ISSN 0006 8241 = Bothalia

Bothalia

A JOURNAL OF BOTANICAL RESEARCH

Vol. 36,2 October 2006

TECHNICAL PUBLICATIONS OF THE SOUTH AFRICAN NATIONAL BIODIVERSITY INSTITUTE PRETORIA

Obtainable from the South African National Biodiversity Institute, Private Bag X101, Pretoria 0001, Republic of South Africa. A catalogue of all available publications will be issued on request.

BOTHALIA

Bothalia is named in honour of General Louis Botha, first Premier and Minister of Agriculture of the Union of South Africa. This house journal of the South African National Biodiversity Institute, Pretoria, is devoted to the furtherance of botanical science. The main fields covered are taxonomy, ecology, anatomy and cytology. Two parts of the journal and an index to contents, authors and subjects are published annually.

Three booklets of the contents (a) to Vols 1–20, (b) to Vols 21–25 and (c) to Vols 26–30, are available.

STRELITZIA

A series of occasional publications on southern African flora and vegetation, replacing *Memoirs of the Botanical Survey of South Africa* and *Annals of Kirstenbosch Botanic Gardens.*

MEMOIRS OF THE BOTANICAL SURVEY OF SOUTH AFRICA

The memoirs are individual treatises usually of an ecological nature, but sometimes dealing with taxonomy or economic botany. Published: Nos 1–63 (many out of print). Discontinued after No. 63.

ANNALS OF KIRSTENBOSCH BOTANIC GARDENS

A series devoted to the publication of monographs and major works on southern African flora. Published: Vols 14–19 (earlier volumes published as supplementary volumes to the *Journal of South African Botany*). Discontinued after Vol. 19.

FLOWERING PLANTS OF AFRICA (FPA)

This serial presents colour plates of African plants with accompanying text. The plates are prepared mainly by the artists at the South African National Biodiverity Institute. Many botanical artists have contributed to the series, such as Fay Anderson, Peter Bally, Auriol Batten, Gillian Condy, Betty Connell, Stella Gower, Rosemary Holcroft, Kathleen Lansdell, Cythna Letty (over 700 plates), Claire Linder-Smith and Ellaphie Ward-Hilhorst. The Editor is pleased to receive living plants of general interest or of economic value for illustration.

From Vol. 55, twenty plates are published at irregular intervals.

An index to Vols 1–49 is available.

FLORA OF SOUTHERN AFRICA (FSA)

A taxonomic treatise on the flora of the Republic of South Africa, Lesotho, Swaziland, Namibia and Botswana. the *FSA* contains descriptions of families, genera, species, infraspecific taxa, keys to genera and species, synonymy, literature and limited specimen citations, as well as taxonomic and ecological notes.

Contributions to the *FSA* also appear in *Bothalia*.

PALAEOFLORA OF SOUTHERN AFRICA

A palaeoflora on a pattern comparable to that of the *Flora of southern Africa*. Much of the information is presented in the form of tables and photographic plates depicting fossil populations. Now available:

Molteno Formation (Triassic) Vol. 1. Introduction. *Dicroidium*, 1983, by J.M. & H.M. Anderson.

Molteno Formation (Triassic) Vol. 2. Gymnosperms (excluding *Dicroidium*), 1983, by J.M. & H.M. Anderson.

Prodromus of South African Megafloras. Devonian to Lower Cretaceous, 1985, by J.M. & H.M. Anderson. Obtainable from:A.A. Balkema Marketing, Box 317, Claremont 7735, RSA.

Towards Gondwana Alive. Promoting biodiversity and stemming the Sixth Extinction, 1999, by J.M. Anderson (ed.).

BOTHALIA

A JOURNAL OF BOTANICAL RESEARCH

Volume 36,2

Scientific Editor: G. Germishuizen
Technical Editor: B.A. Momberg

2 Cussonia Avenue, Brummeria, Pretoria
Private Bag X101, Pretoria 0001

ISSN 0006 8241

Oct. 2006

Acknowledgements to referees

Archer, Mrs C. South African National Biodiversity Institute, Pretoria, RSA.
Bredenkamp, Dr C.L. South African National Biodiversity Institute, Pretoria, RSA.
Burrows, J. P.O. Box 710, Lydenburg 1120, RSA.
Cowling, Prof. R.M. University of Port Elizabeth, RSA.
Dold, A. Selmar Schonland Herbarium, Albany Museum, Grahamstown, RSA.
Fish, Mrs L. South African National Biodiversity Institute, Pretoria, RSA.
Goldblatt, Dr P. Missouri Botanical Garden, St Louis, USA.
Ihlenfeldt, Prof. H-D. Ostseestr. 40, D-24369 Waabs/Langholz, Germany.
Judd, Dr W.S. University of Florida, Gainesville, USA.
Klak, Ms C. University of Cape Town, RSA.
Leistner, Dr O.A., South African National Biodiversity Institute, Pretoria, RSA.
Linder, Prof. H.P. University of Zürich, Switzerland.
Manning, Dr J.C. South African National Biodiversity Institute, Cape Town, RSA.
Phillips, Dr S.M. The Herbarium, Royal Botanic Gardens, Kew, England, UK.
Pysek, Dr P. Academy of Sciences, Pruhonice, Czech Republic.
Rebelo, Dr A.G. South African National Biodiversity Institute, Cape Town, RSA.
Roux, Dr J.P., South African National Biodiversity Institute, Cape Town, RSA.
Singh, Ms Y. South African National Biodiversity Institute, Durban, RSA.
Snijman, Dr D.A. South African National Biodiversity Institute, Cape Town, RSA.
Stevens, Dr P.F. Missouri Botanical Garden, St Loius, USA.
Van Wyk, Prof. A.E. University of Pretoria, RSA.
Wiland-Syzmanska, Dr J. Department of Geobotany, Adam Mickiewicz University, Pozanan, Poland.
Williams, Dr P. Landcare Research, Nelson, New Zealand.

CONTENTS

Bothalia 36,2

New species in Bothalia 36,2 (2006)

Bothalia 36,2: 133–138 (2006)

Two new species of *Spiloxene* (Hypoxidaceae) from the northwestern Cape, South Africa

D.A. SNIJMAN*

Keywords: Hypoxidaceae, new species, South Africa, *Spiloxene* Salisb., taxonomy, winter rainfall region

ABSTRACT

Newly described are two new species of *Spiloxene* Salisb.: *S.* **nana** Snijman from the Bokkeveld Escarpment, Northern Cape Province, is a shade-loving plant with narrow, pale green leaves and small, white or rarely cream-coloured flowers; *S.* **pusilla** Snijman from the Matsikamma, Gifberg and Pakhuis Mountains, Western Cape Province, resembles *S.* **nana** in habit but the yellow- or white-tepalled flowers which are tetramerous or hexamerous have darkly coloured stamens and style and an ovary with a short, solid, narrow prolongation at the apex. Inhabiting rock overhangs formed by quartzitic sandstone sheets, both species are close allies of *S. scullyi* (Baker) Garside from Namaqualand.

With about 30 species, *Spiloxene* Salisb. is the largest genus of the family Hypoxidaceae in the Greater Cape Floristic Region, which corresponds geographically with the winter and all-year rainfall region of southern Africa. The genus, as presently circumscribed, was first separated from *Hypoxis* L. by Williams (1901) who reinstated the name *Ianthe* Salisb. that was originally applied to just three species (Salisbury 1866). Despite its early history, the genus has nevertheless remained one of the most poorly studied groups of Cape geophytes. The last comprehensive revision of the genus was that of Nel (1914) who, having taken into account that the letters I and J are interchangeable in the transliteration of the Greek letter 'iota', re-introduced the spelling *Janthe*, which was first used by Pax (1887) for a section of *Hypoxis*. Fourcade (1932) then changed the name to *Spiloxene* following the discovery that *Ianthe* Salisb. (Salisbury 1866) is a later homonym of *Janthe* Griseb. (Grisebach 1844), which has become a synonym of *Celsia* L. in the family Scrophulariaceae.

In two recent regional treatments, the accounts of *Spiloxene* included an undescribed species, which was referred to as 'sp.1' (Snijman 2000a; Manning *et al.* 2002). In the short period following the preparation of these publications, however, new material has been collected that clarifies what was proposed as the new species. It has become apparent that what was previously regarded as one species actually comprises two species of shade-loving plants that are separated from one another geographically. The new species are described and illustrated here as *Spiloxene nana* from the Bokkeveld Escarpment near Nieuwoudtville, Northern Cape, and *S. pusilla* from the Matsikamma–Gifberg massif near Vanrhynsdorp and the Pakhuis Mountains in the northern Cederberg, Western Cape.

Spiloxene nana *Snijman*, sp. nov., quoad habitum et floribus parvis ad *S. pusillae* Snijman, sed ab ea differt filamentis e basi libris, antheras et stigmatibus luteolis (haud rubiginosis). Ab *S. scullyi* (Baker) Garside foliis 1.5–5.0 mm (nec 3–14) mm latis, floribus 2 (nec 2–5), albis raro cremeis (non luteis), ovario triloculare (non uniloculare) et placentatio axilis (non parietali) facile distinguitur. Figura 1.

TYPE.—Northern Cape, 3119 (Calvinia): Oorlogskloof Nature Reserve, 773 m, (–AC), 11-10-200 *W.A.J. Pretorius 589* (NBG, holo.; K, MO, PRE).

Deciduous, entirely glabrous, softly herbaceous, cormous plant, 95–350 mm high. *Corms* growing horizontally or geotropically; new corms somewhat globose, 4–10 mm diam., loosely covered by brown tunics; old corms persisting for a few seasons as withered, flattened discs; innermost tunics papery, outermost softly fibrous; fibres fine, reticulate and free from corm base; roots dimorphic, arising from near base of new corm, slender and spreading, contractile and geotropic. *Shoot* arising laterally, surrounded at base by a membranous cataphyll up to 45 mm long. *Foliage leaves* synanthous, 2–6, 3-ranked in a basal tuft, sheathing from ± 10–30 mm at base; blades suberect to slightly arched, narrowly lanceolate, V-shaped in t/s, 35–350 × 1.5–5.0 mm, the innermost narrowest, pale green, soft and thin-textured, keeled abaxially almost to apex; margins entire. *Inflorescences* 2 or more, erect, a 2-flowered umbel-like raceme; scape 30–150 × 0.5–2.0 mm, laterally compressed, pale green with membranous lateral edges; bracts 2, opposite, partially sheathing pedicels proximally, lanceolate, 10–40 × 3–4 mm, foliaceous, shallowly keeled, inconspicuously nerved, pale green, with translucent margins. *Flowers* stellate, usually opening sequentially, unscented; pedicels suberect at anthesis thereafter spreading horizontally, triangular in t/s, 35–80 × 1 mm, slender, pale green; tepals 6, reflexed when fully open, narrowly lanceolate, 2.5–7.0(–12.0) mm long, white or rarely cream-coloured, occasionally flushed pink, backed with pale green in outer whorl, outer tepals 1.5–2.5 mm wide and mucronate, inner tepals 1–2 mm wide and minutely mucronate. *Stamens* 6, slightly spreading, unequal, outer whorl slightly shorter than inner; filaments inserted at base of tepals and joined to sinus between anther lobes, filiform, 0.5–1.5 mm long, yellow; anthers latrorse, oblong, 1.5–2.0 mm long before opening, yellow, apical and basal lobes slightly spreading and ± 0.05 mm long; pollen yellow. *Ovary* inferior, narrowly tubular to ellipsoidal, 2.5–8.0(–11.0) × 0.7–2.0 mm, 3-locular with axile placentation, narrowed distally

* Compton Herbarium, South African National Biodiversity Institute, Private Bag X7, 7735 Claremont, Cape Town.
MS. received: 2006-04-18.

FIGURE 1.—*Spiloxene nana*: A, B, *Pretorius 589*; C–F, *Rourke 2218.* A, whole plant, including t/s leaf; B, corm; C, flower; D, stamens, style column and stigmatic branches; E, capsule; F, seed. Scale bars: A, 5 mm; B, 2 mm; C, 2.5 mm; D, 1 mm; E, 3 mm; F, 0.2 mm. Artist: John Manning.

into an inconspicuous, solid, ± 0.5 mm prolongation that sometimes extends up to 1 mm after anthesis; ovules 15–20 per locule; style column cylindrical, 0.3–0.5 mm long, white; stigmatic branches 3, erect but eventually spreading, 1.2–3.0 mm long, tapering upwards from broad base, with edges of abaxial surface slightly folded together, densely papillate on margins and edges of adaxial surface, white. *Capsule* narrowly ellipsoidal, 2.5–11.0 × 1.0–2.0 mm, thin-walled, shedding withered ovary beak and perigone; dehiscence loculicidal, irregularly longitudinal; placental ridges remaining contiguous axially; septa disintegrating. *Seeds* depressed-ellipsoidal, 0.53 × 0.43 mm; funicle stout, attached in chalazal hemisphere; micropyle prominent; testa brittle, lustrous black with wicker basket-like ornamentation, consisting of ± 15 longitudinal rows of closely set, transversally widened cells; outer periclinal walls each with a central, conical, raised papilla. Figure 1.

Phenology: *Spiloxene nana* is spring flowering, mostly from the middle of September to late October. The leaves are green during the winter and spring but die back during the onset of the dry conditions which extend through summer and autumn.

Distribution and habitat: the species is known only from the Bokkeveld Escarpment near Nieuwoudtville, Northern Cape (Figure 2), where it was first collected by Mrs L. Bolus in 1930. Surrounded by sheer quartzitic sandstone cliffs belonging to the Nardouw Formation, the Escarpment is deeply dissected by the Oorlogskloof River which flows through a 100 m deep gorge. *Spiloxene nana* is found on the Escarpment's southwest-facing slopes which are relatively moist and cool, unlike the hotter and drier slopes that face northeast. Several populations, sometimes comprising as many as 500 plants in each, have been recorded in and around the Oorlogskloof Nature Reserve. Individuals are usually massed together in shallow soil under damp, shaded rock ledges at 730–770 m. Although locally dominant in small patches, other tiny, shade-loving plants may co-occur, especially the softly herbaceous, annual species, *Crassula strigosa*.

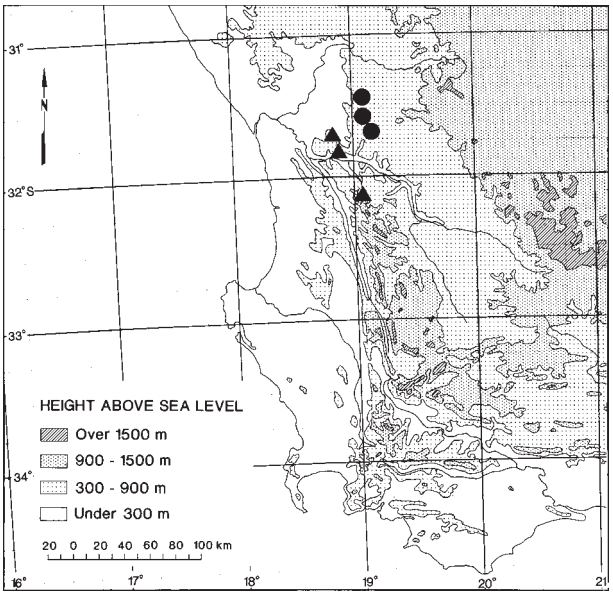

FIGURE 2.—Known distribution of *Spiloxene nana*, ●, in the Northern Cape Province; and *S. pusilla*, ▲, in the Western Cape Province.

Diagnostic features: as the epithet suggests, *Spiloxene nana* is characterized by slender leaves, 1.5–5.0 mm wide, and relatively small flowers ranging from 5–12(–20) mm across. In addition, the flowers are inconspicuously coloured—white or rarely cream-coloured with a pink flush, but always with pale green on the backs of the outer tepals—and the tepals usually reflex downwards when fully mature. Although the leaves are fairly long (up to ± 350 mm) they are characteristically soft and pale green with a delicate appearance.

Its affinities seem to lie primarily with *Spiloxene pusilla*, which closely resembles *S. nana* in habit. Furthermore, the somewhat membranous leaves and the thin-textured, pale green foliaceous bracts suggest that *S. nana* and *S. pusilla* are allied to *S. scullyi* (Baker) Garside, a species found in the granite hills of Namaqualand and which belongs to Nel's Aquaticae group (Nel 1914). Although Nel described the corms of the five species in this group as lacking persistent fibres and the disc-like remnants of old corms, those of *S. scullyi* may sometimes be softly fibrous towards the apex and may retain a few old discoid corms laterally. Both these features are shown, for example, in *Pearson 6585* (BOL) and *Scully s.n.* (Herbarium Normale Austro-Africanum *1381* in SAM). *S. scullyi* differs from *S. nana* and *S. pusilla*, however, in generally being more robust. It has broader leaves, 3–9(–14) mm wide, and considerably larger flowers, 14–28(–38) mm across, which are plain yellow above. Most importantly, the ovary in *S. scullyi* is unilocular with parietal placentation. Like most other *Spiloxene* species, the ovary in *S. nana* or *S. pusilla* is trilocular with axile placentation.

The similarities and differences between *Spiloxene nana* and *S. pusilla* are fully discussed below under *S. pusilla*.

Other specimens examined

NORTHERN CAPE.—3119 (Calvinia): stream feeding waterfall ± 10 miles out of Nieuwoudtville, (–AC), *L.Bolus* (*BOL19597*); Oorlogskloof trail near Nieuwoudtville, (–AC), *Esterhuysen s.n.* (NBG); 9 km SW of Nieuwoudtville on Groot Tuin 653, near hiking trail, (–AC), *Helme 3075* (NBG); Oorlogskloof Nature Reserve, (–AC), *W.A.J. Pretorius 279* (NBG), near Eland se Kliphuis, *Rourke 2218* (NBG, PRE), *Snijman 1865a* (NBG, PRE), Annex Uitkomst 797, ± 425 m NE of Dolfontein camp, on a steep SSW-facing slope under a damp, shaded rock ledge, *R.C. Turner 1374* (NBG, PRE); Lokenburg, under overhanging rocks, (–CA), *Acocks 19725* (NBG, PRE); Uitkomst Farm, SW of Nieuwoudtville, (–CA), *W.F. Barker 10730* (NBG); Farm Driefontein, 18 km S of Nieuwoudtville, (–CA), *Goldblatt & Manning 19725* (NBG, PRE).

Spiloxene pusilla *Snijman*, sp. nov., habitu et textura *S. nanae* Snijman similis, praecipue differt filamentis ad stylum connatis, ovario breviter rostrato, antherae connectivo et stylo rubiginoso. Figura 3.

TYPE.—Western Cape, 3118 (Vanrhynsdorp): Driekoppen Peak, Gifberg Mtns, on floor of low overhangs, (–DB), 6-9-1964, *Esterhuysen 30747* (NBG, holo.; B, BOL, K, MO, PRE, Z).

Delicate, deciduous, entirely glabrous, cormous herb, 70–190(–300) mm high. *Corms* growing horizontally or geotropically, new corms somewhat globose, 4–7 mm diam., loosely covered by dark brown tunics, withering after fruiting and persisting for a few seasons as flat-

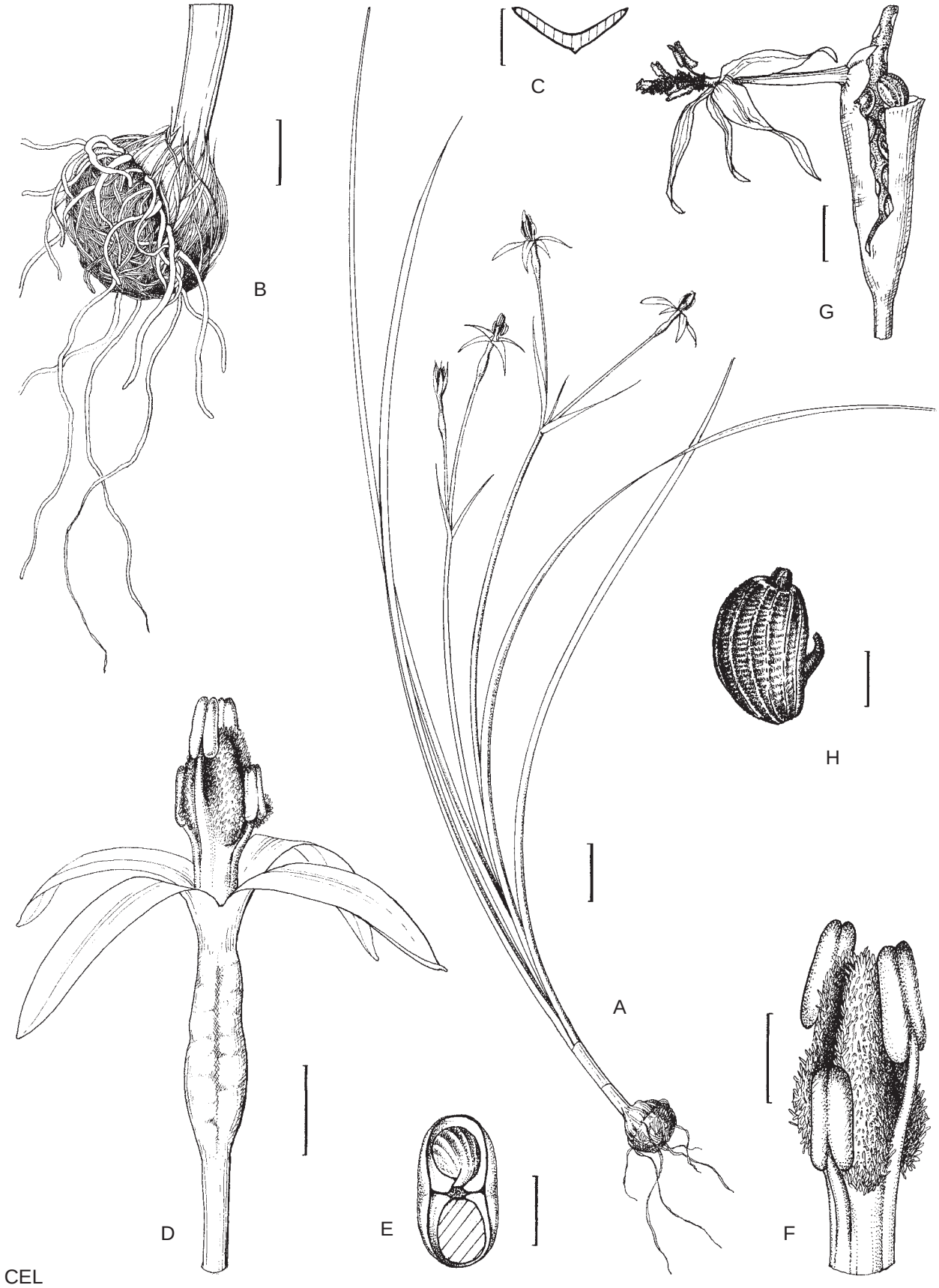

FIGURE 3.—*Spiloxene pusilla*, *Snijman 1623*. A, whole plant; B, corm; C, t/s leaf; D, flower; E, t/s ovary; F, stamens, style column and stigmatic branches; G, capsule; H, seed. Scale bars: A, 5 mm; B, 2 mm; C, D, G, 1 mm; E, F, 0.5 mm; H, 0.2 mm. Artist: Claire Linder Smith.

tened discs; innermost tunics papery, outermost softly fibrous; fibres reticulate and free from corm base; roots dimorphic, arising from base of new corm, slender and spreading, contractile and geotropic. *Shoot* arising laterally, surrounded at base by a membranous cataphyll up to 10 mm long. *Foliage leaves* synanthous, 2–6, 3-ranked in a basal tuft, sheathing for up to 10 mm at base; blades suberect to slightly arched, narrowly lanceolate, V-shaped in t/s, 45–160(–300) × 1.0–2.5 mm, pale green, soft and thin-textured, keeled abaxially almost to apex; margins entire. *Inflorescences* 2 or more, erect, a 2(rarely 3)-flowered umbel-like raceme; scape 20–100 × 0.5–1.5 mm, laterally compressed, sharp-edged, pale green; bracts 2(3), opposite, partially sheathing pedicels proximally, lanceolate, 15–25 × 1–3 mm, foliaceous, shallowly keeled, inconspicuously nerved, pale green, with translucent margins. *Flowers* stellate, usually opening sequentially; pedicels suberect at anthesis and thereafter, terete, 20–50(–80) mm long, slender, pale green; tepals 4 or 6, rarely 5, reflexed when fully open, narrowly lanceolate, 3–4 mm long, yellow or white, backed with pale green mostly in outer whorl, outer tepals 1.5 mm wide and mucronate, inner tepals 1.0–1.2 mm wide and minutely mucronate. *Stamens* as many as tepals, suberect proximally to slightly spreading distally, unequal, outer whorl slightly shorter than inner; filaments joined to sinus between anther lobes, filiform, 1.4–2.2 mm long, yellow, maroon-tipped, outer whorl adnate to style base for up to ± 0.5 mm, inner whorl adnate to style for up to ± 1 mm; anthers latrorse, oblong, 1.0–1.4 mm long before opening, apical and basal lobes ± 0.17 mm long and slightly spreading; thecae and pollen yellow; connective dark red. *Ovary* inferior, narrowly ellipsoidal, 2.3–3.0 × 0.8–1.2 mm, 2- or 3-locular with axile placentation, narrowed distally into a solid, 0.5–1.0 mm prolongation that lengthens up to 1.5 mm after anthesis; ovules 15–20 per locule; style column cylindrical, 1.5 mm long, yellow; stigmatic branches 2 or 3, erect, 0.9–1.5 mm long, slightly broader than style column, with edges of abaxial surface slightly folded together, densely papillate on margins and edges of adaxial surface, dark red. *Capsule* narrowly ellipsoidal, 2.5–5.0 × 1.0–1.5 mm, thin-walled, partially topped with withered, persistent ovary beak and perigone; dehiscence irregularly apical and longitudinal; placental ridges remaining contiguous axially; septa disintegrating. *Seeds* ovate, ± 0.5 × 0.4 mm; raphe continuous with a short, straight, persistent funicle attached in chalazal hemisphere; micropyle slightly raised; testa brittle, shiny black, of transversally widened cells, ornamented with ± 12 widely spaced, longitudinal ribs; outer periclinal walls each with a central, blunt, raised papilla; papillae closely aligned giving ribbed appearance. Figure 3.

Phenology: flowering extends throughout spring from early September to mid-October. The leaves remain green for slightly longer until the onset of the summer dry period, when they are shed. New leaves emerge each year with the onset of winter rain which often starts to fall in autumn. Most species of *Spiloxene* depend on sunshine to open their flowers (lasting from ± 11:00 to ± 16:00), but those of *S. pusilla* are able to open in the shade and to remain open throughout the day.

Distribution and habitat: *Spiloxene pusilla* is restricted to the northwestern Cape Fold Mountains (Figure 2), where populations are found on the relatively moist, cool summit of the Gifberg and Matzikamma massif, near Vanrhynsdorp, and on the Pakhuis Mountains east of Clanwilliam, at 460–760 m. These mountains have large areas of exposed, flat, quartzitic sandstone sheets that are often waterlogged in winter and are extremely dry in summer. The plants shelter under south-facing, overhanging rocks in shallow, sandy soil, where they escape the severe conditions of the exposed rock sheets. *S. pusilla* is often the sole inhabitant of these cool, shady, shelf-like habitats, where it forms dense mats having the appearance of soft, pale green turf.

Diagnostic features: one of the most unusual features of this species, and perhaps the most important reason why it has remained unnamed for so long, despite several collections having been made since its discovery by E.P. Phillips in 1911, is the fusion of the inner filaments to the style. Handwritten notes by the late Ms M.F. Thompson (Mrs Rand), author of several papers on Cape Hypoxidaceae (Thompson 1969, 1976a, b, 1978, 1979), suggest that she regarded the fusion of the filaments to the style to be sufficiently significant to delay formally describing the species until its relationships were more clearly understood. Fortunately, the availability of many more collections of the newly described and apparently closely related *S. nana* has made this description possible.

Morphologically *Spiloxene pusilla* bears a striking resemblance to *S. nana*. Both are shade-loving plants with delicate, narrow, pale green, extremely soft-textured leaves and small flowers, often only 10 mm in diameter. In addition, both species inhabit rock overhangs where the plants form dense, turf-like patches.

The particular features that separate *Spiloxene pusilla* from *S. nana* are those of the flower. The inner filaments are shortly fused to the style (versus free from the style); the anther connectives and stigmatic branches are dark red (as opposed to yellow); and the ovary is constricted into a short (0.5–1.0 mm) but distinct solid, neck-like prolongation at anthesis (compared with an indistinct prolongation of up to ± 0.5 mm that sometimes lengthens slightly after anthesis).

Elsewhere in the family a solid prolongation of the ovary, most often referred to as the ovary beak, is found in *Empodium* Salisb., *Curculigo* Gaertn., *Molineria* Colla, *Rhodohypoxis* Nel and *Saniella* Hilliard & B.L.Burtt (Hilliard & Burtt 1978), and although infrequent in *Spiloxene*, it is well developed in *S. alba* (Garside 1950). Moreover, the darkly coloured stamens and style, in otherwise yellow or white flowers, are only known in *Spiloxene*, particularly in the southwestern Cape species, *S. canaliculata* Garside, *S. capensis* (L.) Garside and *S. serrata* (Thunb.) Garside, which belong to a guild of beetle pollinated plants (Steiner 1998). Undoubtedly the flowers of *S. pusilla* are too small to support monkey beetles, but their dark filaments and stigmas may attract specific, albeit tiny, pollinators—an aspect which is yet to be studied. Records show that this dark coloration is constant throughout the distribution range but that populations on the Matsikamma Mountain and Gifberg consistently have yellow tepals, whereas those in the northern Cederberg have white or cream-coloured tepals.

Although Figure 3 shows a plant with tetramerous flowers, this is not constant in the populations, and hexamerous flowers also frequently occur, occasionally even on the same plant. Only very rarely has a pentamerous flower been noted. This variation in the number of floral parts is not unique and is also known in species of *Hypoxis* and *Empodium*.

Lastly, the only other member of Hypoxidaceae that has parts of the androecium fused to the style is *Pauridia* Harv., a small Western Cape genus of two species. *Pauridia*, however, is characterized by tepals that are joined below to form a cup-shaped or tubular perigone; an inner whorl of fertile stamens which is inserted in the perigone throat; and an outer whorl of staminodes that is fused to the style. Moreover, the stigmatic branches are slender and distinctly shorter than the style column. This is in contrast to *Spiloxene pusilla*, in which all six stamens are fertile, the flowers are stellate, and the stigmatic branches are distinctly broader and longer than the style column. These features, together with the cormous habit, are common to all the currently known species of *Spiloxene*, which suggests that this northwestern Cape species is best placed within *Spiloxene*.

Despite clear evidence from leaf anatomy and *rbc*L sequence data that *Spiloxene* and *Pauridia* are closely related (Thompson 1976a; Hilliard & Burtt 1978; Nordal 1998; Rudall *et al.* 1998; Burtt 2000; Judd 2000), both genera have been consistently retained in local floras (Garside 1950; Snijman 2000a, b). Should future studies reveal, however, that *Spiloxene* and *Pauridia* comprise one monophyletic genus, it nevertheless seems likely, given the different relative positions of the structures involved, that the fusion of filaments to style in *S. pusilla* is not homologous with the fusion of staminodes to style in *P. minuta* (L.f.) Durand & Schinz and *P. longituba* M.F.Thomps.

Other specimens examined

WESTERN CAPE.—3118 (Vanrhynsdorp): Matsikamma Mtn, Op de berg 314, Dreyers Kloof, (–DB), *Helme 1358* (NBG); Matsikamma, Farm Sewefontein, (–DB), *Snijman 1623* (NBG, PRE), *Snijman 1860* (NBG); Gifberg, (–DD), *Compton 20847* (NBG), *Esterhuysen 22062* (BOL, NBG, PRE), *E.P. Phillips 7569* (SAM); summit of Gifberg Pass, near De Kom, (–DD), *Snijman 1864* (NBG). 3219 (Wuppertal): Pakhuis, N Cederberg, (–AA), *Esterhuysen 21722* (BOL, NBG), *Esterhuysen 21910* (BOL, NBG, PRE); N Cederberg, Diagonal Kloof N of Ribbokberg, (–AA), *H.C. Taylor 11869* (NBG).

ACKNOWLEDGEMENTS

I am most grateful to Claire Linder Smith and John Manning for the accompanying illustrations and to Nick Helme, Colin Paterson-Jones, Wessel Pretorius, Dave and Betty Schlebusch, and Ross Turner for their kind assistance in the field. The Northern Cape Department of Nature and Environmental Conservation and the Western Cape Nature Conservation Board are thanked for granting permits to collect specimens of the above species.

REFERENCES

BURTT, B.L. 2000. *Saniella* and its relation to other South African genera of Hypoxidaceae. *Edinburgh Journal of Botany* 57: 63–70.

FOURCADE, H.G. 1932. Contributions to the flora of the Knysna and neighbouring divisions. *Transactions of the Royal Society of South Africa* 21: 75, 76.

GARSIDE, S. 1950. *Spiloxene*. In R.S. Adamson & T.M. Salter, *Flora of the Cape Peninsula*: 214–217. Juta, Cape Town.

GRISEBACH, A.H.R. 1844. *Spicilegium florae rumelicae et bithymicae* 1. Vieweg, Braunschweig.

HILLIARD, O.M. & BURTT, B.L. 1978. Notes on some plants from southern Africa chiefly from Natal: VII. *Notes from the Royal Botanic Garden Edinburgh* 36: 43–76.

JUDD, W.S. 2000. The Hypoxidaceae in the southeastern United States. *Harvard Papers in Botany* 5: 79–98.

MANNING, J., GOLDBLATT, P. & SNIJMAN, D. 2002. *The color encyclopedia of Cape bulbs.* Timber Press, Oregon and Cambridge.

NEL, G. 1914. Die afrikanischen Arten der Amaryllidaceae–Hypoxideae. *Botanische Jahrbücher* 51: 287–340.

NORDAL, I. 1998. Hypoxidaceae. In K. Kubitzki, *The families and genera of vascular plants III: flowering plants—Monocotyledons Lilianae (except Orchidaceae)*: 286–294. Springer, Berlin.

PAX, F. 1887. Amaryllidaceae (Hypoxidoideae–Hypoxideae). In A. Engler & K. Prantl, *Die natürlichen Pflanzenfamilien*, Teil 2, Abteiling 5: 121, 122. Engelmann, Leipzig.

RUDALL, P.J., CHASE, M.W., CUTLER, D.F., RUSBY, J. & DE BRUIJN, A.Y. 1998. Anatomical and molecular systematics of Asteliaceae and Hypoxidaceae. *Botanical Journal of the Linnean Society* 127: 1–42.

SALISBURY, R.A. 1866. *The genera of plants: a fragment containing part of Liriogamae*. Van Voorst, London.

SNIJMAN, D.A. 2000a. Hypoxidaceae. In P. Goldblatt & J.C. Manning, Cape Plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9: 108–110. National Botanical Institute, Pretoria & Missouri Botanical Garden, St. Louis.

SNIJMAN, D.A. 2000b. Hypoxidaceae. In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 621–623. National Botanical Institute, Pretoria.

STEINER, K.E. 1998. Beetle pollination of peacock moraeas (Iridaceae) in South Africa. *Plant Systematics and Evolution* 209: 47–65.

THOMPSON, M.F. 1969. *Spiloxene capensis* and *S. canaliculata*. *The Flowering Plants of Africa* 39: t. 1557A & B.

THOMPSON, M.F. 1976a. Studies in the Hypoxidaceae. I. Vegetative morphology and anatomy. *Bothalia* 12: 111–117.

THOMPSON, M.F. 1976b. *Empodium namaquensis*. *The Flowering Plants of Africa* 44: t. 1727.

THOMPSON, M.F. 1978. Studies in the Hypoxidaceae. II. Floral morphology and anatomy. *Bothalia* 12: 429–435.

THOMPSON, M.F. 1979. Studies in the Hypoxidaceae. III. The genus *Pauridia*. *Bothalia* 12: 621–625.

WILLIAMS, F.N. 1901. On *Ianthe*, a genus of Hypoxidaceae. *Journal of Botany* 39: 289–294.

Bothalia 36,2: 139–145 (2006)

New species of Iridaceae from the Hantam-Roggeveld Centre of Endemism, and the Bokkeveld, Northern Cape, South Africa

J.C. MANNING* and P. GOLDBLATT**

Keywords: Iridaceae, *Ixia amethystina* J.C.Manning & Goldblatt, *Moraea marginata* J.C.Manning & Goldblatt, new species, *Romulea singularis* J.C.Manning & Goldblatt, South Africa, taxonomy

ABSTRACT

Three new species of Iridaceae are described from the Bokkeveld and Roggeveld Escarpments. *Ixia* **amethystina**, a member of section *Dichone*, is endemic to the edge of the Roggeveld Escarpment. It shares an unusual, inclined spike that is nodding in bud with *I. trifolia* but is distinguished by its blackish purple (not yellow) anthers, narrower leaves 1.5–2.0 mm wide, medium-textured corm tunics that form a distinct neck at the base of the stem, and short style branches 2.0–2.5 mm long. *Moraea* **marginata**, another Roggeveld endemic, is a member of section *Polyanthes* and florally similar to *M. fistulosa* and *M. monticola* but differs in its linear, channelled leaves 5–7 mm wide, with unusual, thickened margins. *Romulea* **singularis**, from the edge of the Kobee River Valley in the Bokkeveld Mountains, is a member of section *Ciliatae*. It is unique in the genus in its narrowly funnel-shaped, mauve to purple flowers with slender perianth tube 10–11 mm long, and unusually long filaments, 8–9 mm long, inserted in the lower half of the tube.

INTRODUCTION

Plant geographers have been aware of the high levels of endemism in the flora of the winter rainfall region along the western margin of the Upper Karoo for almost a century, culminating in its recent recognition as the Hantam-Roggeveld Centre of Endemism (Van Wyk & Smith 2001). The Hantam-Roggeveld occupies the high-lying southwestern portion of the South African interior plateau and includes the Hantams, Roggeveld and Nuweveld Mountains. The vegetation is primarily succulent karroid shrubland, with renosterveld at the higher elevations and in moister areas. The region is exceptionally rich in geophytes, which may account for nearly 40% of the flora in some places (Snijman & Perry 1987). The richest and most interesting geophyte flora is found along its western rim, on the main Roggeveld Escarpment and on the Hantamsberg, which receives more rain than the surrounding country. Among the geophyte flora are some 90 species of Iridaceae, many endemic to the region (Manning *et al.* 2002).

The Bokkeveld Mountains, which border the Hantam-Roggeveld in the northwest, constitute the northern limit of the Cape Floral Region (Goldblatt & Manning 2000). This sandstone escarpment supports dry fynbos vegetation, with a narrow belt of renosterveld along its interior margin. Although not recognized as a separate centre of endemism by Van Wyk & Smith (2001), the region is a centre of diversity for several geophyte genera (Manning *et al.* 2002), and its flora includes numerous endemic Iridaceae (Manning & Goldblatt 1997).

Here we describe two new species from the Roggeveld-Hantam plateau, *Ixia amethystina* and *Moraea marginata*, and a third, *Romulea singularis*, from the Bokkeveld Mountains. All three species appear to be most closely allied to other endemics from their respective regions, emphasizing the importance of local radiation in the floras of these two regions. Two of these species, *M. marginata* and *R. singularis*, were brought to our attention by botanist and ardent plant enthusiast, Nick Helme, who has been responsible for the discovery of several new species in the Cape region in the past few years (Manning & Goldblatt 2001a; Van Jaarsveld & Thomas 2003; Goldblatt 2004).

Ixia amethystina *J.C.Manning & Goldblatt*, sp. nov.

Species habitu floribusque *Ixia trifolia* G.J.Lewis similis sed floribus pallide purpureis centro tuboque atropurpureis, antheris atropurpureis, ramis stylorum inconspicuis filamentis brevioribus 2.0–2.5 mm longis, et foliis angustioribus 1.5–2.0 mm latis differt.

TYPE.—Northern Cape, 3220 (Sutherland): west of Farm Agterkop, near the top of Gannaga Pass, (–AA), 16 September 1997, *P. Goldblatt & J.C. Manning 10745A* (NBG, holo.; MO, iso.).

Plants 150–300 mm high. *Corms* globose, 12–20 mm diam.; tunics of medium-textured, wiry, reticulate fibres, extending up in papery neck 30–70 mm long. *Stem* erect, unbranched or with up to two branches that are erect below and then inclined, 1.0–1.5 mm diam. below base of main spike. *Cataphylls* submembranous, flushed reddish brown, upper one reaching above ground level and then papery and dark reddish brown. *Leaves* 3 or 4, all basal, uppermost completely sheathing lower two thirds of stem, remainder suberect or lowermost slightly falcate, 1.5–2.0 mm wide, reaching to near top of stem, firm-textured, margins and midrib hyaline, slightly thickened, plane or slightly twisted in upper half, with an additional one or two membranous, scale-like leaves in upper third of stem, in axils of which lateral branches may develop. *Spike* inclined, crowded, 5–7-flowered, branches 1–4-flowered, inflorescences nodding in bud; bracts scarious, translucent or flushed purple above,

* Compton Herbarium, South African National Biodiversity Institute, Private Bag X7, 7735 Claremont, Cape Town.
** B.A. Krukoff Curator of African Botany, Missouri Botanical Garden, P.O. Box 299, St. Louis, Missouri 63166, USA.
MS. received: 2006–04–11.

outer 5–7 mm long, acute or obscurely three-dentate, inner bracts about as long as outer or slightly shorter, bicuspidate, margins connate in lower 1.5 mm around ovary. *Flowers* rotate, pale purple with small, dark purple eye, faintly scented; perianth tube filiform and clasping style for entire length, 2.0–2.5 mm long, widened only in upper 1 mm; tepals obovate, somewhat narrowed below into short claw, spreading and slightly cucullate distally, 12–13 × 7–8 mm. *Filaments* inserted at apex of tube and occluding throat, blackish purple, free, diverging above, 2.5 mm long; anthers oblong-sagittate, 4.5–5.0 × 1.5 mm, erect, thecae narrowly separated by connective and dehiscing laterally by narrow slits extending length of thecae, blackish purple; pollen creamy yellow. *Ovary* ovoid, 2.5–3.0 mm long; style straight and erect, ± 2 mm long, dividing at or just below mouth of tube, branches involute-filiform and stigmatic at apex only, purple, arching outward, 2.0–2.5 mm long. *Flowering time*: late September to early October. Figure 1A–F.

Distribution and ecology: Ixia amethystina is known from a small area southwest of Middelpos on the edge of the Roggeveld Escarpment (Figure 2). The three known collections were made within a few kilometres of each other on the Farms Zoekop and Agterkop. Plants grow in stony clay in renosterveld (*Elytropappus rhinocerotis*)

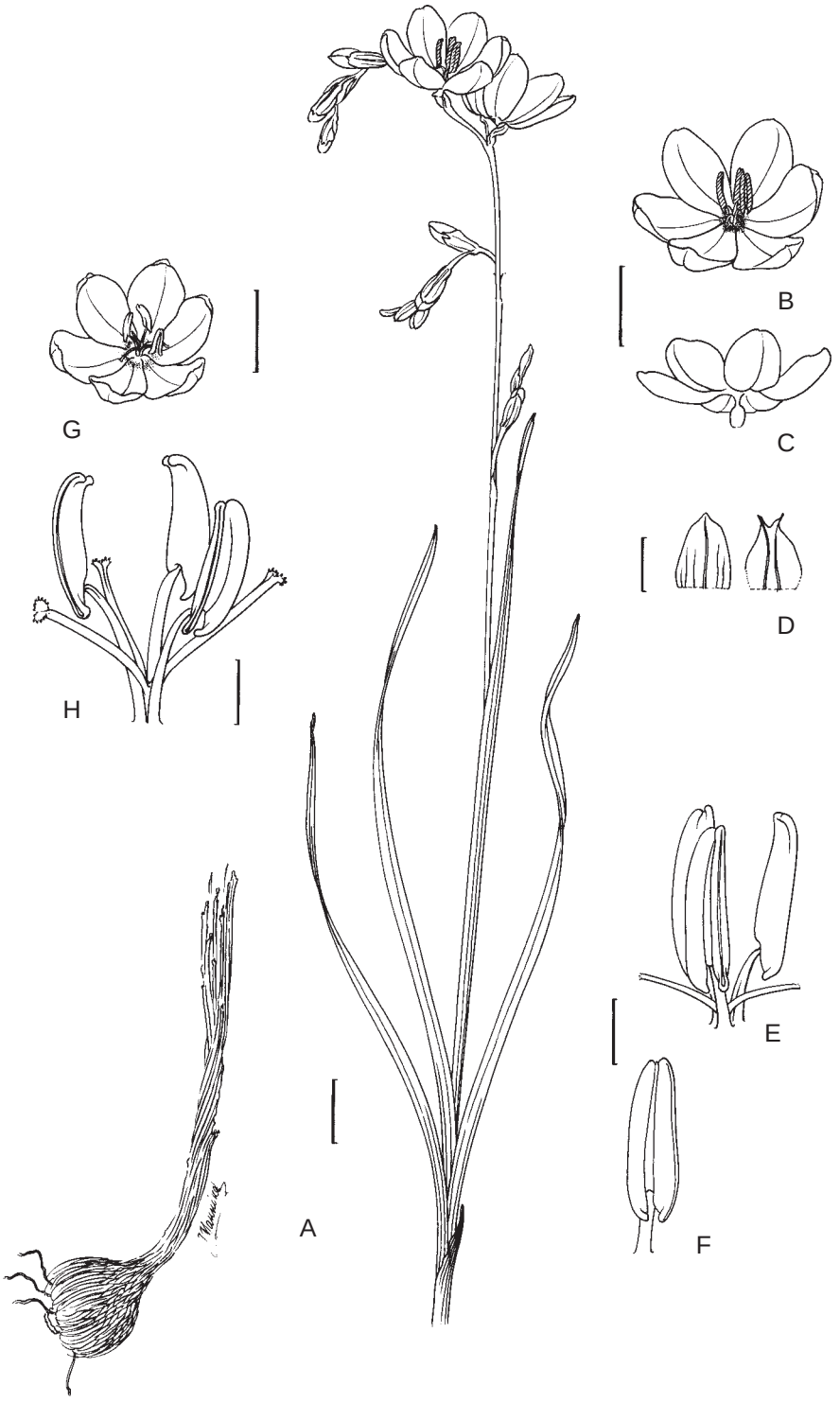

FIGURE 1.—*Ixia amethystina*, *NBG192794*: A, corm and flowering stem; B, flower, three-quarter view; C, flower, side view; D, floral bracts, outer (left) and inner (right); E, stamens and style branches; F, stamen, abaxial view. *Ixia trifolia*, *Helme 1662* (NBG): G, flower, three-quarter view; H, stamens and style branches. Scale bars: A–C, G, 10 mm; D, 5 mm; E, F, H, 2 mm. Artist: John Manning.

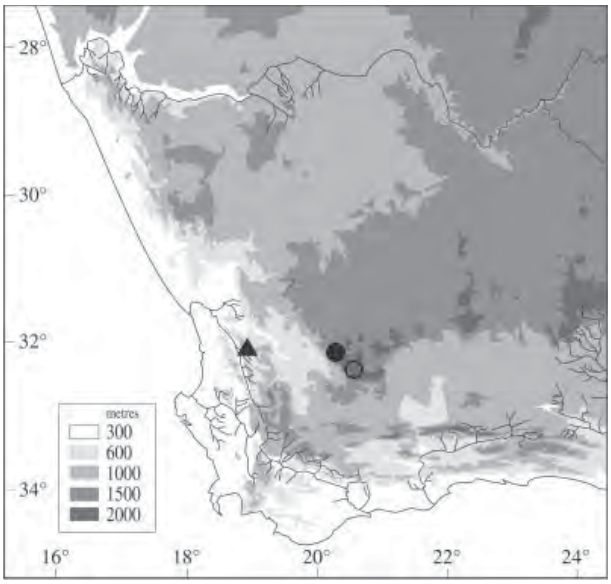

FIGURE 2.—Distribution of *Ixia amethystina*, ●; *Moraea marginata*, ○; and *Romulea singularis*, ▲.

shrubland. *I. amethystina* appears to be less sensitive to light and temperature than other species in the subgenus. The flowers open widely around 08:00, even in cool, overcast conditions and remain fully open until late afternoon, whereas those of *I. trifolia*, like many other species of section *Dichone*, will not open fully under cooler conditions.

Diagnosis and relationships: *Ixia amethystina* is an attractive species distinguished by its pale purple flowers with small, dark eye, relatively broad, blackish anthers that dehisce laterally so that the pollen forms a contrasting pale margin to each anther, and short style branches that are subequal to the filaments in length, thus scarcely projecting from between the stamens. The lovely amethyst-coloured flowers are borne on inclined spikes so that they face directly upward in an elegant, arching spray.

The filiform perianth tube clasping the style for its whole length and the involute-filiform style branches stigmatic only at the extreme apex, place *Ixia amethystina* in section *Dichone* of subgenus *Ixia* (Goldblatt & Manning 1999). Here it falls among a small group of species that are endemic or near-endemic to the Roggeveld Escarpment, including *I. brevituba* G.J.Lewis, *I. trifolia* G.J.Lewis and *I. curvata* G.J.Lewis. These species share relatively unspecialized, longitudinally dehiscent anthers, 4–5 mm long. The species of section *Dichone* from the southwestern Cape below the Escarpment, in contrast, fall into two groups defined by their derived stamens, the one characterized by its very short anthers, 2–4 mm long and the other by their curious attachment, resulting in their reclinate orientation.

Among the Roggeveld species of section *Dichone*, *Ixia amethystina* appears to be most closely allied to *I. trifolia* (Figure 1G, H) on the basis of their unusual, inclined spikes, and lateral branches that are decurved and nodding when young. All other species have spikes that are erect from bud to fruit. Although not explicitly mentioned in the original description of *I. trifolia* (Lewis 1962), this feature was later noticed and illustrated by De Vos (1999). The two species both have a perianth tube 2–3 mm long, which is longer than in *I. brevituba* (1.0–1.5 mm) but shorter than in *I. curvata* (3–5 mm). *I. amethystina* differs from *I. trifolia* in its blackish purple anthers, purple perianth tube, which gives the flowers a small, dark, central eye, consistently narrower leaves 1.5–2.0 mm wide, and medium-textured corm tunics drawn into a well-developed neck. *I. trifolia*, like all other species in section *Dichone*, has yellow anthers, although the filaments may be pale mauve, and a pale perianth tube, giving the flowers a well-defined, whitish eye. The observation by Lewis (1962) and later De Vos (1999) that *I. trifolia* may occasionally have a dark eye is not corroborated by examination of living plants. The pale eye in this species is usually surrounded by darker shading, which in pressed specimens may give the eye a dark appearance. The leaves of *I. trifolia* are broader than in *I. amethystina*, (2.5–)5.0–12.0 mm wide, and the tunics are more coarsely fibrous, with the lower fibres developed into woody claws but not drawn into a neck above. In addition, the style branches in *I. trifolia* are longer than the filaments, 4–5 mm long, and project conspicuously between them.

The unusual pale purple of the flowers of *Ixia amethystina* occurs occasionally in both *I. trifolia* and *I. brevituba* (Lewis 1962) although the flowers in these two species are more usually bright pink. Other species of section *Dichone* invariably have pale to deep pink flowers. *I. trifolia* is more widely distributed along the Roggeveld Escarpment than *I. amethystina* and has been collected from several places along the escarpment from Uitkyk in the north to Komsberg in the south and thence to Laingsburg and Tweedside below the escarpment. The two species are parapatric, with *I. amethystina* occurring immediately to the north of the range of *I. trifolia*. The differences in their flowers appear to be related to their pollination biology. *I. amethystina* has flowers that conform to the hopliine beetle pollination syndrome (Goldblatt *et al*. 1998) and the beetle *Kubousia axillaris* Burmeister has been collected on the flowers. All individuals of this insect carried pure loads of *Ixia*-type pollen on their dorsal thorax and frons (unpublished data). In contrast, *I. trifolia* is pollinated by solitary female anthophorine bees (unpublished observations).

Etymology: named for the distinctive colour of the flowers.

Other material examined

NORTHERN CAPE.—3220 (Sutherland): Zoekop Farm, 3 km S of entrance along road to Gannaga Pass, (–AA), 26 September 2002, *NBG192794* (NBG); Farm Zoekop, past ruins near edge of escarpment, (–AA), 24 September 2002, *Rosch 154* (NBG).

Moraea marginata *J.C.Manning & Goldblatt*, sp. nov.

Species habitu floribusque *Moraea fistulosa* Goldblatt affinis sed breviora 100–150 mm alta, foliis canaliculatis et marginibus incrassatis hyalinis 20–25 × 5–7 mm, et floribus parvioribus tepalis 9–13 mm longis differt.

TYPE.—Northern Cape, 3220 (Sutherland): Sutherland, 200 m along Bo-Visrivier road south of town, Farm

Tweefontein, stony flats in open karroid scrub, (–BC), 15 November 2005, *J. Manning 2997* (NBG, holo.; K, MO, iso.).

Plants 100–150 mm high. *Corm* globose, 15–20 mm diam.; tunics of coarse black fibres. *Stem* erect, usually with 1–4 branches at upper nodes, dull purplish where exposed; spathes dry and papery at flowering, attenuate, inner 25–30 mm long, outer about half as long. *Foliage leaf* solitary, basal, longer than stem, trailing and slightly twisted and coiled, firm-textured, greyish green with maroon margins but dry at flowering, linear and channelled, 20–25 × 5–7 mm, margins conspicuously thickened and cartilaginous, especially evident when dry; cauline leaves 3 or 4, bract-like and entirely sheathing, imbricate, dry and papery, attenuate. *Flowers* blue-violet; tepals free but contiguous at base, oblanceolate, outer larger, 10–13 × 3.5–4.0 mm, inner 9–12 × 2.5–3.0 mm, shortly unguiculate, claws 1.0–1.5 mm long, erect and held against base of filaments, limbs spreading or slightly reflexed, inner twisted slightly counter-clockwise distally, propeller-like, with small, oblong, yellow nectar guides 1.5–2.0 mm long at base, unscented. *Filaments* free but contiguous at base, 4–5 mm long, suberect, mauve; anthers erect, 4.5–5.0 mm long, yellow, curving inwards above at anthesis. *Ovary* narrowly ellipsoid, 4 mm long; style erect, filiform, mauve, 3.5–4.0 mm long, style branches spreading to ascending between anthers, filiform, 4 mm long. *Capsules* barrel-shaped, 6–8 × 5 mm. *Seeds* subglobose or angled by pressure, ± 2 mm diam., reddish brown, testa surface rugulose. *Flowering time*: November; flowers opening at ± 16:00 and wilting at ± 20:00. Figure 3.

Ecology: known from a single small population on the southern outskirts of the town of Sutherland at an elevation of around 1 550 m (Figure 2). Plants occur locally in fine alluvium over shale at the foot of outcrops of sandstone in open, succulent karroid scrub. The leaves are quite dry and withered at flowering, and the attractive, blue-violet flowers, 20–25 mm in diameter, open in early summer in the late afternoon for just a few hours, withering around sunset.

Diagnosis and relationships: *Moraea marginata* is recognized by the combination of stellate, purplish flowers with free stamens and filiform style branches, and a solitary, linear, channelled leaf with conspicuous, maroon margins that are conspicuously thickened when dry. The distinctive flower form places *M. marginata* with the two species previously segregated as the genus *Roggeveldia*. This genus was established by Goldblatt (1979) for *R. fistulosa* Goldblatt, a *Moraea*-like plant that was anomalous in *Moraea* as then circumscribed in having free stamens and filiform style branches that spread between the stamens, rather than being opposite to and ± appressed to them as in typical species of *Moraea*. A second species of *Roggeveldia*, *R. montana* Goldblatt, very similar to *R. fistulosa* in morphology, was described by Goldblatt (1992) more than a decade later. At this time he suggested that the relationships of the genus lay with *Moraea* section *Polyanthes*, most particularly with *M. crispa* Thunb., with which it shared a similar vegetative and floral morphology, including a rotate, blue-violet perianth, free stamens and narrow style branches without style crests. The genus *Roggeveldia* was subsequently included in *Moraea* sect. *Polyanthes* (Goldblatt 1998), following a revision of the circumscription of *Moraea*. Initially based on evidence from morphology, anatomy and chromosome cytology, this decision received subsequent support from molecular study (Goldblatt *et al.* 2002b).

Moraea marginata is indistinguishable from *M. fistulosa* (Goldblatt) Goldblatt (= *Roggeveldia fistulosa*) and *M. monticola* Goldblatt (= *R. montana*) in its flowers but differs sharply from them in its vegetative morphology. *M. fistulosa* is characterized by an erect, fistulose leaf about as tall as the stem and up to 3 mm in diameter, whereas the smaller *M. monticola* is distinguished by its trailing, filiform leaf, longer than the stem and twisted and slightly coiled, and ± 1 mm in diameter. In both these species, therefore, the leaf is terete/filiform. *M. marginata* is thus unique in the group in its linear, channelled leaf, 5–7 mm wide, with conspicuously thickened and cartilaginous margin. The leaf of *M. marginata*, which is longer than the stem, trailing, and slightly twisted and coiled, represents a remarkable specialization in the *M. crispa* alliance. Similar leaves with thickened margins are also encountered in some plants of *M. crispa* from the Roggeveld Plateau, including *Bond 145* (NBG, SAM) from the Farm Gunstfontein on the Klein Roggeveld, and *Snijman 774* (NBG) from near Williston. Although these collections are vegetatively indistinguishable from *M. marginata*, the partially fused filaments and flattened style branches, bifid at the tips and with small style crests, are entirely consistent with *M. crispa* and there is no doubt that they represent that species.

All the species of the *Roggeveldia* group have a similar phenology, flowering in early summer, in October or November, with individual flowers opening in the late afternoon around 16:00 and withering in the evening between 19:00 and 20:00. The species are concentrated in the western Karoo, along the edge of the central escarpment, and are generally poorly known and collected. *Moraea marginata* and *M. fistulosa* are known only from the type collections, both from the edge of the Roggeveld Escarpment near Sutherland, and *M. monticola* from three collections, one in Namaqualand and two from the southern margin of the Great Karoo. *M. crispa*, in contrast, is widespread through the drier interior mountains of the Cape region and along the western and southern edge of the interior escarpment (Goldblatt 1986). *M. crispa* is probably plesiomorphic in its somewhat flattened and bifid style branches and thus most likely sister to the *Roggeveldia*-group.

Etymology: alluding to the unusual, thickened leaf margin.

Romulea singularis *J.C.Manning & Goldblatt*, sp. nov.

Inter species sectionis *Romulea* floribus malvinis ad lilacinis fauce albo purpureo striato, tubo rubro-ochraceo externe, tubo perianthi anguste infundibuliforme 10–11 mm longo, tepalis lanceolatis ± 13 × 3 mm, filamentis 8–9 mm longis antheris longioribus ad basem puberulis recedens.

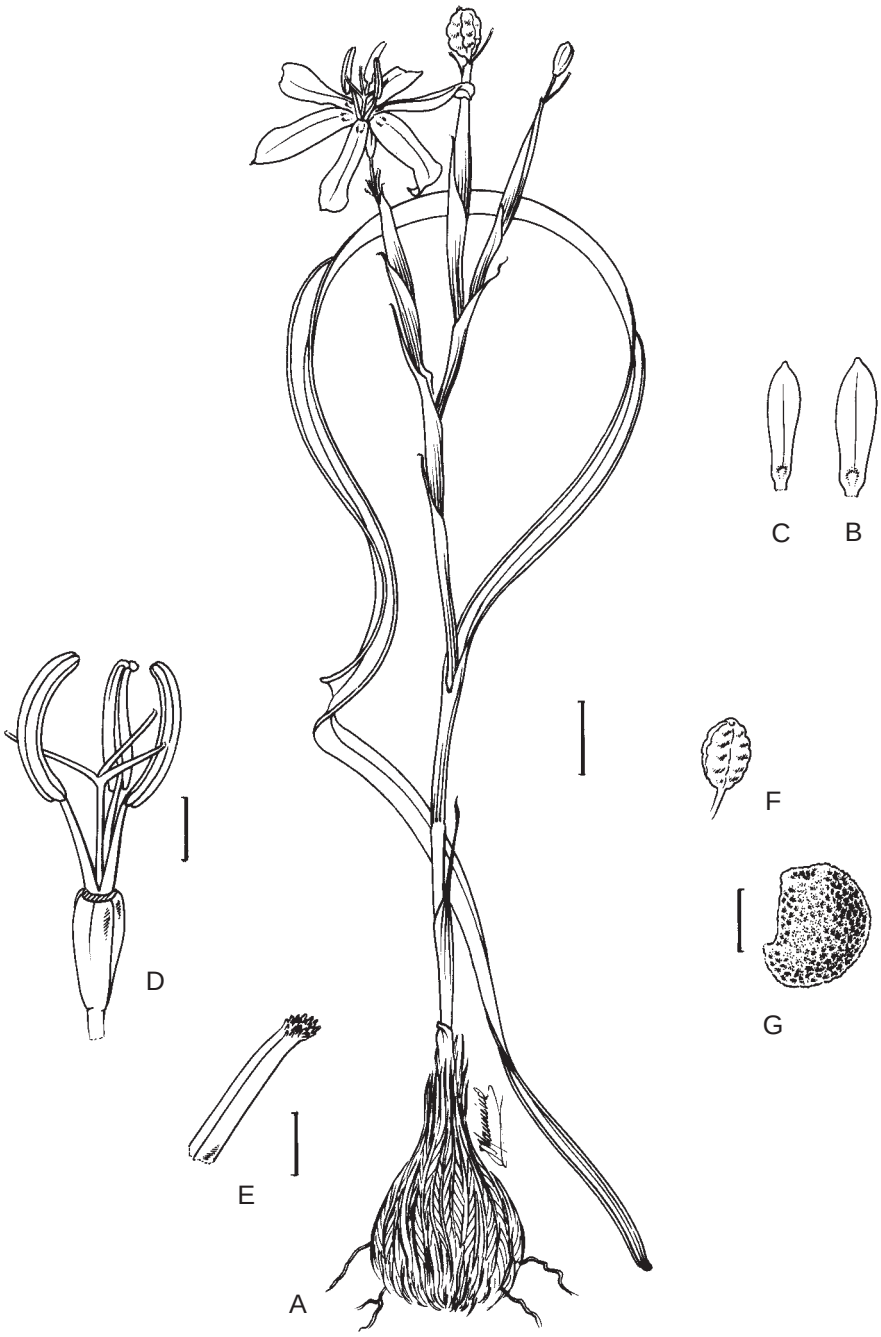

FIGURE 3.—*Moraea marginata*, *Manning 2997* (NBG): A, whole plant; B, outer tepal; C, inner tepal; D, floral details, perianth removed; E, apex of style branch; F, capsule; G, seed. Scale bars: A–C, F, 10 mm; D, 2 mm; E, 0.2 mm; G, 1 mm. Artist: John Manning.

TYPE.—Northern Cape, 3119 (Calvinia): Oorlogskloof Nature Reserve, Farm Uitkomst, 4 km east of Arrie se Punt, overlooking Saaikloof, seasonally moist sandstone pavement in Bokkeveld Sandstone fynbos, 830 m, (–CA), 18 September 2005, *N.A. Helme 3564* (NBG, holo.).

Plants 200–400 mm high; stem subterranean. *Corm* asymmetric with broad, crescent-shaped basal ridge, 10–12 mm diam.; tunics brown, woody, lower margins splitting into fine, parallel fibrils 1.5–2.0 mm long in irregular clusters, drawn into coarse fibres 5–6 mm long above. *Leaves* up to 6, lower 2 basal and longest, remainder cauline but appearing basal through contraction of stem, blades spreading, narrowly 4-grooved, 15–35 × 0.75–1.25 mm. *Inflorescence* of up to 4 single-flowered units; outer bracts ovate, subobtuse, green, with slender, well-spaced veins and narrow, hardly visible translucent margins, 7–10 mm long, inner bracts notched apically, green in centre with broad translucent margins flecked or flushed pale brown, slightly shorter than outer. *Flowers* narrowly funnel-shaped, mauve to lilac with white throat streaked with purple, tube reddish ochre on outside, probably unscented, 12–15 mm diam.; perianth tube narrowly funnel-shaped, 10–11 mm long, with lower, narrow portion 3–4 mm long; tepals lanceolate, ± 13 × 3 mm. *Filaments* inserted at top of lower, narrow portion of tube, sparsely puberulous at base, 8–9 mm long, exserted ± 2 mm; anthers pale yellow, ± 3 mm long. *Ovary* ellipsoid, 2 mm long; style dividing between base of anthers and middle of anthers, branches ± 2 mm long, divided for ± half of their length. *Capsule and seeds* unknown. *Flowering time*: September. Figure 4.

Ecology: known from a single population on the Bokkeveld Escarpment near Nieuwoudtville, on the eastern edge of the Kobee River Gorge in the Oorlogskloof

Nature Reserve. The plants are rare and localized in seasonally wet sand and moss on sandstone pavement in arid fynbos vegetation. At the time that the species was collected in mid-September, most of the plants had finished flowering, suggesting that peak flowering takes place in early September.

Diagnosis and relationships: although known from just two plants, the flowers of *Romulea singularis* are so unusual that they leave no doubt that the species is distinct. *R. singularis* is readily distinguished from all other species by its narrowly funnel-shaped, mauve to purple flowers with slender perianth tube, 10–11 mm long. The unusually long filaments, 8–9 mm long and puberulous at the base, are inserted in the lower part of the tube and are shortly exserted, and the floral bracts are short, 8–10 mm long. The unusual length of the filaments and their insertion in the lower part of the tube, at the top of the basal, narrow portion, are unique among the handful of long-tubed species of *Romulea* that are known (Manning & Goldblatt 2001b). Those with a truly salver-shaped flower [*R. alba* J.C.Manning & Goldblatt, *R. hantamensis* (Diels) Goldblatt, *R. stellata* M.P.de Vos and *R. syringodeoflora* M.P.de Vos] have the filaments inserted near the mouth of the tube, but even *R. kamisensis* M.P.de Vos, with a narrowly funnel-shaped flower, has the filaments inserted in the upper part of the tube. In addition, the filaments in all of these species are glabrous throughout and 3–5 mm in length, thus not unusually long.

The oblique corm with crescent-shaped basal ridge splitting into parallel fibrils, places *Romulea singularis* in section *Ciliatae* of subgenus *Romulea* (Manning & Goldblatt 2001b). Within the section, however, its relationships are more difficult to determine. The narrowly funnel-shaped, mauve to purple flower at first appearance suggests an atypically short-tubed form of *R. kamisensis* M.P.de Vos, a species that is thus far known from central Namaqualand and the northern rim of the Knersvlakte. Closer examination, however, reveals that the resemblance is superficial. The bracts of *R. kamisensis* are much longer, 13–22 mm long, and the filaments, which are inserted in the upper part of the tube, are entirely glabrous, just 4–5 mm long, and are included within the tube. In all these respects *R. kamisensis* is quite unlike *R. singularis* and it is therefore probable that the similarity in flower form in the two species is convergent.

The unusually well-developed, basal ridge on the corm, with the parallel fibrils grouped into small clusters, may suggest a possible relationship with *Romulea toximontana* M.P.de Vos. This species, which is also endemic to seasonally wet sandstone pavement on the Bokkeveld–Matsikamma–Gifberg Mountain complex, is distinctive in section *Ciliatae* in the wide, fan-shaped basal ridge on the corm. Its white, cup-shaped flowers, with short perianth tube, although quite unlike those of *R. singularis* in shape, share with it the darker streaks in the throat and the pale yellow anthers, and the bracts are typically short, 10–20 mm long, with similar slender veins. Unfortunately these features are probably all plesiomorphic and it is therefore only the well-developed rim on the corm that might actually signal a relationship between the two species. Cytology may prove more useful since the chromosome number, $2n = 28$, in *R.*

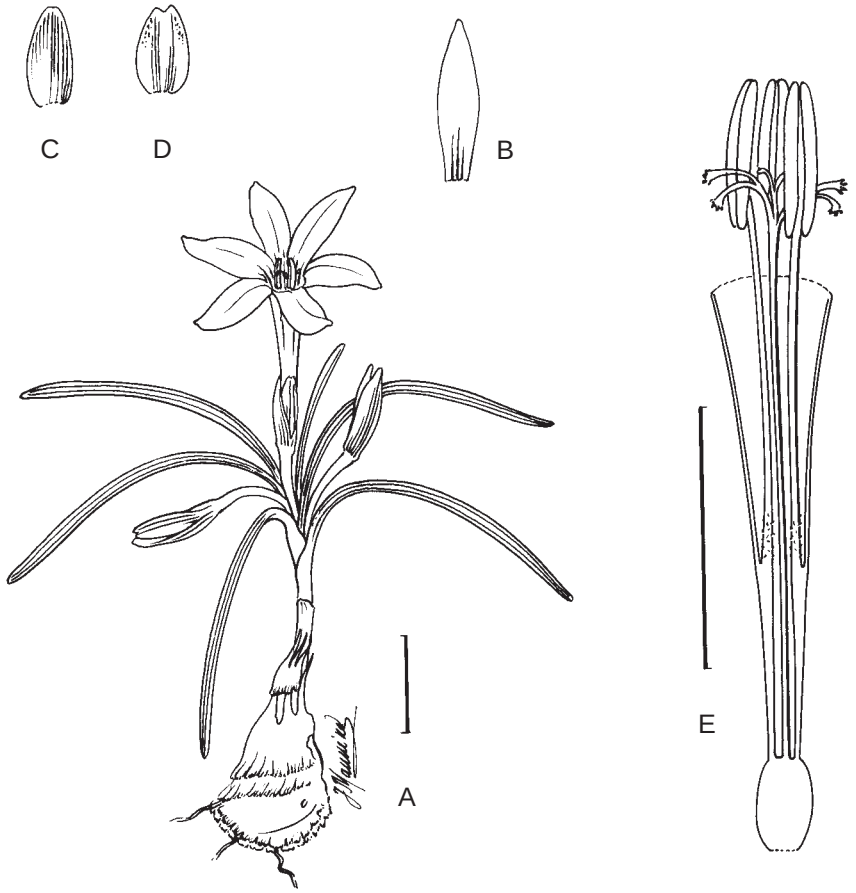

FIGURE 4.—*Romulea singularis*, *Helme 3564* (NBG): A, whole plant; B, tepal; C, outer bract; D, inner bract; E, floral details. Scale bars: A–D, 10 mm; E, 5 mm. Artist: John Manning.

toximontana is unique in section *Ciliate*, where $2n = 24$ is usual (De Vos 1972).

On the basis of the presence of secondary vascular bundles in the leaves, and possibly also their shared chromosome number, $2n = 26$, which is rare in section *Ciliatae*, it is likely that the long-tubed *Romulea kamisensis* shares a short-tubed ancestor with *R. namaquensis* M.P.de Vos (Manning & Goldblatt 2001b). *R. singularis* may be similarly but independently derived from some other short-tubed species and it does appear as if most of the long-tubed species of *Romulea* are independently derived within the genus in response to pollination by long-tongued insects. The pollination biology of the genus has been fairly well studied (Goldblatt *et al*. 2002a), and most of the other long-tubed species have been shown to be adapted to pollination by long-proboscid flies in the family Nemestrinidae. A similar pollination system is thus likely for *R. singularis*, and the species will most probably prove to be another member of the *Prosoeca peringueyi* pollination guild, which is well-developed in the Bokkeveld Mountains (Manning & Goldblatt 1996).

Etymology: named for its unusual flowers.

ACKNOWLEDGEMENTS

We are most grateful to Nick Helme for bringing *Moraea marginata* and *Romulea singularis* to our attention. Thanks are due also to Elizabeth Parker for facilitating the trip to collect the type material of *M. marginata*. Material was collected under permits issued by the Departments of Nature Conservation of the Northern and Western Cape.

REFERENCES

DE VOS, M.P. 1972. The genus *Romulea* in South Africa. *Journal of South African Botany*, Suppl. vol. 9.

DE VOS, M.P. 1999. *Ixia*. *Flora of southern Africa* 7,2,1: 1–87. National Botanical Institute, Pretoria.

GOLDBLATT, P. 1979. *Roggeveldia*, a new genus of southern African Iridaceae–Irideae. *Annals of the Missouri Botanical Garden* 66: 839–844.

GOLDBLATT, P. 1986. The moraeas of southern Africa. *Annals of Kirstenbosch Botanic Gardens* 14. National Botanic Gardens, Cape Town and Missouri Botanical Garden, St Louis.

GOLDBLATT, P. 1992. New species, chromosome cytology and notes on the southern African Iridaceae–Irideae: *Moraea*, *Roggeveldia* and *Homeria*. *South African Journal of Botany* 58: 209–214.

GOLDBLATT, P. 1998. Reduction of *Barnardiella*, *Galaxia*, *Gynandriris*, *Hexaglottis*, *Homeria* and *Roggeveldia* in *Moraea* (Iridaceae: Irideae). *Novon* 8: 371–377.

GOLDBLATT, P. 2004. A synoptic review of the African genus *Hesperantha* (Iridaceae: Crocoideae). *Annals of the Missouri Botanical Garden* 90: 390–443.

GOLDBLATT, P., BERNHARDT, P. & MANNING, J.C. 1998. Pollination of petaloid geophytes by monkey beetles (Scarabaeidae: Rutelinae: Hopliini) in southern Africa. *Annals of the Missouri Botanical Garden* 85: 215–230.

GOLDBLATT, P., BERNHARDT, P. & MANNING, J.C. 2002a. Floral biology of *Romulea* (Iridaceae: Crocoideae): a progression from a generalist to a specialist pollination system. *Adansonia* 24: 243–262.

GOLDBLATT, P. & MANNING, J.C. 1999. New species of *Sparaxis* and *Ixia* (Iridaceae: Ixioideae) from Western Cape, South Africa, and taxonomic notes on *Ixia* and *Gladiolus*. *Bothalia* 29: 59–63.

GOLDBLATT, P. & MANNING, J.C. 2000. Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9. National Botanical Institute, Cape Town & Missouri Botanical Garden, St. Louis.

GOLDBLATT, P., SAVOLAINEN, V., PORTEOUS, O., SOSTARIC, I., POWELL, M., REEVES, G., MANNING, J.C., BARRACLOUGH, T.G. & CHASE, M.W. 2002b. Radiation in the Cape flora and the phylogeny of peacock irises *Moraea* (Iridaceae) based on four plastid DNA regions. *Molecular Phylogeny and Evolution* 25: 341–360.

LEWIS, G.J. 1962. South African Iridaceae: the genus *Ixia*. *Journal of South African Botany* 27: 45–195.

MANNING, J.C. & GOLDBLATT, P. 1996. The *Prosoeca peringueyi* (Diptera: Nemestrinidae) pollination guild in southern Africa: long-tongued flies and their tubular flowers. *Annals of the Missouri Botanical Garden* 83: 67–86.

MANNING, J.C. & GOLDBLATT, P. 1997. *Nieuwoudtville*. South African Wild Flower Guide 9. Botanical Society of South Africa, Cape Town.

MANNING, J.C. & GOLDBLATT, P. 2001a. Three new species of *Tritoniopsis* (Iridaceae: Crocoideae) from the Cape Region of South Africa. *Bothalia* 31: 175–181.

MANNING, J.C. & GOLDBLATT, P. 2001b. A synoptic review of *Romulea* (Iridaceae: Crocoideae) in sub-Saharan Africa, the Arabian Peninsula and Socotra, including new species, biological notes, and a new infrageneric classification. *Adansonia* 23: 59–108.

MANNING, J.C., GOLDBLATT, P. & SNIJMAN, D.A. 2002. *The color encyclopedia of Cape bulbs*. Timber Press, Portland.

SNIJMAN, D.A. & PERRY, P. 1987. A floristic analysis of the Nieuwoudtville Wild Flower Reserve, north-western Cape. *South African Journal of Botany* 53: 445–454.

VAN JAARSVELD, E.J. & THOMAS, V. 2003. *Freylinia helmei*. *Flowering Plants of Africa* 58: 112–116, t. 2197.

VAN WYK, A.E. & SMITH, G.F. 2001. *Regions of floristic endemism in southern Africa: a review with emphasis on succulents*. Umdaus Press, Hatfield, Pretoria.

Bothalia 36,2: 147–155 (2006)

Three new species of *Lachenalia* (Hyacinthaceae: Massonieae) from Western and Northern Cape, South Africa

G.D. DUNCAN* and T.J. EDWARDS**

Keywords: Hyacinthaceae, *Lachenalia* J.Jacq. ex Murray, new species, South Africa

ABSTRACT

This is the sixth in a series of papers on *Lachenalia*, towards a revision of the genus. Three new species are described, *L.* **lutea** from the southwestern part of the Western Cape, *L.* **cernua** from the southern Cape Peninsula and the Worcester Valley of the Western Cape, and *L.* **nardousbergensis** from the Bokkeveld Plateau of the Northern Cape, and the Nardousberge and Middelburg Plateaus of the Western Cape.

INTRODUCTION

The horticulturally important and botanically diverse genus *Lachenalia* J.Jacq. ex Murray is endemic to southern Africa and comprises 120 species of deciduous geophytes, almost all of which are winter growing (Duncan *et al.* 2005). The distribution of *Lachenalia* extends from southwestern Namibia into the western, southern, eastern and central parts of South Africa, and the centre of diversity is in the Worcester grid (3319), divided between the Succulent Karoo and Fynbos Biomes, in the mountains and valleys of the winter rainfall region of the Western Cape (Duncan 2005).

Species delimitation in *Lachenalia* is usually unambiguous, but in some instances there is gradation between species. Other species display extensive variation which has led to considerable taxonomic confusion due to overemphasis of minor morphological differences. Variation within a species occurs in several macro-morphological characters such as overall plant size, leaf number, pedicel length, degree of stamen exsertion, flower size, flower colour and orientation, and flowering period. Variable species often display population stability in features such as bulb and flower shape, and seed morphology; however, a number of species are exceedingly variable (Duncan *et al.* 2005).

In a cladistic analysis of morphological data, it was concluded that a number of evolutionary pressures have driven divergence of vegetative and floral characters in *Lachenalia*. The convergent adaptation to conditions of aridity appears to be the main reason for homoplasy in whole sets of vegetative characters, and similarly, the convergent modification of flowers to similar pollinators is probably the main reason for homoplasy in whole sets of reproductive characters (Duncan *et al.* 2005).

The genus was last revised by Baker (1897) in which 42 species were recognized. The new species described here form part of a series of papers towards a revision of the genus (Duncan 1993, 1996, 1997, 1998, Duncan & Edwards 2002).

Lachenalia lutea *G.D.Duncan*, sp. nov.

Plantae 160–240 mm alta; bulbus globosus, 15–20 mm in diametro, folia 2, lanceolata, coriacea, patentia ad suberecta, claro viridia, pagina superior immaculata vel maculis atroviridibus, 90–140 × 12–30 mm, marginibus coriaceis, inflorescentia spicata, erecta, densa, 70–110 mm longa, pedunculus vivido viridis vel immaculatus maculis brunneo-purpureis, flores oblongo-campanulati, suberecti, pallide ad claro viridi-flavi, demum obscure sanguinei, peraromatici, perianthii tubum cyathiforme, 3 mm longa, tepala exteriora ovata, 6–7 × 4 mm, gibbis claro viridibus vel atroflavis, tepala interiora obovata, trans tepala exteriora bene exsertis, 8–9 × 4–5 mm, carinis claro viridibus vel atroflavis, stamina inclusa vel trans perianthium parum exserta, filamenta recta albida, 5–6 mm longa, ovarium ellipsoideum, 3 × 2.5 mm, stylum rectum, albidum, 5–6 mm longa, capsula ellipsoidea, 8–9 × 4–5 mm, semina globosa, 0.9 × 0.8 mm, strophiolo inflato, 0.5–0.6 mm longa.

TYPE.—Western Cape, 3418 (Simonstown): Vergelegen Farm, Somerset West, low hillside near reservoir, in heavy clay soil, (–BB), 7-10-1959, *W.F. Barker 9088* (NBG, holo.!).

Deciduous, winter-growing geophyte 160–240 mm high. Bulb globose, 15–20 mm diam., offset-forming, white, surrounded by dark brown, spongy outer tunics; cataphyll subterranean, translucent white, tightly surrounding clasping leaf base, apex obtuse. Leaves 2, lanceolate, 90–140 × 12–30 mm, spreading to suberect, flat or weakly canaliculate, leathery, bright green or greenish magenta, plain or marked with dark green spots on upper surface, lower surface sometimes marked with brownish purple spots; margins thickened; clasping base 10–30 mm long, greenish white to deep magenta, plain or occasionally barred with brownish purple in upper part. Inflorescence an erect, dense, few- to many-flowered spike 70–110 mm long, with sterile tip 15–20 mm long; peduncle erect, sturdy, 70–150 mm long, pale green or brownish green, plain or marked with large, irregularly scattered brownish purple blotches; rachis pale green, shading to greenish yellow in upper third; bracts ovate at base of inflorescence, becoming lanceolate above, 2–7

* South African National Biodiversity Institute, Kirstenbosch, Private Bag X7, 7735 Claremont, Cape Town.
** Botany Department, University of KwaZulu-Natal, Private Bag X01, 3209 Scottsville, Pietermaritzburg.
MS. received: 2006-01-13.

× 1–5 mm, translucent white. Flowers sessile, suberect, oblong-campanulate, sweetly scented; perianth tube cup-shaped, 3 mm long, pale greenish yellow; outer tepals ovate, 6–7 × 4 mm, pale to bright greenish yellow with bright green gibbosities; inner tepals obovate, 8–9 × 4–5 mm, protruding well beyond outer tepals, apices subacute, upper inner tepals overlapping, lower inner tepal slightly recurved, pale greenish yellow with bright green keels in upper half. Stamens usually well included within perianth, rarely just exserted; filaments straight, usually 5–6 mm long, white, rarely up to 8 mm long; anthers dull brownish maroon prior to anthesis, bright yellow at anthesis, maturing to black after anthesis. Ovary ellipsoid, 3 × 2.5 mm, pale yellowish green; style 5–6 mm long, straight. Capsule ellipsoid, 8–9 × 4–5 mm. Seed globose, 0.9 × 0.8 mm, shiny black, with inflated, smooth strophiole 0.5–0.6 mm long. Flowering time: late July to early October. Figures 1A; 2.

Etymology: the specific epithet *lutea* is named for the pale to bright yellow flowers.

History: the earliest known record of *Lachenalia lutea* is that of J.F. Solly (*Solly sub PRE11352*) who collected it in August 1915 at the foot of Sir Lowry's Pass east of Cape Town, where this species is common, and has been collected on numerous occasions. It has since been widely collected in the southwestern and southern parts of the Western Cape.

Diagnostic features and affinities: *Lachenalia lutea* has for many years been overlooked as a distinct taxon. It belongs to the group of species having sessile, oblong-campanulate flowers with straight stamens, and most closely resembles *L. arbuthnotiae*. *L. lutea* is recognized by its dense inflorescence of suberect, heavily sweet-scented, pale to bright yellow, oblong-campanulate flowers with spreading inner tepals that protrude well beyond the outer tepals (Figures 1A; 2). The outer tepals have bright green gibbosities, the inner tepals have subacute apices and the stamens are usually included within the perianth or rarely slightly exserted. The sturdy peduncle is pale green or brownish green and may be plain or heavily marked with brownish purple blotches. The two leathery, lanceolate leaves are spreading to suberect and bright green or greenish magenta, with or without darker green or greenish magenta blotches on the upper surface. The globose seeds have a shiny black testa and a smooth, inflated strophiole.

The similar oblong-campanulate flowers of *Lachenalia arbuthnotiae* are also heavily sweet-scented but are slightly curved and distinctly longer, with the inner tepals only slightly longer than the outer ones, and scarcely spreading. The inner tepal apices in this species are obtuse and undulate, and flower orientation is spreading to weakly suberect. It has much longer filaments, 8–9 mm long, a much longer style, 9 mm long and its anthers emerge at the mouth of the perianth or are shortly exserted. The style protrudes conspicuously beyond the perianth as the ovary enlarges. Like those of *L. lutea*, the seeds of *L. arbuthnotiae* are globose with a shiny testa, but its similar inflated,

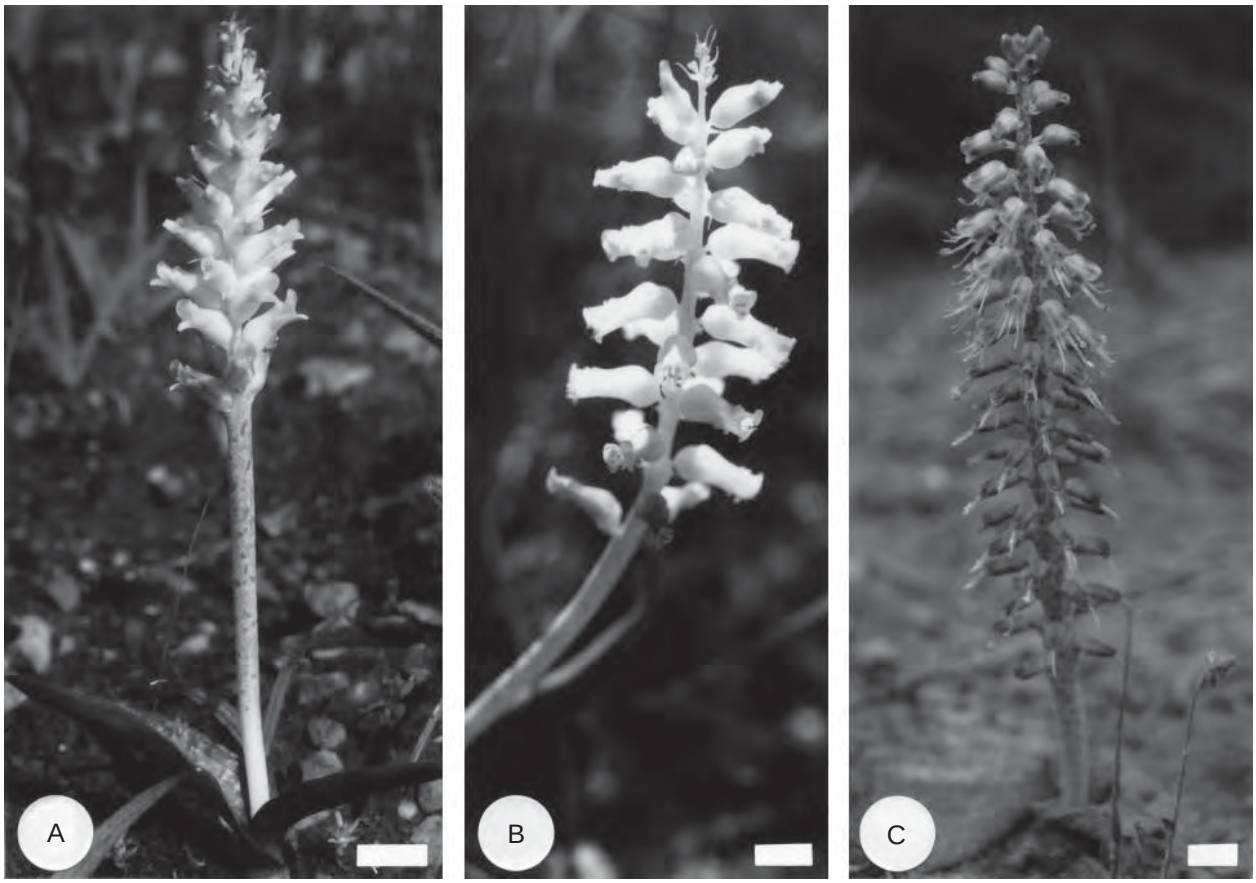

FIGURE 1.—Flowering specimens of three new species of *Lachenalia*. A, *L. lutea, Duncan 430*, in habitat, Elgin; B, *L. cernua, Duncan 470*, in habitat, Wolseley; C, *L. nardousbergensis, Duncan 198*, in habitat, Nieuwoudtville. Scale bars: 10 mm.

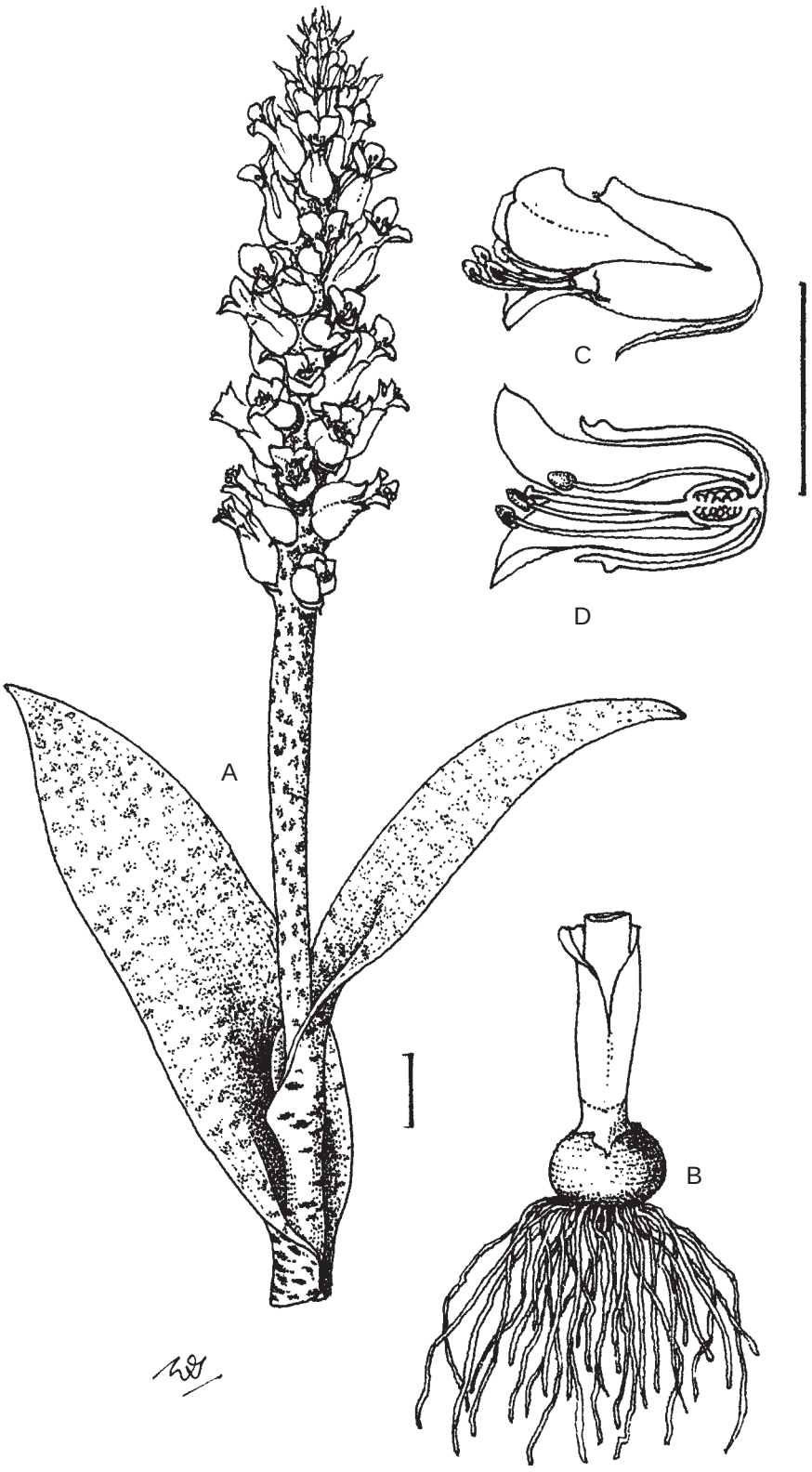

FIGURE 2.—*Lachenalia lutea*, *Duncan 430* (NBG). A, inflorescence and leaves; B, bulb; C, single flower; D, l/s flower. Scale bars: A–D, 10 mm. Artist: Vicki Thomas.

smooth strophiole is slightly longer. As in *L. lutea*, *L. arbuthnotiae* grows in colonies but is an altogether larger plant occurring in a completely different habitat, confined to the Cape Flats Lowlands from Wetton to Faure, in isolated coastal fynbos remnants in seasonally inundated, deep sandy soil (Duncan 1988a). The peak flowering period for *L. arbuthnotiae* is mid-September, whereas *L. lutea* generally flowers earlier, with a peak period from mid-August to early September.

Distribution and habitat: *Lachenalia lutea* occurs in the Fynbos Biome in the southwestern Cape, its distribution extending between Strand and Bot River, and Tulbagh to Villiersdorp (Figure 3). It usually occurs in stony, heavy clay soil in renosterveld, or rarely in sandy soil, and is found in a variety of habitats including seasonally moist, low-lying flats and hills, and on shale bands of higher mountain slopes, growing as scattered individuals or in small groups of two to three plants within large colonies. It flowers particularly well

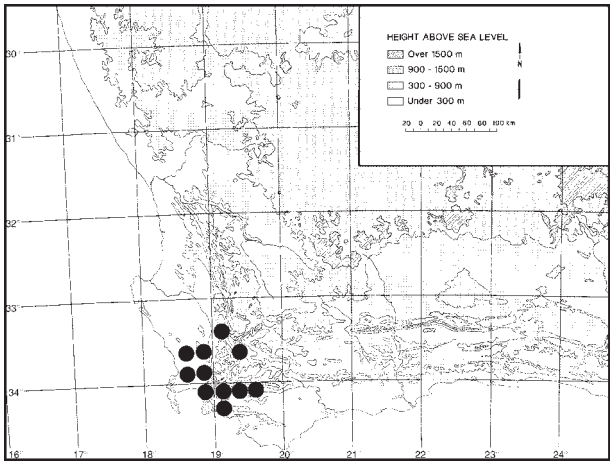

FIGURE 3.—Distribution of *Lachenalia lutea*.

following summer bush fires and is frequently seen growing in association with *L. orchioides* (L.) Aiton var. *orchioides* that flowers later in the season. *L. lutea* is still a common species across most of its range but its numbers have been much reduced by the establishment of deciduous fruit orchards, and in recent years it has been greatly reduced on the clay flats near Somerset West, east of Cape Town, due mainly to industrial and housing development.

Additional specimens examined

WESTERN CAPE.—3318 (Cape Town): Klipheuwel, (–DA), 14-8-1962, *Lewis 6134* (NBG); Zuider Paarl, (–DB), 9-1917, *Adendorff 17637* (PRE); Langverwacht Farm above Kuilsrivier, (–DC), 25-8-1973, *Oliver 4363* (NBG); Assegaaibosch, (–DD), 9-1969, *Van der Merwe 994* (PRE); Stellenbosch, (–DD), 27-8-1963, *Taylor 5032* (PRE). 3319 (Worcester): Tulbagh Kloof, (–AC), 10-1920, *Andreae 616* (PRE); 2 miles [3.2 km] west of Ceres, (–AC), 11-9-1968, *Marsh 767* (PRE); 1 mile [1.6 km] south of Tulbagh Road Station, (–AC), 2-8-1967, *Rourke 789* (NBG); Palmiet Valley, Wolseley, (–AC), Aug. 2003, *Van Warmelo s.n.* (NBG); Botha's Halt near Worcester, (–CB), 30-8-1946, *Compton 18283* (NBG); Wangenheim Farm, Rawsonville, (–CB), 30-9-1963, *Walters 952* (NBG). 3418 (Simonstown): road from Strand to Gordon's Bay, (–BB), 12-9-1947, *Parker 4240* (NBG); Gordon's Bay, (–BB), 23-9-1958, *Werdermann 137* (PRE); Sir Lowry's Pass, (–BB), 27-9-1958, *Werdermann 210* (PRE); road to Sir Lowry's Pass (–BB), 12-10-1955, *De Wet 930* (PRE); Sir Lowry's Pass (–BB), 19-8-1915, *Solly sub PRE11352* (PRE); Steenbras River mouth, (–BB), 16-9-1951, *Esterhuysen 18843* (PRE). 3419 (Caledon): Freshwoods, Elgin, (–AA), 25-11-1998, *Duncan 419* (NBG); Aprilskraal, Elgin, (–AA), 7-10-2000, *Duncan 430* (NBG); Theewaterskloof, Villiersdorp, (–AA), 3-9-1975, *Thomas s.n.* (NBG); Happy Valley Farm, southeast of Villiersdorp, (–AB), 30-9-1971, *Barker 10840* (NBG); between Hawston and Karwyderskraal, (–AC), 29-9-1967, *Barker 10513* (NBG); Ysterklip Farm, Kleinmond, (–AC), 8-11-1967, *Barker 10514* (NBG); Bot River, (–AC), 16-8-1982, Bot River-Hermanus Road, (–AC), 30-8-1973, *Barker 10884* (NBG); 2.5 km from turnoff at bridge on Hermanus Road, (–AC), 30-8-1973, *Barker 10886* (NBG); Bot River Vlei, (–AC), 16-8-1982, *O'Callaghan 249* (NBG); Kleinmond, (–AC), 8-1963, *Topper 149* (NBG); Greyton, (–BA), 15-8-1969, *Barker 10641* (NBG); Heuningkloof Farm beyond Caledon, (–BA), 7-9-1974, *Barker 10917* (NBG); Middelplaas turnoff near Genadendal, (–BA), 7-9-1974, *Barker 10918* (NBG), Greyton Commonage, (–BA), *Hofmeyer s.n.* (NBG); 46 km E of Caledon, (–BA), 3-9-1975, *Thomas s.n.* (NBG).

Lachenalia cernua *G.D.Duncan*, sp. nov.

Plantae 150–270 mm altae, bulbus globosus, 15–25 mm in diametro, folium solitarium, interdum 2, lanceolatum, patens, viride que immaculatum, vel in pagina superiore marroninum maculis plus atromarroninis, 110–260 × 10–28 mm, inflorescentia racemosa erecta vel suberecta, 30–100 mm longa, pedunculus pallide viridis maculis marronino-purpureis, 60–130 mm longa, pedicelli suberecti, 2 mm longi, flores urceolati, tempore primo ad medio florendi deinde cernui, in fructo patentes, pallide cremeo-flavi, perianthii tubum cyathiforme, 3 mm longum, tepali exteriora ovata, base obscure caerulei suffusi, gibbis flavo-viridibus, 6–8 × 5 mm, tepala interiora obovata, trans tepalis exteriora bene exserta, carinis flavis, marginibus recurvatis, 11–12 × 5 mm, stamina trans perianthium breviter exserta, filamenta recta, alba, 11–13 mm longa, ovarium ellipsoideum, 4 × 3 mm, stylum rectum, album, 12 mm longum, capsula ellipsoidea, 9–10 × 6 mm, semina globosa, 1.2 × 1.1 mm, strophiolo inflato, 1 mm longo.

TYPE.—Western Cape, 3319 (Worcester): Palmiet Valley Farm, hillside behind homestead, in open aspects and semi-shade of sandstone boulders, (–AC), 21-9-2002, *Duncan 470* (NBG, holo., PRE, iso.).

Deciduous, winter-growing geophyte 150–270 mm high. *Bulb* globose, shallow or deep-seated, 15–25 mm diam., white with several layers of membranous, dark brown outer tunics; cataphyll subterranean, translucent white, loosely surrounding lowermost portion of clasping leaf base, apex obtuse; clasping leaf base relatively long depending on depth of bulb, usually completely subterranean, occasionally emerging slightly above ground level, 15–85 mm long, white, sometimes forming bulbils along subterranean margins. *Leaves* usually solitary, occasionally 2, spreading, narrowly lanceolate, weakly canaliculate, 110–260 × 10–28 mm, uniformly pale to dark green, or pale to dark maroon and sporadically or heavily marked with darker maroon blotches on upper surface. *Inflorescence* an erect or suberect, few- to many-flowered raceme 30–100 mm long, with a short sterile tip; peduncle erect or suberect, 60–130 mm long, pale green, slightly to heavily marked with dark maroon or maroonish purple blotches; rachis, 50–175 mm long, pale green, immaculate or heavily blotched with maroon or maroonish purple; bracts ovate in lower half of inflorescence, becoming lanceolate in upper half, 1–5 × 1–7 mm, translucent white; pedicels suberect, 2 mm long, white. *Flowers* urceolate, suberect in bud, cernuous from early to mid-flowering, becoming spreading at late flowering and fruiting stage, creamy white and pale yellow with green markings; perianth tube cup-shaped, 3 mm long, creamy white, occasionally tinged with dull blue in upper half; outer tepals ovate, 6–8 × 5 mm, creamy white or greenish yellow, occasionally tinged with dull blue at base, with a yellowish green gibbosity near apex; inner tepals obovate, protruding well beyond outer tepals, 11–12 × 5 mm, creamy white or greenish white with pale to dark yellow keels in upper half, apices slightly recurved. *Stamens* ± straight, subequal, exserted 1–2 mm beyond tip of perianth; filaments 11–13 mm long, white. *Ovary* ellipsoid, 4 × 3 mm, bright green; style straight, white, 12 mm long. *Capsule* ellipsoid, 9–10 × 6 mm, olive green. *Seed* globose, 1.2 × 1.1 mm, shiny black, with smooth, inflated strophiole 1 mm long. *Flowering time*: late September to mid-October. Figures 1B; 4.

Etymology: the specific epithet *cernua* is named for the slightly drooping orientation of its flowers during the early and mid-flowering stage.

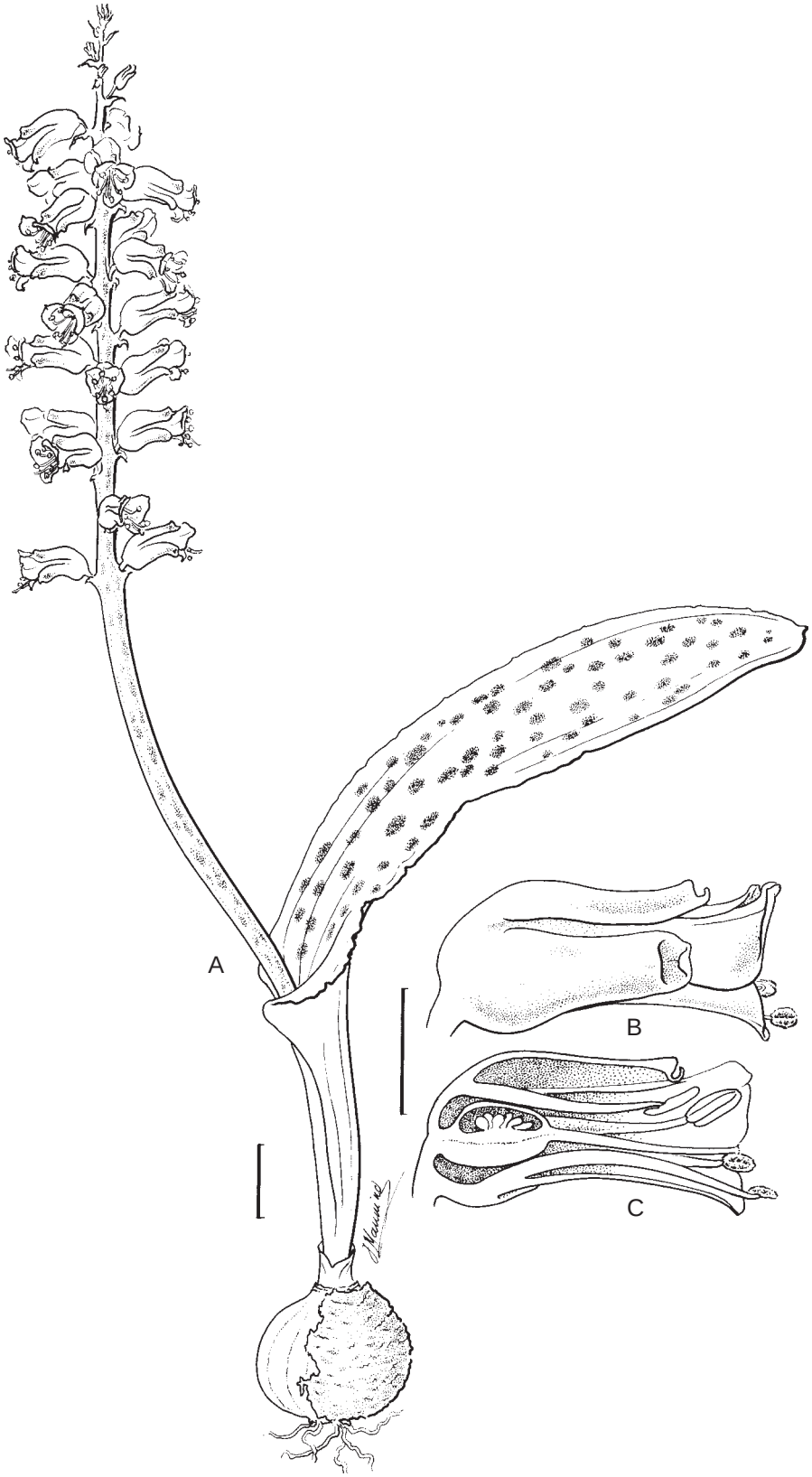

FIGURE 4.—*Lachenalia cernua*, *Duncan 470* (NBG). A, inflorescence, leaf and bulb; B, single flower; C, l/s flower. Scale bars: A, 10 mm; B, C, 5 mm. Artist: John Manning.

History: the earliest known record of *Lachenalia cernua* is a sheet housed in the National Herbarium, Pretoria, collected by the amateur botanist Dr F.Z. van der Merwe in October 1937 (*Van der Merwe sub PRE35699*) on a hillside above the spa baths at Goudini in the Worcester Valley of the southwestern Cape. Two further collections in NBG were made at this locality by J.W. Loubser in October 1971 and September 1972 respectively (*Loubser s.n. 2181*). In early October 2000, flowering specimens were collected by the first author some distance to the northwest of Goudini, on a hillside just south of Wolseley (*Duncan 428*). In July 2001, leafing specimens of an unidentified *Lachenalia* were collected by Adam Harrower of Kirstenbosch at the naval base at Klavervlei near Simonstown in the southern Cape Peninsula (*Harrower 104*). When one of these flowered

in the Kirstenbosch nursery in October the same year, it matched those of the Goudini and Wolseley collections. The discovery of the Simonstown population is remarkable for a genus previously thought to have been extensively documented in the southern Cape Peninsula, and is the first record since 1949 of a new species in this genus from the Cape Peninsula since the publication of the endemic Cape Peninsula species *L. capensis* W.F.Barker, and *L. variegata* W.F.Barker, that occurs from the Cape Peninsula to Clanwilliam (Barker 1949). The restricted environment of the naval base no doubt accounts for it having remained undetected there for so long, and no other populations are known to occur on the Cape Peninsula. In late September 2002, the Wolseley locality was visited again, and the type collection was made (*Duncan 470*).

Diagnostic features and affinities: *Lachenalia cernua* is a member of the group of species having small pedicellate, urceolate flowers with straight stamens, and includes *L. peersii* Marloth ex W.F.Barker, which it most closely resembles. *L. cernua* is recognized by its moderately dense inflorescence of urceolate, pale creamy yellow flowers that are cernuous during early and mid-flowering, becoming spreading during late flowering and fruiting stage (Figures 1B; 4). The inner tepals are creamy white or greenish white with pale to dark yellow keels in the upper half, and are well exserted beyond the outer tepals, with slightly recurved apices. The outer tepals are creamy white or greenish yellow, and have yellowish green gibbosities. The stamens are exserted 1–2 mm beyond the tip of the perianth. The usually solitary leaf is narrowly lanceolate and spreading, and varies in colour from uniformly pale to dark green, to pale to dark maroon with scattered darker maroon blotches on the upper surface. The clasping leaf base is entirely subterranean or occasionally slightly emerging above ground level, and the globose seeds have a shiny black testa and a long inflated strophiole, 1 mm long.

Lachenalia cernua resembles *L. peersii* in the shape of its urceolate flowers with the inner tepals protruding well beyond the outer tepals, but the latter has pure white, spreading flowers with included stamens, and inner tepals that are distinctly recurved at their tips. *L. cernua* has longer inner tepals and its flowers emit a weak, spicy scent, whereas those of *L. peersii* are strongly carnation-scented. The peduncle of *L. cernua* is pale green and slightly to heavily marked with dark maroon or maroonish purple blotches, whereas the peduncle of *L. peersii* is always immaculate. *L. cernua* usually has a solitary, weakly canaliculate spreading leaf, often with dark maroon blotches on the upper surface, whereas *L. peersii* almost always has two, ± flat, lanceolate leaves that are always unmarked. The flowering period of the two species does not overlap as *L. cernua* starts flowering in late September and ends in mid-October, whereas *L. peersii* starts flowering in late October. The flowers of *L. cernua* fade to dull red and become spreading during the fruiting stage, whereas those of *L. peersii* fade to dull pink and become suberect to erect at the fruiting stage. Both species have globose seeds with inflated strophioles 1 mm long. The two species are geographically well separated: *L. cernua* occurs on hillsides in the southern Cape Peninsula, the Worcester Valley and near Wolseley, whereas *L. peersii* is confined to flats and lower mountain slopes along the southern Cape Atlantic coastline stretching from Betty's Bay to Caledon (Duncan 2003).

Distribution and habitat: *Lachenalia cernua* has a restricted distribution in the southwestern Cape where it is currently known from just three populations, one from the western end of the Worcester Valley at Goudini, another to the northwest of Goudini just south of Wolseley, and the third near Simonstown in the southern Cape Peninsula. The population at Goudini is the closest spatially to the Simonstown population, a disjunction of more than 100 km (Figure 5). The Wolseley population occurs on an east-facing hill slope in the semi-shade of large sandstone boulders, as well as at a slightly lower altitude in full sun. The plants growing in semi-shade tend to occur in small groups and flower erratically, whereas those in full sun usually occur singly and flower reliably every year. At the single known population on the southern Cape Peninsula at Klavervlei near Simonstown, plants grow under similar conditions, mainly between large sandstone boulders on shaded, east- and southeast-facing ridges at 363 m, and also in open aspects at a slightly lower altitude, just above a seasonal stream in which *Moraea ramosissima* occurs, flowering at the same time of year. Other notable companion species at this locality include *Protea cynaroides* and *Watsonia tabularis*.

Additional specimens examined

WESTERN CAPE.—3319 (Worcester): Palmiet Valley, (–AC), 7-10-2000, *Duncan 428* (NBG); Goudini, (–CB), 11-10-1971, *Loubser 2181* (NBG); 27-9-1972, *Loubser s.n.* (NBG); Oct. 1937, *Van der Merwe sub PRE35699* (PRE). 3418 (Simonstown): Klavervlei, Simonstown, (–AB), 19-10-2001, *Duncan 463* (NBG); 17-7-2001, *Harrower 104* (NBG).

Lachenalia nardousbergensis *G.D.Duncan*, sp. nov.

Plantae 150–310 altae; bulbum subglobosum, 15–20 mm in diametro; folia 2, late lanceolata, prostrata, olivacea, 100–180 × 25–55 mm, pagina superior venis depressis longitudinalibus et pustulis magnis atroviridibus, marginibus coriaceis albis; inflorescentia racemosa erecta, 80–180 mm longa, floribus multis; pedunculus robustus, in parte superiore inflatus, pallide viridis, maculis brunneo-purpureis, 80–120 mm longus; pedicelli suberecti, 2–6 mm longi; flores oblongo-campanulati, cernui ad patentes, pallide ad atromagentei; perianthii tubum cyathiforme, 1–2 mm longum; tepala exteriora ovata, 7–8 × 4–5 mm, gibbis carinisque atromagenteis vel viridibus; tepala interiora obovata, 8–9 × 4–5 mm, trans tepala exteriora exserta, carinis atromagentis; stamina trans perianthium bene exserta, filamenta declinata, in parte $^{2}/_{3}$ inferiore alba, in parte $^{1}/_{3}$ superiore magentea, 14–16 mm longum; ovarium obovoideum, 3 × 2 mm; stylum declinatum, in parte $^{2}/_{3}$ inferiore album, in parte $^{1}/_{3}$ superiore magenteum, 13–14 mm longum; capsula obovoidea, 6–8 × 5–7 mm; semen globosa, 1.2 × 1.3 mm; strophiolo rudimentario, 0.6–0.7 mm longo.

TYPE.—Western Cape, 3118 (Vanrhynsdorp): road to Nardousberge Plateau southeast of Klawer, in deep

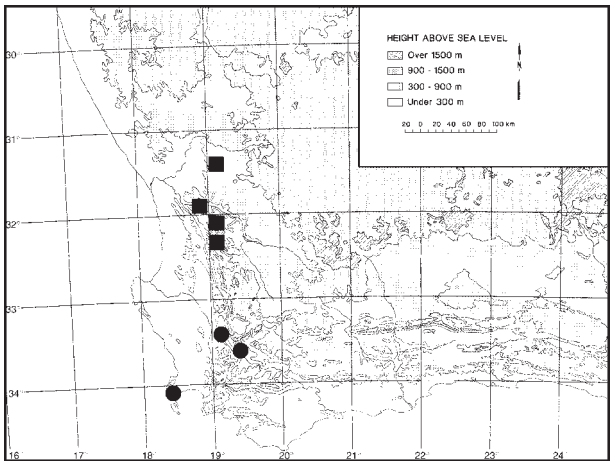

FIGURE 5.—Distribution of *Lachenalia cernua*,●; *L. nardousbergensis*, ■.

red sand, (–DD), 2-9-1945, *W.F. Barker 3630* (NBG, holo.!).

Deciduous, winter-growing geophyte, 150–310 mm high. *Bulb* subglobose, 15–20 mm diam., clump-forming or sometimes solitary, dark yellow, surrounded by several layers of dark brown, spongy outer tunics; cataphyll subterranean, translucent white, tightly adhering to clasping leaf base, apex obtuse. *Leaves* 2, broadly lanceolate, 100–180 × 25–55 mm, prostrate, upper surface olive-green with distinct depressed longitudinal veins and large, irregularly scattered, dark green, flattened pustules; margins white, coriaceous; clasping base subterranean, 10–20 mm long, white. *Inflorescence* an erect, many-flowered raceme 80–180 mm long, with a short sterile tip; peduncle erect, sturdy, 80–120 mm long, usually distinctly inflated in upper portion, pale green, heavily marked with small to large, pale to dark brownish purple blotches; rachis pale green, inflated in lower portion, heavily marked with pale to dark brownish purple blotches; pedicels suberect, 2–6 mm long, brownish green to brownish magenta, shortest at base of inflorescence; bracts ovate at base of inflorescence, becoming lanceolate above, 1–5 × 3–5 mm. *Flowers* oblong-campanulate, nodding or spreading, pale to deep magenta; perianth tube cup-shaped, 1–2 mm long, white throughout or dull blue at base shading to white above; outer tepals ovate, 7–8 × 4–5 mm, pale magenta with darker magenta, brownish magenta or green keels and gibbosities; inner tepals obovate, 8–9 × 4–5 mm, apices subacute, slightly spreading, protruding well beyond outer tepals, pale magenta with prominent, dark magenta keels. *Stamens* well exserted beyond perianth, declinate; filaments 14–16 mm long, white in lower two thirds, shading to deep magenta in upper third; anthers dull magenta prior to anthesis, yellow at anthesis. *Ovary* obovoid, 3 × 2 mm, pale green; style declinate, well exserted beyond perianth, 13–14 mm long, white in lower one third, shading to pale to deep magenta in upper two thirds. *Capsule* obovoid, 6–8 × 5–7 mm, brownish green. *Seed* globose, 1.2 × 1.3 mm, shiny black with smooth, rudimentary strophiole, 0.6–0.7 mm long. *Flowering time*: late August to early October. Figures 1C; 6.

Etymology: *Lachenalia nardousbergensis* is named after the Nardousberge southeast of Klawer in the Western Cape, where the type collection and several other collections of this species have been made.

History: the earliest known collection of *Lachenalia nardousbergensis* was made by W.F. Barker on 2 September 1945 along a road leading off the N7 to the Nardousberge Plateau southeast of Klawer (*Barker 3630*). No further collections appear to have been made until September 1968, when W. Chater collected it in the same area (*Chater s.n.*). It has since been recorded from the Bokkeveld Plateau near Nieuwoudtville (*Duncan 198*) and the northern Cederberg (*Nicklin 179*; G. Summerfield pers. obs.).

Diagnostic features and affinities: *Lachenalia nardousbergensis* falls into the group of species having pedicellate, oblong-campanulate flowers with well-exserted, declinate stamens, and most closely resembles *L. purpureo-caerulea* Jacq. *L. nardousbergensis* is recognized by its usually distinctly inflated peduncle that is marked with large brownish purple blotches, and its many-flowered, moderately dense raceme of nodding or spreading, pale to deep magenta, oblong-campanulate flowers with well-exserted, declinate stamens, with the filaments deep magenta in the upper third (Figures 1C; 6). Its two prostrate, broadly lanceolate, olive-green leaves have conspicuous longitudinal grooves along the upper surface, and are covered with large, dark green, flattened, oval pustules. The leaves are partially or completely withered at flowering but remain green under cultivation if plants are kept well watered in late winter and spring. The flesh of the subglobose bulb is dark yellow and the bulb is surrounded by several layers of dark brown, outer tunics. Its globose, shiny black seeds have a rudimentary strophiole, 0.6–0.7 mm long.

The oblong-campanulate flowers of *Lachenalia purpureo-caerulea* differ from those of *L. nardousbergensis* in their deep purplish blue colour and in being larger and more widely flared, with rounded, recurved, deep purple inner tepal apices and a much shorter style 8 mm long and stamens 9–10 mm long. The peduncle of *L. purpureo-caerulea* is unmarked and non-inflated, and it has two bright green, prostrate lanceolate leaves densely covered with small green, dome-shaped pustules. Like those of *L. nardousbergensis*, the leaves of *L. purpureo-caerulea* are partially or completely withered at flowering in the wild and the two species are geographically widely separated, *L. purpureo-caerulea* having a highly restricted distribution in the Darling/Mamre District of the southwestern Cape, occurring on sandy gravel flats in renosterveld, and flowering later in the season, from mid-October to mid-November (Duncan 1988b). Like those of *L. nardousbergensis*, the shiny black, globose seeds of *L. purpureo-caerulea* fall into the group having smooth, rudimentary strophioles.

Distribution and habitat: *Lachenalia nardousbergensis* has a limited distribution in the Fynbos Biome in the northwestern part of the Northern Cape and the northwestern part of the Western Cape, extending from the Bokkeveld Plateau at Nieuwoudtville, southwest to the Nardousberge Plateau southeast of Klawer, and southeast to the Middelburg Plateau at the northern end of the Cederberg (Figure 5). The plants occur in areas of

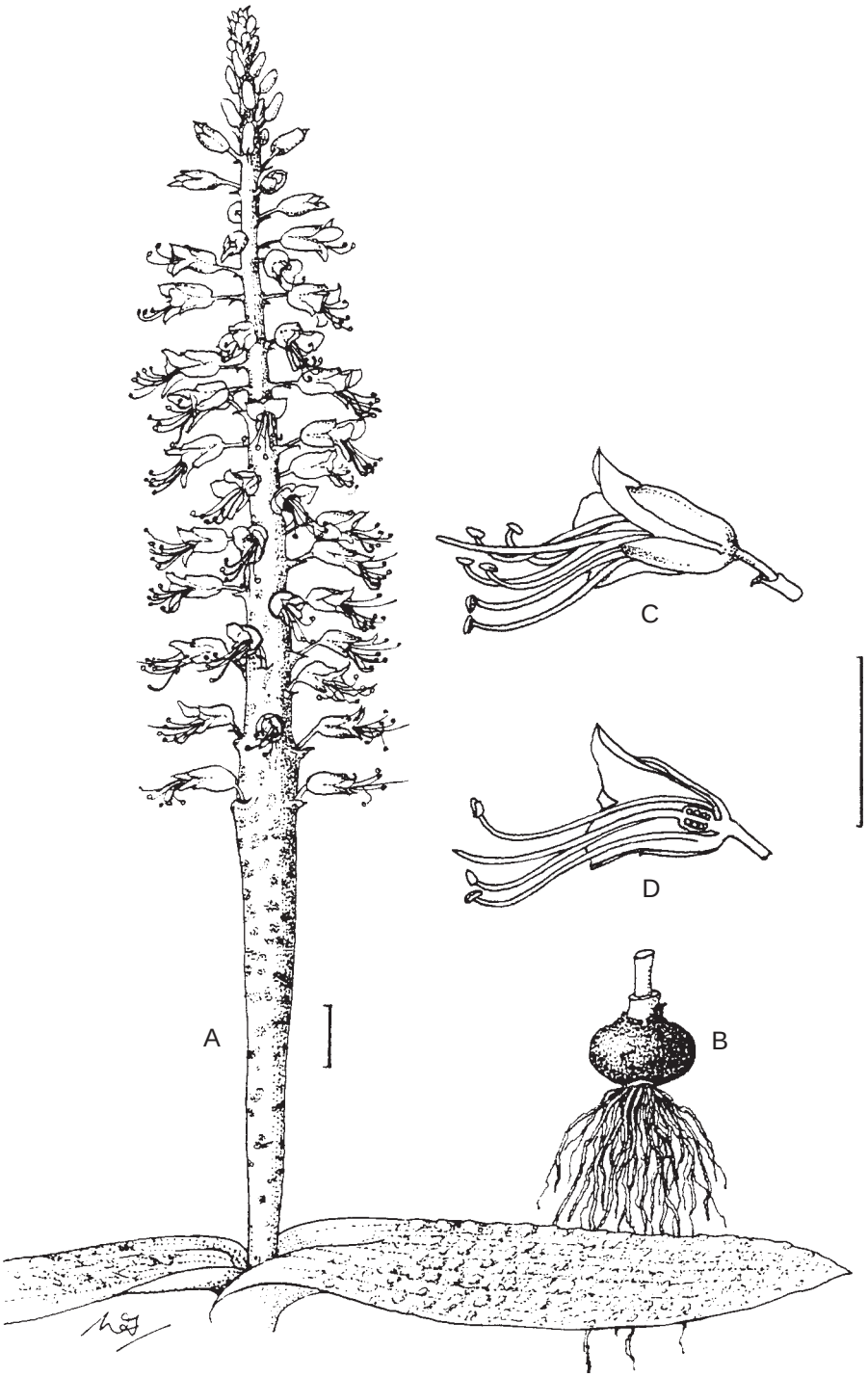

FIGURE 6.—*Lachenalia nardousbergensis*, *Duncan 198* (NBG). A, inflorescence and leaves; B, bulb; C, single flower; D, l/s flower. Scale bars: A–D, 10 mm. Artist: Vicki Thomas.

fairly level, high-lying ground, in deep red or yellowish brown sand, growing as scattered individuals or in small colonies in fynbos vegetation, among low succulent undergrowth or restios.

Additional specimens examined

NORTHERN CAPE.—3119 (Calvinia): Farm Oorlogskloof, Nieuwoudtville, (–AC), 1-10-1973, *Barker 10890* (NBG); Farm Glen Ridge, Nieuwoudtville, (–AC), 12-9-1985, *Duncan 198* (NBG).

WESTERN CAPE.—3118 (Vanrhynsdorp): Nardousberge Escarpment, (–DD), 17-9-1968, *Chater s.n.* (NBG). 3219 (Wuppertal): 2 miles [3.2 km] on road Brandewynrivier to Calvinia, (–AA), 27-9-1970, *Barker 10724* (NBG); Middelberg Plateau, (–AC), 4-8-1985, *Nicklin 179* (NBG).

ACKNOWLEDGEMENTS

We extend our thanks to Dr Ted Oliver for translating the diagnoses into Latin, Ms Vicki Thomas and Dr John Manning for preparing the line drawings, and Adam Harrower and Gordon Summerfield for their assistance in the field.

REFERENCES

BAKER, J.G. 1897. *Lachenalia* Jacq. In W.T. Thistleton-Dyer, *Flora capensis* 6: 421–436. Reeve, London.

BARKER, W.F. 1949. *Plantae Novae Africanae*. *Journal of South African Botany* 15: 37–39.

DUNCAN, G.D. 1988a. *Lachenalia arbuthnotiae*. *The Flowering Plants of Africa* 50: t. 1961.

DUNCAN, G.D. 1988b. *Lachenalia purpureo-caerulea*. The *Lachena-*

lia handbook. *Annals of Kirstenbosch Botanical Gardens* 17: 56, 57. National Botanical Gardens, Cape Town.

DUNCAN, G.D. 1993. *Lachenalia thomasiae*. *The Flowering Plants of Africa* 52: t. 2061.

DUNCAN, G.D. 1996. Four new species and one new subspecies of *Lachenalia* (Hyacinthaceae) from arid areas of South Africa. *Bothalia* 26:1–9.

DUNCAN, G.D. 1997. Five new species of *Lachenalia* (Hyacinthaceae) from arid areas of South Africa. *Bothalia* 27: 7–15.

DUNCAN, G.D. 1998. Five new species of *Lachenalia* (Hyacinthaceae) from arid areas of Namibia and South Africa. *Bothalia* 28: 131–139.

DUNCAN, G.D. 2003. *Lachenalia peersii*. *Curtis's Botanical Magazine* 20: 202–207.

DUNCAN, G.D. 2005. *Character variation and a cladistic analysis of the genus* Lachenalia *Jacq.f. ex Murray (Hyacinthaceae: Massonieae)*. M.Sc. thesis, University of KwaZulu-Natal, Pietermaritzburg.

DUNCAN, G.D. & EDWARDS, T.J. 2002. A new species of *Lachenalia* from Namaqualand, South Africa (Hyacinthaceae: Massonieae). *Bothalia* 32: 190–192.

DUNCAN, G.D., EDWARDS, T.J. & MITCHELL, A. 2005. Character variation and a cladistic analysis of the genus *Lachenalia* Jacq.f. ex Murray (Hyacinthaceae). *Acta Horticulturae* 673: 113–120.

Bothalia 36,2: 157–162 (2006)

New species and taxonomic changes within *Pentaschistis* (Danthonioideae, Poaceae) from Western Cape, South Africa

C.A. GALLEY* and H.P. LINDER*

Keywords: Cape Floristic Region, Danthonioideae, fynbos, new species, *Pentaschistis* (Nees) Stapf, Poaceae, South Africa

ABSTRACT

Three new species of *Pentaschistis* (Nees) Stapf are described from the Cape Floristic Region, *P.* **trifida**, *P.* **clavata** and *P.* **horrida**. The former has been collected from inland ranges of the Cape Fold Belt, from the Cederberg to the Groot Swartberg, the last two each from single sites in the Koue Bokkeveld: *P.* **clavata** on the wetter western border, and *P*. **horrida** on the Baviaansberg. *Pentaschistis juncifolia* Stapf is re-instated, a species from the coastal plains (Hardeveld) between Bredasdorp and Riversdale, which had been included in *P. eriostoma* (Nees) Stapf.

INTRODUCTION

The remarkable field work of Ms Esterhuysen resulted in the description of many new species of *Pentaschistis* (Nees) Stapf (Linder & Ellis 1990), but ongoing fieldwork and taxonomic research on the grasses of the Cape Floristic Region (CFR) (Goldblatt 1978) is resulting in the occasional discovery of new grass species.

Pentaschistis comprises 66 recognized species and is the most species-rich grass genus in the CFR (Linder 1989; Goldblatt & Manning 2000). Most species are endemic to or centred in this region. Additionally there are eleven species in the Drakensberg region, seven species in the tropical east African mountains from Malawi to Ethiopia, one species on Mt Cameroon, three species in Madagascar, one endemic species in the Imatong Mountains, Sudan, and one endemic species on St Paul and Amsterdam Islands in the South Indian Ocean. A few of the more drought-tolerant species occur in the drier northwest of South Africa in the Greater Cape Floristic Region (Jürgens 1991).

Despite the recent revision of the genus (Linder & Ellis 1990), there are still a number of taxonomic problems remaining. Some species show enormous variation over habitat and geographical range, such as the *Pentaschistis pictigluma* complex in eastern Africa (Phillips 1994), and the *P. pallida* complex in the CFR. There have also been a steady rate of discovery and descriptions of new species in the genus over the past 15 years (Phillips 1986; Linder & Ellis 1990; Phillips 1995). Here we describe a further three new species. *Pentaschistis trifida* was found by the first author on a recent collecting trip; *P. clavata* was found by the late Mr Hugh Taylor and recognized as new by Mrs Lyn Fish of PRE. *P. horrida* had already been recognized as distinctive by Dr Roger Ellis and the second author (Linder & Ellis 1990), but they included it under *P. rigidissima*. After extensive field work we were convinced that it is indeed a distinct species, for the reasons given below. We also resurrect *Pentaschistis juncifolia* Stapf to species level following observation of differences in ecology and habit between this taxon and *P. eriostoma* (Nees) Stapf.

* Institute of Systematic Botany, University of Zurich, Zollikerstrasse 107, CH-8008 Zurich, Switzerland.
MS. received: 2005-07-20.

Pentaschistis trifida *C.A.Galley*, sp. nov., *P. trisetae* (Thunb.) Stapf similis sed differt spiculis unifloris, glandibus ellipticis, dimensionibus spiculorum multo parvioribus: gluma inferiore 4.5–5.5 mm (non 15–18 mm) longa, lemma 2.4–4.8 mm (non 6–8 mm) longa, arista lemmatis 18–24 mm (non 25–35 mm) longa, glumis omnino parce puberulis, lemmatibus inter venas dense villosis, paleis glabris, et ramis floriferis trifurcatis.

TYPE.—Western Cape, 3319 (Ceres): Baviaansberg, north of the Hex River Mountains, 1 050 m, 33º12' 14.6"S, 19º37'04.5" E, (–BA), 11 Nov. 2004, *C.A. Galley 577* (ZH, holo.; BOL, K, NBG, PRE).

Perennial; single or few stems. *Culms* 80–200 mm tall; nodes glabrous; basal sheaths white shiny, persistent; prophylls truncate, often bilobed, keels remaining parallel to apex; innovation buds intravaginal. *Glands* multicellular, elliptical, linear, common on inflorescence branches. *Leaves* basal; sheaths red-purple, sparsely puberulous; sheath mouth glabrous; blades puberulous; ligules 0.25 mm long fringe of hairs; blades 20–50 × 0.5–1 mm, rolled; apex acute; margins scaberulous; old blades persisting, entire. *Inflorescence* widely paniculate, 50–75 × 40–60 mm, open, trichotomously branched, with 15–35 spikelets; pedicels mostly erect, longer or shorter than spikelets; inflorescence branches longer than spikelets, glabrous; nodes glabrous. *Spikelets* 1-flowered. *Lower glume* 4.5–5.5 mm long, longer than floret, acute, 1-veined, puberulous, pale yellow with purplish base and green tip; margins same texture as body of glume. *Upper glume* similar to lower glume but slightly shorter. *Lemma* 2.4–2.8 mm long, hairs villous, scattered on back of lemma between veins, veins 5; apex lobed, lobes acute, 0.5 mm long, lobe setae 6–8 mm long; lemma awn geniculate, 18–24 mm long, column twisted, 5.5 mm long; veins 5. *Palea* linear to lorate, 3 × 0.4 mm, acute, as long as lemma, keels parallel, glabrous. *Callus* up to 0.8 mm long, densely hairy with short hairs at base and long hairs at top. *Anthers* 0.9–1.2 mm long. *Ovary* stalked, turbinate; styles two. *Flowering time*: late October to early November. Figure 1A–H.

Etymology: the specific epithet *trifida* is named after the unique trichotomous branching pattern in parts of the inflorescence; in the rest of the genus the branches are paired.

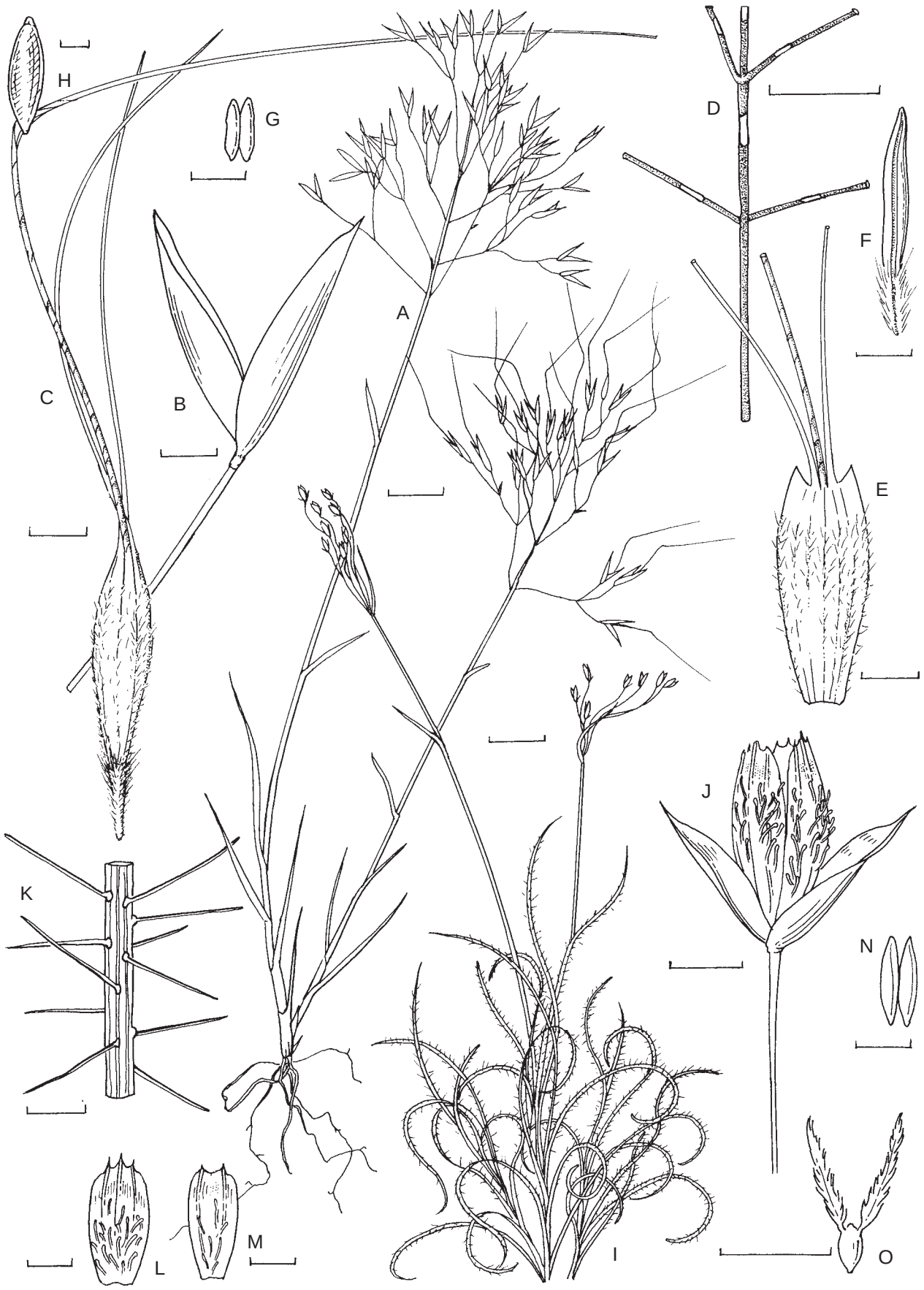

FIGURE 1.—*Pentaschistis trifida*, *Galley 577*: A, whole plant; B, glume pair; C, floret showing long callus; D, inflorescence stem showing glands; E, lemma; F, palea with callus; G, anther; H, caryopsis. *Pentaschistis clavata*, *Galley 567*: I, whole plant; J, spikelet showing clavate hairs; K, leaf showing tubercle-based hairs; L, lemma; M, palea; N, anther; O, ovary and styles. Scale bars: A, I, 10 mm; B, F–H, J–O, 1 mm; C, E, 0.7 mm; D, 0.5 mm. Artist: Claire Linder-Smith.

TABLE 1.—Comparison between *Pentaschistis trifida* and other species

	P. trifida	*P. triseta*	*P. caulescens*	*P. pusilla*	*P. clavata*
Life form	perennial	annual	perennial	perennial	perennial
Habit	caespitose	n/a	tangled	forming mats	cushion
Leaves	highly reduced	not highly reduced	not highly reduced	not highly reduced	not highly reduced
Inflorescence size	50–75 × 40–60 mm	70–100 × 30–90 mm	30–50 × 20–40 mm	20 × 15 mm	20–35 ×15–35 mm
Florets per spikelet	one	two	two	one	one
Lemma					
awn	present	present	present	absent	absent
length	2.4–4.8 mm	6–8 mm	3 mm	1.5–3.0 mm	2.3 mm
Glume					
length	4.5–5.5 mm	15–18 mm	8–12 mm	2.5–3.0 mm	2.2–2.5 mm
indumentum	sparsely puberulous all over	tuberculate hairs along margins	glabrous	glabrous	glabrous

Diagnostic characteristics: *Pentaschistis trifida* resembles *P. triseta* (Thunb.) Stapf by having reduced leaves and a long lemma awn in relation to the spikelet. It resembles *P. pusilla* (Nees) H.P.Linder and *P. clavata* (described here) by the single floret per spikelet, and *P. caulescens* H.P.Linder, as both species occupy disturbed habitats and have reduced leaves with red/purple leaf sheaths. However, it can be easily distinguished from these four species by the characteristics shown in Table 1. Unique to this new species is the elongated callus, the trifurcating inflorescence branches and the elliptically shaped linear-type glands on the inflorescence branches (Figure 1D), which contrast clearly with the purple branches.

Distribution and habitat: this species was collected from a shaded disturbed (pathside) habitat of deep, sandy soil derived from Table Mountain sandstone in a fairly arid area on the eastern side of the Baviaansberg (Figure 2). Although this is perhaps a more opportunistic habitat typical of an annual species [e.g. *P. airoides* (Nees) Stapf subsp. *airoides* habitat] this plant is a perennial; the highly reduced leaves suggest that the water requirement of this species is, however, probably low. Although locally common, this was the only population found in the vicinity.

Pentaschistis clavata *C.A.Galley*, sp. nov., ab *P. pusilla* (Nees) H.P.Linder differt pilis clavatis lemmatis, lamina foliorum setosa, involuta.

TYPE.—Western Cape, 3219 (Wuppertal): Koue Bokkeveld Mountains south of Hexberg, on the Farm De Boom, 1 212 m, 32º44'32.1"S, 19º11'35.2"E, (–BA), 7 Nov. 2004, *C.A. Galley 567* (ZH, holo.; BOL, E, G, K, MO, NBG, NSW, NY, PRE, S, UPS, W).

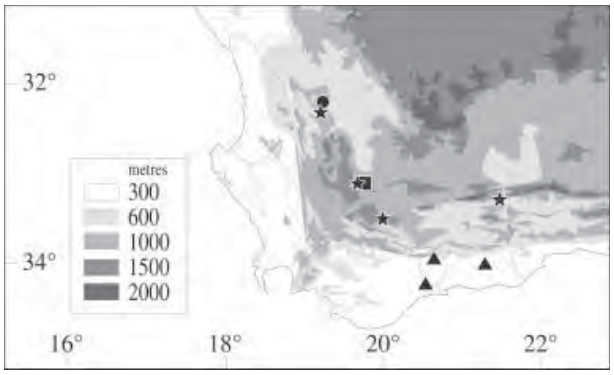

FIGURE 2.—Distribution of *Pentaschistis clavata*, ●; *P. horrida*, ★; *P. trifida*, ■; and *P. juncifolia*, ▲.

Plants perennial, forming neat, rounded cushions, up to 100 mm in diam. *Multicellular glands* absent. *Culms* 80–200 mm tall; nodes puberulous; basal sheaths white shiny, persistent; prophylls truncate, often bilobed, keels remaining parallel to apex; innovation buds intravaginal. *Leaves* cauline; sheaths glabrous or with sparse, 2 mm long tubercle-based hairs; sheath mouth with a ring of 2 mm long, stiff bristles; ligules 0.2 mm long fringes of hair; blades 40–50 × 1 mm, expanded at base, with sparse, scattered 2 mm long tubercle-based bristles; apex keeled, acute; margins smooth; old blades persisting, entire. *Inflorescence* widely paniculate, 20–35 × 15–35 mm, open, with 10–20 spikelets; pedicels mostly erect, longer than spikelets; inflorescence branches longer than spikelets, puberulous; nodes villous with long erect hairs. *Spikelets* 1-flowered, 2.5 mm long. *Lower glume* 2.0–2.5 mm long, as long as or shorter than floret, acute, 1-veined, straw-coloured with purplish base; margins same texture as body of glumes, glabrous. *Upper glume* similar to lower glume, but somewhat shorter and narrower. *Lemma* 2.2–2.5 mm long, clavate hairs scattered between veins on back, veins 7, not anastomosing, apex finely tridentate. *Palea* linear to lorate, truncate, 2.2 × 0.5 mm, glabrous or with few clavate hairs found between the keels, as long as lemma; keels parallel, glabrous. *Lodicules* without microhairs or bristles; obtriangular, 3-veined. *Anthers* 1.6–1.9 mm long. *Ovary* stalked, turbinate; styles two. *Flowering time*: November and December. Figure 1I–O.

Etymology: the species epithet *clavata* is named after the clavate lemma hairs.

Diagnostic characteristics: *Pentaschistis clavata* resembles *P. pusilla* in the single-flowered spikelet. This is generally a rare feature in the Danthonioideae, and within *Pentaschistis* is only found in two species, *P. pusilla* (Linder & Ellis 1990) and *P. trifida* described in this paper. *P. clavata* has a finely tridentate lemma apex, similar to that of *P. pusilla*, and in addition the generally soft, orthophyllous leaves and weakly perennial habit are reminiscent of that found in *P. pusilla*. However, there are several convincing differences (Table 2). The new species has scattered, stout, clavate hairs on the lemma back, the only known case of clavate hairs in *Pentaschistis*. Clavate hairs occur in several other genera of the Danthonioideae, such as *Karroochloa* (Conert

TABLE 2.—Comparison between *Pentaschistis clavata* and *P. pusilla*

	P. clavata	*P. pusilla*
Leaf		
indumentum	with scattered bristles	glabrous
insertion	on aerial shoots	basal
Inflorescence indumentum	nodes villous	glabrous
Lemma indumentum (abaxial)	scattered, stout clavate hairs	fine tapering hairs (some collections from eastern range almost glabrous)

& Türpe 1969), *Schismus* (Conert & Türpe 1974) and *Tribolium* (Linder & Davidse 1997), but these genera are all rather distantly related to *Pentaschistis*.

Distribution and habitat: this new species is known from a single locality above De Boom in the Koue Bokkeveld, at an altitude of 1 270 m (Figure 2). The species was first collected by Mr Hugh Taylor in 1989, describing the habitat as 'streambank in moist soil with moss'. Further investigations in 1998 and 2005 showed that the species is quite common in the area, occurring on damp sand derived from Table Mountain sandstone as well as streambanks in wet moss. The habitat therefore differs slightly from that of *P. pusilla*. It is possible that the species is much more widespread—these mountains are still poorly explored, and more populations may be found in similar habitats.

Other specimen examined

WESTERN CAPE.—3219 (Wuppertal): south of Hexberg, Koue Bokkeveld Mountains, 1 270 m, (–CC), *H.C. Taylor 12095* (PRE).

Pentaschistis horrida *C.A.Galley*, sp. nov., *P. rigidissimae* Pilger ex H.P. Linder similis sed differt longitudine majore culmorum et foliorum, ramificatione caulium, indumento superficiei foliorum et dimensione majore antherarum, 2.1–2.8 mm (non 1.4–1.8 mm).

TYPE.—Western Cape, 3319 (Ceres): Baviaansberg, north of the Hex River Mountains, 1 900 m, (–BA), 26 Oct. 1997, *H.P. Linder 6799* (ZH, holo.; BOL, E, G, K, MO, NBG, NSW, PRE).

Perennial, caespitose or mat-forming; older plants forming 'fairy rings' (with the centre of the ring dying), up to several metres diam. *Multicellular glands* absent. *Culms* 150–400 mm tall; nodes glabrous; basal sheaths white shiny, persistent; prophylls truncate, often bilobed, upper margin ciliate or bristly, keels remaining parallel to apex, scaberulous or dentate, extended into 20 mm long awns; innovation buds intravaginal. *Leaves* cauline; sheaths glabrous; sheath mouth glabrous; ligules 0.5–1.0 mm long fringe of hairs; blades 150–200 × 1 mm, rolled, rigid, with sparse, villous hairs at base of blade; apex pungent; margins smooth; old blades persisting, entire. *Inflorescence* widely paniculate, 70–90 × 25–50 mm, open at anthesis (soon closing again), with 30–60 spikelets; pedicels mostly patent, shorter than spikelets; inflorescence branches as long as or longer than spikelets, scaberulous; nodes sparsely hairy, puberulous to villous. *Spikelets* 2-flowered, 7.5 mm long. *Lower glume* 6.5–7.5 mm long, longer than florets, acute to acuminate, 1-veined, pale green; margins scaberulous, same texture as body of glumes; upper glume similar to lower glume. *Lemma* 2.25–3.0 mm long, with scattered hairs on the back; veins 7, anastomosing near apex; lemma lobes acute, 1.1 mm long, shorter than the lemma body; lemma awn geniculate, 8 mm long, column twisted, 3 mm long thus as long as lemma lobe setae. *Palea* linear to lorate, 3.5 × 0.5 mm, apex rounded to acute or bi-lobed, longer than lemma, glabrous; keels parallel, glabrous. *Lodicules* without microhairs or bristles, obtriangular, 3-veined. *Anthers* 2.1–2.8 mm long. *Ovary* stalked, turbinate; styles two. *Flowering time*: October to November. Figure 3.

Etymology: the species epithet *horrida* is named after the prickly, pungent leaves.

Diagnostic characteristics: the linear inflorescence, pungent leaves and cushion habit associate this species with *Pentaschistis rigidissima* Pilg. ex H.P.Linder. Specimens of *P. horrida* were previously included within this species and were considered as one extreme of a continuous gradient of size and spinescent variation (Linder & Ellis 1990). There are several differences that separate these species, including their growth form (Table 3). Although both species may form 'cushions' the plant base differs. The new species forms cushions that expand in size over time by means of a branching culm system; this effectively moves the living part of the plant outwards from the cushion centre, which eventually dies, so that a whole plant forms a 'fairy ring'. *P. rigidissima*, by contrast, always forms small tufts, rather like a shaving brush, and never forms rings. They have been found in sympatry at several localities, and the morphological and habit differences were consistently maintained. Lastly, phylogenetic analysis of chloroplast data places these two species in different clades (unpubl. data). *P. horrida* is sister to *P. rosea*.

Distribution and habitat: *Pentaschistis horrida* has been collected from the inland ranges of the Cape Fold Belt, from the Cederberg to the Great Swartberg (Figure 2). All populations occur in soils derived from sandstone. These areas are not only dry, but have a more continental climate with severe frost in winter and fierce heat and a long dry period in summer. The plants grow in soil in open vegetation, sometimes on open plains (such as on the summit of the Rooihoogte Pass over the Waboomsberg, and on the summit plateau of Wolfberg in the Cederberg), and sometimes on steep slopes (such as on the Baviaansberg in the Koue Bokkeveld). *P. rigidissima* by contrast is found more towards the coastal areas on the coastal ranges of the Cape Fold Belt, where the climate is more mesic. There are also microhabitat differences. *P. rigidissima* is restricted to crevices in the sandstone rocks and boulders, often in shady, cool and protected places along the sides of boulders or even underneath them. In contrast, *P. horrida* is found in open areas, or at most between boulders, but never in crevices.

Other specimens examined

WESTERN CAPE.—3219 (Wuppertal): central Cederberg, Sleeppad Hut to Sneeukop, 1 500–1 900 m (–AC), *H.P. Linder 4464* (BOL); Bokkeveld, Tafelberg 5500' (1 676m), (–CD), *Esterhuysen*

FIGURE 3.—*Pentaschistis horrida*, *Linder 6799*: A, plant base and lower plant; B, upper plant and inflorescence; C, glume pair; D, florets; E, lemma showing setae and awn; F, palea with callus; G, ovary and styles. Scale bars: A, B, 10 mm; C–G, 1 mm. Artist: Claire Linder-Smith.

TABLE 3.—Comparison between *Pentaschistis horrida* and *P. rigidissima*

	P. horrida	*P. rigidissima*
Culm length	270–400 mm	150–200 mm
Leaf		
length	150–300 mm	up to 100 mm
indumentum	sparsely villous at base of leaves on upper surface	glabrous
Anther length	2.1–2.8 mm	1.4–1.8 mm

3931 (BOL). 3319 (Worcester): top of Rooihoogte Pass, 1 234 m, 33º36'12"S, 19º51'02" E, (–BD), *C.A. Galley 374* (BOL, ZH). 3320 (Montagu): south of Matroosberg station, 3800' (1 158m), (–BD), *Acocks 19088* (BOL). 3321 (Ladismith): Towerkop, 1 750 m 33º27' 42"S, 21º13'01" E, (–AC), *Linder, Hardy & Moline L7410* (BOL); Towerkop, Swartberg, (–AC), *Esterhuysen 26744* (BOL); Sewe Weeks Poort, 2 000 m, (–AD), *Linder 5486* (BOL); Montagu to Matroosberg, 3700' (1 128m), *MRL 370* (BOL); Swartberg Pass, (–BD), *Barker 999* (BOL): Great Swartberg, 1 800 m (–BD), *Linder 4571* (BOL). 3322 (Prince Albert): Zwartbergen, 4000' (1 219m), (–AC), *Bolus 11673* (BOL). 3323 (Uniondale): Kouga Mountains, 5500' (1 676m), (–DA), *Esterhuysen 27974* (BOL).

Pentaschistis juncifolia

Pentaschistis juncifolia was originally described by Stapf in *Flora capensis* (1899), and is distinct from *P. eriostoma* (Nees) Stapf based on the absence of densely woolly or villous leaf sheaths. Linder & Ellis (1990) sank this species into *P. eriostoma* on the basis of similar spikelets and inflorescences, regarding it as a local form of the very variable *P. eriostoma*. After recent fieldwork, however, we are now convinced that these taxa are indeed distinct, and that *P. juncifolia* should be recognized as a separate species. The most striking difference between the two taxa is the absence of a woolly indumentum at the leaf sheath mouth in *P. juncifolia*. Aside from this, *P. juncifolia* can be recognized as distinct from *P. eriostoma* in the field as it forms much more neatly defined tussocks and has a much paler inflorescence. The habitats of the two taxa differ, with *P. eriostoma* occurring on shales and sandstones and *P. juncifolia* associated with eroded silcrete surfaces on the coastal plains between Bredasdorp and Riversdale. They were observed in sympatry near a silcrete outcrop (Verkykerskop) along the road from Malgas to Heidelberg (34°13'25" S, 20°43'14" E) and were both abundant, maintaining morphological and habitat distinctions. This morphological and ecological evidence is backed up by phylogenetic analysis of chloroplast data where *P. eriostoma* and *P. juncifolia* are separate on the cladogram and *P. juncifolia* is sister to a large clade that includes *P. eriostoma* (Galley & Linder in review). *P. juncifolia* has been collected in flower in early October.

Specimens examined

WESTERN CAPE.—3420 (Bredasdorp): Swellendam Division, Buffelsjachtsrivier, 1000–2000 ft (305–610 m), *Zeyher 4545* (K!); road from De Hoop to Malahas, 141 m, 34°21'44"S, 20°28'45" E, (–AD), 7 Oct. 2003, *C.A.Galley 341* (BOL, ZH). 3421 (Riversdale): hills near Zoetmelksrivier, *Burchell 6761* (K!); hills near Zoetmelksrivier, *Burchell 6750* (K, lectotype!).

ACKNOWLEDGEMENTS

This research was funded by the University of Zurich, the Swiss Science Foundation, the Swiss Academy of Sciences and the 'Georges und Antoine Claraz-Schenkung'. Thanks to L. Fish, and N. Bergh, A. Verboom and the Bolus herbarium for assistance with field work. Also many thanks to Claire Linder-Smith for the elegant illustrations.

REFERENCES

CONERT, H.J. & TÜRPE, A.M. 1969. *Karroochloa*, eine neue Gattung der Gramineen (Poaceae, Arundinoideae: Danthonieae). *Senckenbergiana Biologica* 50: 289–318.

CONERT, H.J. & TÜRPE, A.M. 1974. Revision der Gattung *Schismus* (Poaceae: Arundiniodeae: Danthonieae). *Abhandlungen der Senckenbergischen Naturforschenden Gesellschaft* 532: 1–81.

GALLEY, C. & LINDER, H.P. (in review). The phylogeny of the *Pentaschistis* clade (Danthonioideae, Poaceae) and the evolution and loss of complex characters: multicellular glands, evolution.

GOLDBLATT, P. 1978. An analysis of the flora of southern Africa: its characteristics, relationships, and origins. *Annals of the Missouri Botanical Garden* 65: 369–436.

GOLDBLATT, P. & MANNING, J.C. 2000. Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9. National Botanical Institute, Cape Town & Missouri Botanical Garden, St. Louis.

JÜRGENS, N. 1991. A new approach to the Namib Region. *Vegetatio* 97: 21–38.

LINDER, H.P. 1989. Grasses in the Cape Floristic Region: phytogeographical implications. *South African Journal of Science* 85: 502–505.

LINDER, H.P. & DAVIDSE, G. 1997. The systematics of *Tribolium* Desv. (Danthonieae: Poaceae). *Botanische Jahrbüche* 119: 445–507.

LINDER, H.P. & ELLIS, R.P. 1990. A revision of *Pentaschistis* (Arundineae: Poaceae). *Contributions from the Bolus Herbarium* 12: 1–124.

PHILLIPS, S.M. 1986. Four new grasses from northeast tropical Africa. *Kew Bulletin* 41: 1027–1030.

PHILLIPS, S.M. 1994. Variation in the *Pentaschistis pictigluma* complex (Gramineae). In J.H. Seyani & A.C. Chikuni, *Proceedings of the XIII Plenary Meeting of AETFAT, Zomba, Malawi, 2–11 April 1991*: 359–372. National Herbarium and Botanic Gardens of Malawi, Zomba.

PHILLIPS, S.M. 1995. A new species of *Pentaschistis* (Gramineae) from Ethiopia. *Kew Bulletin* 50: 615–617.

STAPF, O. 1899. Graminae. In W.T. Thiselton-Dyer, *Flora capensis* 7: 310–750. Reeve, London.

Bothalia 36,2: 163–174 (2006)

Notes on African plants

VARIOUS AUTHORS

MESEMBRYANTHEMACEAE

THE IDENTITY OF *RUSCHIA PROMONTORII*

INTRODUCTION

The entity *Ruschia promontorii*, a Red Listed plant endemic to the Cape Peninsula, was first described by H.M.L. Bolus (1929). Type material (*Rohland NBG1543/20*) was illustrated by Mary Page (unpublished plate, BOL). Much later, Hartmann (1998b) placed this taxon in synonomy under *Amphibolia hutchinsonii*, and upon discovering an earlier homonym, Hartmann (2001) placed *A. hutchinsonii* as a synonym of *Amphibolia laevis.*

Desmet (2000) mentions this taxon as belonging to *Antimima*, namely *A. promontorii* ('*promontoni*' and '*promontori*') noting differences in distribution ranges of *Amphibolia laevis* and this taxon. However, no formal transfer was undertaken.

Initially I believed this taxon to be an *Acrodon*, but upon closer examination concluded that certain features mentioned below exclude it from that genus.

DISTRIBUTION AND ECOLOGY

This decumbent, mat-forming mesemb is found only on the Cape Peninsula where it grows on the slopes of Chapman's Peak, Cape Point and a few other localities (Figure 1). The plant colonizes steep, rocky scree slopes often devoid of plant cover, with little competition from other plants, but well above the salt spray of the ocean.

The lithology comprises sediments of the Cape Supergroup, with sandstones of the Peninsula Formation (up to 1 550 m thick) underlain by characteristic reddish sandstone and shale of the Graafwater Formation. Granites of the Cape Peninsula Pluton intrude the pre-Cape rocks in places (SACS 1980).

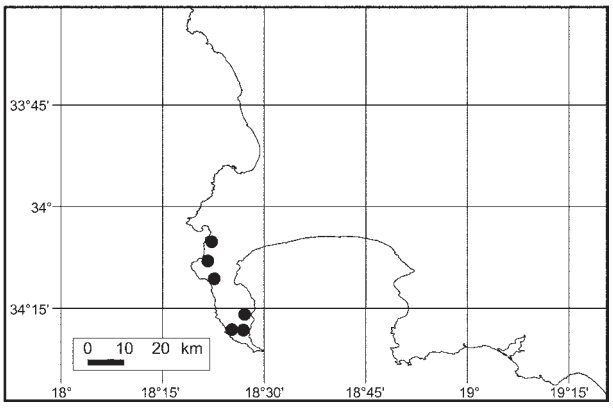

FIGURE 1.—Distribution of *Ruschia promontorii*.

RELATIONSHIPS

The creeping, mat-forming habit (Figure 2A) and triquetrous leaves of *Ruschia promontorii* (Figure 2B) exclude it from *Amphibolia*, where it was placed by Hartmann (1996, 2001) under the synonomy of *Amphibolia laevis*. The latter is shrubby with decumbent branches and club-shaped leaves with rounded tips (Hartmann 1996). Rectangular valve wings, a character always present in capsules of *Amphibolia*, are absent in *R. promontorii.* The type of *R. promontorii*, however, lacks fruit, which has possibly led to the erroneous placement of *R. promontorii* in the genus *Amphibolia*.

Ruschia promontorii was first thought to belong to the genus *Acrodon* because of its mat-forming habit,

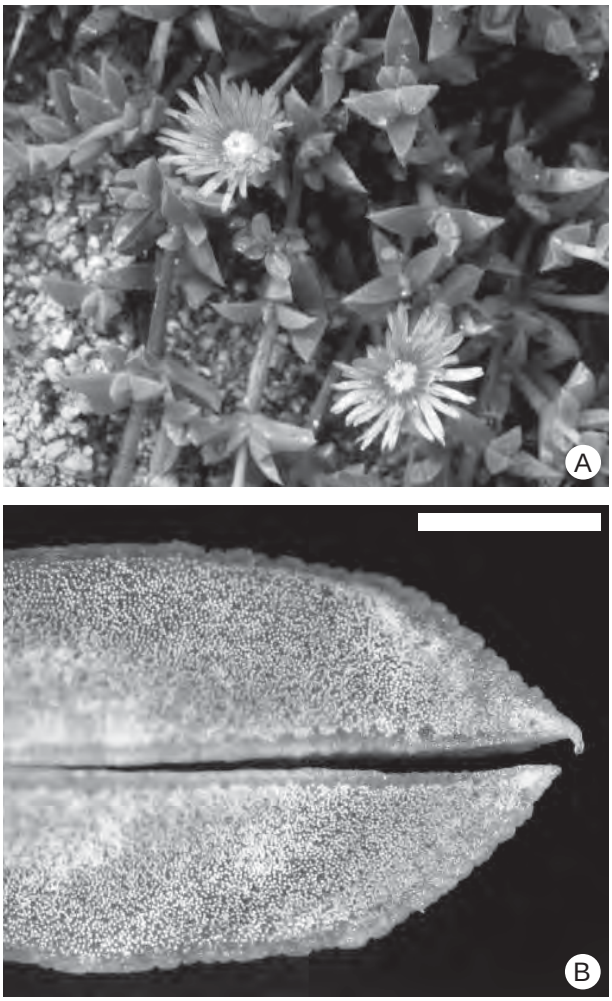

FIGURE 2.—*Ruschia promontorii*. A, creeping, mat-forming habit, *Burgoyne 6703*; B, leaves with a smooth epidermis and epidermal thickening at margin. Scale bar: B, 5 mm.

FIGURE 3.—Flowers of *Ruschia promontorii, Burgoyne 6703*, showing filamentous staminodes gathered into a cone and petals with a darker central stripe.

triquetrous leaves, bract and flower characters (Figure 3) and white pollen (Table 1). However, its seeds lack baculae (Figure 4A) and microbaculae (Figure 4B) preventing its transfer to *Acrodon* in which baculae and microbaculae are always present (Glen 1986). Although seed characters are of limited taxonomic importance, it has been found that the presence of baculae and microbaculae is constant within the genus *Acrodon* (Glen 1986).

Comparisons between the capsule morphology (Figure 5A–D) of *Ruschia sarmentosa* the type of the subgenus *Sarmentosae*, *R. promontorii*, *Acrodon* and *Amphibolia* are given in Table 1.

Ruschia promontorii shares more characters with *R. sarmentosa* than with any other taxon. The creeping, sarmentose habit and presence of similar closing bodies and absence of valve wings in the capsule are characters shared with the subgenus *Sarmentosae* as a whole. Closing devices present on the distal ends of the covering membranes are present in both *R. promontorii* and *R. sarmentosa*.

Differences between these two species (Table 1) include habitat preference, with *Ruschia sarmentosa* growing in flat sandy areas close to the sea. The flowers of *R. sarmentosa* are borne in cymes of three, whereas those of *R. promontorii* are mainly single or in cymes of three, the central one maturing while the other two mostly abort. Leaves of *R. sarmentosa* are longer (30–45 mm long) and are clustered at the nodes, and the side branches stand upright at the long internodes, whereas

TABLE 1.—Comparison between *Ruschia sarmentosa* (subgenus *Sarmentosae*), *R. promontorii*, *Acrodon* and *Amphibolia* based on selected characters

Character	*Ruschia sarmentosa* (subgenus *Sarmentosae*)	*R. promontorii*	*Acrodon*	*Amphibolia*
Habitat	diverse, flat sandy areas close to sea	scree slopes of Cape Peninsula	diverse	coastal lowlands along West Coast
Habit	sarmentose, creeping	mat-forming, creeping	mat-forming, creeping	shrubby with decumbent branches
Internodes	light- or dark-coloured	light-coloured, sometimes red	light- or dark-coloured	light-coloured
Leaves	triquetrous or rounded	triquetrous with sharp tip	triquetrous	club-shaped with rounded tip
teeth on leaf margin	absent	absent	present	absent
Floral bracts	small; bracteoles also present	large; bracteoles absent	large; bracteoles absent	small; bracteoles absent
Flowers	in cymes	single/cymes of 3, central one maturing while others mostly abort	single	single, giving appearance of one-sided panicle
petals	pink, striped or solid colours	pale pink with darker central stripe	pale pink with darker central stripe	various shades of pink with complex markings at tip and base
filamentous staminodes	collected into central cone	collected into central cone	collected into central cone	leaning inwards
pollen	white or yellow	white	white	unknown
Capsule				
morphology	woody, dark brown	woody, dark brown	woody, dark brown	woody, white to grey
hygrochasty	closing again once open	closing again once open	closing again once open	not closing again once open
valves	remaining half open	remaining half open	remaining half open	opening fully
closing bodies	large or small	large	large	small
covering membranes	thin, translucent, with closing devices	thin, translucent, with closing devices	thin, translucent, with no closing devices	thin, translucent, with closing devices
valve wings	absent	absent	absent	rectangular, present
Seed				
colour	dark brown	dark brown	dark brown	pale brown
surface	baculae or microbaculae absent	baculae or microbaculae absent	baculae with microbaculae present	baculae or microbaculae absent

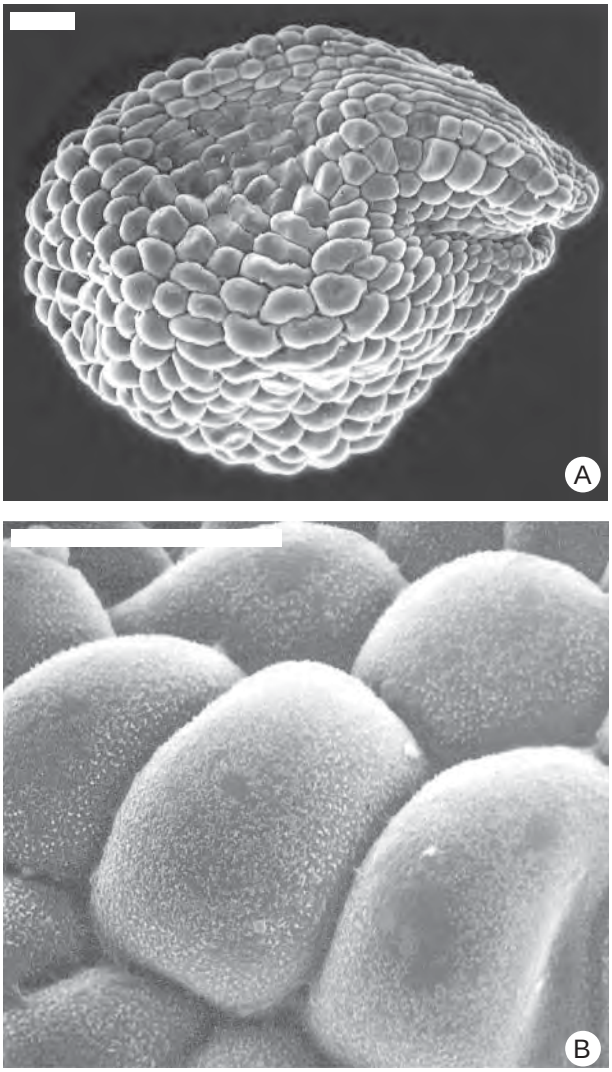

FIGURE 4.—Seeds of *Ruschia promontorii*. A, no baculae, *Burgoyne 6703*; B, wax platelets on surface. Scale bars: A, 100 μm; B, 10 μm.

in *R. promontorii* the shorter leaves (18–35 mm long) are usually borne one pair per node. Internodes are much shorter and side branches are mostly decumbent.

Herbarium specimens of the two species are easy to distinguish, as once pressed and dried, the leaves of *Ruschia promontorii* are pale grey resulting from a prominent wax covering, whereas those of *R. sarmentosa* remain dark green.

As previously mentioned, Desmet (2000) noted that this taxon was better placed in *Antimima*. However, this species does not belong to the genus *Antimima*, as the criteria for inclusion to that genus, such as capsules opening fully, and large closing bodies completely blocking the distal ends of locules (Hartmann 1998a), are not met. Capsules of *Ruschia promontorii* never open fully (Figure 5A), the closing bodies being hook-shaped and not large, therefore excluding it from the genus *Antimima*.

It is interesting to note that the origin of the type material of *Ruschia sarmentosa* described by Haworth (1812) is from 'Nova Hollandia', a term used to describe the Australian continent at that time. Salm Dyck (1840) states: '*M. sarmentosum* was sent to the good Haworth in the year 1806 by Mr Donn and it was said to have arisen from Australian seeds. *M. simile* arose at Kew in 1819, most certainly from Cape seed; from which [fact] doubt remains in my mind as to which homeland *M. sarmentosum* is to be attributed to. It is not possible to separate these two plants, as is clear from the description' (translated from Latin by H.F. Glen).

The description by Haworth and an unpublished plate done by J. Duncanson at Kew (numbered 127), dated April 1826, predates the publication of Salm-Dyck (1840) by 14 years and therefore would have been material seen by Haworth, thus constituting the earliest type. The holotype of *Ruschia sarmentosa*, therefore, is the unpublished plate by J. Duncanson at Kew (numbered 127, dated April 1826) and not that of Salm-Dyck 1840: §17 f 3.

CONSERVATION STATUS

This Red List species is restricted to the Cape Peninsula. It was first known only from the Cape of Good Hope Nature Reserve (Smuts 1994) growing on cliffs below the Cape Point lighthouse. Later its distribution was extended from the lighthouse to further along the False Bay coast also growing in rocky cliff situations. Listed as endangered, using the old IUCN categories (Hilton Taylor 1996), it has now been found growing on the slopes of Chapmans Peak. This species has recently been placed under further threat as the slopes of Chapman's Peak Drive have been cleared of loose material to make it safer for motorists. It is not known how many plants of *Ruschia promontorii* have been affected by this activity, but as *R. promontorii* tends to grow on scree slopes which are naturally disturbed due to rock turnover, more niches may have been created for these plants resulting from the clearing of loose rock. The situation should be monitored to observe the effect this activity has had on the plant population.

The current Red List status of this species using the latest criteria (IUCN 2001) is Endangered, B1 ab (I, II, III, IV & V) +2ab (I, II, III, IV) (Klak & Victor 2001) as it has an area of occupancy of less than 1 km², while the extent of occurrence is less than 100 km².

Pressure from developers to build more homes along the coast where this species grows is a constant threat to the habitat. Only a few highly fragmented populations exist, but plants are healthy and produce numerous flowers that are pollinated, often producing an abundance of seed. Consecutive years of low rainfall may affect the number of flowers and seed produced. Fires have ravaged the area over the last few years but it is not known whether this has influenced the population in any way. All populations visited showed a healthy demography with juvenile, mature and older plants present.

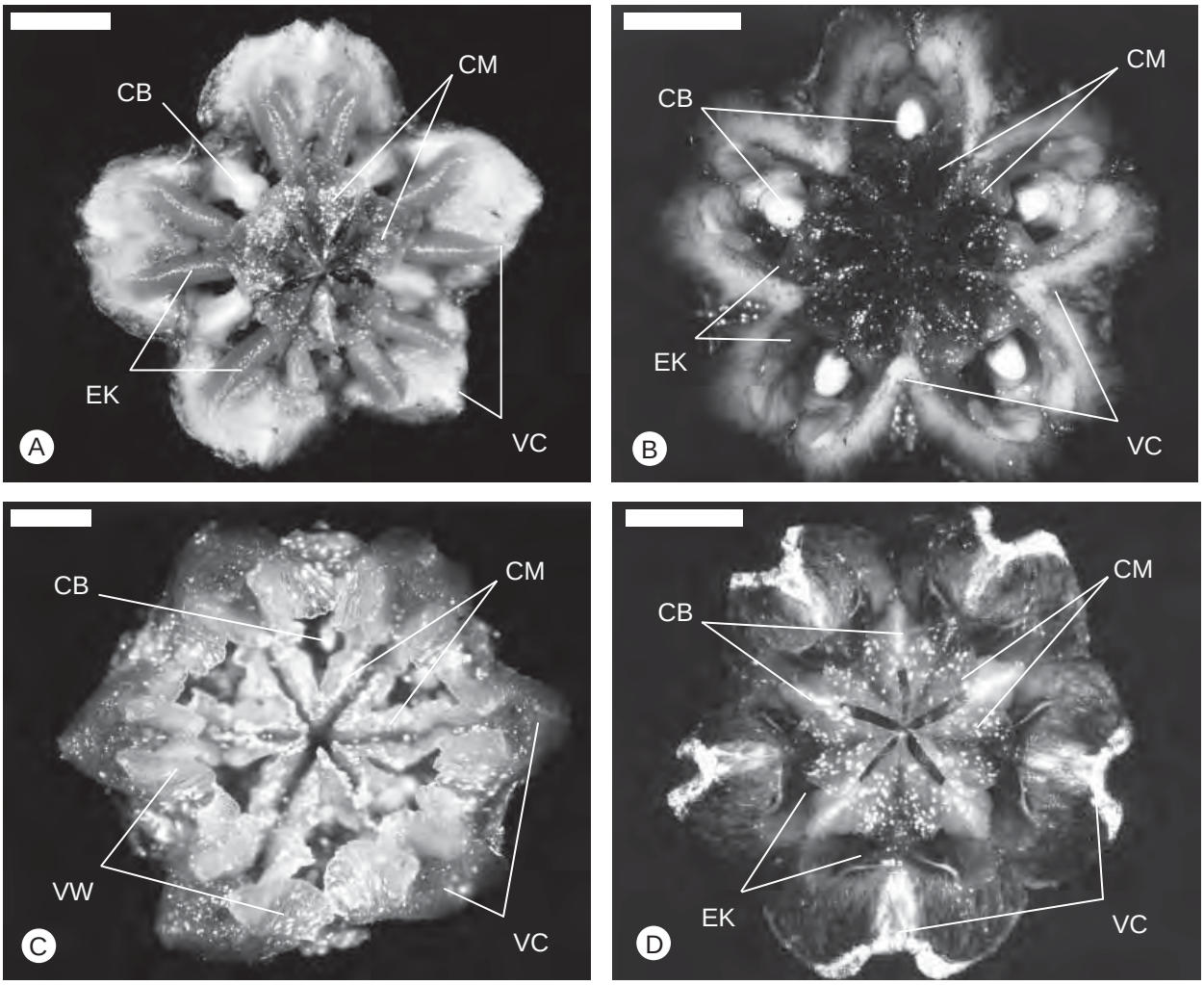

FIGURE 5.—Fruit. A, *Ruschia promontorii*, *Burgoyne 6703*; B, *R. sarmentosa*, *Burgoyne 6702*; C, *Amphibolia hutchinsonii*, *Burgoyne, Smith & Van Wyk 8160*; D, *Acrodon purpureostylus*, *Burgoyne 6730*. Scale bars: 10 mm. CB, closing bodies; CM, covering membranes; EK, expanding keels; VC, valve covers; VW, valve wings.

CONCLUSION

Ruschia promontorii is better placed in the genus *Ruschia* on the basis of the characters shared with *R. sarmentosa* (subgenus *Sarmentosae*). However, it shares a number of characters with *Acrodon*.

TAXONOMY

Ruschia promontorii *L.Bolus*, Notes on Mesembrianthemum and allied genera 2: 121 (1929).

Mesembryanthemum pansifolium N.E.Br. (manuscript name)

Antimima promontorii Desmet 64 (2000), nom. illeg. as 'promontoni' and 'promontori'.

Specimens examined

Ruschia promontorii

WESTERN CAPE.—3418 (Simon's Town): Simon's Town, (–AB), *Burgoyne 6703, 7475* (PRE), *Van Jaarsveld 3163, 3172* (PRE); Simon's Town, (–AD), *Van Jaarsveld 3954, 12905* (PRE).

Ruschia sarmentosa

WESTERN CAPE.—3318 (Cape Town): Bellville, (–DC), *Hilton-Taylor 4989* (PRE). 3418 (Simon's Town): Simon's Town, (–AB), *Burgoyne 6702* (PRE); Simon's Town, (–AD), *Van Jaarsveld 3633, 12921* (PRE).

Amphibolia laevis

WESTERN CAPE.—3017 (Hondeklipbaai): Hondeklipbaai, (–AD), *Burgoyne 7542* (PRE), *Burgoyne, Smith & Van Wyk 8160*, (PRE). 3117 (Lepelfontein): Baievlei, (–BD), *Van Rooyen 2231*, (PRE). 3118 (Vanrhynsdorp): Doringbaai, (–CC), *Boucher, 4049* (PRE). 3218 (Clanwilliam): Lambert's Bay, (–AB), *O'Callaghan, Van Wyk & Morley 140* (PRE); Velddrif, (–CC), *Marloth 7961* (PRE), *Van Jaarsveld 5685* (PRE). 3318 (Cape Town): Cape Town, (–CD), *Van Jaarsveld 3942* (PRE).

Acrodon purpureostylus

WESTERN CAPE.—3320 (Montagu): Montagu, (–CC), *Burgoyne 6730* (PRE).

ACKNOWLEDGEMENTS

The curator of Bolus Herbarium is thanked for the opportunity to study specimens at the Herbarium and for the use of colour plates. Western Cape Nature Conservation and Annelise le Roux in particular are thanked for issuing permits to collect *Ruschia promontorii* at short notice. Hugh Glen is thanked for translation

of the Latin. Dick Brummit, Kew, is thanked for tracing the N.E. Brown manuscript names.

REFERENCES

BOLUS, H.M.L. 1929. Notes on *Mesembryanthemum* and allied genera, part 2: 121

DESMET, P. 2000. Captions to slides for MSG. *Mesemb Study Group Bulletin* 4: 64.

GLEN, H.F. 1986. Numerical taxonomic studies in the subtribe Ruschiinae (Mesembryanthemaceae)—*Astridia*, *Acrodon* and *Ebracteola*. *Bothalia* 16: 203–226.

HARTMANN, H.E.K. 1996. Miscellaneous taxonomic notes on Aizoaceae. *Bradleya* 14: 20–56.

HARTMANN, H.E.K. 1998a. New combinations in *Antimima* (Ruschioideae, Aizoaceae) from southern Africa. *Bothalia* 28: 67–82.

HARTMANN, H.E.K. 1998b. New combinations in Ruschioideae, based on studies in *Ruschia* (Aizoaceae). *Bradleya* 16: 44–91.

HARTMANN, H.E.K. 2001. *Illustrated handbook of succulent plants: Aizoaceae A–E*. Springer-Verlag, Berlin.

HAWORTH, A.H. 1812. *Synopsis plantarum succulentarum*: 283. Taylor, London.

HILTON TAYLOR, C. 1996. Red Data List of southern African plants. *Strelitzia* 4. National Botanical Institute, Pretoria.

IUCN 2001. *IUCN Red List Categories and Criteria*: version 3.1. IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK.

KLAK, C. & VICTOR, J.E. 2001. *Red List data*. South African National Biodiversity Institute, Pretoria. Unpublished.

SALM-REIFFERSCHEIDT-DYCK, J. Duke of. 1836–1863. *Monographia generum Aloe et Mesembryanthemi*. I–V: Arnz, Dusseldorf; V, VI: Henry & Cohen, Bonn; VII: M. Cohen & fil., Bonn.

SMUTS, L.M. 1994. *ISEP (Information System for Endangered Plants) file*. Cape Nature Conservation. Unpublished.

SOUTH AFRICAN COMMITTEE FOR STRATIGRAPHY (SACS) 1980. Stratigraphy of South Africa. Part 1 (compiled by L.E. Kent). Lithostratigraphy of the Republic of South Africa, South West Africa/Namibia, and the Republics of Bophuthatswana, Transkei and Venda. *Handbook of the Geological Survey of South Africa* No. 8: 201–235. Government Printer, Pretoria.

P.M. BURGOYNE*

* National Herbarium, South African National Biodiversity Institute, Private Bag X101, 0001 Pretoria.
MS. received: 2000-10-27.

‘FORSYTH (*FL.* 1835)’: A PHANTOM BOTANICAL COLLECTOR AT THE CAPE OF GOOD HOPE EXPLAINED

At the instigation of Dr Peter Goldblatt, I have attempted to establish the veracity of the inclusion of a collector named Forsyth by Gunn & Codd (1981: 157) in their roster of botanical exploration of southern Africa. This individual was credited as follows: ‘Collected at the Cape 1835; also in Indonesia and Mascarenes Is.’. Those authors cited Hedge & Lamond (1970) as their source. In the index to collectors in the herbarium of the Royal Botanic Garden, Edinburgh, Hedge & Lamond (1970) noted that the Forsyth specimens were not dated and that they were included in the herbarium of Archibald Menzies.

Among African specimens associated with this Forsyth are the type specimens of *Ferraria macrochlamys* (Baker) Goldblatt & J.C.Manning (Goldblatt & Manning 2004) and *Babiana spiralis* Baker (Goldblatt & Manning 2005: 72). Both species are endemic to Namaqualand, but no collector named Forsyth is known to have visited Namaqualand before 1835.

Concerning the first taxon, Baker (1876: 338) noted that he had seen only one specimen ‘without a note of its special locality’, and gave the collection data in the following form: ‘*C. B. Spei.* Forsyth in Herb. Bentham!’. Regarding the second taxon, Baker (1892: 183) reported that he had described it ‘from specimens in the herbarium of Forsyth’, adding later (Baker 1896) that the two specimens ‘without locality ... [were] in the Forsyth’s herbarium, purchased by Mr. Bentham in 1835.’

Forsyth is not an unfamiliar name in British horticulture—*Forsythia* (Oleaceae) was named by Vahl to honour William Forsyth (1737–1804), a distinguished Scottish horticulturist and one of the founders of the (Royal) Horticultural Society of London. His son, also named William (1772–1835), was a nurseryman in London throughout his life. Desmond & Ellwood (1994) list several others with this surname, but none of these individuals is recorded as having been a plant collector at the Cape of Good Hope. There is no entry for Forsyth in Lanjouw & Stafleu (1957).

The date 1835 and Baker’s allusion to specimens from Forsyth’s herbarium purchased by Bentham in 1835 provided the clues to unravelling this enigma.

The younger William Forsyth, who died on 28 July 1835, ‘had an excellent horticultural library’ (Desmond & Ellwood 1994: 257) which was sold by auction by Sotheby in London during November 1835 (Sotheby 1835; Chalmers-Hunt 1976). An annotated copy of the catalogue of the sale (Sotheby 1835) survives in the Botany Library, The Natural History Musuem, London, and indicates that 2 597 lots were auctioned including this, the penultimate, one: ‘2596. A very extensive and well-arranged *hortus siccus* contained in ten cases, forming a range, with five mahogany doors’. William Pamplin, publisher, bookseller and dealer in botanical specimens, who annotated the catalogue, noted that it was sold for £17 6s. 6d.

George Bentham’s manuscript diary, which survives in the Archives of the Royal Botanic Gardens, Kew, confirms that Bentham attended this auction, buying a few books as well as Forsyth’s entire herbarium:

> 18 November 1835: ‘... to Sotheby’s sale rooms to the auction of Forsyth’s books, but got there too late for today’s sale ...’.
>
> 20 November 1835: ‘... to Forsyth’s sale where bid for several books but they all went too dear ...’.
>
> 21 November 1835: ‘... then for the whole afternoon to Forsyth’s sale where bought Vahl’s works & two or three others also, [and] the herbarium which appears to contain a large quantity of W. Indian plants for which I gave 16½ guineas’.

Sixteen and a half guineas equal £17 6s. 6d. A copy of Vahl's *Symbolae botanicae* (1790–1794), inscribed 'Will F. 1800' on the verso of the title page, and with a book plate 'Presented by George Bentham Esq 1854', is in the Linnean Collection in the library at the Royal Botanic Gardens, Kew (J. Flanagan pers. comm., 19 September 2005). Pamplin noted that it was sold for £1 17s. 0d.

On 23 November Bentham went to Sotheby's premises '... to settle for my Saturday's purchase which had taken to the Hort Soc in order there to get rid of superfluous paper—then at the Hort Soc looking over several parcels which appear very satisfactory'. Bentham spent the following two weeks at the premises of the Horticultural Society, of which he was the Honorary Secretary (Stevens 2003), sorting Forsyth's herbarium; by 28 November he had packed '25 large bundles' which he arranged to 'bring home'. Bentham must subsequently have shared duplicates with other botanists including Archibald Menzies—that is the most likely explanation for presence of 'Forsyth 1835' specimens in Menzies' herbarium in the Royal Botanic Garden, Edinburgh.

It may safely be concluded, therefore, that annotations on southern African specimens indicating Forsyth and 1835 came from this miscellaneous collection which Bentham purchased on 21 November 1835, and that they should not be read as indicating a collector and collection date.

Who actually collected these specimens must remain a matter of conjecture, unless other evidence, in the form of contemporary annotations, occurs on the herbarium sheets.

REFERENCES

BAKER, J.G. 1876. New Gladioleae. *Journal of Botany, British and foreign*, new ser. 5: 333–339.

BAKER, J.G. 1892. *Handbook of the Irideae*. Bell, London.

BAKER, J.G. 1896. *Babiana spiralis*. In W.T. Thiselton-Dyer, *Flora capensis* 6: 111. Reeve, London.

CHALMERS-HUNT, J.M. 1976. *Natural history auctions 1700–1972. A register of sales in the British Isles.* London.

DESMOND, R.G.C. & ELLWOOD, C. 1994. *Dictionary of British and Irish botanists and horticulturists*. London.

GOLDBLATT, P. & MANNING, J.C. 2004. New species of *Ixia* (Crocoideae) and *Moraea* (Iridoideae), and taxonomic notes on some other African Iridaceae. *Novon* 14: 288–298.

GOLDBLATT, P. & MANNING, J.C. 2005. Taxonomic notes on *Babiana* and *Ferraria* in arid southern Africa (Iridaceae). *Bothalia* 35: 71–74.

GUNN, M. & CODD, L.E. 1981. *Botanical exploration of southern Africa*. Balkema, Cape Town.

HEDGE, I.C. & LAMOND, J.M. 1970. *Index of collectors in the Edinburgh Herbarium*. Edinburgh.

LANJOUW, J. & STAFLEU, F.A. 1957. Index herbariorum, part 2 Collectors E–M. *Regnum vegetabile* 9.

SOTHEBY. 1835. *Catalogue of the united libraries of William Forsyth ... and of the late William Forsyth ... together with his ... collection of unpublished manuscripts ... which will be sold by auction by Mr. Sotheby and Son ... Strand on ... November 11th 1835 and nine following days*. London.

STEVENS, P.F. 2003. George Bentham (1800–1884): the life of a botanist's botanist. *Archives of natural history* 30,2: 189–202.

E.C. NELSON*

* Tippitiwitchet Cottage, Hall Road, Outwell, Wisbech, Cambridgeshire, PE14 8PE, UK.

MS. received: 2005-10-12.

MALVACEAE

A NEW SPECIES OF *CORCHORUS* IN SOUTHERN AFRICA

INTRODUCTION

Corchorus L., a genus of Malvaceae *s.l.* (previously in Tiliaceae) comprises ± 100 species widely distributed throughout the tropics, subtropics and warm temperate regions of the world (Wild 1984; Edmonds 1990; Heywood 1993; Bayer & Kubitzki 2003). Species of *Corchorus* are either annual or perennial herbs or small shrubs, sometimes arising from a woody rootstock, with simple to stellate hairs (Wild 1984; Edmonds 1990). *Corchorus* species occupy a wide range of habitats ranging from swamps and riverine conditions, to forest, bushland, woodland and open savanna, and cultivated fields. They also colonize diverse soil types ranging from sand, clay, black turf and loam, on quartz and granite to limestone (Edmonds 1990; Lebrun & Stork 2003).

Recent molecular phylogenetic analyses of the chloroplast genes *atp*B, *rbc*L and *ndh*F have placed the Tiliaceae among the core Malvales *sensu lato* (Angiosperm Phylogeny Group 1998). Within this group, analyses show Tiliaceae to be paraphyletic, with *Corchorus* excluded from Tiliaceae *sensu stricto* (Alverson *et al*. 1998, 1999; Bayer *et al*. 1999; Whitlock *et al*. 2001).

Since Linnaeus established the first four *Corchorus* species, *C. capsularis* L., *C. hirsutus* L., *C. olitorius* L., and *C. siliquosus* L. in *Species plantarum* (Linnaeus 1753) and *Genera plantarum* (Linnaeus 1754), (*C. olitorius* being the type species of the genus), many additional species have been described. The last floristic account of *Corchorus* in southern Africa was published by Wild in 1984 in which 15 species were recognized. Despite this publication, confusion regarding species limits and relationships within the genus is still not resolved or fully understood. This is evident from the herbarium studies which have shown that many specimens have been misidentified and that there are different opinions as to what constitutes real species.

Current taxonomic treatments do not allow for effective identification of certain species, resulting in curatorial problems in all southern African herbaria. The genus is currently under revision. A new species of *Corchorus* was discovered during field excursions and the study of morphological variation within the genus. The new species together with *C. trilocularis* L. and *C. confusus* Wild are very similar in floral and vegetative morphology and

it is difficult to identify them from herbarium specimens when capsules are not available. *Corchorus trilocularis* L. and the related species form a distinct group distinguished by the ± straight capsules and fruiting pedicels. *Corchorus trilocularis* is an annual, whereas *C. confusus* and the new species are perennials. These three species form a group that is confined to the eastern parts of Africa extending up to Tanzania, with *C. trilocularis* occurring in other tropical and subtropical regions of tropical Africa, Madagascar, Asia, Australia and the Middle East. DNA studies also support this grouping (Moeaha *et al*. in press).

Corchorus argillicola *M.J.Moeaha & P.J.D.Winter*, sp. nov.

TYPE.—Limpopo, 2328 (Mokopane): ± 2 km N of Mapela, ± 30 km N of Mokopane (Potgietersrus), (–DD), 4 June 2002, *P.J.D. Winter 5764* (PRE).

C. confuso Wild et *C. triloculari* L. capsuli pedicellisque fructificantibus plusminusve rectis affinis sed capsuli omnino hirsutis non porcatis ab ambabus speciebus differt.

Perennial herb with prostrate or spreading stems from a woody rootstock; branches with pubescence all around stem, or sometimes with line of short hairs on one side of stem only. *Leaf blade* narrowly ovate, 30–50(–80) × 10–18(–25) mm, obtuse in basal leaves, crenate or serrate-crenate, sometimes with pair of basal setae, pubescent on both surfaces, especially on nerves, hairs not tubercle-based; petiole up to 15 mm long, pubescent; stipules up to 7 mm long, setaceous, pubescent. *Inflorescence* of (1)2–4-flowered cymes opposite upper leaves; peduncles 3–5(–20) mm long, pubescent, pedicels up to 3–5(–7) mm long, pubescent. *Sepals* narrowly lanceolate, up to 8 mm long, pubescent abaxially. *Petals* yellow, narrowly obovate, up to 8 × 5 mm, with short ciliate claw, androgynophore ± 0.5 mm long, with an annulus. *Stamens* numerous. *Ovary* cylindrical, densely pubescent; style ± 2.5 mm long, slender, glabrous, stigma cuspidate. *Capsules* up to 90 mm long; fruiting pedicel straight, densely or sparsely pubescent, without longitudinal ridges. *Seeds* numerous, black, ± 1.5 × 1 mm. Figure 6.

Diagnostic characters and relationships: this species was included in *Corchorus confusus* by Wild (1958), but

FIGURE 6.—*Corchorus argillicola*. A, flowering branch, × 1; B, base of plant showing smaller basal leaves with rounder apices, × 1; C, flower, × 2; D, base of leaf showing seta, × 4; E, capsules, × 1; F, apically oriented palmate hairs found on capsules, × 50. Artist: G. Condy.

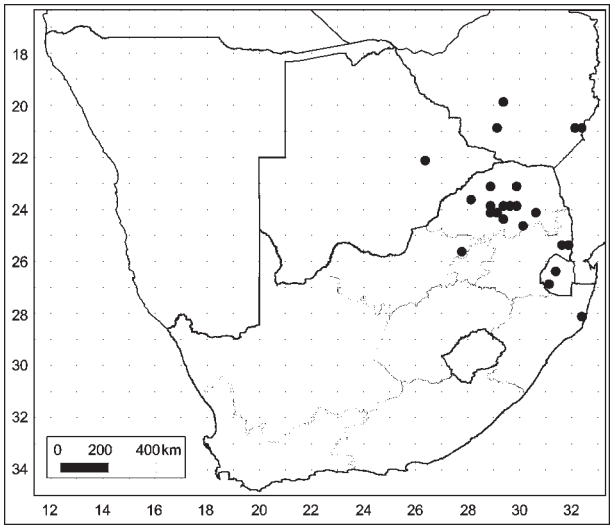

FIGURE 7.—Known distribution of *C. argillicola*.

the comparison of live and herbarium material indicates that two distinct taxa are involved and that the populations from deep black turf or clay soils represent a distinct species, ecologically separated from *C. confusus*. *Corchorus argillicola* is related to *C. confusus* and *C. trilocularis* by the more or less straight capsules and fruiting pedicels. Herbarium specimens of these three species may easily be confused. Wild (1958, 1984) hypothesized the confusion of *C. confusus* and *C. trilocularis* in herbarium material to the possibility that *C. confusus* is of hybrid origin with *C. trilocularis* and *C. asplenifolius* as putative parents. However, field visits have indicated that these species are quite different. The new species differs mainly in the distribution of trichomes, which occur all over the surface on the capsules, and in the lack of longitudinal ridges on the capsules at all stages of development. In contrast, the capsules of *C. confusus* are angular, and sparsely scabrous on the angles or glabrous, whereas in *C. trilocularis* they have trichomes confined to the ridges and on the angles, and are otherwise glabrous. Furthermore, this new taxon is a perennial, whereas *C. trilocularis* is an annual weed of cultivation.

Distribution and habitat: *Corchorus argillicola* is restricted to deep black turf and clayey soils below 1 300 m. It occurs mainly in the Limpopo basin, but extends to the Chipinge District in SE Zimbabwe and to Maputaland in northern KwaZulu-Natal (Figure 7). It seems to be an ecologically specialized relative to *C. confusus*, which occurs in a much wider range of conditions including rocky and sandy habitats in savanna and Grassland Biomes at altitudes up to 1 600 m.

Etymology: the specific epithet *argillicola* refers to the clay soils to which this species is restricted.

Specimens examined

ZIMBABWE.—1929 (Gweru): Shangani Dist., (–CD), *Feiertag s.n.* (SRGH). 2032 (Chipinge): 7 km S of Chisumbanja, (–CC), *Pope & Müller 1532* (SRGH); Chipinge Dist., *Phipps 99* (SRGH); 6 km S of Rusongo Hill, (–CD), *Biegel, Pope & Russell 4903* (SRGH).

BOTSWANA.—2226 (Serowe): 60 km NW of Serowe, (–AB), *Wild & Drummond 7286* (PRE, SRGH).

LIMPOPO.—2328 (Baltimore): on Farm Wellust 426 LR, (–CA), *Schmidt 174* (PRU); ± 2 km N of Mapela, ± 30 km N of Mokopane [Potgietersrus], (–DD), *P.J.D. Winter 5764* (PRE). 2329 Polokwane [Pietersburg]: Ben-Lavin Nature Reserve, (–BB), *James 262* (PRU); near turn-off to Chuenespoort from Polokwane, (–CD), *M.J. Moeaha 47* (UNIN); Turfloop Water Course, N of Suiferkuil Experimental Farm, (–DC), *M.J. Moeaha 13* (UNIN). 2428 (Nylstroom): S of Rooisloot, (–BB), *P.J.D. Winter s.n.* (UNIN). 2429 (Zebediela): 8 km W of Moletlane, (–AD), *M.J. Moeaha 49* (UNIN). 2430 (Pilgrim's Rest): 1 mile N of Mokopane (–AA), *Gillett 2807* (PRE); on road between Tzaneen and Hoedspruit, above Selati River, (–BA), *M.J. Moeaha 27* (UNIN); Steelpoort, on Farms Driekop and Winterveld, (–CA), *Siebert & Du Plessis 1550* (PRU).

NORTH-WEST.—2527 (Rustenburg): Brits, as exiting town area to the east on R566, just north of Brits Abbatoir and south of railway shunter, (–DB), *S.P. Bester 6056* (PRE).

MPUMALANGA.—2531 (Komatipoort): Nelspruit, on road between Malelane and Komatipoort, 5 km E of turn-off to Coopersdal, (–BC), *M.J. Moeaha 36* (UNIN); Nelspruit, in sugarcane fields ± 5 km S of Komatipoort, (–BD), *M.J. Moeaha 34* (UNIN).

SWAZILAND.—2631 (Mbabane): Gollel, Hlatikulu, (–AD), *Compton 29425* (PRE).

KWAZULU-NATAL.—2832 (Mtubatuba): False Bay Park, S sector, (–AB), *Ward 7723* (PRE).

ACKNOWLEDGEMENTS

I would like to thank my supervisor Pieter Winter for drawing my attention to the taxonomy of the genus *Corchorus* and for his continuous encouragement and support during the early stages of my research, and also for his inspiration and constructive criticism, guidance, enthusiasm, genuine interest in my work and for guidance and participation with field work. I am very grateful to the staff and curators of the herbaria mentioned above for making their material available for this study. Special thanks are due to Dr O.A. Leistner for the Latin translation of the diagnosis, Ms Gill Condy for line drawings and Ms Hester Steyn for the distribution map. I am also grateful to Dr J.C. Manning for his valuable comments on the manuscript. A taxonomic analysis of *Corchorus* is a registered M.Sc project at the University of Limpopo.

REFERENCES

ALVERSON, W.S., KAROL, K.G., BAUM, D.A., CHASE, M.W., SWENSEN, S.M., McCOURT, K.J. & SYTSMA, K.J. 1998. Circumscription of the core Malvales and relationships to other Rosidae: evidence from *rbc*L sequence data. *American Journal of Botany* 85: 857–887.

ALVERSON, W.S., WHITLOCK, B.A., NYFFELER, R., BAYER, C. & BAUM, D.A. 1999. Phylogeny of the core Malvales: evidence from *ndh*F sequence data. *American Journal of Botany* 86: 1474–1486.

ANGIOSPERM PHYLOGENY GROUP (APG). 1998. An ordinal classification for the families of flowering plants. *Annals of the Missouri Botanical Garden* 82: 247–277.

BAYER, C., FAY, M.F., DE BRUIJN, A.Y., SAVOLAINEN, V., MORTON, C.M., KUBITZKI, K., ALVERSON, W.S. & CHASE, M.W. 1999. Support for the expanded family concept of Malvaceae within a recircumscribed order Malvales: a combined analysis of plastid *atp*B and *rbc*L DNA sequences. *Botanical Journal of the Linnean Society* 129: 267–303.

BAYER, C. & KUBITZKI, K. 2003. Malvaceae. In K. Kubitzki & C. Bayer. *The families and genera of vascular plants*, vol. 5. Springer, Berlin.

EDMONDS, J.M. 1990. Herbarium survey of African *Corchorus* L. species. *Systematic and ecogeographic studies on crop genepools* 4. International Board for Plant Genetic Resources, Rome.
HEYWOOD, V.H. 1993. *Flowering plants of the world*. Mayflower, New York.
LEBRUN, J.P. & STORK, A.L. 2003. *Tropical African flowering plants. Ecology and distribution* 1. Conservatoire et Jardin Botaniques, Genève.
LINNAEUS, C. 1753. *Species plantarum*, vol. 1. Holmiae, Stockholm.
LINNAEUS, C. 1754. *Genera plantarum*, edn 5. Lugdoni Batavorum, Stockholm.
MOEAHA, M.J, WINTER, P.J.D., VAN DER BANK, M. & GROBLER, P. in press. Molecular phylogenetic analysis of selected *Corchorus* species (Malvaceae *s.l.*) in southern Africa. *International Journal of Plant Sciences*.
WHITLOCK, B.A., BAYER, C. & BAUM, D.A. 2001. Phylogenetic relationships and floral evolution of the Byttnerioideae ('Sterculiaceae' or Malvaceae *s.l.*) based on sequences of the chloroplast gene, *ndh*F. *Systematic Botany* 26: 420–437.
WILD, H. 1958. Notes and new records of African flowering plants (Tiliaceae). *Bothalia* 7: 422–424.
WILD, H. 1984. Tiliaceae. In O.A. Leistner, *Flora of southern Africa* 21: 32–42.

M.J. MOEAHA*

*National Herbarium, South African National Biodiversity Institute, Private Bag X 101, Pretoria, 0001.
MS. received: 2005-08-11.

ASTERACEAE

ARCTOTIS DECURRENS (ARCTOTIDEAE), THE CORRECT NAME FOR *A. MERXMUELLERI* AND *A. SCULLYI*

The genus *Arctotis* L. comprises an estimated 50–60 species and belongs to the tribe Arctotideae. The representatives of this genus are indigenous to the *Flora of southern Africa* (*FSA*) region, with the highest concentration of taxa in Western Cape. One species, *A. venusta* Norl., has the widest distribution, extending to Angola and southern Zimbabwe. Some species are in cultivation and have been introduced into other countries, e.g. *A. stoechadifolia* P.J.Bergius (Pope 1992).

The taxonomy of *Arctotis* is extremely chaotic, owing largely to a great duplicity of published names and confusion over the correct application of many names. The last revision of the genus was undertaken by Lewin (1922), who used mainly fruit, involucre and pappus characters to distinguish between species. Unfortunately, he failed to resolve many of the nomenclatural problems and added to the confusion by misinterpreting some species and publishing additional superfluous names. Furthermore, recent morphological and molecular studies (McKenzie *et al*. 2005, 2006) indicate that the circumscription of the genus also requires reappraisal.

A monographic revision of *Arctotis* is being undertaken by the first author at Rhodes University, to resolve the taxonomic disarray within the genus. In preparation for the *Conspectus of the Trans-Cape Succulent Karoo Flora of South Africa* (Snijman in prep.), two species, *A. merxmuelleri* Friedrich and *A. scullyi* Dümmer, from Northern Cape, and a third species, *A. decurrens* Jacq., of uncertain provenance, were studied.

In a series of lavishly illustrated works published around the turn of the nineteenth century, N.J. von Jacquin and his son J.F. von Jacquin described 29 *Arctotis* species (excluding those names now known to apply to species in other genera). Of relevance to the present investigation, Jacquin (1797) described *A. decurrens* from cultivated material 'Ex Promontorio bonae Spei' grown in the Royal Schönbrunn garden, Vienna. The source, provenance and date of the original collection in South Africa are unknown. The name *A. decurrens* Jacq. has not been typified and application of the name by previous workers has varied, resulting in uncertainty as to what species the name applies to and, indeed, whether it is a valid species. A search of authentic Jacquin material in the Naturhistorisches Museum Herbarium, Vienna (W) revealed two specimens (*W0006629* and *0006630*) determined as *A. decurrens* with labels bearing 'Hort. Schönbr.' (i.e. Hortus Schönbrunnensis) in the lower left corner. A third specimen (*W0006628*) bore a label with 'Hort. Bot. Vindob.' (i.e. Hortus Botanicus Vindobonensis) in the lower left corner. The Hortus Schönbrunnensis specimens are likely to have been prepared prior to publication of the name *A. decurrens* by Jacquin (1797) and can be considered as possible type material. They are consistent in all important details (particularly involucral bract and leaf morphology) with the illustration and description of *A. decurrens* in Jacquin (1797). Therefore in all likelihood Jacquin based his concept of *A. decurrens* on material represented by the sheets *W0006629* and *0006630*. Herein the sheet *W0006630* is designated as the lectotype, as it contains the most complete material (three capitula, two also with upper stem leaves, and six individual lower stem leaves). The sheet *W0006629*, comprising a single flowering shoot without lower stem leaves, is designated an isotype.

The Hortus Botanicus Vindobonensis specimen differs from the Hortus Schönbrunnensis specimens in possessing leaves with a dense lanate tomentum on the abaxial surface, and the outer involucral bracts have shorter apical appendages with lanate trichomes on the abaxial surface. Given its origin from different cultivated material from the Hortus Schönbrunnensis specimens, it cannot be considered as type material.

Arctotis scullyi was described by Dümmer (1914) prior to publication of Lewin's (1922) revision of *Arctotis*, but Lewin stated that he did not see the publication until after the end of the First World War. He therefore did not include *A. scullyi* within his revision, but referred to the

species in a postscript and commented that the information on the involucre and cypselae was incomplete. The precise locality of the holotype of *A. scullyi* (*W.C. Scully 221*) is unknown, as the label only states 'Nama'land Minor' (i.e. Little Namaqualand). For a long time, no specimens of this species were lodged in the National Herbarium, Pretoria (PRE). Only recently, a few specimens collected between 1983 and 1998 were submitted, identified and lodged as *A. scullyi* in PRE.

Friedrich (1980) described *A. merxmuelleri* from material (*H.-C. Friedrich 498*) collected from 'sukkulentenreiches Strandveld östlich Port Nolloth bei 5 Miles' in Little Namaqualand and cultivated in the Botanischer Garten München. In his description, he added beautiful illustrations of *inter alia* the involucral bracts and cypselae. The holotype of *A. merxmuelleri* is lodged in M, and isotypes are lodged in BOL, K and PRE. No subsequent collections have been lodged in PRE.

After close examination of the Jacquin specimens in W, the illustrations by Friedrich (1980), concentrating especially on the involucral bracts, and isotypes of *A. merxmuelleri* and *A. scullyi* lodged in BOL and PRE, we concluded that the names *A. decurrens*, *A. merxmuelleri* and *A. scullyi* apply to the same species. The earliest legitimate name is *A. decurrens*, to which *A. merxmuelleri* and *A. scullyi* are placed in synonymy herein.

Arctotis decurrens *Jacq.*, Plantarum rariorum horti caesarei Schoenbrunnensis descriptiones et icons II. 20. t. 165 (1797). Type: 'Hort. Schönbr.' [Hortus Schönbrunnensis], ex Hb. Jacq. (W, lecto & iso!), here designated by R.J. McKenzie.

A. scullyi Dümmer: 152 (1914), syn. nov. Type: Northern Cape, 'Nama'land Minor' [Little Namaqualand], *W.C. Scully 221* (BOL!, holo; K (scanned image: http://www.kew.org/herbcat/!), PRE!).

A. merxmuelleri Friedrich: 13 (1980), syn. nov. Type: Northern Cape, 2916BD Little Namaqualand, Port Nolloth, 8-12-1974, *H.-C. Friedrich 498* (M, holo; BOL!, K (scanned image: http://www.kew.org/herbcat/!), PRE!).

The leaf tomentum appears to vary significantly. They are most commonly sparsely to densely brownish or whitish scabrous on both sides and/or glandular-pilose, but sometimes densely tomentose on both surfaces with no glands.

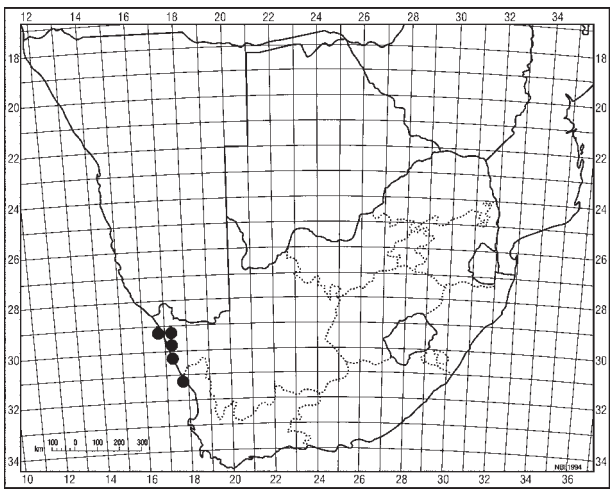

FIGURE 8.—Known distribution of *Arctotis decurrens* in southern Africa.

This species is seemingly endemic to the Strandveld of the West Coast (Namaqualand Sandveld) (Figure 8) where it grows near the coast and further inland on sand dunes in well-drained, sandy soil in full sun. It seems to be quite frequent to abundant in this area but is not often collected. At present it does not seem to be threatened but its habitat is becoming increasingly under threat of open mining activities, whereas overgrazing, land use changes, informal housing and urban development appear to be of a lesser threat.

Additional specimens examined

NORTHERN CAPE.—2916 (Port Nolloth): about 10 km east from Port Nolloth on road to Steinkopf, (–BD), 23-08-1998, *Koekemoer 1175* (PRE); 16 km east of Port Nolloth, (–BD), 21-08-1980, *A. le Roux 2703* (BOL); 11 km east of Port Nolloth, (–BD), 14-09-1976, *E. J. van Jaarsveld 1423* (NBG). 2917 (Springbok): Oograbies, (–AC), 27-07-1993, *L. van der Walt 274* (PRE); Kleinzee, Schulpfonteinpunt, (–CA), 30-11-1983, *G.K. Theron 3871* (PRE, PRU); Brazil, southeast of Kleinzee, beside road to Swartlintjiesrivier, (–CC), 5-09-2005, *R. J. McKenzie 1302* (GRA). 3017 (Hondeklipbaai): Swartlintjies River mouth, (–AD), 16-10-1980, *A. le Roux & Parsons 34* (PRE); Hondeklip Bay, at *Aristea* shipwreck, (–AD), 17-09-2003, *L. Mucina 170903/20* (GRA); coast 4 miles south of Hondeklip Bay, (–AD), 10-1924, *N.S. Pillans 18133* (BOL); sandy hills round Hondeklip Bay, (–AD), 10-1924, *N.S. Pillans 18136* (BOL); ± 103 km from Springbok on sand road to Hondeklipbaai (near coast), (–AD), 28-09-1986, *D. Strydom 10* (PRE). 3117 (Lepelfontein): Brandsebaai, (–BD), 29-09-1992, *M.W. van Rooyen 2140* (PRE, PRU), 1-10-1992, *M.W. van Rooyen 2248* (PRE, PRU). Without precise locality: 'Hort. Bot. Vindob.' [Hortus Botanicus Vindobonensis], ex Hb. Jacq., *Jacquin s.n.* (W); cultivated in National Botanic Gardens, 09-1920, *Anon.* (BOL); cultivated at Kirstenbosch National Botanic Garden, no. 407/18, 04-1922, *Phillimore s.n.* (BOL); cultivated at Kirstenbosch National Botanic Garden, no. 407/18, 07-1922, *Phillimore s.n.* (BOL).

ACKNOWLEDGEMENTS

We thank the W herbarium (especially Ernst Vitek and Anton Igersheim) for access to authentic Jacquin specimens; curators of the BOL, NBG and PRU herbaria for the loan of specimens; the Rhodes University Joint Research Committee and the National Research Foundation of South Africa (grant number 2069059 to N.P. Barker and a Postdoctoral Fellowship to R.J. McKenzie) for financial support.

REFERENCES

DÜMMER, R.A. 1914. A new *Arctotis*. *Journal of Botany* 52: 152, 153.

FRIEDRICH, H.-C. 1980. *Arctotis merxmuelleri*, eine neue Sippe aus dem kleinen Namaqualand. *Mitteilungen der Botanischen Staatssammlung München* 16, *Beiheft*: 11–17.

JACQUIN, N.J. VON 1797. *Plantarum rariorum horti caesarei Schoenbrunnensis descriptiones et icons*, vol. 2. Wappler, Viennae; White, Londini; & Luchtmans, Lugduni Batavorum.

LEWIN, K. 1922. Systematische Gliederung und geographische Verbreitung der Arctotideae–Arctotidinae. *Repertorium specierum novarum regni vegetabilis, Beihefte* 11: 1–75.

MCKENZIE, R.J., MULLER, E.M., SKINNER, A.K.W., KARIS, P.O. & BARKER, N.P. 2006. Phylogenetic relationships and generic

delimitation in subtribe Arctotidinae (Asteraceae: Arctotideae) inferred by DNA sequence data from ITS and five chloroplast regions. *American Journal of Botany* 93. In press.

MCKENZIE, R.J., SAMUEL, J., MULLER, E.M., SKINNER, A.K.W. & BARKER, N.P. 2005. Morphology of cypselae in subtribe Arctotidinae (Compositae–Arctotideae) and its taxonomic implications. *Annals of the Missouri Botanical Garden* 92: 569–594.

POPE, G.V. 1992. Compositae. In G.V. Pope, *Flora zambesiaca* 6,1: 1–264. Royal Botanic Gardens, Kew.

SNIJMAN, D. in prep. *Conspectus of the Trans-Cape Succulent Karoo Flora of South Africa.*

R.J. MCKENZIE*†, P.P.J. HERMAN** and N.P. BARKER*

* Molecular Ecology and Systematics Group, Department of Botany, Rhodes University, P.O. Box 94, 6140 Grahamstown, South Africa.
** South African National Biodiversity Institute, Private Bag X101, 0001 Pretoria.
† Corresponding author.
MS. received: 2006-04-28.

PTERIDOPHYTA: PTERIDACEAE

CHEILANTHES DELTOIDEA, A NEW LOCALITY IN GAUTENG, SOUTH AFRICA

Cheilanthes deltoidea Kunze is a small fern with a short, creeping rhizome covered in narrowly lanceolate, pale brown scales, thick black roots and old stipe bases. Fronds are closely spaced and erect. The dark brown, glabrous stipe is up to 75 mm long. The lamina, 18–100 × 16–110 mm, is triangular in outline, 2-pinnatifid to deeply 3-pinnatifid and entirely glabrous with obscure venation. Lamina margins are irregular and entire. Sori form a marginal line around the lobe apices, with the indusium continuous (Jacobsen 1983; Burrows 1990).

The species is endemic to southern Africa and occurs in the western and northwestern parts of Northern Cape, the Cederberg area in Western Cape and in southern Namibia. An isolated record from the Waterberg in the Limpopo Province is also known (Figure 9). It grows only in sheltered rock crevices on southern aspects, where it is completely sheltered from sunlight. Here it forms ribbon-like clusters of densely crowded fronds. It is found mostly on granite or gneiss rock formations. During the dry season it shrivels up completely and revives when sufficient moisture is available (Jacobsen 1983; Burrows 1990).

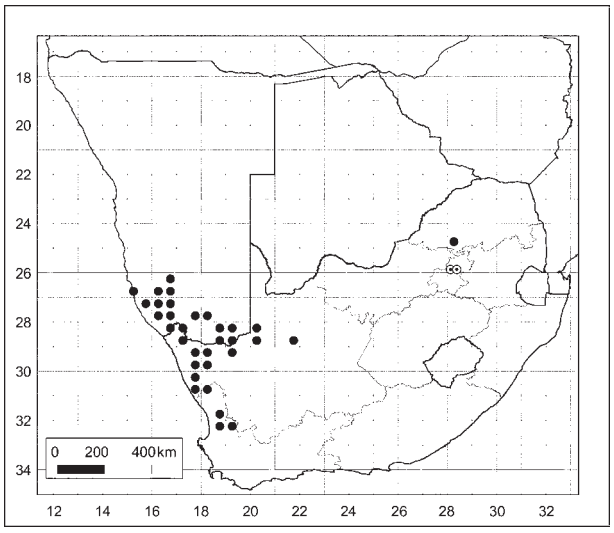

FIGURE 9.—Distribution of *Cheilanthes deltoidea*, adapted from the map in Burrows (1990), with his kind permission: localities based on specimens kept at PRE and NBG, ●; new localities in Gauteng, ⊙.

After above-average rainfall in January and early February 2006, a population of *C. deltoidea* was discovered in Centurion, Gauteng, on a property that is earmarked for development. The population consists of ± 13 plants in a relatively small area in the transition between Carletonville Dolomite Grassland and Rocky Highveld Grassland. Plants are very small, no more than 50 mm tall and grow in mainly southwest-facing soil pockets and rock crevices in chert rock. The chert outcrops are associated with dolomite and form part of the Dolomite Series of the Transvaal System. The fern has only been found on the chert and not the associated dolomite.

Upon further investigation of a similar site adjacent to the Rietvlei Nature Reserve, another population of several plants was found. Unfortunately this site is also earmarked for development. On this site, plants grow in northwest-facing rock crevices on a single isolated chert boulder. These plants seem to be somewhat smaller and more stunted than those on the other site, perhaps because they are to some extent more exposed. More populations of this fern were subsequently found on two other sites nearby that are to be developed.

Since the above-mentioned populations are threatened by development, rocky outcrops in the Rietvlei Nature Reserve were searched, with the hope of finding this species inside the reserve. However, since the geology of the reserve falls within the Pretoria Series of the Transvaal System, the specific chert rock on which the fern grows at the other sites was not found and no population of this fern could be located in the reserve. Follow-up visits will be carried out and one of the rangers has agreed to keep searching for the fern in the reserve. Fortunately a healthy population was later found on the grounds of the Smuts House Museum.

Owing to its small size and the fact that it shrivels up completely during dry times, it is possible that many other populations of this fern have been overlooked in the past. It is only now, after exceptionally good rains, and while the plants are still green, that they are easily spotted. It is unfortunate that much of the suitable habitat, where populations could be found, has already been destroyed through massive urban expansion.

The specimens from these new localities will be examined further and compared to material from the

distribution range of the species in Namaqualand, as well as with the available specimens from the Waterberg. The preliminary view is that it warrants description as a new infraspecific taxon.

GAUTENG.—2528 (Pretoria): Centurion, Portion 107 on Farm Doornkloof 391-JR, (–CC), *P. Lemmer 623* (PRE), Portion 198 (part of remainder of Portion 335), *R.R. Klopper, J. Nel & A. Nel 216* (PRE); Centurion, Irene, Farm Doornkloof 391-JR, rocky ridges between Smutskoppie and M57, (–CC), *A.E. van Wyk 13630*, *13653* (PRU); Centurion, Irene, Smuts House Museum, on koppie close to monument, (–CC), *R.R. Klopper & A.W. Klopper 217* (PRE); Centurion, Farm Rietvallei 377-JR, adjacent to Rietvlei Nature Reserve, close to where Olifantsfontein road crosses Sesmylspruit, (–CD), *R.R. Klopper & A.W. Klopper 215* (PRE).

ACKNOWLEDGEMENTS

The authors would like to thank the following people: Reinhard Lemmer for finding the initial population at Doornkloof; Koos Roux and John Burrows for confirming the identification of the Doornkloof specimen; Matthys Dippenaar for confirming the rock type on which the fern grows; John Burrows for providing permission to use the distribution map of this species from his book *Southern African ferns and fern allies* (1990); Riaan Marais for giving permission to search for the fern in the Rietvlei Nature Reserve; Cecil Labuschagne for his time and for taking us to the rocky outcrops in the Rietvlei Nature Reserve; Ate Berga for taking the time to look for and find the fern at the Smuts House Museum; Emelia Baumgartner for giving permission to collect a specimen on the property of the Smuts House Museum. We are also grateful to two anonymous referees for helpful comments on improving the manuscript.

REFERENCES

BURROWS, J.E. 1990. *Southern African ferns and fern allies*. Frandsen Publishers, Sandton.

JACOBSEN, W.B.G. 1983. *The ferns and fern allies of southern Africa*. Butterworths, Durban.

R.R. KLOPPER*, P. LEMMER** and J. NEL***

* National Herbarium, South African National Biodiversity Institute, Private Bag X101, 0001 Pretoria.

** Galago Ventures, P.O. Box 912878, 0127 Silverton, South Africa.

*** Fern Society of Southern Africa, P.O. Box 73125, 0040 Lynnwood Ridge, Pretoria.

MS. received: 2006-04-04.

ASPHODELACEAE

CORRECTIONS TO THE EPONYMY AND GEOGRAPHICAL DISTRIBUTION OF *ALOE VANROOYENII*

For the sake of providing appropriate recognition to the discoverer of a plant, or those who draw the attention of systematists to the existence of new taxonomic entities, taxa are often named for such key individuals. However, not all relevant biographical information is always documented by the nomenclaturist, much often being presumed without regard for possible misinterpretation by subsequent botanists. *Aloe greenii* Baker represents an example of a name about which uncertainty lingers regarding the identity of the person commemorated (Reynolds 1950; Van Wyk & Smith 2004), some 130 years following its circumscription (Baker 1880: 165). Accordingly, and as a necessary courtesy, we correct the recent etymological explanation of the specific epithet chosen for *Aloe vanrooyenii* Gideon F.Sm. & N.R.Crouch (Smith & Crouch 2006). These authors inadvertently gave a Mr Gert van Rooyen as the person honoured; the plant actually commemorates Mr Pieter van Rooyen of Greytown who stimulated and facilitated further taxonomic studies of this unique maculate aloe.

Additionally, we provide a more complete distribution map for this KwaZulu-Natal endemic (Figure 10), based on specimens housed at NU and NH.

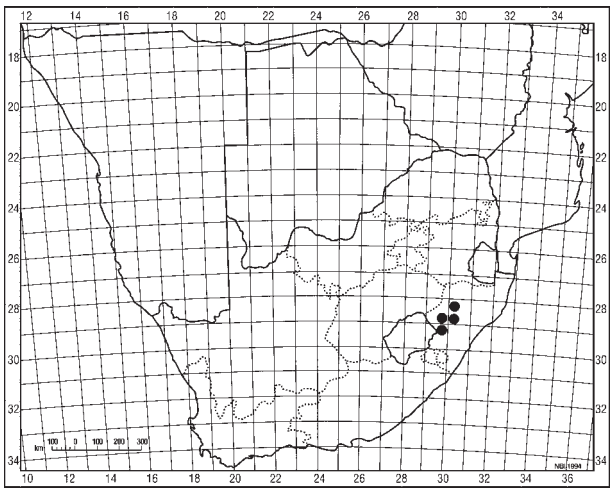

FIGURE 10.—Known distribution range of *Aloe vanrooyenii*.

REFERENCES

BAKER, J.G. 1880. A synopsis of Aloineae and Yuccoideae. *Journal of the Linnaean Society* 18: 148–241.

REYNOLDS, G.W. 1950. *The aloes of South Africa*. The Trustees of the Aloes of South Africa Book Fund, Johannesburg.

SMITH, G.F. & CROUCH, N.R. 2006. Asphodelaceae. *Aloe vanrooyenii*: a distinctive new maculate aloe from KwaZulu-Natal, South Africa. *Bothalia* 36: 73–75.

VAN WYK, B-E. & SMITH, G. 2004. *Guide to the aloes of South Africa*, edn 2. Briza Publications, Pretoria.

G.F. SMITH* & N.R. CROUCH**

* South African National Biodiversity Institute, Private Bag X101, 0001 Pretoria / Schweickerdt Herbarium, Department of Botany, University of Pretoria, 0002 Pretoria.

** Ethnobotany Unit, South African National Biodiversity Institute, P.O. Box 52099, 4007 Berea Road / School of Chemistry, University of KwaZulu-Natal, 4041 Durban, South Africa.

MS. received: 2006-08-11.

Bothalia 36,2: 175–189 (2006)

Patterns of plant diversity and endemism in Namibia

P. CRAVEN* and P. VORSTER**

Keywords: Namibia, phytogeography, plant endemism

ABSTRACT

Species richness, endemism and areas that are rich in both species and endemic species were assessed and mapped for Namibia. High species diversity corresponds with zones where species overlap. These are particularly obvious where there are altitudinal variations and in high-lying areas. The endemic flora of Namibia is rich and diverse. An estimated 16% of the total plant species in Namibia are endemic to the country. Endemics are in a wide variety of families and sixteen genera are endemic. Factors that increase the likelihood of endemism are mountains, hot deserts, diversity of substrates and microclimates. The distribution of plants endemic to Namibia was arranged in three different ways. Firstly, based on a grid count with the phytogeographic value of the species being equal, overall endemism was mapped. Secondly, range restricted plant species were mapped individually and those with congruent distribution patterns were combined. Thirdly, localities that are important for very range-restricted species were identified. The resulting maps of endemism and diversity were compared and found to correspond in many localities. When overall endemism is compared with overall diversity, rich localities may consist of endemic species with wide ranges. The other methods identify important localities with their own distinctive complement of species.

INTRODUCTION

Species diversity was traditionally measured by counting the number of different species recorded in a specific area or grid (Linder 2001). The 'weight' of the species was not taken into consideration. Today various measures of diversity have been proposed that give greater value to species that are taxonomically, geographically, ecologically or economically distinct, but no 'best' method for mapping species diversity has yet been found (Craven 2002b). The development of floristic databanks allows quick and efficient retrieval of phytogeographic data that can produce computerized distribution maps. This study used the computerized data of specimens housed in the National Herbarium of Namibia (WIND) and the National Herbarium in Pretoria (PRE) to survey distribution patterns of plant diversity, overall endemism and centres of endemism and diversity on a quarter-degree scale in Namibia. The endemic flora were also analysed and factors that may have contributed to the resulting distribution patterns were discussed briefly when evident from the use of map overlays. Known centres of endemism were not redefined, only species with similar patterns of distribution were recorded.

Caldecott *et al.* (1996) separated the current knowledge of biodiversity into global, regional, national, ecoregional and site information. Patterns of diversity in Namibia have been shown on continental-scale diversity maps (Mutke *et al.* 2001) and included in region-based studies such as those of Goldblatt (1978), Cowling *et al.* (1989) and Gibbs Russell (1985, 1987). The account of Linder (2001) on patterns of plant species endemism and richness for the African flora does not include arid areas such as most of Namibia.

The first national assessment and map of relative species richness in Namibia was that of Maggs *et al.* (1994). It was based on distributional data per magisterial district following Merxmüller (1966–1972), as well as other literature. Species diversity was re-assessed for the Biodiversity Country and mapped on half-degree grid squares (Maggs 1998; Maggs *et al.* 1998). This study updates the underlying data used in Maggs (1998) on a finer scale.

A taxon is endemic if confined to a particular area (Major 1988) which may be large or small. Clearly, data on endemism would be more useful if given by floristic province rather than political divisions (Major 1988; Van Wyk & Smith 2001), but datasets between different countries are seldom compatible in quality or quantity. Due to the fact that Namibia is home to a considerable number of endemics with adequate data, this assessment only reviews species limited to Namibia (Figure 1). An endemic is therefore defined here as a taxon that is restricted to within the political borders of Namibia. Taxa that extend marginally into another region, i.e. beyond the political borders of Namibia are referred to as near-endemic.

Centres of outstanding species diversity and endemism such as the Kaokoveld and Gariep have long attracted attention, but their boundaries, floristic elements and origins remain fairly sketchy. Different approaches and methodologies have also contributed to the centres (sometimes with the same name) not being compatible or comparable (Van Wyk & Smith 2001; Craven 2002b). Stott (1981) suggested that the process consists of stages i.e. after taxonomic study (essential for elucidating closely related taxonomic units) using specimens, species distributions are plotted and areas of congruence identified. The plants are then arranged into recognizable groups, which on further analysis would identify phytogeographic centres determined by a high concentration of taxa with restricted distributions. This approach was pioneered in southern Africa by Weimarck (1941) and is found in taxonomic literature, for example in Nordenstam (1969) and Hilliard (1994). The approach looks at the geographical ranges of species regardless of their growth form or other factors such as topography and present

* To whom correspondence should be addressed: P.O. Box 399, Omaruru, Namibia.
** Botany Department, University of Stellenbosch, Private Bag X1, 7602 Matieland, Stellenbosch.
MS. received: 2004-07-29.

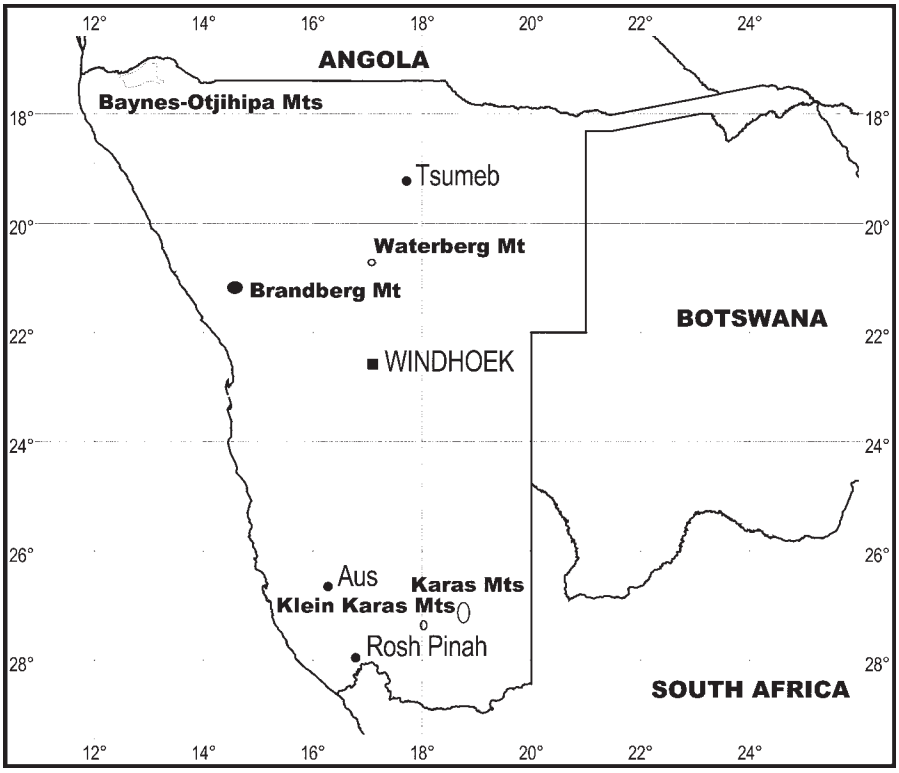

FIGURE 1.—Namibia, its neighbours, capital city and some important mountains and towns.

climate, and identifies particular geographical areas inhabited by species that are restricted to these ranges. Once such a centre is recognized, explanations are sought on how they may have arisen (e.g. past climate) and how they are being maintained. This knowledge is fundamental to understanding the origin, migration, and speciation of plants and is essential for developing strategies for biological conservation. This study did not attempt to redefine the centres presently known for Namibia, but attributes a number of new species to the centres.

Maps presenting overall patterns of diversity and endemism in Namibia have been used to identify regions of importance for conservation (Simmons *et al.* 1998; Mendelsohn *et al.* 2002). This paper shows two other methods of mapping important areas for endemics, which should also be taken into consideration.

MATERIALS AND METHODS

Database

Georeferenced specimens on the specimen database (SPMNDB) in WIND provided the grid-diversity count. This database has ± 120 000 specimens and includes specimens housed in PRE that were collected in Namibia. All specimens of higher plants were used in the evaluation. A sizable proportion was georeferenced following the quarter-degree square system of Edwards & Leistner (1971). Gaps in coverage due to collecting biases and database input errors were corrected where possible (Craven 2002b). The number of species present in each quarter-degree square was calculated and mapped.

Distribution data for endemic species were obtained from the specimen dataset as well as literature sources. Records for endemic species were found in 722 out of over 1 200 quarter-degree squares in Namibia. These were variously arranged and mapped: 1, endemic families, genera and species individually; 2, the number of endemic species per quarter-degree square; 3, the number of quarter-degree squares in which species occurred; and 4, areas where species restricted to only one or two quarter-degree squares were found.

Degree scale

Quarter-degree squares were chosen for the grid scale in order to show patterns of distribution on as fine a resolution as possible and allowing small or more localized centres of diversity to be apparent. Sufficient information at that scale is available for Namibia and the total area or number of quarter-degree square grids is manageable. Where no or few records were recorded in a quarter-degree square, the grids were 'revisited' and any such 'empty' square individually rechecked and improved. Records from keyword searches and literature sources, i.e. checklists for specific areas such as those of Rodin (1985), Giess & Snyman (1986), Hines (1992) and Clarke (1999) as well as collections of the first author, were incorporated.

GIS data

Shapefiles produced in ArcView [Environmental Systems Research Institute (ESRI) 2000] of Namibian features such as soils, topography and rainfall by the Agro-Ecological Zoning Programme (1996–ongoing) and Atlas of Namibia Project (2002), as well as the positions of important mountains (adapted from Irish 2002) were superimposed onto the grid-based plant data. They were used to draw accurate borders, define localities and help pinpoint possible reasons for the variations in diversity. Profiles showing altitude change across the country that were taken at selected latitudes to cut through various notable topographic features (Atlas of Namibia Project

2002) were also overlaid. The vertical scales have been exaggerated to highlight the changes in altitude.

The methodology and tables used, and examples of all stages of the process, is described in more detail in Craven (2002b).

Inventory

The inventory of species endemic to Namibia, taxonomic limits and nomenclature of species follows Craven (1999). The numerous sources for endemic status and updates are listed in Craven (2002b). Genera listed as endemic follow Leistner (2000). Over 600 species (Appendix 1) were investigated and eventually, records for ± 540 endemic spermatophyte species were available for the analysis and maps. Not all endemics were included in the analysis because endemism in some genera appears inflated due to numerous infraspecific taxa (Maggs *et al.* 1998), whereas other genera e.g. *Crassula* (Crassulaceae), *Euphorbia* (Euphorbiaceae), *Salsola* (Chenopodiaceae), *Tetragonia* (Aizoaceae) and some in the family Mesembryanthemaceae need to be revised. Species that are known to occur just over the border of the country were not included, e.g. a number of species in the genus *Commiphora* (Burseraceae) and family Acanthaceae, particularly the genus *Petalidium*.

Maps

Arcview (ESRI 2000) was used to produce the maps. Overall species richness and overall endemism could therefore be superimposed to find possible geographical correlation. Similarly, the shapefiles of the ± 540 species endemic to Namibia for Craven (2002b) were overlaid and the resulting maps scrutinized for congruent patterns. Areas were identified and their species listed, because as Van Wyk & Smith (2001) point out, such areas will have their own distinctive complement of species.

Endemic species not included by previous authors were assigned to known centres, i.e. Kaokoveld, Gariep, Waterberg-Otavi and Namibia Central and Southern Highland Centres, where possible. This required looking at locality data of collected specimens for the last two centres, as elements occur at higher elevations or on a specific substrate. The large data set of georeferenced specimens was also used to find subcentres or more localized areas of significance.

RESULTS

Overall patterns of species richness and endemism

Species diversity is higher in localities where one vegetation type shifts to another. Variations in altitude and the maximum altitude in any grid are also significantly related to grid diversity (Figure 2). Only two localities in the northeast region can attribute high species richness to high rainfall. Where summer rainfall species overlap with winter rainfall species, however, there is an increase in diversity, e.g. the Rosh Pinah area. Another influencing factor is mist that occurs along the Namibian coast, which may be responsible for more favourable microclimates and increased species richness inland, e.g. the Namukluft near Rosh Pinah and Aus areas.

Namibian endemics were not found in the northeast, which forms part of the Zambezian Domain of White (1983) as this domain continues into countries further north. The southeast is part of the Kalahari Desert, which extends into Botswana, and no endemics were found there because of the general paucity of species and the

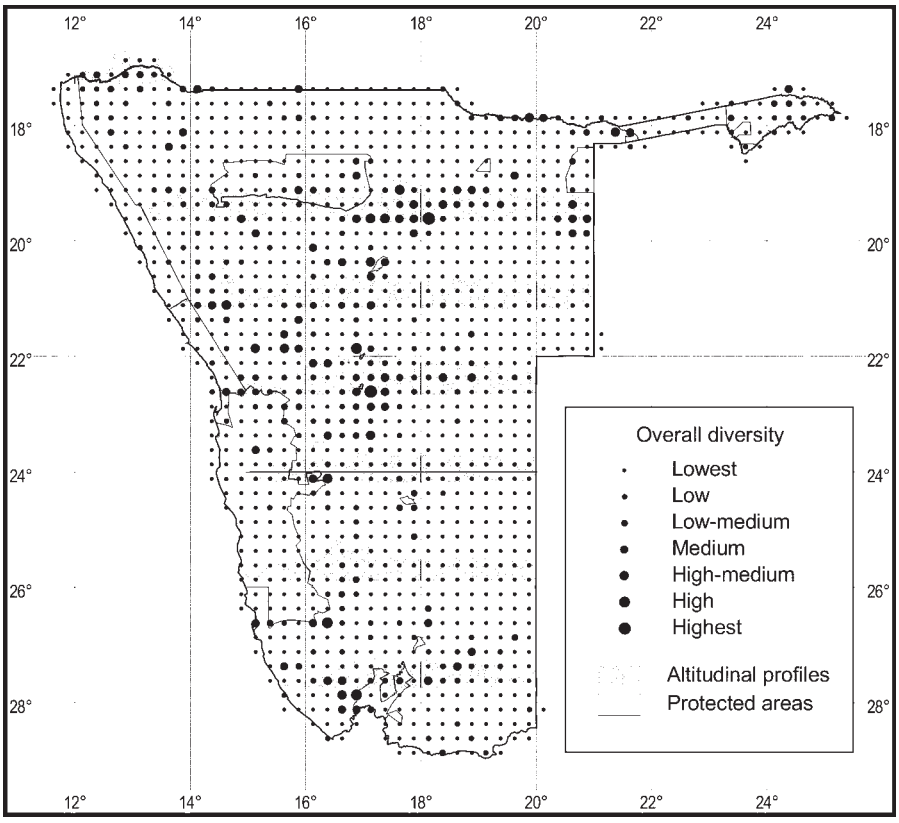

FIGURE 2.—Grid-diversity for Namibia depicted in five classes with altitude profiles showing correlation between changes in altitude and diversity.

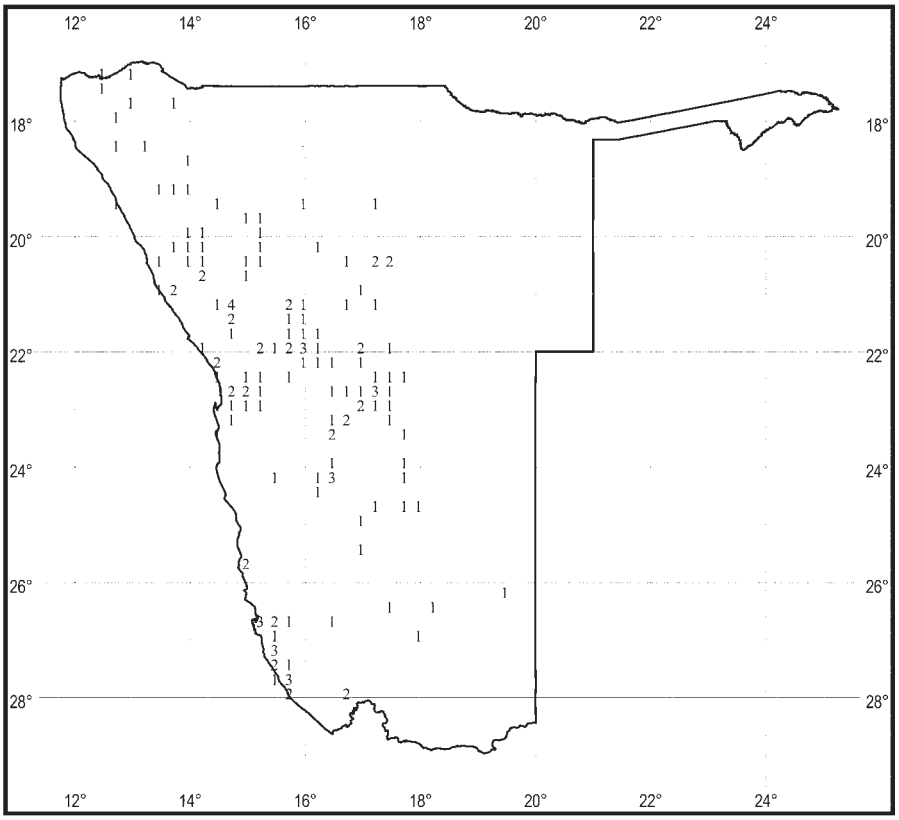

FIGURE 3.—Distribution and number of Namibian endemic genera per quarter-degree grid.

artificial definition of endemic used here. In the rest of Namibia, the map of overall distribution of endemic species does not show any particular spatial pattern. Localities where the quarter-degree squares with the most endemics occur, are often associated with mountains in Namibia. The best example is the Brandberg, which also confirms that endemism increases when mountains are located in deserts. Substrate-specific endemic plants are well known and in Namibia, four *Jamesbrittenia* species occur only in the limestone of the Waterberg-Otavi area (Hilliard 1994). Hot deserts have very high endemism in spite of their limited flora and vegetation and this has been shown in Namibia by the number of endemic species confined to the Namib (Craven 2002b). ArcView shapefiles for physical features of Namibia, e.g. soils, aspects of climate, did not show marked patterns of similarity at this level of resolution.

Geographical comparison of the overall pattern of diversity and that of endemism, as well as areas of importance for localized endemics and that of overall endemics, show a degree of congruence. Important localized areas however, do not always coincide. Because the count is based purely on the number of species or endemics within that square, areas of richness cannot be distinguished by a particular combination of plant species or endemics. In addition, squares with associated floral elements cannot be identified. Thus a particularly rich area may consist of very widespread species.

Families endemic to Namibia

There are no families of higher plants restricted to the political borders of Namibia. The most well-known family that occurs only in southwest Angola and Namibia is Welwitschiaceae.

Genera endemic to Namibia

The natural ranges of sixteen genera fall within Namibia (Figure 3). They are listed in Table 1 with an indication of the number of quarter-degree square grids in which they have been found. With the exception of the genus *Ondetia* (Asteraceae), most of the endemic genera occur in the central and western parts of Namibia. *Arthraerua* (Amaranthaceae), *Marlothiella* (Apiaceae), *Eremothamnus* (Asteraceae), *Namibia*, *Synaptophyllum* (Mesembryanthemaceae) and *Neoluederitzia* (Zygophyllaceae) occur along the coast, whereas *Baynesia* (Apocynaceae) and *Namacodon* (Campanulaceae) grow at higher altitudes. *Manuleopsis*

TABLE 1.—Genera endemic to Namibia and the number of quarter-degree squares in which they occur

Family	Genus	No. QDS
Asteraceae	*Ondetia*	42
Scrophulariaceae	*Manuleopsis*	28
Amaranthaceae	*Arthraerua*	18
Poaceae	*Kaokochloa*	16
Scrophulariaceae	*Chamaegigas*	12
Campanulaceae	*Namacodon*	9
Asteraceae	*Eremothamnus*	8
Apiaceae	*Phlyctidocarpa*	6
Apiaceae	*Marlothiella*	5
Mesembryanthemaceae	*Synaptophyllum*	5
Mesembryanthemaceae	*Namibia*	3
Apocynaceae	*Baynesia*	1
Mesembryanthemaceae	*Jensenobotrya*	1
Mesembryanthemaceae	*Ruschianthus*	1
Scrophulariaceae	*Dintera*	1
Zygophyllaceae	*Neoluederitzia*	1

QDS, quarter-degree square.

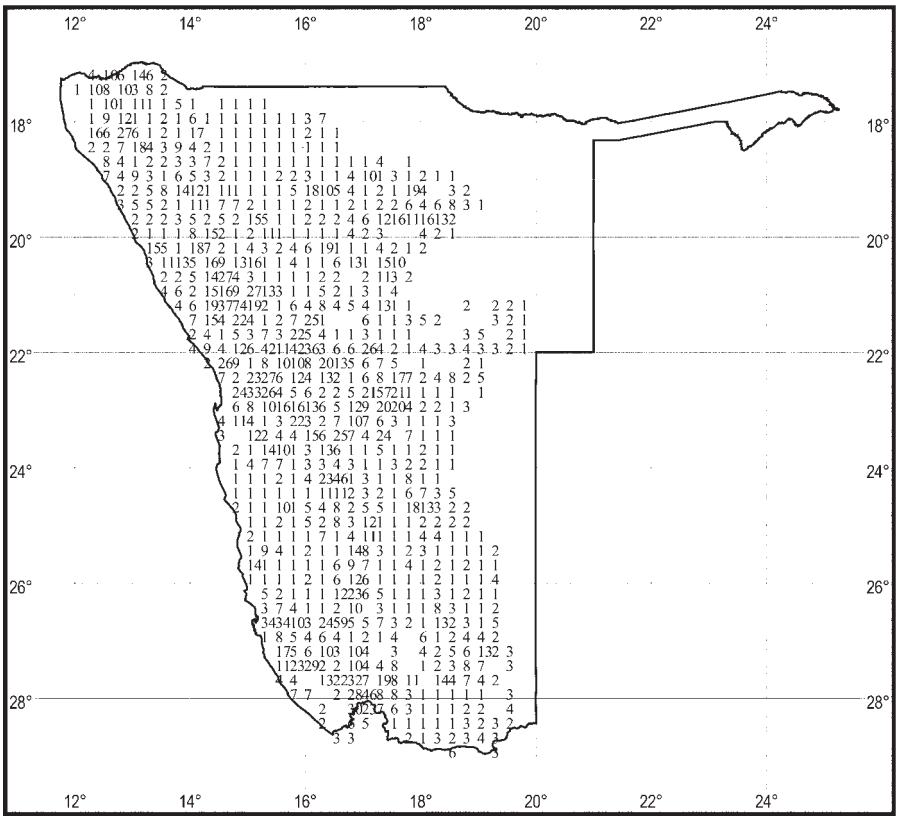

FIGURE 4.—Distribution and number of Namibian endemic species per quarter-degree grid.

(Scrophulariaceae) is fairly widespread, but generally found on higher ground. *Chamaegigas* (Scrophulariaceae) is a hydrophyte that inhabits pools in granite outcrops in central Namibia.

All four genera in family Mesembryanthemaceae occur in the winter rainfall region of southwest Namibia. Family Apiaceae, with two endemic genera, is of particular interest as it has very few representatives in species and number of individuals in Namibia. A recently described genus, *Baynesia* (Bruyns 2000), attests to the fact that new genera may still be described in Namibia, especially in certain families that require revision, e.g. Mesembryanthemaceae. *Ondetia* occurs close to Botswana and may eventually be found there (Craven & Klaassen 1998). It is very closely related to *Geigeria* (which is presently under revision) and often mistaken for a *Geigeria* species in the field.

There are also four near-endemic genera, i.e. they occur in Namibia and southwestern Angola, namely *Antiphiona* (Asteraceae), *Marcelliopsis* (Amaranthaceae), and *Welwitschia* (Welwitschiaceae). *Volkiella* (Cyperaceae) has been recorded once in Zambia. *Ruschianthemum* (Mesembryanthemaceae), which occurs just over the border in the northern Cape, has been included in *Stoeberia* (Chesselet & Van Wyk 2002).

Species endemic to Namibia

Approximately 600 of the nearly 4 000 indigenous species recorded for Namibia are considered endemic to within the borders of the country (Figure 4) and are found in many different families and genera; 62 of the 157 families in Namibia have endemic species, whereas 231 genera out of 958 genera have endemic species.

The most important families are the Mesembryanthemaceae, Asteraceae and Acanthaceae. The genera *Aloe* (Asphodelaceae), *Euphorbia* (Euphorbiaceae), *Hermannia* (Sterculiaceae), *Jamesbrittenia* (Scrophulariaceae), *Petalidium* (Acanthaceae), *Salsola* (Crassulaceae), *Stipagrostis*, *Eragrostis* (Poaceae) and *Zygophyllum* (Zygophyllaceae) have the most endemic species besides *Conophytum* and *Lithops* (Mesembryanthemaceae), which have numerous infraspecific taxa. Distributions of about 600 endemic species and certain families and genera are mapped in Craven (2002b). Two examples showing distinctive patterns are illustrated here. Family Mesembryanthemaceae (Figure 5) is mainly restricted to the southwestern corner of Namibia which is also the only area with winter rainfall. Figure 6 shows endemism in *Commiphora* which occurs more commonly in the north with few plants in the winter rainfall zone. Some species have very widespread distributions and are well represented in the collection, whereas others are limited to one locality and one collection. One endemic was recorded in 195 different quarter-degree squares, and nine quarter-degree squares had more than 40 endemics. The quarter-degree square with the highest number of species were tabulated (Table 2) and the grid in which the Brandberg occurs is shown to have the most endemic species, followed by the Windhoek area.

Species endemic to localized areas are found mainly in western Namibia, but also in the central regions associated with high elevations. A number of localities were found to house four or more very restricted-range species.

The dominant life form of the endemics of the southwest winter rainfall region is succulents, whereas further inland, i.e. east of the Hunsberg, dwarf shrubs are more

common. The only region with endemic trees is the Kaokoveld. The distribution of endemic grasses shows them to be widespread.

Namibian near-endemic species

Near-endemics are defined here as species that extend marginally into another region, i.e. beyond the political borders of Namibia. Two noteworthy areas for endemics and near-endemics in Namibia have been identified under the auspices of the IUCN Plant Conservation Programme. These centres of exceptional species richness and endemism (Davis & Heywood 1994) are the Kaokoveld in the northwest and the Gariep in the southwest. Further analysis of near-endemics is needed, including the species in this study. The number of species per quarter-degree square in the northwest and south will be higher.

Taxon phytogeographic centres

Kaokoveld Centre

Considering the topography and climate, it is no wonder that mapped plant distributions show two main subregions besides the Brandberg, namely the coastal strip, which is affected by fog and cooler temperatures, and the inland highlands. Endemics of the coast include *Ectadium rotundifolium*, *Merremia multisecta*, *Hermannia gariepina* and grasses such as *Chloris flabellata* and *Sporobolus virginicus*. Most of the endemic taxa occurring on the highlands will not be found on the coastal plains. They are more numerous and often confined to mountainous areas.

Subcentres of importance are the Baynes Mountains and the area around Sanitatis and Orupembe. Both areas have six localized endemics each. Four endemics are found in the Sesfontein area. The family with the most endemics is the Acanthaceae with five representatives and the other endemics are from a wide variety of families.

Gariep Centre

Relatively numerous local endemics were found around Aus, the Huib Hoch Plateau to Namus Mountains, the Hunsberg and a section of the Warmbad District. Species limited to these subcentres come from a variety of families and vary from grasses and geophytes to succulent Euphorbiaceae and Mesembryanthemaceae. Life form type shows a certain degree of uniformity in some of the subcentres. Dwarf shrubs such as *Caesalpinia merxmuellerana* and *Petalidium cymbiforme* are characteristic of the endemics of the Hunsberg, whereas more succulent species, including three in *Euphorbia*, are found on the western side of the Hunsberg in the Numas Mountains. Three succulent mesembs are also endemic to the Warmbad District, namely *Antimima eendornensis*, *Schwantesia constanceae* and *S. succumbens*. No specific life forms are characteristic of the Aus area, which is characterized by varying substrates, or the Huib Hoch Plateau areas. Although field work will probably result in many of these species being recorded further afield, some conspicuous plants such as *Caesalpinia merxmuellerana* and *Zygophyllum giessii* have not been found to be widespread despite intense searching.

Waterberg-Otavi Centre

Additional species restricted to this centre identified here, but not necessarily only occurring on limestone, are *Heteromorpha papillosa* (Apiaceae), *Pentatrichia avasmontana* (Asteraceae), *Plectranthus dinteri* (Lamiaceae)

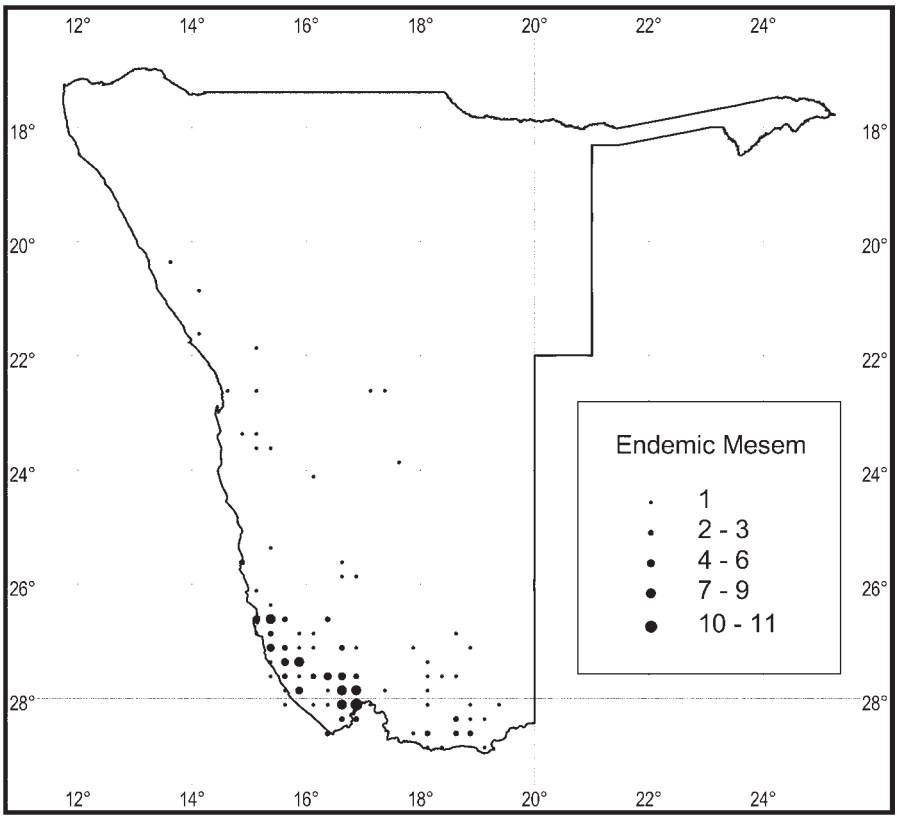

FIGURE 5.—Distribution of endemic plants in Mesembryanthemaceae and diversity per quarter-degree grid.

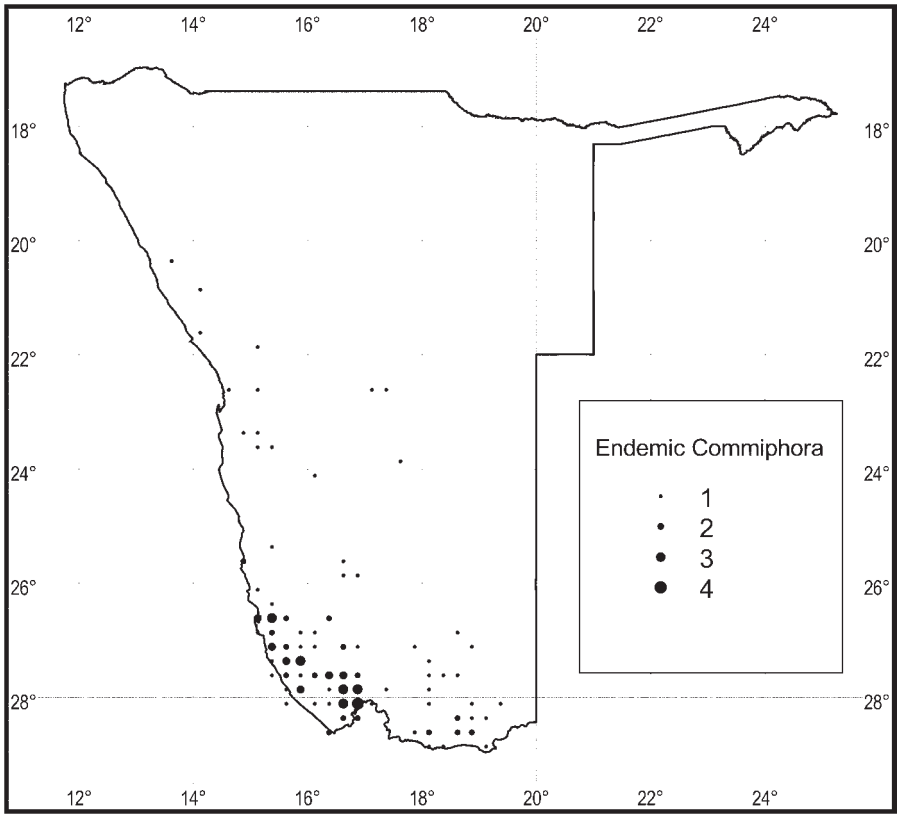

FIGURE 6.—Distribution of endemic plants in *Commiphora* and diversity per quarter-degree grid.

which is also in the Windhoek region, and *Thesium xerophyticum* (Santalaceae) also on the Gamsberg. In addition, *Thesium* is in need of revision and although both the genera *Plectranthus* and *Heteromorpha* have been revised, little or no field work was carried out in Namibia. *Pentatrichia* is presently under revision. Species reported to date only from the Waterberg are *Dintera pterocaulis* (Scrophulariaceae), *Eriospermum citrinum* and *E. lavranosii* (Eriospermaceae).

Central Namibia and Southern Highland Centre

Fifteen Manuleae (Scrophulariaceae) were found to occur in a highland centre (Hilliard 1994) that included the Brandberg, Erongo, Khomashochland, Auas, Gamsberg, Naukluft, Tiras, Karasberg and surrounding high ground, usually above ± 900 m. It excludes the limestone area of the Waterberg, but may stretch into Botswana. An analysis of mapped endemics and habitat data show that numerous range-restricted species are confined to higher elevations, as prescribed by the definition of this centre by Hilliard (1994). The floristic elements range from shrubs (*Nicotiana africana*) and dwarf shrubs (*Corchorus merxmuelleri*, *Hermannia merxmuelleri*) to geophytes (*Haemanthus avasmontanus*, *Lapeirousia avamontana*) with a few very localized succulents (*Ebracteola montis-moltkei*, *Euphorbia monteiroi* subsp. *brandbergensis*, *Aloe viridiflora*).

DISCUSSION

Numerous hypotheses have been proposed to explain patterns of species diversity (Schmida & Wilson 1985), but none have been found to apply well to all bodies of data. Underlying datasets and resolution can also result in different patterns of diversity. This is seen when Namibia is mapped continentally (Mutke *et al.* 2001), regionally (Rebelo 1994) or nationally (Maggs *et al.* 1994). In spite of the finer resolution used here, the most species-rich areas in Namibia do not differ much from those first indicated (Maggs *et al*. 1994). The differences lie in better definition of the boundaries, additional localities and important smaller localities. Examples are the Naukluft, Windhoek and Aus regions. The inclusion of the Naukluft as an important area by Maggs *et al.* (1994) was suspected to be an artifact of high collecting intensity and this was proved here to be the case. On the other hand, species richness in the Windhoek area is not necessarily an artifact of good collecting, despite being close to a high population of potential collectors. It includes the second highest mountain in Namibia (Irish 2002), and a number of grasses (Klaassen & Craven 2003), and other species that are not known from elsewhere in Namibia are found here. It indicates that this flora includes outliers from more distant areas and is in agreement with Major (1988), who considers mountains to be mesic refugial islands, which form ideal refuges in times of climate change. Another area of high diversity, near Aus, housed a concentration camp during World War II where the interned German citizens botanized to

TABLE 2.—Quarter-degree squares (QDS) with the most endemic species recorded

QDS	Locality	No. endemic spp.
2114BA	Brandberg area	74
2217CA	Windhoek/Auas Mtn area	63
2616CB	Region around town of Aus	55
2416AB	East of Naukluft Mtns/Farm Bullspoort	49
2716DD	Namuskluft Farm, Namus Mtns	43

pass the time. Factors that contribute to the richness of this area include the diverse nature of the topography (the start of the escarpment) and varying substrate (scattered granite outcrops in the area) as well as the fog coming inland from the coast.

Although the plant species diversity map is the most detailed map of its kind for Namibia, care should be taken before using it for management purposes or predictions. Both the delimited areas and the numbers of species predicted for the regions need further refinements. Two aspects of conservation value that it does indicate are: 1, that many areas are more diverse than may appear during periods of harsh conditions, which may last for years or decades; and 2, the relationship between areas set aside as formal conservation areas and diversity. It is apparent that certain areas of high species richness are not afforded any formal protection.

The first map to show the overall distribution of endemic species in Namibia (Maggs *et al.* 1994) was based on 145 species. Endemics of southern Africa, including Namibia, were mapped by Rebelo (1994). Differences between the latter map (regional) and the present one for Namibia (national) are noticeable because of the scale, definition of the word endemic, and datasets used. Maps published in Simmons (1998) and Simmons *et al.* (1998) were based on updated data in Maggs *et al.* (1997) using half-degree squares, because according to Simmons *et al.* (1998), bird data show that this scale reduces collecting bias. The results presented here justify the use of quarter-degree, because working on a national level, more quality control of the data is possible and other sources such as literature, field work and shapefiles of physical features can be used. An undefined 'escarpment' area was said to be the main centre for endemic plants by Simmons *et al.* (1998). Overlaying a defined escarpment developed by the Atlas of Namibia Project (2002) onto the endemic data indicates that this is only partially correct. Although there is an association between increased numbers of endemic species and the escarpment, the area between the northern and southern escarpments also show localities of importance, not only in general, but also for those with limited ranges.

The maps resulting from this study are published by the Atlas of Namibia Project (2002), where they are also combined with maps of Namibian fauna. Mendelsohn *et al.* (2002) conclude that the most notable zones of high diversity for fauna and flora occur in the northeast, in the Karstveld around Tsumeb, in highland areas in the centre of Namibia, and in various scattered areas of higher ground further west. Plant endemism was also combined with that of animals, and Mendelsohn *et al.* (2002) conclude that the overall patterns of endemism in Namibia are quite different from those of overall diversity. The greatest majority of endemics are found in the dry, western and northwestern regions of Namibia. On a regional scale of plants only (and lower resolution), Rebelo (1994) reports a stronger correlation between species richness and endemicity.

Namibian endemic plants, as in other parts of the world, are usually associated with altitude, substrate, or variations in geography, which provide numerous microhabitats. The most important areas for species richness in Namibia, however, are 'transitional' areas, which Shmida & Wilson (1985) define as areas between different ecological regions, i.e. zones in which species overlap. Variations in altitude and the maximum altitude in any grid are significant as reported for Africa as a whole (Linder 1999). Superimposing altitudinal profiles onto the shapefile of species richness shows this clearly (Figure 2). It is also substantiated by studies which show variations in species diversity with altitude for specific sites or localities (Moisel 1982; Rutherford 1992).

Centres of diversity and endemism in Namibia, such as the Kaokoveld and the Gariep Centre, although lacking consistency in definition, have been discussed by numerous authors. Volk (1964) proposed a Kaoko Element, which was elaborated on by Nordenstam (1974). Hilliard (1994) included two taxa, *Jamesbrittenia canescens* var. *laevior* and *J. heucherifolia* (Scrophulariaceae), which are confined to southern Angola and northern Namibia. Other authors that recognized the Kaokoveld Centre are Hilton-Taylor (1994a), Maggs *et al*. (1994), Maggs *et al.* (1998), Van Wyk & Smith (2001) and Craven (2002a). Hilton Taylor (1994b) considers the Gariep to be essentially a geographic rather than a phytogeographic centre, but both Nordenstam (1969) and Hilliard (1994) recognize it as a taxon phytogeographic centre of importance for numerous species.

Mapping all Namibian endemics has shown that the distributions of many elements need to be reassessed. Species presently regarded as e.g. Kaokoveld elements, (*Welwitschia mirabilis*, *Acanthosicyos horridus*, *Cyphostemma currorii*, *Acacia robynsiana* and *Moringa ovalifolia)* may stretch far beyond what is generally regarded as the centre. Another example is the Brandberg, which is considered an outlier of the Kaokoveld Centre by Nordenstam (1974) and Hilton Taylor (1994a). Provisional results of the floristic elements of the Brandberg (Craven & Craven 2000) show that numerous range-restricted species also occur on other highlands further south and it is rather a part of the Highland Centre as suggested by Hilliard (1994).

The Kaokoveld and the Gariep Centres are basically geographic regions, so inclusion of species within the centres was based on presence or absence in the area. This is not possible with the Namibia Central and Southern Highland Centre and the Waterberg-Otavi Centre as they are identified by determinants such as habitat or substrate specificity. These centres do not show a clear geographic pattern of distribution on a map until altitude contours or outlines of mountains are included. More endemic species will probably be included in these centres once more is known about such habitat requirements.

The name, Gariep, has also been used in large-scale mapping by Jürgens (1991) despite a different approach, i.e. including life form and climate in the analyses. Such approaches must not be confused with that of taxon phytogeography as discussed here.

In general, the variable nature of most aspects of Namibia's rainfall, as well as the paucity of overall climatic data, precludes using climate at this level of resolution. It is, however, true to say that Namibia differs from Africa as a whole, because the most species-rich areas

are in the wetter parts of the continent (Linder 1999). This study highlighted the need for the microclimatic conditions in which so many endemics thrive, to be studied and documented in a systematic way. Defining these habitats is essential to understanding the distributions of endemic plants. The same can be said for peculiar or isolated substrata (serpentine, limestone, quartzite, calcareous sands) which is a widespread phenomenon in some areas (Major 1988; Cowling *et al.* 1992), and Namibia is no exception.

Although distribution of endemics among life form classes was not studied here in detail, it is evident that life forms change with locality as recorded for endemic species in general (Major 1988). This is ascribed to climate, history of the flora and competition with the associated flora (Major 1988).

Certain taxa require floristic study and field work, but a provisional assessment suggests that a locality may be home to a variety of species from various taxonomic groups as suggested by Cowling *et al.* (1992).

Knowledge of local endemism will help create a better basis for future policy (Brenan 1978). This study does provide sufficient information on certain aspects of Namibia's endemic plants to start formulating conservation strategies, but there is still a need for satisfactory taxonomic knowledge as well as more distribution data. It is also imperative that the information is used correctly. Simmons *et al.* (1998) concluded that another 11% of the land area would be required to protect Namibia's endemic plants. If the endemic plants already found within protected areas had been removed from the dataset prior to the analysis, the resulting value would be much lower. No matter how highly a species is regarded, as soon as it is adequately conserved, it is no longer used as an argument to conserve another area (Kirkpatrick 1983). Because species are not spread evenly around the world and unique concentrations may occur in relatively small areas, i.e. within the political borders of a country like Namibia, the onus is on Namibia to protect these species.

ACKNOWLEDGEMENTS

The National Herbarium of Namibia, especially the database manager, Esmerialda Klaassen are thanked for the use of SPMNDB. John Mendelsohn and the Atlas team are also thanked for the final maps on diversity and endemism produced for the *Atlas of Namibia*. The Agro-Ecological Zoning Programme is thanked for the use of shapefiles. The unpublished plant lists of Craig Hilton-Taylor for the Kaokoveld and Gariep Centres is greatly appreciated. The contribution made by SABONET, i.e. the database and funding for further study, is greatly appreciated.

REFERENCES

AGRO-ECOLOGICAL ZONING PROGRAMME. 1996–ongoing. Directorate of Agricultural Research and Training, Ministry of Agriculture, Windhoek.

ATLAS OF NAMIBIA PROJECT. 2002. Directorate of Environmental Affairs, Ministry of Environment and Tourism, Windhoek. http://www.dea.met.gov.na.

BRENAN, J.P.M. 1978. Some aspects of the phytogeography of tropical Africa. *Annals of the Missouri Botanical Garden* 65: 437–478.

BRUYNS, P.V. 2000. *Baynesia*, a new genus of stapeliad from the northwestern-most corner of Namibia (Apocynaceae). *Novon* 10: 354–358.

CALDECOTT, J.O., JENKINS, M.D., JOHNSON, T.H. & GROOMBRIDGE, B. 1996. Priorities for conserving global species richness and endemism. *Biodiverity & Conservation* 5: 699–727.

CHESSELET, P. & VAN WYK, A.E. 2002. Mesembs with nut-like schizocarpic fruit and *Ruschianthemum* Friedrich sunk under *Stoeberia*. *Bothalia* 32: 187–190.

CLARKE, N.V. 1999. Flora of the Cuvelai wetlands, northern Namibia. *Cimbebasia* 15: 99–115.

COWLING, R.M., GIBBS RUSSELL, G.E., HOFFMAN, M.T. & HILTON-TAYLOR, C. 1989. Patterns of plant species diversity in southern Africa. In B.J. Huntley, *Biotic diversity in southern Africa: concepts and conservation*: 19–50. Oxford University Press, Cape Town.

COWLING, R.M., HOLMES, P.M. & REBELO, A.G. 1992. Plant diversity and endemism. In R.M. Cowling, *The ecology of fynbos: nutrients, fire and diversity*: 62–112. Oxford University Press, Cape Town.

CRAVEN, P. 1999. *Checklist of Namibian plant species*. Southern African Botanical Diversity Network Report No. 7. SABONET, Windhoek.

CRAVEN, P. 2002a. Plant species diversity in the Kaokoveld, Namibia. In M. Bollig, E. Brunotte & T. Becker, *Kaokoland—Interdisziplinäre Perspektiven zu Kultur- und Landschaftswandel im ariden und semi-ariden Nordwesten Namibias*: 75–80. Kölner Geographische Arbeiten 77, Cologne.

CRAVEN, P. 2002b. *Phytogeography of the Namibian flora: a taxon approach*. M.Sc. thesis, University of Stellenbosch, Stellenbosch.

CRAVEN, P. & CRAVEN, D. 2000. The flora of the Brandberg, Namibia. In A.H. Kirk-Sprigs & E. Marais, Biodiversity of the Brandberg Massif, Namibia. *Cimbebasia Memoir* 9: 49–67.

CRAVEN, P. & KLAASSEN, E. 1998. *Ondetia*, the problematic cousin of *vermeerbos*. *Spotlight on Agriculture.* Ministry of Agriculture, Water and Rural Development, Windhoek.

DAVIS, S.D. & HEYWOOD, V.H. 1994. *Centres of plant diversity: a guide and strategy for their conservation*. Oxford University Press, Oxford.

EDWARDS, D. & LEISTNER, O.A. 1971. A degree reference system for citing biological records in South Africa. *Mitteilungen aus der Botanischen Staatssammlung, München* 10: 501–509.

ENVIRONMENTAL SYSTEMS RESEARCH INSTITUTE (ESRI). 2000. *ArcView 3.2a Software*. Redlands, USA.

GIBBS RUSSELL, G.E. 1985. Analysis of the size and composition of the southern African flora. *Bothalia* 15: 613–629.

GIBBS RUSSELL, G.E. 1987. Preliminary floristic analysis of the major biomes in southern Africa. *Bothalia* 17: 213–227.

GIESS, W. & SNYMAN, J.W. 1986. The naming and utilization of plant life by the Zu'hoasi Bushmen of the Kau-Kauveld. In R. Vossen & K. Keuthmann, *Contemporary studies on Khoisan* 1: 237–246.

GOLDBLATT, P. 1978. An analysis of the flora of southern Africa: its characteristics, relationships and origins. *Annals of the Missouri Botanical Garden* 65: 369–436.

HILLIARD, O.M. 1994. *The Manuleae. A tribe of Scrophulariaceae*. Edinburgh University Press, Edinburgh.

HILTON-TAYLOR, C. 1994a. Centres of plant diversity: Karoo-Namib region: the Kaokoveld. In S.D. Davis & V.H. Heywood, *Centres of plant diversity: a guide and strategy for their conservation:* 201–203. Oxford University Press, Oxford.

HILTON-TAYLOR, C. 1994b. Centres of plant diversity: Karoo-Namib region: Western Cape domain (Succulent Karoo). In S.D. Davis & V.H. Heywood, *Centres of plant diversity: a guide and strategy for their conservation:* 204–217. Oxford University Press, Oxford.

HINES, C.J.H. 1992. *An ecological study of the vegetation of eastern Bushmanland (Namibia) and its implications for development*. M.Sc. thesis, Institute of Natural Resources, University of Natal, Pietermaritzburg.

IRISH, J. 2002. *Namibian mountains: biodiversity potential based on topography*. Report for the Mountain Ecosytem Working Group of the National Biodiversity Task Force, Windhoek.

JÜRGENS, N. 1991. A new approach to the Namib region. I. Phytogeographic subdivision. *Vegetatio* 97: 21–38.
KIRKPATRICK, J.B. 1983. An iterative method for establishing priorities for the selection of nature reserves: an example from Tasmania. *Biological Conservation* 25: 127–134.
KLAASSEN, E. & CRAVEN, P. 2003. *Checklist of grasses in Namibia*. Southern African Botanical Diversity Network Report No. 20. SABONET, Pretoria & Windhoek.
LEISTNER, O.A. (ed.). 2000. Seed plants of southern Africa: families and genera. *Strelitzia* 10. National Botanical Institute, Pretoria.
LINDER, H.P. 1999. Phytogeography of African plants—symposium overview. In J. Timberlake & S. Kativu, *African plants: biodiversity, taxonomy and uses*: 129. Proceedings of the 1997 AETFAT Congress Harare, Zimbabwe. Royal Botanic Gardens, Kew.
LINDER, H.P. 2001. Plant diversity and endemism in sub-Saharan tropical Africa. *Journal of Biogeography* 28: 169–182.
MAGGS, G.L. 1998. Plant diversity in Namibia. In P. Barnard, *Biological diversity in Namibia: a country study*: 116–122. The Namibian National Biodiversity Task Force, Windhoek.
MAGGS, G.L., CRAVEN, P. & KOLBERG, H.H. 1998. Plant species richness, endemism and genetic resources in Namibia. *Biodiversity & Conservation* 7: 435–446.
MAGGS, G.L., CRAVEN, P., KUBIRSKE, R., KLAASSEN, E.S., MANNHEIMER, C.A. & UIRAS, M.M. 1997. *Flora of Namibia*. Report for the Annual Research Reporting Conference. Ministry of Agriculture, Water and Rural Development, Windhoek.
MAGGS, G.L., KOLBERG, H.H. & HINES, C.J.H. 1994. Botanical diversity in Namibia—an overview. In B.J. Huntley, Botanical diversity in southern Africa. *Strelitzia* 1: 93–104. National Botanical Institute, Pretoria.
MAJOR, J. 1988. Endemism: a botanical perspective. In A.A. Myers & P.S. Giller, *Analytical biogeography. An integrated approach to the study of animal and plant distributions*: 117–146. Chapman & Hall, London.
MENDELSOHN, J., JARVIS, A., ROBERTS, C. & ROBERTSON, A. 2002. *Atlas of Namibia: a portrait of the land and its people*. David Phillip Publishers, Cape Town.
MERXMÜLLER, H. (ed.). 1966–1972. *Prodromus einer Flora von Südwestafrika*. Cramer, Lehre.
MOISEL, L. 1982. Wanderungen im Brandbergmassiv. *Dinteria* 16: 21–26.
MUTKE, J., KIER, G., BRAUN, G., SCHULTZ, C. & BARTHLOTT, W. 2001. Patterns of African vascular plant diversity—a GIS-based analysis. *Systematic Geography of Plants* 71: 1125–1136.
NORDENSTAM, B. 1969. Phytogeography of the genus *Euryops* (Compositae). *Opera Botanica* 23: 1–77.
NORDENSTAM, B. 1974. The flora of the Brandberg. *Dinteria* 11: 3–67.
REBELO, A.G. 1994. Iterative selection procedures: centres of endemism and optimal placement of reserves. In B.J. Huntley, Botanical diversity in southern Africa. *Strelitzia* 1: 231–257. National Botanical Institute, Pretoria.
RODIN, R.J. 1985. The ethnobotany of the Kwanyama Ovambos. *Monographs in Systematic Botany* 9: 1–165.
RUTHERFORD, M.C. 1992. Notes on the flora and vegetation of the Omuverume Plateau-Mountain, Waterberg, South West Africa. *Dinteria* 8: 3–55.
SCHMIDA, A. & WILSON, M.V. 1985. Biological determinants of species diversity. *Journal of Biogeography* 12: 1–20.
SIMMONS, R.E. 1998. Areas of high species endemism. In P. Barnard, *Biological diversity in Namibia: a country study*: 72–74. The Namibian National Biodiversity Task Force, Windhoek.
SIMMONS, R.E., GRIFFIN, M., GRIFFIN, R.E., MARAIS, E. & KOLBERG, H. 1998. Endemism in Namibia: patterns, processes and predictions. *Biodiversity & Conservation* 7: 513–530.
STOTT, P. 1981. *Historical plant geography: an introduction*. Allen & Unwin, London.
VAN WYK, A.E. & SMITH, G.F. 2001. *Regions of floristic endemism in southern Africa. A review with emphasis on succulents*. Umdaus Press, Pretoria.
VOLK, O.H. 1964. Die afro-meridionale-occidentale Floren-Region in Südwestafrika. *Beiträge zur Phytologie zu Ehren Prof. H. Walters 65 Geburtatages.* Ulmar, Stuttgart.
WEIMARCK, H. 1941. Phytogeographical groups, centres and intervals within the Cape flora. *Lunds Universitets Arsskrift N.F.Afd*. 2,37: 1–143.
WHITE, F. 1983. *The vegetation of Africa: a descriptive memoir to accompany the UNESCO/AERFAT/UNSO vegetation map of Africa*. United Nations Educational Scientific Cultural Organization, Paris.

APPENDIX 1.—List of Namibian endemic plants used in the evaluation

= Species name in italics indicates a synonym used in the original evaluation.
* Endemic species not used in the evaluation due to lack of data or species described since the evaluation.
• Species that have been collected outside Namibia since the evaluation. Unless otherwise stated, species indicated by • are near-endemic and mainly based on collections of Craven or Bruyns, particularly from Angola.

Acanthaceae
Barleria
•damarensis *T.Anderson*
dinteri *Oberm.*
jubata *S.Moore*
kaloxytona *Lindau*
lanceolata *(Schinz) Oberm.*
meeuseana *P.G.Mey.*
merxmuelleri *P.G.Mey.*
solitaria *P.G.Mey.*
Blepharis
ferox *P.G.Mey.*
fleckii *P.G.Mey.*
gigantea *Oberm.*
meyeri *Vollesen*
pruinosa *Engl.*
spinifex *Merxm.*
Hygrophila gracillima *(Schinz) Burkill*
Justicia
cuneata *Vahl* subsp. hoerleiniana *(P.G.Mey.) Immelman*
guerkeana *Schinz*
•platysepala *(S.Moore) P.G.Mey.*
Monechma
calcaratum *Schinz*
callothamnum *Munday*
crassiusculum *P.G.Mey.*
desertorum *(Engl.) C.B.Clarke*
grandiflorum *Schinz*
leucoderme *(Schinz) C.B.Clarke*
serotinum *P.G.Mey.*
tonsum *P.G.Mey.*
Peristrophe
grandibracteata *Lindau*
hereroensis *(Schinz) K.Balkwill*
namibiensis *K.Balkwill*
subsp. brandbergensis *K.Balkwill*
subsp. namibiensis
Petalidium
canescens *(Engl.) C.B.Clarke*
cymbiforme *Schinz*
giessii *P.G.Mey.*
lanatum *(Engl.) C.B.Clarke*
linifolium *T.Anderson*
luteo-album *A.Meeuse*
*ohopohense *P.G.Mey.*
pilosi-bracteolatum *Merxm. & Hainz*
ramulosum *Schinz*
rautanenii *Schinz*
subcrispum *P.G.Mey.*
Rhinacanthus kaokoensis *K.Balkwill & S.Williamson*
Ruellia
aspera *(Schinz) E.Phillips*
brandbergensis *Kers*

Aizoaceae
Aizoanthemum
dinteri *(Schinz) Friedrich*
galenioides *(Fenzl ex Sond.) Friedrich*
rehmannii *(Schinz) H.E.K.Hartmann = Aizoanthemum membrum-connectens* Dinter ex Friedrich
Aizoon giessii *Friedrich*
Tetragonia
rangeana *Engl.*
•schenckii *(Schinz) Engl.*
Trianthema hereroensis *Schinz*

Alliaceae
Tulbaghia calcarea *Engl. & K.Krause*, insuff. known

Amaranthaceae
Arthraerua leubnitziae *(Kuntze) Schinz*
Calicorema squarrosa *(Schinz) Schinz*
Hermbstaedtia spathulifolia *(Engl.) Baker*
Marcelliopsis splendens *(Schinz) Schinz*

Amaryllidaceae
Ammocharis nerinoides *(Baker) Lehmiller*
Crinum
paludosum *I.Verd.*
rautanenianum *Schinz*
Haemanthus avasmontanus *Dinter*
*Namaquanula bruynsii *Snijman*
*Nerine pusilla *Dinter*
Strumaria
hardyana *D.Müll.-Doblies & U.Müll.-Doblies*
phonolithica *Dinter*

Anacardiaceae
Rhus
problematodes *Merxm. & Roessler*
volkii *Suess.*

Apiaceae
Anginon streyi *(Merxm.) I.Allison & B.-E.van Wyk*
Heteromorpha papillosa *C.C.Towns.*
Marlothiella gummifera *H.Wolff*
Phlyctidocarpa flava *Cannon & W.L.Theob.*
Polemanniopsis sp. = *Merxmuller & Giess 32010*

Apocynaceae
•Australluma peschii = *Caralluma peschii* Nel
Baynesia lophophora *Bruyns*
Brachystelma
blepharanthera *H.Huber*
codonanthum *Bruyns*
recurvatum *Bruyns*
schinzii *(K.Schum.) N.E.Br.*
schultzei *(Schltr.) Bruyns*
•Ceropegia dinteri *Schltr.*
Cynanchum meyeri *(Decne.) Schltr.*
Ectadium
latifolium *(Schinz) N.E.Br.*
rotundifolium *(H.Huber) Venter & Kotze*
•Gomphocarpus semiplectens *K.Schum.*
Hoodia
juttae *Dinter*
officinalis *(N.E.Br.) Plowes* subsp. delaetiana *(Dinter) Bruyns*
ruschii *Dinter*
triebneri *(Nel) Bruyns*
Huernia
hallii *E.Lamb & B.M.Lamb*
plowesii *L.C.Leach*
Larryleachia tirasmontana *Plowes = Lavrania picta* (N.E.Br.) Plowes subsp. *parvipunctata* Bruyns
Lavrania haagnerae *Plowes*
Microloma
hereroense *Wanntorp*
penicillatum *Schltr.*
Orbea
albocastanea *(Marloth) Bruyns*
maculata *(N.E.Br.) L.C.Leach*
•subsp. kaokoensis *Bruyns*
subsp. rangeana *(Dinter & A.Berger) Bruyns*
Raphionacme
haeneliae *Venter & R.L.Verh.*
namibiana *Venter & R.L.Verh.*
Stapelia
kwebensis *N.E.Br. = Stapelia longipedicellata* (A.Berger) N.E.Br., not endemic
pearsonii *N.E.Br.*
*remota *R.A.Dyer*
schinzii *A.Berger & Schltr.*
*var. bergeriana *(Dinter) L.C.Leach*
var. schinzii
•Stapeliopsis urniflora *Lavranos*
Stigmatorhynchus hereroensis *Schltr.*
Tridentea
marientalensis *(Nel) L.C.Leach* subsp. albipilosa *(Giess) L.C.Leach*
•pachyrrhiza *(Dinter) L.C.Leach*
Tromotriche ruschiana *(Dinter) Bruyns*
•Tylophora fleckii *(Schltr.) N.E.Br.*

Aponogetonaceae
Aponogeton azureus *H.Bruggen*

Asphodelaceae
Aloe
argenticauda *Merxm. & Giess*
asperifolia *A.Berger*
corallina *I.Verd.*
dewinteri *Giess*
•dinteri *A.Berger*
erinacea *D.S.Hardy*
*hereroensis *Engl.* var. lutea *A.Berger*
namibensis *Giess*
omavandae *Van Jaarsv.*
pachygaster *Dinter*
sladeniana *Pole Evans*
viridiflora *Reynolds*
Bulbine
caput-medusae *G.Will.*
francescae *G.Will. & Baijnath*
namaensis *Schinz*
praemorsa = *Bulbine tetraphylla* Dinter, not endemic
*rhopalophylla *Dinter*
Trachyandra
ensifolia *(Sölch) Roessler*
glandulosa *(Dinter) Oberm.*
lanata *(Dinter) Oberm.*
peculiaris *(Dinter) Oberm.*

Asteraceae
Amphiglossa thuja *(Merxm.) Koekemoer*
Anisopappus
pinnatifidus *(Klatt) O.Hoffm. ex Hutch.*
pseudopinnatifidus *S.Ortiz & Paiva*
Antiphiona
fragrans *(Merxm.) Merxm.*
pinnatisecta *(S.Moore) Merxm.*
Arctotis frutescens *T.Norl.*
Aspilia eenii *S.Moore*
Berkheya schinzii *O.Hoffm.*
Calostephane marlothiana *O.Hoffm.*
*Chrysocoma puberula *Merxm.*
Crassocephalum coeruleum *(O.Hoffm.) R.E.Fr.*
Dauresia alliariifolia *(O.Hoffm.) B.Nord. & Pelser = Senecio alliariifolius* O.Hoffm.
Dicoma
cuneneensis *Wild*
dinteri *S.Moore*
*obconica *S.Ortiz & Pulgar*
Eremothamnus marlothianus *O.Hoffm.*
Eriocephalus
dinteri *S.Moore*
giessii *M.A.N.Müller*
kingesii *Merxm. & Eberle*
klinghardtensis *M.A.N.Müller*
pinnatus *O.Hoffm.*
Euryops
mucosus *B.Nord.*
walterorum *Merxm.*
Felicia
alba *Grau*
gunillae *B.Nord.*
smaragdina *(S.Moore) Merxm.*
*Garuleum schinzii *O.Hoffm.* subsp. crinitum *(Dinter) Merxm.*
Gazania thermalis *Dinter*

Geigeria
odontoptera *O.Hoffm.*
ornativa *O.Hoffm.* subsp. ornativa var. filifolia (Mattf.) *S.Ortiz & Rodr.Oubiña = G. englerana* Muschl. & *Geigeria otaviensis* (Merxm.) Merxm.
pilifera *Hutch.*
plumosa *Muschl.*
*subsp. angustifolia *S.Ortiz & Rodr.Oubiña*
subsp. brachycephala *S.Ortiz & Rodr.Oubiña = G. brachycephala* Muschl.
rigida *O.Hoffm.*
Gorteria diffusa *Thunb.* subsp. parviligulata *Roessler*
Helichrysum
amboense *Schinz*
deserticola *Hilliard*
erubescens *Hilliard*
marlothianum *O.Hoffm.*
Lasiopogon
ponticulus *Hilliard*
volkii *(B.Nord.) Hilliard*
Myxopappus hereroensis *(O.Hoffm.) Källersjö*
Nicolasia
heterophylla *S.Moore*
subsp. affinis *(S.Moore) Merxm.*
subsp. heterophylla
Nidorella nordenstamii *Wild*
Nolletia tenuifolia *Mattf.*
*Norlindhia aptera *B.Nord.*
Ondetia linearis *Benth.*
Osteospermum
montanum *Klatt*
muricatum *E.Mey. ex DC.* subsp. longiradiatum *T.Norl.*
Othonna
brandbergensis *B.Nord.*
clavifolia *Marloth*
•graveolens *O.Hoffm.*
sparsiflora *(S.Moore) B.Nord.*
Pegolettia
pinnatilobata *(Klatt) O.Hoffm. ex Dinter*
plumosa *M.D.Hend.*
Pentatrichia
avasmontana *Merxm.*
rehmii *(Merxm.) Merxm.*
*Philyrophyllum brandbergense *P.P.J.Herman*
Pentzia tomentosa *B.Nord.*
Pteronia
eenii *S.Moore*
polygalifolia *O.Hoffm.*
pomonae *Merxm.*
rangei *Muschl.*
spinulosa *E.Phillips*
Rennera eenii *(S.Moore) Källersjö*
Senecio
engleranus *O.Hoffm.*
giessii *Merxm.*
hermannii *B.Nord.*
windhoekensis *Merxm.*
Sphaeranthus wattii *Giess ex Merxm.*
Tripteris nervosa *Hutch.*
Ursinia frutescens *Dinter*
Vernonia
obionifolia *O.Hoffm*
subsp. dentata *Merxm.*
subsp. obionifolia

Boraginaceae
*Ehretia namibiensis *Retief & A.E.van Wyk* subsp. kaokoensis *Retief & A.E.van Wyk*
Heliotropium albiflorum *Engl.*
*Trichodesma angustifolium *Harv.* subsp. argenteum *Retief & A.E.van Wyk*

Brassicaceae
Heliophila
*deserticola *Schltr.* var. micrantha *A.Schreib.*
obibensis *Marais*

Burseraceae
Commiphora
*dinteri *Engl.*
giessii *J.J.A.van der Walt*
*kaokoensis *W.Swanepoel*
kraeuseliana *Heine*
•saxicola *Engl.*
•virgata *Engl.*

Campanulaceae
Namacodon schinzianum *(Markgr.) Thulin*
Wahlenbergia
densicaulis *Brehmer*
erophiloides *Markgr.*
*intricata *(Dinter & Markgraf) P.Craven*, ined. = *Lightfootia dinteri* Engl. ex Dinter
subumbellata *Markgr.*

Capparaceae
Cleome
carnosa *(Pax) Gilg & Gilg-Ben.*
foliosa *Hook.f.* var. namibensis *(Kers) Codd*
laburnifolia *Roessler*
suffruticosa *Schinz*

Chenopodiaceae
*Chenopodium amboanum *(Murr) Aellen*
Salsola
albisepala *Aellen*
arborea *C.A.Sm. ex Aellen*
*aroabica *Botsch.*
campyloptera *Botsch.*
cauliflora *Botsch.*
columnaris *Botsch.*
cryptoptera *Aellen*
denudata *Botsch.*
dinteri *Botsch.*
dolichostigma *Botsch.*
etoshensis *Botsch.*
*garubica *Botsch.*
gemmata *Botsch.*
giessii *Botsch.*
hoanibica *Botsch.*
hottentottica *Botsch.*
huabica *Botsch.*
kleinfonteini *Botsch.*
koichabica *Botsch.*
marginata *Botsch.*
mirabilis *Botsch.*
namibica *Botsch.*
okaukuejensis *Botsch.*
*omaruruensis *Botsch.*
*parviflora *Botsch.*
procera *Botsch.*
ptiloptera *Botsch.*
robinsonii *Botsch.*
*schreiberae *Botsch.*
scopiformis *Botsch.*
seminuda *Botsch.*
*seydelii *Botsch.*
spenceri *Botsch.*
swakopmundi *Botsch.*
ugabica *Botsch.*
unjabica *Botsch.*
Suaeda
articulata *Aellen*
salina *B.Nord.*

Colchicaceae
Androcymbium exiguum *Roessler* subsp. exiguum
Ornithoglossum calcicola *K.Krause & Dinter*

Convolvulaceae
Convolvulus argillicola *Pilg.*
Merremia
bipinnatipartita *(Engl.) Hallier f.*
guerichii *A.Meeuse*

Crassulaceae
Adromischus
schuldtianus *(Poelln.) Poelln.*
*subsp. brandbergensis *B.Nord. & Van Jaarsv.*
subsp. juttae *(Poelln.) Toelken*
subsp. schuldtianus

Crassula
aurusbergensis *G.Will.*
ausensis *Hutchison*
subsp. ausensis
subsp. giessii *(Friedrich) Toelken*
*subsp. titanopsis *Pavelka*
elegans *Schönland & Baker f.* subsp. namibensis *(Friedrich) Toelken*
luederitzii *Schönland*
numaisensis *Friedrich*
Tylecodon
aridimontanus *G.Will.*
*aurusbergensis *G.Will. & Van Jaarsv.*

Cucurbitaceae
Citrullus rehmii *De Winter*
Cucumella clavipetiolata *J.H.Kirkbr.*

Cyperaceae
•Bulbostylis mucronata *C.B.Clarke*
Cyperus rehmii *Merxm.*

Ebenaceae
Euclea asperrima *Friedr.-Holzh.*

Eriospermaceae
Eriospermum
buchubergense *Dinter*, insuff. known
citrinum *P.L.Perry*
flexum *P.L.Perry*
*graniticolum *Dinter ex Poelln.*, insuff. known
halenbergense *Dinter*
lavranosii *P.L.Perry*
volkmanniae *Dinter*

Euphorbiaceae
Euphorbia
angrae *N.E.Br.*
baliola *N.E.Br.*
caperonioides *R.A.Dyer & P.G.Mey.*
chamaesycoides *B.Nord.*
•cibdela *N.E.Br.*
damarana *L.C.Leach*
friedrichiae *Dinter*
giessii *L.C.Leach*
insarmentosa *P.G.Mey.*
juttae *Dinter*
kaokoensis *(A.C.White, R.A.Dyer & B.Sloane) L.C.Leach*
lavrani *L.C.Leach*
leistneri *R.H.Archer*
mauritanica *L.* var. foetens *Dinter ex A.C.White, R.A.Dyer & B.Sloane*
monteiroi *Hook.f.* subsp. brandbergensis *B.Nord.*
namibensis *Marloth*
namuskluftensis *L.C.Leach*
otjipembana *L.C.Leach*
pergracilis *P.G.Mey.*
*pseudoduseimata *A.C.White, R.A.Dyer & B.Sloane*
rudis *N.E.Br.*
*spartaria *N.E.Br.*
*spinea *N.E.Br.*
venenata *Marloth*
verruculosa *N.E.Br.*
volkmanniae *Dinter*
Phyllanthus dinteri *Pax*
Tragia
dinteri *Pax*
lancifolia *Dinter ex Pax & K.Hoffm.*

Fabaceae
•Acacia montis-usti *Merxm. & A.Schreib.*
Bolusia amboensis *(Schinz) Harms*
Caesalpinia
merxmuellerana *A.Schreib.*
pearsonii *L.Bolus*
Crotalaria
aurea *Dinter ex Baker f.*
colorata *Schinz* subsp. colorata
kurtii *Schinz*
Decorsea dinteri *(Harms) Verdc.*
Elephantorrhiza
rangei *Harms*
schinziana *Dinter*
Eriosema harmsiana *Dinter*
Erythrina decora *Harms*
Haematoxylum dinteri *(Harms) Harms*
Indigofera
acanthoclada *Dinter*
anabibensis *A.Schreib.*
giessii *A.Schreib.*
hochstetteri *Baker* subsp. streyana *(Merxm.) A.Schreib.*
merxmuelleri *A.Schreib.*
pechuelii *Kuntze*
rautanenii *Baker f.*
Lebeckia
dinteri *Harms*
obovata *Schinz*
Lessertia
acanthorhachis *(Dinter) Dinter*
cryptantha *Dinter*
eremicola *Dinter*
Lotononis
bracteosa *B.-E.van Wyk*
mirabilis *Dinter*
pachycarpa *Dinter ex B.-E.van Wyk*
pallidirosea *Dinter & Harms*
schreiberi *B.-E.van Wyk*
Sesbania pachycarpa *DC.* subsp. dinterana *J.B.Gillett*
Tephrosia
griseola *H.M.L.Forbes*
monophylla *Schinz*
pallida *H.M.L.Forbes*

Frankeniaceae
Frankenia pomonensis *Pohnert*

Geraniaceae
Monsonia
deserticola *Dinter ex R.Knuth*
drudeana *Schinz*
ignorata *Merxm. & A.Schreib.*
trilobata *Kers*
Pelargonium
cortusifolium *L'Hér.*
mirabile *Dinter*
otaviense *R.Knuth*
paniculatum *Jacq.*
Sarcocaulon
inerme *Rehm*
marlothii *Engl.*
peniculinum *Moffett*

Hyacinthaceae
Albuca
amboensis *(Schinz) Oberm.*
*englerana *K.Krause & Dinter*
hereroensis *Schinz*
*karasbergensis *P.E.Glover*
*reflexa *Dinter & K.Krause*
Drimia
namibensis *(Oberm.) J.C.Manning & Goldblatt = Rhadamanthus namibensis* Oberm.
secunda *(B.Nord.) J.C.Manning & Goldblatt = Rhadamanthus secundus* B.Nord.
Lachenalia
giessii *W.F.Barker*
klinghardtiana *Dinter*
namibiensis *W.F.Barker*
nutans *G.D.Duncan*
pearsonii *(P.E.Glover) W.F.Barker*
Ledebouria scabrida *Jessop*
Ornithogalum
candidum *Oberm.*
rautanenii *Schinz*
stapffii *Schinz*
tubiforme *(Oberm.) Oberm.*

Hypoxidaceae
Hypoxis dinteri *Nel*

Iridaceae
Babiana longicollis *Dinter*
•Ferraria schaeferi *Dinter*
Lapeirousia
avasmontana *Dinter*
gracilis *Vaupel*

Moraea
garipensis *Goldblatt*
*graniticola *Goldblatt*
hexaglottis *Goldblatt*
namibensis *Goldblatt*
rigidifolia *Goldblatt*

Kirkiaceae
Kirkia dewinteri *Merxm. & Heine*

Lamiaceae
Acrotome fleckii *(Gürke) Launert*
Aeollanthus namibiensis *Ryding*
Hemizygia floccosa *Launert*
Plectranthus
dinteri *Briq.*
unguentarius *Codd*
Stachys dinteri *Launert*
•Tetradenia kaokoensis *Van Jaarsv. & A.E.van Wyk*

Lobeliaceae
Lobelia hereroensis *Schinz*

Loranthaceae
Agelanthus discolor *(Schinz) Balle*

Lythraceae
Nesaea luederitzii *Koehne* var. hereroensis *Koehne*

Malvaceae
Hibiscus
dinteri *Hochr.*
discophorus *Hochr.*
fleckii *Gürke*
merxmuelleri *Roessler*
sulfuranthus *Ulbr.*
Pavonia rehmannii *Szyszyl.*

Mesembryanthemaceae
Amphibolia saginata *(L.Bolus) H.E.K.Hartmann*
Antimima
argentea *(L.Bolus) H.E.K.Hartmann*
aurasensis *H.E.K.Hartmann*
buchubergensis *(Dinter) H.E.K.Hartmann*
dolomitica *(Dinter) H.E.K.Hartmann*
eendornensis *(Dinter) H.E.K.Hartmann*
modesta *(L.Bolus) H.E.K.Hartmann*
quarzitica *(Dinter) H.E.K.Hartmann*
Astridia hallii *L.Bolus*
Brownanthus
•arenosus *(Schinz) Ihlenf. & Bittrich*
namibensis *(Marloth) Bullock*
pubescens *(N.E.Br. ex Maasss) Bullock*
Cephalophyllum
*compressum *L.Bolus*
confusum *(Dinter) Dinter & Schwantes*
Cheiridopsis caroli-schmidtii *(Dinter & A.Berger) N.E.Br.*
Conophytum
halenbergense *(Dinter & Schwantes) N.E.Br.*
klinghardtense *Rawe*
subsp. baradii *(Rawe) S.A.Hammer*
subsp. klinghardtense
quaesitum *(N.E.Br.) N.E.Br.* subsp. densipunctum *(L.Bolus) S.A.Hammer*
ricardianum *Loesch & Tischer*
subsp. ricardianum
subsp. rubiflorum *Tischer*
taylorianum *(Dinter & Schwantes) N.E.Br.*
subsp. ernianum *(Loesch & Tischer) de Boer ex S.A.Hammer*
subsp. taylorianum
Delosperma klinghardtianum *Schwantes*
Dinteranthus microspermus *(Dinter & Derenb.) Schwantes* subsp. impunctatus *N.Sauer*
*Dracophilus delaetinus *(Dinter) Dinter & Schwantes*
Drosanthemum
nordenstamii *L.Bolus*
pauper *(Dinter) Dinter & Schwantes*
Eberlanzia clausa *(Dinter) Schwantes*
Ebracteola
derenbergiana *(Dinter) Dinter & Schwantes*
montis-moltkei *(Dinter) Dinter & Schwantes*
Fenestraria rhopalophylla *(Schltr. & Diels) N.E.Br.* subsp. rhopalophylla
Jensenobotrya lossowiana *A.G.J.Herre*
Juttadinteria
attenuata *Walgate*
*ausensis *(L.Bolus) Schwantes*
deserticola *(Marloth) Schwantes*
simpsonii *(Dinter) Schwantes*
Lithops
dinteri *Schwantes*
subsp. dinteri
*subsp. multipunctata *(de Boer) D.T.Cole*
*francisci *(Dinter & Schwantes) N.E.Br.*
*gracilidelineata *Dinter* subsp. brandbergensis *(de Boer) D.T.Cole*
*hermetica *D.T.Cole*
julii *(Dinter & Schwantes) N.E.Br.* subsp. julii
karasmontana *(Dinter & Schwantes) N.E.Br.*
*subsp. bella *(N.E.Br.) D.T.Cole*
*subsp. eberlanzii *(Dinter & Schwantes) D.T.Cole*
*optica *(Marloth) N.E.Br.*
pseudotruncatella *(A.Berger) N.E.Br*
*subsp. archerae *(de Boer) D.T.Cole*
*subsp. dendritica *(Nel) D.T.Cole*
*subsp. volkii *(Schwantes ex de Boer & Boom) D.T.Cole*
*ruschiorum *(Dinter & Schwantes) N.E.Br.*
schwantesii *Dinter*
*subsp. gebseri *(de Boer) D.T.Cole*
subsp. schwantesii
*vallis-mariae *(Dinter & Schwantes) N.E.Br.*
werneri *Schwantes ex H.Jacobsen*
*Malephora engleriana *(Dinter & A.Berger) Schwantes*
Mesembryanthemum pellitum *Friedrich*
Namibia
cinerea *(Marloth) Dinter & Schwantes = Namibia ponderosa* (Dinter & Schwantes) Dinter & Schwantes
pomonae *(Dinter) Dinter & Schwantes ex Walgate*
Psammophora
*nissenii *(Dinter) Dinter & Schwantes*
*saxicola *H.E.K.Hartmann*
Psilocaulon
gessertianum *(Dinter & A.Berger) Dinter & Schwantes*
•salicornioides *(Pax) Schwantes*
Ruschia
deminuta *L.Bolus*
*namusmontana *Friedrich*
*odontocalyx *(Schltr. & Diels) Schwantes*
*pollardii *Friedrich*
*ruschiana *(Dinter) Dinter & Schwantes*
vulvaria *(Dinter) Schwantes*
Ruschianthus falcatus *L.Bolus*
Schwantesia
constanceae *N.Zimm.*
succumbens *(Dinter) Dinter*
Synaptophyllum juttae *(Dinter & A.Berger) N.E.Br.*
*Titanopsis schwantesii *(Schwantes) Schwantes*
*Trichodiadema littlewoodii *L.Bolus*

Molluginaceae
*Corbichonia rubriviolacea *(Friedrich) Jeffrey*
Hypertelis caespitosa *Friedrich*
Mollugo walteri *Friedrich*
Suessenguthiella caespitosa *Friedrich*

Nyctaginaceae
Boerhavia deserticola *Codd*
Commicarpus
*decipiens *Meikle*
fruticosus *Pohnert*

Orobanchaceae
Alectra
pseudobarleriae *(Dinter) Dinter*
schoenfelderi *Dinter & Melch.*

Oxalidaceae
Oxalis
ausensis *R.Knuth*
hunsbergensis ined.

Oxalis (cont.)
luederitzii *Schinz*
pseudo-cernua *R.Knuth*
schaeferi *R.Knuth*

Passifloraceae
•Adenia pechuelii *(Engl.) Harms*

Pedaliaceae
Rogeria bigibbosa *Engl.*
Sesamothamnus leistneranus, ined. = *De Winter & Leistner 5504*
Sesamum
abbreviatum *Merxm.*
marlothii *Engl.*

Plumbaginaceae
Limonium dyeri *Lincz.*
Plumbago
pearsonii *L.Bolus*
wissii *Friedrich*

Poaceae
*Brachiaria schoenfelderi *C.E.Hubb. & Schweick.*
Eragrostis
aristata *De Winter*
kingesii *De Winter*
omahekensis *De Winter*
pygmaea *De Winter*
sabinae *Launert*
scopelophila *Pilg.*
stenothyrsa *Pilg.*
walteri *Pilg.*
•Kaokochloa nigrirostris *De Winter*
Merxmuellera rangei *(Pilg.) Conert*
*Panicum pearsonii *F.Bolus*
Pennisetum foermeranum *Leeke*
Pogonarthria leiarthra *Hack.*
Setaria finita *Launert*
Sporobolus nebulosus *Hack.* (endemic to southern Africa)
Stipagrostis
•damarensis *(Mez) De Winter*
garubensis *(Pilg.) De Winter*
gonatostachys *(Pilg.) De Winter*
•hermannii *(Mez) De Winter*
lanipes *(Mez) De Winter*
namibensis *De Winter*
pellytronis *De Winter*
•ramulosa *De Winter*
sabulicola *(Pilg.) De Winter*
seelyae *De Winter*

Polygalaceae
•Polygala guerichiana *Engl.*

Portulacaceae
Anacampseros filamentosa *(Haw.) Sims* subsp. tomentosa *(A.Berger) Gerbaulet*
Avonia dinteri *(Schinz) G.D.Rowley* = *Anacampseros dinteri* Schinz
•Ceraria longipedunculata *Merxm. & Podlech*

Rubiaceae
Amphiasma
divaricatum *(Engl.) Bremek.*
merenskyanum *Bremek.*
Kohautia
amboensis *(Schinz) Bremek.*
azurea *(Dinter & K.Krause) Bremek.*

Santalaceae
Thesium xerophyticum *A.W.Hill*

Scrophulariaceae
Anticharis
ebracteata *Schinz*
imbricata *Schinz*
inflata *Marloth & Engl.*
Aptosimum
arenarium *Engl.*
suberosum *F.E.Weber*
Chamaegigas intrepidus *Dinter ex Heil*
Cromidon pusillum *(Roessler) Hilliard*
Diclis tenuissima *Pilg.*
Dintera pterocaulis *Stapf*
Jamesbrittenia
acutiloba *(Pilg.) Hilliard*
barbata *Hilliard*
bicolor *(Dinter) Hilliard*
chenopodioides *Hilliard*
dolomitica *Hilliard*
fimbriata *Hilliard*
fleckii *(Thell.) Hilliard*
fragilis *(Pilg.) Hilliard*
giessii *Hilliard*
hereroensis *(Engl.) Hilliard*
lyperioides *(Engl.) Hilliard*
pallida *(Pilg.) Hilliard*
pilgeriana *(Dinter) Hilliard*
primuliflora *(Thell.) Hilliard*
sessilifolia *(Diels) Hilliard*
Manulea
dubia *(Skan) Overkott ex Roessler*
namibensis *(Roessler) Hilliard*
tenella *Hilliard*
Manuleopsis dinteri *Thell.*
Nemesia
karasbergensis *L.Bolus*
violiflora *Roessler*
•Phyllopodium hispidulum *(Thell.) Hilliard*
Selago
amboensis *Rolfe*
lepida *Hilliard*
nachtigalii *Rolfe*

Solanaceae
Lycium grandicalyx *Joubert & A.M.Venter*
Nicotiana africana *Merxm.*
Solanum
damarense *Bitter*
dinteri *Bitter*
rigescentoides *Hutch.*

Sterculiaceae
Dombeya rotundifolia *(Hochst.) Planch.* var. velutina *I.Verd.*
Hermannia
amabilis *Marloth ex K.Schum.*
*complicata *Engl.*
elliottiana *(Harv.) K.Schum.*
engleri *Schinz*
glandulosissima *Engl.*
juttae *Dinter & Engl.*
merxmuelleri *Friedr.-Holzh.*
minimifolia *Friedr.-Holzh.*
solaniflora *K.Schum.*

Tecophilaeaceae
•Eremiolirion amboensis = *Cyanella amboensis Schinz*

Tiliaceae
Corchorus merxmuelleri *Wild*

Turneraceae
Turnera oculata *Story* var. paucipilosa *Oberm.*

Verbenaceae
Priva auricoccea *A.Meeuse*

Vitaceae
Cyphostemma
bainesii *(Hook.f) Desc.*
•juttae *(Dinter & Gilg) Desc.*
omburense *(Gilg & M.Brandt) Desc.*

Zygophyllaceae
Neoluederitzia sericeocarpa *Schinz*
Zygophyllum
applanatum *Van Zyl*
cylindrifolium *Schinz*
giessii *Merxm. & A.Schreib.*
hirticaule *Van Zyl*
longistipulatum *Schinz*
•stapffii *Schinz*, previously known as *Z. orbiculatum* in Angola

Bothalia 36,2: 191–199 (2006)

Phytogeography of *Passerina* (Thymelaeaceae)

C.L. BREDENKAMP*+ and A.E. VAN WYK**

Keywords: Afromontane, Cape Floristic Region, distribution, endemism, fynbos, grassland, *Passerina* L., phytogeography, Red Data List, relict, Thymelaeaceae

ABSTRACT

Passerina L. comprises 20 species and four subspecies of microphyllous, wind-pollinated shrubs. Once considered cosmopolitan, the genus as currently defined, is endemic to southern Africa. Endemism within the genus is highest in the Cape Floristic Region (CFR), where all members show morphological and anatomical adaptations to the winter rainfall and dry warm summers of the Mediterranean or semi-Mediterranean climate of the region. The Western Cape is the centre of diversity for *Passerina*, from where certain species extend to the west, north and east. The outlier populations of *Passerina montana* Thoday on the interior plateau of South Africa and Zimbabwe, as well as the Auas Moutains in Namibia, most probably originated in the CFR and formed part of a previously wider northern temperate Afromontane grassland-dominated vegetation during the Quarternary, of which relicts remained in the high mountain areas. *P. burchellii* Thoday and *P. paludosa* Thoday have the most restricted distribution and are regarded as Vulnerable. All other species are either widespread or under no immediate threat.

INTRODUCTION

Meisner (1840, 1857) redefined *Passerina* L. by clarifying the taxonomic position of 92 'species exclusae', thus changing the status of the genus from cosmopolitan to endemic in southern Africa, an opinion also reflected in the now outdated taxonomic revision of the group by Thoday (1924). A recent monograph of *Passerina* recognized 20 species and four subspecies (Bredenkamp 2002; Bredenkamp & Van Wyk 2003); these are listed in Tables 1 and 2. All members of *Passerina* are woody, evergreen shrubs or subshrubs with microphyllous leaves and small, rather insignificant wind-pollinated flowers. It is the only exclusively anemophilous genus of the Thymelaeaceae and the plants usually grow gregariously.

Taking the most southerly distribution of *Passerina montivaga* Bredenkamp & A.E.van Wyk into consideration, no less than 18 species of *Passerina* occur in the Cape Floristic Region (CFR). The CFR is also acknowledged as the smallest of the world's six floristic kingdoms (Van Wyk & Smith 2001). Following a taxonomic revision of *Lachnaea* L. (Thymelaeaceae), Beyers (2001) reviewed the recognition of local centres of endemism within the CFR, from the initial descriptions by Weimarck (1941) up to those of Goldblatt & Manning (2000). In this paper we follow the interpretation of Goldblatt & Manning (2000), which identifies the following six principal local centres of endemism: the Northwestern (NW), Southwestern (SW), Agulhas Plain (AP), Karoo Mountain (KM), Langeberg (LB) and Southeastern (SE) Centres.

Species of *Passerina* endemic to the CFR (Table 1) are morphologically and anatomically adapted to the winter rainfall and dry warm summers of the Mediterranean or semi-Mediterranean climate in the region (Bredenkamp & Van Wyk 1999, 2000, 2001). Most species in the CFR are associated with fynbos, a sclerophyllous vegetation type on oligotrophic soils derived mainly from quartzitic Cape Supergroup rocks. These species are adapted to a variety of habitats, e.g. high-mountain peaks above the snowline, where plants are often surrounded by mist (throughout the year) or covered by snow especially during the winter months; forest and mountain fynbos; vleis and marshes; coastal limestone deposits and limestone hills; coastal fynbos, where the plants grow on sand dunes and in sandy areas. Many species are pioneers growing along roadsides and in disturbed places.

Species near-endemic to the CFR are more widespread (Table 1). They have adapted to a wider amplitude of environmental conditions: where ranges extend north of the southern Cape mountain ranges, they are often adapted to arid karroid vegetation and summer rainfall; certain species are adapted to forest margins and others tolerate periodic falls of snow at high altitudes.

The few species of *Passerina* endemic to the northern Drakensberg or near-endemic to the Great Escarpment of southern Africa (Table 2) are associated with the high moisture levels prevalent on the eastern escarpment and conditions of summer rainfall. These plants are often found in the ecotonal belt between forest and grassland; they also grow along streams and riverbanks and on mountain slopes.

In this contribution we describe, for the first time in one paper, the patterns of geographical distribution shown by members of *Passerina*. Patterns are interpreted in terms of geology, climate, vegetation type and historical change, and the conservation status of threatened taxa is suggested.

MATERIAL AND METHODS

All infrageneric taxa of *Passerina* were studied during extensive field work covering the complete geographi-

* South African National Biodiversity Institute, Private Bag X101, 0001 Pretoria.
+ Student affiliation: Department of Botany, University of Pretoria, 0002 Pretoria.
** H.G.W.J. Schweickerdt Herbarium, Department of Botany, University of Pretoria, 0002 Pretoria.
MS. received: 2004-11-19.

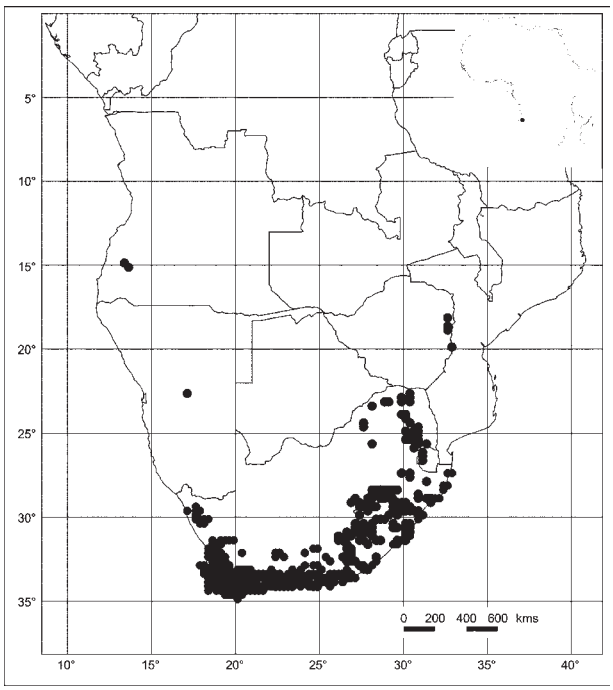

FIGURE 1.—Known geographical distribution of the genus *Passerina*. Distribution in Angola on Huíla Plateau near Lubango and Chela Mountains is shown in insert.

cal range of the genus. Live material was collected, as far as possible, from at least five different localities for every taxon. Habitat and distribution data from 22 national and international herbaria were compiled in a Microsoft Access Database and integrated with the Pretoria Computerised Information System (PRECIS), from which distribution maps for all taxa were generated. For mapping purposes the degree square system was used (Edwards & Leistner 1971). Categories used to indicate Red List status of taxa are based on the criteria of the IUCN Species Survival Commission (2000).

OBSERVATIONS

The combined distribution of all species of *Passerina* is shown in Figure 1. The number of species per one-degree square is indicated in Figure 2. In *Passerina* the highest numbers of species per one-degree square are concentrated in a belt including those grids between 33° and 34°S and 18° to 27°E. The CFR (mainly Western Cape) is clearly the centre of diversity for *Passerina*, from where certain species extend to the west, north and east (see also Bredenkamp & Van Wyk 2001). The highest numbers of species occur in the grids 3321 (Ladismith), 3322 (Oudtshoorn) and 3419 (Caledon). The highest

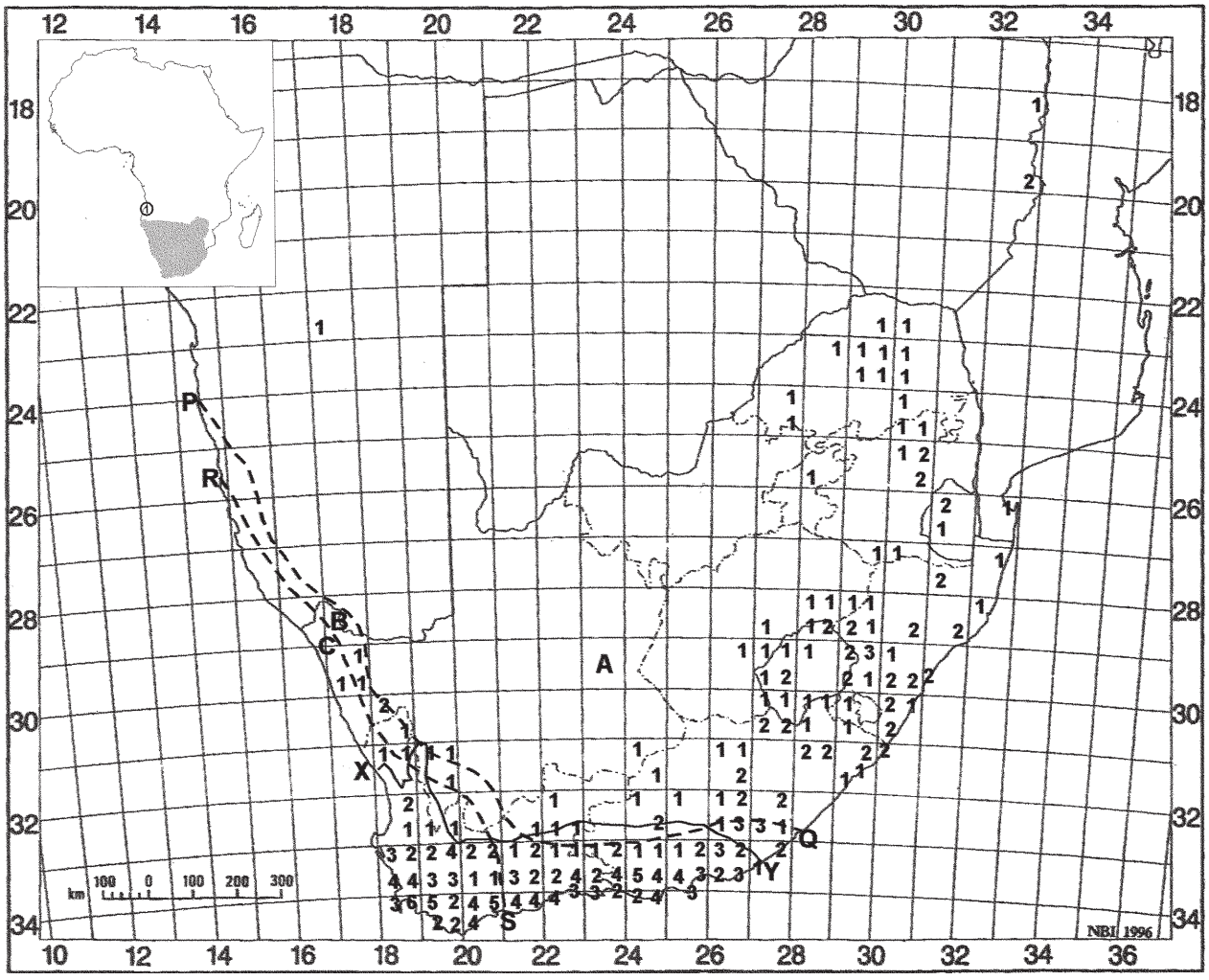

FIGURE 2.—Number of species of *Passerina* per one-degree grid square. Lines PQ and RS: boundaries between summer (A), intermediate (B) and winter (C) rainfall areas. Line XY shows northern boundary of Cape Supergroup rock outcrops. Distribution on Huíla Plateau and Chela Mountains in Angola is shown in insert.

diversity of species (six per half-degree square) occurs in the False Bay area, from Seekoeivlei, including the Cape Flats, to De Mond at the Palmiet River (3418B) (Bredenkamp 2002). Levyns (1938) was the first to show that the Caledon District is the centre of species richness in the CFR with a reduction in numbers to the north and east. Oliver *et al*. (1983) regard the quarter-degree square 3418BB as the richest area in the CFR. Beyers (2001), also working in the Thymelaeaceae, found that the highest number of *Lachnaea* L. species occurred in the quarter-degree square 3319AD (Worcester).

Species endemic or near-endemic to the CFR (Table 1)

Passerina shows a high percentage of endemism within the CFR, as nine species out of 20 (45%), as well as the three subspecies, are endemic to this region. High percentages of species, 25%–65%, are also demonstrated in each of the local centres of endemism. *P. esterhuyseniae* (Northwestern Centre), *P. paludosa* (Southwestern Centre), *P. galpinii* (Agulhas Plain Centre) and *P. pendula* (Southeastern Centre) are all endemic to one local centre of endemism only.

The Northwestern Centre has a relatively high concentration of *Passerina* species, as 40% of the species occur there. The occurrence of 65% of *Passerina* species in the Southwestern Centre, confirms that the grids 3419 (Caledon) and 3418 (Simonstown) can be regarded as centres of total species richness [Levyns (1938) and Oliver *et al*. (1983)]. Geology and soils play an important role in the species composition of the Agulhas Plain Centre, where limestones extensively outcrop along the southern coast from the Agulhas Peninsula to Mossel Bay (Goldblatt & Manning 2000). Thirty percent of *Passerina* species occur in this centre. The percentages of *Passerina* species represented in the Karoo Mountain Centre (25%) and the Langeberg Centre (35%) are relatively low, and no *Passerina* species are endemic to either of these Centres. The Southeastern Centre has a relatively high concentration of *Passerina* species, with 40% of the species occurring there.

Species considered near-endemic to the CFR are *Passerina comosa* and *P. nivicola*, distributed from the CFR to the Northern Cape and *P. falcifolia*, *P. rubra* and *P. truncata* subsp. *truncata* distributed from the CFR to the Eastern Cape. *Passerina nivicola*, restricted mostly to mountainous areas, is possibly still under-collected.

Species endemic to the Northern, Western and Eastern Cape and KwaZulu-Natal (Table 1)

P. obtusifolia and *P. corymbosa* (= *P. vulgaris*) are so-called Cape ubiquists (Weimark 1941) as they are very common and adapted to a wide range of Cape habitats. Their distributions currently include all the Centres within the CFR and both occur in three other South African provinces. *Passerina rigida* is confined to coastal areas from South Africa's western coast to the northeastern coast of KwaZulu-Natal.

Species endemic or near-endemic to the Great Escarpment of southern Africa

Endemism of *Passerina drakensbergensis*, *P. montana* and *P. montivaga* is indicated in Table 2.

Based on fossil pollen evidence, Scott *et al*. (1997) regard the dryer forest types of East Africa and Australia as the best apparent analogies for the palaeovegetation of southern Africa during the terminal Cretaceous to the early Tertiary. During the Neogene, plant communities in southern Africa evolved into equivalents of modern biomes of the subcontinent. Currently, temperate grassland is widespread on the interior plateau and includes fynbos-like vegetation in moist higher-altitude areas (O'Connor & Bredenkamp 1997). During the Quaternary, highveld grassland expanded at the expense of woody vegetation, coupled by a southward spread of relatively dry mountain fynbos elements. Evidence for the presence of such fynbos vegetation during the Holocene in the contemporary Grassland Biome has been found as far north as the Nyanga Mountains of Zimbabwe (Scott *et al*. 1997). A phylogenetic study by Bredenkamp (2002) indicates that *Passerina filiformis* and *P. paludosa* (both common in the Cape Peninsula) are probably the most primitive extant members of the genus, and *P. truncata*, *P. montana* and *P. paleacea* as the most advanced. We hypothesize that *P. montana* probably originated from an ancestor in the CFR and adapted to the environmental conditions of the high-mountain Afromontane grassland, which had a wider northerly distribution during the Quaternary. Because of environmental changes since the beginning of the Quaternary, the boundaries of the Grassland and Savanna Biomes changed, resulting in relicts of Afromontane grassland and fynbos elements in high-altitude areas such as Nyanga, the Huíla Plateau and the Auas Mountains. In descriptions of the Afromontane Region, White (1981, 1983) and Cowling & Hilton-Taylor (1997) mention the significant outliers of this phytochorion occurring on the high mountains of West Africa, the Eastern Zimbabwe Highlands and Angola (Huíla Plateau). Although this broad pattern of distribution (Cape centre, eastern African extension with reduced species) is common to other genera as well, *Passerina* is unusual because it is represented in all the more pronounced Afromontane refuges in southern Africa, especially those isolated western outliers in Namibia and Angola.

Rennie (1936) argued that the occurrence of certain species, including species of *Passerina*, on the Auas Mountains in Namibia could be interpreted as relicts of the CFR, suggesting that northward expansion of at least certain elements of that flora took place along the west coast into present-day Namibia. Unfortunately the *Passerina* specimens from the Auas Mountains available to him were sterile, resulting in their incorrect identification as *P. truncata* (= *P. glomerata*). As the most northerly known distribution of *P. truncata* at the time was Steinkopf in Namaqualand, he concluded that *P. truncata* once ranged further north through Namibia to the Auas Mountains. However, the specimens from both Auas and Huíla are unmistakeably *P. montana*, a species

TABLE 1.—Endemism of *Passerina* species in Cape Floristic Region (CFR), as well as in various provinces of South Africa

Taxa	Habitat & altitude	Centres of endemism						South African provinces				*Conserv. status
		NW	SW	AP	KM	LB	SE	NC	WC	EC	KZN	
Species and subspecies endemic to CFR												
burchellii Thoday	High mtns		▲Genadendal, Villiersdorp			▲Towerkop at Ladismith						VU D2
ericoides L.	Beaches and salt marshes		▲Melkbosstrand and Cape Peninsula, eastward	▲De Mond in Bredasdorp Dist.								NT
esterhuyseniae Bredenk. & A.E.van Wyk	Mountain Fynbos (Rebelo 1998), mtn summits	◆Groenberg, Konpoort in Cederberg										LC
filiformis L. subsp. *filiformis*	Rocky areas, east-facing mtn slopes	▲Piquetberg, southeastward	▲Cape Peninsula, eastward			▲Attaquaskloof						LC
filiformis L.subsp. *glutinosa* (Thoday) Bredenk. & A.E.van Wyk	Strandveld (Acocks 1988)	Doring Bay, southward	St Helena Bay									NT
galpinii C.H.Wright	Stony flats, coastal limestone deposits and limestone hills, 0–290 m			◆Elim to Bredasdorp, eastward to Mossel Bay								LC
paleacea Wikstr.	Beaches and salt marshes		▲Langebaan south- and eastward	▲Bredasdorp Dist., eastward		▲Stilbaai Dist.						LC
paludosa Thoday	Marshy areas		◆Muizenberg, Rondevlei Nature Reserve, Zeekoevlei and Strandfontein Road (Smuts 1996)									VU B1B2abcd

◆, spp. endemic to one centre of endemism only; ▲, spp. endemic to more than one centre of endemism; ●, spp. near-endemic to CFR; ■ spp. endemic to CFR and adjacent provinces of South Africa; NW, Northwestern; SW, Southwestern ; AP, Agulhas Plain; KM, Karoo Mountain; LB, Langeberg; SE, Southeastern; NC, Northern Cape; WC, Western Cape; EC, Eastern Cape; KZN, KwaZulu-Natal. *Conserv. status: VUD2, Vulnerable; NT, Near Threatened; LC, Least Concern; VUB1B2abcd, Vulnerable.

TABLE 1.—Endemism of *Passerina* species in Cape Floristic Region (CFR), as well as in various provinces of South Africa (cont.)

Taxa	Habitat & altitude	Centres of endemism						South African provinces				*Conserv. status
		NW	SW	AP	KM	LB	SE	NC	WC	EC	KZN	
Species and subspecies endemic to CFR (cont.)												
pendula Eckl. & Zeyh. ex Thoday	Mtn slopes and river-banks, 383–600 m						◆E Kouga to Great Winter-hoek Mtns, upper Swart-kops and Boesmans Rivers at Port Elizabeth					LC
quadrifaria Bredenk. & A.E.van Wyk	Rocky peaks and mtn sum-mits, 1 500–1 670 m				▲Langeberg and Swart-berg	▲Swartberg	▲Kouga, Tsitsikamma and Great Winterhoek Mtns					LC
truncata (Meisn.) Bredenk. & A.E.van Wyk subsp. *mon-ticola* Bredenk. & A.E.van Wyk	In rock cre-vices on mtn summits, 2 000 m	Clanwilliam, south- and eastward	Table Mtn, Helderberg, Hex River and Rivier-sonderend Mtns									LC
Species and subspecies near-endemic to CFR												
comosa C.H.Wright	Mtn summits, slopes, 1 000–1 200 m	●Roggeveld	●Tafelberg in Worcester Dist.		●Witteberg, Klein Swart-berg			●Kamiesberg to Calvinia				LC
falcifolia C.H.Wright	Mtn plateaus, southeast-facing slopes, 0–1 100 m		●Near Cale-don				●Mossel Bay to Port Eliza-beth			●Somerset East Dist., Grahams-town to Boknes		LC

◆, spp. endemic to one centre of endemism only; ▲, spp. endemic to more than one centre of endemism; ●, spp. near-endemic to CFR; ■ spp. endemic to CFR and adjacent provinces of South Africa; NW, Northwestern; SW, Southwestern ; AP, Agulhas Plain; KM, Karoo Mountain; LB, Langeberg; SE, Southeastern; NC, Northern Cape; WC, Western Cape; EC, Eastern Cape; KZN, KwaZulu-Natal. *Conserv. status: VUD2, Vulnerable; NT, Near Threatened; LC, Least Concern; VUB1B2abcd, Vulnerable.

TABLE 1.—Endemism of *Passerina* species in Cape Floristic Region (CFR), as well as in various provinces of South Africa (cont.)

Taxa	Habitat & altitude	Centres of endemism						South African provinces				*Conserv. status
		NW	SW	AP	KM	LB	SE	NC	WC	EC	KZN	
Species and subspecies near-endemic to CFR (cont.)												
nivicola Bredenk. & A.E.van Wyk	Escarpment Mountain Renosterveld, Mountain Fynbos Renosterveld and Central Mountain Renosterveld (Rebelo 1998)	●Ceres Dist.	●Tafelberg, Worcester Dist.					● Sneeukrans in Roggeveld Escarpment				LC
rubra C.H.Wright	Calcareous soils, dunes, limestone		●Swellendam Dist., Bontebok National Park			●Muiskraal near Garcia Pass	●Sedgefield Dist. to Port Elizabeth, ancient dunes northward to Cradock			●Grahamstown Dist.		LC
truncata (Meisn.) Bredenk. & A.E.van Wyk subsp. *truncata*	Dry areas of Namaqualand , karoo environment, rocky slopes of several mtn ranges	●Vanrhynsdorp, southward	●Ceres Dist.		●Matjiesfontein, southeastward		●Baviaanskloof near Patensie	●Steinkopf, southward to Calvinia Dist.				LC
Species endemic to CFR and adjacent provinces of South Africa												
obtusifolia Thoday	Karoo habitats, north-facing aspect of mtns in sthn Cape, ecotone between Fynbos and Karoo, 670–1 400 m	■Van Rhyn's Pass	■Worcester and Caledon Dist., Hex River Mtns	■Bredasdorp and Riversdale Dist.	■Montagu and Ladismith Dist., Swartberg	■Noukloof Nature Reserve to Ladismith, Langeberg	■Steytlerville Dist. to Humansdorp, eastward to Port Elizabeth	■Calvinia Dist.	■Beaufort West Dist.	■Lady Grey southward to Storms River, eastward to Grahamstown		LC

◆, spp. endemic to one centre of endemism only; ▲, spp. endemic to more than one centre of endemism; ●, spp. near-endemic to CFR; ■ spp. endemic to CFR and adjacent provinces of South Africa; NW, Northwestern; SW, Southwestern ; AP, Agulhas Plain; KM, Karoo Mountain; LB, Langeberg; SE, Southeastern; NC, Northern Cape; WC, Western Cape; EC, Eastern Cape; KZN, KwaZulu-Natal. *Conserv. status: VUD2, Vulnerable; NT, Near Threatened; LC, Least Concern; VUB1B2abcd, Vulnerable.

TABLE 1.—Endemism of *Passerina* species in Cape Floristic Region (CFR), as well as in various provinces of South Africa (cont.)

Taxa	Habitat & altitude	Centres of endemism						South African provinces				*Conserv. status
		NW	SW	AP	KM	LB	SE	NC	WC	EC	KZN	
Species endemic to CFR and adjacent provinces of South Africa (cont.)												
rigida Wikstr.	Along coast, littoral and hammock dunes, marshy places, river mouths	■Lambert's Bay southward	■Witsand River Mouth, along Cape Peninsula to Hermanus	■Arniston to Mossel Bay			■Buffalo Bay to Keurboomsrivier			■Jeffrey's Bay to Port Edward	■Uvongo to Lake Sibayi	LC
corymbosa Eckl. ex C.H.Wright	Mtn slopes, rear dunes along coast, riverbanks, roadsides. up to 1 300 m	■Leipoldtville to Velddrift and Piquetberg	■Hopefield to Cape Peninsula, eastward to Swellendam	■Baardskeerdersbos to Riversdale and Mossel Bay Dist.	■Laingsburg Dist. to Uniondale	■Malgas to Mossel Bay	■George Dist. to Port Elizabeth		■Clanwilliam Dist., Nuweveld in Beaufort West Dist.	■Lady Grey to Humansdorp, eastward to Grahamstown	■Outliers at Ngome, Port Natal (Durban), Dumisa Station at Alexandra	LC
◆+▲ No. endemic spp. (CFR)		2	5	3	1	4	2					
● No. near-endemic spp. (CFR)		3	5		2	1	3	3		2		
■ No. endemic spp. (CFR & adjacent SA prov.)		3	3	3	2	2	3	1	2	3	2	
◆+▲+●+■ Total no. spp. (CFR & adjacent SA prov.)		8	13	6	5	7	8	4	2	5	2	
Percentage spp. (CFR & SA prov.)		40	65	30	25	35	40	20	10	25	10	
Percentage endemic spp. (CFR)		5	5	5			5					

◆, spp. endemic to one centre of endemism only; ▲, spp. endemic to more than one centre of endemism; ●, spp. near-endemic to CFR; ■ spp. endemic to CFR and adjacent provinces of South Africa; NW, Northwestern; SW, Southwestern ; AP, Agulhas Plain; KM, Karoo Mountain; LB, Langeberg; SE, Southeastern; NC, Northern Cape; WC, Western Cape; EC, Eastern Cape; KZN, KwaZulu-Natal. *Conserv. status: VUD2, Vulnerable; NT, Near Threatened; LC, Least Concern; VUB1B2abcd, Vulnerable.

TABLE 2.—*Passerina* species endemic or near-endemic to Great Escarpment of southern Africa, often with outliers in Afromontane refuges

Species	Habitat & altitude	Status	South Africa	Swaziland	Lesotho	Zimbabwe	Mozambique	Angola	Namibia	*Conserv. status
drakensbergensis Hilliard & B.L.Burtt	Transitional belt between forest and grassland, along streams, mtn slopes, 1 500–1 980 m	Endemic to Drakensberg Alpine Centre	KwaZulu-Natal, Bergville Dist. in nthn Drakensberg, Royal Natal National Park to Giant's Castle Game Reserve		Not yet recorded, but probably present along border with KZN					LC
montana Thoday	Bordering on montane forest, mtn slopes, stream and riverbanks, 1 200–3 000 m	Near-endemic to Great Escarpment of sthn Africa	Limpopo Province (Soutpansberg, Blouberg and Krantzberg), Mpumalanga, KwaZulu-Natal, Free State, and Eastern Cape	Mbabane	Widespread	Nyanga	Manica and Sofala	High mtn areas, Huíla Plateau, Lubango and Chela Mtns	Moltkeblick on Auas Mtns	LC
montivaga Bredenk. & A.E.van Wyk	Ecotonal zone between forest and grassland, rocky mtn slopes, river valleys, 42–2 070 m	Near-endemic to Great Escarpment of sthn Africa	Limpopo Province, Mpumalanga, KwaZulu-Natal, Western and Eastern Cape	Mbabane		Chimanimani Mtns	Manica and Sofala			LC

*Conserv. status: LC, Least Concern.

distributed mainly along the eastern Great Escarpment. The present distribution of *P. montana* renders Rennie's interpretation rather improbable.

CONCLUSIONS

In *Passerina* the highest numbers of species per one-degree square are concentrated in a belt between the 33° and 34°S and 18° to 27°E, occurring in the grids 3321 (Ladismith), 3322 (Oudtshoorn) and 3419 (Caledon). The highest diversity of species occurs in the False Bay area, from Seekoeivlei to the Palmiet River (3418B). Hence the CFR (Western Cape) is the centre of diversity for *Passerina*.

Passerina demonstrates a high degree of regional endemism, with 45% of the species endemic to the CFR. Of these endemics, 20% are endemic to one of four centres of the CFR; 10% (*P. montana* and *P. montivaga*) are near-endemic to the Great Escarpment and 5% (*P. drakensbergensis*) is endemic to the Bergville District in the northern Drakensberg.

Passerina species that are near-endemic or endemic to the Great Escarpment probably originated in the CFR and adapted to conditions associated with the high-mountain Afromontane grassland, a vegetation type which is hypothesized to have had a much wider distribution during the Quaternary. The widely disjunct distribution of *P. montana* is probably due to subsequent environmental changes. The boundaries of the Grassland and Savanna Biomes shifted, resulting in relicts of temperate grassland and fynbos elements (such as *P. montana*) in isolated high-altitude refuges such as the Waterberg Plateau in Limpopo (South Africa), Nyanga-Chimanimani Highlands in eastern Zimbabwe, Huíla Plateau in Angola and the Auas Moutains in Namibia.

ACKNOWLEDGEMENTS

The authors would like to thank Emsie du Plessis for the technical editing of the manuscript and Sandra Turck for the figures.

REFERENCES

ACOCKS, J.P.H. 1988. Veld types of South Africa. *Memoirs of the Botanical Survey of South Africa* No. 57: 85–87.

BEYERS, J.B.P. 2001. The Cape genus *Lachnaea* (Thymelaeaceae): a monograph. *Strelitzia* 11: 1–115.

BREDENKAMP, C.L. 2002. *A monograph of the genus* Passerina *L. (Thymelaeaceae)*. Ph.D. thesis, University of Pretoria.

BREDENKAMP, C.L. & VAN WYK, A.E. 1999. Structure of mucilaginous epidermal cell walls in *Passerina* (Thymelaeaceae). *Botanical Journal of the Linnean Society* 129: 223–238.

BREDENKAMP, C.L. & VAN WYK, A.E. 2000. The epidermis in *Passerina* (Thymelaeaceae): structure, function and taxonomic significance. *Bothalia* 30: 69–86.

BREDENKAMP, C.L. & VAN WYK, A.E. 2001. Leaf anatomy of the genus *Passerina* (Thymelaeaceae): taxonomic and ecological significance. *Bothalia* 31: 53–70.

BREDENKAMP, C.L. & VAN WYK, A.E. 2003. Taxonomy of the genus *Passerina* (Thymelaeaceae). *Bothalia* 33: 59–98.

COWLING, R.M. & HILTON-TAYLOR, C. 1997. Phytogeography, flora and endemism. In R.M. Cowling, D.M. Richardson & S.M. Pierce, *Vegetation of southern Africa*: 43–61. Cambridge University Press, Cambridge.

EDWARDS, D. & LEISTNER, O.A. 1971. A degree reference system for citing biological records in southern Africa. *Mitteilungen der Botanischen Staatssammlung, München* 10: 501–509.

GOLDBLATT, P. & MANNING, J. 2000. Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9. National Botanical Institute, Cape Town and Missouri Botanical Garden, St Louis.

IUCN Species Survival Commission 2000. *IUCN Red List Categories. As approved by the 51st Meeting of the IUCN Council*. Gland, Switzerland.

LEVYNS, M.R. 1938. Some evidence bearing on the history of the Cape Flora. *Transactions of the Royal Society of South Africa* 26: 401–424.

MEISNER, C.F. 1840. *Passerina* L. *Linnaea* 14: 493–605.

MEISNER, C.F. 1857. Ordo CLXVII. Thymelaeaceae. In A.L.P.P. de Candolle, *Prodromus systematus naturalis* 14: 493–605. Masson, Paris.

O'CONNOR, T.G. & BREDENKAMP, G.J. 1997. Grassland. In R.M. Cowling, D.M. Richardson & S.M. Pierce, *Vegetation of southern Africa*: 215–257. Cambridge University Press, Cambridge.

OLIVER, E.G.H., LINDER, H.P. & ROURKE, J.P. 1983. Geographical distribution of present-day Cape taxa and their phytogeographical significance. *Bothalia* 14: 427–440.

REBELO, A.G. 1998. Fynbos Biome. In A.B. Low & A.G. Rebelo, *Vegetation of South Africa, Lesotho and Swaziland*: 62–74. Department of Environmental Affairs & Tourism, Pretoria.

RENNIE, J.V.L. 1936. On the flora of a high mountain in South-West Africa. *Transactions of the Royal Society of South Africa* 13: 259–263.

SCOTT, L., ANDERSON, H.M. & ANDERSON, J.M. 1997. Vegetation history. In R.M. Cowling, D.M. Richardson & S.M. Pierce, *Vegetation of southern Africa*: 62–84. Cambridge University Press, Cambridge.

SMUTS, L.M. 1996. *Passerina paludosa*. Information system for endangered plants, Cape Nature Conservation, Stellenbosch.

THODAY, D. 1924. XVIII. A revision of *Passerina*. *Bulletin of Miscellaneous Information, Kew* 4: 146–168.

VAN WYK, A.E. & SMITH, G.F. 2001. *Regions of floristic endemism in southern Africa: a review with emphasis on succulents*. Umdaus Press, Pretoria.

WEIMARCK, H. 1941. Phytogeographical groups, centres and intervals within the Cape flora. *Acta Universitatis Lundensis*, ser. 2, 37: 37–43.

WHITE, F. 1981. The history of the Afromontane archipelago and the scientific need for its conservation. *African Journal of Ecology* 19: 33–54.

WHITE, F. 1983. *The vegetation of Africa*. UNESCO, Paris.

Bothalia 36,2: 201–222 (2006)

Comparisons of invasive plants in southern Africa originating from southern temperate, northern temperate and tropical regions

L. HENDERSON*

Keywords: alien invasive plants, comparisons, southern Africa, temperate and tropical origins

ABSTRACT

A subset of invasive alien plant species in southern Africa was analysed in terms of their history of introduction, rate of spread, countries/region of origin, taxonomy, growth forms, cultivated uses, weed status and current distribution in southern Africa, and comparisons made of those originating from south of the tropic of Capricorn, north of the tropic of Cancer and from the tropics. The subset of 233 species, belonging to 58 families, includes all important declared species and some potentially important species. Almost as many species originate from temperate regions (112) as from the tropics (121). Most southern temperate species came from Australia (28/36), most tropical species from tropical America (92/121) and most northern temperate species from Europe (including the Mediterranean) and Asia (58/76). Transformers account for 33% of all species. More transformers are of tropical origin (36) than of northern temperate (24) and southern temperate origin (18). However, 50% of southern temperate species are transformers, compared to 32% of northern temperate and 29% of tropical species. Southern temperate transformer species are mainly woody trees and shrubs that were established on a grand scale as silvicultural crops, barriers (hedges, windbreaks and screens) and cover/binders. Most aquatics, herbs, climbers and succulent shrubs are from the tropics. Ornamentals are the single largest category of plants from all three regions, the tropics having contributed twice as many species as temperate regions.

INTRODUCTION

All terminology relating to invasive plants such as ‘alien’, ‘invasive’, ‘naturalized’, ‘weed’, ‘environmental weed’ and ‘transformer’ are according to Richardson *et al.* (2000) unless stated otherwise in the text. More than 1 000 alien plant species are known to be naturalized in southern Africa (Wells *et al.* 1986). A high proportion of these species are herbaceous, ruderal and agrestal weeds. This paper concentrates on a subset of 233 species extracted from the book ‘Alien weeds and invasive plants’ by Henderson (2001) and which contains all the major and some of the emerging environmental weeds. Major invaders are those invasive alien species that are well established, and which already have a substantial impact on natural and semi-natural ecosystems; emerging invaders currently have less influence but have attributes and potentially suitable habitat that could result in increased range and consequences in the next few decades (Nel *et al.* 2004). The list of species selected for this study includes virtually all the declared plants whose control, propagation and trade are subject to the Conservation of Agricultural Resources Act, Act 43 of 1983 (CARA), as amended in 2001.

Southern Africa has had a long history of plant introductions from various parts of the world (Wells *et al.* 1986). This paper aims to compare the plants that have originated from northern temperate, southern temperate and tropical regions in terms of their history of introduction, rate of spread, countries/region of origin, taxonomy, growth forms, cultivated uses, weed status and current distribution in southern Africa.

* Agricultural Research Council: Plant Protection Research Institute, c/o SANBI, Private Bag X101, 0001 Pretoria.
e-mail: henderson@sanbi.org
MS. received: 2005-09-08.

METHODS

The subset of 233 alien plant species selected for this study includes all declared species under CARA, excluding two hybrids that originated in South Africa (*Rubus ×proteus* and *Psidium ×durbanensis*), and two eucalypts for which there is little evidence of their invasiveness, *Eucalyptus paniculata* and *E. sideroxylon.* The regions of origin were checked against the United States Department of Agriculture’s ARS Germplasm Resources Information Network (GRIN) database, the Missouri Botanical Garden’s MBG: W3TROPICOS database, Mabberley (1997), and other literature sources.

Southern temperate species are defined as those species whose region of origin is entirely south of, or straddles, the tropic of Capricorn. This region includes the South American countries of Uruguay, Argentina, Chile and southern Brazil. It also includes New Zealand, Tasmania and Australia (Australian Central Territory, New South Wales, Victoria, South Australia, Western Australia and southern Queensland).

Northern temperate species are defined as those species whose region of origin is entirely north of, or straddles, the tropic of Cancer. This region includes Europe, North Africa, much of Asia, and North America.

Tropical species are defined as those species whose region of origin occurs entirely within the tropics or straddles either the tropics of Cancer or Capricorn. This region includes tropical America (the northern half of South America, Central America, Mexico and the West Indies), tropical Africa and Asia (much of India, Thailand and Malaysia), Indonesia, and tropical Australia.

The earliest dates of occurrence in southern Africa were obtained from specimen records in the Pretoria National Herbarium (PRE) and various literature sources. The quarter-degree squares occupied and current naturalized distributions of the species were obtained from the Southern African Plant Invaders Atlas (SAPIA) data-

base and the Pretoria National Herbarium. The SAPIA database which is housed at the Agricultural Research Council (ARC)—Plant Protection Research Institute in Pretoria, currently contains 50 000 locality records of more than 500 alien plant species. The database includes records from roadside surveys undertaken from 1979–1993 and from the SAPIA mapping project conducted from January 1994 until December 1998 (Henderson 1998), with further ad hoc records added to the present.

Weed status was extracted from Henderson (2001). The definitions of the various categories of environmental weeds are after Swarbrick (1991).

Environmental weeds

Transformers—plants which can dominate or replace any canopy or subcanopy layer of a natural or seminatural ecosystem, thereby altering its structure, integrity and functioning.

Potential transformers—plants that are already invading natural or seminatural habitats, and have the potential to dominate any canopy or subcanopy layer but not yet having a marked effect. They are either transformers elsewhere in the world or showing signs of this ability in southern Africa.

Special effect weeds—plants which can significantly degrade the value or purpose for which a natural or seminatural ecosystem is valued without necessarily dominating it or greatly altering its vegetational structure or functioning. Examples include weeds which compete with and replace similar native plants, are of high visual impact, poisonous, or have chemical irritants.

Minor weeds—plants that invade and persist in any canopy or subcanopy layer of a natural or seminatural ecosystem but cannot or do not dominate that layer or seriously alter the vegetation structure or its functioning, although the accumulation of several to many species may do so.

Ruderal and agrestal weeds

Mostly annual or biennial plants which are primarily weeds of waste places (ruderals) and cultivated lands (agrestals).

The lists of species originating from southern temperate, northern temperate and tropical regions are given in Appendices 1, 2 & 3.

RESULTS AND DISCUSSION

History of introduction of invasive species

Only 15 species were introduced before 1800 and all had their origins in northern temperate and tropical regions (Figure 1). The earliest species to arrive before the colonization of the Cape by the Dutch in 1652, were *Ricinus communis* (castor-oil plant) and *Achyranthes aspera* (burweed), believed to be of tropical African origin, and *Catharanthus roseus* (Madagascar periwinkle). All three species are likely to have had a long association with humans in Africa. *Ricinus communis* and *C. roseus* would have been used for their medicinal value, whereas *A. aspera* would have been dispersed by domestic livestock. There is evidence that *R. communis* was in the Eastern Cape more than 1 200 years ago (Brink 1988) and this begs the question whether it should be regarded as indigenous and not alien. All three of the aforementioned species are widespread in southern Africa but have not become major invaders.

The arrival of the Dutch at Cape Town in 1652 marks the start of the introduction of plant species from other continents that would eventually become major invaders. Seven species arrived between 1652 and 1700. Species of northern temperate origin were: *Nasturtium officinale* (watercress), *Quercus robur* (English oak), *Salix babylonica* (weeping willow), *Pinus pinaster* (cluster pine) and *P. pinea* (stone pine). Species of tropical origin were: *Opuntia ficus-indica* (sweet prickly pear) and *Datura stramonium* (common thorn apple). A further five species arrived before 1800. *Arundo donax* (giant reed) was the only northern temperate species, whereas species from the tropics were *Canna indica* (Indian shot), *Xanthium spinosum* (spiny cocklebur), presumably an accidental introduction, *Opuntia monacantha* (cochineal prickly pear) and *Psidium guajava* (guava). Six of the species introduced before 1800 (*Arundo donax, Opuntia ficus-indica, O. monacantha, Pinus pinaster, Psidium guajava* and *Salix babylonica*) are, or were previously,

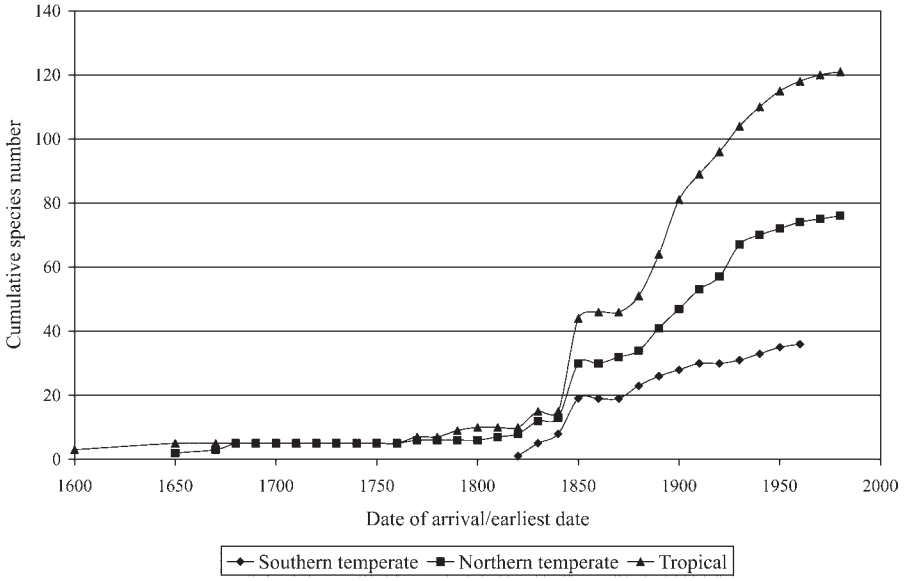

FIGURE 1.—History of introduction of species from tropical, northern temperate and southern temperate regions.

major invaders in southern Africa and have transformed landscapes. They have either reached or are close to the limits of their distribution in southern Africa. *Opuntia ficus-indica* and *O. monacantha* had reached pest status in South Africa by the early 1900s but following successful biological control are no longer regarded as problems in most parts of the country.

The greatest rate of arrival of species (1.45 species/year) occurred from 1820–1899. It was during this period that the first southern temperate species, *Acacia longifolia* (long-leaved wattle), was introduced in 1827 from Australia (Stirton 1978), 170 years after the introduction of the first northern temperate species. From the 1830s to the 1880s many more Australian woody species, belonging to the genera *Acacia, Atriplex, Eucalyptus, Grevillea, Hakea, Leptospermum, Paraserianthes, Pittosporum* and *Syzygium* were introduced as sand-binders, hedges, fodder plants and for timber. The first southern temperate species of South American origin to be introduced was *Opuntia aurantiaca* (jointed cactus) as an ornamental rockery plant in 1843.

Almost as many species arrived during the 1900s (103 species) as in the 1800s (115 species). Plants introduced prior to 1850 were largely utility plants, whereas after 1850 a greater proportion of the species were of ornamental value. This trend becomes more obvious in the 1900s. Up to the 1840s there is not a vast difference between the numbers of species from each of the three regions (southern temperate—10, northern temperate—19, tropical—15). After 1850 many more species of tropical origin were introduced than of northern temperate and southern temperate origin. The cumulative species curves in Figure 1 show a surge in species arrival during the 1850s. This may partly be an artefact of the very detailed records of plants in the Cape Town Botanic Gardens provided by McGibbon in 1858. Seventy one species in cultivation in the Cape Town Botanic Garden at this time are now on the list of 233 major and emerging invaders. This includes some of the worst environmental weeds such as *Chromolaena odorata* (triffid weed), *Lantana camara* (lantana), *Opuntia aurantiaca* (jointed cactus) and *Pereskia aculeata* (pereskia).

Rate of spread

Only a very rough estimate of rate of spread (total quarter-degree squares (QDS) divided by years since arrival) can be determined with the available data (Appendices 1, 2 & 3). This estimate is the average rate of spread of the entire known history of a species in southern Africa. One would not expect the rate to be constant over this time period. Historical data from the SAPIA database provides evidence that some species have had a slow rate of spread over much of their time period followed by exponential growth e.g. *Azolla filiculoides* (red water fern) and *Campuloclinium macrocephalum* (pompom weed).

The species that have shown the fastest average rate of spread in southern Africa are *Azolla filiculoides* (4.418 QDS/year, ornamental, tropical), *Prosopis glandulosa* var. *torreyana* and hybrids (mesquite trees: 4.097 QDS/year, agricultural crops, northern temperate), *Populus* ×*canescens* (grey poplar: 3.945 QDS/year, cover/binder, northern temperate), *Acacia mearnsii* (black wattle: 3.007 QDS/year, silvicultural crop, southern temperate), *Agave americana* (American agave: 2.986 QDS/year, barrier, tropical), *Melia azedarach* (seringa: 2.764 QDS/year, ornamental, tropical) and *Opuntia ficus-indica* (2.501 QDS/year, agricultural crop, tropical). While the dispersal of all these species has been assisted by humans, the current distributions of *Agave americana* and *Populus* ×*canescens* are almost entirely attributed to human-assisted dispersal. *Populus* ×*canescens* spreads only vegetatively by suckering, whereas *Agave americana* spreads mainly by suckering but also to a limited extent by seed.

The earliest introductions from all regions of origin have, on average, spread the furthest. This is shown in Figure 2 which plots the mean QDS occupied in 2003 against mean residence time for each of the regions of origin. The conclusion that can be drawn from this graph is that most species still have a long way to go before reaching their potential spread.

Countries/regions of origin

Almost as many species originated from temperate regions (112) as from the tropics (121) (Table 1). Most southern temperate species came from Australia (28/36), most tropical species from tropical America (Central and northern South America, Mexico and West Indies) (93/121) and most northern temperate species from Europe, the Mediterranean coastline of southern Europe and North Africa, and Asia (57/76). Only nine species are entirely of African and Madagascan origin.

Taxonomy

The subset of 233 species belongs to 58 families (Table 1). Most families (41) are of tropical origin; 28 families are of northern temperate origin and 11 families of southern temperate origin. The Fabaceae is by far the largest family with 41 species. Only the Fabaceae, Cactaceae and Poaceae have species from all three regions of origin.

The top families, with the most number of species in each of the regions are: Fabaceae, Myrtaceae and Proteaceae from southern temperate regions; Rosaceae, Fabaceae, Pinaceae, Oleaceae and Salicaceae from northern temperate regions and Fabaceae, Asteraceae, Solanaceae, Cactaceae and Myrtaceae from tropical regions.

Most genera are of tropical origin (Table 1). However, the largest genus, *Acacia*, with 13 species is from the southern temperate region (Australia). *Opuntia* is the only genus with species from all three regions (one from southern temperate, three from northern temperate, six from tropical regions). Few other genera are represented in more than one region (*Cortaderia, Cuscuta, Eucalyptus, Myriophyllum, Oenothera, Pinus, Solanum, Syzygium*).

Ten of the 58 families (17%) are alien to southern Africa (Appendices 1, 2 & 3). One family (Myoporaceae) is from southern temperate regions, three families (Fagaceae, Liliaceae *sensu stricto*, and Pinaceae) from northern temperate regions and six families (Agavaceae, Aristolochiaceae, Cannaceae, Casuarinaceae, Papaveraceae, Pinaceae and Salviniaceae) from the tropics. The

TABLE 1.—Summary of taxonomy, growth forms, weed status, region of origin and cultivated uses of species originating from southern temperate, northern temperate and tropical regions. Transformer species are given in bold

Characteristics	Southern temperate	Northern temperate	Tropical	Total
Taxonomy				
No. species	36 (**18**)	76 (**24**)	121 (**35**)	233 (**77**)
No. genera	17	45	74	128
No. families	11	28	41	58
Fabaceae spp.	14 (**9**)	8 (**3**)	19 (**4**)	41 (**16**)
Asteraceae spp.		2	12 (**3**)	14 (**3**)
Cactaceae spp.	2 (**1**)	3 (**1**)	9 (**6**)	14 (**8**)
Myrtaceae spp.	6 (**2**)		7 (**3**)	13 (**5**)
Solanaceae spp.	1		11(**3**)	12 (**3**)
Rosaceae spp.		11 (**4**)		11 (**4**)
Poaceae spp.	3 (**2**)	2 (**1**)	5 (**1**)	10 (**4**)
Pinaceae spp.		8 (**5**)	1 (**1**)	9 (**6**)
Convolvulaceae spp.		2	5 (**2**)	7 (**2**)
Oleaceae spp.		7		7
Salicaceae spp.		6 (**4**)		6 (**4**)
Passifloraceae spp.			5	5
Proteaceae spp.	5 (**3**)			5 (**3**)
Zingiberaceae spp.		4 (**4**)	1	5 (**4**)
Anacardiaceae spp.			3	3
Bignoniaceae spp.			3 (**2**)	3 (**1**)
Hydrocharitaceae spp.	1			1
Chenopodiaceae spp.	2 (**1**)	1		3 (**1**)
Myoporaceae spp.	1			1
Pittosporaceae spp.	1			1
Haloragaceae spp.		1	1 (**1**)	2 (**1**)
Brassicaceae spp.		2		2
Boraginaceae spp.		2		2
Liliaceae spp.		1		1
Lythraceae spp.		1		1
Onagraceae spp.		2	2	4
Simaroubaceae spp.		1		1
Ulmaceae spp.		3		3
Lauraceae spp.		1 (**1**)	1 (**1**)	2 (**2**)
Clusiaceae spp.		1		1
Cupressaceae spp.		1		1
Malvaceae spp.		1		1
Moraceae spp.		1 (**1**)		1 (**1**)
Apocynaceae spp.		1	2	3
Fagaceae spp.		1		1
Tamaricaceae spp.		2		2
Azollaceae spp.			1 (**1**)	1 (**1**)
Pontederiaceae spp.			2 (**1**)	2 (**1**)
Araceae spp.			1 (**1**)	1 (**1**)
Salviniaceae spp.			1 (**1**)	1 (**1**)
Amaranthaceae spp.			1	1
Papaveraceae spp.			2	2
Crassulaceae spp.			1	1
Cannaceae spp.			2	2
Davalliaceae spp.			1 (**1**)	1 (**1**)
Phytolaccaceae spp.			2	2
Asclepiadaceae spp.			1	1
Aristolochiaceae spp.			1	1
Basellaceae spp.			1	1
Polygonaceae spp.			2	2
Sapindaceae spp.			2 (**1**)	2 (**1**)
Agavaceae spp.			2	2
Myrsinaceae spp.			1	1
Casuarinaceae spp.			2	2
Verbenaceae spp.			2 (**1**)	2 (**1**)
Meliaceae spp.			2 (**1**)	2 (**1**)
Lamiaceae spp.			1	1
Euphorbiaceae spp.			1	1
Growth forms				
Grass spp.	3 (**2**)	2 (**1**)	5 (**1**)	10 (**4**)
Aquatic spp.	1	2	6 (**5**)	9 (**5**)
Herbaceous spp.	2	14 (**4**)	23 (**3**)	39 (**7**)
Climber spp.	0	3	22 (**6**)	25 (**6**)
Succulent tree & shrub spp.	2 (**1**)	3 (**1**)	10 (**5**)	15 (**7**)
Woody tree & shrub spp.	28 (**15**)	52 (**18**)	53 (**15**)	133 (**48**)
Region of origin				
Temperate Australian spp.	28 (78%)			
Temperate S American spp.	7 (19%)			
New Zealand spp.	1 (3%)			
Temperate Asian spp.		27 (36%)		
N American spp.		18 (24%)		
Eurasian spp.		16 (21%)		
European & Mediterranean spp.		14 (18%)		
Canary Isles spp.		1 (1%)		
Tropical American spp.			93 (77%)	
Tropical Asian & Australian spp.			18 (15%)	
Tropical African & Madagascan spp.			9 (7%)	
Pantropical spp.			1 (1%)	
Cultivated uses				
Ornamental spp.	29 (**12**)	61 (**17**)	106 (**34**)	196 (**63**/**32%**)
Barrier spp.	27 (**13**)	32 (**11**)	30 (**12**)	89 (**36**/**40%**)
Agricultural crop spp.	8 (**3**)	30 (**14**)	22 (**4**)	60 (**21**/**35%**)
Silvicultural crop spp.	9 (**7**)	11 (**8**)	4 (**3**)	24 (**18**/**75%**)
Cover/binder spp.	8 (**7**)	8 (**4**)	9 (**1**)	25 (**12**/**48%**)
Species with no uses	4 (**3**)	7 (**0**)	10 (**0**)	21 (**3**/**14%**)
Primary cultivated use				
Ornamental spp.	12 (**2**)	31 (**7**)	86 (**27**)	129 (**36**/**28%**)
Barrier spp.	10 (**6**)	14 (**3**)	7 (**2**)	31 (**11**/**35%**)
Agricultural crop spp.	1 (**0**)	13 (**6**)	11 (**3**)	25 (**9**/**36%**)
Silvicultural crop spp.	5 (**3**)	7 (**4**)	3 (**3**)	15 (**10**/**66%**)
Cover/binder spp.	4 (**4**)	4 (**4**)	4 (**0**)	12 (**8**/**66%**)
Species with no uses	4 (**3**)	7 (**0**)	10 (**0**)	21 (**3**/**14%**)

Pinaceae with nine species is the largest alien family. If it were not for *Rhipsalis baccifera*, the sole indigenous cactus in southern Africa, the Cactaceae would also be an alien family.

Ninety of 128 genera (70%) are alien to southern Africa (Appendices 1, 2 & 3). Eleven alien genera are of southern temperate origin, 33 alien genera are of northern temperate origin and 53 alien genera are of tropical origin. The remaining genera, with both alien and indigenous species, have some of the major invaders

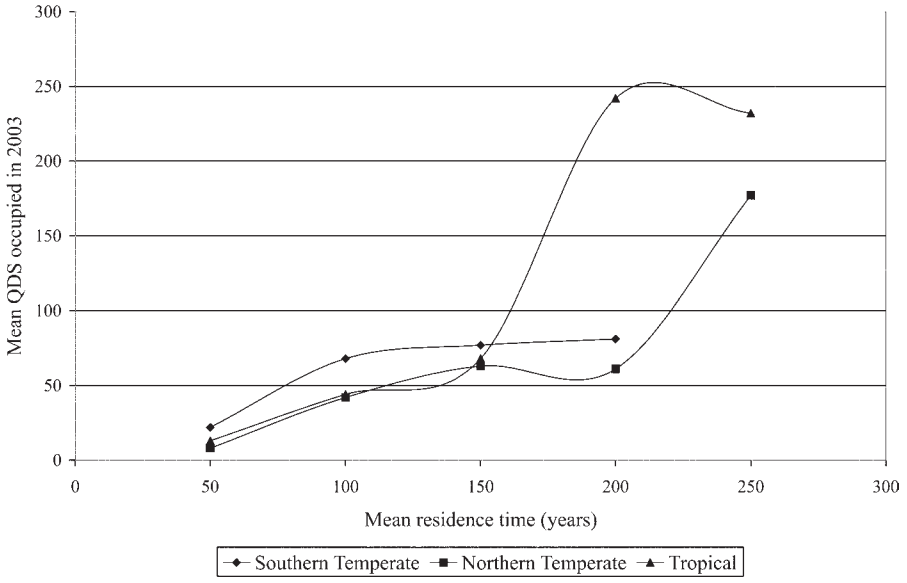

FIGURE 2.—Mean quarter-degree squares (QDS) occupied in 2003 against Mean residence time (years).

e.g. *Acacia, Azolla, Caesalpinia, Eichhornia, Lantana, Rubus, Salix, Solanum, Sesbania*.

Growth forms

Most aquatics, herbs, climbers and succulent shrubs are from the tropics (61 species) compared to only 27 species from temperate regions. Climbers are almost exclusively of tropical origin (22/25 species). Most woody trees and shrubs are from temperate regions (80 species) compared to 53 from tropical regions. Equal numbers of grasses (five species) originate from temperate and tropical regions (Table 1).

Cultivated uses

Ornamentals are the single largest category of plants from all three regions with 196/233 species having been used for ornamentation. Of these species, 129 have been used primarily (i.e. as a major use) as ornamentals, with twice as many species from tropical regions (86) than northern temperate (31) and southern temperate regions (12).

Barrier plants (hedges, windbreaks and screens) are the next largest category of cultivated plants. Thirty-one species have been used primarily as barriers, with more species from temperate regions (24 species) than the tropics (7 species). Almost equal numbers of agricultural crop species originated from temperate (14 species) and tropical regions (11 species). Most silvicultural crops are of temperate origin (12/15 species).

Weed status

Transformers account for 33% of all species. Thirty-five transformers are of tropical origin compared to 24 of northern temperate and 18 of southern temperate origin. However, 50% of southern temperate species are transformers, compared to 32% of northern temperate and 29% of tropical species. Southern temperate transformer species are mainly woody trees and shrubs that were established on a grand scale as silvicultural crops, barriers and cover/binders.

Although ornamentals constitute the largest category of cultivated plants, all the other categories (barriers, crops, cover/binders) have a much higher percentage of transfomer species. Sixty-six percent (18/27 species) of silvicultural crops and cover/binders are transformers, with seven species from southern temperate regions, eight species from northern temperate regions and three species from the tropics.

Thirty-one alien genera have transformer species; six are from southern temperate regions; 10 from northern temperate regions and 18 from tropical regions. Sixteen genera that have both alien and indigenous species have transformer species.

Current naturalized distributions

A visual examination of the current distributions of all species showed that there are about eight major distribution patterns or zones. These zones are illustrated in Figures 3 & 4. Further analysis of the species within each of the three major regions of origin showed that there was a concentration of species within certain zones which correlate with the biomes of southern Africa as defined by Rutherford (1997). The highest percentage (36%) of northern temperate species occur in the central high interior or Grassland Biome (Figure 5A which uses *Pyracantha angustifolia*, yellow firethorn, as an example). Forty-four percent of southern temperate species occur along the southern and southwestern seaboard, which includes the whole of the Fynbos and Forest Biomes (Figure 5B which uses *Acacia saligna*, Port Jackson, as an example). Fifty-three percent of tropical species are distributed along the eastern seaboard and northeastern interior, which coincides with the Savanna Biome (Figure 5C which uses *Jacaranda mimosifolia*, jacaranda, as an example).

CONCLUSIONS

All three regions of origin have made large contributions to alien plant invasion in southern Africa. Almost equal numbers of species, genera and families came from temperate and tropical regions, with the least from the southern temperate region and most from the tropics. The earliest introductions from all three regions have spread the furthest and most species still have a long way to go before reaching their potential spread.

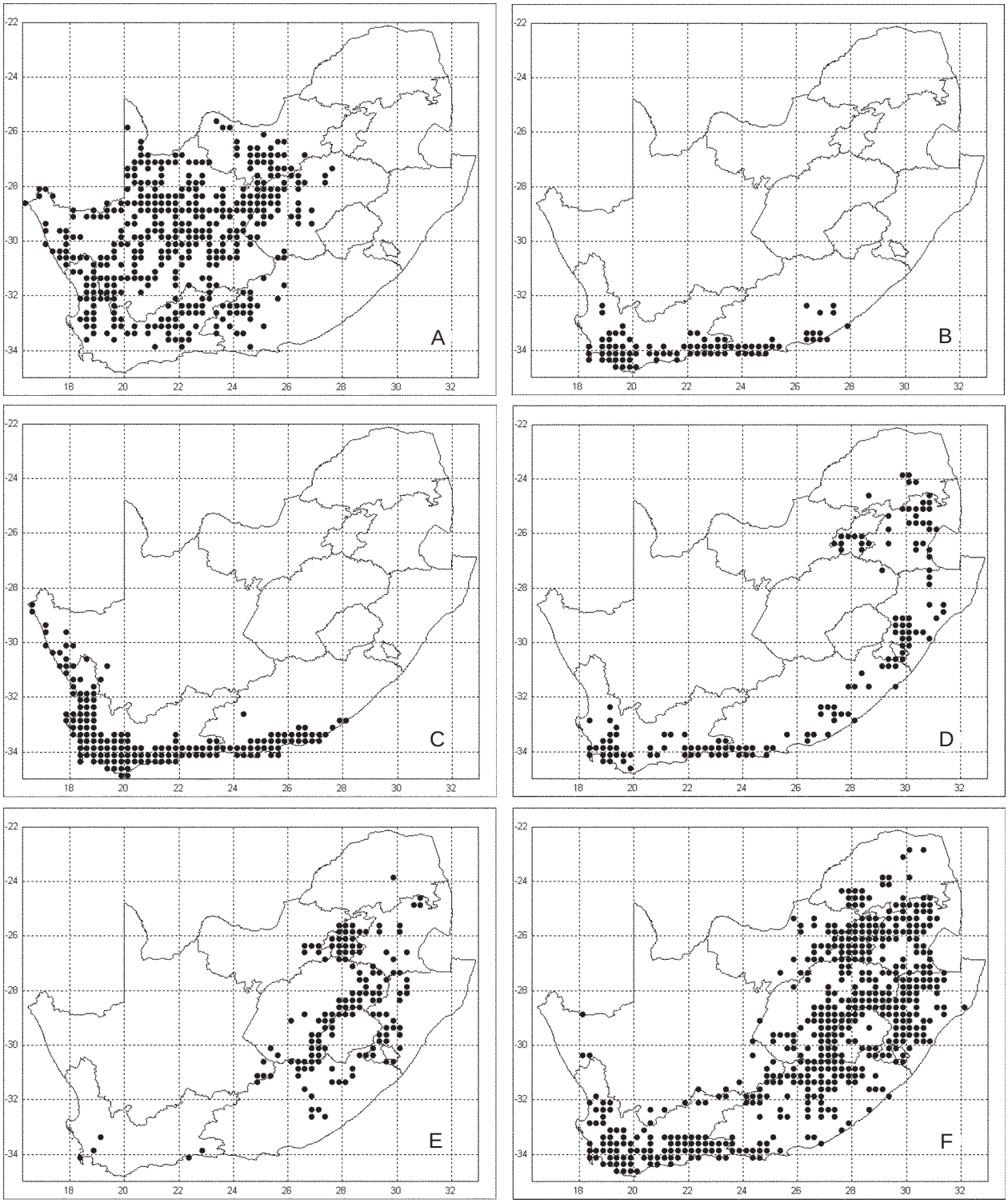

FIGURE 3.—A, Zone 1: western and central arid zone e.g. *Prosopis* species, mesquite trees; B, Zone 2A: southern 'Mediterranean' zone e.g. *Pinus pinaster*, cluster pine; C, Zone 2B: southern and southwestern 'Mediterranean' zone e.g. *Acacia cyclops*, red eye/rooikrans; D, Zone 3: southern and eastern cool, moist zone e.g. *Acacia melanoxylon*, Australian blackwood; E, Zone 4A: highveld zone e.g. *Pyracantha angustifolia*, yellow firethorn; F, Zone 4B: highveld zone with extension to seaboard e.g. *Populus ×canescens*, grey poplar.

Ornamentals are the single largest category of plants from all three regions but the tropics has contributed twice as many species as temperate regions. Temperate regions have provided slightly more transformers than the tropics and these are mainly plants that have been cultivated for non-ornamental purposes. The southern temperate region, with species mainly from Australia, has provided a disproportionate number of transformers (18/36 species or 50%), compared with 32% from northern temperate and 29% from tropical regions.

The current distributions of invasive plants in southern Africa are a reflection of the climatic zones of their origin. Northern temperate species are concentrated in the cold, high interior or Grassland Biome. Southern temperate species are concentrated along the southern and southwestern seaboard which includes the whole

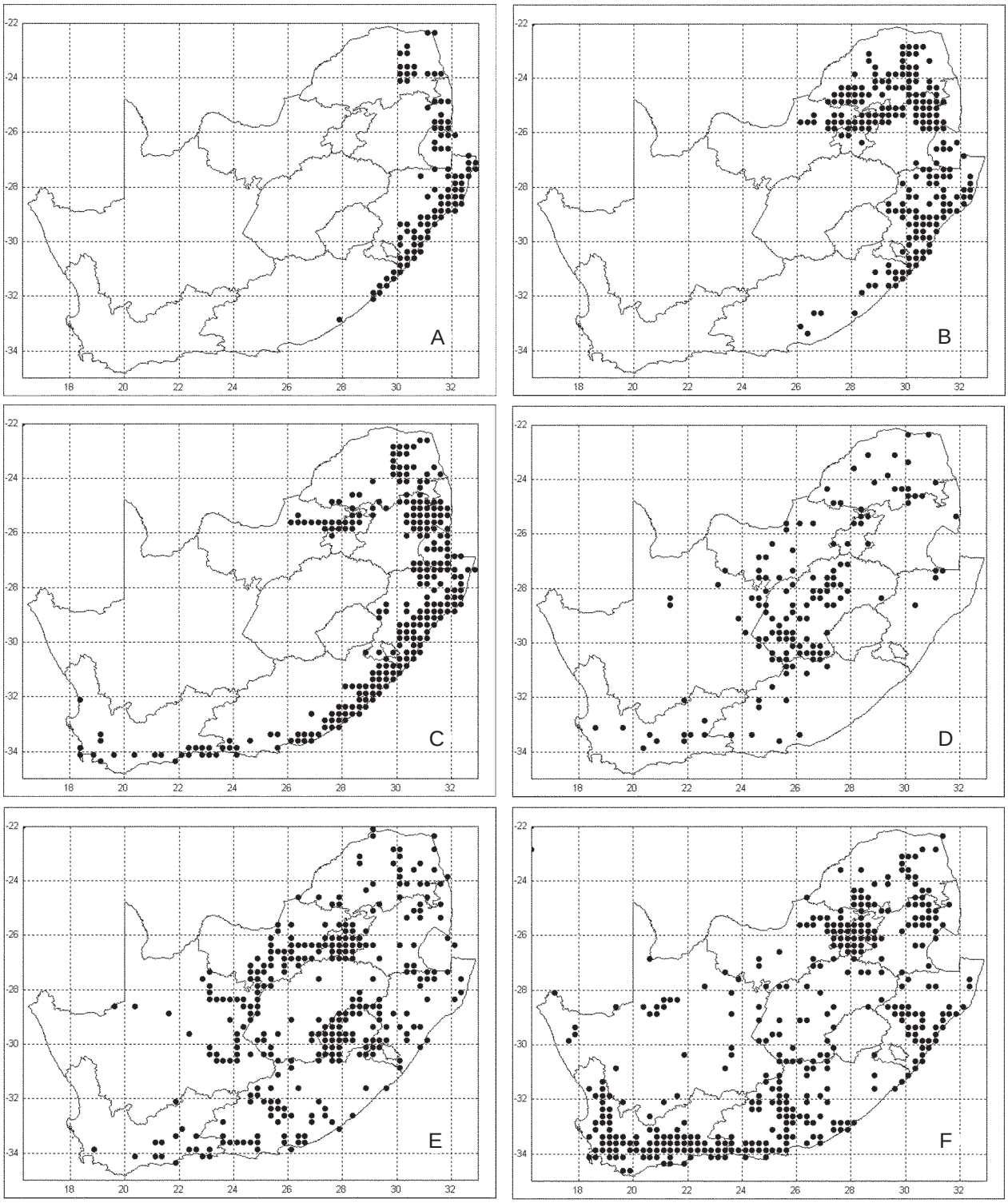

FIGURE 4.—A, Zone 5: eastern seaboard and escarpment e.g. *Chromolaena odorata*, triffid weed; B, Zone 6A: eastern seaboard, escarpment and middleveld e.g. *Jacaranda mimosifolia*, jacaranda; C, Zone 6B: eastern seaboard and escarpment e.g. *Lantana camara*, lantana; D, Zone 7A: dry interior e.g. *Opuntia imbricata*, imbricate cactus; E, Zone 7B: dry interior and extension to moister areas e.g. *Datura stramonium*, common thorn apple; F, Zone 8: widespread e.g. *Arundo donax*, giant reed.

of the Fynbos and Forest Biomes. Tropical species are concentrated along the eastern seaboard and northeastern interior which coincides with the greater part of the Savanna Biome.

REFERENCES

BRADLOW, F.R. 1965. *Baron Von Ludwig and the Ludwig's-burg garden.* Balkema, Cape Town.

BRINK, E. 1988. Interesting record. *The elephant's child.* Newsletter of the Albany Museum 11: 3.

CHIPPINDALL, L.K.A. 1955. A guide to the identification of grasses in South Africa. In D. Meredith, *The grasses and pastures of South Africa*: 5–527. Central News Agency, Cape Town.

COETSEE, J. 1989. Waak teen dié bose kaktus. *Landbouweekblad,* 24 March 1989: 24–27.

CRAN, M. 1927. *The gardens of Good Hope.* Jenkins, London.

DE BEER, H. & ZIMMERMANN, H.G. 1986. Harrisia cactus. Weeds A.11/1986. *Farming in South Africa.*

ECKLON, C.F. 1830. A list of plants found in the district of Uitenhage

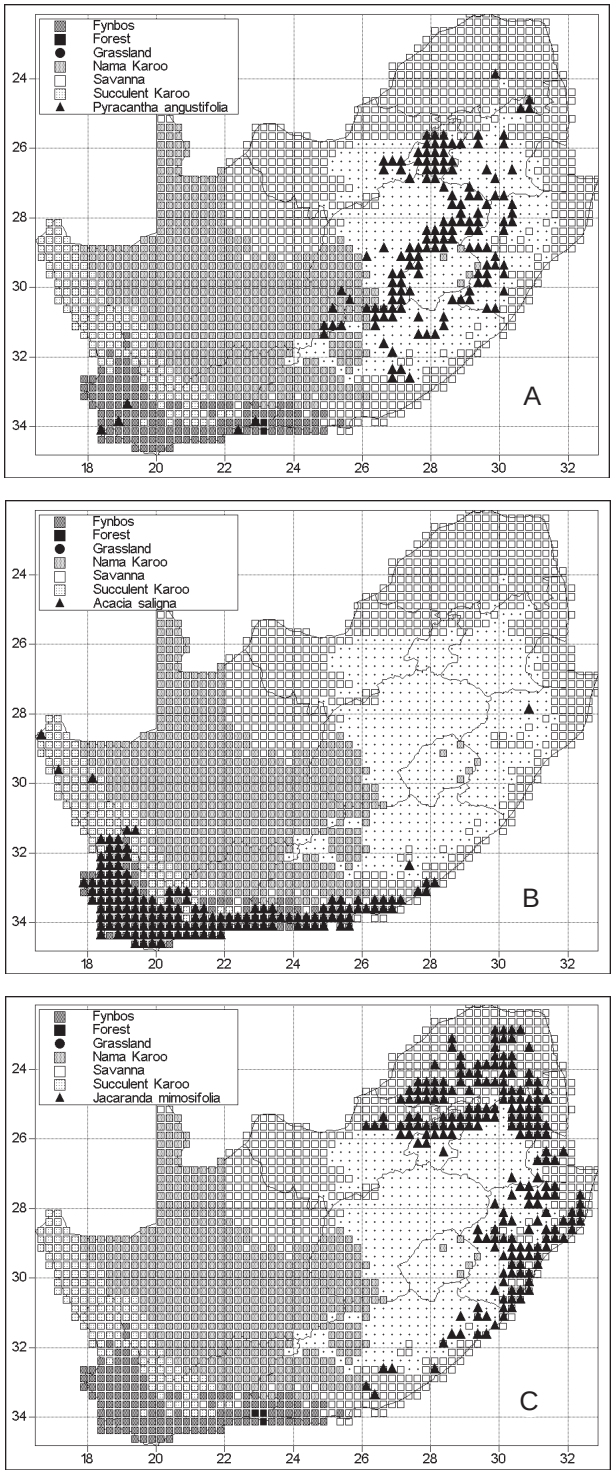

FIGURE 5.—A, northern temperate species are concentrated in the cold, high interior or Grassland Biome e.g. *Pyracantha angustifolia*, yellow firethorn (zone 4A); B, southern temperate species are concentrated along the southern and south western seaboard or Fynbos and Forest Biomes e.g. *Acacia saligna*, Port Jackson (zone 2B); C, tropical species are concentrated along the eastern seaboard and north eastern interior or the greater part of the Savanna Biome e.g. *Jacaranda mimosifolia*, jacaranda (zone 6A). Biomes according to Rutherford (1997).

between the months of July 1829 and February 1830. *South African Quarterly Journal* 1: 358–380.

GELDENHUYS, C.J., LE ROUX, P.J. & COOPER, K.H. 1986. Alien invasions in indigenous evergreen forest. In I.A.W. Macdonald, F.J. Kruger & A.A. Ferrar, *The ecology and management of biological invasions in southern Africa*: 119–131. Oxford University Press, Cape Town.

HENDERSON, L. 1998. Southern African Plant Invaders Atlas (SAPIA). *Applied Plant Sciences* 12: 31, 32.

HENDERSON, L. 2001. *Alien weeds and invasive plants*. Plant Protection Research Institute Handbook No. 12. Agricultural Research Council, Pretoria.

HENDERSON, M. & ANDERSON, J.G. 1966. Common weeds in South Africa. *Memoirs of the Botanical Survey of South Africa* No. 37.

HENDERSON, M., FOURIE, D.M.C., WELLS, M.J. & HENDERSON, L. 1987. *Declared weeds and alien invader plants in South Africa.* Bulletin 413, Department of Agriculture and Water Supply, Pretoria.

HUBBARD, C.S. 1926. A review of the species of *Populus* introduced into South Africa. *South African Journal of Science* 23: 340–365.

MABBERLEY, D.J. 1997. *The plant-book*, edn 2. Cambridge University Press, Cambridge.

MCGIBBON, J. 1858. *Catalogue of plants in the botanic garden, Cape Town, Cape of Good Hope.* Saul & Solomon, Cape Town.

MEDLEY WOOD, J. 1894. *Preliminary catalogue of indigenous Natal plants.* Natal Mercury, Durban.

MISSOURI BOTANICAL GARDEN. *VAST (VAScular Tropicos) nomenclatural database (MBG: W3TROPICOS).* Available at http://www.mobot.mobot.org/W3T/search/vast.html.

NEL, J.L., RICHARDSON, D.M., ROUGET, M., MGIDI, T.N., MDZEKE, N., LE MAITRE, D.C., VAN WILGEN, B.W., SCHONEGEVEL, L., HENDERSON, L. & NESER, S. 2004. A proposed classification of alien invasive plant species in South Africa: towards prioritizing species and areas for management action. *South African Journal of Science* 100: 53–64.

NESER, S. & ANNECKE, D.P. 1973. Biological control of weeds in South Africa. *Entomological Memoir* No. 28. Department of Agricultural Technical Services, Pretoria.

OOSTHUIZEN, G.J. & WALTERS, M.M. 1961. Control of water fern with diesoline. *Farming in South Africa* 37: 35–37.

PHILLIPS, E.J., HARDING, J.J. & DU TOIT, R. 1939. American bramble. *Farming in South Africa* 14: 272–274.

POYNTON, R.J. 1959. *Notes on exotic forest trees in South Africa.* Bulletin No. 38. The Government Printer, Pretoria.

RICHARDSON, D.M., PYŠEK, P., REJMÁNEK, M., BARBOUR, M.G., PANETTA, F.D. & WEST, C.J. 2000. Naturalization and invasion of alien plants: concepts and definitions. *Diversity and Distributions* 6: 93–107.

RUTHERFORD, M.C. 1997. Categorization of biomes. In R.M. Cowling, D.M. Richardson & S.M. Pierce, *Vegetation of southern Africa*: 91–98. Cambridge University Press, Cambridge.

SHAUGHNESSY, G.L. 1986. A case study of some woody plant introductions to the Cape Town area. In I.A.W. Macdonald, F.J. Kruger & A.A. Ferrar, *The ecology and management of biological invasions in southern Africa*: 37–43. Oxford University Press, Cape Town.

SIM, T.R. 1905. *Tree planting in Natal*. Davis, Pietermaritzburg.

SIM, T.R. 1919. *Flowering trees and shrubs for use in South Africa.* The Specialty Press, Johannesburg.

SMITH, C.A. 1966. Common names of South African plants. *Memoirs of the Botanical Survey of South Africa* No. 35: 1–642.

SMITH, H.H. 1929. *Sisal production and preparation.* Bale, London.

STIRTON, C.H. 1978. *Plant invaders*: *beautiful but dangerous.* The Department of Nature and Environmental Conservation of the Cape Provincial Administration, Cape Town.

STORR LISTER, J. 1884. *Practical hints on tree-planting in the Cape Colony*. Cape Colonial Forestry Department, Cape Town.

SWARBRICK, J.T. 1991. Towards a rating scheme for environmental weeds. *Plant Protection Quarterly* 6: 185.

UNITED STATES DEPARTMENT OF AGRICULTURE: ARS, NATIONAL GENETIC RESOURCES PROGRAM. *Germplasm Resources Information Network—(GRIN*) [Online Database] National Germplasm Resources Laboratory, Beltsville, Maryland. Available at http://www.ars-grin.gov/npgs/tax/index.html.

VAN DEN BERG, M.A. 1977. Natural enemies of certain acacias in Australia. *Proceedings of the Second National Weeds Conference of South Africa, Stellenbosch*: 75–82. Balkema, Cape Town.

WELLS, M.J., POYNTON, R.J., BALSINHAS, A.A., MUSIL, K.J., JOFFE, H., VAN HOEPEN, E. & ABBOTT, S.K. 1986. The history of introduction of invasive plants to southern Africa. In I.A.W. Macdonald, F.J. Kruger & A.A. Ferrar, *The ecology and management of biological invasions in southern Africa*: 21–35. Oxford University Press, Cape Town.

WILD, H. 1961. Harmful aquatic plants in Africa and Madagascar. Joint CCTA / CSA Project No. 14. *Kirkia* 2 supplement.

ZIMMERMANN, H.G. & VAN DE VENTER, H.A. 1981. Jointed cactus. Weeds A1/1981. *Farming in South Africa.*

APPENDIX 1.—Southern temperate species: summary of information. Quarter-degree squares (QDS) were obtained from SAPIA database

Scientific name	Family	Growth form	Cultivated use	Origin	Earliest date	Weed status	QDS	No. years up to 2003	Rate of spread (QDS/no. years)	Distrib. zone
Acacia baileyana	Fabaceae	Woody tree/ shrub	#Ornament, barrier	Australia	1919 (Sim 1919)	Invasive, potential transformer	87	84	1.036	4B
Acacia cyclops	Fabaceae	Woody tree/ shrub	#Cover/binder, barrier	Australia	?1835 (Stirton 1978)	Transformer	169	168	1.006	2B
Acacia dealbata	Fabaceae	Woody tree/ shrub	Silvicultural crop, #barrier, ornament	Australia	1858 (McGibbon 1858)	Transformer	259	145	1.786	4B
Acacia decurrens	Fabaceae	Woody tree/ shrub	Silvicultural crop, #barrier, ornament	Australia	1880–1890 (Van den Berg 1977)	Transformer	103	123	0.837	4A
Acacia elata	Fabaceae	Woody tree/ shrub	#Ornament, barrier	Australia	1937 (PRE)	Invasive, potential transformer	35	66	0.530	3
Acacia implexa	Fabaceae	Woody tree/ shrub	Ornament	Australia	?1850s	Invasive, potential transformer	2 u	153	0.013	2A
Acacia longifolia	Fabaceae	Woody tree/ shrub	#Cover/binder, barrier, ornament	Australia	1827 (Stirton 1978)	Transformer	96	176	0.545	3
Acacia mearnsii	Fabaceae	Woody tree/ shrub	#Silvicultural crop, barrier, ornament	Australia	1858 (McGibbon 1858)	Transformer	436	145	3.007	3
Acacia melanoxylon	Fabaceae	Woody tree/ shrub	#Silvicultural crop, barrier, ornament	Australia	1848 (Stirton 1978)	Transformer	138	155	0.890	3
Acacia paradoxa	Fabaceae	Woody tree/ shrub	#?Ornament, barrier	Australia	1858 (McGibbon 1858)	Naturalized, potential transformer	1	145	0.007	2A
Acacia podalyriifolia	Fabaceae	Woody tree/ shrub	#Ornament, barrier	Australia	1942 (PRE)	Invasive, potential transformer	58	61	0.951	6B
Acacia pycnantha	Fabaceae	Woody tree/ shrub	#Silvicultural crop, cover/binder, barrier, ornament	Australia	1892 (Stirton 1978)	Transformer	35	111	0.315	2A
Acacia saligna	Fabaceae	Woody tree/ shrub	Silvicultural crop, agricultural crop, #cover/binder, barrier, ornament	Australia	?1833 (Stirton 1978)	Transformer	161	170	0.947	2B
Atriplex inflata (= *A. lindleyi* subsp. *inflata*)	Chenopodiaceae	Herb	None	Australia	1906 (PRE)	Transformer	166	97	1.711	1
Atriplex nummularia	Chenopodiaceae	Woody tree/ shrub	#Agricultural crop, barrier	Australia	?1887 (PRE literature)	Invasive, potential transformer	173	116	1.491	1
**Cortaderia selloana*	Poaceae	Grass	#Ornament, cover/binder	S America	1955 (Chippindall 1955)	Invasive, potential transformer	9	48	0.188	3
**Echinopsis spachiana*	Cactaceae	Succulent tree/shrub	#Ornament, barrier	S America	?1940 (PRE)	Invasive, potential transformer	57	63	0.905	1
**Egeria densa*	Hydrocharitaceae	Aquatic	Ornament	S America	1966 (Henderson & Anderson 1966)	Invasive, potential transformer	3	37	0.081	6B
**Eucalyptus cladocalyx*	Myrtaceae	Woody tree/ shrub	#Silvicultural crop, agricultural crop (honey), barrier, ornament	Australia	1883 (Poynton 1959)	Invasive, potential transformer	37 u	120	0.308	2A

*Alien genera and families not indigenous in southern Africa; PRE, Pretoria National Herbarium; u, underestimated; #, primary use.

APPENDIX 1.—Southern temperate species: summary of information. Quarter-degree squares (QDS) were obtained from SAPIA database (cont.)

Scientific name	Family	Growth form	Cultivated use	Origin	Earliest date	Weed status	QDS	No. years up to 2003	Rate of spread (QDS/no. years)	Distrib. zone
**Eucalyptus conferruminata* (*E. lehmannii* misapplied)	Myrtaceae	Woody tree/ shrub	Silvicultural crop, cover/binder, #barrier, agricultural crop (honey)	Australia	1900 (PRE)	Transformer	41	103	0.398	2B
**Eucalyptus diversicolor*	Myrtaceae	Woody tree/ shrub	#Silvicultural crop, barrier, agricultural crop (honey), ornament	Australia	1881 (Poynton 1959)	Invasive, potential transformer	49	122	0.402	2B
**Grevillea robusta*	Proteaceae	Woody tree/ shrub	#Ornament, barrier, silvicultural crop	Australia	1858 (McGibbon 1858)	Invasive, potential transformer	55	145	0.379	6B
**Hakea drupacea*	Proteaceae	Woody tree/ shrub	Ornament, #cover/binder, barrier	Australia	1850 (Shaugnessy 1986)	Transformer	29	153	0.190	2A
**Hakea gibbosa*	Proteaceae	Woody tree/ shrub	Ornament, #barrier	Australia	1835 (Shaugnessy 1986)	Transformer	21	168	0.125	2A
**Hakea salicifolia*	Proteaceae	Woody tree/ shrub	Ornament, #barrier	Australia	1858 (McGibbon 1858)	Naturalized	5	145	0.034	3
**Hakea sericea*	Proteaceae	Woody tree/ shrub	Ornament, cover/binder, #barrier	Australia	1858 (Shaugnessy 1986)	Transformer	83	145	0.572	2A
**Leptospermum laevigatum*	Myrtaceae	Woody tree/ shrub	Ornament, #barrier, cover/binder	Australia	1850 (Shaugnessy 1986)	Transformer	40	153	0.261	2A
Metrosideros excelsa	Myrtaceae	Woody tree/ shrub	Ornament, #barrier, agricultural crop (honey)	New Zealand	?1843 (Bradlow 1965)	Invasive, potential transformer	2	160	0.013	2A
**Myoporum tenuifolium*	*Myoporaceae	Woody tree/ shrub	Ornament, #barrier	Australia	1911 (PRE)	Invasive, potential transformer	32	92	0.345	2B
**Nassella tenuissima*	Poaceae	Grass	None	S America	1899–1902 (Wells *et al.* 1986)	Transformer	1	104	0.010	4A
**Nassella trichotoma*	Poaceae	Grass	None	S America	1899–1902 (Wells *et al.* 1986)	Transformer	12	104	0.115	4A
**Opuntia aurantiaca*	Cactaceae	Succulent tree/shrub	Ornament	S America	1843 (Zimmermann & Van de Venter 1981)	Transformer	63 u	160	0.394	7A
**Paraserianthes lophantha*	Fabaceae	Woody tree/ shrub	#Ornament, agricultural crop (honey)	Australia	1833 (Stirton 1978)	Transformer	54	170	0.318	2B
Pittosporum undulatum	Pittosporaceae	Woody tree/ shrub	Ornament, #barrier	Australia	1858 (McGibbon 1858)	Invasive, potential transformer	4 u	145	0.028	2A
Solanum elaeagnifolium	Solanaceae	Herb	None	S America	1952 (Henderson *et al.* 1987)	Ruderal & agrestal weed	53	51	1.040	7B
Syzygium paniculatum	Myrtaceae	Woody tree/ shrub	#Ornament, barrier, agricultural crop	Australia	1858 (McGibbon 1858)	Invasive, potential transformer	3 u	145	0.021	6B

*Alien genera and families not indigenous in southern Africa; PRE, Pretoria National Herbarium; u, underestimated; #, primary use.

APPENDIX 2.—Northern temperate species: summary of information. Quarter-degree squares (QDS) were obtained from SAPIA database

Scientific name	Family	Growth form	Cultivated use	Origin	Earliest date	Weed status	QDS	No. years up to 2003	Rate of spread (QDS/no. years)	Distrib. zone
**Ailanthus altissima*	Simaroubaceae	Woody tree/ shrub	#Ornament, barrier	Asia	1834 (Bradlow 1965)	Invasive, potential transformer	33	169	0.195	3
**Alhagi maurorum*	Fabaceae	Woody tree/ shrub	None	Europe & Asia	1922 (PRE)	Agrestal weed & potential transformer	10	81	0.123	1
**Arundo donax*	Poaceae	Grass	#Agricultural crop, ornamental, barrier	Mediterranean & Asia	?1700s (PRE) 1811	Transformer	379	>200	1.895	8
Celtis australis	Ulmaceae	Woody tree/ shrub	Ornament	Mediterranean	1894 (Sim 1905)	Invasive, special effect weed	?	109	?	4A
Celtis occidentalis	Ulmaceae	Woody tree/ shrub	Ornament	N America	1905 (Sim 1905)	Invasive, special effect weed	?	98	?	4A
Celtis sinensis	Ulmaceae	Woody tree/ shrub	Ornament	Asia	1905 (Sim 1905)	Invasive, special effect weed	?	98	?	4A
**Cinnamomum camphora*	Lauraceae	Woody tree/ shrub	#Ornament, silvicultural crop, agricultural crop (honey)	Asia	1846 (PRE)	Transformer	10 u	157	0.064	6B
**Cirsium vulgare*	Asteraceae	Herb	None	Europe, N Africa & Asia	1898 (PRE)	Agrestal, ruderal & special effect weed	192	105	1.829	4B
Convolvulus arvensis	Convolvulaceae	Climber	None	Europe & Asia	1900 (PRE)	Agrestal & ruderal weed	23	103	0.223	4B
**Coreopsis lanceolata*	Asteraceae	Herb	Ornament	N America	1962 (PRE)	Invasive, special effect weed	16	41	0.390	6A
**Cotoneaster franchetii*	Rosaceae	Woody tree/ shrub	Ornament, #barrier, agricultural crop (honey)	Asia	1937 (PRE)	Invasive, potential transformer	7	91	0.077	4A
**Cotoneaster pannosus*	Rosaceae	Woody tree/ shrub	Ornament, #barrier, agricultural crop (honey)	Asia	1931 (PRE)	Invasive, potential transformer	25	72	0.347	4A
Cuscuta campestris	Convolvulaceae	Climber	None	N America	1894 (PRE)	Invasive, special effect weed	82	109	0.752	7B
**Cytisus scoparius*	Fabaceae	Woody tree/ shrub	#Ornament, barrier	Europe	1858 (McGibbon 1858)	Invasive, potential transformer	10	145	0.069	4A
**Echium plantagineum*	Boraginaceae	Herb	#Ornament, agricultural crop (honey)	Europe & Asia	1858 (McGibbon 1858)	Agrestal & ruderal weed	51	145	0.352	2A
**Echium vulgare*	Boraginaceae	Herb	#Ornament, agricultural crop (honey)	Europe & Asia	1913 (PRE)	Agrestal & ruderal weed	29	90	0.322	2A
**Eriobotrya japonica*	Rosaceae	Woody tree/ shrub	Ornament, #agricultural crop	Asia	1858 (McGibbon 1858)	Invasive, special effect weed	5	145	0.034	6B
**Genista monspessulana* (= *Cytisus monspessulanus*)	Rosaceae	Woody tree/ shrub	Ornament	Mediterranean	1900 (PRE)	Invasive, potential transformer	3	103	0.029	2A

*Alien genera and families not indigenous in southern Africa; PRE, Pretoria National Herbarium; u, underestimated; #, primary use.

APPENDIX 2.—Northern temperate species: summary of information. Quarter-degree squares (QDS) were obtained from SAPIA database (cont.)

Scientific name	Family	Growth form	Cultivated use	Origin	Earliest date	Weed status	QDS	No. years up to 2003	Rate of spread (QDS/no. years)	Distrib. zone
**Gleditsia triacanthos*	Fabaceae	Woody tree/ shrub	#Agricultural crop, cover/ binder, ornament	N America	1831 (Bradlow 1965)	Invasive, potential transformer	115	172	0.669	4A
**Hedychium coccineum*	Zingiberaceae	Herb	Ornament	Asia	1957 (PRE)	Transformer	4	46	0.087	6B
**Hedychium coronarium*	Zingiberaceae	Herb	Ornament	Asia	1931 (PRE)	Transformer	15	72	0.208	6B
**Hedychium flavescens*	Zingiberaceae	Herb	Ornament	Asia	1931 (PRE)	Transformer	6	72	0.083	6B
**Hedychium gardneria-num*	Zingiberaceae	Herb	Ornament	Asia	1930 (PRE)	Transformer	12	73	0.164	6B
Hypericum perforatum	Clusiaceae	Woody tree/ shrub	#Ornament, agricultural crop (medicinal)	Mediterranean & Eurasia	1942 (Henderson *et al.* 1987)	Invasive, special effect weed	13	61	0.213	2A
Jasminum humile	Oleaceae	Woody tree/ shrub	#Ornament, barrier	Asia	1881 (PRE)	Naturalized, special effect weed	2	122	0.016	4A
**Juniperus virginiana*	Cupressaceae	Woody tree/ shrub	Ornament, #barrier	N America	1906 (Poynton 1959)	Invasive, potential transformer	17	97	0.175	4A
Lepidium draba	Brassicaceae	Herb	None	Mediterranean & Eurasia	1931 (Henderson & Ander-son 1966)	Agrestal & ruderal weed	4	72	0.056	4A
**Ligustrum japonicum*	Oleaceae	Woody tree/ shrub	Ornament, #barrier	Asia	1927 (PRE)	Invasive, potential transformer	7 u	76	0.092	4A
**Ligustrum lucidum*	Oleaceae	Woody tree/ shrub	Ornament, #barrier	Asia	1858 (McGibbon 1858)	Invasive, potential transformer	12 u	145	0.083	4A
**Ligustrum ovalifolium*	Oleaceae	Woody tree/ shrub	Ornament, #barrier	Asia	1932 (PRE)	Invasive, potential transformer	3 u	71	0.042	6A
**Ligustrum sinense*	Oleaceae	Woody tree/ shrub	Ornament, #barrier	Asia	1924 (PRE)	Invasive, potential transformer	8 u	79	0.101	6A
**Ligustrum vulgare*	Oleaceae	Woody tree/ shrub	Ornament, #barrier	Asia	1858 (McGibbon 1858)	Invasive, potential transformer	3 u	145	0.021	6A
**Lilium formosanum*	*Liliaceae	Herb	Ornament	Asia	1962 (PRE)	Invasive, special effect weed	16	41	0.390	6A
**Lonicera japonica*	Oleaceae	Climber	#Ornament, barrier	Asia	1858 (McGibbon 1858)	Invasive, potential transformer	5	145	0.034	6A
**Lythrum salicaria*	Lythraceae	Herb	Ornament	Eurasia	1976 (PRE)	Naturalized, poten-tial transformer	1	27	0.037	2A
**Malva dendromorpha* (= *Lavatera arborea*)	Malvaceae	Woody tree/ shrub	Ornament, #?agricultural crop (fodder & honey)	Europe	1858 (McGibbon 1858)	Ruderal & special effect weed	18	145	0.124	2B
Morus alba	Moraceae	Woody tree/ shrub	Ornament, #agricultural crop	Asia	1831 (Bradlow 1965)	Transformer	133	172	0.773	6A
**Myriophyllum spicatum*	Halorogaceae	Aquatic	Ornament	Europe, N Africa & Asia	1830 (Ecklon 1830)	Invasive, potential transformer	24	173	0.139	6B

*Alien genera and families not indigenous in southern Africa; PRE, Pretoria National Herbarium; u, underestimated; #, primary use.

APPENDIX 2.—Northern temperate species: summary of information. Quarter-degree squares (QDS) were obtained from SAPIA database (cont.)

Scientific name	Family	Growth form	Cultivated use	Origin	Earliest date	Weed status	QDS	No. years up to 2003	Rate of spread (QDS/no. years)	Distrib. zone
**Nasturtium officinale* (= *Rorippa nasturtium-aquaticum*)	Brassicaceae	Aquatic	Agricultural crop	Europe	1650s (Wells *et al*. 1986)	Invasive, special effect weed	51	350	0.146	4B
**Nerium oleander*	Apocynaceae	Woody tree/ shrub	#Ornament, barrier	Mediterranean	1811 (Stirton 1978)	Invasive, special effect weed	24	192	0.125	1
**Oenothera biennis*	Onagraceae	Herb	Ornament, #agricultural crop (medicinal)	N America	?1858 (McGibbon 1858)	Invasive, potential transformer	19	145	0.131	4A
**Opuntia engelmannii* (= *O. lindheimeri*)	Cactaceae	Succulent tree/shrub	Ornament	N America	1937 (PRE)	Invasive, potential transformer	12	63	0.190	1
**Opuntia fulgida*	Cactaceae	Succulent tree/shrub	Ornament	N America	1940s (Coetsee 1989)	Transformer	10	66	0.152	7A
**Opuntia humifusa*	Cactaceae	Succulent tree/shrub	Ornament	N America	?1930s	Invasive, potential transformer	26	73	0.356	6A
**Orobanche minor*	Onagraceae	Herb	None	Europe	1951 (PRE)	Agrestal & ruderal weed	4	52	0.077	2A
**Pinus canariensis*	*Pinaceae	Woody tree/ shrub	#Silvicultural crop, barrier, ornament	Canary Isles	1884 (Poynton 1959)	Invasive, potential transformer	7	119	0.059	2A
**Pinus elliottii*	*Pinaceae	Woody tree/ shrub	#Silvicultural crop, barrier	N America	1919 (Poynton 1959)	Transformer	34	84	0.405	6A
**Pinus halepensis*	*Pinaceae	Woody tree/ shrub	Silvicultural crop, #barrier, ornament	Mediterranean	1827 (Shaughnessy) 1986)	Transformer	85	176	0.483	2A
**Pinus pinaster*	*Pinaceae	Woody tree/ shrub	#Silvicultural crop, barrier	Mediterranean	1685–1693 (Shaughnessy 1986)	Transformer	86	318	0.270	2A
**Pinus pinea*	*Pinaceae	Woody tree/ shrub	#Silvicultural crop, ornament, agricultural crop, barrier	Mediterranean	1685–1693 (Shaughnessy 1986)	Invasive, special effect weed	18	318	0.057	3
**Pinus radiata*	*Pinaceae	Woody tree/ shrub	#Silvicultural crop, barrier	N America	1858 (McGibbon 1858)	Transformer	71	145	0.490	2B
**Pinus roxburghii*	*Pinaceae	Woody tree/ shrub	#Barrier, ornamental	Asia	1858 (McGibbon 1858)	Invasive, potential transformer	4	145	0.028	4A
**Pinus taeda*	*Pinaceae	Woody tree/ shrub	#Silvicultural crop, barrier, ornament	N America	1899 (Poynton 1959)	Transformer	7	104	0.067	6A
**Populus alba*	Salicaceae	Woody tree/ shrub	Silvicultural crop, #barrier, ornament	N Africa, Europe & Asia	1858 (McGibbon 1858)	Transformer	15	145	0.103	4A
**Populus deltoides*	Salicaceae	Woody tree/ shrub	#Silvicultural crop, agricultural crop (honey), ornament	N America	1878 (Poynton 1959)	Naturalized, potential transformer	100	125	0.800	4A

*Alien genera and families not indigenous in southern Africa; PRE, Pretoria National Herbarium; u, underestimated; #, primary use.

APPENDIX 2.—Northern temperate species: summary of information. Quarter-degree squares (QDS) were obtained from SAPIA database (cont.)

Scientific name	Family	Growth form	Cultivated use	Origin	Earliest date	Weed status	QDS	No. years up to 2003	Rate of spread (QDS/no. years)	Distrib. zone
**Populus nigra* var. *italica*	Salicaceae	Woody tree/ shrub	Ornament, #barrier, cover/ binder, agricultural crop (honey)	Europe & Asia	1858 (McGibbon 1858)	Naturalized, potential transformer	90	145	0.621	4A
**Populus ×canescens*	Salicaceae	Woody tree/ shrub	Silvicultural crop, #cover/ binder, barrier, ornament	Europe & Asia	1875 (Hubbard 1926)	Transformer	505	128	3.945	4B
**Prosopis glandulosa* var. *torreyana* and hybrids	Fabaceae	Woody tree/ shrub	#Agricultural crop, ornament (shade)	N America	1900 (Stirton 1978)	Transformer	422	103	4.097	1
**Prosopis velutina*	Fabaceae	Woody tree/ shrub	#Agricultural crop, ornament (shade)	N America	1914 (PRE)	Transformer	48	89	0.539	1
**Pyracantha angustifolia*	Rosaceae	Woody tree/ shrub	Ornament, #barrier	Asia	1919 (PRE)	Transformer	159	84	1.893	4A
**Pyracantha crenulata*	Rosaceae	Woody tree/ shrub	Ornament, #barrier	Asia	1918 (PRE)	Invasive, potential transformer	25	84	0.300	4A
**Quercus robur*	*Fagaceae	Woody tree/ shrub	#Ornament, agricultural crop	Europe & Asia	1656 (Geldenhuys *et al.* 1986)	Invasive, potential transformer	50	347	0.144	3
**Robinia pseudoacacia*	Fabaceae	Woody tree/ shrub	Ornament, #cover/binder, barrier, agricultural crop (honey)	N America	1858 (McGibbon 1858)	Transformer	110	145	0.759	4B
**Rosa multiflora*	Rosaceae	Woody tree/ shrub	#Ornament, barrier	Asia	1945 (PRE)	Naturalized, potential transformer	5	58	0.086	6A
**Rosa rubiginosa*	Rosaceae	Woody tree/ shrub	#Ornament, barrier, agricultural crop	Asia	1937 (PRE)	Transformer	120	66	1.818	4A
Rubus cuneifolius	Rosaceae	Woody tree/ shrub	Agricultural crop	N America	1898 (Phillips *et al.* 1939)	Transformer	75	105	0.714	6A
Rubus flagellaris	Rosaceae	Woody tree/ shrub	?Agricultural crop	N America	1981 (PRE)	Invasive, potential transformer	4	22	0.182	3
Rubus fruticosus	Rosaceae	Woody tree/ shrub	Agricultural crop	Europe	1858 (McGibbon 1858)	Transformer	89	145	0.614	3
Salix babylonica	Salicaceae	Woody tree/ shrub	Ornament, #cover/binder, agricultural crop	Asia	1679–1699 (Smith 1966)	Transformer	476	324	1.469	4B
Salix fragilis	Salicaceae	Woody tree/ shrub	Ornament, #cover/binder, ?agricultural crop	Asia	1914 (PRE)	Transformer	75	89	0.843	4A
Salsola tragus (in part misapplied as *S. kali*)	Chenopodiaceae	Herb	None	Europe & Asia	1899–1902 (Henderson & Anderson 1966)	Ruderal weed & potential transformer	157	104	1.510	1
Sorghum halepense	Poaceae	Grass	Agricultural crop	Mediterranean	1894 (Medley-Wood 1894)	Agrestal, ruderal & special effect weed	45	109	0.413	7B

*Alien genera and families not indigenous in southern Africa; PRE, Pretoria National Herbarium; u, underestimated; #, primary use.

APPENDIX 2.—Northern temperate species: summary of information. Quarter-degree squares (QDS) were obtained from SAPIA database (cont.)

Scientific name	Family	Growth form	Cultivated use	Origin	Earliest date	Weed status	QDS	No. years up to 2003	Rate of spread (QDS/no. years)	Distrib. zone
**Spartium junceum*	Fabaceae	Woody tree/ shrub	#Ornament, barrier	Europe	1858 (McGibbon 1858)	Invasive, potential transformer	20	145	0.138	2A
Tamarix chinensis	Tamaricaceae	Woody tree/ shrub	#?Ornament, cover/binder, agricultural crop (honey)	Asia	1858 (McGibbon 1858)	Invasive, potential transformer	4	145	0.028	1
Tamarix ramosissima	Tamaricaceae	Woody tree/ shrub	#?Ornament, cover/binder, agricultural crop (honey)	Europe & Asia	1923 (PRE)	Invasive, potential transformer	7	80	0.088	1
**Ulex europaeus*	Fabaceae	Woody tree/ shrub	#Ornament, barrier, agri-cultural crop (honey)	Europe	1858 (McGibbon 1858)	Invasive, potential transformer	9	145	0.062	4A

*Alien genera and families not indigenous in southern Africa; PRE, Pretoria National Herbarium; u, underestimated; #, primary use.

APPENDIX 3.—Tropical species: summary of information. Quarter-degree squares (QDS) were obtained from SAPIA database

Scientific name	Family	Growth form	Cultivated use	Origin	Earliest date	Weed status	QDS	No. years up to 2003	Rate of spread (QDS/no. years)	Distrib. zone
**Achyranthes aspera*	Amaranthaceae	Herb	None	Africa	<1652 (Wells *et al.* 1986)	Invasive, special effect weed	78	>350	0.223	6B
**Agave americana*	*Agavaceae	Succulent tree/shrub	Ornament, #barrier, agricultural crop	America	1858 (McGibbon 1858)	Naturalized, special effect weed	433	145	2.986	7B
**Agave sisalana*	*Agavaceae	Succulent tree/shrub	Barrier, #agricultural crop, ornament	America	1929 (Smith 1929)	Naturalized, potential transformer	171	74	2.311	6B
**Ageratina adenophora*	Asteraceae	Herb	Ornament	America	1958 (PRE)	Invasive, potential transformer	11	45	0.244	6B
**Ageratina riparia*	Asteraceae	Herb	Ornament	America	<1980s (PRE)	Invasive, special effect weed	1	23	0.043	6B
**Ageratum conyzoides*	Asteraceae	Herb	Ornament	America	1894 (Medley Wood 1894)	Invasive, special effect weed	41	109	0.376	6B
**Ageratum houstonianum*	Asteraceae	Herb	Ornament	America	1858 (McGibbon 1858)	Invasive, special effect weed	26	145	0.179	6B
Albizia lebbeck	Fabaceae	Woody tree/shrub	Ornament	Asia	1905 (Sim 1905)	Transformer	6	98	0.061	5
Albizia procera	Fabaceae	Woody tree/shrub	Ornament	Asia	1885 (Sim 1905)	Transformer	1 u	118	0.008	5
**Alpinia zerumbet*	Zingiberaceae	Herb	Ornament	Asia	1909 (PRE)	Naturalized, potential transformer	5	94	0.053	6B
**Anredera cordifolia*	Basellaceae	Climber	Ornament	America	1894 (PRE)	Invasive, potential transformer	25	109	0.229	6B
**Antigonon leptopus*	Polygonaceae	Climber	Ornament	America	1927 (Cran 1927)	Invasive, special effect weed	5	76	0.066	5
**Araujia sericifera*	Asclepiadaceae	Climber	Ornament	America	1918 (PRE)	Invasive, special effect weed	37	85	0.435	6B
**Ardisia crenata*	Myrsinaceae	Woody tree/shrub	Ornament	Asia	1955 (PRE)	Invasive, potential transformer	2 u	48	0.042	5
**Argemone mexicana*	*Papaveraceae	Herb	None	America	1894 (Medley Wood 1894)	Agrestal, ruderal & special effect weed	34	109	0.312	5
**Argemone ochroleuca*	*Papaveraceae	Herb	None	America	1885 (PRE)	Agrestal, ruderal & special effect weed	161	118	1.364	7B
Aristolochia elegans	Aristolochiaceae	Climber	Ornament	America	1914 (PRE)	Invasive, special effect weed	6	89	0.067	6A
Azolla filiculoides	Azollaceae	Aquatic	Ornament	America	1948 (Oosthuizen & Walters 1961)	Transformer	243	55	4.418	4B

*Alien genera and families not indigenous in southern Africa; PRE, Pretoria National Herbarium; u, underestimated; #, primary use.

APPENDIX 3.—Tropical species: summary of information. Quarter-degree squares (QDS) were obtained from SAPIA database (cont.)

Scientific name	Family	Growth form	Cultivated use	Origin	Earliest date	Weed status	QDS	No. years up to 2003	Rate of spread (QDS/no. years)	Distrib. zone
Bauhinia purpurea	Fabaceae	Woody tree/ shrub	Ornament	Asia	1858 (McGibbon 1858)	Invasive, special effect weed	1 u	145	0.007	6A
Bauhinia variegata	Fabaceae	Woody tree/ shrub	Ornament	Asia	1891 (PRE)	Invasive, special effect weed	9 u	112	0.080	6A
**Bryophyllum delagoense*	Crassulaceae	Herb	Ornament	Madagas-car	1939 (PRE)	Invasive, special effect weed	8	64	0.125	6A
Caesalpinia decapetala	Fabaceae	Climber	#Barrier, ornament	Asia	1858 (McGibbon 1858)	Transformer	128	145	0.883	5
**Campuloclinium macrocephalum*	Asteraceae	Herb	Ornament	America	1962 (PRE)	Transformer	38	41	0.927	4A
**Canna indica*	*Cannaceae	Herb	Ornament	America	<1800 (Wells *et al.* 1986)	Naturalized, potential transformer	27	>200	0.135	6B
**Canna ×generalis*	*Cannaceae	Herb	Ornament	America	1964 (PRE)	Naturalized, potential transformer	9	39	0.231	6B
Cardiospermum grandiflorum	Sapindaceae	Climber	Ornament	America	1912 (PRE)	Transformer	48	91	0.527	6A
Cardiospermum halicacabum	Sapindaceae	Climber	Ornament	America	1858 (McGibbon 1858)	Naturalized, minor weed	31	145	0.214	6A
**Casuarina cunninghamiana*	*Casuarinaceae	Woody tree/ shrub	Ornament, cover/ binder, #barrier	Australia	1903 (PRE)	Invasive, potential transformer	10	100	0.100	6B
**Casuarina equisetifolia*	*Casuarinaceae	Woody tree/ shrub	Ornament, #cover/ binder, barrier	Pantropical	1858 (McGibbon 1858)	Invasive, potential transformer	23	145	0.159	5
**Catharanthus roseus*	Apocynaceae	Herb	#Ornament, agri-cultural crop (me-dicinal)	Madagas-car	< 1652 (Wells *et al.* 1986)	Invasive, special effect weed	41	>350	0.117	6A
**Cereus jamacaru*	Cactaceae	Succulent tree/shrub	#Ornament, barrier	America	1925 (PRE)	Transformer	136	78	1.744	7A
**Cestrum aurantiacum*	Solanaceae	Woody tree/ shrub	#Ornament, barrier	America	1850–1900 (Wells *et al.* 1986)	Invasive, special effect weed	9	153	0.059	6B
**Cestrum elegans*	Solanaceae	Woody tree/ shrub	#Ornament, barrier	America	? early 1900s	Invasive, special effect weed	3	100	0.030	5
**Cestrum laevigatum*	Solanaceae	Woody tree/ shrub	#Ornament, barrier	America	1892 (PRE)	Transformer	73	111	0.658	6B
**Cestrum parqui*	Solanaceae	Woody tree/ shrub	#Ornament, barrier	America	1927 (PRE)	Transformer	1	76	0.013	4A
**Chromolaena odorata*	Asteraceae	Woody tree/ shrub	Ornament	America	1858 (McGibbon 1858)	Transformer	99	145	0.683	5
**Cortaderia jubata*	Poaceae	Grass	#Ornament, cover/ binder	America	1958 (PRE)	Invasive, potential transformer	9	45	0.200	4A

*Alien genera and families not indigenous in southern Africa; PRE, Pretoria National Herbarium; u, underestimated; #, primary use.

APPENDIX 3.—Tropical species: summary of information. Quarter-degree squares (QDS) were obtained from SAPIA database (cont.)

Scientific name	Family	Growth form	Cultivated use	Origin	Earliest date	Weed status	QDS	No. years up to 2003	Rate of spread (QDS/no. years)	Distrib. zone
Cuscuta suaveolens	Convolvulaceae	Climber	None	America	1894 (Medley Wood 1894)	Invasive, special effect weed	7	109	0.064	7B
**Datura ferox*	Solanaceae	Herb	None	America	1908 (PRE)	Agrestal, ruderal & special effect weed	190	95	2.000	7B
**Datura inoxia*	Solanaceae	Herb	None	America	1886 (PRE)	Agrestal, ruderal & special effect weed	56	117	0.479	7B
**Datura stramonium*	Solanaceae	Herb	#agricultural crop (medicinal)	America	1650–1799 (Wells *et al.* 1986)	Agrestal, ruderal & special effect weed	299	353	0.847	7B
**Duranta erecta*	Verbenaceae	Woody tree/ shrub	#Ornament, barrier	America	1858 (McGibbon 1858)	Invasive, special effect weed	34	145	0.234	6A
Eichhornia crassipes	Pontederiaceae	Aquatic	Ornament	America	1884 (Stirton 1978)	Transformer	99	119	0.832	6B
**Eucalyptus camaldulensis*	Myrtaceae	Woody tree/ shrub	#Silvicultural crop, barrier, ornament, agricultural crop (honey)	Australia	1896 (Poynton 1959) ?1884 (Storr Lister 1884 as *E. rostrata*)	Transformer	127	107	1.187	7B
**Eucalyptus grandis*	Myrtaceae	Woody tree/ shrub	#Silvicultural crop, barrier, ornament, agricultural crop (honey)	Australia	1885 (Poynton 1959)	Transformer	103	118	0.873	6A
Eugenia uniflora	Myrtaceae	Woody tree/ shrub	#Ornament, barrier, agricultural crop	America	1834 (Bradlow 1965)	Invasive, potential transformer	4	169	0.024	5
**Harrisia martinii*	Cactaceae	Succulent tree/shrub	Ornament	America	?early 1900s (De Beer & Zimmermann 1986)	Transformer	21	100	0.210	6A
Ipomoea alba	Convolvulaceae	Climber	Ornament	America	1858 (McGibbon 1858)	Transformer	23	145	0.159	6A
Ipomoea carnea subsp. *fistulosa*	Convolvulaceae	Woody tree/ shrub	Ornament, #barrier	America	1953 (PRE)	Invasive, special effect weed	23	50	0.460	6A
Ipomoea indica	Convolvulaceae	Climber	Ornament	America	1890 (PRE)	Transformer	23 u	113	0.204	6B
Ipomoea purpurea	Convolvulaceae	Climber	Ornament	America	1830 (PRE literature)	Invasive, special effect weed	41 u	173	0.237	6A
**Jacaranda mimosifolia*	Bignoniaceae	Woody tree/ shrub	Ornament	America	1830s (Bradlow 1965)	Transformer	203	173	1.173	6A
Lantana camara	Verbenaceae	Woody tree/ shrub	#Ornament, barrier	America	1858 (McGibbon 1858)	Transformer	268	145	1.848	6B
**Leucaena leucocephala*	Fabaceae	Woody tree/ shrub	#Agricultural crop, cover/binder, ornament	America	1850–1900 (Wells *et al.* 1986)	Invasive, potential transformer	39	153	0.255	6A

*Alien genera and families not indigenous in southern Africa; PRE, Pretoria National Herbarium; u, underestimated; #, primary use.

APPENDIX 3.—Tropical species: summary of information. Quarter-degree squares (QDS) were obtained from SAPIA database (cont.)

Scientific name	Family	Growth form	Cultivated use	Origin	Earliest date	Weed status	QDS	No. years up to 2003	Rate of spread (QDS/no. years)	Distrib. zone
**Litsea glutinosa*	Lauraceae	Woody tree/ shrub	Ornament	Asia	1902–1903 (Sim 1905)	Transformer	8	100	0.080	5
**Macfadyena unguis-cati*	Bignoniaceae	Climber	#Ornament, barrier	America	1927 (Cran 1927)	Transformer	32	76	0.421	6A
**Melia azedarach*	Meliaceae	Woody tree/ shrub	Ornament	Australasia	1800 (Smith 1966)	Transformer	561	203	2.764	6B
**Mimosa pigra*	Fabaceae	Woody tree/ shrub	Ornament	America	1954 (PRE)	Invasive, potential transformer	7	49	0.143	6A
**Montanoa hibiscifolia*	Asteraceae	Woody tree/ shrub	Ornament	America	1910 (PRE)	Invasive, special effect weed	24	93	0.258	5
**Myriophyllum aquaticum*	Haloragaceae	Aquatic	Ornament	America	1921 (PRE)	Transformer	49	82	0.598	6B
Nephrolepis exaltata	Davalliaceae	Herb	Ornament	America	?early 1900s	Transformer	14 u	100	0.140	6B
**Nicotiana glauca*	Solanaceae	Woody tree/ shrub	Ornament	America	1830s (Bradlow 1965)	Ruderal & special effect weed	399	173	2.306	7B
**Oenothera jamesii*	Onagraceae	Herb	Ornament	America	1858 (McGibbon 1858)	Invasive, potential transformer	16 u	145	0.110	4A
**Oenothera rosea*	Onagraceae	Herb	Ornament	America	1858 (McGibbon 1858)	Invasive, potential transformer	4 u	145	0.028	4A
**Opuntia exaltata*	Cactaceae	Succulent tree/shrub	#Ornament, barrier	America	1936 (PRE)	Invasive, potential transformer	6	67	0.090	4A
**Opuntia ficus-indica*	Cactaceae	Succulent tree/shrub	Barrier, #agricul- tural crop	America	?1656 (Wells *et al.* 1986)	Transformer	868	347	2.501	7B
**Opuntia imbricata*	Cactaceae	Succulent tree/shrub	Ornament	America	1913 (PRE)	Transformer	135	90	1.500	7A
**Opuntia monacantha*	Cactaceae	Succulent tree/shrub	#Agricultural crop, barrier	America	1772 (Neser & Annecke 1973)	Invasive but minor weed	48	231	0.208	6B
**Opuntia spinulifera*	Cactaceae	Succulent tree/shrub	#Ornament, barrier	America	1934 (PRE)	Invasive, potential transformer	9	69	0.130	4A
**Opuntia stricta*	Cactaceae	Succulent tree/shrub	Ornament	America	1937 (PRE)	Transformer	115	66	1.742	7A
Parkinsonia aculeata	Fabaceae	Woody tree/ shrub	Ornament	America	1858 (McGibbon 1858)	Invasive, potential transformer	16	145	0.110	7A
**Parthenium hysterophorus*	Asteraceae	Herb	None	America	1894 (Medley Wood 1894)	Invasive, special effect weed	25	109	0.229	6A
**Passiflora caerulea*	Passifloraceae	Climber	Ornament	America	1858 (McGibbon 1858)	Invasive, special effect weed	12	145	0.083	3
**Passiflora edulis*	Passifloraceae	Climber	Ornament, #agricul- tural crop	America	1858 (McGibbon 1858)	Invasive, special effect weed	36	145	0.248	6B

*Alien genera and families not indigenous in southern Africa; PRE, Pretoria National Herbarium; u, underestimated; #, primary use.

APPENDIX 3.—Tropical species: summary of information. Quarter-degree squares (QDS) were obtained from SAPIA database (cont.)

Scientific name	Family	Growth form	Cultivated use	Origin	Earliest date	Weed status	QDS	No. years up to 2003	Rate of spread (QDS/no. years)	Distrib. zone
**Passiflora suberosa*	Passifloraceae	Climber	Ornament	America	1858 (McGibbon 1858)	Invasive, special effect weed	6	145	0.041	6A
**Passiflora subpeltata*	Passifloraceae	Climber	Ornament	America	1858 (McGibbon 1858)	Invasive, special effect weed	21	145	0.145	6A
**Passiflora tripartita* var. *mollissima* (= *P. mollissima*)	Passifloraceae	Climber	Ornament, #agricultural crop	America	1951 (PRE)	Invasive, potential transformer	4	52	0.077	3
Pennisetum clandestinum	Poaceae	Grass	#Cover/binder, agricultural crop	Africa	1915 (PRE)	Invasive, potential transformer	50	88	0.568	3
Pennisetum purpureum	Poaceae	Grass	Barrier, #agricultural crop, ornament	Africa	1930 (PRE literature)	Transformer	42	73	0.575	6A
Pennisetum setaceum	Poaceae	Grass	#Ornament, cover/binder	Africa	1936 (PRE)	Invasive, special effect weed	69	67	1.030	7B
Pennisetum villosum	Poaceae	Grass	Ornament, #?cover/binder	Africa	1917 (PRE)	Invasive, special effect weed	22	86	0.256	4B
**Pereskia aculeata*	Cactaceae	Climber	#Barrier, ornament	America	1858 (McGibbon 1858)	Transformer	21	145	0.145	6B
Phytolacca dioica	Phytolaccaceae	Woody tree/shrub	Ornament	America	1858 (McGibbon 1858)	Invasive, special effect weed	30	145	0.207	3
**Pinus patula*	*Pinaceae	Woody tree/shrub	#Silvicultural crop, barrier, ornament	America	1907 (Poynton 1959)	Transformer	90	96	0.938	6A
**Pistia stratiotes*	Araceae	Aquatic	Ornament	America	1894 (Medley Wood 1894)	Transformer	29	109	0.266	6B
Plectranthus comosus	Lamiaceae	Woody tree/shrub	Ornament	Asia	1947 (PRE)	Invasive, special effect weed	17	56	0.304	6B
**Pontederia cordata*	Pontederiaceae	Aquatic	Ornament	America	1945 (PRE)	Invasive, special effect weed	7	58	0.121	6A
**Psidium cattleianum*	Myrtaceae	Woody tree/shrub	#Ornament, agricultural crop	America	1948 (PRE)	Invasive, potential transformer	5	55	0.091	5
**Psidium guajava*	Myrtaceae	Woody tree/shrub	#Agricultural crop, ornament	America	1700s (Wells *et al.* 1986)	Transformer	168	300	0.560	6B
**Psidium guineense*	Myrtaceae	Woody tree/shrub	Ornament	America	?early 1900s	Invasive, special effect weed	2	100	0.020	5
**Pueraria montana* var. *lobata* (= *P. lobata*)	Fabaceae	Climber	Ornament, #cover/binder, agricultural crop	Asia	1946 (PRE)	Invasive, potential transformer	6	57	0.105	6A
**Ricinus communis*	Euphorbiaceae	Woody tree/shrub	#Agricultural crop (medicinal), ornament	Africa	± 800 (Brink 1988)	Invasive, special effect weed	472	>1200	0.393	6B

*Alien genera and families not indigenous in southern Africa; PRE, Pretoria National Herbarium; u, underestimated; #, primary use.

APPENDIX 3.—Tropical species: summary of information. Quarter-degree squares (QDS) were obtained from SAPIA database (cont.)

Scientific name	Family	Growth form	Cultivated use	Origin	Earliest date	Weed status	QDS	No. years up to 2003	Rate of spread (QDS/no. years)	Distrib. zone
**Rivina humilis*	Phytolaccaceae	Herb	Ornament	America	1944 (PRE)	Invasive, special effect weed	7	59	0.119	6A
**Salvinia molesta*	Salviniaceae	Aquatic	Ornament	America	1961 (Wild 1961)	Transformer	44	42	1.048	6B
**Schinus molle*	Anacardiaceae	Woody tree/ shrub	#Ornament, barrier	America	1883 (PRE)	Invasive, special effect weed	232	120	1.933	7A
**Schinus terebinthifolius*	Anacardiaceae	Woody tree/ shrub	Ornament, #barrier	America	1926 (PRE)	Invasive, potential transformer	32	77	0.416	5
Senna bicapsularis	Fabaceae	Climber	#Ornament, barrier	America	1858 (McGibbon 1858)	Invasive, potential transformer	17	145	0.117	5
Senna corymbosa	Fabaceae	Woody tree/ shrub	#Ornament, barrier	America	1858 (McGibbon 1858)	Invasive, special effect weed	5	145	0.034	6A
Senna didymobotrya	Fabaceae	Woody tree/ shrub	Ornament, #barrier	Africa	1909 (PRE)	Invasive, special effect weed	143	94	1.521	6A
Senna hirsuta	Fabaceae	Woody tree/ shrub	Ornament	America	1850–1900 (Wells *et al.* 1986)	Invasive, special effect weed	9	153	0.059	5
Senna mutliglandulosa	Fabaceae	Woody tree/ shrub	Ornament	America	1898 (PRE)	Invasive, special effect weed	11	105	0.105	3
Senna occidentalis	Fabaceae	Woody tree/ shrub	Ornament, #?agricultural crop (coffee; medicinal)	America	1858 (McGibbon 1858)	Ruderal & special effect weed	56	145	0.386	6A
Senna pendula var. *glabrata*	Fabaceae	Climber	Ornament	America	1933 (PRE)	Invasive, potential transformer	19	70	0.271	5
Senna septemtrionalis	Fabaceae	Woody tree/ shrub	Ornament	America	1909 (PRE)	Invasive, special effect weed	64	94	0.681	6A
Sesbania punicea	Fabaceae	Woody tree/ shrub	Ornament	America	1858 (McGibbon 1858)	Transformer	326	145	2.248	3
Solanum mauritianum	Solanaceae	Woody tree/ shrub	Ornament	America	1862 (PRE)	Transformer	270	141	1.915	3
Solanum seaforthianum	Solanaceae	Climber	Ornament	America	1902 (PRE)	Invasive, special effect weed	35	101	0.347	6A
Solanum sisymbriifolium	Solanaceae	Woody tree/ shrub	None	America	1906 (PRE)	Ruderal, agrestal & minor weed	43	97	0.443	6B
* *Sphagneticola trilobata* (= *Thelechitonia trilobata*)	Asteraceae	Herb	#Ornament, cover/ binder	America	1979 (PRE)	Ruderal weed & transformer	5	24	0.208	5
Syzygium cumini	Myrtaceae	Woody tree/ shrub	#Ornament, agricultural crop	Asia	1917 (PRE)	Invasive, potential transformer	11	86	0.128	5

*Alien genera and families not indigenous in southern Africa; PRE, Pretoria National Herbarium; u, underestimated; #, primary use.

APPENDIX 3.—Tropical species: summary of information. Quarter-degree squares (QDS) were obtained from SAPIA database (cont.)

Scientific name	Family	Growth form	Cultivated use	Origin	Earliest date	Weed status	QDS	No. years up to 2003	Rate of spread (QDS/no. years)	Distrib. zone
Syzygium jambos	Myrtaceae	Woody tree/ shrub	#Ornament, agricultural crop	Asia	1858 (McGibbon 1858)	Invasive, potential transformer	3	145	0.021	6B
Tecoma stans	Bignoniaceae	Woody tree/ shrub	#Ornament, barrier	America	1858 (McGibbon 1858)	Invasive, potential transformer	66	145	0.455	6A
**Thevetia peruviana*	Apocynaceae	Woody tree/ shrub	Ornament	America	?1858 (McGibbon 1858)	Invasive, special effect weed	15	145	0.103	5
**Tipuana tipu*	Fabaceae	Woody tree/ shrub	Ornament	America	1916 (PRE)	Invasive, potential transformer	26	87	0.299	6A
**Tithonia diversifolia*	Asteraceae	Woody tree/ shrub	Ornament	America	?early 1900s	Invasive, special effect weed	52	100	0.520	6B
**Tithonia rotundifolia*	Asteraceae	Woody tree/ shrub	#Ornament, agricultural crop (honey)	America	?early 1900s	Invasive, special effect weed	23	100	0.230	6A
**Toona ciliata*	Meliaceae	Woody tree/ shrub	#Ornament, silvicultural crop	Australasia	1902 (PRE)	Invasive, potential transformer	30	101	0.297	5
**Toxicodendron succedaneum* (= *Rhus succedanea*)	Anacardiaceae	Woody tree/ shrub	Ornament	Asia	1932 (PRE)	Invasive, special effect weed	12	71	0.169	5
**Triplaris americana*	Polygonaceae	Woody tree/ shrub	Ornament	America	?1970s (PRE literature)	Invasive, potential transformer	3	30	0.100	5
**Xanthium spinosum*	Asteraceae	Herb	None	America	1650–1799 (Wells *et al.* 1986)	Ruderal & special effect weed	85	353	0.241	7B
**Xanthium strumarium*	Asteraceae	Herb	None	America	1893 (PRE)	Ruderal & special effect weed	152	110	1.382	7B

*Alien genera and families not indigenous in southern Africa; PRE, Pretoria National Herbarium; u, underestimated; #, primary use.

Bothalia 36,2: 223–242 (2006)

South African National Biodiversity Institute: administration and research staff 31 March 2006, publications 1 April 2005–31 March 2006

Compiler: B.A. Momberg

CHIEF DIRECTORATE (ADIR)

CAPE TOWN—PEARSON HOUSE

Huntley, Prof. B.J. M.Sc. Chief Executive Officer
Laidler, Mrs S.A. B.Sc.(Agric.)(Hons). Senior Provisioning Admin. Officer. Personal Assistant
Finca, Ms N.F. Specialist Cleaner

PRETORIA

Mabeba, Ms K.L. B.A.(Hons). Secretary to SANBI Board

WORKING FOR WETLANDS PROJECT (EDIR/WF)

Dini, J.A. B.Sc.(Hons). Programme Manager. Pretoria (contract worker)

Beetge, A. N.Dip.(Forestry). Regional Co-ordinator. Mpumalanga (contract worker)
Buckle, J.D. B.Sc.(Hons). Technical Advisor, Southern region. Port Elizabeth (contract worker)
Goge, M.C. M.Sc. (Environmental Science). Provincial Coordinator, KwaZulu Natal (contract worker)
Mangqalaza, Ms S.M. M.Ed. Social Development & Training Co-ordinator. Pretoria (contract worker)
Manyeza, Ms I.M. Provisioning Admin. Officer (contract worker)
Mokhutsane, T.J. Regional Co-ordinator, Limpopo. Pretoria (contract worker)
Mukhoro, M. B.Sc.(Hons)(Environm.Managem.). Project Manager, National Wetland Inventory (contract worker)
Munzhedzi, T.E. B.A.(Ed.). Regional Co-ordinator, North-West and Free State. Rustenburg (contract worker)

GLOBAL INVASIVE SPECIES PROGRAMME (GISP)

CAPE TOWN

Jackson, Ms L.F. Ph.D. Director (contract worker)
Barnard, Ms P.E. Ph.D. Senior Specialist Scientist. Working Group Co-ordinator/Scientific and Technical Co-ordinator (contract worker)
Matthews, Ms S.G. Communications Co-ordinator (contract worker)
Whiting, Ms D.M. Senior Administrator (contract worker)

MARKETING AND COMMUNICATION DIRECTORATE (AMAR)

PRETORIA

Director: vacant
Liebenberg, Mrs E.J.L. M.Sc. Control Agricultural Technician. Acting Manager (North)

CAPE TOWN

Van Aswegen, Ms C.E. HED, B.A.(History & Psych.). Principal Communications Officer. Admin. support

HUMAN RESOURCES DIRECTORATE (APER)

PRETORIA

Netshiombo. M.J. B.Admin.(Hons), DPLR(UNISA), AHR(UNISA). Chief Director

Baloyi, Ms I. N.Dip.(Manag. Assist.). Senior Secretary IV
Leboho, Ms N. B.Com.(Human Res.), Dip.(Personnel Manag.), Dip.(Public Rela.). Senior Personnel Practitioner
Mokale, Ms M.C. Clerk (contract worker)

CAPE TOWN

Kriel, Mrs G.A. Dip.(Sec.). Senior Secretary IV
Haupt, Mrs C.S. Specialist Cleaner. Guest house
Karlie, Ms F. Cleaner I

PERSONNEL—CAPE TOWN

Engelbrecht, B. N.Dip.(Hort.), N.Dip.(PRM), Dip.(Forestry). Deputy Director: Human resources management and health & safety co-ordination
Staal, P.B. Dip.(Soc. Sci.), Cert.Indust. Relations. Assistant Director. Labour & staff relations

Claassen, Ms G.E. Senior Telkom Operator III. Admin. Support, front line duties
Crowie, A.C. Senior Registry Clerk II
Dollie, Mrs N.J. Specialist Cleaner
Du Toit, Ms R. HED. Assistant Director. Training and development
Fredericks, C.H. Driver II. Courier services
Nicholas, Mrs W.L. Senior Photocopy Machine Operator
Oosthuizen, Ms G. Senior Provisioning Admin. Clerk III. Recruitment Clerk
Petersen, R.E. Senior Personnel Practitioner. Employment equity
Sass, Ms D. Senior Provisioning Admin. Clerk II. Leave & IOD admin.

FINANCE DIRECTORATE (AFIN)

PRETORIA

Singh, S.. B.Com.(Hons). Chief Director. Finance
Matsie, T.J. B.Com.(Hons). Deputy Director. Financial management

CAPE TOWN

Rawoot, N.A. B.Acc.Sc. Deputy Director: Financial management
Maholwana, S. B.Com.(Hons). Assistant Director. Asset management
Neuwirth, Ms E.V. B.Com.(Hons). Assistant Director: Employee salaries & benefits and Principal Officer: Retirement Fund
Van Zyl, J.M. M.Econ.(Indust. Psych.). Assistant Director: Organizational Development & Training

Bean, Ms S.E. Dip.(Human Res.). Project Admin. (contract worker)
Cassiem, Ms S. Chief Accounting Clerk. Salaries
Cooper, S.K. Senior Accounting Clerk II. Creditors
Goodman, Mrs I.W. State Accountant. Supervisor: Creditors
Jacobs, F.H. Senior Accounting Clerk II. Staff benefits
Jacobs, Ms S. Dip.(Finan.Managem.). Assistant Director. Financial management: general ledger
Mcontsi, Ms N. N.Dip.(Acc.). Senior Accounting Clerk III. Creditors
Paulse, Mrs D.W.S. Dip.(Bookkeep.), Dip.(Sec.). Chief Accounting Clerk III. Creditors
Potgieter, Ms G. Salaries Clerk (contract worker)

ENVIRONMENTAL EDUCATION DIRECTORATE (EDIR, EENT/GP)

PRETORIA

Qwathekana, Ms N.M. B.A.(Hons), B.A.(Eng., Geog. & Film Studies III), Dip. (Ed.), M.Phil.(Geog. & Envir. Sci.) Director
Mpungose, J.E. B.Paed., B.A.(Hons) (Geog.), Advanced Postgrad.Cert.(Ed. Mngt.), M.Phil. (Geog.). Assistant Director: Environm. Ed. Co-ordinator

Canham, B.J. B.A.(Sociol. & Eng.). Programme Manager. Greening of the Nation (contract worker)
Eyssell, Ms A. B.Sc.(Hons)(Hort.). Senior Environm. Ed. Officer. Outreach Horticulturist
Kutumela, M.S. (student)
Mahasha, Ms P.M. N.T.C.III(Hort.). (student)
Maphuta, Mrs M.S. Specialist Cleaner, Assistant to centre manager
Maseola, C.G. N.Dip.(Nat.Cons.) (contract worker)
Mashiyi, G. B.Com. Admin./Finance Officer. Greening the Nation (contract worker)
Mathaba, T.C. Environm. Ed. Officer
Novellie, Mrs E. HED, B.Sc.(Hons)(Zoo. & Mammology). Principal Environm. Ed. Officer
Pillay, Ms R. Senior Provisioning Admin. Officer
Ramabulane, S.A. N.T.C.III(Hort.). (student)
Sikhauli, Ms N. B.Sc. (student)

CAPE TOWN

Belle, E. (student)
Dlamini, Ms N. (student)
Motsoko, Ms N. (student)
Nketu, M.J. (student)

EASTERN CAPE

Mchunu, Ms E.N. B.A. Project Officer. Butterworth (contract worker)
Mpongwana, Ms S.N. B.Bib. Project officer. Cradock (contract worker)
Zondani, V. B.A.(Hons). Regional Co-ordinator: Greening of the Nation (contract worker)

WESTERN CAPE (EECT/C)

Coe, W.F. Regional Co-ordinator (contract worker)
Katise, Ms T.C. (student)
Van Dayar, Ms M.M. HED IV (contract worker)

GOLDFIELDS CENTRE—CAPE TOWN (EECT)

Fullard, D. B.Sc.Ed., B.Ed.(Hons). Deputy Director. Environm. Ed. Co-ordinator

Boyana (Magija), Ms N.F. N.Dip.(Hort.), B.Tech.(Environm. Managem.). Senior Environm. Ed. Officer. Outreach greening
Ellman, Ms R.S. HED, B.Sc. Senior Environm. Ed. Officer. Resource development
Hey, Ms S.J. HED, B.A.(Geog.). Senior Environm. Ed. Officer. Garden-based programme
Matthews, M.Z. Specialist groundsman. Outreach greening
Mgodeli, W.M. Driver II
Mjuleni, Ms L.M. N.Dip.(Hort.). Outreach greening (student)
Mswazi, M.Q. B.Soc. (student)
September, Ms M. Senior Provisioning Admin. Clerk II. Admin. support

HAROLD PORTER NBG—BETTY'S BAY

Xaba, P.A. N.Dip.(Hort.). Senior Environmental Education Officer. Overberg Useful Plants Project (YARP/CF) (contract worker)
Williams, Ms L. N.Dip.(Nature Cons.) (student)

LOWVELD NBG—NELSPRUIT (EENT/MP)

Mamatsharaga, L.A. M.Sc.(Ed.). Assistant Director: Environm. Ed.

Hlalu, Ms X. N.Dip.(Hort.). Outreach Horticulturist (contract worker)
Matshaya, Ms N.N. N.Dip.(Hort.) (student)
Mavimbela, Ms S.W. (student)
Nyathi, Ms G.S. N.Dip.(Pers.Assist.). Senior Provisioning Admin. Clerk II
Randima, Ms G.D. Specialist Cleaner

FREE STATE NBG—BLOEMFONTEIN (EENT/FS)

Moletsane, M.E. B.Ed.(Hons). Principal Environm. Ed. Officer. Admin. support
Ngena, Ms K.M.G. Provisioning Admin. Clerk I
Phangoa, M.P. (student)
Tshabalala, Ms B.N.W. (student)

WALTER SISULU NBG—ROODEPOORT (EENT/GW)

Konanani, L.N. (student)
Kondlo, Ms M. N.Dip.(Hort.), Advanced Cert.Environm.Ed. Outreach Horticulturist
Molefe, Ms K.E. Dip.(Nature Cons.). Senior Environm. Ed. Officer. Outreach education
Moore, Mrs J.M. N.H.Dip.(Sec.). Senior Provisioning Admin. Clerk II. Admin. support
Vatsha, M.L. B.A., HED. Principal Environm. Ed. Officer

BIODIVERSITY PROGRAMMES, POLICY AND PLANNING DIRECTORATE (DBIO)

PRETORIA

Maze, Ms K.E. M.Sc. Director. Biodiversity policy and planning
Matlala, Ms J. Senior Administrative Officer

BIOREGIONAL POLICY AND MONITORING UNIT—PRETORIA (DBIO/DD)

Driver, Ms A.L. M.A., M.B.A. Deputy Director. Bioregional policy and monitoring
Smith, Ms T.J. Ph.D. Bioregional Policy and Products Officer

BIODIVERSITY, KRC—CAPE TOWN (DBIO/C)

Roberts, R. B.Sc.(Hons). Chief Information Technology Advisor (contract worker)
Rogers, Ms I.M. Supervisor: data ecoding and georeferencing (contract worker)

BIODIVERSITY PLANNING—PRETORIA (DBIO/PL)

Rouget, M.J.F. Ph.D. Biodiversity Planning Manager. Alien plant invasions, conservation planningJonas, Ms Z.R. M.Sc.(Conserv. & GIS). Conservation Planner (Cape Town)

Mohamed, Ms B.M. B.Sc.(Hons). TSP GIS Specialist
Wistebaar, Ms N.P. B.Sc.(Hons). (student)
Tshitangano, N.F. B.Sc. (student)

EASTERN CAPE CO-ORDINATION UNIT—PORT ELIZABETH (DBIO/EC)

Cadman, M.J. Ph.D. Bioregional Programmes Co-ordinator: Eastern Cape (contract worker)

Cumming, T.L.C. B.Sc.(Hons). Project Developer (contract worker)
Hartmann, N.R. B.Sc.(Hons)(GIS). Intern Project Officer (contract worker)
Myles, Ms M.L. B.A. Senior Administrative Officer (contract worker)

BIODIVERSITY GIS (BGIS)—CAPE TOWN

Willoughby, S.W. M.A.(Geogr. Sci.). Biodiversity GIS Project Manager (contract worker)

Cocks, M. M.Sc.(Bot.).Web Developer (contract worker)
Khatieb, Ms S. B.Sc.(Hons). GIS Technician (contract worker)
Potgieter-Haung, Ms W. Financial Admin.

THREATENED SPECIES PROGRAMME—PRETORIA (YDBR/TS)

Foden, Ms W.B. M.Sc.(Cons. Biol.). Programme Manager (contract worker)

Naidoo, Ms K. B.Sc.(Hons). Red List Officer (contract worker)
Potter, Ms L. M.Sc.(Cons.Biol.). Red List Officer (contract worker)
Rigala, Ms Z.C. N.Dip.(Hort.). Data Encoder (contract worker)
Victor, Ms J.E. M.Sc.(Plant Syst.), H.Dip.(Journ.). Control Agricultural Scientist. Red List Scientist. Taxonomy of Rutaceae, Asclepiadaceae

CUSTODIANS OF RARE AND ENDANGERED WILD FLOWERS (CREW) THREATENED PLANT PROJECT

Raimondo, Ms D.C. M.Sc. (Cons. Biol.). National Programme Manager (Pretoria)

Ebrahim, I. N.Dip.(Hort.). Fynbos Programme Manager (Cape Town)
Jacobs, L.E.O. Data Encoder. Cape Town (contract worker)
Von Witt, Ms C.G. Project Co-ordinator: Cape Floristic Region (contract worker)

SUCCULENT KAROO ECOSYSTEM PROGRAMME (SKEP)—CAPE TOWN (YDBR/SK)

Henderson, O.C. Programme Manager

Hartney, Ms D.J. B.A.(Hons)(Envir. & Geogr. Sci.) Programme Developer (contract worker)
Mathys, Ms C.N.Dip.(Journ.).Communications Intern (contract worker)
Williams, Mrs B. Dip.(Admin.). Programme Administrator (contract worker)

NATIONAL GRASSLANDS BIODIVERSITY PROGRAMME—PRETORIA (YDBR/GG)

Nazare, Ms F.C. M.Sc. Programme Co-ordinator (contract worker)

CAPE ACTION PLAN FOR PEOPLE (CAPE) PROJECT

CAPE TOWN

Sandwith, T. Programme Co-ordinator (contract worker)

Barnett, M. Ph.D. Programme Developer (contract worker)
Madaka, R. eForum Library Intern (contract worker based at UCT)

Court, Ms S.J. N.Dip.(Computer Admin.). Finance and Procurement Manager (contract worker)
Damons, Ms M.H. B.A.(Dev. & Env.). Project Development Intern (contract worker)
Parker, Mrs A. B.A.(Hons). Project Developer (contract worker)

GARDENS DIRECTORATE—ADMIN STAFF (GDIR)

PRETORIA

Willis, C.K. M.Sc.(Cons. Biol.). Chief Director: Gardens and Horticultural Services

Bagus, Mrs J. N.Dip.(Account.). Senior State Accountant. Poverty Relief Projects
Heilgendorff, J.P. N.H.Dip.(Hort.). Gardens IT Manager
Els, Ms L. N.Dip.(Sec.). Senior Secretary IV

CAPE FLATS NATURE PROJECT—CAPE TOWN (YAPR/CF)

Goldman, Ms T. B.Soc.Sci.(Hons). Project Manager (contract worker)

Hathorn, Ms P.M. B.A.(Hons), N.Dip.(Hort.). Capacity building Manager (contract worker)
Martin, Ms M. Cert.Masters Business Serv.(CMBS). Admin. Co-ordinator (contract worker)

URBAN CONSERVATION—CAPE TOWN (GDIR/UC)

Davis, G.W. Ph.D. Deputy Director: Communication. Project management and fund raising

Peter, L.M. Dip.(Hort.). Principal Communications Officer. Communications Manager. Edith Stevens Reserve
Phoswayo, Ms V. Senior Provisioning Admin. Clerk II. Admin. support

INTERPRETATION (GINN)

Roff, J. Cert.Envir.Interpr. & Ed. Communication Officer. Interpretation (Pietermaritzburg)

BUILDING PLANNING, MAINTENANCE & DEVELOPMENT—CAPE TOWN (BPMD)

Linde, D.C. N.T.C.III(Civil & Structural: Building), N.T.C.III (Inspector of Works: Building), M.S.A.I.D, Cert. Estate Agency. Control Works Inspector
Abrahams, P. Handyman. Building maintenance
Manasse, S.P. Dip.(Masonry). Artisan Foreman. Building maintenance
Peck, W.I. Senior Handyman. Building maintenance
Tomlinson E.C. Handyman. Building maintenance

CURATORS

Behr, Ms C.M. Curator: Pretoria NBGBritz, R.M. Curator: Lowveld NBG (Nelspruit)
Gavhi, M.P. Curator: Free State NBG (Bloemfontein)
Le Roux, P.H. Deputy Director. Curator: Kirstenbosch NBG (Cape Town)
Oliver, I.B. Curator: Karoo Desert NBG (Worcester)
Tarr, B.B. Curator: Natal NBG (Pietermaritzburg)
Willcock (née Turner), Mrs S.L. Curator: Walter Sisulu NBG (Roodepoort/Mogale City)
Xaba, Ms A.C. Curator: Harold Porter NBG (Betty's Bay)

HAROLD PORTER NBG—BETTY'S BAY (GHPG)

Xaba, Ms A.C. N.Dip.(Hort.). Control Agricultural Technician. Curator

Abrahamse, F. Senior Foreman. Estate maintenance and development
Arendse, L.P. Auxiliary Services Officer II. Access control
Arendse, Ms M. Auxiliary Services Officer II. Access control
Bebe, Ms N. Cleaner I
Bezuidenhout, Mrs H.M. Chief Provisioning Admin. Officer
Carolus, Ms B.J. B.Tech.(Hort.). Chief Agricultural Development Technician. Horticulture
Forrester, Ms J.A. N.T.C.III(Hort.). Chief Agricultural Development Technician. Horticulture
Julies, C.A. Provisioning Admin. Clerk
October, Ms R.P. Dip.(Ed.). Senior Auxiliary Services Officer. Plant records and admin. support
Smith, E.J. Foreman. General Garden Maintenance
Van Wyk, Ms I. (student)
Van Wyk, A.B. Artisan. General maintenance

KAROO DESERT NBG—WORCESTER (GKAR)

Oliver, I.B. N.Dip.(Hort.), N.Dip.(Parks Recrea. & Admin), N.Parks Dip. (Parks Recrea. & Management). Control Agricultural Technician. Curator

Harris, Ms S. N.Dip.(Hort). Senior Agricultural Development Technician. Scientific collections
Kwayimani, P. N.Dip.(Hort.). Senior Agricultural Development Technician. Garden management
Makubalo, F.N. Principal Foreman. Nursery
Mpeke, Ms E.N. Specialist Cleaner
Salonika, Ms A.S.D. Senior Provisioning Admin. Clerk III. Admin. support
Sibozo, N.E. Driver II. Plant sales
Simani, D.K. Principal Foreman. Plant collections
Viljoen, D.M. N.Dip.(Hort.). Chief Agricultural Development Technician. Records Officer

KIRSTENBOSCH NBG—CAPE TOWN (GKBC)

Le Roux, P.H. Dip.(Forestry), N.Dip.(Hort.), N.Dip.(Parks & Recr.), Cert.Turf Management. Deputy Director: Garden Management. Curator

Adams, T.D. B.Tech.(Hort.). Senior Agricultural Development Technician. Supervisor: Greenhouse
Hitchcock, A.N. N.H.Dip.(Hort.). Control Agricultural Development Technician. Nursery Manager
Morkel, A.T. N.Dip.(Nature Cons.). Control Agricultural Development Technician. Estate Manager
Notten, Ms A.L. B.Sc., N.Dip.(Hort.). Chief Agricultural Development Technician. Interpretive Officer
Trautman, C.E. Artisan. Supervisor: Workshop

Adonis, A. Principal Foreman. Dell & ericas
Adonis, S.J. Senior Foreman. Alien vegetation control
Arends, Ms S.J. Principal Auxiliary Services Officer. Plant records
Barnes, M. (student)
Bowler, M. Principal Foreman. Annuals
Brown, B.M. N.Dip.(Hort.). Agricultural Development Technician. Seed room
Crowie, R.W. Principal Foreman. General garden
De Abreu, Ms P. (student)
Emms, P. Kirstenbosch Scholar 2006 (contract worker)
Duncan, G.D. M.Sc., N.Dip.(Hort.). Control Agricultural Development Technician. Bulbs, systematics of *Lachenalia*
Engelbrecht, F. Senior Provisioning Admin. Clerk II. Stores
Engelbrecht, Mrs L.D. Control Auxiliary Services Officer. Plant records
Fani, L.B. (student)
Grace, T. Senior Provisioning Admin. Clerk III. Stores & admin. support
Harrower, A.D. B.Sc.(Bot. & Zoo.) Ball Agreement. Project Manager
Hope, C.F. Senior Handyman. Construction
Jacobs, H.C. Principal Foreman. Plant production
Jansen, K. Principal Foreman. Drivers
Jodamus, Ms N.L. N.Dip.(Hort.). Chief Agricultural Development Technician. Annuals, Rutaceae, alpines and Cape endemics
Kamalie, Ms S. Senior Typist. Receptionist
Kayster, G.J. Principal Foreman. Construction
Kuscus, G.W. Principal Foreman. General maintenance
Lusithi, Ms X. (student)
Mathys, Mrs S.S.B. Senior Accounting Clerk III. Revenue and garden statistics
Matthews, I.N. Principal Foreman. Estate & trails
Mbambezeli, N.G. N.Dip.(Hort). Agricultural Development Technician. Trees & shrubs
Mitchells, G. Control Specialist Groundsman. Senior Foreman. Casual staff projects
Morris, J.N.M. Senior Foreman. Proteas
Newman, W. Artisan. Mechanical workshop
Oliver, R.C. N.Dip.(Hort.). Senior Specialist Groundsman. Nursery (student)
Picane, Ms S. Auxiliary Services Officer II. Tissue culture
Prins, F.B. Security Officer III
Rudolph, A. Security Officer III
Shanks, G.R. Ball Agreement. Glass House Assistant (contract worker)
Smith, Mrs A. Senior Provisioning Admin. Clerk II. Admin. support
Solomons, T.C. Senior Security Officer II
Tamboer, J.S. Principal Foreman. Nursery services
Twine, Ms M. Chief Agricultural Development Technician. Proteas & restios
Van Gusling, E.J. Principal Foreman. Mowers
Van der Walt, Mrs L.E. N.Dip.(Hort.). Chief Agricultural Development Technician. Herbaceous collections
Van Jaarsveld, E.J. M.Sc., N.Dip.(Hort.). Control Agricultural Technician. Succulents
Van Wyk, F. Principal Auxiliary Services Officer II. Lable Maker
Viljoen, Ms C.C. N.Dip.(Hort.). Chief Agricultural Development Technician. Plant production
Voigt, W.E. N.Dip.(Hort.). Chief Agricultural Development Technician. Dell
Wall, Ms K.E. (student)

VISITORS CENTRE—CAPE TOWN (GKBC/VC)

Struys, Ms S. B.A.(Hons)(Directing), Postgrad.Dip.(Market. Manag.). Assistant Director: Communication. Events & Centre Manager

Fredericks, Ms N.C.E. Senior Auxiliary Services Officer. Visitors' Centre. Information services
Jacobs, A.P. Chief Auxiliary Services Officer. Visitors' Centre. Information services

Malan, Ms C.E. B.Sc.(Hons). Principal Communication Officer: Tour co-ordinator
Pekeur, Ms A. Senior Provisioning Administration Clerk II: Events Co-ordinator
Phillips, R. Senior Provisioning Admin. Clerk. Facilities Officer
Williams, G.C. Senior Auxiliary Services Officer. Information

LOWVELD NBG—NELSPRUIT (GLOW)

Britz, R.M. N.Dip.(Forestry). Control Agricultural Technican. Curator

Froneman, W.C.F. N.T.C.III(Hort.), N.Dip.(Nature Cons. & Man.), N.Dip.(Parks & Rec. Admin.), N.T.C.III(Hort.). Control Agricultural Technician. Nursery management & garden development
Hurter, P.J.H. B.Sc.(Hons). Control Agricultural Technician. Garden Manager. Cycad conservation
Le Roux, Ms L. N.H.Dip.(Nature Cons.). Chief Auxiliary Services Officer II. Interpretation
Maqungo, Ms V.L.B. Auxiliary Services Officer. Front line Officer
Mathebula, Ms I.N. Senior Auxiliary Services Officer. Front line Officer
Mathebula, Ms N.R. Senior Accounting Clerk I. Admin. Support
Mlombo, Ms T.C. Foreman. Garden
Mukoma, T. Dip.(Hort.), B.Tech.(Agric. Managem.), B.Tech.(Hort.). Agricultural Development Technician. Horticulturist
Ndlovu, L.D. Senior Foreman. Handyman
Ngwenya, P.S. Senior Auxiliary Services Officer II. Kiosk
Shongwe, V.P. Foreman. Garden
Sibanyoni, Ms S.M. Cleaner II
Van der Walt, Mrs G.A.M. Chief Provisioning Admin. Clerk
Xozumti, M.M. Principal Foreman. Supervisor. Garden

KWAZULU-NATAL NBG—PIETERMARITZBURG (GKZN)

Tarr, B.B. N.Dip.(Parks & Rec. Admin.), Advanced Dip.(Adult Educ.). Control Agricultural Technician. Curator

Dlungwane, T.R. Principal Foreman. Garden maintenance
Johnson, Ms I. HED, M.Sc. Control Agricultural Development Technician
Ngiba, S.E. (student)
Nonjinge, S.H.B. N.T.C.III(Hort.). Chief Agricultural Development Technician
Sibiya, Ms C.P.T. Cleaner II
Van der Merwe, Mrs M.E.H. Senior Provisioning Admin. Clerk III
Zimu, M.J. Principal Foreman. Garden

FREE STATE NBG—BLOEMFONTEIN (GFSG)

Gavhi, M.P. N.Dip.(Hort.). Control Agricultural Technician. Curator

Barnard, Ms A.D. Senior Provisioning Admin. Clerk III (part time)
Katise, Ms T.C. (student)
Lepitla, M.H. Senior Foreman. Garden
Mankazana, Ms N. (student)
May, T.S. Foreman. Garden
Ngalo, M.S. Senior Auxiliary Services Officer. Interpretation
Nyuleka, Ms N.A. Senior Accounting Clerk I
Raditlhare, Mrs E.M. Cleaner II
Rambuwani, L.D. N.Dip.(Hort.). Senior Agricultural Development Technician. Nursery
Sebolai, R.P.A.N. Senior Handyman. General maintenance

PRETORIA NBG (GPTA)

Behr, Ms C.M. B.Sc.(Hons). Control Agricultural Development Technician. Curator

Baloyi, K.J. Senior Auxiliary Services Officer II. Information Officer. Garden records
Baloyi, M.S. Dip.(IBM), Dip.(PTM), Dip.(Payroll Admin.). Senior Provisioning Admin. Clerk I. Leave records and H.R. support
Bell, Ms F.C. HED, N.Dip.(Hort.). Chief Agricultural Development Technician.
Creighton, Ms D.D. Senior Provisioning Admin. Clerk III. Admin. support
Difoloko, J.A. Dip.(Ed.), N.Dip.(Hort.). Senior Agricultural Development Technician.
Ferreira, Ms L. B.A.(Fine Art), N.Dip.(Nature Cons.). Chief Auxiliary Services Officer. Information
Keyter, B.A. Senior Security Officer II
Kutama, B.T. Principal Foreman. Garden: hard landscape development and maintenance
Lithudza, E.F. Dip.(Hort.). Chief Agricultural Development Technician
Mabapa, K.I. Cleaner II
Mahange, M.J. B.Tech.(Public Managem. & Admin.). Senior Provisioning Admin. Officer
Makgobola, Ms M.R. Auxiliary Services Officer II. Reception & admin. Support
Mahlangu, J.F. Senior Foreman. Garden: machine operators and irrigation
Mahlangu, R.E. Cert.(Office Admin.), Cert.(Plater.). Senior Artisan. Workshop and general maintenance
Mangoale, F.L. Artisan. Building construction development and maintenance
Masimula, Ms B.M. Specialist Groundsman.
Mkhasibe, Mrs N.S. Dip.(Office Admin.). Senior Provisioning Admin. Clerk I. Leave records and H.R. support

Modisha, M.D. Cleaner II
Naidoo, D.A. N.Dip.(Hort.), Dip.(Fund & Managem.). Control Agricultural Development Technician.
Ngcobo, Ms B.P. (student)
Schiel, A. Cert.(Plater). Artisan. Building construction development and maintenance
Sibiya, Ms T.R. Cleaner II
Singh, Mrs R. Senior Provisioning Admin. Clerk III. Admin. support
Solomons, Ms C.V. Principal Auxiliary Services Officer. Plant records clerk

WALTER SISULU NBG—ROODEPOORT (GSIS)

Willcock (née Turner), Mrs S.L. B.Sc.(Hons), N.Dip.(Hort.). Control Agricultural Technician. Curator

Aubrey, Mrs A.E. B.Tech.(Hort.). Chief Agricultural Development Technician. Plant records, interpretation, information (part time)
Baloyi, S.J. Handyman. Stores
Dlamini, M.D. N.Dip.(Hort.). Senior Agricultural Development Technician. Garden, nursery
Hankey, A.J. N.Dip.(Hort.), B.Tech.(Hort.). Control Agricultural Development Technician. Garden, estate, collections, nursery
Head, Mrs S.E. Dip.(Shorthand & Typing). Provisioning Admin. Officer
Mabela, H.L. (horticultural student)
Mamosebo, M.A. Factotum
Manyikana, T.M. Factotum
Mmola, Mrs B.E. Cleaner II
Mtsweni, P. N.Dip.(Hort.). Senior Agricultural Development Technician. Support services, estate
Ndou, A.P. Senior Auxiliary Services Officer II. Information services
Ndzondo, Ms N.L. Senior Provisioning Admin. Clerk I
Ndzondo, Mrs P.G. Cleaner II
Nedambale, M.P. Senior Foreman. Garden
Nemalili, M.E. Senior Foreman. Machines and vehicles
Nenungwi, M.S. Senior Foreman. Nursery
Tiro, D.W. Senior Accounting Clerk II

RESEARCH DIRECTORATE (RDIR)

PRETORIA

Smith, Prof. G.F. Ph.D., F.L.S. Chief Director: Research & Scientific Services
Marais, Mrs A.C. Senior Provisioning Admin. Officer. Personal Assistant

Arnold, T.H. Head: Data Management (Pretoria)
Crouch, Prof. N.R. Head: Ethnobotany Unit (Durban)
Donaldson, Dr J.S. Director: Kirstenbosch Research Centre (Cape Town)
Koekemoer, Dr M. Curator: National Herbarium (Pretoria)
Leistner, O.A. D.Sc. F.L.S. Agricultural Scientist (contract worker)
Meyer, Mrs N.L. B.Sc.(Hons). Agricultural Development Technician (contract worker)
Roux, Dr J.P. Curator: Compton Herbarium (Cape Town)
Singh, Ms Y. Curator: Natal Herbarium (Durban)
Steenkamp, Ms Y. Assistant Director: SABONET Regional Project Co-ordinator (Pretoria)
Wolfson, Dr M.M. Director: Research Support Services

KWAZULU-NATAL HERBARIUM—DURBAN (RHED)

Singh, Ms Y. HED, M.Sc. Control Agricultural Development Technician. Taxonomy of Araceae, Hypoxidaceae. Curator

Apollos, Mrs C.E. Senior Provisioning Admin. Clerk II. Marketing
Glen, H.F. Ph.D. Specialist Scientist. Taxonomy of trees, cultivated plants; botanical history
Glen, Mrs R.P. M.Sc. Control Agricultural Technician. Wetland plants of southern Africa
Hlongwane, Mrs N.C. Cleaner II & messenger
Keswa, V. B.Sc. Field worker. Zulu Botanical Knowledge Project (contract worker)
Magubane, M.M. Dip.(Agric.). Field work Supervisor. Zulu Botanical Knowledge Project (contract worker)
Ngwenya, M.A. Senior Agricultural Development Technician. Herbarium Officer. Plant identification and information, Zulu Botanical Knowledge Project
Mazibuko, J.V.G. Senior Auxiliary Services Officer. Herbarium Assistant
Noble, Mrs H-E. Chief Provisioning Admin. Clerk III
Parbhoo, Ms S. B.Sc.(Microbiol.). Data capturer (contract worker)

ETHNOBOTANY UNIT—DURBAN (RETH)

Crouch, Prof. N.R. Ph.D. Deputy Director. Ethnobotany of southern African flora, bioprospecting
Douwes, E. B.Sc.(Hons). (student)

NATIONAL HERBARIUM—PRETORIA (RHEN)

Koekemoer, Ms M. Ph.D. Deputy Director. Herbarium management. Taxonomy of Asteraceae: Gnaphalieae

Bredenkamp, Mrs C.L. Ph.D. Control Agricultural Scientist. Assistant Curator: Public relations. Taxonomy of *Vitex*, *Passerina*, Malvaceae, Sterculiaceae, and other related families

Fish, Mrs L. B.Sc. Principal Agricultural Scientist. Assistant Curator: Collections Manager. Taxonomy of Poaceae

Herman, P.P.J. M.Sc. Principal Agricultural Scientist. Assistant Curator: Personnel. Taxonomy of Asteraceae

Mothogoane, M.S. Chief Auxiliary Services Officer. Assistant Curator: Herbarium assistants. Wing C

Sebothoma, P.N. Cert.Sec. Principal Auxiliary Services Officer. Assistant Curator: Service room. Plant identifications co-ordinator

Van Rooy, J. Ph.D. Control Agricultural Scientist. Assistant Curator: Technical staff. Taxonomy and biogeography of mosses

Anderson, J.M. Ph.D. Specialist Scientist. Molteno Palaeoflora, Gondwana Alive

Archer Mrs C. M.Sc. Principal Agricultural Scientist. Taxonomy of Cyperaceae, monocotyledons (general)

Archer, R.H. Ph.D. Principal Agricultural Scientist. Taxonomy of mainly Celastraceae, Euphorbiaceae

Bester, S.P. M.Sc. Senior Agricultural Scientist. Taxonomy of Apocynaceae, Ericaceae, Rutaceae

Burgoyne, Ms P.M. M.Sc. Control Agricultural Scientist. Mesembryanthemaceae and Crassulaceae

Götzel, Ms A. Senior Provisioning Admin. Clerk III

Govender, Ms M. B.Sc. Senior Agricultural Development Technician. Curation and plant ID in Wing C

Jordaan, Mrs M. M.Sc. Principal Agricultural Scientist. Taxonomy of Celastraceae: Celastroideae, interactive key to the trees of southern Africa

Kgaditsi, T.W. Senior Auxiliary Services Officer. Specimen mounter, general assistant

Klopper, Ms R.R. M.Sc. Senior Agricultural Scientist. Pteridophyta and selected monocotyledonous families

Makgakga, M.C. B.Sc. Agricultural Development Technician. Curation and plant ID in Wing B

Makgakga, K.S. Principal Auxiliary Services Officer. Herbarium Assistant. Encoding plant specimens, data capturing, labels typist, curation of Wing D

Makholela, Ms T.M. Ph.D. Principal Agricultural Scientist. Taxonomy of Acanthaceae and Rubiaceae

Maserumule, M.K. Principal Auxiliary Services Officer. Curation of Wing B

Masombuka, Ms A.S. N.Dip.(Nature Cons.). Principal Auxiliary Services Officer. Herbarium Assistant. Curation of Wing A

Meyer, J.J. HED. Chief Agricultural Development Technician. Bioprospecting Project

Mothapo, M.A. H.Cert.Off.Admin.(DMS). Principal Auxiliary Services Officer. Label typist

Mpongo, T. B.Sc. Senior Agricultural Development Technician. Curation and plant ID in Wing A

Nkoane, Ms G.K. Principal Auxiliary Services Officer. Loans, exchanges, gifts, parcelling, stores

Phahla, T.J. Senior Auxiliary Services Officer. Specimen mounter of cryptogams, packer, general assistance

Phephu, Ms N. B.Sc. Agricultural Development Technician. Mosses (contract worker)

Ready, Mrs J.A. N.Dip.(Hort.). Principal Auxiliary Services Officer. Plant identifications, *Helichrysum*. Curation of Wing D

Retief, Ms E. Ph.D. Principal Agricultural Scientist. Taxonomy of Boraginaceae, Verbenaceae, Lamiaceae, Asteraceae, Rubiaceae, Geraniaceae, Oxalidaceae, Vitaceae

Smithies, Mrs S.J. M.Sc., Dip.Ed.(Moray House). Chief Agricultural Development Technician. Taxonomy of Scrophulariaceae *sens. lat.*, Pedaliaceae, Bignoniaceae, Lentibulariaceae, Gesneriaceae, Martyniaceae, Orobanchaceae

Steyn, Ms C.C. Principal Auxiliary Services Officer. Scientific support

Swelankomo, Ms N. B.Sc.(Hons). Senior Agricultural Development Technician. Curation and plant ID in Wing D

Welman, Ms W.G. M.Sc. Principal Agricultural Scientist. Taxonomy of Convolvulaceae, Solanaceae, Cucurbitaceae, Asteraceae: Senecioneae, Acanthaceae

Winter, P.J.D. M.Sc. Principal Agricultural Scientist. Taxonomy of mainly Apiaceae

AFRICAN PLANTS INITIATIVE [API] (CEPF)

PRETORIA

Rampho, Ms E.T. B.Sc. Chief Agricultural Development Technician. Project Co-ordinator (RHEN)

Chiliza, S.B. Senior Herbarium Assistant (contract worker)

Grunyuza, Ms T. N.Dip.(Fine Art). Senior Herbarium Assistant (contract worker)

Khumalo, Ms A.N. Senior Herbarium Assistant (contract worker)

Madlala, E.N. Senior Herbarium Assistant (contract worker)

Mashua, Ms T.J. (student)

Mnengwane, Ms J.J.J. Senior Herbarium Technician (contract worker)

Moeaha, Ms M.J. Senior Herbarium Technician. Poaceae Project (contract worker)

Mudau, Ms A.C. Senior Herbarium Technician. Poaceae Project (contract worker)
Nembudani, M.T. B.Sc. Senior Herbarium Technician. Poaceae Project (contract worker)
Nthungeni, N. Senior Herbarium Assistant (contract worker)
Tshidada, Ms N.J. B.Sc. Senior Herbarium Assistant (contract worker)

COMPTON HERBARIUM—CAPE TOWN

Arendse, S. M.Sc. Project Co-ordinator (contract worker)
Davids, Ms N. Data Capturer (contract worker)
Smith, Ms M. Data Capturer (contract worker)
Mannie, Ms L. M.Sc. (contract worker)
Vlotman, Ms L.R. Data Capturer (contract worker)
Williams, Mrs V.J. Dip.(Ed.). Data Capturer (contract worker)

DURBAN

Majola, S.B. Data Capturer (contract worker)
Marimuthoo, Ms D. Data Capturer (contract worker)

DATA MANAGEMENT—PRETORIA (RPDC)

Arnold, T.H. M.Sc. Principal Data Technologist. Assistant Director. Computer database application especially in taxonomy

Boman, Ms M.J. PRECIS data typist
Botha, Mrs A.G. Chief Auxiliary Services Officer. Administrative Assistant
De Wet, Mrs B.C. B.Sc.(Comp. Sci.), B.A., H.D.L.S. Principal Agricultural Datametrician. Chief PRECIS programmer (contract worker)
Mashilo, M.B. B.Sc.(Info.Technol.), IT Support Officer: API medicinal plants (contract worker)
Montshonyane, Ms E.M. Senior Herbarium Assistant: API medicinal plants (contract worker)
Mostert (née Joubert), Mrs R.E. B.Sc.(Hons). Agricultural Scientist. PRECIS Information Officer
Mphephu, T.A. Scientific Officer (contract worker)
Sachse, Ms B. B.Sc.(Hons). Medicinal Plants Project (contract worker)
Snyman, Mrs E.E. B.Sc. N.Dip.(Comp. Data Proc.). Senior Agricultural Development Technician. PRECIS Information Officer
Steenkamp, Ms Y. M.Sc. Principal Agricultural Scientist. PRECIS Information Co-ordinator
Steyn, Ms H.M. Senior Agricultural Scientist. PRECIS Information Officer

RESEARCH SUPPORT SERVICES—PRETORIA (EDIR)

Wolfson, Mrs M.M. Ph.D. Director. HDE Policy and Legislation related to Access and Benefit-sharing, Bioprospecting and Intellectual Property

Liebenberg, Mrs E.J.L. Head: Research Support Services, Publications
Naicker, K. Head: Admin. and OHASA
Potgieter, Mrs E. Principal Librarian
Ramatlo, Ms N. N.Dip.(Sec.). Senior Secretary IV
Van Wyk, E. Project manager, Millenium Seed Bank Project

ADMINISTRATION AND OHASA—PRETORIA (RPTA)

Naicker, K. Dip.(Bookkeep.), Cert.(Sales & Market. Managem.), H.Cert.(Prac. Accounting), H.Dip.(Business Managem.), Dip.(Professional Business Communic.). Assistant Director

Adams, Ms E.M. Cert.IBMDisk.Op. Senior Provisioning Admin. Officer.
Thibela, A. Dip.(Road Transport). Senior Foreman. Supervisor: Cleaning services
Bosheilo, M.S. Cleaner II
Khumalo, N.P. Cert.Labour Rela. Senior Registry Clerk II
Malefo, R.P. Cleaner II
Marule, P.M. Artisan. General maintenance
Neveling, Mrs V.H. Chief Accounting Clerk
Nkosi, Mrs M.P. Specialist Cleaner
Phaahla, M.C. Cleaner II
Ramsey, Y.K. Handyman. General maintenance
Tloubatla, J.M. Driver II. Courier services
Thobakgale, Ms N.R. N.Dip.(Comp. Sci.). Sen. Telekom Operator I. Receptionist. Herbarium Building

PUBLICATIONS—PRETORIA (RPUB)

Liebenberg, Mrs E.J.L. M.Sc. Control Agricultural Technician. Cytotaxonomy. Manager

Condy, Ms G.S. M.A. Chief Industrial Technician. Botanical artist
Du Plessis, Mrs E. B.Sc.(Hons), S.E.D. Chief Language Practitioner. Technical editor. Editing, translating, layout

Germishuizen, G. M.Sc. Assistant Director. Scientific Editor
Mapheza, T.P. Senior Provisioning Admin. Clerk III. Bookshop Manager
Momberg, Mrs B.A. B.Sc.(Entomol. & Zoo.). Principal Language Practitioner. Technical editor. Editing, layout (part time)
Maree, Ms D.J. HED. Senior Computer Operator.
Sithole, A.M. Provisioning Admin. Clerk II. Bookstore
Turck, Mrs S. B.A.(Information Design). Control Industrial Technician. Graphic design

MARY GUNN LIBRARY—PRETORIA (RLBP)

Potgieter, Ms E. B.Libr. Principal Librarian

Fourie, Mrs A. H.Dip.(Libr.Sci.). Principal Librarian (part time)
Moseki, Ms M. Library Assistant
Shipalana, Ms K.M. N.Dip.(Libr. Info. Studies). Senior Library Assistant II

MILLENNIUM SEED BANK PROJECT

PRETORIA (YRDR/MS)

Van Wyk, E. M.Sc.(Plant Ecol.). Principal Agricultural Scientist. Project manager

Mabatha, F.W. B.Envir.Sc. Chief Auxiliary Services Officer. Project Assistant (contract worker)
Nkuna, L.A. B.Envir.Sc. Senior Agricultural Development Technician. Pretoria Collecting Team Co-ordinator (contract worker)

KIRSTENBOSCH (YKBG/MS)

Cowell, Ms C.R. B.Tech.(Hort.). Senior Agricultural Development Technician. Cape Collecting Team Co-ordinator (contract worker)
Nurrish, Ms L.M. B.Tech.(Hort.). Auxiliary Services Officer. Project Assistant (contract worker)
Pekeur, Ms O.R. N.Dip.Nature Cons.). Chief Auxiliary Services Officer. Project Assistant (contract worker)

KIRSTENBOSCH RESEARCH CENTRE (RREL)

CAPE TOWN

Donaldson, J.S. Ph.D.(Zoo.). Director
Morkel, Ms L. N.Dip.(Office Admin.). Senior Secretary IV. Personal Assistant to Director

COMPTON HERBARIUM—CAPE TOWN (RHEC)

Roux, J.P. N.T.C.III(Hort.), F.L.S., Ph.D. Deputy Director. Collections Manager. Systematics of Pteridophyta
Manning, J.C. Ph.D. Senior Specialist Scientist. Research Leader, Systematics. Systematics of Iridaceae and Hyacinthaceae; anatomy

Cupido, C.N. M.Sc. Principal Scientist. Systematics of Campanulaceae (Campanuloideae)
Cupido, Ms C.S. Senior Auxiliary Services Officer II. Technical Assistant
Foster, Mrs S.E. Senior Secretary IV
Krige, Ms A. Research Intern (contract worker)
Leith, Mrs J. Cert.Primary Sch.Teacher. Senior Provisioning Admin. Clerk III
Marinus, Ms E.D.A. Dip.(Ed.). Control Auxiliary Services Officer. Herbarium Assistant
Ngcakana, S.G. Dip.(Ecol.) (student)
Parker-Allie, Ms F. M.Sc. Senior Agricultural Scientist. Taxonomy of Thymelaeaceae
Paterson-Jones, D.A. (née Snijman) Ph.D. U.E.D. Specialist Scientist. Systematics of Amaryllidaceae and Hypoxidaceae; flora of the Succulent Karoo region
Von Wit, Ms C.G. Threatened Species Programme. Project Assistant (contract worker)

GLOBAL CHANGE

Midgley, G.F. Ph.D. Chief Specialist Scientist. Plant ecophysiology, stress ecology, modelling

Arnolds, Ms J.L. Chief Auxiliary Services Officer
Kgope, B.S. M.Sc. Principal Agricultural Scientist. Plant ecophysiology
Mantlana, K.B. Principal Agricultural Scientist. Plant ecophysiology
Musil, C.F. Ph.D. Senior Specialist Scientist. Ecophysiology, modelling
Parker-Allie, F. M.Sc. Senior Scientist. Invasion biology, modelling
Snyders, S.G. Principal Auxiliary Services Officer II. Greenhouse, maintenance
Thuiller, W. Post doctoral scientist. Niche-based modelling, climate impacts modelling
De Witt, D.M. Chief Auxiliary Services Officer. Scientific research assistant

CONSERVATION BIOLOGY

Donaldson, J.S. Ph.D.(Zoo.). Cycad biology

Bösenberg, J. de Wet. B.Sc.(Hons). Chief Agricultural Development Technician. Cycad biology, Pollination Project
Ebrahim, I. N.Dip.(Hort.). Custodians of Rare and Endangered Wildflowers Programme (CREW). Co-ordinator (contract worker)
Mills, A.J. Ph.D.(Soil Sci.). Post doctoral fellow
Marinus, E.M. N.Cert.(Building & Structures). Chief Auxilliary Services Officer. Conservation farming
Nänni, Ms I. HED, B.Sc. Control Agricultural Development Technician. Project Co-ordinator
Petersen, Ms A. B.Sc.(Hons). Senior Agricultural Development Technician. Land use and vegetation mapping

LANDSCAPE ECOLOGY

Rutherford, M.C. Ph.D., Dip.(Datamet.). Chief Specialist Scientist. Modelling, global change

Daniels, Ms F. B.Sc.(Hons)(Bot. & Plant Ecol.). Threatened species research (contract worker)
Parenzee, Ms H.A. Dip.(Ed.). Senior Provisioning Admin. Clerk III
Powrie, L.W. M.Sc. Chief Information Technology Advisor. Spatial modelling, databases
Rebelo, A.G. Ph.D.(Zoo.). Control Agricultural Scientist. Protea Atlas Project

HARRY MOLTENO LIBRARY (RRLC)

Reynolds, Ms P.Y. B.Bib.(Hons), M.A.(Info. Sci.), B.Proc., Dip.(Datamet.). Chief Librarian. SANBI Website Manager

Ntsham, Ms N.L. B.Bibl. Library/website Assistant (contract worker)
Jagger, B.W. B.A.(Soc. Sci.), PGDip.Lis. Senior Librarian

SANBI WEBSITES (AMWS)

Reynolds, Ms P.Y. B.Bib.(Hons), M.A.(Info. Sci.), B.Proc., Dip.(Datamet.). Website Manager

LESLIE HILL MOLECULAR SYSTEMATICS LABORATORY

Tolley, K.A. Ph.D. Research Leader

Rossouw, Ms L. B.Sc.(Hons). Scientific Officer. DNA laboratory manager and DNA bank manager
Conrad, Ms F. M.Sc. Principal Agricultural Scientist. Molecular systematics
Houniet, D.T. DNA lab. intern (contract worker)
Khunou, Ms A. Agricultural Scientist. AFLP Manager
Mabunda, Ms M.A. B.Sc.(Hons). NBI Masters student. DNA barcoding (contract worker)
Reeves, Ms G. Ph.D. Senior Agricultural Scientist (contract worker)

INFORMATION TECHNOLOGY (RRIT)

CAPE TOWN

Evans, N. Chief Information Technology Officer. Network Controller.
Pekeur, Ms B.L. Chief Provisioning Admin. Clerk. IT support

PRETORIA

Smit, G.C. A+ (CTU), NT Workstation 4, NT Server 4. Chief Network Controller

SUPPORT SERVICES

Bardien-Overmeyer, Ms S. B.A.(Pharm.). Principal State Admin. Officer. Admin. Manager

Anderson, D.L. Artisan
Boonzaaier, I. Specialist Groundsman. Maintenance
Bowler, Mrs M. Admin. Aid II. Cleaner. Assistant: teas and functions
De Witt, D.M. Senior Artisan (B-Group). Maintenance

AFFILIATIONS

WORLD CONSERVATION UNION (IUCN) SPECIES SURVIVAL COMMISSION (SSC)—CAPE TOWN

Dublin, Ms H. Ph.D.(Zool.). Chairman. African Elephant Specialist Group, IUCN governance, Red List process, strategic planning, fundraising
Poole, Mrs C. M.Phil.(Environm. Managem.). Personal Assistant (contract worker)

AGRICULTURAL RESEARCH COUNCIL, PLANT PROTECTION RESEARCH INSTITUTE—PRETORIA

Henderson, Ms L. B.Sc.(Hons). Principal Researcher. Invasive alien plants. Project Manager of Southern African Plant Invaders Atlas (SAPIA)

NETCB SOLUTIONS

Els, Ms F. MCSE, A+, N+, Dip.(Comput.Engin.). Technical Support Officer
Modukanele, A.N. N.Cert.(Info. & Communic.), N+, Cert.Novell & Linux Sales

PUBLICATIONS BY THE STAFF

1 April 2005–31 March 2006

ADAMS, T. 2005-07. *Freylinia densiflora* Benth. (Scrophulariaceae). Internet 2 pp. http://www.plantzafrica.com/plantefg/freylindens.htm.

ADAMS, T. 2005-08. *Freylinia helmei* Van Jaarsv. (Scrophulariaceae). Internet 2 pp. http://www.plantzafrica.com/plantefg/freylinhelm.htm.

ADAMS, T. 2005-10. *Pelargonium peltatum* (L.) L'Hér. (Geraniaceae). Internet 3 pp. http://www.plantzafrica.com/plantnop/pelargpelt.htm.

ADAMS, T. 2005-11. *Pelargonium capitatum* (L.) L'Hér. (Geraniaceae). Internet 2 pp. http://www.plantzafrica.com/plantnop/pelargcapit.htm.

ANDERSON, J.M. 2005. Abstract: A brief history of gymnosperms: diversity trends. XVII International Botanical Congress, Vienna, Austria, 17–23 July 2005: 68.

ARAÚJO, M.B., PEARSON, R.G., THUILLER, W. & ERHARD, M. 2005. Validation of species climate impact models under climate change. *Global Change Biology* 11: 1504–1513.

ARCHER, C. 2005-08. Family Cyperaceae. Internet 4 pp. http://www.plantzafrica.com/plantcd/cyperaceae.htm.

ARCHER, C. & CONDY, G. (Artist). 2005a. *Habenaria bicolor* and *H. kraenzliniana*. *Flowering Plants of Africa* 59: 52–59, t. 2208, 2209.

ARCHER, C. & CONDY, G. (Artist). 2005b. *Satyrium sphaerocarpum*. *Flowering Plants of Africa* 59: 68–73, t. 2211.

ARCHER, R.H. & ARCHER, C. 2005-07. *Brunsvigia radulosa* Herb. (Amaryllidaceae). Internet 3 pp. http://www.plantzafrica.com/plantab/brunsvigrad.htm.

ARCHER, R.H. & JORDAAN, M. 2005. *Salix*: the correct application of the name *Salix mucronata*, and a new combination (Salicaceae). *Bothalia* 35: 92.

ARNOLD, T.H. & STEYN, H.M. 2005. *PRECIS.pc National Herbarium, Pretoria (PRE) Computerised Information System Specimen database user guide*. Southern African Botanical Diversity Network Report No. 39. SABONET, Pretoria.

AUBREY, A. 2005-05. *Rhus leptodictya* Diels. (Anacardiaceae). Internet 4 pp. http://www.plantzafrica.com/plantqrs/rhuslepto.htm.

BARNARD, P. & JACKSON, L. 2005. Invasive alien species—coping with aliens: invasive species—a global issue, with global solutions. In *Proceedings of Biodiversity Loss and Species Extinctions: Managing risk in a changing world, a Global Synthesis Workshop convened at the IUCN World Conservation Forum, 18–20 November, 2004, Bangkok, Thailand.* CD publication.

BARNARD, P., MIDGLEY, G. & THUILLER, W. 2005. Invasive species under global change—signs from a homogenized world. *GISPNews—Newsletter of the Global Invasive Species Programme* 4: 8–11.

BARRACLOUGH, T.G. & REEVES, G. 2005. The causes of speciation in flowering plant lineages: species-level DNA trees in the African genus *Protea*. In F.T. Bakker, L.W. Chatrou, B. Gravendeel & P.B. Pelser, *Plant species-level systematics: new perspectives on pattern and process*: 30–45. Gantner Verlag, Ruggell, Liechtenstein.

BALOYI, J.K. with additions by REYNOLDS, Y. 2005-11. *Rothmannia globosa* (Hochst.) Keay (Rubiaceae). Internet 2 pp. http://www.plantzafrica.com/plantqrs/rothmanglob.htm.

BEATTIE, A.J., BARTHLOTT, W., ELIZABETSKY, E., FARREL, R., KHENG, C.T., PRANCE, I., ROSENTHAL, J., SIMPSON, D., LEAKEY, R., WOLFSON, M. & TEN KATE, K. 2005. New products and industries from biodiversity. In R. Hassan, R. Scholes & N. Ash, *Ecosystems and human wellbeing: current state and trends: findings of the Condition and Trends Working Group*, vol. 1: 271–295. Millenium Ecosystem Assessment. Island Press, Washington, Covelo, London.

BEHR, K. 2005-06. *Ochna pulchra* Hook.f. (Ochnaceae). Internet 3 pp. http://www.plantzafrica.com/plantnop/ochnapul.htm.

BEHR, K. 2005-08. *Dombeya pulchra* N.E.Br. (Sterculiaceae). Internet 3 pp. http://www.plantzafrica.com/plantcd/dombeypul.htm.

BESTER, S.P. 2005-10. *Ancylobotrys capensis* (Oliv.) Pichon (Apocynaceae). Internet 5 pp. http://www.plantzafrica.com/plantab/ancylobcap.htm.

BESTER, S.P. 2006. *Orbea* Haw. (Apocynaceae). Internet 8 pp. http://www.plantzafrica.com/plantnop/orbea.htm.

BESTER, S.P., ARCHER, R.H. & CONDY, G. (Artist). 2005. *Hoodia flava* (Apocynaceae: Asclepiadoideae). *Flowering Plants of Africa* 59: 100–106, t. 2215.

BESTER, S.P. & RETIEF, E. 2005. *Ehretia namibiensis* subsp. *namibiensis*: a new distribution record in the *Flora of southern Africa* (*FSA*) region. *Bothalia* 35: 163.

BESTER, S.P. & VICTOR, J.E. 2005. *Schizoglossum umbelluliferum*: an unusual milkweed re-collected in Pretoria after 109 years. *Veld & Flora* 91: 166.

BOMHARD, B., RICHARDSON, D.M., DONALDSON, J.S., HUGHES, G.O., MIDGLEY, G.F., RAIMONDO, D.C., REBELO, A.G., ROUGET, M. & THUILLER, W. 2005. Potential impacts of future land use and climate change on the Red List status of the Proteaceae in the Cape Floristic Region, South Africa. *Global Change Biology* 11: 1452–1468.

BREDENKAMP, C.L. 2005-11. *Nylandtia scoparia* (Eckl. & Zeyh.) Goldblatt & J.C.Manning (Polygalaceae). Internet 3 pp. http://www.plantzafrica.com/plantnop/nyladscop.htm.

BREDENKAMP, C.L. & SMITH, G.F. 2006. Abstract: Flora of the Eastern Cape. *Proceedings of the Annual Congress of the South African Association of Botanists, Nelson Mandela Metropolitan University, Port Elizabeth* 32: 87.

BROENNIMANN, O., THUILLER, W., HUGHES, G.O., MIDGLEY, G.F., ALKEMADE, J.M.R. & GUISAN, A. 2006. Do geographic distribution, niche property and life form explain plants' vulnerability to global change? *Global Change Biology* 12: 1079–1093.

BURGOYNE, P.M. 2005-10. *Delosperma* N.E.Br. (Mesembryanthemaceae). Internet 6 pp. http://www.plantzafrica.com/plantcd/delosperma.htm.

BURGOYNE, P.M. 2006. Searching for *Delosperma* in Eastern Cape. *Plantlife* 32: 29–33.

BURGOYNE, P.M., VAN WYK, A.E., ANDERSON, J.M. & SCHRIRE, B.D. 2005. Phanerozoic evolution of plants on the African plate. *Journal of African Earth Sciences* 43: 13–52.

BURRING, J.H. 2005-08. *Scolopia mundii* (Eckl. & Zeyh.) Warb. (Flacourtiaceae). Internet 4 pp. http://www.plantzafrica.com/plantqrs/scolopmund.htm.

BURRING, J.H. & VAN DER WALT, L. 2006. The weed exchange. A new garden at Kirstenbosch puts the spotlight on problem plants South Africa has given the World. *Veld & Flora* 92: 18–22.

BURROWS, J.E. & WILLIS, C.K. (eds). 2005. *Plants of the Nyika Plateau: an account of the vegetation of the Nyika National Parks of Malawi and Zambia*. Southern African Botanical Diversity Network Report No. 31. SABONET, Pretoria.

CAROLUS, B. 2005-09. *Erica leucotrachela* H.A.Baker (Ericaceae). Internet 2 pp. http://www.plantzafrica.com/plantefg/ericaleucotrach.htm.

CAROLUS, B. 2005-12. *Erica fastigiata* L. (Ericaceae) Internet 2 pp. http://www.plantzafrica.com/plantefg/ericafast.htm.

CHESSELET, P. 2005-05. *Sceletium tortuosum* (L.) N.E.Br. (Mesembryanthemaceae). Internet 3 pp. http://www.plantzafrica.com/plantqrs/sclettort.htm.

CHESSELET, P. & PIGNAL, M. 2005. Lamarck's new species of Mesembryanthemaceae and the types of their names. *Bothalia* 35: 29–33.

CRAVEN, P. & STEENKAMP, Y. 2005. Centres of plant endemism and diversity in SABONET countries. *SABONET News* 9: 16.

CROUCH, N.R., LANGLOIS, A., MULHOLLAND, D.A. & NAIR, J.J. 2005. A novel alkylamide from the leaves of *Acmella caulirhiza* (Asteraceae), a traditional surface analgesic. *South African Journal of Botany* 71: 228–230.

CROUCH, N.R., LÖTTER, M.C., KRYNAUW, S. & POTTAS-BIRCHER, C. 2005. *Siphonochilus aethiopicus*. In G. Nichols, *Growing rare plants: a practical handbook on propagating the threatened plants of southern Africa*: 149–152. Southern African Botanical Diversity Network Report No. 36. SABONET, Pretoria.

CROUCH, N.R., SMITH, G.F. & CONDY, G. (Artist). 2005. *Impatiens flanaganiae*. (Balsaminaceae). *Flowering Plants of Africa* 59: 84–92, t. 2213.

CROUCH, N.R. & SYMMONDS, R. 2006. Propagation technologies for medicinal plants. In N. Diederichs, *Commercializing medicinal plants*: *a southern African guide*: 55–66. Sun Press, Stellenbosch.

CROUCH, N.R., SYMMONDS, R., SPRING, W. & DIEDERICHS, N. 2005. Fact sheet for growing popular medicinal plant species. In N. Diederichs, *Commercializing medicinal plants*: *a southern African guide*: 99–144. Sun Press, Stellenbosch.

CUPIDO, C. 2005-08. *Aspalathus* L. (Fabaceae). Internet 5 pp. http://www.plantzafrica.com/ plantab/aspalathus.htm.

CUPIDO, C. 2005-12. *Merciera* A.DC. (Campanulaceae). Internet 3 pp. http://www.plantzafrica.com/plantklm/merciera.htm.

DAVIDOFF, S., STRUTHERS, K. & VAN JAARSVELD, E.J. 2005. The Towerland succulent roof garden. *Veld & Flora* 91: 142–144.

DAVIS, K., WILLIAMS, C. & WOLFSON, M. 2006. DNA banking and the Convention on Biological Diversity. In V. Savolainen, M.P. Powell, K. Davis, G. Reeves & A. Corthals, *DNA and tissue banking for biodiversity and conservation: theory, practice and uses*: 18–29. Kew Publishing in association with IUCN.

DAVIS, K., WILLIAMS, C., WOLFSON, M. & DONALDSON, J. 2006. Practical implementation of the CBD and CITES. In V. Savolainen, M.P. Powell, K. Davis, G. Reeves & A. Corthals, *DNA and tissue banking for biodiversity and conservation: theory, practice and uses*: 36–46. Kew Publishing in association with IUCN.

DEMISSEW, S., NIC LUGHADHA, E. & SMITH, G.F. 2005. Abstract: The African Plants Initiative: digitising and datasharing through Aluka. *Abstracts of the International Botanical Congress, Vienna, Austria* 17: 209.

DIFOLOKO, J.A. 2005-06. *Faidherbia albida* (Delile) A.Chev. (Fabaceae). Internet 3 pp. http://www.plantzafrica.com/plantefg/faidalb.htm.

DLAMINI, M.D. 2005-06. *Acacia polyacantha* Willd. subsp. *campylacantha* (Hochst. ex A.Rich.) Brenan (Fabaceae: Mimosoideae). Internet 4 pp. http://www.plantzafrica.com/plantab/acaciapoly.htm.

DLAMINI, M.D. 2005-10. *Mystroxylon aethiopicum* (Thunb.) Loes. (Celastraceae). Internet 3 pp. http://www.plantzafrica.com/plantklm/mystroxaeth.htm.

DLAMINI, M.D. 2005-12. *Acacia erioloba* E.Mey. (Fabaceae). Internet 4 pp. http://www.plantzafrica.com/plantab/acaciaeriol.htm.

DLAMINI, M.D. 2005-12. *Croton gratissimus* Burch. (Euphorbiaceae). Internet 3 pp. http://www.plantzafrica.com/plantcd/crotongrat.htm.

DONALDSON, J.S. 2006a. Review: Ex situ plant conservation: supporting species survival in the wild, by E.O. Guerrant Jr, K. Havens & M. Maunder, 2004. *South African Journal of Botany* 72: 306.

DONALDSON, J.S . 2006b. Preventing plant extinctions due to unsustainable international trade. In C.K. Willis, Conserving South Africa's plants: a South African response to the Global Strategy for Plant Conservation. *SANBI Biodiversity Series* 1: 47–49. South African National Biodiversity Institute, Pretoria.

DUNCAN, G. 2005. *Haemanthus* and their cultivation. *The Plantsman* 4: 220–226.

DUNCAN, G. 2005-06. *Onixotis stricta* (Burm.f.) Wijnands (Colchicaceae). Internet 3 pp. http://www.plantzafrica.com/plantnop/onixotis.htm.

DUNCAN, G. 2005-07. *Babiana pygmaea* (Burm.f.) Baker (Iridaceae). Internet 3 pp. http://www.plantzafrica.com/plantab/babianpyg.htm.

DUNCAN, G. 2005-09. *Moraea gigandra* L.Bolus (Iridaceae). Internet 4 pp. http://www.plantzafrica.com/plantklm/moragigan.htm.

DUNCAN, G. 2005-10. *Dierama pendulum* (L.f.) Baker (Iridaceae). Internet 4 pp. http://www.plantzafrica.com/plantcd/dieramapend.htm.

DUNCAN, G., McMASTER, C. & McMASTER, R. 2005. Out of the ashes (*Lachenalia sargeantii*). *Veld & Flora* 91: 66–69.

DU TOIT, K., ELGORASHI, E.E., MALAN, S.F., DREWES, S.E., VAN STADEN, J., CROUCH, N.R. & MULHOLLAND, D.A. 2005. Anti-inflammatory activity and QSAR studies of compounds isolated from Hyacinthaceae species and *Tachiadenus longiflorus* Griseb. (Gentianaceae). *Bioorganic & Medicinal Chemistry* 13 : 2561–2568.

EBRAHIM, I., VON WITT, C.G. & COHEN, C. 2005. Peacocks, ploughs and porcupines: the plight of the peacock moraeas. *Veld & Flora* 91: 185–187.

FERREIRA, L. 2005-11. *Panicum maximum* Jacq. (Poaceae). Internet 3 pp. http://www.plantzafrica.com/plantnop/panicummax.htm.

FISH, L. 2005a. Cyperaceae, Commelinaceae, Poaceae. In J.E. Burrows & C.K. Willis, *Plants of the Nyika Plateau: an account of the vegetation of the Nyika National Parks of Malawi and Zambia*: 294–305, 338–366. Southern African Botanical Diversity Network Report No. 31. SABONET, Pretoria.

FISH, L. 2005b. *Eragrostis superba* Peyr. (Poaceae). Internet 2 pp. http//www.plantzafrica.com/plantefg/eragrostsup.htm.

FISH, L. 2005-07. *Pogonarthria squarrosa* (Roem. & Schult.) Pilg. (Poaceae). Internet 3 pp. http://www.plantzafrica.com/plantnop/pogonsqua.htm.

FODEN, W., MIDGLEY, G.F., HUGHES, G.O., THUILLER, W., BISHOP, J., BOND, W.J., HOFFMAN, M.T., KALEME, P., REBELO, P. & HANNAH, L. 2005. The impacts of climate change on *Aloe dichotoma* (the *kokerboom*): implications for the conservation and management of threatened plants. *South African Journal of Botany* 71: 265.

FODEN, W. & SMITH, G.F. 2006. Objective 1: understanding and documenting plant diversity. Plants under threat: Red Data Lists to the rescue. Target 2: a preliminary assessment of the conservation status of all known plant species, at national, regional and international levels. In C.K. Willis, Conserving South Africa's plants. A South African response to the Global Strategy for Plant Conservation. *SANBI Biodiversity Series* 1: 15–18. South African National Biodiversity Institute, Pretoria.

FOREST, F. & SAVOLAINEN, V. 2005. Species-level phylogenies from continental biodiversity hotspots. In F.T. Bakker, L.W. Chatrou, B. Gravendeel & P.B. Pelser, *Plant species-level systematics: new perspectives on pattern and process*: 17–30. Gantner Verlag, Ruggell, Liechtenstein.

FORRESTER, J. 2005-04. *Pelargonium grossularioides* (L.) L'Hér. (Geraniaceae). Internet 3 pp. http://www.plantzafrica.com/plantnop/pelarggross.htm.

FORRESTER, J. 2005-08. *Pterocelastrus tricuspidatus* (Lam.) Sond. (Celastraceae). Internet 4 pp. http://www.plantzafrica.com/plantnop/pterocelastri.htm.

FRAZEE, S., BARNARD, P. & COWLING, R.M. 2005. |Ai-|Ais-Richtersveld-Sperrgebiet: transboundary conservation in an arid hotspot. In R.A. Mittermeier, C.F. Kormos, C.G. Mittermeier, G.P. Robles, T. Sandwith & C. Besançon, *Transboundary conservation: a new vision for protected areas*: 257–263. CEMEX/ Conservation International.

FULLARD, D. 2005. Biodiversity education at Kirstenbosch Botanical Garden. World Heritage Convention. *Roots* 2,1: 26–28.

GERMISHUIZEN, G., CROUCH, N.R. & CONDY, G. (Artist). 2005. *Afzelia quanzensis*. (Fabaceae: Caesalpinioideae). *Flowering Plants of Africa* 59: 74–83, t. 2212.

GLEN, H.F. 2005-06. *Dierama reynoldsii* I.Verd. (Iridaceae). Internet 4 pp. http://www.plantzafrica.com/plantcd/dieramrey.htm.

GLEN, H.F. 2005-10. *Bruguiera gymnorrhia* (L.) Lam. (Rhizophoraceae). Internet 5 pp. http://www.plantzafrica.com/plantab/brugym.htm.

GLEN, H.F. 2005a. What's in a name? Where do these names come from? *The Gardener*, Aug.: 39.

GLEN, H.F. 2005b. What's in a name? Ferrari and his Tale of Limax and Bruchus! *The Gardener*, Sept.: 54, 55.

GLEN, H.F. 2005c. What's in a name? Grünes, Paradieser, Kukuruz, Grürken. *The Gardener*, Oct.: 41.

GLEN, H.F. 2005d. What's in a name? More hot stuff! *The Gardener*, Nov.: 48.

GLEN, H.F. 2005e. What's in a name? More hot stuff! *The Gardener*, Dec.: 58.

GLEN, R. 2005. Review: Floating islands: a global bibliography, by C. van Duzer, 2004. *African Journal of Aquatic Science* 30: 219, 220.
GLEN, R. 2005-12. *Gunnera perpensa* L. (Gunneraceae). Internet 4 pp. http://www.plantzafrica.com/plantefg/gunnerperp.htm.
GOLDBLATT, P., BERNHARDT, P. & MANNING, J.C. 2005. Pollination mechanisms in the African genus *Moraea* (Iridaceae, Iridoideae): floral divergence and adaptation for pollinators. *Adansonia*, sér. 3, 27: 21–46.
GOLDBLATT, P., DOLD, A.P. & MANNING, J.C. 2005. Three cryptic new species of *Aristea* (Iridaceae) from southern Africa. *Bothalia* 35: 1–6.
GOLDBLATT, P. & MANNING, J.C. 2005. Taxonomic notes on *Babiana* and *Ferraria* in arid western southern Africa (Iridaceae). *Bothalia* 35: 71–74.
GOLDBLATT, P., MANNING, J.C. & BERNHARDT, P. 2005. The floral biology of *Melasphaerula* (Iridaceae: Crocoideae): is this monotypic genus pollinated by March flies (Diptera: Bibionidae)? *Annals of the Missouri Botanical Garden* 92: 268–274.
GOLDBLATT, P., MANNING, J.C. & SNIJMAN, D. 2005. Cape plants: corrections and additions to the flora. 1. *Bothalia* 35: 35–46.
GRYZENHOUT, M., GLEN, H.F., WINGFIELD, B.D. & WINGFIELD, M.J. 2005. (1686) Proposal to conserve the name *Cryphonectria* (Diaporthales) with a conserved type. *Taxon* 54: 539, 540.
GUISAN, A. & THUILLER, W. 2005. Predicting species distribution: offering more than simple habitat models. *Ecology Letters* 8: 993–1009.
HANKEY, A. 2005-06. *Mimusops zeyher* Sond. (Sapotaceae). Internet 3 pp. http://www.plantzafrica.com/plantklm/mimusopzey.htm.
HANKEY, A. 2005-09. *Cussonia transvaalensis* Reyneke (Araliaceae). Internet 3 pp. http://www.plantzafrica.com/plantcd/cussontrans.htm.
HANKEY, A. 2005a. Letter from Johannesburg. *South African Gardening*, Sept.: 105.
HANKEY, A. 2005b. Africa tamed. *South African Gardening*, Dec.: 30–33.
HANKEY, A. 2005c. Choosing the right tree for the job. *My World* 3: 59.
HANKEY, A. 2005d. Nature's wonder drink, rooibos. *My World* 6: 47, 48.
HANNAH, L., MIDGLEY, G., HUGHES, G. & BOMHARD, B. 2005. The view from the Cape: extinction risk, protected areas, and climate change. *BioScience* 55: 231–242.
HARROWER, A. Review: Cotyledon and Tylecodon, by E. van Jaarsveld & D. Koutnik. *Veld & Flora* 91: 93.
HERMAN, P.P.J. 2005a. Infraspecific taxa in a southern African *Pavetta* species (Rubiaceae). *Bothalia* 35: 84–87.
HERMAN, P.P.J. 2005b. Review: Riches of the forest: for health, life and spirit in Africa, edited by Citlalli López & Patricia Shanley, 2004. *Bothalia* 35: 185, 186.
HERMAN, P.P.J. 2005-07. *Dimorphothea jucunda* E.Phillips (Asteraceae/Compositae). Internet 4 pp. http://www.plantzafrica.com/plantcd/dimorphjuc.htm.
HERMAN, P.P.J. 2005-09. *Hymenolepis parviflora* (L.) DC. (Asteraceae/Compositae). Internet 3 pp. http://www.plantzafrica.com/planthij/hymenolepparv.htm.
HITCHCOCK, A. 2006. Restoration conservation at Kirstenbosch. *Veld & Flora* 92: 40–44.
HUNTLEY, B.J., WILLIS, C.K. & PRIVETT, S.D.J. 2006. Training in plant conservation. In C.K. Willis, Conserving South Africa's plants: a South African response to the Global Strategy for Plant Conservation. *SANBI Biodiversity Series* 1: 63–65. South African National Biodiversity Institute, Pretoria.
HURTER, P.J.H. & VAN WYK, A.E. 2005. *Acacia ormocarpoides* (Mimosoideae) from Sekhukhuneland (Fabaceae). *Bothalia* 35: 166–169.
JODAMUS, N. 2005-04. *Diosma prama* I.Williams (Rutaceae). Internet 3 pp. http://www.plantzafrica.com/plantcd/diosprama.htm.
JODAMUS, N. 2005-05. *Acmadenia obtusata* (Thunb.) Bartl. & H.L.Wendl. (Rutaceae). Internet 3 pp. http://www.plantzafrica.com/plantab/acmadenobst.htm.
JODAMUS, N. 2005-05. *Adenandra obtusata* Sond. (Rutaceae). Internet 3 pp. http://www.plantzafrica.com/plantab/adenandobt.htm.
JODAMUS, N. 2005-11. *Diosma hiruta* L. 'Blue Downs'. (Rutaceae). Internet 4 pp. http://www.plantzafrica.com/plantcd/diosmahirsutbd.htm.
JOHNSON, I.M. 2005-10. *Anemone fanninii* Harv. ex Mast. (Ranunculaceae). Internet 2 pp. http://www.plantzafrica.com/plantab/anemonfan.htm.
JOHNSON, I.M., EDWARDS, T.J. & CONDY, G. (Artist). 2005. *Gerbera aurantiaca* (Asteraceae). *Flowering Plants of Africa*. 59: 134–139, t. 2220.
JOHNSON, I.M. & TARR, B. 2005. *Gerbera aurantiaca*. The Hilton daisy. In G. Nichols, *Growing rare plants: a practical handbook on propagating the threatened plants of southern Africa*: 78, 79. Southern African Botanical Diversity Network Report No. 36. SABONET, Pretoria.
JORDAAN, M. 2005a. Die ghwarries van Suid-Afrika. *Dendron* 37: 23–27.
JORDAAN, M. 2005b. *FSA* contributions 18: Salicaceae *s. str*. *Bothalia* 35: 7–20.
JORDAAN, M. 2005-11. *Ficus ingens* (Miq.) Miq. (Moraceae). Internet 4 pp. http://www.plantzafrica.com/plantefg/ficusingens.htm.
JORDAAN, M. & VAN WYK, A.E. 2005. A new species of *Gymnosporia* (Celastraceae) from southern Africa. *Novon* 15: 301–304.
KGOPE, B.S., MIDGLEY, G.F., BOND, W.J. & WOODWARD, F.I. 2005. Evidence for a CO_2 controlled mechanism to explain tree invasion of African savannas and adjacent grasslands. *South African Journal of Botany* 71: 267.
KHANYILE, S. 2006-01. *Gnidia triplinervis* Meisn. (Thymelaeaceae). Internet 2 pp. http://www.plantzafrica.com/plantefg/gnidiatrip.htm.
KHANYILE, S. 2006-01. *Watsonia canaliculata* Goldblatt (Iridaceae). Internet 2 pp. http://www.plantzafrica.com/plantwxyz/watsoncanal.htm.
KLOPPER, R.R. 2005a. Collecting good herbarium specimens (Part 2). *Pteridoforum* 73: 1–3.
KLOPPER, R.R. 2005b. Now you know! William Townsend Aiton (1766–1849). *Pteridoforum* 73: 6.
KLOPPER, R.R. 2005c. Ferns in outer space. *Pteridoforum* 75: 3–5.
KLOPPER, R.R. 2005-09. *Ornithogalum saundersiae* Baker (Hyacinthaceae). Internet 4 pp. http://www.plantzafrica.com/plantnop/ornithogsaund.htm.
KLOPPER, R.R. 2005-11. *Galtonia candicans* (Baker) Decne. (Hyacinthaceae). Internet 2 pp. http://www.plantzafrica.com/plantefg/galtoncand.htm.
KLOPPER, R.R. 2006. *Thelypteris* or not *Thelypteris*? *Pteridoforum* 76: 1–4.
KLOPPER, R.R., SMITH, G.F., GAUTIER, L., CHATELAIN, C. & SPICHIGER, R. 2006. Abstract: The African Plant Checklist and Database Project. *Proceedings of the Annual Congress of the South African Association of Botanists*, Nelson Mandela Metropolitan University, Port Elizabeth 32: 93.
KNIGHT, A., DRIVER, A., COWLING, R.M., MAZE, K., DESMET, P., LOMBARD, A.T., ROUGET, M., BOTHA, M., BOSHOFF, A.F., CASTLEY, G.J., GOODMAN, P., MACKINNON, K., PIERCE, S.M., SIMS-CASTLEY, R., STEWART, W. & VON HASE, A. 2005. Improving our practice through social learning: perspectives and lessons from conservation planning in South Africa. *Conservation Biology* 20: 739–750.
KOEKEMOER, M. 2005. Bryophyta, Asteraceae. In J.E. Burrows & C.K. Willis, *Plants of the Nyika Plateau: an account of the vegetation of the Nyika National Parks of Malawi and Zambia*: 21–24, 78–113. Southern African Botanical Diversity Network Report No. 31. SABONET, Pretoria.
KOEKEMOER, M. 2005-04. *Euryops tenuissimus* (L.) DC. (Asteraceae). Internet 3 pp. http://www.plantzafrica.com/plantefg/euryoptenu.htm.
KOORBANALLY, C., MULHOLLAND, D.A. & CROUCH, N.R. 2005a. A novel 3-hydroxy-3-benzyl-4chromanone-type homoisoflavonoid from *Albuca fastigiata* (Ornithogaloideae: Hyacinthaceae). *Biochemical Systematics and Ecology* 33: 545–549.
KOORBANALLY, C., MULHOLLAND, D.A. & CROUCH, N.R. 2005b. A novel homoisoflavonoid from *Drimia delagoensis* (Urgineoideae: Hyacinthaceae). *Biochemical Systematics and Ecology* 33: 743–748.
KURZWEIL, H. 2005a. Observations on the development of the placentas and closing bodies in the fruit capsules of some Mesembryanthema (Aizoaceae). *Botanische Jahrbücher* 126: 385–401.
KURZWEIL, H. 2005b. Taxonomic studies in the genus *Disperis* (Orchidaceae) in southeast Asia. *Blumea* 50: 143–152.
KURZWEIL, H. 2005-08. *Satyrium coriifolium* Sw. (Orchidaceae). Internet 3 pp. http://www.plantzafrica.com/plantqrs/satyrcori.htm.

KURZWEIL, H. 2005-12. *Bonatea speciosa* (L.f.) Willd. (Orchidaceae). Internet 3 pp. http://www.plantzafrica.com/plantab/bonatspec.htm.

KURZWEIL, H. & BURROWS, S. (Artist). 2005. *Platycoryne mediocris* (Orchidaceae). *Flowering Plants of Africa* 59: 60–66, t. 2210.

KURZWEIL, H. & MANNING, J.C. 2005. A synopsis of the genus *Disperis* Sw. (Orchidaceae). *Adansonia*, sér. 3, 27: 155–207.

LANGLOIS, A., MULHOLLAND, D.A., DUNCAN, G.D., CROUCH, N.R. & EDWARDS, T.J. 2005. A novel 3-benzylchromone from the South African *Lachenalia rubida* (Hyacinthaceae). *Biochemical Systematics and Ecology* 33: 961–966.

LEISTNER, O.A., WINTER, P.J.D. & CONDY, G. (Artist). 2005. *Hibiscus coddii* subsp. *barnardii* (Malvaceae). *Flowering Plants of Africa* 59: 94–99, t. 2214.

LE ROUX, L. 2005-05. *Bauhinia tomentosa* L. (Fabaceae). Internet 3 pp. http://www.plantzafrica.com/plantab/bauhintoment.htm.

LEZAR, A., DEARLOVE, K. & WOLFSON, M.M. 2006. Target 9: conserving crop diversity. In C. Willis, Conserving South Africa's plants: a South African response to the Global Strategy for Plant Conservation. *SANBI Biodiversity Series* 1: 40, 41.

LINDER, H.P., KURZWEIL, H. & JOHNSON, S.D. 2005. The southern African orchid flora: composition, sources and endemism. *Journal of Biogeography* 32: 29–47.

LITHUDZHA, E. 2005-08. *Boophone disticha* (L.f.) Herb. (Amaryllidaceae). Internet 3 pp. http://www.plantzafrica.com/plantab/boophdist.htm.

LOVETT, J.C., BARNARD, P. & MIDGLEY, G.F. 2006. Policy piece: National Climate Change Conference in South Africa. *African Journal of Ecology* 43: 279–281.

LOVETT, J.C., MIDGLEY, G.F. & BARNARD, P. 2006. Policy piece: Climate change and ecology in Africa. *African Journal of Ecology* 43: 167–169.

LOW, B., POND, U. & VAN JAARSVELD, E.J. 2006. *Aloe kouebokkeveldensis*. A new species of *Aloe* endemic to the Cape fynbos. *Veld & Flora* 92: 30–33.

LUCKOW, M., HUGHES, C., SCHRIRE, B., WINTER, P., FAGG, C., FORTUNATO, R., HURTER, J., RICO, L., BRETELER, F.J., BRUNEAU, A., CACCAVARI, M., CRAVEN, L., CRISP, M., DELGADOS, A., DEMISSEW, S., DOYLE, J.J., GRETHER, R., HARRIS, S., HERENDEEN, P.S., HERNÁNDEZ, H.M., HIRSCH, A.M., JOBSON, R., KLITGAARD, B.B., LABAT, J.-N., LOCK, J.M., MACKINDER, B., PFEIL, B., SIMPSON, B.B., SMITH, G.F., SOUSA S., M., TIMBERLAKE, J., VAN DER MAESEN, J.G., VAN WYK, A.E., VORSTER, P., WILLIS, C.K., WIERINGA, J.J. & WOJCIECHOWSKI, M.F. 2005. *Acacia*: the case against moving the type to Australia. *Taxon* 54: 513–519.

MAKGAKGA. C. 2005-09. *Tapinanthus oleifolius* (J.C.Wendl.) Danser (Loranthaceae). Internet 2 pp. http://www.plantzafrica.com/planttuv/tapinanoleif.htm.

MALAN, C. & NOTTEN, A. 2005-04. *Trema orientalis* (L.) Blume (Celtidaceae). Internet 3 pp. http://www.plantzafrica.com.planttuv/tremorient.htm.

MALAN, C. & NOTTEN, A. 2005-05. *Crassula ovata* (Miller) Druce (Crassulaceae). Internet 4 pp. http://www.plantzafrica.com/plantcd/crassovat.htm.

MALAN, C. & NOTTEN, A. 2006-01. *Carpobrotus edulis* (L.) L.Bolus (Mesembryanthemaceae). Internet 5 pp. http://www.plantzafrica.com/plantcd/carpobed.htm.

MANNING, J.C. 2005a. Pollination in *Clivia*. *Clivia* 7: 17–22.

MANNING, J.C. 2005b. The significance of colour and ultraviolet patterning in *Clivia miniata*. *Clivia* 7: 23–25.

MANNING, J.C. 2006. Plant profile: not grandma's horticulture. *Horticulture* Jan./Feb. 2006: 50–55.

MANNING, J.C., FOREST, F. & MANNHEIMER, C.A. 2005. *Eremiolirion*, a new genus of southern African Tecophilaeaceae, and taxonomic notes on *Cyanella alba*. *Bothalia* 35: 115–120.

MANNING, J.C. & GOLDBLATT, P. 2005a. A new species of *Freesia* (Iridaceae: Crocoideae) from the Succulent Karoo, South Africa, and notes on nomenclature and infrageneric classification. *Novon* 15: 168–172.

MANNING, J.C. & GOLDBLATT, P. 2005b. Radiation of pollination systems in the Cape genus *Tritoniopsis* (Iridaceae: Crocoideae) and the development of biomodal pollination strategies. *International Journal of Plant Sciences* 166: 459–474.

MANNING, J.C. & GOLDBLATT, P. 2005c. Two new species of Asteraceae from Northern and Western Cape, South Africa and a new synonym. *Bothalia* 35: 55–61.

MANNING, J.C. & GOLDBLATT, P. 2005d. A new species of *Harveya* from Western Cape, South Africa (Orobanchaceae). *Bothalia* 35: 89–91.

MBAMBEZELI, G. 2005-05. *Athrixia phylicoides* DC. (Asteraceae). Internet 2 pp. http://www.plantzafrica.com/plantab/athrixphyl.htm.

MBAMBEZELI, G. 2005-08. *Albuca batteniana* Hilliard & B.L.Burtt (Hyacinthaceae). Internet 2 pp. http://www.plantzafrica.com/plantab/albucabat.htm.

MBAMBEZELI, G. 2005-12. *Cryptocarya woodii* Engl. (Lauraceae). Internet 2 pp. http://www.plantzafrica.com/plantcd/crytocarwood.htm.

McCLEAN, C.J., LOVETT, J.C., KÜPER, W., HANNAH, L., SOMMER, J.H., BARTHLOTT, W., TERMANSEN, M., SMITH, G.F., TOKUMINE, S. & TAPLIN, J.R.D. 2005. African plant diversity and climate change. *Annals of the Missouri Botanical Garden* 92: 139–152.

MIDGLEY, G.F. 2005. Review: Climate change and the Kyoto protocol's Clean Development Mechanism, by M. Orford, S. Raubenheimer & B. Kantor, 2004. *Veld & Flora* 91: 149.

MIDGLEY, G.F. 2006a. Review: Adaptations and responses of woody plants to environmental stress, edited by Rajeev Arora. Food Products Press, New York, 2004. *South African Journal of Botany* 72: 185, 186.

MIDGLEY, G.F. 2006b. The Kyoto Protocol. In D. Parry-Davies, *Enviropaedia*: Environmental Encyclopaedia and Networking Directory for southern Africa. Eco-Logic Publishing, Cape Town.

MIDGLEY, G.F., CHAPMAN, R.A., HEWITSON, B., JOHNSTON, P., DE WIT, M., ZIERVOGEL, G., MUKHEIBIR, P., VAN NIEKERK, L., TADROSS, M., VAN WILGEN, B.W., KGOPE, B., MORANT, P.D., THERON, A., SCHOLES, R.J. & FORSYTH, G.G. 2005. *A status quo, vulnerability and adaptation assessment of the physical and socio-economic effects of climate change in the Western Cape*. CSIR Report No. ENV-S-C 2005-073.

MIDGLEY, G.F., REEVES, G., KLAK, C. & RICHARDSON, J. 2005. Late Tertiary and Quaternary climate change and centres of endemism in the southern African flora. In A. Purvis, J. Gittleman & T. Brooks, *Phylogeny and conservation*: 230–242. Cambridge University Press, Cambridge.

MIDGLEY, G.F., SCHOLES, R.J., HEWITSON, B. & SCHULZE, R.E. 2005. Climate change: no trivial threat. *Farmers Weekly* 95035: 10, 11.

MIDGLEY, G.F. & THUILLER, W. 2005. Global environmental change and the uncertain fate of biodiversity. *New Phytologist* 167: 638–641.

MILLS, A.J. 2006. The role of salinity and sodicity in the dieback of *Acacia xanthophloea* in Ngorongoro Caldera, Tanzania. *African Journal of Ecology* 44: 61–71.

MILLS, A.J. & COWLING, R.M. 2006. Rate of carbon sequestration at two thicket restoration sites in the Eastern Cape, South Africa. *Restoration Ecology* 14: 38–49.

MILLS, A.J., COWLING, R.M., FEY, M.V., KERLEY, G.I.H., DONALDSON, J.S., LECHMERE-OERTEL, R.G., SIGWELA, A.M., SKOWNO, A.L. & RUNDEL, P. 2005. Effects of goat pastoralism on ecosystem carbon storage in semi-arid thicket, Eastern Cape, South Africa. *Austral Ecology* 30: 797–804.

MILLS, A.J. & FEY, M.V. 2005. Interactive response of herbivores, soils and vegetation to annual burning in a South African savanna. *Austral Ecology* 30: 435–444.

MILLS, A.J., O'CONNOR, T.G., DONALDSON, J.S., FEY, M.V., SKOWNO, A.L., SIGWELA, A.M., LECHMERE-OERTEL, R.G. & BOSENBERG, J.D. 2005. Ecosystem carbon storage under different land uses in three semi-arid shrublands and a mesic grassland in South Africa. *South African Journal of Plant and Soil* 22: 183–190.

MNENGWANE, J. 2005-10. *Helichrysum appendiculatum* (L.f.) Less. (Asteraceae). Internet 3 pp. http://www.plantzafrica.com/planthij/helichrysappend.htm.

MOODLEY, K. 2005-10. *Syncolostemon rotundifolius* E.Mey. ex Benth. (Lamiaceae). Internet 3 pp. http://www.plantzafrica.com/plantqrs/syncolosrotund.htm.

MPONGO, T. 2005-04. *Merxmuellera macowanii* (Stapf) Conert (Poaceae). Internet 2 pp. http://www.plantzafrica.com/plantklm/merxmac.htm.

MTSWENI, P. 2005-10. *Podocarpus latifolius* (Thunb.) R.Br. ex Mirb. (Podocarpaceae). Internet 3 pp. http://www.plantzafrica.com/plantnop/podocarplati.htm.

MUCINA, L. & RUTHERFORD, M.C. (eds). 2005 (2004-02). *Vegetation map of South Africa, Lesotho and Swaziland: shapefiles of basic mapping units. Beta version 4.0.* South African National Biodiversity Institute, Cape Town.

MUCINA, L., RUTHERFORD, M.C. & POWRIE, L.W. (eds). 2005. *Vegetation map of South Africa, Lesotho and Swaziland*; 1:1 000 000 scale sheet maps. South African National Biodiversity Institute, Pretoria.

MUKOMA, T. 2005-05. *Pelargonium tranvaalense* Knuth (Geraniaceae). Internet 3 pp. http://www.plantzafrica.com/plantnop/pelargtransvaal.htm.

MUKOMA, T. 2005-07. *Becium obovatum* (E.Mey. ex Benth.) N.E.Br. subsp. *obovatum* var. *obovatum* (Lamiaceae). Internet 2 pp. http://www.plantzafrica.com/plantab/beciumob.htm.

MUKOMA, T. 2005-07. *Hoslundia opposita* Vahl. (Lamiaceae). Internet 2 pp. http://www.plantzafrica.com/planthij/hoslundop.htm.

MUSIL, C.F., MILTON, S.J. & DAVIS, G.W. 2005. The threat of alien invasive grasses to lowland Cape floral diversity: an empirical appraisal of the effectiveness of practical control strategies. *South African Journal of Science* 101: 337–344.

NAIDOO, A. 2005-11. *Gomphocarpus fruticosus* (L.) Aiton f. (Asclepiadaceae). Internet 2 pp. http://www.plantzafrica.com/plantefg/gomphocarpfrut.htm.

NAIDOO, D., COOMBES, P.H., MULHOLLAND, D.A., CROUCH, N.R. & VAN DEN BERGH, A.J.J. 2005. N-substituted acridone alkaloids from *Toddaliopsis bremekampii* (Rutaceae: Toddalioideae) of south-central Africa. *Photochemistry* 66: 1724–1728

NDOU, A.P. 2005-05. *Berchemia zeyheri* (Sond.) Grubov (Rhamnaceae). Internet 3 pp. http://www.plantzafrica.com/plantab/berchemzy.htm.

NEILSON, R.P., PITELKA, L.F., SOLOMON, A., NATHAN, R., MIDGLEY, G.F., FRAGOSO, J., LISCHE, H. & THOMPSON, K. 2005. Forecasting regional to global plant migration in response to climate change: challenges and directions. *BioScience* 55: 749–759.

NELSON, E.C. & OLIVER, E.G.H.. 2005. Chromosome numbers in *Erica*—an updated checklist. *Heathers* 2: 57, 58.

NGWENYA, M.A. 2005-06. *Acridocarpus natalitius* A.Juss. var. *natalitius* (Malpighiaceae). Internet 3 pp. http://www.plantzafrica.com/plantab/acridnatal.htm.

NGWENYA, M.A. 2005-06. *Gardenia cornuta* Hemsl. (Rubiaceae). Internet 3 pp. http://www.plantzafrica.com/plantefg/gardencorn.htm.

NONKENGE, S. & NOTTEN, A. 2005-09. *Watsonia borbonica* (Pourr.) Goldblatt (Iridaceae). Internet 5 pp. http://www.plantzafrica.com/plantwxyz/watsonborb.htm.

NORDENSTAM, B. & VAN JAARSVELD, E. 2005. *Othonna cremnophila*, a new species of the Asteraceae-Senecioneae from the Richtersveld, Northern Cape Province, South Africa. *Aloe* 42: 4–7.

NOTTEN, A. 2005-05. *Calpurnia aurea* (Aiton) Benth. subsp. *aurea* (Fabaceae). Internet 4 pp. http://www.plantzafrica.com.plantcd/calpurnaur.htm.

NOTTEN, A. 2005-05. *Morella cordifolia* (L.) Killick (Myricaceae). Internet 5 pp. http://www.plantzafrica.com/plantklm/morelcord.htm.

NOTTEN, A. 2005-06. *Cassine peragua* L. (Celastraceae). Internet 4 pp. http://www.plantzafrica.com/plantcd/casspera.htm.

NOTTEN, A. 2005-12. *Vernonia natalensis* Sch.Bip. ex Walp. (Asteraceae). Internet 4 pp. http//www.plantzafrica.com/planttuv/vernonnat.htm.

NOTTEN, A. 2006-01. *Agapanthus campanulatus* F.M.Leight. (Agapanthaceae). Internet 4 pp. http://www.plantzafrica.com/plantab/agapancamp.htm.

NOTTEN, A. 2006-01. *Agapanthus praecox* Willd. subsp. *minimus* (Lindl.) F.M.Leight. 'Adelaide' (Agapanthaceae). Internet 3 pp. http://www.plantzafrica.com/plantab/agapanadelaide.htm.

NOTTEN, A. 2006-02. *Dissotis princeps* (Kunth) Triana (Melastomataceae). Internet 4 pp. http://www.plantzafrica.com/plantcd/dissotprin.htm & http://www.plantzafrica.com/plantcd/plimagescd/dissotprinstamens.jpg.

OLIVER, I.B. 2005. *Grow succulents*. Kirstenbosch Gardening Series, edn 2. South African National Biodiversity Institute, Cape Town.

OLIVER, I.B. 2005-04. *Dioscorea elephantipes* (L'Hér.) Engl. (Dioscoreaceae). Internet 3 pp. http://www.plantzafrica.com/plantcd/dioscoreleph.htm.

OLIVER, I.B. 2005-04. *Nymania capensis* (Thunb.) Lindb. (Meliaceae). Internet 3 pp. http//www.plantzafrica.com/plantnop/nymancap.htm.

OLIVER, I.B. 2005-05. *Crassula rupestris* Thunb. (Crassulaceae). Internet 3 pp. http://www.plantzafrica.com/plantcd/crassularupest.htm.

OLIVER, I.B. 2005-07. *Euphorbia stellispina* Haw. (Euphorbiaceae). Internet 3 pp. http://www.plantzafrica.com/plantefg/euphorbstel.htm.

OLIVER, I.B. 2005-07. *Hoodia gordonii* (Masson) Sweet ex Decne. (Apocynaceae). Internet 3 pp. http://www.plantzafrica.com/planthij/hoodgord.htm.

OLIVER, I.B. 2005-07. *Lithops* N.E.Br. (Aizoaceae). Internet 3 pp. http://www.plantzafrica.com/plantklm/lithops.htm.

OLIVER, I.B. 2005-08. *Crassula atropurpurea* (Haw.) D.Dietr. (Crassulaceae). Internet 3 pp. http://www.plantzafrica.com/plantcd/crassatrop.htm.

PIERCE, S.M., COWLING, R.M., KNIGHT, A., LOMBARD, A.T., ROUGET, M. & WOLF, T. 2005. Systematic conservation planning products for land-use planning: interpretation for implementation. *Biological Conservation* 125: 441–548.

PIERCE, S.M., COWLING, R.M., LOMBARD, M., ROUGET, M., WOLF, T., VLOK, J., KNIGHT, A., BOSHOFF, A. & WILSON, S. 2005. A STEP/forward. Safeguarding the biodiversity of the south-eastern Cape region. *Veld & Flora* 91: 86–89.

PORCHES, S., COWLING, R.M., GOLDBLATT, P., MANNING, J.C. & SNIJMAN, D.A. 2006. An overview of the Cape geophytes. *Biological Journal of the Linnean Society* 87: 27–43.

PYKE, C.R., ANDELMAN, S.J. & MIDGLEY, G. 2005. Identifying priority areas for bioclimatic representation under climate change: a case study for Proteaceae in the Cape Floristic Region, South Africa. *Biological Conservation* 125: 1–9.

RAIMONDO, D. 2005. Conservation news: members of the CREW. *Veld & Flora* 91: 64, 65.

RAIMONDO, D., NEWTON, D., FELL, C., DONALDSON, J.S. & DICKSON, B. 2005. Devil's claw, *Harpagophytum* spp. in South Africa: conservation and livelihoods issues. *Traffic Bulletin* 20,3: 99–112.

RAMBUWANI, L.D., GAVHI, M.P. & REYNOLDS, Y. 2005-09. *Diospyros lycioides* Desf. (Ebenaceae). Internet 3 pp. http://www.plantzafrica.com/plantcd/diospyroslyc.htm.

REEVES, G., MANNING, J.C., GOLDBLATT, P., RAIMONDO, D. & WOLFSON, M. 2006. Genetic resources, systematics and the CBD: a case for DNA banking in South Africa. In V. Savolainen, M.P. Powell, K. Davis, G. Reeves & A. Corthals, *DNA and tissue banking for biodiversity and conservation: theory, practice and uses*: 72–81. Kew Publishing in association with IUCN.

RETIEF, E. 2005-05. *Cynoglossum hispidum* Thunb. (Boraginaceae). Internet 2 pp. http://www.plantzafrica.com/plantcd/cynogloshipsp.htm.

RETIEF, E. 2005-05. *Trichodesma physaloides* (Frenzl) A.DC. (Boraginaceae). Internet 3 pp. http://www.plantzafrica.com/planttuv/trichodesphy.htm.

RETIEF, E., VAN WYK, A.E. & CONDY, G. (Artist). 2005. *Codon royenii* (Boraginaceae). *Flowering Plants of Africa* 59: t. 2217, 114–121.

RICHARDSON, D.M., ROUGET, M., RALSTON, S. & COWLING, R.M. 2005. Determinants of alien plant species richness in South Africa: environmental correlates and the relationship with native plant species richness. *EcoScience* 12: 391–402.

ROFF, J., WILLIS, C.K. & FODEN, W. 2006. Making plants relevant to real life. In C.K. Willis, Conserving South Africa's plants: a South African response to the Global Strategy for Plant Conservation. *SANBI Biodiversity Series* 1: 57–62. South African National Biodiversity Institute, Pretoria.

ROUGET, M., COWLING, R.M., LOMBARD, A.T., KNIGHT, A. & KERLEY, G.I.H. 2006. Designing large-scale conservation corridors for pattern and process. *Conservation Biology* 20: 549–561.

ROURKE, J.P. 2005. A new *Leucadendron* (Proteeae) from Western Cape, South Africa. (Proteaceae). *Bothalia* 35: 63–67.

ROUX, J.P. 2005. Ferns. In G. Nichols, *Growing rare plants*. Southern African Botanical Diversity Network Report No. 36: 19–21.

ROUX, J.P. 2005-05. *Pyrrosia* Mirb. (Polypodiaceae). Internet 3 pp. http://www.plantzafrica.com/plantnop/pyrrosia.htm.

SAVOLANINEN, V., POWELL, M.P., DAVIS, K., REEVES, G. & CORTHALS, A. 2006. *DNA and tissue banking for biodiversity and conservation: theory, practice and uses*. Kew Publishing, in association with IUCN.

SCHURR, F.M., BOND, W.J., MIDGLEY, G.F. & HIGGINS, S.J. 2005. A mechanistic model for secondary seed dispersal by wind and its experimental validation. *Journal of Ecology* 93: 1017–1028.

SIEBERT, S.J. & SMITH, G.F. 2005. Plant Red Data List assessments in southern Africa: financial costs of a collaborative project. *Taxon* 54: 1051–1055.

SIMMONS, R. & BARNARD, P. 2005. Turning up the heat—looking at climate change impacts on African birds. *Africa Birds and Birding* 10,5: 52–60.

SINGH, Y. 2005-12. *Ornithogalum thyrsoides* Jacq. (Hyacinthaceae). Internet 4 pp. http://www.plantzafrica.com/plantnop/ornithogthyr.htm.

SMITH, G.F. 2005a. The rich floral heritage of South Africa. *Proceedings of the International Science and Technology Exposition*: 60–68. Department of Science and Technology, Aichi, Japan.

SMITH, G.F. 2005b. Aalwyne vir Afrika. *Tuinpaleis* June: 10–13, 15.

SMITH, G.F. 2005c. *Gardening with succulents. Horticultural gifts from extreme environments and the arid world*. Struik, Cape Town.

SMITH, G.F. 2005d. The fascinating world of the grass aloes of South Africa. In C. Craib, *Grass aloes of the South African veld*. Umdaus Press, Hatfield, Pretoria.

SMITH, G.F. 2005e. The Boyce Thompson Arboretum near Superior, Arizona: a stunning botanical and succulent garden in cowboy country. *Aloe* 42: 28–34.

SMITH, G.F. 2005f. SABONET—some ten years on. *SABONET News* 9: 4.

SMITH, G.F. 2005g. 2003 Compton Prize awarded to trio from the Western Cape. *SABONET News* 9: 69.

SMITH, G.F. & CRAIB, C. 2005. *Aloe craibii* and its environment. *Cactus and Succulent Journal (U.S.)* 77: 202–204.

SMITH, G.F. & SMITH, T.J. 2006. Objective 1: understanding and documenting plant diversity. Catalogues of South African plant life: documenting diversity for the benefit of all. Target 1: a widely accessible working list of known plant species, as a step towards a complete world flora. In C.K. Willis, Conserving South Africa's plants. A South African response to the Global Strategy for Plant Conservation. *SANBI Biodiversity Series* 1: 12–14. South African National Biodiversity Institute, Pretoria.

SMITH, G.F. & STEYN, E.M.A. 2005a. Notes on the phenology, natural geographical distribution range and taxonomy of *Aloe dichotoma* (Aloaceae). *Bradleya* 23: 17–22.

SMITH, G.F. & STEYN, E.M.A. 2005b. Notes sur *Echium simplex* (Boraginaceae), une endémique des Iles Canaries naturalisée en Afrique du Sud. *Succulentes* 28,1: 21–25.

SMITH, G.F., STEYN, E.M.A. & CROUCH, N.R. 2005. *Aloe affinis* (Aloaceae). *Curtis's Botanical Magazine* 22: 95–99, t. 524.

SMITH, G.F., VAN WYK, A.E., LUCKOW, M. & SCHRIRE, B. 2006. Conserving *Acacia* Mill. with a conserved type. What happened in Vienna? *Taxon* 55: 223–225.

SMITH, T.J. 2005. *Important plant areas in southern Africa*. Combined Proceedings of Workshops held in Mozambique, Namibia and South Africa. Southern African Botanical Diversity Network Report No. 39.

SMITHIES, S.J. 2005-10. *Felicia amelloides* (L.) Voss. (Asteraceae). Internet 6 pp. http://www.plantzafrica.com/plantefg/feliciamell.htm.

SNIJMAN, D.A. 2005a. Three new species and a new synonym in *Strumaria* (Amaryllidaceae: Amaryllideae) from southern Africa. *Bothalia* 35: 21–27.

SNIJMAN, D.A. 2005b. A new species of *Namaquanula* (Amaryllidaceae: Amaryllideae) from Namibia with notes on the genus. *Bothalia* 35: 153–156.

SNIJMAN, D.A. 2005-04. *Brunsvigia* Heist. (Amaryllidaceae). Internet 4 pp. http://www.plantzafrica.com/plantab/brunsvig.htm.

SNIJMAN, D.A. 2005-08. *Haemanthus* L. (Amaryllidaceae). Internet 5 pp. http://www.plantzafrica.com/planthij/haemanthus.htm.

SNIJMAN, D.A., DUNCAN, G.D. & THOMAS, V. (Artist). 2005. *Haemanthus nortieri* (Amaryllidaceae). *Flowering Plants of Africa* 59: 14–20, t. 2203.

SNIJMAN, D.A. & VICTOR, J. 2005 (2003–2004). Threatened Amaryllidaceae of South Africa. *Herbertia* 58: 91–108.

STEENKAMP, Y. 2005a. Terminal evaluation of the SABONET Project. *SABONET News* 9: 70.

STEENKAMP, Y. 2005b. SABONET Steering Committee concludes business. *SABONET News* 9: 78.

STEENKAMP, Y. 2005c. New books from SABONET. *SABONET News* 9: 79–81, 84.

STEENKAMP, Y. & DE VOS BELGRAVER, C. (eds). 2005a. *SABONET News* 9. Southern African Botanical Diversity Network, Pretoria.

STEENKAMP, Y. & DE VOS BELGRAVER, C. 2005b. Letter from the editors. *SABONET News* 9: 3.

STEENKAMP, Y., SIEBERT, S.J., SMITH, G.F., HUNTLEY, B.J. & WILLIS, C.K. 2006. *Final Project Report. Looking back on the SABONET Project: a triumph of regional cooperation*. Southern African Botanical Diversity Network Report No. 43. SABONET, Pretoria.

STEENKAMP, Y. & SMITH, T.J. 2005. The paper chase. *SABONET News* 9: 85–91.

STEENKAMP, Y., VAN WYK, A.E., SMITH, G.F. & STEYN, H. 2005. Floristic endemism in southern Africa: a numeric classification at generic level. In I. Friis & H. Balslev, Plant diversity and complexity patterns. Local, regional and global dimensions. *Biologiske Skrifter* 55: 253–271. The Royal Danish Academy of Sciences and Letters, Copenhagen.

STEYN, E.M.A., VAN WYK, A.E. & SMITH, G.F. 2005a. Ovule-to-seed development in *Dovyalis caffra* (Salicaceae: Flacourtiaceae) with notes on the taxonomic significance of the extranucellar embryo sac. *Bothalia* 35: 101–108.

STEYN, E.M.A., VAN WYK, A.E., & SMITH, G.F. 2005b. Ovule and seed structure in *Scolopia zeyheri* (Scolopieae), with notes on the embryology of Salicaceae. *Bothalia* 35: 175–183.

STOCK, W.D., LUDWIG, F., MORROW, C. & MIDGLEY, G.F., WAND, S.J.E., ALLSOPP, N. & BELL, T. 2005. Long-term effects of elevated atmospheric CO_2 on species composition and productivity of a southern African C_4 dominated grassland in the vicinity of a CO_2 exhalation. *Plant Ecology* 178: 211–224.

SWELANKOMO, N. 2005-11. *Helichrysum foetidum* (L.) Moench (Asteraceae). Internet 4 pp. http://plantzafrica.com/planthij/helichryfoet.htm.

SYMMONDS, R. & CROUCH, N. 2005. *Warburgia salutaris*. In G. Nichols, *Growing rare plants: a practical handbook on propagating the threatened plants of southern Africa*: 86, 87. Southern African Botanical Diversity Network Report No. 36. SABONET, Pretoria.

TARR, B.B. 2005a. *Apodytes dimidiata*. Tree of the issue. *Urban Green File* 10,5: 56.

TARR, B.B. 2005b. *Clivia gardenii*, autumn's delight. *Clivia* 7: 63–66.

TARR, B.B. 2005-10. *Tridactyle bicaudata* (Lindl.) Schltr. subsp. *bicaudata* (Orchidaceae). Internet 3 pp. http://www.plantzafrica.com/planttuv/tridactbicaud.htm.

TARUS, P.K., COOMBES, P.H., CROUCH, N.R., MULHOLLAND, D.A. & MOODLEY, B. 2005. Furoquinoline alkaloids from the southern African Rutaceae *Teclea natalensis*. *Phytochemistry* 66: 703–706.

THUILLER, W., BROENNIMANN, O., HUGHES, G.O., ALKEMADE, J.R.M., MIDGLEY, G.F. & CORSI, F. 2006. Vulnerability of African mammals to anthropogenic climate change under conservative land transformation assumptions. *Global Change Biology* 12: 424–440.

THUILLER, W., LAVOREL, S., ARAÚJO, M.B., SYKES, M.T. & PRENTICE, I.C. 2005. Climate change threats to plant diversity in Europe. *Proceedings of the National Academy of Sciences of the United States of America* 102: 8245–8250.

THUILLER, W., MIDGLEY, G.F., HUGHES, G.O., BOMHARD, B., DREW, G., RUTHERFORD, M.C. & WOODWARD, F.I. 2006. Endemic species and ecosystem sensitivity to climate change in Namibia. *Global Change Biology* 12: 759–776.

THUILLER, W., RICHARDSON, D.M., PYSEK, P., MIDGLEY, G., HUGHES, G.O. & ROUGET, M. 2005. Niche-based modelling as a tool for predicting the risk of alien plant invasions at a global scale. *Global Change Biology* 11: 2234–2250.

TOLLEY, K.A., BURGER, M., TURNER, A.A. & MATTHEE, C.A. 2006. Biogeographic patterns and phylogeography of dwarf chameleons (*Bradypodion*) in an African biodiversity hotspot. *Molecular Ecology* 15: 781–793.

UNWIN, M., BAYER, R., WARD, J., BREITWIESER, I. & KOEKEMOER, M. 2005. Abstract: A global molecular phylogeny of the Gnaphalieae (Asteraceae). *XVII International Botanical Congress, Vienna, Austria, 17–23 July*, 2005: 115.

VAN DER WALT, L. 2005-07. *Myrsine africana* L. (Myrsinaceae). Internet 3 pp. http://www.plantzafrica.com/plantklm/myrsinafr.htm.

VAN DER WALT, L. 2005-10. *Lobostemon fruticosus* (L.) H.Buek (Boraginaceae). Internet 4 pp. http://www.plantzafrica.com/plantklm/lobostemfrut.htm.

VAN DER WALT, L. 2005-12. *Arctotis stoechadifolia* P.J Bergius (Asteraceae). Internet 4 pp. http://www.plantzafrica.com/plantab/arctotstoech.htm.
VAN JAARSVELD, E.J. 2005a. Vra vir Ernst. *Beeld* weekly article.
VAN JAARSVELD, E.J. 2005b. Vra vir Ernst. *Buite Burger* (Western Cape) weekly article.
VAN JAARSVELD, E.J. 2005c. *Kleinia venteri*, a new succulent species from Limpopo Province. *Aloe* 42: 12, 13.
VAN JAARSVELD, E.J. 2005d. Review: Gardening the Mediterranean way, by H. Gildemeister. *Veld & Flora* 91: 148.
VAN JAARSVELD, E.J. 2005e. Succulent plants in copper. *Aloe* 42: 43–47.
VAN JAARSVELD, E.J. 2005-05. *Gasteria acinacifolia* (J.Jacq.) Haw. (Asphodelaceae). Internet 3 pp. http://www.plantzafrica.com/gasteracina.htm.
VAN JAARSVELD, E.J. 2005-08. *Bulbine latifolia* (L.f.) Roem. et Schult. (Asphodelaceae). Internet 3 pp. http://www.plantzafrica.com/plantab/bulbinlati.htm.
VAN JAARSVELD, E.J. 2005-09. *Stoeberia arborea* Van Jaarsv. (Mesembryanthemaceae). Internet 3 pp. http://www.plantzafrica.com/plantqrs/stoebarbor.htm.
VAN JAARSVELD, E.J., CARRS, S., EMS, P., HURTER, J., SWANEPOEL, W. & VOIGT, W. 2005. The Slangkloof Expedition. *Veld & Flora* 91: 172–177.
VAN JAARSVELD, E.J., HAMMER, S. & VAN WYK, A.E. (Braam). 2005. *Bulbine retinens*, a new cliff-dweller from the Eastern Cape. *Aloe* 42: 14, 15.
VAN JAARSVELD, E.J. & VAN WYK, A.E. 2005a. Two new succulent cliff-dwelling species of *Drimia* (Hyacinthaceae) from the Eastern Cape, South Africa. *Aloe* 42: 53–55.
VAN JAARSVELD, E.J. & VAN WYK, A.E. 2005b. *Aeollanthus rydingianus*, a new species from northern Namibia and southern Angola (Lamiaceae). *Bothalia* 35: 157–160.
VAN JAARSVELD, E.J. & VAN WYK, A.E. 2005c. *Gasteria tukhelensis*, a new species from KwaZulu-Natal, South Africa (Asphodelaceae). *Bothalia* 35: 164–166.
VAN JAARSVELD, E.J. & VAN WYK, A.E. 2005d. *Ornithogalum juncifolium* var. *emsii*, a new cliff-dwelling *Ornithoglum* from Eastern Cape, South Africa (Hyacinthaceae). *Bothalia* 35: 82–84.
VAN JAARSVELD, E.J. & VAN WYK, A.E. 2005e. *Oscularia cremnophila*, a rare new species from Western Cape, South Africa (Mesembryanthemaceae). *Bothalia* 35: 160–163.
VAN JAARSVELD, E.J. & VAN WYK, A.E. 2005f. A new cliff-dwelling *Bulbine* species (Asphodelaceae) from the Eastern Cape. *Aloe* 42: 48–51.
VAN JAARSVELD, E.J. & VAN WYK, A.E. 2005g. A new subspecies of *Aloe arborescens* from the Mzimnyati River, KwaZulu-Natal. *Aloe* 42: 40–42.
VAN JAARSVELD, E.J., VAN WYK, A.E. & CONDY, G. (Artist). 2005. *Aloe omavandae* (Asphodelaceae). *Flowering Plants of Africa* 59: 2–6, t. 2201.
VAN WYK, A.E., SMITH, G.F. & STEENKAMP, Y. 2005. Plant endemism in southern Africa and the identification of priority areas for conservation. In T.J. Smith, *Important plant areas in southern Africa*: 8–12. Southern African Botanical Diversity Network Report No. 39.
VAN WYK, A.E. & SMITH, G.F. 2005. Hertipifisering van *Acacia*: uitslag van stemming in Wenen. *Dendron* 37: 5–7.
VAN WYK, B-E., SMITH, G.F., VILJOEN, A.M., TREUTLEIN, J. & WINK, M. 2005. Abstract: Secondary metabolites in relation to molecular phylogenies in *Aloe* and related genera (family Asphodelaceae). *Abstracts of the International Botanical Congress* 17: 36. Vienna, Austria.
VILE, D., GARNIER, E., SHIPLEY, B., LAURENT, G., NAVAS, M-L., ROUMET, C., LAVOREL, S., DÍAZ, S., HODGSON, J.G., LLORET, F., MIDGLEY, G.F., POORTER, H., RUTHERFORD, M.C., WILSON, P.J. & WRIGHT, I.J. 2005. Specific leaf area and dry matter content estimate thickness in laminar leaves. *Annals of Botany* 96: 1129–1136.
VILJOEN, C. 2005-04. *Senecio tamoides* DC. (Asteraceae). Internet 3 pp. http://www.plantzafrica.com/plantqrs/senectam.htm
VILJOEN, C. 2005-09. *Cliffortia ferruginea* L.f. (Rosaceae). Internet 3 pp. http://www.plantzafrica.com/plantcd/cliffortfer.htm.
VILJOEN, C. 2005-09. *Nylandtia spinosa* (L.) Dumort. (Polygalaceae). Internet 3 pp. http://www.plantzafrica.com/plantnop/nylandspin.htm.
VILJOEN, C. 2005-11. *Ekebergia pterophylla* (C.DC.) Hofmeyr (Meliaceae). Internet 3 pp. http://www.plantzafrica.com/plantefg/ekebergptero.htm.
VOIGT, W. 2005-07. *Aloe perfoliata* L. (Asphodelaceae). Internet 4 pp. http://www.plantzafrica.plantab/aloeperfol.htm.
VOIGT, W. 2005-08. *Kalanchoe thyrsiflora* Harv. (Crassulaceae). Internet 3 pp. http://www.plantzafrica.com/plantklm/kalanthyrs.htm.
VOIGT, W. 2005-10. *Crassula multicava* Lem. (Crassulaceae). Internet 4 pp. http://www.plantzafrica.com/plantcd/crassmulticav.htm.
VOIGT, W. 2005-11. *Ruschia* Schwantes (Mesembryanthemaceae). Internet 7 pp. http://www.plantzafrica.com/plantqrs/ruschia.htm.
VON WITT, C.G. 2006. Rare plants discovered in Ratelrivier wetland. *Village Life* 16: 3, 4.
VON WITT, C.G. 2006-03. *Mimetes hirtus*. Internet. http://www.plantzafrica.com/plantklm/mimehirt.htm.
WELMAN, M. 2005-05. *Momordica cardiospermoides* Klotzsch (Cucurbitaceae). Internet 3 pp. http://www.plantzafrica.com/plantklm/momordcard.htm.
WELMAN, M. 2005-06. *Lagenaria siceraria* (Mol.) Standl. (Cucurbitaceae). Internet 4 pp. http://www.plantzafrica.com/plantklm/lagensic.htm.
WELMAN, M. 2006-03. *Trochomeria macrocarpa* (Sond.) Hook.f. (Cucurbitaceae). Internet 3 pp. http://www.plantzafrica.com/planttuv/trochommacro.htm.
WELMAN, M. 2006. Climbers and scramblers in southern African *Senecio* and allied genera. *PlantLife* 32: 21–26.
WELMAN, M. & CONDY, G. (Artist). 2005. *Ipomoea ommanneyi* (Convolvulaceae). *Flowering Plants of Africa* 59: 108–112, t. 2216.
WILLIAMS, P., HANNAH, L., ANDELMAN, S., MIDGLEY, G.F., ARAUJO, M., HUGHES, G., MANNE, L., MARTINEZ-MEYER, E. & PEARSON, R. 2005. Planning for climate change: identifying minimum-dispersal corridors for the Cape Proteaceae. *Conservation Biology* 19: 1063–1074.
WILLIAMSON, G. & KURZWEIL, H. 2005. Orchidaceae. In J.E. Burrows & C.K. Willis, *Plants of the Nyika Plateau: an account of the vegetation of the Nyika National Parks of Malawi and Zambia*: 314–338. Southern African Botanical Diversity Network Report No. 31. SABONET, Pretoria.
WILLIS, C.K. 2005a. National Botanical Gardens: embassies of South Africa's biodiversity and culture. *BGCI BGjournal* 2,2: 9–12.
WILLIS, C.K. 2005b. News from South Africa's National Botanical Gardens: December 2004 to November 2005. *African Botanic Gardens Network Bulletin*, Nov.: 8–12.
WILLIS, C.K. 2005c. Introduction and botanical exploration. In J.E. Burrows & C.K. Willis, *Plants of the Nyika Plateau: an account of the vegetation of the Nyika National Parks of Malawi and Zambia*: 1–17. Southern African Botanical Diversity Network Report No. 31. SABONET, Pretoria.
WILLIS, C.K. (ed.) 2006a. Conserving South Africa's plants: a South African response to the Global Strategy for Plant Conservation. *SANBI Biodiversity Series* 1. South African National Biodiversity Institute, Pretoria.
WILLIS, C.K. 2006b. Introduction. In C.K. Willis, Conserving South Africa's plants: a South African response to the Global Strategy for Plant Conservation. *SANBI Biodiversity Series* 1: 2–11. South African National Biodiversity Institute, Pretoria.
WILLIS, C.K. 2006c. Providing models with protocols for plant conservation. In C.K. Willis, Conserving South Africa's plants: a South African response to the Global Strategy for Plant Conservation. *SANBI Biodiversity Series* 1: 19, 20. South African National Biodiversity Institute, Pretoria.
WILLIS, C.K. 2006d. SANBI: Institutional response to implementing the International Agenda. *BGCI BGjournal* 3,1: 11–13.
WILLIS, C.K., SMITH, G.F. & OLIVER, I. 2006. From Whitehill to Worcester. *Veld & Flora* 92: 34–39.
WILLIS, C.K. & VAN WYK, E. 2006. Integrating *ex situ* and *in situ* conservation. In C.K. Willis, Conserving South Africa's plants: a South African response to the Global Strategy for Plant Conservation. *SANBI Biodiversity Series* 1: 35–39. South African National Biodiversity Institute, Pretoria.
WINTER, J. 2005-04. *Encephalartos villosus* Lem. (Zamiaceae). Internet 3 pp. http://www.plantzafrica.com/plantefg/encephvill.htm.
WINTER, J. 2005-12. *Clivia caulescens* R.A.Dyer. (Amaryllidaceae). Internet 3 pp. http://www.plantzafrica.com/plantcd/cliviacaul.htm.
WINTER, P.J.D. 2005. Acanthaceae, Apiaceae, Crassulaceae, Lamiaceae. In J.E. Burrows & C.K. Willis, *Plants of the Nyika Plateau: an account of the vegetation of the Nyika National*

Parks of Malawi and Zambia: 48–67, 133–135, 183–192. Southern African Botanical Diversity Network Report No. 31. SABONET, Pretoria.

WINTER, P.J.D. 2005-09. *Ceratotheca* sp. aff. *reniformis* Abels (Pedaliaceae). Internet 3 pp. http://www.plantzafrica.plantcd/ceratothecspafren.htm.

WINTER, P.J.D. & VAN JAARSVELD, E.J. 2005. *Plectranthus porcatus*, a new species endemic to the Sekhukhuneland Centre of Plant Endemism, Limpopo Province, South Africa (Lamiaceae). *Bothalia* 35: 169–173.

WOLFSON, M. 2005a. Challenges and gaps in developing and implementing national legislation on access and benefit-sharing in South Africa. *International Expert Workshop on Access to Genetic Resources and Benefit-sharing (ABS) Cape Town, South Africa, 20–23 September 2005*: 45–50. Norwegian Ministry of the Environment.

WOLFSON, M. 2005b. Review: Seeds conservation: turning science into practice, edited by R.D. Smith, J.B. Dickie, S.H. Linington, H.W. Pritchard & R.J. Probert, 2003. *Bothalia* 35: 111–113.

XABA, A. 2005-04. *Rapanea melanophloeos* (L.) Mez (Myrsinaceae). Internet 3 pp. http://www.plantzafrica.com/plantqrs/rapanmelan.htm.

XABA, A. 2005-09. *Prionium serratum* (L.f.) Drège ex E.Mey. (Prioniaceae). Internet 3 pp. http://www.plantzafrica.com/plantnop/prionserr.htm.

XABA, A. 2005-12. *Pseudoselago serrata* (P.J.Bergius) Hilliard (Scrophulariaceae). Internet 3 pp. http://www.plantzafrica.com/plantnop/pseudoselser.htm.

ZONNEVELD, B.J.M. & VAN JAARSVELD, E.J. 2005. Taxonomic implications of genome size for all species of the genus *Gasteria* Duval (Aloaceae). *Plant Systematics and Evolution* 251: 217–227.

Bothalia 36,2: 243–252 (2006)

Guide for authors to *Bothalia*

This guide is updated when necessary and includes an index. **Important points and latest additions appear in bold type.**

Bothalia is named in honour of General Louis Botha, first Premier and Minister of Agriculture of the Union of South Africa. This house journal of the South African National Biodiversity Institute (SANBI), Pretoria, is devoted to the furtherance of botanical science. The main fields covered are taxonomy, ecology, anatomy and cytology. Two parts of the journal and an index to contents, authors and subjects are published annually.

1 Editorial policy

1.1 *Bothalia* welcomes original papers dealing with flora and vegetation of southern Africa and related subjects. Full-length papers and short notes, as well as book reviews and obituaries of botanists, are accepted. The editor should be notified that an article is part of a series of manuscripts; please submit a list of the parts of a series; all parts should preferably be published in one journal.

1.2 Submission of a manuscript to *Bothalia* implies that it has not been published previously and is not being considered for publication elsewhere.

1.3 Authors whose first language is not English are requested to have their MS edited by an English speaker before submission.

1.4 Articles are assessed by referees, both local and overseas. Authors are welcome to suggest possible referees to judge their work. Authors are responsible for the factual correctness of their contributions. *Bothalia* maintains an editorial board (see title page) to ensure that international standards are upheld.

1.5 **Page charges:** as stated in our notification included in volume 23,1 (May 1993), MSS submitted for publication in *Bothalia* are subject to payment of page charges of R125,00 per printed page, VAT included. The following are exempt from these charges: 1, SANBI members; 2, persons/institutions who have been granted exemption by the Executive Committee of the SANBI; 3, authors of contributions requested by the Editor; 4, contributors to the column '*FSA* contributions'. The Editor's decision on the number of pages is final. An invoice will be sent to the author, who must arrange for payment as soon as possible to SANBI, Publications Section, Private Bag X101, Pretoria 0001.

1.6 Deadline dates for submission of MS: for possible inclusion of the MS for the May issue—August of the previous year, and for the October issue—March of the same year.

2 Requirements for a manuscript

2.1 The original manuscript should be typed on one side of A4-size paper, double line spacing throughout (including abstract, captions to figures and literature references, and have a margin of at least 30 mm all round. **Tables should be typed in single line spacing on a separate page at the end of the article**. Three photocopies (all pages photocopied on both sides of the paper, including figures, to reduce weight for postage) of all items, including text, line drawings, tables and lists should be submitted, and the author should retain a complete set of copies. Three photographs (or high quality photocopies) of each photograph/photograph mosaic should be submitted for review purposes. The electronic version should be submitted with the final (accepted) manuscript (see 3).

2.2 Papers should conform to the general style and layout of recent issues of *Bothalia* (from volume 26 onwards).

2.3 Material should be presented in the following sequence: title page with title, name(s) of author(s), keywords, abstract (and information that should be placed in a footnote on the title page, such as address(es) of author(s) and mention of granting agencies).

2.4 The sequence continues with Introduction and aims, Contents (see 8), Material and methods, Results, Interpretation (Discussion), Specimens examined (in revisions and monographs), Acknowledgements, References, Index of names (recommended for revisions dealing with more than about 15 species), Tables, Captions for figures and figures. In the case of short notes, obituaries and book reviews, keywords and an abstract are superfluous.

2.5 All pages must be numbered consecutively beginning with the title page to those with references, tables, captions for figures and figures.

2.6 Special characters: use your own word or code that is unique and self-explanatory, enclosed between ANGLE BRACKETS, e.g. <mu>m for µm. Please supply us with a list of the codes.

2.7 Use a non-breaking space (in MS Word—Ctrl, shift, space) to keep two elements together on the same line, e.g. 3 500.

2.8 DO NOT JUSTIFY LINES.

2.9 Do not break words, except hyphenated words.

2.10 A **hyphen** is designated as one dash, with no space between the letter and the dash, e.g. ovate-lanceolate. See also 17.6.

2.11 An **N-dash** is typed in MS Word code (alt + 0150) or as **three** hyphens with no space between the letter and the hyphen, e.g. 2- - -5 mm (typeset, it looks like this, 2–5 mm). See also 17.6.

2.12 An **M-dash** is typed in MS Word code (alt + 0151) or as **two** hyphens with no space between the letter and the hyphen, e.g. computers- -what a blessing! (typeset, it looks like this: computers—what). See also 17.6.

2.13 Do not use a double space anywhere between words, after commas, full stops, colons, semicolons or exclamation marks.

2.14 Use lower case x as times sign, with one space on either side of the x, e.g. 2 x 3 mm.

2.15 Use single (not double) opening and closing quotes, e.g. the so-called 'stiffy' refers to a rigid diskette. In MSWord the codes are alt+0145 and alt+0146.

2.16 Keys—put only three leader dots before number of taxon (with one space before and after each dot), regardless of how far or near the word is from the right margin, e.g. . . . 1. *R. ovata* (see 13.18, see 2.1).

3 **Requirements for diskettes/stiffies/image files** (text to be submitted only with final/accepted version, see 2.1)

3.1 **USE NORMAL STYLE ONLY.**

3.2 Electronic files can be provided on 1.4 MB stiffie disks, or on CD.

3.3 Data must be in **MSWord.**

3.4 All lines, headings, keys, etc., should start flush at the margin, therefore NO INDENTATIONS, FOOTNOTES, TABS OR STYLES of any kind.

3.5 In MS Word, italics and bold should be used where necessary.

3.6 Paragraphs and headings are delineated by a carriage return (ENTER) but **no indentation**.

3.7 **Graphics i.e. drawings, graphs or photographs: submit in a separate file, do not include it in the text.**

3.8 Image files with a bigger file size than **2MB** cannot be e-mailed as the SANBI has a 2MB limitation on the network's firewall at Head Office. Files smaller than 2MB can be emailed to: **momberg@sanbi.org**.

3.9 If any image file was originated in CorelDraw **up to version 12 or Adobe Illustrator up to version CS 2**, please provide the image file as a CDR file (please include fonts). The conversion to TIF or other file extensions will be accommodated by the SANBI (see 12.2–12.4).

3.10 If extensive changes to image files are proposed by the editor, the author will be contacted and the specific image file will have to be re-submitted after the indicated corrections have been implemented.

3.11 **Tracked changes must not be included when submitting a MS on diskette or electronically.**

4 **Author(s)**

When there are several authors, the covering letter should indicate clearly which of them is responsible for correspondence and, if possible, telephonically available while the article is being processed. The contact address, telephone number and email address should be mentioned if they differ from those given on the letterhead.

5 **Title**

The title should be as concise and as informative as possible. In articles dealing with taxonomy or closely related subjects, the family of the taxon under discussion (see also 13.2) should be mentioned in brackets but author citations should be omitted from plant names (see also 13.6).

6 **Keywords**

Up to 10 keywords (or index terms) should be provided in English in alphabetical sequence. The following points should be borne in mind when selecting keywords:

6.1 Keywords should be unambiguous, internationally acceptable words and not recently coined little-known words.

6.2 They should be in a noun form and verbs should be avoided.

6.3 They should not consist of an adjective alone; adjectives should be combined with nouns.

6.4 They should not contain prepositions.

6.5 The singular form should be used for processes and properties, e.g. evaporation.

6.6 The plural form should be used for physical objects, e.g. augers.

6.7 **Location** (province and/or country); taxa (species, genus, family) and vegetation type (community, veld type, biome) should be used as keywords.

6.8 Keywords should be selected hierarchically where possible, e.g. both family and species should be included.

6.9 They should include terms used in the title.

6.10 They should answer the following questions:

6.10.1 What is the *active concept* in the document (activity, operation or process).

6.10.2 What is the *passive concept* or object of the active process (item on which the activity, operation or process takes place).

6.10.3 What is the means of accomplishment or how is the active concept achieved (technique, method, apparatus, operation or process).

6.10.4 What is the environment in which the active concept takes place (medium, location).

6.10.5 What are the independent (controlled) and dependent variables?

6.11 Questions 6.10.1 to 6.10.3 should preferably also be answered in the title.

7 **Abstract**

7.1 Abstracts of no more than 200 words should be provided. Abstracts are of great importance and should convey the essence of the article.

7.2 They should refer to the geographical area concerned and, in taxonomic articles, mention the number of taxa treated. They should not contain information not appearing in the article.

7.3 In articles dealing with taxonomy or closely related subjects all taxa from the rank of genus downwards should be accompanied by their author citations (see also 13.6).

7.4 Names of new taxa and new combinations should not be italicized but put in bold. If the article deals with too many taxa, only the important ones should be mentioned.

8 **Table of contents**

A table of contents should be given for all articles longer than about 60 typed pages, unless they follow the strict format of a taxonomic revision.

9 **Acknowledgements**

Acknowledgements should be kept to the minimum compatible with the requirements of courtesy. Please give all the initials of the person(s) you are thanking.

10 **Literature references**

In text

10.1 Literature references in the text should be cited as follows: 'Jones & Smith (1986) stated...', or '...(Jones & Smith 1986)' or (Ellis 1988: 67) when giving a reference simply as authority for a statement. For treatment of literature references in taxonomic papers see 14.

10.2 When more than two authors are involved in the paper, use the name of the first author followed by *et al*.

10.3 When referring to more than one literature reference, they should be arranged chronologically and separated by a semicolon, e.g. (Nixon 1940; Davis 1976; Anon. 1981, 1984).

10.4 Titles of books and names of journals should preferably not be mentioned in the text. If there is good reason for doing so, they should be treated as described in 10.12 and 10.13.

10.5 Personal communications are given only in the text, not in the list of references. Please add the person's full initials to identify the person more positively, e.g. C. Boucher pers. comm.

In References at end of article

10.6 References of the same author are arranged in chronological sequence.

10.7 Where two or more references by the same author are listed in succession, the author's name is repeated with every reference, except in an obituary, where the name of the deceased in the list of publications (not in the references) is replaced by an N-dash.

10.8 All publications referred to in the text, including those mentioned in full in the treatment of correct names in taxonomic papers, but no others, and no personal communications, are listed at the end of the manuscript under the heading References.

10.9 The references are arranged alphabetically according to authors and chronologically under each author, with a, b, c, etc. added to the year, if the author has published more than one work in a year. This sequence is retained when used in the text, irrespective of the chronology.

10.10 If an author has published both on his own and as a senior author with others, the solo publications are listed first and after that, in strict alphabetical sequence, those published with one or more other authors.

10.11 Author names are typed in **capital letters**.

10.12 Titles of journals and of books are written out in full and are italicized as follows: *Transactions of the Linnean Society of London* 5: 171–217, or *Biology and ecology of weeds*: 24.

10.13 Titles of books should be given as in *Taxonomic literature*, edn 2 by Stafleu & Cowan and names of journals as in the latest edition of *World list of scientific periodicals*.

10.14 Examples of references:

Collective book or Flora

BROWN, N.E. 1909. Asclepiadaceae. In W.T. Thiselton-Dyer, *Flora capensis* 6,2: 518–1036. Reeve, London.

CUNNINGHAM, A.B. 1994. Combining skills: participatory approaches in biodiversity conservation. In B.J. Huntley, Botanical diversity in southern Africa. *Strelitzia* 1: 149–167. National Botanical Institute, Pretoria.

Book

DU TOIT, A.L. 1966. *Geology of South Africa*, edn 3: 10–50**.** S.M. Haughton (ed.). Oliver & Boyd, London.

HUTCHINSON, J. 1946. *A botanist in southern A*frica: 69**.** Gawthorn, London.

Journal

DAVIS, G. 1988. Description of a proteoid-restioid stand in Mesic Mountain Fynbos of the southwestern Cape and some aspects of its ecology. *Bothalia* 18: 279–287.

SMOOK, L. & GIBBS RUSSELL, G.E. 1985. Poaceae. *Memoirs of the Botanical Survey of South Africa* No. 51: 45–70.

STEBBINS, G.L. Jr. 1952. Aridity as a stimulus to plant evolution. *American Naturalist* 86: 35–44.

In press, in preparation

TAYLOR, H.C. in press. *A reconnaissance of the vegetation of Rooiberg State Forest*. Technical Bulletin, Department of Forestry.

VOGEL, J.C. 1982. *The age of the the Kuiseb river silt terrace at Homeb. Palaeoecology of Africa* 15. In press.

WEISSER, P.J., GARLAND, J.F. & DREWS, B.K. in prep. Dune advancement 1937–1977 and preliminary vegetation succession chronology at Mlalazi Nature Reserve, Natal, South Africa. *Bothalia*.

Thesis

KRUGER, F.J. 1974. *The physiography and plant communities of the Jakkalsrivier Catchment*. M.Sc. (Forestry) thesis, University of Stellenbosch.

MUNDAY, J. 1980. *The genus* Monechma *Hochst*. (*Acanthaceae tribe Justiciae*) *in southern Africa*. M.Sc. thesis, University of the Witwatersrand, Johannesburg.

Miscellaneous paper, report, unpublished article, technical note, congress proceedings

ANON. no date. *Eetbare plante van die Wolkberg*. Botanical Research Unit, Grahamstown. Unpublished.

BAWDEN, M.G. & CARROL, D.M. 1968. *The land resources of Lesotho*. Land Resources Study No. 3, Land Resources Division, Directorate of Overseas Surveys, Tolworth.

BOUCHER, C. 1981. Contributions of the Botanical Research Institute. In A.E.F. Heydorn, *Proceedings of workshop research in Cape estuaries*: 105–107. National Research Institute for Oceanology, CSIR, Stellenbosch.

NATIONAL BUILDING RESEARCH INSTITUTE 1959. *Report of the committee on the protection of building timbers in South Africa against termites, woodboring beetles and fungi*, edn 2. CSIR Research Report No. 169.

11 Tables (also digital submissions)

11.1 Each table should be presented on a separate sheet and be assigned an Arabic numeral, i.e. the first table mentioned in the text is marked 'Table 1'.

11.2 In the captions of tables the word 'TABLE' is written in capital letters. See recent numbers of *Bothalia* for the format required.

11.3 Avoid vertical lines, if at all possible. Tables can often be reduced in width by interchanging primary horizontal and vertical heads.

12 Figures (also digital submissions)

12.1 Figures should be planned to fit, after reduction, into a width of either 80, 118 or 165 mm, with a maximum vertical length of 230 mm. Allow space for the caption in the case of figures that will occupy a whole page.

12.2 Line drawings (artwork) **should be in jet-black Indian ink, preferably on fine art paper, 200 gsm, or on draughtsman's film**. Lines should be **clear** enough and letters/symbols large enough to stand reduction. If submitted electronically, provide each drawing as a separate **TIF or JPG file at 600 dots/pixels per inch (dpi/ppi) and a hard copy of the figure**.

12.3 **Graphs and histograms should be submitted as XLS files. Do not submit graphs in colour. If tints are used they should be easily discernible. If the files were generated in other software programmes, export them as TIF or JPG files.**

12.4 Photographs should be of **excellent quality** on glossy paper with clear detail and moderate contrast **so that the figures can be scanned without retouching them electronically**, and they should be the same size as required in the journal. If submitted electronically, provide as a **TIF or JPG file at 300 dpi/ppi and NOT AS A DOC, PDF, EXCEL OR POWERPOINT FILE**. Include a hard copy of good quality.

12.5 Photograph mosaics should be submitted complete, the component photographs mounted neatly on a white flexible card base (can be curved around drum of scanner) leaving a narrow gap of uniform width (2 mm) between each print. Note that grouping photographs of markedly divergent contrast results in poor reproductions. **If submitted electronically, lettering and scale bars must be included**.

12.6 Lettering on photograph mosaics, in capital letters, should be put on a small white disk ± 7 mm in diameter, if the background is dark, and placed in the lower left hand corner of the relevant photo.

12.7 If several illustrations are treated as components of a single composite figure they should be designated by capital letters.

12.8 Note that the word 'Figure' should be written out in full, both in the text and the captions and should begin with a capital 'F' (but see 14.7 for taxonomic papers).

12.9 In the text the figure reference is then written as in the following example: 'The stamens (Figure 4A, B) are...'

12.10 In captions, 'FIGURE' is written in capital letters.

12.11 Scale bars or scale lines should be used on figures, **or appropriate magnifications should be put in the captions**.

12.12 In figures accompanying taxonomic papers, voucher specimens should be given in the relevant caption.

12.13 Figures are numbered consecutively with Arabic numerals in the order they are referred to in the text. These numbers, as well as the author's name and an indication of the top of the figure, must be written in soft pencil on the back of all figures.

12.14 Captions of figures must **not** be pasted under the photograph or drawing and must also **not** be included in any electronic version of the figures.

12.15 Captions for figures should be collected together and typed at the end of the MS and headed *Captions for figures*.

12.16 Authors should indicate in pencil in the text where they would like the figures to appear.

12.17 Authors wishing to have the originals of figures returned must inform the editor in the original covering letter and must mark each original 'To be returned to author'.

12.18 Authors wishing to use illustrations already published elsewhere must obtain written permission before submitting the manuscript and inform the editor of this fact.

12.19 It is strongly recommended that taxonomic articles include dot maps as figures to show the distribution of taxa. **Maps will be reduced to column width (80 mm): the dots and numbers** used must be large enough to stand reduction (recommended size: 5 mm diameter)—see12.21.

12.20 Blank distribution maps of southern Africa, Africa and the world are available from the Bookshop, SANBI Pretoria.

12.21 A dot map PC programme for distribution of taxa in South Africa, called **MAPPIT2** is available for purchase from the Data Section, South African National Biodiversity Institute, Pretoria. **Please submit as a high resolution JPG file at 600 dpi to fit the column width of 80 mm.**

12.22 ArcView GIS maps are acceptable. The layout representing all the appropriate themes (including grid lines) should be **submitted as an encapsulated file (EPS)**.

12.23 Colour figures are permitted only if: a) it will clarify the article and b) the cost of reproduction and printing is borne by the author.

12.24 **Magnification of figures in the caption should be given for the size as submitted.**

13 **Text**

13.1 As a rule, authors should use the plant names (but not of all authors of plant names—see 13.6) as listed in PRECIS (National Herbarium **PRE**toria **C**omputerised **I**nformation **S**ystem).

13.2 Names of genera and infrageneric taxa are usually italicized, with the author citation (where relevant; see 13.6) not italicized. Exceptions include names of new taxa in the abstract, correct names given in the synopsis or in paragraphs on species excluded from a given supraspecific group in taxonomic articles; in checklists and in indices, where the position is reversed, correct names are not italicized and synonyms are italicized.

13.3 Names above generic level are not italicized.

13.4 In articles dealing with taxonomy, the complete scientific name of a plant (with author citation) should be given at the first mention in the text. The generic name should be abbreviated to the initial thereafter, except where intervening references to other genera with the same initial could cause confusion (see 16.6).

13.5 In normal text, Latin words are italicized, but in the synopsis of a species, Latin words such as *nom. nud.* and *et al.* are not italicized (see 16.4, 17.9).

13.6 In accordance with Garnock-Jones & Webb (1996) in *Taxon* 45: 285, 286, authors of plant names are not to be added to plant names except in taxonomic papers. Names of authors of plant names should agree with the list published by the Royal Botanic Gardens, Kew, entitled, *Authors of plant names*, edited by R.K. Brummitt & C.E. Powell (1992).

13.7 Modern authors not included in the list should use their full name and initials when publishing new plant names. Other author names not in the list should be in agreement with the recommendations of the Code.

13.8 Names of authors of publications are written out in full, without initials, except in the synonymy in taxonomic articles where they are treated like names of authors of plant names.

13.9 Names of plant collectors are italicized whenever they are linked to the number of a specimen. The collection number is also italicized, e.g. *Acocks 14407*.

13.10 Surnames beginning with 'De', 'Du' or 'Van' begin with a capital letter unless preceded by an initial.

13.11 For measurements use only units of the International System of Units (SI). **In taxonomic papers only mm and m, should be used; in ecological papers cm or m should be used.**

13.12 The use of '±' is preferred to c. or ca (see 17.7).

13.13 Numbers 'one' to 'nine' are spelt out in normal text, and from 10 onwards they are written in Arabic numerals.

13.14 In descriptions of plants, numerals are used throughout. Write 2.0–4.5 (not 2–4.5) and 2.0–4.5 × 6–9. When counting members write 2 or 3 (not 2–3), but 2–4.

13.15 Abbreviations should be used sparingly but consistently. No full stops are placed after abbreviations ending with the last letter of the full word (e.g. edition = edn; editor = ed.); after units of measure; after compass directions; after herbarium designations; after countries, e.g. USA and after well-known institutions, e.g. CSIR.

13.16 Apart from multi-access keys, indented keys should be used with couplets numbered 1a–1b, 2a–2b, etc. (without full stops thereafter).

13.17 Keys consisting of a single couplet have no numbering.

13.18 Manuscripts of keys should be presented as in the following example:

1a Leaves closely arranged on elongated stem; a submerged aquatic with only capitula exserted . . . 1b. *E. setaceum* var. *pumilum*

1b Leaves in basal rosettes; stems suppressed; small marsh plants, ruderals or rarely aquatics:

2a Annuals, small, fast-growing pioneers, dying when habitat dries up; capitula without coarse white setae; receptacles cylindrical:

3a Anthers white . . . 2. *E. cinereum*

3b Anthers black . . . 3. *E. nigrum*

2b Perennials, more robust plants; capitula sparsely to densely covered with short setae:

13.19 Herbarium voucher specimens should be referred to wherever possible, not only in taxonomic articles.

13.20 The word Figure should be written out in full and should begin with a capital F, also in captions where the whole word is in capital letters (see 12.8–12.10).

14 **Species treatment in taxonomic papers**

14.1 The procedure to be followed is illustrated in the example (17.9), which should be referred to, because not all steps are described in full detail.

14.2 The correct name (bold, not italicized) is to be followed by its author citation (italicized) and the full literature reference, with the name of the publication written out in full (not italicized).

14.3 Thereafter all literature references, including those of the synonyms, should only reflect author, page and year of publication, e.g. C.E.Hubb. in Kew Bulletin 15: 307 (1960); Boris et al.: 14 (1966); Boris: 89 (1967); Sims: t. 38 (1977); Sims: 67 (1980).

14.4 The description and the discussion should consist of paragraphs commencing, where possible, with italicized leader words such as *flowering time*, *etymology*, *diagnostic characters*, *distribution and habitat*, **with a colon**

following the leader word and the first word of the sentence beginning with a lower case letter.

14.5 When more than one species of a given genus is dealt with in a paper, the correct name of each species should be prefixed by a sequential number followed by a full stop. Infraspecific taxa are marked with small letters, e.g. 1b., 12c., etc.

14.6 Names of authors are written as in 13.6, irrespective of whether the person in question is cited as the author of a plant name or of a publication.

14.7 The word 'figure' is written as 'fig.', and 't.' is used for both 'plate' and 'tablet' (but see 12.8 for normal text).

14.8 Literature references providing good illustrations of the species in question may be cited in a paragraph commencing with the word Illustrations followed by a colon. This paragraph is given after the last paragraph of the synonymy, see 17.9.

14.9 When new combinations are made, the full literature reference must be given for the basionym, e.g.:

Antimima saturata (*L.Bolus*) *H.E.K. Hartmann*, comb. nov.

Ruschia saturata L.Bolus in Notes on Mesembrianthemum and allied genera, part 2: 122 (1929). *Mesembryanthemum atrocinctum* N.E.Br.: 32 (1930). Type: *Pillans* BOL18952 (BOL, holo.!).

15 Citation of specimens

15.1 Type specimen in synopsis: the following should be given (if available): country (if not in RSA), province, grid reference (at least for new taxa), locality as given by original collector, modern equivalent of collecting locality in square brackets (if relevant, e.g. Port Natal [now Durban]), quarter-degree square, date of collection (optional), collector's name and collecting number (both italicized).

15.2 The abbreviation s.n. (*sine numero*) is given after the name of a collector who usually assigned numbers to his collections but did not do so in the specimen in question (see 15.11), or the herbarium number can then be cited with no space between the herbarium and its number e.g. *Marloth SAM691* (see 17.9). The herbaria in which the relevant type(s) are housed are indicated by means of the abbreviations given in the latest edition of *Index Herbariorum*.

15.3 The holotype (holo.) and its location are mentioned first, followed by a semicolon, the other herbaria are arranged alphabetically, separated by commas.

15.4 Authors should indicate by means of an exclamation mark (!) which of the types have been personally examined.

15.5 If only a photograph or microfiche was seen, write as follows: *Anon. 422* (X, holo.–BOL, photo.!).

15.6 Lectotypes or neotypes should be chosen for correct names without a holotype. It is not necessary to lectotypify synonyms.

15.7 When a lectotype or a neotype are newly chosen, this should be indicated by using the phrase 'here designated' (see 17.9). If reference is made to a previously selected lectotype or neotype, the name of the designating author and the literature reference should be given. In cases where no type was cited, and none has subsequently been nominated, this may be stated as 'not designated'.

15.8 In brief papers mentioning only a few species and a few cited specimens the specimens should be arranged according to the grid reference system: Provinces/countries (typed in capitals) should be cited in the following order: Namibia, Botswana, Limpopo (previously Northern Transvaal, Northern Province), North-West (previously north-eastern Cape and southwestern Transvaal), Gauteng (previously PWV), Mpumalanga (previously Eastern Transvaal), Free State (previously Orange Free State), Swaziland, KwaZulu-Natal (previously Natal), Lesotho, and Northern Cape, Western Cape and Eastern Cape (Figure 1).

15.9 Grid references should be cited in numerical sequence.

15.10 Locality records for specimens should preferably be given to within a quarter-degree square. Records from the same one-degree square are given in alphabetical order, i.e (–AC) precedes (–AD). Records from the same quarter-degree square are arranged alphabetically according to the collectors' names; the quarter-degree references must be repeated for each specimen cited.

15.11 The relevant international code of the herbaria in which a collection was seen should be given in brackets after the collection number; the codes are separated by commas. The following example will explain the procedure:

KWAZULU-NATAL.—2731 (Louwsburg): 16 km E of Nongoma, (–DD), *Pelser 354* (BM, K, PRE); near Dwarsrand, *Van der Merwe 4789* (BOL, M). 2829 (Harrismith): near Groothoek, (–AB), *Smith 234*; Koffiefontein, (–AB), *Taylor 720* (PRE); Cathedral Peak Forest Station, (–CC), *Marriot s.n.* (KMG); Wilgerfontein, *Roux 426*. Grid ref. unknown: Sterkstroom, *Strydom 12* (NBG).

15.12 For records from outside southern Africa authors should use degree squares without names, e.g.:

KENYA.—0136: Nairobi plains beyond race course, *Napier 485*.

15.13 Monographs and revisions: in the case of all major works of this nature it is assumed that the author has investigated the relevant material in all major herbaria and that he has provided the specimens seen with determinavit labels. It is assumed further that the author has submitted distribution maps for all relevant taxa and that the distribution has been described briefly in words in the text. Under the heading 'Vouchers' no more than five specimens should be cited, indicating merely the collector and the collector's number (both italicized). Specimens are alphabetically arranged according to collector's name. If more than one specimen by the same collector is cited, they are arranged numerically and separated by a comma. **A collector's name and the voucher number(s) is separated from the next collector by a semicolon.** The purpose of the cited specimens is not to indicate distribution but to convey the author's concept of the taxon in question.

15.14 The herbaria in which the specimens are housed are indicated by means of the abbreviation given in the latest edition of *Index Herbariorum*. They are given between brackets, arranged alphabetically and separated by commas behind every specimen as in the following example:

Vouchers: *Arnold 64* (PRE); *Fisher 840* (NH, NU, PRE); *Flanagan 831* (GRA, PRE), *840* (NH, PRE); *Marloth 4926* (PRE, STE); *Schelpe 6161, 6163, 6405* (BOL); *Schlechter 4451* (BM, BOL, GRA, K, PRE).

15.15 If long lists of specimens are given, they must be listed together before Acknowledgements under the heading *Specimens examined*. They are arranged alphabetically by the collector's name and then numerically for each collector. The species is indicated in brackets by the number that was assigned to it in the text and any infraspecific taxa by a small letter. If more than one genus is dealt with in a given article, the first species of the first genus mentioned is indicated as 1.1. This is followed by the international herbarium designation. Note that the name of the collector and the collection number are italicized:

Acocks 12497 (2.1b) BM, K, PRE; 14724 (1.13a) BOL, K, P. *Archer 1507* (1.4) BM, G.
Burchell 2847 (2.8c) MB, K. *Burman 2401* (3.3) MO, S. *B.L. Burtt 789* (2.6) B, KMG, STE.

16 **Synonyms**

16.1 In a monograph or a revision covering all of southern Africa, all synonyms based on types of southern African origin, or used in southern African literature, should be included.

16.2 Illegitimate names are designated by *nom. illeg*. after the reference, followed by non with the author and date, if there is an earlier homonym.

16.3 Nomina nuda (*nom. nud*.) and invalidly published names are excluded unless there is a special reason to cite them, for example if they have been used in prominent publications.

16.4 In normal text, Latin words are italicized, but in the synopsis of a species Latin words such as *nom. nud., et al*. are not italicized (see 13.5, 17.9).

16.5 Synonyms should be arranged chronologically into groups of nomenclatural synonyms, i.e. synonyms based on the same type, and the groups should be arranged chronologically by basionyms, except for the basionym of the correct name which is dealt with in the paragraph directly after that of the correct name.

16.6 When a generic name is repeated in a given synonymy it should be abbreviated to the initial, except where intervening references to other genera with the same initial could cause confusion (see 13.4).

17 **Description and example of species treatment**

17.1 Descriptions of all taxa of higher plants should, where possible, follow the sequence: Habit; sexuality; underground parts (if relevant). *Indumentum* (if it can be easily described for the whole plant). *Stems/branches. Bark. Leaves*: arrangement, petiole absent/present, pubescence; blade: shape, size, apex, base, margin; midrib: above/below, texture, colour; petiole; stipules. *Inflorescence*: type, shape, position; bracts/bracteoles, involucral bracts: inner, outer. *Flowers*: shape, sex. *Receptacle. Calyx. Corolla. Disc. Androecium. Gynoecium. Fruit. Seeds. Flowering time. Chromosome number (reference). Conservation status*. Figure number (word written out in full).

17.2 As a rule, shape should be given before measurements.

17.3 In general, if an organ has more than one of the parts being described, use the plural, otherwise use the singular, for example, petals of a flower but blade of a leaf.

17.4 Language must be as concise as possible, using participles instead of verbs.

17.5 Dimension ranges should be cited as in 17.9.

17.6 Care must be exercised in the use of dashes and hyphens. A *hyphen* is a short stroke joining two syllables of a word, e.g. ovate-lanceolate or sea-green, with no space between the letter and the stroke. An *N-dash* (*en*) is a longer stroke commonly used instead of the word 'to' between numerals, '2–5 mm long' (do not use it between words but rather use the word 'to', e.g. 'ovate to lanceolate'; it is produced by typing three hyphens with spaces in between, or in MS Word the code is alt + 0150. An *M-dash* (*em*) is a stroke longer than an N-dash and is used variously, e.g. in front of a subspecific epithet instead of the full species name; it is produced by typing two hyphens with spaces in between, or in MS Word the code is alt + 0151. See also 2.10–2.12.

17.7 The use of '±' is preferred to c. or ca when describing shape, measurements and dimensions (see 13.12).

17.8 The decimal point replaces the comma in all units of measurement, e.g. leaves 1.0–1.5 mm long.

17.9 Example:

1. **Englerophytum magalismontanum** (*Sond*.) *T.D.Penn*., The genera of Sapotaceae: 252 (1991). Type: Gauteng, Magaliesberg, *Zeyher 1849* (S, holo.–BOL, photo.!).

Bequaertiodendron magalismontanum (Sond.) Heine & Hemsl.: 307 (1960); Codd: 72 (1964); Elsdon: 75 (1980).

Chrysophyllum magalismontanum Sond.: 721 (1850); Harv.: 812 (1867); Engl.: 434 (1904); Bottmar: 34 (1919). *Zeyherella magalismontana* (Sond.) Aubrév. & Pellegr.: 105 (1958); Justin: 97 (1973).

Chrysophyllum argyrophyllum Hiern: 721 (1850); Engl.: 43 (1904). *Boivinella argyrophylla* (Hiern) Aubrév. & Pellegr.: 37 (1958); Justin et al.: 98 (1973). Types: Angola, *Welwitsch 4828* (BM!, lecto., here designated; PRE!); Angola, *Welwitsch s.n.* (BM!).

Chrysophyllum wilmsii Engl.: 4, t. 16 (1904); Masonet: 77 (1923); Woodson: 244 (1937). *Boivinella wilmsii* (Engl.) Aubrév. & Pellegr.: 39 (1958); Justin: 99 (1973). Type: without locality and collector [B, holo.†; K!, P!, lecto., designated by Aubrév. & Pellegr.: 38 (1958), PRE!, S!, W!, Z!].

Bequaertiodendron fruticosa De Wild.: 37 (1923), non Bonpl.: 590 (1823); D.Bakker: 167 (1929); H.Fr.: 302 (1938); Davy: 640 (1954); Breytenbach: 117 (1959); Clausen: 720 (1968); Palmer: 34 (1969). Type: Mpumalanga, Tzaneen Dist., *Granville in Herb. Pillans K48625* (K, holo.!; G!, P!, PRE!, S!).

B. fragrans auct. non Oldemann: Glover: 149, t. 19 (1915); Henkel: 226 (1934); Stapelton: 6 (1954).

Illustrations: Harv.: 812 (1867); Henkel: t. 84 (1934?); Codd: 73 (1964); Palmer: 35 (1969).

Woody perennial; main branches up to 0.4 m long, erect or decumbent, grey woolly-felted, leafy. *Leaves* linear to oblanceolate, 3–10(–23) × 1.0–1.5(–4.0) mm, obtuse, base broad, half-clasping. *Heads* heterogamous, campanulate, 7–8 × 5 mm, solitary, sessile at tip of axillary shoots; involucral bracts in 5 or 6 series, inner

exceeding flowers, tips subopaque, white, very acute. *Receptacle* nearly smooth. *Flowers* ± 23–30, 7–11 male, 16–21 bisexual, yellow, tipped pink. *Achenes* ± 0.75 mm long, elliptic. *Pappus* bristles very many, equalling corolla, scabridulous. *Flowering time*: September. *Chromosome number*: 2n = 22. Figure 23B.

18 **New taxa**

18.1 The name of a new taxon must be accompanied by at least a Latin diagnosis. Authors should not provide full-length Latin descriptions unless they have the required expertise in Latin at their disposal.

18.2 It is recommended that descriptions of new taxa be accompanied by a good illustration, **preferably a line drawing, or a photograph (second choice)** and a distribution map.

18.3 Example:

109. **Helichrysum jubilatum** *Hilliard*, sp. nov., *H. alsinoidei* DC. affinis, sed foliis ellipticis (nec spatulatis), inflorescentiis compositis a foliis non circumcinctis, floribus femineis numero quasi dimidium hermaphroditorum aequantibus (nec capitulis homogamis vel floribus femineis 1–3 tantum) distinguitur.

Herba annua e basi ramosa; caules erecti vel decumbentes, 100–250 mm longi, tenuiter albo-lanati, remote foliati. *Folia* plerumque 8–30 × 5–15 mm, sub capitulis minora, elliptica vel oblanceolata, obtusa vel acuta, mucronata, basi semi-amplexicauli, utrinque cano-lanato- arachnoidea. *Capitula* heterogama, campanulata, 3.5– 4.0 × 2.5 mm, pro parte maxima in paniculas cymosas terminales aggregata; capitula subterminalia interdum solitaria vel 2 vel 3 ad apices ramulorum nudorum ad 30 mm longorum. *Bracteae involucrales* 5-seriatae, gradatae, exteriores pellucidae, pallide stramineae, dorso lanatae, seriebus duabus interioribus subaequalibus et flores quasi aequantibus, apicibus obtusis opacis niveis vix radiantibus. *Receptaculum* fere laeve. *Flores* ± 35–41. *Achenia* 0.75 mm longa, pilis myxogenis praedita. *Pappi* setae multae, corollam aequantes, apicibus scabridis, basibus non cohaerentibus.

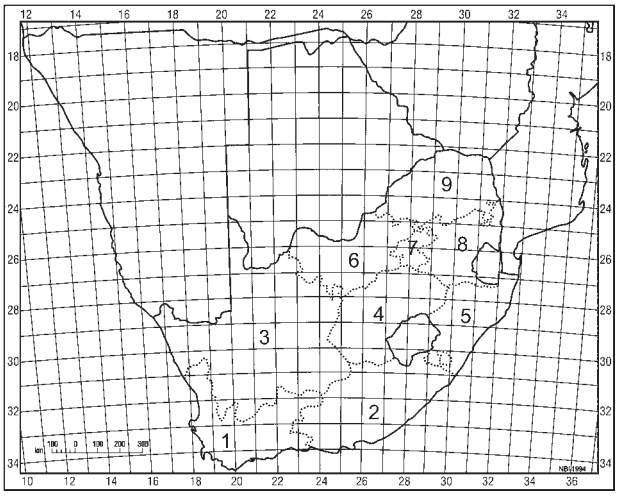

FIGURE 1.—1, Western Cape; 2, Eastern Cape; 3, Northern Cape; 4, Free State (previously Orange Free State); 5, KwaZulu-Natal (previously Natal); 6, North-West (previously northeastern Cape and southwestern Transvaal); 7, Gauteng (previously PWV); 8, Mpumalanga (previously Eastern Transvaal); 9, Limpopo (previously Northern Transvaal, Northern Province).

TYPE.—Northern Cape, 2817 (Vioolsdrif): Richtersveld, (–CC), ± 5 miles E of Lekkersing on road to Stinkfontein, kloof in hill south of road, annual, disc whitish, 7-11-1962, *Nordenstam 1823* (S, holo.; E, NH, PRE).

19 **New provinces of South Africa** (Oct. 1996)

20 **Proofs**

Only page proofs are normally sent to authors. They should be corrected in red ink and be returned to the editor **as soon as possible**. Do not add any new information.

21 **Reprints**

Authors receive 100 reprints free. If there is more than one author, this number will have to be shared between them.

22 **Documents consulted**

Guides to authors of the following publications were made use of in the compilation of the present guide: *Annals of the Missouri Botanic Garden*, *Botanical Journal of the Linnean Society*, *Flora of Australia*, *Smithsonian Contributions to Botany*, *South African Journal of Botany* (including instructions to authors of taxonomic papers), *South African Journal of Science*.

23 **Address of editor**

Manuscripts should be submitted to: The Editor, *Bothalia*, South African National Biodiversity Institute, Private Bag X101, Pretoria 0001.

24 ***FSA* contributions**

24.1 Figures and text must conform to *Bothalia* format.

24.2 These articles will be considered as a full contribution to the *Flora of southern Africa* and will be listed as published in the '*Plan of Flora of southern Africa*', which appears in all issues of the *FSA* series.

25 **Place names**

Ensure that local place names are correct. If in doubt, consult the Internet at http://sagns.dac.gov.za/searchplacenamedatabase.asp

INDEX

Book Reviews

LEGUMES OF THE WORLD, edited by GWILYM LEWIS, BRIAN SCHRIRE, BARBARA MACKINDER & MIKE LOCK. 2005. *Royal Botanic Gardens, Kew*, Richmond, Surrey, TWA 3AB, UK. Pp. xiv + 578. Hard cover: ISBN 1-900347-80-6, price R794.17, £76.88.

In the foreword to *Legumes of the world*, Bernard Verdcourt mentions that it is appropriate that this book containing all the genera of the Leguminosae, should have been written at an institute whose involvement in legume research stretches from the middle of the 19th century through the work of George Bentham, to the latter half of the 20th century through the contributions of J.B. Gillett, J.P.M. Brenan and R.M. Polhill. In addition, *Advances in legume systematics*, consisting of 11 volumes and forerunner to this publication, has further enhanced our knowledge on legume research.

The four editors of this book are all legume experts at Kew and have elicited the help of 20 internationally renowned legume scientists to compile this comprehensive and scientifically accurate, well-illustrated guide to all 727 genera of the Leguminosae throughout the world. The over 1 100 illustrations are in the form of clear, high-quality colour photographs, black-and-white line drawings and paintings by numerous photographers and artists, all mentioned in the acknowledgements. The artist Pat Halliday was commissioned to produce 105 drawings of genera for which no other suitable image could be found. The unique painting of pods, seeds, leaves and flowers by the botanical artist Rachel Pedder-Smith featured on the end papers of the book adds a special touch and celebrates the diversity of shapes and forms of this interesting plant family. The thick, glossy paper used for the inside work furthermore enhances the quality of the book.

The introduction deals with the issue of Leguminosae versus Fabaceae, the classification of the Leguminosae into three subfamilies with 36 tribes and briefly with the economic importance of this family. Of interest, the top 20 genera are listed according to the number of species in each, the genus *Astragalus* coming out tops with 2 400 species of the current total of 19 327 species for the entire family. Legume products are of world-wide importance, contributing to the economy in the form of food, pharmaceuticals and medicine, furniture and crafts, just to name a few. A good example of the economic importance of this family in the South African context is the *rooibos* (*Aspalathus*) and honeybush (*Cyclopia*) tea industry.

A whole chapter is devoted to the biogeography of the Leguminosae. Initially the distribution of some 730 legume genera world-wide had to be ascertained. The increasing knowledge of phylogenies now available for Leguminosae provides a novel tool to explore distribution patterns.

The bulk of the book comprises descriptions of the tribes with diagrammatic representations of the latest view of phylogenetic relationships among genera or informal groups. A full-page colour photograph of a spectacular member of the tribe is given pride of place at the beginning of the account. The 727 genera within their tribes are given a full account featuring the main synonyms, the number of species, geographical range, etymology, ecology, phylogenetic notes and economic uses. A species, or often more than one species per genus, is further illustrated, either by clear, high-quality photographs, by black-and-white drawings or by paintings, showing the habit or plant parts such as inflorescences, individual flowers or fruits.

The main accounts are followed by a comprehensive 34-page list of references and indices to illustrations, vernacular names and scientific names (including phylogenetic and biogeographical terms).

A book of this kind has long been overdue as most of the other larger important families (e.g. Asteraceae, Mesembryanthemaceae) in the world have been featured. The four editors and numerous authors are to be congratulated on producing this illustrated reference work for legume specialists. The only negative aspect is the lack of formal descriptions of all genera, and keys to the genera but the editors explain in the 'About the book' section that this omission would be addressed at a future date once the project develops further.

This book is a must for the bookshelf of the professional researcher, student and the layperson.

G. GERMISHUIZEN*

* South African National Biodiversity Institute, Private Bag X101, 0001 Pretoria.

PLANTS OF THE SIMEN. A FLORA OF THE SIMEN MOUNTAINS AND SURROUNDINGS, NORTHERN ETHIOPIA (*Scripta Botanica Belgica* 37), by CHRISTIAN PUFF and SILESHI NEMOMISA. 2005. *National Botanic Gardens of Belgium, Meise*. Pp. 258, 230 × 172 mm. Hard cover: ISBN 90-72619-65-X, price £43.50.

Mention the Simen Mountains in Ethiopia (name explained in text) and images of giant lobelias, Gelada baboons and Walia ibex spring to mind. This plant guide will enlighten discerning travellers in this unique region.

The first section describes various aspects of the Simen region, for example the position of the Simen within Ethiopia (with maps and diagrams), geology and climate, with differences between the upland and lowland vegetation fully explained and vegetation, wildlife and people put into perspective. Useful tips to visitors follow, with references and a glossary.

The botanical section lists all species known to occur in the Simen region, starting with the gymnosperms followed by the dicots and then the monocots listed at the end. The genera and species are given according to the order of *Flora of Ethiopia* or *Flora of Ethiopia and Eritrea.*

The reader is aided by the illustrations on the facing pages of the descriptions which are concise, each 30 to 60 words long. Keys are provided only if there are more than three taxa per genus, and subfamilies within genera, giving an insight into their differentiation. The keys are easy to use and are not peppered with unnecessary botanical jargon. The presence of each species in upland, lowland or escarpment situations is provided, giving the reader a good idea whether a species is a generalist plant or whether it prefers a more specific habitat. Where relevant, the endemic status of plants in Ethiopia or in the Simen is also given, helping the reader to gain insight into the broader or more local distribution of any given taxon.

Apart from the odd spelling of *Buddleja* (*Buddleia* in this work), my only criticism is that the invasive status of some plants that are not of Ethiopian origin, such as *Ricinus communis*, could have been added.

The Simen is amazingly similar to the Drakensberg in southern Africa, owing to the basaltic extrusions which they share. However, this region is at a higher altitude and is home to giant lobelias, which the Drakensberg lacks. A surprisingly large amount of Simen plants also occur in southern Africa. Some examples are *Halleria lucida*, *Hebenstretia angolensis*, *Myrsine africana*, *Ficus sur*, *Hypericum revolutum* and *Combretum molle*. Some taxa in Ethiopia show only minor differences to those in southern Africa, facilitating the establishment of subspecies, e.g. *Monopsis stellarioides* subsp. *stellarioides* found in the higher rainfall areas of southern Africa and subsp. *schimperiana* which occurs only in the Simen.

Being a lover of succulents, I was astonished to find *Delosperma abyssinicum*—a new record for me. Images of *Rosularia semiensis* endemic to the Simen, which is depicted in a novel way at the top of each page, recalls memories of a hike at high altitude in that part of Africa in 2003 to view this splendid plant.

This guide is a good example of what can be achieved by two authors through collaboration over time.They have obviously spent much time in the region and know the flora intimately. The photographs are superb and show the important features intended, while the text is descriptive and concise. Had this book been available when I visited the region, I would have had a much better grasp of various aspects of the area, especially the identity of various species of *Indigofera*. A second trip to Ethiopia seems a likely excuse to make use of this fine guide to the flora of Simen, and certainly worthy of more than one visit.

P.M. BURGOYNE*†

* South African National Biodiversity Institute, Private Bag X101, 0001 Pretoria.

† Research Fellow, Department of Environmental Sciences, University of South Africa, P.O. Box 392, 0003 UNISA, Pretoria.

BOTHALIA

Volume 36,2 Oct. 2006

CONTENTS

Abstracted, indexed or listed in • AETFAT Index • AGRICOLA • AGRIS • BIOSIS: *Biological Abstracts/RRM* • CABS • CABACCESS • CAB ABSTRACTS • ISI: *Current Contents, Scisearch, Research Alert* • *Kew Record of Taxonomic Literature* • *Taxon*: reviews and notices.

ISSN 006 8241