *Hoarea*. Because of the very small petals, *P. leipoldtii* is closely related to *P. parvipetalum*. Both have very small, white petals; *P. parvipetalum* always has five petals, whereas *P. leipoldtii* has two, seldom more. The petals of *P. leipoldtii* are also very similar to those of *P. asarifolium* and *P. ellaphieae*. In all three species the petals have undulate margins. *P. leipoldtii* has white petals with red markings, whereas the other two species have wine-red flowers.

P. leipoldtii commemorates the famous South African author and poet Dr C.L. Leipoldt (1880-1947), who had a great interest in plants and collected many species new to science.

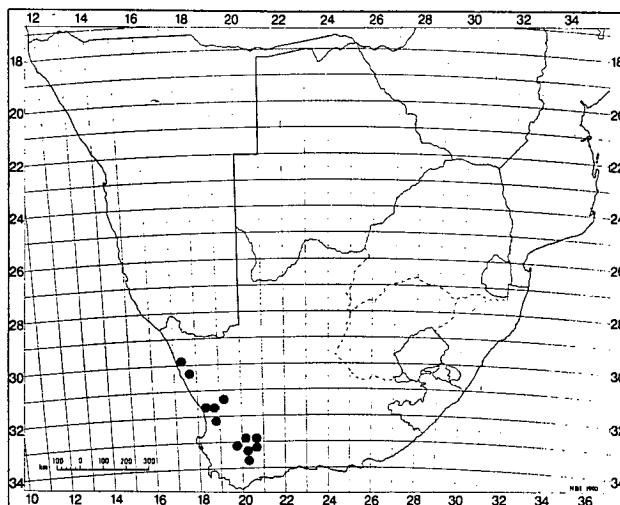


Figure 8.48.2 Geographical distribution of *P. leipoldtii*.

Geographical distribution and ecology

P. leipoldtii has a rather large distribution area if compared with other two-petalled species of section *Hoarea*. It also has the most northern distribution of this group and occurs along the western escarpment of the Cape Province from Komaggas near Springbok in the north, around Vanrhynsdorp and Clanwilliam, and as far south-east as Moordenaarshoogte south-east of Touwsrivier (Figure 8.48.2). This area receives an annual rainfall of 100--200 mm, mainly in winter. It grows on dry outcrops in sandy soil but also in clay in succulent vegetation. The occurrence of this species varies from rare to fairly frequent and usually in the shelter of shrublets. *P. leipoldtii* flowers in spring from August to November with the peak in October. In this respect it also differs from the other two-petalled species which flower during the hot summer months from December to April.

Material studied

- 2917 (Springbok): 40 km NE of Riethuis, on road to Komaggas (-CD), *Drijfhout* 2821 (STEU).
- 3017 (Hondekliipbaai): Walle Kraal (-BC), *Pillans* 17959, 18524 (BOL).
- 3118 (Vanrhynsdorp): 15 km from Lutzville on road to Strandfontein (-CB), *Marais* 316 (STEU); Windhoekberg (-DA), *Leipoldt* 4094 (BOL); 1 km W of Vanrhynsdorp (-DA), *Van Zyl s.n.* (STEU); Vleikraal, 8 km E of Klawer (-DA), *Walters* 2 (STEU).
- 3119 (Calvinia): Nieuwoudtville (-AC), *Herre s.n.* (BOL); *Leipoldt s.n. sub BOL* 9396 (BOL, K).
- 3218 (Clanwilliam): Clanwilliam Pass (-BB), *Alice & Godman* 575 (BM); Clanwilliam (-BB), *Bolus* 8950 (BOL, K); *Leipoldt s.n. sub SAM* 48326 (SAM); *Van Niekerk s.n.* (STEU); Clanwilliam dam, E bank (-BB), *Marais* 207, 403 (STEU); Nuwevei, on gravelled road between Clanwilliam & Klawer (-BB), *Marais* 317 (STEU).
- 3220 (Sutherland): On top of Thyshoogte (-CC), *Marais* 220, 221, 222, 223 (STEU); 38 km N of Matjiesfontein (-DC), *Hall* 1424/50 (NBG).
- 3319 (Worcester): 4 km N of Karoo Poort (-BA), *Lavranos & Pehlemann* 17482 (STEU); Karoo Poort, 2 km on Sutherland road (-BA), *Marais* 215, 216 (STEU); Karoo Poort (-BA), *Marloth* 9165 (PRE); 25 km N of Karoo Poort (-BB), *Hall* 5098 (NBG); Ceres Karoo, turnoff to Rooifontein (-BB), *Hiemstra & Hardick* 185 (NBG).
- 3320 (Montagu): Between Touwsrivier and Montagu, 1 km from railway crossing (-AC), *Marais* 100, 101, 102 (STEU); Between Touwsrivier and Montagu, 5 km from railway crossing (-AC), *Marais* 104 (STEU); Between Touwsrivier and Montagu, 2 km from Bloutoring (-AC), *Muller* 4036 (STEU); 2 km S of Lettaskraal (-AD), *Muller* 4038 (STEU); White Hill (-BA), *Marais* 98 (STEU); Moordenaarshoogte (-CB), *Marais* 109 (STEU).



Figure 8.49.1 *Pelargonium ellaphieae*. A, flowering plant x1; B, plant with leaves x1; C, flower without petals x2; D, petals x4; E, gynoecium x4; F, androecium x4; G, mericarp x2.

8.49 *Pelargonium ellaphieae* E.M. Marais in Marais *et al.*, Journal of South African Botany 47: 573 (1981); substitute name for *P. marginatum* Knuth: 350 (1912); Van der Walt & Vorster: 57, fig. (1981); Marais: t. 1987 (1989b). TYPE - Cape Province: "Am fusse des Muizenberg," *Bolus* 8054 (Z lecto!; BOL!, GRA!, K!, NH!, PRE!).

Pelargonium marginatum Knuth: 350 (1912); Adamson & Salter: 512 (1950); non (Cav.) Link (1822). TYPE - Cape Province: "Am fusse des Muizenberg," *Bolus* 8054 (Z lecto!; BOL!, GRA!, K!, NH!, PRE!).

A geophyte 100--300 mm high when in flower. **Tuber:** turnip-shaped or elongated root, 30--130 mm long and 8--20 mm in diameter. **Leaves** mostly simple, occasionally compound with 2 or more lateral pinnae at base of lamina, bright green, petiolate; lamina (or median pinna) lanceolate or sometimes elliptic, base cuneate, apex acute, margin entire, 35--65(-115) mm long and 10--15(-20) mm wide, mainly abaxially sericeous, margins sometimes with dense, white, adpressed bristles, bristles prominent when leaves are dried; small lateral pinnae elliptic, 6--20 mm long and 3--10 mm wide; petiole 15--35(-100) mm long, rigid, erect, pilose; stipules subulate, adnate to petioles for more than half their length, *ca.* 15 mm long and 1,5 mm wide, membranous, hirsute. **Inflorescence:** scape 40--180 mm long, branched, bearing 2--5 pseudo-umbellets with 6--15 flowers each; peduncles 25--190 mm long, hirsute and densely covered with glandular hairs; bracts narrowly triangular, apex attenuate, 4--9 mm long, abaxially hirsute. **Pedicel** *ca.* 0,5 mm long. **Hypanthium** 9--15 mm long, wine-red, indumentum as on peduncle. **Sepals** 5, posterior one triangular, remaining 4 lanceolate, apices acute, 7--10 mm long and 1,5--4 mm wide, posterior one erect, others reflexed, wine-red with conspicuously white margins, indumentum abaxially as on peduncle. **Petals** 2 in posterior position, rarely 3, dark wine-red, spatulate to elliptic, 7--11 mm long (almost the same length as the sepals), 2--3 mm wide, bases cuneate, apices rounded, reflexed at *ca.* 90°, margins undulate. **Stamens** staminal column 4--6,5 mm long, papillate; perfect stamens 5, protruding from the flower, posterior one 7--11 mm long, lateral two 8--12 mm long, anterior two 8,5--12 mm long, wine-red; staminodes 4,5--7 mm long; anthers dark red, 1,5--2 mm long, pollen orange. **Gynoecium:** ovary 3,5--5 mm long; style 1,5--5 mm long, with 5 rows of ordinary and glandular hairs, red; stigma branches *ca.* 1 mm long, wine-red. **Fruit:** bases of mericarps 6--8 mm long, with glandular hairs, tail up to 37 mm long. (Figure 8.49.1).

Diagnostic features and affinities

A noteworthy feature of *P. ellaphieae* is the lanceolate leaves with prominent adpressed bristles on the margins of the dried laminae. The flowers, strongly scented, have only two petals and five fertile stamens. The petals and the protruding androecium are conspicuously dark wine-red. The floral structure and specially that of the protruding androecium is similar to that of the other two-petalled species of section *Hoarea*. It also shows affinities with *P. auritum*, *P. bubonifolium* and *P. parvipetalum*, all five-petalled species of section *Hoarea*. Although the flowers of the two-petalled species (previously known as section *Seymouria*, but now included in section *Hoarea*, Marais 1989a & b) are very similar, each one has a distinctive leaf form and can be easily identified.

Geographical distribution and ecology

Originally *P. ellaphieae* was only known from Muizenberg in the Cape Peninsula from where the last collection was made by T.M. Salter in 1941. Since 1963 *P. ellaphieae* was fortunately rediscovered and collected in bergfynbos near Piketberg, on Versveld Pass, Piekenierskloof Pass, between Piekenierskloof and Paleisheuvel, Elandskloof near Citrusdal, Pakhuis Pass and Ezelsbank (Figure 8.49.2). All these localities are about 150 km or more north of Muizenberg. Because of this larger distribution area, I would not regard *P. ellaphieae* as in danger of extinction in the Cape flora. Populations are usually very small which may be why it is so poorly collected and although it occurs in the Cape Peninsula, it was only described as a new species in 1912. This may also be the reason it has not been found in the Cape Peninsula in recent times, with the added possibility that land development has in fact destroyed every possible habitat. The habitat of *P. ellaphieae* in both distribution areas is fynbos and may be part of two relic populations in this veld type, and the reason that it has not been collected in the remaining west coast renosterveld in the heavily cultivated Swartland.

P. ellaphieae grows in sandy soil in bergfynbos. Both distribution areas receive an annual rainfall of 400 to 600 mm, which occurs mainly during winter. The summers are warm to hot and the winters are cool without frost. It flowers in midsummer, from November to February, usually after the leaves have dried. New leaves appear after the first winter rains and are covered with soft hairs. This indumentum is lost during senescence and at the time of flowering the dried leaves show only white, adpressed bristles on the leaf margins, one of the characters which Knuth (1912) used

when he gave this species the apt name of *P. marginatum*. This was an illegitimate name and therefore it was renamed after Ellaphie Ward-Hilhorst, the well-known botanical artist and illustrator of the *Pelargoniums* of southern Africa.

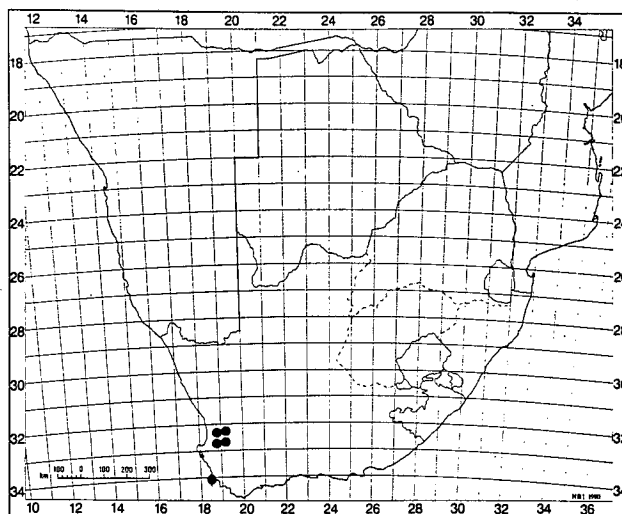


Figure 8.49.2 Geographical distribution of *P. ellaphieae*.

Material studied

--3218 (Clanwilliam): 23 km from Piekenierskloof on the Paleisheuvel road (-BD), *Marais 306* (STEU); Piekenierskloof Pass (-DB), *Marais 197* (STEU); 17 km from Piekenierskloof on the Paleisheuvel road (-DB), *Marais 305* (STEU); Piketberg Mountain (-DC), *Esterhuysen 35316* (BOL); Versveld Pass (-DC), *Nordenstam 3358* (S).

--3219 (Wuppertal): Pakhuis Pass (-AA), *Marais 193, 204a* (STEU); S of Eselbank (-AC), *Van der Walt 1520* (STEU); Elandskloof, near Citrusdal (-CA), *Hugo s.n.* (STEU); *Van der Walt 1411* (STEU); 3,5 km from Citrusdal to Ceres (-CA, *Marais 383* (STEU).

--3418 (Simonstown): Muizenberg (-AB), *Bolus 7959* (BOLx2, K); *Bolus 8054* (BOL, GRA, K, NH, PRE, Z); *Bolus s.n.* (BOL); Steenberge (-AB); *Ecklon & Zeyher 465* (S, SAM); Peck's Valley, E slopes of Muizenberg (-AB), *Pillans 3212* (BOL, PRE); Bergvliet Farm (-AB), *Purcell 242* (SAMx3); *Salter 6525* (BOLx2, K); Cape flats, W of Zeekoeivlei (-AB), *Salter 8706* (BOL); Retreat (-AB), *Wolley Dod 2232* (BOL).

8.50 *Pelargonium asarifolium* (Sweet) Loudon, An encyclopaedia of plants, 1st edn: 572 (1829); G. Don: 731 (1831); Loudon: 273 (1832); Steud.: 283 (1841); Harv.: 271 (1860); Knuth: 349 (1912); Van der Walt: 4, fig. (1977).
ICONOTYPE: Sweet, Geraniaceae 3: t. 206 (1824).



Figure 8.50.1 *Pelargonium asarifolium*. 1, flowering plants x1; 2, plant with leaves x1; 3, flower without petals x1; 4, androecium x3; 5, gynoecium x3; 6, petals x2,5.

Seymouria asarifolia Sweet: t. 206 (1824); Sweet: 77 (1826c). ICONOTYPE: Sweet, Geraniaceae 3: t. 206 (1824).

Geranospermum asarifolium (Sweet) Kuntze: 94 (1891).

A geophyte 130--230 mm tall when in flower. **Tuber:** a turnip-shaped or elongated, sometimes moniliform root 10--50(-70 mm long and 8--30 mm in diameter). **Leaves** simple, petiolate; lamina cordate, apex obtuse, margin entire, 25--65(-100) mm long and 15--65(-80) mm wide, adaxially bright green, glabrous, abaxially grey due to the matted cover of hairs (tomentose); petiole 15--90 mm long and 2--4 mm in diameter, rigid, prostrate or patent-erect, villous; stipules subulate, adnate to petioles with apices free, 8--12 mm long and *ca.* 2 mm wide, membranous, abaxially hirsute. **Inflorescence:** scape 30--110 mm long, 2--3 mm in diameter, branched, bearing 2--4(-10) pseudo-umbellets with 3--10(-12) flowers each; peduncles 30--100 mm long, 1--2 mm in diameter, reddish-green, villous interspersed with long glandular hairs; bracts subulate, 2,5--4 x 1 mm, abaxially villous. **Pedicel** *ca.* 0,5 mm long. **Hypanthium** 7--12 mm long, reddish brown, indumentum as on peduncle. **Sepals** 5, lanceolate, apices acute, 5,5--9 mm long, 1--2,5 mm wide, recurved, wine-red with white margins, indumentum abaxially as on peduncle. **Petals** 2 in posterior position, rarely 3, dark wine-red, ligulate to spatulate, 8--14,5 x 1,5--4 mm, bases cuneate, apices obtuse, rounded or emarginate, reflexed from about the middle. **Stamens:** staminal column 3,5--8 mm long, wine-red, papillate; perfect stamens 5, protruding from the flower, posterior one 7--11,5 mm long, lateral two 7,5--12 mm long, anterior two 7,5--13 mm long, wine-red; staminodes 4,5--9 mm long; anthers dark red, 1,5--2 mm long, pollen orange. **Gynoecium:** ovary 3--6,5 mm long; style 1--4,5 mm long, wine-red; stigma branches 0,8--1,5 mm long, wine-red. **Fruit:** bases of mericarps 5--6 mm long, without glandular hairs, tails 21--30 mm long. (Figure 8.50.1).

Diagnostic features and affinities

P. asarifolium is a geophyte with small tubers and entire, cordate, prostrate leaves. A noteworthy feature of this species is the small wine-red flowers with only two reflexed petals. The sepals are shorter than the five fertile stamens and also recurved so that the stamens protrude from the flower. The staminal column is long, wine-red and papillate. The flowers of *P. asarifolium* are similar to those of *P. ellaphieae* but because each one has a distinctive leaf form and a different indumentum, they can easily be distinguished. The structure of the androecium of *P. asarifolium* resembles

that of all the two-petalled species of section *Hoarea* and that of *P. auritum*, *P. bubonifolium* and *P. parvipetalum*.

The specific epithet *asarifolium* refers to the resemblance between the leaves of this species and those of *Asarum*, a member of the family Aristolochiaceae.

Geographical distribution and ecology

P. asarifolium is confined to the south-western Cape. It occurs from Piketberg and Porterville in the north, along the western coastal plain as far south as Sir Lowry's Pass, but also in the Worcester area and as far east as Matroosberg (Figure 8.50.2). This area receives an annual rainfall of 400--600 mm mainly in winter. *P. asarifolium* grows on flats amongst small shrubs or on dry rocky slopes in sand or clay. Plants flower from November to May with the peak of the flowering time during the hot months of January to March.

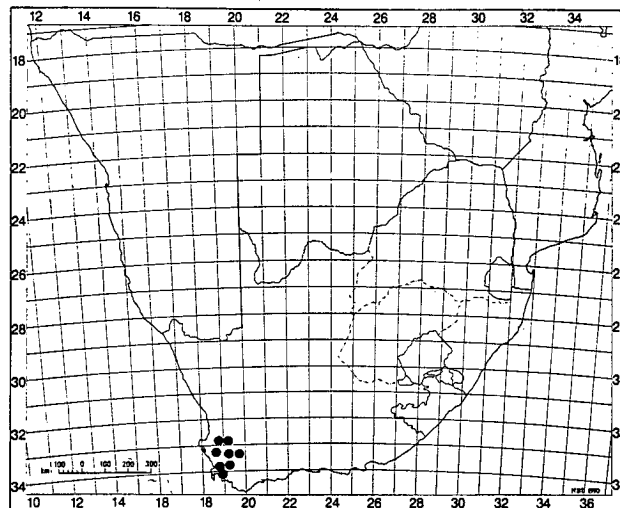


Figure 8.50.2 Geographical distribution of *P. asarifolium*.

Material studied

- 3218 (Clanwilliam): Piketberg (-DD), *Hugo s.n.* (STEU).
- 3219 (Wuppertal): Dasklip road, Porterville (-CC), *Marais 183, 293* (STEU).
- 3318 (Cape Town): Lucasfontein, Moorreesburg (-BA), *Marais 262* (STEU); Diepkloof turnoff on N7, Malmesbury (-BC), *Marais 258* (STEU); Malmesbury (-BC), *Wasserfall 765* (NBG); Klein Drakenstein (-DB) *Drège 1994* (P); Tygerberg (-DC), *Leighton 982* (BOL); Stellenbosch, flats and hill slopes (-DD), *Duthie 1076* (STEU); Stellenbosch, First River terrace (-DD), *Duthie s.n.* (BOL);

Stellenbosch flats (-DD), *Duthie s.n.* (BOL); *Marloth 10339* (BOL); Near Stellenbosch (-DD), *Duthie s.n.* (BOL); Stellenbosch, Jan Marais Park (-DD), *Duthie s.n.* (BOL); *Ward-Hilhorst 113a* (NBG); Stellenbosch, Bothmaskop (-DD), *Duthie s.n.* (BOL); Stellenbosch, Pappegaaiberg (-DD), *Duthie s.n.* (BOL); Groot Drakenstein (-DD), *Marloth 9444* (PRE); Eerste Rivier (-DD), *Zeyher 341* (BOL).

--3319 (Worcester): Tulbach (-AC), *Bolus 5487* (BOL); Head of Tulbagh valley (-AC), *Esterhuysen 16900* (BOL); Between Nuwekloof and Elandskloof Mountain (-AC), *Drège s.n.* (G, K, W); Romansrivier, Wolseley (-AC), *Van der Walt 573* (STEU); Waterfall, Tulbagh (-AC), *Van Wyk 752* (STEU); Ovenstone's Farm, 10 miles from Ceres (-AD), *Barker 8885* (NBG); Between Prince Alfred Hamlet and Gydo (-AD), *Fischer 343* (STEU); Matroosberg (-BC), *Stokoe NBG7922* (NBG); Bailey's Peak (-CA), *Esterhuysen 22337* (BOL); *Esterhuysen 22737* (BOL, K, PRE); Bainskloof (-CA), *Schlechter 10256* (BOL); St. Sebastians Kloof (-CA), *Stokoe SAM59410* (SAM); Eikeboom, on Slanghoek road (-CA), *Van der Walt 1062* (STEU); Worcester Shooting Range (-CB), *Bayer 2629* (NBG); Brandwacht Valley (-CB), *Esterhuysen 20022* (BOL); Between Worcester Shooting Range and Rainbow Chicken Farm (-CB), *Forrester 297* (NBG); Hartebeesrivier (-CB), *Walters 1826* (NBG); Wemmershoek (-CC), *Esterhuysen 17710* (BOL).

--3418 (Simonstown): Sir Lowry's Pass (-BB), *Stokoe SAM60605* (SAM).

8.51 *Pelargonium dipetalum* L'Hérit., Geranologia: t. 43 (1792); Willd.: 642 (1800); Pers.: 226 (1806); Ait. f.: 159 (1812); DC.: 650 (1824); Spreng.: 51 (1826); Loudon: 572 (1829); Loudon: 273 (1832); Steud.: 285 (1841); Harv.: 271 (1860); Knuth: 350 (1912). ICONOTYPE: L'Héritier, Geranologia: t. 43 (1792).

Geranium dipetalum (L'Hérit.) Poir.: 744 (1812).

Geranospermum dipetalum (L'Hérit.) Kuntze: 95 (1891).

Seymouria l'héritieri Sweet: t. 206 (1824): substitute name for *P. dipetalum*; Sweet: 77 (1826c).

Pelargonium l'héritieri (Sweet) G. Don: 731 (1831).

Hoarea erythrophylla Eckl. & Zeyh.: 60 (1835). TYPE - Cape Province: " Rivier Zonder Einde apud villam Knoblauch (Zwellendam). " *Ecklon & Zeyher 457* (S, lecto!, designated here, S!, SAM!).

Pelargonium erythrophyllum (Eckl. & Zeyh.) Steud.: 285 (1841).

Pelargonium nivenii Harv.: 271 (1860); Knuth: 350 (1912). TYPE - Cape Province: " Elevated places in Sweetmilk Valley " *Niven s.n.* (S, holol!).

Geranospermum nivenii (Harv.) Kuntze: 95 (1891).

A geophyte 90--350 mm tall when in flower. **Tuber:** a turnip-shaped or elongated, sometimes moniliform root 10--55 mm long and 10--25 mm in diameter. **Leaves**

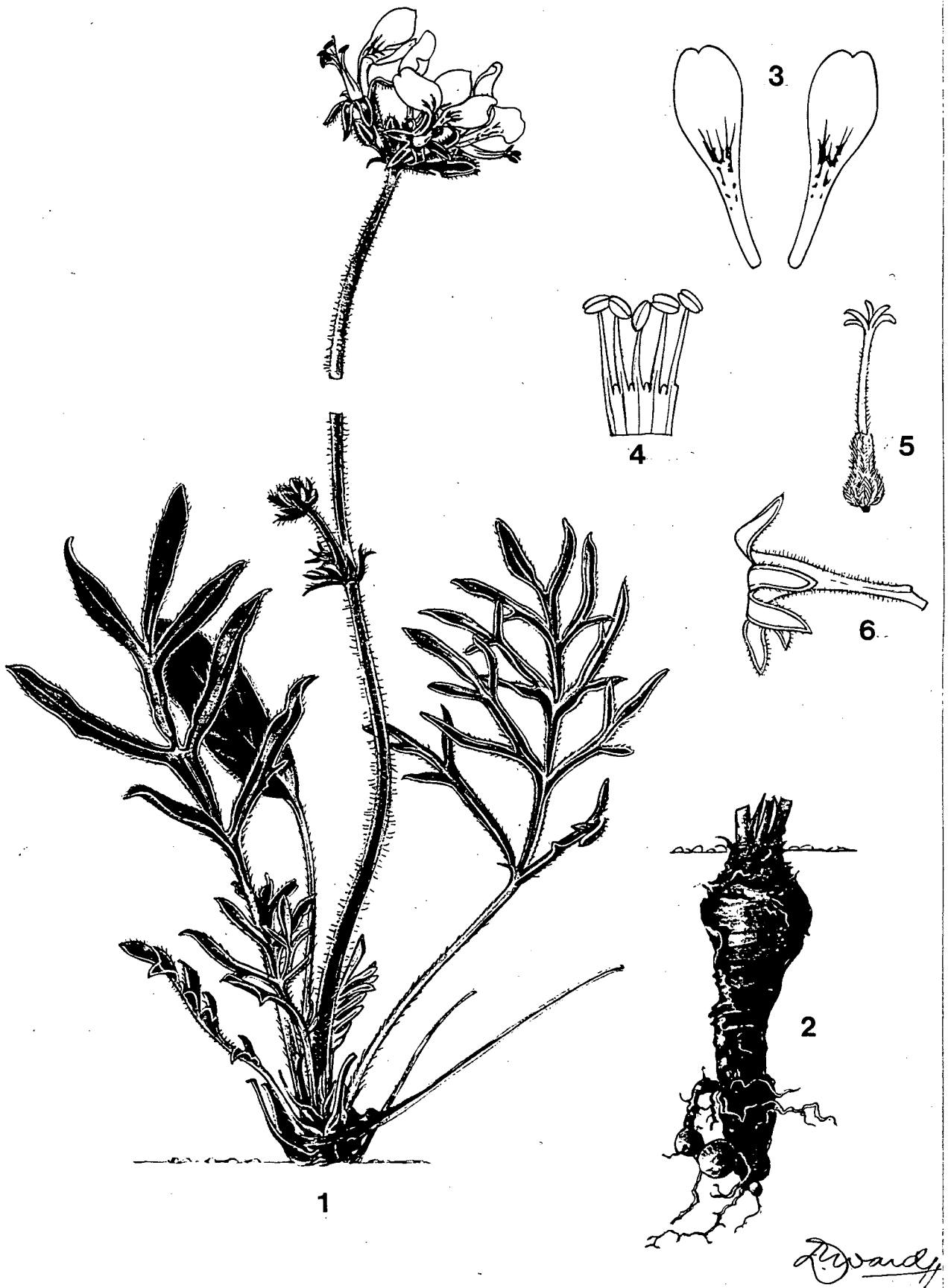


Figure 8.51.1 *Pelargonium dipetalum*. 1, flowering plant x1; 2, tuber x1; 3, petals x2; 4, androecium x3; 5, gynoecium x3; 6, hypanthium with sepals x2.

green, sometimes adaxially purple, petiolate; lamina elliptic, 20--120 mm long, varies from simple to irregularly pinnatisect to bipinnatisect; simple leaves 13--30 mm wide, apices acuminate, bases cuneate, margins entire; incised leaves with segments lacinate, segments 20--60 x 1--3 mm, adaxially and abaxially hirsute with long appressed hairs; petiole 30--200 mm long and 0,5--2 mm in diameter, rigid, erect, hirsute with appressed or patent hairs; stipules subulate, adnate to petioles for two thirds of their length, apices free, 12--37 mm long and 1--2 mm wide, ciliate. **Inflorescence:** scape 30--200 mm long, 1--4 mm in diameter, branched, bearing 2--3(-5) pseudo-umbellets with (3-)4--8(-12) flowers each; peduncles 25--150 mm long, 0,5--2 mm in diameter, green, covered with glandular hairs interspersed with bristle-like hairs; bracts subulate, 3--7 x 1--2 mm, abaxially hirsute with distally appressed hairs. **Pedicel** ca. 0,5 mm long. **Hypanthium** 7--18-(35--50) mm long, reddish brown, densely covered with glandular hairs interspersed with bristle-like hairs. **Sepals** 5, lanceolate, apices acute, 5--11,5 mm long, 1,2--4 mm wide, reflexed, green to reddish brown, indumentum abaxially as on peduncle. **Petals** 2 in posterior position, white, pale pink to bright pink, with dark red feather-like markings, obovate to spatulate, 12--19 x 3--7(-10) mm, bases cuneate, apices emarginate, recurved during anthesis. **Stamens:** staminal column 1,5--4,5 mm long, white to pale pink, papillate; perfect stamens 5, protruding from the flower, posterior one 6,5--11 mm long, lateral two 7,5--12 mm long, anterior two 7,5--12 mm long, free filaments wine-red; staminodes 2--5,5 mm long; anthers dark red, 1,5--2,5 mm long, pollen orange. **Gynoecium:** ovary 3--6 mm long; style 1,5--6 mm long, lengthens during anthesis, pink; stigma branches 1--3 mm long, adaxially wine-red. **Fruit:** bases of mericarps 5--8 mm long, without glandular hairs, tails 20--31 mm long. (Figure 8.51.1).

Diagnostic features and affinities

P. dipetalum, as indicated by the epithet, is one of the two-petalled species of section *Hoarea*. The petals of *P. dipetalum* are very similar to those of *P. ternifolium*, but because of their distinctive leaf shape, they can be easily distinguished. The former has five fertile stamens and the latter only four. The indumentum of these two species is also very similar. The structure of the androecium, that is the fertile stamens of almost the same length and the papillate staminal column, corresponds to that of all the other two-petalled species of section *Hoarea* and that of *P. auritum*, *P. bubonifolium* and *P. parvipetalum*. The length of the hypanthia (7--18 mm) in the majority of specimens of *P. dipetalum* coincides with that of all the species in this

group. However, three populations with exceptionally long hypanthia (35--50 mm) were found amongst the other populations.

The large variation in leaf form, from simple to irregularly pinnatisect and bipinnatisect is quite common in section *Hoarea* and occurs in *P. auritum* of this group, but also in *P. longifolium* and *P. proliferum*, both belonging to different floral structure groups.

Geographical distribution and ecology

P. dipetalum occurs along the southern coastal plain from Betty's Bay in the west to Keurboomsrivier in the east (Figure 8.51.2), an area with an annual rainfall of 200--600 mm. In the west the precipitation occurs mainly during the winter, whereas the eastern part receives rain throughout the year. It grows on foothills or flats on limestone ridges, on sandstone slopes or on shale, in short coastal fynbos or renosterveld. Plants occur in partial shade of shrublets or in direct sunlight. The frequency varies from rare to locally fairly common. Flowering time of this species is from February to April, but occasionally flowers are found as early as December and as late as May. Usually the leaves have died when the flowers appear, but leaf remnants may still be present.

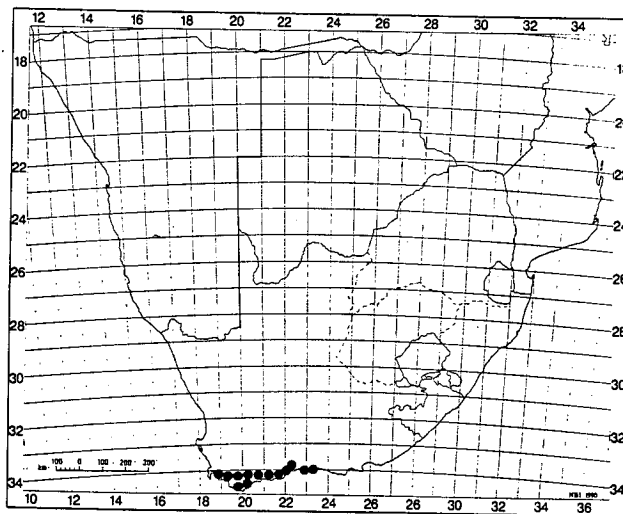


Figure 8.51.2 Geographical distribution of *P. dipetalum*.

Material studied

- 3322 (Oudtshoorn): George (-CD), *Schlechter 2401* (Z).
- 3418 (Simonstown): Betty's Bay (-BD), *Levyns 11417* (BOL).
- 3419 (Caledon): Viljoen's Pass (-AA), *Acocks 4368* (S); Elgin (-AA), *Compton 14323* (NBG); *Smith 2539* (PRE); Houw Hoek (-AA), *Guthrie 2225* (NBG); *Schlechter 7561* (BOL, E, Gx3, K, MO, NH, P, PREx2, S, W, Z); Houw Hoek Pass (-AA), *Vorster 2852, 2853, s.n.* (STEU); Palmiet River, Oude Brug (-AA), *Leighton 503* (BOL); 4 km E of Theewaterkloof bridge to Greyton (-AA), *Vorster 2900* (STEU); Near Caledon (-AB), *Bolus 9902* (BOL, K); Caledon, hill N of Bath (-AB), *Marloth 11085* (PRE, STE); Caledon (-AB), *Purcell SAM45919* (SAM); Driebosch, Kleinmond (-AC), *Marais s.n.* (NBG); Suikerboskop, E of Botrivier Lagoon (-AC), *Oliver 5798* (PRE, STE); Kleinmond (-AC), *Stokoe 1327* (BOL); *Van der Walt 1525* (STEU); Groot Hagelkraal, near Pearly Beach (-AC), *Van Wyk 1154* (STE); Happy Valley, Riviersonderend (-BA), *Compton 10665* (NBG); Zwarteberg near Sandfontein (-BA), *Schlechter 10358* (BOL); Foothills of Riviersonderend Mountains (-BB), *Lewis 63209* (PRE); *Stokoe s.n.* (PRE); Riviersonderend, near Olifantsbos (-BB), *Marloth 11090* (PRE); Riviersonderend (-BB), *Middlemost 1509* (NBG); Sweetmilk Valley (-BB), *Niven s.n.* (S); Neetling's farm, Riviersonderend (-BB), *Wilman 978* (BOL, PRE); Sandy's Glen, near Sandfontein (-BC), *Hugo 908* (PRE, STE); Mierkraal, 10 km from Bredasdorp to Elim (-BD), *Fischer 277* (STEU); Koksrivier (-DA), *Hugo 1606* (STE); Vlei between Elim and Die Poort (-DA), *Leighton s.n.* (BOL, K); Hills NW of Elim (-DA), *Oliver 3344* (STE); Haelkraalrivier (-DA), *Oliver 5895* (STE); Poort near Hagelkraalrivier (-DA), *Thompson 3917* (STE); Road from Elim to Die Dam (-DA), *Van Wyk 801* (STE); Rietfontein Nature Reserve (-DB), *Beyers s.n.* (STEU); Uitvlugt, S slopes of Bredasdorp Mountains (-DB), *Boucher 3775* (STE); Zoutendalsvlei (-DB), *Fellingham 398* (STE); 15 km from Bredasdorp to Heuningrug (-DB), *Fischer 286* (STEU); Mierkraal SW of Bredasdorp (-DB), *Hugo 823* (STE); 4 miles from Elim (-DB), *Maguire 845* (NBG); Vogelvlei, near Napier (-DB), *Schlechter 1867* (PRE); *Schlechter 10494* (BOL, PRE).
- 3420 (Bredasdorp): Knoblauch, Swellendam (-AB), *Ecklon & Zeyher 457* (Sx2, SAM); Bontebok Park, Swellendam (-AB), *Van der Walt 541* (STEU); De Hoop farm (-AC), *Van der Merwe 2015* (STE); De Hoop Nature Reserve (-AD), *Hugo 881* (STE); Zuurbraak (-BA), *Thode A2301* (PRE); Potberg Nature Reserve (-BC), *Burgers 1810* (STE); Uyshoek, 7 km N of Arniston (CA), *Hugo 840* (PRE, STE); Elandsvlei between Bredasdorp & Spitskop (-CA), *Hugo 1174* (STE); Near Bredasdorp (-CA), *Leighton s.n.* (BOL); *Leighton NBG671/33* (K).
- 3421 (Riversdale): Farm Watergat, Riversdale (-AA), *Marais 172, 173* (STEU); Dekriet siding (-AB), *Oliver 5692* (STE); Schoemanshoek, Albertinia (-BA), *Boucher 3720* (STE); Canca, 12 km of Albertinia (-BA), *Oliver 5717* (STEU); Rykdalersplaas, Albertinia (-BC), *Marais 170* (STEU).
- 3422 (Mossel Bay): Mossel Bay, near Golden Rendezvous Hotel (-AA), *Vlok 1855* (STE); Belvidere, Knysna (-BB), *Duthie 500* (BOL, BOL-FOURCADE, K, NH, P, PRE, SAM, STE); *Duthie s.n.* (BOL, NH); *Van der Walt 842, 844* (STEU).

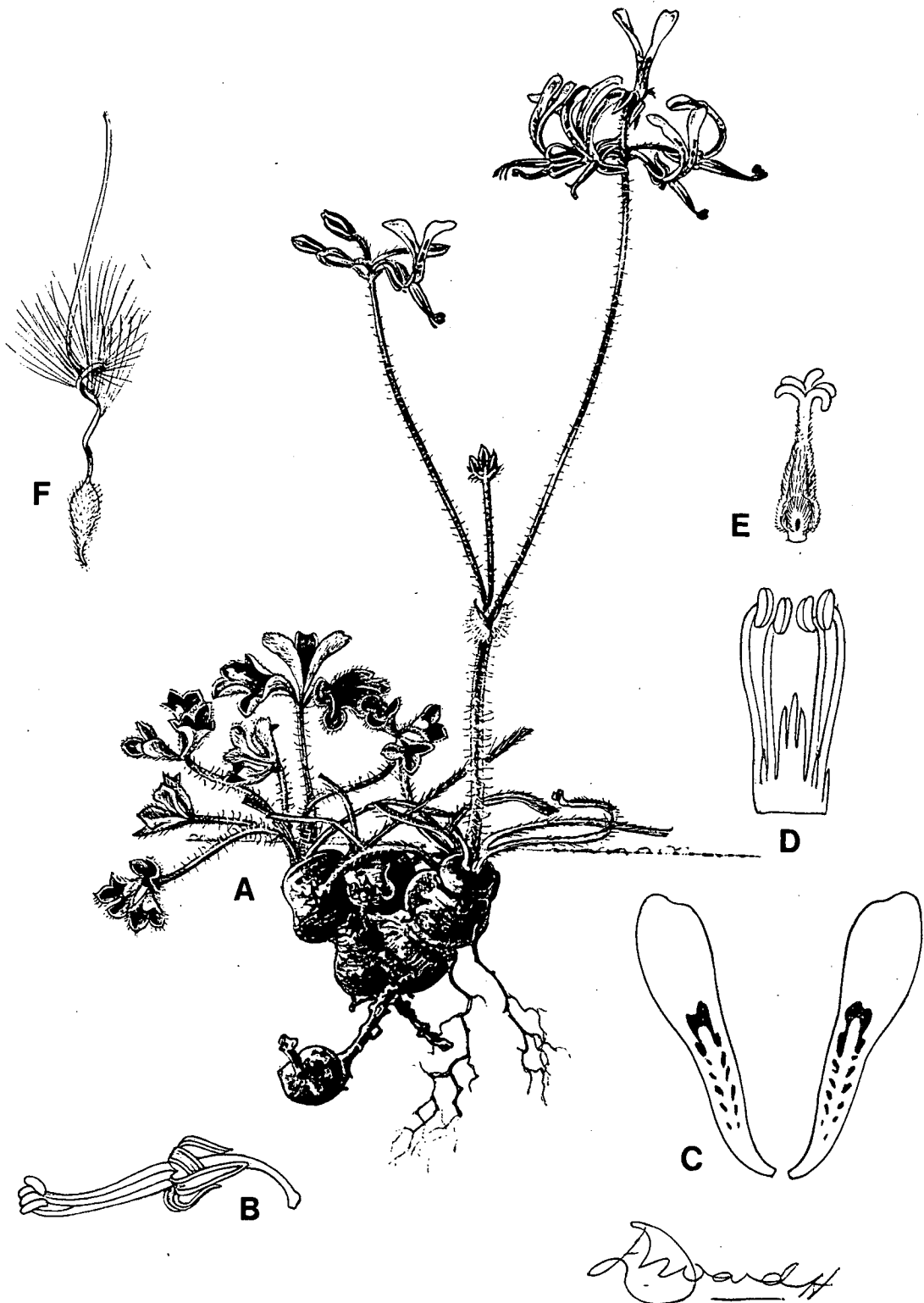


Figure 8.52.1 *Pelargonium ternifolium*. A, flowering plant x1, B, flower without petals x2; C, petals x3; D, androecium x3; E, gynoecium x4; F, mericarp x3.

--3423 (Knysna): Knysna (-AA), *Breyer 23973, 25210* (PRE); *Duthie s.n.* (BOL); Knysna Heads (-AA), *Fourcade 2018* (BOL, BOL-FOURCADE, K); Keurboomsrivier, Knysna (-AB), *Adamson D331* (PRE).

8.52 *Pelargonium ternifolium* Vorster in Van der Walt & Vorster, *Bothalia* 13: 431 (1981b); substitute name for *P. trifoliatum* Harv.: 271 (1860); Van der Walt & Vorster: 141, fig. (1981a). TYPE - Cape Province: " . . Klein Drakenstein & Dal Josefats . . " *Drège 7497* (S, lecto!, designated here; G!, K!, L!, MO!, Px2!, W!).

Pelargonium trifoliatum Harv.: 271 (1860); Knuth: 351 (1912); non Sweet: t. 394 (1826a); nec (Eckl. & Zeyh.) Steud. (1841). TYPE - Cape Province: " . . Klein Drakenstein & Dal Josefats . . " *Drège 7497* (S, lecto!, designated here; G!, K!, L!, MO!, Px2!, W!).

Geranium trifoliatum (Harv.) Kuntze: 95 (1891).

A geophyte 90--250 mm tall when in flower. **Tuber:** a turnip-shaped, often moniliform root 6--10 mm long and 6--8 mm in diameter. **Leaves** green, petiolate; lamina cordate to circular in outline, 10--20(-30) x 15--35(-70) mm, trifoliate; pinnae widely obtrullate, apices 2--6 times deeply incised, 7--18(-40) x 9--18(-45) mm, adaxially and abaxially conspicuously hirsute with long appressed hairs; petiole 30--100 mm long and *ca.* 1 mm in diameter, rigid, spreading horizontally from the growing point and bending vertically in the middle, hirsute with stiff hairs and distally appressed curly hairs interspersed with short glandular hairs; stipules subulate, adnate to petioles with apices free, 4--14 mm long and 1--2 mm wide, ciliate. **Inflorescence:** scape 25--160 mm long, 1--1,5 mm in diameter, branched, bearing 2--3(-4) pseudo-umbellets with 3--7 flowers each; peduncles 25--130 mm long, *ca.* 1 mm in diameter, green, sparsely strigose interspersed with very short glandular hairs; bracts lanceolate, 2--3 x 1 mm, abaxially strigose with distally appressed hairs. **Pedicel** *ca.* 0,5 mm long. **Hypanthium** 7--10 mm long, green to reddish brown, strigose with glandular hairs interspersed. **Sepals** 5, lanceolate, apices acute, 5--8 mm long, 1--2 mm wide, reflexed during anthesis, green to reddish brown with white margins, indumentum abaxially as on peduncle. **Petals** 2 in posterior position, white to pink with dark red feather-like markings, spatulate to obovate, 11--18 x 2,5--6 mm, bases cuneate, apices rounded or emarginate, reflexed through more than 90°. **Stamens:** staminal column 3--4,5 mm long, white to pink, papillate; perfect stamens 4, protruding from the flower, lateral two 8,5--10 mm long, anterior two 9--11 mm long, free filaments wine-red; staminodes 3--8 mm long with short stiff hairs on the posterior ones; anthers wine-red, 1,5--2 mm long, pollen orange. **Gynoecium:**

ovary 2,5--6 mm long; style 1,5--4,5 mm long, pink; stigma branches 1--1,5 mm long, wine-red. **Fruit:** bases of mericarps *ca.* 5 mm long, without glandular hairs, tails 22--27 mm long. (Figure 8.52.1).

Diagnostic features and affinities

P. ternifolium is a geophyte with very small, often moniliform tubers and trifoliolate leaves, hence the specific epithet. The flowers have only two white to pink petals. The sepals are reflexed and the long stamens protrude from the flower. *P. ternifolium* has only four fertile stamens which are almost of the same length. The papillate staminal column resembles that of all the other two-petalled species of section *Hoarea* as well as that of *P. auritum*, *P. bubonifolium* and *P. parvipetalum*.

The orientation of the petioles of *P. ternifolium* resembles that of *P. fergusoniae*, *P. reflexum* and *P. nephrophyllum*. All four species have long thin petioles, spreading horizontally from the stem-growing point and bending vertically in the middle. *P. fergusoniae* and *P. reflexum* have palmately compound leaves and *P. nephrophyllum* has palmately veined, kidney-shaped leaves. All four species belong to different floral structure groups.

Geographical distribution and ecology

P. ternifolium is confined to the south-western coastal plain, from Moorreesburg in the north to Stellenbosch in the south, and from Darling in the west to Du Toitskloof in the east (Figure 8.52.2). The annual rainfall of this area occurs mainly during winter and varies from 400 mm in the west to 700 mm in the east. *P. ternifolium* usually occurs on foothills but it has been found at a height of over 1000 m in the Hawequas Mountains, but it was also collected on the flats around Stellenbosch. It grows in dry renosterveld, but also in wet fynbos in clay, sand or loam, on quartzite reefs or granite slopes and flowers from December to April with the peak during the hot months of February and March, after the leaves have died.

Material studied

--3318 (Cape Town): Between Mamre and Darling (-AD), *Esterhuysen 18863* (BOL); Goudmyn, Moorreesburg (-BA), *Marais 164* (STEU); Neulfontein, Moorreesburg (-BA), *Marais 320* (STEU); Near Malmesbury (-BC), *Bolus s.n.* (BOL); Malmesbury (-BC), *Drijfhout 1535* (STEU); Diepkloof turnoff on N7 (-BC), *Marais 260* (STEU); Modderasvlei, Riebeck-Kasteel (-BD), *Drijfhout 1627*

(STEU); Farm Jonkershoek, E of Porseleinberg (-BD), *Marais 319* (STEU); Riebeek-Kasteel (-BD), *Pillans 9994* (BOL); *Salter 2007* (K); Voorspoed, Malmesbury (-BD), *Van der Walt 1036* (STEU); Klipheuwel (-DA), *Boucher 3534* (STE); Swellengift (-DA), *Marais 134* (STEU); Klein Drakenstein & Dal Josefats (-DB), *Drège 7497* (G, K, L, MO, Px2, S, W); Between Klapmuts & Paarl (-DB), *Esterhuysen 21195* (BOL); Farm Lemoenkloof, Paardeberg (-DB), *Marais s.n.* (STEU); SW of Paardeberg (-DB), *Salter & Leighton s.n.* (BOL); Wellington (-DB), *Zeyher s.n.* (BOL); Bottelary, 9 km from Stellenbosch (-DD), *Acocks 4338, 4359* (S); Klapmuts (-DD), *Acocks 4341* (S); Hercular's Pillar (-DD), *Acocks 4348* (S); *Salter 6566* (BOL, K); Bonterivier (-DD), *Buys 87* (STEU); Farm Rustenberg (-DD), *Drijfhout 2627* (STEU); Hill slopes near Stellenbosch (-DD), *Duthie 1075* (PRE); *Duthie 1075a* (BOL); *Duthie s.n.* (BOLx4); Stellenbosch (-DD), *Duthie s.n.* (BOLx2, K, SAMx2, STEU); Botmaskop (-DD), *Duthie s.n.* (BOLx2, STEUx2); *Garside 15951* (BOL); Mountain slopes near Stellenbosch (-DD), *Duthie s.n.* (BOL); Stellenbosch flats (-DD), *Duthie s.n.* (STEU); Pappegaaiberg (-DD), *Garside 661* (K); *Garside s.n.* (STEU); Stellenboschberg (-DD), *Schonken 167* (STEU).

--3319 (Worcester): Vogelvlei, Gouda (-AC), *Esterhuysen 18823* (BOL); Hawequas Mountains (-CA), *Esterhuysen s.n.* (BOL); Du Toitskloof (-CA), *Esterhuysen 20993* (BOLx2); *Van der Walt s.n.* (STEU); Die Poort, Du Toitskloof (-CA), *Marais 337* (STEU); Vondeling, W slope of Groenberg, Wellington (-CA), *Marais 382* (STEU); Elandskloof, off Du Toitskloof (-CC), *Esterhuysen 15727* (BOL).

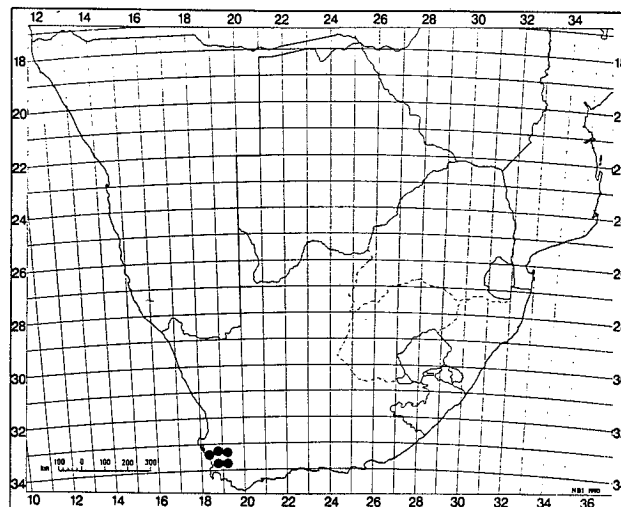


Figure 8.52.2 Geographical distribution of *P. ternifolium*.

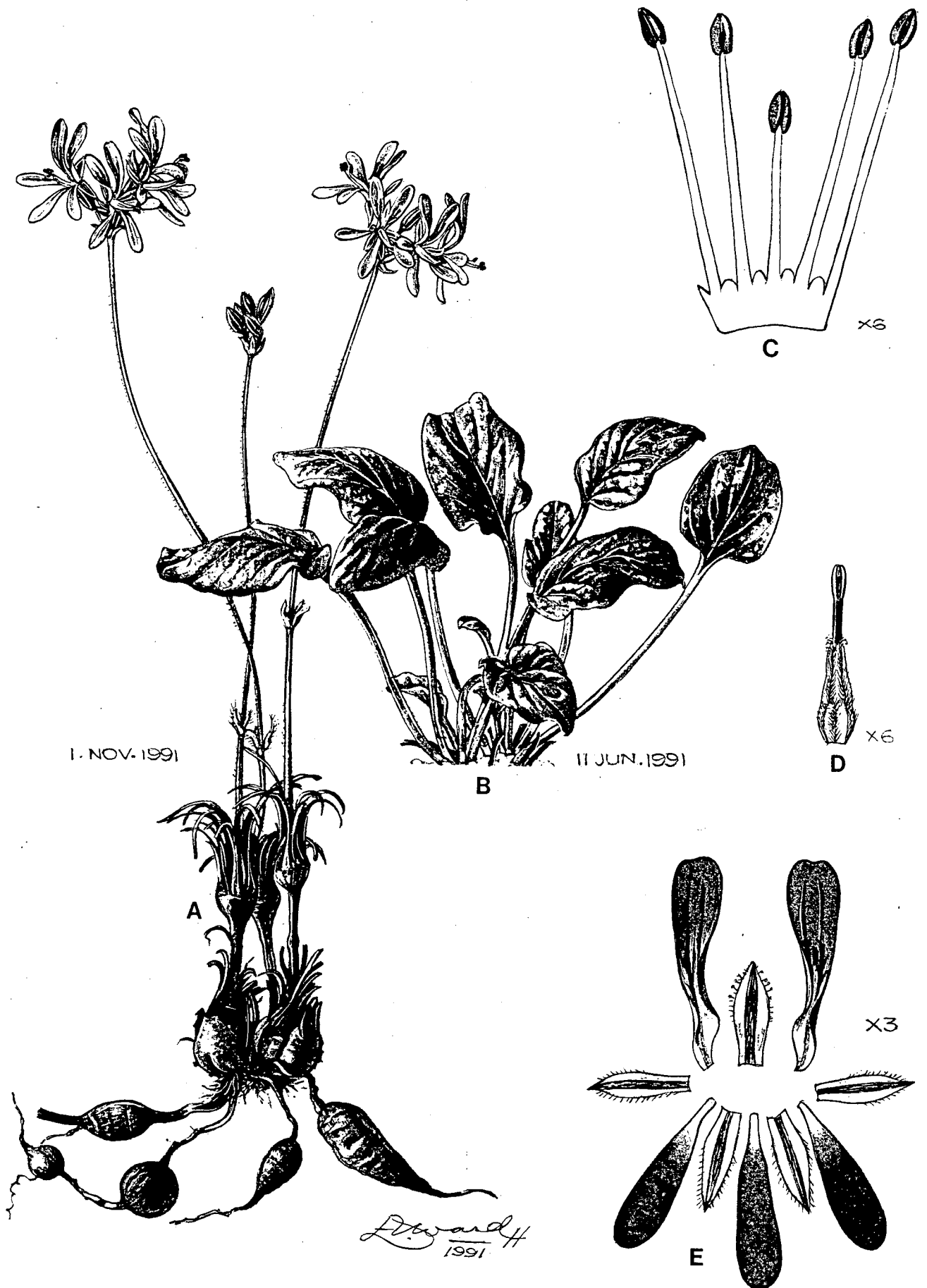


Figure 8.53.1 *Pelargonium triphyllum*. A, flowering plant x1; B, plant with leaves x1; C, androecium x6; D, gynoecium x6; E, petals and sepals x3.

TRIPHYLLUM GROUP

Geophytes with simple or trifoliate leaves. Scape branched, bearing 2--4 pseudo-umbellets with 3--10 flowers each. Hypanthium short, 7--19 mm long. Flowers with pale pink or bright pink, ligulate petals; claws of the posterior two petals are auriculate. Stamens 5, more or less of the same length, much longer than the sepals, protrude from the flower; staminal column smooth. Tectum of pollen striate-reticulate.

8.53 *Pelargonium triphyllum* Jacq., Collectanea 4: 199 (1791b); Jacq.: 9, t. 515 (1792); Willd.: 647 (1800); Pers.: 227 (1806); DC.: 651 (1824); Spreng.: 52 (1826); Loudon: 568 (1829); G. Don: 726 (1831); Loudon: 271 (1832); Steud.: 290 (1841); Harv.: 266 (1860); Knuth: 336 (1912). TYPE - "Ex Promontorio bonae Spei" (W, holotype!).

Geranium triphyllum (Jacq.) Poir.: 746 (1812).

Hoarea triphylla (Jacq.) Sweet: 76 (1826c).

Geranospermum triphyllum (Jacq.) Kuntze: 95 (1891).

A geophyte 70--170 mm tall when in flower. **Tuber:** a turnip-shaped or elongated, sometimes moniliform root with several stem-growing points, 10--35(-60) mm long and 5--30 mm in diameter. **Leaves** simple or compound with 2 or more lateral pinnae at the base of the laminae, green, petiolate; lamina (or median pinna) ovate or widely ovate, base cuneate or truncate, apex obtuse or rounded, margin entire, 10--30(-40) x 5--20(-35) mm; small lateral pinnae ovate, 4--9 x 4--6 mm, adaxially and abaxially sparsely hirsute with long appressed hairs interspersed with short glandular hairs, margins ciliate; petiole 10--50 mm long and 0,5--1 mm in diameter, prostrate to erecto-patent, hirsute with appressed curly hairs interspersed with long and short glandular hairs and sometimes long stiff non-glandular hairs; stipules subulate, adnate to the petioles for two thirds to almost their total length, 5--12 mm long and 1--2 mm wide, ciliate. **Inflorescence:** scape 20--60(-100) mm long, 1--2 mm in diameter, branched, bearing 2--4 pseudo-umbellets with 3--10 flowers each; peduncles 20--75(-90) mm long, 0,5--1 mm in diameter, hirsute with appressed curly hairs interspersed with long and short glandular hairs; bracts lanceolate, 2,5--4 mm long, 1--2 mm wide, abaxially hirsute with appressed hairs interspersed with glandular hairs. **Pedicel** ca. 0,5 mm long. **Hypanthium** 7--19 mm long, reddish brown, densely hirsute with appressed curly hairs interspersed with long glandular hairs. **Sepals** 5, lanceolate, apices acute, 6--8 mm long, 1,5--2 mm wide, recurved, reddish brown with white or pink margins, indumentum as on hypanthium. **Petals** 5, pale pink to bright pink, apices recurved during anthesis; posterior two with

wine-red feather-like markings or a single blotch in the centre, ligulate, claws white or pale pink, auriculate, 4--6 mm long, apices rounded, truncate or emarginate, 10,5--15 x 2--4 mm; anterior three unguiculate-spathulate, claws filiform, 2--3,5 mm long, apices rounded, 7,5--13 x 1,5--3 mm. **Stamens:** staminal column 1--3 mm long, white, smooth; perfect stamens 5, protrude from the flower, remaining straight during anthesis, posterior one 7--10 mm long, lateral two 7,5--10,5 mm long, anterior two 8--11 mm long, pink to wine-red; staminodes 1,2--3 mm long; anthers wine-red, 1,5--2 mm long, pollen orange. **Gynoecium:** ovary 3--5 mm long; style 2--5 mm long, with glandular and non-glandular hairs, wine-red; stigma branches 1--2,5 mm long, wine-red. **Fruit:** bases of mericarps 4--6 mm long, with glandular hairs, tails 17--30 mm long. (Figure 8.53.1).

Diagnostic features and affinities

P. triphyllum is a small geophyte with simple or three-parted to many-parted leaves. The specific epithet *triphyllum* refers to the sometimes three-parted laminae. The colour of the small flowers varies from pink to a striking bright pink and the claws of the posterior petals are auriculate. Another outstanding feature of this species is the long protruding stamens, with the stamens always longer than the sepals. This is similar to what is the case of the *Auratum* type of flower, although in *P. auratum* the staminal column is papillate, whereas in *P. triphyllum* the staminal column is smooth.

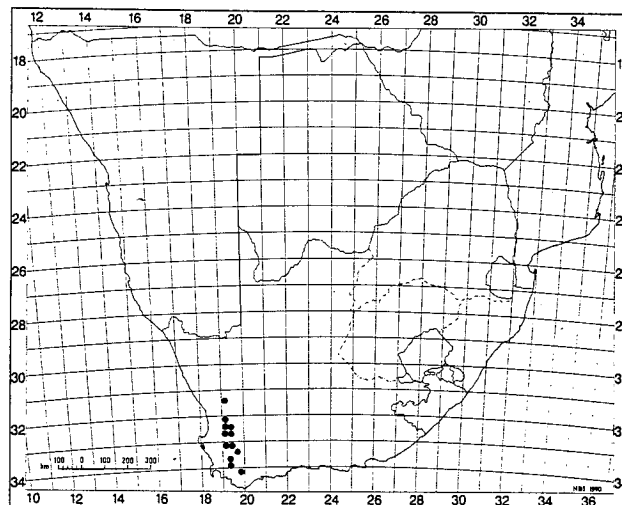


Figure 8.53.2 Geographical distribution of *P. triphyllum*.

Geographical distribution and ecology

P. triphyllum occurs in mountain fynbos on the mountain slopes of the south-western escarpment from Nieuwoudtville in the north to Riviersonderend in the south (Figure 8.53.2), an area receiving an annual rainfall of 400--1000 mm mainly in winter. Plants grow in moist places in coarse or stony sand or on shale bands, usually in shallow soil. Locally plants are fairly frequent and flower from October to December. In most cases flowers appear after the leaves have died.

Material studied

--3119 (Calvinia): De Lande, Nieuwoudtville (-AC), *Von Willert s.n.* (STEU).

--3219 (Wuppertal): Krakadouw Peak (-AA), *Taylor 11953* (STE); Tafelberg, Cederberg (-AC), *Esterhuysen 14338* (BOL); Wolfberg, Cederberg (-AD), *Esterhuysen 18111* (BOL, K); *Esterhuysen 22451* (BOL); Elandskloof (-CA), *Compton 16769, 16772, 16773* (NBG); Sneeuberg, Cederberg (-CA), *Esterhuysen 18020* (BOL, K); Hexberg, Kouebokkeveld Mountains (-CA), *Esterhuysen 18478* (BOL); Top of Sneeuberg (-CA), *Leipoldt 472* (BOL); Sandfontein Peak, Cederberg (-CB), *Esterhuysen s.n.* (BOL).

--3319 (Worcester): Groot Winterhoek (-AA), *Esterhuysen 19775* (BOL, K); Slagboom, Agter-Witzenberg (-AB), *Cillié s.n.* (STEU); Gydouw (-AB), *Leipoldt 4005* (BOL); *Leipoldt 4006* (BOL, K); Lakenvlei (-BC), *Barker 1299* (NBG); Sonklip Peak, N of Matroosberg (-BC), *Esterhuysen 18742* (BOL); Bushmans Vlei, Botha's Halt (-CB), *Pica Survey 597* (PRE); Rooihogte, Villiersdorp (-CD), *Bayer 3172* (NBG); Villiersdorp (-CD), *Esterhuysen 4311* (BOL).

--3419 (Caledon): Riviersonderend (-BB), *Leipoldt s.n.* (Z).

CAROLI-HENRICI GROUP

Geophytes with simple or pinnately compound, irregularly bipinnatisect leaves. Scape and peduncles usually thick (3--5 mm in diameter), wine-red or brownish green. Scape branched, bearing 2--5 pseudo-umbellets with 6--30(-50) flowers each. Flowers white, cream-coloured or yellow. Stamens 2 or 4 fertile, longer than the sepals, and remaining straight during anthesis.



L. D. Dandy
9/1984

Figure 8.54.1 *Pelargonium githagineum*. A, flowering plant x1; B, androecium x3; C, gynoecium x3; D, petals x2.

8.54 Pelargonium githagineum *E.M. Marais*, sp. nov. in sectione *Hoarea*.

Herba perennis acaulescens tuberosa. **Tuber** subterraneum, napiforme vel oblongum, 35--40 mm longum, 20--40 mm in diam. **Folia** hysterantha, rosulata, viridia, petiolata; lamina elliptica, ovata vel triangulata, crenata, 20--70 mm longa, 10--65 mm lata, adaxiale pilosa et glandulosa, abaxiale velutina; petiolus 15--80 mm longus, prostratus, pilosus et glandulosus; stipulae petiolo adnatae. **Inflorescentia**: scapus pseudoumbellis 2--5, utraque 6--27 floribus; pedunculus githagineus. **Pedicellum** ca. 0,5 mm longum. **Hypanthium** 9--20 mm longum, githagineum, dense glandulosum. **Sepala** 5, lanceolata, githaginea, 6--8 mm longa, 1,5--3 mm lata, unum posterium erectum, cetera patentia. **Petala** 5, alba, dua postica ligulata vel spathulata, 8,5--10 mm longa, 2--3 mm lata, tria antica spathulata, 6,5--9 mm longa, 1,5--2,5 mm lata. **Stamina** fertilia 4, staminodia 6, petalis longiora.

TYPE - Cape Province: S of Sutherland, 3 km on the Ouberg turnoff, *Marais 243* (STE, holo; BOL, K, MO, NBG, PRE).

A deciduous geophyte with a regularly shaped subterranean tuber, 120--300 mm tall when in flower. **Tuber**: a turnip-shaped or elongated root with a short flattened stem, covered with flaking dark brown periderms, 35--40 mm long and 20--40 mm in diameter. **Leaves** radical, hysteranthous, rosulate, simple, green, petiolate; lamina elliptic, ovate or triangular, base cuneate to truncate, apex rounded, margin deeply crenate, 20--70 x 10--65 mm, adaxially pilose with patent hairs interspersed with very short glandular hairs, abaxially velutinous; petiole 15--80 mm long and 1,5--4 mm in diameter, prostrate, densely pilose with patent hairs interspersed with glandular hairs; stipules triangular to subulate, adnate to petioles for half their length, 7--15 mm long and 1,5--5 mm wide, ciliate. **Inflorescence**: scape 5--25 mm long, 3--5 mm in diameter, greenish red, branched, bearing 2--5 pseudo-umbellets with 6--27 flowers each; peduncles 65--260 mm long, 2--5 mm in diameter, greenish red, densely covered with glandular hairs interspersed with patent non-glandular hairs; bracts subulate, reclinate, 3--8 mm long, 1--2 mm wide, hirsute; flower buds, flowers and fruits erect. **Pedicel** 0,5--2 mm long. **Hypanthium** 9--20 mm long, greenish red, indumentum as on peduncle. **Sepals** 5, lanceolate, apices acute, 6--8 mm long, 1,5--3 mm wide, posterior one erect, others patent, greenish red with white margins, indumentum abaxially as on peduncle. **Petals** 5, white; posterior two ligulate to spathulate, 8--11 x 2--3 mm, bases cuneate, apices truncate to emarginate, recurved during anthesis; anterior three connivent, spathulate, bases attenuate, apices rounded, 6,5--9 x 1,5--2,5 mm. **Stamens** 10, basally connate, staminal column 1,5--3 mm long, white, smooth; perfect stamens 4, protruding from the flower, 9--12 mm long, free filaments wine-red; staminodes 3--6 mm long; anthers wine-red, ca. 2 mm long, pollen orange. **Gynoecium**: ovary superior, oblong-conical,

5-lobed, 3,5--6 mm long, densely sericeous; style filiform, 3--7,5 mm long, white; stigma with 5 recurved branches, 0,6--1,5 mm long, adaxially pink. **Fruit:** a schizocarp consisting of 5 mericarps, bases of mericarps 5--6 mm long, without glandular hairs, tails 28--35 mm long. (Figure 8.54.1).

Diagnostic features and affinities

P. githagineum is a geophyte with a dense mass of simple prostrate, pilose leaves and very small white flowers. The flowers have only four fertile stamens with long wine-red filaments. The small white flowers of *P. githagineum*, with the stamens longer than the petals, resemble those of *P. parvipetalum*. In *P. githagineum* however, the staminal column is smooth and the number of stamens four, whereas in *P. parvipetalum* the column is papillate and the number of stamens five. Although the flowers of *P. githagineum* are protandrous, closed stigma branches protrude from the flower buds. During anthesis the filaments lengthen more than the style and when the anthers open, the stigma branches are concealed in the androecium. Eventually, when the anthers are dropped, the stigma branches open to take the position previously occupied by the anthers.

The rosette growth form as well as the structure of the leaf resemble that of *P. punctatum*, *P. triandrum* and *P. curviandrum*. The flowers of these three species are much larger and of a different structure than those of *P. githagineum*.

The scape is very short and the scape and peduncles are very thick if compared with other species of section *Hoarea*. In this *P. githagineum* resembles *P. caroli-henrici*, another species with only four fertile stamens, but with no further resemblance in the floral structure. The specific epithet *githagineum* refers to the greenish red colour of the scape, peduncles and the hypanthia.

Geographical distribution and ecology

P. githagineum occurs on the Roggeveld plateau and around Matjiesfontein (Figure 8.54.2), an area with an annual rainfall of 100--200 mm during the winter months. Plants grow on sandstone ridges under bushes, and are locally abundant. It is an early flowering species of section *Hoarea* and flowers from September to October, before the leaves wither.

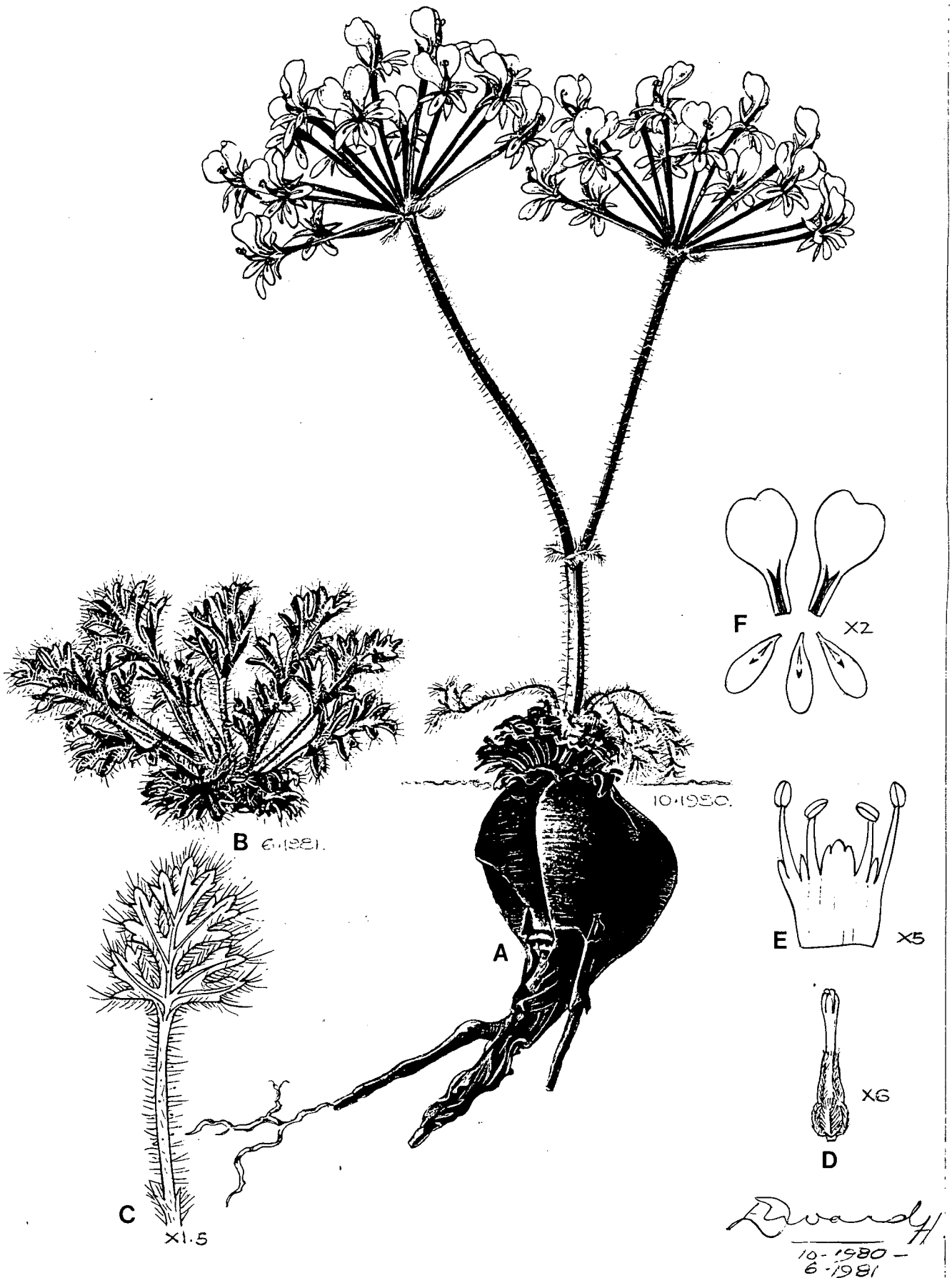


Figure 8.55.1 *Pelargonium caroli-henrici*. A, flowering plant x1; B, plant with leaves x1; C, leaf x1,5; D, gynoecium x6; E, androecium x5; F, petals x2.

Material studied

--3220 (Sutherland): S of Sutherland, 3 km on the Ouberg turnoff (-BC), *Marais 243* (BOL, K, MO, NBG, PRE, STE); Komsberg, farm De Kom (-DA), *Marais 143* (STEU).

--3320 (Montagu): Whitehill Ridge, Laingsburg (-BA), *Leighton 254* (BOL); 4 km from Matjiesfontein on Sutherland road (-BA), *Marais 211* (STEU).

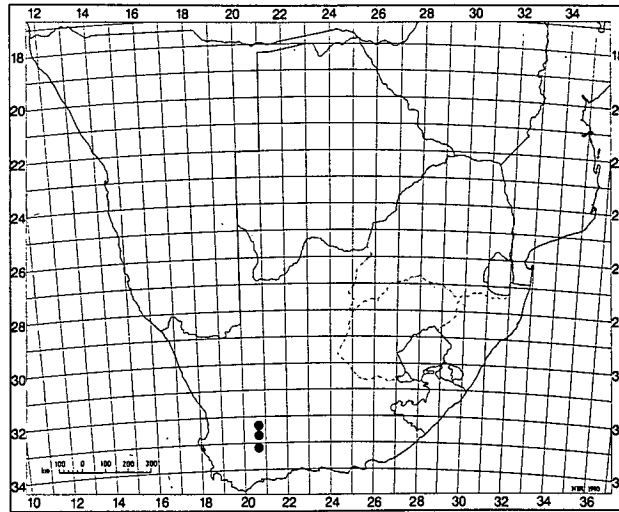


Figure 8.54.2 Geographical distribution of *P. githagineum*.

8.55 *Pelargonium caroli-henrici* B. Nord., *Plant Systematics and Evolution* 155: 333 (1987). TYPE - Cape Province: Koekenaap. *Nordenstam 2883a* (S, holo!).

A geophyte 110--250 mm tall when in flower. **Tuber:** a turnip-shaped root 30--60 mm long and 15--40 mm in diameter. **Leaves:** green, petiolate; lamina broadly ovate, base cuneate, 20--30(-50) x 20--40 mm, pinnately compound, irregularly pinnatilobed to bipinnatisect, densely pilose with white patent hairs interspersed with glandular hairs; pinnae 10--15 x 6--8 mm, apices obtuse; petiole 10--30(-50) mm long and 1--2 mm in diameter, erecto-patent, indumentum as on lamina; stipules subulate, adnate to petioles for almost their total length, *ca.* 10 mm long and *ca.* 1 mm wide, hirsute. **Inflorescence:** scape 10--40 mm long, 2--5 mm in diameter, branched, bearing 2--5 pseudo-umbellets with (10-)15--25(-50) flowers each; peduncles green to wine-red, 50--200 mm long, 2,5--4 mm in diameter, densely covered with glandular hairs interspersed with patent white hairs; bracts green, patent or reflexed, subulate, 3--8 mm long, 1--1,5 mm wide, abaxially hirsute interspersed with glandular hairs. **Pedice** *ca.* 0,5 mm long. **Hypanthium** 22--33 mm long, wine-red, covered with glandular hairs, sparsely

interspersed with patent non-glandular hairs. **Sepals** 5, lanceolate, apices acute, 4--6 mm long, 1--2,5 mm wide, patent, base wine-red and apex green, with white margins, hirsute, interspersed with glandular hairs. **Petals** 5, yellow to cream-coloured, patent during anthesis; posterior two unguiculate-spathulate to unguiculate-obcordate, cotyliform, claws dark red, cuneate, apices rounded or emarginate, 8--15 x 3--7 mm; anterior three with dark red blotches in the centre, spathulate to broadly spathulate, bases attenuate, apices rounded, 4,5--11 x 2--4 mm. **Stamens**: staminal column 2,5--4 mm long, pink, smooth; perfect stamens 4, protruding from the flower, lateral two 6--9 mm long, anterior two 6,5--9 mm long, free filaments wine-red, twisted so that pollen surfaces of the anthers are turned to the front; staminodes 3--5 mm long; anthers wine-red, *ca.* 1,5 mm long, pollen yellow. **Gynoecium**: ovary 2,5--4,5 mm long; style 1--4 mm long, wine-red; stigma branches 0,5--1 mm long, adaxially wine-red. **Fruit**: bases of mericarps 4--5 mm long, without glandular hairs, tails 25--28 mm long. (Figure 8.55.1).

Diagnostic features and affinities

P. caroli-henrici is a geophyte with pinnatilobed to bipinnatisect, densely pilose leaves and thick wine-red peduncles, bearing many-flowered (15--25 flowers) pompon-like pseudo-umbellets. The yellow or cream-coloured flowers have long (20--33 mm), wine-red hypanthia and only four fertile stamens. The free filaments are twisted so that pollen surfaces are turned to the front. This is in contrast with the majority of species of *Pelargonium* where the dehisced anthers are borne in such a way that the pollen-covered surfaces show backwards and could be touched by the abdomen of a visiting insect trying to get to the nectar in the hypanthium (Scott Elliot 1891). The petals are patent in a cup-shaped manner. The dark red claws of the posterior petals and the dark red blotches on the anterior ones together with the wine-red filaments form prominent nectar guide-lines in the centre of the cup-shaped flower.

P. caroli-henrici resembles *P. rubiginosum* in respect to the leaf structure, the indumentum and colour of the scape, the peduncles and the hypanthia, the colour and the markings of the petals and the form of the anterior petals. These two species differ from each other in respect to the form of the posterior petals, the number of the fertile stamens (two fertile stamens in *P. rubiginosum*), the structure of the androecium and the pattern of the tectum of the pollen grains. The two species occupy two separate, but adjacent distribution areas.

The thick wine-red peduncles and long hypanthia of *P. caroli-henrici* resemble those of *P. rubiginosum*, *P. moniliforme* and *P. vinaceum*. *P. githagineum* shows similar characteristics, but with much shorter hypanthia. The leaves of *P. caroli-henrici* and *P. rubiginosum* are pinnatilobed to bipinnatifid, whereas the others have simple or trifoliolate leaves.

P. caroli-henrici is named in honour of professor Karl Heinz Rechinger, a friend of B. Nordenstam, the author of this species.

Geographical distribution and ecology

P. caroli-henrici occurs on the lowland quartzite areas of the Knersvlakte, from the flats west of Garies in the north to Koekenaap in the south (Figure 8.55.2). This is a hot and arid area with an annual rainfall of 50--150 mm in winter. Populations are usually very small and single plants grow on flat areas with white quartzite pebbles and very short succulent vegetation. *P. caroli-henrici* flowers in October after the leaves have died.

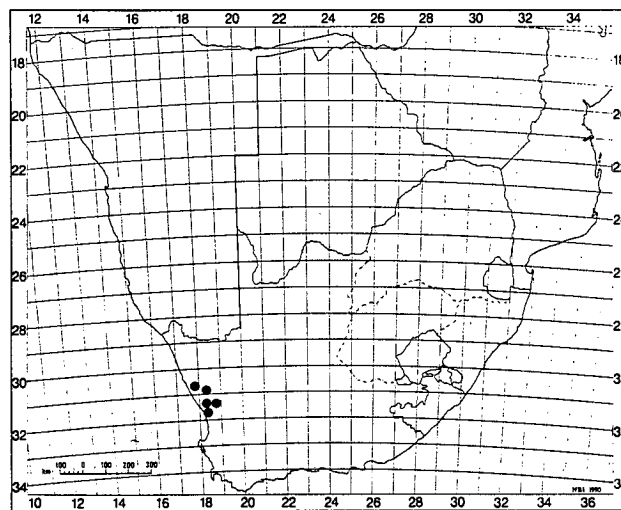


Figure 8.55.2 Geographical distribution of *P. caroli-henrici*.

Material studied

--3017 (Hondeklipbaai): Baievlei & Rooiberg, at Soutfontein turnoff (-DB), *Drijfhout 2708* (STEU).

--3018 (Kamiesberg): 6 km on Kliprand road, N of Bitterfontein (-CD), *Marais 281* (STEU); Kamagab, 10 km NE of Bitterfontein (-CD), *Nordenstam & Lundgren 1464* (S).

--3118 (Vanrhynsdorp): Groot Graafwater (-AD), *Hall 2460* (STEU); Groot Graafwater turnoff (-BC), *Bayer 2209* (NBG); N7 road, at Groot Graafwater turnoff (-BC), *Marais 130* (STEU); Knersvlakte, 8 km

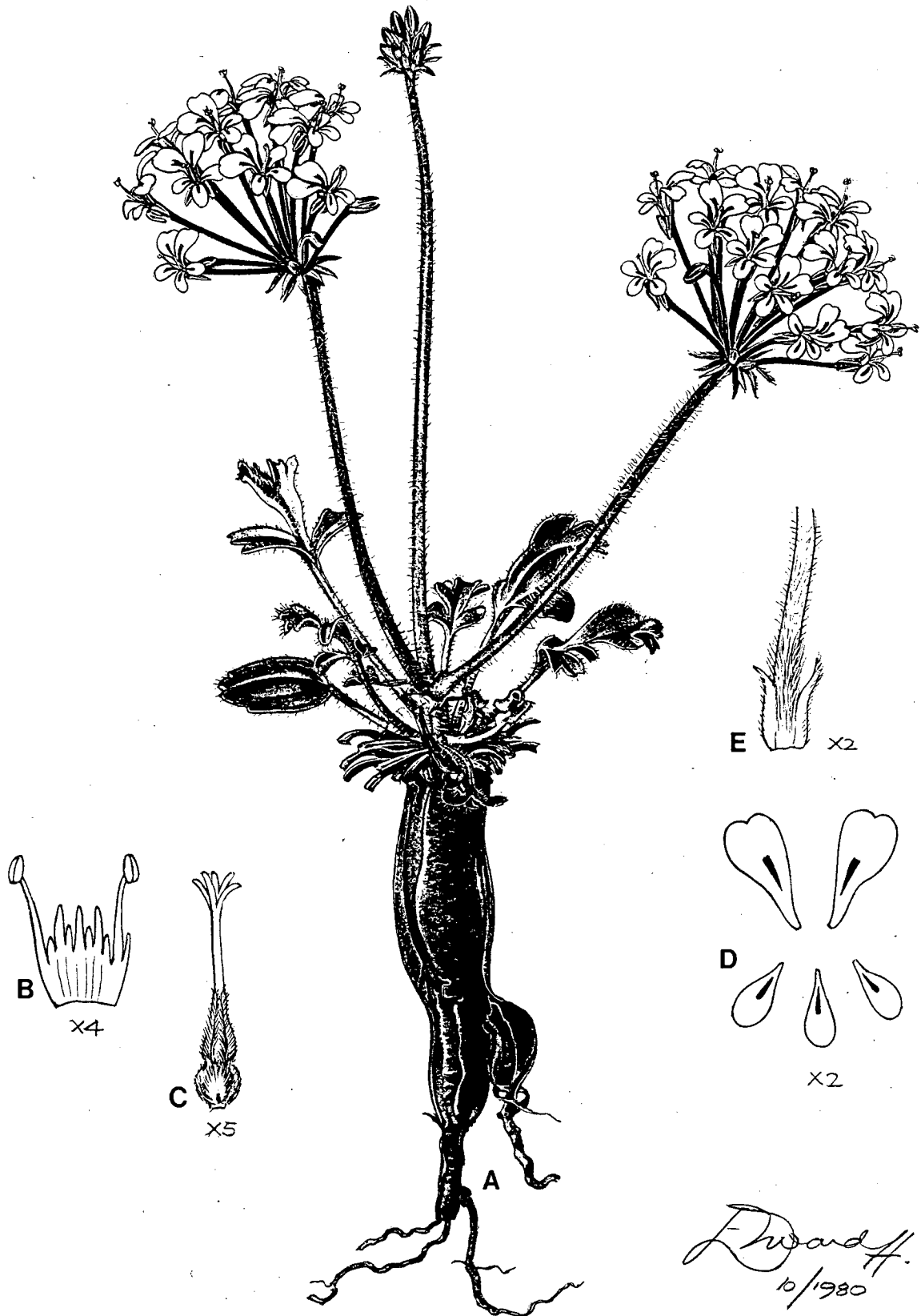


Figure 8.56.1 *Pelargonium rubiginosum*. A, flowering plant x1; B, androecium x4; C, gynoecium x5; D, petals x2; E, leaf base with stipules x2.

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E of Varsrivier bridge on N7 road (-BD), *Nordenstam & Lundgren 1944* (S); Moedverloor, 4 km N of Holrivier bridge (-CB), *Nordenstam 2950* (S); Koekenaap (-CB), *Nordenstam 2883a* (S); Koekenaap, 1 km E of the road (-CB), *Nordenstam & Lundgren 1679* (S).

8.56 *Pelargonium rubiginosum* E.M. Marais, sp. nov. in sectione *Hoarea*.

Herba perennis acaulescens tuberosa. **Tuber:** subterraneum, napiforme vel oblongum, 20--60 mm longum, 15--20 mm in diam. **Folia:** hysterantha, rosulata, petiolata; lamina ovata, irregulariter pinnatilobata vel bipinnatifida, 15--60 mm longa, 10--45 mm lata, viridia, dense albopilosa et glandulosa; petiolus 10--60 mm longus, erecto-patens, glandulosus et pilosus; stipulae petiolo adnae. **Inflorescentia:** scapus pseudumbellus 2--5, utraque 10--30 floribus; pedunculus rubiginosus. **Pedicellum** ca. 0,5 mm longum. **Hypanthium** 14--32 mm longum, rubiginosum, glandulosum et sparsim hirsutum. **Sepala** 5, lanceolata, 4,5--6 mm longa, 1--3 mm lata, reflexa. **Petala** 5, alba, cremea vel pallide flava, dua postica unguiculato-spathulata vel unguiculato-obcordata, 9--16 mm longa, 2,5--4,5 mm lata, tria antica spathulata, 5,5--13 mm longa, 1,5--4 mm lata. **Stamina:** fertilia 2, staminodia 8.

TYPUS - Cape Province: "Jenkinskop, 17 km N of Eksteenfontein, Richtersveld", *Van Jaarsveld 4100* (STE, holo., BOL, K, MO, NBG, PRE).

A deciduous geophyte with a small regularly shaped subterranean tuber, 70--200 mm tall when in flower. **Tuber:** a turnip-shaped or elongated root with a short flattened stem, covered with flaking dark brown periderms, 20--60 mm long and 15--20 mm in diameter. **Leaves** radical, hysteranthous, erecto-patent, green, petiolate; lamina broadly ovate, base cuneate, apex rounded, 15--60 x 10--45 mm, pinnately compound, irregularly pinnatilobed to bipinnatisect, densely pilose with white patent hairs interspersed with glandular hairs; segments linear, 5--10 mm long, 2--6 mm wide, apices obtuse; petiole 10--60 mm long and 1--3 mm in diameter, erecto-patent, indumentum as on lamina; stipules subulate, adnate to petioles for one third of their length, 3--7 mm long and ca. 1 mm wide, hirsute. **Inflorescence:** scape 10--30 mm long, 2--5 mm in diameter, branched, bearing 2--5 pseudo-umbellets with 10--30 flowers each; peduncles wine-red to brown-red, 30--170 mm long, 1--2,5 mm in diameter, pilose with glandular hairs interspersed; bracts green, erect, subulate, 3--6 mm long, 1 mm wide, abaxially hirsute; flower buds, flowers and fruits erect. **Pedicel** ca. 0,5 mm long, green. **Hypanthium** 14--32 mm long, wine-red to brown-red, covered with glandular hairs interspersed with non-glandular hairs. **Sepals** 5, lanceolate, apices acute, 4,5--6 mm long, 1--2 mm wide, reflexed, green, indumentum abaxially as on hypanthium. **Petals** 5, white, cream-coloured or yellow with red or crimson markings in the centre, patent during anthesis;

posterior two unguiculate-spathulate to unguiculate-obcordate, bases cuneate, apices rounded to emarginate, 9--16 x 2,5--4,5 mm; anterior three spathulate, bases attenuate, apices rounded, 5,5--13 x 1,5--4 mm. **Stamens** 10, basally connate, staminal column 1,5--3 mm long, white, smooth; perfect stamens 2 (anterior position), white, 5--9 mm long, protruding from the flower; staminodes 2--6,5 mm long; anthers pale pink, *ca.* 1 mm long, pollen yellow. **Gynoecium**: ovary superior, oblong-conical, 5-lobed, 2,5--4,5 mm long, densely sericeous interspersed with glandular hairs; style filiform, 1,5--4,5 mm long, pink; stigma with 5 branches, 0,5 mm long, pink. **Fruit**: a schizocarp consisting of 5 mericarps, bases of mericarps 4--5 mm long, without glandular hairs, tails 22--30 mm long. (Figure 8.56.1).

Diagnostic features and affinities

P. rubiginosum is a geophyte with pinnatilobed to bipinnatisect, densely pilose leaves and thick wine-red or brown-red peduncles, bearing many-flowered (10--30 flowers) pompon-like pseudo-umbellets. The white, yellow or cream-coloured flowers have long (14--33 mm), wine-red or brown-red hypanthia and only two fertile stamens. The specific epithet *rubiginosum* refers to the wine-red or brown-red peduncles and hypanthia.

The stigma branches are very short and not recurved as in most species of *Pelargonium*. In this *P. rubiginosum* resembles *P. punctatum* and *P. triandrum*, both species with a reduction in the number of fertile stamens, but with a different floral structure. The structure of the tectum of the pollen grains of these three species is identical.

P. rubiginosum resembles *P. fumariifolium* in that the flowers of both species have a very delicate appearance. In both cases the hypanthia are long, and both have only two fertile stamens, but the position of the fertile stamens differs. In *P. rubiginosum* the anterior two filaments bear anthers, and in *P. fumariifolium* the lateral ones do.

P. rubiginosum resembles *P. caroli-henrici* in respect of the leaf structure, the indumentum and colour of the scape, the peduncles and the hypanthia, the colour and the markings of the petals and the form of the anterior petals. However, these two species differ from each other in respect to the form of the posterior petals, the number of fertile stamens (four fertile stamens in *P. caroli-henrici*) as well as the structure of the androecium. The two species occupy separate distribution areas. *P. rubiginosum* occurs north of the 30° latitude and *P. caroli-henrici* occurs south of the same latitude.

Geographical distribution and ecology

P. rubiginosum occurs in the Richtersveld, from Khubus in the north to Eksteenfontein in the south. It was also collected on the foothills of the Kourkamma Mountains south of Komaggas (Figure 8.56.2). This area receives a scant rainfall of less than 100 mm per annum, occurring during the winter months only. *P. rubiginosum* occurs on granite, in coarse sand or quartzite and plants are found in rock crevices at high elevations or on foothills in direct sunlight or light shade. The plants are usually locally abundant. *P. rubiginosum* flowers from October to November. Herbarium specimens collected in the field do not have leaves and flowers together, but in the garden there are still leaves present at flowering time.

Material studied

--2816 (Oranjemund): S of Khubus (-BD), *Nordenstam 1775* (S, STE); Doornpoort (-DB), *Hall NBG706/53* (NBG).

--2817 (Vioolsdrif): Jenkioskop (-CB), *Van Jaarsveld 4100* (BOL, K, MO, NBG, PRE, STE); 2 miles NE of Eksteenfontein (-CD), *Nordenstam 1839* (S, STE).

--2917 (Springbok): Kourkamma Mountain (-CD), *Drijfhout 2811* (STEU); *Van Jaarsveld s.n.* (STEU).

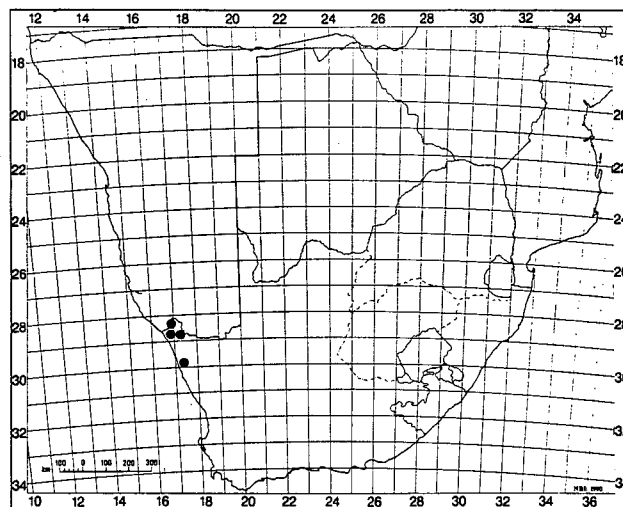


Figure 8.56.2 Geographical distribution of *P. rubiginosum*.

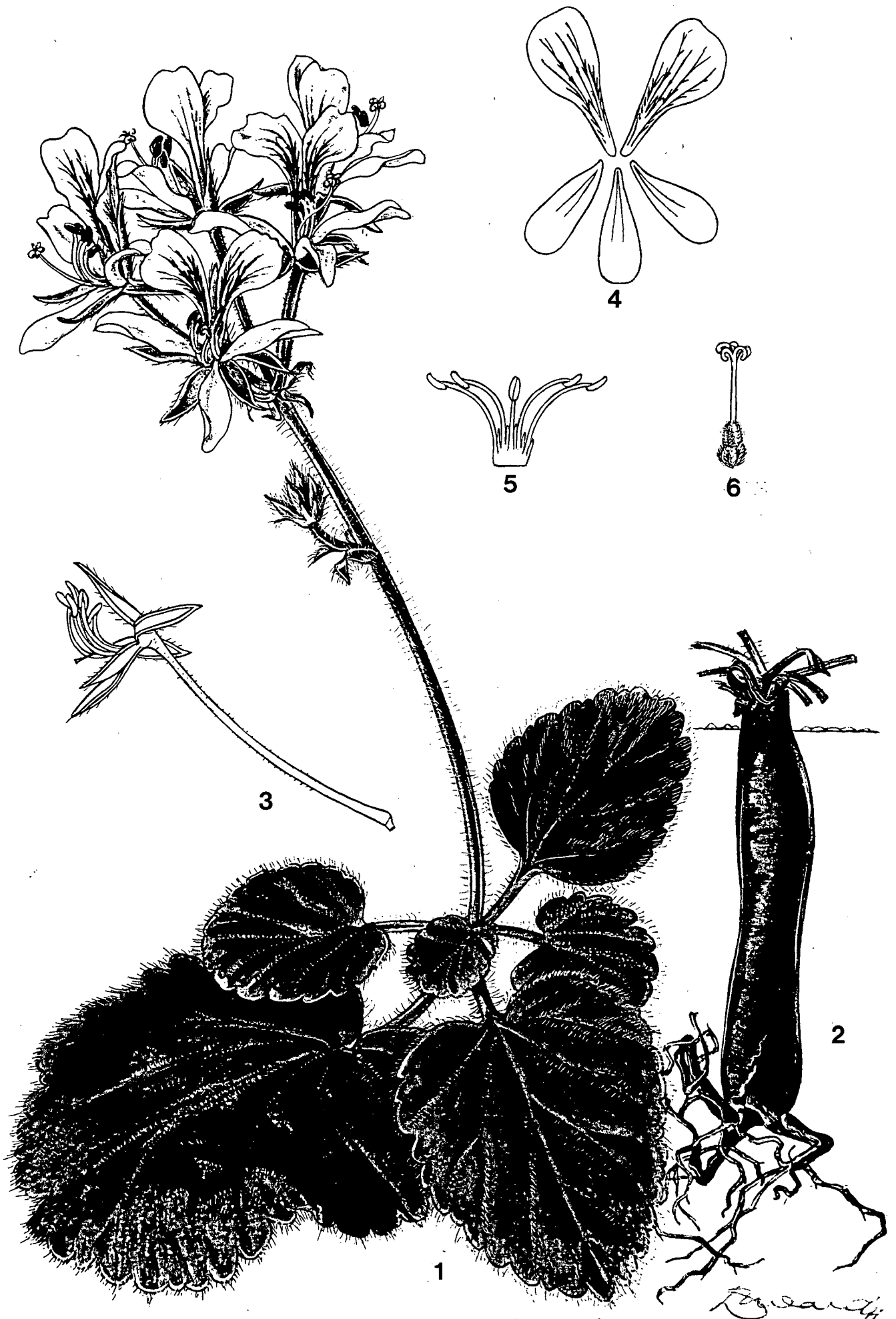


Figure 8.57.1 *Pelargonium oblongatum*. 1, flowering plant x1; 2, tuber x1; 3, flower without petals x1; 4, petals x1; 5, androecium x1; 6, gynoecium x1,5.

PUNCTATUM GROUP

Geophytes with simple prostrate leaves. Scape branched, bearing 2--8 pseudo-umbellets with 4--45(-60) flowers each. Flowers cream-coloured or yellow. Stamens 2, 3, 4 or 5 fertile, very long and protrude from the flower, curved upwards during anthesis.

8.57 *Pelargonium oblongatum* Harv. in Flora Capensis 1: 263 (1860); Hooker: t. 5996 (1872); Knuth: 329 (1912); Van der Walt: 29, fig. (1977). TYPE - Cape Province: Kaus Mountain, near Kookfontein, Namaqualand, *Drège s.n. sub. P. oblongatum* (TCD, lecto!, designated here, E!, Gx2!, K!, L!, MEL!, MO!, OXF!, P!, S!, W!).

Geranospermum oblongatum (Harv.) Kuntze: 95 (1891).

A geophyte 160--300 mm tall when in flower. **Tuber:** an oblong or turnip-shaped root 30--150 mm long and 20--30 mm in diameter. **Leaves** bright green, petiolate; lamina simple, ovate or orbicular, base cordate or truncate, apex obtuse or rounded, margin irregularly dentate, 25--110 x 20--105 mm, adaxially covered with long and short glandular hairs, abaxially densely covered with short soft patent hairs interspersed with glandular hairs, margins ciliate; petiole 10--70(-100) mm long and 2--3(-6) mm in diameter, prostrate, covered with long glandular hairs; stipules triangular, adnate to the petioles for half or more than half their length, 5--25 mm long and 2--5 mm wide, ciliate, apices laterally curved. **Inflorescence:** scape 10--180 mm long, 2--5 mm in diameter, branched, bearing 2--5(-7) pseudo-umbellets with 4--8(-24) flowers each; peduncles 10--70 mm long, 1,5--2,5 mm in diameter, covered with glandular hairs, sparsely interspersed with long soft patent hairs; bracts lanceolate, 8--10 mm long, 3--5 mm wide, reflexed, abaxially hirsute with patent hairs. **Pedicel** ca. 0,5 mm long. **Hypanthium** 33--68 mm long, green, densely covered with glandular hairs interspersed with long stiff patent hairs. **Sepals** 5, lanceolate, apices attenuate, 13--20 mm long, 2--5 mm wide, posterior one erect, others patent, green, indumentum as on peduncle. **Petals** 5, pale yellow or cream-coloured, patent during anthesis with apices recurved; posterior two with wine-red feather-like markings, unguiculate-obovate to widely unguiculate-obovate, bases cuneate, apices truncate or emarginate, 22--35 x 7,5--15 mm; anterior three widely spatulate, bases narrowly cuneate, apices rounded, 15--28 x 5--10 mm. **Stamens:** staminal column 2--4 mm long, white; perfect stamens 5, protruding from the flower, bending upwards, posterior one 8--20 mm long, lateral two 14,5--25 mm long, anterior two 17--31 mm long, white; staminodes 4--6 mm long; anthers wine-red, 3--4 mm long, pollen orange. **Gynoecium:** ovary 3,5--8 mm long; style 6--14 mm long,

white or pale green; stigma branches 1,2--2,5 mm long, adaxially pink. **Fruit:** bases of mericarps 6--7 mm long, with prominent glandular hairs, tails *ca.* 30 mm long. (Figure 8.57.1).

Diagnostic features and affinities

P. oblongatum is a very attractive species with bright green simple leaves and very large pale yellow or cream-coloured flowers. The specific epithet *oblongatum* refers to the sometimes oblong tuber. The indumentum on the scape, peduncle and hypanthia are very similar to that of *P. carneum* and *P. radiatum*, both species with also very large flowers. However, the stamens of the latter two species are borne straight during anthesis, whereas those of *P. oblongatum* are bending upwards. Similar long curved stamens are also present in *P. punctatum*, *P. triandrum* and *P. curviandrum*. These three species have also simple prostrate leaves like *P. oblongatum*, but the petals of *P. punctatum*, *P. triandrum* and *P. curviandrum* are very narrow (posterior ones 2--5,5 mm wide), whereas those of *P. oblongatum* are wide (posterior ones 7,5--15 mm wide).

Geographical distribution and ecology

P. oblongatum is restricted to Namaqualand and the Richtersveld and occurs from Stinkfontein Mountain in the north to the Kamiesberg in the south (Figure 8.57.2). This is a very hot and arid area with a scant annual rainfall of less than 200 mm occurring mainly in winter. *P. oblongatum* flowers in October and November after the leaves have died.

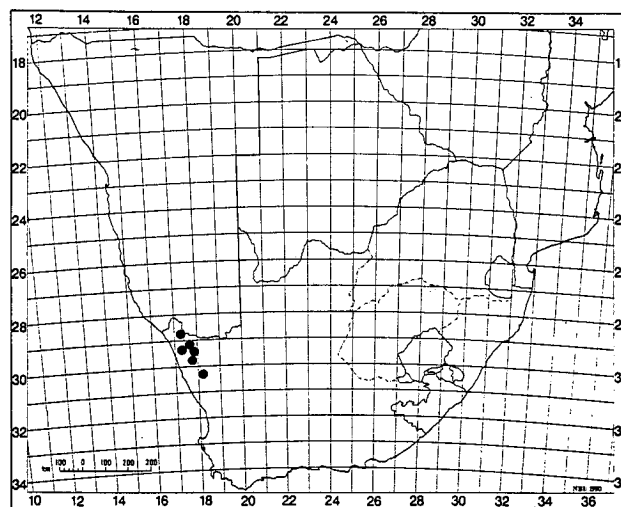


Figure 8.57.2 Geographical distribution of *P. oblongatum*.

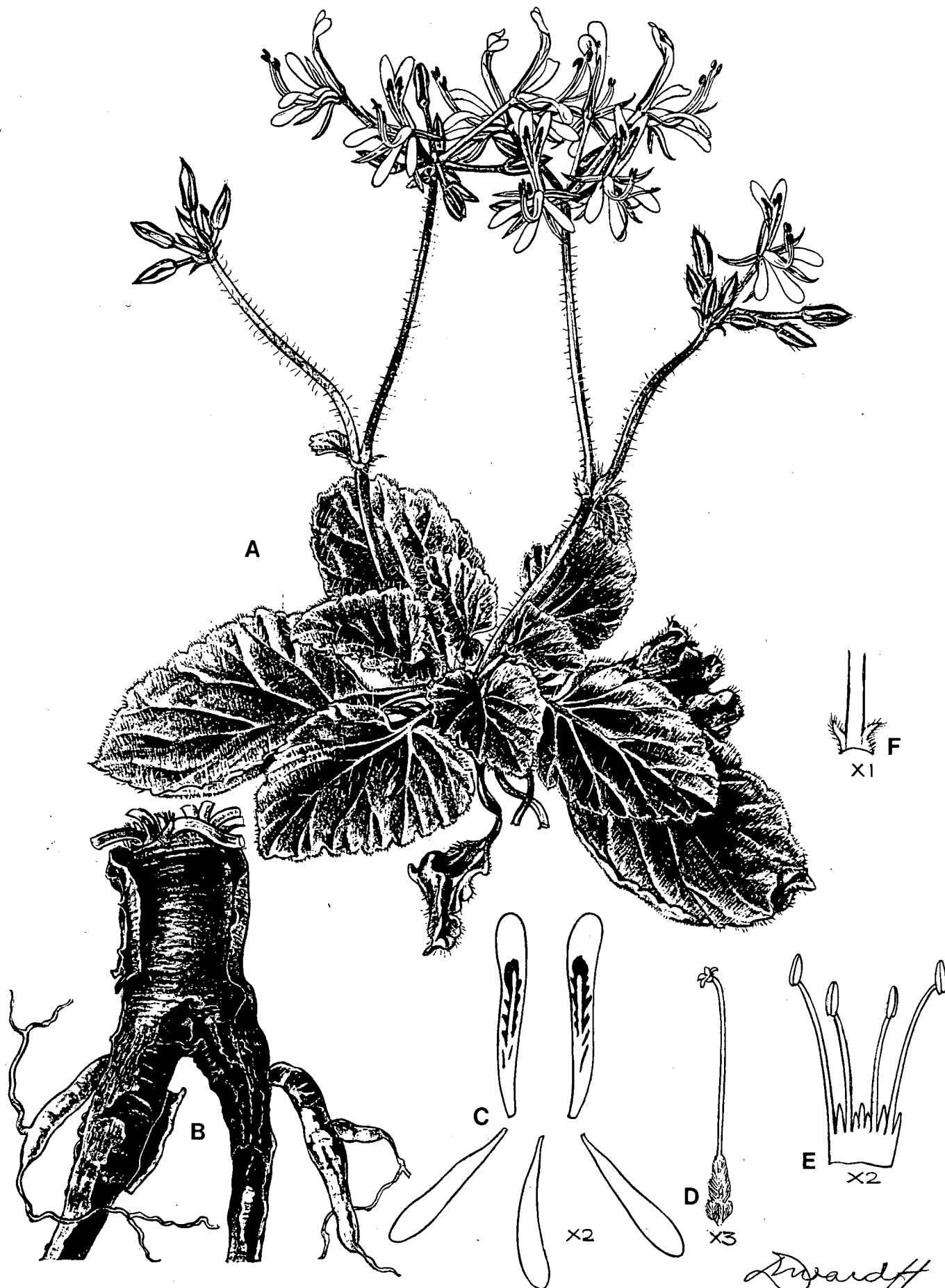


Figure 8.58.1 *Pelargonium curviandrum*. A, flowering plant x1; B, tuber x1; C, petals x2; D, gynoecium x3; E, androecium x2; F, leaf base with stipules x1.

Material studied

--2817 (Vioolsdrif): Stinkfontein Mountain (-CA), *Herre s.n.* (BOL); Stinkfontein Mountain, above Eksteenfontein (-CD), *Williamson 4463* (STEU).

--2917 (Springbok): Kaus Mountain, near Kookfontein (-AD), *Drège 3237* (P); *Drège s.n. sub P. oblongatum* (E, Gx2, K, L, MEL, MO, OXF, P, S, TCD, W); Rabas, near Steinkopf (-BA), *Compton s.n.* (NBG); Aninaus Pass, 9 km W of Steinkopf (-BA), *Nordenstam 1593* (S); Ratelpoort (-BD), *Hall s.n.* (NBG); Okiep (-DB), *Pillans s.n.* (K); Klein Komaggas (-DC), *Herre s.n.* (BOL); Komaggas (-DC), *Herre s.n.* (BOL).

--3018 (Kamiesberg): Studer's Pass (-AC), *Van der Walt s.n.* (STEU).

8.58 *Pelargonium curviandrum* E.M. Marais, sp. nov. in sectione *Hoarea*, *P. punctato* affine.

Herba perennis acaulescens tuberosa. **Tuber** subterraneum, napiforme vel oblongum, 15--50 mm longum, 12--25 mm in diam. **Folia** hysterantha, rosulata, viridia, petiolata; lamina ovata, crenata, 25--80 mm longa, 20--60 mm lata, adaxiale glandulosa et pilosa, abaxiale velutina et glandulosa; petiolus 10--55 mm longus, prostratus, glandulosus et pilosus; stipulae petiolo adnatae, ciliatae. **Inflorescentia**: scapus pseudumbellis 2--4(-6), utraque 7--23(-29) floribus. **Pedicellum** ca. 0,5 mm longum. **Hypanthium** 18--30 mm longum, sparsim breveque glandulosum et hirsutum. **Sepala** 5, lanceolata, 7--12 mm longa, 1,5--3 mm lata, patentia. **Petala** 5, alba, dua postica ligulata, 17--23 mm longa, 2,5--3 mm lata, subtiliter carmineo-rubra, tria antica anguste spathulata, 12--15 mm longa, 2,5--3 mm lata. **Stamina** fertilia 4, dua anterioria 13--20 mm long sursum curvata, staminodia 6.

TYPE - Cape Province: 12 km E of Vanwyksdorp, *Lavranos 20941* (STE, holo, BOL, K, MO, NBG, PRE).

A deciduous geophyte with a small regularly shaped subterranean tuber, 100--300 mm tall when in flower. **Tuber**: a turnip-shaped or elongated root with a short flattened stem, covered with flaking dark brown periderms, 15--50 mm long and 12--25 mm in diameter. **Leaves** radical, hysteranthous, rosulate, simple, green, petiolate; lamina ovate, apex obtuse, base cuneate to truncate, margin crenate, 25--80 x 20--60 mm, adaxially covered with long glandular hairs interspersed with very long soft patent non-glandular hairs, abaxially velutinous interspersed with long glandular hairs; petiole 10--55 mm long and 2--4 mm in diameter, prostrate, covered with short glandular hairs and long soft patent non-glandular hairs; stipules subulate, adnate to petioles for half of their

length, 4--8 mm long and 1--2 mm wide, ciliate, apices laterally curved. **Inflorescence:** scape 30--200 mm long, 1--3 mm in diameter, branched, bearing 2--4(-6) pseudo-umbellets with 7--23(-29) flowers each; peduncles 50--120 mm long, 1--2 mm in diameter, covered with short glandular hairs interspersed with long soft patent non-glandular hairs; bracts narrowly triangular, 4--5 mm long, 1--1,5 mm wide, hirsute; flower buds, flowers and fruits erect. **Pedicel** ca. 0,5 mm long. **Hypanthium** 18--30 mm long, reddish brown, sparsely covered with short glandular hairs and non-glandular hairs. **Sepals** 5, lanceolate, apices acute, 7--12 mm long, 1,5--3 mm wide, patent, reddish brown with white margins, indumentum abaxially as on peduncle. **Petals** 5, white to cream-coloured, patent during anthesis; posterior two with wine-red feather-like markings, ligulate, bases cuneate, apices rounded, 17--23 x 2,5--3 mm; anterior three narrowly spatulate, bases attenuate, apices rounded, 12--15 x 2,5--3 mm. **Stamens** 10, basally connate, staminal column 1,5--3,5 mm long, white, smooth; perfect stamens 4, lateral two 11--18 mm long, anterior two 13--20 mm long, protruding from the flower, curved upwards during anthesis, white; staminodes 2,5--6 mm long; anthers wine-red, 2--2,5 mm long, pollen orange. **Gynoecium** lengthens conspicuously during anthesis; ovary superior, oblong-conical, 5-lobed, 3,5--5,5 mm long, densely sericeous; style filiform, 6--12 mm long, white; stigma with 5 branches, 0,5--1 mm long, adaxially pink. **Fruit:** a schizocarp consisting of 5 mericarps, bases of mericarps 5--6 mm long, with glandular hairs, tails 22--25 mm long. (Figure 8.58.1).

Diagnostic features and affinities

P. curviandrum is a geophyte with simple prostrate leaves, with the older leaves bigger than the younger ones. The long and narrow ligulate petals are white to cream-coloured and as a result of the orientation of the two posterior petals the feather-like markings on them appear as a unit.

P. curviandrum has four fertile stamens which are nearly twice the length of the sepals and protrude from the flower. The flower is protandrous and the stamens are initially bent upwards during anthesis, hence the specific epithet *curviandrum*. After some time the anthers are dropped and the filaments bend downwards. At the same time the gynoecium lengthens and the stigma finally takes the original position of the anthers, a situation which indicates the involvement of a special pollinator.

P. curviandrum seems to be related to *P. punctatum* and *P. triandrum*. All of them have simple rosulate leaves and a similar floral structure. The petals of all three species are long and narrow with feather-like markings on the posterior two. All three of them have

very long protruding stamens, long styles and very short stigma branches. *P. curviandrum* has ten filaments and four fertile stamens, a structure that fits in with the androecium of the genus. Both *P. punctatum* and *P. triandrum* have a reduced number of filaments with only two fertile stamens in *P. punctatum* or three fertile stamens in *P. triandrum*. The tectum pattern of the pollen grains of *P. curviandrum* is striate-reticulate and differs from that of *P. punctatum* and *P. triandrum* which is striate.

P. punctatum and *P. triandrum* sometimes show a reduction in the number of carpels also, and can have a four- or a five-lobed ovary. *P. curviandrum* always has a five-lobed ovary.

Geographical distribution and ecology

P. curviandrum occurs in the southern Cape on the mountain ranges between the 33^o and 34^o latitudes, from Montagu in the west to Oudtshoorn in the east (Figure 8.58.2), an area with an annual rainfall of 100–200 mm. It grows in mountain fynbos or in spekboomveld and usually occurs in very small populations. The peak of the flowering time is from October to November.

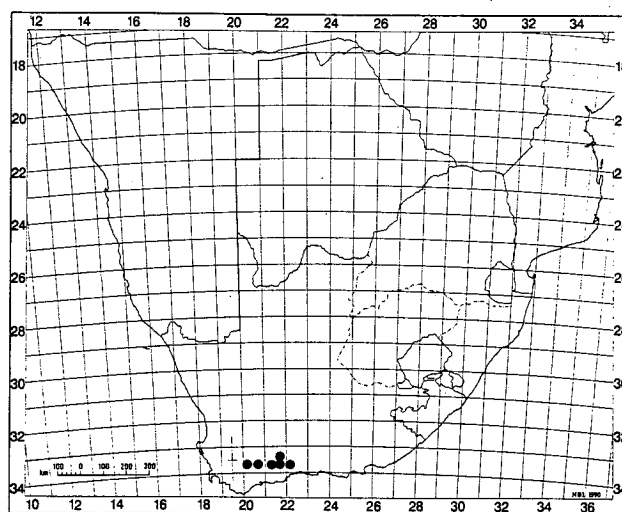


Figure 8.58.2 Geographical distribution of *P. curviandrum*.

Material studied

–3320 (Montagu): 8 km N of Montagu (-CA), Hall 2117 (NBG); Joubertskop (-DA), Van Jaarsveld 10324 (STEU).

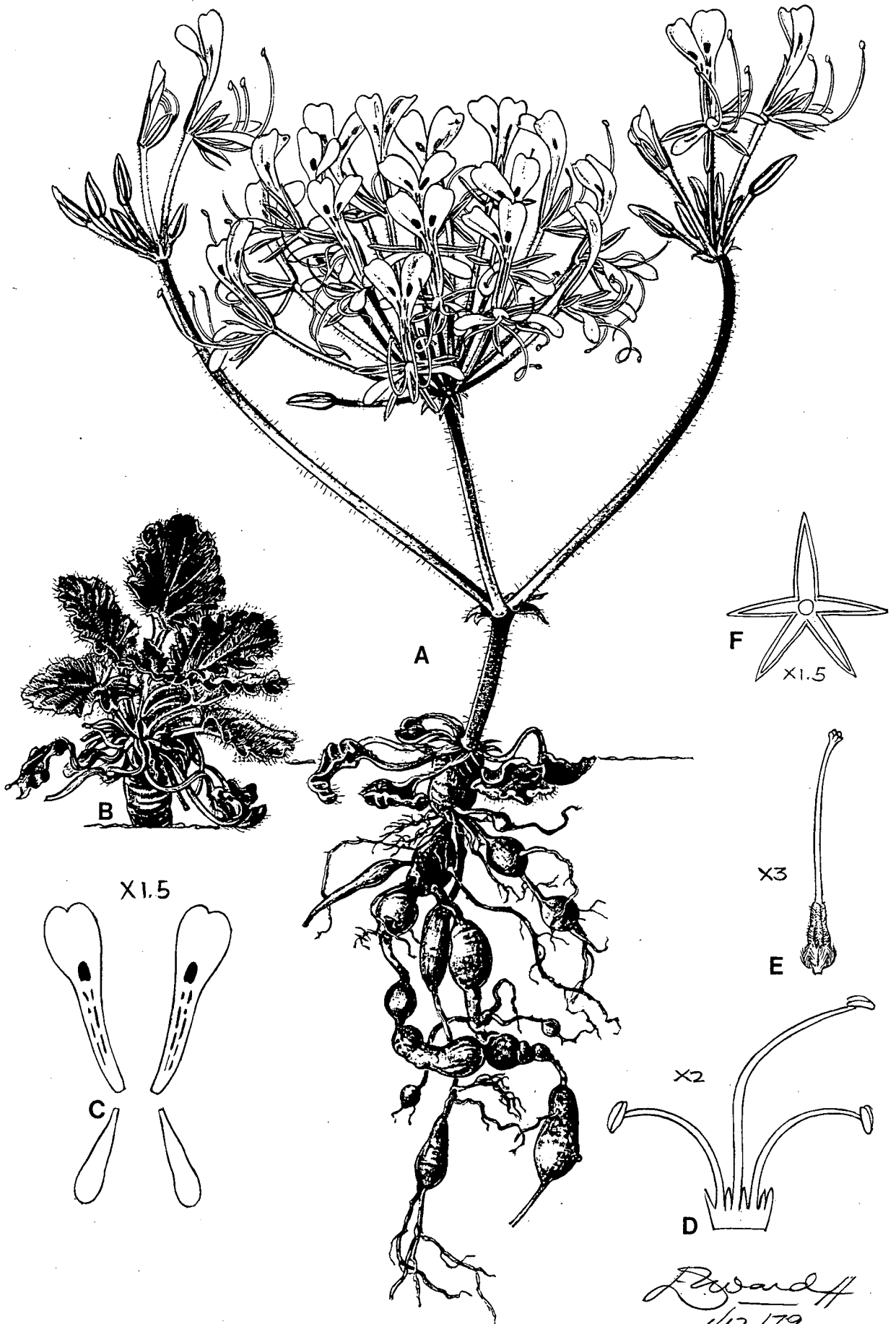


Figure 8.59.1 *Pelargonium triandrum*. A, flowering plant x1; B, plant with leaves x1; C, petals x1,5; D, androecium x2; E, gynoecium x3; F, sepals x1,5.

--3321 (Ladismith): Huisrivier Pass, Matjiesvlei turnoff (-BC), *Marais 168* (STEU); Roodeberg, Ladismith (-CB), *Compton 3864* (BOL); 12 km E of Vanwyksdorp (-DA), *Lavranos 20941* (BOL, K, MO, NBG, PRE, STE).

--3322 (Oudtshoorn): Bakenskraal, 12 km S of Oudtshoorn (-CA), *Barker 65* (BOL, K).

8.59 *Pelargonium triandrum* E.M. Marais, sp. nov. in sectione *Hoarea* distincta propter stamina fertilia solum tria, *P. punctato* affine.

Herba perennis acaulescens tuberosa. **Tuber** subterraneum, napiforme, interdum moniliforme, 20--60 mm longum, 10--15 mm in diam. **Folia** hysteroantha, rosulata, viridia, petiolata; lamina ovata, crenata, 15--75 mm longa, 15--65 mm lata, adaxiale et abaxiale pilosa et glandulosa; petiolus 14--80 mm longus, prostratus, pilosus et glandulosus; stipulae petiolo adnatae. **Inflorescentia**: scapus pseudoumbellus 2--4(-7), utraque 7--26(-30) floribus. **Pedicellum** ca. 0,5 mm longum. **Hypanthium** 23--32 mm longum, glandulosum et sparsim hirsutum. **Sepala** 5, lanceolata, 7--11 mm longa, 1--3 mm lata, unum posterium erectum, cetera patentia. **Petala** 4, cremea vel pallida flava, dua postica ligulata vel unguiculata spathulata, subtiliter carmineo rubra, 19--25 mm longa, 3--5,5 mm lata, tria antica anguste spathulata, 9,5--17 mm longa, 2--3 mm lata. **Stamina** fertilia 3, unicum anterium 20--32 mm longum, staminodia 5.

TYPE - Cape Province: 27 km N of Citrusdal on old road to Clanwilliam, at turnoff to Algeria Forestry Station, *Van der Walt & Vorster 1276* (STE, holo, BOL, K, MO, NBG, PRE).

A deciduous geophyte with a small regularly shaped subterranean tuber, 100--200 mm tall when in flower. **Tuber**: a turnip-shaped or elongated, sometimes moniliform root with a short flattened stem, covered with flaking dark brown periderms, 20--60 mm long and 10--15 mm in diameter. **Leaves** radical, hysteroanthous, rosulate, simple, green, petiolate; lamina broadly ovate, apex rounded or obtuse, base cuneate, truncate or cordate, margin irregularly crenate, 15--50 x 15--65 mm, adaxially and abaxially densely pilose and densely covered with glandular hairs; petiole 14--80 mm long and 1--4 mm in diameter, prostrate, densely pilose interspersed with glandular hairs; stipules subulate, adnate to petioles for half their length, 10--14 mm long and 1--2 mm wide, ciliate, apices laterally curved. **Inflorescence**: scape 20--90 mm long, 2--4 mm in diameter, branched, bearing 2--4(-7) pseudo-umbellets with 7--26(-30) flowers each; peduncles 30--90 mm long, 1,5--2 mm in diameter, covered with glandular hairs interspersed with patent non-glandular hairs; bracts lanceolate, 5--7 mm long, 1--2 mm wide, abaxially hirsute; flower buds, flowers and fruits erect. **Pedicel** ca. 0,5 mm long. **Hypanthium** 23--32 mm long, straw-coloured to pale reddish brown, indumentum as on peduncle. **Sepals** 5,

lanceolate, apices acute, 7--11 mm long, 1--3 mm wide, posterior one erect, others patent, pale reddish brown with margins white, indumentum abaxially as on peduncle. **Petals** 4, cream-coloured to pale yellow, patent during anthesis; posterior two with wine-red feather-like markings, ligulate to unguiculate-spathulate, bases cuneate, apices emarginate, 19--25 x 3--5,5 mm; anterior two narrowly spathulate, bases attenuate, apices rounded, 9,5--17 x 2--3 mm. **Stamens** 8, basally connate, staminal column 1,5--3 mm long, white, smooth; perfect stamens 3, protruding from the flower, curved upwards during anthesis, lateral two 11--21,5 mm long, anterior one 20--32 mm long, white; staminodes 2--5 mm long; anthers dark pink, 1,5--2 mm long, pollen orange. **Gynoecium**: lengthens conspicuously during anthesis; ovary superior, oblong-conical, 4--5-lobed, 3--4,5 mm long, densely sericeous; style filiform, 3,5--10 mm long, white to pale pink; stigma with 4--5 branches, 0,3--0,5 mm long, adaxially dark pink. **Fruit**: a schizocarp consisting of 4--5 mericarps, bases of mericarps 4 mm long, without glandular hairs, papillate at distal end, tails 23--32 mm long. (Figure 8.59.1).

Diagnostic features and affinities

P. triandrum is characterized by the reduced number of filaments (eight) and only three very long fertile stamens, hence the specific epithet. This structure of the androecium is unique for the genus. *P. triandrum* resembles *P. punctatum* and *P. curviandrum* in that all three species have simple prostrate leaves, pseudo-umbellets with a large number of flowers, long hypanthia, very long and narrow petals, very long protruding fertile stamens, long styles and very short stigma branches. In all three species there is a marked lengthening of the style during anthesis. This and the way in which the stamens are borne indicate an involvement of a special pollinator for these three species. The number of the fertile stamens, however differs in the different species. *P. curviandrum* has four fertile stamens, *P. triandrum* only three, and *P. punctatum* only two.

Geographical distribution and ecology

P. triandrum is known from a small distribution area along the Olifantsrivier, from Clanwilliam in the north to Algeria in the south. Recently it was also collected in Hartnekskloof on the Ceres-Karoo side of the escarpment (Figure 8.59.2). This area receives an annual rainfall of 100--200 mm occurring mainly in winter. *P. triandrum* occurs in broken succulent veld or dry fynbos on sandstone. Plants grow amongst rocks in red loam or under bushes in partial shadow or in direct sunlight and are usually locally abundant. It flowers from late October to November.

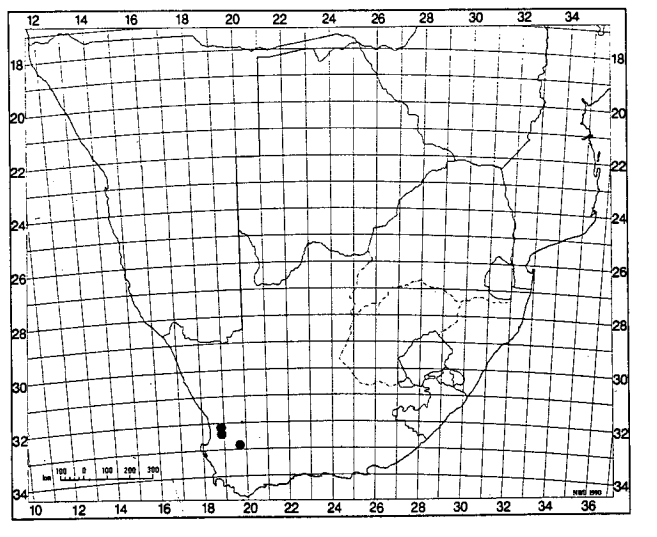


Figure 8.59.2 Geographical distribution of *P. triandrum*.

Material studied

--3218 (Clanwilliam): Clanwilliam (-BB), *Hall NBG719/52* (NBG); *Van Niekerk s.n.* (STEU); 8 km S of Clanwilliam on gravelled road (-BB), *Marais 304* (STEU); Ramskop Nature Reserve, Clanwilliam (-BB), *Van der Walt 1278* (STEU); 20 km from Algeria to Clanwilliam (-BB), *Van der Walt s.n.* (STEU); Rondegat, 25 km S of Clanwilliam (BD), *Friedrich 452* (STEU); Kriedouwkrantz (-BD), *Leighton 3346* (BOL); *Pocock 771* (PRE); Olifantsrivier, at turnoff to Algeria (-BD), *Van der Walt s.n.* (STEU); *Van der Walt & Vorster 1276* (BOL, K, MO, NBG, PRE, STE).

--3219 (Wuppertal): Hartnekskloof, Ceres Karoo (-DC), *Van Zyl s.n.* (STEU).

8.60 *Pelargonium punctatum* (Andr.) Willd., *Species plantarum* 3: 645 (1800); Pers.: 226, 227 (1806); Dietr.: 49 (1807); Ait. f.: 161 (1812); DC.: 650 (1824); Spreng.: 51 (1826); Loudon: 568 (1829); G. Don: 729 (1831); Loudon: 271, 272 (1832); Steud.: 289 (1841); Harv.: 264 (1860); Knuth: 332 (1912); Van der Walt & Vorster: 117, fig. (1981). ICONOTYPE: Andrews, *The Botanist's Repository* 1: t. 60 (1799).

Geranium punctatum Andr.: t. 60 (1799); Poir.: 746 (1812). ICONOTYPE: Andrews, *The Botanist's Repository* 1: t. 60 (1799).

Dimacria punctata (Andr.) Sweet: 77 (1826c).

Geranospermum punctatum (Andr.) Kuntze: 95 (1891).



Figure 8.60.1 *Pelargonium punctatum*. 1, flowering plants x1; 2, petals x1,5; 3, androecium x2; 4, gynoecium x5.

A geophyte 100--300 mm tall when in flower. **Tuber:** a turnip-shaped or sometimes moniliform root 14--30 mm long and 14--25 mm in diameter. **Leaves** simple, green, petiolate; lamina broadly ovate, apex rounded or obtuse, base cuneate, truncate or cordate, margin irregularly crenate, 16--90 x 12--100 mm, adaxially sparsely pilose, with short glandular hairs sparsely interspersed, abaxially densely pilose, interspersed with glandular hairs; petiole 25--60 mm long and 2--5 mm in diameter, prostrate, densely pilose, interspersed with glandular hairs; stipules subulate, adnate to petioles for half their length, 10--18 mm long and 1--2 mm wide, ciliate, apices laterally curved. **Inflorescence:** scape 20--160 mm long, 2--5 mm in diameter, branched, bearing 2--8 pseudo-umbellets with (10-)17--45(-60) flowers each; peduncles 20--100 mm long, 1--2 mm in diameter, covered with short glandular hairs interspersed with long patent non-glandular hairs; bracts lanceolate, 6--7 mm long, 1--2 mm wide, abaxially hirsute interspersed with glandular hairs. **Pedicel** ca. 0,5 mm long. **Hypanthium** 20--30 mm long, pale reddish brown, indumentum as on peduncle. **Sepals** 5, lanceolate, apices acute, 5--8,5 mm long, 0,8--2,5 mm wide, posterior one erect, others reflexed, pale reddish brown with margins white, indumentum abaxially as on peduncle. **Petals** 5, cream-coloured to pale yellow, patent during anthesis; posterior two with wine-red feather-like markings or small dots, ligulate or narrowly unguiculate-spathulate, bases cuneate, apices rounded or emarginate, 11--20 x 2--5 mm; anterior three narrowly spathulate, bases attenuate, apices rounded, 8--13 x 1,5--3,2 mm. **Stamens** 7; staminal column 1,5--2,5 mm long, white; perfect stamens 2, in anterior position, 10--18 mm long, protruding from the flower, curved upwards during anthesis, white; staminodes 1,5--4 mm long; anthers yellow, 1--1,5 mm long, pollen yellow. **Gynoecium:** lengthens conspicuously during anthesis; ovary 4--5-lobed, 2--4 mm long; style 2,5--9 mm long, pink to pale pink; stigma with 4--5 branches, 0,3--0,5 mm long, adaxially dark pink. **Fruit:** 4--5 mericarps, bases of mericarps 3--4 mm long, without glandular hairs, papillate at distal end, tails 21--25 mm long. (Figure 8.60.1).

Diagnostic features and affinities

P. punctatum is characterized by its simple, prostrate leaves and extremely zygomorphic flowers. The hairy leaves are arranged in a rosette with the older leaves bigger than the younger ones. The cream-coloured or pale yellow flowers are extremely zygomorphic because of the orientation of the long and narrow petals. The ligulate to narrowly spathulate posterior petals are borne together, with the wine-red feather-like markings or small dots forming a unit. The specific epithet *punctatum* refers to these dots. The anterior petals are patent during anthesis. There is a reduction in the number of filaments from ten to seven, and a reduction in the number of fertile stamens to two. In the

majority of specimens there is also a reduction in the number of carpels from five to four. The flowers are protandrous and initially the fertile stamens are very long and protrude from the flower. The style lengthens conspicuously during anthesis and when the anthers are dropped the stigma takes the original position of anthers. This mechanism ensuring cross pollination is not confined to section *Hoarea*, but is typical for *Pelargonium*. The stigma branches in this species are very short, much shorter than the stigmas of the majority of species of section *Hoarea*.

P. punctatum is related to *P. triandrum* and *P. curviandrum*, because they reveal similarities in leaf and floral structures.

Geographical distribution and ecology

P. punctatum has a small distribution area in the drier parts of the south-western Cape. It was collected at Botterkloof, Lokenburg and north of Nieuwoudtville on the eastern side of the Bokkeveld Mountain range, but also along the Olifantsrivier around Klawer to the west of this escarpment (Figure 8.60.2). This is a dry area where high temperatures are reached during summer. Although low temperatures can be reached in winter, the area remains frost-free. The annual rainfall of 100--300 mm occurs usually during the winter months. Plants occur in dry fynbos or in karroid vegetation with many succulents and are found on rocky hillsides under bushes in well-drained soil derived from sandstone. Although the distribution area of this species is small, populations usually consist of numerous plants.

When in flower, *P. punctatum* is a spectacular sight. The scape is branched, bearing two to eight pseudo-umbellets, each with a large number of flowers. Flowering time for this species is during the early summer months of October and November. Individual plants have a relative long flowering period due to the large number of pseudo-umbellets per plant and the large number of flowers per pseudo-umbellet opening in succession.

Fruitset in cultivation is very poor, but in field collections, every flower was found to produce a mericarp. This implies that in nature there is no imperfection in the reproductive biology of this species. At the same time it indicates that a special pollinator may be involved which is not present in the garden.

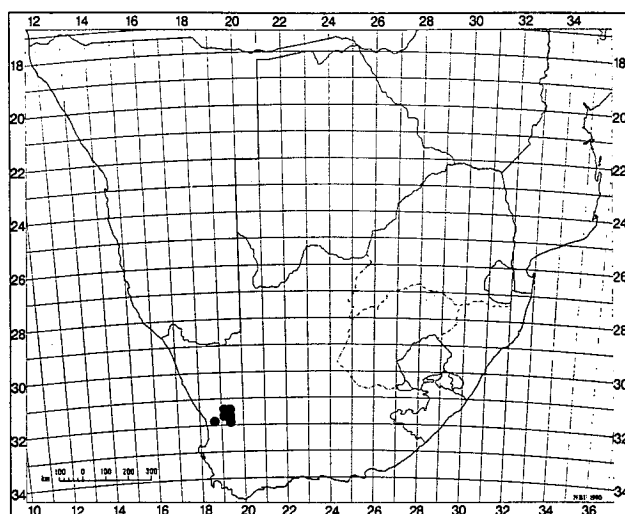


Figure 8.60.2 Geographical distribution of *P. punctatum*.

Material studied

--3118 (Vanrhynsdorp): Olifantsrivier Valley (-DC), *Pillans s.n.* (BOL); Near Klawer station (-DC), *Marloth 12554* (PRE).

--3119 (Calvinia): 12 km from Nieuwoudtville to Brandkop (-AC), *Fischer 34* (STEU); Rondekop, Nieuwoudtville (-AD), *Lavranos & Pehlemann 18876* (STEU); Lokenburg, Stinkfonteinberg (-CA), *Marais 69* (STEU); At crossing of Clanwilliam/Calvinia and Nieuwoudtville roads (-CB), *Meve 273* (STEU); Botterkloof Pass (-CD), *Franson s.n.* (PRE); *Hall 961* (NBG), *Marais 67* (STEU); *Van der Walt 944* (STEU); *Weber 2* (STEU).

INSUFFICIENTLY KNOWN SPECIES

8.61 *Pelargonium bifolium* (*Burm. f.*) *Willd.*, *Species plantarum* 3: 645 (1800); *Pers.*: 226 (1806); *DC.*: 650 (1824); *Spreng.*: 51 (1826); *G. Don*: 726 (1831); *Steud.*: 677 (1840); *Steud.*: 284 (1841); *Harv.*: 265 (1860); *Knuth*: 332 (1912).
 ICONOTYPE: *Burman*, *Rariorum africanarum plantarum*: 90, t. 35, f. 1 (1738).

Geranium bifolium *Burm. f.*: 52, n. 73 (1759); *Cav.*: 254, t. 115, f. 3 (1787). ICONOTYPE: *Burman*, *Rariorum africanarum plantarum*: 90, t. 35, f. 1 (1738).

Geranospermum bifolium (*Burm. f.*) *Kuntze*: 94 (1891).

8.62 *Pelargonium calviniae* Knuth in Pflanzenreich 4, 129: 344 (1912). TYPE - Cape Province: "Calvinia, nördlich von Waterkloof, um 6 m, Diels 751 (B, holo+).

8.63 *Pelargonium coronillifolium* (Andr.) Pers., Synopsis plantarum 2: 227 (1806) (as "*coronillaefolium*"); Ait. f.: 163 (1812); DC.: 653 (1824); Spreng.: 53 (1826); Loudon: 570 (1829); G. Don: 728 (1831); Loudon: 272 (1832); Steud.: 677 (1840); Steud.: 285 (1841). ICONOTYPE: Andrews, The Botanist's Repository 5: t. 305 (1803b).

Geranium coronillifolium Andr.: t. 305 (1803b); Poir.: 757 (1812). ICONOTYPE: Andrews, The Botanist's Repository 5: t. 305 (1803b).

Dimacria coronillifolium (Andr.) Sweet: 77 (1826c).

8.64 *Pelargonium eupatoriifolium* (Eckl. & Zeyh.) Steud., Nomenclator botanicus, 2nd edn, 2: 286 (1841) (as "*eupatoriaefolium*"). TYPE - Cape Province: ". Collibus argillosis non procul a 'Luisfontein' (Clanwilliam)", Ecklon & Zeyher 494 (Not seen).

Hoarea eupatoriifolia Eckl. & Zeyh.: 64 (1835). TYPE - Cape Province: ". Collibus argillosis non procul a 'Luisfontein' (Clanwilliam)", Ecklon & Zeyher 494 (Not seen).

8.65 *Pelargonium gracile* (Eckl. & Zeyh.) Steud., Nomenclator botanicus, 2nd edn, 2: 286 (1841). TYPE - Cape Province: ". Collibus argillosis inter 'Kochmannskloof' et flumen 'Gauritzrivier' terra 'Kannaland' (Zwellendam) ", Ecklon & Zeyher 491 (S, lecto!, designated here, S!).

Hoarea gracilis Eckl. & Zeyh.: 64 (1835). TYPE - Cape Province: ". Collibus argillosis inter 'Kochmannskloof' et flumen 'Gauritzrivier' terra 'Kannaland' (Zwellendam) ", Ecklon & Zeyher 491 (S, lecto!, designated here, S!).

8.66 *Pelargonium gracilipes* Knuth in Pflanzenreich 4, 129: 331 (1912). TYPE - Cape Province: Pakhuis, Clanwilliam, in hard clay soil on hill slopes, Leipoldt 517 (BOL, holo!).

8.67 *Pelargonium hantamianum* Knuth in Pflanzenreich 4, 129: 344 (1912). Cape Province: Hantam-Gebirge, Meyer s.n. (B+, holo.).

8.68 *Pelargonium hemicyclicum* Hutch. & C.A. Smith in Kew Bulletin 1928: 272 (1928). TYPE - Cape region. Described from a living specimen at Kew, the tuber collected by Mr. Ingram.

8.69 *Pelargonium ladysmithianum* Knuth in Repertorium specierum novarum regni vegetabilis 28: 90 (1930). TYPE - Cape Province: Huisrivier Mountains, Marloth 13121 (B+, holo.; PRE, lecto.!, designated here).

8.70 *Pelargonium ochroleucum* Harv. in Flora capensis 1: 263 (1860); Knuth: 331 (1912). TYPE - Cape Province: Near the Great Fish River. Drège s.n. sub. *P. reflexum* E Meyer. (TCD, lecto.!, designated here, CGE!, E!, Gx4!, K!, MEL!, MO!, OXF!, Px3!, PRE!, S!, SAM!).

Geranospermum ochroleucum (Harv.) Kuntze: 94 (1891).

8.71 *Pelargonium oxaloides* (Burm. f.) Willd., Species plantarum 3: 642 (1800); Pers.: 226 (1806); DC.: 650 (1824) (excl. *G. oxalioides* Andr.); Spreng: 51 (1826); G. Don: 726 (1831); Steud: 679 (1840); Steud: 288 (1841); Harv.: 264 (1860); Knuth: 334 (1912). TYPE - "Cap bon Spei" (G, lecto.!, designated here).

Geranium oxaloides Burm. f.: 51, n. 71 (1759); Burm. f.: 19 (1768); Cav.: 237, t. 97, f. 2 (1787). TYPE - "Cap bon Spei" (G, lecto.!, designated here).

Geranium prolificum var. *oxaloides* (Burm. f.) L.: 949 (1763).

Geranospermum oxalodes (Burm. f.) Kuntze: 95 (1891) (by mistake).

8.72 *Pelargonium pulchellum* Salisb., Paradisis londinensis 1: t. 39 (1807); non Sims (1801). ICONOTYPE: Salisbury, Paradisis londinensis 1: t. 39 (1807).

8.73 *Pelargonium setosum* (Sweet) DC., Prodrumus 1: 652 (1824); Loudon: 570 (1829); G. Don: 727 (1831); Loudon: 271 (1832); Steud.: 290 (1841); Harv.: 270 (1860). ICONOTYPE: Sweet, Geraniaceae 1: t. 38 (1820).

Hoarea setosa Sweet: t. 38 (1820); Sweet: 76 (1826c). ICONOTYPE: Sweet, Geraniaceae 1: t. 38 (1820).

Geranospermum setosum (Sweet) Kuntze: 95 (1891).

8.74 *Pelargonium sulphureum* Knuth in Pflanzenreich 4, 129: 326 (1912); non (Sweet) Steud.: 295 (1841). TYPE - Cape Province: "Hex-River, an durren Stellen um 500 m", Bolus 13048 (BOL, holo!).

8.75 *Pelargonium theianthum* (Eckl. & Zeyh.) Steud., Nomenclator botanicus, 2nd edn, 2: 290 (1841). TYPE - Cape Province: ". . . Lapidosis deserti 'Karro' ad fluvium 'Gauritzrivier' (Zwellendam)". Ecklon & Zeyher 490 (S, lecto.!, designated here, S!).

Hoarea theiantha Eckl. & Zeyh.: 63 (1835). TYPE - Cape Province: ". . . Lapidosis deserti 'Karro' ad fluvium 'Gauritzrivier' (Zwellendam)". Ecklon & Zeyher 490 (S, lecto.!, designated here, S!).

8.76 *Pelargonium trifidum* (Burm. f.) Willd., Species plantarum 3: 646 (1800); Pers.: 227 (1806); DC.: 651 (1824); Spreng.: 52 (1826); G. Don: 726 (1831); Steud.: 680 (1840); Steud.: 290 (1841); Harv.: 267 (1860); Knuth: 337 (1912). ICONOTYPE: Plukenet, Phytographia: 186, t. 6 (1691).

Geranium trifidum Burm. f.: 52, n. 74 (1759); Cav.: 254, t. 115, f. 1 (1787). ICONOTYPE: Plukenet, Phytographia: 186, t. 6 (1691).

Geranospermum trifidum (Burm. f.) Kuntze: 95 (1891).

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