Bothalia 25,2: 133–139 (1995)

Three subspecies of *Pelargonium laevigatum* (Geraniaceae)

C.M. VAN WYK* (née SCHONKEN) and J.J.A. VAN DER WALT**

Keywords: Geraniaceae, *Pelargonium laevigatum*, subspecies, taxonomy

ABSTRACT

Pelargonium laevigatum (L. f.) Willd. is a variable species. The macromorphology, anatomy of the leaves, chromosome numbers and geographical distribution of the species were studied, and it is concluded that three subspecies should be distinguished. The subsp. **diversifolium** (Wendl.) Schonken stat. nov. and subsp. **oxyphyllum** (DC.) Schonken stat. nov. were originally described as species. A key to identify the three subspecies, a distribution map, and illustrations of the macromorphological characters as well as anatomical features of the leaves, are provided.

UITTREKSEL

Pelargonium laevigatum (L. f.) Willd. is 'n variërende spesie. Die makromorfologie, anatomie van die blare, chromosoomgetalle en geografiese verspreiding van die spesie is bestudeer en daar is tot die gevolgtrekking gekom dat drie subspesies onderskei moet word. Die subsp. **diversifolium** (Wendl.) Schonken stat. nov. en subsp. **oxyphyllum** (DC.) Schonken stat. nov. is oorspronklik as spesies beskryf. 'n Sleutel om die drie subspesies te identifiseer, 'n verspreidingskaart, en illustrasies van die makromorfologiese kenmerke sowel as anatomiese kenmerke van die blare, word voorsien.

INTRODUCTION

Harvey (1860) described the section *Glaucophyllum* and recognized *Pelargonium laevigatum* (L. f.) Willd. as one of the species in the section. Van der Walt *et al.* (1990) altered the composition of the section *Glaucophyllum* but concluded that *P. laevigatum* should remain in the section.

P. laevigatum is a variable species and Schonken (1980) suggested that three subspecies should be distinguished. For this study the macromorphology, leaf anatomy, chromosome numbers and geographical distribution of the species have been studied to determine whether it is justified to recognize infraspecific taxa.

MATERIAL AND METHODS

For the morphological and geographical distribution studies, specimens of altogether 17 herbaria were studied. This was followed by extensive field work on different populations in the entire distribution area, mainly to determine the variation in morphological features.

Transverse sections, 12–15 µm thick, of wax-embedded terminal leaflets and petioles were cut with a rotary microtome and stained with Alcian Green-Safranin (Joel 1983). The sections were made through the middle part of the terminal leaflets and petioles.

Specimens examined for leaf anatomy and chromosome numbers

1. Subsp. *laevigatum*: Maggs 16, Willowmore 3502+; *Van der Walt 734*, 2n = 22, Swartberg Pass, Oudtshoorn 1444+; *Van der Walt 1594*, Rooiberg Pass, Calitzdorp 4093+; 2n = 22, *Schonken 150*, Swartberg Pass 2014+.

2. Subsp. *diversifolium*: *Van der Walt 1592*, Tweedside, Matjiesfontein 4051+; *Van der Walt 1063*, 2n = 22; Gydouw, Ceres 4132+.

3. Subsp. *oxyphyllum*: *Van der Walt 1604*, 2n = 22, Cedarberg 4133+; *Stirton 6401*, Wupperthal 1085+.

For mitosis, root tips were treated with 0.002 mol 8-hydroxiquinoline for 24 h at 20°C, fixed in 3:1 absolute ethanol and glacial acid, and stained with aceto-carmine.

RESULTS

Pelargonium laevigatum *(L. f.) Willd.*, Species plantarum 3,1: 685 (1800); Knuth: 436 (1912). Type: 'Cap. Bonae Spei', *Thunberg s.n.* (*UPS 15620*, lecto.!, here designated).

Erect and compact or prostrate and lax subshrub, much branched, evergreen, 0.3–0.5 (–1m) high and 0.3–0.5 m in diameter. *Stems* smooth, herbaceous, glabrous or glabrescent, grey or glaucous. *Leaves* unifoliolate to trifoliolate, articulated to petiole, subsucculent, glabrous or pilose to hirsute, with sparse glandular hairs, glaucous; pinnae sessile, lanceolate to terete, bases cuneate, apices acute, margins entire or irregularly dentate to incised with linear segments, pinnae (10–)20–40(–70) × 1–10 mm; petiole (4–)15–20(–40) mm long; stipules free, subulate, 3–11 × 0.2–1.0 mm, somewhat succulent, glabrous to pilose. *Inflorescence*: *flowers* borne singly or in reduced pseudo-umbels of 2–5 flowers each, peduncle (6–)30–50 (–100) mm long, glabrous to pilose. *Pedicel* 0.5–13 mm long, glabrous or with glandular hairs. *Hypanthium* 4–38 mm long, glabrous or with glandular hairs. *Sepals* 5, narrowly ovate, adaxially concave, apices acute, glabrous or pilose to hirsute, green to reddish brown with hyaline margins, 6–12 × 1.5–3.5 mm. *Petals* 5, white or cream-coloured or pink; posterior 2 spathulate with apices obtuse

* National Botanical Institute, Private Bag X101, Pretoria 0001.
**Department of Botany, University of Stellenbosch Stellenbosch 7600.
MS. received: 1994-05-11.
+ project locality no.

or rounded or retuse, 11–30 × 4–9 mm, reflexed at ± 90° from the middle, with reddish purple markings at base; anterior 3 spathulate to narrowly obovate with apices obtuse or rounded or retuse, somewhat smaller (11–20 × 3–6 mm) and somewhat lighter in colour than posterior petals, gradually recurved so that apices are at an angle of ± 90° with bases, with fine purplish lines near bases. *Stamens*: fertile 7 (4 long, 1 medium, 2 short), staminodes 3, filaments basally fused forming a staminal column 2–3 mm long; pollen yellow to orange. *Ovary* ovate, 5-lobed, pilose; style glabrous or sparsely pilose basally, 1–4 mm long; stigmas 5, purplish, 1–2 mm long. *Mericarps*: 20–30 mm long; bases 3.5–6.0 mm long, tails 16–24 mm long. 2n = 22.

Key to subspecies

1a Leaves trifoliolate, pinnae incised, southern Cape to E Cape . . . . . 1. subsp. *laevigatum*

1b Leaves unifoliolate or trifoliolate, pinnae not incised, SW Cape to southern Cape:

2a Leaves, glabrous, trifoliolate, flowers usually borne singly, restricted to Cedarberg Mountains . . . . . 3. subsp. *oxyphyllum*

2b Leaves hirsute, unifoliolate to trifoliolate, usually more than 1 flower per pseudo-umbel, Western Cape . . . . . 2. subsp. *diversifolium*

1. subsp. **laevigatum**

Pelargonium laevigatum (L. f.) Willd., Species plantarum 3,1: 685 (1800); Pers.: 233 (1806); DC.: 667 (1824); Drège: 122 (1843); Harv.: 297 (1860); Compton: 295 (1931); Clifford: 218 (1970); Van der Walt & Vorster: 87 (1981). Type: as for *P. laevigatum* (L. f.) Willd.

Geranium laevigatum L. f.: 306 (1781); L.: 619 (1784); Cav.: 255 (1787); Thunb.: 115 (1794); Thunb.: 522 (1823). *Eumorpha laevigata* (L. f.) Eckl. & Zeyh.: 78 (1834–1837).

G. acuminatum Thunb.: 526 (1823). *Pelargonium acuminatum* (Thunb.) DC.: 680 (1824); R. Knuth: 542 (1912). Type: locality and collector unknown, specimen *UPS 15555* with Thunberg's handwriting (lecto.!, here designated).

P. laevigatum (L. f.) Willd. var. *compositum* L'Hér. ex DC.: 667 (1824). Type: locality and collector unknown, specimen *G-DC 667-190* with De Candolle's handwriting (holo.!).

P. macowanii Bolus: 157 (1890). Type: Cape Province, Boschberg near Somerset East, *MacOwan 1647* (BOL, holo.!; GRA, K!, SAM!, Z!).

Diagnostic morphological features

Leaves trifoliolate, pinnae variously incised, glabrous to sparsely hirsute, flattened, 1–5 flowers per pseudo-umbel (Figure 1).

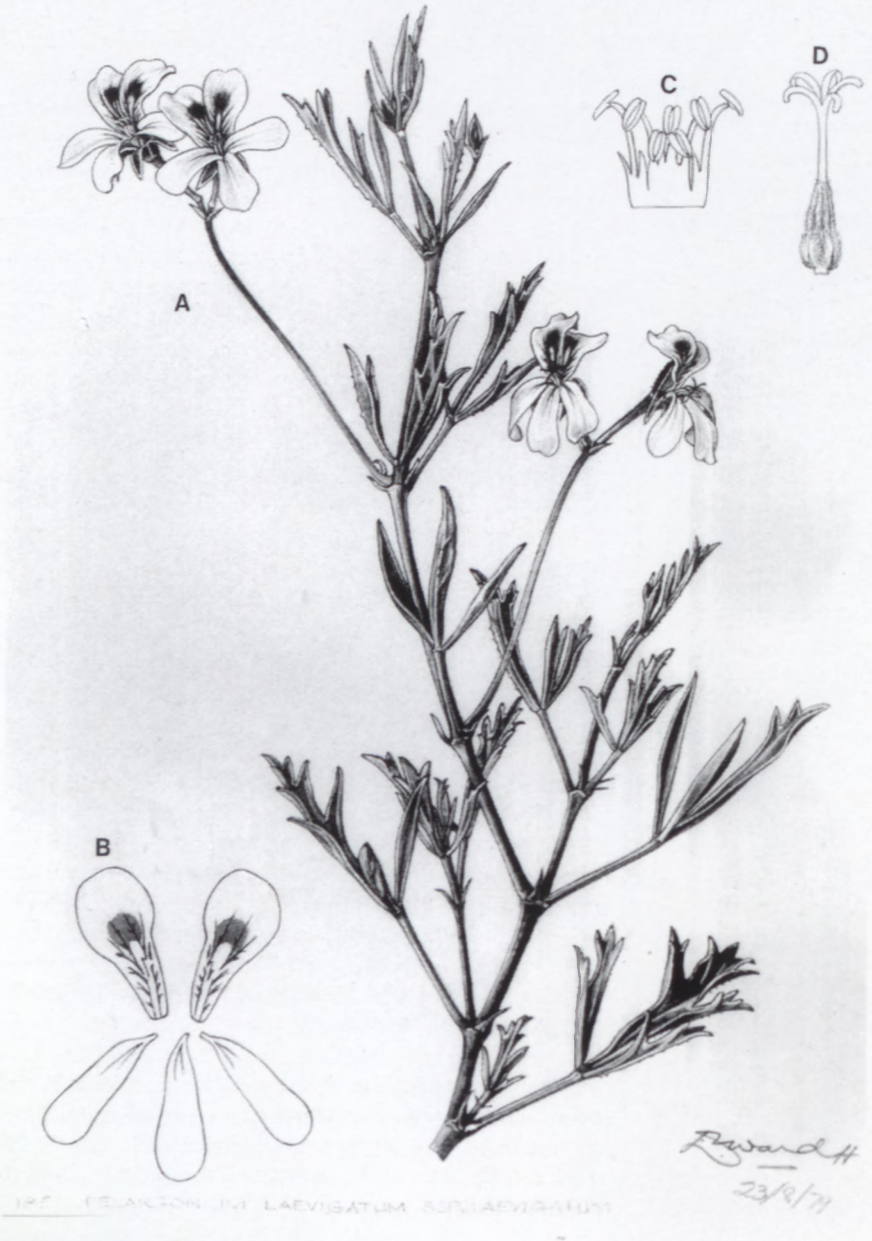

FIGURE 1.—*P. laevigatum* subsp. *laevigatum*, *Ward-Hilhorst 185*. A, flowering branch, × 0.7; B, petals, × 1; C, androecium, × 2; D, gynoecium, × 2.

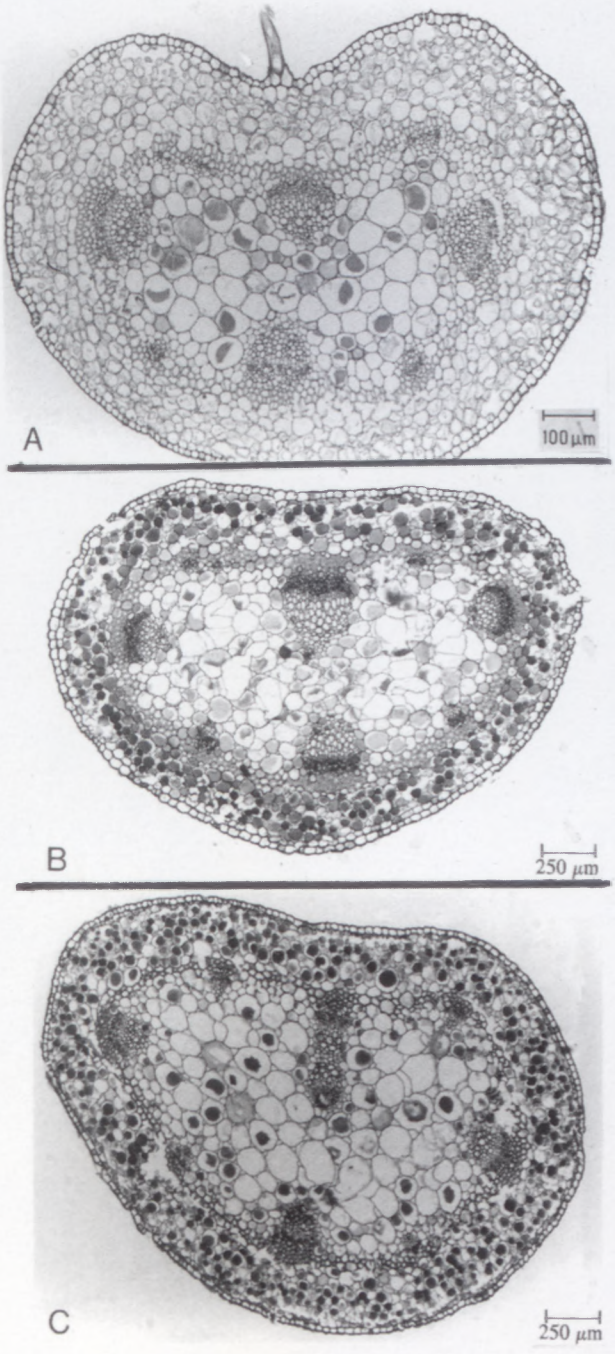

FIGURE 2.—Transverse section of petiole of *P. laevigatum*. A, subsp. *laevigatum*, *Maggs 16*; B, subsp. *diversifolium*, *Van der Walt 1603*; C, subsp. *oxyphyllum*, *Van der Walt 1604*.

Diagnostic anatomical features of leaves

Petiole: cordiform in transverse section, glandular hairs multicellular, non-glandular hairs unicellular, hypodermis not clearly differentiated, parenchymatous cortex 4–6 layers, extraxylary sclerenchyma cylinder continuous and 2–4 layers wide, main vascular bundles 4, smaller bundles 2–6, medullary bundle usually lacking (Figure 2A). *Lamina*: V-shaped to more or less flattened in transverse section, trichomes as on petiole, stomata evenly distributed in ad- and abaxial epidermis, mesophyll not clearly differentiated in palisade and spongy parenchyma, 2 adaxial palisade layers larger than 1 abaxial layer (Figure 3A).

Specimens examined

EASTERN CAPE.—3225 (Somerset East): Boschberg, (–DC), *MacOwan 1479* (SAM), *1647* (BOL, GRA, K, MEL, SAM, Z). 3323 (Willowmore): Slypsteenberg, (–AC), *Esterhuysen 6278* (BOL); near Willowmore, (–AD), *Maggs 16* (STEU); Buispoort, (–AD), *Theron 1011* (PRE); Baviaanskloof, (–BC), *Van Wyk 384* (STE); 37 km E of Willowmore, (–DA), *Olivier 1643* (STEU); between Miskraal and Smitskraal, (–DA), *Hugo 1451* (STE); Studtis, (–DB), *Manson 53, 67* (STE); 15 km W of Joubertina, (–DC), *Van der Walt 856* (STEU); Joubertina, (–DD), *Esterhuysen s.n.* (BOL), *Fourcade 3217* (BOL), *Horn s.n.* (PRE); near Joubertina, (–DD), *Esterhuysen 7040, 22797* (BOL). 3324 (Steytlerville): Langkloof, (–AB), *Ecklon & Zeyher 609* (SAM); Kouga Hills, (–CA), *Esterhuysen 6661* (BOL, PRE); Kouga Mountains, (–CA), *Bayliss 6382* (MO, NBG, WAG); Kouga, (–CA), *Compton 10525* (BOL, NBG); between Cambria and Smitskraal, (–CB), *Oliver 4551* (STE); Kareedouw, (–CD), *Compton 4516* (BOL); Mordenaarskloof, (–CD), *Stayner s.n.* (NBG); Baviaanskloof, (–DA), *Bayliss 4423* (MO); NW of Cambria, Baviaanskloof, (–DA), *Oliver 4535* (PRE, STE). 3325 (Port Elizabeth): Otterford Forest Reserve, (–CC), *Oliver 4443* (PRE), *Rodin 1109* (BOL, MO, PRE). 3424 (Humansdorp): Krommerivier Heights, (–BA), *Fourcade 2704* (BOL, PRE, STE).

WESTERN CAPE.—3321 (Ladismith): Rooiberg, (–DA), *Compton 3917* (BOL, NBG), *Esterhuysen 17144* (BOL), *Oliver 5330* (PRE, STE), *Schonken 150* (STEU), *Taylor 9796* (STE), *Van der Walt 1594* (STEU); Gamka Mountain Reserve, (–DB), *Boshoff 360* (STE). 3322 (Oudtshoorn): Baviaanskloof, (–AC), *Bayliss 4423* (NBG), *Boucher 38* (STEU), *Gill 19* (BOL, PRE); Swartberg Pass, (–AC), *Bolus 11739* (BOL, PRE), *Compton 10419* (NBG), *Hafström & Acocks 753* (BOL, PRE), *Moffett 696* (STEU), *Pocock 120* (PRE), *Schonken 150, 189, 190* (STEU), *Stokoe s.n.* (SAM), *Thompson 2195* (PRE, STE) *Van der Walt 734, 1148, 1589* (STEU); Kamanassie Mountains, (–DA/DB), *Zinn s.n.* (SAM). 3323 (Willowmore): 13 km W of Uniondale, (–CA), *Wells 2835* (GRA, PRE); Bo-Koega, (–CB), *Bayliss 7081* (MO); Kouga Mountains, (–CB), *Wisura 2173* (NBG); Prince Alfred Pass, (–CC), *Fourcade 2091* (BOL).

Subsp. *laevigatum* occurs in the southern and eastern Cape, and it is known from Rooiberg near Calitzdorp, eastwards to Otterford Forest Reserve near Port Elizabeth (Figure 4). It has been collected from 180 m above sea level near Humansdorp to 1 600 m in the Swartberg Range. The rainfall in its distribution area varies from 200–600 mm per annum.

Subsp. *laevigatum* is morphologically very variable but a continuous variation pattern makes it impossible to divide it into different taxa. Varying characters are the number of flowers per pseudo-umbel and the size of the petals, as well as the indumentum and degree of incision of the leaf margins. To complicate matters, there seem to be natural hybrids between subsp. *laevigatum* and *Pelargonium fruticosum* (Cav.) Willd. *P. laevigatum* depicted in Van der Walt & Vorster (1981) with greenish leaves is most probably an example of such a hybrid. These suspected hybrids occur in the Swartberg Pass where subsp. *laevigatum* and *P. fruticosum* are common.

The plants occurring at Boschberg near Somerset East have finely divided leaves superficially resembling those of *P. fruticosum*. This form was described by Bolus (1890) as *P. macowanii* and quoted by Knuth (1912) as *P. divaricatum* (Thunb.) DC. var. *scabrum* Harv. However, the glaucous leaves and floral characters of these plants are typical of *P. laevigatum* and we concluded that they represent a form of subsp. *laevigatum*. The atypical leaves are probably the result of the local environmental conditions and geographical isolation.

Some plants growing in Long Kloof (*Fourcade 2704*) and in the Otterford Forest Reserve (*Wilman 1109*) have up to five flowers per pseudo-umbel and the petals are exceptionally large. The pinnae of these plants are also relatively wide.

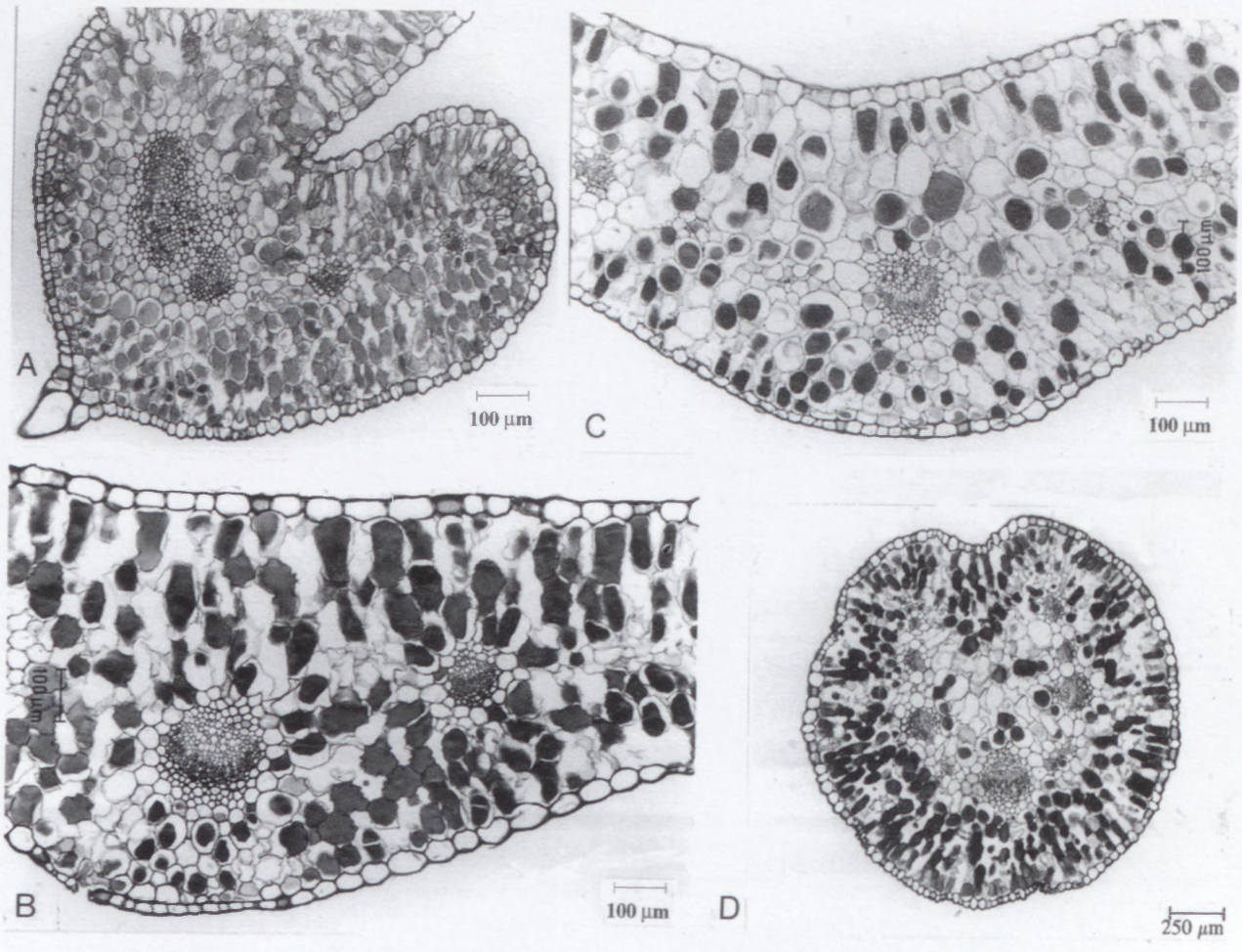

FIGURE 3.—Transverse sections of terminal leaflets of *P. laevigatum*. A, subsp. *laevigatum*, *Maggs 16*; B, subsp. *diversifolium*, *Van der Walt 1603*. C, D, subsp. *oxyphyllum*: C, flattened leaf, *Van der Walt 1501*; D, centric leaf, *Van der Walt 1604*.

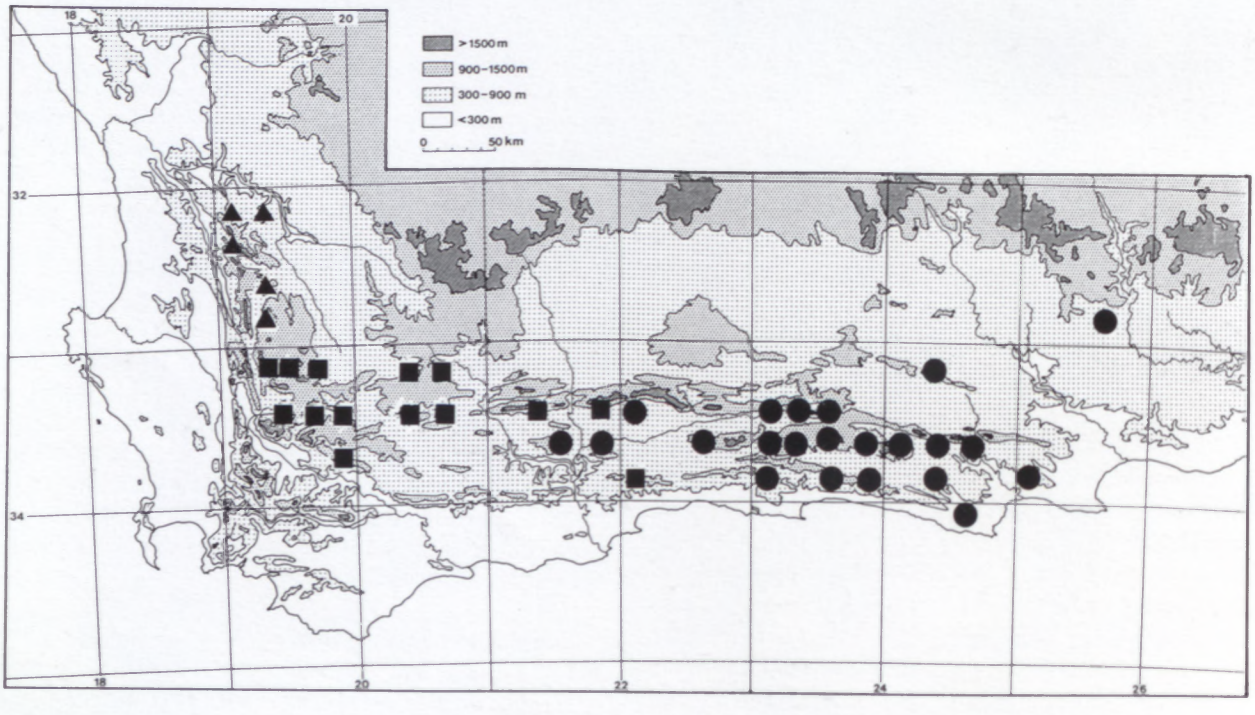

FIGURE 4.—Known geographical distribution of *P. laevigatum*: subsp. *laevigatum*, ●; subsp. *diversifolium*, ■; subsp. *oxyphyllum*, ▲.

2. subsp. **diversifolium** *(Wendl.) Schonken* stat. nov.

Pelargonium diversifolium Wendl., Botanische Beobachtungen: 52 (1798); Willd.: 664 (1800); Pers.: 230 (1806); Wendl.: 53 (1809). Iconotype: Wendland, Collectio plantarum 2,4: t. 58 (1809).

Geranium trifoliatum Andr.: (1805). *Pelargonium trifoliatum* (Andr.) Sweet: 294 (1826). Iconotype: Andrews, Geraniums c. ic. (1805).

Diagnostic morphological features

Leaves unifoliolate to trifoliolate, pinnae not incised, hirsute to densely hirsute, flattened, 1–2 *flowers* per pseudo-umbel (Figure 5).

Diagnostic anatomical features of leaves

Petiole: adaxially flattened, glandular hairs multicellular, non-glandular hairs unicellular, hypodermis clearly differentiated, parenchymatous cortex 5–6 layers, extraxylary sclerenchyma cylinder continuous and 2–6 layers wide, main vascular bundles 4, smaller bundles 4–8, medullary bundle 1 or 0 (Figure 2B). *Lamina*: flattened, trichomes as on petiole, more stomata abaxially, mesophyll differentiated in palisade and spongy parenchyma, 2 adaxial palisade layers larger than 1 abaxial layer (Figure 3B).

Specimens examined

WESTERN CAPE.—3319 (Worcester): Agter-Witzenberg, (–AB), *Marais 47* (STEU); Elandsfontein, Skurweberge, (–AB), *Schlechter 1750* (PRE), *10020* (BOL, E, MO, P, PRE, W, Z); 11 km N of Gydouw Pass, (–AB), *Hutchinson 1040* (BOL), *Van der Walt 1603* (STEU); Farm Merino, Theronsberg, (–AD), *Cillie 686* (STEU); Baviaansberg, Ceres, (–BA), *Compton 12850* (NBG), *Stokoe s.n.* (SAM); Ertjieslandkloof, Ceres, (–BA), *Wilman 2266* (BOL, MO); Hottentotskloof, (–BC), *Pearson 4945* (BOL); Bokkerivier farms, Ceres, (–BD), *Barker 10144* (NBG), *Booysen 60* (NBG); between Concordia and Triangle, (–BD), *Barnard 754* (SAM); Bonteberg, Worcester, (–BD), *Compton 9936* (NBG), *Esterhuysen 3712* (BOL); Eendracht, (–DB), *Lewis 1777* (SAM). 3320

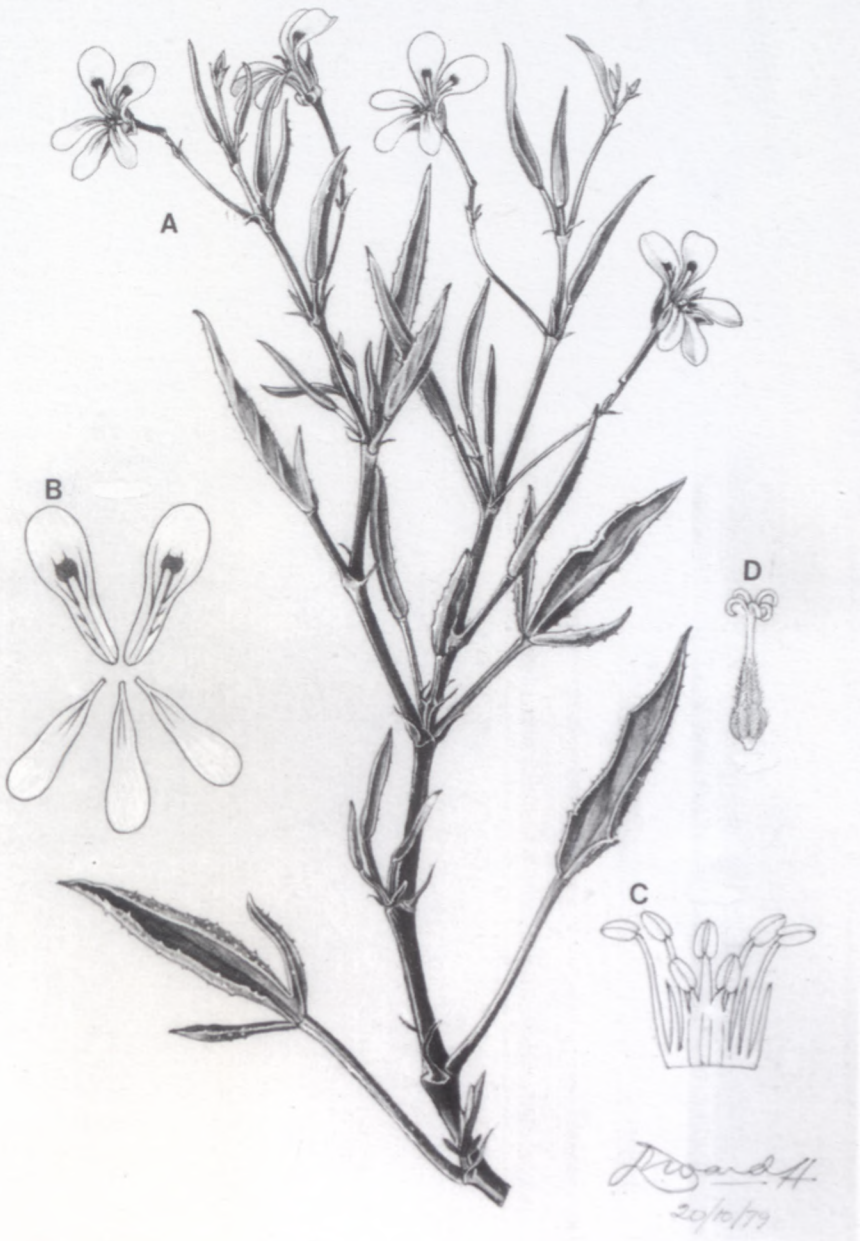

FIGURE 5.—*P. laevigatum* subsp. diversifolium, *Ward-Hilhorst 111*. A, flowering branch, × 0.8; B, petals, × 1.6; C, androecium, × 3.2; D, gynoecium × 3.2.

FIGURE 6.—*P. laevigatum* subsp. *oxyphyllum*, *Ward-Hilhorst 210*. A, flowering branch, × 0.7; B, petals, × 1; C, androecium, × 3; D, gynoecium, × 3.

(Montagu): Tweedside, (–AB), *Barker 20602* (BOL), *Marloth 10848, 12096* (PRE, STE), *Van der Walt 1592* (STEU); Cabidu, (–AB), *Hall* 171 (NBG), *Oliver s.n.* (NBG); Pieter Meintjies, (–AD), *Rogers 17887* (PRE); Witteberg, (–AD/BC), *Adamson s.n.* (BOL), *Compton 2680* (BOL), *12213* (NBG); Matjiesfontein, (–BA), *Marloth 2961* (BOL, PRE); Whitehill, (–BA), *Compton 7957* (NBG), Fisantekraal, (–BC), *Compton 21110* (NBG). 3321 (Ladismith): Elandskloof between Vleiland and Seweweekspoort, (–AD), *Maggs 28* (STEU); Ladismith, (–BD), *Geldenhuys 454* (STE); Rietkloof, (–BD), *Lewis 1168* (SAM). 3322 (Oudtshoorn): Robinson Pass, (–CC), *Taylor s.n.* (BOL).

Subsp. *diversifolium* occurs from Gydouw near Ceres eastwards to the Robinson Pass between Oudtshoorn and Mossel Bay (Figure 4). It is often found in mountainous habitats in a variety of vegetation types. Its distribution area falls entirely in the winter rainfall region, but it usually occurs on the lower slopes of mountains or on hills where the rainfall is relatively low in comparison to habitats higher up on the mountains.

3. subsp. **oxyphyllum** *(DC.) Schonken* stat. nov.

Pelargonium oxyphyllum DC., Prodromus systematis naturalis regni vegetabilis 1: 667 (1824); Drège: 209 (1843). Type: locality and collector unknown, specimen *G-DC 667-190* with De Candolle's handwriting (holo.!).

P. laevigatum (L. f.) Willd. var. *oxyphyllum* (DC.) Harv.: 297 (1860).

Diagnostic morphological features

Leaves trifoliolate, pinnae not incised, glabrous, subterete to flattened, usually 1 flower per pseudo-umbel (Figure 6).

Diagnostic anatomical features of leaves

Petiole: adaxially flattened to cordiform, without trichomes, hypodermis not clearly differentiated, parenchyma cortex 5–6 cell layers, extraxylary sclerenchyma cylinder continuous and 2–5 layers wide, main vascular bundles 4, smaller bundles 6–8, medullary bundle 1 or 0 (Figure 2C). *Lamina*: more or less flattened to centric, more stomata abaxially, mesophyll differentiated in palisade and spongy parenchyma, 1 adaxial palisade layer

larger than 2 abaxial layers, mesophyll in centric leaves not clearly differentiated (Figure 3C, D).

Specimens examined

WESTERN CAPE.—3219 (Wupperthal): Heuningvlei, Wupperthal road, (–AA), *Schonken 86* (STEU); Middelberg, (–AA/AC), *Compton 7503* (NBG); *Kerfoot 6150* (NBG); Sneeukop road, (–AC), *Strauss 63* (NBG); between Algeria and Dwarsrivier, (–AC), *Schonken 81* (STEU); Hoogvertoon, (–AC), *Haynes 1205* (PRE, STE); Cedarberg, (–AC), *Van der Walt 1604* (STEU); Matjesrivier, (–AC), *Wagener 281* (NBG); Dwarsrivier, (–AC), *Rycroft 2641* (MO, NBG, STE); Tafelberg, (–AC), *Barnard s.n.* (SAM), *Lamb 1* (STE); between Eselbank and Wupperthal, (–AC), *Van der Walt 1501, 1502* (STEU); Eselbank, (–AC), *Drège s.n.* (MEL, PRE); Wupperthal, (–AC), *Stirton 6401* (PRE, STEU), *Thode A1965* (NH, PRE); Gideonskop, (–CB), *Stokoe s.n.* (NBG); Juriesberg, (–CB), *Compton 12742* (NBG); Zoo Ridge, Suurvlakte, (–CD), *Taylor 6120* (PRE, STE); Skurweberge E of Citrusdal, (–CD), *Prismos s.n.* (SAM).

Subsp. *oxyphyllum* is confined to the Cedarberg Range, occurring from Heuningvlei in the vicinity of Wupperthal southwards to the district of Citrusdal (Figure 4). It grows in flat areas on deep sandy soil derived from sandstone. The annual rainfall in its distribution area varies from 200–500 mm.

DISCUSSION

P. laevigatum is taxonomically a complicated species because it displays a high degree of phenoplasticity. Almost all the populations studied have unique combinations of characters. The floral structure and many leaf characters of the plants investigated are, however, basically identical and therefore it was decided to consider them as conspecific. The three subspecies which are distinguished, have the same somatic chromosome number of 2n = 22. The rank of subspecies rather than variety was chosen for the three infraspecific taxa because they are allopatric.

The phenoplasticity of the species is also reflected in the leaf anatomy. The leaflets of subsp. *oxyphyllum* for example vary from flattened to centric. A medullary vascular bundle can be present or absent in the petioles of all three subspecies, even in different leaves of the same plant. The occurrence of hairs on the leaves of subsp. *laevigatum* is also extremely variable. Anatomical features of the leaves of *P. laevigatum* are therefore of limited taxonomic importance.

ACKNOWLEDGEMENTS

We are indebted to Prof. Dr Focke Albers for assisting us to determine the chromosome numbers and the Brenthurst Library (copyright) for permission to reproduce the water-colour paintings by Ellaphie Ward-Hilhorst.

REFERENCES

ANDREWS, H.C. 1805. *Geraniums: or a monograph of the genus* Geranium, Vol. 2. Taylor, London.

BOLUS, H. 1890. Contributions to South African botany. *Journal of the Linnean Society, Botany* 25: 157.

CAVANILLES, A.J. 1787. *Monadelphiae classis dissertationes decem. Quarta dissertatio botanica*, de Geranio, F.A. Didot, Paris.

CLIFFORD, D. 1970. *Pelargoniums including the popular Geranium*, edn 2. Blandford Press, London.

COMPTON, R.H. 1931. The flora of the Whitehill District. *Transactions of the Royal Society of South Africa* 19: 295.

DE CANDOLLE, A.L.L.P. 1824. *Prodromus systematis naturalis regni vegetabilis*. Treutel & Würtz, Paris.

DRÈGE, J.F. 1843. *Zwei pflanzengeographische Documente nebst einer Einleitung von E. Meyer*. Jena & Leipzig.

ECKLON, C.F. & ZEYHER, K.L.P. 1834–1837. *Enumeratio plantarum africae australis extratropicae*. Perthes, Hamburgii.

HARVEY, W.H. 1860. Geraniaceae. *Flora capensis* 1: 254–308.

JOEL, D.M. 1983. A.G.S. (Alcian Green-Safranin)—a simple differential staining of plant material for light microscopy. *Proceedings of the Royal Microscopy Society* 18/3: 149–151.

KNUTH, R.G.P. 1912. Geraniaceae. *Das Pflanzenreich* 4, 129 (Heft 53). Wilhelm Engelmann, Berlin.

LINNAEUS, C. (fil.) 1781. *Supplementum plantarum*. Impensis orphanotrophei, Braunschweig.

LINNAEUS, C. 1784. *Systema vegetabilium*, 4th edn. Göttingen.

PERSOON, C.H. 1806. *Synopsis plantarum* 2, Cotta, Tübingen.

SCHONKEN, C.M. 1980. *'n Morfologiese en taksonomiese studie van die seksie* Glaucophyllum *van* Pelargonium. M.Sc. thesis, University of Stellenbosch.

SWEET, R. 1826. *Geraniaceae*, Vol. 3: 294. James Ridgway, London.

THUNBERG, C.P. 1794. *Prodromus plantarum capensium*, Part 1. Edman, Uppsala.

THUNBERG, C.P. 1823. *Flora capensis*, edn 3. Stuttgart.

VAN DER WALT, J.J.A., ALBERS, F. & GIBBY, M. 1990. Delimitation of *Pelargonium* sect. *Glaucophyllum* (Geraniaceae). *Plant Systematics and Evolution* 171: 15–26.

VAN DER WALT, J.J.A. & VORSTER, P.J. 1981. *Pelargoniums of southern Africa*, Vol. 2. Juta, Cape Town.

WENDLAND, J.C. 1798. *Botanische Beobachtungen*. Hannover.

WENDLAND, J.C. 1809. *Collectio plantarum*. Hannover.

WILLDENOW, C.L. 1800. *Caroli a Linnè species*, 4th edn, Vol. 3. Nauk, Berlin.