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Ornithoglossum pulchrum (Colchicaceae: Colchiceae), a new species from southern Namibia

D.A. SNIJMAN*, B. NORDENSTAM** and C. MANNHEIMER***

Keywords: Colchicaceae, Colchiceae, new species, *Ornithoglossum* Salisb., southern Namibia, taxonomy

ABSTRACT

We describe a new species in the sub-Saharan genus *Ornithoglossum* Salisb. from southern Namibia. *Ornithoglossum pulchrum* from near Aus, is remarkable in having bright to dark pink flowers, a feature previously unknown in the genus. The perigone is almost concolorous apart from a contrasting, pale yellow nectary region, narrowly outlined with darker red, near the base of each tepal. The undulate leaves together with the long filaments, which are nearly as long as the tepals, suggest a relationship with *O. undulatum*, a widespread species in the western parts of southern Africa, and *O. zeyheri* from Namaqualand and the northwestern Cape.

INTRODUCTION

Ornithoglossum Salisb. is a small, sub-Saharan genus in the family Colchicaceae (Nordenstam 1998). All but one of the eight species recognized by Nordenstam (1982) are concentrated in the western half of southern Africa, mostly in the winter rainfall region. Only *O. vulgare* B.Nord. is found in southern Africa's eastern parts and as far north as East Africa. Previously the genus was placed in the tribe Iphigenieae (Buxbaum 1936), but in a new classification, based on an analysis of molecular data of the family, the genus now falls within the tribe Colchiceae, together with *Colchicum* L., *Gloriosa* L., *Hexacyrtis* Dinter and *Sandersonia* Hook. (Vinnersten & Manning 2007).

Considering its small size, the genus shows remarkable diversity in floral morphology. The perianth is actinomorphic or zygomorphic in form and coloured cream to attractive yellow, green, brown or purple, sometimes almost black, and often bicoloured. In species such as *Ornithoglossum undulatum* Sweet, the flowers are large, showy and sweetly scented, but in *O. parviflorum* B.Nord. they are small, inconspicuous, dull and unscented (Manning *et al.* 2002). Other variable features are the shape of the nectaries on the basal part of the tepals and the length and thickness of the filaments. Several micromorphological differences in the pollen and seeds also help to distinguish groups of species. All the species are reported to be highly toxic to stock due to their colchicine-type alkaloids, which accounts for their common name '*slangkop*' (Watt & Breyer-Brandwijk 1962).

While collecting material for a photographic guide to the wildflowers of the southern Namib, the third author found an unusual population of *Ornithoglossum* near the small town of Aus, Namibia, in which the flowers were

deep pink to crimson and almost concolorous except for a pale yellow patch towards the base of each tepal. Due to their undulate leaves, the plants were initially thought to be *O. undulatum* (Mannheimer *et al.* 2008), a species that has been recorded previously from southern Namibia (Nordenstam 1982). Subsequent examination of these specimens, however, has revealed further distinguishing characters, which together with the unique flower colour, justify the description of the plants as a new species of *Ornithoglossum*.

***Ornithoglossum pulchrum* Snijman, B.Nord. & Mannheimer, sp. nov.**

Cormus ovoideus, brevilobus. Caulis simplex gracilis ad ± 110 mm altus. Folia 4–7, lanceolata margine conspicue crispato-undulato. Racemus 3–10-florus ad 40–80 mm longus. Perianthium actinomorphum, segmentis 27–32 $\times$ 4–5 mm, roseis vel rubineis, luteolis prope basim. Nectarii margo simplex. Filamenta plerumque longitudine tepala aequantia. Antherae 2.5 $\times$ 0.5 mm. Styli ± 25 mm longi.

TYPE.—Namibia: 2616 (Aus): riverbed, western extent of Aus town lands, 1 386 m, (–CA), 22 Jun. 2005, C.A. Mannheimer CM2710 (WIND, holo.).

Glabrous, cormous herb. *Corm* ovoid, $\pm 45 \times 30$ mm, shallowly bilobed at base with lobes directed downwards, interior firm, whitish; tunics leathery, dark brown, extended into a slender neck up to 80 mm long, sheathing subterranean portion of stem, inner tunics rust-coloured. *Cataphyll* apparently absent. *Stem* erect, simple, subterranean part slender, up to ± 110 mm long, as long as leafy aerial portion, terminated by a bracteate, racemose inflorescence. *Leaves* alternate, 4–7, lanceolate from sheathing base, recurved, 10–180 $\times$ 8–15 mm, broadest at base, tapering distally to a narrow, mucronate tip, $\pm$ conduplicate, glaucous, margins undulate, often crisped. *Inflorescence* a compact, 3–10-flowered raceme, 40–80 mm long and clustered among upper leaves; bracts leaf-like, narrowly lanceolate, successively smaller acropetally, 30–50 $\times$ 4–6 mm, as long as or slightly longer than pedicels, glaucous tinged pinkish, margins plane. *Flowers* suberect to spreading on

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FIGURE 1.—*Ornithoglossum pulchrum*. A, plant in habitat showing sheathing, undulate leaves and compact inflorescence; B, detail of campanulate flower showing long stamens and six large, concave nectaries each with a simple margin near base of tepals. Photographs: C. Mannheimer.

erecto-patent pedicels 20–35 mm long, actinomorphic, $\pm$ widely campanulate, $\pm$ 40 mm diam.; tepals equally spreading, $27\text{--}32 \times 4\text{--}5$ mm, claw tubular-flattened, $\pm 4.0 \times 1.5$ mm, blade lanceolate, faintly 7–9-veined, slightly canaliculate, bright to dark pink, with a pale yellow nectary region narrowly outlined with darker red, becoming paler with age; nectary concave, wide-mouthed, ventral margin simple. *Stamens* slightly spreading; filaments straight, slightly curved distally, $\pm$ filiform but slightly thickened in proximal half, 25–28 mm long, uniformly dark pink; anthers oblong, 2.5×0.5 mm, slightly curved, dull yellow. *Ovary* oblong-globose, 5.0×3.5 mm, dark pink; styles free from base, spreading, straight proximally, slightly curved distally, $\pm$ 25 mm long, dark pink; stigma capitate, minutely papillate. *Capsule* elliptical-oblong, shortly and bluntly lobed, 7×4 mm (when immature but not known when mature), erect, coriaceous. *Seeds* unknown. *Flowering time*: June to early Aug. Figures 1; 2.

Distribution and ecology: *Ornithoglossum pulchrum* is currently known from just one locality in the pro-Namib, a broad, undulating plain in southern Namibia (Figure 3). The species has been recorded in ephemeral watercourses from the uplands near Aus, which lie just below the inland escarpment, at approximately 1 380 m. The plants grow in coarse gravel, close to gneiss outcrops of the Namaqua Metamorphic Complex. Lying on the border of the winter and summer rainfall zones, Aus has bimodal rainfall, averaging 85 mm per year. Most rain falls in late summer (January to April) with a second, lower peak in June (Pallett 1995). Precipitation also occurs in the form of occasional fog which moves in from the coast, as well as rare snowfalls. Winds in the region are a powerful climatic force which can severely limit plant growth. Like most other *Ornithoglossum* species from southern Africa's winter rainfall region, *O. pulchrum* flowers in winter, usually from mid to late June into August.



FIGURE 2.—*Ornithoglossum pulchrum*. A, type specimen, Mannheimer CM2710 (WIND); B, specimen on left shows shallowly bilobed corm, specimen on right shows undulate, crisulate-edged leaves and young, upright capsules, Mannheimer CM4004a (WIND). Scale bars: A, B, 100 mm.

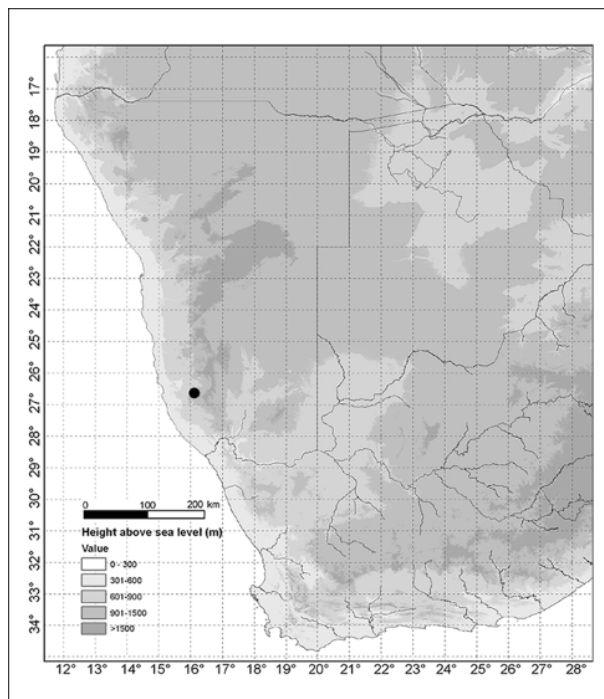


FIGURE 3.—Known distribution of *Ornithoglossum pulchrum*.

Diagnosis and relationships: *Ornithoglossum pulchrum* is distinguished by its flowers, which are suberect to spreading in a compact raceme that barely exceeds the leaves, and in which the $\pm$ filiform filaments are almost as long as the tepals. The flowers are easily distinguishable from those of other *Ornithoglossum* species by their bright to dark pink colour (47C, 48C in R.H.S Colour Chart 1966). This colouring is almost unbroken apart from a pale yellow patch, narrowly outlined with dark red, near the base of each tepal in the region of the nectary. *O. pulchrum* shares the character of undulate, crispulate-edged leaves with four other taxa in the genus, viz. *O. undulatum*, *O. gracile* B.Nord. and *O. zeyheri* B.Nord., and also *O. parviflorum* var. *namaquense* B.Nord. Compared with the floral characters, however, this vegetative feature is of less taxonomic importance, as quite plane-edged leaves are known in some populations of *O. undulatum* (Nordenstam 1979, 1982). Nevertheless, the undulate leaves together with the long filaments, which nearly equal the length of the tepals, suggest a relationship with both *O. undulatum*, a widespread species in the western parts of southern Africa, and *O. zeyheri* which is confined to Namaqualand between the Steinkopf region and the lower Olifants River Valley. *O. undulatum* differs from *O. pulchrum* in its markedly asymmetric flowers in which one or two tepals point downwards and the other tepals flare upwards at anthesis. These are slightly smaller than those of *O. pulchrum* (16–30 $\times$ 2–5 mm vs 27–32 $\times$ 4–5 mm) and are bicoloured, white in the centre with reddish purple tips. In contrast, the flowers of *O. pulchrum* are actinomorphic and campanulate, features that are shared with *O. zeyheri*. Unlike *O. pulchrum*, however, this species has few and inconspicuous flowers which are typically produced in May, with tepals that are short and narrow (12–15 $\times$ 1–3 mm) and coloured pale greenish with a purplish tinge towards the base and tip. The regular symmetry of the flowers of *O. pulchrum* prevent possible confusion

with any other species from southern Namibia even in the early fruiting stages, since its withered tepals remain evenly spread around the developing suberect to spreading capsule, unlike those of *O. undulatum* which are distinctly reflexed from a markedly down-turned capsule. Both *O. zeyheri* and *O. undulatum* share a simple-margined nectary with *O. pulchrum*, although this feature is variable in *O. undulatum*, sometimes taking the form of an entire or bifid lobe.

Ornithoglossum pulchrum has only been collected twice so far, once when in flower and again in the early stages of fruiting. As yet, mature fruits and seeds are not available for comparison with other species.

Species from other families that are narrowly endemic to the Aus area are *Moraea graniticola* Goldblatt (Iridaceae) and *Oxalis ausensis* R.Knuth. (Oxalidaceae), both geophytic herbs, and the succulent shrub *Juttadintheria ausensis* (L.Bolus) Schwantes (Aizoaceae). *M. graniticola* and *J. ausensis* flower only after winter rain and when temperatures begin to rise. *O. ausensis* is one of four autumn-flowering *Oxalis* species in the vicinity of Aus.

Other specimen seen

NAMIBIA.—2616 (Aus): Aus town lands, (–CA), 11 Sept. 2008, C.A.Mannheimer CM4004a (WIND).

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REFERENCES

- BUXBAUM, F. 1936. Die Entwicklungslinien der Liliodeae. I. Die Wurmhaeideae. *Botanisches Archiv* 38: 213–293.
- MANNHEIMER, C., MAGGS-KÖLLING, G., KOLBERG, H. & RÜGHEIMER, S. 2008. *Wildflowers of the southern Namib*. Macmillan, Namibia.
- MANNING, J., GOLDBLATT, P. & SNIJMAN, D. 2002. *The color encyclopedia of Cape bulbs*. Timber Press, Oregon and Cambridge.
- NORDENSTAM, B. 1979. *Ornithoglossum undulatum*. *The Flowering Plants of Africa* 45: t. 1799.
- NORDENSTAM, B. 1982. A monograph of the genus *Ornithoglossum* (Liliaceae). *Opera Botanica* 64: 1–51.
- NORDENSTAM, B. 1998. Colchicaceae. In K. Kubitzki, *The families and genera of vascular plants*, vol. 3. *Flowering plants, monocotyledons, Liliaceae (except Orchidaceae)*. Springer-Verlag, Berlin.
- PALLET, J. 1995. *The Sperrgebiet Namibia's least known wilderness. An environmental profile of the Sperrgebiet or Diamond Area 1 in south-western Namibia*. NAMDEB Diamond Corporation, Windhoek.
- R.H.S. COLOUR CHART. 1966. The Royal Horticultural Society, London.
- VINNERSTEN, A. & MANNING, J. 2007. A new classification of Colchicaceae. *Taxon* 56: 171–178.
- WATT, J.M. & BREYER-BRANDWIJK, M.G. 1962. *The medicinal and poisonous plants of southern and eastern Africa*. Livingston, Edinburgh.

Maireana brevifolia (Chenopodiaceae: Camphorosmeae), a new naturalized alien plant species in South Africa

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Keywords: Australia, Chenopodiaceae, distribution, *Maireana brevifolia* (R.Br.) Paul G. Wilson, new naturalized species, semi-arid South Africa

ABSTRACT

We describe and discuss the distribution of a new, naturalized alien species, *Maireana brevifolia* (R.Br.) Paul G. Wilson (Chenopodiaceae), a native of Australia, in the western regions of South Africa. First discovered near Worcester, Western Cape in 1976, the species is now established in disturbed karoo shrubby rangelands, along dirt roads and on saline alluvia, from northern Namaqualand to the western Little Karoo. In the South African flora, *M. brevifolia* is most easily confused with the indigenous *Bassia salsoloides* (Fenzl) A.J. Scott, from which it is distinguished by the flat to cup-shaped and almost glabrous perianth with woolly-ciliate lobes, and the hardened and winged fruiting perianth.

INTRODUCTION

Several ecological groups of Australian alien plants have been incorporated into the South African flora, including a number of Fabaceae, predominantly *Acacia* species (most importantly *A. cyclops* A. Cunn. ex G. Don, *A. longifolia* (Andrews) Willd., *A. mearnsii* De Wild., *A. melanoxylon* R.Br., *A. pycnantha* Benth., *A. saligna* (Labill.) H.L. Wendl.), and several species of Chenopodiaceae. These vary from herbaceous weeds such as *Dysphania cristata* (F. Muell.) Mosyakin & Clemants (= *Chenopodium cristatum* F. Muell.), *D. pumilio* (R.Br.) Mosyakin & Clemants (= *Chenopodium pumilio* R.Br.) to weeds of karoo shrublands and disturbed sites in the arid biomes of southern Africa, including several notorious species of *Atriplex*, namely *A. eardleyae* Aellen, *A. lindleyi* Moq., *A. nummularia* Lindl. and *A. semibaccata* R.Br. (Goldblatt & Manning 2000; Makgaka 2003). *Atriplex nummularia* in particular has been cultivated widely, especially on heavy alluvial soils in South Africa as a dry-season fodder plant (L. Mucina pers. obs.). In many places (especially in the Little Karoo), the species has escaped cultivation to become an established weed, especially on alluvia of intermittent semi-desert rivers.

During the preparation of an account for the Chenopodiaceae in *Plants of the Greater Floristic Region 2: the Extra Cape flora* (Mucina & Snijman ined.), it became apparent that yet another adventive species of Chenopodiaceae, native to Australia, is present in several places in the western regions of South Africa.

Maireana brevifolia

Maireana brevifolia (R.Br.) Paul G. Wilson is the newest addition in Chenopodiaceae to the alien flora of the South African semi-deserts (Figure 1B). It has been found to become established in disturbed karoo shrubby rangelands, along dirt roads, and on saline allu-

via. The latter habitat is that preferred by *M. brevifolia* in its homeland—Australia. In its native range, it covers a large distribution area (Figure 1A) characterized by ‘transitional’ rainfall (where the influence of western frontal systems meets that of poorly predictable cyclonic summer rainfall). The footprint of the distribution area of this species marks the extent of unique temperate *Eucalyptus* open woodlands that have been cleared, especially in many parts of Western Australia, South Australia, New South Wales, southern Queensland and northern Victoria. The native status of this species in the Northern Territory needs revisiting. This species has a moderate salinity and waterlogging tolerance and prefers heavy clay or sandy-clay alluvial soils. In Western Australia it has been found to be one of the pioneers of recolonization of abandoned salinized pastures.

Maireana brevifolia is also an established weed in Chile (Marticorena 1997), the Middle East (Danin 2000b) and the Canary Islands (Brandes 2006). Climate-niche modelling (Figure 1C) predicts that *M. brevifolia* could establish with high probability throughout the Mediterranean, around the Gulf of Mexico, eastern Argentina and neighbouring countries, as well as southern China.

Maireana brevifolia might have been introduced to South Africa when targeted as potential dry-season fodder or accidentally as seed admixtures with *Atriplex nummularia*. The first herbarium record for the species in South Africa, made in 1976, is from the Worcester area, Western Cape. With her knowledge of the Western Australian flora, the late Pauline Bond, formerly of the Compton Herbarium, recognised the collection as an alien species and was the first to identify the plants as *M. brevifolia*. Since then the species has been collected four more times, once in Namaqualand and on three separate occasions in the Western Cape, dating from the late 1990s onwards. The identity of two of these collections has been independently confirmed by R.J. Chinnock of the State Herbarium of South Australia, Adelaide, and H. Freitag, Kassel, Germany.

In Australia, *Maireana brevifolia* has been used to ameliorate salt-laden pastures (Runciman & Malcolm 1991; Barrett-Lennard & Malcolm 1995; Barrett-Len-

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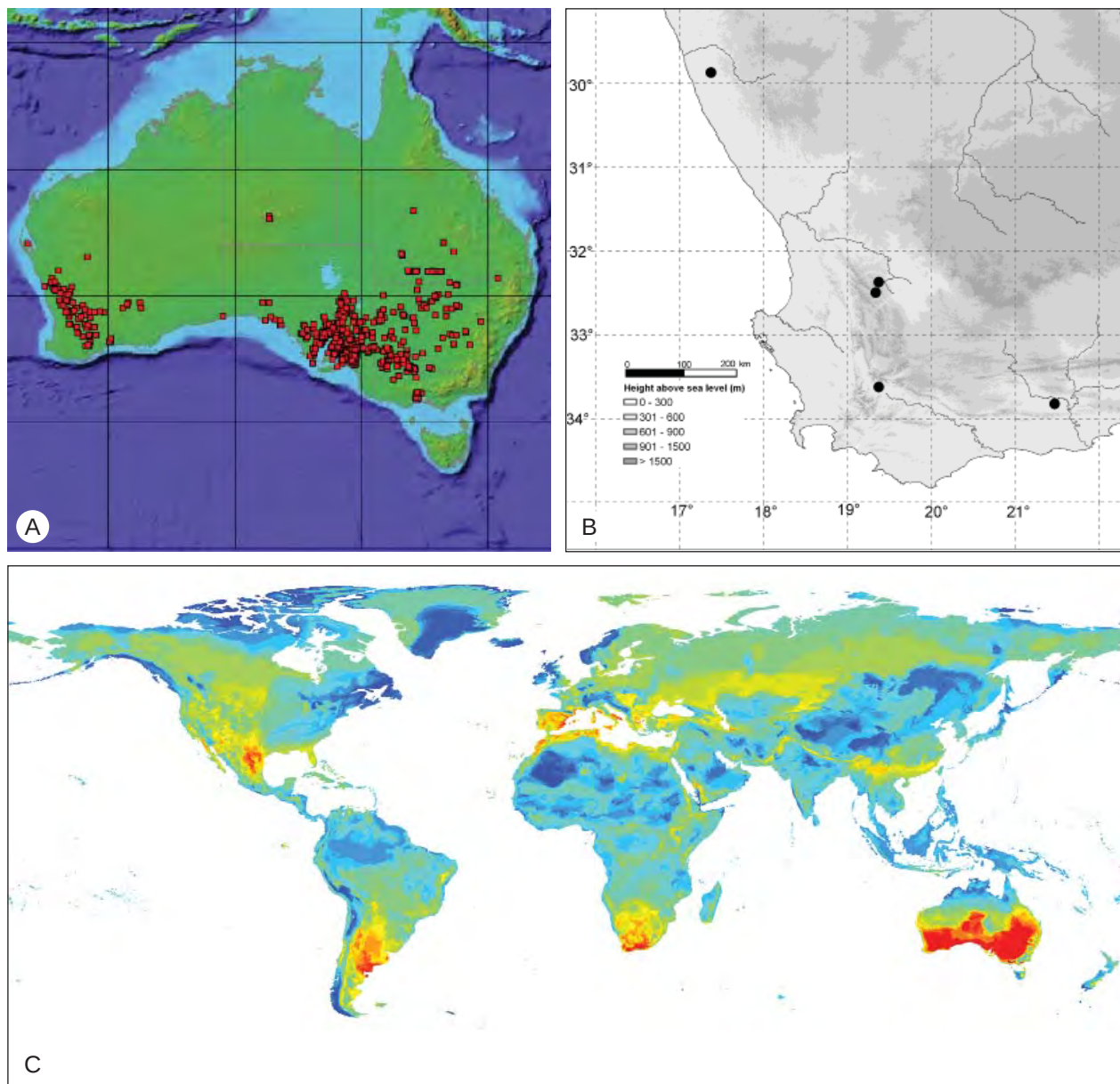


FIGURE 1.—A, distribution map of *Maireana brevifolia* in Australia (courtesy of Australian Virtual Herbarium, <http://avh.rbhv.vic.gov.au/avh/>); B, distribution map of *M. brevifolia* in South Africa (original); C, modelled distribution of *M. brevifolia* using Australian localities (stored by www.gbif.org) as basis of model. Openmodeller generated the probability distribution using Envelope Score Algorithm (see <http://openmodeller.sourceforge.net> for computation details). Colour scheme (spanning hot/red colours to cool/blue colours) used in map designates a gradient of probability of high vs low probability of occurrence of *M. brevifolia* under the given climate-niche scenario.

nard *et al.* 2003) and with less success, also mine spoil dumps (Jefferson 2004; Jefferson & Pennacchio 2005). Outside Australia, *M. brevifolia* has been introduced for saline soil improvement and dry-season fodder production in Pakistan (Ilyas *et al.* 2000), Iraq (Abdul-Halim *et al.* 1990) and Israel (Danin 2000a).

***Maireana brevifolia* (R.Br.) Paul G. Wilson** in Nuytsia 2: 22 (1975). Type: Australia, South Australia, Bay XI, south coast, R. Brown (BM, holo.).

Kochia brevifolia R.Br.: 409 (1810).

Succulent-leaved shrub, up to 1 m high, with mostly erect, slender, striate, sparsely woolly branches. Leaves alternate, obovoid to narrowly fusiform, (1–)2–5 mm long, fleshy, narrowed into a short petiole, glabrous.

Flowers bisexual, solitary, ebracteolate, glabrous except for woolly-ciliate lobes. *Fruiting perianth* glabrous; tube shallowly hemispherical, thin-walled, ± 2 mm in diam.; wings 5, rarely absent, equal, horizontal, thin, fan-shaped, 2–3 mm long, glabrous, with delicate brown venation when dry, with pale to dark pink tint; perianth lobes thick and fleshy, sharply demarcated from wings. (Description based on Wilson 1984). *Flowering time*: (Aug.–)Nov. to Apr. Figure 2.

Common names in Australia: Small-leaf Bluebush, Eastern Cotton Bush, Yanga Bush. None is yet known in South Africa.

Distribution in South Africa: to date *Maireana brevifolia* has been recorded from Namaqualand, between Anenous and Komaggas, on the lower slopes of the



FIGURE 2.—*Maireana brevifolia*, habitat and habit: A, typical habitat of *M. brevifolia*—disturbed edge of dirt road crossing a shallow depression (alluvium of intermittent river) near Komaggas (Namaqualand, South Africa); B, extensively used pasture on saline alluvium near Kondinin (Western Australia) with a bush of *M. brevifolia* in foreground and scattered individuals in the rear. C, D, *Mucina* 280407/03 MJG, NBG; from Komaggas, South Africa: C, form with deep pink fruit; D, erect-branched habit of *M. brevifolia* bushes. E, *Mucina* 102010/03 Curtin Univ. Herbarium from Corrigin, Western Australia: form with pale pink fruit. All photographs: L. Mucina.

eastern Cederberg Mtns bordering on the Tanqua Karoo, the Worcester-Robertson Karoo and the western Little Karoo. As long as disturbed habitats such as those formed along dirt roads and on saline alluvia are available for this colonizer, *M. brevifolia* will persist as an established alien in the South African flora.

Notes: the genus *Maireana* is native to mainland Australia and has ± 57 species. *M. brevifolia* is the only species of the genus known to have been introduced into South Africa so far. Within the South African flora, *Maireana* is most closely related to *Bassia* All., which is the only native genus belonging to tribe Camphorosmeae (*sensu* Akhiani *et al.* 2007). *Maireana* is distinguished from *Bassia* by flowers that are usually solitary or in pairs in the leaf axils, the flat to cup-shaped and mostly glabrous perianth (except in *M. brevifolia* where the lobes are woolly-ciliate), and the hardened and winged fruiting perianth. In contrast, *Bassia* has solitary flowers or flowers arranged in spicate inflorescences, an urn-shaped perianth, and the fruiting perianth has spine-like or tubercle-like appendages or membranous, scarious wings. *M. brevifolia* is most easily confused with *B. salsoloides* (Fenzl) A.J.Scott, commonly known as the *basterinkbos*, which is widespread in sandy, alluvial soils along water courses and seasonal washes from the Free State in the northeast, through the central Karoo to

Matjiesfontein, Western Province, in the southwest. *B. salsoloides* has linear to filiform, succulent leaves that are $\pm$ pubescent, flowers borne in tight, short, spike-like clusters, a pubescent perianth, and a fruiting perianth that enlarges into short, firm, brown-streaked wings, with irregularly toothed margins.

Specimens examined

NORTHERN CAPE.—2917 (Springbok): Namaqualand, northwest of Komaggas, sandy-clayey saline donga, 29°17'51.76"S, 17°28'10.02"E, (–CD), 28 Apr. 2007, L. Mucina 280407/05 (MJG).

WESTERN CAPE.—3219 (Wuppertal): Matjies River Nature Reserve, Upland Succulent Karoo, stony soil, 760 m, 32°29.90'S, 19°20.30'E, (–AD), 21 Nov. 1999, A.B. Low 5835 (NBG); Matjies River Nature Reserve, roadsides and valley bottom on old fields, on sandy or loamy soils, 32°30'03"S, 19°20'18"E, (–CB), Apr. 2002, P.M. Holmes s.n. (NBG). 3319 (Worcester): Karoo Garden, Worcester, in *Euphorbia mauritanica* patches, 300 m, (–CB), Mar. 1976, M.B. Bayer 149 (NBG). 3321 (Ladismith): 0.4 km east of T-junction of R327 with connecting road to R323 just west of Langberg [Langeberg], abundant along roadsides in *Acacia karroo* / Aizoaceae low shrubland, on stony brown loam, $\pm 33^{\circ}49'30''$ S, $21^{\circ}28'07''$ E, (–CD), 21 Aug. 1998, R.J. Chinnock 9194 (NBG).

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REFERENCES

- ABDUL-HALIM, R.K., AL-BADRI, F.R., YASIN, S.H. & ALI, A.T. 1990. Survival and productivity of chenopods in salt-affected lands of Iraq. *Agriculture, Ecosystems and Environment* 31: 77–84.
- AKHANI, H., EDWARDS, G. & ROALSON, E.H. 2007. Diversification of the Old World Salsola s.l. (Chenopodiaceae): molecular phylogenetic analysis of nuclear and chloroplast data sets and a revised classification. *International Journal of Plant Science* 168: 931–956.
- BARRETT-LENNARD, E.G. & MALCOLM, C.V. 1995. *Saltland pastures in Australia*. West Australian Dept. of Agriculture Bulletin No. 4312. Dept of Agriculture, Perth.
- BARRETT-LENNARD, E.G., MALCOLM, C.V. & BATHGATE, A. 2003. *Saltland pastures in Australia—a practical guide*, edn 2. CRC for Plant-based Management of Dryland Salinity, Perth.
- BRANDES, D. 2006. Urbanizaciones: Die Entstehung städtischer Lebensräume aus der Halbwüste. *Geobotanische Kolloquien* 20: 13–20.
- BROWN, R. 1810. *Prodromus florae Novae Hollandiae*. Johnson, London.
- DANIN, A. 2000a. The inclusion of adventive plants in the second edition of *Flora Palaestina*. *Willdenowia* 30: 305–314.
- DANIN, A. 2000b. Species ‘new to’ the *Flora Palaestina* area. *Flora Mediterranea* 10: 109–172.
- GOLDBLATT, P. & MANNING, J.C. 2000. Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9. National Botanical Garden, Pretoria & Missouri Botanical Garden, St Louis.
- ILYAS, M., HASSAN, M., MUHAMMAD, W. & MUHAMMAD, N. 2000. Study of yield and yield components of exotic *Atriplex* and *Maireana* in the saline environments of NWFP. *Pakistan Journal of Biological Sciences* 3: 1873–1876.
- JEFFERSON, L.V. 2004. Implications of plant density on the resulting community structure of mine site land. *Restoration Ecology* 12: 429–438.
- JEFFERSON, L.V. & PENNACCHIO, M. 2005. The impact of shade on establishment of shrubs adapted to the high light irradiation of semi-arid environments. *Journal of Arid Environments* 63: 706–716.
- MAKGAKGA, M.C. 2003. Chenopodiaceae. In G. Germishuizen & N.L. Meyer, Plants of southern Africa: an annotated checklist. *Strelitzia* 14. National Botanical Institute, Pretoria.
- MARTICORENA, C. 1997. La presencia de *Maireana brevifolia* (R.Br.) Paul G. Wilson en Chile continental. *Revista Gayana Botánica* 54: 193, 194.
- MITCHELL, T.L. 1848. *Journal of an expedition into the interior of tropical Australia*. Longman, London.
- MUCINA, L. & SNIJMAN, D.A. ined. Amaranthaceae. In D.A. Snijman, Plants of the Greater Cape Floristic Region 2: the Extra Cape flora. *Strelitzia*. South African National Biodiversity Institute, Cape Town.
- RUNCIMAN, H.V. & MALCOLM, C.V. 1991. *Forage shrubs and grasses for revegetating saltland*. West Australian Dept of Agriculture Bulletin No. 4153.
- WILSON, P.G. 1975. A taxonomic revision of the genus *Maireana* (Chenopodiaceae). *Nuytsia* 2: 2–82.
- WILSON, P.G. 1984. Chenopodiaceae. In A.S. George, *Flora of Australia* 4: 81–330. Australian Government Publishing Service, Canberra.

Taxonomic revision of the genus *Thereianthus* (Iridaceae: Crocoideae)

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Keywords: Crocoideae, Iridaceae, new species, pollen, southern Africa, taxonomy, *Thereianthus* G.J.Lewis

ABSTRACT

Thereianthus G.J.Lewis is revised, with full descriptions and synonymy, distribution maps, and notes on ecology and taxonomic history. All species are illustrated, and capsule and seed morphology are described for many of the species for the first time. Novel characteristics of the bract, seed, and pollen operculum are used to separate the species into two sections: sect. **Brevibracteae** Goldblatt & J.C.Manning is distinguished by relatively small bracts, 3–8 mm long and uniformly leathery or soft-textured without thickened veins, seeds with filiform chalazal extension, and pollen grains with 1-banded operculum; and sect. *Thereianthus* by relatively larger bracts, (7–)8–15 mm long with prominently sclerified veins, seeds without any extension to the chalazal crest, and pollen grains with $\pm$ 2-banded operculum. Species in sect. *Thereianthus* are further segregated into ser. *Thereianthus*, with heavily ribbed leaves and suberect flowers with arcuate or erect stamens, and ser. *Bracteolatus*, with plane, inconspicuously veined leaves and $\pm$ spreading flowers with declinate stamens. Eleven species are recognized in the genus, all restricted to the southwestern portion of Western Cape. Two new species are described in sect. *Thereianthus*: *T. bulbiferus* Goldblatt & J.C.Manning, known from three populations along the West Coast, is distinguished by the unique development of cornels in the lower leaf axil, and by its actinomorphic perianth with white marks at the base of each tepal and $\pm$ declinate stamens; and *T. elandsmontanus* Goldblatt & J.C.Manning, known from a single population in Elandsberg Nature Reserve near Wellington, has distinctive cream-coloured, moderately long-tubed flowers with unusually narrow, linear tepals heavily marked with purple near the base. In addition, *T. lapeyrousioides* [now *T. minutus*] var. *elatior* G.J.Lewis in sect. **Brevibracteae** is raised to species status as *T. intermedius* Goldblatt & J.C.Manning, differing from typical *T. minutus* by the shorter perianth tube (10–13 vs 20–30 mm), shorter bracts (3–5 vs 6–8 mm), and smaller, ovoid capsules, 4–5 mm long, containing ovoid seeds vs flask-shaped capsules 6–8 mm long and fusiform seeds.

INTRODUCTION

Thereianthus G.J.Lewis is a small genus of deciduous geophytes endemic to the southwestern, winter rainfall region of Western Cape, where it is essentially restricted to mainly montane soils derived from quartzitic sandstone (Manning *et al.* 2002). Eight species are currently recognized, all of them flowering during the hot summer months, mostly November to January. Most are $\pm$ pyrophytes, flowering most profusely in the season after the veld has been cleared by burning.

Cladistic analysis of plastid DNA sequence data locates *Thereianthus* as sister to *Micranthus* (Pers.) Eckl., with these two genera together placed as sister to *Watsonia* Mill. plus *Pillansia* L.Bolus (Reeves *et al.* 2002; Goldblatt *et al.* 2008). These four genera, with *Cyanixia* Goldblatt & J.C.Manning, *Lapeyrousia* Pourr. and *Savannosiphon* Goldblatt & Marais, are now treated as the tribe Watsonieae of subfamily Crocoideae (Goldblatt *et al.* 2008; Goldblatt & Manning 2008), characterized by axillary corm development in which the current season's corm develops from an axillary bud at the base of the stem rather than by expansion of the lower stem internodes as in other crocid genera. Morphological synapomorphies for *Micranthus* plus *Thereianthus* are the superposed leaves, small, blue flowers, and $\pm$ dry bracts with membranous margins (Goldblatt *et al.* 2006). The leaves in both *Micranthus* and *Thereianthus*

are all strictly cauline (Lewis 1954), with the lowermost sub-basal, and the corm tunics are thus formed solely from the cataphylls, without any contribution from the bases of the lower leaves. Chromosome number, $2n = 20$, and a karyotype of one long and nine short chromosome pairs in *Micranthus* and *Thereianthus* is likely plesiomorphic for the tribe. *Watsonia*, in contrast, has a derived base chromosome number of $x = 9$.

The moderately short spikes of spirally inserted flowers, bracts with narrow membranous margins, and monosulcate pollen distinguish *Thereianthus* from *Micranthus*, which has elongate, distichous spikes, bracts with broad membranous margins, and zonosulcate pollen (Goldblatt & Manning 2008). Our investigation of leaf anatomy in the genus (see Results and discussion of characters) indicates that a simple leaf margin is an additional anatomical apomorphy for *Thereianthus*.

Thereianthus was published by Lewis (1941), who recognized seven species in the genus. One new species has been described since then (Manning & Goldblatt 2004), at which time we also reduced *T. lapeyrousioides* var. *elatior* G.J.Lewis to synonymy in *T. minutus* (= *T. lapeyrousioides* var. *lapeyrousioides*). We have now had the opportunity of examining fresh material of var. *elatior*, which makes it clear that this taxon is in fact a distinct species. We also describe another two new species that appeared after a burn near Tulbagh, bringing the total number of species in the genus to eleven.

Taxonomic history: the taxonomic history of *Thereianthus* is closely linked to that of *Micranthus*, reflecting the marked similarities between the two genera and the uncertainty that existed around their circumscription. The first species of both genera known to science were referred to either *Ixia* or to *Gladiolus*, following the rather vague generic circumscriptions prevailing at

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the time but Ker Gawler (1804) subsequently included all known species in *Watsonia* based on their divided style branches. This treatment was not followed by Ecklon (1827), who concluded that the two genera were distinct from *Watsonia* and who also appreciated the differences between them. His new genus *Micranthus* (Ecklon 1827), which was established for the small-flowered species with strongly distichous spikes, was recognized by most later authors but acceptance of a second new genus for the larger-flowered species with longer perianth tubes was less than universal. Ecklon (1827) placed the two species of *Thereianthus* then known, *Gladiolus spicatus* L. (now *T. spicatus*) and *G. triticeus* Thunb. (now *T. bracteolatus*), in his new genus *Beilia* but failed to provide a validating description, and *Beilia* was thus not validly published. Heynhold (1847) remained unconvinced that generic rank was appropriate for Ecklon's species of *Beilia*, preferring to include them with the species of *Micranthus*, and he accordingly made the new combinations *M. spicatus* (L.) Heyn. and *M. triticeus* (Thunb.) Heyn. English bulb specialist, J.G. Baker (1877), in his account of the family, was of yet another opinion, reverting to Ecklon's circumscription of *Micranthus* but following Ker Gawler (1804) in retaining *Thereianthus* in *Watsonia*, as the unranked taxon *Beilia*. Here he recognized just one species, *W. punctata* (Andrews) Ker Gawl., with the earlier name, *Gladiolus spicatus* L., in synonymy. At the same time he described the third known species of *Thereianthus*, *T. juncifolius*, in the genus *Morphixia* (now a synonym of *Ixia*). *Beilia* was subsequently accorded the rank of subgenus within *Watsonia* by Baker (1892, 1896), who admitted four taxa at species rank, among them his erstwhile *Morphixia juncifolia* and also *W. lapeyrousoides*. At this stage, therefore, although Baker (1896) accepted both *Micranthus* and *Thereianthus* as currently circumscribed, only the former was accorded generic rank.

Klatt (1882), a contemporary of Baker's, utterly confused the situation in his account of the Iridaceae. Here, he included only two species in *Micranthus*, *M. spicatus* (L.) Klatt and *M. triticeus* (Burm.f. [sic]) Klatt, both of them actually species of *Thereianthus*, evidently unaware that Heynhold (1847) had already made the combinations for these species in *Micranthus*. We also assume that the attribution of the basionym to Burman fil. was an error for Thunberg, as *Ixia triticea* Burm.f. (1768) is a very different species [*Tritoniopsis triticea* (Burm.f.) Goldblatt]. Like Baker (1877) before him, Klatt (1882) did not associate *T. juncifolius* with the other two species, treating it instead in the genus *Anomatheca* as *A. calamifolia*. He then spread his options still wider by describing a fourth species of *Thereianthus* in *Watsonia* as *W. racemosa* Klatt. Inexplicably, Klatt overlooked any species of *Micranthus* (as now understood) in his account, an omission that he later partly corrected (Klatt 1894) when he included *M. plantagineus* [= *M. alopecuroides* (L.) Eckl.] in *Micranthus* with one variety, var. *juncus* Baker [now *M. juncus* (Baker) N.E.Br.]. In this work, *T. spicatus* remained in *Micranthus* and *T. racemosus* in *Watsonia*, where it was joined by *T. bracteolatus* (as *W. subulatus*) but *T. juncifolius* was transferred to *Freesia* as *F. juncifolia* (Klatt 1894). This confusing species was later removed to yet another genus by Brown (1931) as *Lapeirousia juncifolia*, by

which time it had been shuffled among no less than five different genera. Lewis (1941) had no doubt that it correctly belonged in *Thereianthus*.

The nomenclatural tangle between *Micranthus* and *Thereianthus* took a further turn when Kuntze (1891) erected a new genus, *Paulomagnusia*, in which he included both what are now *Micranthus alopecuroides* and *Thereianthus spicatus*. The lectotype of *Paulomagnusia* is *P. alopecuroides* (now *M. alopecuroides*), designated by Goldblatt & Manning (2008) and the genus is now a nomenclatural synonym of *Micranthus*. Ecklon's *Beilia* was raised to generic rank by Kuntze (1898), who included only *B. spicata* (L.) Eckl. ex Kuntze in the genus. Unfortunately *Beilia* Kuntze is nomenclaturally superfluous since Kuntze listed the validly published *Paulomagnusia* in synonymy without any further explanation. Kuntze also recognized var. *brevifolia* in his *B. spicata*, and although this taxon has never been identified, its provenance from the Cape Town suburb of Mowbray, and its broad leaves (10–20 mm) make it certain this is not a species of *Thereianthus*. It remained for G.J. Lewis (1941), over a century after Ecklon proposed *Beilia*, to publish the genus *Thereianthus* for the two species of Ecklon's *Beilia* plus an additional four more species that were until then included in *Watsonia*.

Chromosome cytology: chromosome numbers are known for just two species of *Thereianthus*, *T. minutus* (sect. *Brevibracteae*) and *T. bracteolatus* (sect. *Thereianthus*). Both have a diploid number of $2n = 20$ and an identical karyotype of one long and nine short chromosome pairs (Goldblatt 1971). A report of $2n = 20$ by Goldblatt & Takei (1997) for *T. spicatus* is an error for *T. bracteolatus*, thus representing a second count for that species. The base number and karyotype match exactly those of *Micranthus* but both are likely plesiomorphic and thus uninformative about relationships. The two species of *Thereianthus* counted, one from each section of the genus, and the matching counts for *Micranthus*, suggest that the basic karyotype is unlikely to differ among the other species of *Thereianthus*.

Pollination systems: there are few published observations on the pollination of *Thereianthus*, and neither Scott Elliot (1891) nor Vogel (1954) mentioned the genus in their early studies of pollination in the South African flora. Flowers of the genus are, however, diverse and obviously adapted to a variety of mainly long-tongued insect pollinators. At least *T. ixioides* has been reported to be visited by the hopliine beetles, *Heterochelus* sp. and *Peritrichia* sp. (Scarabaeidae: Hopliini). Individuals of *Peritrichia* were observed moving indiscriminately between the flowers of this species and the remarkably similar blooms of *Ixia metelkampi*, the pale mauve flowers of which also have a dark centre (Goldblatt et al. 2000). These authors suggested this was a possible example of Batesian mimicry. Although both species have a filiform perianth tube in which the style is tightly enclosed by the walls of the tube, *T. ixioides* offers small amounts of nectar, visible at the mouth of the tube, suggesting that the species offers a secondary reward and may have a more generalist pollination system than *I. metelkampi*, which does not offer nectar. Goldblatt et al. (1998) also reported apparent pollination of *T. racemosus* by the hopliine, *Khoina bilateralis*, in

the Grootwinterhoek Wilderness area. This species, too, produces traces of nectar and has a strong floral scent and is likely to have alternative pollinators, probably various bees.

Goldblatt & Manning (2006) inferred long-proboscid fly pollination for *Thereianthus longicollis*, which has a perianth tube 25–40 mm long. That prediction has recently been validated: the long proboscis fly, *Philolichne rostrata* (proboscis $\pm$ 40 mm long), was captured visiting flowers of this species in the mountains above Tulbagh Waterfall in December 2010 (unpublished obs.). Other representatives of this pollination guild at the site included *T. minutus*, *Geissorhiza confusa* (Iridaceae) and a long-tubed and large-flowered race of *Lobelia coronopifolia* (Lobeliaceae) with a pink corolla. Visits by *P. rostrata* to *T. minutus* (perianth tube 20–30 mm long) were also recorded at this site. Another species, *T. elandsmontanus*, also has flowers with the hallmarks of long-proboscid fly pollination, notably a slender perianth tube mostly 20–23 mm long and a white or pale pinkish perianth with red markings. We predict that it is also pollinated by the long-proboscid flies *Prosoeca gulosa* and/or *P. rostrata*.

We have noted the butterfly, *Cynthia cardui* (Nymphalidae), visiting the moderately long-tubed flowers of *Thereianthus spicatus* at Jonkershoek, and moving from flower to flower in a constant pattern. This insect may be one of the legitimate pollinators of this widespread species. We infer bee or generalist pollination for the shorter-tubed species *T. bracteolatus*, *T. bulbiferus* and *T. intermedius*. The long-tubed, violet flowers of *T. montanus* appear to be adapted for pollination by long-proboscid flies or butterflies.

MATERIALS AND METHODS

All relevant types were examined, as well as all herbarium material from BOL, NBG and SAM (acronyms after Holmgren *et al.* 1990), the primary collections of species from the southwestern Cape. Most species were also studied in the field.

For SEM work, fresh pollen grains were fixed in FAA, critical point dried following standard procedures, and examined at the SEM Unit, University of Cape Town by Miranda Waldron. For operculum and sculpturing study, dry pollen from herbarium specimens was rehydrated and stained in Calberla's fluid (Goldblatt *et al.* 1991). Pollen was sampled from at least two flowers per voucher. Seed shape and size was determined by examining seeds from one or more capsules from two or more different plants of each species.

For anatomical investigation, fresh material was fixed in FAA and then embedded in wax before sectioning and double-staining with alcian blue and safranin following Rudall (1995). Mature leaf anatomy of the following species was examined: *Thereianthus racemosus*, *T. minutus*, *T. bulbiferus* and *T. spicatus*. Anatomical descriptions and terminology follow Rudall (1995). Bract and bracteole anatomy was examined in *T. minutus* and *T. spicatus*.

RESULTS AND DISCUSSION OF CHARACTERS

Leaf blade anatomy (Figures 1A–F; 2)

Outline: surfaces smooth and $\pm$ parallel in *Thereianthus bulbiferus*, *T. minutus* and *T. racemosus* (Figures 1A–C; 2A–D), terete in *T. juncifolius* (Figure 1F), elliptical and fistulose in *T. bracteolatus* (Figures 1D; 2E), and abruptly raised over larger vascular bundles in *T. spicatus* and surface thus ribbed or corrugated (Figures 1E; 2F); pseudomidrib not evident except in *T. minutus* but never raised in fresh leaves.

Margin: simple, i.e. without prominent marginal vein or subepidermal sclerenchyma, rarely with small marginal bundle along one edge in *T. bulbiferus*; epidermal cells unspecialized.

Mesophyll: cells $\pm$ isodiametric with no tissue differentiation except at midrib area in *T. minutus* or with evident differentiation between parenchyma and chlorenchyma (*T. bulbiferus* and *T. juncifolius*) or $\pm$ radially elongated with clear differentiation between peripheral chlorenchyma and central mesophyll (*T. bracteolatus*, *T. racemosus* and *T. spicatus*).

Vascular bundles: arranged in two rows, with larger (primary and secondary bundles) in opposite pairs and smaller (tertiary) bundles opposite or subopposite, xylem poles usually separated, rarely fused in lateral secondary bundles in *T. minutus*; primary bundles in *T. bulbiferus* with tertiary bundle on each side contiguous with sclerenchyma sheath; a single pair of primary bundles can be identified in all species but this is most evident in *T. minutus* with differentiation between the primary bundle and secondary bundles less marked in other species, particularly *T. spicatus*.

Bundle sheaths: bundle sheath sclerenchyma extending to epidermis as girder in primary bundles in all species and also in secondary bundles in *T. bracteolatus*, *T. bulbiferus* and *T. spicatus*, cells of outer bundle sheath each containing solitary styloid crystal at phloem poles in larger bundles; larger (primary) bundles with complete sclerenchyma sheaths in *T. bulbiferus*, *T. bracteolatus*, *T. juncifolius*, *T. minutus* and *T. spicatus* but sclerification restricted to phloem caps in *T. racemosus*.

The most obvious distinction in leaf outline among the species is between the ribbed/corrugated blade of *Thereianthus spicatus* and the smooth blades of the other species examined. The leaves of *T. minutus* and *T. racemosus* are least sclerified, with only the primary bundle significantly sclerified, compared with *T. bulbiferus*, *T. bracteolatus*, *T. juncifolius* and *T. spicatus*, in which some or all of the secondary vascular bundles have completely sclerified sheaths. This is most marked in *T. spicatus*.

Leaf blade anatomy in *Thereianthus* accords with the general description for the genus (Rudall 1995) with the significant exception that the leaf margin in all species examined is essentially simple (i.e. lacking a prominent marginal vascular bundle and with unspecialized epidermis) (Figure 2A, C–F). Rudall (1995), who examined only *T. spicatus*, describes this species as possessing a marginal vascular bundle. The outermost vascular bundle is treated as marginal if it is prominent and solitary (not paired) and oriented at right angles to the margin with the phloem pole facing the margin. In *T. minutus* and *T. spicatus* the outermost bundles at the leaf edges

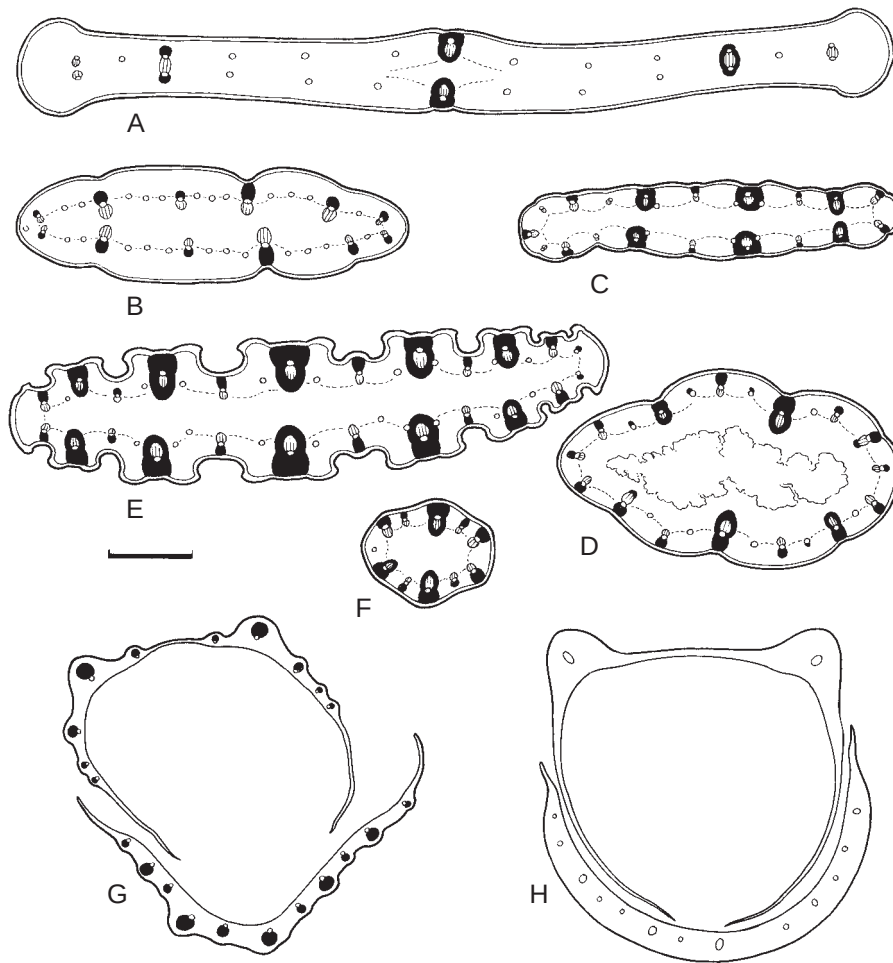


FIGURE 1.—A–F, leaf tissue plans of *Thereianthus* species: A, *T. minutus*; B, *T. racemosus*; C, *T. bulbiferus*; D, *T. bracteolatus*; E, *T. spicatus*; F, *T. juncifolius*. G, H, bract tissue plans: G, *T. spicatus*; H, *T. minutus*. Scale bar: A–F, 500 µm; G, H, 2 mm. Sclerenchyma solid shading; xylem hatched. Artist: John Manning.

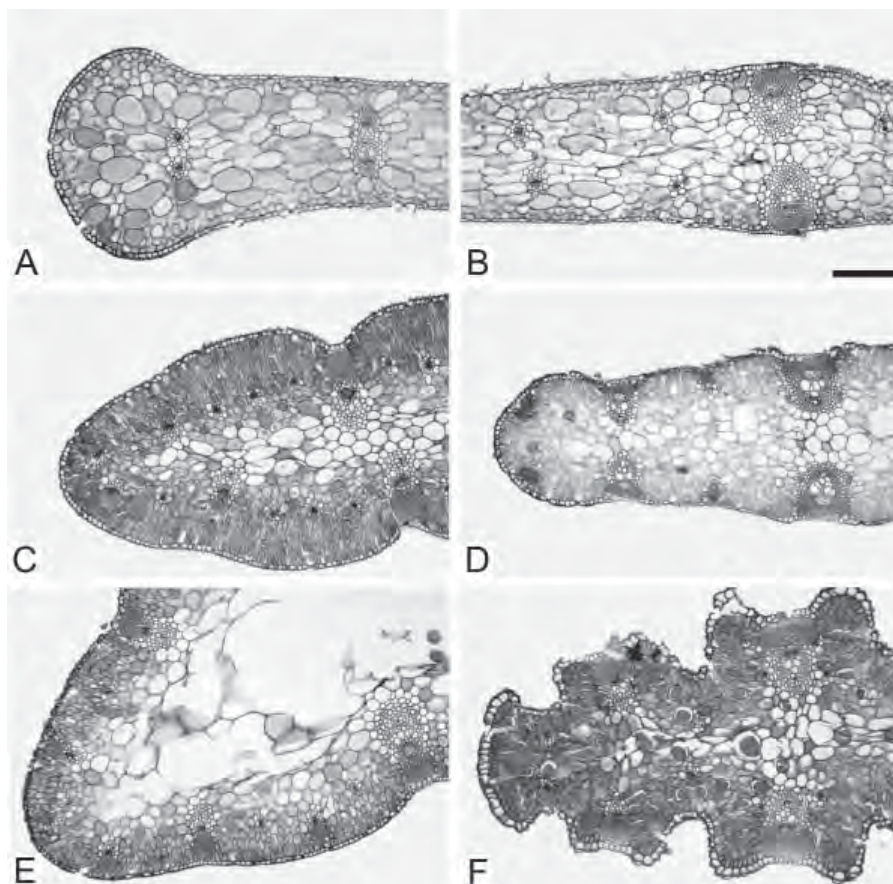


FIGURE 2.—Leaf anatomy of *Thereianthus* species: A, *T. minutus* leaf margin; B, *T. minutus* pseudomidrib; C, *T. racemosus* margin; D, *T. bulbiferus* margin; E, *T. bracteolatus* margin; F, *T. spicatus* margin. Scale bar: 200 µm.

are clearly paired with the phloem poles facing the leaf surface, and the leaves thus clearly lack marginal veins. This is evidently also the condition in centric-leaved *T. bracteolatus* and *T. juncifolius* but is less clear in *T. bulbiferus*, in which a smaller bundle is located marginally along only one edge of the leaf. In *T. racemosus* a very small tertiary bundle occurs in a similar position along one margin but is embedded within the chlorenchyma and not located at the parenchyma/chlorenchyma boundary as usual and is thus probably a minor branch. A simple leaf margin is also characteristic of *Pillansia* but not of *Micranthus* and *Watsonia*, both of which have a well-developed marginal bundle with sclerenchyma girder (Rudall 1995).

The presence of a marginal bundle is likely the plesiomorphic condition in Watsonieae (Rudall 1995). Optimizing leaf margin condition on the molecular phylogeny of the family in Goldblatt *et al.* (2006, 2008) indicates that it is most parsimonious to treat the simple leaf margin as independently derived in *Thereianthus* and *Pillansia*. Reversals to the simple leaf margins have occurred several times elsewhere in the Crocoideae (e.g. some species of *Geissorhiza* Ker Gawl., *Hesperantha* Ker Gawl. and *Lapeirousia*). The character is most parsimoniously treated as a homoplasious autapomorphy in each instance.

Bract anatomy (Figure 1G, H)

The floral bracts of *Thereianthus minutus* are inconspicuously veined, with the vascular bundles lacking sclerified phloem caps (Figure 1G), in contrast to the prominently veined bracts in *T. spicatus*, in which the

vascular bundles have well-developed sclerenchyma phloem caps (Figure 1H). As the bracts dry and the mesophyll tissue collapses, the vascular bundles in *T. spicatus* become raised and very conspicuous whereas those in *T. minutus* remain inconspicuous.

Pollen aperture and sculpturing (Figure 3)

Pollen aperture condition and exine sculpturing of most species of *Thereianthus* was examined by Goldblatt *et al.* (1991). Their findings and those of the present study covering the remaining species, are presented here (Table 1). Pollen in all species is monosulcate and operculate, with a tectate-columellate, sparsely scabrate tectum. Operculum condition and exine sculpturing vary in the genus. Exine sculpturing in most species is perforate (diameter of the lumina $0.25\text{--}1.0 \times$ the width of the intervening walls) (Figure 3A, B) but is reticulate (diameter of the lumina $2\text{--}3 \times$ the width of the intervening walls) in *T. intermedius* (Figure 3C, D), *T. montanus* and *T. racemosus*, except on the operculum, where it is perforate. The reticulate exine in these species recalls the pollen of the sister genus *Micranthus*, the only other genus of Crocoideae with reticulate exine but this genus differs from *Thereianthus* and other Crocoideae in its zonasulcate aperture (Goldblatt *et al.* 1991).

The operculum in most species is 1-banded (Figure 3A, B) but is completely or incompletely 2-banded in *Thereianthus intermedius* (Figure 3C), *T. juncifolius*, *T. minutus*, *T. montanus* and *T. racemosus* (Table 1). A completely 2-banded (rarely 1-banded) operculum (the bands well separated by the apertural membrane) is characteristic of *T. intermedius*, *T. juncifolius* and *T.*

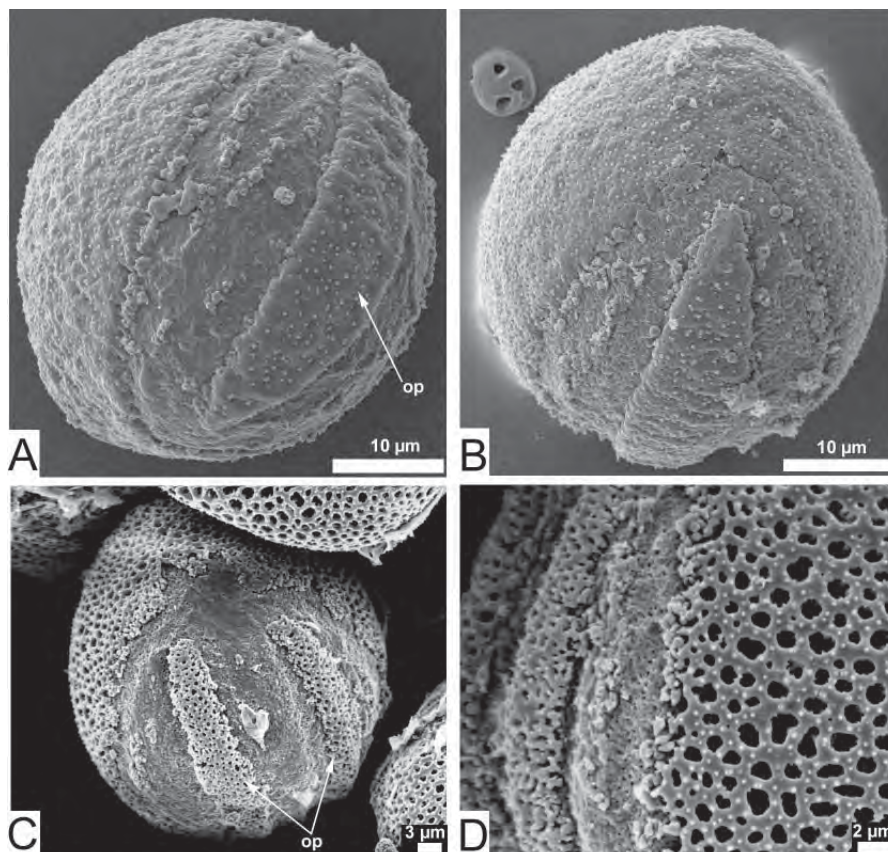


FIGURE 3.—Pollen morphology of *Thereianthus* species. A, B, *T. bracteolatus*: A, aperture with 1-banded operculum (arrowed); B, monosulcate grain with microperforate tectum. C, D, *T. intermedius*: C, aperture with 2-banded operculum (arrowed); D, reticulate exine.

TABLE 1.—Pollen operculum type and exine sculpturing in *Thereianthus*. Square brackets [] indicate closely associated operculum bands, and curved brackets () indicate the less common operculum character state

Species	Operculum	Exine sculpturing	Reference or voucher
Sect. <i>Brevibracteae</i>			
<i>T. racemosus</i>	2(1)-banded	Reticulate	Goldblatt <i>et al.</i> 1991
<i>T. intermedius</i>	2-banded	Reticulate	Hanekom & Tilney s.n. (NBG)
<i>T. montanus</i>	[2](1)-banded	Reticulate	Oliver 12197 (NBG)
<i>T. minutus</i>	[2]-banded	Perforate	Goldblatt <i>et al.</i> 1991
<i>T. juncifolius</i>	2-banded	Perforate	Goldblatt <i>et al.</i> 1991
Sect. <i>Thereianthus</i>			
<i>T. bulbiferus</i>	1-banded	Perforate	Manning 3212 (NBG)
<i>T. bracteolatus</i>	1-banded	Perforate	Goldblatt <i>et al.</i> 1991
<i>T. spicatus</i>	1-banded	Perforate	Goldblatt <i>et al.</i> 1991
<i>T. ixioides</i>	1-banded	Perforate	Goldblatt <i>et al.</i> 1991
<i>T. elandsmontanus</i>	1-banded	Perforate	Manning 3213 (NBG)
<i>T. longicollis</i>	1-banded	Perforate	Goldblatt <i>et al.</i> 1991

racemosus but the operculum is incompletely 2-banded in *T. minutus* and *T. montanus*. In these two species the operculum is apparently 1-banded but lacks exine along the centre of the operculum in some or all grains, suggesting incomplete fusion of two separate bands (Goldblatt *et al.* 1991).

A 2-banded operculum and perforate exine are likely plesiomorphic conditions for Crocoideae, and more specifically for Watsonieae (Goldblatt *et al.* 1991), suggesting that the species in sect. *Brevibracteae* with reticulate exine as well as those species in sect. *Thereianthus* with 1-banded operculum are derived in these two respects.

MORPHOLOGY AND CLASSIFICATION

Thereianthus is, relative to its size, quite as diverse florally as other genera of Crocoideae (Goldblatt & Manning 2006). Although the reproductive biology remains poorly known, the species display a variety of floral syndromes, including adaptations to short-tongued, generalist, hopliine beetles, and to several variants of long-proboscid fly or butterfly pollination systems. Floral symmetry and perianth tube length are valuable characters for discriminating the species. Vegetative differences also provide critical diagnostic characters. Four types of leaf blade are evident: linear or lanceolate and plane with a single main or primary vein (pseudomidrib) evident but not raised when fresh and without evident secondary veins, the pseudomidrib

becoming raised in herbarium material through collapse of the mesophyll tissue (*T. minutus*); linear and plane with more than one $\pm$ equally strong primary vein plus secondary veins (*T. bulbiferus*, *T. intermedius*, *T. minutus*, *T. montanus* and *T. racemosus*); linear-filiform and elliptic or terete in section without evident primary vein (pseudomidrib) (*T. bracteolatus* and *T. juncifolius*); and linear-corrugate with several equally strongly thickened and raised primary veins plus secondary veins (*T. elandsmontanus*, *T. ixioides*, *T. longicollis* and *T. spicatus*).

The striking variation in capsule shape and especially in seed form that is evident in the genus has remained undocumented until now. The remarkable seeds of *Thereianthus minutus*—fusiform with a long, thread-like chalazal extension—were first noted by Manning & Goldblatt (2004), who mistakenly interpreted the thread-like extension as an elongated funicle. From later examination of freshly opened, mature capsules, we are able to confirm that the thread-like structure represents a prolongation of the chalazal crest and not the funicle. Similar filiform chalazal extensions of variable length also characterize the seeds of *T. intermedius*, *T. juncifolius* and *T. racemosus* (seeds unknown for *T. montanus*). The thread-like chalazal extension is least developed in *T. racemosus*, in which it is shorter than the seed body and $\pm$ straight, but in *T. intermedius*, *T. minutus*, and *T. juncifolius* the extension is two to three times longer than the seed body and sharply bent back $\pm$ midway to form a hooked or crook-like extension. The latter two species have fusiform seeds and the chalazal extension extends significantly beyond the seed body before bending back. In these two species the chalazal extensions are largely accommodated in the elongated neck or beak of the flask-shaped capsules. The function of the thread-like extension is unknown.

Variation in pollen morphology in *Thereianthus* was first documented by Goldblatt *et al.* (1991), who discovered two distinct types of operculum and exine sculpturing among the species that they examined. The pollen operculum in *T. bracteolatus*, *T. ixioides*, *T. longicollis* and *T. spicatus* was clearly 1-banded but was completely or incompletely 2-banded in *T. juncifolius*, *T. minutus* and *T. racemosus*. The latter condition was interpreted as basic for the genus. Most species examined had the usual microperforate tectum. The sole exception, *T. racemosus*, had unusual reticulate exine sculpturing, which was also found to characterize all species of *Micranthus*. We have now examined pollen morphology in all *Thereianthus* species.

Thereianthus species fall into two distinct, evidently monophyletic groups on the basis of bract size and venation, seed shape, and pollen operculum condition: the *T. racemosus* group, treated here as sect. *Brevibracteae*, which is characterized by shorter bracts lacking prominent veins, evidently specialized seeds with a filiform chalazal extension (unknown in *T. montanus*), and pollen with a plesiomorphic, 2-banded operculum; and the *T. spicatus* group, treated here as sect. *Thereianthus*, which has larger, prominently veined bracts, seeds with an unspecialized chalazal crest, and apomorphic pollen with a 1-banded operculum. Leaf and bract anatomy, as well as filament orientation and length, further group the

members of sect. *Thereianthus* into two groups, treated here as series. The four species with strongly thickened and raised primary veins and shorter, erect or arcuate filaments comprise ser. *Thereianthus*, and the remaining two species with plane or smooth leaves and longer, declinate filaments comprise ser. *Bracteolatus*.

TAXONOMY

Thereianthus G.J.Lewis in Journal of South African Botany 7: 33 (1941). Lectotype: *Thereianthus spicatus* (L.) G.J.Lewis, designated by Goldblatt & Manning: 130 (2008).

Beilia Eckl.: 43 (1827), nom. nud.

Beilia Eckl. ex Kuntze: 305 (1898), nom. illegit. superfl. pro *Paulomagnusia* Kuntze (1891) [= *Micranthus* (Pers.) Eckl., nom. cons.]. Type: *Beilia spicata* (L.) Eckl. ex Kuntze (= *Thereianthus spicatus* (L.) G.J.Lewis).

Watsonia unranked *Beilia* Eckl. ex Baker 16: 158 (1877). Type: *Watsonia punctata* (Andrews) Ker Gawl. (= *Thereianthus bracteolatus* (Lam.) G.J.Lewis).

Watsonia subgen. *Beilia* Eckl. ex Baker: 177 (1892). Lectotype: *Watsonia punctata* (Andrews) Ker Gawl. (= *Thereianthus bracteolatus* (Lam.) G.J.Lewis), here designated.

Etymology: from the Greek, *thereios*, summer, *anthos*, flower.

Deciduous geophytes with globose corm, axillary in origin and rooting from below, tunics of coarsely netted fibres. *Cataphylls* 2. *Leaves* 3 or 4(6), all cauline and

superposed, usually $\pm$ dry at flowering, lowermost sub-basal, longest, inserted on stem above corm but below ground level, blade falcate or linear with margins not thickened, plane and either with definite main or primary vein (pseudomidrib) or with several equally prominent veins, or $\pm$ terete, glabrous or rarely scabridulous, usually dry at flowering, upper leaves progressively shorter, uppermost sometimes entirely sheathing. *Stem* usually unbranched, rarely with short branch from upper leaf axil, terete in section. *Inflorescence* a crowded or rarely lax spike, flowers spirally arranged or $\pm$ 2-ranked in bud, entire spike loosely spirally twisted at anthesis; bracts firm-textured, short, often overlapping, green below with apices dry and brown or entirely dry, smooth or prominently veined, inner 2-nerved and apically forked but splitting to base as capsule matures, mostly membranous (leathery in *T. juncifolius*). *Flowers* actinomorphic or zygomorphic, long-lived, closing at night, usually blue to purple, rarely white or pinkish, unmarked or lower three tepals with darker markings in lower $\frac{1}{2}$, sometimes all tepals with white markings, usually unscented, with nectar from septal nectaries; perianth tube short to elongate, funnel-shaped or cylindric; tepals subequal, $\pm$ spreading. *Stamens* unilateral and arcuate or declinate or central and symmetrically arranged; filaments inserted shortly below top of perianth tube, slender, free; anthers linear, dehiscent longitudinally, usually purple. *Ovary* subglobose; style filiform, branches slender and deeply divided, recurved. *Capsules* woody, ovoid to spindle- or flask-shaped, tardily dehiscent. *Seeds* angular-elongate with chalazal crest or narrowly ovoid-fusiform with thread-like or filiform chalazal extension, smooth or wrinkled, matte. **Basic chromosome number:** $x = 10$.

Eleven species, South Africa, restricted to the winter rainfall zone in the southwestern portion of western Cape, mostly in nutrient-poor, stony sandstone soils; two

Key to species

- 1a Bracts short, 3–8 mm long, uniformly leathery or soft-textured and without prominent veins (sect. *Brevibracteae*):
 - 2a Leaf blades filiform-terete; spike lax, bracts distant (lower internodes 3–5 $\times$ longer than bracts); inner bracts as long as or slightly longer than outer and similar in texture, both uniformly green with dry, papery apices; tepals ovate-obovate; stamens central 5. *T. juncifolius*
 - 2b Leaf blades linear to falcate, plane; spike dense, bracts $\pm$ imbricate (lower internodes < twice as long as bracts); inner bracts shorter than outer and membranous-papery except along veins; tepals lanceolate; stamens unilateral-arcuate:
 - 3a Perianth tube very short, 1.0–1.5 mm long, included in bracts 1. *T. racemosus*
 - 3b Perianth tube longer, 10–30 mm long, exerted from bracts:
 - 4a Bracts 3–5 mm long; perianth tube 10–13 mm long; capsules ovoid, 4–5 mm long; plants of the Cold Bokkeveld, mountains around Ceres, and Piketberg 2. *T. intermedius*
 - 4b Bracts (5–)6–8 mm long; perianth tube 20–30 mm long; plants from Grootwinterhoek to Riviersonderend Mtns and Kogelberg:
 - 5a Leaves $\pm$ falcate, lowermost mostly 3–7 mm wide and usually much shorter than stem, with evident pseudomidrib but without evident secondary veins, the pseudomidrib raised when dry but secondary veins never raised; perianth magenta or deep pink, anthers pale yellow; filaments 3–4 mm long; capsules flask-shaped, 6–8 mm long 4. *T. minutus*
 - 5b Leaves linear, lowermost 2.5–2.8 mm wide and mostly longer than stem, with main and secondary veins raised when dry; perianth and anthers purple; filaments 6–8 mm long; capsules unknown 3. *T. montanus*
 - 1b Bracts longer, (7–)8–15 mm long, with prominently raised, closely set veins (sect. *Thereianthus*):
 - 6a Leaves leathery without strongly raised veins; perianth tube curved and flowers thus $\pm$ nodding; filaments declinate, 6–10 mm long (ser. *Bracteolatus*):
 - 7a Stem developing cluster of large cormels in axil of lowest leaf; leaves linear with evident veins; perianth tube 7–9 mm long; tepals pale to mid-blue with white markings at base, veins not mottled, lateral longitudinal veins with numerous branches in distal half; filaments 6–8 mm long 6. *T. bulbiferus*
 - 7b Stem without cormels; leaves terete or elliptic in section, without evident veins; perianth tube (7–)8–10(–15) mm long; tepals purple to violet with prominent, darkly mottled veins, lateral longitudinal veins mostly without branches in distal half; filaments 8–10 mm long 7. *T. bracteolatus*
 - 6b Leaves striate or corrugate with strongly raised veins; perianth tube straight or slightly curved distally and flowers thus suberect; filaments central or arcuate, 3–5 mm long (ser. *Thereianthus*):
 - 8a Perianth tube 25–40 mm long, > twice as long as tepals 11. *T. longicollis*
 - 8b Perianth tube 7–25 mm long, < twice as long as tepals:
 - 9a Perianth tube filiform, tightly clasping style for most of length and then abruptly dilated at mouth; filaments central, symmetrical and completely exposed, blocking mouth of perianth tube 9. *T. ixoides*

9b Perianth tube narrowly funnel-shaped or $\pm$ cylindrical, not tightly clasping style; filaments arcuate, included within upper part of tube and not blocking mouth:

- 10a Flowers usually blue, rarely white or pink, lower three tepals with white markings near base outlined distally with dark blue chevron; tepals lanceolate, 3–5 mm wide 8. *T. spicatus*
 10b Flowers pale flesh-pink with purple tube, lower three tepals marked with purple in basal half; tepals linear, 1.5–3.0 mm wide 10. *T. elandsmontanus*

species, *Thereianthus juncifolius* and *T. minutus*, grow in seepages and along streams.

Sect. **Brevibracteae** Goldblatt & J.C.Manning, sect. nov.

Plantae foliis filiformibus teretibusque vel lineari-falcatis planisque, cum vel sine nervo principali prominenti sed nunquam fortiter nervatis marginibus non incrassatisque; bracteis brevibus, 3–8 mm longis uniformiter coriaceis vel modice mollibus sine costis prominentibus; seminibus (ubi cognitis) ellipsoideo-fusiformibus cum appendice chalazae gracili vel filiformi, rubro-brunneis, testa longitudinaliter rugosa vel obscure scalariformi; grano pollinis operculo $\pm$ 2-vittato, exinio perforato vel reticulato.

Type species: *T. racemosus* (Klatt) G.J.Lewis.

Leaves filiform and terete, or linear to falcate and plane, with or without prominent main vein but never strongly ribbed; bracts short, 3–8 mm long, uniformly leathery or moderately soft-textured, without prominent veins. *Pollen* operculum $\pm$ 2-banded, exine perforate or reticulate. *Seeds* (where known) ellipsoid-fusiform with filiform or thread-like chalazal extension, reddish brown, testa sculpturing longitudinally rugose or obscurely scalariform.

1. ***Thereianthus racemosus*** (Klatt) G.J.Lewis in Journal of South African Botany 7: 36 (1941). *Watsonia racemosa* Klatt 15: 354 (1882). Type: South Africa, [Western Cape], ‘in montibus ad Vier en Twintig Rivieren’, Dec. without year, Zeyher 1609 (B, holo.; BOL!, GRA, K (2 sheets)!, PRE, SAM (3 sheets)!, iso.).

Plants 130–250 mm high. *Corm* globose, $\pm$ 10 mm diam.; tunics of moderately fine-textured to coarsely netted fibres, sometimes forming short neck. *Cataphylls* dry and papery, reddish brown. *Stem* erect or flexed slightly outward above sheath of second leaf, unbranched or very rarely with short branch from upper leaf axil, 0.8–1.0 mm diam. below spike. *Leaves* (3)4(5), lowermost inserted below ground, blade reaching base of spike or not, drying from tip at flowering, linear or falcate, 60–130(–190) $\times$ 1–3(–4) mm, thick-textured, plane with main vein not thickened or raised when fresh and usually without evident secondary veins, rarely with 1 secondary vein visible on each side, upper 3 leaves cauline with lower 2 inserted on lower $\frac{1}{3}$ of stem, sheathing for $\frac{1}{2}$ to $\frac{2}{3}$ length with blades 20–40 mm long, uppermost leaf entirely sheathing, well separated from spike, all sheaths shortly imbricate or uppermost a little distant. *Spike* erect, moderately densely 5–25-flowered; bracts shortly imbricate, outer 3–5 mm long, up to 1 internode long, acute, green below or entirely brown and leathery with narrow membranous margins and papery tip, without evident veining, inner $\pm$ as long or slightly longer, notched apically, $\pm$ membranous with narrow brown zone along veins. *Flowers* suberect, pale blue, lower

three tepals white at base with purple median chevron in lower $\frac{1}{4}$, strongly honey-scented; perianth sub-actinomorphic, funnel-shaped; tube straight, 1.0–1.5 mm long, narrowly funnel-shaped, included in bract; tepals elliptical-ob lanceolate, subequal, spreading and slightly cupped, 7–9 $\times$ 3–4 mm. *Stamens* unilateral but laterals slightly spreading; filaments arcuate, 3–4 mm long, exerted 1.5–2.5 mm from tube; anthers 4–5 mm long, dark blue; pollen pale blue. *Ovary* ovoid, $\pm$ 2 mm long; style arching over stamens, dividing between base and middle of anthers, branches 2.0–2.5 mm long, divided for $\pm \frac{1}{2}$ their length. *Capsules* ovoid, 4–5 $\times$ 2.5–3.0 mm. *Seeds* ovoid, $\pm$ 1 mm long, with $\pm$ straight, thread-like chalazal extension $\pm$ 0.5 mm long, reddish brown. *Flowering time*: Dec. Figure 4.

Distribution and ecology: *Thereianthus racemosus* appears to be restricted to the Voorberg (also known as the Twenty Four Rivers Mtns) above Porterville (Figure 5), where it occurs on seasonally moist or marshy, sandy flats in restioid communities. Most collections are from the Suurvlakte in the Grootwinterhoek Wilderness Area. It is an obligate pyrophyte, flowering only in the summer following a burn.

The short-tubed, pale blue flowers are strongly honey-scented and are evidently adapted to a variety of short-tongued pollinators, including various Hymenoptera, Lepidoptera, and Coleoptera. Goldblatt *et al.* (1998) reported pollination of *T. racemosus* by the hopliine beetle, *Khoinea bilateralis*, in the Grootwinterhoek Wilderness area.

Diagnosis and relationships: the short floral bracts, 3–5 mm long, and the very short perianth tube, 1.0–1.5 mm long, and well included within the bracts, are diagnostic for the species. Uniquely for the genus, the flowers are fragrant and strongly honey-scented. The narrow, leathery leaves with $\pm$ distinct main vein but usually without evident secondary veins, the very short capsules, small seeds, 1.0–1.5 mm long, and reticulate pollen exine suggest that the species is most closely allied to *Thereianthus intermedius* from the Cold Bokkeveld. That species has darker blue flowers with a much longer perianth tube, 10–13 mm long, and seeds with the chalazal extension longer than the seed body.

History: the species was first collected by botanical collector Carl Ludwig Zeyher, who was active in the Western Cape in the first half of the nineteenth century. Although the type collection is not dated, Zeyher appears to have collected on the Twenty Four Rivers Mtns only once, in 1831, when he made a rich haul of specimens from the mountains around Tulbagh in the company of his sometime partner Christian Frederick Ecklon (Glen & Germishuizen 2010), and the species was probably discovered then. It has since been collected just a handful of times on the same mountains, always following veld fires.



FIGURE 4.—*Thereianthus racemosus*. A–D, Goldblatt 10454: A, whole plant; B, flower, front view; C, flower, side view; D, details of stamens and stigma. E, F, Manning 3289: E, capsule; F, seed. Scale bar: A–C, 10 mm; D, 3 mm; E, 2 mm; F, 0.5 mm. Artist: John Manning.

Additional specimens examined

WESTERN CAPE.—3319 (Worcester): Twenty Four Rivers Mtns above Porterville, (–AA), 16 Dec. 1949, Esterhuysen 16620 (BOL);

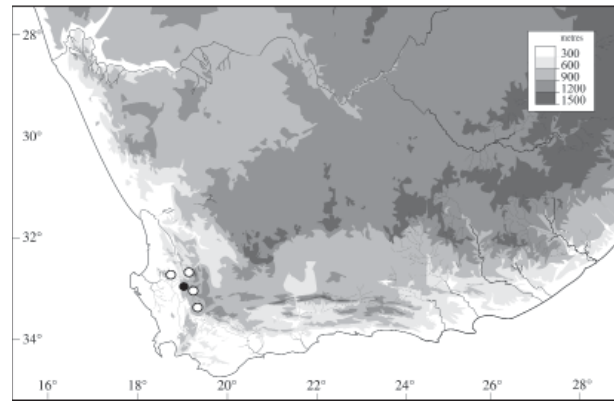


FIGURE 5.—Known distribution of *Thereianthus racemosus*, ●; *T. intermedius*, ○.

Groot Winterhoek Wilderness Area, (–AA), 14 Dec. 1995, Steiner 3061 (NBG); near Groot Winterhoek Forest Station, (–AA), 27 Dec. 1995, Goldblatt 10454 (MO, NBG); Grootwinterhoek Wilderness Area, Suurvlakte, (–AA), 8 Jan. 2010 (fr.), Manning 3289 (NBG).

2. *Thereianthus intermedius* J.C.Manning & Goldblatt, nom. et stat. nov., *T. lapeyrousioides* var. *elatior* G.J.Lewis in Journal of South African Botany 7: 38 (1941). Type: South Africa, [Western Cape], Ceres Hills, Jan. 1892, L. Guthrie 2208 (BOL, holo.!).

Plants 200–350 mm high. *Corm* globose, ± 10 mm diam.; tunics of fine-textured, netted fibres accumulating with age and forming neck around base of stem. *Cataphylls* dry and papery, reddish brown. *Stem* erect, flexed slightly outward above sheath of second leaf, unbranched, 1.0–1.5 mm diam. below spike. *Leaves* (3)4, lowermost inserted below ground, blade reaching base of spike or not, drying from tip at flowering, linear, $70\text{--}150 \times 2\text{--}3$ mm, thick-textured, with main vein $\pm$ evident but not thickened or raised when fresh, plus a pair of secondary veins, upper (2)3 leaves cauline with lowermost (1)2 inserted on lower $\frac{1}{3}$ of stem, sheathing for $\frac{1}{2}$ to $\frac{2}{3}$ length with blades 30–60 mm long, uppermost leaf entirely sheathing or with short blade up to 20 mm long, well separated from spike, all sheaths shortly imbricate or uppermost a little distant. *Spike* erect, moderately densely 12–40-flowered; bracts not or scarcely imbricate, outer 3–5 mm long, up to 1 internode long, obtuse, brown and leathery with narrow membranous margins, without evident veining, inner $\pm$ as long or slightly longer, notched apically but sometimes splitting to base after fertilization by enlarging capsule, $\pm$ membranous with narrow brown zone along veins. *Flowers* suberect, violet (rarely pale blue), lower three tepals whitish at base with purple or dark blue median chevron in lower $\frac{1}{4}$; perianth subactinomorphic; tube straight or slightly arching in upper ± 3 mm, 10–13 mm long, cylindrical and widening slightly in upper ± 3 mm; tepals narrowly oblanceolate, subequal, spreading and slightly cupped, $10\text{--}11 \times 3.0\text{--}3.5$ mm. *Stamens* unilateral; filaments erect, ± 7 mm long, exserted ± 4 mm from tube; anthers purple, 4–5 mm long; pollen violet. *Ovary* ovoid, 2.0–2.5 mm long; style arching over stamens, dividing below base of anthers, branches ± 2.5 mm long, divided for $\pm \frac{1}{2}$ their length. *Capsules* ovoid, $4\text{--}5 \times 3\text{--}4$ mm. *Seeds* ovoid, $\pm 1.5 \times 1.0$ mm, with thread-like chalazal extension up to 3 mm long abruptly reflexed from near middle, reddish brown, testa striate-rugulose. *Flowering time*: Dec. Figure 6A–F.

Distribution and biology: originally recorded from two unlocalized collections made near Ceres (Lewis 1941), *Thereianthus intermedius* has now also been collected in the Cold Bokkeveld at the headwaters of the



FIGURE 6.—A–F: *Thereianthus intermedius*, Hanekom & Tilney s.n. A, whole plant; B, half flower; C, outer bract; D, inner bract; E, capsule; F, seeds. G–J: *T. montanus*, Oliver 12197. G, whole plant; H, flower, front view; I, half flower; J, outer (left) and inner (right) bracts. Scale bars: A, B, G–J, 10 mm; C–E, 2 mm; F, 0.5 mm. Artist: John Manning.

Olifants River and at high elevations on Zebrakop in the Piketberg (Figure 5). In the north it has been collected from the farms Elandskloof and Kunje along the eastern foot of the Cold Bokkeveld Mtns, with another collection from Visgat on the western edge of the Skurweberg, and in the south from Castle Rocks at the western edge of the Hex River Mtns above Ceres. It is restricted to seasonally waterlogged or marshy, sandy flats dominated by restioids, between ± 500 and 1 000 m, and flowers only after fire.

We assume that the moderately long-tubed flowers are pollinated by various long-tongued insects, including anthophorine bees (Apidae: Anthophorinae) and butterflies.

Diagnosis and relationships: *Thereianthus intermedius* is recognized by its linear leaves, 2–3 mm wide, elongate spike with short floral bracts, 3–5 mm long, and violet (pale blue on Piketberg) flowers with moderately long floral tubes, 10–13 mm long, and slightly longer than the tepals. The leaves have an additional pair of secondary veins, one running on each side of the central vein close to the leaf margin, and the spike is moderately dense, with the bracts shorter than or scarcely as long as the internodes. The small, ovoid capsules, 4–5 mm long, contain distinctive seeds, with an ovoid seed body and long, thread-like chalazal extension $\pm$ twice as long as the seed body and sharply bent backwards along the length of the seed.

Thereianthus intermedius is most likely to be confused with *T. minutus*, which has similar plane leaves (but with the pseudomidrib much less distinct), short bracts, and long-tubed flowers. It differs most obviously from *T. minutus* in its purple or blue (vs magenta or deep pink) flowers with a shorter floral tube (10–13 mm vs 20–30 mm), shorter bracts (3–5 mm vs 6–8 mm) and in its smaller capsules (ovoid and 4–5 mm long vs flask-shaped and 6–8 mm long) capsules containing ovoid (vs fusiform) seeds. The distribution of the two species is complementary, with *T. intermedius* ranging from the Cold Bokkeveld to the Skurweberg, the western Hex River Mtns and Piketberg (Figure 5), and *T. minutus* distributed from the Grootwinterhoek Mtns above Tulbagh through the Franschoek and Du Toitskloof Mtns to the Kogelberg and western end of the Riviersonderend Mtns (Figure 7).

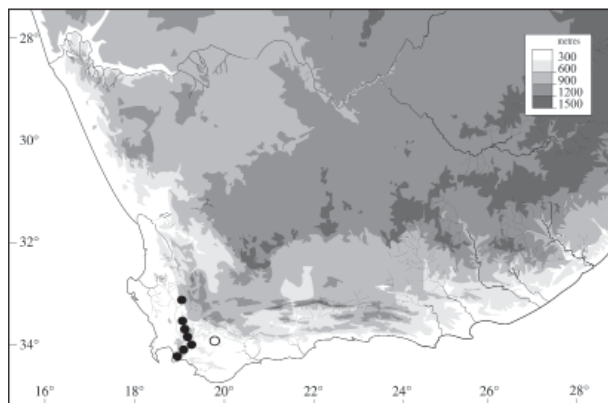


FIGURE 7.—Known distribution of *Thereianthus minutus*, ●; *T. montanus*, ○.

History: the species seems to have been first collected by botanist Louise Guthrie in January 1892, and has been recorded only sporadically since then, most recently by local landowner Louis Hanekom, who noticed it flowering for the first time on his Farm Kunje in Dec. 2009 after the extensive wildfire that swept the area in the summer of 2008/09. He passed the plants on to Jeanetta Tilney, who has been documenting the species on her property on Middelberg Pass for some years and who in turn brought it to our attention.

Thereianthus intermedius was first described as var. *elator* of *T. lapeyrousioides* [now *T. minutus* (Klatt) G.J.Lewis (Goldblatt 1989)], distinguished from the typical variety by its taller stature (240–460 mm high), slightly longer, narrower leaves, and longer, more floriferous (12–40-flowered) spike with shorter bracts $\pm$ 5 mm long (Lewis 1941). Subsequently, Manning & Goldblatt (2004) argued that collections of *T. minutus* from Bainskloof displayed the full range of variation in these features and concluded that var. *elator* could not be recognized at any taxonomic level. The recent collection of fresh material of the plants from the Farm Kunje shows that we were wrong and that other, more significant differences not identified by Lewis (1941) exist between the two taxa, justifying their recognition as distinct species. These include perianth colour, floral tube length, shape and size of the capsule, seed shape and pollen exine sculpturing.

Etymology: *Thereianthus intermedius* approaches *T. minutus* in its seeds with filiform chalazal extension but resembles *T. racemosus* in its short capsules and reticulate pollen sculpturing, and we thus propose the name *T. intermedius* in recognition of its somewhat intermediate character.

Additional specimens seen

WESTERN CAPE.—3218 (Clanwilliam): Piketberg, SW slopes of Zebrakop, (DA–DB), 4 Jan. 1995, Goldblatt & Manning 10168 (MO). 3219 (Wuppertal): Elandskloof, marshy places, 3000' [915 m], (–CA), 18 Dec. 1948, Levyns 9349 (BOL). 3319 (Worcester): Visgat, upper Olifants River Valley, (–AA), 28 Dec. 1946, Esterhuysen 13435 (BOL, NBG, PRE); Ceres, 1700' [518 m], (–AD), Jan. 1903, Bolus 8342 (BOL, PRE); Ceres, (–AD), Jan. 1929, Thode A2287 (NBG, PRE); Ceres, (–AD), Jan. 1932, Leslie s.n. NBG46/32 (BOL); Ceres, Castle Rocks, vlakte [flats] on NE slopes, abundant after fire, 3800' [1 158 m], (–AD), 14 Jan. 1960, Esterhuysen 28430 (BOL, MO).

3. *Thereianthus montanus* J.C.Manning & Goldblatt in Bothalia 34: 103 (2004). Type: South Africa, Western Cape, Riviersonderend, Pilaarkop, ridge WNW of peak, 31 Jan. 2004, E.G.H. Oliver 12197 (NBG, holo.!, MO, iso.!).

Plants 200–350 mm high. *Corm* globose, 7–10 mm diam.; tunics of fine-textured, netted fibres accumulating with age and forming neck around base of stem. *Stem* erect, flexed outward above sheath of second leaf, unbranched, 1.0–1.5 mm diam. below spike. *Cataphylls* dry and papery, reddish brown. *Leaves* 3 or 4, lowermost inserted below ground, blade reaching or exceeding spike, linear, 150–300 $\times$ 2.5–2.8 mm, thick-textured, with main vein evident but not thickened or raised when fresh, plus 1 or 2 evident secondary veins on each side, upper 2 or 3 leaves cauline with lower 1 or 2 inserted on lower $\frac{1}{3}$ of stem, sheathing for $\frac{1}{2}$ to $\frac{2}{3}$ length with short

blades 15–25 mm long, uppermost leaf well separated from spike, short and entirely sheathing, all sheaths distant. *Spike* erect, compact, densely 7–10-flowered; bracts imbricate, outer 6–8 mm long, obtuse to truncate, green and leathery below, dry and brown in upper $\frac{1}{2}$, ± 2 internodes long, inner ± 1.5 mm shorter than outer, notched apically, brown and papery with narrow darker zone along veins. *Flowers* suberect, purple, lower three or all tepals each with spear-shaped, purple median streak near base, throat and lower part of tube white; perianth subactinomorphic, salver-shaped; tube straight or slightly arching in upper ± 5 mm, $22\text{--}27 \times 1.2\text{--}1.5$ mm, cylindrical and widening slightly in upper ± 5 mm; tepals spreading and slightly cupped, narrowly elliptical to lanceolate, subequal, $9\text{--}15 \times 3.5\text{--}5.0$ mm. *Stamens* unilateral; filaments erect, 6–8 mm long, exerted 3–4 mm from tube; anthers 4–5 mm long, purple; pollen violet. *Ovary* ovoid, 2.0–2.5 mm long; style arching over stamens, dividing between base and middle of anthers, branches ± 2.5 mm long, divided for $\pm \frac{1}{2}$ their length. *Capsules and seeds* unknown. *Flowering time*: late Jan.–Feb. Figure 6G–J.

Distribution and biology: *Thereianthus montanus* is known from a single population on steep, south-facing slopes of Pilaarkop in the Riviersonderend Mtns (Figure 7). Plants are scattered in moist, loamy soil in short, grassy fynbos at an altitude of $\pm 1\ 500$ m.

The long-tubed, violet flowers appear to be adapted for pollination by long-proboscid flies or butterflies (Manning & Goldblatt 2004), and accumulate nectar only in the lower few millimetres, which is consistent with pollination by long-proboscid insects with mouthparts 20–25 mm long.

Diagnosis and relationships: *Thereianthus montanus* is distinguished by its linear leaves without thickened or raised main vein when fresh, although the mesophyll tissue collapses on drying to leave the central and secondary veins apparently raised in herbarium specimens, and compact spikes of salver-shaped, purple flowers with slender perianth tube 22–27 mm long and purple anthers. It is most likely to be confused with long-tubed *T. minutus* with similarly long-tubed flowers and which has been recorded from the western Riviersonderend Mtns, but this species is generally shorter, mostly 100–200 mm tall, with a broader, mostly falcate lower leaf, $(1.5\text{--})3.0\text{--}7.0$ mm wide and rarely reaching the base of the spike, and with a prominent pseudomidrib but inconspicuous secondary veins. On drying, the main vein in the leaves of *T. minutus* becomes raised through collapse of the surrounding blade tissue but the secondary veins are never pronounced. The flowers in *T. minutus* are a distinctive magenta colour, with yellow anthers. Unfortunately fruits and seeds are not known in *T. montanus* and so cannot be compared with the distinctive flask-shaped capsules and fusiform seeds with thread-like chalazal extension of *T. minutus*. The two species differ in pollen exine sculpturing. *T. minutus* has an unspecialized perforate pollen exine, unlike the unusual reticulate pollen exine of *T. montanus*, which suggests that its closest allies are actually *T. racemosus* from Grootwinterhoek and *T. intermedius* from the Cold Bokkeveld, being the only other two species in the genus with reticulate exine.

History: a single flowering stem of the species was first collected by botanists Ted and Inge Oliver in February 1999, and the type material was collected by Ted Oliver from the same locality five years later, in January 2004.

Additional specimen examined

WESTERN CAPE.—3419 (Caledon): Riviersonderend Mtns, Pilaarkop, ridge WNW of peak, $\pm 1\ 500$ m, (–BB), 26 Feb. 1999, E.G.H. & I.M. Oliver 11228 (NBG).

4. *Thereianthus minutus* (Klatt) G.J.Lewis in Journal of South African Botany 7: 43 (1941). *Watsonia minuta* Klatt: 353 (1882). Type: South Africa, [Western Cape], Tulbagh Waterfall, Ecklon & Zeyher Irid. 189 (B, lecto.), designated by Goldblatt 19: 143 (1989); MO!, S!, SAM!, islecto.) [Syntype: South Africa, [Western Cape], Dutoitskloofberge am Wasserfall, Drège 1551 (B ‘Herb. Lübeck’, believed destroyed)].

Watsonia lapeyrousioides Baker: 178 (1892). *Thereianthus lapeyrousioides* (Baker) G.J.Lewis 7: 38 (1941). Type: South Africa, [Western Cape], clivis montium inter Villiersdorp & French Hoek [Franschhoek], Nov. 1879, Bolus 5251 (BOL, lecto.), here designated; K, islecto.) [Syntype: South Africa, [Western Cape], Du Toitskloof, without date [‘1840’ on specimen], Drège s.n. (K[K320511]!, ?SAM[SAM21067]!).

Plants 100–200(–300) mm high. *Corm* globose, 7–10 mm diam.; tunics of fine-textured, netted fibres, sometimes accumulating with age and forming short neck around base of stem. *Stem* usually inclined but flexed outward above sheath of second leaf and then erect, unbranched, 0.8–1.5 mm diam. below spike. *Cataphylls* dry and papery, reddish brown. *Leaves* 3 or 4(–6), lowermost inserted below ground, blade mostly much shorter than spike, rarely exceeding it, mostly falcate, rarely linear-arcuate, $(30\text{--})40\text{--}100\text{--}(350) \times (1.5\text{--})3\text{--}7$ mm, thick-textured, with main vein evident but not raised when fresh (becoming raised when dry), plus 1 or 2 evident secondary veins on each side, upper leaves cauline with lower 1 or 2 inserted on lower $\frac{1}{3}$ of stem, sheathing for $\frac{1}{2}$ to $\frac{2}{3}$ length with blades 20–40 mm long, uppermost leaf well separated from spike, short and entirely sheathing, all sheaths shortly imbricate or distant. *Spike* erect, compact, moderately densely (3–)5–10(–20)-flowered; bracts shortly imbricate, outer (5–)6–8 mm long, obtuse to truncate, green and leathery below, dry and brown in upper $\frac{1}{2}$, ± 1.5 internodes long, inner $\pm 1.0\text{--}1.5$ mm shorter than outer, notched apically, brown and papery with narrow darker zone along veins. *Flowers* suberect, dark pink to magenta, lower three tepals usually with darker median mark near base, throat white; perianth subactinomorphic, salver-shaped; tube straight, $20\text{--}30 \times 1.2\text{--}1.5$ mm, widening gradually and evenly from base; tepals spreading and slightly cupped, elliptical to oblanceolate, subequal, $7\text{--}10 \times 2\text{--}4$ mm. *Stamens* unilateral; filaments erect, 3–4 mm long, exerted ± 2 mm from top of tube; anthers 3–4 mm long, pale yellow; pollen cream-coloured. *Ovary* ovoid, 2.0–2.5 mm long; style arching over stamens, dividing just below or just above base of anthers, branches ± 4 mm long, divided for $\pm \frac{1}{2}$ their length. *Capsules* flask-shaped, 6–8 mm long. *Seeds* fusiform, 1.5–2.0 mm long, with chalazal extension to 4 mm long, thus $\pm$ twice as long as seed body, sharply bent back $\pm$ midway and hooked or crook-like, sometimes twisting around adjacent seeds, reddish brown, longitu-

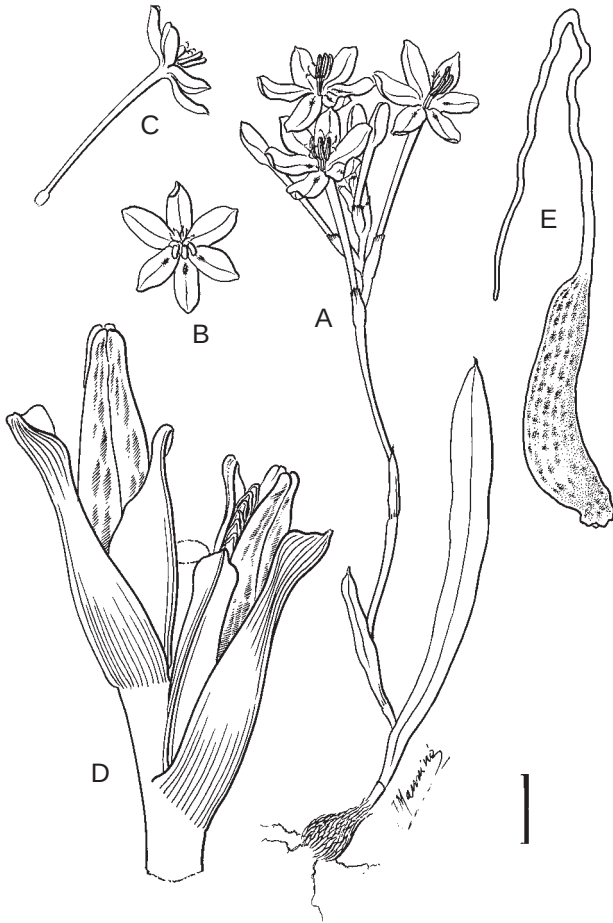


FIGURE 8.—*Thereianthus minutus*. A–C, Goldblatt & Manning 9505: A, whole plant; B, flower, front view; C, flower, side view. D, E, Manning 3327: D, capsules; E, seed. Scale bar: A–C, 10 mm; D, 2 mm; E, 0.5 mm. Artist: John Manning.

dinally rugulose. *Flowering time*: Dec.–Jan., rarely as early as late Oct. Figure 8.

Distribution and ecology: endemic to the mountains in the extreme southwestern part of Western Cape, from above Porterville southwards to the Kogelberg and western Riviersonderend Mtns (Figure 7). *Thereianthus minutus* is restricted to moist habitats such as rock ledges, damp cliffs and streamsides, growing in flushes, peaty seepages and mossy turf. Fires are necessary for flowering to occur in plants on deeper, more heavily vegetated soils but in exposed habitats plants flower regularly without burning.

The long-tubed, magenta flowers are consistent with pollination by long-proboscid flies and we have observed visits to the species by *Philoliche rostrata* (Tabanidae) above Tulbagh Waterfall in December 2010.

Diagnosis and relationships: *Thereianthus minutus* is distinguished by its mostly falcate, relatively broad lower leaf blade, mostly 3–7 mm wide, with a pronounced main vein, and dark pink to magenta flowers with perianth tube 20–30 mm long. On drying and in herbarium material the pseudomidrib becomes raised through collapse of the surrounding mesophyll tissue but the secondary veins remain inconspicuous. The short bracts, 5–8 mm long, without prominent veins are typi-

cal of sect. *Brevibracteae* but the pale yellow anthers are unusual in the genus and found elsewhere only in *T. jun-cifolius* (sect. *Brevibracteae*) and *T. bracteolatus* (sect. *Thereianthus*). It is most likely to be confused with *T. intermedius* and *T. montanus*, both of which have similar long-tubed flowers but of the more typical blue to purple colour and with purple stamens. The three species have complementary ranges: *T. intermedius* from the Piket-berg, Cold Bokkeveld and Skurweberg has a perianth tube 10–13 mm long, shorter bracts 3–5 mm long, and smaller, ovoid capsules 4–5 mm long; *T. montanus* from the eastern Riviersonderend Mtns has similar bract and perianth tube dimensions but longer filaments, 6–8 mm long and exserted 3–4 mm from the tube, and mostly narrower leaves, 2.5–2.8 mm wide, with the main and also secondary veins becoming raised on drying and in herbarium material. *T. montanus* is generally a taller species, 200–300 mm tall, with the lower leaf longer than the spike. In addition, the perianth tube in *T. mon-tanus* is virtually cylindrical throughout, widening only in the upper 5 mm, unlike the tube in *T. minutus*, which is slightly narrower below but widening gradually and evenly towards the top.

The fruit and seeds of *Thereianthus montanus* are unfortunately not known but the flask-shaped capsules of *T. minutus* are distinctive, as are the fusiform seeds with long, thread-like chalazal extension $\pm$ twice as long as the seed body. The placenta is restricted to the lower portion of the capsule and the tapered neck or beak accommodates the chalazal extensions of the seeds.

History: *Thereianthus minutus* was first collected by the botanical collectors Christian Frederick Ecklon and Carl Ludwig Zeyher at Tulbagh Waterfall, possibly in 1831 when they visited this site (Glen & Germishuizen 2010), and almost contemporaneously by the naturalist and traveller Carl Drège, who found it in the Du Toitskloof Mtns sometime between 1826 and 1834. The date 1840 marked on the type collection at Kew is not the date of collection as Drège returned to Europe in 1834 (Glen & Germishuizen 2010), and is probably the date that the specimen was offered for sale and acquired by the herbarium. These two collections formed the basis of both *Watsonia minuta* Klatt (1882) and *W. lapeyrousioides* Baker (1892). At the time of her revision of *Thereianthus*, Lewis (1941) had not been able to identify Klatt's *W. minuta* and although she transferred the name to *Thereianthus* she treated the taxon as a doubtful species, possibly near *T. racemosus*, based on Klatt's curious and quite mistaken description of the perianth tube as a mere 4 mm long. She accordingly recognized *T. lapeyrousioides* as a separate species. Ironically, and quite inexplicably, she overlooked the significance of the Ecklon & Zeyher 189 syntype of *W. minuta* at SAM, which she cited under *T. lapeyrousioides* and which would have established the identity of Klatt's species. It was left to Goldblatt (1989) to recognize that this was the earliest name for the species.

The Ecklon & Zeyher collections were distributed under the unpublished name *Beilia triticea* Eckl. (now applied to *Thereianthus bracteolatus*), while the Drège material was misidentified as *Anomatheca juncea* (Ker Gawl.) Ker Gawl. (= *Freesia verrucosa*). Plants from the Cold Bokkeveld, treated by Lewis (1941) as *T. lapey-*

rousioides var. *elator* G.J.Lewis, are recognized here as a distinct species, *T. intermedius*.

Additional specimens examined

WESTERN CAPE.—3318 (Cape Town): Jonkershoek Mtns, (–DD), 1826, *Marloth s.n.* (PRE); Jan. 1888, *Marloth s.n.* (NBG); Jonkershoek State Forest, Stellenboschberg, (–DD), 8 Dec. 1975, *Haynes 1180* (NBG); Stellenbosch, Swartboskloof, (–DD), 25 Oct. 1960, *Van der Merwe 23-94* (NBG, PRE). 3319 (Worcester): Winterhoeksborg, (–AA), Nov., *Ecklon & Zeyher Irid. 188* (72.11) (MO); Tulbagh, Watervalsberge, east of Suurvvalakte Falls, (–AC), 29 Dec. 2000, *Hansford 22* (NBG); lower Wellington Sneekop, (–CA), 23 Dec. 1945, *Esterhuysen 1254* (BOL); Bain's Kloof [Bainskloof], (–CA), 12 Nov. 1896, *Schlechter 9126* (BOL, MO, PRE); 28 Nov. 1926, *Grant 2648* (BOL, MO); 27 Nov. 1939, *Bond 5* (NBG); 17 Jan. 1945, *Compton 16922* (NBG); 9 Nov. 1946, *Compton 18682* (NBG); 6 Nov. 1948, *Acocks 15238* PRE); Nov. 1949, *Stokoe s.n. SAM60115* (SAM); Dec. 1957, *Loubser 866* (NBG); 24 Nov. 1979, *Goldblatt 5221* (PRE); 27 Nov. 1990, *Steiner 2265* (MO, NBG); Baviaanskloof, above pools in middle of valley, (–CA), 12 Jan. 1993, *Goldblatt & Manning 9505* (MO); (–CA), 15 Jan. 2011 [fruiting], *Manning 3327* (NBG); Wolwekloof Forest Reserve, (–CA), 20 Oct. 1946, *Barker 4249* (NBG); Limietberg, (–CA), 2011, *Esterhuysen 35830* (MO, PRE), *Jackson s.n.* (NBG); Slanghoek Mtns, Witte River Valley, (–CA), Nov. 1922, *Thorne SAM46563* (SAM), 21 Nov. 1943, *Wasserfall 614* (NBG), 28 Dec. 1975, *Esterhuysen s.n.* (MO); Du Toit's Kloof, (–CA), Jan. 1880, *Bolus 5497* (BOL); 10 Dec. 1945, *Esterhuysen 12369* (BOL); Dec. 1949, *Stokoe s.n.* (NBG, SAM60114); Rawsonville, veld opposite Farm Gevonden, (–CA), 3 Nov. 1962, *Walters 912* (NBG); Du Toit-skloof Mtns, Elandsberg catchment, (–CC), 29 Dec. 2000, *Low 6770* (NBG); Slanghoek Valley, The Cossacks, (–CC), 16 Dec. 1997, *Oliver 11004* (NBG); Paarl, Haalhoek Spitzkop, (–CC), 2 Jan. 1947, *Esterhuysen 13528* (BOL, NBG), 19 Dec. 1981 *Esterhuysen 35731* (BOL, MO); Wemmershoek area, Klein Drakenstein Mtns above Zachariashoek, (–CC), 1 Jan. 1983, *Oliver 7928* (NBG, PRE); French Hoek [Franschhoek], (–CC), 23 Dec. 1895, *Bolus 4010* (MO, NBG, PRE), Jan. 1949, *Stokoe s.n. SAM60178* (SAM); Franschhoek Pass, Adolph's Kop, (–CC), 15 Dec. 1944, *Esterhuysen 11047* (BOL, PRE); western Riviersonderend Mtns, 26.4 km west of Olifantsberg, (–CD), 18 Dec. 2007, *Helme 5172* (NBG). 3418 (Simonstown): Jonkershoek Valley, near top of Kurktrekker, (–BB), 1 Dec. 1989, *Oliver 9352* (NBG); Kogelberg Forest Reserve, near Rooiels, (–BD), 11 Nov. 1952, *Rycroft 1354* (NBG). 3419 (Caledon): Villiersdorp, (–AB), 23 Nov. 1930, *Nel s.n.* (NBG).

5. *Thereianthus juncifolius* (Baker) G.J.Lewis in *Journal of South African Botany* 7: 37 (1941). *Morphixia juncifolia* Baker: 238 (1876a). *Watsonia juncifolia* (Baker) Baker: 178 (1892). *Freesia juncifolia* (Baker) Klatt in T.A.Durand & Schinz 5: 188 (1894). *Lapeirousia juncifolia* (Baker) N.E.Br.: 194 (1931). Type: South Africa, [Western Cape], without precise locality or date, [Piquetberg Div. fide Baker (1896)], *Zeyher 1619* (K [K320516 ex herb. Wallich], lecto!, here designated; BOL!, K (3 sheets)!, S!, SAM! (2 sheets), isolecto.) [The Herb. Wallich duplicate is selected as lectotype from among four duplicates at Kew as having been available to Baker at the time and as bearing the inscriptions '*Morphixia juncifolia* Baker' and 'Type'].

Anomatheca calamifolia Klatt: 355 (1882), nom. superfl. pro *Morphixia juncifolia* Baker (1876b). Type: South Africa, [Western Cape], Twenty Four Rivers, *Zeyher* [as *Drege*] 1619 (S, 'Herb. Klatt', holo.!; BOL!, K (3 sheets)!, S!, SAM (2 sheets)!, iso.).

Ixia zeyheri Baker: 166 (1892), nom. superfl. pro *Morphixia juncifolia* Baker (1876a) [based on the same type]. Type: South Africa, [Western Cape], without precise locality or date, *Zeyher 1619* (K [K320516 ex herb. Wallich], lecto!, here designated; BOL!, K (3 sheets)!, S!, SAM (2 sheets)!, isolecto.).

Slender plants 120–200(–300) mm high. *Corm* globose, 5–10 mm diam.; tunics of fine-textured, netted fibres, accumulating with age and forming thick neck up

to 60 mm long around base of stem. *Stem* flexed outward above sheath of second leaf and then erect, unbranched or rarely with short branch from axil of uppermost scale-leaf, 0.5–1.0 mm diam. below spike. *Cataphylls* dry and papery, reddish brown, uppermost long and reaching to lower leaf blade. *Leaves* (3)4, lowermost inserted below ground, blade mostly reaching to spike or exceeding it, filiform-terete, 150–500 × 0.5–1.5 mm, thick-textured, striate with slightly raised veins when dry, upper leaves cauline with lower 1 or 2 inserted on lower $\frac{1}{3}$ of stem and mostly imbricate with lowermost sheathing for < $\frac{1}{2}$ length with blades (20–)40–100 mm long, uppermost 1 or 2 leaves scale-like and entirely sheathing, inserted $\pm$ midway between foliage leaves and spike and well separated from spike. *Spike* erect, elongate, laxly (2)3–10-flowered, lower internodes 3–5(–7) × longer than bracts but progressively shorter acropetally and uppermost internodes $\pm$ as long as bracts; bracts not imbricate, outer 3–5 mm long, acute to truncate, soft-textured and green with papery brown tips, inner slightly longer than outer and similar in texture, acute or truncate. *Flowers* suberect, purple to lilac with white throat; perianth actinomorphic, salver-shaped; tube straight, 11–18 mm long, widening gradually and evenly from base, 1.0–1.5 mm diam. at mouth; tepals spreading and slightly cupped, ovate or obovate, subequal, 10–15 × 3.5–6.0 mm. *Stamens* central; filaments erect, 4–6 mm long, exerted 3–4 mm from tube; anthers 3–4 mm long, lilac or pale yellow; pollen lilac or cream-coloured. *Ovary* ovoid, $\pm$ 1.5 mm long; style central, dividing between base and middle of anthers, branches $\pm$ 3 mm long, divided for > $\frac{1}{2}$ their length, spreading or recurved. *Capsules* flask-shaped, 9–15 mm long. *Seeds* fusiform, 6–7 mm long, with chalazal thread $\pm$ 13 mm long, thus $\pm$ twice as long as seed body, sharply bent back $\pm$ midway and hooked or crook-like, sometimes twisting around adjacent seeds, reddish brown, longitudinally rugulose. *Flowering time*: Dec.–Feb., rarely to Mar. Figure 9.

Distribution and ecology: a mainly montane species occurring from the southern Cedarberg through the Olifants River Mtns to the Skurweberg north of Ceres, with a disjunction to the Hottentots Holland, Kogelberg and Klein River Mtns in the south, and also recorded on the lower southern slopes of the Riviersonderend Mtns (Figure 10). The species is thus apparently absent from the mountains between Ceres and Stellenbosch. Plants are restricted to seeps, streamsides, drainage lines and marshy ground, and may be locally abundant, mostly between 500 and 1 000 m but to near sea level along coastal ranges. The leaves are still green and fresh at flowering. As in most species in the genus, flowering is stimulated by fire.

The long-tubed, salver-shaped, purple flowers suggest pollination by long-proboscid flies, possibly Bombyliidae or Tabanidae, and butterflies but we have not observed any visits.

Diagnosis and relationships: one of the most distinctive members of the genus, *Thereianthus juncifolius* is characterized by its slender habit, filiform-terete leaves, 0.5–1.5 mm diam., and very lax spike of salver-shaped, purple flowers with slender tube 11–18 mm long and ovate-obovate tepals. The lower flowers are well sepa-

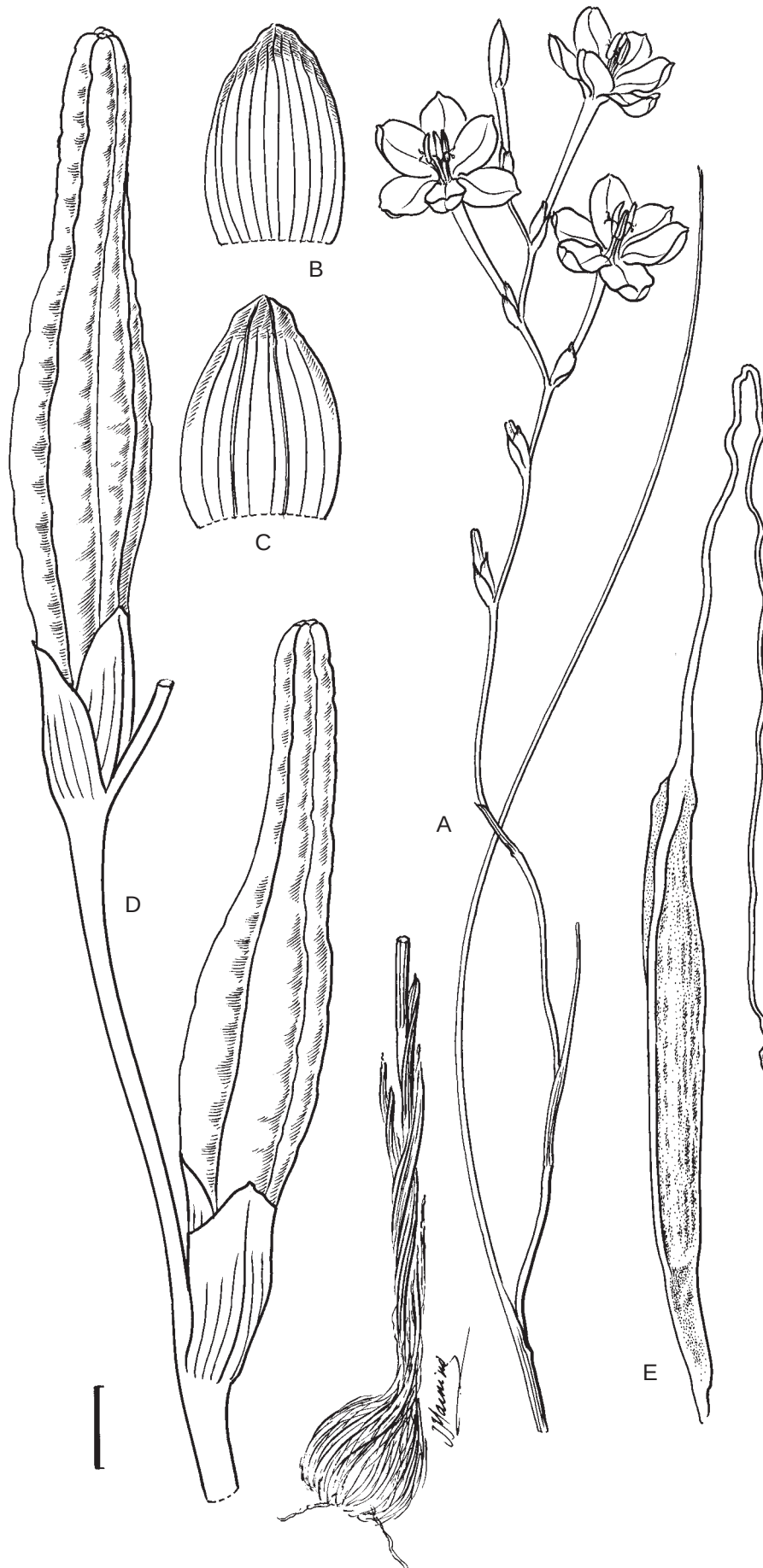


FIGURE 9.—*Thereianthus juncifolius*, Manning 3329. A, whole plant; B, outer bract; C, inner bract; D, capsules; E, seed. Scale bar: A, 10 mm; B–D, 2 mm; E, 0.5 mm. Artist: John Manning.

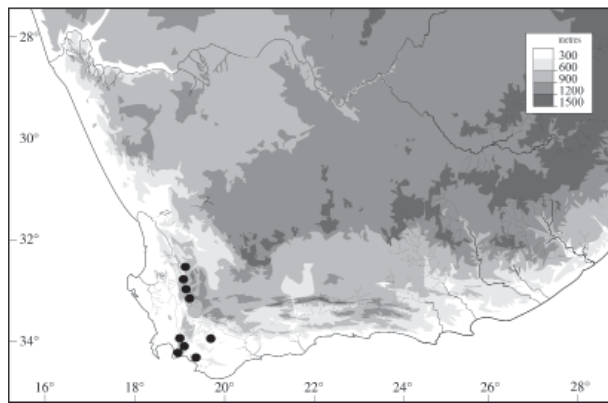


FIGURE 10.—Known distribution of *Thereianthus juncifolius*, ●.

rated from one another by internodes three to five times longer than the bracts. The species is also distinctive in its bracts, the inner as long as or slightly longer than and similar in texture to the outer, both soft-textured and green throughout except for the brown, papery tips. In all other species the inner bracts are shorter than the outer and membranous or papery except along the veins. The capsules are markedly flask-shaped with a narrow, tapering neck and fusiform seeds with a long, filiform chalazal extension $\pm$ twice as long as the seed body. The placenta is restricted to the lower portion of the capsule and the tapered neck or beak accommodates the chalazal extensions of the seeds, which extend up the neck of the capsule to the apex and then flex sharply back towards the seed body. This combination of unusual characteristics sets the species apart from others in the genus but the flask-shaped capsules and the seeds with long, filiform chalazal extensions indicate a close alliance with *T. minutus*.

History: the unusual morphology of the species caused a great deal of uncertainty about its generic position among early workers. The lax spike and salver-shaped flowers determined its initial description in the genus *Morphixia* (Baker 1876a) but the subsequent realization of the taxonomic importance of divided style branches encouraged various authors to place it in all possible genera with this character, namely *Watsonia* (Baker 1892), *Freesia* (Klatt 1894) and *Lapeirousia* (Brown 1931). Although Baker (1892) initially misunderstood the affinities of *Thereianthus juncifolius*, he rapidly appreciated its relationship to other species in the genus by including it with them in subgen. *Beilia* of *Watsonia*. His simultaneous redescription of the species as *Ixia zeyheri*, based on the same collection, is best viewed as an aberration since none of the herbarium material seen by him bears this name. Klatt's (1882) independent description of the species in the genus *Anomatheca* Ker Gawl., again based on the same collection by Zeyher, anticipates his later inclusion of that genus in *Freesia*.

Additional specimens examined

WESTERN CAPE.—3219 (Wuppertal): S Cedarberg, Sneeuwberg, (–AC), 1 Mar. 1947, *Esterhuysen* 13842 (BOL); Algeria Forest Station, Sneeuwberg, 4200–4800' [1 280–1 460 m], (–AC), 5 Feb. 1982, *Viviers* 121 (NBG); Apollo Mtn., Kromrivier Valley, 1 340 m, (–AC), 24 Jan. 1986, *Taylor* 11482 (NBG); Elands-kloof, Hexberg slopes, marshy site, (–CA), 12 Dec. 1982, *Esterhuysen* 35847A (MO); Keerom, E foot of

Twenty Four River Mtns [Olifantsrivierberge], (–CC), 3 Dec. 1950, *Esterhuysen* 17863 (BOL, NBG); Grootfontein, next to Ratelrivier, (–CC), 12 Dec. 1982, *Van Zyl* 2418 (NBG); Koue Bokkeveld, Skoonegsig, Fonteinbult, (–CC), 29 Dec. 1978, *Hanekom* 2573 (MO, PRE); Grootwinterhoek Forest Station, rocky flats, along stream, (–CC), 27 Dec. 1995, *Goldblatt* 10455 (MO); 3319 (Worcester): mtns near Porterville, (–AA), Nov. 1912, *Edwards* s.n. BOL16150 (BOL); Groot Winterhoek Forestry Station, 650 m, (–AA), 2 Dec. 1983, *De Kock* 52 (NBG); Groot Winterhoek, road to De Tronk at Groot Kliphuis river crossing, (–AA), 10 Dec. 2007, *Helme* 5091 (NBG); eastern slopes of Witsenbergen, (–AA), Dec. 1919, *Andreae* 178 (NBG); Skurfdebergen near Wagensboom River, (–AB), 27 Jan. 1897, *Schlechter* 10169 (BOL); Schurfteberg Pass, (–AB), 20 Dec. 1944, *Compton* 16799 (NBG). 'Worcester, beim Waterfall,' (–AC), Dec. *Ecklon & Zeyher* Irid. 297 (1.12) (MO). 3418 (Simonstown): margins of streams flowing into Buffels River near Pringle Bay, (–BD), 27 Jan. 1936, *Pillans* 8185 (BOL); Betty's Bay, (–BD), 10 Feb. 1956, *Levyns* 10451 (BOL); marsh on mtns behind Rooiels–Stalberg–Pringle E Peak, (–BD), 10 Jan. 1971, *Esterhuysen* 32561 (BOL, MO); Kogelberg, (–BD), 16 Jan. 1944, *Esterhuysen* 10010 (BOL); mtns north of Palmiet River Mouth, (–BD), 26 Jan. 1947, *Esterhuysen* 13667 (BOL, NBG); mtns above Betty's Bay, marshy slopes in valley at base of Platberg, (–BD) 27 Jan. 1980, *Esterhuysen* 35387 (BOL, MO); Kogelberg State Forest, Oudebosch, 80 m, (–BD), 20 Jan. 1992, *Kruger* 302 (MO, NBG). 3419 (Caledon): Hottentots Holland Mtns, east of Landdroskop Hut, (–AA), 6 Jan. 2000, *Oliver & Oliver* 11470 (NBG); Grabouw, (–AA), Jan. 1943, *Stokoe* s.n. SAM55716 (SAM); Nuweberg Forest Reserve, slopes of Landdroskop, damp gully above path to Somersdorp Sneeuwberg, (–AA), 11 Jan. 1987 *Goldblatt* 8351 (MO); Aries Kraal, (–AA), 1 Jan. 1945, *Compton* 16851 (NBG); Lebanon, (–AA), Jan. 1968, *Kruger* 640 (NBG); Highlands Forest Reserve, hiking trail, marshy places, (–AC), 29 Jan. 1987 *Goldblatt* 8469 (MO); summit of Klein River Mtns, Bellevue, (–AD), 2 Feb. 2008, *Helme* 5322 (NBG); Vogelgat, N of Mt Frustration, (–AD), 1 Mar. 1987, *Williams* 3785 (NBG); Vogelgat, Rock-in-the-Path, (–AD), 1 Feb. 1986, *Williams* 3643 (NBG); Hermanus, Fernkloof Nature Reserve, 400' [122 m] (–AD), 21 Jan. 1981, *Orchard* 583 (MO); Greyton, foot of Riviersonderend Mtns, (–CA), 16 Jan. 1988, *Oakes* s.n. (NBG).

Sect. *Thereianthus*

Leaves linear or falcate, plane and either leathery without raised veins or strongly ribbed or corrugate with prominently raised veins, or ellipsoid in section; bracts (7–)8–15 mm long, closely and prominently veined with raised veins (sclerenchymatous phloem caps prominent). *Pollen* operculum 1-banded, exine perforate. *Seeds* (where known) ellipsoid-ovoid and angled, without chalazal extension, brown to blackish.

Ser. *Bracteolatus* J.C.Manning & Goldblatt, ser. nov.

Lamina foliorum non costata nec corrugata sine nervis prominentibus vel incrassatis, floribus actinomorphis tepalis patentibus et tubo curvato, staminibus $\pm$ declinatis.

Type species: *Thereianthus bracteolatus* (Lam.) G.J.Lewis.

6. *Thereianthus bulbiferus* Goldblatt & J.C.Manning, sp. nov.

Plantae 140–200 mm altae, cormo globoso 10–15 mm diam., tunicis fibrosis crassis interdum infra unguiscentibus, caule usitate eramoso cormelos 5–7 in axilla folii infimi facienti, foliis 4, infimo lineari-falcato, 70–120 $\times$ (1.5–)2–3 mm, coriaceis, spica erecta dense 7- ad 15-flora, bracteis breviter imbricatis, bractea externa 7–9(–10) mm longa interna quam $\frac{1}{2}$ – ad $\frac{3}{4}$ plo brevior, floribus coeruleis tepalis inferioribus prope basin nota alba mediana munitis, perianthio actinomorfo, tubo

7–9 mm longo infundibuliformi, tepalis subaequalibus vel interioribus paucioribus oblanceolatis patentibus parum cupulatis (10–)13–20 × 3–6 mm, staminibus ± declinatis, filamentis 6–8 mm longis ± 5–6 mm ex tubo exsertis, antheris 4 mm longis purpureis, ramis styli profunde furcatis 3–5 mm longis.

TYPE.—Western Cape, 3319 (Worcester): Bo-Hermon, Elandsberg Nature Reserve, alluvial flats near river, after fire, (–AC), 7 Nov. 2010, J.C. Manning 3312 (NBG, holo.; MO, iso.).

Plants 140–200 mm high. *Corm* globose, 10–15 mm diam.; tunics of coarsely netted fibres, sometimes forming claws below, accumulating with age and forming short neck around base of stem. *Stem* erect, flexuous or flexed outward only above sheath of second leaf, usually unbranched, rarely with short branch from upper leaf axil, 2.0–2.5 mm diam. below spike, developing conspicuous cluster of 5–7 cormels, each 3–4 mm diam., in axil of lowest leaf. *Cataphylls* dry and papery, reddish brown. *Leaves* 4, lowermost inserted below ground, blade reaching base of spike or not, ± dry at flowering, linear-falcate, often sinuous-twisted, 70–120 × (1.5–)2–3 mm, leathery, with 3 ± equally distinct veins or with main vein slightly more distinct, not thickened or raised when fresh but prominent when dry, upper 3 leaves cauline with lower 2 inserted on lower $\frac{1}{3}$ of stem and sheathing for ± $\frac{1}{2}$ length, sheaths shortly imbricate, blades 50–70 × 3–4 mm, uppermost leaf a little distant from lower leaves and well separated from spike, usually with short blade 20–50 mm long, rarely almost entirely sheathing. *Spike* erect, densely 7–15-flowered; bracts imbricate for ± $\frac{1}{2}$ their length, outer 7–9(–10) mm long and up to two internodes long, obtuse or truncate, either green below or entirely brown and leathery, conspicuously and closely veined, with narrow membranous margins, inner bract $\frac{1}{2}$ to $\frac{3}{4}$ as long as outer, bifid, ± membranous with narrow brown zones along veins. *Flowers* patent, pale to mid-blue, lower three tepals with white median mark near base; perianth actinomorphic; tube slightly curved, 7–9 mm long, funnel-shaped, exserted 2–5 mm beyond bracts; tepals oblanceolate, subequal or inner slightly broader, spreading and slightly cupped, (10–)13–20 × 3–6 mm. *Stamens* ± declinate; filaments 6–8 mm long, exserted ± 5–6 mm from tube; anthers all facing upwards or median (lower) facing downwards or outwards, 4 mm long, purple; pollen lilac. *Ovary* obovoid, 2.0–2.5 mm long; style ± deflexed to lie beneath stamens, dividing at middle of anthers, branches 3–5 mm long, divided to near base. *Capsules* ovoid, 6 × 3 mm long, slightly shorter to slightly longer than bract. *Seeds* subglobose-angled, 1.5–2.0 mm long, chalaza ± excavated, yellowish brown, obscurely scalariform-rugulose. *Flowering time*: Nov. (early Dec.). Figure 11.

Distribution and ecology: a local endemic between Piketberg and Wellington, *Thereianthus bulbiferus* is most common along the western foot of the Elandskloof Mtns near Hermon, where it is known from several populations on Elandsberg Nature Reserve (Figure 12). The southernmost population near Agter Paarl, known only from a single specimen collected over forty years ago, is now likely extinct through agriculture. Plants at Elandsberg Nature Reserve grow on seasonally moist or wet alluvial flats, primarily in Swartland Alluvial Fynbos

(Mucina & Rutherford 2006) communities but extending into adjacent Swartland Alluvial Renosterveld. Flowering is most prolific after fire but occasional individuals will flower in open or cleared spaces in the intervening years. The species co-occurs throughout its range with *T. spicatus*, which favours drier soils. At Elandsberg, *T. bulbiferus* occurs as single-species communities on the lower, moister flats but on the slopes, where it is restricted to drainage lines, it interdigitates with *T. spicatus* growing on adjacent drier sites. The single collection from near Agter Paarl (Thompson 622) is a mixed gathering comprising a single stem of *T. bulbiferus* and two stems of *T. spicatus*, suggesting that the two species grew in close proximity there too, and both species have also been collected on the Piketberg, although in different localities.

Visits by monkey beetles (Coleoptera: Hopliini) have been observed at Elandsberg Nature Reserve (unpublished obs.) but the relatively short-tubed flowers produce nectar and are probably also visited by anthophorine bees.

Diagnosis and relationships: *Thereianthus bulbiferus* is diagnosed by its leathery leaves without raised central and secondary veins when fresh, the lower leaf mostly characteristically falcate or arcuate and often sinuous-twisted, and by the moderately dense spikes of blue flowers with relatively short, funnel-shaped perianth tube, 7–9 mm long exserted up to 5 mm beyond the bracts, actinomorphic perianth with white markings at the base of all the tepals, and ± declinate stamens and style. Flowers with declinate stamens are found elsewhere in sect. *Thereianthus* only in *T. bracteolatus*, and in both species the perianth tube is curved so that the flowers face sideways rather than upwards. Both species also have inconspicuously veined leaves. The seeds, with an unusual chalazal depression or small excavation rather than crest, are distinctive for *T. bulbiferus*.

Thereianthus bulbiferus is unique in the genus in producing a cluster of cormels from the axil of the lowermost leaf. These cormels, 3–4 mm diam., are present at flowering time, and although they may be lost from some pressed specimens, their presence can be readily inferred by the split in the leaf sheath through which they protruded. Florally, the species is distinguished from *T. bracteolatus* by the light to mid-blue perianth with white markings on all tepals, which are inconspicuously veined, the outer longitudinal veins ± evenly branched along their entire length. The flowers of *T. bracteolatus*, in contrast, are dark blue to purple without evident white markings but with the longitudinal veins splashed or spotted with purple. The outer longitudinal veins in this species are typically only weakly branched in the distal half so that the tepals appear to be parallel-veined from the base.

All other members of sect. *Thereianthus* have strongly and closely ribbed leaves, and mostly arcuate stamens (except *T. ixioides*, which has symmetrical stamens). Fresh leaves of the members of the *T. spicatus* alliance have the veins separated from one another but as the leaves dry and shrink, the veins become closely appressed, leaving no gaps between them. The leaves of *T. bracteolatus* and *T. elandsmontanus*, in contrast, are ±

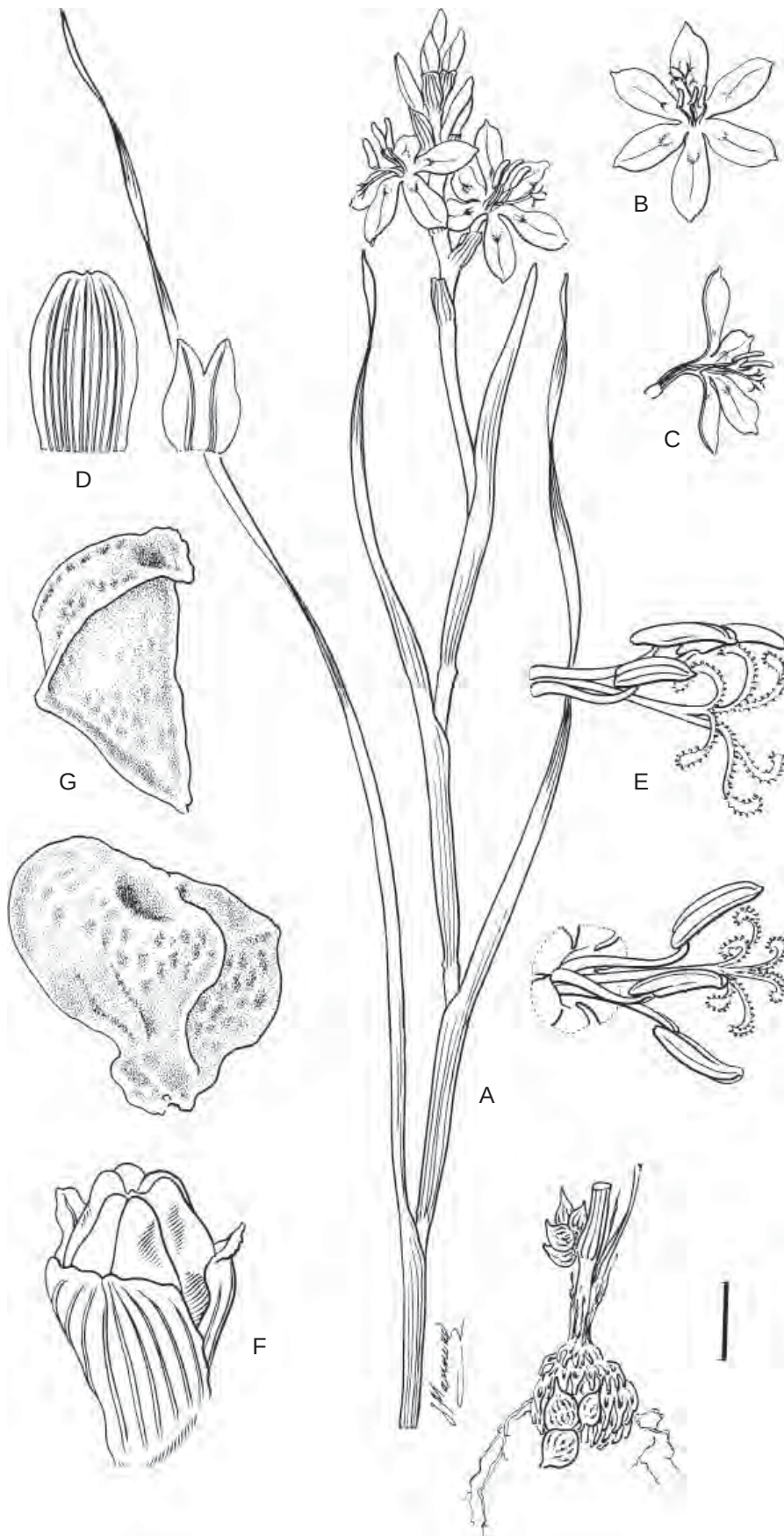


FIGURE 11.—*Thereianthus bulbiferus*, Manning 3312. A, whole plant; B, flower, front view; C, half flower; D, outer (left) and inner (right) bract; E, details of stamens and stigma; F, capsule; G, seeds. Scale bar: A–C, 10 mm; D, E, 3 mm; F, 2 mm; G, 0.5 mm. Artist: John Manning.

smooth and leathery when fresh and although the veins become evident as the leaf dries, they remain separated from one another by intervening blade tissue and by lower order veins.

History: although collected on two separate occasions several decades ago, *Thereianthus bulbiferus* was confused with both *T. bracteolatus* and *T. spicatus*, and it was only in 2010 when we were able to properly

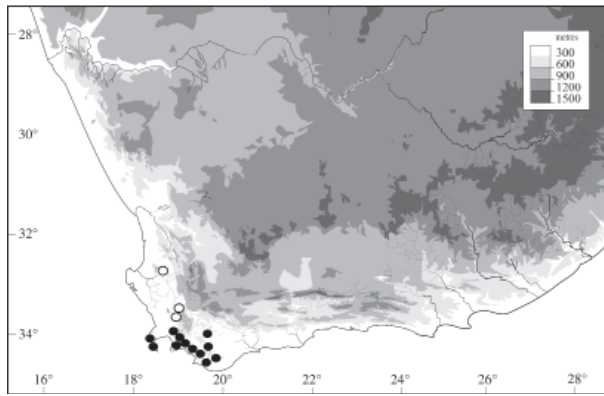


FIGURE 12.—Known distribution of *Thereianthus bracteolatus*, ●; *T. bulbiferus*, ○.

examine living plants in the field at Elandsberg Nature Reserve that it became clear that they represent a distinct species.

Etymology: the specific epithet alludes to the characteristic cormels on the lower part of the stem.

Additional specimens examined

WESTERN CAPE.—3218 (Clanwilliam): Piketberg, Sandleegte [Buglerspost, at top of Versveld Pass], 2400' [730 m], (–DC), 3 Dec. 1973, *Linder 130* (BOL). 3318 (Cape Town): Pause's plot on Protea F.U.C. road off Agter-Paarl road, (–CB), 2 Dec. 1968, *Thompson 622A* (NBG). 3319 (Worcester): Bo-Hermon, Elandsberg Nature Reserve, Vervlak, sandstone flats burned in Mar., (–AC), Nov. 1999, *Manning s.n.* (NBG); 7 Nov. 1999, *Parker 390* (NBG).

7. *Thereianthus bracteolatus* (Lam.) G.J.Lewis in *Journal of South African Botany* 7: 42 (1941). *Gladiolus bracteolatus* Lam.: 725 (1788). Type: South Africa, without precise locality, said to have been collected by *Sonnerat s.n.* (P: Herb. Lamarck, holo!).

Ixia punctata Andrews: t. 177 (1801). *Watsonia punctata* (Andrews) Ker Gawl.: 229 (1804). *Gladiolus punctatus* (Andrews) Roem. & Schult.: 425 (1817). Type: South Africa, 'Cape of Good Hope', said to have been collected and sent by G. Hibbert, illustration in Andrews, *The botanist's repository* 3: t. 177 (1801).

Gladiolus subulatus Vahl: 97 (1805), nom. illegit. superfl. pro *G. bracteolatus* Lam. (1788). *Watsonia subulata* Klatt, nom. nov. pro *G. subulatus* Vahl, nom. illegit. et superfl. pro *G. bracteolatus* Lam. Type: South Africa, without precise locality or date, *Bulow s.n.* C1000844 (C, holo!).

Gladiolus triticeus Thunb.: 194 (1807). *Watsonia triticea* (Thunb.) Spreng.: 150 (1824). *Beilia triticea* (Thunb.) Eckl.: 43 (1827). *Micranthus triticeus* (Thunb.) Heynh.: 405 (1847). *Watsonia punctata* var. *triticea* (Thunb.) Baker: 177 (1892). *Beilia spicata* var. *triticea* (Thunb.) Kuntze: 305 (1898). Type: South Africa, without precise locality, *Thunberg s.n.* UPS-THUNB1084 (UPS-THUNB, holo!).

Plants (80–)150–200(–300) mm high. *Corm* globose, 10–15 mm diam., developing several large cormels at base; tunics of coarsely netted fibres, thickened and forming woody claws below, accumulating with age and forming collar up to 20 mm long around base of stem. *Stem* erect, flexuous or flexed outward only above sheath of second leaf, unbranched, (1.5–)2.0–2.5 mm diam. below spike. *Cataphylls* dry and papery, reddish brown. *Leaves* 4(5), lowermost inserted below ground, blade reaching base of spike or not, $\pm$ dry at flowering, linear, elliptic or terete in section, 70–170 $\times$ 0.5–1.5(–2.0) mm, leathery, with 3 $\pm$ equally distinct veins or with

main vein slightly more distinct, not thickened or raised when fresh but prominent when dry, upper 3(4) leaves cauline with lower 2 inserted on lower $\frac{1}{3}$ of stem and sheathing for $\pm \frac{1}{2}$ length, sheaths usually shortly imbricate, blades 50–70 mm long, uppermost leaf a little distant from lower leaves and well separated from spike, entirely sheathing or with short blade 20–50 mm long. *Spike* erect, densely 7–15(–30)-flowered; bracts imbricate for $\pm \frac{1}{2}$ their length, 8–10(–12) mm long and $\pm$ two internodes long, outer entirely brown and leathery, obtuse or truncate (rarely apiculate), conspicuously and closely veined, with narrow membranous margins, inner $\frac{1}{2}$ to $\frac{3}{4}$ as long as outer, bifid, $\pm$ membranous with narrow brown zones along veins. *Flowers* $\pm$ patent, purple to violet with dark blotches and streaks on longitudinal veins and especially midline; perianth actinomorphic; tube slightly curved, (7–)8–10(–15) mm long, funnel-shaped, usually exserted 2–6(–10) mm beyond bracts, rarely just included; tepals oblanceolate, subequal or inner slightly broader, spreading and slightly cupped, (10–)11–17 $\times$ 3–6 mm. *Stamens* unilateral, $\pm$ declinate, sometimes weakly so and then $\pm$ central; filaments 8–10 mm long, exserted $\pm$ 6–8 mm from tube, usually flexed sharply upwards apically; anthers all facing upwards, usually white (rarely purple), 4–6 mm long; pollen white (rarely brown when anthers purple). *Ovary* obovoid, 2.0–2.5 mm long; style $\pm$ deflexed to lie beneath stamens, dividing opposite middle of anthers, branches 3–5 mm long, divided to near base. *Capsules* ovoid, $\pm$ 6 mm long. *Seeds* subglobose- or ellipsoid-angled, $\pm$ 2 mm long, chalaza truncate, brown, testa colliculate. *Flowering time*: late Nov.–early Jan. Figure 13A–G.

Distribution and ecology: the only species of *Thereianthus* on the Cape Peninsula, *T. bracteolatus* occurs from the Peninsula and Stellenbosch along the coastal ranges of the Hottentots Holland, Kogelberg and Klein River/Babilonstoring Mtns to Bredasdorp in the east, with isolated records from near Caledon (Drayton Siding) and the lower slopes of the Riviersonderend Mtns above Greyton (Figure 12). Somewhat surprisingly, the species has not been recorded from the Caledon Swartberg. Although there is an early record, *Zeyher 1068* (SAM), from the Twenty Four Rivers Mtns near Porterville, the species has never been re-collected here and as this collection is a mixed one that includes a stem of *T. longicollis*, which is known from this location, the association of *T. bracteolatus* with the locality is probably an error.

The species is locally common after fire on sandy flats and lower slopes below 1 000 m, although plants will also flower in cleared places along roads in the absence of fire. The distribution of *Thereianthus bracteolatus* largely overlaps with that of *T. spicatus*, with the notable exception of the Cape Peninsula where only *T. bracteolatus* is found, but *T. spicatus* favours more stony sites and often heavier soils. We have encountered both species growing adjacent to each other at Kogelberg, with *T. bracteolatus* on damper soils and flowering in December and *T. spicatus* immediately adjacent on rocky slopes and flowering in January.

The purple or violet flowers with a relatively short perianth tube are evidently adapted to pollination by various nectar-feeding bees.



FIGURE 13.—*Thereianthus bracteolatus*. A–E, Goldblatt 9032: A, whole plant; B, flower, side view; C, outer tepal; D, inner tepal; E, details of stamens and stigma. F, G, Rodgers 2829: F, capsule; G, seeds. *T. spicatus*. H–J, Goldblatt 6837: H, whole plant; I, flower, front view; J, flower, side view. K, L, Goldblatt & Manning 9567: K, capsules; L, seed. Scale bars: A, B, H–J, 10 mm; C, D, F, K, 2 mm; E, 3 mm; G, L, 0.5 mm. Artist: John Manning.

Diagnosis and relationships: *Thereianthus bracteolatus* is unmistakable when seen alive, with very narrow leaves, 0.5–1.5(–2) mm diam., and terete or elliptic in section, and dense spikes of sideways-facing, deep purple or violet flowers with curved perianth tube (7–)8–10(–15) mm long, and relatively long, unilateral, declinate stamens. The flowers, which lack nectar guides, have darkly pigmented veins, giving them a characteristic blotched-striate appearance. Although Lewis (1941) noted that the branching pattern of the veins was distinctive for the species, this difference is not evident in all plants. Like other species in the genus, each tepal

has three primary longitudinal veins but unlike other species, the lateral veins are often only branched in the basal half so that the tepals appear to be $\pm$ parallel-veined for most of their length. In the other species the veins are not darkly pigmented and thus not evident, and the lateral longitudinal veins are $\pm$ evenly branched throughout their length.

Perianth tube length is somewhat variable, usually 8–10 mm but 10–15 mm long in an isolated population at Drayton Siding east of Caledon (Goldblatt 394). The anthers and pollen are usually white but plants from

the Silvermine area of the Cape Peninsula have purple anthers with brown pollen. Another isolated population, from the lower slopes of the Riviersonderend Mtns above Greyton (*Esterhuysen* 20763), has stamens that are less obviously declinate than usual but matches the species in vegetative and other floral characters, including the distinctive tepal venation. This population may repay further consideration.

The smooth leaves and especially the declinate stamens (but not the characteristic tepal venation) are both shared with *Thereianthus bulbiferus* from gravelly flats between Malmesbury and Paarl. This species has pale to mid-blue flowers with distinct white blotches at the base of each tepal, and shorter filaments, 6–8 mm long. Most characteristically, the plants develop a cluster of cormels in the axil of the lower leaf, whereas cormels in *T. bracteolatus* are developed at the base of the parent corm. Although *T. bracteolatus* is sometimes confused with *T. spicatus*, especially in the dried state when details of the perianth coloration and stamen orientation are obscured, the two are readily distinguished by the difference in leaf texture: leathery and terete or elliptic in section without raised veins in *T. bracteolatus* versus plane and ribbed or corrugate with raised veins in *T. spicatus*. Living plants of *T. spicatus* are readily separated by their blue (rarely white or pink) flowers with white markings on the lower three tepals outlined with a purple chevron and lacking darker venation, the $\pm$ straight or distally curved perianth tube, 12–25 mm long, and the much shorter, arcuate filaments, 3–4 mm long.

History: the second species of *Thereianthus* to be described after *T. spicatus*, *T. bracteolatus* was named in the genus *Gladiolus* by French biologist J.P.B. Lamarck (1788) from specimens said to have been collected by naturalist and draughtsman Pierre Sonnerat, who could only have collected this material in 1773, on the outgoing leg of his voyage to Isle de France (now Mauritius). This name was overlooked by the English botanical artist and engraver, Henry Andrews (1801), who described *Ixia punctata* from plants cultivated in London that had been sent to collector and botanical patron G. Hibbert from the Cape of Good Hope. In continental Europe, the species was described under the name *Gladiolus triticeus* for a third time a few years later by Thunberg (1807), based on his own collections from the Cape. At the time, Thunberg expressed doubt as to whether his species was truly different from *G. spicatus* L. (i.e. *T. spicatus*) and must have appreciated the similarity between these species, ultimately to be treated in a separate genus. J.G. Baker (1892) subsequently treated Thunberg's name as a variety of Andrew's species, which had by now been transferred to *Watsonia* as *W. punctata* (Andrews) Ker Gawl. The nomenclature was clarified by Lewis (1941), who correctly identified Lamarck's name as the earliest for the species, and also established the genus *Thereianthus* for plants until then treated as subgen. *Beilia* of *Watsonia*.

Additional specimens examined

WESTERN CAPE.—3318 (Cape Town): Table Mountain, (–CD), Jan. 1898, *Thode* 6017 (NBG), Dec. 1950, *Pillans* 10276 (MO); Cape Peninsula, Camps Bay, (–CD), Dec. without year, *Zeyher* 5038 (SAM); 5 July 1943 [fr.], *Barker* 2416 (NBG); above S end of Kirstenbosch, (–CD), 28 Nov. 1953, *Esterhuysen* 22404 (BOL); Kenil-

worth, (–CD), Dec. without year, *Bolus* 3305 (NBG); Kenilworth Race Course, (–CD), 11 Dec. 1969, *Esterhuysen* 32359 (BOL, MO, NBG); near Stellenbosch, (–DD), Dec. 1924, *Rogers* 28929 (BOL, NBG). 3319 (Worcester): Franschhoek Pass, east side, (–CC), 26 Nov. 1939, *Compton* 8185 (NBG). 3418 (Simonstown): Vlaggenberg [Vlakkenberg], (–AB), 1 Jan. 1896, *Wolley Dod* 345 (BOL); Bergvliet Farm, (–AB), 16 Dec. 1976, *Purcell* 152 (SAM); Constantia Nek, (–AB), 24 Jan. 1929, *Gillett* 3365 (BOL, NBG); Steenberg Plateau, (–AB), Dec. 1944, *Lewis* 56067 (SAM); Silvermine Valley, (–AB), Dec. 1944, *Lewis* 56066 (SAM); mntns above Muizenberg, (–AB), Jan. 1881, *Bolus* 3305 (BOL, NBG); Red Hill, (–AB), 21 Dec. 1963, *Taylor* 5616 (NBG); Farm Buffelsfontein W of Redhill, (–AB), 17 Dec. 1984, *Snijman* 833 (NBG); Patreis Vlei [Patrys Vlei], (–AD), 3 Jan. 1941, *Salter* 8586 (BOL, NBG); Cape Point Reserve, sandy plain on Circular Drive, (–AD), 31 Dec. 1989, *Goldblatt* 9032 (MO); Cape Point, (–AD), 1 Jan. 1968, *Taylor* 7267 (NBG); Steenbras, (–BB), Dec. 1945, *Lewis* 58735 (SAM); Palmiet River Valley, (–BD), Nov. 1944, *Lewis* 56408 (SAM); between Kogel Baai and Rooi Els, (–BD), Nov. 1945, *Lewis* 58736 (SAM); Kogelberg State Forest, Palmiet River Valley, (–BD), 29 Nov. 1991, *Kruger* 97 (NBG); Palmiet River Mouth, (–BD), 7 Dec. 1962, *Grobler* 71 (NBG). 3419 (Caledon): Aries Kraal, (–AA), 18 Nov. 1944, *Leighton* 808 (BOL); 18 Nov. 1944, *Leighton* 3361 (NBG); Lebanon Forest Reserve, (–AA), 14 Jan. 1971, *Haynes* 510 (NBG); Grabouw near Palmiet River, (–AA), Dec. 1899, *Bolus* 3305 (BOL); Bot River, (–AC), 9 Dec. 1951, *Taylor* 3810 (NBG); Honingklip, (–AC), without date, *Taylor* 5119 (NBG); Hermanus Mtn, (–AD), 26 Dec. 1943, *Leighton* 357 (BOL); Hermanus, Rotary Way, (–AC), 8 Jan. 1975, *Walters* 1452 (NBG); Hermanus, Vogelgat Nature Reserve, (–AD), 7 Jan. 1984, *Burman* 1273 (BOL); Fernkloof Nature Reserve, 500 m, (–AD), 2 Jan. 1976, *Orchard* 359 (MO, NBG); top of Shaw's Pass, (–AD), Jan. 1957, *Lewis* 63514 (BOL); foothills of River Sonder End [Riviersonderend] Mtns, (–BA), Apr.–May 1950 [fr.], *Lewis* 2280 (SAM); Zonder End [Riviersonderend], (–BA), without date, *Barnard* 448 (SAM); Riviersonderend Mtns near Greyton, (–BA), 30 Nov. 1952, *Esterhuysen* 20763 (BOL, MO, NBG); Caledon, Drayton Siding, (–BA), 16 Dec. 1968, *Goldblatt* (BOL); north end of Akkedisberg Pass, fynbos slopes, burned last summer, (–BC), 19 Nov. 1979, *Goldblatt* 5186 (MO); Elandskloof, (–BD), 17 Dec. 1896, *Schlechter* 9765 (BOL, MO); between Gansbaai and Baardscheidersbos, (–DA), 11 Nov. 1980, *Snijman* 380 (NBG); between Wolvengat and Elim, Farm 239, (–DA), 25 Nov. 2000, *Mucina* 251100/5 (NBG); Bredasdorp, plateau on mountain top, (–DB), 19 Dec. 1930, *Galpin* 22442 (BOL). *Doubtful locality:* 3319 (Worcester): Twenty Four Rivers, (–AA), without date, *Zeyher* 1608 [excluding single specimen of *T. longicollis* as indicated] (SAM).

Ser. *Thereianthus*

Leaves ribbed or corrugate, with thickened and raised veins. *Flowers* suberect with $\pm$ straight tube; perianth actinomorphic or more usually zygomorphic. *Stamens* arcuate, rarely central.

8. *Thereianthus spicatus* (L.) G.J.Lewis in *Journal of South African Botany* 7: 39 (1941). *Gladiolus spicatus* L.: 37 (1753). *Ixia spicata* (L.) Willd.: 200 (1797), hom. illegit. non Burm.f. (1768). *Gladiolus alopecuroides* Pers.: 46 (1805), nom. illegit. pro *Gladiolus spicatus* L. et hom. illegit. non L. (1756). *Micranthus spicatus* (L.) Heynh.: 405 (1847). *Paulomagnusia spicata* (L.) Kuntze: 702 (1891). *Beilia spicata* (L.) ex Kuntze: 305 (1898) [*Beilia spicata* (L.) Eckl. nom. inval.]. Type: from South Africa without any details ex Herb. van Royen (?L, not found). Neotype, designated here: South Africa, [Western Cape], Jonkershoek Valley, contour path below Berg River Neck, 29 Dec. 1989, *Goldblatt & Manning* 9028 (NBG, neo.; K, MO, PRE, iso.).

Thereianthus spicatus var. *linearifolius* G.J.Lewis: 40 (1941). Type: South Africa, [Western Cape], mountains near Franschhoek, *Salter* 2973 (BOL, holo.).

Gladiolus rubens Vahl: 98 (1805). *Watsonia rubens* (Vahl) Ker Gawl.: sub t. 1072 (1807). Type: South Africa, not cited, probably at C.

Plants (150–)200–500(–600) mm high. *Corm* globose, 10–20 mm diam.; tunics of coarsely netted fibres, thickened and claw-like at base, accumulating with age and forming neck up to 20 mm long around base of stem. *Stem* erect or flexed outward above sheath of second leaf, unbranched or rarely with short branch from axil of uppermost leaf, 1.5–3.0 mm diam. below spike. *Cataphylls* dry and papery, reddish brown. *Leaves* 4(5), lowermost inserted below ground, blade reaching or exceeding spike (rarely shorter than spike), $\pm$ dry at flowering, linear, (100–)200–250 $\times$ 1–2(–4) mm, closely 3–5(–7)-ribbed, glabrous or minutely scabridulous along ribs and margins, upper 3 leaves cauline, second and third leaves usually $\pm$ imbricate and enveloping stem but uppermost leaf distant, blades successively shorter, uppermost leaf only rarely reaching base of spike, entirely sheathing or with short blade 20–60 mm long. *Spike* erect, densely (3–)6–20(–30)-flowered; bracts imbricate for $\frac{1}{2}$ to $\frac{2}{3}$ length, (7–)8–13(–15) mm long and two or three internodes long, outer acute, either green below or entirely brown and leathery, conspicuously and closely veined, with narrow membranous margins, inner slightly shorter, bifid, $\pm$ membranous with narrow brown zones along veins. *Flowers* suberect, mostly pale to mid-blue, rarely white or pink, lower three tepals each with white marking near base outlined distally with purple chevron; perianth subactinomorphic or weakly zygomorphic; tube $\pm$ straight or slightly curved outwards in distal 3 mm, (12–)15–18(–25) mm long, 1.0–1.5 mm diam. at mouth, $\pm$ dilated gradually and evenly from base to tip, exerted 6–15 mm beyond bracts, 0.8–1.8 $\times$ as long as tepals; tepals elliptical-oblancheolate, inner three slightly smaller, spreading and slightly cupped, 10–18 $\times$ 3–5 mm. *Stamens* arcuate; filaments 3–4 mm long, exerted 2 mm from tube; anthers 4–5 mm long, purple; pollen purple. *Ovary* obovoid, 2.0–2.5 mm long; style arching above anthers, dividing at $\pm$ middle of anthers, branches 4–5 mm long, divided to near base. *Capsules* narrowly ovoid, 6–7 $\times$ 3 mm. *Seeds* ellipsoid-angled, $\pm$ 2 mm long, black or brown, testa striate-colliculate. *Flowering time*: (Nov.) Dec.–Jan., rarely into early Feb. Figure 13H–L.

Ecology and distribution: the most common species in the genus, *Thereianthus spicatus* is distributed along the coastal mountains and foothills in the southwestern part of Western Cape, from Piketberg and Porterville southwards to the Palmiet River Mouth and onto the lower slopes of the Riviersonderend Mtns but is absent from the Cape Peninsula (Figure 14). The species is mostly found on sandstone slopes but also grows on shale bands and on granite, from near sea level to over 1 000 m. Flowering is strongly stimulated by fire but plants will bloom in older, open veld and in fire-breaks.

Flower colour is somewhat variable in the species, usually mid- to deep blue but sometimes white or pink. Although the different forms are often mixed, there is an altitudinal component to perianth colour in populations in the Jonkershoek Valley, where the proportion of white flowers increases with elevation. The relatively great variation in perianth tube length suggests adaptation to the local pollinator fauna. Mostly 15–20 mm long, the perianth may be as long as 25 mm in plants from Grootwinterhoek (Helme 5141) and in Idas Valley, Stel-

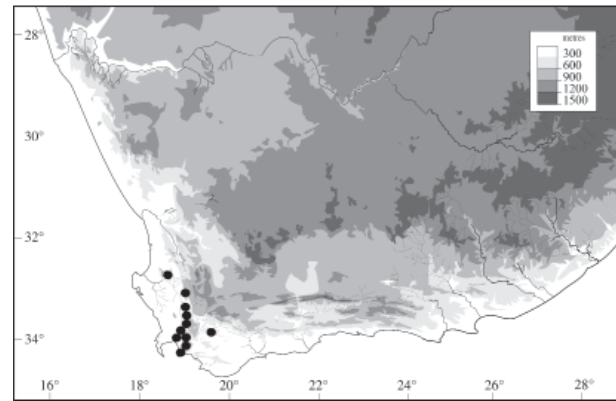


FIGURE 14.—Known distribution of *Thereianthus spicatus*, ●.

lenbosch (Levy's 1458), and as short as 12 mm around Somerset West (Martley s.n. BOL22440, Schlechter 7245). Leaf width in the species is mostly 1–2 mm but plants with broader leaves, 3–4 mm wide, are known from Bainskloof, Stellenbosch, Kuils River and Somerset West. A collection of unusually delicate plants, with small tepals 8 mm long (Esterhuysen 22748) from Bailey's Peak matches the species in other respects, notably the ribbed leaves, and perianth tube 15–20 mm long, and we regard it as a local, montane form.

The moderately long-tubed flowers are evidently adapted to pollination by correspondingly long-tongued insects, and we have seen the species being visited by the butterfly *Cynthia cardui* (Nymphalidae) at Jonkershoek. The perianth tube is narrowed towards the base, and nectar wells up for some distance into the tube, where it is accessible to long-tongued anthophorine bees as well, which probably also play a role in pollination.

Diagnosis and relationships: the central species in series *Thereianthus*, *T. spicatus* is distinguished from the other members of the genus with strongly ribbed leaves (*T. elandsmontanus*, *T. ixioideus* and *T. longicollis*) by flowers with a moderately long perianth tube, (12–)15–18(–25) mm long, usually curved outwards slightly near the tip and dilating gradually and evenly from base to apex. The tepals are relatively large, elliptical-oblancheolate, 10–18 $\times$ 3–5 mm, and the stamens are arcuate, with filaments 3–4 mm long. Although usually glabrous, the leaves in some plants are scabridulous along the ribs and margins. This is especially evident in the collection from Piketberg but occurs sporadically elsewhere as well.

Perianth length is more variable in this species than in others, and longer-tubed forms are sometimes misidentified as *Thereianthus longicollis*—both species have been collected in the mountains above Tulbagh Waterfall and above Saron. We have seen both in the field and there is no doubt that they are distinct. Longer-tubed plants of *T. spicatus*, such as those from the Grootwinterhoek Mtns above Porterville with tubes reaching to 25 mm long, are distinguished from *T. longicollis* by their proportionally larger tepals, always less than twice as long as the tube. The critical differences separating *T. spicatus* from the closely allied *T. ixioideus* and also from *T. bracteolatus* (ser. *Bracteolatus*), with which it has been confused in the past, are discussed under those species.

History: the earliest known species in the genus, *Thereianthus spicatus*, was first named in the genus *Gladiolus* (Royen 1740; Linnaeus 1753) but subsequently transferred to various other genera, including *Ixia* L., *Watsonia*, *Micranthus* and the invalidly published *Beilia* (Ecklon 1827). This reflects the uncertainty about generic circumscriptions that prevailed for many years. The original collector and date of collection are unknown but the species was evidently cultivated in the botanical gardens at Leiden, The Netherlands, in the 1740s. Forms with narrower leaves were distinguished by Lewis (1941) as var. *linearifolius* but this distinction has no taxonomic merit (Manning & Goldblatt 2004), with individual collections showing a range of leaf widths from 1–3 mm (e.g. *Esterhuysen* 13673).

Nomenclatural note: the species was based by Linnaeus (1753) on the polynomial *Gladiolus foliis linearibus, caule simplicissimo, floribus spicatus* (Royen 1740) but no specimen under this inscription could be located at Leiden (G. Thijssen pers. comm. Nov. 2010) and must be presumed lost—types of the other three *Gladiolus* species listed by Royen (1740) are all at Leiden. Possibly, therefore, no authentic material was available to Linnaeus. A specimen with the binomial *G. spicatus* in the Linnean Herbarium (LINN 59.3) and inferred to have come from Traugott Gerber (fl. 1739–1741) by Jackson (1912), was regarded by Jarvis (2007) as original material. Critically, however, this specimen does not match the protologue, having just a single sheathing leaf, and it cannot therefore be considered to be original material. Although it was identified as the holotype by Manning & Goldblatt (2004), their designation is not nomenclaturally effective in lacking a definitive phrase designating it as a lectotype (Jarvis 2007; Art. 9.21: McNeill *et al.* 2006). Significantly, the specimen is not in fact *T. spicatus* as currently understood, being a species of *Gladiolus*, evidently *G. communis*. The current taxonomic association of the name can be traced to Thunberg (1807) (*UPS-THUNB1072*) but the basis for this remains unknown. We designate a neotype here to fix its application in this sense.

Additional specimens examined

WESTERN CAPE.—3218 (Clanwilliam): Piketberg, suurvlaakte [west of Avontuur near top of Versveld Pass], 780 m, (–DC), 23 Dec. 1973, *Linder* 187 (BOL). 3318 (Cape Town): Paarl Mtn, near top, (–DB), 2 Dec. 1929, *Grant* 5027 (BOL, MO); Penhill, Eersterivier, (–DC), 10 Dec. 1977, *Raitt* 288 (NBG); Kuils River, (–DC), Dec. 1931, *Basson* s.n. BOL2430 (BOL); Joostenberg, (–DD), 14 Nov. 1965, *Lewis* 6222 (NBG); Jonkershoek, (–DD), 11 Dec. 1975, *Kruger* 119 (NBG); Jonkershoek Valley, below Berg River Nek, (–DD), 29 Dec. 1989, *Goldblatt* 9028 (MO, NBG); Jonkershoek, Swartboskloof, (–DD), 5 Dec. 1960, *Van der Merwe* 24–43 (NBG); 15 Jan. 1988, *Forsyth* 504 (NBG); Jonkershoek, Dwarsberg, (–DD), 9 Feb. 1959, *Rycroft* 2147 (NBG); Stellenboschberg above Coetzenberg, (–DD), Nov. 1992, *De Vos* 2739 (NBG); Stellenbosch, Idas Valley, (–DD), 5 Dec. 1925, *Levy* 1458 (BOL). 3319 (Worcester): Groot Winterhoek, road to De Tronk at Groot Kliphuis river crossing, (–AA), 10 Dec. 2007, *Helme* 5141 (NBG); Tulbagh, Watervalberge, east of Suurvlak Falls, (–AC), 29 Dec. 2000, *Hansford* 21 (NBG); Elandsberg Nature Reserve, Bosplaas trek, (–AC), 18 Nov. 1996, *Parker* 114 (NBG); Bainskloof Mtns, Bailey's Peak, (–CA), 21 Feb. 1954, *Esterhuysen* 22748 (BOL); Bainskloof, (–CA), 1 Jan. 1941, *Kies* s.n. NBG62273 (NBG); Limietberg, (–CA), 6 Jan. 1983, *Goldblatt* 6837 (MO, NBG); Wemmershoek Mtns, April Peak, (–CC), 15 Dec. 1940, *Esterhuysen* 4098 (BOL); Klein Drakenstein Mtns, upper Kasteelkloof, (–CC), 9 Jan. 1969, *Kruger* 879 (NBG); Du Toitskloof, (–CC), Jan. 1882, *Tyson* 905 (SAM); 1 Jan. 1950, *Hall* 285 (MO, NBG); Elandspad Catchment in Agtertafelberg Kloof, (–CC), 28 Dec. 2000, *Low* 6769 (NBG); Zach-

ariaskloof Catchment, (–CC), 28 Dec. 1978, *Kruger* 1777 (NBG); Franschhoek Pass, (–CC), Dec. 1929, *Thode* A2223 (NBG); 17 Jan. 1939, *Gillett* s.n. NBG62371 (BOL, NBG); 25 Jan. 1933, *Pillans* 7624 (BOL). 3418 (Simonstown): Somerset West, (–BA), Dec. 1930, *Martley* s.n. BOL22440 (BOL); Somerset West, Schaapenberg, (–BA), 14 Nov. 2006, *Helme* 4097 (NBG); Helderberg Nature Reserve, Porcupine Buttress, (–BB), 3 Dec. 1993, *Runnalls* 639 (NBG); Sir Lowry's Pass, (–BB), 15 Jan. 1896, *Schlechter* 7245 (BOL); Dec. 1899, *Bolus* 4210 (BOL); 19 Dec. 1942, *Compton* 14222 (NBG); near foot of Sir Lowry's Pass, (–BB), 27 Jan. 1993, *Goldblatt* & *Manning* 9567 (MO, NBG); Steenbrasdam, (–BB), 22 Dec. 1983, *De Kock* 73 (NBG); Steenbras Forest Reserve, (–BB), 24 Jan. 1951, *Barker* 7211 (BOL, NBG); Elgin Forest Reserve, (–BB), Jan. 1951, *Lewis* 2906 (SAM); Kogelberg Forest Reserve, Blousteenberg, (–BD), 22 Dec. 1969, *Boucher* 972 (NBG); Betty's Bay, (–BD), 13 Dec. 1973, *Vogts* s.n. NBG173047 (NBG); Harold Porter Reserve, (–BD), 22 Nov. 1963, *Topper* s.n. NBG70755 (NBG); Kogelberg, Oudebosch, (–BD), Dec. 1952, *Stokoe* s.n. NBG173067 (NBG); slopes above Palmiet River Mouth, (–AC), 20 Dec. 1934, *Salter* 5180 (BOL); 26 Jan. 1947, *Esterhuysen* 13673 (BOL, NBG). 3419 (Caledon): Aries Kraal, (–AA), 30 Dec. 1944, *Compton* 16823 (NBG); sandy plateau above Viljoens pass, (–AA), 31 Jan. 1986, *Goldblatt* 7627 (MO); Palmiet River Mtns, (–AC), Jan. 1947, *Stokoe* s.n. (MO); Genadendal, (–BA), 28 Dec. 1894, *Guthrie* 3584 (NBG).

9. *Thereianthus ixioides* G.J.Lewis in *Journal of South African Botany* 7: 41 (1941). Type: South Africa, [Western Cape], Bain's Kloof [Bainskloof] at summit, 8 Dec. 1934, *T.M. Salter* 5117 (BOL, *holo.*!).

Watsonia filifolia E.Mey. in *Drège*: 82 (1843), *nom. nud.* [South Africa, Du Toitskloof, without date, *Drège* s.n. (MO)]. *Watsonia punctata* var. *filifolia* E.Mey. ex Baker: 16: 159 (1877), *nom. nud.*

Plants 250–500 mm high. *Corm* globose, 12–20 mm diam.; tunics of coarsely netted fibres, thickened and claw-like at base, accumulating with age and forming short neck around base of stem. *Stem* erect or flexed outward above second sheath, unbranched, 1.0–1.5 mm diam. below spike. *Cataphylls* dry and papery, reddish brown. *Leaves* 4(5), lowermost inserted below ground, blade reaching or exceeding spike, green or dry at flowering, linear, 200–400 × 1.0–2.0 mm, closely 3-ribbed, upper 3(4) leaves cauline, sheaths of all except uppermost ± imbricate, blades successively shorter, up to 150 mm long, uppermost leaf entirely sheathing, distant from next lower and separated from base of spike. *Spike* erect, compact, densely 6–12-flowered; bracts imbricate for $\frac{1}{2}$ to $\frac{2}{3}$ length, 8–13 mm long and two or three internodes long, outer acute or obtuse, either green below or entirely brown and leathery, conspicuously and closely veined, with narrow membranous margins, inner slightly shorter, bifid, ± membranous with narrow brown zones along veins. *Flowers* suberect, white to pale mauve (rarely mid-blue), unmarked or lower three tepals each with purple marking near base (rarely ± all tepals marked); perianth actinomorphic; tube straight, 7–12(–15) mm long, 0.5–1.0 mm diam. at mouth, filiform and tightly clasping style throughout, abruptly expanded in distal 1 mm, exerted 1–9 mm beyond bracts, 0.5–1.0 × as long as tepals; tepals elliptical-oblongate, spreading and slightly cupped or flat, 12–15 × 4–6 mm. *Stamens* central, erect or diverging apically with anthers spreading; filaments 3–4 mm long, swollen slightly at base and occluding mouth of perianth tube; anthers 5–7 mm long, lilac or pale yellow; pollen cream-coloured. *Ovary* obovoid, 2.0–2.5 mm long; style central, dividing between base and middle of anther, branches ± 3–4 mm long, divided to near base. *Capsules* ovoid, 7–10 × 3–5 mm. *Seeds* ellipsoid-angled, 2–3 mm long, yellowish brown testa striate-colliculate. *Flowering time*: late Nov.–Dec. or early Jan. Figure 15.

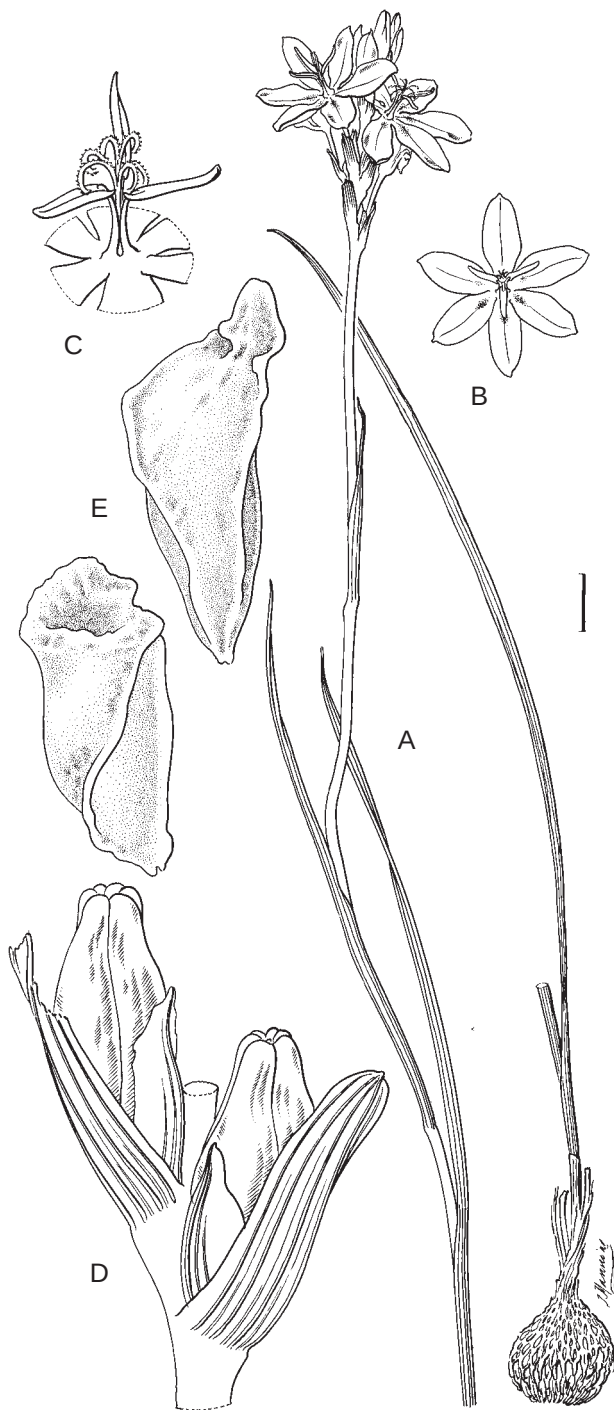


FIGURE 15.—*Thereianthus ixioides*. A–C, Manning 2198: A, whole plant; B, flower, front view; C, details of stamens and stigma. D, E, Manning 3326: D, capsules; E, seeds. Scale bar: A, B, 10 mm; C, 3 mm; D, 2 mm; E, 0.5 mm. Artist: John Manning.

Distribution and ecology: *Thereianthus ixioides* is a narrow endemic of the mountains between Wellington and Franschhoek, with most collections predictably from the Bainskloof and Du Toitskloof Passes that traverse the Limietberg and Klein Drakenstein Mtns respectively, and from the Zachariaskloof catchment in the Wemmershoek Mtns (Figure 16). Plants are locally common on cooler, south-facing sandstone slopes at mid altitudes, mainly around 1 000 m, often in seasonally damp places, along drainage lines or water courses. Flowering is stimulated by fire but plants also bloom in open veld several years old.

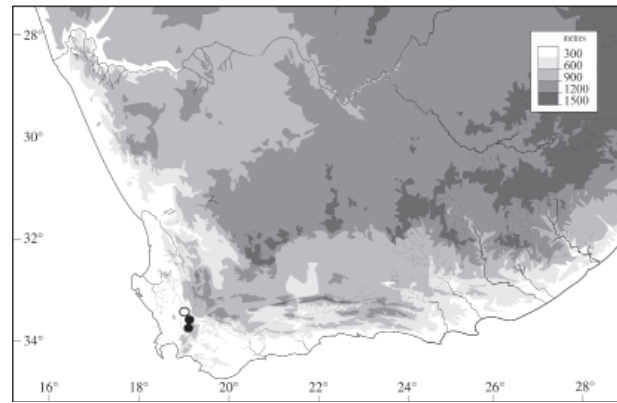


FIGURE 16.—Known distribution of *Thereianthus ixioides*, ●; *T. elandsmontanus*, ○.

The compact spikes of white to lilac (rarely blue), actinomorphic flowers are probably adapted to a generalist pollination system and visited by a variety of insects. The filiform perianth tube clasps the style tightly for most of its length, with the mouth occluded by the swollen bases of the filaments. Each flower produces only trace amounts of nectar, which rises to the mouth of the filiform perianth tube through capillary action, where it can be accessed by insects with short mouthparts. The flowers have a remarkable similarity in shape, colour and markings to those of *Ixia metelerkampiae*, another local endemic of the mountains near Wellington and visits by the hopliine beetle (Scarabaeidae: Hopliini), *Peritrichia* sp., to both species were reported by Goldblatt *et al.* (2000). Visits by hopliine beetles (*Heterochelus* sp.) have also been observed at Franschhoek Pass (R. Saunders, pers. comm. Jan. 2011), and pollination by these beetles may be the primary strategy.

Diagnosis and relationships: *Thereianthus ixioides* is recognized by its compact, subcapitate spike of actinomorphic, white or pale lilac (rarely mid-blue) flowers with filiform, straight perianth tube 7–12(–15) mm long and up to 1 mm diam., tightly clasping the style for most of its length and abruptly dilated only in the distal 1 mm, with the filaments thus completely exerted. The stamens are symmetrically arranged, with $\pm$ horizontally spreading anthers, and the filaments occlude the mouth of the perianth tube. It has been confused with *T. spicatus* but that species has a mostly longer, $\pm$ cylindrical perianth tube (12–)15–25 mm long that is evenly and gradually dilated from the base and not tightly clasping the style, and unilateral, arcuate stamens, with the base of the filaments shortly included within the top of the perianth tube and not occluding the mouth.

History: *Thereianthus ixioides* appears to have been first collected in Du Toitskloof by botanical collector Johann Franz Drège, who was active in the southwestern Cape from 1826–1834. This material was distributed under the name *Watsonia filifolia* E.Mey., and although published by Meyer (Drège 1843), the name was not accompanied by a description and is thus nomenclaturally illegitimate. It was later treated as a variety of *T. spicatus* by Baker (1877) under the name *W. punctata* var. *filifolia*. Our association of the name *W. filifolia* with *T. ixioides* is based on a duplicate of the Drège collection bearing this name in the herbarium of the Missouri

Botanical Garden (MO). The species was re-collected from the same locality half a century later in 1882 by the botanist William Tyson. His material, also identified as *Watsonia punctata* (now *T. bracteolatus*), raised no interest. The next collection, that of Adele Grant made in Bainskloof in 1926 was, however, recognized as representing a new species of *Watsonia* (the genus to which species of *Thereianthus* were then customarily referred), an opinion that was confirmed when T.M. Salter, specialist on the genus *Oxalis*, also came across it in Bainskloof in December 1934. The species was subsequently described by Lewis (1941) in her newly established genus *Thereianthus*, based largely on Salter's ample material, and remained the most recent species to be recognized in the genus for more than half a century (Manning & Goldblatt 2004).

Additional specimens examined

WESTERN CAPE.—3319 (Worcester): Bain's Kloof [Bainskloof], (–AC), 26 Nov. 1926, *Grant 2644* (BOL, MO); Dec. 1957, *Loubser 865* (NBG); Limietberg, north of Bain's Kloof [Bainskloof], 3000' [914 m], (–CA), 6 Jan. 1983, *Goldblatt 6837* (MO, NBG); Bainskloof, just before summit, (–AC), 26 Nov. 1998, *Manning 2198* (NBG); Baviaanskloof, above pools in middle of valley, (–CA), 15 Jan. 2011 [fruiting], *Manning 3326* (NBG); Klein Drakenstein, Haalhoek Spitzkop, (–CC), 2 Jan. 1947, *Esterhuysen 13541* (BOL); Klein Drakenstein Mtns, 1.5 km SE Hugenootskop, (–CC), 14 Jan. 2007, *Helme 4510* (NBG); Du Toitskloof, (–CC), Oct.–Jan, without year [1826–1834], *Drège s.n.* (MO); 1882 [without month], *Tyson 904* (SAM); Dec. 1950, *Lewis 2292* (SAM); 10 Dec. 1950, *Barker 7166* (NBG); Dec. 1951, *Stokoe s.n. SAM63513* (SAM); Wemmershoek Valley, Dec. 1944, *Lewis 849* (SAM); Wemmershoek, (–CC), 14 Dec. 1940, *Esterhuysen 4039* (BOL); Haalsneuwkopp, 4000' [1 220 m], (–CC), Dec. 1944, *Stokoe s.n. SAM56189* (SAM); near Pofadder Pool on Elandspad River, (–CC), 24 Nov. 1985, *Fischer s.n. NBG133017* (NBG); Du Toitskloof Mtns, Elandspad catchment in Agtertafelberg Kloof, 1 020 m, (–CC), 28 Dec. 2000, *Low 6773* (NBG); Zachariashoek, Kasteelkloof catchment, (–CC), 2100' [640 m], 14 Dec. 1972, *Smith 69* (NBG); 30 Dec. 1982, *Viviers 1122* (NBG); Zachariashoek catchment, (–CC), 18 Dec. 1969, *Haynes 260* (NBG).

10. *Thereianthus elandsmontanus* Goldblatt & J.C.Manning, sp. nov.

Plantae 140–240 mm altae, cormo globoso 10–15 mm diam., tunicis fibrosis crassis, caule erecto eramoso, cataphyllis papyraceis rubro-brunneis, foliis 4, infimum sub terra insertum laminis linearibus 3- vel 4-nervosis, spica erecta dense 7- ad 15-flora, bracteis imbricatis 8–10(–13) mm longis, bractea externa infra viridi vel omnino brunnea coriacea, interna pauciter brevior, floribus cremeis ad pallide carneis tepalis inferioribus in medio marroninis striatis, perianthio leviter zygomorpha, tubo (17–) 20–23 mm longo cylindrico, tepalis lineari-oblancoelatis patentibus pauciter cupulatis 12–15 × 2–3 mm, staminibus unilateralibus arcuatis, filamentis 4–5 mm longis ex tubo 2–3 mm exsertis, antheris 4 mm longis atropurpureis, styli ramis fere ad basem furcatis ± 3 mm longis.

TYPE.—Western Cape, 3319 (Worcester): Bo-Hermon, Elandsberg Nature Reserve, Slangkop, low sandstone ridge, two years after fire, (–AC), 7 Nov. 2010, *J.C.Manning 3313* (NBG, holo.; MO, iso.).

Plants 140–240 mm high. *Corm* globose, 10–15 mm diam.; tunics of coarse, matted fibres, accumulating with age and forming short neck around base of stem. *Stem* erect, unbranched, ± 1.5 mm diam. below spike. *Cataphylls* dry and papery, reddish brown. *Leaves* 4, lower-

most inserted below ground, blade exceeding spike, ± dry at flowering, linear, 200–250 × 2–3 mm, closely 3- or 4-ribbed, upper 3 leaves cauline, sheaths ± imbricate and enveloping entire stem, blades successively shorter, up to 100 mm long, uppermost leaf sheath ± reaching to base of spike, with short blade 20–30 mm long. *Spike* erect, densely 7–15-flowered; bracts imbricate for 1/2 to 2/3 length, 8–10(–13) mm long and two or three internodes long, outer acute, either green below or entirely brown and leathery, conspicuously and closely veined, with narrow membranous margins, inner bract slightly shorter, bifid, ± membranous with narrow brown zones along veins. *Flowers* suberect, cream-coloured to pale flesh-pink, flushed purple on tube, lower three tepals with median linear maroon streak extending halfway along blade; perianth weakly zygomorphic; tube slightly curved outwards in distal 3 mm, (17–)20–23 mm long, ± 1.5 mm diam. at mouth, ± cylindrical but widening slightly distally, exserted 13–15 mm beyond bracts; tepals linear-oblancoelate, inner three slightly smaller, spreading and slightly cupped, 12–15 × 1.5–3.0 mm. *Stamens* arcuate; filaments 4–5 mm long, exserted 2–3 mm from tube; anthers 4 mm long, blackish purple; pollen purple. *Ovary* obovoid, 2.0–2.5 mm long; style arching above anthers, dividing between base and middle of anthers, branches, ± 3 mm long, divided to near base. *Capsules* narrowly ovoid, 5–7 × 3 mm. *Seeds* ellipsoid-angled, ± 2 mm long, yellowish brown, testa striate-colliculate. *Flowering time*: Nov. Figure 17.

Distribution and ecology: *Thereianthus elandsmontanus* is known from a single small population on Slangkop, a low sandstone ridge on Elandsberg Nature Reserve near the foot of the Elandsberg Mtns near Hermon (Figure 16). Just a couple of dozen individuals were found. Although only discovered two years after a fire had cleared the site, it is clear that the species also flowered in the first year after the burn since one of the individuals had the remains of a previous flowering stem still associated with the corm.

The moderately long-tubed, cream-coloured to flesh-pink flowers with conspicuous narrow, maroon markings on the lower three tepals bear a striking resemblance to those of several co-occurring species of Iridaceae, notably *Lapeirousia anceps* (L.f.) Ker Gawl. and *Tritonia undulata* (Burm.f.) Baker, that are adapted to pollination by long-proboscid tabanid flies in the genus *Philoliche*, and it is likely that *Thereianthus elandsmontanus* is also a member of this pollination guild.

Diagnosis and relationships: *Thereianthus elandsmontanus* is distinguished from the other ribbed-leaved species in the genus (ser. *Thereianthus*), by its cream-coloured to pale flesh-pink flowers with moderately long tube, 17–23 mm long and 1.5–1.8 × as long as the narrow, ± linear tepals which are 1.5–3.0 mm wide, the lower three each with a conspicuous maroon median streak extending over the lower half. Unfortunately the flowers do not retain their colour in the herbarium, drying bluish lilac. *T. elandsmontanus* is most likely to be confused with *T. spicatus*, which has a tube of similar length and which also occurs at Elandsberg Nature Reserve but this species has blue (rarely white or pink flowers) with broader, lanceolate tepals, 3–5 mm wide, the lower three marked with a white flash at the base

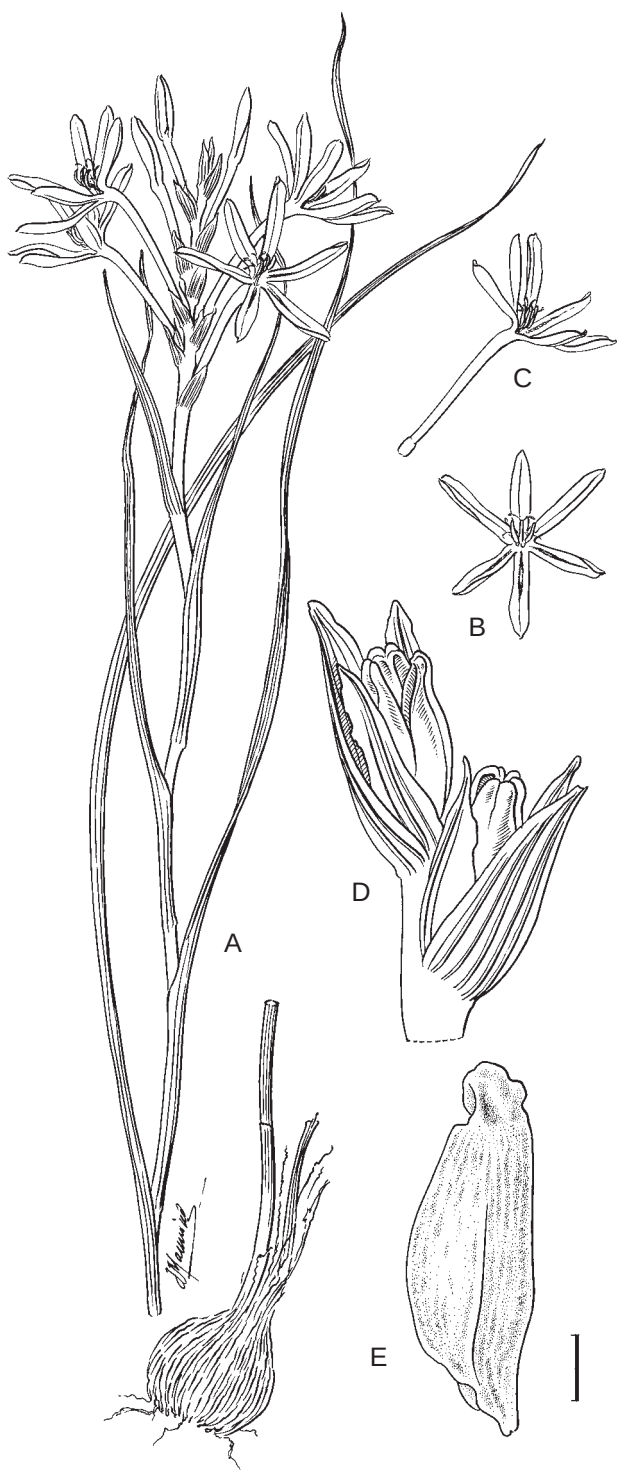


FIGURE 17.—*Thereianthus elandsmontanus*, Manning 3313. A, whole plant; B, flower, front view; C, flower, side view; D, capsules; E, seed. Scale bar: A–C, 10 mm; D, 2 mm; E, 0.5 mm. Artist: John Manning.

bordered distally by a small blue chevron, and slightly shorter filaments, 3–4 mm long vs 4–5 mm long. Although these differences may seem minor, we are familiar with both species on the reserve and are convinced that they are distinct. Another related species, *T. longicollis* from the nearby Saronsberg and Elandskloof Mtns, has a much longer tube, 25–40 mm long and 2.0–2.5 × longer than the tepals, the lower three of which are marked with a dark, transverse chevron. The

leaves in *T. elandsmontanus* are often slightly broader than in *T. longicollis*, 2–3 mm vs 1–2 mm, with 3 or 4 vs consistently 3 raised veins. We considered the possibility that the Elandsberg plants might be an isolated, short-tubed form of this species, possibly recognizable at subspecific rank but the consistent morphological and ecological differences between them suggest that recognition at species level is more appropriate. Typical *T. longicollis* is a montane species and the clear separation in tube length between it and *T. elandsmontanus* argues for complete genetic isolation between them.

History: the most recently discovered species in the genus, *Thereianthus elandsmontanus* was collected for the first time in November 2010 on a low sandstone ridge on Elandsberg Nature Reserve. This ridge has been explored botanically since 1996 by the owners of the property, Dale and Elizabeth Parker, but the species was only noticed when it flowered in response to a controlled burn of the ridge in early 2008.

Etymology: the name derives from the Elandsberg Nature Reserve, where the species appears to be endemic.

11. *Thereianthus longicollis* (Schltr.) G.J.Lewis in Journal of South African Botany 7: 39 (1941). *Watsonia longicollis* Schltr.: 106 (1900). Type: South Africa, [Western Cape], Tulbagh Waterfall, in saxosis, ± 1200' [365 m], 10 Nov. 1896, R. Schlechter 9055 (B, holo.; BOL!, GRA!, MO!, PRE! (4 sheets), iso.).

Watsonia punctata var. *longicollis* Baker: 177 (1892). Type: South Africa, [Western Cape], Worcester [District], Zeyher s.n. K400455 (K, holo.).

Plants 150–350 mm high. *Corm* globose, 10–15 mm diam.; tunics of coarsely netted fibres, thickened and claw-like at base, accumulating with age and forming short neck around base of stem. *Stem* erect, unbranched, ± 1.5 mm diam. below spike. *Cataphylls* dry and papery, reddish brown. *Leaves* 4, lowermost inserted below ground, blade reaching or exceeding spike, ± dry at flowering, linear, 200–250 × 1–2 mm, closely 3-ribbed, upper 3 leaves cauline, sheaths ± imbricate and enveloping entire stem or slightly distant, blades successively shorter, up to 150 mm long, uppermost leaf sheath reaching to base of spike or separated from it, with short blade 20–60 mm long. *Spike* erect, densely 7–15(–20)-flowered; bracts imbricate for $\frac{1}{2}$ to $\frac{2}{3}$ length, 8–12(–17) mm long and two or three internodes long, outer acute, either green below or entirely brown and leathery, conspicuously and closely veined, with narrow membranous margins, inner slightly shorter, bifid, ± membranous with narrow brown zones along veins. *Flowers* suberect, white or pale pink to purple-pink with purple tube, lower three tepals each with purple chevron or diamond-shaped markings near base; perianth weakly zygomorphic; tube slightly curved outwards in distal 3 mm, 25–40 mm long, ± 2 mm diam. at mouth, ± cylindrical but dilated slightly distally, exserted 20–30 mm beyond bracts, 2.0–2.5 × longer than tepals; tepals oblong-oblancheolate, inner three slightly smaller, spreading and slightly cupped, 12–17 × 2.5–5.5 mm. *Stamens* arcuate; filaments 6 mm long, exserted 3 mm from tube; anthers 4–6 mm long, purple; pollen purple. *Ovary* obovoid, 2.0–2.5 mm long; style arching above anthers,

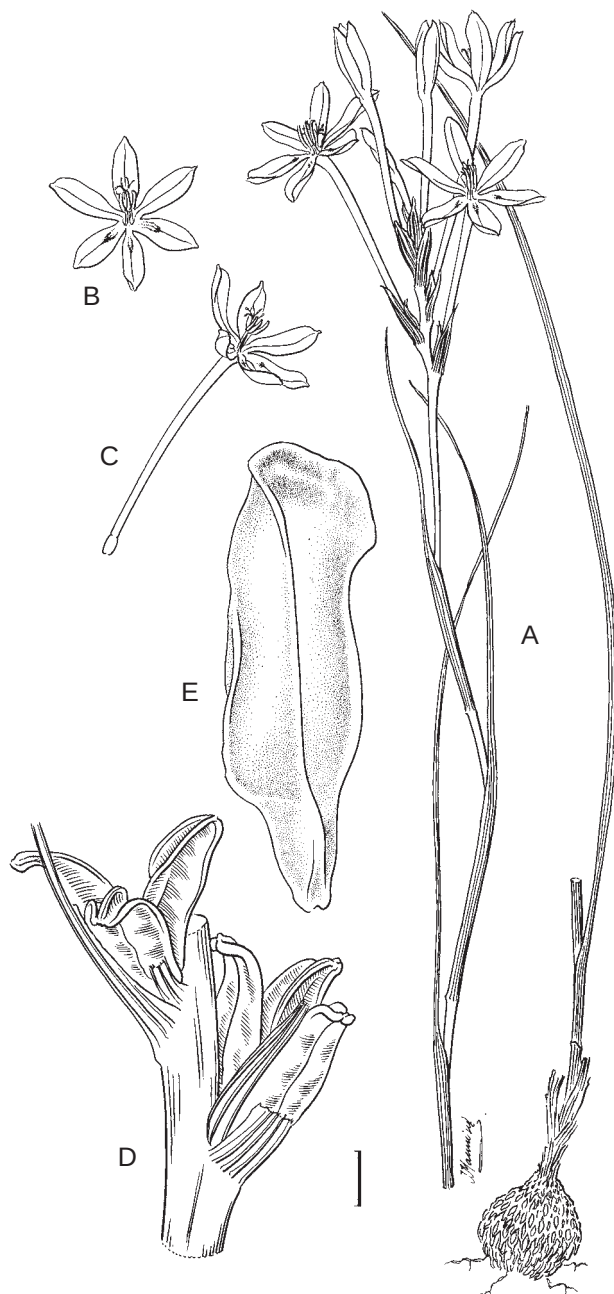


FIGURE 18.—*Thereianthus longicollis*, Manning 3325. A, whole plant; B, flower, front view; C, flower, side view; D, dehiscent capsules; E, seed. Scale bar: A–C, 10 mm; D, 2 mm; E, 0.5 mm. Artist: John Manning.

dividing at $\pm$ middle of anthers, branches $\pm$ 4–5 mm long, divided to near base. *Capsules* narrowly ovoid, 6–7 $\times$ 2.5–3.0 mm. *Seeds* ellipsoid-angled, $\pm$ 2.5 mm long, yellowish brown, testa striate-colliculate. *Flowering time*: mostly mid-Nov.–late Dec. Figure 18.

Distribution and ecology: *Thereianthus longicollis* is a narrow endemic of the mountains between Porterville and Wolsley (Figure 19), thus including the southern end of the Grootwinterhoek Mtns, Saronsberg and the Elandsbloof Mtns. The species has been collected several times at the type locality near the Tulbagh Waterfall but is otherwise known from just a few records to the north above Saron and Porterville, and most recently from Elandsberg Nature Reserve on the lower western

slopes of the Elandsbloof Mtns. Plants grow in sandy gravel or loamy ground on rocky sandstone slopes, and flower regularly in open proteoid or restioid fynbos.

The very long-tubed, pink or purple-pink flowers with purple markings on the lower three tepals have the stereotypical adaptations for pollination by long-proboscid flies. At or near the type locality above Tulbagh Waterfall we observed pollination visits by the tabanid fly, *Philoliche rostrata*, the proboscis of which measured $\pm$ 40 mm, a close match to the tube length in *Thereianthus longicollis*. At this site other representatives of this pollination guild included *T. minutus*, *Geissorhiza confusa* (Iridaceae) and a long-tubed and large-flowered race of *Lobelia coronopifolia* (Lobeliaceae) with a pink corolla.

Diagnosis and relationships: *Thereianthus longicollis* is separated from all other species in the genus by its unusually long perianth tube, 25–40 mm long and 2.0–2.5 times longer than the tepals. The species could only be confused with longer-tubed forms of *T. spicatus*, which have also been recorded from the mountains above Porterville and which we have seen ourselves above Tulbagh Waterfall but the perianth tube in *T. spicatus* is shorter, mostly less than 20 mm long (rarely up to 25 mm) and always less than twice as long as the tepals, and also narrower, at most 1.5 mm diam. at the mouth. A second species in ser. *Thereianthus* with long-tubed flowers, *T. elandsmontanus* from the foothills of the Elandsbloof Mtns, has a consistently shorter perianth tube, 17–23 mm long, narrower tepals 2–3 mm wide, with the lower half largely covered by linear purple markings, and often broader leaves with 3 or 4 ribs (see that species for further discussion).

History: *Thereianthus longicollis* was first encountered by botanical collectors Christian Frederick Ecklon and Carl Ludwig Zeyher, who were active in the Cape Colony through the middle of the nineteenth century (Glen & Germishuizen 2010). Their material from Tulbagh Waterfall was distributed under the name *Watsonia (Beilia) triticea* (now *T. bracteolatus*) and the taxon was first formally recognized as a long-tubed variant of *T. bracteolatus* under the name *Watsonia punctata* var. *longicollis* by Baker (1892, 1896). Although no material was initially listed under this variety, Baker (1896) later cited Zeyher s.n. under this name, thereby typifying it unambiguously against a specimen bearing that inscription.

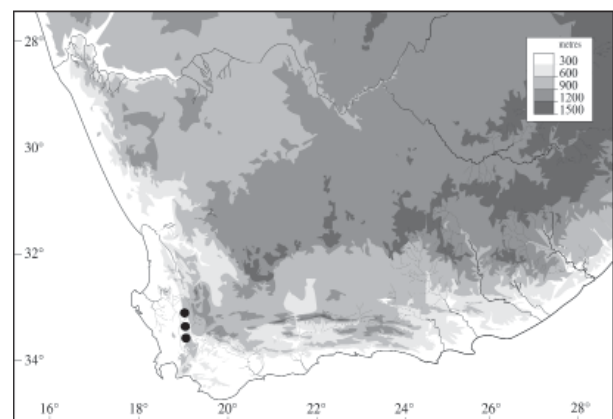


FIGURE 19.—Known distribution of *Thereianthus longicollis*, ●.

tion at the Kew Herbarium, which had been acquired on 1 April 1865 from H.G. Reichenbach. The species was subsequently re-collected at Tulbagh Waterfall on 10 November 1896 by botanist Rudolph Schlechter, who realized that Baker was incorrect in associating the plants with *T. bracteolatus* and described it as a distinct species under the name *W. longicollis*, citing only his collection. Although the labels on his specimens indicate that Schlechter had initially intended to recombine Baker's variety at specific rank, the name as later published is presented as a new species and we treat it as such.

Additional specimens examined

WESTERN CAPE.—3319 (Worcester): Twenty Four Rivers, (–AA), without date, *Zeyher 1608* [only one of the specimens as indicated on sheet] (SAM); De Hoek Estate, near Saron, (–AA), Nov. 1941, *Stokoe s.n. SAM55617* (SAM); slopes of Great Winterhoek Mtns near Saron, (–AA), Nov. 1941, *Stokoe s.n.* (BOL); Porterville, plateau above [Farm] Gelukwards, (–AA), Dec. 1910, *Edwards 80* (BOL); Bo-Hermon, Elandsberg Nature Reserve, lower slopes of Elandskloof Mtns at southern boundary of farm at end of fence-road, (–AC), 5 Dec. 2010, *Manning 3325* (NBG); Tulbagh Waterfall, (–AC), Nov. without year, *Ecklon & Zeyher s.n. SAM70719* (SAM); 16 Nov. 1941, *Compton 12413* (NBG); [Elandskloof Mtns], Ontongskop [Ontongskop], lower slopes, (–AC), 16 Nov. 1941, *Isaac s.n.* (BOL); Voëlvleiberge [Elandskloofberge], ascent to Protea plain, (–AC), 29 Dec. 2000, *Hansford 20* (NBG).

EXCLUDED SPECIES

Beilia spicata var. *brevifolia* Kuntze: 305 (1898). Type: South Africa, [Western Cape], Mowbray bei Capstadt, collector and date unknown (specimen not located). The brief description of this taxon '*foliis brevibus 1–2 cm latis acuminatis*' and its collection at Mowbray, a suburb of Cape Town, make it certain that it is not *Thereianthus spicatus*, which has much narrower leaves and is absent from the Cape Peninsula. The only possibility in *Thereianthus* is thus *T. bracteolatus* but the broad leaves are inconsistent with this species as well and suggest that it might be a species of *Watsonia* but its identity remains unclear.

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REFERENCES

- ANDREWS, H. 1801. *Ixia punctata*. *The botanist's repository* 3: t. 177.
BAKER, J.G. 1876a. New species of Ixiaceae. *Journal of Botany, London* 14: 236–239.
BAKER, J.G. 1876b. New Gladioleae. *Journal of Botany, London* 14: 333–339.
BAKER, J.G. 1877 [as 1878]. *Systema iridearum*. *Journal of the Lin-*

- nean Society, Botany* 16: 61–180.
BAKER, J.G. 1892. *Handbook of the Iridaceae*. George Bell, London.
BAKER, J.G. 1896. Iridaceae. In W.T. Thiselton-Dyer, *Flora capensis* 6: 7–71. Reeve, Ashford.
BROWN, N.E. 1931. XXIX. Notes upon South African plants. *Bulletin of Miscellaneous Information, Royal Botanic Gardens, Kew* 1931: 191–197.
BURMAN, N.L. 1768. *Prodromus florum capensis*. Cornelius Haak, Leiden.
DRÈGE, J.F. 1843. Zwei pflanzengeographische Dokumente. *Flora* 1843. Leipzig.
ECKLON, C.F. 1827. *Topographisches Verzeichniss der Pflanzensammlung von C.F. Ecklon*. Reiseverein, Esslingen.
GLEN, H.F. & GERMISHUIZEN, G. 2010. Botanical exploration of southern Africa, edn 2. *Strelitzia* 26. South African National Biodiversity Institute, Pretoria.
GOLDBLATT, P. 1971. Cytological and morphological studies in the southern African Iridaceae. *Journal of South African Botany* 37: 317–460.
GOLDBLATT, P. 1989. The genus *Watsonia*. *Annals of Kirstenbosch Botanic Garden* 19: 1–148.
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. 2000. Adaptive radiation of pollination mechanisms in *Ixia* (Iridaceae: Crocoideae). *Annals of the Missouri Botanical Garden* 87: 564–577.
GOLDBLATT, P., DAVIES, T.J., MANNING, J.C., VAN DER BANK, M. & SAVOLAINEN, V. 2006. Phylogeny of Iridaceae subfamily Crocoideae based on a combined multigene plastid analysis. *Aliso* 22: 399–411.
GOLDBLATT, P. & MANNING, J.C. 2006. Radiation of pollination systems in the Iridaceae of sub-Saharan Africa. *Annals of Botany (London)* 97: 317–344.
GOLDBLATT, P. & MANNING, J.C. 2008. *The Iris family: natural history and classification*. Timber Press, Oregon.
GOLDBLATT, P., MANNING, J.C. & BARI, A. 1991. Sulcus and operculum structure in the pollen grains of Iridaceae subfamily Ixioidae. *Annals of the Missouri Botanical Garden* 78: 950–961.
GOLDBLATT, P., RODRIGUEZ, A., POWELL, M.P., DAVIES, T.J., MANNING, J.C., VAN DER BANK, M. & SAVOLAINEN, V. 2008. Iridaceae 'Out of Australasia'? Phylogeny, biogeography, and divergence time based on plastid DNA sequences. *Systematic Botany* 33: 495–508.
GOLDBLATT, P. & TAKEI, M. 1997. Chromosome cytology of Iridaceae, base numbers, patterns of variation and modes of karyotype change. *Annals of the Missouri Botanical Garden* 84: 285–304.
HEYNHOLD, G. 1847 [as 1846]. *Alphabetische und synonymische Aufzählung der Gewächse*. Dresden & Leipzig.
HOLMGREN, P.K., HOLMGREN, N.H. & BARNETT, L.C. 1990. *Index herbariorum, part 1: the herbaria of the World*. New York Botanical Garden, New York.
JACKSON, B.D. 1912. Index to the Linnean Herbarium with indication of the types of species marked by Carl von Linné. *Proceedings of the Linnean Society (London)*, session 124, Suppl.: 1–152.
JARVIS, C. 2007. *Order out of chaos*. The Linnean Society of London and Natural History Museum, London.
KER GAWLER, J. 1804. Ensatorum ordo. *Annals of Botany (König & Sims)* 1: 219–247.
KER GAWLER, J. 1807. *Watsonia rosea*. *Pyramidal watsonia*. *Curtis's Botanical Magazine* 27: sub t. 1072.
KLATT, F.W. 1882. Ergänzungen und Berichtigungen zu Baker's Systema Iridacearum. *Abhandlungen der Naturforschenden Gesellschaft zu Halle* 15: 44–404.
KLATT, F.W. 1894. Iridaceae. In T.H. Durand & H. Schinz, *Conspectus florum Africae* 5: 187–192.
KUNTZE, O. 1891. *Revisio generum plantarum*, vol. 2. Felix, Leipzig.
KUNTZE, O. 1898. *Revisio generum plantarum*, vol. 3, part 3. Felix, Leipzig.
LAMARCK, J.B.A.P.M.DE. 1788. *Encyclopédie méthodique botanique* 2. Paris.
LEWIS, G.J. 1941. Iridaceae. New genera and species and miscellaneous notes. *Journal of South African Botany* 7: 19–59.
LEWIS, J.G. 1954. Some aspects of the morphology, phylogeny and taxonomy of the South African Iridaceae. *Annals of the South African Museum* 40: 15–113.
LINNAEUS, C. 1753. *Species plantarum*. Laurentius Salvius, Stockholm.

- LINNAEUS, C. 1756. *Centuria plantarum* II. Höjer, Uppsala.
- MANNING, J.C. & GOLDBLATT, P. 2004. A new species of *Thereianthus* (Iridaceae: Crocoideae) from Western Cape, South Africa, nomenclatural notes and a key to the genus. *Bothalia* 34: 103–106.
- MANNING, J.C., GOLDBLATT, P. & SNIJMAN, D. 2002. *The color encyclopedia of Cape bulbs*. Timber Press, Oregon.
- MCNEILL, J., BARRIE, F.R., BURDET, H.M., DEMOULIN, V., HAWKSWORTH, D.L., MARHOLD, K., NICOLSON, D.H., PRADO, J., SILVA, P.C., SKOG, J.E., WIERSMA, J.H. & TURLAND, N.J. (eds). 2006. International Code of Botanical Nomenclature (Vienna Code) adopted by the seventeenth International Botanical Congress, Vienna, Austria, July 2005. Gantner, Liechtenstein. *Regnum Vegetabile* 146.
- MUCINA, L. & RUTHERFORD, M.C. 2006. The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia* 19. South African National Biodiversity Institute, Pretoria.
- PERSOON, C.H. 1805. *Synopsis plantarum*, vol. 1. Cramer, Paris.
- REEVES, G., CHASE, M.W., GOLDBLATT, P., RUDALL, P., FAY, M.F., COX, A.V., LEJEUNE, B. & SOUZA-CHIES, T. 2002. Molecular systematics of Iridaceae: evidence from four plastid DNA regions. *American Journal of Botany* 88: 2074–2087.
- ROEMER, J.J. & SCHULTES, J.A. 1817. *Systema vegetabilium secundum*, vol. 1. Stuttgart.
- ROYEN, R. VAN. 1740. *Florae leydensis prodromus*. Luchtmans, Leiden.
- RUDALL, P. 1995. VIII. Iridaceae. In D.F. Cutler & M. Gregory, *Anatomy of the monocotyledons*. Clarendon Press, Oxford.
- SCHLECHTER, R. 1900. *Plantae schlechterianae novae vel minus cognitae describuntur* II. *Botanische Jahrbücher* 27: 86–220.
- SCOTT ELLIOT, G. 1891. Notes on the fertilisation of South African and Madagascan flowering plants. *Annals of Botany* 5: 333–405.
- SPRENGEL, K. 1824. *Systema vegetabilium*, vol. 1. Dietrich, Göttingen.
- THUNBERG, C.P. 1784. *Dissertatio de Gladiolus*. Edman, Uppsala.
- THUNBERG, C.P. 1807. *Flora capensis*. Edman, Uppsala.
- VAHL, M. 1805. *Enumeratio plantarum*, vol. 2. Copenhagen.
- VOGEL, S. 1954. Blütenbiologische Typen als Elemente der Sippenliederung. *Botanische Studien* 1: 1–338.
- WILLDENOW, C.L. 1797. *Species plantarum*, edn. 4. Berlin.

Romulea pilosa* and *R. quartzicola* (Iridaceae: Crocoideae), two new species from the southern African winter rainfall region, with nomenclatural corrections including new names for *R. amoena*, *R. neglecta* and *R. rosea* var. *reflexa

J.C. MANNING*, P. GOLDBLATT** and A.D. HARROWER***

Keywords: Iridaceae, new species, nomenclature, *Romulea* Maratti, southern Africa, taxonomy

ABSTRACT

Romulea pilosa J.C.Manning & Goldblatt and *R. quartzicola* J.C.Manning & Goldblatt are two narrow endemics from the southern African winter rainfall region. An early, fragmentary collection of *R. pilosa* from Riviersonderend lacked the diagnostic corm and was thus mistakenly associated with *R. tetragona* (sect. *Ciliatae*) as var. *flavandra* M.P.de Vos because of the highly distinctive pilose, H-shaped leaf. The rediscovery of the taxon in the wild shows it to be a previously unrecognized member of sect. *Aggregatae*, distinguished by its unusual foliage and bright orange flowers. *R. quartzicola* was grown to flowering from seeds collected from quartz patches in southern Namaqualand and proved to be a new species of sect. *Ciliatae*, distinguished by its early flowering, short, subclavate leaves with reduced sclerenchyma strands, and bright yellow flowers with short bracts. *R. neglecta* M.P.de Vos, a rare endemic from the Kamiesberg in Northern Cape, is a later homonym for the Mediterranean *R. neglecta* Jord. & Fourr., and the earliest name for this plant is shown to be *R. speciosa* (Ker Gawl.) Baker, typified by an illustration in Andrews' *The botanist's repository*. An epitype is designated to fix the application of the name. We have also examined the type illustration of *R. pudica* (Sol. ex Ker Gawl.) Baker, hitherto treated as an uncertain species, and are confident that it represents the species currently known as *R. amoena* Schltr. ex Bég., and takes priority over it as being the earlier name. The type of *R. reflexa* Eckl., a new name for the later homonym *I. reflexa* Thunb. and the basionym of *R. rosea* var. *reflexa* (Eckl.) Bég., has been mistakenly identified as an Ecklon collection but is in fact the collection that formed the basis of Thunberg's *I. reflexa*. This collection is actually a form of *R. flava* Lam., and the name *R. rosea* var. *reflexa* is thus moved to the synonymy of that species. The variety currently known under this name should now be known as *R. rosea* var. *muirii* (N.E.Br.) Goldblatt & J.C.Manning. Finally, the protologue of *R. parviflora* Eckl., until now treated under the synonymy of *R. obscura* Klatt var. *obscura*, is in fact consistent with *R. rosea* var. *australis* (Ewart) M.P.de Vos, and we therefore include the name in the synonymy of the latter.

INTRODUCTION

Romulea Maratti, one of the larger genera of Iridaceae (Goldblatt & Manning 2008), is widely distributed through eastern sub-Saharan Africa, the Mediterranean and the Near East. It is centred in the winter rainfall region of southern Africa, where 80 % of the species occur (De Vos 1972, 1983; Manning & Goldblatt 2001, 2004, 2006).

Flower structure in the genus is conservative (Goldblatt *et al.* 2002), with a few notable exceptions, and characters of the corm are essential in the primary subdivision of the genus into subgenera and sections (Manning & Goldblatt 2001, 2004). Flower colour and markings, as well as the texture and details of the membranous margins of the bracts provide the primary specific characters. Additional valuable anatomical characters include the distribution of vascular bundles in the leaf and the development of sclerenchyma caps and strands.

Five new species have been described since the last review of the genus (Manning & Goldblatt 2001,

2004, 2006), and a further two highly local endemics are described here, bringing to 83 the number of species recorded from southern Africa and raising the total number in the genus to ± 97 spp.

Romulea pilosa, a spring-flowering species endemic to stony renosterveld in the Overberg south of Riviersonderend, was collected at least as long ago as the early 1930s but the fragmentary material was misidentified until recently. It is named for the distinctive, pilose leaves. *R. quartzicola*, a recently discovered, winter-flowering species from quartz patches in the southwestern corner of the Knersvlakte, is named for its unusual habitat. We also deal with the nomenclature of *Romulea neglecta* M.P.de Vos (1983), a later homonym. The earliest legitimate name for the species is *R. speciosa* (Ker Gawl.) Baker (1877), which coincidentally has the same type as *R. neglecta*.

Collections at BOL, NBG, PRE and SAM, the main herbaria with good representation of Cape species, were consulted (herbarium acronyms after Holmgren *et al.* 1990).

TAXONOMY

1. *Romulea pilosa* J.C.Manning & Goldblatt, sp. nov.

Ad sectionem *Aggregatae* M.P.de Vos pertinens et recognita caule subterraneo vel breviter aërio, foliis relative brevibus falcatis H-formibus 4–6 mm latis, margin-

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bus late alatis ciliatisque, floribus salmoneis vel auran-
taciis cupulo flavo, tubo perianthii infundibuliformi $\pm$ 5
mm longo parte inferiori $\pm$ 1 mm longo, tepalis oblan-
ceolatis $20\text{--}30 \times 7\text{--}10$ mm, filamentis $5\text{--}6$ mm longis
minute pilosis in dimidio inferiori, antheris $\pm$ 4 mm
longis.

TYPE.—Western Cape, 3420 (Bredasdorp): Farm
Fonteinkloof, between Riviersonderend and Proteem, hill
W of homestead, (–AA), 15 Aug. 2009, Manning 3220
(NBG, holo.; MO, iso.).

Plants $\pm$ 60 mm high; stem subterranean or shortly
aerial, simple or with up to 2 branches. *Corm* subglo-
bose, asymmetric, obliquely flattened towards base
with crescent-shaped basal ridge; tunics hard, smooth,
dark brown, split into clusters of convergent fibrils
on basal ridge and splitting along clusters into nar-
row vertical strips, drawn into short fibrils up to 2 mm
long above. *Cataphylls* 3, membranous, flushed green-
ish above ground. *Foliage leaves* 2, lowermost 1 basal,
blades falcate, H-shaped in section, lowermost $50\text{--}70$
 $\times 4\text{--}6$ mm, upper shorter, lateral ribs reduced, median
(apparently marginal) ribs extended laterally to form
flange-like wings $1\text{--}2$ mm wide along each side of
blade, densely villous along margins of wings with hairs
 $1\text{--}2$ mm long in two diverging rows. *Inflorescence* of
solitary flowers; peduncles angled in section and vil-
lous along angles in distal part; outer bracts subobtus-
e, $13\text{--}15$ mm long, green with narrow, translucent mem-
branous margins, strongly keeled along median and
submarginal veins, longitudinally inflexed along sub-
marginal veins, median keel sometimes double, keel
and submarginal veins densely pubescent, inner bracts
green with broad translucent white margins, $\pm$ as long
as outer, bicarinate with keels densely pubescent. *Flow-
ers* deeply cup-shaped, cup $\pm$ 10 mm deep, salmon-pink
to dull orange but golden yellow in lower half to two
thirds, yellow extending beyond cup margin onto lower
third of limb, outer tepals flushed coppery on reverse,
unscented, $30\text{--}40$ mm diam.; perianth tube funnel-
shaped, 5 mm long with lower narrow portion $\pm$ 1 mm
long, tepals oblanceolate, $20\text{--}30 \times 7\text{--}10$ mm. *Stamens*
yellow; filaments inserted at base of cup, free, $5\text{--}6$ mm
long, minutely pilose in lower half; anthers parallel, 4
mm long. *Style* dividing opposite lower half of anthers,
branches $\pm$ 1.5 mm long, divided for $\pm$ half their length.
Capsules oblong-ellipsoid, $7\text{--}9 \times 5$ mm long, fruiting
peduncles diverging, straight. *Seeds* subglobose, $\pm$ 2 mm
diam. *Flowering time*: Aug. Figure 1.

Distribution and ecology: known with certainty only
from a single locality south of Riviersonderend on the
Farm Fonteinkloof (Figure 2), where a small population,
numbering less than fifty plants, occurs in a remnant
patch of renosterveld vegetation, too stony to plough.
The plants are wedged among small vertical ripples of
shale on the crest of a hill as part of a Rûens Silcrete
Renosterveld community, a highly endangered veg-
etation type found as scattered pockets in the Overberg
region (Mucina & Rutherford 2006).

Diagnosis and relationships: the oblique corm with
tunics split along the basal ridge into clusters of con-
verging fibrils place *Romulea pilosa* in sect. *Aggrega-
tae* M.P.de Vos (1972), making it the ninth member of

this small group. Its relatively short, falcate, H-shaped
leaves $4\text{--}6$ mm wide, with ciliate, winged margins, and
its salmon to orange flowers with a yellow cup, make
it instantly recognizable in the genus. Similar winged,
ciliate leaves are known only in two other species in
the genus, *R. hirsuta* Schltr. and *R. tetragona* M.P.de
Vos. Although associated in sect. *Hirtae* Bég. by De
Vos (1972) on the basis of their similar leaf morphol-
ogy, these two species have fundamentally different
corm tunic morphologies, leading Manning & Gold-
blatt (2001) to segregate them respectively to subgen.
Romulea sect. *Cilatae* (M.P.de Vos) J.C.Manning &
Goldblatt and subgen. *Spatalanthus* (Sweet) Baker. The
discovery of a third, evidently unrelated species with
similar, H-shaped and winged leaves now suggests that
this unusual leaf morphology has evolved independently
at least three times within the genus. The three species
concerned occupy quite different geographical regions
with differing ecology, and the adaptive value of this
leaf type is not immediately clear.

Within sect. *Aggregatae*, *Romulea pilosa* is evidently
most closely allied to *R. dichotoma* (Thunb.) Baker and
R. jugicola M.P.de Vos, both of which typically have
aerial stems, ciliate peduncles, and a solitary basal leaf
with ciliate rib margins. The leaves of *R. dichotoma* in
particular tend to have wider longitudinal grooves, with
the marginal ribs prominently expanded and almost
wing-like. Both species are found on clay soils in renos-
terveld communities in the southern Cape. *R. jugicola*,
known only from the foothills of the Kammanassie Mtns
in the Little Karoo, is distinguished by its well-exserted
aerial stems, up to 30 mm tall, with a well-developed,
fibrous neck around the base, and orange-yellow peri-
anth; *R. dichotoma* is more widespread, extending from
Stanford to Humansdorp, and has mostly magenta or
rarely salmon-pink flowers with a yellow cup. It is most
evidently separated from *R. pilosa* by its generally taller
stem, up to 350 mm high, usually branched dichoto-
mously near the top, and narrower, distinctly 4-ribbed
leaves, $1\text{--}2$ mm in diameter.

The leaves of *Romulea pilosa* are anatomically con-
sistent with sect. *Aggregatae* in their well-developed
sclerenchyma girders joining the primary vascular bun-
dles to the epidermis (Manning & Goldblatt 2001), an
evidently apomorphic character state that is only inter-
mittently developed in subgen. *Romulea*. Although gird-
ers are also developed in the secondary bundles in other
members of the series, they are almost confined to the
primary bundles in *R. pilosa* (occurring only rarely in
one or two secondary bundles near the wing margins in
some leaves). Stomata are present on the blade and
'inner' wing surfaces but are lacking on the 'outer' wing
surface, i.e. those making the acute angle along the leaf
margins.

Morphologically similar, H-shaped leaves have
evolved repeatedly in several genera of the Cape Iri-
daceae. Notable examples in *Gladiolus* sect. *Homoglos-
sum* are the *Gladiolus gracilis*–*G. caeruleus*–*G. recur-
vus* group in ser. *Carinatus* as well as most members
of ser. *Homoglossum* and *Tristis*; and some members of
Geissorhiza sect. *Engysiphon*. We have observed that the
wings in these species curve inward over the stomatif-
erous grooves when the plants are water-stressed, and

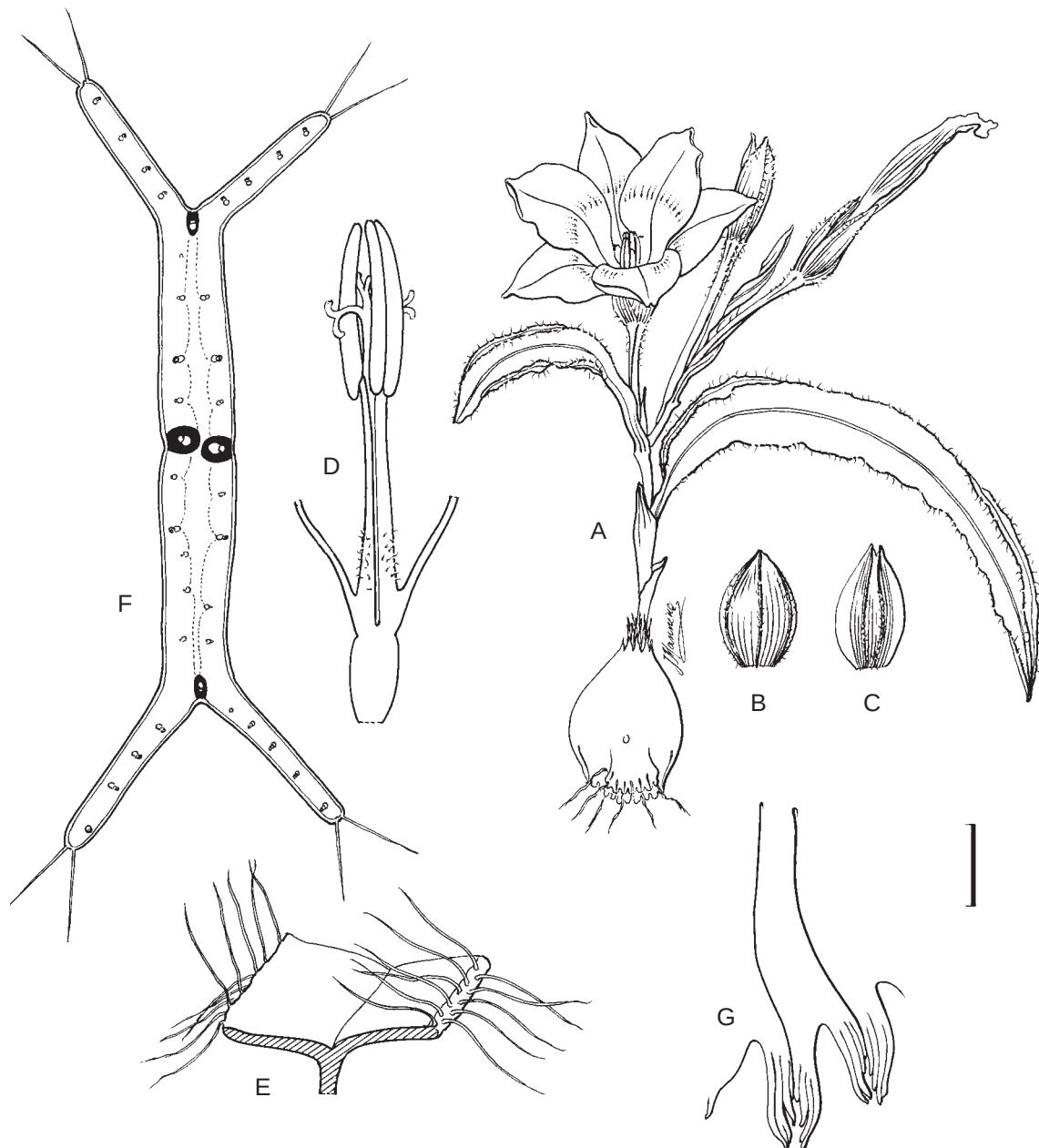


FIGURE 1.—*Romulea pilosa*, Manning 3220. A, whole plant; B, outer bract; C, inner bract; D, stamens and style; E, detail of leaf margin; F, t/s leaf; G, detail of corm fibril clusters. Scale bars: A–C, 10 mm; D, 2.5 mm; E, 1 mm; F, 0.5 mm; G, 0.2 mm. Artist: John Manning.

speculate that this mechanism facilitated the development of a relatively broader photosynthetic leaf surface while still controlling water loss.

History: described here from a population discovered in August 2009 by Napier residents and dedicated conservationists, Cameron and Rhoda McMaster, the species appears to have been first collected in 1932 or 1933 by Grace Neethling of Riviersonderend. This discovery is represented by a fragmentary specimen in the Bolus herbarium, comprising a solitary detached leaf and a single dissected flower. The plant from which these parts were picked was cultivated at Kirstenbosch but subsequently disappeared and thus no corm was preserved. The fragments are accompanied by a coloured painting of the floral parts showing the distinctive orange tepals

with their yellow cup. Although initially intending to describe the collection as a new species, De Vos (1972) subsequently treated it as *Romulea tetragona* var. *flavandra* M.P.de Vos (otherwise endemic to the southwestern Karoo), although noting the anomalous colour of the flowers of the Riviersonderend collection. With the discovery of a wild population, it is now evident that this plant is quite unrelated to *R. tetragona* and does indeed represent a distinct species. The locality where Miss Neethling found her plant is unknown, although the Neethling family owned the Farm Bon Esperance at the foot of the Riviersonderend Mtns at the time (Lewis 1947). Most of the natural vegetation below these mountains has since disappeared under cultivation and we will never know if her collection came from the present locality or from another population in the vicinity.

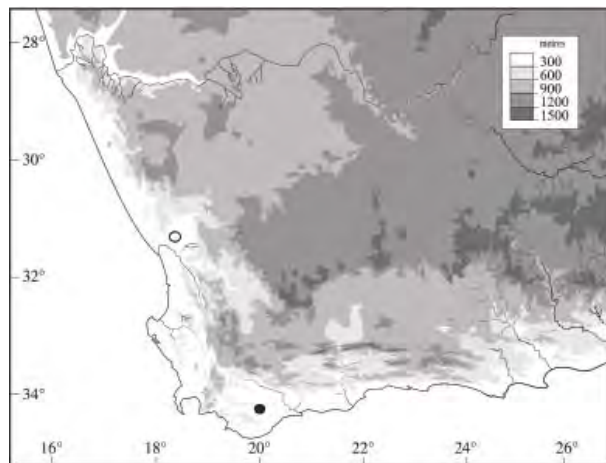


FIGURE 2.—Known distribution of *Romulea pilosa*, ○; *R. quartzicola*, ●.

Additional material seen

WESTERN CAPE.—3419 (Caledon): Riviersonderend, (–BB), fld. [flowered] at Kirstenbosch, 24 Aug. 1933, G. Neethling s.n. BOL24789 (BOL).

2. *Romulea quartzicola* J.C.Manning & Goldblatt, sp. nov.

Ad sectionem *Ciliatae* (M.P.de Vos) J.C.Manning & Goldblatt pertinens et recognita florentia praecoci, foliis relative brevibus obtusis subclavatis, floribus grandis canarinis, tubo perianthii profundo 7–8 mm longo, tepalis 20–22 × 6–10 mm, filamentis, 7–9 mm longis quem antheris longioribus, bracteis ovatis vel suborbicularibus 8–13 mm longis, marginibus membranaceis angustis ecloratis vel purpureo-suffusis.

TYPE.—Western Cape, 3118 (Vanrhynsdorp): Knersvlakte, Farm Moedverloor, ± 15 km NE of Lutzville, (–AD), 21 June 2010, A.D. Harrower & J.C.Manning 4395 (NBG, holo.; MO, iso.).

Plants 50–80 mm high; stem aerial, up to 35 mm long, simple or with 1 branch. *Corm* subglobose, ± 10 mm diam., asymmetric, obliquely flattened towards base with crescent-shaped basal ridge; tunics hard, smooth, dark brown, split into numerous fine parallel fibrils on basal ridge and into narrow teeth up to 5 mm long above. *Cataphylls* 3, membranous, flushed greenish above ground. *Foliage leaves* (1)2, all basal, blades mostly ± as long as flowering stem, cylindrical-subclavate, obtuse, narrowly 4-grooved, 30–80 × (1.0–) 1.5–2.5 mm; cauline leaf present only when lateral inflorescence developed, inserted midway or two thirds up stem, much shorter than basal leaves, entirely sheathing or with blade up to 30 mm long. *Inflorescence* of solitary flowers; outer bracts broadly elliptical-suborbicular, concave, obtuse, green with narrow, translucent (sometimes purplish tinted) membranous margins, 8–13 mm long, inner bracts similar but with broader membranous margins, ± as long as outer, notched apically. *Flowers* deeply cup-shaped, 25–30 mm diam., cup 12–15 mm deep, bright chrome-yellow (rarely peach-coloured), with 3–5 inconspicuous dark veins at base of cup, rarely flushed copper or pale green on reverse, weakly clove-scented; perianth tube funnel-shaped, 7–8 mm long

with lower narrow portion ± 1 mm long, tepals oblan-ceolate, 20–22 × 6–10 mm. *Stamens* yellow; filaments inserted at base of cup, lower 2–4 mm included within perianth tube, free, pubescent in lower two thirds, especially towards base, 7–9 mm long; anthers parallel, 4–5 mm long, thecae well separated by broad connective 0.50–0.75 mm wide. *Style* dividing opposite upper half of anthers, branches ± 3 mm long, divided for entire length into six filiform branchlets. *Capsules and seeds* unknown. *Flowering time*: mid-June to July. Figure 3.

Distribution and ecology: known so far from several small populations on the Farm Moedverloor, northeast of Lutzville in the extreme southwestern Knersvlakte (Figure 2). Plants are restricted to the drainage basin of the Moedverloor River, where they are localized on southern or southwest-trending slopes, typically just below the crest of the quartzite outcrops that fringe the eastern edge of the basin, but occasionally on the lower slopes. The species is relatively common where it occurs but populations never extend over a large area. Plants grow among quartz pebbles only in relatively dense stands of Knersvlakte Dwarf Vygieveld (Mucina & Rutherford 2006), a dwarf succulent shrubland dominated by various small Aizoaceae in the genera *Argyrodema*, *Cheiridopsis*, *Conophytum* and *Monilaria*. This highly specific ecology appears to be determined largely by the cooler aspect and by the associated higher precipitation. The rocky crests on which the species mostly occurs face the ocean, and the localized presence of lichens on the summit rocks suggests that coastal fogs, which are a feature of the region in the autumn and winter, play an important role in providing additional moisture to these sites, as attested also by the relatively dense associated succulent shrublets compared with adjacent slopes with a more northerly aspect. The Moedverloor basin has exposed an extensive and rather localized area of these quartzite slopes, the Moedverloorberg to the north being granitic and the hills to the south primarily loamy sand. A localized distribution and low population size is a characteristic of other quartz-loving species in the region (Snijman & Harrower 2009). Local changes in soil chemistry, depth, particle size, aspect, insolation and available moisture appear to be responsible for this very patchy ecology (Schmiedel & Jürgens 1999).

Other locally endemic geophytes from the southwestern Knersvlakte include *Bulbine dactylopsoides* and *B. haworthioides* (Asphodelaceae), *Lachenalia patula*, *Ornithogalum naviculum*, and the recently described *Drimia fimbri-marginata* (all Hyacinthaceae) (Snijman & Harrower 2009).

The flowers open between 13:00–14:00 in the afternoon and close in the evening near sunset. They remain closed in cold and overcast weather.

Diagnosis and relationships: the corm with a fimbriate basal ridge places *Romulea quartzicola* in sect. *Ciliatae* (M.P.de Vos) J.C.Manning & Goldblatt of subgen. *Romulea*, where it is distinguished by its early flowering, relatively short, obtuse, subclavate leaves, large, deeply funnel-shaped, canary-yellow flowers with tepals 20–22 × 6–10 mm and perianth tube 7–8 mm long, and the relatively long filaments, 7–9 mm long, much longer than the anthers. The bracts are ovate or suborbicular,

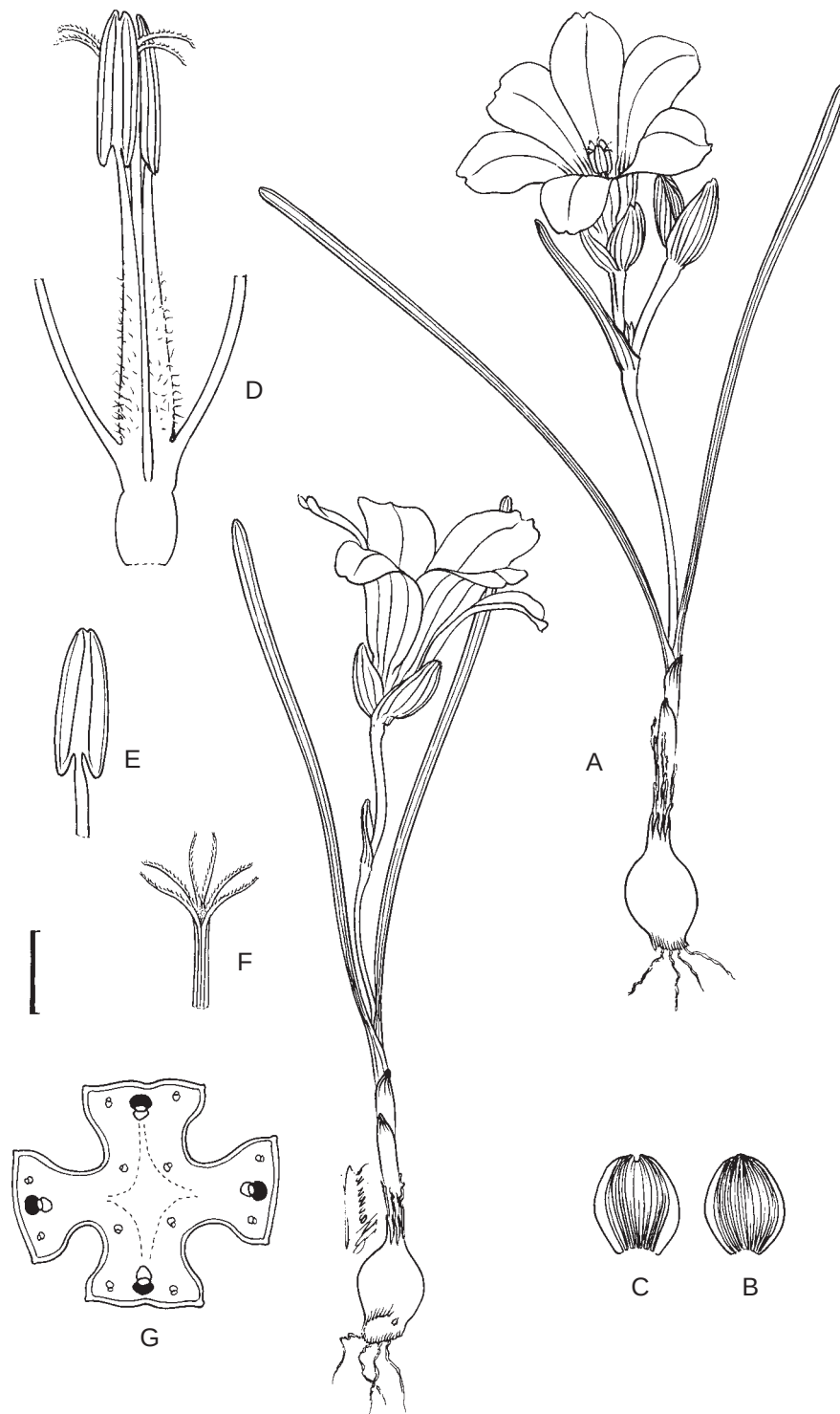


FIGURE 3.—*Romulea quartzicola*, Harrower 2756. A, whole plants; B, outer bract; C, inner bract; D, stamens and style; E, anther, outer face; F, details of style branches; G, t/s leaf. Scale bars: A–C, 10 mm; D, E, 2.5 mm; F, 0.5 mm. Artist: John Manning.

8–13 mm long, and both the inner and outer bracts have narrow, colourless or purple-flushed membranous borders. The leaves of *R. quartzicola* are morphologically distinctive in broadening appreciably in the distal half, thus somewhat clavate in appearance, but they are anatomically simple in lacking vascular girders as well as rib marginal bundles or strands. All four primary bundles have incomplete sclerenchyma sheaths restricted to phloem caps, and even these are absent in the secondary bundles. This is a relatively uncommon condition, as most species in the section have complete sclerenchyma bundle sheaths around the lateral primary bundles (De Vos 1972; Manning & Goldblatt 2001). The leaves of

R. quartzicola are thus among the least sclerified in the entire genus, matched in this regard, as far as is known, only by *R. namaquensis* M.P.de Vos.

The combination of yellow flowers and green bracts without the conspicuous, brown-streaked membranous margins that characterize the *Romulea pearsonii* group of species, places *R. quartzicola* in a small group of sect. *Ciliatae* that comprises *R. citrina* Baker, *R. elliptica* M.P.de Vos, *R. lutea* J.C.Manning & Goldblatt, *R. montana* Bég. and *R. sulphurea* Bég. Among this group it is readily distinguished from all except *R. sulphurea* by the relatively long filaments, $\pm$ twice as long as the

anthers. The rarely collected *R. sulphurea*, which was represented only by the type (collected in 1897) until we relocated it in 1999 (Manning & Goldblatt 2001), is still known only from the Pakhuis Pass in the northern Cedarberg, where it forms dense populations on seasonally wet sandstone pavement, flowering in early spring, in July and August. It is distinguished from *R. quartzicola* not only by its ecology and distribution but by its filiform leaves, ± 0.5 mm diam., smaller, sweetly scented flowers with elliptical tepals 12–20 mm long, mostly smaller bracts, 7–10 mm long, the inner with broad, brown-speckled membranous margins, and by the shorter anthers, 2.5–3.0 mm long.

Perianth colour is an important character in *Romulea* to the extent that species are either pink- or yellow-flowered but never both. Plain yellow flowers without dark blotches on the inner surface are uncommon in *Romulea* and restricted to a handful of species of sect. *Ciliatae*, only one of which, *R. lutea* J.C.Manning & Goldblatt, has been recorded from southern Namaqualand. This species, a recent discovery from sandy washes west of Koekenaap (Manning & Goldblatt 2008), has plain, golden yellow flowers superficially similar to those of *R. quartzicola* but it differs not only in its later flowering, August to September, but in its narrower leaves, ± 1 mm in diameter, with only the lowermost leaf basal, shorter perianth tube, ± 3 mm deep, and shorter filaments, 4 mm long and $\pm$ as long as the anthers. The two species differ also in leaf anatomy. In *R. lutea* the lateral primary bundles have complete sclerenchyma sheaths and the secondary bundles have well-developed phloem caps extending to the epidermis as girders. Both of these conditions are lacking in *R. quartzicola*.

History: the species was originally collected as a single fruit in July 2005. Seed was germinated in April 2006 in the nursery at Kirstenbosch Botanical Garden, and four plants were grown to maturity. These flowered for the first time on 6 June 2009, when it became clear that they represented an undescribed species. Type material was collected the following year.

Additional material seen

WESTERN CAPE.—3118 (Vanhynsdorp): Knersvlakte, Farm Moedverloor, ± 15 km NE of Lutzville, (–AD), 15 May 2010 [flowered in cultivation, plants originally collected 22 July 2005], A.D. Harrower 2756 (NBG); 21 June 2010, A.D. Harrower & J.C. Manning 4397 (NBG), 4399 (NBG).

NAME CHANGES AND NOMENCLATURAL CORRECTIONS

1. The protologue of *Trichonema pudica* (Ker Gawler 1810), the basionym for *Romulea pudica* (Ker Gawl.) Baker (1877), includes a painting of a pink-flowered species of *Romulea* with dark longitudinal streaks in a pale cup. This plant was brought from the Cape by a Miss Symonds and given to Messrs Whitley and Borne of Brompton, London, in whose greenhouse it was raised. They later provided the flowering specimen to the artist who executed the painting reproduced in *Curtis's Botanical Magazine*. Depicting a plant with two basal leaves and a symmetrical, bell-shaped corm with a neatly scalloped basal rim, this illustration clearly represents the species currently known under the name *R. amoena*, a

narrow endemic of the Bokkeveld Mtns south of Nieuwoudtville in Northern Cape. Ker Gawler (1810) cited one specimen in the protologue, *Ixia pudica* Sol. *ms* in Herb. Banks (now the herbarium of the British Museum of Natural History). The plant so annotated by Solander was collected by Oldenburg and has no date, precise locality or number. De Vos (1972, 1983) identified it as *R. flava* Lam. and we agree with her determination after having examined a digital image of the specimen.

Ker Gawler first listed the name *Ixia pudica* when he described the genus *Trichonema* (Ker Gawler 1802), including it among one of several species that he believed correctly belonged in his new genus. He later (Ker Gawler 1804, 1809) listed '*Trichonema pudica* Gawl.' as one of several species of *Trichonema* but it was only in 1810 that the validating protologue was published (Ker Gawler 1810). De Vos (1983) cited the painting as the type ('iconotype') of *T. pudica* and we endorse her action. The painting, showing a plant with red perianth, pale, darkly striped cup, and two basal leaves, differs sharply from the alternative choice of type, the Oldenburg specimen, which has a single basal leaf and apparently had a white perianth with a plain yellow cup. Significantly, the trivial name, rose-flowered trichonema, that accompanies the protologue, provides a direct and clear reference to the painting. Only the painting, therefore, accords with the words and title of the protologue and we formally designate it the lectotype. Although De Vos (1983) was not able to associate the painting (and thus the name) with any wild species, we are confident that it is a good representation of *R. amoena* (Béguinot 1907), the only known species of this genus with a dark pink to red perianth with pale, streaked cup, two basal leaves, and a bell-shaped corm scalloped along the basal rim. We accordingly reduce *R. amoena* to synonymy under *R. pudica*, a combination provided by Baker (1877). Daniel Solander evidently provided the inspiration for the name of the species but the specimen bearing his annotation is not the type.

***Romulea pudica* (Sol. ex Ker Gawl.) Baker** in *Journal of the Linnean Society, Botany* 16: 89 (1877). *Trichonema pudicum* Sol. ex Ker Gawl.: t. 1244 (1810) [*T. pudicum* Sol. ex Ker Gawl.: 223 (1804) et sub t. 1225 (1809), nom. nud.] *Ixia pudica* (Sol. ex Ker Gawl.) Roem. & Schult.: 377 (1817). *Geissorhiza pudica* (Sol. ex Ker Gawl.) Klatt: 655 (1866). *Bulbocodium pudicum* (Sol. ex Ker Gawl.) Kuntze: 700 (1891). *Romulea rosea* var. *pudica* (Sol. ex Ker Gawl.) Baker: 42 (1896). Lectotype here designated: South Africa, without precise locality, illustration in Ker Gawl. in *Curtis's Botanical Magazine* 31: t. 1244 (1810). [The syntype, without precise locality, *Oldenland s.n.* annotated *Ixia pudica* by Solander (BM) = *R. flava* Lam. is in serious conflict with the protologue.]

Romulea amoena Schltr. ex Bég.: 334 (1907), syn. nov. Type: South Africa, [Northern Cape], Bokkeveld Mtns, Papelfontein [Papkuilsfontein], *Schlechter 10896* (G, holo.; BM, BOL, GRA, K, MO, PRE, S, Z, iso.).

2. The phrase '*Blumen rosenroth klein*' (flowers rose-red, small) constitutes the entire diagnosis for C.F.Ecklon's *Romulea parviflora*, which he collected on the Cape Peninsula near Green Point. The species, typified by a specimen in the Stockholm Herbarium so annotated by Ecklon (Nordenstam 1972), was determined as

R. obscura Klatt by De Vos (1972). Nordenstam (1972) felt that this diagnosis was sufficient to validate Ecklon's species, and that, as the earlier name it should thus replace *R. obscura*. De Vos (1973) disagreed, regarded Ecklon's species as inadequately diagnosed and therefore invalidly published, and accordingly listed the name in synonymy both under *R. obscura* var. *obscura* and under *R. rosea* var. *australis* Ewert (De Vos 1972). Later, in the *Flora of southern Africa* (De Vos 1983) she cited it solely as a synonym of *R. obscura* var. *obscura*. This species usually has yellow to apricot, occasionally pale pink flowers (De Vos 1972), whereas *R. rosea*, including its varieties, has pale to deep pink or red flowers. We are of the opinion that the species is therefore better assigned to *R. rosea* on the basis of flower colour. The small flower size indicates that it should be assigned to synonymy under *R. rosea* var. *australis*.

***Romulea rosea* var. *australis* (Ewart) M.P.de Vos** in *Journal of South African Botany*, Supplement 9: 254 (1972). *Romulea cruciata* var. *australis* Ewart: 43 (1907). Type: Australia, Victoria, near Melbourne, Tovey s.n. [MEL, lecto., designated by De Vos: 252 (1972); BOL, iso.].

Romulea parviflora Eckl.: 19 (1827). *Trichonema parviflorum* (Eckl.) Steud.: 702 (1841), syn. nov. Type: South Africa, [Western Cape], Cape Peninsula, Green Point, Sept. 19–24, Ecklon s.n. (S, holo.).

3. First described as *Ixia reflexa* by Thunberg (1811), the epithet was transferred to *Romulea* by Ecklon (1827), who explicitly cited Thunberg's species as the basionym. *Ixia reflexa* of Thunberg is, however, a homonym for a species of that name described by Andrews (1797) [now, incidentally, *Ixia scillaris* L.]. Ecklon's use of the name is to be treated nomenclaturally as a new name dating from 1827 (McNeil et al. 2006: Art. 58.1) but it remains typified by the type of Thunberg's homonym. The taxon is conspecific with *R. flava* var. *flava* (De Vos 1972; 1983). Béguinot (1908), and later De Vos, however, mistakenly regarded Ecklon's name as typified by his (Ecklon's) own collections bearing that name, which are a form of *R. rosea*, and accordingly treated them as var. *reflexa* of that species. Based on the actual type, however, *R. rosea* var. *reflexa* is a nomenclatural synonym of *R. flava*. The variety var. *reflexa* sensu Béguinot, a local endemic of the Riversdale District, then requires a new name and its only synonym, at species rank, is *R. muirii*, which is available for the taxon. We accordingly provide the combination below.

***Romulea rosea* var. *muirii* (N.E.Br.) J.C.Manning & Goldblatt**, comb. et stat. nov. *Romulea muirii* N.E.Br.: 467 (1932). Type: South Africa, [Western Cape], Riversdale, Muir 4848 (K, holo.).

R. rosea var. *reflexa* sensu Bég. (1908) et De Vos (1972), non (Eckl.) Bég. (1908) [= *R. flava* (Lam.) M.P.de Vos].

***Romulea flava* (Lam.) M.P.de Vos** in *Journal of South African Botany*, Supplement 9: 98 (1972). *Ixia flava* Lam.: 109 (1791). Type: without precise locality or collector [P: Herb. Lamarck, lecto., designated by M.P. de Vos: 99 (1972)].

R. rosea var. *reflexa* (Eckl.) Bég.: 158 (1908). *R. reflexa* Eckl.: 18 (1827), as nom. nov. pro *Ixia reflexa* Thunb.: 55 (1811), hom. illegit., non *I. reflexa* Andr. (1797), syn. nov. Type: South Africa, without pre-

cise locality, Thunberg s.n. UPS-THUNB984 [UPS-THUNB, lecto., designated by De Vos: 27 (1983)].

4. In her *Flora of southern Africa* account of *Romulea*, De Vos (1983) recognized *Ixia neglecta* Schult. (1822) as an earlier name for what was until then *R. oliveri* M.P.de Vos, a narrow endemic of the Kamiesberg in Namaqualand, Northern Cape. While true, the combination that she proposed in *Romulea* is technically a new name because she deliberately excluded the type of both *I. neglecta* and its synonym *Trichonema speciosum* Ker Gawl. Her new name is, however, a homonym for the Mediterranean *R. neglecta* Jord. & Fourr. (1868). *Ixia neglecta* of Schultes (1822) was itself a new name in *Ixia* for *Trichonema speciosum* (Ker Gawler 1804)—not the later account of the species in 1812 cited by De Vos—because *I. speciosa* Andrews bars its transfer to *Ixia*. The type of *T. speciosum* (and of *I. neglecta* Schult.) is a plate in Andrews (1801) titled *Ixia bulbocodium* var. *flore speciosissimo*, a polynomial. Ker Gawler's *Trichonema speciosa* is based solely on the Andrews illustration and not, as De Vos and others believed, on the illustration in Curtis's *Botanical Magazine*: t. 1476 (Ker Gawler 1812), which is the type that De Vos cited for *R. neglecta*. This plate is, nevertheless, evidently the same species (and probably the same plant or its descendants) as was illustrated by Andrews. Baker (1877) provided the combination *R. speciosa*, citing *Ixia bulbocodium* var. *speciosa* Andrews (in error for the polynomial listed above), and Ker Gawler's *Trichonema speciosa*. In addition, Baker listed in synonymy *R. tabularis* Eckl., at the time a manuscript name on specimens distributed by Ecklon, later *R. tabularis* Eckl. ex Bég. in 1907. Baker also correctly listed in synonymy, *Ixia neglecta* Schult.

The type of *Trichonema speciosa* and *Ixia neglecta* is a painting of a red-flowered *Romulea*, the dark tepal cup pale at the base and the reverse of the outer tepals boldly striped with pale and dark longitudinal lines. The poorly rendered corm seems consistent with *R. neglecta* but the plant is illustrated with one basal and one sub-basal leaf. The bracts are consistent with *R. neglecta* as understood by De Vos, the inner with membranous, darkly streaked margins. Andrews's plant was provided in 1801 by George Hibbert, Member of Parliament and patron of botany, who we suspect received corms from James Niven. Hibbert had commissioned Niven in 1798 to collect plants for him at the then Cape Colony and Niven is known to have visited the Kamiesberg in 1799, where he collected specimens of the endemic *Moraea longiflora* Ker Gawl., which was illustrated in Curtis's *Botanical Magazine*: t. 712 (Ker Gawler 1804; Goldblatt 1986: 104). Thus this early illustration of a then remote Namaqualand endemic is not unprecedented.

The presence of two, rather than a single basal leaf, is not consistent with *Romulea neglecta*, which usually has a single basal leaf, but the anomaly may be the result of its cultivation in England or of a misrepresentation by the artist. The plant illustrated later in Curtis's *Botanical Magazine* however, also from stock derived from Hibbert's introduction, has a single basal leaf. Because of this inconsistency, we designate an epitype for *R. speciosa*, the name that must now be applied to the species. As the type collection of *R. oliveri* still represents the

only actual specimen of *R. speciosa* that is known, we designate this collection as the epitype.

***Romulea speciosa* (Ker Gawl.) Baker** in Journal of the Linnean Society, Botany 16: 89 (1877). *Trichonema speciosum* Ker Gawl.: 223 (1804). *Ixia neglecta* Schult.: 279 (1822), nom. nov. pro *Trichonema speciosum* Ker Gawl. [non *Ixia speciosa* Andrews (1801)]. *Bulbocodium speciosum* (Ker Gawl.) Kuntze: 700 (1891). Type. South Africa, without precise locality, possibly collected by J. Niven, illustration in Andrews (1801), The botanist's repository 3: t. 170 '*Ixia bulbocodium* var. *flore speciosissimo* (1801). Epitype: South Africa, [Northern Cape], Kamiesberg, Farm Welkom, 14 Sept. 1970, Oliver 3169 (NBG, epi.!; PRE, iso.).

R. oliveri M.P.de Vos: 116 (1972). Type: South Africa, [Northern Cape], Kamiesberg, Farm Welkom, 14 Sept. 1970, Oliver 3169 (NBG, holo.!; PRE, iso.).

R. neglecta M.P.de Vos: 29 (1983), hom. illegit., non *R. neglecta* Jord. & Fourr. (1868). Type: South Africa, without precise locality, possibly collected by J. Niven, illustration in Curtis's Botanical Magazine 14: t. 1476 '*Ixia speciosa*' (Ker Gawler 1812).

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REFERENCES

- ANDREWS, H. 1797. *Ixia reflexa*. Reflex flowered ixia. *The botanist's repository*, vol. 1. Bensley [for author], London.
- ANDREWS, H. 1801. *Ixia bulbocodium* var. *flore speciosissimo*. *The botanist's repository*, vol. 3. Bensley [for author], London.
- BAKER, J.G. 1877 [as 1878]. *Systema Iridearum*. *Journal of the Linnean Society, Botany* 16: 61–180.
- BAKER, J.G. 1896. Iridaceae. In W.T. Thiselton-Dyer, *Flora capensis* 6: 7–71. Reeve, Ashford.
- BÉGUINOT, A. 1907. Diagnoses Romulearum novarum vel minus cognitarum (Schluss). *Botanische Jahrbücher für Systematik* 38: 323–339.
- BÉGUINOT, A. 1908. Revisione delle *Romulea* dell'erbario Delessert (Ginevra). *Annuaire du Conservatoire et du Jardin Botaniques de Genève* 11–12: 144–163.
- BROWN, N.E. 1932. *Romulea rosea*. *The Gardeners Chronicle*, ser. 3, 92: 467.
- DE VOS, M.P. 1972. The genus *Romulea* in South Africa. *Journal of South African Botany*, Suppl. vol. 6. National Botanic Gardens of South Africa, Kirstenbosch.
- DE VOS, M.P. 1973. Note on *Romulea parviflora* Ecklon. *Journal of South African Botany* 39: 111.
- DE VOS, M.P. 1983. *Romulea*. In O.A. Leistner, *Flora of southern Africa* 7, 2, fascicle 2: 10–73. Botanical Research Institute, Pretoria.
- ECKLON, C.F. 1827. *Topographisches Verzeichniss der Pflanzensammlung von C.F. Ecklon*. Reiseverein, Esslingen.
- EWART, A.J. 1907. Contribution to the flora of Australia. *Proceedings of the Royal Society of Victoria* 19: 43.
- GOLDBLATT, P. 1986. The moraeas of southern Africa. *Annals of Kirstenbosch Botanical Garden* 14. National Botanic Gardens, Cape Town in association with the Missouri Botanical Garden, St. Louis.
- GOLDBLATT, P., BERNHARDT, P. & MANNING, J.C. 2002. 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. 2008. *The iris family: natural history and classification*. Timber Press, Oregon.
- HOLMGREN, P.K., HOLMGREN, N.H. & BARNETT, L.C. 1990. *Index herbariorum. Part 1: the herbaria of the World*. New York Botanical Garden, New York.
- JORDAN, C.T.A. & FOURREAU, J.P. 1868. *Breviarum plantarum novarum*. Savy, Paris.
- KER GAWLER, J. 1802. *Trichonema cruciatum*. Channel-leaved trichonema. *Curtis's Botanical Magazine* 16: t. 575.
- KER GAWLER, J. 1804 [as 1805]. *Ensatorum ordo*. König & Sims *Annals of Botany* 1: 219–247.
- KER GAWLER, J. 1809. *Trichonema roseum*. Rose-coloured trichonema. *Curtis's Botanical Magazine* 30: t. 1225.
- KER GAWLER, J. 1810. *Trichonema pudicum*. Blush-coloured trichonema. *Curtis's Botanical Magazine* 31: t. 1244.
- KER GAWLER, J. 1812. *Trichonema speciosa*. Crimson trichonema. *Curtis's Botanical Magazine* 14: t. 1476.
- KLATT, F.W. 1866. *Revisio Iridearum*. *Linnaea* 34: 537–689.
- KUNTZE, O. 1891. *Revisio generum plantarum*, vol. 2. Felix, Leipzig.
- LAMARCK, J.B.A.P.M. 1791. *Tableau encyclopédique et méthodique botanique*, vol. 1. Pancoucke, Paris.
- LEWIS, J.G. 1947. *Gladiolus stokoei*. *The Flowering Plants of Africa* 26: t. 1004.
- MANNING, J.C. & GOLDBLATT, P. 2001. 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*, sér. 3, 23: 59–108.
- MANNING, J.C. & GOLDBLATT, P. 2004. Two new species of *Romulea* (Iridaceae: Crocoideae) from the western Karoo, Northern Cape and notes on infrageneric classification and range extensions. *Bothalia* 34: 17–22.
- MANNING, J.C. & GOLDBLATT, P. 2006. New species of Iridaceae from the Hantam-Roggeveld centre of endemism, and the Bokkeveld, Northern Cape, South Africa. *Bothalia* 36: 139–145.
- MANNING, J.C. & GOLDBLATT, P. 2008. *Romulea lutea* and *R. tubulosa* (Iridaceae: Crocoideae), two new species from Namaqualand, South Africa. *Bothalia* 38: 78–82.
- MCNEILL, J., BARRIE, F.R., BURDET, H.M., DEMOULIN, V., HAWKSWORTH, D.L., MARHOLD, K., NICOLSON, D.H., PRADO, J., SILVA, P.C., SKOG, J.E., WIERSMA, J.H. & TURLAND, N.J. (eds). 2006. International Code of Botanical Nomenclature (Vienna Code) adopted by the seventeenth International Botanical Congress, Vienna, Austria, July 2005. *Regnum Vegetabile* 146. Gantner, Liechtenstein.
- MUCINA, L. & RUTHERFORD, M.C. 2006. The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia* 19. South African National Biodiversity Institute, Pretoria.
- NORDENSTAM, B. 1972. Types of Ecklon's 'Topographisches Verzeichniss' in the Swedish Museum of Natural History in Stockholm. *Journal of South African Botany* 38: 277–298.
- ROEMER, J.J. & SCHULTES, J.A. 1817. *Systema vegetabilium*, vol. 1. Cotta, Stuttgart.
- SCHMIEDEL, U. & JÜRGENS, N. 1999. Community structure on unusual habitat islands: quartz-fields in the Succulent Karoo, South Africa. *Plant Ecology* 142: 57–69.
- SCHULTES, J.A. 1822. *Mantissa systematis vegetabilium*, vol. 1. Cotta, Stuttgart.
- SNIJMAN, D.A. & HARROWER, A.D. 2009. A new species of *Drimia* (Urgineoideae) from the Knersvlakte, Western Cape, South Africa. *Bothalia* 39: 233–237.
- STEUDEL, E.T. 1841. *Nomenclator botanicus*, edn 2. Cotta, Stuttgart.
- THUNBERG, C.P. 1811. *Flora capensis*. Edman, Uppsala.

FSA contributions 19: Asteraceae: Anthemideae: *Eumorphia*

N. SWELANKOMO*

INTRODUCTION

The genus *Eumorphia* DC. belongs to the tribe Anthemideae in the subfamily Asteroideae of the family Asteraceae. It consists of six species and two subspecies (Hilliard & Burt 1982), which are endemic to southern Africa. It occurs widely in southern Africa in Limpopo, Mpumalanga, Swaziland, Free State, KwaZulu-Natal, Lesotho, Western and Eastern Cape (Herman *et al.* 2003).

MATERIAL AND METHODS

A total of seven *Eumorphia* taxa were studied from herbarium specimens housed in PRE. In each species, morphological characters were investigated. The length of the corolla, length and width of the involucre, length of the style and ovary, number of ray florets, where possible, and length of cypselae were measured with the aid of a Bausch & Lomb StereoZoom® Series microscope. Two cypselae in each taxon, except in the case of *E. swaziensis* and *E. corymbosa*, were examined by means of a scanning electron microscope (JSM-840, JEOL, Tokyo, Japan). Anthers were studied under a dissecting and light microscope and photographs were taken with a digital camera (Canon Powershot S80 Digital Camera) mounted on the light microscope (Olympus Vanox-S). Type specimens seen on the website are distinguished by the code e! in citations below. Acronyms for herbaria are listed in Holmgren *et al.* (1990) and in Smith & Willis (1999).

Eumorphia DC., Prodrum 6: 2 (1838); Harvey: 153 (1865); Källersjö: 538 (1985); Bremer & Humphries: 94 (1993); Bremer: 448 (1994); Herman *et al.*: 137 (2000); Oberprieler *et al.*: 355 (2007); Oberprieler *et al.*: 643 (2009). Type species: *E. dregeana* DC.

Shrubs or shrublets, glabrous or pubescent. *Leaves* opposite, alternate in *E. davyi* and *E. swaziensis*, ericoid, sometimes clustered, entire or lobed. *Capitula* heterogamous, radiate, terminal, solitary or corymbose in *E. corymbosa* and *E. swaziensis*, shortly pedunculate or subsessile. *Involucre* campanulate to subglobose or cylindrical in *E. corymbosa*. *Involucral bracts* in 3–5 rows, outer sometimes with 2–5 glands on back near apex, inner ciliate near apex, sometimes all with broad, membranous apices. *Receptacle* flat or convex, rarely conical, paleate or sometimes epaleate in *E. davyi*; paleae longer than disc florets, linear, sometimes with bent, apical appendage. *Ray florets* female, fertile; corolla white sometimes flushed rose-pink, lamina

oblong to linear, 3-toothed, 2–4 times as long as tube, glandular. *Style* slightly branched to branched with stigmatic areas along edges. *Disc florets* bisexual, fertile, yellow; corolla tube sometimes campanulate above, with 5 ovate lobes. *Anthers* minutely caudate with linear, apical appendages; endothelial tissue polarized. *Style* linear, branched, truncate, branches with stigmatic areas along edges. *Cypselae* ribbed, non-myxogenic, cylindrical, minutely papillose especially on ribs, with dentate or entire apical rim. *Pappus* absent. Figure 1A–C.

Etymology: the generic name *Eumorphia* is derived from the Greek words, *eu-* meaning well and *morphe* meaning form; referring to the neatness of the foliage (Jackson 1990: 91).

Conservation status: according to the latest Red List of South African plants (Raimondo *et al.* 2009), all species are listed as LC (Least Concern).

Key to species

- 1a Capitula corymbosely arranged, ≤ 5 mm diam.:
 - 2a Leaves opposite, narrowly linear, entire 1. *E. corymbosa*
 - 2b Leaves alternate, mostly trifid just above middle of stem 2. *E. swaziensis*
- 1b Capitula solitary, > 5 mm diam.:
 - 3a Leaves alternate 3. *E. davyi*
 - 3b Leaves opposite:
 - 4a Subshrub up to 0.6 m tall, receptacle epaleate or with few marginal paleae 4. *E. prostrata*
 - 4b Erect shrubs to 1 m tall, receptacle paleate:
 - 5a Leaves linear-terete, closely imbricate, up to 3.5 mm long 5. *E. dregeana*
 - 5b Leaves entire or 3-lobed, up to 8 mm long 6. *E. sericea*

1. *Eumorphia corymbosa* E. Phillips in Journal of South African Botany 16: 20 (1950). Type: Western Cape, 3222 (Beaufort West): on top of Molteno Pass, 5500' [1804 m], (–BA), May, J.P.H. Acocks 14340, (PRE, holo.).

Woody subshrub, 0.1–1.0 m high, single-stemmed at base becoming branched, glabrous; stem very rough. *Leaves* opposite, narrowly linear, entire, upper 4–5 × 1.2 mm, lower 10–18 × 1.2 mm, some clustered at nodes, acuminate. *Capitula* heterogamous, radiate, small, 5 × 2.5 mm when pressed, corymbose at ends of branches, shortly pedunculate. *Involucre* cylindrical; involucral bracts in 5 rows, imbricate, glabrous; outer ovate, 1 × 0.5 mm, membranous along edges; middle ovate-lanceolate, 1.1 × 1 mm, membranous along edges; inner 5 × 1 mm, lacerate, tips membranous. *Receptacle* flat, paleate; paleae linear-lanceolate, 2 mm long, almost as long as disc florets. *Ray florets* female, white; corolla limb glandular, 3 mm long, 3-toothed; corolla tube shorter than limb, sparsely glandular. *Style* terete, 1.5 mm long, branches linear, obtuse, 0.4 mm long. *Ovary* ellipsoid, ribbed, glabrous. *Disc florets* bisexual, fertile, yellow; corolla tube 1.2 mm long, glandular; corolla limb 1 mm long, glandular, 5-lobed; lobes ovate, 0.2 mm long.

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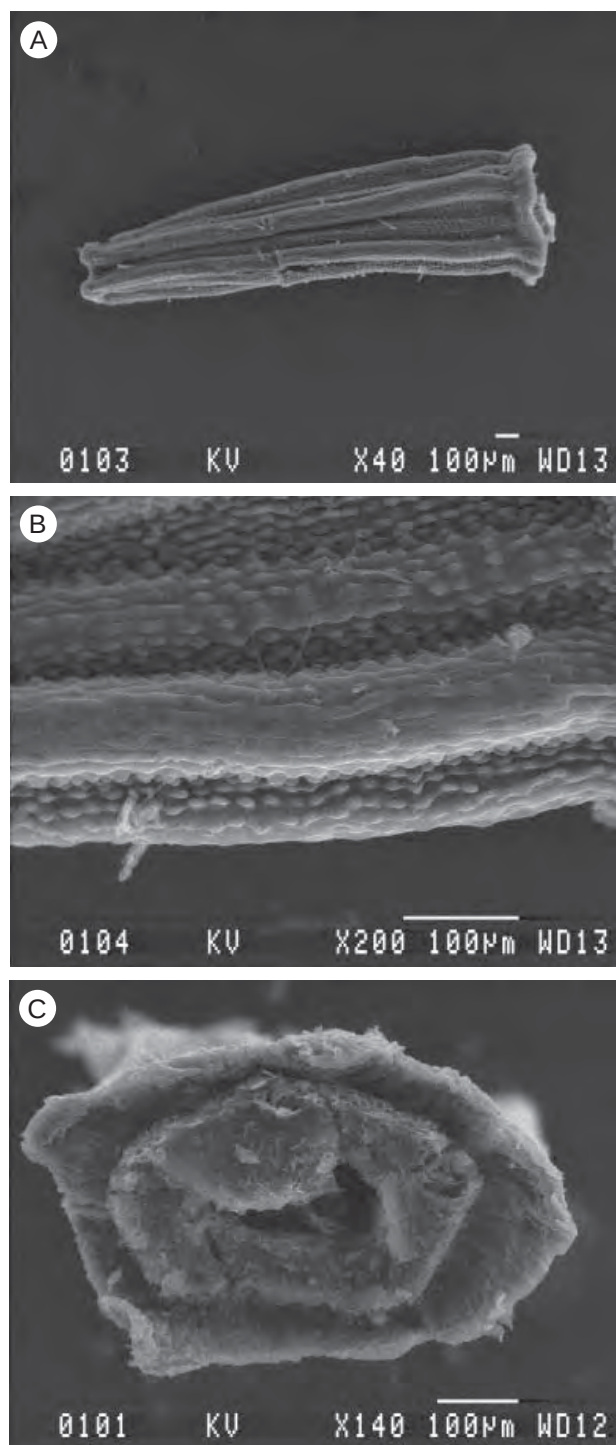


FIGURE 1.—A–C, scanning electron micrographs of cypsela of *E. davyi*, *Brusse 5010*: A, surface with papillae especially on ribs; B, surface at higher magnification; C, showing apical rim.

Anthers linear, minutely caudate, with lanceolate apical appendage. *Style* terete, branches linear, truncate, 2 mm long. *Ovary* 1.2 mm long, $\pm$ ellipsoid, slightly striate, glabrous. *Cypsela* 2 mm long, glabrous, cylindrical, minutely papillose especially on ribs, crowned with thickened apical rim. *Pappus* absent. *Flowering time*: Feb.–Mar.

Distribution and habitat: *Eumorphia corymbosa* is endemic to the Western Cape in the Beaufort West Division, from the National Park, Mountain View, down to

the foot of the Nuweveld Mtns as far as Molteno Pass (Figure 2), at 1 000–1 828 m. It grows in seasonal wet soils along rivers and in marshy habitats.

Notes: *Eumorphia corymbosa* can be distinguished from other species in the genus by the small corymbosely arranged capitula at the branch endings; cylindrical involucre and opposite leaves.

Other specimens examined

WESTERN CAPE.—3222 (Beaufort West): Karoo National Park, Mountain View, (–BA), 2 Jan. 1985, *Shearing 828* (PRE); near Abrahamspoor Farm, on top of Nuweveldsberg Plateau, (–BA), 9 Mar. 1990, *Vlok 2276* (PRE); foot of Nuweveld Mtns, on bank of small river flowing at foot of mountain, (–BA), 15 Feb. 1978, *Gibbs Russell, Robinson, Herman & Downing 235* (PRE); Mountain View Farm, among dolerite boulders at top of hill, (–BA), 14 Feb. 1978, *Gibbs Russell, Robinson, Herman & Downing 124* (PRE); Matjieskloof, 24 miles [38.4 km] north of Beaufort West, (–BA), 16 May 1950, *Acocks 15893* (PRE).

2. ***Eumorphia swaziensis* Compton** in *Journal of South African Botany* 33: 300 (1967). Type: Swaziland, 2631 (Mbabane): hill northeast of Mbabane, (–AC), 4000' [1 312 m], 15 Mar. 1960, *R.H. Compton 29963*, (SDNH, holo.e!; PRE, two sheets!, NBG e!, iso.).

Small, mainly glabrous shrub, 0.3–0.6 m high, with erect woody stems, densely branched in upper floriferous parts. *Leaves* alternate, very numerous, erectopatent, mostly trifid just above the middle; rachis and lobes filiform, flexuous, apiculate, lobes subopposite, up to 20 mm long; many leaves in upper parts of stems undivided, filiform. *Inflorescence* irregularly corymbose, capitula numerous, erect, each borne on short peduncle, subtended by short linear bract; peduncle and bract finely and sparsely hairy. *Involucre* $\pm 5 \times 2$ mm, compact, campanulate, glabrous. *Involucral bracts*: 3 rows, imbricate; outer ovate, 1.2×0.5 mm; middle 2.2×1 mm; inner 3.5×1.1 mm, with narrowly membranous-fimbriate margins. *Receptacle* paleate; paleae membranous, linear, slightly shorter than disc florets. *Ray florets* 5, female, white; corolla limb broadly oblong to ovate, $\pm 3 \times 2$ mm, shortly 3-lobed, glabrous; corolla tube sparsely glandular, 1 mm long. *Style* linear, slightly curved, 0.1 mm long with stigmatic areas along edges.

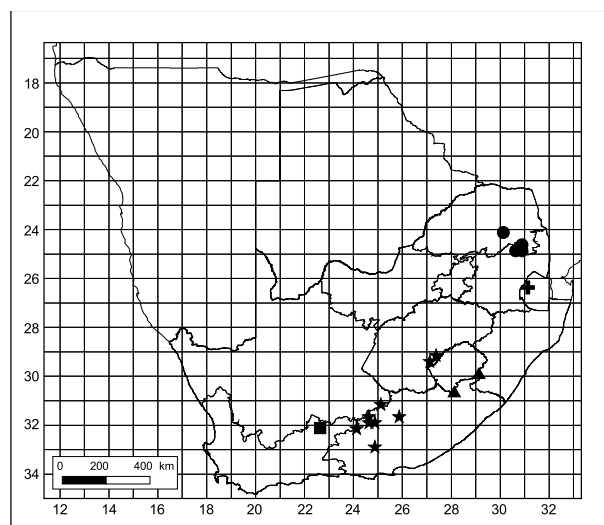


FIGURE 2.—Known distribution of *Eumorphia corymbosa*, ■; *E. davyi*, ●; *E. dregeana*, ★; *E. prostrata*, ▲; and *E. swaziensis*, +.

Ovary 1.8 mm long, slightly striate. *Disc florets* bisexual, 5-lobed, yellow; lobes ovate, 0.1 mm long; corolla glandular; corolla limb 1 mm long; corolla tube 1 mm long. *Anthers* minutely caudate, with short apical appendages; filaments thickened. *Style* 2 mm long, branched, style branches linear, truncate, 0.15 mm long, with stigmatic areas along edges. *Ovary* linear, 1.1 mm long, slightly striate. *Cypselas*: mature ones not seen. *Pappus* absent. *Flowering time*: Mar.–Apr.

Distribution and habitat: *Eumorphia swaziensis*, as the name suggests, is endemic to Swaziland, where it occurs in grassland on the hilltops, at 1 219–1 372 m around Mbabane (Figure 2).

Notes: *Eumorphia swaziensis* can be distinguished from other species in the genus by having alternate leaves; irregularly corymbose inflorescences and campanulate involucre.

Specimen examined

SWAZILAND.—2631 (Mbabane): Black Umbuluzi Valley, (–AC), 24 Mar. 1978, Kemp 1304 (PRE).

3. *Eumorphia davyi* Bolus in Transactions of the South African Philosophical Society 16: 387 (1906); Retief & Herman: 306 (1997). Type: Eastern Transvaal [Mpumalanga], 2430 (Pilgrim's Rest): Graskop, near Pilgrim's Rest, (–DD), 29 Jan. 1906, J. Burt Davy 1474, (BOL, holo. e!; PRE!, K e!, iso.).

Ericoid shrub, 0.18–2.0 m high, single-stemmed at base becoming branched only in upper third, forming a compact, rounded bush, glabrous. *Stem* very rough. *Leaves* alternate, imbricate, up to 11 × 0.5 mm, glabrous, acute, mucronulate. *Capitula* shortly pedunculate or sessile, radiate. *Involucre* campanulate, 5–6 × 6 mm, finely hairy. *Involucral bracts* in 3 rows, imbricate; outer narrow, 3–4 × 0.5 mm, slightly hairy; middle lanceolate, 4–6 × 1 mm, acuminate, lacerate membranous; inner with ovate apex, 6–7 × 1 mm, membranous, discolorous. *Receptacle* conical, epaleate. *Ray florets* female, fertile, white; corolla limb oblong, 3-toothed, 7 mm long; corolla tube 2 mm long. *Style* up to 1.8 mm long, linear, branched, style branches 0.2 mm long, round with stigmatic areas along edges. *Ovary* 3 mm long, slightly striate. *Disc florets* many, bisexual, fertile, yellow; corolla limb 1 mm long; corolla tube 0.8 mm long, 5-lobed; lobes ovate, 0.15 mm long. *Anthers* minutely caudate, apex round; filaments thickened. *Style* linear, 1.8 mm long, branched, style branches 0.2 mm long, truncate with stigmatic areas along edges. *Ovary* 1.8 mm long. *Cypselas* closely ribbed, slightly curved, 2.2 mm long, glabrous but minutely papillose especially on ribs, crowned with thickened apical rim. *Pappus* absent. *Flowering time*: Sept.–April.

Distribution and habitat: *Eumorphia davyi* is found in Mpumalanga at Graskop, Pilgrim's Rest and as far north as Mariepskop, and in Limpopo Province in Polokwane [Pietersburg] and The Downs (Figure 2) at 1 200–2 286 m. *E. davyi* grows in grassveld.

Notes: *Eumorphia davyi* is named in honour of Joseph Burt Davy (1870–1940), a British botanist, founder of the Pretoria National Herbarium, a student of the flora of California, agriculturist, silviculturist and

ecologist (Stafleu & Richard 1976). *E. davyi* can be distinguished from other species in the genus by alternate leaves and a conical, epaleate receptacle.

Other specimens examined

LIMPOPO.—2430 (Pilgrim's Rest): The Downs, (–AA), Nov. 1918, Rogers 21557, 22003 (PRE).

MPUMALANGA.—2430 (Pilgrim's Rest): at top of Mariepskop, (–DB), 15 Jan. 1960, Van der Schijff 4835 (PRE); Mount Sheba, road up mountain from Mount Sheba Hotel to main Lydenburg-Pilgrim's Rest tar road, (–DC), 17 Apr. 1987, Brusse 5010 (PRE); Graskop, (–DD), 28 Mar. 1979, Kluge 1845 (PRE).

4. *Eumorphia prostrata* Bolus in Transactions of the South African Philosophical Society 16: 388 (1906); Hilliard: 332 (1977). Type: Eastern Cape, 3028 (Matatiele): Barkly East, summit Doodman's Krans Mtn, (–CA), 8 Mar. 1904, E.E. Galpin, 6700, (BOL, holo. e!; K e!, PRE, two sheets!, SAM e!, iso.).

Low, erect, spreading subshrub, up to 0.6 m high, often prostrate over rock sheets or hanging down cliff faces; branches sericeous, soon glabrous, old ones rough with leaf scars, often rooting, twigs closely leafy. *Leaves* opposite, sericeous, silvery, hairs appressed, primary leaves linear or 2- or 3-forked at tips, up to 10 × 1.5 mm, appearing fascicled from closely leafy axillary shoots. *Capitula* solitary, terminal, shortly pedunculate, radiate. *Involucre* campanulate, up to 7 × 9 mm when pressed, villous. *Involucral bracts* in 3 rows, imbricate; outer narrowly ovate, 2.5–5.5 × 0.5 mm; middle obtuse, 5.5–6.0 × 1.1 mm, tips membranous; inner oblong, 6.5–7.0 × 1.1 mm, discolorous, membranous. *Receptacle* epaleate or with a few marginal paleae. *Ray florets* female, 3-toothed, white tinged pink at base or sometimes at back; corolla limb 5–7 mm long; corolla tube 1.8 mm long. *Style* up to 2.2 mm long, branched, style branches 0.8 mm long, with stigmatic areas along edges. *Ovary* 1.2 mm long, slightly striate. *Disc florets* bisexual, 5-lobed, yellow; lobes ovate, 0.1 mm long; corolla limb 2 mm long; corolla tube 1 mm long. *Anthers* minutely caudate, apical appendage elongated, obtuse, filaments thickened. *Style* up to 2.8 mm long, slightly branched, style branches 0.2 mm long with stigmatic areas along edges and papillate appendages. *Ovary* 1.1 mm long. *Cypselas* narrowly cylindric, 2 mm long, closely ribbed, minutely papillose especially on ribs, crowned with thickened apical rim. *Pappus* absent. *Flowering time*: Dec.–Apr. Figure 3.

Distribution and habitat: *Eumorphia prostrata* is only known from a small area of the high Drakensberg, from Tina Head (Doodman's Krans and Naudesnek) where the boundaries of Lesotho, the Barkly East and Maclear Districts meet, to Thamathu Pass (Bushman's Nek area) and the Drakensberg Garden area in Underberg District, KwaZulu-Natal (Hilliard 1977), at 1 830–2 970 m (Figure 2). In its natural environment, it appears to tolerate extreme cold (–10°C) in winter, strong buffeting winds and fairly high daytime temperatures in summer (Oliver 1989). *E. prostrata* grows in mountain grassveld in seasonally wet areas.

Notes: although it seems close to *Eumorphia sericea*, this species has a prostrate habit and a receptacle epaleate or with a few marginal paleae.

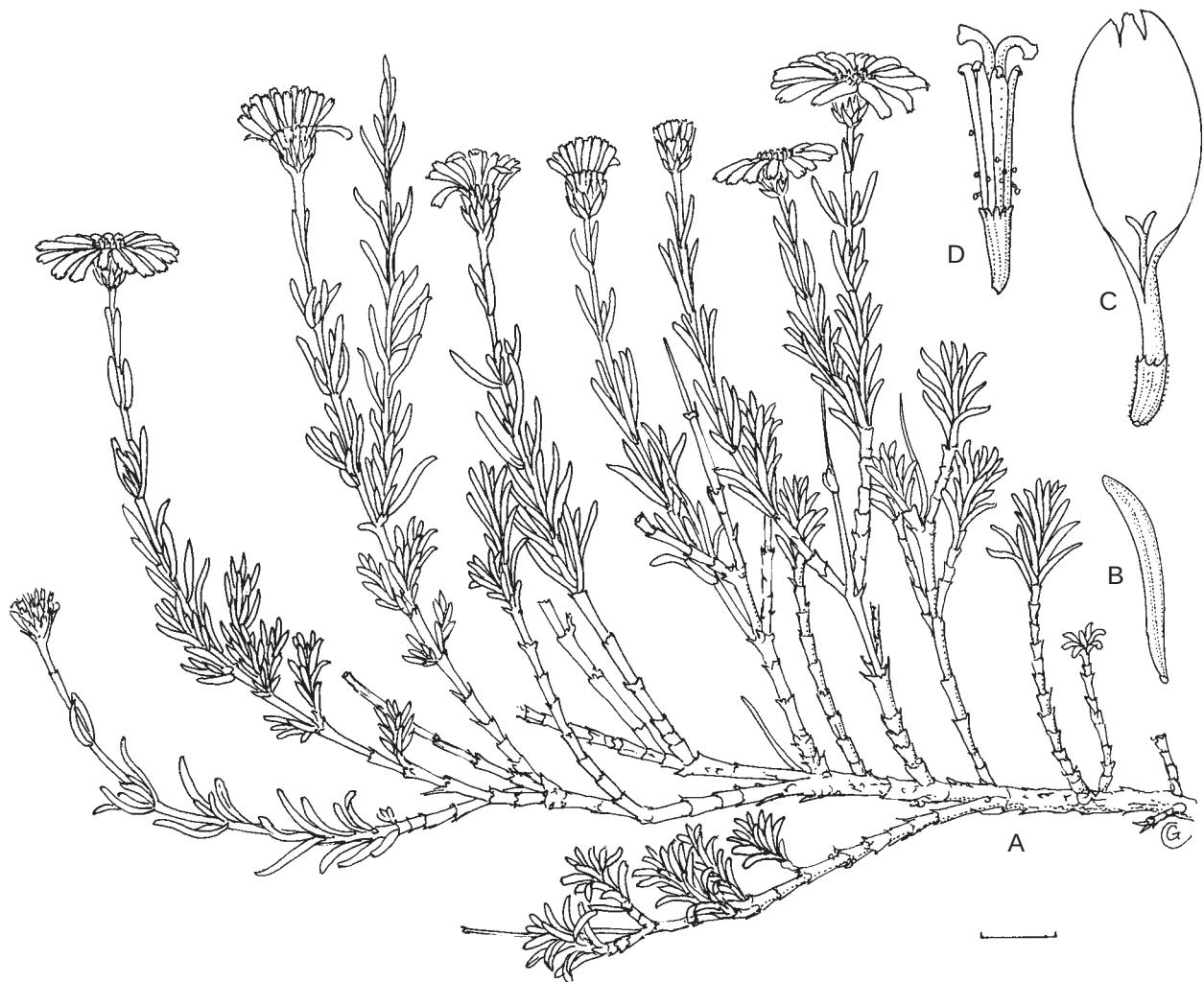


FIGURE 3.—*Eumorphia prostrata*. A, habit; B, leaf surface; C, ray floret; D, disc floret, Hoener 1722. Scale bar: A, 10 mm; B–D, 0.33 mm. Artist: Gillian Condy.

Specimens examined

KWAZULU-NATAL.—2929 (Underberg): Bushman's Nek, Thamathu Pass, (–CC), 4 Nov.1976, Hilliard & Burt 8930 (PRE); vicinity of Tarn Cave above Bushman's Nek, (–CC), 20 Jan. 1984, Hilliard & Burt 17400 (PRE); Thamatuwe (= Thamathu) Pass, (–CC), 17 Jan.1969, Killick & Vahrmeijer 3996 (PRE).

LESOTHO.—2929 (Underberg): Sehlabathebe National Park, Matsa a Mafikeng, (–CC), 16 Dec.1967, Hoener 1722 (PRE).

EASTERN CAPE.—3028 (Matatiele): Rhodes gravel road/jeep track between Naudesnek and Ben Macdhui, (–CA), 12 Dec. 1999, Koekemoer 1632 (PRE).

5. *Eumorphia dregeana* DC., Prodrum 6: 3 (1838); Harv.: 153 (1865). Type: Eastern Cape, 3124 (Hanover): Middelburg, Sneeuweberg between Kompasberg and Rhenosterberg, 5000–6000' [1 640–1 964 m], (–DC), Sept., Drège s.n., (G-DC, holo. e!; MO e!, M e!, PRE!, SAM e!, E e!, P e!, K e!, NBG e!, iso.).

Multi-stemmed, erect subshrub, 0.3–1.0 m high. Leaves linear-terete, closely imbricate, opposite, slightly pubescent, up to 3.5 mm long, $\pm$ 1 mm broad, entire. Capitula shortly pedunculate, radiate, solitary. Involucre campanulate, 4–7 mm wide when pressed. Involucral bracts in 3 rows, imbricate; outer ovate, glabrous or slightly pubescent, 2×1 mm; middle 2.2×1.2 mm; inner 2.5×1.25 mm, obtuse with membranous tips.

Receptacle paleate; palea membranous, linear, 4 mm long. Ray florets female, 3-toothed, white; corolla limb 5 mm long; corolla tube 1 mm long. Style up to 1.2 mm long, slightly branched, style branches 0.8 mm long, with stigmatic areas along edges. Ovary 2 mm long, slightly striate. Disc florets bisexual, fertile, 5-lobed, yellow; lobes ovate, 0.2 mm long; corolla limb glandular, 1.2 mm long; corolla tube glandular, 1 mm long. Anthers minutely caudate, apical appendage elongated, obtuse. Style up to 1.2 mm long, branched, style branches 0.25 mm long with stigmatic areas along edges and papillate appendages. Ovary 1.5 mm long, slightly striate. Cypsela closely ribbed, 1.5–1.8 mm long, slightly curved, glabrous but minutely papillose especially on ribs, crowned with thickened apical rim. Pappus absent. Flowering time: Feb.–Apr.

Distribution and habitat: *Eumorphia dregeana* occurs in the southeastern Free State and the northwestern Eastern Cape, at 1 311–1 980 m (Figure 2). According to specimens in the National Herbarium, *E. dregeana* grows in False Mountain Renosterveld (Karoo Escarpment Grassland), on sandy slopes and in vleis.

Notes: *Eumorphia dregeana* is named in honour of Jean François (Johann Franz) Drège (1794–1881), a Ger-

man plant collector in South Africa (1826–1834) (Stafleu & Richard 1976). *E. dregeana* can be distinguished from other species in the genus by having closely imbricate, opposite leaves and paleate receptacles.

Specimens examined

FREE STATE.—2927 (Maseru): Thaba Phatshwa Mtn, south of Tweespruit, high up on eastern slope of mountain, (–AC), 3 Apr. 1973, *Muller 1163* (PRE).

EASTERN CAPE.—3124 (Hanover): Cradock, Wapadsberg, plateau, (–DD), 28 Mar. 1947, *Acocks 13552* (PRE). 3125 (Steynsburg): Middelburg, Leeukop Farm, (–DB), 12 Mar. 1950, *Theron 746* (PRE). 3224 (Graaff-Reinet): Oudeberg, (–DD), Apr. 1890, *Bolus 1063* (PRE).

NORTHERN CAPE.—3124 (Hanover): Noupoot, 11 km from Noupoot on road to Colesberg via Oorlogspoort, (–BB), 3 Apr. 1981, *Herman 533* (PRE).

6. ***Eumorphia sericea*** J.M.Wood & M.S.Evans in *Journal of Botany* 35: 488 (1897); Grierson: t. 608 (1972); Hilliard: 332 (1977). Type: Natal, summit of Drakensberg, near Bushman's River Pass, 8000–10 000' [2 624–3 280], Apr. 1896, *M.S. Evans 751*, (NH, holo.; PRE!, K, iso.).

Key to subspecies of *Eumorphia sericea*

- 6a Plant with thick, silky, woolly indumentum, cypselas crowned by a thickened slightly lobulate rim 6a. *E. sericea* subsp. *sericea*
6b Plant more robust with thinner indumentum, pappus scales forming a corona on cypselas 6b. *E. sericea* subsp. *robustior*

6a. subsp. *sericea*

Much-branched, dwarf shrub, 0.2–1.3 m high; outer branches sometimes decumbent, nude below, rough with leaf scars, grey (because of its thick indumentum) silky-woolly, glabrescent, twigs closely leafy. *Leaves* opposite, grey silky-woolly, hairs fluffed up from leaf surface, primary leaves linear or digitately 3-lobed, $\pm 8 \times 1.5$ mm, appearing fascicled from closely leafy, dwarf axillary shoots. *Capitula* solitary, shortly pedunculate, radiate. *Involucre* campanulate, $\pm 7 \times 10$ mm when pressed, villous. *Involucral bracts*: 3 rows, imbricate; outer 3×1.5 mm, ovate; middle 4×1.5 mm; inner 6.5×1.5 mm, obtuse with scarious and lacerate tips. *Receptacle* paleate; paleae membranous, narrowly lanceolate, $\pm 5 \times 0.5$ mm. *Ray florets* female, 3-toothed usually white, but sometimes rose-pink, or white flushed with pink; corolla glandular; corolla limb 10.5 mm long; corolla tube up to 1.8 mm long. *Style* 3 mm long, branched, style branches 0.3 mm long with stigmatic areas along edges. *Ovary* 2.2 mm long, slightly striate. *Disc florets* bisexual, glandular, 5-lobed, yellow; lobes ovate, 0.1 mm long; corolla limb 2 mm long; corolla tube 1 mm long. *Antthers* minutely caudate, apical appendages elongated, obtuse; filaments thickened. *Style* up to 2.5 mm long, branched, style branches 0.18 mm long with stigmatic areas along edges. *Ovary* 2.2 mm long, slightly striate. *Cypselas* narrowly cylindric, ± 2.5 mm long, closely ribbed, glabrous but minutely papillose especially on ribs, crowned with thickened apical rim. *Pappus* absent. *Flowering time*: Nov.–Apr.

Distribution and habitat: *Eumorphia sericea* subsp. *sericea* occurs in Free State, KwaZulu-Natal, Lesotho and Eastern Cape Province, at 2 296–3 414 m (Figure 4). *E. sericea* subsp. *sericea* grows in seasonally wet areas.

Note: although close to *E. prostrata*, it has paleate receptacles.

Specimens examined

FREE STATE.—2828 (Bethlehem): Mont-aux-Sources, summit above chain ladder, (–DB), 14 Jan. 1982, *Roux 1083* (PRE).

KWAZULU-NATAL.—2929 (Underberg): top of Sani Pass, (–CB), 23 Mar. 1962, *Acocks 22159* (PRE).

LESOTHO.—2928 (Marakabeis): Tsienyane Valley, over Meniameng Pass, (–AA), 8 Jan. 1955, *Coetzee 484* (PRE). 2929 (Underberg): Castle Butress, on summit of Drakensberg, (–AA), 18 Dec. 1952, *Killick 1873* (PRE).

EASTERN CAPE.—3028 (Matatiele): Barkly East, Drakensberg, Doodman's Krans Mtn, (–CA), 7 Mar. 1904, *Galpin 6699* (PRE).

6b. subsp. ***robustior*** Hilliard & B.L.Burt in *Notes from the Royal Botanic Garden Edinburgh* 40: 248 (1982). Type: Eastern Cape, 3127 (Lady Frere): Elliot, Fetcani Pass, common bush up to 5' [1.64 m], on slopes and especially in rock-fall scrub, (–BB), 7500' [2 460 m], 22 Jan. 1979, *O.M. Hilliard & B.L. Burt 12331* (NU, holo.; E, PRE!, K, M, S, NBG, iso.).

Green bush because of its thinner indumentum on leaves, more robust, hence its name, pappus scales forming a corona on cypselas. *Flowering time*: Dec.–May.

Distribution and habitat: *Eumorphia sericea* subsp. *robustior* is found in Naudesnek down to Spitskop Farm, at 2 073–2 755 m (Figure 4). This subspecies grows in damp areas.

Specimens examined

EASTERN CAPE.—3027 (Lady Grey): Barkly East, Rhodes to Naudesnek, at foot of cliff, (–DD), 22 Feb. 1971, *Hilliard & Burt 6732* (PRE); Rhodes, roadside between Ugie and Barkly East, (–DD), 10 May 1985, *Hutchings 1706* (PRE). 3028 (Matatiele): Barkly East, Naudesnek, (–CA), 28 Nov. 1971, *Hilliard 5213* (PRE); Naudesnek, between Maclear and Rhodes, (–CC), 7 Dec. 1983, *Van Wyk 6713* (PRE). 3127 (Lady Frere): Elliot, *bastervoeetpad*, rocky ground on hillside and along stream, (–BB), 15 Feb. 1983, *Hilliard & Burt 16657* (PRE).

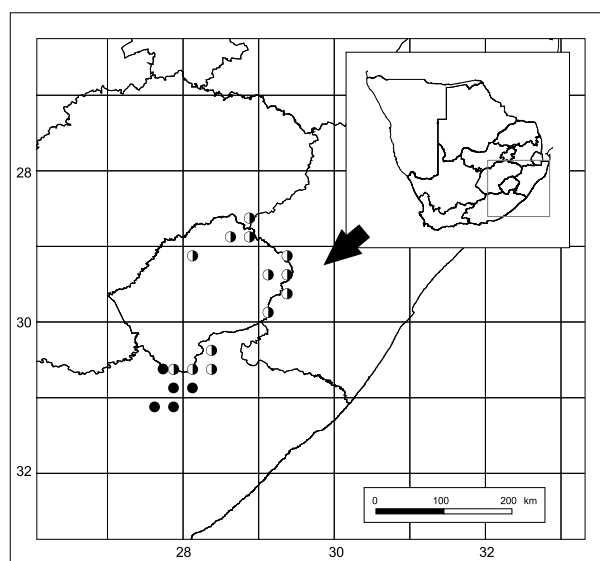


FIGURE 4.—Known distribution of *Eumorphia sericea* subsp. *sericea*, ○; and subsp. *robustior*, ●.

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REFERENCES

- BOLUS, H. 1906. Contributions to the African flora. *Transactions of the South African Philosophical Society* 16: 387, 388.
- BREMER, K. 1994. *Asteraceae: cladistics and classification*. Timber Press, Portland, Oregon.
- BREMER, K. & HUMPHRIES, C. 1993. Generic monograph of the Asteraceae–Anthemideae. *Bulletin of the Natural History Museum, Botany Series* 23: 71–177.
- CANDOLLE, A.P. DE. 1838. *Compositae*. *Prodromus* 6. Treuttel & Würtz, Paris.
- COMPTON, R.H. 1967. *Plantae novae africanae*. *Journal of South African Botany* 33: 293–304.
- GRIERSON, A.J.C. 1972. *Eumorphia sericea*. *Curtis's Botanical Magazine* 178, new series: t. 608.
- HARVEY, W.H. 1865. *Compositae*. *Flora capensis* 3: 44–530.
- HERMAN, P.P.J., RETIEF, E., KOEKEMOER, M. & WELMAN, W.G. 2000. Asteraceae. In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 101–170. National Botanical Institute, Pretoria.
- HERMAN, P.P.J., WELMAN, W.G., RETIEF, E., KOEKEMOER, M. & NETNOU, N. 2003. Asteraceae. In G. Germishuizen & N.L. Meyer, Plants of southern Africa: an annotated checklist. *Strelitzia* 14: 217. National Botanical Institute, Pretoria.
- HILLIARD, O.M. 1977. *Compositae in Natal*. University of Natal Press, Pietermaritzburg, South Africa.
- HILLIARD, O.M. & BURTT, B.L. 1982. Notes on some plants of southern Africa chiefly from Natal: IX. *Notes from the Royal Botanic Garden Edinburgh* 40: 248, 249.
- HOLMGREN, P.K., HOLMGREN, N.H. & BARNETT, L.C. 1990. *Index Herbariorum, part 1: the herbaria of the World*. New York Botanical Garden, New York.
- JACKSON, W.P.U. 1990. *Origins and meanings of names of South African plant genera. Pteridophytes, gymnosperms and monocotyledonous angiosperms*. University of Cape Town, South Africa.
- KÄLLERSJÖ, M. 1985. Fruit structure and generic delimitation of *Athanasia* (Asteraceae–Anthemideae) and related South African genera. *Nordic Journal of Botany* 5: 527–542.
- OBERPRIELER, C., HIMMELREICH, S., KÄLLERSJÖ, M., VAL-LÈS, J., WATSON, L.E. & VOGT, R. 2009. Anthemideae. In V.A. Funk., A. Susanna, T.F. Stuessy. & R.J. Bayer, *Systematics, evolution and biogeography of Compositae*. International Association for Plant Taxonomy, Vienna, Austria.
- OBERPRIELER, C., VOGT, R. & WATSON, L.E. 2007. XVI. Tribe Anthemideae Cass. In K. Kubitzki, *The families and genera of vascular plants. VIII. Flowering plants—eudicots, Asterales* (eds J.W. Kadereit & C. Jeffrey): 342–374. Springer, Berlin.
- OLIVER, I.B. 1989. *Eumorphia prostrata* H.Bol. An indigenous ground cover with horticultural potential. *Veld & Flora* 75: 40.
- PHILLIPS, E.P. 1950. Descriptions and changes of name. *Journal of South African Botany* 16: 20.
- RAIMONDO, D., VON STADEN, L., FODEN, W., VICTOR, J.E., HELME, N.A., TURNER, R.C., KAMUNDI, D.A. & MANYAMA, P.A. (eds). 2009. Red List of South African plants 2009. *Strelitzia* 25. South African National Biodiversity Institute, Pretoria.
- RETIEF, E. & HERMAN, P.P.J. 1997. Plants of the northern provinces of South Africa: keys and diagnostic characters. *Strelitzia* 6. National Botanical Institute, Pretoria.
- SMITH, G.F. & WILLIS, C.K. 1999. *Index herbariorum: southern African supplement*, edn 2: 128. Southern African Botanical Diversity Network Report No. 8. SABONET, Pretoria.
- STAFLEU, A.S. & RICHARD, S.C. 1976. *Taxonomic literature. A selective guide to botanical publications and collections with dates, commentaries and types*, vol. 1: A–G, edn 2. Bohn, Scheltema & Holkema, Utrecht.
- WOOD, J.M. & EVANS, M.S. 1897. New Natal plants. *Journal of Botany* 35: 488. West, Newman, London.
- WEBSITE: Aluka digital library. <http://plants.jstor.org> (accessed June 2011).

Review of the genus *Xenoscapa* (Iridaceae: Crocoideae), including *X. grandiflora*, a new species from southern Namibia

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Keywords: Iridaceae, new species, southern Africa, taxonomy, *Xenoscapa* (Goldblatt) Goldblatt & J.C.Manning

ABSTRACT

The small genus *Xenoscapa* (Goldblatt) Goldblatt & J.C.Manning, endemic to the southern African winter rainfall region, is reviewed. The new species *X. grandiflora* is described from the deeply dissected southern part of the Huib Hoch Plateau in southern Namibia. It differs from the two known species in the genus in its significantly larger, pale lilac flowers. Full descriptions and accounts of all three known species are provided, with distribution maps and illustrations.

INTRODUCTION

Xenoscapa (Goldblatt) Goldblatt & J.C.Manning, one of the smallest genera in Iridaceae, currently comprises two species from the winter rainfall region of southern Namibia and southwestern South Africa. Both are small, deciduous geophytes with two or three, soft-textured, prostrate foliage leaves and unusual, single-flowered, mostly shortly branched spikes (Goldblatt & Manning 1995, 2008). The vegetative similarity between them extends to the flowers, which are long-tubed with relatively small, narrow tepals and shortly exserted, arcuate stamens.

The distinctive combination of single-flowered spikes, tubular flowers, and deeply divided style branches caused a great deal of uncertainty about the taxonomic position of the genus. The slender perianth tube and divided style branches caused the first known species, *Xenoscapa fistulosa* (Spreng. ex Klatt) Goldblatt & J.C.Manning, to be described in the genus *Ovieda* Spreng. (an illegitimate later synonym of *Lapeirousia* Pourr.), from which it was subsequently transferred to *Lapeirousia* (Baker 1877). The rounded corms with fibrous tunics are anomalous there, however, and it was accordingly moved to *Anomatheca* as the monotypic section *Xenoscapa* (Goldblatt 1972). A later morphological cladistic analysis indicated that the species was also misplaced here, combining a unique mix of mainly apomorphic character states, notably the unusual inflorescence, reduced leaf number and cylindrical capsules, containing plesiomorphic, angled seeds. As a result, *Xenoscapa* was recognized as an independent genus, and increased to two species with the addition of a new species from central Namaqualand, *X. uliginosa* Goldblatt & J.C.Manning. The precise relationships of *Xenoscapa* remained uncertain until recent analysis of plastid sequence data placed it as sister to the clade comprising *Devia-Crocasmia-Freesia* (Goldblatt *et al.* 2006). The four genera are currently treated as the tribe *Freesieae* (Goldblatt & Manning 2008).

The two known species of *Xenoscapa* are distinguished by small differences in perianth size and colour, height of the flowering stems in fruit, and the presence or absence of floral fragrance (Table 1). *X. fistulosa* is relatively widespread, occurring throughout the range of the genus, from the Huib Hoch Plateau in southern Namibia southwards along the Namaqualand escarpment and the interior mountains of the southwestern Cape, with two outlying populations along the West Coast (Goldblatt & Manning 2000a). *X. uliginosa*, in contrast, is a highly local endemic restricted to middle and upper elevations of the Kamiesberg, where it may co-occur with *X. fistulosa* (Goldblatt & Manning 1995). A recent collection from the summit of Hohenzollern Peak in the Hunsberge in southern Namibia, slightly east of the recorded range of *X. fistulosa*, is distinctive in its significantly larger, pale lilac flowers with relatively larger anthers, and represents a third species, described here as *X. grandiflora*. We take this opportunity to provide a review of the genus *Xenoscapa*.

MATERIALS AND METHODS

This study is based on an examination of living plants in the field and of specimens in the following herbaria: BOL, MO, NBG, PRE and SAM (acronyms according

TABLE 1.—Distinguishing morphological characters in *Xenoscapa*

Character	<i>fistulosa</i>	<i>grandiflora</i>	<i>uliginosa</i>
Plant height (mm)	(50–)70–200	40–100	30–50
Floral fragrance	Sweet-spicy	None	None
Tube length (mm)	18–25(–33)	33–35	(20–)22–28
Tepal colour	White	Pale lilac with dark nectar guides on lower tepals	Dark pink/purple with dark nectar guides on lower tepals
size (mm)	4–7 × 1–3	12–14 × 4.0–5.5	6–7 × 2–3
dorsal orientation	Erect	Erect	Suberect or erect
Anther length (mm)	1.0–2.5	3.5–4.0	± 2
Capsule length (mm)	(8–)12–20	10–13	± 10

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to Holmgren *et al.* 1990). The abbreviation of author names follows Brummitt & Powell (1992).

TAXONOMY

***Xenoscapa* (Goldblatt) Goldblatt & J.C.Manning** in Systematic Botany 20: 172 (1995). *Anomatheca* sect. *Xenoscapa* Goldblatt: 88 (1972). Type species: *X. fistulosa* (Spreng. ex Klatt) Goldblatt & J.C.Manning.

Seasonal perennials with small, globose corm, rooting from the base and axial in origin; tunics of finely reticulate fibres. *Cataphylls* 2 or 3, pale and membranous. *Leaves* 2 or 3, unifacial, prostrate, soft-textured, with definite midrib; margins with columnar epidermal cells. *Stem* short or long, erect, terete, often with 1–3 short branches. *Inflorescence* of solitary, sessile flowers terminal on axes; bracts green, leathery, inner bracts slightly shorter or more often slightly longer than outer, often notched apically. *Flowers* zygomorphic, tubular or salver-shaped, either cream-coloured and sweetly scented or pink with contrasting markings on lower tepals and unscented, with nectar from septal nectaries; perianth tube cylindric and elongate; tepals subequal, spreading or dorsal erect, slightly larger, and spoon-shaped. *Stamens* unilateral and arcuate, filaments shortly exserted. *Ovary* globose, sessile; style filiform, with short, deeply divided, recurved branches. *Capsules* oblong to cylindric, cartilaginous. *Seeds* strongly angled, with prominent chalazal crest, slightly wrinkled, matte, surface colliculate-rugulose. *Basic chromosome number* $x = 11$.

Three species, in the southern African winter rainfall zone of southern Namibia and western South Africa.

Etymology: from the Greek, *xenos*, for strange and *scapa*, for flowering stem, because of the inflorescence, unusual for subfamily Crocoideae in bearing solitary flowers on the main and lateral branches instead of spikes of multiple flowers.

Key to species

- 1a Flowers white or cream-coloured (rarely very pale pink), without contrasting nectar guides but perianth tube often flushed purple, fragrant; perianth tube 1.0–1.5 mm diam. at mouth; tepals 4–7 × 1–3 mm; anthers 1.0–2.5 mm long; capsules (8–)12–18 mm long 3. *X. fistulosa*
- 1b Flowers lilac to dark pink or purple with contrasting nectar guides on lower tepals, unscented; perianth tube 1.5–2.0 mm diam. at mouth; tepals 6–14 × 2.0–5.5 mm; anthers 2–4 mm long; capsules 10–13 mm long:
 - 2a Flowers dark pink; perianth tube 22–28 mm long; tepals 6–7 × 2–3 mm; anthers ± 2 mm long; plants from Kamiesberg in central Namaqualand 2. *X. uliginosa*
 - 2b Flowers pale lilac; perianth tube 33–35 mm long; tepals 12–14 × 4.0–5.5 mm; anthers 3.5–4.0 mm long; plants from Hunsberge in southern Namibia 1. *X. grandiflora*

1. ***Xenoscapa grandiflora* Goldblatt & J.C.Manning**, sp. nov.

Haec species quoad folia prostrata oblonga et capsulas oblongo-cylindricas *Xenoscapae fistulosae* et *X. uliginosae* similis, sed ab eis floribus pallide lilacinis inodoris, tepalis inferioribus dilute malvino-suffusis, tubo

perianthii 33–35 mm longo, et tepalis 12–14 × 4.0–5.5 mm differt.

TYPE.—Namibia, 2717 (Chamaite): Hunsberge, Hohenzollern Peak, (–CC), 1 July 2007 [fl. in cult. 13 July 2010], *E. van Jaarsveld* sub *J.C. Manning* 3303 (NBG, holo.).

Deciduous geophyte, 40–100 mm high, including flowers. *Corm* subglobose, 6–8 mm diam., tunics of coarse, netted fibres. *Leaves* 3, basal, prostrate, oblong, lower two largest, 45–60 × 15–20 mm, upper leaf ± half as large. *Stem* terete, inclined at base but then stiffly erect, up to 45 mm long, with up to 3 short branches 10–15 mm long, each subtended by a short cauline bract. *Inflorescence* of solitary flowers on main and lateral axes; bracts green, 8–9 mm long, inner slightly longer than outer and often shortly forked apically. *Flowers* zygomorphic with angle widest between upper and lower lateral tepals, tinged pale lilac, darker on tube, lower 3 tepals each with pale creamy yellow patch at base outlined in purple, unscented; perianth tube erect, cylindric, 33–35 mm long, wider and curved just below apex, 2 mm diam. at mouth; tepals subequal but inner slightly wider than outer, 12–14 × 4.0–5.5, weakly cucullate apically, dorsal erect, others spreading horizontally at right angles to tube. *Stamens*: filaments 3–5 mm long, exserted 2–4 mm from tube; anthers 3.5–4.0 mm long, dark purple, pollen grey-blue. *Ovary* ellipsoid; style branching opposite anther bases, branches 4 mm long, deeply forked and apically recurved. *Capsule* oblong-cylindric, 10–13 × 3–4 mm. *Seeds* ± 1 mm diam. *Flowering time*: June–July. Figure 1A–D.

Distribution and ecology: known only from the type collection, made on the summit of Hohenzollern Peak at the southern end of the Hunsberge in southern Namibia (Figure 2) on 1 July 2007 by horticulturist Ernst van Jaarsveld. The plants were tightly wedged in crevices in the shelter of rock outcrops immediately below the eastern edge of the summit plateau, and were just past flowering. Corms that were collected then have subsequently flowered in cultivation. Vegetatively, these plants match photographs of wild plants taken at the time and there is no reason to expect that the dimensions derived from the cultivated specimens will differ in any meaningful way from specimens in the wild. The Hunsberge, in the deeply dissected southern part of the Huib Hoch Plateau, are a recognized site of ecological importance in Namibia, known for a high level of endemism among vertebrates (Barnard *et al.* 1998).

Diagnosis and relationships: *Xenoscapa grandiflora* is distinguished by its large, unscented, pale lilac flowers marked with purple chevrons on the lower tepals, a perianth tube 33–35 mm long and the tepals 12–14 × 4.0–5.5 mm.

Xenoscapa grandiflora is most likely to be confused with *X. uliginosa* from the Kamiesberg, both of which have relatively larger, unscented, generally pink flowers with darker chevrons on the lower tepals but the latter has bright pink or purple flowers with a shorter perianth tube, 22–28 mm long, and smaller tepals, 6–7 mm long, with the dorsal tepal typically suberect or spreading to expose the stamens and style rather than remaining erect



FIGURE 1.—*Xenoscapa* species: A–D, *X. grandiflora*, Van Jaarsveld sub Manning 3303: A, flowering plant; B, flower, front and side views; C, capsules; D, seed. E, F, *X. uliginosa*, Goldblatt & Manning 9244: E, flowering plant; F, capsule. G, H, *X. fistulosa*, Goldblatt & Manning 9374: G, flower and capsule; H, capsule. Scale bar: 10 mm. Artist: John Manning.

after anthesis (Figure 1E). The common and widespread *X. fistulosa* has smaller flowers with uniformly white or cream-coloured (rarely pale pink) tepals (although the tube is usually flushed maroon) and a distinct and noticeable floral fragrance (described as sweetly clove-like).

Both *Xenoscapa fistulosa* and *X. grandiflora* are self-fertile and autogamous, with all flowers setting full capsules of seed that appear well formed (reproductive biology is unknown in *X. uliginosa*). The unscented, lilac flowers with elongate perianth tube and dark purple markings on the lower tepals of *X. grandiflora* are consistent with pollination by long-proboscid flies, the pollination system in *X. uliginosa* (Manning & Goldblatt 1996; Goldblatt & Manning 2000b).

2. *Xenoscapa uliginosa* Goldblatt & J.C.Manning in Systematic Botany 20: 173 (1995). Type: South Africa, [Northern Cape], Namaqualand, Farm Modderfontein, lower east-facing slopes of Sneekop, $\pm 1\ 400$ m, 18 Sept. 1981, Goldblatt & Manning 9244 (NBG, holo.!; K!, MO!, PRE!, iso.).

Deciduous geophyte, 30–50 mm high, including flowers. *Corm* subglobose, 5–8 mm diam.; tunics of fine, netted fibres. *Leaves* 3, basal, prostrate, oblong, lower two largest, $20\text{--}40 \times 5\text{--}18$ mm, upper leaf $\pm$ half as large. *Stem* terete, inclined at base but then stiffly erect, up to 40 mm long, with up to 3 short branches 5–10 mm long, each subtended by a short cauline bract. *Inflorescence* of solitary flowers on main and lateral axes; bracts green,

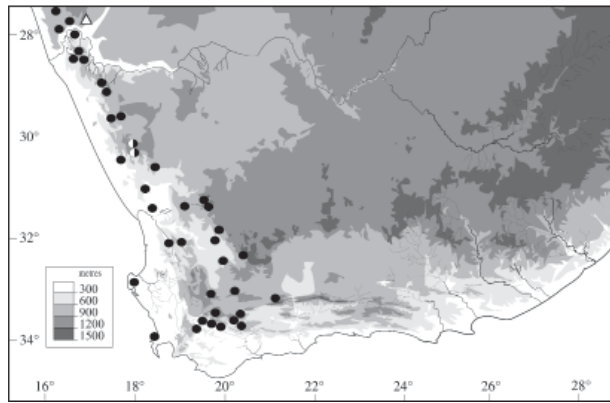


FIGURE 2.—Known distribution of *Xenoscapa fistulosa*, ●; *X. grandiflora*, △; *X. uliginosa*, ○.

6–7 mm long, inner slightly longer than outer and often shortly forked apically. Flowers zygomorphic, dark pink or purple, darker on tube, lower 3 tepals each with pale creamy yellow patch at base outlined in purple, unscented; perianth tube erect, cylindric, (20–) 22–28 mm long, wider and curved just below apex, 1.5–2 mm diam. at mouth; tepals subequal but inner slightly wider than outer, 6–7 × 2–3 mm, weakly cucullate apically, dorsal erect or suberect and exposing anthers. Stamens: filaments 3–5 mm long, exserted ± 2 mm from tube; anthers ± 2 mm long, dark purple, pollen grey-blue. Ovary ellipsoid; style branching opposite anther bases, branches 2 mm long, deeply forked and apically recurved. Capsule oblong, ± 10 × 3–4 mm. Seeds ± 1 mm diam. Flowering time: mid Sept.–Oct., rarely into early Nov. Figure 1E, F.

Distribution and ecology: restricted to the Kamiesberg in central Namaqualand, and known originally only from Sneeuwberg but recently collected in the Langkloof east of Stalberg, at the foot of Rooiberg (Figure 2). *Xenoscapa uliginosa* has a specialized habit along the margins of seasonal seeps and in rock flushes. During the growing season the roots are constantly irrigated by water percolating through the mossy sward in which the corms are anchored.

The long-tubed, bright pink flowers are pollinated by the long proboscis fly *Prosoeca peringueyi* (Nemestrinidae) (Manning & Goldblatt 1996).

Diagnosis and relationships: *Xenoscapa uliginosa* is recognized by its moderately large, dark pink or purple, unscented flowers marked with purple chevrons on the lower tepals, perianth tube 22–28 mm long, and tepals 6–7 × 2–3 mm. Plants from the Sneeuwberg have the dorsal tepal ± suberect to expose the anthers and style but a recent collection from the Langkloof on the southern flank of the Rooiberg massif (Goldblatt & Porter 13575), representing the second known station for the species, has the dorsal tepal erect over the stamens and style, and the length of the perianth tube at the lower end of the range recorded for the species. In other respects, however, including the short, oblong capsules, the Rooiberg plants match those from the type locality and there is at present no reason to suspect that they are not conspecific.

The species might be confused with *Xenoscapa grandiflora* from southern Namibia but that species has larger, pale lilac flowers with a much longer perianth tube, 33–35 mm long, and the dorsal tepal 12–14 mm long. Flowering in *X. uliginosa* is also generally later, in September and October (rarely into November) rather than in mid-winter.

Additional material examined

NORTHERN CAPE.—3017 (Hondekliopbaai): Modderfonteinberg, (–BB), 4 Nov. 1830, Drège 2635 (P); Sneeuwkop, above Modderfontein Farm, (–BB), 15 Sept. 1990, Rourke & Nelson 1936 (NBG); Sneeuwkop, Bovlei Farm, (–BB), 28 Sept. 1991, Bean & Trinder-Smith 2634 (BOL). 3018 (Kamiesberg): Langkloof, Farm Naartjiesdam, (–AC), 23 Sept. 2010, Goldblatt & Porter 13575 (NBG, MO).

3. *Xenoscapa fistulosa* (Spreng. ex Klatt) Goldblatt & J.C. Manning in Systematic Botany 20: 172 (1995). *Ovieda fistulosa* Spreng. ex Klatt: 781 (1863). *Lapeirousia fistulosa* (Spreng. ex Klatt) Baker: 155 (1877). *Anomatheca fistulosa* (Spreng. ex Klatt) Goldblatt: 88 (1972). Type: South Africa, [Western Cape], Olifants River, Clanwilliam, without date, Ecklon & Zeyher Irid. 254 (B, holo.; MO!, PRE!, iso.).

Deciduous geophyte, (50–)70–200 mm high, including flowers. Corm subglobose, 5–8 mm diam.; tunics of fine to medium-textured, netted fibres. Leaves 3, basal, prostrate, oblong, lower two largest, 20–50(–70) × 5–18(–20) mm, upper leaf ± half as large. Stem terete, inclined at base but then stiffly erect, up to 180 mm long, with up to 4 short or longer branches 5–30 mm long, each subtended by a short cauline bract. Inflorescence of solitary flowers on main and lateral axes, sometimes a second inflorescence developing in axil of upper leaf; bracts green, 5–7 mm long, inner slightly longer than outer and often shortly forked apically. Flowers zygomorphic, white or cream-coloured, rarely pale pink, flushed purplish on tube, unmarked, with sweet-spicy fragrance; perianth tube erect, cylindric, 18–25(–33) mm long, wider and curved just below apex, 1.0–1.5 mm diam. at mouth; tepals subequal, 4–7 × 1–3 mm, weakly cucullate apically, dorsal erect but others spreading ± horizontally at right angles to tube. Stamens: filaments 3–5 mm long, exserted ± 2 mm from tube; anthers 1.0–2.5 mm long, dark purple, pollen grey-blue. Ovary ellipsoid; style branching between base and middle of anthers, branches 2 mm long, deeply forked and apically recurved. Capsule oblong to cylindric, (8–)12–20 × 2.5–4.0 mm. Seeds ± 1 mm diam. Flowering time: mainly Aug.–Sept., rarely in late July. Figure 1G, H.

Distribution and ecology: widely distributed along the near interior of the southern African Atlantic coast and the western Karoo, *Xenoscapa fistulosa* extends from Aurusberg and the southern edge of the Huib Hoch Plateau in southern Namibia through the higher-lying parts of the Richtersveld and Namaqualand into Western Cape, where it occurs in the northern Cedarberg and inland onto the Roggeveld Escarpment, thence southwards into the Worcester Valley as far east as Montagu and thence to Laingsburg and the northern foothills of the Klein Swartberg, with two isolated stations along the coast, one at Vredenburg and the other on the lower slopes of Lions Head on the Cape Peninsula (Figure 2).

The species is mostly restricted to shale or gneiss/granite substrates, rarely on other rock types in the Richtersveld and southern Namibia, from near sea level to almost 1 300 m. It does not occur on sandstone-derived soils of the Cape System and is thus virtually absent from the southwestern Cape mountain systems—the two coastal stations in the southwestern Cape are on granite outcrops.

Plants are invariably restricted to cool, seasonally moist or wet and largely shaded situations in the lee of rocks or boulders, with the corms often anchored in moss pads. The flowering season is substantially lengthened in years of favourable rainfall by the development of a secondary inflorescence from the upper leaf axil. This has not been observed in the other two species.

The pale, mostly white or cream-coloured flowers of *Xenoscapa fistulosa* with their sweet-spicy fragrance suggest that the species is adapted to moth pollination. It co-occurs with long-proboscid fly-pollinated *X. uliginosa* in the Kamiesberg (Bean & Trinder-Smith 2642 & 2634 respectively), and hybrids between the two (Goldblatt 9244A MO) are known (Goldblatt & Manning 1995).

Diagnosis and relationships: *Xenoscapa fistulosa* is recognized by relatively long-tubed, white or cream-coloured (rarely pale pink) flowers with a strong sweet-spicy fragrance. The slender perianth tube is mostly 18–25 mm long, exceptionally 30–33 mm long in plants from Pakhuis Pass and the northern Cedarberg (Leipoldt s.n., Goldblatt 544), and only 1.0–1.5 mm in diameter at the mouth. The tepals are mostly smaller and narrower, 4–6(–7) × 1–3 mm, than in pink-flowered *X. grandiflora* and *X. uliginosa* (Table 1). Most collectors remark on the strong floral fragrance, which immediately distinguishes the species from its unscented congeners.

Although the species is typically white-flowered, populations from the Richtersveld and southern Namibia often have pale pink flowers [see Williamson (2000): 127 *Xenoscapa fastuosa* (sic.) for illustration]. The smallest-flowered species in the genus, *X. fistulosa* may grow much taller than the other species, the stem reaching up to 180 mm long, with the lateral branches up to 30 mm long. The capsules are similarly often significantly longer, up to 18 mm long and strongly cylindric. The two outlying coastal populations, from Witteklip at Vredenburg and Lion's Head on the Cape Peninsula, although well separated geographically from the main range of the species, do not evidently differ morphologically from inland populations.

Additional material examined

NAMIBIA.—2716 (Witputz): Karas, Aurusberge, saddle overlooking Roter Kamm, (–CB), 28 Sept. 1996, Mannheimer & Burke 393 (WIND); Rosh Pinah, Spitskop, (–DC), 25 Sept. 1981, Müller & Horn 1599 [sic] (WIND); 9 Aug. 2000, Bruyns 8314 (NBG); Rosh Pinah, Sonberg, (–DD), 3 Sept. 2000, Bruyns 8855 (NBG); Witputz, Zebrafontein, (–DD), 22 Sept. 1981, Müller & Horn 1599 [sic] (PRE). 2816 (Oranjemund): Diamond Area No. 1, Obib Mtn. Peak, (–BA), 3 Sept. 1989, Van Wyk 9028 (PRE).

NORTHERN CAPE.—2817 (Vioolsdrif): Langermanskop, (–AA), 29 Jul. 1993, Van Jaarsveld & Bezuidenhout 13430 (NBG); Rosyntjesberg, neck north of Lelieshoek, (–AC), 30 Aug. 1977, Oliver, Tolken & Venter 294 (PRE); Stinkfontein Mtns, Cornellsberg, (–CA),

6 Sept. 1977, Oliver, Tolken & Venter 710 (PRE); summit of Ploegberg complex, (–CD), 5 Aug. 1979, Van Berkel 104 (NBG). 2917 (Springbok): Steinkopf, (–AA), Aug. 1925, Marloth 6769 (NBG, PRE); Spektakelberg, Farm Naries, (–AA), 26 Aug. 1983, Van Wyk 6452 (PRE); Bulletrap–Nigramoep road, 1 km east of Doringrivier, (–BC), 26 Aug. 1981, Van Berkel 426 (NBG); Springbok, NE of Platjiesfontein Farm, (–DA), Sept. 1995, G & F Williamson 5703 (NBG); Concordia, (–DB), Sept. 1883, Bolus 695 (BOL, SAM). 3017 (Hondeklipbaai): Sneekop, Bovlei Farm, (–BB), 28 Sept. 1991, Bean & Trinder-Smith 2642 (BOL); 16 miles [25.6 km] SW of Garies, (–DB), without date, Hall 3763 (NBG). 3018 (Kamiesberg): granite dome NE of Farm Outuin, (–AA), 21 Aug. 2001, Goldblatt & Porter 11734 (MO, NBG); Studer's Pass, (–AC), 19 Aug. 1986, Bean 1717 (BOL); Grasberg, (–CB), 22 Aug. 1999, Desmet 166 (NBG); Klippoort-se-Berg, (–CB), 21 Aug. 1999, Desmet 140 (NBG); Langberg, W of Loeriesfontein, (–DB), 5 Sept. 2006, Goldblatt & Porter 12766 (MO, NBG). 3119 (Calvinia): Menzieskraal Farm, (–AC), Sept. 1899, Leipoldt 825 (SAM); lower slopes of Hantam Mtns, Akkerendam, (–BD), 22 Jul. 1961, Lewis 5807 (NBG); Menzieskraal Farm, (–CB), 22 Aug. 1986, Snijman 1077 (NBG); Keiskie-se-poort, (–DB), 17 Sept. 2008, Goldblatt & Porter 13134 (MO, NBG). 3220 (Sutherland): Tankwa Karoo National Park, Farm Klipfontein, (–AA), 14 Sept. 2007, Sachse 554 (PRE); Tankwa Karoo National Park, Farm Kleinfontein, (–AA), 6 Aug. 2006, Kloppe 335 (PRE); Agterkop Farm, (–AA), 5 Aug. 2006, Steyn 901 (PRE); Soekop Farm, Bohoek, (–AA), 8 Aug. 2006, Rösch 462 (NBG); Tankwa Karoo National Park, near Paulshoek, (–AC), 27 Aug. 2004, Steyn 589 (PRE); Kuduberg, Muis-hondhoogte, (–CA), Sept. 1921, Marloth 10382 (PRE); Houthoek, (–CA), 15 Aug. 1968, Hanekom 1092 (PRE); Verlatekloof Pass, (–DA), 25 Aug. 2004, Steyn 553 (PRE).

WESTERN CAPE.—3118 (Vanrhynsdorp): Mauwerskop, (–DB), 20 Aug. 1986, Snijman 1058 (NBG). 3217 (Vredenburg): Witteklip, near Vredenburg, (–DD), 1 Sept. 1944, Lewis 890 (SAM). 3218 (Clanwilliam): Olifants River, (–BB), 25 Aug. 1894, Schlechter 5024 (BOL); east bank of lower Clanwilliam Dam, (–BB), 8 Sept. 1976, Thompson 2819 (NBG). 3219 (Wuppertal): Clanwilliam, Alpha Farm, (–AA), 20 July 1941, Bond 1054 (NBG); Pakhuis Pass, (–AA), 3 Sept. 1933, Leipoldt s.n. BOL45054 (BOL); near top of Bidouw Pass, (–AA), 14 Sept. [without year], Goldblatt 544 (BOL). 3220 (Sutherland): Farm Thyskraal, (–CC), 7 Sept. 1986, Cloete & Haselau 292 (NBG). 3318 (Cape Town): Lions Head, (–CD), Aug. 1924, Rennie & Giffen s.n. SAM27416 (SAM); slopes of Lions Head, (–CD), Aug. 1940, Lewis 4293 (SAM). 3319 (Worcester): Karooport, (–BA), 18 Sept. 1938, Hafstrom & Acocks 315 (PRE); 16 Sept. 1971, Thompson 1261 (NBG); Hex River Pass, near top, (–BD), 2 Sept. 1992, Goldblatt & Manning 9374 (PRE); Worcester, Karoo Garden, (–CB), 28 July 1975, Dobay 21 (NBG); 13 Aug. 1970, Bayer 2 (NBG); Stettyn area, Farm Kleindoom, (–CD), 1971 [without precise date], Oliver 3280 (NBG, PRE); N end of Farm Alfalfa, near Moordkuil, (–DA), 26 Sept. 1983, Goldblatt & Snijman 6971A (MO, NBG). 3320 (Montagu): Whitehill Ridge, (–BA), 17 Aug. 1942, Compton 13377 (NBG); Oudeberg, NE of Montagu, (–CB), 27 July 1959, Acocks 20533 (PRE); 8 km SE of Montagu, Farm Amanzi, (–CD), 15 Aug. 1993, Manning 2028 (NBG); S foothills of Voetpadsberg, Farm Doringkloof, (–DB), 23 Aug. 1985, Van der Kooy 30 (NBG). 3321 (Ladismith): Kleinswartberg foothills, road to Seweweekspoort, Farm Modderfontein, (–AC), 21 Sept. 2003, Goldblatt & Porter 12327 (MO, NBG).

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REFERENCES

- BAKER, J.G. 1877 [1878]. Systema iridearum. *Journal of the Linnean Society, Botany* 16: 61–180.
- BARNARD, P., BETHUNE, S. & KOLBERG, H. 1998. Biodiversity of terrestrial and freshwater habitats. In P. Barnard, *Biological diversity in Namibia: a country study*: 57–187. Namibian National Biodiversity Taskforce, Windhoek.

- BRUMMITT, R.K. & POWELL, C.E. 1992. *Authors of plant names*. Royal Botanic Gardens, Kew.
- GOLDBLATT, P. 1972. Revision of *Lapeirousia* and *Anomatheca* in the winter rainfall area of southern Africa. *Contributions from the Bolus Herbarium* 4: 1–111.
- GOLDBLATT, P., DAVIES, T.J., MANNING, J.C., VAN DER BANK, M. & SAVOLAINEN, V. 2006. Phylogeny of Iridaceae subfamily Crocoideae based on a combined multigene plastid analysis. *Aliso* 22: 399–411.
- GOLDBLATT, P. & MANNING, J.C. 1995. Phylogeny of the African genera *Anomatheca* and *Freesia* (Iridaceae: Ixioideae), and a new genus *Xenoscapa*. *Systematic Botany* 20: 161–178.
- GOLDBLATT, P. & MANNING, J.C. 2000a. 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. & MANNING, J.C. 2000b. The long-proboscid fly pollination system in southern Africa. *Annals of the Missouri Botanical Garden* 87: 146–170.
- GOLDBLATT, P. & MANNING, J.C. 2008. *The iris family: natural history and classification*. Timber Press, Oregon.
- HOLMGREN, P.K., HOLMGREN, N.H. & BARNETT, L.C. 1990. *Index herbariorum, Part 1: the herbaria of the World*. New York Botanical Garden, New York.
- KLATT, F.W. 1863. Revisio iridearum. *Linnaea* 32: 689–784.
- 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.
- WILLIAMSON, G. 2000. *Richtersveld. The enchanted wilderness*. Umduas, Hatfield, Pretoria.

Notes on African plants

VARIOUS AUTHORS

NYCTAGINACEAE

NOTES ON *COMMICARPUS* IN SOUTHERN AFRICA, INCLUDING A NEW RECORD FOR NAMIBIA

Commicarpus Standl. is a genus in the Nyctaginaceae with its main distribution range in Africa (Meikle 1978). In southern Africa, nine species occur which are widely distributed in the region, with its centre of diversity in Namibia (Germishuizen & Meyer 2003). No formal taxonomic research has specifically been conducted on *Commicarpus* in southern Africa. Most of the existing knowledge of the group is based on floras from elsewhere in Africa (Baker & Wright 1909; Hutchinson & Dalziel 1927; Meikle 1954; Stannard 1988; Whitehouse 1996).

Anthocarp morphology is considered to provide the most differential characters of the family (Smith 1976; Willson & Spellenberg 1977; Bohlin 1988; Douglas & Manos 2007). An anthocarp consists of a fruit (an achene or utricle) enclosed in a persistent, accrescent, hard, leathery or fleshy base of the calyx tube (Bogle 1974). The anthocarp of the southern African *Commicarpus* species is 5–10 × 2–3 mm, cylindrical, fusiform, clavate or elliptic-clavate with ten obscure ribs and large, dark, mucilaginous, wart-like glands scattered over the surface. The apex is surrounded by ten glands which are either stalked or sessile.

An investigation of the anthocarp morphology of the southern African *Commicarpus* species has revealed numerous misidentifications in southern African herbaria. These misidentifications were probably based on leaf morphology and growth form which do not vary considerably between *Commicarpus* species. Finer morphological differences of the anthocarps facilitate the construction of a key to accurately differentiate between the taxa below genus level.

Key to species

- 1a Anthocarp cylindrical with sessile glands around apex 1. *C. chinensis* subsp. *natalensis*
- 1b Anthocarp fusiform, clavate or elliptic-clavate with stalked and sessile glands around apex:
 - 2a Anthocarp elliptic-clavate 2. *C. pilosus*
 - 2b Anthocarp fusiform or clavate:
 - 3a Anthocarp fusiform:
 - 4a Ring of five stalked glands alternating with five sessile glands around apex; anthocarp 4–6 mm long 3. *C. squarrosus* or 4. *C. fruticosus*
 - 4b Ring of ten stalked glands around apex; anthocarp 7–9 mm long:
 - 5a Surface of anthocarp below apex covered sparsely with short-stalked glands (< 1 mm long) grouped together 5. *C. plumbagineus*
 - 5b Surface of anthocarp below apex covered with scattered sessile glands 6. *C. fallacissimus*
 - 3b Anthocarp clavate:
 - 6a Anthocarp broadly clavate; surface covered with prominent glandular hairs; apex surrounded by ten short-stalked glands (< 1 mm) 7. *C. decipiens*
 - 6b Anthocarp clavate; surface glabrous to puberulent; apex surrounded by five stalked glands alternating with five sessile glands:
 - 7a Apex surrounded by five thick-stalked glands, stalks < 1 mm long 8. *C. pentandrus*
 - 7b Apex surrounded by five thin-stalked glands, stalks 1–2 mm long 9. *C. helenae* var. *helenae*

The key has facilitated the re-identification of large-fruited *Commicarpus* specimens collected from Namibia. We have identified these specimens as *Commicarpus helenae* (Roem. & Schult.) Meikle var. *helenae*, a variety with a wide distribution from the Middle East into Africa, which also occurs on the islands of the Canaries, Cape Verde and the type locality, St Helena (Meikle 1978). In the *Flora of southern African (FSA)* region, it was hitherto only known from Botswana and the Limpopo Province of South Africa and was not considered to occur in Namibia (Germishuizen & Meyer 2003). In southern Africa, the taxon has been regarded as of limited occurrence, as the circumscription of *Commicarpus helenae* var. *helenae* has generally been misunderstood. Based on anthocarp structure, we can confirm that many southern African specimens of *C. helenae* var. *helenae* have been misidentified and erroneously placed under *C. fallacissimus* (Heimerl) Heimerl ex Oberm., Schweick. & I. Verd., *C. pentandrus* (Burch.) Heimerl, *C. pilosus* (Heimerl) Meikle, *C. plumbagineus* (Cav.) Standl. var. *plumbagineus* and *C. squarrosus* (Heimerl) Standl. Especially the misidentifications as *C. fallacissimus*, *C. pilosus* or *C. squarrosus* can be ascribed to the semisucculent leaves and growth form that these taxa share with *C. helenae* but the anthocarps differ considerably in shape and gland characters (Figure 1). As a result, the distribution patterns of these taxa in the FSA region have also been misinterpreted.

We can therefore confirm the presence of *Commicarpus helenae* var. *helenae* in Namibia based on the anthocarp structure of the specimens being most similar to what is generally regarded as typical for the species (Struwig *et al.* 2010). The anthocarp is clavate and tapers markedly from the apex to the base with a ring of five, long, stalked glands around the apex and two rings of sessile glands below. However, a specimen from Khowarib (Struwig 44) in the Kaokoveld, differs from other specimens in that the five stalked glands around the apex are longer (2 mm) than those recorded for other specimens from southern Africa (1 mm) (Figure 2). This taxon is being investigated further.

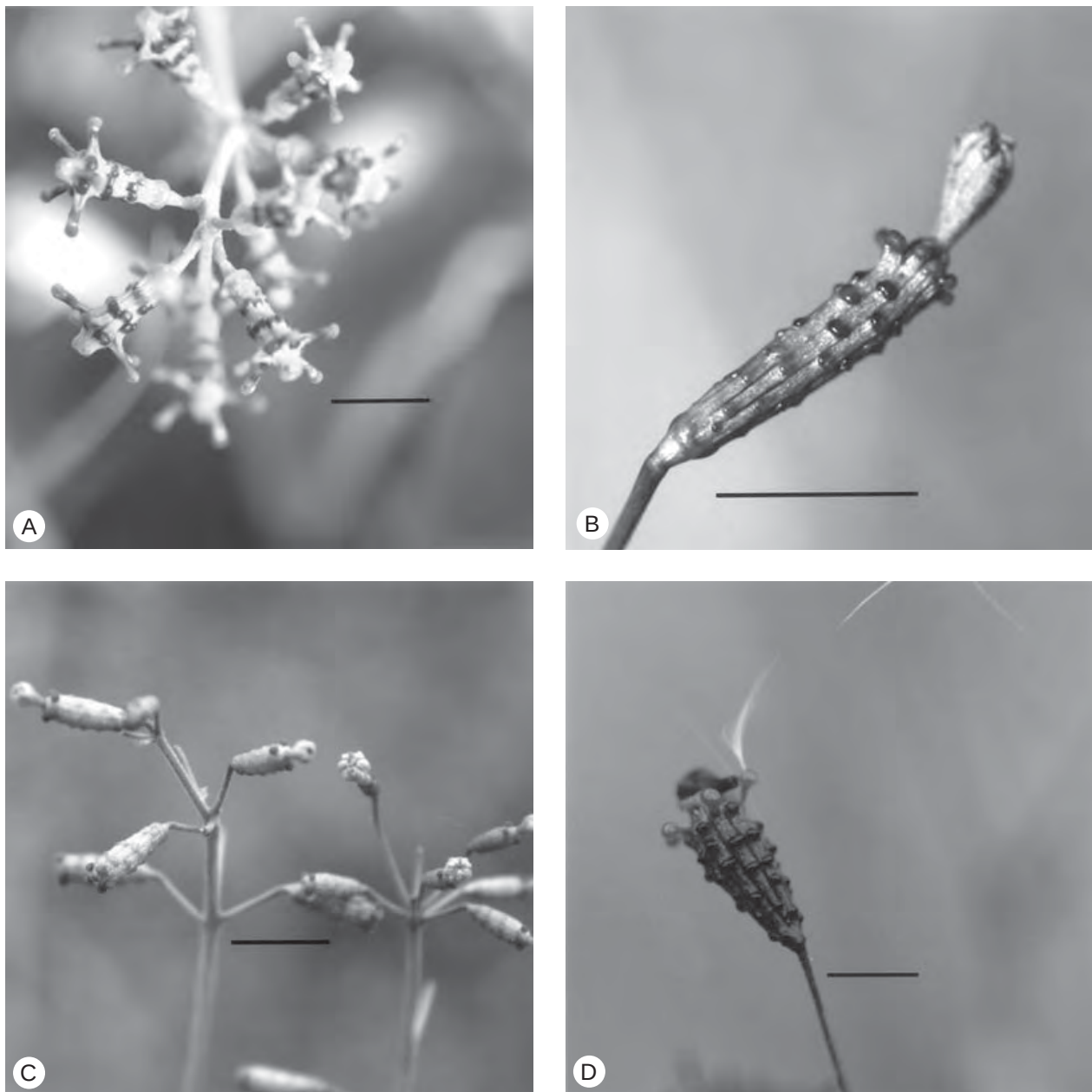


FIGURE 1.—Anthocarps of *Commicarpus*: A, *C. helenae* var. *helenae*; B, *C. fallacissimus*; C, *C. pilosus*; and D, *C. squarrosus*. Scale bars: 5 mm. Photographs: S.J. Siebert.

***Commicarpus helenae* (Roem. & Schult.) Meikle** in Hooker's *Icones Plantarum* 7, 4: t. 3694 (1971). *Boerhavia helenae* Roem. & Schult.: 73 (1822). Type: St Helena, Ladder Hill, *Burchell 1* [K, neo., designated by Whitehouse (1996).—Aluka image, website accessed 08-02-2010].

Boerhavia stellata Wight: 6, t. 875 (1843) non *B. stellata* Bojer: 188 (1842) nom. illegit. *C. stellatus* (Wight) Berhaut: 51 (1953). Type: India.

[*C. verticillatus* sensu Baker & Wright: 6 (1909); sensu Hutchinson & Dalziel: 153 (1927); sensu Heimerl: 117 (1934); sensu Balle: 86 t. 7 (1951); sensu Meikle: 1 (1954); non Standl.: 101 (1916)].

Commicarpus helenae* (Roem. & Schult.) Meikle var. *helenae

Herb, from a woody rootstock. *Stems* 1.0–1.5 m long, slender, erect, decumbent or scrambling, branching,

pubescent or glabrous. *Leaves* ovate, 15–50 × 10–40 mm, ± fleshy, pubescent to glabrous, apex rounded to acute, apiculate, base cordate, rounded or more or less truncate, slightly attenuate along petiole; margins entire to somewhat repand; petioles, 4–22 mm long, sparsely pubescent. *Inflorescence* narrow, verticillate, long-pedunculate, peduncles sparsely pubescent; bracts linear-lanceolate, 1–2 mm long, pubescent. *Flowers* sessile to very shortly pedicellate. *Perianth* 4.0–5.0(–6.5) mm long, lower portion sulcate with 5 prominent viscid glands around apex, upper portion 2.0–3.0(–4.5) mm long, widely infundibuliform with a short (1 mm) inconspicuous tube, pubescent; sepals purple, mauve, magenta, pink, white or yellow. *Stamens* 2 or 3; filaments 4–5(–6) mm long; anthers transverse-elliptic to rounded, 0.3–0.5 mm long. *Ovary* ellipsoid, shortly stipitate, 0.5–0.6 mm long, glabrous; style 3.0–3.5(–5.5) mm long. *Anthocarp* clavate, tapering markedly

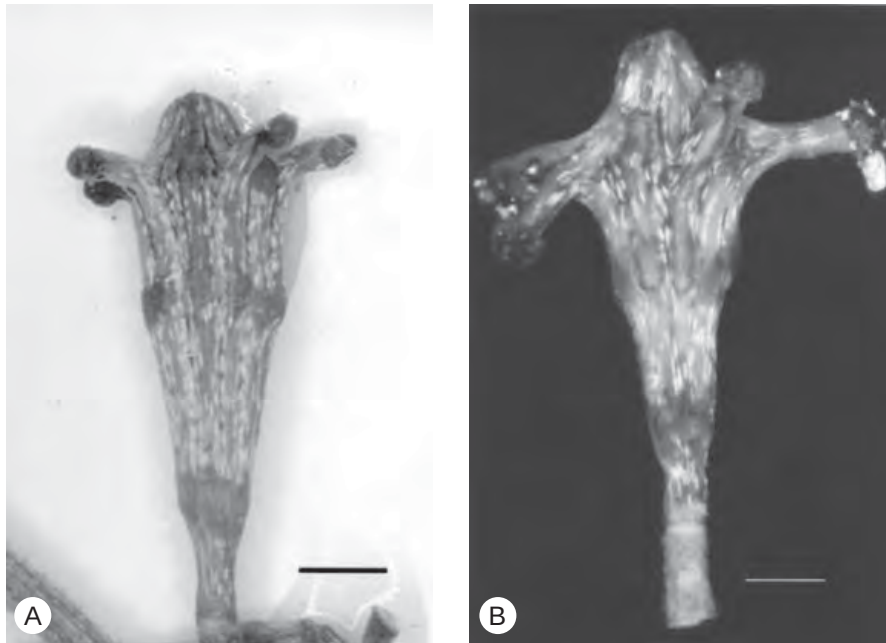


FIGURE 2.—Light microscope micrographs of anthocarps of *Commicarpus helenae* var. *helenae*. A, specimen collected from Kruger National Park, South Africa, *Zambatis* 1954; B, specimen collected from Khowarib, Namibia, *Struwig* 44. Scale bars: 1 mm.

from apex to base, $3.5\text{--}7.0 \times 1.0\text{--}2.5$ mm, sessile viscid glands in rings, 5 stalked viscid glands, 1–2 mm long, alternating with 5 sessile glands around apex Figures 1A; 2A, B.

Commicarpus helenae has two varieties based on characters of a morphological and biogeographical nature. *Commicarpus helenae* (Roem. & Schult.) Meikle var. *barbatus* Meikle differs from the typical variety in having remarkably hairy stems and leaves (Meikle 1979, 1983). Its distribution is restricted to tropical Africa (Klopper *et al.* 2006; African Plant Database 2010). In Africa, the typical variety occurs as far south as N'watinwambu in the Kruger National Park, South Africa (*Maurin & Van der Bank* OM348).

Distribution and habitat: previously only 11 localities of *Commicarpus helenae* var. *helenae* were known for southern Africa, but our redeterminations have increased this figure to 25, suggesting that the taxon is much more

part of the southern African flora than was previously thought (Figure 3). It has been recorded from similar habitat types in Namibia and South Africa. Labels generally describe the habitat as rocky, in sandy, loamy or alluvial soil in calcrete or sandstone areas.

Specimens examined

NAMIBIA.—1713 (Swartbooisdrif): Omitengundi, 500 m north of road junction, (–AB), 09-04-1998, *Schulte* 108530 (WIND). 1913 (Sesfontein): Khowarib Rest Camp, underneath *Acacia* and Mopani trees, (–BD), 09-02-2009, *Struwig* 44 (PUC, WIND). 1916 (Gobaub): Etosha National Park, Charitsaubplain, near pan with *Acacia reficiens*, (–AA), 18-04-1973, *Le Roux* 520 (WIND, PRE). 2115 (Karibib): Spitzkoppe, (–DC), 03-03-1985, *Craven* 2022 (WIND). 2216 (Otjimbingwe): Okomitundu Farm, underneath *Acacia* trees in front of gate to house, (–AB), 12-04-2010, *Struwig* 183 (PUC, WIND).

BOTSWANA.—2022 (Lake Ngami): Lake Ngami, Mwaku Pan near Sehitwa, slopes around Mwaku Pan, (–BD), 12-1969, *Van der Spuy* 30 (PRE, UCBG); north of Ngwanalekau Hills, open areas (often termitaria) in *Terminalia prunioides* woodland, (–DB), 14-03-1969, *Burger* 1149 (PRE, UCBG). 2122 (Kobe): ± 10 km past Kuke Village on road to Maun, (–AB), 06-03-1996, *Burgoyne & Snow* 5283 (PRE, UCBG). 2123 (Pink Pan): central Kalahari, (–AA), 02-02-1991, *Barnard* 586 (PRE, UCBG). 2125 (Lothlekane): Orapa, (–AD), 16-03-1975, *Kerfoot* 7748 (PRE, UCBG).

LIMPOPO.—2229 (Waterpoort): Breslau Game Farm, base of koppie, (–AC), 05-05-2000, *Straub* s.n. (PUC); Breslau Game Farm, (–AC), 30-05-2000, *Straub* 831 (PRE); Langjan Nature Reserve, (–CC), 12-1974, *Zwanziger* 496 (PRE); Soutpan 193, thinly scattered in outer circle of salt pan, (–CD), 19-11-1932, *Obermeyer, Schweickerdt & Verdoorn* 19 (PRE); Soutpan, west side of pan, (–CD), 21-01-1931, *Bremekamp & Schweickerdt* 249 (PRE, PRU). 2230 (Messina): Tshipiza work station (Greater Kudu Safari), (–CB), 06-12-1984, *Van Wyk* 6887 (PRE, PRU). 2331 (Phalaborwa): 50 m west of Shingwedzi River, over cement drift on bank, (–AA), 11-03-2010, *Struwig* 141 (KNP, PUC); 150 m west of cement drift over Shingwedzi River, upstream of Red Rocks, (–AA), 14-01-1994, *Zambatis* 1954 (KNP, PRE); Letaba River, western border Mhlangene, (–CA), 01-12-1992, *Van Rooyen & Bredenkamp* 582 (PRU). 2431 (Acornhoek): Kingfisherspruit, Timbavati, (–AD), 21-12-1962, *Biologiese Afdeling* 4592 (KNP, PRE); Klaserie Nature Reserve, Farm Ross 55KU, (–AD), 16-12-1981, *Zambatis* 1306 (PRE); Timbavati Private Nature Reserve, Hans Hoheisen Wildlife Reserve Station, Kempiana 90KU, (–AD), 18-12-1982, *Zambatis* 1526 (PRE); Kruger National Park, Acornhoek, in grassland, (–BC), 03-1975, *Gertenbach* 5042 (PRE).

MPUMALANGA.—2431 (Acornhoek): Kruger National Park, Nkuhlu Partial Exclosure, Sabie River, (–DD), 08-12-2010, *Van Collier*,

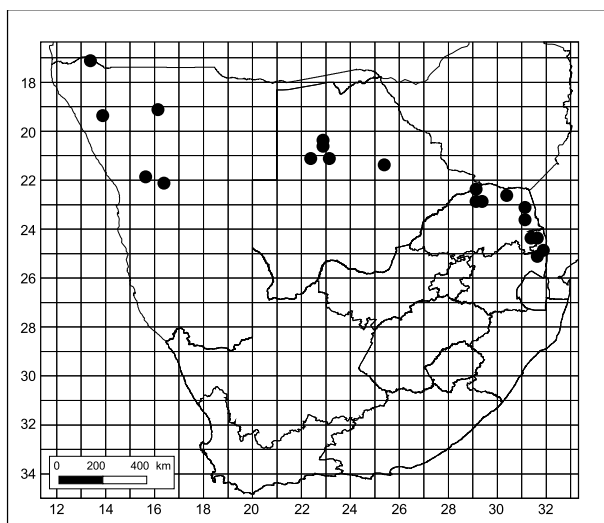


FIGURE 3.—Distribution of *Commicarpus helenae* var. *helenae* in southern Africa.

Siebert & Siebert, 4339 (PUC), 2531 (Komatipoort): N'watinwambu firebreak about 1 km from S114 road, (–BA), 05-12-2005, Maurin & Van der Bank OM348 (KNP).

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REFERENCES

- AFRICAN PLANT DATABASE. 2010. Version 3.3. Conservatoire et Jardin botaniques de la Ville de Genève and South African National Biodiversity Institute, Pretoria. <http://www.ville-ge.ch/musinfo/bd/cjb/africa/> (accessed Aug. 2010).
- BAKER, J.G. & WRIGHT, C.H. 1909. Order Nyctagineae. In W.T. Thiselton-Dyer, *Flora of tropical Africa* 6,1: 1–9. Reeve, London.
- BALLE, S. 1951. Nyctaginaceae. In W. Robyns, P. Staner, F. Demaret, R. Germain, G. Gilbert, L. Hauman, M. Homès, F. Jurion, J. Lebrun, M. Van den Abeele & R. Boutique, *Flore du Congo Belge et du Ruanda-Urundi. Spermatophytes* 2: 86, t. 7. Institut National pour l'Étude Agronomique du Congo Belge, Belgium.
- BERHAUT, R.P. 1953. Les *Boerhaavia* (Nyctaginacées) du Sénégal. *Bulletin de la Société Botanique de France, Paris* 100: 48–53.
- BOGLE, A.L. 1974. The genera of Nyctaginaceae in the southeastern United States. *Journal of the Arnold Arboretum* 55: 1–37.
- BOHLIN, J-E. 1988. A monograph of the genus *Colignonia* (Nyctaginaceae). *Nordic Journal of Botany* 8: 231–252.
- BOJER, M.W. 1842. Descriptions de diverses plantes nouvelles de Madagascar, des îles Comores et de l'île Maurice. *Boerhaavia* Linn. In A.D. Brongniart & J. Decaisne, *Annales des Sciences Naturelles, Botanique* 2,18: 188, 189. Fortin, Masson & C. Libraires-éditeurs, Paris.
- DOUGLAS, N.A. & MANOS, P.S. 2007. Molecular phylogeny of Nyctaginaceae: taxonomy, biogeography and characters associated with a radiation of xerophytic genera in North America. *American Journal of Botany* 96: 856–872.
- GERMISHUIZEN, G. & MEYER, N.L. 2003. Plants of southern Africa: an annotated checklist. *Strelitzia* 14: 749, 750. National Botanical Institute, Pretoria.
- HEIMERL, A. 1934. Nyctaginaceae. In A. Engler & K. Prantl, *Die natürlichen Pflanzenfamilien* 2,16c. Duncker & Humblot, Berlin.
- HOLMGREN, P.K., HOLMGREN, N.H. & BARNETT, L.C. 1990. *Index Herbariorum, part 1: the herbaria of the World*. New York Botanical Garden.
- HUTCHINSON, J. & DALZIEL, J.M. 1927. Nyctaginaceae. In J. Hutchinson & J.M. Dalziel, *Flora of West tropical Africa* 1,1: 151–153. Crown Agents for the Colonies, London.
- KLOPPER, R.R., CHATELAIN, C., BÄNNINGER, V., HABASHI, C., STEYN, H.M., DE WET, B.C., ARNOLD, T.H., GAUTIER, L., SMITH, G.F. & SPICHTER, R. 2006. *Checklist of the flowering plants of sub-Saharan Africa. An index of accepted names and synonyms*. South African Botanical Diversity Network Report No. 42: 506–508. SABONET, Pretoria.
- MEIKLE, R.D. 1954. Nyctaginaceae. In J. Hutchinson & J.M. Dalziel, *Flora of West tropical Africa* 1,1: 176–178. Crown Agents for Oversea Governments and Administrations, London.
- MEIKLE, R.D. 1971. *Commicarpus boissieri* (Heimerl) Cufondotis. Nyctaginaceae. Tribus Mirabileae. *Hooker's Icones Plantarum* 37: t. 3694. Bentham–Moxon Trustees, Royal Botanical Gardens Kew, Richmond.
- MEIKLE, R.D. 1978. A key to *Commicarpus*. *Notes from the Royal Botanical Garden Edinburgh* 36: 235–249.
- MEIKLE, R.D. 1979. Supplementary notes on *Commicarpus* (Nyctaginaceae). *Kew Bulletin* 34: 341–343.
- MEIKLE, R.D. 1983. Additional notes on *Commicarpus* (Nyctaginaceae). *Kew Bulletin* 38: 481–484.
- ROEMER, J.J. & SCHULTES, J.A. 1822. *Boerhavia helenae*. *Systema vegetabilium* 1: 73. Stuttgartiae.
- SMITH, J.M. 1976. A taxonomic study of *Acleisanthes* (Nyctaginaceae). *Wrightia* 5: 261–276.
- STANDLEY, P.C. 1916. Systematic investigations of tropical American plants. *Contributions from the United States National Herbarium* 18: 101. Government Printing Office, Washington.
- STANNARD, B.L. 1988. Nyctaginaceae. In E. Launert, *Flora zambesiaca* 9,1: 12–28. Halesworth Press, London.
- STRUWIG, M., SIEBERT, S.J., JORDAAN, A. & BURGOYNE, P.M. 2010. Anthocarp structure as a diagnostic character for *Boerhavia* L. and *Commicarpus* Standl. species in southern Africa. *South African Journal of Botany* 76: 415, 416.
- WHITEHOUSE, C. 1996. Nyctaginaceae. In R.M. Polhill, *Flora of tropical East Africa*: 1–19. Balkema, Kew.
- WIGHT, R. 1843. Nyctagineae. *Icones Plantarum Indiae Orientalis* 3,2: 6, t. 875. Franck, Madras.
- WILLSON, J. & SPELLENBERG, R. 1977. Observations on anthocarp anatomy in the subtribe Mirabilinae (Nyctaginaceae). *Madrono* 24: 104–111.

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AIZOACEAE

NEW COMBINATIONS IN *ANTIMIMA* AND *OCTOPOMA* (RUSCHIOIDEAE)

1. A new combination in *Antimima* for *Ruschia paripetala* (L.Bolus) L.Bolus

Antimima is a large and still unrevised genus of ± 100 species (Dehn 1989; Hartmann 1998b). Many species, most of which were described by L.Bolus, were not compared with similar species, making it unclear to which species they were most similar.

Features by which species of *Antimima* may be recognized include 5(or 6)-locular fruits with large closing bodies and shallow locules, heterophyllous leaves, and 1(–3)-flowered inflorescences (rarely aggregated in well-developed cymes) (Dehn 1989; Hartmann 1998b).

In addition, the leaves in species of *Antimima* often have a papillate epidermal surface, whereas they are typically smooth in *Ruschia*. Notably, 6-locular fruits are rare in both *Ruschia* and *Antimima*.

A six-locular species of *Ruschia* from Namaqualand, *R. hexamera* L.Bolus, was recently found to be conspecific with *Antimima crassifolia* (L.Bolus) H.E.K.Hartmann and to represent the earlier name for the taxon (Klak 2010). A further collection by Pillans from Wallekraal near Hondeklip Bay in Namaqualand, described as *R. paripetala* by L.Bolus in 1927, is also very similar to *A. hexamera* (L.Bolus) Klak. The type specimens of both *A. hexamera* and *R. paripetala* pos-

sess six-locular fruits with closing bodies and both lack valve wings; the epidermis of the leaves is papillate; the inflorescence is 1–3-flowered; and the petaloid and filamentous staminodes are pink to white. In addition, L. Bolus described a further collection by Pillans, collected between Sendelings Drift and Doornpoort, as *R. paripetala* var. *occultans* L.Bolus (1929: 125). This variety was considered a synonym of *A. perforata* (L.Bolus) H.E.K.Hartmann (Hartmann 1998b). Both var. *occultans* and *A. perforata* have six-locular fruits and a somewhat similar habit, but differ from *R. paripetala* and *A. hexamera* by having smaller flowers, up to 14 mm diam. in *A. perforata* and var. *occultans*, compared to 27 mm diam. in *R. paripetala* and *A. hexamera*. Hartmann (2001) described the closing body of *R. paripetala* as small (as opposed to large in *A. perforata*), which is generally a characteristic of species of *Ruschia*. The somewhat smaller than usual closing body in *R. paripetala* may have been the main reason for retaining *R. paripetala* in *Ruschia*. However, a reinvestigation of the closing bodies in the types of *R. paripetala*, *R. paripetala* var. *occultans*, *A. hexamera* and *A. perforata* found that in none of them were the bodies sufficiently large to block the entire exit of the locule. The somewhat smaller size of the closing bodies in *A. crassifolia* and *A. hexamera* was previously discussed by Klak (2010). In other characteristics, such as the presence of expanding keels which extend into awns, the shallow locules, the papillate epidermis and the overall similar habit, the type specimens are in agreement. The morphological evidence thus suggests that *R. paripetala* is best placed in *Antimima*, where it is the earliest available name for this group of taxa. The new combination and full synonymy is given below.

The most northerly collection of this species was made in the Richtersveld and collections have been made as far south as Hondeklip Bay in Namaqualand.

***Antimima paripetala* (L.Bolus) Klak, comb. nov.** *Mesembryanthemum paripetalum* L.Bolus, Annals of the Bolus Herbarium 4: 87 (1927). *Ruschia paripetala* (L.Bolus) L.Bolus: 221 (1950). Type: South Africa, [Northern Cape], from the coast at Hondeklip Bay, Oct. 1924, Pillans 17759 (BOL, sheet I, lecto.!, here designated).

R. hexamera L.Bolus: 144 (1928). *Antimima hexamera* (L.Bolus) Klak: 307 (2010). Type: South Africa, [Northern Cape], hills near Brakfontein, between Sept. and Oct. 1926, Pillans 5703 (BOL, holo.!).

R. hexamera L.Bolus var. *longipetala* L.Bolus: 237 (1931), syn. nov. Type: South Africa, [Northern Cape], Port Nolloth, without date, M. Schlechter sub SUG8367 (BOL, holo.!).

R. crassifolia L.Bolus: 338 (1958), syn. nov. *Antimima crassifolia* (L.Bolus) H.E.K.Hartmann: 71 (1998b). Type: South Africa, [Northern Cape], Lekkersing, June 1954, H.Hall sub BOL25758 (BOL, holo.!).

Additional material examined

NORTHERN CAPE.—2816 (Oranjemund): Alexander Bay, along road from Port Nolloth to Lekkersing, (–BD), 3 Sept. 2001, Klak 776 (BOL); Boegoeberg Suid, (–DC), 26 Oct. 1985, Van Jaarsveld 8229 (NBG). 2916 (Port Nolloth): between Port Nolloth and Holgat, (–BB), May 1929, Pillans 5766 (BOL). 2917 (Springbok): Vioolsdrif, between Port Nolloth and Lekkersing, (–AA), 4 Sep. 2001, Klak 780 (BOL); Karrachab Poort, (–AA), 18 July 1970, Wisura 1625 (NBG).

2. A new combination in *Octopoma* for *Ruschia nana* L.Bolus

Octopoma is a genus of nine species, which can be subdivided into two groups, one occurring in Namaqualand and the other in the Little Karoo (Klak 2010). The main characteristics of *Octopoma*, which distinguish it from *Ruschia* and *Leipoldtia*, are the 6- to 8-locular fruits, with no or only narrow valve wings (Hartmann 1998a). In *Ruschia*, the fruits are 5 (rarely 6)-locular, with no valve wings or rarely with narrow valve wings, whereas in *Leipoldtia* the fruits are $\pm$ 10-locular with broad valve wings. Recently, a new species, *Octopoma tanquanium* Klak, was described. This is found in the Tanqua and Little Karoo and differs from the other species of *Octopoma* by its 6-locular fruits and broad valve wings (Klak 2010).

Examination of herbarium specimens currently placed in *Ruschia* indicates that the little-known species, *R. nana* L.Bolus, is conspecific with *O. tanquanium*. The type of *R. nana* was collected at Matjiesfontein by H. Bolus in September 1908. Unfortunately, this specimen lacks fruits, so that the internal morphology of its capsule remains uncertain. However, the presence of six calyx lobes and six styles indicate that the fruits would be 6-locular. The presence of six-locular fruits is very rare in *Ruschia* and is an indication that the species may not belong in *Ruschia*. A comparison of the type of *R. nana* with the type of *O. tanquanium* shows that both have extremely similar leaves, which are trigonous, fused towards the bases and finely serrated along the keel towards the apex. Also, both type collections have solitary, cream-coloured flowers and bracteoles which embrace the base of the flower. Both *O. tanquanium* and *R. nana* flower in late spring to early summer (end of October to November and December respectively). Since both type collections are from the Matjiesfontein area, there is little doubt that the two species are conspecific. The absence of mature fruits on the type of *R. nana* could have been one reason why this species was not previously transferred to *Octopoma* (Hartmann 1998a). The following new combination and synonym are provided.

***Octopoma nanum* (L.Bolus) Klak, comb. nov.** *Ruschia nana* L.Bolus, Notes on Mesembryanthemum and allied genera 2: 75 (1929). *Mesembryanthemum reductum* N.E.Br.: 32 non 33 (1930). Type: South Africa, [Western Cape], Matjiesfontein, Sept. 1908, fl. Cape Town in Dec. 1908, H.Bolus 13417 (BOL, holo.!).

O. tanquanium Klak: 302 (2010), syn. nov. Type: South Africa, Western Cape, Tanqua Karoo, 7 km west of Matjiesfontein, Farm Aasvoëlbos, 26 May 2007, Bruyns 10797 (BOL, holo.!).

Additional specimens examined

NORTHERN CAPE.—3220 (Sutherland): between Hottentots Kloof and Sutherland, (–CC), Leipoldt s.n. (BOL).

WESTERN CAPE.—3319 (Worcester): Karooport, (–BA), Littlewood sub KG534/59 (BOL); east of Karooport, (–BB), 17 Aug. 2002, Bruyns 9158 (BOL); 5.5 miles [8.8 km] from Touws River on Worcester road (–BD), Acocks 15289 (BOL). 3320 (Montagu): Touws River Dist., Tanqua Karoo, Melkboskraal Farm, (–AA), 12 Sept. 2006, Klak 1373, (BOL); 7 km west of Matjiesfontein, Aasvoëlbos Farm, (–BA), 28 May 2007, Klak 1441 (BOL); Matjiesfontein, (–BA), Pillans 2057 (BOL); Ceres Karoo, Herre SUG10508 (BOL); Bloutoring station, (–CB), 22 June 2009, Bruyns 11381 (BOL); Sewefontein Farm, (–DA), Bruyns 11389 (BOL); Tilney Farm, (–DC), 26 May 2002, Bruyns 9025 (BOL).

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REFERENCES

- BOLUS, H.M.L. 1927. Novitates Africanæ. *Annals of the Bolus Herbarium* 4: 87.
- BOLUS, H.M.L. 1928. Notes on *Mesembryanthemum* and allied genera, part 1: 144.
- BOLUS, H.M.L. 1929. Notes on *Mesembryanthemum* and allied genera, part 2: 75, 125.
- BOLUS, H.M.L. 1931. Notes on *Mesembryanthemum* and allied genera, part 2: 237.
- BOLUS, H.M.L. 1950. Notes on *Mesembryanthemum* and allied genera, part 3: 221.
- BOLUS, H.M.L. 1958. Notes on *Mesembryanthemum* and allied genera, part 3: 338.
- BROWN, N.E. 1930. *Mesembryanthemum*. *Gardeners' Chronicle* ser. 3, 87: 32.
- DEHN, M. 1989. Untersuchungen zum Merkmalsbestand und zur Stellung der Gattung *Antimima* N.E.Br. emend. Dehn (Mesembryanthemaceae Fenzl). *Mitteilungen aus dem Institut für Allgemeine Botanik Hamburg* 22: 189–215.
- HARTMANN, H.E.K. 1998a. New combinations in Ruschioideae, based on studies in *Ruschia* (Aizoaceae). *Bradleya* 16: 44–91.
- HARTMANN, H.E.K. 1998b. New combinations in *Antimima* (Ruschioideae, Aizoaceae) from southern Africa. *Bothalia* 28: 67–82.
- HARTMANN, H.E.K. 2001. *Illustrated handbook of succulent plants: Aizoaceae F–Z*. Springer, Berlin, Germany.
- KLAK, C. 2010. Three new species and two new combinations, in the Aizoaceae from the Western and Northern Cape of South Africa. *South African Journal of Botany* 76: 299–307.

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VITACEAE

A NEW AND AN OVERLOOKED RECORD OF *CYPHOSTEMMA* IN ANGOLA

The family Vitaceae was recently catalogued for *Plants of Angola* (Figueiredo & Smith 2008) by Retief (2008), who recognised 20 species in the genus. During ongoing work on the flora of Angola, two additional species of *Cyphostemma* (Planch.) Alston were recently newly recorded for the country. These are *Cyphostemma wittei* (Staner) Wild & R.B.Drumm. and *C. congestum* (Baker) Desc. ex Wild & R.B.Drumm. *C. congestum* had already been recorded for Angola in an obscure publication that was overlooked by previous reviewers of the family in Angola.

***Cyphostemma congestum* (Baker) Desc. ex Wild & R.B.Drumm.** in *Flora zambesiaca* 2,2: 473 (1966). *Vitis congesta* Baker in Oliv.: 412 (1868). *Cissus congesta* (Baker) Planch. in A.DC. & C.DC.: 590 (1887). *Cyphostemma congestum* (Baker) Desc.: 120 (1960), comb. inval. [ICBN Art. 33.4, no clear indication of basionym]. Type: Angola, Chibiza, Meller s.n. (K, holo.).

Cissus fleckii Schinz: 640 (1908a). *Cyphostemma fleckii* (Schinz) Desc.: 121 (1960), comb. inval. [ICBN Art. 33.4, no clear indication of basionym]. *Cyphostemma fleckii* (Schinz) Desc.: 221 (1967). Type: South West Africa [Namibia], Hereroland, *Fleck* 762 (Z, holo.).

Cissus amboensis Schinz: 699 (1908b). Type: South West Africa [Namibia], Hereroland, *Dinter* 186 (syn.), *Amboland*, *Wulffhorst* 176 (syn.).

Cyphostemma congestum has been recorded from Namibia, Botswana, South Africa, Mozambique, Zambia and Zimbabwe (African Plants Database 2010). This species shows variation in the density of stem glands: in Namibia in the west, the stems can be moderately to sparsely glandular, while they are more so towards the eastern parts of its distribution range. The PRE specimens from the Angolan side of the Ruacanã Falls, cited below, have stems that are puberulous with multicellular hairs, without capitate glandular hairs.

Merxmüller & Schreiber (1969) synonymized *Cissus amboensis* with *Cyphostemma congestum* and men-

tioned the occurrence of the taxon in Angola. This was overlooked by Retief (2008). The specimens listed here confirm the occurrence of *C. congestum* in Angola.

Specimens examined

ANGOLA.—Cunene, Ruacanã Falls, 30 April 1962, *Kotze* 57 (PRE!); Cunene, top of Ruacanã Falls on Angolan side, 30 April 1962, *Rycroft* 2423 (PRE!). Figure 4.

***Cyphostemma wittei* (Staner) Wild & R.B.Drumm.** in *Kirkia* 2: 141 (1961). *Cissus wittei* Staner in *Wildeman & Staner*: 49 (1932). Type: from Congo (Katanga).

Cyphostemma wittei was previously only known from the Democratic Republic of Congo, Tanzania and Zambia. It is a variable species with the stems sometimes glandular, whereas in other cases they are eglandular.

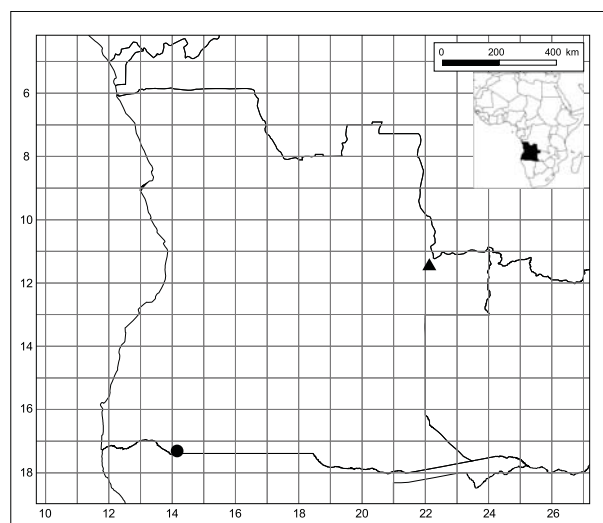


FIGURE 4.—Distribution of *Cyphostemma congestum*, ●; and *C. wittei*, ▲, in Angola.

This variation has even been encountered on the same plant (*Milne-Redhead* 2839, K, cited by Wild & Drummond 1966). The stems on the LISC specimen from Angola cited below are eglandular.

Specimen examined

ANGOLA.—Moxico, Cameia, Barros Machado ANG.XII.54–51 (LISC!). Figure 4.

The two new records bring the total number of *Cyphostemma* species known for the country, to 22. Nine of these known Angolan species of *Cyphostemma* are endemic.

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REFERENCES

- AFRICAN PLANTS DATABASE (version 3.3). 2010. Conservatoire et Jardin botaniques de la Ville de Genève and South African National Biodiversity Institute, Pretoria. <http://www.ville-ge.ch/musinfo/bd/cjb/afrika/> (accessed August 2010).
- CANDOLLE, A.L.P.P. DE & CANDOLLE, A.C.P. DE. 1887. *Monographiae Phanerogamarum. Prodrumi nunc continuatio, nunc revisio auctoribus Alphonso et Casimir de Candolle aliisque botanicis ultra memoratis*. Part 5,2: 305–654. Masson, Paris.
- DESCOINGS, B. 1960. Un genre méconnu de Vitacées: compréhension et distinction des genres *Cissus* L. et *Cyphostemma* (Planch.) Alston. *Notulae Systematicae* 16: 113–125.
- DESCOINGS, B. 1967. Note rectificative à propos de la nomenclature des *Cyphostemma* (Vitacées). *Naturalia Monspeliensia, Série Botanique*, 18: 226.
- FIGUEIREDO, E. & SMITH, G.F. 2008. Plants of Angola/Plantas de Angola. *Strelitzia* 22. South African National Biodiversity Institute, Pretoria.
- MERXMÜLLER, H. & SCHREIBER, A. 1969. 80. Vitaceae. *Prodrum einer Flora von Südwestafrika*: 1–8.
- OLIVER, D. 1868. *Flora of tropical Africa*, vol. 1. Reeve, Ashford, Kent.
- RETIEF, E. 2008. Vitaceae. In E. Figueiredo & G.F. Smith, Plants of Angola/Plantas de Angola, *Strelitzia* 22: 168, 169. South African National Biodiversity Institute, Pretoria.
- SCHINZ, H. 1908a. Beiträge zur Kenntnis der Afrikanischen Flora (suite). *Bulletin de l'Herbier Boissier*, sér. 2, 8: 625–640.
- SCHINZ, H. 1908b. Beiträge zur Kenntnis der Afrikanischen Flora (suite). *Bulletin de l'Herbier Boissier*, sér. 2, 8: 699–703.
- WILD, H. & DRUMMOND, R.B. 1961. Vitaceae from the *Flora zambesiaca* area: 2. *Kirkia* 2: 132–143.
- WILD, H. & DRUMMOND, R.B. 1966. Vitaceae. In E. Launert, *Flora zambesiaca* 2, 2: 439–492. Flora Zambesiaca Managing Committee, London.
- WILDEMAN, E. DE & STANER, P. 1932. *Contribution à l'étude de la Flore du Katanga*, supplément 4:1–116. D. van Keerberghen, Bruxelles.

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APOCYNACEAE (ASCLEPIADOIDEAE–CEROPEGIEAE)

FIRST RECORDS OF *ORBEA COOPERI* IN GAUTENG AND MPUMALANGA PROVINCES, FSA REGION

The last full revision of the genus *Orbea* (N.E.Br.) L.C.Leach by Bruyns (2002), consisted of 56 species distributed throughout Africa and southwestern Arabia with $\pm$ 31 species south of the equator and $\pm$ 24 in South Africa (Bruyns 2002, 2005). As a result of some taxonomic changes, more species were moved to the genus (Plowes 2004, 2007; Bruyns 2005; Raffaelli *et al.* 2008; Meve 2009) bringing the total in *Orbea* to the current 61 species (*sensu* Bruyns).

The current known distribution records show that *Orbea cooperi* (N.E.Br.) L.C.Leach occurs in the drier western and central interior of South Africa. Charles Craib and Gillian Condry, Warren McClelland, Tony de Castro and eventually the second author reported the existence of an *Orbea* (presumably *O. cooperi*) from Mpumalanga during 2008–2009. New distribution records were also collected from the Devon area (Leeukop, Gauteng) and near Greylingstad (Platkop, Mpumalanga). The new records constitute a northeastern extension of the distribution range of *O. cooperi* (Figure 5).

The habitat at the new sites is stony ground characterized by dolerite outcrops and sheets, surrounded by grassland with predominantly black turf soil. *O. cooperi* grows amongst the rocks in these dolerite outcrops. This habitat becomes waterlogged and muddy in spring and summer after rain. As the season progresses, the soil dries out and becomes hard and cracked in winter. Associated species found at these localities include succulents such as *Crassula setulosa* and *Euphorbia clavarioides*, the karroid dwarf shrub, *Eriocephalus karrooicus* and herbs, including *Lessertia* cf. *depressa* and *Jamesbrittenia stricta*, intermixed with other herbs and grasses.

At first, the new records were thought to represent a new species or subspecies based on the flowers that were produced by various cuttings grown in the nursery of the Pretoria National Botanical Garden (PNBG). The flowers of these plants were devoid of vibratile hairs (marginal cilia) and were much smaller than the reported size for *Orbea cooperi* (Figure 6). The exact same plants grown in the PNBG's nursery did, however, in the third

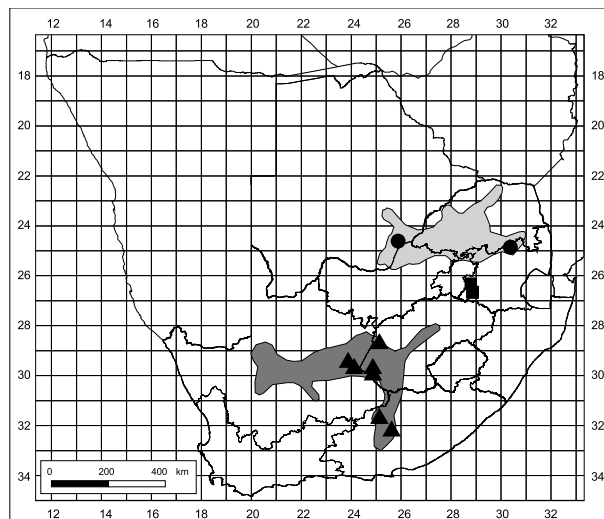


FIGURE 5.—Known distribution adapted from Bruyns 2005 of *Orbea tapscottii* (shaded light grey) and *O. cooperi* (shaded dark grey). Point records for material housed at PRE as follows: *Orbea tapscottii*, ●; *O. cooperi*, ▲. New distributions of *O. cooperi* reported here, ■ (both sight records and herbarium specimens at PRE).

year of flowering produce normal-sized flowers. In addition, the second author also collected flowering material from a site in the vicinity of Greylingstad, Mpumalanga, that was furnished with vibratile hairs. Therefore, the first author could confirm in 2009 that all these new records were *Orbea cooperi*.

The first sterile cutting presented by Craib was thought to be *Orbea tapscottii* (I. Verd.) L.C. Leach. *Orbea cooperi* and *O. tapscottii* are closely related. The main distinguishing characters are listed in Table 1 for comparison. It has been proposed that because of the absence of marginal cilia in the Devon population, it may warrant assignment of subspecific rank (Darrel Plowes pers. comm.). The authors are, however, uncertain whether this would be wise, as specimens from the Leeukop population do possess marginal cilia. Although no other populations between Devon and Leeukop have been located, the habitats are similar to each other and markedly dissimilar to other habitats of *O. cooperi*.

TABLE 1.—Comparison of main characters to distinguish between *Orbea cooperi* and *O. tapscottii*

Features	<i>O. cooperi</i>	<i>O. tapscottii</i>
Tubercles	4–8 mm long	10–25 mm long
Flower diameter	22–35 mm	20–60 mm
Annulus	Sometimes somewhat raised and thickened	Clearly defined
Inner corona	As broad as outer corona lobes Much shorter than in <i>O. tapscottii</i>	Much thinner than outer corona lobes Much longer than in <i>O. cooperi</i> forming a column above centre of flower
	Apical ends without papillate knob	Apical ends thickened and ending in distinct papillate knob
Habitat	Karoo vegetation	Savanna vegetation

Proper investigation of a large quantity of flowers at each population needs to be done in order to resolve this issue.

This new distribution is, however, disjunct from any of the other known collections made of this species. This may indicate (as for many other species) that vast areas still need to be surveyed in order to ascertain the complete distribution range of this taxon (and many others). In addition, the vegetation at the newly discovered locations in Mpumalanga is open grassland with predominantly black turf interspersed by dolerite outcrops and intrusions, which makes that habitat quite unusual for this taxon. The distribution of *Orbea cooperi* and its nearest relative *O. tapscottii* is given in Figure 5. The listed new records all come from an area between the distribution ranges of these two sister species. *Orbea tapscottii* is usually associated with acacia savanna and *O. cooperi* is mainly found in both karoo and acacia savanna vegetation.

Voucher specimens of new collections of *Orbea cooperi*

GAUTENG.—2628 (Johannesburg): Highveld Bridge, Farm Leeuwkop, ± 2.15 km directly N of Devon, 26°20'06.7" S, 28°47'01.0" E, (–BD), fl. 13-11-2008, Bester 8539 (PRE!).

MPUMALANGA.—2628 (Johannesburg): Balfour Dist., Farm Platkop just outside Greylingstad, 26°41'00" S, 28°51'41" E, (–DB), fl. 29-11-2009, Berruti 53A (PRE!); 26°41'02.58" S, 28°51'41.46" E,



FIGURE 6.—Flower and stems of *Orbea cooperi* from Leeukop locality, Bester 8539: A, vertical view; B, angled side view. Scale bars: A, B, 6 mm.

Berruti 53B (PRE!); 26°40'59.76" S, 28°51'42.6" E, fl. 3-10-2009, *Berruti* 52 (PRE!); Lucas Kloppers' farm, 26°39'49.92" S, 28°51'57.78" E (sight record, S. Berruti); Farm Platkop, 543 IR, rocky area adjacent to district road, 26°39'46" S, 28°51'54" E, fl. 22-02-2009, *McClelland* PRE850944 (PRE! in spirits).

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REFERENCES

- BRUYNS, P.V. 2002. Monograph of *Orbea* and *Ballyanthus* (Apocynaceae–Asclepiadoideae–Ceropegieae). *Systematic Botany Monographs* 63: 1–195.
- BRUYNS, P.V. 2005. *Stapeliads of southern Africa and Madagascar*, vol. 1. Umdaus Press, Hatfield, Pretoria.
- MEVE, U. 2009. Taxonomic changes in Arabian taxa of *Orbea* Haw. (Ceropegieae). *Asklepios* 105: 19–22.

- PLOWES, D.C.H. 2004. *Orbea elegans* Plowes sp. nov., an attractive new stapeliad from northern South Africa (Apocynaceae–Asclepiadoideae–Ceropegieae). *Asklepios* 90: 14–17.
- PLOWES, D.C.H. 2007. Two new stapeliads from Yemen. *Excelsa* 21: 11–14.
- PLOWES, D.C.H. 2008. *Angolluma taitica* (Bruyns) Plowes comb. nov. *Asklepios* 103: 4.
- PLOWES, D.C.H. 2009. The Transkei *Orbea* saga. *Asklepios* 105: 9–18.
- PLOWES, D.C.H. 2010. When is a *Caralluma* not a *Caralluma*? *Asklepios* 107: 3–22.
- RAFFAELLI, M., MOSTI, S. & TRADELLI, M. 2008. Apocynaceae of Oman: *Orbea nardii*, sp. nov. and *Pentatropis bentii*, first finding. *Webbia* 63: 161–167.

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HYACINTHACEAE

ORNITHOGALUM LEBAEENSE TRANSFERRED TO ALBUCA

Extensive phylogenetic analysis of nuclear and plastid DNA sequence data has unequivocally demonstrated that *Ornithogalum* L. is paraphyletic as traditionally circumscribed (e.g. Obermeyer 1978). Two alternative, generic treatments for subfamily Ornithogaloideae have recently been proposed, both derived essentially from the same data set and representing alternative hierarchical treatments of comparable monophyletic groups. The more conservative (Manning *et al.* 2009) recognizes four genera: *Dipcadi* Medik. and *Pseudogaltonia* (Kuntze) Engl. remain as conventionally circumscribed; *Albuca* L. is enlarged to include *Ornithogalum* subgen. *Osmyne* and subgen. *Urophyllon*; and *Ornithogalum* includes the remaining species in the genus plus *Galtonia* Decne. and *Neopatersonia* Schönland. In this system, the major lineages within *Albuca* and *Ornithogalum* are treated as subgenera and sections. The second option (Martínez-Azorín *et al.* 2011) is a much more radical departure from the traditional classification, treating all major lineages at generic level, resulting in the recognition of 19 genera in the subfamily, many of them new. Although theoretically defensible, the practical value of this option in sub-Saharan Africa is severely limited by the low level of morphological support for several of the genera. One consequence of this is that the South African species *O. toxicarium* C.Archer & R.H.Archer remains unplaced in this classification until molecular data are forthcoming.

The recently described *Ornithogalum lebaense* Van Jaarsv. (2010) from Angola is currently unplaced in either classification but is closely allied to the taxon previously treated as *O. longibracteatum* Jacq. (Obermeyer 1978) and now treated either as *Albuca bracteata* (Thunb.) J.C.Manning & Goldblatt (Manning *et al.* 2009) or as *Stellarioides canaliculata* Medik. (Martínez-

Azorín *et al.* 2011). As we have already argued (Manning *et al.* 2009), we favour a more conservative treatment of the genera and have already implemented this treatment in various local floras. We therefore advocate treating this species in *Albuca* subgen. *Urophyllon* (Salisb.) J.C.Manning & Goldblatt and provide the requisite new combination to facilitate this.

***Albuca lebaensis* (Van Jaarsv.) J.C.Manning & Goldblatt, comb. nov. *Ornithogalum lebaense* Van Jaarsv. in *Herbertia* 64: 92 (2010).**

REFERENCES

- MANNING, J.C., FOREST, F., DEVEY, D.S., FAY, M.F. & GOLDBLATT, P. 2009. A molecular phylogeny and a revised classification of Ornithogaloideae (Hyacinthaceae) based on an analysis of four plastid DNA regions. *Taxon* 58: 77–107.
- MARTÍNEZ-AZORÍN, M., CRESPO, M.B., JUAN, A. & FAY, M. 2011. Molecular phylogenetics of subfamily Ornithogaloideae (Hyacinthaceae) based on nuclear and plastid DNA regions, including a new taxonomic arrangement. *Annals of Botany* 107: 1–37.
- OVERMEYER, A.A. 1978. *Ornithogalum*: a revision of the southern African species. *Bothalia* 12: 323–376.
- VAN JAARSVELD, E.J. 2010. *Ornithogalum lebaense*, a new cliff-dwelling *Ornithogalum* (Hyacinthaceae) from southwest Angola (Benguela Province). *Herbertia* 64: 91–103.

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FABACEAE

A NEW SPECIES OF *XIPHOTHECA* FROM THE WESTERN CAPE, SOUTH AFRICA

Xiphotheca Eckl. & Zeyh. is a papilionaceous genus which belongs to the tribe Podalyrieae, together with *Amphithalea* Eckl. & Zeyh., *Liparia* L., *Podalyria* Lam., *Stirtonanthus* B.-E. van Wyk & A.L. Schutte, *Cyclopia* Vent., *Virgilia* Poir. and *Calpurnia* E. Mey. (Schutte & Van Wyk 1998).

In a taxonomic revision of the genus, Schutte (1997) recognized nine distinct species, all of which are endemic to the Cape Floristic Region of South Africa. Based on a cladistic analysis of morphological data, two sections were established within the genus: *Xiphotheca* sect. *Congestae* A.L. Schutte, comprising four species (all with congested, non-pedunculate inflorescence units and the lower calyx lobe longer than the lateral lobes) and *X.* sect. *Xiphotheca*, comprising five species (all with extended and pedunculate flowering units and the lower calyx lobe as long as the lateral lobes).

While doing field work during 2000 and 2001 as part of the Cape Lowland Project of the Botanical Society of South Africa, Nick Helme collected an odd specimen in the Overberg area. Follow-up field work confirmed that it is indeed an unknown species of *Xiphotheca*. This species is described below.

Xiphotheca rosmarinifolia A.L. Schutte, sp. nov., *X. phyllicoidi* A.L. Schutte & B.-E. van Wyk similis, sed foliis angustioribus, floribus minoribus, pedunculis, pedicellis bracteisque brevioribus differt.

TYPE.—Western Cape, 3420 (Bredasdorp): 33 km NE of Bredasdorp on Farm Plaatjieskraal 54; 0.6 km NW of farmhouse on road to Sonderkopskop, 240 m, (–AD), 1 Aug. 2001, N.A. Helme 2086 (NBG, holo.).

Erect, multi-stemmed shrub, up to 0.5 m tall, sprouting from woody rootstock after fire. Branches sericeous, glabrescent. Leaves alternate, simple, 10–16 × 1–2 mm, lamina linear, with strongly revolute margins, pubescent on adaxial surface, glabrescent, densely sericeous on abaxial surface, apex acute; petiole ± 1 mm long, sericeous; stipules inconspicuous. Inflorescences axillary, with paired (geminate) flowers, grouped into flowering units of up to 20 flowers; peduncle short, < 1 mm long, sericeous. Bracts linear, ± 1 mm long, fused at base with pedicel for 0.5 mm. Pedicel 3 mm long, sericeous. Bracteoles minute, situated at thickening on pedicel. Corolla yellow, fading brown with age, longer than calyx, glabrous. Calyx narrowed to base, not intrusive; lobes triangular, acuminate; upper two lobes fused higher up than lower three lobes; lower lobe as long as upper four lobes, pubescent. Standard petal suborbicular, apex emarginate, base cuneate. Wing petals oblong, longer than keel; auricle weakly developed, pocket developed as a thickened lobe towards inside, inconspicuous on outer surface. Keel petals oblong, pocket weakly developed, apex obtuse. Stamens diadelphous, vexillary filament free; anthers ± uniform in shape and size, alternately dorsifixed and sub-basifixed. Ovary with 2 or 3 ovules, densely sericeous; pistil sessile; style slender, curved upwards, glabrous. Pods coriaceous,

obliquely oblong, laterally compressed, constricted between seeds, 2- or 3-seeded, densely pubescent, glabrescent. Seeds oblong-reniform, brown to deep dark brown; hilum elliptic, surrounded by a fleshy collar-like aril. Flowering time: August (flowering after fire). Figure 7.

Diagnostic features and affinities: *Xiphotheca rosmarinifolia* falls within *X.* sect. *Xiphotheca*, owing to its characteristic pedunculate inflorescences, extended flowering units and the lower lobe of the calyx being as long as the lateral lobes. Within this section, it is closely related to *X. phyllicoides*—both species are sprouters and both have leaves with strongly revolute margins. However, *X. rosmarinifolia* differs from *X. phyllicoides* in the narrower and linear leaves, 1–2 mm wide, the shorter peduncle (< 1 mm long), bracts (± 1 mm long) and pedicel (3 mm long). In *X. phyllicoides* the leaves are 2.5–5.0 mm wide and elliptic, the peduncle is 1.5–2.5 mm long, the bracts are 3–4 mm long and the pedicel is 3.5–5.0 mm long. The two species are allopatric, with the latter recorded from three localities on the Outeniqua Mtns near Mossel Bay, whereas *X. rosmarinifolia* is known only from a single locality near Bredasdorp.

The specific epithet refers to the leaves that resemble those of the well-known herb, rosemary.

Distribution and habitat: the species is known only from the type locality on the Farm Plaatjieskraal near Bredasdorp (Figure 8), where it was discovered by Nick Helme in 2001. It grows in Renosterbos-Fynbos transitional vegetation in a very dry habitat on the northwestern slope of a silcrete hill in deep, pink, clayey soil with white quartz pebbles.

The type material was collected in flower during August 2001, following a fire in summer earlier that year. This species appears to flower only within the first year after a fire. Follow-up visits to the site during spring in subsequent years confirmed this observation.

Conservation: *Xiphotheca rosmarinifolia* appears to be a very restricted species, known from only a single location in the Lower Breede River Valley. Despite additional field work in the area, no more populations could be found. This species is seriously threatened because it grows in an area of high agricultural potential that could be ploughed in future. In addition, the area is subject to inappropriate fire management and grazing by livestock. Less than 200 mature individuals are known. Hence the species is listed as Critically Endangered (CR) in Raimondo *et al.* (2009).

According to Mucina & Rutherford (2006) the vegetation type in the area is classified as Eastern Rûens Shale Renosterveld, which is classified as Critically Endangered, since over 80 % of the original extent of this vegetation has been lost, mainly for cropland. The Farm Plaatjieskraal harbours one of the largest remaining patches of this vegetation type in the Overberg area. Several other threatened species have also been recorded from this site: *Acmadenia macropetala*

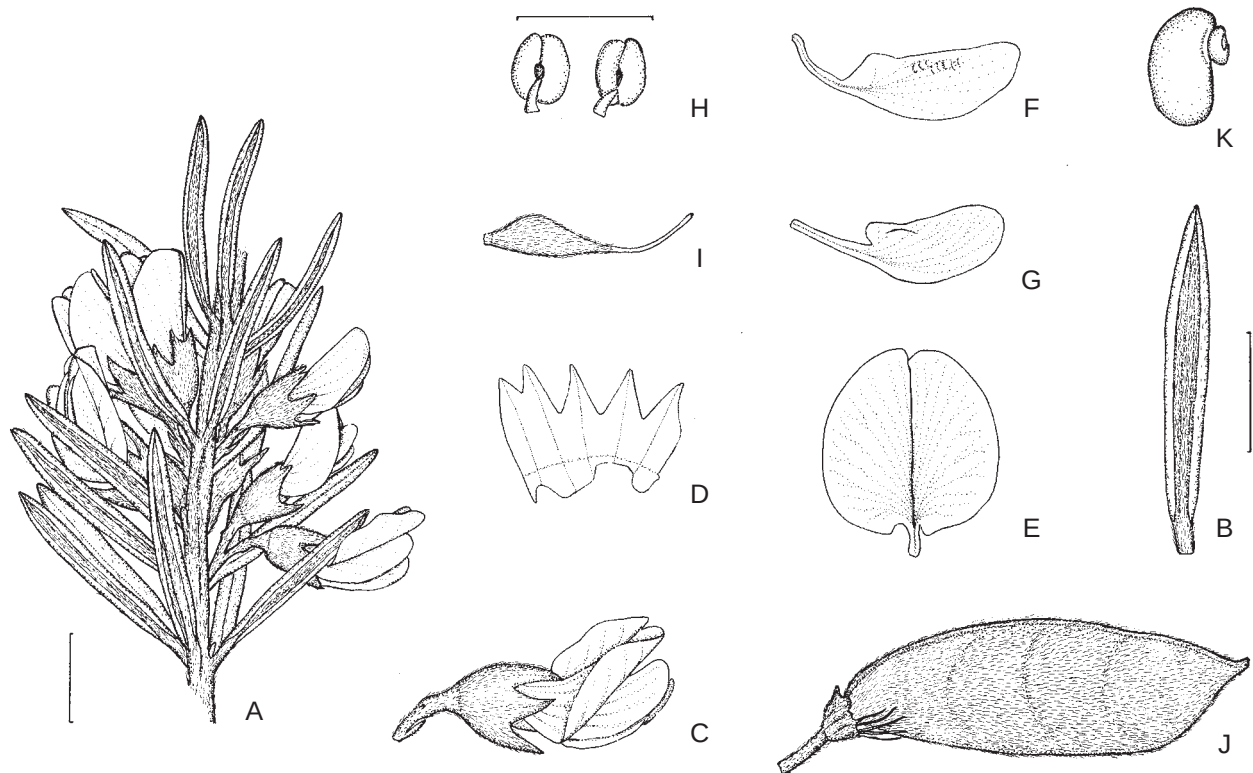


FIGURE 7.—*Xiphothea rosmarinifolia*. A–I, Helme 2086, NBG: A, flowering branch, showing arrangement of flowers; B, leaf abaxial view, showing revolute margins; C, flower in lateral view; D, calyx (upper lobes to left); E, standard petal, adaxial view; F, wing petal; G, keel petal; H, anthers; I, pistil. J, K, Vlok & Schutte 445, NBG: J, pod in lateral view; K, seed. Scale bars: A, J (at A), 5 mm; B–G, I, K (at B), 5 mm; H, 1 mm. Artist: A.L.Schutte-Vlok.

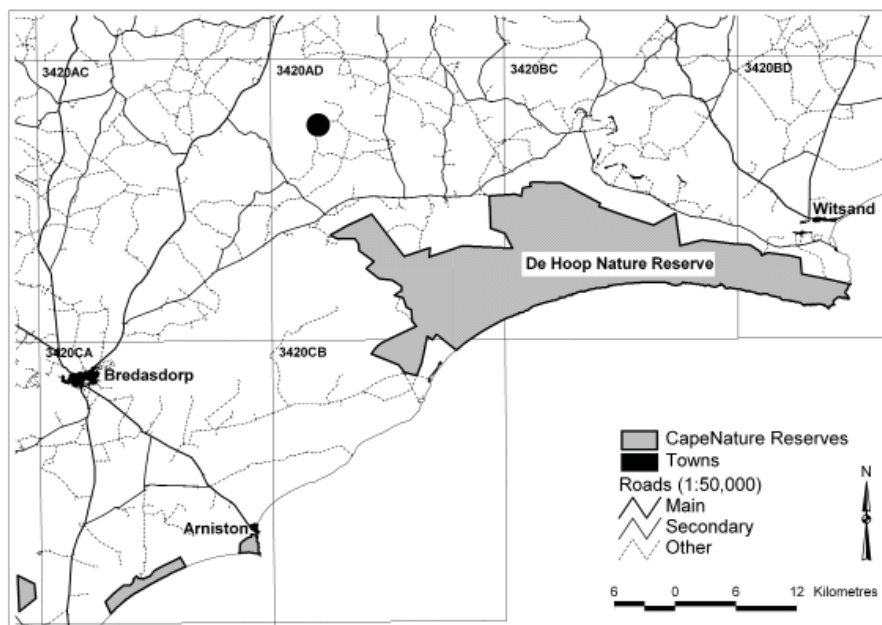


FIGURE 8.—Known distribution of *Xiphothea rosmarinifolia*, ●.

(VU = Vulnerable), *Acrodon deminutus* (VU), *Aspalathus grobleri* (EN = Endangered), *Brownanthus fraternus* (EN), *Drosanthemum quadratum* (EN), *Erica venustiflora* subsp. *glandulosa* (VU), *Gibbaeum haaglenii* (EN), *Leucadendron coriaceum* (EN) and *Relhania garnotii* (VU) (pers. obs.; N.A. Helme pers. comm.). The site is therefore of very high conservation significance and every effort should be made to secure this site under the Stewardship programme of CapeNature (Western Cape Nature Conservation Board).

Other material examined

WESTERN CAPE.—3420 (Bredasdorp): Farm Plaatjieskraal, NE of Bredasdorp, on silcrete hill NW of farmhouse on road to Sonderkopskop, (–AD), 09-09-2001, J.H.J. Vlok & A.L. Schutte 445 (NBG).

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ting me the opportunity to take sabbatical leave. This publication stems from the revision of *Xiphotheca* which formed part of a Ph.D. thesis in Botany at the Rand Afrikaans University (now University of Johannesburg). I am indebted to Prof. B.-E. van Wyk for supervising the study. My husband, Jan Vlok, kindly accompanied and assisted me on field trips. Dr O. Leistner kindly assisted with the translation of the diagnosis into Latin.

REFERENCES

- MUCINA, L. & RUTHERFORD, M.C. (eds). 2006. The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia* 19. South African National Biodiversity Institute, Pretoria.
- RAIMONDO, D., VON STADEN, L., FODEN, W., VICTOR, J.E., HELME, N.A., TURNER, R.C., KAMUNDI, D.A. & MAN-

YAMA, P.A. (eds). 2009. Red List of South African plants 2009. *Strelitzia* 25. South African National Biodiversity Institute, Pretoria.

- SCHUTTE, A.L. 1997. A revision of the genus *Xiphotheca* (Fabaceae). *Annals of the Missouri Botanical Garden* 84: 90–102.
- SCHUTTE, A.L. & VAN WYK, B.-E. 1998. Evolutionary relationships in the Podalyrieae and Liparieae (Fabaceae) based on morphological, cytological and chemical evidence. *Plant Systematics & Evolution* 209: 1–31.

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CYPERACEAE

NEW NAMES AND NEW COMBINATIONS IN *CYPERUS* FOR SOUTHERN AFRICA

Since the genus *Mariscus* Vahl is no longer upheld (Archer 2000) and the genus *Monandrus* Vorster was never published, several taxa treated by Vorster (1978) for southern Africa require new combinations or new names in *Cyperus* L. in order to reflect current taxonomic treatments incorporating molecular data (Muasya *et al.* 2009; Huygh *et al.* 2010).

1. ***Cyperus atriceps* (Kük.) C.Archer & Goetgh.**, comb. & stat. nov. Types: South West Africa [Namibia], Grootfontein, *Dinter* 7377 (B*, lecto., here designated–PRE, photo.!; B** (second sheet), K, PRE!).

C. aristatus Rottb. var. *atriceps* Kük. in Mitteilungen des Thüringischen Botanischen Vereins 2, 50: 8 (1943). *Mariscus aristatus* (Rottb.) Cherm. var. *atriceps* (Kük.) Podlech: 523 (1960).

Monandrus atriceps (Kük.) Vorster, comb. nov. ined.: 333 (1978).

Vorster (1978) found this to be a distinctive species, widely distributed in Namibia, Botswana and central South Africa. In his key, based on fruit characters, he distinguished it from *Cyperus squarrosus* L. (syn. *C. aristatus* Rottb.) by ‘Fruits obovoid, covered with conical sparsely-spaced papillae’ vs ‘Fruits obpyramidal, covered with closely-spaced flat-topped papillae’.

2. ***Cyperus austro-africanus* C.Archer & Goetgh.**, nom. nov. Type: South Africa, Eastern Cape, Basche, *Drège* 4383 (B, lecto., designated by Vorster (1981); B (second sheet), P (three sheets), S).

Mariscus dregeanus Kunth, Enumeratio plantarum 2: 120 (1837); Vorster: 245 (1978), non *Cyperus dregeanus* Kunth [= *C. pulcher* Thunb.].

M. dregeanus var. *buchananii* C.B.Clark: 188 (1897). Type: Natal [KwaZulu-Natal], Durban Flat, *Buchanan s.n.* (K, holo.).

M. dubius sens. lat.: auctt. plur.

Due to the pre-existing *Cyperus dregeanus* Kunth, the species requires a new name upon transfer to *Cyperus* [cf. International Code of Botanical Nomenclature Art.

53.1 (McNeill *et al.* 2006)]; the chosen epithet describes the almost exclusively southern African distribution of this taxon.

3. ***Cyperus decurvatus* (C.B.Clark) C.Archer & Goetgh.**, comb. & stat. nov. Type: Mocambique [Mozambique], Ressano Garcia, *Schlechter* 11952 (K, holo.–PRE, photo.!; B, BOL, BR, G, GRA, PRE!, Z).

Mariscus vestitus (Hochst.) C.B.Clark var. ? *decurvatus* C.B.Clark in Botanischer Jahrbücher 38: 134 (1906). *Cyperus indecorus* Kunth var. *decurvatus* (C.B.Clark) Kük.: 545 (1936). *Mariscus indecorus* (Kunth) Podlech var. *decurvatus* (C.B.Clark) Podlech: 524 (1960).

C. indecorus Kunth var. *dinteri* Kük.: 545 (1936). *Mariscus indecorus* (Kunth) Podlech var. *dinteri* (Kük.) Podlech: 524 (1960). Type: South West Africa [Namibia], Gneisberge bei Farm Hoffnung, 1 700 m, *Dinter* 2724 (B, SAM).

Mariscus rehmannianus C.B.Clark: 196 (1898); Vorster: 280 (1978), non *Cyperus rehmannianus* (C.B.Clark) Kuntze [= *Pycneus rehmannianus* C.B.Clark]. Type: South Africa, Transvaal [Gauteng], lagoon near Pienaars River, *Nelson* 13 (K–PRE, photo.!); Pretoria, *Rehmann* 4479 (K–PRE, photo.!; Z–PRE, photo.!); Transvaal, without precise locality, *Holub s.n.* (K–PRE, photo.!).

According to Vorster (1978: 280), the sheet of *Schlechter* 11952 at B has the name *Mariscus rehmannianus* inscribed in Clarke’s handwriting. There is no inscription on any of the sheets relating to *M. vestitus* var. *decurvatus*; however, the K sheet, which has ample material, is presumed to be the holotype.

4. ***Cyperus palmatus* (Lye) C.Archer & Goetgh.**, comb. & stat. nov. Type: Tanganyika [Tanzania], Ufipa Dist., Milepa-Zimba, *Bullock* 3625 (K, holo.).

C. usitatus Burch. subsp. *palmatus* Lye in Nordic Journal of Botany 3: 228, fig. 22 (1983).

C. fulgens C.B.Clark var. *contractus* Kük.: 122 (1935), non *Cyperus contractus* Steud. Type: South West Africa [Namibia], Amboland [Ovamboland], Otjituo, auf dem sandige Boden des Omuramba-Omatoko, *Dinter* 894 (B, holo.–PRE, photo.!; K–PRE, photo.!; SAM–PRE, photo.!).

C. fulgens sens. lat.: Podlech: 14 (1967).

C. palmatus Vorster, sp. nov. ined.: 347 (1978).

* Sheet bearing Kükenthal’s determinavit label dated 12.vi.1937.

** Sheet bearing Kükenthal’s determinavit label dated 2.i.1940.

In addition to Tanzania, this species is recorded from northern South Africa, Zambia and Kenya. The first author has not seen the type or cited specimens of *Cyperus usitatus* subsp. *palmatus*, but is convinced from the description and illustration provided that the synonymy listed above all relates to this taxon. It appears to be coincidental that Vorster (1978) used the same epithet for his new species as Lye (1983) did for his new sub-species.

The species undoubtedly belongs to the group including *Cyperus fulgens* and *C. usitatus* (plus several more in tropical Africa), all of which produce small, tunicated corms (not often collected) distant from the plant base at the tips of very thin, easily broken rhizomes. This group does require revision, but *C. palmatus* has such a distinctive inflorescence form (aptly described by the specific epithet) that in the interim it is preferable to treat it at species level.

5. *Cyperus uitenhagensis* (Steud.) C.Archer & Goetgh., comb. nov. Type: South Africa, Eastern Cape, Uitenhagen [Uitenhage], Zeyher 91 (B, holo.–PRE, photo.!).

Mariscus uitenhagensis Steud., Synopsis plantarum glumacearum. 2. Cyperaceae: 317 (1855); Vorster: 253 (1978).

Mariscus marlothii (Boeck.) C.B.Clarke var. *globospica* C.B.Clarke: 187 (1897). *Cyperus capensis* (Steud.) Endl. var. *pseudomarlothii* forma *globospica* (C.B.Clarke) Kük.: 540 (1936). Type: South Africa, Western Cape Province, Uniondale Div., rocky hill near Groot River, Burchell 5020 (K, holo.; PRE [fragment]!).

C. capensis (Steud.) Engl. var. *pseudomarlothii* Kük.: 540 (1936). Types: South Africa, Transvaal [Gauteng], Pretoria, Rehmann 4035 (B, K, Z), 4728 (not seen); Mogg 578 (K, PRE!); [Pretoria], Hügel über Aapies Rivier, Rehmann 4324 (B, Z); Johannesburg, Moss 5924 (J, K); Transvaal [Mpumalanga], Witbank, Rogers 2569 (J, GRA, Z); Natal [KwaZulu-Natal], Pietermaritzburg, Wilms 2359 (K); Mozambique, Ressano Garcia bei Lourenço Marques, Schlechter 11926 [= *C. austroafricanus*], 11950 (B, Z). Note: *C. capensis* var. *polyanthemus* Kük.: 540 (1936) was treated as a synonym of *Mariscus chersinus* N.E.Br. [*Cyperus chersinus* (N.E.Br.) Kük.].

Mariscus marlothii sensu C.B.Clarke: 590 (1894) non (Boeck.) C.B.Clarke.

M. capensis sensu Schönland: 29 (1922), p.p., non (Steud.) Schrad.

REFERENCES

- ARCHER, C. 2000. Cyperaceae. In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 594–605.
- CLARKE, C.B. 1894. Cyperaceae. In T. Durand & H. Schinz, *Conspectus florae Africae* 5: 526–692. Charles vande Weghe, Brussels.
- CLARKE, C.B. 1897. Cyperaceae. In W.T. Thiselton-Dyer, *Flora capensis* 7: 149–192. Reeve, Kent.
- CLARKE, C.B. 1898. Cyperaceae. In W.T. Thiselton-Dyer, *Flora capensis* 7: 193–310. Reeve, Kent.
- CLARKE, C.B. 1906. Cyperaceae africanae. In A. Engler, Beiträge zur Flora von Afrika 29. *Botanische Jahrbücher* 38: 131–136.
- HUYGH, W., LARRIDON, I., REYNDERS, M., MUASYA, A.M., GOVAERTS, R., SIMPSON, D.A. & GOETGHEBEUR, P. 2010. Nomenclature and typification of names of genera and subdivisions of genera in Cyperaceae (Cyperaceae): 1. Names of genera in the *Cyperus* clade. *Taxon* 59: 1883–1890.
- KUNTH, C.S. 1837. *Enumeratio plantarum* 2. Cotta, Stuttgart.
- KÜKENTHAL, G. 1935. Cyperaceae–Scirpoideae–Cypereae. In A. Engler, *Das Pflanzenreich* Fam. IV, 20, Heft 101: 1–160. Engelmann, Berlin.
- KÜKENTHAL, G. 1936. Cyperaceae–Scirpoideae–Cypereae. In A. Engler, *Das Pflanzenreich* Fam. IV, 20, Heft 101: 161–671. Engelmann, Berlin.
- KÜKENTHAL, G. 1943. Neue oder nicht genügend bekannte Cyperaceen. *Mitteilungen des Thüringischen Botanischen Vereins* N.F. 50: 1–13.
- LYE, K.A. 1983. Studies in African Cyperaceae 25. New taxa and combinations in *Cyperus* L. *Nordic Journal of Botany* 3: 213–232.
- MCNEILL, J., BARRIE, F.R., BURDET, H.M., DEMOULIN, V., HAWKSWORTH, D.L., MARHOLD, K., NICOLSON, D.H., PRADO, J., SILVA, P.C., SKOG, J.E., WIERSEMA, J.H. & TURLAND, N.J. 2006. International Code of Botanical Nomenclature (Vienna Code). *Regnum Vegetabile* 146.
- MUASYA, A.M., VRIJDAGHS, A., SIMPSON, D.A., CHASE, M.W., GOETGHEBEUR, P. & SMETS, E. 2009. What is a genus in Cyperaceae: phylogeny, character homology assessment and generic circumscription in Cyperaceae. *Botanical Review* 75: 52–66.
- PODLECH, D. 1960. Über einige Cyperaceen Südafrikas. *Mitteilungen der Botanischen Staatssammlung München* 3: 521–530.
- PODLECH, D. 1967. Cyperaceae. In H. Merxmüller, *Prodromus einer Flora von Südwestafrika* 165. Cramer, Lehre.
- SCHÖNLAND, S. 1922. Introduction to South African Cyperaceae. *Memoirs of the Botanical Survey of South Africa* No. 3. Government Printer, Pretoria.
- STEUDEL, E.G. 1855. *Synopsis plantarum glumacearum* 2. Cyperaceae. Metzler, Stuttgart.
- VORSTER, P.J. 1978. *Revision of the taxonomy of Mariscus Vahl and related genera in southern Africa*. D.Sc. thesis, University of Pretoria.
- VORSTER, P.J. 1981. The identity and typification of *Mariscus dregeanus*. *Bothalia* 13: 444–446.

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SCROPHULARIACEAE

ANTICHARIS JUNCEA, AN OVERLOOKED RECORD FOR SOUTH AFRICA, WITH NOTES ON ITS TYPE LOCALITIES AND FLOWER MORPHOLOGY

The genus *Anticharis* Endl. consists of ± 10 species in Africa, Arabia and India, six of which are known from the *Flora of southern Africa* region (Smithies 2000). The plants are small, erect or suberect perennials (rarely annuals), sometimes suffruticose herbs or dwarf shrubs, glabrous to glandular-pubescent with alternate, entire leaves. The purple corolla tube is elongated and broad with a wide open, usually white throat. *Anticharis* is easily distinguished from the genera *Aptosimum* Burch. ex

Benth. and *Peliostomum* E.Mey. ex Benth (all members of tribe Aptosimeae) by having only two fertile stamens and not four (Hiern 1904; Smithies 2000).

In recent floristic inventories only two species of *Anticharis*, namely *A. scoparia* (E.Mey. ex Benth.) Hiern ex Benth. & Hook.f. and *A. senegalensis* (Walp.) Bhandari, are listed as occurring in South Africa (in Northern Cape and in Northern Cape and Limpopo respectively) (Smithies & Ready 2003; Smithies 2006).

A specimen of *A. juncea* L.Bolus (Steyn 1696), collected during a field trip to the Northern Cape in August 2009, was initially thought to be the first record of the species for South Africa. Up to now *A. juncea* (= *A. genistoides* Schinz) was considered in regional inventories as being confined to Namibia (Smithies & Ready 2003). The purpose of this contribution is to report on the floristic significance of this find, to provide clarity on the original collecting localities of the species and to designate a lectotype. The availability of live material also permits a more complete morphological description of the flowers, and we provide the first close-up images of the fresh flowers to be published for the species.

An investigation into the localities of the specimens of *Anticharis juncea* housed in PRE and NBG proved informative. These collections are incorporated in the National Herbarium's Pretoria (PRE) Computerised Information System (PRECIS), a mega-database used, amongst others, to produce checklists of the South African flora and to plan itineraries of collecting trips. Most collections of *A. juncea* are from the Warmbad District

(Namibia) but the protologue of *A. juncea* cites three syntypes, *Pearson 3609* and *3600* from Bushmanland and *Pearson 4002* from Great Namaqualand, south of Warmbad, Namibia (Brown *et al.* 1915). The specimens from Bushmanland were collected near a place called Wortel in January 1909. There are a number of references to a place with the name of Wortel. These range from the Rehoboth area (Bethanie District) of Namibia in the north to Gamoep further south in the Namaqualand part of the Northern Cape of South Africa. A close look at Pearson's itinerary reveals that he was collecting in Bushmanland (South Africa) during December 1908 and January 1909. Only in late January 1909 did he start collecting in the Bethanie District, Namibia. It is very likely that Pearson's specimens from Bushmanland were collected near the Farm Wortel (2918BB), northwest of Pella, South Africa. Pearson was therefore not only the first botanist to have discovered *A. juncea*, but also the first to have collected herbarium material of this species in South Africa, a record which has hitherto not been reflected by floristic inventories.

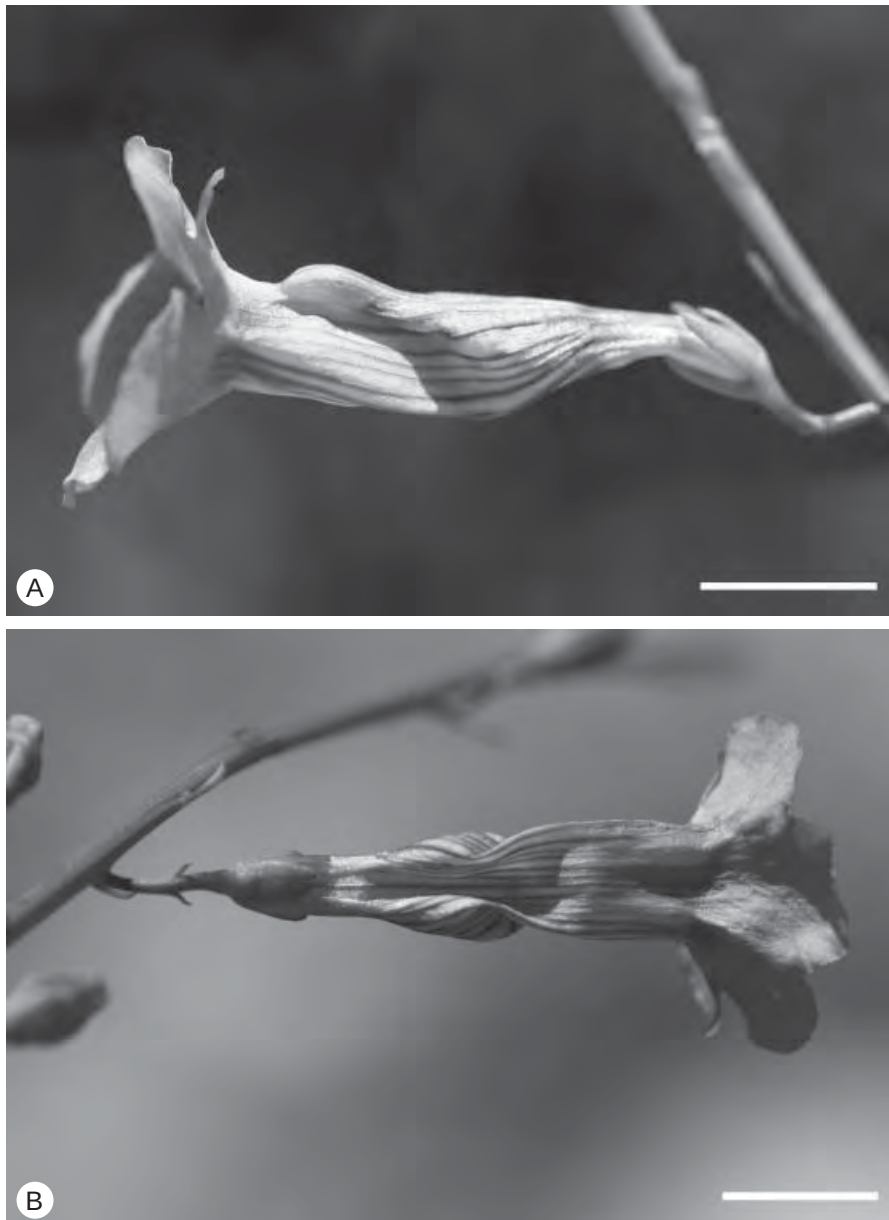


FIGURE 9.—*Anticharis juncea*, close-up of corolla, A, side view; B, view from below. Scale bars: 5 mm. Photographs: M. Koekemoer.

Anticharis juncea is a glabrous, perennial shrublet up to 300 mm high, with striate stems that are almost leafless to distantly leafy, with alternate, narrow, linear leaves, $2-5 \times 1$ mm. The flowers are axillary, solitary, tubular and carried on a bi-bracteolate pedicel, 2–4 mm long. The corolla tube is 18–21 mm long, purple, narrow at the base and dilated distally, with two shallow, lateral pouches (or pockets) near the base, a prominent, dorsal pouch towards the distal end, a marked diagonal constriction, best seen from the side, and a longitudinal, ventral groove in the proximal half (Figure 9A, B). These floral features are clearly visible in live material but are obscured when the flowers are pressed and dried, although the presence of pouches can be vaguely discerned. The two fertile anterior stamens are inserted above the base of the corolla and extend a little beyond the middle of the corolla tube. The capsule is ovate, bisulcate with an acute apex and dehisces mainly septicidally but also loculicidally. Although the specific pollinator(s) of *A. juncea* is unknown, there is a marked and widespread association between pollen wasps (Vespidae: Masarinae) and the members of the Scrophulariaceae tribe Aptosimeae (Benth.) Benth. & Hook.f., namely *Aptosimum* Burch. ex Benth., *Peliostomum* Benth. and *Anticharis* (Gess & Gess 2004, 2010).

Although it most closely resembles the mainly annual *Anticharis senegalensis*, *A. juncea* differs from the former in being perennial, glabrous, with fewer, smaller leaves and shorter pedicels (Brown *et al.* 1915). The three South African species may be distinguished using the following key:

- 1a Plants perennial or annual, glandular-pubescent:
 2a Plants usually annual; leaves linear, 10–40 mm long; pedicels 8–12 mm long *A. senegalensis*
 2b Plants perennial; leaves linear-lanceolate, 4–13 mm long; pedicel 3–8 mm long *A. scoparia*
 1b Plants perennial, glabrous; distantly leaved, leaves linear, 2–5 mm long; pedicel 2–4 mm long *A. juncea*

Anticharis senegalensis [= *A. linearis* (Benth.) Hochst. ex Asch.] has a wide and markedly disjunct transequatorial range, occurring in Limpopo and North-

ern Cape in South Africa, Botswana, Namibia (Figure 10), also in Angola and Zimbabwe in the south, then further north in arid parts of North Africa through Arabia to India. The distribution of *A. juncea*, on the other hand, is much more restricted, with all known records confined to a small area in the extreme south of Namibia and adjacent parts of the Northern Cape. It is usually found on stony or rocky soils within the Succulent Karoo Biome (Rutherford & Westfall 1968), or the Desert Biome in South Africa and the bordering Nama-Karoo Biome in Namibia (Mucina & Rutherford 2006). Biogeographically, *A. juncea* is endemic to the Gariep Centre of Endemism (Van Wyk & Smith 2001), in particular the very hot and arid, deeply dissected region along the Lower Orange River Valley, downstream from the Augrabies waterfalls. The distribution of *A. juncea* overlaps with that of *A. scoparia*, also a perennial and Gariep Centre endemic, but a species with a more northwesterly range (Figure 10). *A. scoparia* is glandular-pubescent with linear-oblong leaves (Hiern 1904).

Anticharis juncea is an example of a species that was overlooked and left out of South African floristic checklists for more than 100 years since its first discovery, because of the incorrect interpretation of the localities in the protologue. Computerized herbarium specimens offer improved access to large quantities of data as well as expanded analytical potential (Rhoads & Thompson 1992). However, to be analysed spatially, botanical data must have locality information that can be related to a point on a map. It is very important that the locality information should be related to the **correct** point on a map.

***Anticharis juncea* L.Bolus** in N.E.Br., L.Bolus & E.Phillips in Annals of the South African Museum 9,4: 263, 264 (1915). Type: Northern Cape, 2918 (Gamoep): Bushmanland, Wortel, pass near base of kopje, (–BB), 10 Jan. 1909, *Pearson 3600* (BOL, scan!, lecto., designated here).

Note: all three syntypes mentioned in the protologue are mounted together on the same sheet in BOL where Louisa Bolus worked. The three collections are, however, clearly delineated by pencil lines and each has its own label. The syntype *Pearson 3600* is considered the better specimen and is chosen here as lectotype. There are two sheets of the syntype *Pearson 3609* in NBG [marked I and II]. Sheet II represents *Anticharis juncea* and although it carries the number 3609, is rather confusingly numbered and apparently contains material from two different collections. On one of the two specimens mounted on this sheet is a field note with the number 5413. At a later stage, someone has written 4002 on it, this number being that of the third Pearson syntype.

Other specimens seen

NAMIBIA.—2818 (Warmbad): Great Namaqualand [southern Namibia], kopje south of Warmbad, (–CD), 27 Jan. 1909, *Pearson 4002* (BOL, scan!); Goodhouse Poort, (–CD), 22 June 1989, *Van Wyk 8639* (PRE). 2819 (Ariamsvlei): Warmbad Dist., 16 miles [25.6 km] SSW of Charly's Puts, Geinab Gorge, (–BA), 17 May 1955, *Acocoks 18173* (PRE); Warmbad Dist., Farm Vellorsdrift: WAR 93, Granitberge am Oranje bei Brücke, (–CB), 17 May 1963, *Giess, Volk & Bleissner 7051* (PRE); Warmbad, ± 1 km NW of Orange River along road between Onseepkans and Karasburg, (–CB), 1 Feb. 1974, *Davidse & Loxton 6197* (PRE).

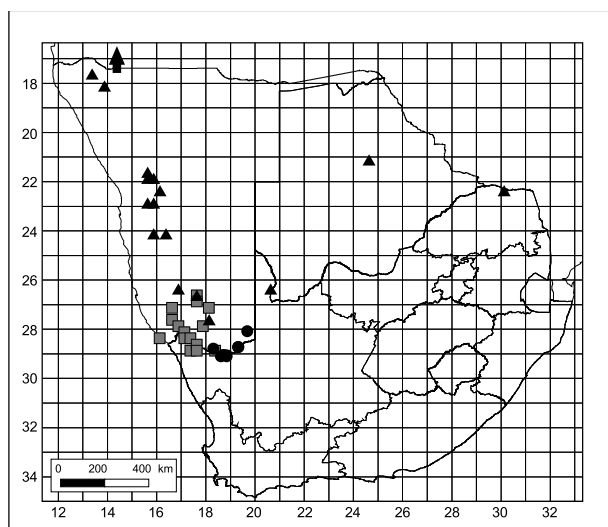


FIGURE 10.—Known distribution of *Anticharis juncea*, ●; *A. scoparia*, ■; and *A. senegalensis*, ▲.

NORTHERN CAPE.—2918 (Gamoep): ridge E of Goodhouse turn-off en route to Klein Pella, (–BA), 23 Aug. 2009, *Steyn* 1696 (PRE); Bushmanland, near Wortel, (–BB), 10 Jan. 1909, *Pearson* 3609 (BOL, scan!; NBG Sheet I, scan!).

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REFERENCES

- BROWN, N.E., BOLUS, L. & PHILLIPS, E.P. 1915. Scrophulariaceae. *Annals of the South African Museum* 9,4: 263, 264.
- GESS, S.K. & GESS, F.W. 2004. Distributions of flower associations of pollen wasps (Vespidae: Masarinae) in southern Africa. *Journal of Arid Environments* 57: 17–44.
- GESS, S.K. & GESS, F.W. 2010. Pollen wasps and flowers in southern Africa. *SANBI Biodiversity Series* 18. South African National Biodiversity Institute, Pretoria.
- HIERN, W.P. 1904. Scrophulariaceae. In W.T. Thiselton-Dyer, *Flora capensis* 4,2: 121–420. Reeve, London.
- MUCINA, L. & RUTHERFORD, M.C. 2006. The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia* 19. South African National Biodiversity Institute, Pretoria.
- RHOADS, A.F. & THOMPSON, L. 1992. Integrating herbarium data into a geographic information system: requirements for spatial analysis. *Taxon* 41: 43–49.
- RUTHERFORD, M.C. & WESTFALL, R.H. 1986. *Biomes of southern Africa—an objective categorization*. Botanical Research Institute, Pretoria.
- SMITHIES, S.J. 2000. Scrophulariaceae. In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 508–537.
- SMITHIES, S.J. 2006. Scrophulariaceae. In G. Germishuizen, N.L. Meyer, Y. Steenkamp & M. Keith, *A checklist of South African plants*. Southern African Botanical Diversity Network Report No. 41. SABONET, Pretoria.
- SMITHIES, S.J. & READY, J.A. 2003. *Anticharis*. In G. Germishuizen & N.L. Meyer, Plants of southern Africa: an annotated checklist. *Strelitzia* 14: 863. National Botanical Institute, Pretoria.
- 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.

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ASTERACEAE

LACHNOSPERMUM NEGLECTUM (ASTEROIDEAE: GNAPHALIEAE), A NEW AND OVERLOOKED SPECIES FROM THE WORCESTER VALLEY, WESTERN CAPE

Lachnospermum Willd., a small genus in the *Metasia* group of tribe Gnaphalieae, is distinguished by its solitary or few, relatively large, campanulate capitula; multicellular hairs on the outside (abaxial) surface of the corolla lobes; long, unicellular hairs on the cypselas; and a rim or shallow cup at the top of the cypselas surrounding the pappus (Hilliard & Burtt 1981; Ward *et al.* 2009). It currently comprises three named species (Koekemoer 2002), although a fourth unnamed species was included by Goldblatt & Manning (2000) in their enumeration of the genus as *L. sp.* 1. Vegetatively similar to *L. fasciculatum* (Thunb.) Baill., this taxon had been identified by the German botanist Rudolf Schlechter as a distinct species under the manuscript name *L. neglectum*, based on a collection of his from Brandvlei near Worcester made in the late nineteenth century. Schlechter was familiar with both species, having collected true *L. fasciculatum* a short distance further up the Breede River Valley just four years earlier, but the superficial similarity between the taxa led most botanists to identify both as *L. fasciculatum*, with the signal exception of British botanist N.E. Brown. The earliest collection of the Brandvlei taxon appears to have been made by W. Tyson in the Hex River Valley in 1881, and an indication that N.E. Brown concurred with Schlechter in considering it to represent a novelty, is borne out by an annotation on the duplicate at the Bolus Herbarium to this effect by Cape Town botanist Harry Bolus, dated 10 January 1903.

The Brandvlei taxon has now been collected from multiple different populations in the Worcester and Hex River Valleys. Although vegetatively similar to *Lachnospermum fasciculatum*, these populations differ consist-

ently from that species in several features, notably the size and shape of the capitula, the colour and disposition of the involucre bracts, and the size of the florets. We follow Schlechter in treating them as a distinct species under his epithet *neglectum*, which is now even more apposite than it was at the time that he suggested it.

Specimens from BOL, NBG, PRE and SAM, the main herbaria with good representation of Cape species, were consulted for records of the two new species (herbarium acronyms after Holmgren *et al.* 1990). The Aluka website (www.aluka.org) was searched for duplicates of the Schlechter collection of *Lachnospermum neglectum*.

***Lachnospermum neglectum* Schltr. ex J.C.Manning & Goldblatt, sp. nov.**

Lachnospermum fasciculatum (Thunb.) Baill. habitu suffruticoso intricato ramoso similis sed capitulis late cylindricis, 7–9 × 6–8 mm, paleis ± 10 subulato-pilosis, phyllariis ± 100 in seriebus ± 12 imbricatis externis 1–2 mm longis internis 6.0–7.0 × 1.5 mm oblongis marginibus membranaceis distaliter dense coactis in laminam attenuatam subulatam deflexam stramineam 0.5–2.0 mm longam contractis, flosculis flavis ± 5.5 mm longis, et cupula apicali ovarii cypselarumque symmetrica differt.

TYPE.—Western Cape, 3118 (Worcester): ‘in colibus aridis prope Brand Vlei’ [Brandvlei], (–CB), 9 Jan. 1896, *Schlechter* 9934 [K, holo.; BOL, HBG, PRE (2 sheets), S, Z, iso.].

Intricately branched shrublet, 400–800 mm high; branches often spreading horizontally, densely whitish

or yellowish tomentose with matted hairs, $\pm$ sparsely leafy. *Leaves* ericoid, spreading or declinate, with rosette-like axillary fascicles $\pm$ half as long, to as long as subtending leaf, involute, narrowly lanceolate-ericoid, $2.0\text{--}2.5 \times 1$ mm, acute or apiculate, mostly $\pm$ half twisted, adaxial surface felted, abaxial surface arachnose. *Capitula* discoid, $7\text{--}9 \times 6\text{--}8$ mm, terminal on primary and secondary branches, solitary or up to three in umbellate clusters, $\pm$ 20-flowered. *Involucre* broadly campanulate, $7\text{--}9 \times 6\text{--}8$ mm; bracts $\pm$ 100 in $\pm$ 12 imbricating series, progressively longer acropetally, outermost 1–2 mm long, innermost $6.0\text{--}7.0 \times 1.5$ mm, oblong with cartilaginous stereome and membranous margins, glabrous in basal half but densely felted in distal half with cohering, white hairs, tapering into an attenuate, sharply deflexed, brown-papery, awl-like lamina 0.5–2.0 mm long. *Receptacle* paleate; paleae $\pm$ 10, setaceous, $\pm$ 6 mm long, sparsely villous distally. *Florets* yellow, $\pm$ 5.5 mm long; lower part of tube cylindrical, 3 mm long, limb narrowly campanulate, 5-lobed, lobes lanceolate, $\pm$ erect and not spreading, $\pm$ 1 mm long with thickened margins, ciliate along inner margin and penicillate apically with sparse gland-tipped hairs on abaxial surface. *Anthers* 2.5 mm long including ovate apical appendage, base tailed. *Ovary* cylindrical with shallow, fimbriate crown, 6-winged, wing ribs densely pubescent; style terete with swollen base on distinct stylopodium, branching just below mouth of tube, branches $\pm$ 1 mm long, lateral margins stigmatic, apices truncate, penicillate. *Cypselas* cylindric with six longitudinal ribs or wings and shallow 8–10-lobed crown, $3.0\text{--}3.5 \times 1.5$ mm, ribs asymmetrically disposed, with one median rib on inner face and five ribs congested on outer face, ribs densely villous along ridges with long, eglandular hairs in several rows plus scattered gland-tipped hairs, crown fimbriate and adpressed scabridulous, pale straw-coloured. *Pappus* bristles $\pm$ 80, connate basally and also shortly fused into fascicles, $\pm$ 4.5 mm long, barbellate with apical barbs longer. *Flowering time*: Jan.–Feb. Figures 11A–I; 12.

Distribution and ecology: *Lachnospermum neglectum* is confined to the upper Breede River Valley and its tributaries, where it has been collected from around De Doorns in the Hex River Valley and between Worcester and Robertson in the Breede River Valley itself, extending onto the lower northern slopes of Jonaskop at the western end of the Riviersonderend Mtns (Figure 13). Plants are recorded as locally common in transitional renosterveld-fynbos on sandstone alluvium and on sandy flats, from 200–600 m, or on lower sandstone slopes.

Several other ericoid shrubs are narrow endemics of the Worcester Valley, notably *Euchaetis pungens* (Rutaceae), *Polhillia obsoleta* (Fabaceae) and *Leucadendron flexuosum* (Proteaceae).

Diagnosis and relationships: *Lachnospermum neglectum*, like *L. fasciculatum*, is a well-branched, moderately densely leafy shrublet, with small, ericoid leaves developing rosette-like axillary brachyblasts, and bearing 1–3 capitula per branch. The brown, scale-like limbs to the involucre bracts set them apart from the remaining two species, *L. imbricatum* (P.J.Bergius) Hilliard and *L. umbellatum* (L.f.) Pillans, both of which have conspicuously petaloid, white or pink bracts.

Lachnospermum neglectum is distinguished from *L. fasciculatum* by its mostly markedly horizontal branches and generally smaller involucres, $7\text{--}9 \times 6\text{--}8$ mm, obtuse at the base, and by the sharply deflexed, pale straw-coloured, attenuate and awl-like, papery limbs to the bracts. In *L. fasciculatum* the branches are mostly $\pm$ ascending and the capitula are larger, $10\text{--}15 \times 8\text{--}11$ mm, and obconic at the base (Figure 11J), and the involucre bracts have smaller, erect or suberect, scale-like, acute or acuminate limbs that are chestnut-brown or plum-red. The florets in *L. neglectum* are also substantially smaller than in *L. fasciculatum*, $\pm$ 5.5 mm long vs $7\text{--}9$ mm long (Figure 11K), and the apical cup on the ovary and cypselas is symmetrically developed on all sides vs asymmetrical and reduced to a rim on one side in *L. fasciculatum* (Figure 11L; see also Koekemoer 2002: plate 31.1, fig. 14).

The two species are geographic vicariants, with *Lachnospermum fasciculatum* more widely spread through the southwestern Cape. Considered until recently to be endemic to the Cape Floristic Region, with its northernmost station in the Pakhuis Mtns (Goldblatt & Manning 2000; Koekemoer 2002), *L. fasciculatum* has now been collected north of the Olifants River at Brand se Baai on the southern Namaqualand coast. From here it ranges through the Cedarberg and Cold Bokkeveld to Villiersdorp and Greyton at the southern foot of the Riviersonderend Mtns (Figure 13), extending onto the West Coast and the Cape Flats, from Mamre to Kuils River. It is largely absent inland of the coastal ranges, except at the head of the Breede River Valley, where it has been collected from the foot of the Waaihoek Mtns. This station is just 30 km northwest of the most northerly of the known populations of *L. neglectum*.

Additional specimens examined

Lachnospermum neglectum

WESTERN CAPE.—3319 (Worcester): in clivis montis Hex River Valley, 1500' [450 m], (–BC), Jan. 1881, *Tyson* 786 (SAM); in convalle Hex River, prope De Doorns, (–BC), Jan. 1908, *H. Bolus* 13125 (BOL); Sandberg Hills on Skerpenheuvel Road, 300–600 m, (–DA), 28 Oct. 1982, *Forrester & Bayer* 237 (NBG); Jonaskop, roadside to FM tower, (–DC), 14 Jan. 1979, *Boucher* 4247 (PRE); Jonaskop, second gate from bottom, 600 m, (–DC), 9 Feb. 1981, *Boucher* 5006 (NBG); base of Sencor road, N side of Jonaskop, 30 Jan. 2004, *Bergh* 1105 (NBG); 7 km SW of Robertson, S side of Sandberg, (–DD), 31 Jan. 2007, *Helme* 4562 (NBG).

Lachnospermum fasciculatum

WESTERN CAPE.—3117 (Lepelfontein): Brand se Baai, Harteebeeste Kom, 74 m, (–BD), 26 Mar. 2003 [fr.], *Desmet & Helme* 3434 (NBG). 3118 (Vanrhynsdorp): 11.2 km S of Redelinghuys, (–DA), 7 June 1970, *Acocks* 24271 (PRE); between turn-off to Papkuilsfontein and Brakvlei, (–DD), 20 Mar. 1996, *Koekemoer* 1217 (PRE). 3218 (Clanwilliam): rocky slopes west of Clanwilliam on road to Graafwater, (–BB), 6 Oct. 2004 [fr.], *Goldblatt & Porter* 12633 (NBG). 3219 (Wuppertal): northern Cedarberg, Ribboksvlei Farm, N of Kliphuis Peak, $\pm$ 920 m, (–AA), 14 Feb. 1984, *Taylor* 10913 (NBG, PRE); Pakhuisvlakte at top of pass, $\pm$ 900 m, (–AA), 14 Jan. 1986, *Taylor* 11468 (NBG, PRE); 17 km from Clanwilliam on road to Pakhuis, (–AA), 25 Aug. 1995, *Rodriguez-Oubina & Cruces* 2076 (PRE); foot of Pakhuis Pass on E side, (–AA), 21 Mar. 1996, *Koekemoer* 1220 (PRE); near Algeria Forest Station, Mar. 1940, *Stokoe* 56987 (SAM); 1 km N of Algeria Forest Station on Nieuwoudt's Pass, $\pm$ 517 m, (–AC), 27 Apr. 1981, *Le Maitre* 196 (NBG, PRE); Algeria, (–AC), 14 Feb. 1936, *Compton* 6186 (NBG); Op-de-Berg, Tuiskloof Farm, 756 m, (–CA), 8 Jan. 2003, *Botha* (3)012 (NBG); along R303 between Op-de-Berg and Citrusdal, (–CA), 11 Feb. 2007, *Koekemoer* 3483 (PRE); Citrusdal, Allendal Farm, Grysboeknek,

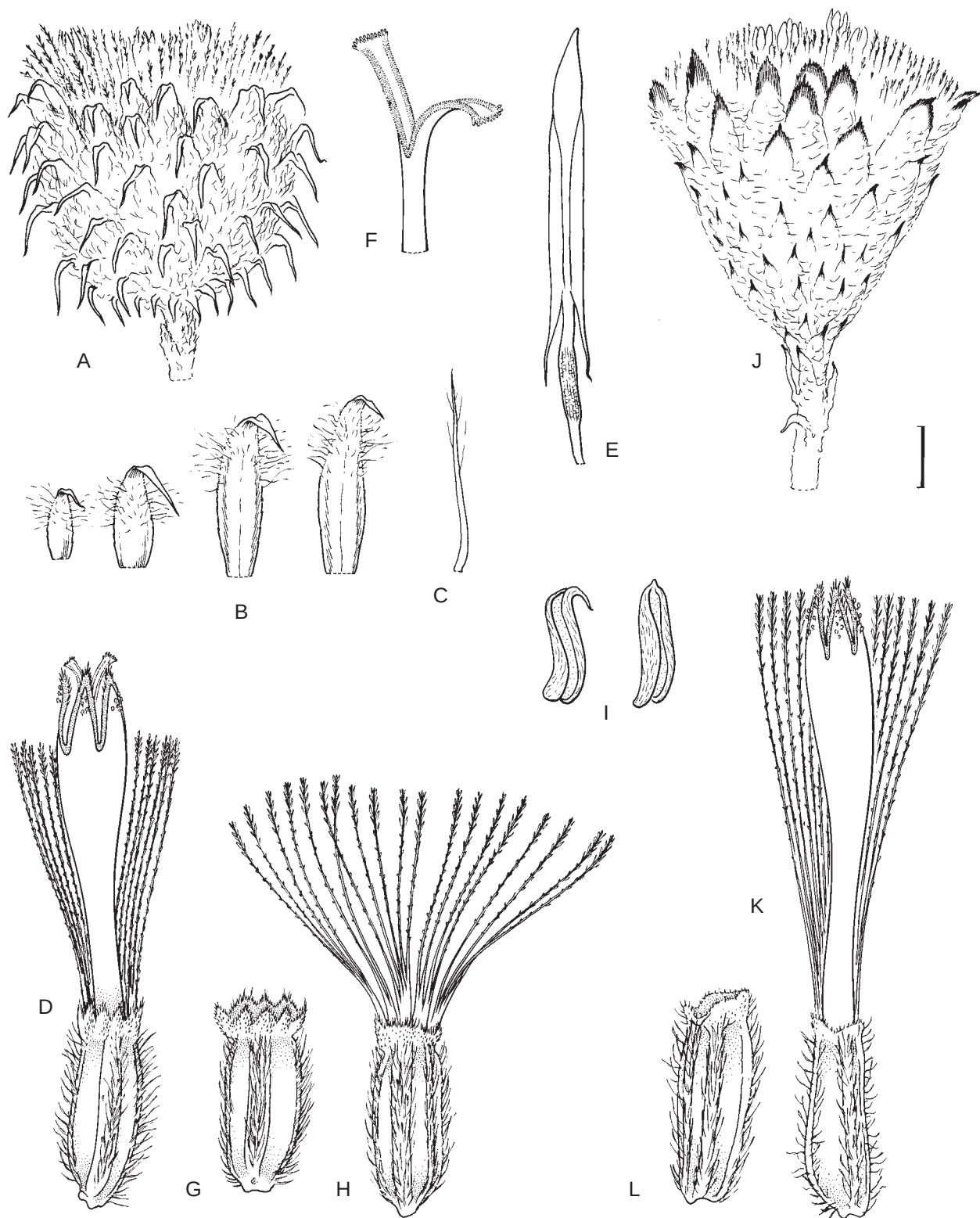


FIGURE 11.—*Lachnospermum neglectum*: A–H, Boucher 5006. A, capitulum; B, involucre bracts (outermost on left and innermost on right); C, palea; D, floret, side view; E, anther; F, stigma; G, cypselum (inner face, pappus removed); H, cypselum (outer face). I, primary leaves (left Tyson 5877, right Helme 4562). *L. fasciculatum*, J–L, Hanekom 3381: J, capitulum; K, floret, side view; L, cypselum (side view, pappus removed). Scale bar: A–C, J, 2 mm; D, G, H, I, K, L, 1 mm; E, F, 0.5 mm. Artist: J.C. Manning.

800 m, (–CA), 23 Mar. 2002, Hanekom 3381 (NBG, PRE); 23 miles [37 km] N of Grootriver turn-off on road from Ceres to Citrusdal, (–CA), 8 Mar. 1966, Taylor 6755 (NBG); Kromrivier, on path to Disa Pools, (–CB), 12 Mar. 2003, Koekemoer 2686 (PRE); La Fontein, (–CC), 10 Feb. 1978, Boucher 3655 (NBG, PRE). 3318 (Cape Town): sand flats NE of Blaauwberg, (–CD), Jan. 1927, Pillans 6822 (BOL); Malmesbury

Road, (–DA), 9 Mar. 1973, Montgomery 381 (NBG); Malmesbury Dist., Burgers Post Farm near Pella, 200 m, (–DA), 15 Mar. 1979, Boucher & Shepherd 4269 (NBG, PRE), 17 Jan. 1980, Boucher & Shepherd 4929 (NBG, PRE); Kuils River, (–DC), 11 Mar. 1933, Levyns 4251 (BOL); Klapmuts, (–DD), 9 Mar. 1959, Barker 8863 (NBG); ± 3 km E of Pniel, Farm Normandy, 300 m, (–DD), 5 Apr. 2004, Helme 2986 (NBG); Bot-

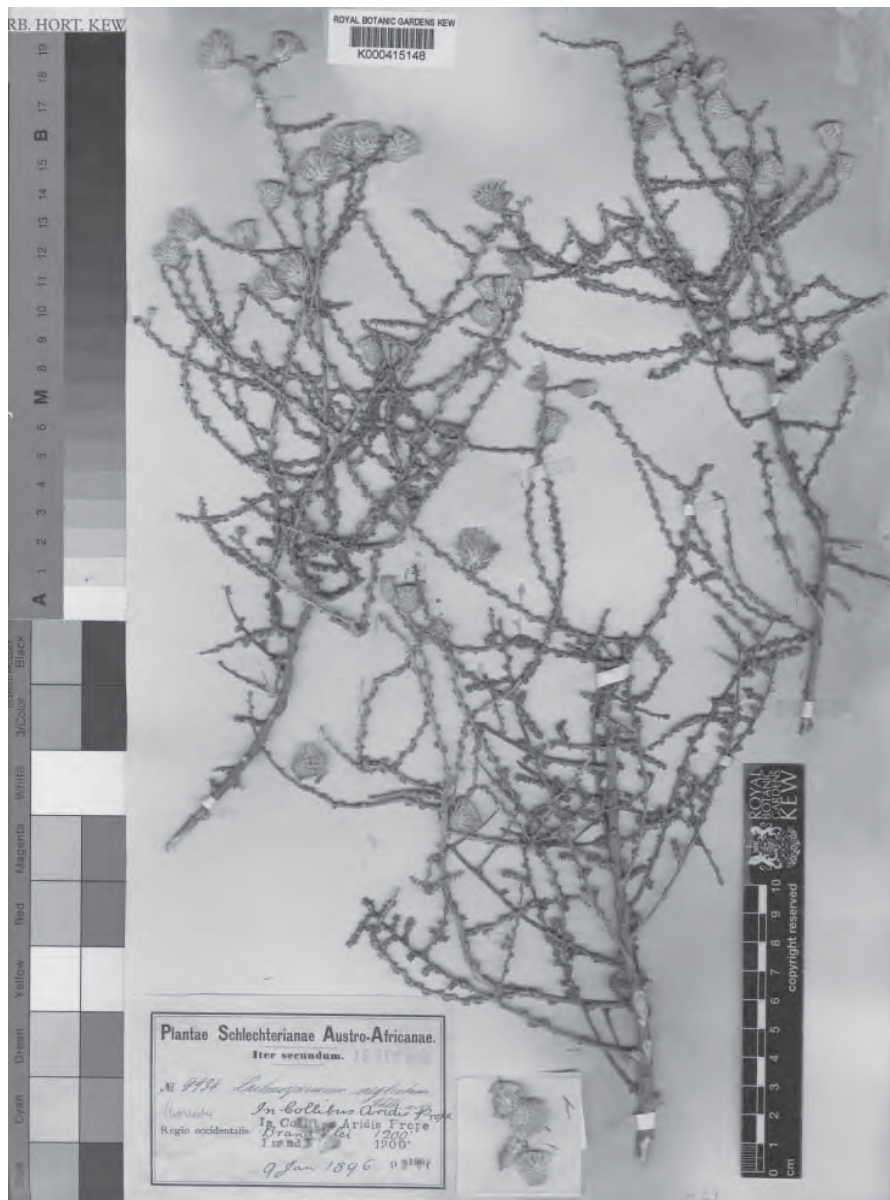


FIGURE 12.—*Lachnospermum neglectum*, Schlechter 9934 (holotype). Digital image courtesy of Aluka website (www.aluka.org).

telary, (–DD), 18 Jan. 1941, *Compton 10380* (NBG). 3319 (Worcester): Ceres, slopes of Elandsbloof, (–AC), 5 Apr. 1952, *Levyns 9834* (BOL); 25 km N of Wellington, Elandsberg Nature Reserve, (–AC), 12 Nov. 1986, *De Villiers 40* (NBG, PRE); ‘in planitie ad pedem montis Mostertsberg’, (–AC), 30 Jan. 1892, *Schlechter 857* (BOL); Romans River Nature

Reserve, (–AC), 4 Feb. 1981, *Nilsson 133* (PRE); Zachariaskloof Catchment, ± 1100' [366 m], (–CC), 20 Feb. 1970, *Haynes 293* (NBG, PRE); Franschoek Pass on Villiersdorp side, (–CC), 26 Feb. 1948, *Compton 20472* (NBG). 3419 (Caledon): near bridge over River Zonder Eide [Riversonderend], between Viljoen's Pass and Villiersdorp, (–AB), Mar. 1933, *L. Bolus 21492* (BOL); near Genadendal, (–BA), 3 Mar. 1935, *Levyns 4864* (BOL); E of Greyton west of Gobos River, 220 m, (–BA), 23 Feb. 2006, *Helme 3899* (NBG).

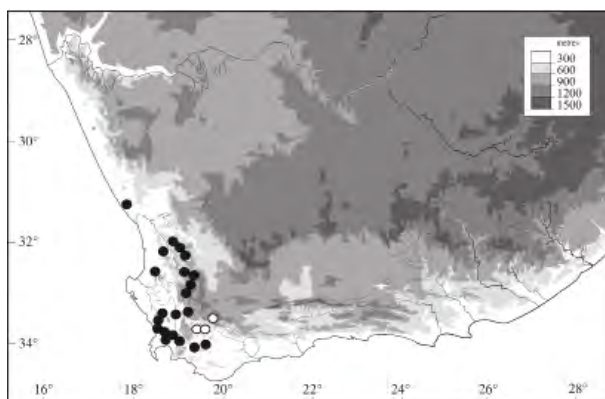


FIGURE 13.—Known distribution of *Lachnospermum neglectum*, ○; and *L. fasciculatum*, ●.

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REFERENCES

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.

- HILLIARD, O.M. & BURTT, B.L. 1981. Some generic concepts in Compositae–Gnaphaliinae. *Botanical Journal of the Linnean Society* 82: 181–232.
- HOLMGREN, P.K., HOLMGREN, N.H. & BARNETT, L.C. 1990. *Index herbariorum*. Part 1: *The herbaria of the World*. New York Botanical Garden, New York.
- KOEKEMOER, M. 2002. Systematics of the *Metalasia* group in the Relhaniinae (Asteraceae–Gnaphalieae). Unpublished Ph.D. thesis, Faculty of Science, Rand Afrikaans University, Johannesburg.
- WARD, J., BAYER, R.J., BREITWEISER, I., SMISSEN, R., GALBANY-CASALS, M. & UNWIN, M. 2009. Gnaphalieae. In V.A.

Funk, A. Susanna, T.F. Stuessy & R.J. Bayer, *Systematics, evolution, and biogeography of Compositae*: 539–588. International Association for Plant Taxonomy, Vienna.

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AMARYLLIDACEAE

AMMOCHARIS DESERTICOLA (AMARYLLIDACEAE), A NEW SPECIES FROM NAMIBIA AND A KEY TO SPECIES OF THE GENUS

Ammocharis Herb. is a small, sub-Saharan genus in the family Amaryllidaceae. When last revised in 1939 the genus included five species (Milne-Redhead & Schweickert 1939). More recently, phylogenetic analyses using nuclear and limited plastid non-coding DNA sequences (Meerow *et al.* 2003; Kwembeya *et al.* 2007) have supported the taxonomic reassessments of two anomalous species from genera closely related to *Ammocharis* (Lehmiller 1992; Snijman & Williamson 1994): *Cyristetes longifolia* (L.) Milne-Redh. & Schweick. was reinstated in *Ammocharis* and *Crinum nerinoides* Baker was transferred to *Ammocharis* (Snijman & Archer 2003). In addition, Nordal (1982) reduced *A. heterostyla* (Bullock) Milne-Redh. & Schweick. to synonymy in *A. angolensis* (Baker) Milne-Redh. & Schweick.

The genus is most closely allied to *Crinum* L. from which it is distinguished by leaves that, unlike those of *Crinum*, are not obviously sheathing at the base and have an intercalary meristem allowing the base of a leaf to continue developing intermittently over several growing seasons. Due to this pattern of regrowth after a leaf has died back, the mature leaves characteristically have truncate tips. In addition, the leaves are biflabellately arranged and most often have flat blades. *Ammocharis*, like all taxa in the tribe Amaryllideae, has fleshy, recalcitrant seeds which fail to become dry and dormant before germinating. In contrast to the other genera, however, *Ammocharis* has two modes of seed dispersal. Most commonly the seeds are dispersed by means of the fleshy fruits being released individually from the fruiting head in close proximity to the mother plant. *A. longifolia*, which occupies the extreme western parts of winter rainfall southern Africa, is exceptional in having a wind-dispersed infructescence. The entire fruiting head rapidly dries off and is shed as a single unit that is dispersed by rolling away in the wind.

The genus comprises two widespread species, *Ammocharis coranica* (Ker Gawl.) Herb. which occurs in seasonally damp areas throughout the summer rainfall area of southern Africa (Milne-Redhead & Schweickert 1939), and *A. tinneana* (Kotschy & Peyr.) Milne-Redh. & Schweick., which inhabits grassland or wooded grassland, extends from Ethiopia southwards to Botswana and northern Namibia (Nordal 1982). Other species, which have relatively restricted distribution ranges, occupy more specific habitats within the landscape: flood plains of rivers [*A. baumii* (Harms) Milne-Redh. & Schweick.]

and limestone pans (*A. nerinoides*). Namibia has all but one species of *Ammocharis* within its borders, whereas other countries have two species at most.

While on a botanical expedition in the extremely arid Namib Naukluft Park in late February 2006, Namibian botanist Dr Patricia Craven photographed flowering plants of an unknown species that has leaves like *Ammocharis coranica* and *A. longifolia* but exceptionally long flowers. Four years later, flowering and fruiting plants were collected in the same region. The infructescences were remarkable in being dry, with widely radiating, straight pedicels, a condition previously known only in *A. longifolia*. Following exceptionally good summer rains in 2011, additional collections of this taxon were made, allowing a more thorough study of the plants. The strap-shaped leaves, with truncate tips characteristic of an intercalary meristem, the unusually long flowers and the dry infructescences indicate clearly that these newly discovered Namibian plants are an undescribed species of *Ammocharis*, closely related to *A. longifolia*. We describe this new species here as *A. deserticola* and provide a key to identify the seven species currently recognized in *Ammocharis*.

***Ammocharis deserticola* Snijman & Kolberg, sp. nov.**

Bulbus ± ovatus, tunicatus, 80–110 mm latus, superne conspicue attenuatus, collum ± 80 × 25–35 mm. *Folia* 6–8, disticha, biflabellatim disposita, patentia vel adpressa, ligulata 7–250 × 8–30 mm, vetustiora apice truncata. *Scapus* compressus, ad 210 × 12–18 mm. *Umbella* 11–25-flora. *Pedicelli* 30–60 × 3–4 mm, transverse ± trigoni, sub fructu valde elongati, rigidi et radiantes. *Flores* actinomorphi, tubaeformes, rosei; perigonii tubus cylindricus, rectus, 50–90 mm longus; segmenta oblanceolata, 70–80 × 8–12 mm, patentes, recurvi versus apicem; stamina e perigonii tubo valde exserta; filamenta actinomorpha, 53–60 mm longa; antherae oblongae, curvatae, 5 × 1.5 mm, pallidae; ovarium obtuse 3-angulatum, 10–15 mm longum; stylus filiformis, exsertus; stigma integrum. *Capsula* indehiscens, obovoidea, 20–40 × 15–45 mm, valde 6-costata, rostrata; rostrum 14–50 mm longum. *Semina* carnosa, subglobosa, ± 15 mm lata, pallida.

TYPE.—Namibia, 2215 (Trekopje): Erongo region, Namib Naukluft Park, 5 km N of Langer Heinrich mine

on track towards Swakop River, 565 m, (–CD), 17 Feb. 2011, H. Kolberg & T. Tholkes HK2998 (WIND, holo., NBG, iso.).

Deciduous bulbous herb, 200–350 mm tall when flowering. *Bulb* solitary, hypogeal, $\pm$ ovate, 80–110 mm diam., extended into a neck, $\pm$ 80 $\times$ 25–35 mm, outer tunics brown to tan-coloured, with darker brown longitudinal veins, leathery to somewhat brittle, inner tunics cream-coloured, with tan longitudinal veins. *Leaves* 6–8, green at flowering, in 2 opposite spreading fans, laxly spreading, later becoming prostrate, some curved sideways at base, strap-shaped, 7–250 $\times$ 8–30 mm, plane, glaucous-green, glabrous; margin pale, smooth; apex of mature leaves dying back as if cut across. *Inflorescence* 1 or rarely 2 mature at once, laxly 11–25-flowered, umbel-like, $\pm$ 250 mm diam.; scape erect, longitudinally compressed, up to 210 $\times$ 12–18 mm, green sometimes flushed pink near base or apex; spathe valves 2, oblong-lanceolate, up to 50–80 $\times$ $\pm$ 20 mm, soon reflexed and dry; bracteoles filiform, $\pm$ 35 mm long. *Flowers* erect in bud, soon spreading; pedicels erect at first, soon spreading, 30–60 $\times$ 3–4 mm, trigonous in cross section, green; perigone trumpet-shaped, actinomorphic, dark pink, with paler pink tube, backed with narrow, brownish pink median stripes on segments, faintly scented; tube cylindrical, straight, 50–90 mm long, widening slightly up to 5 mm at throat, firm; segments oblanceolate, 70–80 $\times$

8–12 mm, recurved distally, mucronate on tip. *Stamens* inserted in throat, $\pm$ evenly spreading; filaments 53–60 mm long, 3 inner $\pm$ $\frac{2}{3}$ as long as tepals, 3 outer $\pm$ as long as tepals, $\pm$ inwardly curved, pink; anthers dorsifixed, oblong, $\pm$ curved, 5.0 $\times$ 1.5 mm, cream-coloured; pollen cream-coloured. *Ovary* $\pm$ trigonous in cross section, 10–15 mm long, scarcely wider than pedicels and perigone tube, green, style filiform, reaching 10–15 mm beyond outer stamens, pink, stigma small, undivided, minutely penicillate. *Infructescence* dry; pedicels widely radiating, straight, thickened, 50–130 $\times$ 5–8 mm; capsule indehiscent, obovoid, 20–40 $\times$ 15–45 mm, strongly 6-ribbed, with thin, papery walls disintegrating irregularly, with stout, apical beak, 14–50 mm long. *Seeds* few, subglobose, $\pm$ 15 mm diam., fleshy, with a thin, pale, corky covering. *Flowering time*: mid-February to early March. Figures 14, 15.

Distribution and ecology: *Ammocharis deserticola* is currently recorded only from the Namib Naukluft Park, in the central Namib, Namibia (Figure 16). The species occurs along well-drained, sandy rivulets and in gravelly soil on the northern slopes of undulating hills, often benefiting from fog that drifts inland from the coast. The surrounding vegetation is sparse and comprises species of *Stipagrostis* (Poaceae), *Adenolobus pechuelii* (Fabaceae) and *Tetraena stapfii* (Zygophyllaceae). Rainfall occurs in the summer months with an annual

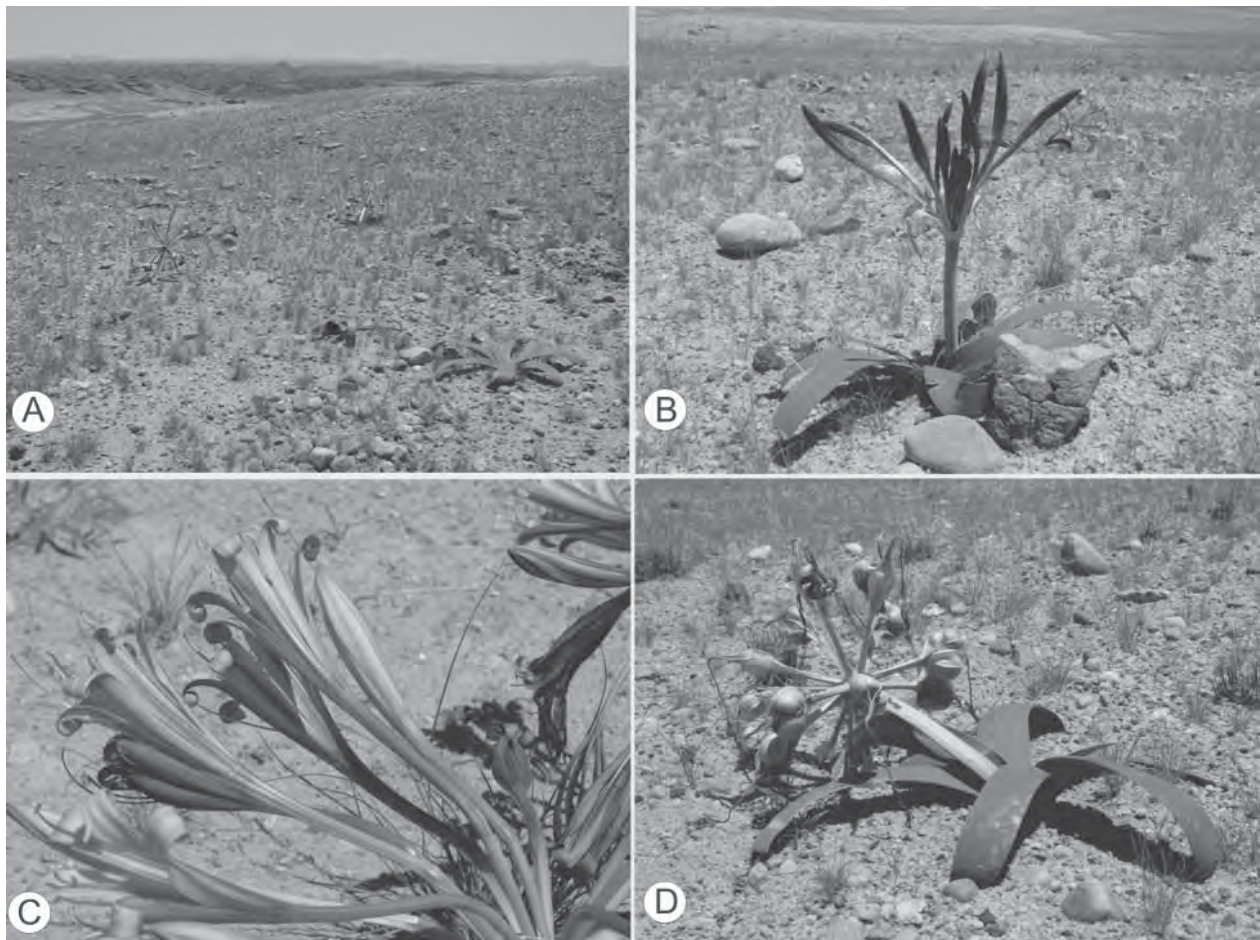


FIGURE 14.—Habitat and habit of *Ammocharis deserticola*. A, typical, open habitat in the Namib Naukluft Park, Namibia, between low hills in gravelly soil; B, plant in bud showing leaves with truncate leaf tips; C, flowering plant showing distinctive, long perigone tube; D, fruiting plant showing dry infructescence. Photographs by H. Kolberg.



FIGURE 15.—*Ammocharis deserticola*. A, dried bulb cut in half lengthwise with pressed leaves and pressed inflorescence; B, pressed infructescence cut in half lengthwise. Voucher specimen: H. Kolberg & T. Tholkes HK2998 (NBG). Scale bars: A, B = 100 mm.

average of 50–100 mm, but it is highly erratic and completely rainless years are not uncommon. Minimum temperatures on average are 9–10°C, whereas they reach an average of 32–33°C in the summer months (Mendelsohn *et al.* 2002). At the type locality, between 300 and 400 plants were visible in February 2011, whereas at two other localities in the same quarter-degree grid, an estimated 100 to 150 plants were seen. Two populations, including the one at the type locality, occur near the Langer Heinrich uranium mine, but are afforded protection by falling within a national park. The third population of up to 100 plants, however, falls within the mine's operational area and the plants there will be endangered. Plans are under way to rescue these and use them in the restoration of mine sites. There are unconfirmed reports of this species occurring also in the quarter-degree grids 2315CA and 2515DA.

Diagnostic features and relationships: *Ammocharis deserticola* is easily identified by a combination of floral and fruiting features. The flowers have a characteristically long perigone tube (50–90 mm) with broad, lanceolate, perigone segments. The infructescence is dry at maturity and has stout pedicels that radiate 'spoke-wise' from their attachment with the scape. Each pedicel carries a dry, heavily 6-ribbed capsule which is topped with a stout, 14–50 mm long, apical beak. The thin, papery walls of the capsules break open irregularly, often allowing the extremely large seeds to drop to the ground before the infructescence is rolled away in the wind. The relatively broad perigone segments and specialized

infructescence which are shared with *A. longifolia* suggest a close alliance with that species. In *A. deserticola*, however, the perigone tube is more than twice as long as that of *A. longifolia* (50–90 vs 8–15 mm long).

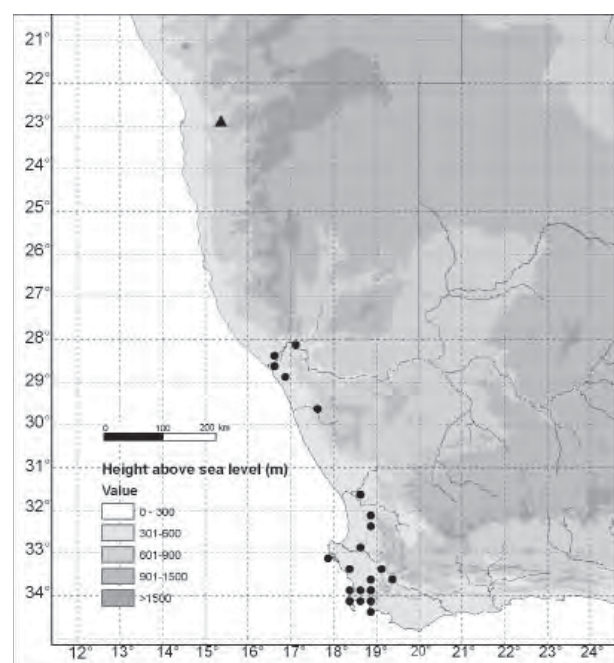


FIGURE 16.—Known distribution of *Ammocharis deserticola*, ▲; and *A. longifolia*, ●.

More than 600 km separate the populations of *Ammocharis deserticola* from the closest known populations of *A. longifolia* in the Sperrgebiet, southern Namibia. Elsewhere, *A. longifolia* is found in South Africa, extending southwards from the sand plains of the Richtersveld, through the Namaqualand lowlands to the sand flats of the Cape Peninsula and Breede River Valley, Western Cape (Figure 16). It is remarkable that such a showy species as *A. deserticola* has been overlooked in the past. This is probably the result of the bulbs not flowering for long intervals until sufficient rain falls and because their area of occupancy was largely inaccessible to botanists prior to the mining activities in the central Namib.

Other specimens examined

NAMIBIA.—2215 (Trekopje): Erongo region, Namib Naukluft Park, track west of Langer Heinrich mine towards Swakop River, 5 km N of main mine road, 560 m, (–CD), 17 Mar. 2010, *H. Kolberg & T. Tholkes HK2915* (NBG, PRE, WIND); Erongo region, Namib Naukluft Park, just W of entrance to Langer Heinrich mine, 625 m, (–CD), 17 Feb. 2011, *H. Kolberg & T. Tholkes HK2997* (NBG).

Key to species

- 1a Leaves linear, straight, ± erect *A. baumii*
- 1b Leaves narrowly to broadly lorate, at least some falcate, spreading on ground:
 - 2a Flowers with style included in perigone tube *A. angolensis*
 - 2b Flowers with style well-exserted from perigone throat:
 - 3a Perigone segments with apex spirally recurved at anthesis *A. tinneana*
 - 3b Perigone segments recurved at anthesis but never spirally:
 - 4a Pedicels not elongating after anthesis; infructescence drooping on ground; fruit walls smooth, membranous:
 - 5a Bulb 20–51 mm diam. at maturity; leaves 2–4(–10) mm wide; scape 2.5–5.0 mm wide; flower head 60–130 mm diam. *A. nerinoides*
 - 5b Bulb 90–160 mm diam. at maturity; leaves (5–)25–75 mm wide; scape 15–25 mm wide; flower head 150–200 mm diam. *A. coranica*
 - 4b Pedicels lengthening after anthesis; infructescence detaching at ground level; fruit walls papery, heavily 6-ribbed:
 - 6a Perigone tube 8–15 mm long *A. longifolia*
 - 6b Perigone tube 50–90 mm long *A. deserticola*

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REFERENCES

- KWEMBEYA, E.G., BJORÅ, C.S., STEDJE, B. & NORDAL, I. 2007. Phylogenetic relationships in the genus *Crinum* (Amaryllidaceae) with emphasis on tropical African species: evidence from *trnL-F* and nuclear ITS DNA sequence data. *Taxon* 56: 801–810.
- LEHMILLER, D.J. 1992. Transfer of *Crinum nerinoides* to *Ammocharis* (Amaryllidaceae). *Novon* 2: 33–35.
- MEEROW, A.W., LEHMILLER, D.J. & CLAYTON, J.R. 2003. Phylogeny and biogeography of *Crinum* L. (Amaryllidaceae) inferred from nuclear and limited plastid non-coding DNA sequences. *Botanical Journal of the Linnean Society* 141: 349–363.
- MENDELSON, J., JARVIS, A., ROBERTS, C. & ROBERTSON, T. 2002. Atlas of Namibia: a portrait of the land and its people. Ministry of Environment and David Phillip Publishers, Cape Town.
- MILNE-REDHEAD, E. & SCHWEICKERDT, H.G. 1939. A new conception of the genus *Ammocharis* Herb. *Journal of the Linnean Society, Botany* 52: 159–197.
- NORDAL, I. 1982. Amaryllidaceae. In R.M. Polhill, *Flora of tropical East Africa*. Balkema, Rotterdam.
- SNIJMAN, D.A. & ARCHER, R.H. 2003. Amaryllidaceae. In G. Germishuizen & N.L. Meyer, *Plants of southern Africa: an annotated checklist*. *Strelitzia* 14: 957–967.
- SNIJMAN, D.A. & WILLIAMSON, G. 1994. A taxonomic re-assessment of *Ammocharis herrei* and *Cybistetes longifolia* (Amaryllidaceae: Amaryllidaceae). *Bothalia* 24: 127–132.

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ALLIACEAE

MICROMORPHOLOGY AND CYTOLOGY OF *PROTOTULBAGHIA SIEBERTII*, WITH NOTES ON ITS TAXONOMIC SIGNIFICANCE

Four genera of the Alliaceae are known to occur in sub-Saharan Africa, in total comprising 35 indigenous and two naturalized alien species (Table 2) (Archer 2003; Klopper *et al.* 2006). *Tulbaghia* L. is the most diverse and widespread genus of the family in southern Africa, but the other two indigenous sub-Saharan genera, *Allium* L. and *Prototulbaghia* Vosa, are each represented by a single restricted-range species, of which the latter has only been described recently (Vosa 2007). This note supplements the existing description of *P. siebertii* Vosa, which is endemic to the Sekhukhuneland Centre of Endemism (Van Wyk & Smith 2001), South Africa (Vosa *et al.* 2011), where it is restricted to the summit of the Leolo Mountain Range, Limpopo Province. Although macro-morphological characters of *Prototulbaghia* have been documented by Siebert *et al.* (2008), little is known about the micromorphology and cytology of *P. siebertii*.

Live material of *Prototulbaghia siebertii* was collected from the wild in November 2005 and cultivated in clay pots in a mixture of compost, peat, sand and garden soil. Plants were housed in a greenhouse at

TABLE 2.—Sub-Saharan genera of Alliaceae and no. species per genus recorded for *Flora of southern Africa* (FSA) (Archer 2003) and tropical African flowering plants (EPFAT*) respectively (Klopper *et al.* 2006)

Genera	Species per genus		Total
	FSA	EPFAT*	sub-Saharan Africa
<i>Allium</i>	1 + †1	2	3 + †1
† <i>Nothoscordum</i>	†1	†1	†1
<i>Prototulbaghia</i>	1	0	1
<i>Tulbaghia</i>	25	9	31
Total: 4	27 + †2	11 + †1	35 + †2

†alien taxa; * Énumération des plantes à fleurs d'Afrique tropicale.

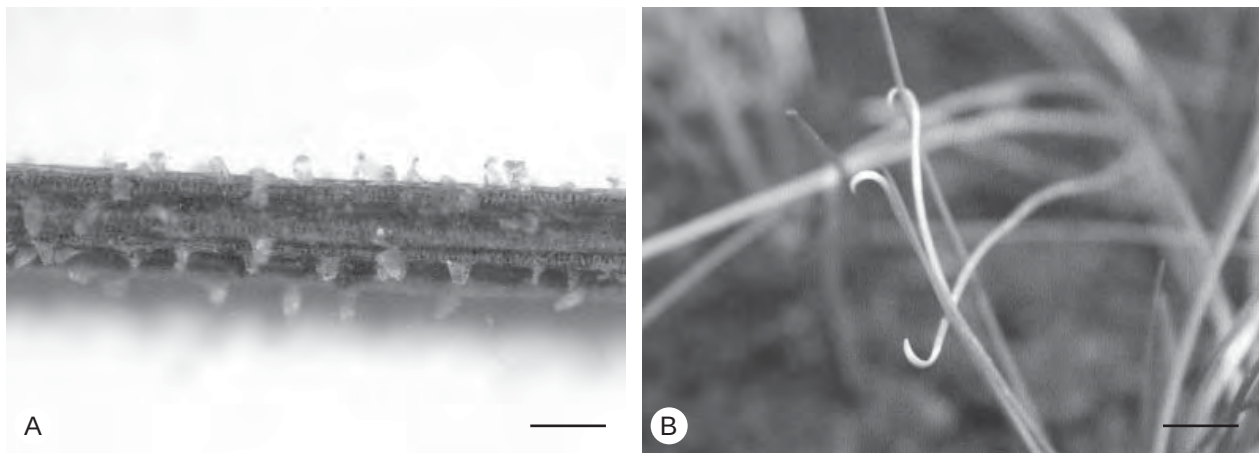


FIGURE 17.—*Prototulbaghia siebertii*. A, micrograph of floral scape showing very small glandular hairs; B, photograph of peculiar hooked tips of leaves. Plant grown from seed originally collected near Schoonoord, Leolo Mountains, Sekhukhuneland. Scale bars: A, 1 mm; B, 0.75 mm.

18 to 22°C. For mitotic preparations, actively growing root tips were collected at about 11: 00, pretreated in an aqueous solution of 0.05 % colchicine for four hours at greenhouse temperature and fixed overnight in 1:3 glacial acetic acid/absolute alcohol (Vosa 2000). After a short hydrolysis in 1N hydrochloric acid at 60°C, the meristematic part of the tip was squashed in a drop of 1.5 % orcein in 45 % acetic acid and stained in Feulgen for one hour (Vosa 2000). For an assessment of meiosis in pollen mother cells, anthers were removed from young flower buds at an appropriate developmental stage, before colouring of the perianth, and squashed in 1.5 % aceto-orcein (Vosa 1961) without pretreatment or fixation on a microscope slide. The slide was left for six hours and pressed between filter paper. The slide was heated slightly over a flame, covered with a cover-slip and sealed with paraffin wax (Vosa 1961). Micrographs of the living material and of the cytological preparations were taken with a digital camera.

Observations of the finer morphological features of *Prototulbaghia*, both in living plants and herbarium specimens. Have revealed four further diagnostic characters of the inflorescence, leaves and anatomy. Most conspicuous is the scape (or peduncle) which is reddish brown in the lower portion during its early stages

of development and is covered by short, whitish, glandular hairs with somewhat recurved tips (Figure 17A). The glandular hairs on the scape are easily rubbed off, revealing underneath a single ridge of small translucent teeth with their tips directed proximally (Figure 18A).

Under higher magnification ($\times 10$), the surface of the leaves is somewhat pruinose, especially distally, and near the apex is a single row of tiny translucent, almost glass-like teeth directed toward the apex. The row of teeth forms a type of low central keel between two indistinct keels on the abaxial surface as described by Vosa (2007) (Figure 18B). The teeth on the distal part of the leaves are easily rubbed off.

The minute teeth on the leaves and scape of *Prototulbaghia siebertii* have not been recorded in any of the species of *Tulbaghia* so far studied. In the allied genus *Allium*, at least in section *Molium*, glandular hairs are present both on the floral scape and on the leaves (Mann 1959). However, many of the over 250 species of *Allium* have not been examined for this character.

The spreading, shiny, dark green leaves of *Prototulbaghia siebertii* have peculiar hooked apices (Figure 17B), which turn black in dried material. The apices of emerging young leaves are slightly coiled outwards,

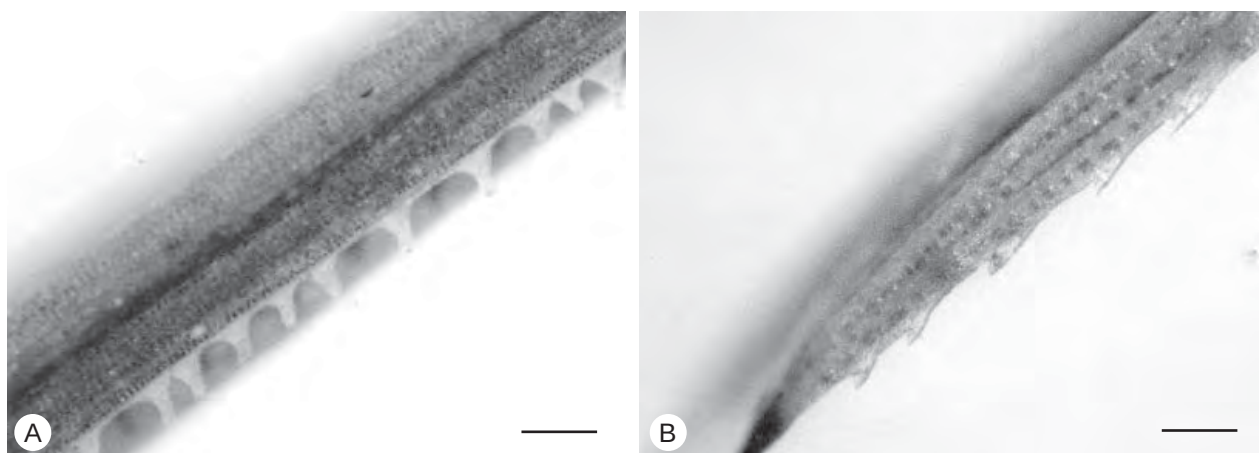


FIGURE 18.—*Prototulbaghia siebertii*. A, micrograph of floral scape showing ridge of tiny translucent teeth; B, micrograph of distal part of leaf showing tiny teeth directed towards apex of leaf. Scale bars: A, B, 1 mm.

the coils relaxing as the leaf develops, but remaining thickened and hook-like in mature leaves. Such hook-like leaf apices have not previously been recorded for the Alliaceae. Plants are easily uprooted when passing a hand or fingers through a clump, because of the entangled hooked apices. We speculate that the hooked leaves function as an additional mechanism of short range vegetative dispersal (Vosa 2007). So far the only other recorded instance of hooked leaf apices assisting in dispersal of a plant is known for *Junaea spectabilis* Kunth. (Arecaceae), the Chilean wine palm (C.G. Vosa pers. obs. in the wild and in cultivation). In the case of the palm, this unusual phenomenon has been observed in the leaflets (pinnae) of the fronds in seedlings and fairly young plants. This palm grows preferentially in soft forest soil, rich in peaty humus, and the hooked or coiled leaflet apices aid in seedling dispersal when dragged around by passing animals. This may also be the case in *Prototulbaghia*, considering the muddy, wet, humus-rich soils of its natural habitat.

The fourth micromorphological (anatomical) observation is a family characteristic. We can confirm the presence of laticifers which on damage exude a clear watery liquid in the leaf tissue of *Prototulbaghia*. Similar laticifers are also present in *Tulbaghia* and *Allium* (Mahlberg 1993).

Prototulbaghia has a diploid chromosome complement of $2n = 12$. The karyotype is very similar to that of Group 5 in *Tulbaghia* (Vosa 1975, 2000, 2009), supporting the suggested close relationship between the two genera. This poses the question how such an isolated species, which is not polyploid, could have persisted with such a presumably limited genetic endowment considering that polyploids are generally believed to display increased genetic variability and evolutionary potential (Hunziker & Schaal 1983).

A preliminary assessment of meiosis in *Prototulbaghia*, based on 18 pollen mother cells at metaphase 1, has revealed six regular bivalents with an average of about 20 chiasmata. Apart from the long arms of the longest chromosome of the complement which are unpaired (Figure 19), crossing over appears to be non-localized. This is very unlike the pattern/situation in those species of *Tulbaghia* so far investigated where crossing over is almost exclusively proximal to the centromere (Vosa 1975, 2000). This pattern may indicate a relatively higher degree of recombination than in *Tulbaghia* where the average chiasmata, based on the analyses of six diploid species, is much lower (Vosa 1966). Gender is one of the most important genetic factors affecting recombination frequency (Burt *et al.* 1991). Hence the existence of a two-track heredity in *Tulbaghia* (Vosa 1972) with a higher degree of genetic recombination in ovules than in microspores, may possibly be somewhat enhanced in *Prototulbaghia* as a compensating recombination mechanism. Overall such hypothetical modified genetic inheritance in *Prototulbaghia* may mean that the macromorphological uniformity observed in nature in its populations hides a complex and specialized genomic arrangement. However, these ideas on recombination frequency in *Prototulbaghia* still require testing.

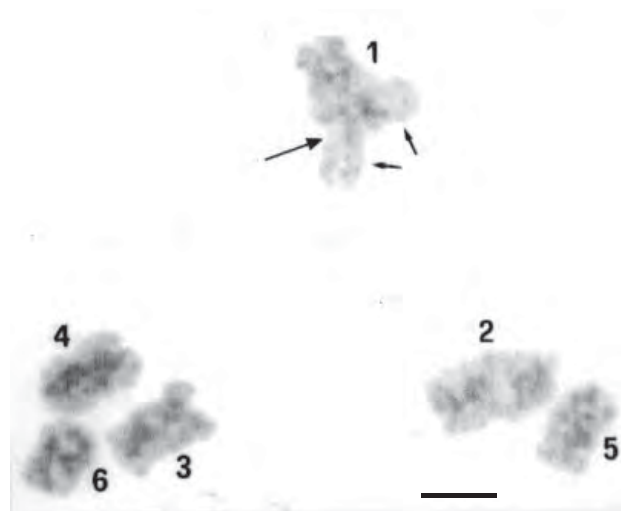


FIGURE 19.—*Prototulbaghia siebertii*. Micrograph of metaphase 1 of meiosis (six bivalents have been numbered in order of decreasing size). Note: in bivalent 1, unpaired segments corresponding to long arms of two involved chromosomes (small arrows). In this metaphase, there are 24 chiasmata, 23 non-localized and one proximal to centromere indicated by larger arrow. Scale bar: 10 μ m.

The lack of recombination in the long arms of the longest chromosome of *Prototulbaghia* (Figure 19) may be a parallel evolutionary trend toward the state found in all the species of the closely related *Tulbaghia*. The existing cytological differences between the two genera may be due to the hypothetical need of high recombination in *Prototulbaghia* for the genome as a whole to maintain genetic variability as a narrow endemic with a single population. The paradox is that although it may seem tempting to regard *Prototulbaghia* as an entity with some plesiomorphic features and most probably sister to *Tulbaghia* and intermediate to *Allium*, the existence of the taxon-specific micromorphological and cytological features noted above may also be an indication of its specialized and geographically isolated evolution ('trapped' on its specialized mountain summit habit).

Observations of the cytology discussed above provide evidence of a diagnostic character that provides support for the hypothesis that *Prototulbaghia* may possess features that are ancestral to *Tulbaghia*. Note, however, that in *Tulbaghia* the grouping of species based on karyotype (Vosa 1975, 2000) corresponds only in part to the subdivisions of the genus into sections based on floral morphology (Vosa 2009). Such discrepancies demonstrate that in *Tulbaghia* floral morphology and the karyotype in many cases seem to follow independent evolutionary pathways (Vosa 2009). Despite the similarity in karyotype, differences in floral morphology between *Prototulbaghia* and *Tulbaghia* have also been documented by Vosa (2007) and Siebert *et al.* (2008).

Available molecular phylogenetic analyses of Alliaceae support a close relationship between *Allium* and *Tulbaghia*, although hitherto only two (*T. simmleri* Beauv. and *T. violacea* Harv.) of the 31 species of *Tulbaghia* were considered (Fay & Chase 1996; Friesen *et al.* 2006; Nguyen *et al.* 2008). In such restricted molecular analyses, the potentially misleading effects of poor taxon sampling on phylogenetic analyses and their appli-

cations should be kept in mind (e.g. Heath *et al.* 2008). There is an obvious need for a well-sampled molecular phylogenetic analysis that includes *Prototulbaghia* and more *Tulbaghia* species, together with other members of the Alliaceae, to test proposed generic demarcations and evolutionary trends in the family.

For the description of *Prototulbaghia siebertii*, see Vosa *et al.* 2011. Newly observed features are:

Leaves have a row of tiny translucent teeth adpressed toward the distal abaxial part below the apex; laticifers present. *Spathes* valves subtend the inflorescence when the flower scape emerges, gradually drying off. *Flower scape* is covered by short, whitish, glandular hairs; keel present towards the base, single, persistent, ridge-like, with translucent teeth. *Flowers* are fugacious. *Perianth* segments are light green in the lower half; inner segments are 4.3 mm wide in the middle. *Gynoecium* has 2–4 ovules per locule. *Capsule* has a withered style on top.

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REFERENCES

- ARCHER, C. 2003. Alliaceae. In G. Germishuizen & N.L. Meyer, Plants of southern Africa: an annotated checklist. *Strelitzia* 14: 956, 957. National Botanical Institute, Pretoria.
- BURT, A., BELL, G. & HARVEY, P.H. 1991. Sex differences in recombination. *Journal of Evolutionary Biology* 4: 259–277.
- FAY, M.F. & CHASE, M.W. 1996. Resurrection of Themidaceae for the Brodiaea alliance, and recircumscription of Alliaceae, Amaryllidaceae and Agapanthoideae. *Taxon* 45: 441–451.
- FRIESEN, N., FRITSCH, R.M. & BLATTNER, F.R. 2006. Phylogeny and new intrageneric classification of *Allium* (Alliaceae) based on nuclear ribosomal DNA ITS sequences. *Aliso* 22: 372–395.
- HEATH, T.A., HEDTKE, S.M. & HILLIS, D.M. 2008. Taxon sampling and the accuracy of phylogenetic analyses. *Journal of Systematics and Evolution* 46: 239–257.
- HUNZIKER, J.H. & SCHAAL, B.A. 1983. Isozyme variation in diploid tropical and octoploid subtropical-temperate species of *Bulnesia*. *The Journal of Heredity* 74: 358–360.
- KLOPPER, R.R., CHATELAIN, C., BÄNNINGER, V., HABASHI, C., STEYN, H.M., DE WET, H.C., ARNOLD, T.H., GAUTIER, L., SMITH, G.F. & SPICHTER, R. 2006. *Checklist of the flowering plants of sub-Saharan Africa. An index of accepted names and synonyms*. Southern African Botanical Diversity Network Report No. 42: 684, 685. SABONET, Pretoria.
- MAHLBERG, P.G. 1993. Laticifers: an historical perspective. *Botanical Reviews* 53: 1–23.
- MANN, L.K. 1959. The *Allium* inflorescence: some species of the Section *Molium*. *American Journal of Botany* 46: 730–739.
- NGUYEN, N.H., DRISCOLL, H.E. & SPECHT, C.D. 2008. A molecular phylogeny of the wild onions (*Allium*; Alliaceae) with a focus on the western North American centre of diversity. *Molecular Phylogenetics and Evolution* 47: 1157–1172.
- SIEBERT, S.J., VOSA, C.G., VAN WYK, A.E. & MULLER, H. 2008. *Prototulbaghia* (Alliaceae), a new monotypic genus from Sekhukhuneland, South Africa. *Herbertia* 62: 76–84.
- 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.
- VOSA, C.G. 1961. A modified aceto-orcein method for pollen mother cells. *Caryologia* 14: 107–110.
- VOSA, C.G. 1966. Chromosome variation in *Tulbaghia*. *Heredity* 21: 305–312.
- VOSA, C.G. 1972. Two-track heredity: differentiation of male and female meiosis in *Tulbaghia*. *Caryologia* 25: 275–281.
- VOSA, C.G. 1975. The cytotaxonomy of the genus *Tulbaghia*. *Annali di Botanica (Roma)* 34: 47–121.
- VOSA, C.G. 2000. The revised cytotaxonomy of the genus *Tulbaghia*. *Caryologia* 53: 83–112.
- VOSA, C.G. 2007. *Prototulbaghia*, a new genus of the Alliaceae family from the Leolo Mountains in Sekhukhuneland, South Africa. *Caryologia* 60: 273–278.
- VOSA, C.G. 2009. An updated and illustrated taxonomic synopsis of the genus *Tulbaghia* (Alliaceae). *Herbertia* 63: 208–219.
- VOSA, C.G., VAN WYK, A.E., SIEBERT, S.J. & CONDY, G. (Artist). 2011. *Prototulbaghia siebertii*. *Flowering Plants of Africa* 62: 22–28, t. 2264.

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HYACINTHACEAE

ALBUCA GARIOPEPENSIS (ORNITHOGALOIDEAE), A NEW SPECIES OF A. SUBGEN. *NAMIBIOGALUM* FROM GORDONIA, SOUTH AFRICA, AND A. *PRASINA* TRANSFERRED TO *ORNITHOGALUM*

INTRODUCTION

Generic limits in Hyacinthaceae: Ornithogaloideae have been intensively reviewed in recent years using molecular techniques (Stedje 1998; Pfosser & Speta 1999; Manning *et al.* 2004, 2009; Martínez-Azorín *et al.* 2011). The broad patterns of phylogenetic relationships in the subfamily are now clear but various options exist for the translation of these patterns into a generic taxonomy (Manning *et al.* 2009; Martínez-Azorín *et al.* 2011). A recent solution, followed here, provides for the expansion of *Albuca* L. to include *Ornithogalum* subgen. *Osmyne* (Salisb.) Baker and *O.* subgen. *Urophyllon* (Salisb.) Baker (Manning *et al.* 2009). *Ornithogalum* is consolidated to include the genera *Galtonia* Decne. and

Neopatersonia Schönland, leaving *Dipcadi* Medik. and *Pseudogaltonia* (Kuntze) Engl. as the remaining genera in the subfamily. In this circumscription, *Albuca* is distinguished from *Ornithogalum* by flowers with thick-textured, whitish or yellowish tepals with a broad, green or brown longitudinal band on the adaxial surface associated with 3–5 mostly simple, medially aggregated veins (Manning *et al.* 2009). In *Ornithogalum*, the tepals are thin- or thick-textured with a narrow or indistinct median band and veins not tightly aggregated in the middle of the tepals, and the outer veins are often ± branched.

Several collections of narrow-leaved plants from the middle reaches of the Orange River in Northern Cape,

with relatively short, pyramidal racemes of green-banded flowers and relatively large, depressed-globose or cordate capsules, have remained unnamed until now or have been identified as *Ornithogalum tenuifolium* subsp. *aridum* Oberm. [now *Albuca virens* subsp. *arida* (Oberm.) J.C.Manning & Goldblatt]. Their large capsules, however, preclude any association with *A. virens*, which has smaller, ovoid capsules, and it is now clear that they represent an undescribed species, which we describe here as *A. gariensis* after the Khoisan name for the Orange River, known to earlier inhabitants of the region as the *gari* or Great River.

Collections at KMG, NBG, PRE and SAM, the main herbaria with good representation of collections of Northern Cape species, were consulted for records of the new species (herbarium acronyms after Holmgren *et al.* 1990).

In addition, examination of herbarium specimens of *Ornithogalum prasinum* Ker Gawl., which was transferred to *Albuca* by Manning *et al.* (2009) on the strength of its supposedly close relationship to *O. seineri* (Engl. & K.Krause) Oberm. (now *A. seineri* (Engl. & K.Krause) J.C.Manning & Goldblatt, reveals that it lacks the perianth features that are diagnostic of *Albuca*. This, combined with its karyology with basic chromosome number $x = 8$, dictates its transfer back to the genus *Ornithogalum*, where its large, retuse capsules suggest a relationship with *O. xanthochlorum* Baker.

TAXONOMY

***Albuca gariensis* J.C.Manning & Goldblatt sp. nov.**

Geophyta decidua 0.03–0.20 m alta, foliis (4)5–8(9) racemum duplo ad sexies longior linearibus pauciter rotatis vel ad apicem tortis canaliculatis 70–200 × 1–4 mm, racemo subpyramidalis dense 8–25-florum, 30–80 mm longo, bracteis lanceolato-aristatis, inferioribus ad 20 × 3 mm submembranaceis ad papyraceis, pediculis ± patentibus (5–)8–10(–15) mm longis, floribus rotatis tepalis liberibus albis carinis viridibus oblongo-ellipticis 7–10 × 2.5–3.5 mm, nervis centralibus tribus congestis, staminibus liberibus erectis, filamentis 4–5 mm longis inferioribus 1.5 mm expansis quadratiformis, ovario ovoideo breve stipitato ± 3 mm longo profunde 3-angulato, stylo erecto ± 3 mm longo, capsula ambita depresso-cordata profunde 3-lobata 10–12 × 15–20 mm diam., seminibus discoideis 5–8 mm diam.

TYPE.—Northern Cape: 2921 (Kenhardt):10–12 km NE of Putsonderwater along roadside, Farm Kareelaagte, (–BB), 6 Mar. 2010, Manning 3294 (NMG, holo.; MO, PRE, iso.).

Deciduous geophyte, 0.03–0.20 m high. *Bulb* solitary, pyriform, 10–25 mm diam.; outer tunics dry and thinly leathery, brownish, sometimes forming a loose neck and finely transversely barred, inner tunics tightly overlapping, white. *Leaves* overtopping raceme and two to six times as long, (4)5–8(9), suberect or spreading, not clasping below, linear, slightly coiled or twisted apically, canaliculate and rounded abaxially, 70–200 × 1–4 mm,

acute, fleshy, dull bluish green. *Inflorescence* usually solitary but up to 3 from a bulb, subpyramidal, densely 8–25-flowered, 30–80 mm long at flowering, elongating slightly and ± cylindrical in fruit, scape green and 1.5–3.0 mm diam. at ground level but subterranean portion tapering strongly and white; bracts lanceolate-aristate, lowermost up to 20 × 3 mm and uppermost ± 7 × 2 mm, apex often slightly coiled, whitish and submembranous when young but becoming papery; pedicels ± spreading, (5–)8–10(–15) mm long. *Flowers* held horizontally, rotate, 14–20 mm diam., faintly scented of lemon-cocunut; tepals biseriate with outer series overlapping inner, free, suberect in basal 1.5–2.0 mm then spreading, white with green keels adaxially, outer tepals oblong-elliptical, 7–10 × 2.5–3.0 mm, slightly keeled apically and penicillate, with 3 centrally congested veins, inner tepals elliptical, 7–10 × 3.0–3.5 mm, concave apically and penicillate, with 3 centrally congested veins. *Stamens* free, erect; filaments 4–5 mm long, two thirds as long as tepals, verruculose, both series with quadrate expansion in basal 1.5 mm, outer expansion ± 1 mm wide, inner 1.5 mm wide; anthers versatile, ± 2 mm long at anthesis, pale creamy yellow. *Ovary* ovoid and shortly stipitate, ± 3 mm long, strongly 3-angled, green; style erect, tapering, 3-angled, ± 3 mm long, acute with trigonous, papillate stigma, green in lower half and white distally. *Capsule* depressed-cordate in outline, deeply 3-lobed, 10–12 × 15–20 mm. *Seeds* discoid, 5–8 mm diam., colliculate, glossy black. *Flowering time*: January to early April. Figures 20; 21.

Distribution and ecology: *Albuca gariensis* seems to be restricted to the central portion of the Orange River drainage basin in northeastern Bushmanland, where it has been collected in a region bounded by the towns of Kakamas, Upington and Kenhardt (Figure 22). The species has been recorded from calcrete plains and sandy flats, often in slight washes or drainage lines where seasonal soil moisture levels are higher. *A. gariensis* appears to be endemic to the Bushmanland Bioregion of the Nama-Karoo Biome, primarily in Bushmanland Arid Grassland (Mucina & Rutherford 2006). Flowering occurs in late summer, the exact timing evidently depending on the seasonal rains. The collection Snijman 244 includes a plant bearing both mature fruiting and flowering stems, indicating two growth flushes some time apart, presumably in response to two distinct rainfall events.

Diagnosis and relationships: the species of *Albuca* with ± monomorphic tepal whorls are segregated among four subgenera that are defined by a combination of vegetative, floral, and fruiting characters (Manning *et al.* 2009). The several, canaliculate leaves and the pyramidal raceme of white flowers with shortly stipitate, 3-lobed ovary developing into a depressed, apically retuse capsule containing large, discoid seeds place *A. gariensis* in subgen. *Namibiogalum* (U.Müll.-Doblies & D.Müll.-Doblies) J.C.Manning & Goldblatt (Manning *et al.* 2009). Here, it is characterized by its several, linear-caliculate leaves that are loosely coiled or twisted apically and much longer (three to six times) than the short inflorescence; its moderate-sized flowers, 14–20 mm in diameter, borne on pedicels mostly 8–10 mm long; and relatively large, deeply 3-lobed capsules. The

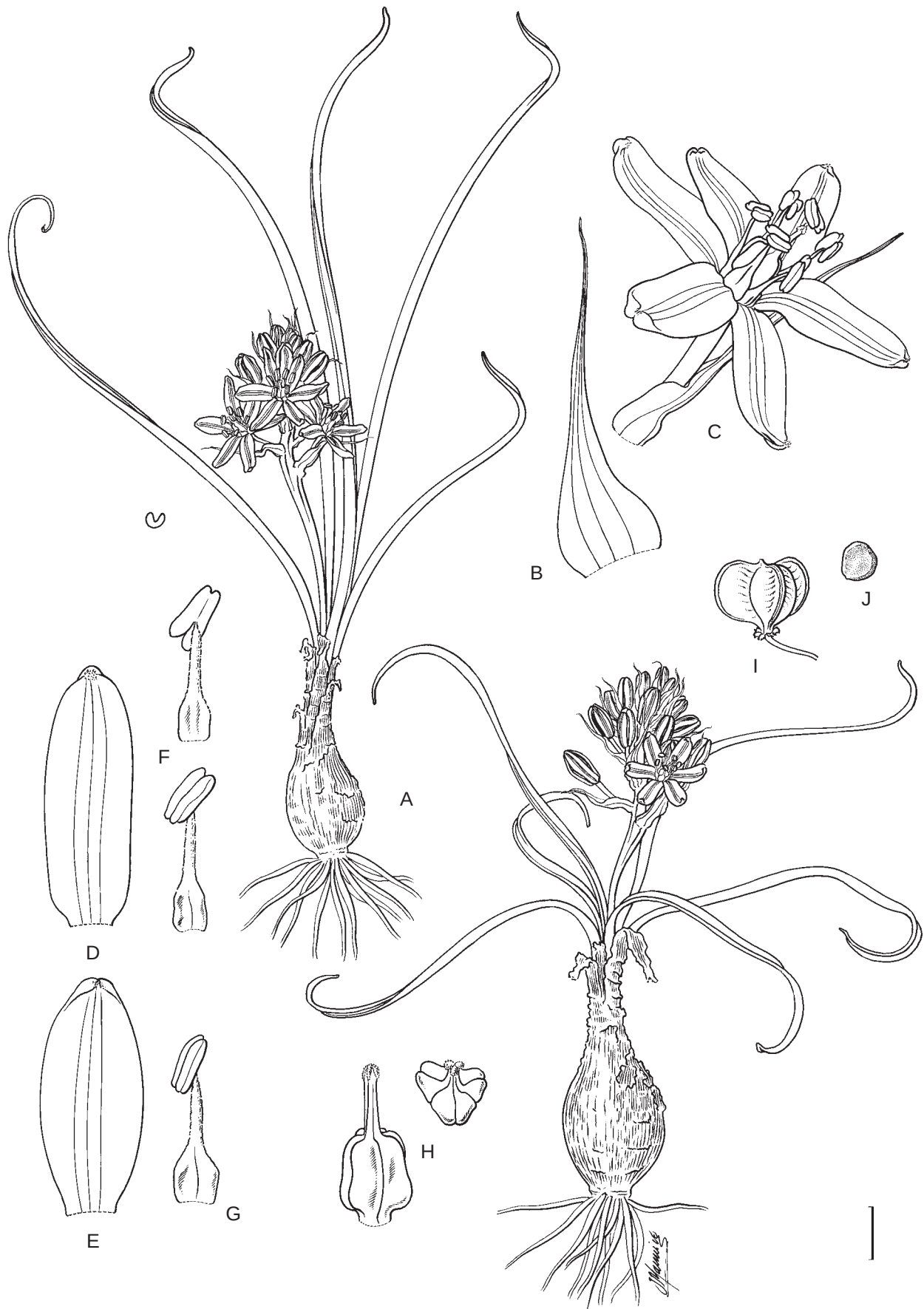


FIGURE 20.—*Albuca gariepensis*, Manning 3294. A, flowering plants; B, bract; C, flower; D, outer tepal; E, inner tepal; F, outer stamen, adaxial (upper) and abaxial (lower) views; G, inner stamen; H, ovary, lateral and dorsal views; I, capsule; J, seed. Scale bar: A–C, I, J, 10 mm; B, C, 3 mm; D–H, 2 mm. Artist: John Manning.

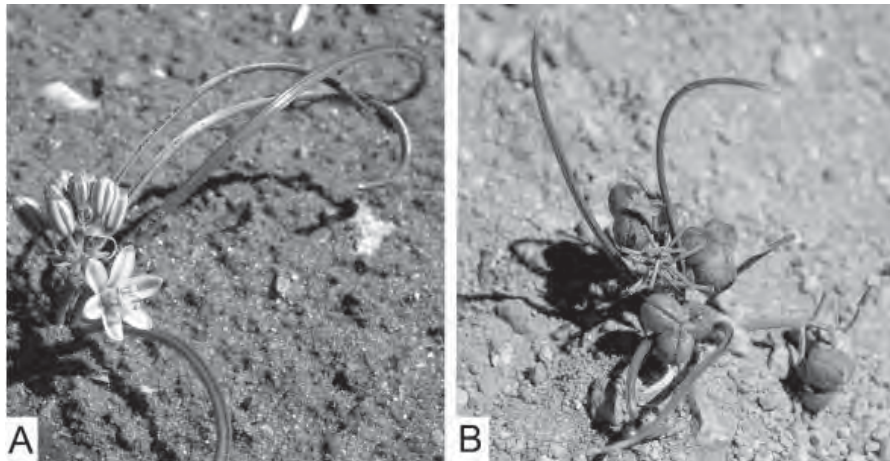


FIGURE 21.—*Albuca gariepensis*. A, flowering plant, Manning 3294. Photograph by John Manning. B, fruiting plant, Magee & Boatwright 229. Photograph by Anthony Magee.

species is most similar to *A. seineri* (Engl. & K.Krause) J.C.Manning & Goldblatt in foliage and inflorescence but the latter is an altogether larger species, with $\pm$ straight or arching leaves up to 400×30 mm (vs $70\text{--}200 \times 1\text{--}4$ mm), and larger flowers $24\text{--}40$ mm in diameter borne on longer pedicels, up to 50 mm long. Its area of occurrence is north of that of *A. gariepensis*, ranging from northern Namibia through Botswana and the northern parts of Northern Cape (Prieska and Hopetown Districts) into the western Free State, northern Mpumalanga and Limpopo (Obermeyer 1978).

Smaller plants of *Albuca gariepensis* may be confused with *A. toxicaria* (C.Archer & R.H.Archer) J.C.Manning & Goldblatt from southern Namibia and central South Africa, which has with similar, almost filiform leaves but which has smaller flowers, ± 10 mm in diameter, very short pedicels $1.5\text{--}2.2$ mm long, minute, deltoid bracts ± 1.2 mm long, and much smaller, ovoid capsules up to 10×5 mm containing elliptical, peripherally winged seeds $8 \times 5\text{--}6$ mm (Archer & Archer 1999).

The filaments in *Albuca gariepensis* are abruptly expanded at the base into quadrate wings, unlike the smoothly tapering filaments in *A. seineri* and *A. toxicaria*. Similar, basally expanded filaments are characteristic of some other species in the subgenus, notably *A. rautanenii* (Schinz) J.C.Manning & Goldblatt and *A. stapfii* (Schinz) J.C.Manning & Goldblatt, but the ovary in both these species is abruptly expanded above the stipe into a 6-lobed disc. Although the ovary in *A. gariepensis* is slightly widened above the stipe, it does not develop the characteristic lobes that are present in these two species.

Additional specimens seen

NORTHERN CAPE.—2820 (Kakamas): 31 km W of Kakamas along road to Pofadder and Onseepkans, 800 m, (–CC), 31 Jan. 1974, *Davidse 6169* (PRE); 20 km S of Kakamas on road to Loeriesfontein, 789 m, (–DC), 14 Mar. 2010, *Magee & Boatwright 229* (MO, NBG). 2821 (Upington): Upington, industrial commonage, 2700 ft [1 680 m], 1 Apr. 1980, *Snijman 244* (NBG). 2921(Kenhardt): near Steenkop, SE of Kenhardt, 900 m, (–AD), 7 Jan. 1989, *Bruyns 3461* (NBG).

Ornithogalum prasinum

Ornithogalum prasinum Ker Gawl. is relatively widespread through the drier parts of central South Africa, extending into Namibia and Botswana (Obermeyer

1978). The species was misattributed to John Lindley by Baker (1897) and subsequent authors, but John Belenden Ker[–Gawler] provided the text of the first 14 volumes of *The botanical register*, whereas Lindley was responsible for volumes 15–33 (Stafleau & Cowan 1976: 724). Placed by Baker (1897) in *O.* subgen. *Osmyne* (Salisb.) Baker, *O. prasinum* was subsequently transferred to subgen. *Urophyllon* (Salisb.) Baker by Obermeyer (1978), who considered it to be closely related to *O. seineri*. This treatment was followed by Müller-Doblies & Müller-Doblies (1996), who included both species in *O.* series *Prasinocorymbosa* Müll.-Doblies & Müll.-Doblies, and later by us when we transferred the members of *O.* subgen. *Urophyllon* to *Albuca* (Manning *et al.* 2009). At this time we had DNA sequence data for *O. seineri* but not for *O. prasinum* and our association of the two species was determined by the opinions of Obermeyer (1978) and Müller-Doblies & Müller-Doblies (1996).

A review of the cytology of subfamily Ornithogaloideae (Goldblatt & Manning 2011) shows *A. prasina* to have a diploid number of $2n = 16$ (Pienaar 1963), thus $x = 8$. This makes the species cytologically anomalous in *Albuca*, in which the most common base number is $x = 9$, and led us to re-examine its floral morphology, particularly the tepal venation, in relation to that of *A. seineri*. We confirm that *A. seineri* (Figure 23A, B), with $2n = 24$ ($x = 6$) (Vosa 1980), has the medially aggregated, mostly simple veins diagnostic of *Albuca* but that *A.*

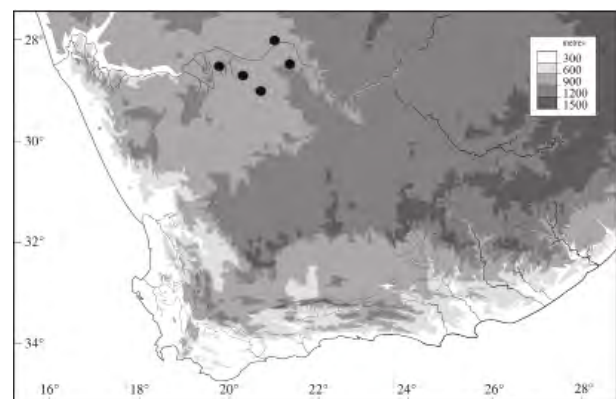


FIGURE 22.—Known distribution of *Albuca gariepensis*.

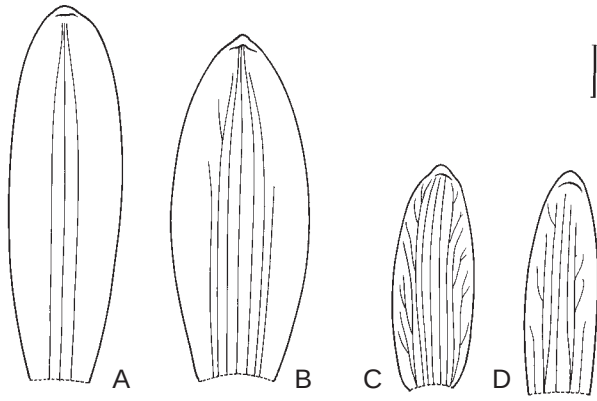


FIGURE 23.—*Albuca seineri*, D'Ewes s.n. (NBG). A, outer tepal; B, inner tepal. *Ornithogalum prasinum*, Barker 7116 (NBG). C, outer tepal; D, inner tepal. Scale bar: 2 mm. Artist: John Manning.

prasina (Figure 23C, D) has a quite different, more diffuse, branched venation which is characteristic of *Ornithogalum*. Colour notes on specimens confirm that the tepals lack the distinct green median band that is characteristic of *Albuca*. This is confirmed by the illustration of cultivated plants from Burchell's type collection (Ker Gawler 1816), which shows the perianth to be uniformly pale greenish white. Floral morphology thus supports our cytological observations that *O. prasinum* is incorrectly placed in *Albuca*, and the species should accordingly be transferred back to *Ornithogalum*.

Within *Ornithogalum*, the relationships of *O. prasinum* evidently lie with *O. haalenbergense* U.Müll.-Doblies & D.Müll.-Doblies and *O. xanthochlorum* Baker in *O.* subgen. *Galtonia* sect. *Xanthochlorum* (U.Müll.-Doblies & D.Müll.-Doblies) J.C.Manning & Goldblatt, based on its leathery outer bulb tunics, several lanceolate leaves, and especially the diagnostic, depressed-globose, apically retuse capsules containing large, discoid seeds 6–8 mm in diameter (Manning *et al.* 2009). All three species also have distinctive pale jade-green, rather obtuse tepals. The basic and most common chromosome number in subgen. *Galtonia* is $x = 8$ (Forrest & Jong 2004 [as *Galtonia*]), providing cytological support for the morphological evidence that *A. prasina* is allied to this subgenus of *Ornithogalum*.

Although Ker Gawler (1816) claimed that Burchell collected *Ornithogalum prasinum* near Graaff-Reinet in Eastern Cape, Burchell's own labels on his collections indicate that he found the plants at Horse's Grave near the Hondeblats (sic.) River in the Colesberg Division. The latter is a reference to one of his collecting localities near De Aar (Leistner & Morris 1976), which accords with the location of Hondeblafrivier that flows through Philipstown. The type locality of the species is thus in Northern Cape, between De Aar and Philipstown. The species has, however, subsequently been collected around Aberdeen in Eastern Cape (Obermeyer 1978), from where it ranges westwards across the interior of the country as far as Aus in southern Namibia (Obermeyer 1978).

***Ornithogalum prasinum* Ker Gawl.** in The botanical register 2: sub. t. 158 (1816). Type: [Northern

Cape], Colesberg Div., Hondeblafs River [Hondeblafrivier], fl. ex hort. 1816/18, *Burchell bulb* 49 (K, holo., iso.). *Albuca prasina* (Ker Gawl.) J.C.Manning & Goldblatt: 92 (2009).

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REFERENCES

- ARCHER, C. & ARCHER, R.H. 1999. A new species of *Ornithogalum* subgenus *Urophyllon* (Hyacinthaceae) from central South Africa and southern Namibia. *South African Journal of Botany* 65: 431–433.
- BAKER, J.G. 1897. Liliaceae. In W.T. Thiselton-Dyer, *Flora capensis* 6: 253–528. Reeve, Ashford.
- FORREST, L.L. & JONG, K. 2004. Bimodality in the karyotype of *Galtonia* (Hyacinthaceae). *Edinburgh Journal of Botany* 60: 569–579.
- GOLDBLATT, P. & MANNING, J.C. 2011. A review of chromosome cytology in Hyacinthaceae subfamily Ornithogaloideae (*Albuca*, *Dipcadi*, *Ornithogalum* and *Pseudogaltonia*) in sub-Saharan Africa. *South African Journal of Botany* 77: 581–591.
- HOLMGREN, P.K., HOLMGREN, N.H. & BARNETT, L.C. 1990. *Index herbariorum, Part 1: the herbaria of the World*. New York Botanical Garden, New York.
- KER-GAWLER, J. 1816. *Ornithogalum prasinum*. *The botanical register* 2: t. 158. Ridgway, London.
- LEISTNER, O.A. & MORRIS, J.W. 1976. South African place names. *Annals of the Cape Provincial Museums* 12. Cape Provincial Museums, Grahamstown.
- MANNING, J.C., FORREST, F., DEVEY, D.S., FAY, M.F. & GOLDBLATT, P. 2009. A molecular phylogeny and a revised classification of Ornithogaloideae (Hyacinthaceae) based on an analysis of four plastid DNA regions. *Taxon* 58: 77–107.
- MANNING, J.C., GOLDBLATT, P. & FAY, M.F. 2004. A revised generic synopsis of Hyacinthaceae in sub-Saharan Africa, based on molecular evidence, including new combinations and the new tribe Pseudoprosperaeae. *Edinburgh Journal of Botany* 60: 533–568.
- MARTÍNEZ-AZORÍN, M., CRESPO, M.B., JUAN, A. & FAY, M.F. 2011. Molecular phylogenetics of subfamily Ornithogaloideae (Hyacinthaceae) based on nuclear and plastid DNA regions, including a new taxonomic arrangement. *Annals of Botany* 107: 1–37.
- MUCINA, L. & RUTHERFORD, M.C. 2006. The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia* 19. South African National Biodiversity Institute, Pretoria.
- MÜLLER-DOBLIES, U. & MÜLLER-DOBLIES, D. 1996. Revisionula incompleta Ornithogalorum Austro-Africanorum (Hyacinthaceae). *Feddes Repertorium* 107: 361–548.
- OBERMEYER, A.A. 1978. *Ornithogalum*: a revision of the southern African species. *Bothalia* 12: 323–376.
- PFOSSER, M. & SPETA, F. 1999. Phylogenetics of Hyacinthaceae based on plastid DNA sequences. *Annals of the Missouri Botanical Garden* 86: 852–875.
- PIENAAR, R. DE V. 1963. Sitogenetische studies in die genus *Ornithogalum* L. *Journal of South African Botany* 29: 111–131.
- STAFLEAU, A. & COWAN, R.S. 1976. *Taxonomic literature* 1: A–G. Bonn, Scheltema & Holkema, Utrecht.
- STEDJE, B. 1998. Phylogenetic relationships and generic delimitation of sub-Saharan *Scilla* (Hyacinthaceae) and allied African genera as inferred from morphological and DNA sequence data. *Plant Systematics and Evolution* 211: 1–11.
- VOSA, C. 1980. Chromosome analysis and heterochromatin recognition in the southern African species of *Ornithogalum*. 1. *Orni-*

thogalum seineri (Engl. & Kr.) Oberm. *Journal of South African Botany* 46: 445–450.

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FABACEAE

A NEW SPECIES OF *RHYNCHOSIA* FROM THE NORTHERN PROVINCES OF SOUTH AFRICA

Inspection of the *Rhynchosia* Lour. collections of the National Herbarium, Pretoria while preparing for a revision of the group for the *Flora of southern Africa*, revealed that a number of specimens identified as *Rhynchosia confusa* Burt Davy did not belong to that taxon. As far as can be established, Dr L.E.W. Codd recognised specimens he collected in 1946 and 1947 as being something different, although the first specimen had been recorded in 1923 by E.E. Galpin.

Rhynchosia coddii Germish., sp. nov., habitu *R. confusae* Burt Davy similis sed indumento aureo glanduloso leguminibusque dehiscis arcte tortilibus differt.

TYPE.—North-West, 2527 (Rustenburg): Rustenburg Dist., Baviaanskraans Farm, on mountain slope at Tierkloof, on well-drained stony, sandy soil, (–CA), 29-10-1977, G. Germishuizen 399 (PRE, holo.).

Erect, decumbent or trailing herb or suffrutex up to 0.6 m tall, with annual stems arising from a thick, woody, underground rootstock up to 20 mm diam.; young parts densely covered with patent, golden-yellow, glandular trichomes. *Stipules* subulate, up to 4.5 mm long, mostly reflexed, reddish brown, strongly ribbed, glandular hairy on outside, glabrous inside. *Stems* and leaves with glandular trichomes, sticky to the touch, with small sand particles adhering to them. *Leaves* alternate; leaflets pinnately 3-foliate, with distinct mucro at apex, up to 0.5 mm long, conspicuously reticulate-veined on both surfaces, covered with patent glandular trichomes especially on veins; lower surface with glandular trichomes interspersed with small, raised, golden glands scattered in intervenal areas; terminal leaflets narrowly elliptic to broadly ovate, (17–)19–24(–30) × 12–20(–25) mm; lateral leaflets oblique or narrowly to broadly ovate, 17–24(–26) × (11–)12–22(–24) mm; petiole variable, 12–23 mm long, glandular hairy; margin entire. *Inflorescence* an axillary, 2–5-flowered raceme. *Corolla* yellow with standard petal dark brown (*vide Galpin M629*) sometimes tinged reddish. *Calyx* with lobes up to 8 mm long, free for almost two thirds their length, upper 2 lobes fused slightly higher up, densely glandular hairy, persistent in fruit. *Standard petal* narrowly suborbicular to broadly ovate, 10–12 × 4–8 mm, apex emarginate, base cuneate. *Wing petal* oblong, 8–10 × 3–4 mm, auricle weakly developed. *Keel petals* oblong, 9–10 × 3–4 mm, pocket weakly developed, apex obtuse. *Stamens* 10, reddish brown; 9 filaments fused into a staminal column, vexillary filament free to base. *Pistil* with ovary flattish, reddish brown; style sigmoid, covered on one side with silky hairs; stigma capitate.

Pods oblong-falcate, 20–22 × 6 mm, straw-coloured to reddish brown, covered with glandular trichomes and raised golden glands especially when young, beaked; beak up to 4.5 mm long, curling up into tight roll when dehiscent. *Seeds* broadly kidney-shaped, 5 × 4 × 4 mm, reddish brown mottled with black; aril yellow, fleshy, persistent. *Flowering time*: Oct.–Mar. Figures 25; 26.

Etymology: the specific epithet honours Dr Leslie Edward Wostall Codd (1908–1999), former director of the Botanical Research Institute [now the South African National Biodiversity Institute] (Glen & Germishuizen 2010), who recorded specimens of this undescribed species in 1946 and 1947 at various localities.

Distribution and ecology: *Rhynchosia coddii* is found in the Northern Cape Province near the border with the North-West Province; also found in Gauteng, Mpumalanga and Limpopo Provinces (Figure 27). Plants grow mostly in SVcb: Marikana Thornveld, and SVcb12: Central Sandy Bushveld (Mucina & Rutherford 2006), often on steep rocky slopes. Plants are heavily grazed (*vide GubbPRE825184*).

Relationships: the new taxon resembles *Rhynchosia confusa* in its sprawling, prostrate habit with annual stems arising from a thick, woody, underground rootstock and initial material was identified as such, but here the resemblance ends. *R. coddii* is immediately distinguished by having a golden-yellow glandular vestiture throughout and pods which curl up into a tight roll when dehiscent. See Table 3 for comparison between the two taxa.

TABLE 3.—Comparison between *Rhynchosia coddii* and *R. confusa*

Characters	<i>Rhynchosia coddii</i>	<i>R. confusa</i>
Vestiture	Golden-yellow, glandular hairy throughout	Brown, hispid throughout
Terminal leaflet size (mm)	(17–)19–24(–30) × 12–20(–25)	27–29(–35) × 17–20
Style vestiture	Silky hairy on one side only	Silky hairy throughout
Pod	Curling up into tight roll when dehiscent	Not curling up when dehiscent

Other material examined

NORTHERN PROVINCE [LIMPOPO].—2229 (Waterpoort): Louis Trichardt, Farm Wellington, (–DC), 25-03-1994, G.L. Rossouw 209 (PRE). 2329 (Polokwane): Louis Trichardt Dist., on Farm



FIGURE 25.—*Rhynchosia coddii*. A–C, *G. Germishuizen* 963: A, habit, $\times 1$; B, flowering branch, $\times 2$; C, fruiting branch and single seed, $\times 1$. *G. Germishuizen* 399: D, rolled-up pod, $\times 1$. Artist: Gillian Condry.

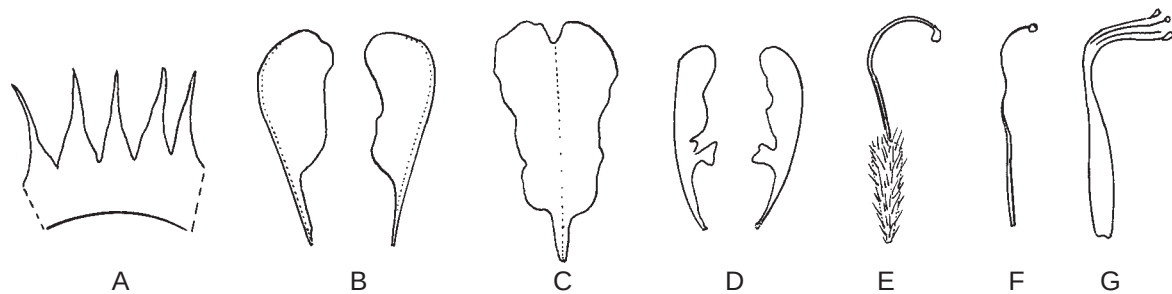


FIGURE 26.—*Rhynchosia coddii*, G. Germishuizen 399, details of flower: A, calyx spread open (upper lobes to right), $\times 3$; B, keel petals, $\times 3$; C, standard petal, $\times 3$; D, wing petals, $\times 3$; E, pistil, $\times 3$; F, vexillary filament, $\times 3$; G, staminal column, $\times 3$. Artist: Gillian Condy.

Lesheba, 50 km from Louis Trichardt on southern Vivo road, (–BA), 25-03-1994, H. Joffe 1066, 1069 (PRE); Louis Trichardt, (–BB), 10-1921, H.G. Brijer s.n. (TRV24380). 2428 (Nylstroom): Waterberg, Ratelhoek, (–AD), 07-11-1978, G. Germishuizen 963 (PRE); Sterk-rivierdam Nature Reserve, gentle S-facing slope, (–BC), 09-02-1972, N. Jacobsen 2071 (PRE); Mosdene, Naboomspruit, on Klipputgat Plateau, (–DA), 12-05-1923, E.E. Galpin M629 (PRE).

NORTH-WEST.—2526 (Zeerust): Rustenburg Dist., Zwartrug-gens, in kloofs, 4100' [1 510 m], (–DA), 11-07-1936, J.D. Sutton 1107 (PRE). 2527 (Rustenburg): Brits, Beestekraal Game Reserve, near Atlanta Station, 1 000 m, (–BA), 16-06-1990, N.P. Barker 896 (PRE); Tonquani, mid-N slopes of Magaliesberg, (–CD), 30-03-1971, A.O.D. Mogg 37617 (PRE).

GAUTENG.—2528 (Pretoria): Middelkop, Middelkop Farm, near Pienaar's River, (–AB), 01-1926, C.A. Smith 2194 (PRE); 38 km from Pretoria on Pietersburg [Polokwane] highway, (–AD), 03-03-1986, G. Germishuizen 3693 (PRE); Pretoria Dist., Botanical Reserve, near

wireless mast, on S side of ridge, (–CA), 06-02-1947, L.E.W. Codd 2588 (PRE); 15 miles [24.1 km] NW of Pretoria, N-facing slopes of Magaliesberg, (–CA), 17-07-1946, L.E.W. Codd 1536 (PRE); Bronkhorstspuit Dist., Rhenosterkop, (–DB), 07-02-1932, R.G.N. Young 2098 (PRE). 2628 (Johannesburg): Heidelberg Dist., Kloof, 2 miles [3.2 km] N of Heidelberg, (–AD), 11-12-1946, L.E.W. Codd 2326 (PRE); Suikerbosrand, entrance at Nolte B2, S-facing slope of kloof, 5500' [1 680 m], (–CB), 15-12-1971, G.J. Bredenkamp 399 (PRE).

MPUMALANGA.—2529 (Witbank): Middelburg Dist., Bothsa-belo Mission, 9 miles [14.4 km] N of Middelburg, on banks of Klein Olifants River, (–CB), 27-04-1947, L.E.W. Codd & R.A.Dyer 2870 (PRE).

NORTHERN CAPE.—2723 (Kuruman): Kuruman Dist., Mansfield Farm, S-facing slope on steep hill, (–CB), 14-03-1981, A.A. Gubb s.n. (PRE 825184).

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Thanks go to Gillian Condy for the drawings, Dr O.A. Leistner, formerly of the South African National Biodiversity Institute (SANBI), Pretoria, for providing the Latin diagnosis, and Hester Steyn of SANBI for producing the distribution map.

REFERENCES

- GLEN, H.F. & GERMISHUIZEN, G. (Compilers). 2010. Botanical exploration, edn 2. *Strelitzia* 26: 1–489. South African National Biodiversity Institute, Pretoria.
MUCINA, L. & RUTHERFORD, M.C. (eds). 2006. The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia* 19. South African National Biodiversity Institute, Pretoria.

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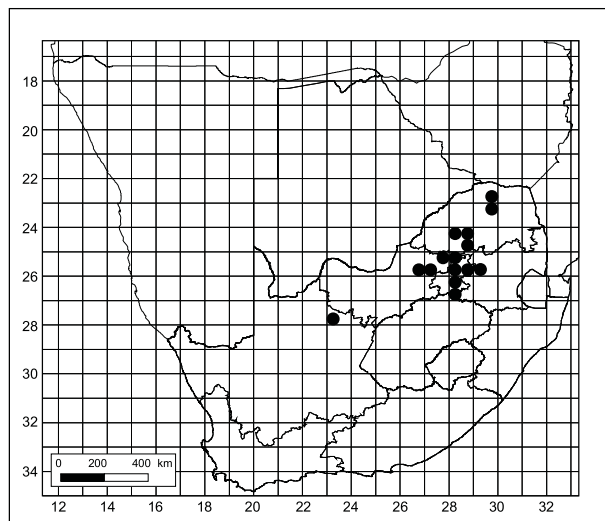


FIGURE 27.—Known distribution of *Rhynchosia coddii* based on specimens in National Herbarium, Pretoria.

LYCOPODIOPHYTA: SELAGINELLACEAE

SELAGINELLA NIVEA, A NEW LYCOPHYTE RECORD FOR SOUTH AFRICA, WITH NOTES ON ITS HABITAT

Selaginella nivea Alston ex Alston was first described from southern Madagascar where it grows on rocks in *Euphorbia* spp. and *Didierea* spp. xerophilous bush (Stefanović & Rakotonrainibe 1996). The species has since been recorded in Botswana, Zimbabwe and Mozam-

bique where it is typically associated with sandy habitat in *Colophospermum mopane* savanna mostly along the Limpopo River Valley (Burrows 1990; Roux 2009).

We here report on the first records of *Selaginella nivea* in South Africa (Figure 28). The first collection of

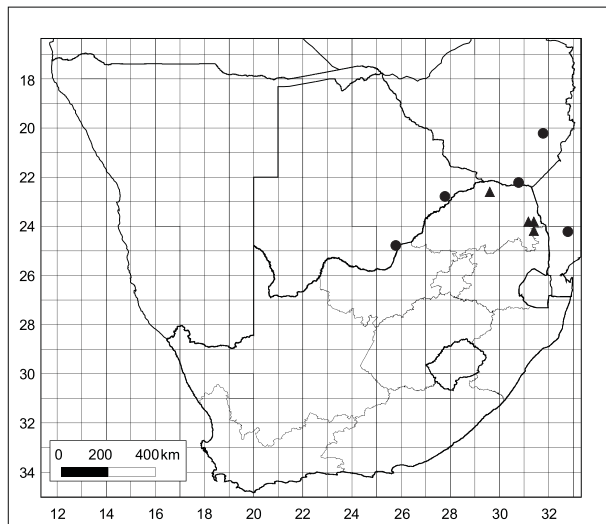


FIGURE 28.—Known distribution of *Selaginella nivea* in southern Africa, ●; new localities in South Africa, ▲.

this species in South Africa was made between Alldays and Musina [Messina] in the Limpopo Province, where it occurs in mixed *Colophospermum mopane* savanna of the Musina Mopane Bushveld vegetation type (Mucina & Rutherford 2006). The species grows in well-drained, fine gravel in open areas, occasionally interspersed with grasses. Despite the recent good rains that occurred, all plants were in a desiccated state and sterile. Plants form colonies up to 1 m² in size. No plants were found on open sandy areas where only stunted *Colophospermum mopane* trees occur, nor in mixed savanna growing on a more rocky substrate.

A second collection of this species was made in the N'tsiri Nature Reserve in northern Mpumalanga. At this site the plants occur in mixed *Colophospermum mopane*–*Acacia*–*Combretum* savanna of the Phalaborwa–Timbavati Mopaneveld vegetation type (Mucina & Rutherford 2006). This area represents the southern-

most extent of mopane savanna in South Africa. Habitat and substrate were similar to that of the record from the Musina region. Plants collected at N'tsiri were fertile, containing a few 4-ranked sporophylls.

During a later visit to the Letaba area of the Kruger National Park (KNP) in northern Limpopo Province, several populations of *Selaginella nivea* were seen in habitat similar to those described above (these are listed under *Sight records*). Most of the plants in the KNP also occur in Phalaborwa–Timbavati Mopaneveld (Mucina & Rutherford 2006). However, the two populations found on road S47 were in Tsende Mopaneveld and on the boundary between Lowveld Rugged Mopaneveld and Mopane Basalt Shrubland (Mucina & Rutherford 2006). For obvious reasons, no specimens could be collected, but negotiations with SANParks to obtain herbarium vouchers from these sites are underway.

Selaginella nivea is a member of *Selaginella* subgen. *Tetragonostachys* Jermy (1986). This species is characterized by 4-ranked strobili, club-shaped terminal branches (Figure 29) with glaucous leaves that turn grey to pale creamy brown when dry and that are seemingly randomly arranged. Furthermore, the dried leaves of *S. nivea* tend to break off early. Other members of this subgenus in southern Africa, with which *S. nivea* can be confused, are *S. dregei* (C.Presl) Hieron., *S. grisea* Alston and *S. caffrorum* (Milde) Hieron. var. *caffrorum*, as well as *S. njamnjamensis* Hieron. that occurs further to the north from Zambia, Malawi, Mozambique and into tropical Africa, with an unconfirmed record from southern Botswana (Schelpe & Anthony 1986; Burrows 1990; Roux 2009). A summary of the features separating *S. nivea* from other *Selaginella* species in subgen. *Tetragonostachys* known from the region is provided in Table 4.

Selaginella nivea is under-collected and often misidentified, given its superficial resemblance to the much more common and widespread *S. dregei*. However, its habitat does not overlap with the other regional



FIGURE 29.—*Selaginella nivea* with short, club-shaped terminal branches. Photograph: A.W. Klopper.

TABLE 4.—Characters separating members of *Selaginella* subgen. *Tetragonostachys*

	<i>S. nivea</i>	<i>S. dregei</i>	<i>S. grisea</i>	<i>S. caffrorum</i>	<i>S. njamnjamensis</i>
Apical seta	< ½ (± ¼) length of leaf blade, straight	½–¾ length of leaf blade, usually recurved	½ as long as or equal to length of leaf blade, straight to decurved	very short, if present, straight	¼ or less length of leaf blade, straight
Leaf arrangement	radially asymmetrical, seemingly random	radially symmetrical to slightly dorsiventral	radially symmetrical to slightly dorsiventral	radially symmetrical	dorsiventral
margins	shortly ciliate	sparsely ciliate	ciliate	sparsely ciliate	shortly ciliate
colour	bluish green when wet, grey to light creamy brown when dry	grey-green to blue-green when wet, silvery grey when dry	green when wet, brown-grey when dry	deep, slightly olive-green when wet, pale coppery brown when dry	green when wet, greyish brown when dry
Sporophylls	4-ranked	2-ranked	2-ranked	4-ranked	4-ranked
Ultimate branches	short, club-shaped (Figure 2)	long	long	long, recurved when dry	long
Habitat	fine gravel in mopane savanna	rock outcrops	rock outcrops	rock outcrops or cliffs	rock outcrops

members of the subgenus, all of which occur on rocky areas only (Burrows 1990). The habitat of a specimen of *S. dregei* (C.C. Straub 516 at PRE) collected in the Pontdrift area was described as ‘rocky sandstone, level places on rock’, but the collector mentions that this plant was ‘also seen in mopane veld’. This probably refers to populations of *S. nivea* in the mopane veld and is an example of the easy misidentification of *S. nivea* and its resultant under-collected status. It may further explain why this taxon was not previously recorded for South Africa, even though, based on the new records reported here, it probably occurs in a very wide area from the extreme north of Mpumalanga and throughout the northern Limpopo Province where suitable habitat is present.

Furthermore, the general areas in which the new collections were made are poorly sampled as far as lycophytes and pteridophytes are concerned. Before the discovery of *Selaginella nivea* in the Musina region, and the simultaneous collecting of *S. dregei* on a nearby rock outcrop, no previous collections of any lycophytes or pteridophytes have been made for this quarter-degree square grid (QDS: 2229DA). Of the surrounding eight QDS grids, a further four currently have no lycophyte or pteridophyte records. As for the N’tsiri QDS (2431AB) only one previous collection, that of *S. dregei*, exists, whereas two of the surrounding QDS currently have no lycophyte or pteridophyte records. Although these dry areas are not rich in lycophyte and pteridophyte flora, they are clearly being neglected as far as the collecting of these taxa is concerned.

Specimens examined

LIMPOPO.—2229 (Waterpoort): Musina Dist., Farm Riebelton 488, (–DA), 13-02-2011, R.R. Klopper & A.W. Klopper 461 (BNRH, NBG, PRE); Musina Dist., Farm Twyfelfontein 483, near house, (–DA), 13-02-2011, R.R. Klopper & A.W. Klopper 462 (PRE).

MPUMALANGA.—2431 (Acornhoek): N’tsiri Nature Reserve, east of Hoedspruit, along Cobra Link road, (–AB), 12-03-2011, L. Smook 12233 (PRE).

Sight records

LIMPOPO.—2331 (Phalaborwa): Kruger National Park, Road S51, 2 km from intersection with H9, near Masorini, (–CC), 02-05-2011; Road H9 near Masorini, (–CC), 02-05-2011; Road S47, 4.2 km from intersection with Road S131, (–CC), 03-05-2011; Road S47, 13 km from intersection with Road S131, (–CC), 03-05-2011; Road H9, near

H14/S51 intersections, (–CD), 02-05-2011; southern point of loop S51, (–CD), 02-05-2011.

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We would like to thank Michael Frosch for giving permission to look for and collect material on Riebelton and Twyfelfontein Farms; Lyn Fish and Lesley Henderson for recognizing and collecting material following casual discussions regarding this taxon; Johan Bezuidenhout from N’tsiri Nature Reserve for assistance in obtaining a GPS reading for the locality; Jan and Alta Saunders for facilitating a joint visit to the Kruger National Park and their help in looking for populations within the park; and two anonymous referees for suggesting improvements to the manuscript.

REFERENCES

- BURROWS, J.E. 1990. *Southern African ferns and fern allies*. Frandsen Publishers, Sandton.
- JERMY, A.C. 1986. Subgeneric names in *Selaginella*. *Fern Gazette* 13: 117, 118.
- MUCINA, L. & RUTHERFORD, M.C. (eds). 2006. The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia* 19. South African National Biodiversity Institute, Pretoria.
- ROUX, J.P. 2009. Synopsis of the Lycopodiophyta and Pteridophyta of Africa, Madagascar and neighbouring islands. *Strelitzia* 23. South African National Biodiversity Institute, Pretoria.
- SCHHELPE, E.A.C.L.E. & ANTHONY, N.C. 1986. Pteridophyta. In O.A. Leistner, *Flora of southern Africa*. Botanical Research Institute, Pretoria.
- STEFANOVIĆ, S. & RAKOTONDRAINIBE, F. 1996. New taxa and a new rank of *Selaginella* (Selaginellaceae) from Madagascar and the Comores. *Novon* 6: 203–209.

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IRIDACEAE

GLADIOLUS DILUVIALIS (CROCOIDEAE), A REPLACEMENT NAME FOR THE ILLEGITIMATE HOMONYM *G. HALOPHILUS*

Katherine Challis, International Plant Name List Editor, has kindly alerted us to the fact that our recently described *Gladiolus halophilus* Goldblatt & J.C.Manning (Manning *et al.* 2011) from southern Namibia is an illegitimate homonym of *G. halophilus* Boiss. & Heldr. (1854) from central Anatolia, northeastern Iraq and western Iran.

We provide the replacement name *Gladiolus diluvialis* for the Namibian species, reflecting its narrow escape from flooding by the proposed dam on the Fish River. In an interesting addition to the ecology of the species, Warren McLeland, the Consulting Ecologist who discovered the species, notes that ‘...what seemed to be unique about the seeps where we did find the *Gladiolus* is the hydraulics of the wetlands. These wetlands are very wet during the middle of the dry season and bone dry during the summer. Our theory is that there is very slow subsurface seepage off the escarpment to the east that recharges these wetlands in winter, while the limited summer rainfall is not sufficient to keep the wetlands wet. As a result we have a winter-flowering *Gladiolus* in a summer rainfall area!’ (McLeland pers. comm. 1 June 2011).

***Gladiolus diluvialis* Goldblatt & J.C.Manning**, nom. nov. pro *G. halophilus* [as ‘*halophila*’] Goldblatt & J.C.Manning in South African Journal of Botany 77: 791 (2011), hom. illegit., non *G. halophilus* Boiss. & Heldr. (Boissier 1854).

REFERENCES

- BOISSIER, P.E. 1854. *Diagnoses plantarum orientalium novarum*, ser. 1, 13. Como, Paris.
MANNING, J.C., MANNHEIMER, C. & GOLDBLATT, P. 2011. Back from the brink: *Gladiolus halophila* (Iridaceae: Crocoideae), a remarkable new species from southern Namibia escapes imminent extinction. *South African Journal of Botany* 77: 790–794.

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ASTERACEAE

BRYOMORPHE AND DOLICHOTHRIX (GNAPHALIEAE–RELHANIINAE): TAXONOMY AND NOMENCLATURE

INTRODUCTION

The genus name *Bryomorphe* Harv. is derived from the Greek *bryon* for moss and *morphe* for form (Harvey 1863; Jackson 1990), to describe an unusual plant with a moss-like habit in the South African Gnaphalieae. The name *Dolichothrix* Hilliard & Burt comes from the Greek *dolicho* for long and *thrix* for hair (Jackson 1990) and refers to the long, silky twin hairs on the cypselas.

These two monotypic genera belong to the *Metalasia* group in the tribe Gnaphalieae, subtribe Relhaniinae, as described by Anderberg (1991). This group of genera is defined by small, xerophytic leaves with a tomentose adaxial surface and by white, pink or plum-red florets (as opposed to the *Relhania* group with yellow florets). Although the two genera are quite distinct and easy to identify, even in a sterile state, their nomenclature has been confused in the past. *Dolichothrix* has very small adpressed, scale-like leaves, white involucre bracts, discoid heads and long, silky, twin hairs on the cypselas, whereas *Bryomorphe* has longer ericoid leaves, chaffy involucre bracts, radiate heads, with small white ray florets, wine-red disc florets and smooth cypselas.

Bryomorphe is restricted to the Western Cape where it is found in mountainous areas from near sea level (Vogelklip, Hermanus) to altitudes of up to 2 250 m (top of Matroosberg, De Doorns). The northernmost collection is from the Cederberg and the easternmost from the Klein Swartberg. It grows in shallow soil in rock crevices in Table Mountain Sandstone and is compact

and well anchored to withstand extreme weather conditions. Plants are often found on exposed rock faces that are ravaged by strong winds, cold, snow and drought. These moss-like cushion plants create within themselves a microclimate of moisture and temperature, and in the process minimize evaporation (Zalensky 1948; Bokhari & Wendelbo 1985) to ensure their survival.

Other unique characteristics of *Bryomorphe* are the presence of aerial roots and the arrangement of hairs on the abaxial leaf surface (Koekemoer 2002). *B. aretioides* is the only species in the *Metalasia* group in which aerial roots were observed. This can possibly be attributed to the cushion growth form of the plants. When the branches in an apparently single cushion are untangled, it is clear that each cushion consists of a number of individual plants. After flowering, capitula disintegrate and many seeds drop into the dense mass of branches in the cushion, where they germinate but are unable to anchor in the ground. Therefore they develop aerial roots to anchor themselves to other branches and to gain access to nutrients. In most species of the *Metalasia* group, a thin, arachnoid, hairy layer covers the abaxial leaf surface. In *Bryomorphe* these hairs are oriented toward the leaf tip, to create a striate or combed appearance.

When in full flower, *Bryomorphe* is a very attractive plant (see illustration in Paterson-Jones 1997) and it could have potential as a horticultural subject for alpine gardens.

Dolichothrix is also endemic to the inland mountains of the Western Cape with a single collection from

near Jansenville in the Eastern Cape. It grows in rock crevices on vertical rocks or on rock slabs in sandstone and quartzite, at altitudes between 1 100 and 2 300 m in slightly more arid environments than *Bryomorphe*. In the Witteberg it is quite common on rock outcrops and grows up to 0.4 m tall.

NOMENCLATURE

Turczaninow (1851) described *Helichrysum aretioides* from the specimen (Zeyher 2908) collected on the Cape Mountains. This Russian botanist and administrator, a civil servant in the Departments of Justice and Finances (Stafleu & Cowan 1986), collected actively in the areas where he served, and published mainly on the Russian and Chinese floras. He is relatively unknown in the history of southern African botany but was a contemporary of Cassini, De Candolle and Thunberg. He most probably received the Zeyher specimen from De Candolle, with whom he corresponded frequently (letters in G, Stafleu & Cowan 1986).

Harvey (1863) described a new genus, *Bryomorphe*, for this unusual plant but was not satisfied to have the sterile specimen of Zeyher 2908 in TCD as a type (duplicates in K, P, PRE, S, SAM and TCD) (acronyms according to Holmgren *et al.* 1990; electronic specimen seen, denoted by e!). He selected a second specimen, Roser 42, on which he based his description and illustration for *B. zeyheri*. In this description Harvey cited *H. aretioides* Turcz. as a synonym, which is based on the same type collection, Zeyher 2908. Unfortunately Harvey (1863) also cited *Klenzea lycopodioides* Sch.Bip. as a synonym. Harvey's citation of these two earlier names makes his name illegitimate and superfluous.

Levyns (1942) therefore chose the oldest name and made the new combination, *Bryomorphe lycopodioides* (Sch.Bip.) Levyns, based on *Klenzea lycopodioides* Sch.Bip. It is very unlikely that she saw the specimen of Krauss before she made this combination because *Bryomorphe* and *Dolichothrix* are very distinct monotypic genera and can not be confused, even on very poor sterile material. The holotype of *K. lycopodioides* in the Paris Herbarium (Krauss s.n., Dist. George, Roodewal) clearly represents a plant we today know as *Dolichothrix ericoides* (Lam.) Hilliard & B.L.Burtt.

Druce (1917) made the correct combination, *Bryomorphe aretioides* (Turcz.) Druce, and he should be followed.

Fairly recently, the name *Helichrysum arctioides* Turcz. has come into use and was taken up in Klopper *et al.* (2006) as a synonym of *Dolichothrix ericoides*. As far as I can establish, Turczaninow never described such a species and the name may just be the result of an orthographic error due to misreading 'are' as 'arc' in poor copies of the original text.

TAXONOMY

Bryomorphe Harv. in Thesaurus capensis 2: 33, t. 151 (1863); Benth.: 324 (1873); Harv.: 277 (1865);

E. Phillips: 800 (1951); Herman *et al.*: 127 (2000). Type species: *Bryomorphe aretioides* (Turcz.) Druce.

***Bryomorphe aretioides* (Turcz.) Druce**, Second supplement to Botanical Society & Exchange Club of the British Isles, Report for 1916, vol. 4: 611 (1917). *Helichrysum aretioides* Turcz.: 79 (1851). Type: South Africa, summits of Table and Hottentots Holland Mtns, common but rarely flowering, Zeyher 2908 (KW, holo.e!; P!, K!, PRE!, S!, SAM!, TCD!, iso.).

B. zeyheri Harv.: 33. t. 151 (1863); Harv.: 277 (1865), nom. illegit. superfl., syn. nov. Type: South Africa, summit of Genadendal Mtn, 5000' [1 524 m], Roser 42 (TCD, holo.!).

B. lycopodioides sensu Levyns: 283 (1942). [Levyns based this name on *Klenzea lycopodioides* Sch.Bip., which is a synonym of *Dolichothrix ericoides* (Lam.) Hilliard & B.L.Burtt.]

Small, tufted, copiously branched, moss-like shrublets, up to 70 mm high. *Main branches* woody, densely leafy throughout, up to 1.5 mm diam., compacted into rock crevices; aerial roots present. *Leaves* sessile, closely imbricate, ascending, linear; slightly incurved; abaxial surface tomentose, hairs longitudinally striate, adaxial surface woolly, margins entire. *Capitula* heterogamous, radiate, 5–6 × 3–4 mm, 12–14-flowered with 6 or 7 ray and 7–9 disc florets; one to three capitula terminal on branches, partially imbedded in uppermost leaves. *Involucral bracts* 24–31; outer bracts ovate, foliaceous in upper part and along midveins, inner bracts linear to narrowly oblong, up to 5 mm long, scarious, tips rounded with large lateral wings clasping florets. *Receptacle* rounded, less than 2 mm diam., alveolate. *Ray florets* white, female, lamina ± 2.0 × 1.5 mm, 3-lobed, tube 4.5–5.5 mm long. *Disc florets* plum-red, bisexual, 5-lobed, 3.5–4.0 mm long. *Anthers* apically acuminate, basally tailed. *Style* bifid, apices of style branches in ray florets rounded, sweeping hairs not tufted, tips of style branches in disc florets truncate, sweeping hairs tufted. *Nectaries* a small disc between style base and cypselas. *Cypselas* terete, ± 1 mm long, straw-coloured, laevigate; pappus setae free, (14–)18–22(–28), ± 4.5 mm long, barbed in lower four-fifths, densely plumose in upper fifth, occasionally interspersed with clavate cells, cell tips acuminate or rounded, often filled with a yellowish residue. *Flowering time*: mainly in Oct. to Jan., occasionally in Aug., Sept. and Feb.

***Dolichothrix* Hilliard & Burtt** in Botanical Journal of the Linnean Society 82: 221 (1981); Herman *et al.*: 134 (2000). Type species: *Dolichothrix ericoides* (Lam.) Hilliard & Burtt.

***Dolichothrix ericoides* (Lam.) Hilliard & Burtt** in Botanical Journal of the Linnean Society 82: 221 (1981). *Xeranthemum ericoides* Lam.: 240 (1789). *Helichrysum ericoides* (Lam.) Pers.: 415 (1807). *Argyrocome ericoides* (Lam.) Lam.: t. 693, f. 2 (1823). *Aphelaxis ericoides* (Lam.) Sweet: 223 (1826). *Gnaphalium argyrocoma* Sch.Bip.: 169 (1845). Type: Cape of Good Hope, Sonnerat s.n. (P-LAM, holo.!).

Stoebe nivea Thunb.: 170 (1800); Willd.: 2408 (1803); Thunb.: 729 (1823). Type: Cape of Good Hope, Thunberg s.n. sub THUNB-UPS 20976 (UPS, holo.!).

Klenzea lycopodioides Sch.Bip.: 973 (1843), syn. nov. *Bryomorphe lycopodioides* (Sch.Bip.) Levyns (1942), syn. nov. Type: Inter rupes

montium prope Roodewal, dist. George in Promontorio bonae spei, Krauss s.n., (P, hol. !).

Woody dwarf shrubs, 0.1–0.2(–0.4) m tall, often with a stunted growth. *Main stems* usually firmly anchored in rock crevices, secondary and tertiary branches erect, often appearing one-sided on herbarium specimens; very old plants may develop a woody base with numerous buds and remains of old stems; main stems up to 8 mm diam., new growth white-woolly, greying with age; secondary stems $\pm$ 2 mm diam., branching copiously from below previous season's capitulum, woolly-hairy; branches foliaceous throughout. *Leaves* small, scale-like, tightly adpressed, not more than 2 mm long and just as wide, adaxial surface woolly-hairy; abaxial surface arachnoid, appearing shiny, very densely glandular. *Capitula* homogamous, discoid, 6–8 mm long, 1–3 terminal on branches, 24–28-flowered, spreading funnel-like from a narrow base; up to 8 mm diam. at opening. *Involucral bracts* 48–52, in several rows, white, not translucent, reflexed in upper third, tips opaque, milky-white; receptacle flat, alveolate, 1.5–1.7 mm diam. *Flor-ets* $\pm$ 3.5 mm long, scarcely widening towards lobes, lobes pilose outside, often reddish. *Anthers*: apical appendages acuminate, basally tailed. *Style* bifid, basally swollen, branches slightly rounded. *Nectaries* absent. *Cypsela* with very dense, white, straight and stiff twin hairs; ribs 5, narrow; pappus fused in a ring at base, 18–24 setae, barbed to shortly plumose throughout, hairs fused into a flat tip with hair apices rounded and inflated. *Flowering time*: sporadic, mainly from Dec. to Mar., rarely in Aug.

The popular name for this plant, 'rock rhenoster', refers to its resemblance to *renosterbos* (*Elytropappus rhinocerotis*). Both species have minute, adpressed, scale-like leaves covered in subsessile glands with overlying arachnoid hairs. Although leaf morphology in sterile specimens can easily lead to wrong identifications, the distinct differences in the capitula and cypsela structures can clearly identify both species.

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REFERENCES

- ANDERBERG, A. 1991. Taxonomy and phylogeny of the tribe Gnaphalieae (Asteraceae). *Opera Botanica* 104: 53.
BENTHAM, G. 1873. Compositae. In G. Bentham & J.D. Hooker, *Genera plantarum* 2,1: 163–533. London.

- BOKHARI, M.H. & WENDELBO, P. 1985. Anatomy of *Dionysia* II: xeromorphic features. *Notes from the Royal Botanic Garden Edinburgh* 42: 327–345.
DRUCE, G.C. 1917. Nomenclatorial notes: chiefly African and Australian. *Second supplement to Botanical Society & Exchange Club of the British Isles, Report for 1916*, vol. 4: 601–653.
HARVEY, W.H. 1863. *Bryomorphe zeyheri*. *Thesaurus capensis* 2: 33. Hodges & Smith, Dublin.
HARVEY, W.H. 1865. Compositae. In W.H. Harvey & O.W. Sonder, *Flora capensis* 3, edn 1. Hodges & Smith, Dublin.
HERMAN, P.P.J., RETIEF, E., KOEKEMOER, M. & WELMAN, W.G. 2000. Asteraceae. In O.A. Leistner, *Seed plants of southern Africa: families and genera*. *Strelitzia* 10: 127, 134. National Botanical Institute, Pretoria.
HILLIARD, O.M. & BURTT, B.L. 1981. Some generic concepts in Compositae–Gnaphaliinae. *Botanical Journal of the Linnean Society* 82: 181–232.
HOLMGREN, P.K., HOLMGREN, N.H. & BARNETT, L.C. 1990. *Index Herbariorum, part 1: the herbaria of the World*. New York Botanical Garden.
JACKSON, W.P.U. 1990. *Origins and meanings of names of South African plant genera*. University of Cape Town Ecolab, Botany Department, Rondebosch.
KLOPPER, R.R., CHATELAIN, C., BÄNNINGER, V., HABASHI, C., STEYN, H.M., DE WET, B.C., ARNOLD, T.H., GAUTIER, L., SMITH, G.F. & SPICHTER, R. 2006. *Checklist of the flowering plants of sub-Saharan Africa. An index of accepted names and synonyms*, South African Botanical Diversity Network Report No. 42. SABONET, Pretoria.
KOEKEMOER, M. 2002. *Systematics of the Metalasia group in the Relhaniinae (Asteraceae–Gnaphalieae)*. Ph.D. thesis, Rand Afrikaans University, Johannesburg.
LAMARCK, J.P.B.A.P.M. DE. 1789. *Encyclopédie méthodique. Botanique* 3: 1–360. Paris.
LAMARCK, J.P.B.A.P.M. DE. 1823. *Tableau encyclopédique et Méthodique* 5: t. 693, f. 2.
LEVYNS, M.R. 1942. Some changes in nomenclature III. *Bryomorphe*. *Journal of South African Botany* 8: 282, 283.
PATTERSON-JONES, C. 1997. *The Cape Floral Kingdom*. New Holland, Cape Town.
PERSOON, C.H. 1807. *Synopsis plantarum* 2. Cramer, Paris.
PHILLIPS, E.P. 1951. The genera of South African flowering plants, edn 2. *Memoirs of the Botanical Survey of South Africa* No. 25. Government Printer, Pretoria.
SCHULTZ BIPONTINUS, C.H. 1843. Compositae. In W.G. Walpers, *Repertorium botanices systematicae* 2: 973. Friderici Hofmeister, Leipzig.
SCHULTZ BIPONTINUS, C.H. 1845. Über die Gattung *Gnaphalium*. *Botanische Zeitung* 3: 169.
STAFLEU, F.A. & COWAN, R.S. 1986. *Taxonomic literature*, vol. 6, Sti–Vuy, edn 2. Bohn, Scheltema & Holkema, Utrecht / Antwerpen.
SWEET, R. 1826. *Sweet's Hortus Britannicus / The British Flower Garden* 1: 223. Ridgeway, London.
THUNBERG, C.P. 1800. *Prodromus plantarum capensium*. Edman, Uppsala.
THUNBERG, C.P. 1823. *Flora capensis*. Stuttgart, Cotta.
TURCZANINOW, N.S. 1851. Synanthereae quaedam hucusque indscriptae. *Bulletin de la Société Impériale des Naturalistes de Moscou* 24,2: 59–95.
WILLDENOW, C.L. 1803. *Caroli a Linné species plantarum* 3,3, edn 4. Berlin.
ZALENSKY, O.V. 1948. About the thermal and hydric regime of cushion plants. *Botaničeskij Žurnal SSSR*. 33: 571–581.

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Phytosociological description of norite koppies in the Rustenburg area, North-West Province and refinement of the distribution of the Norite Koppies Bushveld on the national vegetation classification map of South Africa

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Keywords: Braun-Blanquet method, conservation, Norite Koppies Bushveld, phytosociology, Rustenburg, South Africa, vegetation map

ABSTRACT

The Norite Koppies Bushveld vegetation type boasts a distinctive and contrasting topography and species composition easily distinguished from that of surrounding areas. A phytosociological study was done on the leased mining area of the Impala Platinum Mining Company north of Rustenburg in the North-West Province. Similar norite koppies, situated west of the Norite Koppies Bushveld vegetation, and not yet mapped by Mucina & Rutherford (2006), were identified in the study area and phytosociologically described. Six plant communities and two subcommunities were identified. Multivariate statistical analyses (correspondence analyses) confirmed that the species composition of these areas corresponds with and does therefore form part of the Norite Koppies Bushveld vegetation type as described by Mucina & Rutherford (2006). Some of these communities contain *Boscia albitrunca*, a protected plant species, and should therefore be considered as areas with conservation value.

INTRODUCTION

The Norite Koppies Bushveld vegetation type (Mucina & Rutherford 2006) extends from Rustenburg in the west to Pretoria in the east and forms part of the Savanna Biome of South Africa. It consists of rocky hills that are embedded and isolated in Marikana Thornveld (Mucina & Rutherford 2006). The underlying geology is predominantly gabbro and norite with layered anorthosite of the Pyramid Gabbro-Norite, Rustenburg Layered Suite (Mucina & Rutherford 2006). Soils are mainly shallow and well drained. Percentage soil surface rockiness is high with rock size varying from small rocks to large boulders and sheet rock. The vegetation is characterized by low, semi-open to closed woodland with the woody component reaching heights of up to 5 m (Van der Meulen 1979). A dense layer of deciduous shrubs and trees is found with sparse undergrowth (Mucina & Rutherford 2006). The species composition of the norite koppies differs considerably from that of the surrounding thornveld. Norite koppies support high levels of biodiversity as well as the protected species *Boscia albitrunca* (SANBI 2009). Although this vegetation type is categorized as Least Threatened, based on remotely sensed data, ground truthing has suggested that these areas are in fact rather susceptible to disturbance (Mucina & Rutherford 2006). According to recent assessments, approximately 20 % of the koppies have been transformed mainly due to mining activities and urbanization of surrounding land (Mucina & Rutherford 2006). Thus, transformation has taken place largely around the fringes of these units. Most mining activities on these koppies are granite quarries which cause massive damage to the vegetation. The conservation of the

natural biodiversity of the norite koppies is therefore a matter of concern.

Granite mining in the North-West Province contributes 46 % of the national mining of granite (North-West Department of Agriculture, Conservation and Environment 2010). This style of opencast mining poses various threats to biodiversity. These activities are responsible for the pollution and large-scale consumption of environmental resources (North-West Department of Agriculture, Conservation and Environment 2010). Significant changes in land use, population dynamics and community distribution take place as a result of the concentration and location of the mineral reserves and mines in the province (North-West Department of Agriculture, Conservation and Environment 2010). Air pollution and pollution of surface water from opencast granite mining are important threats to the environment (North-West Department of Agriculture, Conservation and Environment 2010). The pollution can also spread much further than the initial area of impact by means of streams and dams that transport pollutants and cause exchange between surface and ground water sources. Dust from opencast mines and pollutants from the transportation and processing of minerals are major sources of air pollution which also pose a threat to natural biodiversity.

The aim of this paper is to provide more detailed phytosociological information on the Norite Koppies Bushveld vegetation type than previously described by Van der Meulen (1979) and Mucina & Rutherford (2006). It also provides geo-referenced information on the existence of many smaller, isolated norite koppies west of those already described. According to the North-West Spatial Development Framework and Zoning Plan, dolomite and norite koppies are proposed protection sites, and it was further proposed that no development should occur on ridges with a slope of more than 5° in the North-West Province (Maxim Planning Solutions 2004).

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The new geo-referenced information provided by this study will enable the refining of the national vegetation classification map (Mucina & Rutherford 2006) and will consequently aid in the improved conservation of the unique vegetation found on norite koppies in the North-West Province.

STUDY AREA

The study was undertaken in the licensed operating area of the Impala Platinum Mining Company (Figure 1) with the intent of developing a conservation plan for the leased mining area. It is situated 10 km northwest of Rustenburg in the North-West Province. The area covers $\pm 29\,334$ ha.

The Rustenburg area falls in the Savanna Biome, the largest biome in South Africa. The savannas of southern Africa are found in the region of high summer rainfall and winter drought (Mucina & Rutherford 2006). Altitudes range from near sea level to 2000 m. The mean daily maximum temperature for February is rarely under 26°C and daily temperatures often exceed 32°C. The mean daily temperature remains above 10°C in most of the biome during July but on the highveld (southern edge) temperatures can drop below 0°C (Mucina & Rutherford 2006). Frost is uncommon in winter, but does occur between June and August. Outside the Kalahari areas, most of the Savanna has an annual rainfall of 500–750 mm (Mucina & Rutherford 2006). The entire study area includes four vegetation types (Mucina & Rutherford 2006). The largest part of the area is covered by the Zeerust and Marikana Thornveld. A small part in the northeastern corner of the site falls inside the Central Sandy Bushveld vegetation type. A number of norite koppies are present in the lower southeast corner constituting the Norite Koppies Bushveld vegetation type (Figure 2).

METHODS

The Braun-Blanquet vegetation sampling approach (Mueller-Dombois & Ellenberg 1974) was used. Homogenous units based on physiognomy and species composition were identified on the norite koppies through visual observations and aerial photography. Forty-three stratified random relevés of 400 m² were surveyed on both previously mapped (Mucina & Rutherford 2006) and newly mapped norite koppies. Species-area curves were constructed to determine the minimal area for a relevé (Kent & Coker 2000). Environmental characteristics (aspect, gradient, percentage soil surface rockiness) and GPS co-ordinates were taken at each relevé.

The data collected were entered into the computer database, TURBOVEG (Hennekens 1996a) and into MEGATAB, a visual editor for phytosociological tables (Hennekens 1996b). TWINSPLAN was used as a first approximation to construct phytosociological tables and Braun-Blanquet procedures were followed for refinement. Subsequent multivariate analyses were performed with the computer programme CANOCO (Ter Braak 1986) to verify the communities and identify possible environmental gradients that could influence community structure and composition. The communities found on the newly mapped norite koppies were also compared to the norite koppies previously mapped by means of a Correspondence Analysis (CA) ordination in CANOCO. The relevé numbers of newly mapped koppies appear in bold in the phytosociological table to distinguish them from the previously mapped koppies by Mucina & Rutherford (2006). Mapping of the newly identified norite koppies was done in ArcView 9.2 (ESRI 2006).

The plant communities were named by combining a differential and dominant species name and then described. In the description of the first community, however, the names of two differential species were

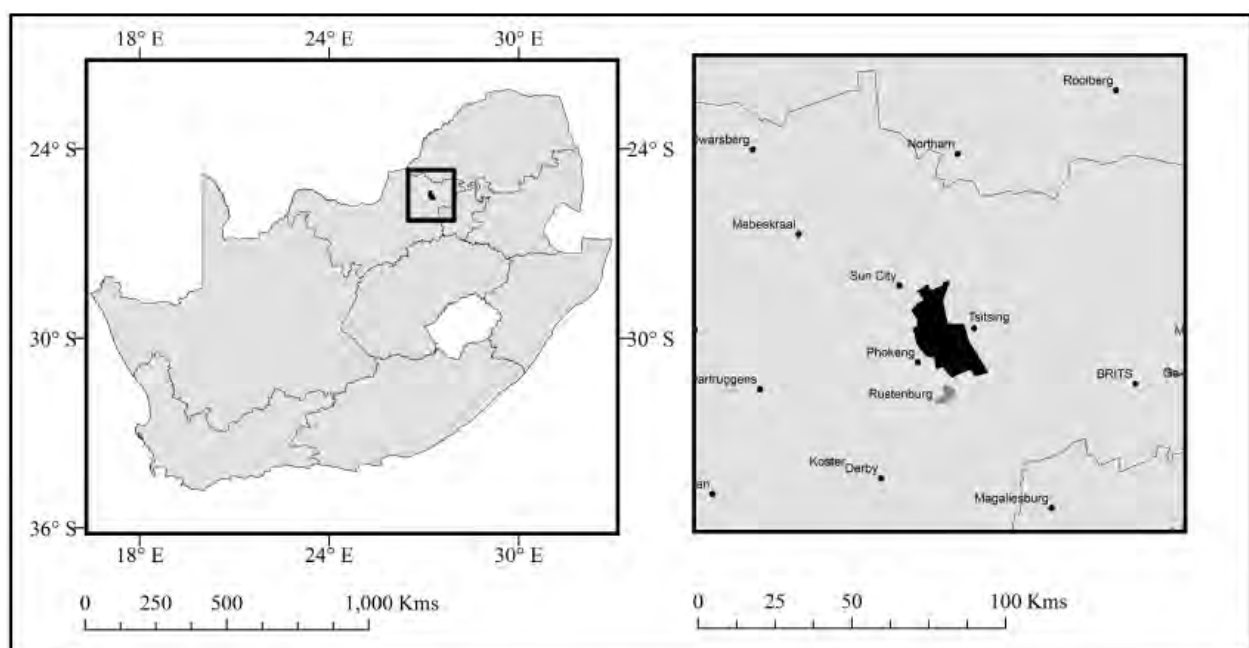


FIGURE 1.—Map of study area in South Africa.

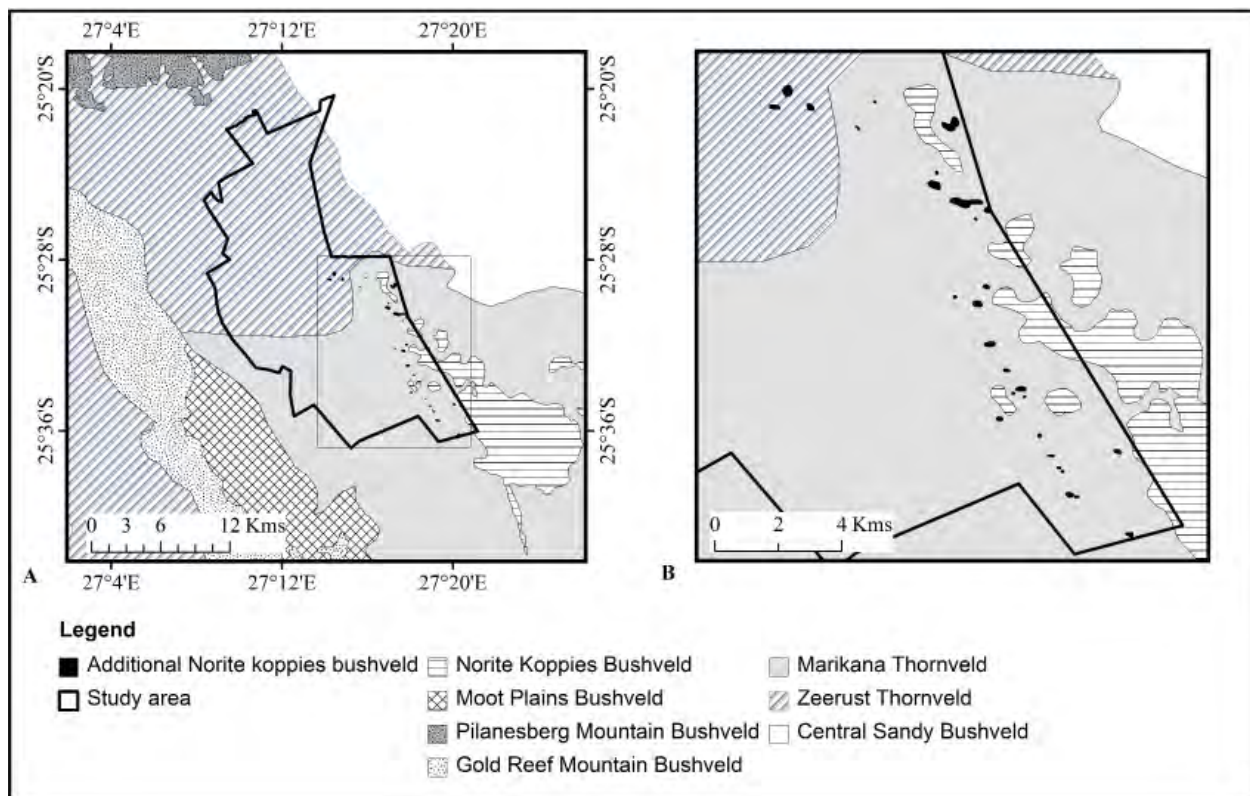


FIGURE 2.—A, map of study area and vegetation types; B, an enlarged illustration of additionally mapped norite koppies.

used instead of combining one name with the name of the dominant species.

Species names are according to Germishuizen *et al.* (2006).

Boscia albitrunca, found in certain described communities, is protected in South Africa (SANBI 2009) and was listed. Declared weeds and invaders (Henderson 2001) were also listed. These plant species are grouped into three categories according to the Conservation of Agriculture Resources Act, 1983 (Act 43 of 1983) (quoted by Henderson 2001).

RESULTS

Plant communities

Four plant communities including two subcommunities were identified, described and mapped in the norite koppies on the leased mining area of Impala Platinum. The Norite Koppies Bushveld vegetation type, as classified by Mucina & Rutherford (2006) was first described by Van der Meulen (1979) as a *Croton gratissimus*–*Setaria lindenberghiana* Woodland Association and also by Panagos (1996) as a *Clerodendrum glabrum*–*Setaria lindenberghiana* Short Closed Woodland Community. The study conducted at Impala Platinum provides data to enable the refining of the broad community described by Van der Meulen in 1979. The following communities were identified and are indicated in a phytosociological table (Appendix). *Maytenus undata* and *Maytenus albata* were not distinguished at the time of the survey but it has since come to our attention that both are

present in the study area. They are therefore listed as one species. An additional list of other species which do not fall into any differential species groups was left out of the phytosociological table for logistic reasons. For any enquiries about these species the first author can be contacted.

1. *Sporobolus stapfianus*–*Microchloa caffra* Community

This community is present on rocky, dome-shaped outcrops appearing on koppies and also on areas of exposed sheet rock found in the thornveld between the koppies. The soil is shallow and the percentage soil surface rockiness is very high, varying between 70 % and 90 %. The degree of surface rock fragmentation can vary considerably. The species composition differs slightly between fragmented outcrops and more solid ones because fragmented surface rock areas form deeper cracks and therefore create a different habitat with deeper soil and more water penetration for certain species to exploit.

Differential species are indicated by Species Group A. They include the grasses *Sporobolus stapfianus* and *Oropetium capense* as well as the fern *Selaginella dregei*. The dominant species is the grass *Heteropogon contortus* (Species Group K) and other species include the grass *Melinis repens* (Species Group F), the tree *Sclerocarya birrea* (Species Group F) and the forb *Chascanum hederaceum* (Species Group B). The grass species *Hyperthelia dissoluta* and *Schizachyrium sanguineum* (both in Species Group A) are two species which can be associated with outcrops that have more fragmented rock surfaces. These species exclusively utilize

the micro-habitat created by the high degree of rock fragmentation and are not present on areas of solid sheet rock.

Protected species: *Boscia albitrunca* (SANBI 2009).

Declared weeds and invaders: *Opuntia ficus-indica* and *Pennisetum setaceum* (both in category 1) (Henderson 2001).

The average species richness is 55 species per relevé of which 5 % are alien species. The grass layer is the dominant stratum in this community (31 % cover). It consists mostly of low-growing species with an average height of 0.3 m but in areas of high rock fragmentation certain species can reach 2 m. Shrubs and trees are less prominent (15 % cover) and the height of the woody component varies from small shrubs (0.3 m) to taller trees of up to 5 m that grow mostly on the edges of these outcrops. The forb layer only covers 9 % of the area and consists mostly of very low growing species although some can be up to 2.2 m high.

2. *Pappea capensis*–*Heteropogon contortus* Community

This community is found on north-facing mid-slopes. The slopes of these areas can vary from 10° to 30° and the percentage soil surface rockiness does not exceed 60 %, which is relatively low compared to the *Ficus abutilifolia*–*Croton gratissimus* Community which is also found on north-facing slopes.

No differential species are found in this community. The community shares species with the *Sporobolus stapfianus*–*Microchloa caffra* (Species Group B) and *Setaria lindenberiana*–*Acacia caffra* Communities (Species Group G). The absence of the differential species of the *Setaria lindenberiana*–*Acacia caffra* Community (Species Group C), which are found on south-facing slopes, characterizes this community. This phenomenon indicates that all differential species found on northern mid-slopes also occur on south-facing slopes. There is, however, a group of differential species present on southern slopes which is not found on north-facing slopes (Species Group C). Thus, this community found on northern mid-slopes is not characterized by the presence of a certain species group but rather by the absence of the differential species group of the south-facing slopes (Species Group C). The dominant species is the grass *Heteropogon contortus* (Species Group K), and other species include the trees *Sclerocarya birrea* (Species Group F) and *Croton gratissimus* (Species Group J), as well as the shrub *Pouzolzia mixta* (Species Group K).

Protected species: *Boscia albitrunca* (SANBI 2009).

Declared weeds and invaders: *Achyranthes aspera* (category 1) (Henderson 2001).

The average species richness is 60 species per relevé of which 6 % are alien species. The woody and grass layers cover nearly 90 % and are the two dominant strata in this community. Various small shrubs are present but tall trees of up to 7 m high are more prominent while the grass layer found under the tree canopy is mostly low but can reach 2 m in height. The forb layer is not as prominent as the other strata (10 % cover) and consists mostly of small forbs but also some climbers that can grow high into trees (up to 2 m).

3. *Setaria lindenberiana*–*Dombeya rotundifolia* Community

This community is found on south-facing slopes but the aspect may vary from west to southeast. Soils are mostly shallow but can be deeper in some places and the percentage soil surface rockiness varies considerably (from 40 % to 90 %).

Differential species are indicated by Species Group C which includes the grass *Setaria lindenberiana*, the tree *Celtis africana* and the forb *Scadoxus puniceus*, while the dominant species is the tree *Dombeya rotundifolia* (Species Group J). Other species include the grass *Themeda triandra*, the shrub *Euclea crispa* and *Acacia caffra* as a tree and a shrub (all in Species Group D).

Declared weeds and invaders: *Achyranthes aspera*, *Cestrum laevigatum*, *Datura stramonium*, *Opuntia ficus-indica* (all in category 1), *Cynodon dactylon* (proposed category 2), *Ipomoea purpurea* (category 3) (Henderson 2001).

The average species richness is 40 species per relevé of which 8 % are alien species. The woody layer found on the south-facing slopes is very dense (64 % cover) and consists mostly of tall trees with an average height of 5 m and some that even reach up to 10 m in height. Shrubs only make up ± 15 % of the woody layer. The grass layer rarely exceeds 1.5 m in height and covers 30 % whereas the forb layer only covers 19 %. The forbs present in this community are mostly small, low-growing species and also climber species which can reach up to 4 m into trees.

This community, found on the south-facing slopes, can be divided into two subcommunities based on the difference in percentage soil surface rockiness.

3.1 *Themeda triandra*–*Acacia caffra* Subcommunity

This is the dominant subcommunity found on the southern slopes of koppies. It is present in areas that have a relatively low percentage soil surface rockiness (40–65 %) in comparison with the other subcommunity. This is the distinguishing environmental factor between the two subcommunities found on south-facing slopes. Soils are mostly shallow but can be deeper in some areas.

Differential species are indicated by Species Group D which includes the grass *Themeda triandra*, the shrub *Euclea crispa* and the forb *Lantana rugosa*. The dominant species is *Acacia caffra* (Species Group D) as a tree and a shrub. Other species in this subcommunity include the shrub *Asparagus suaveolens* (Species Group F), the tree *Dombeya rotundifolia* (Species Group J) and the fern *Pellaea calomelanos* (Species Group K).

Declared weeds and invaders: *Achyranthes aspera*, *Cestrum laevigatum*, *Datura stramonium*, *Opuntia ficus-indica* (all in category 1), *Cynodon dactylon* (proposed category 2), *Ipomoea purpurea* (category 3) (Henderson 2001).

The average species richness is 44 species per relevé of which 4 % are alien species. A dense, woody stratum is present in this subcommunity (63 %) of which 47 % is

low to taller trees (up to 7 m) and the rest is shrubs. The grass layer is well developed (48 %) but consists mostly of low-growing grasses rarely higher than 1.5 m. Forbs cover only 11 % of the area and some species can climb up to 4 m into trees. The reason for the low cover and vigorous climbing is a shortage of space and effective sunlight because of high grass and tree cover.

3.2 *Ficus burkei*–*Dombeya rotundifolia* Subcommunity

This subcommunity is characterized by steep, rocky cliffs with an aspect that can vary from west to south-east. It is located in areas with slopes of $\pm 35^\circ$ and higher. The percentage soil surface rockiness is very high, varying between 65 % and 90 % and consists mostly of large, solid boulders. As mentioned in the description of the first subcommunity, this large percentage of rock cover is the distinguishing factor between the two subcommunities. Soils are very shallow.

Differential species are indicated by Species Group E and they include the tree *Ficus burkei*, the forb *Pavetta eylesii* and the grass *Digitaria sanguinalis*. The dominant species is the tree *Dombeya rotundifolia* (Species Group J), while other species include the forbs *Solanum panduriforme* (Species Group G), *Pupalia lappacea* (Species Group C) and *Abutilon austro-africanum* (Species Group I).

Declared weeds and invaders: *Achyranthes aspera* (category 1) (Henderson 2001).

The average species richness is 35 species per relevé of which 11 % are alien species. Trees which grow up to 10 m in height dominate this community (50 % cover) whereas the shrub layer only covers 15 % and does not grow higher than 1.8 m. A grass layer is nearly absent in this community (5 % cover) because of a shortage of soil and sunlight. The grass species found here do not grow over 0.8 m in height. Various small forbs and climbers are found in this community (28 % cover) which can reach heights of up to 4 m into trees.

4. *Ficus abutilifolia*–*Croton gratissimus* Community

This community is characterized by steep, rocky cliffs facing north or northeast. It is located in areas with very steep slopes varying from 30° to 90° . The percentage soil surface rockiness is very high, varying between 60 % and 90 %, and consists mostly of large boulders. As mentioned in the discussion of the *Pappea capensis*–*Heteropogon contortus* Community, the difference in percentage soil surface rockiness is what distinguishes these two communities found on the north-facing slopes of koppies. Little soil is present because of the large amount of rock and the very shallow soil found in this community.

Differential species are indicated by Species Group H which includes the trees *Ficus abutilifolia* and *Obeia tenax* and the grass *Enteropogon macrostachyus*. The dominant species is the tree *Croton gratissimus* (Species Group J). Other species include the forbs *Abutilon austro-africanum* (Species Group I), *Hibiscus subreniformis* and *Cyphostemma sulcatum* (both in Species Group J).

Declared weeds and invaders: *Datura stramonium* and *Opuntia ficus-indica* (both in category 1) (Henderson 2001).

The average species richness is relatively low with 25 species per relevé of which 4 % are alien species. This community is totally dominated by the woody component (67 %). Most of the woody stratum consists of tall trees that can reach 8 m in height. Because of the lack of sufficient soil and adequate sunlight, the grass cover is only 28 % and grasses are never higher than 1.2 m. Only small forbs that rarely grow over 1.2 m are present in this community and their cover does not exceed 9 %.

DISCUSSION

The four plant communities and two subcommunities that were identified on norite koppies inside the study area correspond with the Norite Koppies Bushveld vegetation type as described and mapped by Mucina & Rutherford (2006). A multivariate statistical comparison done between the communities of the previously mapped koppies and those newly mapped in this study shows a similar species composition. An ordination following correspondence analyses (CA) (Figure 3) was done to illustrate the correlation in species composition between the different communities.

A representative number of the newly mapped koppies were phytosociologically sampled and described to test the correlation in species composition between these koppies and the ones mapped by Mucina & Rutherford in 2006 as the Norite Koppies Bushveld vegetation type.

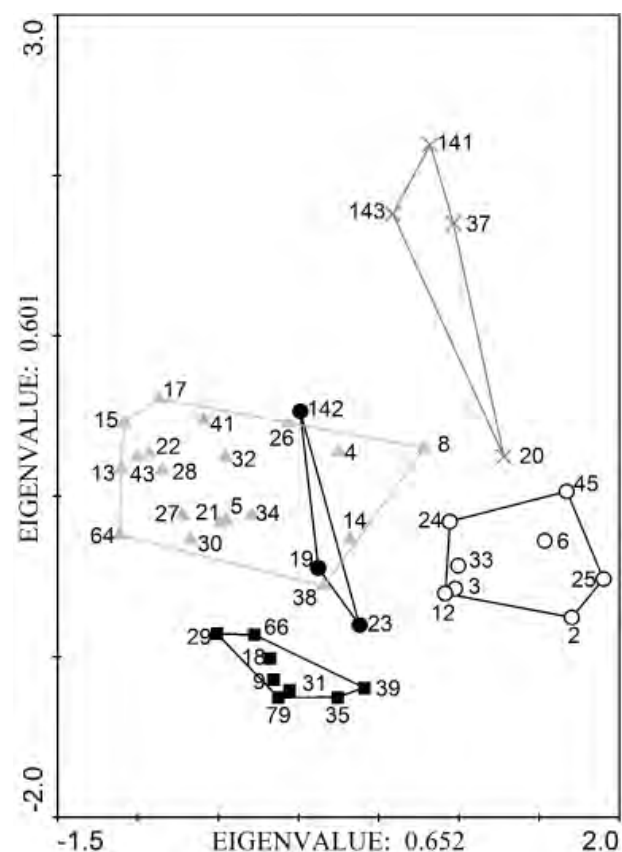


FIGURE 3.—Correspondence Analysis ordination of communities identified; Community 1, ■; Community 2, ●; Subcommunity 3.1, ▲; Subcommunity 3.2, X; Community 4, ○.

The relevés representing Community 1 formed a close grouping indicating the strong correlation in species composition between the different relevés. Community 1 is therefore similar for both the existing mapped koppies and the newly mapped koppies. This indicates that these additional koppies also form part of the Norite Koppies Bushveld vegetation type.

The relevés representing Community 2 also formed a grouping indicating the similarity in species composition between the different relevés. The overlapping of certain relevés between this community and Subcommunity 3.1 in the ordination supports our argument that this community found on the northern slopes shares various species with Subcommunity 3.1 found on south-facing slopes. The absence of certain species from Community 2 that are found in Subcommunity 3.1 is, however, what separates these two communities.

The relevés representing Subcommunity 3.1 formed a separate, larger grouping, indicating a lesser correlation in species composition compared to the correlations of the other communities. The grouping of Subcommunity 3.1 was, however, still distinct from the other communities. As with Community 1, the presence of the community on previously mapped, as well as on the newly mapped koppies indicates that these new koppies also form part of the Norite Koppies Bushveld vegetation type.

The relevés representing Subcommunity 3.2 group together. Once again this indicates a correlation in species composition between the different relevés. The presence of this community on both the mapped and unmapped koppies supports the argument that the unmapped koppies form part of the Norite Koppies Bushveld vegetation type.

The same is true for Community 4.

CONCLUSION

The plant communities identified and described on the newly mapped norite koppies on the leased mining area of the Impala Platinum Company correspond with the Norite Koppies Bushveld described by Mucina & Rutherford (2006). However, the new communities described in this paper offer a more refined description of the phytosociology of the Norite Koppies Bushveld than the broad description of Mucina & Rutherford (2006). Consequently, these new koppies can be spatially included on the vegetation map (Mucina & Rutherford 2006) to refine the map and increase the vegetation data available on the Norite Koppies Bushveld vegetation type (Mucina & Rutherford 2006). Norite koppies were also mapped in the Zeerust Thornveld, whereas Mucina & Rutherford (2006) only described norite koppies in the Marikana Thornveld. The unique species composition found in the Norite Koppies Bushveld (Mucina & Rutherford 2006) has significant conser-

vation importance. For this reason it is proposed by the North-West Spatial Development Framework and Zoning Plan that norite koppies should be protected from development in the North-West Province (Maxim Planning Solutions 2004). The addition of this new information for the geographic extension of the Norite Koppies Bushveld (Mucina & Rutherford 2006) further to the west will aid in the conservation of norite koppies and the plant communities they represent.

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REFERENCES

- ESRI (ENVIRONMENTAL SYSTEMS RESEARCH INSTITUTE). 2006. *ArcView 9.2*. www.esri.com. Redlands, CA, USA.
- GERMISHUIZEN, G., MEYER, N.L., STEENKAMP, Y. & KEITH, M. (eds). 2006. *A checklist of South African plants*. Southern African Botanical Diversity Network Report No. 41. SABONET, Pretoria.
- HENDERSON, L. 2001. *Alien weeds and invasive plants: a complete guide to declared weeds and invaders in South Africa*. Plant Protection Research Institute, Agricultural Research Council, Pretoria.
- HENNEKENS, S.M. 1996a. *TURBOVEG: software package for input, processing and presentation of phytosociological data*. IBNDLO, University of Lancaster.
- HENNEKENS, S.M. 1996b. *MEGATAB: a visual editor for phytosociological tables*. Giesen & Gertus, Ulft.
- KENT, M. & COKER, P. 2000. *Vegetation description and analysis: a practical approach*. Wiley, New York.
- MAXIM PLANNING SOLUTIONS. 2004. North-West Spatial Development Framework and Zoning Plan, vol. 4: 93.
- MUCINA, L. & RUTHERFORD, M.C. 2006. The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia* 19. South African National Biodiversity Institute, Pretoria.
- MUELLER-DOMBOIS, D. & ELLENBERG, H. 1974. *Aims and methods of vegetation ecology*. Wiley, New York.
- NORTH-WEST DEPARTMENT OF AGRICULTURE, CONSERVATION AND ENVIRONMENT. 2010. North-West Province, Environmental outlook: a report on the state of the environment 2008. http://www.nwpg.gov.za/Agriculture/NW_ENVIRONMENTAL_OUTLOOK/index.asp (accessed: 11 February 2010).
- PANAGOS, M.D. 1996. *The natural plant communities of the Onderstepoort Nature Reserve*. Unpublished Report, Agricultural Research Council, Onderstepoort Veterinary Research Institute, Pretoria.
- SANBI (SOUTH AFRICAN NATIONAL BIODIVERSITY INSTITUTE). 2009. Protected plants and plant permits in South Africa. <http://www.sanbi.org/frames/tspfram.htm> (accessed: 19 October 2009).
- TER BRAAK, C.J.F. 1986. Canonical correspondence analysis: a new eigenvector technique for multivariate direct gradient analysis. *Ecology* 67: 1167–1179.
- VAN DER MEULEN, F. 1979. *Plant sociology of the western Transvaal bushveld, South Africa: a syntaxonomic and synecological study*. Gantner, Vaduz.

APPENDIX.—Phytosociological table of Norite koppies (cont.)

Community	1										2										3										4																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
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The extended occurrence of Maputaland Woody Grassland further south in KwaZulu-Natal, South Africa

S.J. SIEBERT*, F. SIEBERT* and M.J. DU TOIT*

Keywords: coastal dunes, endemism, geoxylic suffrutex, Kwambonambi Hygrophilous Grassland, Richards Bay, vegetation mapping

ABSTRACT

The distinctiveness of Maputaland Woody Grassland lies within its richness of geoxylic suffrutices and herbaceous flora. Since it is well documented in the literature and easy to distinguish from other grassland types, it was possible to confirm a locality of this unique vegetation unit west of Richards Bay, where it probably forms the southernmost outlier population of this vegetation unit in the Indian Ocean Coastal Belt Biome. Phytosociological data obtained from the study area were analysed to identify plant communities and subsequent mapping units. Floristic gradients obtained through ordination techniques revealed the relationship that exists between the Woody Grassland of the study area and the Maputaland Woody Grassland of Sileza Nature Reserve. This confirms the occurrence of Maputaland Woody Grassland at Richards Bay. Two of the plant communities identified from the Richards Bay site are distinctively different, despite previously being lumped together by different authorities as either Kwambonambi Grassland or Maputaland Woody Grassland.

INTRODUCTION

Maputaland Wooded Grassland also known as Maputaland (MWG) (Matthews *et al.* 1999) and the name which we prefer to use, is a vegetation unit (CB2) of the Indian Ocean Coastal Belt Biome (Mucina & Rutherford 2006), and is limited to the Maputaland Centre of Endemism that is found along the coastal plain of northern KwaZulu-Natal and southern Mozambique (Van Wyk & Smith 2001). The 'woody grasslands of Maputaland' (Myre 1964), or 'the underground forests of Africa' as described by White (1977), are characterized by the many geoxylic (often rhizomatous) suffrutices that occur there. Geoxylic suffrutices, often referred to as 'underground' or 'stunted' trees, are dwarf woody plants with annual or short-lived woody shoots sprouting from massive or extensive woody, perennial, underground axes (White 1977). Common examples of geoxylic suffrutices that occur in the woody grasslands of Maputaland are *Ancylbotrys petersiana*, *Diospyros galpinii*, *Elephantorrhiza elephantina*, *Eugenia albanensis*, *E. capensis*, *Maytenus nemorosa*, *Pachystigma venosum*, *Parinari capensis* subsp. *incohata* and *Salacia krausii*. MWG is also rich in plant species that are endemic to the Maputaland-Pondoland-Albany hotspot, one of the eight most important biodiversity regions in Africa (Steenkamp *et al.* 2005). A biodiversity hotspot is a region of significant biological richness and a high level of endemism which is threatened with destruction.

According to the Mucina & Rutherford (2006) map, the area west of Richards Bay, KwaZulu-Natal, is situated within the Maputaland Coastal Belt vegetation unit (CB1). The main aim of this account is to provide evidence of the occurrence of an outlying patch of MWG from this area, approximately 10 km southwest of its currently mapped southern distribution limit. MWG is not known to extend south of the Swamp Forests on the eastern side of Lake Mzingazi (Mucina & Rutherford 2006). It is necessary for this new locality to be officially recog-

nised as of conservation importance and mapped, as it is part of the less than 10 % extent of this vegetation unit that has not been transformed in the south (Mucina & Rutherford 2006). Maddock & Benn (2000) highlighted the importance of re-assessing conservation-worthy areas of Zululand at a finer land-parcel scale, especially vegetation types not sufficiently protected by provincial authorities. Quantification is therefore required for the grassland of the study area to qualify as MWG before being considered as of conservation importance. Hence, the objectives of the study were 1, to document the floristic composition of this patch of MWG in the context of the surrounding vegetation; 2, compare its plant species composition with that of typical MWG as defined by Matthews *et al.* (1999) for Sileza Nature Reserve and other locally co-occurring grassland types of the Maputaland (CB1) and KwaZulu-Natal Coastal Belts (CB3); and 3, to map its new locality.

STUDY AREA

The study area comprises 873 hectares (8.73 km²) of land west of Richards Bay, north of the John Ross Highway that connects the former with Empangeni (Figure 1). The precise locality is between latitude 28°45'36"S and 28°46'51"S, and longitude 31°58'14"E and 32°00'39"E. The terrain is slightly undulating. Geologically it consists of Cretaceous to Recent marine sediments, with shallow littoral and coastal dune deposits (Botha 1997). Mean height is 26 m a.s.l., with the highest points at ± 35 m and the lowest at 11 m. The area is drained by a network of interdune depressions that feed into numerous perennial pans just beyond the western and southern boundaries of the study area. Richards Bay lies in the subtropical zone of South Africa, with the mean annual rainfall > 1 000 mm and the mean annual temperature ± 21.5°C (Schultze 1982).

METHODS

Stratification of the study area was based on 1:50 000 stereo aerial photographs and topographical position

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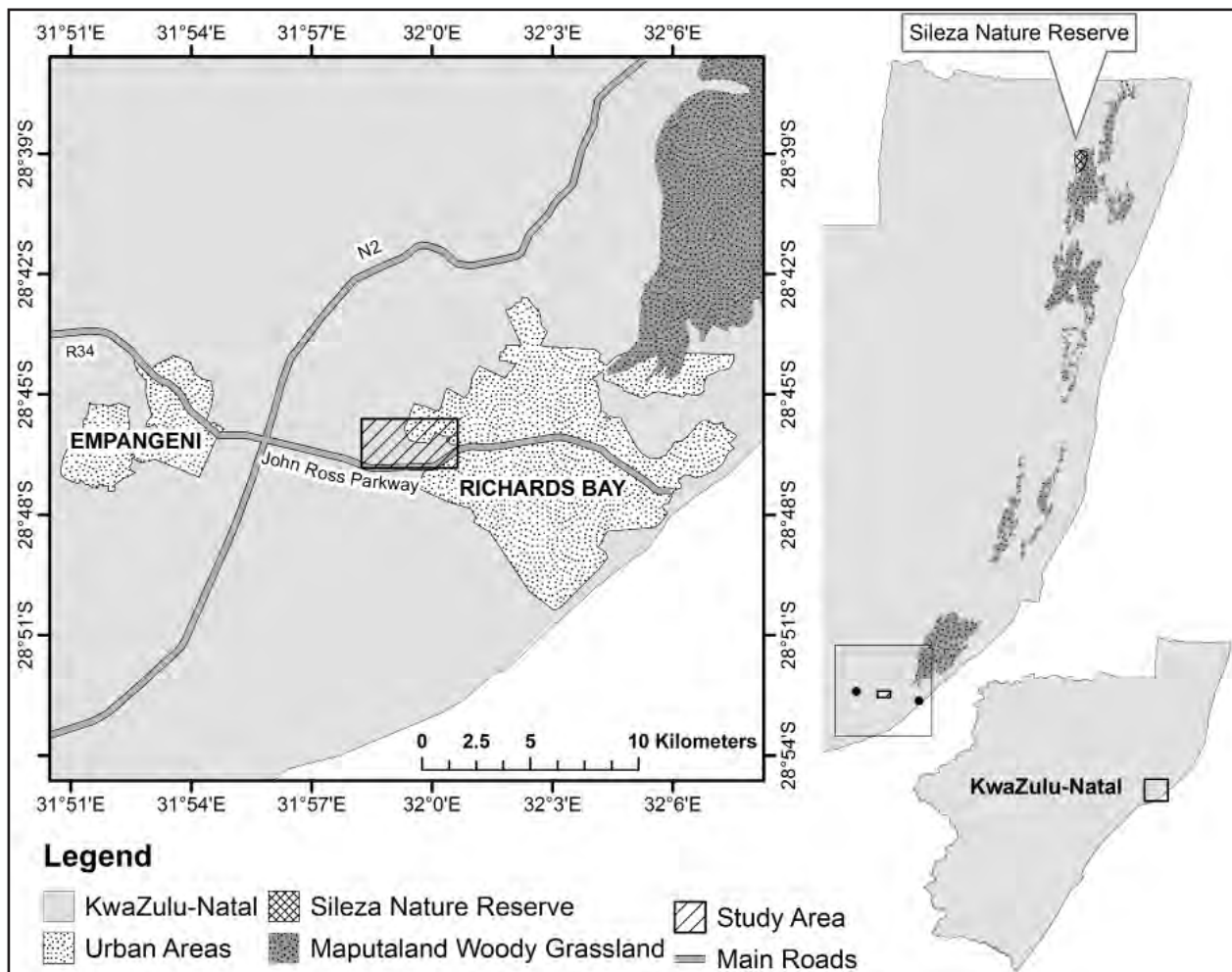


FIGURE 1.—Locality of study area at Richards Bay, KwaZulu-Natal.

using terrain types such as dune crests and interdune depressions. Relevés were compiled in 15 randomly placed sample plots within the study area. Five plots were placed in each of the three stratified homogeneous units. Cultivated and built up areas were excluded from the survey. For comparative purposes with Matthews *et al.* (1999), plot sizes were fixed at 100 m² (10 × 10 m). Within each sample plot, total floristic composition was recorded and a cover-abundance value assigned to each species according to the Braun-Blanquet scale (modified from Mueller-Dombois & Ellenberg 1974).

Braun-Blanquet procedures were used to refine the classification results of the TWINSpan (Hill 1979) application using the MEGATAB computer programme (Hennekens 1996) and are presented in a phytosociological table (Table 1). The plant community names are derived from the names of the two most dominant species along with the prevailing vegetation structure or diagnostic growth form. Dominant alien species were not considered in the naming process as these taxa might in future be successfully removed from the plant community. Results from the classification and subsequent refinement were used to construct a 1:15 000 vegetation map for the study area (Figure 2). Mapping was done at plant community level in ArcMap™ of the Esri ArcGIS 9.1® computer package (ESRI 2006).

Floristic plot data from the study site and Sileza Nature Reserve, and the bordering KwaZulu-Natal Coastal Belt vegetation unit, were subjected to PRIMER (Clarke & Gorley 2001) to elucidate species turnover (spatial floristic change). This multivariate analyses technique represents a complex data matrix (samples and species) in a visual dimensional space, allowing for the assumption that plots clustered closer together resemble similar floristic composition. The derived ordination therefore represents the distance between each plot in rank order with their difference in species composition as determined by the dissimilarity coefficient (Williams 2005).

Average height (m) and canopy cover (%) of the tree, shrub and herbaceous layers were noted, and a mean value was calculated for each layer in each community. Environmental data recorded included aspect, altitude, slope, soil type, soil depth, terrain type, and rockiness of the soil surface (Table 2). Names of taxa and growth forms conform to Germishuizen *et al.* (2006). Some species, such as geophytes, especially the Orchidaceae and species of the Asclepiadoideae (Apocynaceae) could not be identified below genus level. Threatened species were identified from Scott-Shaw (1999), and updated with the latest re-assessments of the South African Red Data List (Raimondo *et al.* 2009).

TABLE 1.—Phytosociological table of 15 plots sampled from study area at Richards Bay, including 65 of 227 recorded species; 29 % of study area's flora

Species	Growth form	Woody Grassland					Woodland Mosaic					Hygrophilous Grassland				
		1	5	10	12	13	2	4	6	7	14	3	8	9	11	15
Species group A: <i>Parinari capensis</i> – <i>Digitaria natalensis</i> Woody Grassland																
<i>Lobelia flaccida</i>	Forb	+	1	+	+	+	-	-	-	-	-	-	-	-	+	-
<i>Parinari capensis</i> •	Suffrutex	A	1	+	1	+	+	-	-	-	-	-	-	-	-	-
<i>Eugenia albanensis</i> •	Suffrutex	1	1	+	+	+	1	-	-	-	-	-	-	-	-	-
<i>Helichrysum kraussii</i> •	Forb	-	+	1	+	+	+	-	-	-	-	-	-	-	-	+
<i>Aristida junciformis</i>	Grass	1	A	-	A	A	-	-	-	-	-	-	-	+	-	-
<i>Diospyros galpinii</i> •	Suffrutex	-	1	+	1	+	-	-	-	+	-	-	-	-	-	-
<i>Helichrysum nudifolium</i>	Forb	+	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Conostomium natalense</i>	Forb	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-
<i>Salacia kraussii</i> •	Suffrutex	-	1	+	+	+	+	-	-	-	-	-	-	-	-	-
<i>Hypoxis iridifolia</i>	Forb	R	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Oxygonum robustum</i> •	Forb	R	+	+	-	+	-	-	-	-	-	-	-	-	+	-
<i>Dactyloctenium aegyptium</i>	Grass	1	-	+	-	+	1	-	-	-	-	-	-	-	-	-
<i>Diospyros lycioides</i> •	Shrub	+	+	+	-	+	-	-	-	-	-	-	-	-	-	-
<i>Helichrysum asperum</i>	Forb	1	1	-	-	+	R	-	-	-	-	-	-	-	-	-
<i>Tephrosia macropoda</i>	Forb	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-
<i>Tristachya leucothrix</i>	Grass	-	A	A	1	+	-	-	-	-	-	-	-	-	-	-
<i>Chamaecrista comosa</i> •	Forb	-	+	+	-	-	-	-	-	-	-	-	+	-	-	-
<i>Cissampelos hirta</i> •	Forb	-	-	+	-	+	-	-	-	-	-	-	-	-	-	-
<i>Agathisanthemum bojeri</i> •	Forb	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Species group B: <i>Trichilia emetica</i> – <i>Panicum maximum</i> Woodland Mosaic																
<i>Conyza canadensis</i> *	Forb	-	-	-	-	-	+	+	+	+	+	-	-	-	-	-
<i>Desmodium incanum</i>	Forb	-	-	-	-	-	+	+	-	+	+	-	-	-	-	-
<i>Chromolaena odorata</i> *	Shrub	+	-	-	-	-	-	1	+	+	-	-	-	-	-	-
<i>Searsia nebulosa</i>	Shrub	-	-	+	-	-	-	+	+	+	-	-	-	-	-	+
<i>Melia azederach</i> *	Tree	-	-	-	-	-	+	1	+	-	+	-	-	-	-	-
<i>Panicum maximum</i>	Grass	-	-	-	-	-	-	A	+	A	-	-	-	1	-	-
<i>Eugenia capensis</i>	Shrub	-	-	-	+	-	+	-	-	+	+	-	-	-	-	-
<i>Commelina benghalensis</i>	Forb	-	-	-	-	-	-	+	-	+	+	-	-	-	-	-
<i>Cyperus esculentus</i>	Forb	-	-	-	-	-	+	-	-	+	+	-	-	-	-	-
<i>Trichilia emetica</i>	Tree	-	-	-	-	-	-	A	+	1	-	-	-	-	-	-
<i>Melinis repens</i>	Grass	+	-	-	-	-	1	-	1	+	-	-	-	-	-	-
<i>Stenotaphrum secundatum</i>	Grass	+	-	-	-	-	-	A	-	+	+	-	-	-	-	-
Species group C																
<i>Lantana camara</i> *	Shrub	+	+	+	+	+	1	+	1	+	+	-	-	+	-	-
<i>Hyphaene coriacea</i> •	Tree	1	+	-	+	-	+	+	-	+	+	-	-	-	-	-
<i>Dichrostachys cinerea</i> •	Shrub	+	+	+	+	+	+	-	-	-	+	-	-	-	-	-
<i>Smilax anceps</i>	Forb	+	-	+	+	+	+	-	-	+	-	-	+	-	-	-
<i>Vernonia centauroides</i>	Forb	+	-	+	+	+	-	-	+	+	-	-	-	-	+	-
<i>Chamaecrista mimosoides</i>	Forb	-	+	+	-	+	+	-	-	+	-	-	-	+	-	-
<i>Abrus precatorius</i>	Forb	+	+	-	-	-	+	+	1	-	-	-	-	-	-	-
<i>Asystasia gangetica</i>	Forb	+	-	+	-	-	1	1	-	+	-	-	-	-	-	-
<i>Raphionacme galpinii</i>	Forb	R	+	-	-	-	R	-	-	+	-	-	-	-	-	-
Species group D: <i>Ischaemum fasciculatum</i> – <i>Imperata cylindrica</i> Hygrophilous Grassland																
<i>Ischaemum fasciculatum</i>	Grass	-	-	-	-	-	-	-	-	+	-	A	+	-	A	+
<i>Pycreus polystachyos</i>	Forb	+	-	-	-	-	-	-	-	-	-	1	+	-	+	+
<i>Cyperus natalensis</i> •	Forb	-	-	-	-	-	-	-	-	-	-	+	-	+	+	+
<i>Eragrostis inamoena</i>	Grass	-	-	-	-	-	+	-	-	-	-	-	+	-	1	+
<i>Juncus kraussii</i>	Forb	-	-	-	-	-	-	-	-	-	-	+	1	+	-	+
<i>Cyclosorus interruptus</i>	Forb	-	-	-	-	-	-	-	-	-	-	-	A	-	-	1
<i>Ethulia conyzoides</i>	Forb	-	-	-	-	-	-	-	-	-	-	-	+	-	+	+

Species	Growth form	Woody Grassland					Woodland Mosaic					Hygrophilous Grassland				
		1	5	10	12	13	2	4	6	7	14	3	8	9	11	15
<i>Abildgaardia hygrophila</i> *	Forb	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-
<i>Dissotis canescens</i>	Forb	-	-	-	-	-	-	-	-	-	-	+	-	+	-	-
Species group E																
<i>Senecio pterophorus</i>	Forb	-	-	-	-	-	-	+	-	+	-	+	+	-	-	-
<i>Desmodium dregeanum</i> *	Forb	-	-	-	-	-	A	-	1	+	+	-	-	+	+	-
<i>Cyperus solidus</i>	Forb	+	-	-	-	-	+	-	-	+	1	+	+	-	-	+
<i>Eucalyptus grandis</i> *	Tree	-	+	-	-	-	A	+	+	A	A	-	-	+	+	-
<i>Panicum dregeanum</i>	Grass	-	-	-	-	-	+	-	-	-	+	-	+	-	-	+
<i>Gomphocarpus physocarpus</i>	Forb	-	-	-	-	-	+	-	-	+	-	+	-	-	-	+
Species group F																
<i>Cassytha filiformis</i>	Forb	+	-	-	+	+	+	+	+	+	+	-	+	-	+	+
<i>Chrysanthemoides monilifera</i>	Shrub	+	-	+	+	+	1	+	+	+	+	-	+	-	-	+
<i>Digitaria natalensis</i> *	Grass	B	1	+	+	A	A	-	+	-	+	-	+	1	+	-
<i>Centella asiatica</i>	Forb	-	-	+	-	-	+	-	+	-	-	+	-	+	-	-
<i>Psidium guajava</i> *	Shrub	+	+	1	-	+	-	-	1	+	+	+	1	1	-	+
<i>Cymbopogon excavatus</i>	Grass	+	-	1	-	-	-	-	1	-	-	-	+	-	-	-
<i>Imperata cylindrica</i>	Grass	1	-	-	1	-	-	-	+	-	-	1	A	1	3	A
<i>Conyza ulmifolia</i>	Forb	+	+	-	-	+	-	-	-	+	-	-	+	-	+	+
<i>Cheilanthes viridis</i>	Forb	+	-	+	-	-	+	-	-	-	+	-	-	+	-	-
<i>Crotalaria lanceolata</i>	Forb	+	-	+	-	-	-	-	+	-	-	-	+	-	-	-
<i>Syzygium cordatum</i>	Tree	-	+	-	-	-	+	-	-	+	-	-	+	-	-	-

*, introduced alien (exotic) species (Henderson 2006); •, typical, frequently occurring Maputaland Woody Grassland species (Mucina & Rutherford 2006). Braun-Blanquet scale adapted and modified from Mueller-Dombois & Ellenberg (1974): R, rare, only one individual recorded; +, > 1 individual, total cover of 1 %; 1, > 1 individual, total cover of 2–5 %; 2A, abundant, total cover of 6–12 %; 2B, abundant, total cover of 13–18 %; 3, abundant, total cover of 19–25 %.

RESULTS AND DISCUSSION

Classification

Three plant communities were identified, classified, described and mapped. Boundaries are not precise, but follow broad patterns. Especially the boundaries between Woody Grassland (plant community 1) and Hygrophilous Grassland (plant community 2) are obscure due to the mosaic nature of the vegetation.

The vegetation structure of these plant communities can be described as open, rolling grassland with scattered patches of mixed woodland and interspersed with shallow seasonal wetlands. All the plant communities are dependent on specific environmental gradients that are determined by soil type, moisture regime and past land use. Higher-lying grassland is characterized by geoxyllic suffrutices. Hygrophilous grassland occurs along most interdune depressions. Indigenous and alien trees became established within remnants of old plantations and wet, disturbed sites. An ordination of the floristic data set of 15 plots (227 species) revealed three distinct assemblages of species or plant communities in the study area (Figure 3): 1, *Parinari capensis*–*Digitaria natalensis* Woody Grassland on crest of dunes; 2, *Trichilia emetica*–*Panicum maximum* Woodland Mosaic; and 3, *Ischaemum fasciculatum*–*Imperata cylindrica* Hygrophilous Grassland of interdune depressions.

Descriptions

The vegetation of the study area is characterized by plant communities representing two major vegetation

units known as Maputaland Coastal Belt and MWG (Mucina & Rutherford 2006). These are unique systems comprising their own species complement, which have been shown to be determined by soil structure, soil depth and past land use (Matthews *et al.* 1999; Siebert *et al.* 2004). At local scales, such as the study site, variations in these environmental factors may result in many different habitat types.

1. *Parinari capensis*–*Digitaria natalensis* Woody Grassland on crest of dunes

This community is related to the *Themedo*–*Salacietum* Woody Grassland (Myre 1964) and Maputaland Wooded Grassland (Mucina & Rutherford 2006).

Environmental data: locally this grassland type occurs at an altitude of 30–34 m on the crests of dunes (level slope of 1–3°). The soil is sandy, with bare patches representing 10–25 % of sampled areas (Table 2). This Woody Grassland is prominent on the eastern side of the study area, but its prominence fades towards the western end, and when in close proximity to the other two plant communities. Woody Grassland and Hygrophilous Grassland of seasonally wet areas form an intricate mosaic, difficult to map at such a fine scale (Figure 2). Land use of this grassland is mainly grazing by roving livestock and duiker. Human activities include hunting with dogs and quad biking. The community also does not extend south of the John Ross Parkway, as in the west it is bordered by vast tracts of sugar cane plantations, in the south by an extended wetland system and in the southeast by a mine dump.

TABLE 2.—Locality data, environmental factors and vegetation structure of each sample plot/plant community

Community	Woody Grassland					Woodland Mosaic					Hygrophilous Grassland				
Plot	1	5	10	12	13	2	4	6	7	14	3	8	9	11	15
Date (d-m-2007)	08-05	08-05	09-05	09-05	09-05	08-05	08-05	08-05	08-05	09-05	08-05	09-05	09-05	09-05	09-05
Co-ordinates:															
South 28°	46'06"	46'12"	46'16"	46'06"	46'14"	45'56"	46'18"	46'01"	46'10"	46'10"	45'59"	46'20"	46'16"	46'05"	46'13"
East 31°	59'19"	58'50"	59'13"	58'58"	59'00"	59'13"	58'59"	59'03"	59'23"	59'04"	59'14"	59'16"	59'16"	58'57"	59'24"
Elevation (m)	31	32	31	34	30	32	30	31	28	28	25	23	28	24	26
Slope (°)	1	2	1	3	1	1	2	1	1	2	0	2	1	0	1
Rock (%)	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0
Bare soil (%)	10	15	10	10	25	30	10	5	10	40	0	0	5	30	0
Land use	Grazed	None	None	Quads	None	Timber	None	Burn	Timber	Timber	None	None	None	None	None
Soil texture	Sand	Sand	Sand	Sand	Sand	Sand	Sand	Red clay	Sand	Sand	Sand	Humus sand	Sand	Sand	Humus sand
Mean height (m):															
Non-tree	0.5	0.5	0.7	0.4	0.5	0.4	0.6	0.5	0.6	0.3	0.5	1	0.5	0.5	0.5
Tree	2.5	5	2	2	2	6	10	11	8	8	1.5	2	4	4	2
Cover (%):															
Grasses	50	30	70	70	50	30	10	70	60	5	80	70	70	90	90
Forbs	30	30	20	15	30	10	20	20	10	10	10	30	10	5	10
Trees	10	20	5	5	0	40	70	50	50	50	0	5	5	10	5
Species/plot (100 m ²)	59	52	49	45	49	45	38	37	41	22	17	34	25	26	36

Species data: species richness was high (Table 2), ranging from 45 to 59 species/100 m² (mean: 50). Forbs are the most dominant growth form with 33 species, also the most recorded for any community in the study area (Figure 4). Trees are rare in this grassland, but where present they have a mean cover of 10 % per sample plot

and are up to 5 m tall. The grass layer has a cover of up to 70 % and the forb layer up to 30 %. Suffrutices occur frequently, but was estimated to have a cover of less than 10 %. The non-tree layer, which includes forbs, grasses and geoxyllic suffrutices has a mean height of 0.5 m.

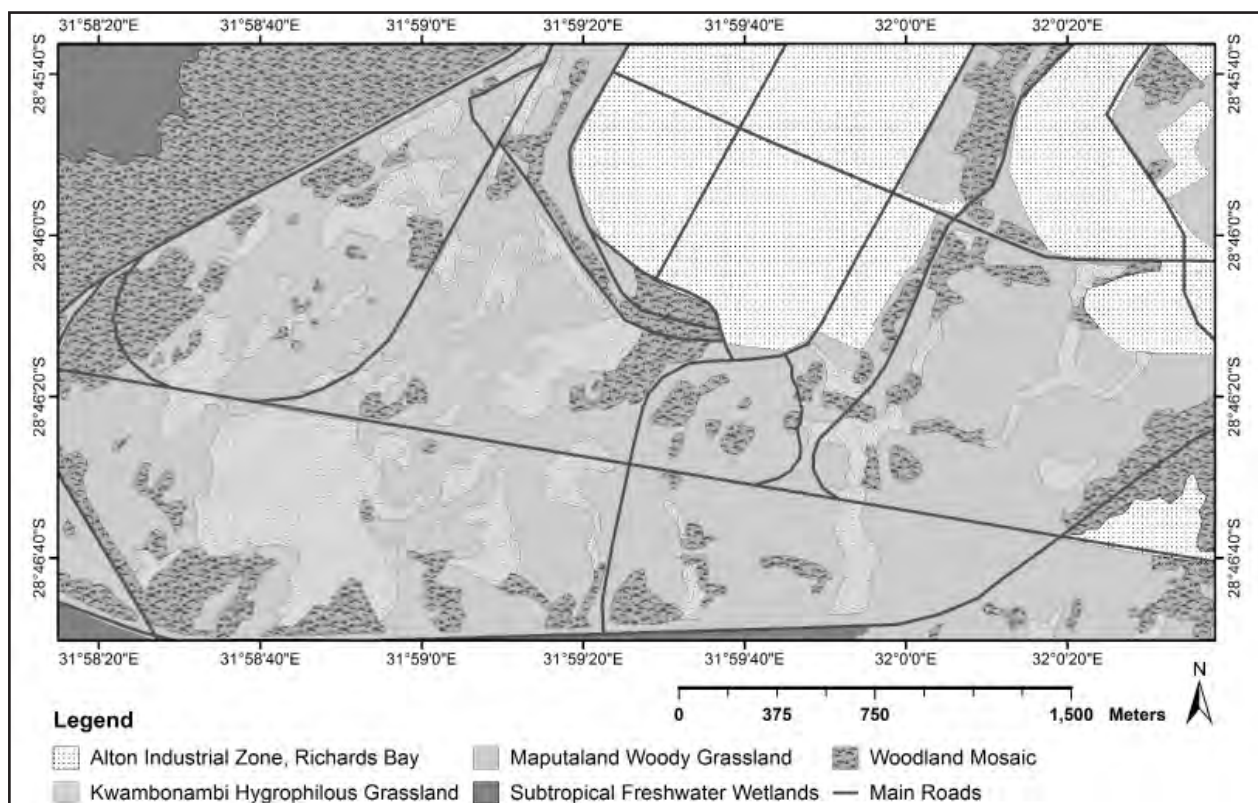


FIGURE 2.—Vegetation map of study area.

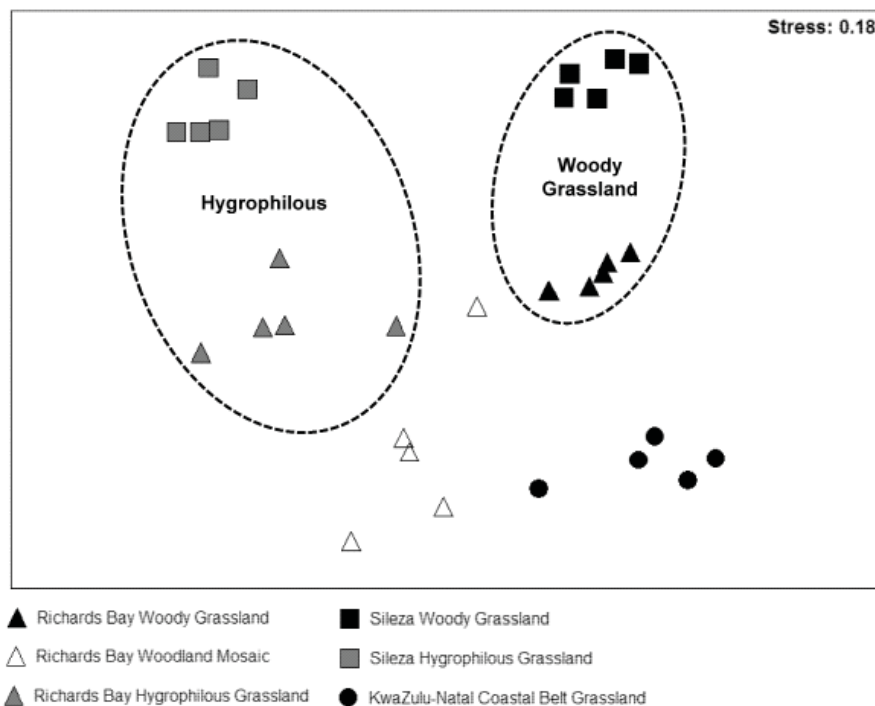


FIGURE 3.—Ordination of sample plots from study area in Richards Bay, Sileza Nature Reserve (Matthews *et al.* 1999), and Mtunzini (KwaZulu-Natal Coastal Belt Grassland).

Diagnostic species: the geoxylic suffrutices *Diospyros galpinii*, *Eugenia albanensis*, *Parinari capensis* and *Salacia kraussii*, the forbs *Conostomium natalense*, *Helichrysum kraussii*, *H. nudifolium*, *Hypoxis iridifolia*, *Lobelia flaccida* and *Oxygonum robustum*, and the grasses *Aristida junciformis*, *Dactyloctenium aegyptium* and *Tristachya leucothrix* (Table 1, species group A).

Species which are specifically shared with Woodland Mosaic include the trees *Hyphaene coriacea* and *Dichrostachys cinerea*, and conspicuous forbs such as *Abrus precatorius*, *Asystasia gangetica* and *Smilax anceps* (Table 1, species group C). Frequently occurring species shared with the other plant communities include the shrub *Chrysanthemoides monilifera*, and the grass *Digitaria natalensis* (Table 1, species group F), the latter which is also the most dominant species in this community. Invasive alien species that occur frequently on dune crests are stunted forms of *Lantana camara* (Table

1, species group C) and *Psidium guajava* (Table 1, species group F).

2. *Trichilia emetica*–*Panicum maximum* Woodland Mosaic

Environmental data: this woodland occurs at a mean altitude of 28–32 m above sea level on dunes (level slope of 1 or 2°) and is usually in close proximity to depressions where water accumulates (suggesting preference for higher water tables). The soil is sandy, except for a man-made embankment (supporting a road) of red clay that bisects the western part of the study area. Bare patches generally make up 5–40 % of sampled areas (Table 2). The embankment is the only habitat containing rocks. The Woodland Mosaic is often on the edges of the study area forming large, continuous clumps, which is interspersed by numerous smaller, scattered patches. Large clumps are probably remnants of commercial *Eucalyptus* plantations that are no longer man-

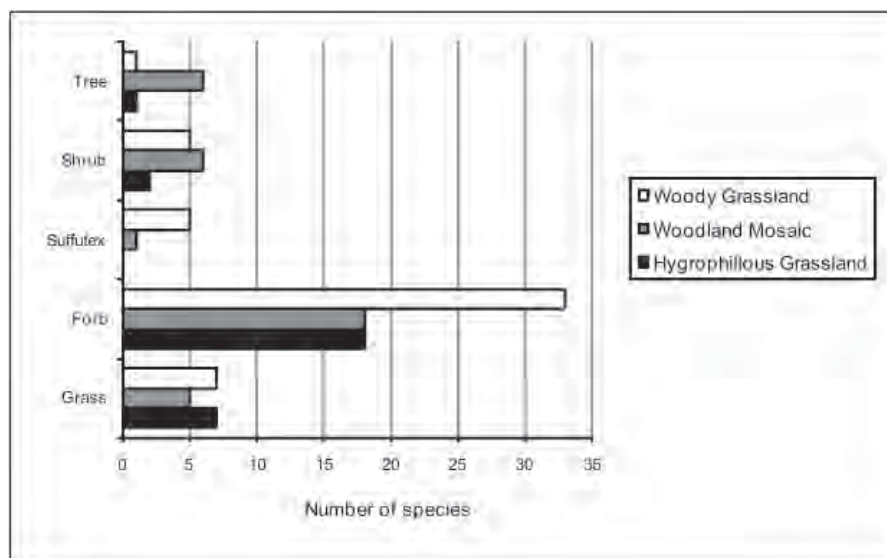


FIGURE 4.—No. species recorded for each of growth forms associated with plant communities of study area.

aged. The smaller patches were natural woodlands that have been invaded by alien trees, shrubs and forbs. Land use of this woodland is mainly associated with informal wood harvesting. The widely scattered plots of this community on the ordination suggest a high beta-diversity (Figure 3). This is probably because this community includes invaded woodlands, Woody Grassland and Hygrophilous Grassland, but the original plant communities here have been highly altered, resulting in a new community, the Woodland Mosaic.

Species data: species richness varies considerably between 22 to 45 species/100 m² (mean: 37) (Table 2). Although forbs are also conspicuous in this plant community, the Woodland Mosaic has the highest number of tree (6) and shrub (6) species in the study area (Figure 4). Trees predominate in this woodland, reaching up to 11 m in height and on average cover $\pm$ 50 % per sample plot (Table 2). The grass layer has a cover of up to 70 % and the forb layer up to 20 %. The non-tree layer, which includes forbs and grasses, has a mean height of 0.4 m.

Diagnostic species: the woody species *Eugenia capensis*, *Searsia nebulosa* and *Trichilia emetica*, the naturalized weed *Conyza canadensis*, the forbs *Cyperus esculentus* and *Desmodium incanum*, and the grasses *Melinis repens*, *Panicum maximum* and *Stenotaphrum secundatum* (Table 1, species group B).

Species commonly present, which are also shared with Hygrophilous Grassland, include the forbs *Cyperus solidus* and *Desmodium dregeanum*, and the grass *Panicum dregeanum* (Table 1, species group E). Species found in Woodland Mosaic which are also present in other plant communities include the tree *Syzygium cordatum*, the forb *Centella asiatica* and the fern *Cheilanthes viridis* (Table 1, species group F). Invasive alien species that occur frequently in the woodlands are *Chromolaena odorata*, *Eucalyptus grandis*, which is locally dominant, *Lantana camara* and *Melia azederach*.

3. *Ischaemum fasciculatum*–*Imperata cylindrica* Hygrophilous Grassland of interdune depressions

This community is related to the *Ischaemum fasciculatum*–*Eragrostis inamoena* Hygrophilous Grassland (Matthews *et al.* 1999), *Ischaemum fasciculatum*–*Centella asiatica* Hygrophilous Grassland (Lubbe 1997), Maputaland Coastal Belt in part (Mucina & Rutherford 2006) and Kwambonambi Hygrophilous Grasslands (Goodman 2007).

Environmental data: this grassland type is associated with interdune depressions at an altitude of 23 to 28 m (slope of 1° or less). It comprises the drainage lines of the study area that feed into a network of scattered, small seasonal pans outside the study site. Many of the drainage lines are invaded by alien woody species and are classified as part of Woodland Mosaic (e.g. plots 7 and 14). The soil is sandy, often humus-rich. Bare patches are rare for most sample plots of interdune depressions, but plot 11 has 30 % bare area (Table 2). The occurrence and abundance of Hygrophilous Grassland is not surprising due to the proximity of the study site to the vast Subtropical Freshwater Wetlands (Mucina & Rutherford 2006) of Richards Bay.

Species data: species richness varies between 17 and 36 species/100 m² (mean: 25) (Table 2). Forbs occur frequently in this community, but Hygrophilous Grassland, like the Woody Grassland, has eight grass species (Figure 4). Trees are not abundant with up to 10 % cover per sample plot and reaching a height of 4 m. The grass layer has a dense cover of up to 90 % and the forb layer up to 30 %. The non-tree layer, which includes forbs and grasses has a mean height of 0.5 m.

Diagnostic species: the sedges *Abildgaardia hygrophila*, *Cyperus natalensis*, *Juncus kraussii* and *Pycnus polystachyos*, the forbs *Dissotis canescens* and *Ethulia conyzoides*, the fern *Cyclosorus interruptus*, and the grasses *Eragrostis inamoena* and *Ischaemum fasciculatum* (Table 1, species group D).

Species which are also found in other plant communities include the forb *Conyza ulmifolia*, and the locally dominant grass *Imperata cylindrica* (Table 1, species group F). An invasive alien species that occurs frequently in wet areas is *Psidium guajava* (Table 1, species group F).

Rare, threatened and endemic plant species

The vegetation units of the Maputaland Coastal Belt and MWG are not protected extensively in many statutory conservation areas due to its high potential for commercial timber and sugar cane plantations (Steenkamp *et al.* 2005), and in the Richards Bay area specifically due to shortage of land for industrial development. Currently, only 17 % of this habitat type is conserved in South Africa and this habitat type is endangered (Mucina & Rutherford 2006).

Red Data plant species are known from the same quarter-degree grids as the study area (2831DD, 2832CC). According to Scott-Shaw (1999) there are two threatened endemic species that could occur in this type of grassland, namely *Asclepias gordon-grayae* (Endangered) and *Kniphofia leucocephala* (Critically Endangered). These species are threatened by multiple factors, including timber and sugar cane plantations, and urbanization. Neither species was recorded during the survey.

Some of the species recorded during this survey are regarded by Mucina & Rutherford (2006) to be of regional biogeographical importance and have grouped *Abildgaardia hygrophila*, *Cyperus natalensis*, *Desmodium dregeanum* and *Eugenia albanensis* as Coastal Belt Elements, *Albertisia delagoensis* and *Cissampelos hirta* as Southern Distribution Limits, and *Oxygonum robustum* as a Maputaland Endemic (which also includes Mozambique and Swaziland).

Endemic species are internationally regarded as important focal taxa to establish critical habitat for conservation priority (Leon-de la Luz & Breceda 2006). Fifteen species endemic to South Africa (Germishuizen *et al.* 2006), and specifically the coastal areas, were recorded in the study area. The endemic species complement consists of one tree, *Acacia kosiensis*, one geoxyllic suffrutex, *Eugenia albanensis*, and 13 forbs (Table 3). Twelve South African endemics occur in the Woody Grassland of the study area, of which eight species are

TABLE 3.—Species considered as South African endemics or Maputaland Woody Grassland floristic elements, represented by 34 of 227 recorded species; 15 % of study area's flora

Species	Growth form	*Status	**Occurrence		
			Woody Grassland	Woodland Mosaic	Hygrophilous Grassland
<i>Acacia kosiensis</i>	Tree	RSA endemic	-	abundant	-
<i>Acalypha ecklonii</i>	Forb	RSA endemic	-	occasional	-
<i>Agathisanthemum bojeri</i>	Forb	MWG element	occasional	-	-
<i>Ancylobotrys petersiana</i>	Suffrutex	MWG element	occasional	-	-
<i>Aristida stipitata</i>	Grass	MWG element	very abundant	-	occasional
<i>Chamaecrista plumosa</i>	Forb	MWG element	frequent	-	occasional
<i>Clutia cordata</i>	Forb	RSA endemic	occasional	-	-
<i>Crotalaria dura</i>	Forb	RSA endemic	occasional	-	-
<i>Cyperus obtusiflorus</i>	Forb	MWG element	occasional	-	-
<i>Dichrostachys cinerea</i>	Shrub	MWG element	abundant	occasional	-
<i>Digitaria natalensis</i>	Grass	MWG element	very abundant	abundant	abundant
<i>Diheteropogon amplexans</i>	Grass	MWG element	occasional	-	-
<i>Diospyros galpinii</i>	Suffrutex	MWG element	very abundant	occasional	-
<i>Diospyros lycioides</i>	Shrub	MWG element	abundant	-	-
<i>Eriosema preptum</i>	Forb	RSA endemic	occasional	-	-
<i>Eugenia albanensis</i>	Suffrutex	RSA endemic	very abundant	frequent	-
<i>Eugenia capensis</i>	Shrub	MWG element	occasional	frequent	-
<i>Gnidia calocephala</i>	Forb	RSA endemic	frequent	-	-
<i>Helichrysum allioides</i>	Forb	RSA endemic	occasional	-	-
<i>Helichrysum asperum</i>	Forb	RSA endemic	abundant	rare	-
<i>Helichrysum auriceps</i>	Forb	RSA endemic	occasional	-	-
<i>Helichrysum kraussii</i>	Forb	MWG element	very abundant	occasional	occasional
<i>Hyphaene coriacea</i>	Tree	MWG element	abundant	abundant	-
<i>Parinari capensis</i>	Suffrutex	MWG element	very abundant	occasional	-
<i>Raphionacme lucens</i>	Forb	RSA endemic	occasional	-	-
<i>Raphionacme palustris</i>	Forb	RSA endemic	occasional	-	-
<i>Rhynchosia stenodon</i>	Forb	RSA endemic	-	occasional	-
<i>Salacia kraussii</i>	Suffrutex	MWG element	abundant	occasional	-
<i>Selago tarachodes</i>	Forb	RSA endemic	occasional	occasional	occasional
<i>Senecio erubescens</i>	Forb	RSA endemic	frequent	-	occasional
<i>Setaria sphacelata</i>	Grass	MWG element	frequent	-	-
<i>Syzygium cordatum</i>	Tree	MWG element	occasional	frequent	occasional
<i>Themeda triandra</i>	Grass	MWG element	frequent	-	-
<i>Urelytrum agropyroides</i>	Grass	MWG element	frequent	-	-

* RSA endemic, species endemic to South Africa; MWG element, floristic element of Maputaland Woody Grassland; ** occurrence: rare, < 5; occasional, 5–10; frequent, 11–30; abundant, 31–60; very abundant, > 60.

locally restricted to it. The four species shared with the other two plant communities are *Eugenia albanensis*, *Helichrysum asperum*, *Selago tarachodes* and *Senecio erubescens*. *Acacia kosiensis*, *Acalypha ecklonii* and *Rhynchosia stenodon* are South African endemics found in the study area, but do not occur in the Woody Grassland.

Of the 133 species recorded for the Woody Grassland of the study area, 19 species, or 14 %, are regarded as floristic elements of MWG by Mucina & Rutherford (2006). This includes the trees *Hyphaene coriacea* and *Syzygium cordatum*, the shrubs *Dichrostachys cinerea* and *Diospyros lycioides*, the geoxylic suffrutices *Ancylobotrys petersiana*, *Diospyros galpinii*, *Eugenia capensis*, *Parinari capensis* and *Salacia kraussii*, the forbs *Ag-*

TABLE 4.—Three most dominant species recorded for each plant community of study area, with mean cover % per species per plant community. Data from Matthews *et al.* (1999) has been included for comparative purposes

Species	Richards Bay			Sileza Nature Reserve	
	WG	WM	HG	WG	HG
<i>Chaetacanthus burchellii</i>	40*	0	0	0	0
<i>Digitaria natalensis</i>	32*	16	14	4	0
<i>Aristida stipitata</i>	30+	0	4	18	0
<i>Centella asiatica</i>	20	40*	40*	0	16
<i>Chrysanthemoides monilifera</i>	16	22*	8	8	0
<i>Desmodium incanum</i>	0	20+	0	0	0
<i>Imperata cylindrica</i>	12	4	40*	0	0
<i>Hemarthria altissima</i>	0	4	24*	0	10
<i>Themeda triandra</i>	6	0	0	34*	0
<i>Parinari capensis</i>	28	4	0	30*	0
<i>Diheteropogon amplexens</i>	8	0	0	24+	0
<i>Ischaemum fasciculatum</i>	0	0	12	0	48*
<i>Sorghastrum stipoides</i>	0	0	0	0	28*
<i>Eragrostis inamoena</i>	0	4	14	0	24+

WG, Woody Grassland; WM, Woodland Mosaic; HG, Hygrophilous Grassland; * greatest dominance of species per vegetation type; *, second greatest dominance; +, third greatest dominance.

thisanthemum bojeri, *Chamaecrista plumosa*, *Cyperus obtusiflorus* and *Helichrysum kraussii*, and the grasses *Aristida stipitata*, *Digitaria natalensis*, *Diheteropogon amplexens*, *Themeda triandra*, *Setaria sphacelata* and *Urelytrum agropyroides* (Table 3).

Species composition and diversity

Siebert *et al.* (2004) showed that Woody Grassland has the highest beta-diversity of grasses of all the coastal vegetation units of Maputaland. This implies that the turnover of grass species is high between different localities of MWG. Therefore, although the Richards Bay locality is characterized by dominant species not only found in MWG (Table 4), it still fits the definition (White 1977), since it is characterized by the presence of geoxylic suffrutices. In the case of the Richards Bay locality, eight geoxylic suffrutices were recorded from the dunes, namely *Ancylobotrys petersiana* (occurring in 20 % of plots), *Diospyros galpinii* (80 %), *Elephantorrhiza elephantina* (20 %), *Eugenia albanensis* (100 %), *Maytenus nemorosa* (40 %), *Pachystigma venosum* (20 %), *Parinari capensis* subsp. *incohata* (100 %), and *Salacia kraussii* (80 %). The presence of these species in association with Maputaland Centre endemics typically found in MWG, such as *Oxygonum robustum* (Mucina & Rutherford 2006), further strengthens our appeal to recognise the Richards Bay locality as containing true MWG.

This argument is supported by an ordination (Figure 3) that relates the species composition of the different plant communities. The stress value is lower than 0.2, suggesting that the ordination is meaningful (Clarke & Gorley 2001). Although all of the plant communities are clearly grouped (Figure 3), it is evident that Woody Grassland from the Richards Bay locality is not identical to typical Woody Grassland at Sileza 300 km further

north, as the ten plots are not grouped but separated in two groups of five. However, it does show that the two Woody Grassland communities are most closely related based on the shortest distance (least dissimilarity) being recorded between these two plant communities (Figure 3). The species composition of the Woody Grassland at Richards Bay showed higher dissimilarity with the Hygrophilous Grassland of interdune depressions at Richards Bay and Sileza, and the KwaZulu-Natal Coastal Belt grassland of the hills near Mtunzini. One Woodland Mosaic sample plot (plot 2) at Richards Bay is probably a Woody Grassland community invaded by alien woody species, hence its outlying position (Figure 3).

Kwambonambi Hygrophilous Grassland

The study area has recently been demarcated as priority conservation land, as it supposedly contained remnants of a highly threatened and endemic terrestrial ecosystem referred to as Kwambonambi Hygrophilous Grassland (KHG) (Goodman 2007). However, Mucina & Rutherford (2006) make no mention of such a vegetation unit, which suggests that it has been included within another vegetation unit. It is this situation that requires further clarification, as KHG is often mistakenly considered by some as MWG, because the former occurs in a mosaic with the latter as shown before (Siebert *et al.* 2004). KHG is associated with inter-dune depressions and MWG with dune crests. These two units correspond to the definitions provided for Woody Grassland and Hygrophilous Grassland respectively in the land-cover classification system for Maputaland (Smith *et al.* 2008).

MWG is well documented in the literature, and easy to distinguish from other grassland types such as Hygrophilous Grassland (Myre 1964; Matthews *et al.* 1999). KHG is poorly defined in the literature, because large tracts of land previously considered as Hygrophilous Grassland have been transformed with *Eucalyptus* plantations and, hence, its composition and boundaries are poorly documented and difficult to determine. KHG is known as the habitat of a set of threatened species considered to be endemic, defined as wet areas such as seasonal pans and interdune depressions (Scott-Shaw 1999). Such habitat types are not typical for MWG, as shown in this paper. We therefore suggest that what we mapped as *Ischaemum fasciculatum*–*Imperata cylindrica* Hygrophilous Grassland in this paper is what is generally referred to as KHG. It, together with other vegetation types, is included as part of what Mucina & Rutherford (2006) refer to as the Maputaland Coastal Belt vegetation unit (CB1). MWG grassland also forms part of this vegetation unit, although Mucina & Rutherford (2006) probably described it as a separate unit due to its peculiar complement of suffrutices.

CONCLUSION

This site-specific study revealed a vegetation structure and floristic diversity that corresponds to the descriptions of MWG made by Matthews *et al.* (1999). This paper confirms that MWG, a limited and threatened ecosystem, has an extent of occurrence that stretches west of Richards Bay, where it probably forms

the southernmost outlier population of the vegetation unit in the Indian Ocean Coastal Belt Biome (Van Wyk & Smith 2001). This mapped range extension of MWG will be made available to the National Vegetation Map Committee to assist in ongoing improvements to the electronic version of the national vegetation map. Another threatened ecosystem, KHG, also occurs extensively at the study site. In an urbanized and already fragmented landscape, it is important to maintain and protect such important ecosystems (Leon-de la Luz & Breceda 2006). Careful management of this patch of MWG and KHG as a green belt within a fragmented industrial zone can transform it into valuable sites in terms of biodiversity conservation (Tang *et al.* 2007).

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REFERENCES

- BOTHA, G.A. 1997. *Maputaland: focus on the Quaternary evolution of the Southeast African Coastal Plain, Field Guide and Abstracts*. Council for Geoscience, Pretoria.
- CLARKE, K.R. & GORLEY, R.N. 2001. *PRIMER v5. User manual/Tutorial*. PRIMER Ltd, Plymouth, UK.
- ESRI (Environmental Systems Research Institute) 2006 [computer package]. *ArcMap™, ArcGIS 9.1*. Redlands, California, USA.
- GERMISHUIZEN, G., MEYER, N.L., STEENKAMP, Y. & KEITH, M. 2006. *A checklist of South African plants*. Southern African Botanical Diversity Network Report No. 41. SABONET, Pretoria.
- GOODMAN, P.S. 2007. *KwaZulu-Natal Terrestrial Conservation Plan (C-Plan), Version 4*. Biodiversity Conservation Planning Division, Ezemvelo KZN Wildlife.
- HENDERSON, L. 2006. Comparisons of invasive plants in southern Africa originating from southern temperate, northern temperate and tropical regions. *Bothalia* 36: 201–222.
- HENNEKENS, S. 1996. *MEGATAB: a visual editor for phytosociological tables*. [Computer program]. Version 1.0. User's guide. Ulft: Giesen & Geurts.
- HILL, M.O. 1979. *TWINSPAN—a FORTRAN program for arranging multivariate data in an ordered two way table by classification of individuals and attributes*. [Computer program]. New York, Cornell University, Ithaca.
- LEON-DE LA LUZ, J.L. & BRECEDA, A. 2006. Using endemic plant species to establish critical habitats in the Sierra de La Laguna Biosphere Reserve, Baja California Sur, Mexico. *Biodiversity and Conservation* 15: 1043–1055.
- LUBBE, R.A. 1997. *Vegetation and flora of the Kosi Bay Coastal Forest Reserve in Maputaland, northern KwaZulu-Natal, South Africa*. M.Sc. thesis, University of Pretoria, Pretoria.
- MADDOCK, A. & BENN, G.A. 2000. Identification of conservation-worthy areas in northern Zululand, South Africa. *Conservation Biology* 14: 155–166.
- MATTHEWS, W.S., VAN WYK, A.E. & VAN ROOYEN, N. 1999. Vegetation of the Sileza Nature Reserve and neighbouring areas, South Africa, and its importance in conserving the woody grasslands of the Maputaland Centre of Endemism. *Bothalia* 29: 151–167.
- MUCINA, L. & RUTHERFORD, M.C. 2006. The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia* 19. South African National Biodiversity Institute, Pretoria.
- MUELLER-DOMBOIS, D. & ELLENBERG, H. 1974. *Aims and methods of vegetation ecology*. Wiley, New York.
- MYRE, M. 1964. *A vegetacao do extremno sul de provincia da Mocambique*. Junta de Investigacoes do Ultramar, Lisboa.
- RAIMONDO, D., VON STADEN, L., FODEN, W., VICTOR, J.E., HELME, N.A., TURNER, R.C., KAMUNDI, D.A. & MANYAMA, P.A. (eds). 2009. *Red List of South African plants 2009*. *Strelitzia* 25. South African National Biodiversity Institute, Pretoria.
- SCHULTZE, R.E. 1982. *Agrohydrology and agroclimatology of Natal*. Agricultural Catchments Research Unit Report 14. University of Natal, Pietermaritzburg.
- SCOTT-SHAW, R. 1999. *Rare and threatened plants of KwaZulu-Natal and neighbouring regions: a plant red data book*. KZN NCS, Cascades.
- SIEBERT, S.J., FISH, L., UIRAS, M.M. & IZIDINE, S.A. 2004. Grass assemblages of conservation areas of the coastal plain south of Maputo Bay, Mozambique. *Bothalia* 34: 61–71.
- SMITH, R.J., EASTON, J., NHANCALE, B.A., ARMSTRONG, A.J., CULVERWELL, J., DLAMINI, S.D., GOODMAN, P.S., LOFFLER, L., MATTHEWS, W.S., MONADJEM, A., MULQUEENY, C.M., NGWENYA, P., NTUMI, C.P., SOTO, B. & LEADER-WILLIAMS, N. 2008. Designing a transfrontier conservation landscape for the Maputaland Centre of Endemism using biodiversity, economic and threat data. *Biological Conservation* 141: 2127–2138.
- STEENKAMP, Y., VAN WYK, B., VICTOR, J., HOARE, D., SMITH, G., DOLD, T. & COWLING, R. 2005. Maputaland-Pondoland-Albany. In R.A. Mittermeier, P. Robles Gil, M. Hoffman, J. Pilgrim, T. Brooks, C. Goettsch Mittermeier, J. Lamoreux & G.A.B. da Fonseca, *Hotspots revisited: Earth's biologically richest and most threatened terrestrial ecoregions*. Conservation International, Washington.
- TANG, B.S., WONG, S.W. & LEE, A.K.W. 2007. Green belt in a compact city: a zone for conservation or transition? *Landscape and Urban Planning* 79: 358–373.
- 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.
- WHITE, F. 1977. The underground forests of Africa: a preliminary review. *Gardens' Bulletin, Singapore* 29: 57–71.
- WILLIAMS, N.S.G. 2005. *The ecology of fragmented native grasslands in urban and rural landscapes*. Ph.D. thesis, University of Melbourne, Australia.

Floristic analysis of domestic gardens in the Tlokwe City Municipality, South Africa

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Keywords: Agavaceae, alien plants, Asteraceae, diversity, grassland, home gardens, native plants, Potchefstroom, urban ecology

ABSTRACT

This paper is a first attempt to describe the flora of domestic gardens from an urban environment in South Africa. A total of 835 plant species of 501 genera in 145 families was recorded from 100 gardens in a 54.9 km² area of the Tlokwe City Municipality [Potchefstroom], North West Province. A substantial number of alien species (580) were recorded, but also many indigenous species (255) that included South African endemics (61) and protected species on the National Red Data list (18). A number of the alien species that were commonly cultivated are declared invasive plants in South Africa (88). Most of the cultivated indigenous taxa originated from the southeastern provinces of South Africa.

This study provides new knowledge on the often overlooked biodiversity of urban areas in a developing, mega-diverse country. Most studies of a similar nature were conducted in the developed countries of Europe and are of limited use in the development of management plans of urban ecosystems in southern Africa.

INTRODUCTION

Urbanization is one of the most significant demographic trends of all times (Pickett *et al.* 2001) and it has a devastating impact on the environment (Wu *et al.* 2003). The increase in population density of urban areas (Pickett *et al.* 2001) results in infrastructure development and the subsequent transformation of natural areas. Significant changes in biological and spatial composition alter the structure of ecosystems, which in turn influence the processes underlying such ecosystems, for example nutrient cycles, water relations and climate systems (Wu *et al.* 2003). Plants play an important role in sustaining urban ecosystems (Savard *et al.* 2000; Colding 2007). Urban green spaces provide physical ecosystem services such as temperature and flood control, removal of carbon from the atmosphere and social ecosystem services such as the increase of aesthetic values and community well-being (Bolund & Hunhammar 1999; Alberti 2005; Hope *et al.* 2006). Knowledge of urban vascular plant floras is therefore a prerequisite to maintaining and improving these ecosystem services of the urban environment and to keep it favourable for life within to persist.

Globally, urban vascular plant floras have higher diversity than that of the surrounding countryside. This trend was noted in California and Phoenix, Arizona in the USA (Hope *et al.* 2003; Williams *et al.* 2005), Brussels in Belgium (Godefroid & Koedam 2007) and several cities in Germany (Kühn *et al.* 2004). In Sheffield, England, the gamma diversity recorded in a relatively small number of domestic gardens equalled that of the native flora in the area, and was expected to become much higher with increasing sample size (Smith *et al.* 2006). The comparatively higher gamma diversity of urban vegetation is mainly the result of the high spatio-temporal heterogeneity in urban environments (Rebele 1994) and an increasing dispersal of alien plant spe-

cies via global transportation and other human actions (McKinney 2008).

The richness of garden floras is related to the size of the species pool available to gardeners (Thompson *et al.*, 2003). A list containing more than 70 000 plant species that are available from United Kingdom nurseries was compiled by Macaulay *et al.* (2009), while Isaacson (2004) presented a list that consisted of 90 000 plant species available for sale in the USA. Glen (2002) published a book on the cultivated plants of southern Africa that contains $\pm 37\ 000$ species (not claimed to be a fully comprehensive list), compared with the little over 21 800 species in the native flora of southern Africa (Germishuizen *et al.* 2006).

The aim of this study is to present a first total floristic survey of domestic gardens in a typical, medium-sized, southern African city. Objectives were to analyse and describe the plant diversity found in domestic gardens at family, genus and species levels, to determine the origin of species under cultivation, and assess the endemic, threatened, useful and invasive plant species in the garden flora. The analysis provides baseline information with which to compare garden floras of other cities and countries, and will contribute to the establishment of a broader understanding of the management and conservation potential of this land use type. Additionally, the comparison of the garden flora with the flora of other urban open spaces (other land use types) in the Tlokwe City Municipality (Cilliers 1998) will shed light on the contribution that domestic gardens make towards total urban plant diversity.

STUDY AREA

This study was conducted in the Tlokwe City Municipality (TCM) in the North West Province, which is situated between 26°39' and 26°44' latitude and 27°00' and 27°08' longitude (Figure 1). It includes the town of Potchefstroom, the township areas of Ikageng, Promosa and Mohadin, the surrounding smallholdings,

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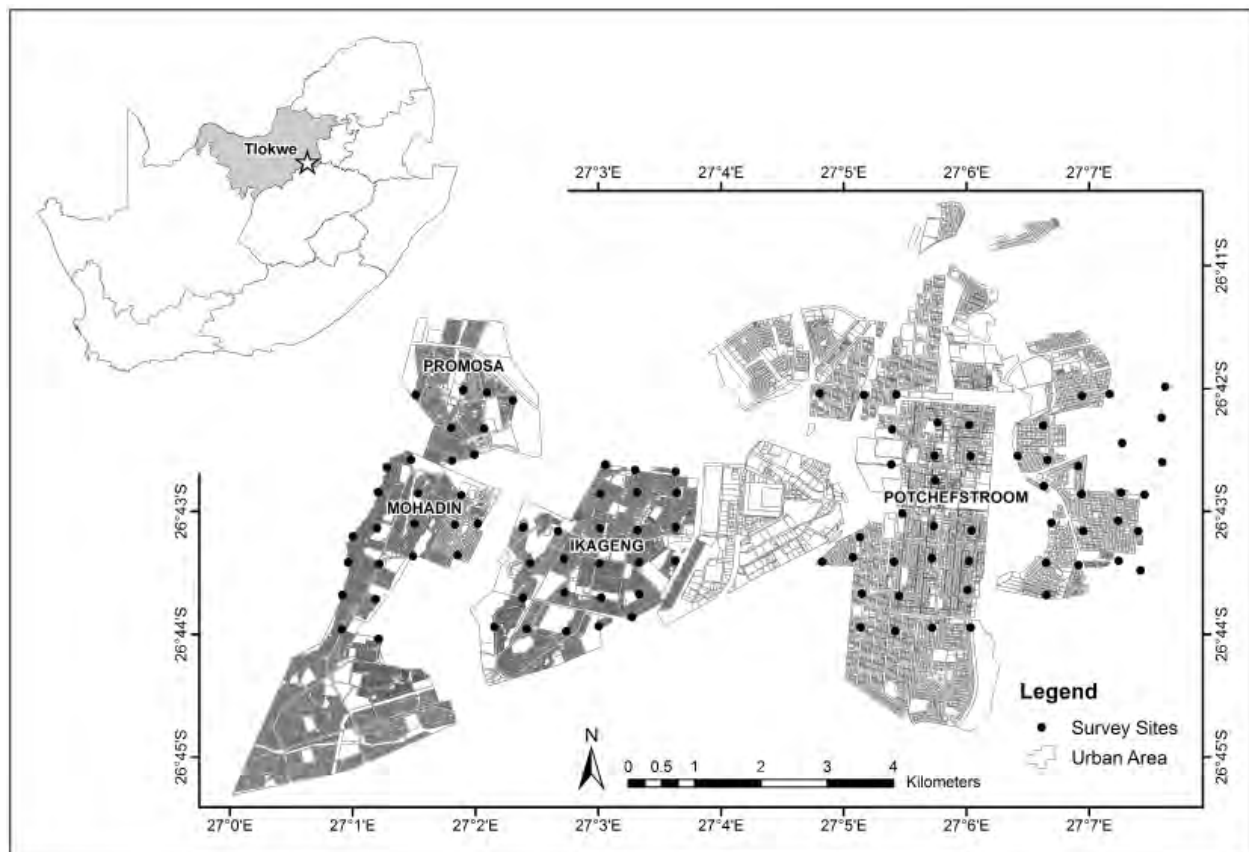


FIGURE 1.—Map of Tlokwe City Municipality (TCM) in South Africa. Survey points indicated by black dots.

and informal settlements on the edges of the city. The area has about 140 500 inhabitants (WorkWell 2004). The study area falls in the Grassland Biome where the Carletonville Dolomite Grassland, Andesite Mountain Bushveld and the Rand Highveld Grassland vegetation units converge (Mucina & Rutherford 2006). It is situated at an altitude of 1 350 m and the climate of the region can be described as arid-temperate (Mucina & Rutherford 2006) with an erratic mean annual rainfall of 593 mm (mainly in the summer months) and cold, dry winters. Dry years can have annual rainfall as low as 230–300 mm. The mean maximum temperature during the summer months (Dec.–Feb.) is 30.7 °C with a mean minimum of 0.3 °C in the winter months (Jun.–Aug.) and frequent frost (Mucina & Rutherford 2006). The greatest threat to the natural vegetation in the province is the transformation of natural land by agriculture, mining and urbanization (Mangold *et al.* 2002), threats that are common in areas containing high biodiversity (Kühn *et al.* 2004; Jha & Bawa 2006).

METHODS

For the purpose of this paper, the following definitions were used with regard to species classification as native, indigenous-cultivated, alien or naturalized:

- native—naturally occurring within the study area, usually not cultivated;
- indigenous-cultivated—indigenous to South Africa and not occurring naturally within the study area, but cultivated in gardens;

- naturalized—not indigenous to South Africa, but occurring in the study area where it sustains self-replacing populations outside of cultivation without direct intervention by people (includes invasive aliens);
- alien cultivated—not indigenous to South Africa and not naturalized in the study area, but cultivated in gardens and including garden hybrid species (includes invasive aliens).

A topographic map of the study area was overlaid with a grid consisting of 500 × 500 m squares in ArcView (Environmental Systems Research Institute—ESRI 2006) to identify sampling co-ordinates. Co-ordinates were determined from grid intersects and the exact position of each point in the field was located with a Global Positioning System. A random selection of any domestic garden in its vicinity (no further than 100 m away) was made. If access to the chosen site was denied (which happened on two occasions), an adjacent garden was sampled. A total of 100 gardens were sampled (Figure 1). Corporate gardens were not included in this study as the management and economic input differ widely from that of domestic gardens.

All the vascular plant species in each garden were noted (presence / absence) to compile a comprehensive list in order to make a qualitative assessment of garden flora. Data from a previous study in the same urban area (Cilliers 1998) were used to compare the garden flora with that of other land use types: natural and semi-natural areas, wetlands, managed areas (parks, pavements and parking areas), roadside verges, vacant lots and railway reserves. In the

case of domestic gardens, native and indigenous-cultivated species were grouped as indigenous, and cultivated alien and naturalized species were grouped together as alien species, as the data from the previous study (Cilliers 1998) did not distinguish between these groups. Cilliers (1998) sampled the vegetation using the Braun-Blanquet method with plot sizes of 16 m² for grassland and 100 m² for woody vegetation to ensure that a representative number of species was detected. Non-random, systematic plantings and high species turnover between gardens due to human preferences enforced a larger plot size for gardens to ensure a representative sample. The mean plot size for the sampling approach in gardens was determined as a quarter of the mean yard size in the TCM (1 648 m², which includes built-up areas such as the house) and was fixed at 20 × 20 m (400 m²) to ensure that no yard would be smaller than the plot. Generally, a large proportion of the whole garden (cultivated area) could be chosen as the sample plot. In cases where the gardens (cultivated area) were smaller than the sample plot, paved areas were also included in the sample, as plants often occurred as container plants or weeds.

The indigenous flora of the TCM is well sampled (Bester *et al.* 2008) and collections in herbaria were sufficient for the identification of indigenous and alien weedy and invasive species that are commonly found. The identification of horticultural plant species was complicated, as these taxa are not well represented in herbaria. Books on gardening and garden plants were used to identify these alien horticultural species (Pienaar 1994, 2000; Joffe 2007; Smith & Van Wyk 2008).

Cross-referencing was done between our checklist and the South African Red Data List of plants (Raimondo *et al.* 2009) to determine which threatened species occurred in the domestic gardens of the TCM. Alien invader species were identified from a list of invader species compiled by Henderson (2001), which is based on national legislation (South Africa 1983; Conservation of Agricultural Resources Act of 1983). The distribution of indigenous and naturalized species of South Africa was extracted from Germishuizen *et al.* (2006). The origin of cultivated alien species as well as the uses of cultivated species was determined from the literature (Van Wyk & Gericke 2000; Glen 2002; United States Department of Agriculture 2009; Aluka 2010; Hawaiian Ecosystems at Risk 2010). The species accumulation curve was based on 100 randomly shuffled runs, done with the statistical package, Primer 5 (Clarke & Gorley 2001).

The species grown in the domestic gardens of the TCM were sorted into seven categories: ornamental, weed, food, medicinal, shade, hedge and windbreak. A category for fuel was not included, as any flammable biomass (e.g. firewood, dung, charcoal) serves this purpose for many poor households in the absence of electricity (Millennium Ecosystem Assessment 2003) and therefore no plants were found to be specifically cultivated for this purpose.

RESULTS

Best represented families

A total of 145 plant families were recorded for the domestic gardens of the TCM and 56 families (39 %) were

represented by only a single species in the study area. The 20 best represented families represent 54 % (455 species) of the total number of species recorded (Table 1). Representation, as indicated here, was determined by the number of species recorded for a given family, regardless of the frequency of occurrence of each species.

Ten of the 20 best represented families in the TCM are on the list (Table 1) of the most species-rich South African families (Germishuizen *et al.* 2006). Asteraceae, Fabaceae and Iridaceae are the most species-rich South African families and are amongst the top five for the study area. The third and fifth most species-rich South African families (Mesembryanthemaceae and Ericaceae, respectively) were not amongst the best represented garden families. The best represented families contain many garden genera and species that are extensively cultivated throughout the world (e.g. Lamiaceae: *Ocimum* spp., *Lavandula* spp., *Plectranthus* spp.; Rosaceae: *Cotoneaster* spp., *Rosa* spp., *Prunus* spp.; Crassulaceae: *Sedum* spp., *Echeveria* spp., *Kalanchoe* spp.) and many naturalized species (e.g. Fabaceae: *Prosopis glandulosa*, *Robinia pseudoacacia*, *Medicago laciniata*; Solanaceae: *Solanum sisymbriifolium*, *Cestrum elegans*; Agavaceae: *Agave americana*).

Twenty-six families (18 % of all plant families recorded for the TCM) could be classified as exclusively alien as none of their constituent species are indigenous to South Africa (Table 2). These alien families generally comprised less than 10 species, with the exception of Agavaceae with 12 species, which is ranked fifteenth of the twenty best represented families in the TCM (Table 1).

Best represented genera

In total, 501 plant genera were recorded in the TCM. Of these, two-thirds were represented by only a single species in the TCM. The ten best represented genera

TABLE 1.—Twenty best represented plant families of domestic gardens in the TCM. Superscript enumerators indicate a family's position as one of the 20 largest families in the South African flora (Snyman 2009)

Position	Plant family	No. spp.	% total no. spp.
1	Asteraceae ¹	75	9.0
2	Poaceae ⁶	52	6.2
3	Lamiaceae	38	4.5
4	Fabaceae ²	36	4.3
5	Rosaceae	33	3.9
6	Solanaceae	29	3.5
7	Crassulaceae ¹⁷	21	2.5
8	Asphodelaceae ⁹	17	2.0
9	Cactaceae	17	2.0
10	Amaryllidaceae	15	1.8
11	Malvaceae ¹⁶	15	1.8
12	Scrophulariaceae ⁷	14	1.7
13	Apocynaceae ⁸	13	1.6
14	Araceae	13	1.6
15	Agavaceae	12	1.4
16	Brassicaceae	11	1.3
17	Euphorbiaceae ¹⁴	11	1.3
18	Iridaceae ⁴	11	1.3
19	Oleaceae	11	1.3
20	Verbenaceae	11	1.3

TABLE 2.—Exclusively alien plant families recorded for domestic gardens of TCM and no. species representing each family

Alien families	No. spp.	Alien families	No. spp.
Agavaceae	12	Platanaceae	2
Caprifoliaceae	8	Cannabaceae	1
Liliaceae <i>sensu stricto</i>	7	Capparidaceae	1
Berberidaceae	5	Casuarinaceae	1
Pinaceae	5	Cycadaceae	1
Aceraceae	3	Elaeagnaceae	1
Alstroemeriaceae	3	Ginkgoaceae	1
Bromeliaceae	3	Juglandaceae	1
Saxifragaceae	3	Punicaceae	1
Cannaceae	2	Saururaceae	1
Fagaceae	2	Simaroubaceae	1
Magnoliaceae	2	Theaceae	1
Marantaceae	2	Tropaeolaceae	1

constituted nine percent of the total number of recorded species (Table 3). Only three of the best represented genera (*Asparagus*, *Cyperus* and *Tradescantia*) belong to families not included amongst the 20 best represented for the study area (Asparagaceae, Cyperaceae and Commelinaceae). Thirty-four of the 78 species (44 %) belonging to the ten best represented genera of urban domestic gardens in the TCM are alien to South Africa.

TABLE 3.—Best represented genera in domestic gardens of TCM and no. species representing each

Genera	Family	No. spp.
<i>Solanum</i>	Solanaceae	12
<i>Aloe</i>	Asphodelaceae	10
<i>Eragrostis</i>	Poaceae	9
<i>Salvia</i>	Lamiaceae	9
<i>Asparagus</i>	Asparagaceae	8
<i>Acacia</i>	Fabaceae	7
<i>Cyperus</i>	Cyperaceae	6
<i>Plectranthus</i>	Lamiaceae	6
<i>Prunus</i>	Rosaceae	6
<i>Tradescantia</i>	Comelinaceae	6

Most frequent species

A total of 835 species was recorded from the domestic gardens of the TCM, of which 235 were recorded only once and most of them were alien (70 %). The species accumulation curve for these 100 sample plots had not reached an asymptote (Figure 2), suggesting that the species will further increase as more gardens are sampled.

The 20 plant species that occurred most frequently were all present in more than half of the sampled gardens (Table 4). *Pennisetum clandestinum*, as the most favoured lawn grass, was the highest ranked species as it occurred in all but one of the gardens (99 %). Another grass species, *Cynodon dactylon*, had the second highest frequency. Three herbaceous species (*Euphorbia prostrata*, *Conyza bonariensis* and *Guilleminea densa*), which are commonly considered as naturalized garden weeds, made up the rest of the top five. *Cynodon dactylon* is the only native species amongst the top five most

frequent species and it is also regarded as a declared weed (Henderson 2001). Ten of the recorded 20 most frequent species are naturalized in South Africa, compared to the seven cultivated (indigenous and alien) and three native species. The best represented families among the twenty most frequent species are the Poaceae (five species) and Asteraceae (three species).

TABLE 4.—Twenty most frequently recorded species from domestic gardens of TCM

Species	Families	Origin	% plots
<i>Pennisetum clandestinum</i> *	Poaceae	CA	99
<i>Cynodon dactylon</i>	Poaceae	IC	84
<i>Euphorbia prostrata</i> *	Euphorbiaceae	N	79
<i>Conyza bonariensis</i> *	Asteraceae	N	76
<i>Guilleminea densa</i> *	Amaranthaceae	N	72
<i>Portulaca oleracea</i> *	Portulacaceae	N	69
<i>Dichondra micrantha</i> *	Convolvulaceae	CA	66
<i>Urochloa panicoides</i>	Poaceae	Nat	66
<i>Cynodon hirsutus</i>	Poaceae	Nat	65
<i>Ligustrum lucidum</i> *	Oleaceae	CA	63
<i>Oxalis corniculata</i> *	Oxalidaceae	N	62
<i>Rosa chinensis</i> *	Rosaceae	CA	61
<i>Alternanthera pungens</i> *	Amaranthaceae	N	59
<i>Euphorbia hirta</i> *	Euphorbiaceae	N	59
<i>Sonchus oleraceus</i> *	Asteraceae	N	59
<i>Bidens bipinnata</i> *	Asteraceae	N	56
<i>Chlorophytum comosum</i>	Anthericaceae	IC	56
<i>Prunus persica</i> *	Rosaceae	CA	56
<i>Amaranthus viridis</i> *	Amaranthaceae	N	55
<i>Eragrostis lehmanniana</i>	Poaceae	Nat	52

* alien spp.; CA, cultivated alien; IC, indigenous-cultivated; Nat, native; N, naturalized.

Endemic species

A list of species endemic to South Africa was recorded for the domestic gardens of the TCM (Table 5). It serves as confirmation of the contribution that domestic gardens make towards the conservation of unique plant species. In total, 61 endemic species were recorded, all of which are commonly cultivated, except for three species that are normally only found as weeds in gardens (Pienaar 1994; Pienaar 2000; Germishuizen *et al.* 2006). *Tulbaghia violacea* was the most commonly cultivated South African endemic as it occurred in 30 % of the sampled gardens. *Portulaca grandiflora* and *Sida spinosa* were both also commonly cultivated (27 %). Nine other endemic species were present in 10 % or more of the sample plots. In contrast, 49 endemic species occurred in less than 10 % of the plots, with 19 found only once.

Endangered and protected species

Eighteen species that have a threat status assigned according to the South African National Red Data List (Raimondo *et al.* 2009), were recorded from domestic gardens in the TCM (Table 6). These include species listed as EN: Endangered (4); VU: Vulnerable (4); NT: Near Threatened (3); Rare (2); and Declining (5). The

most common of these threatened species were *Clivia miniata* (VU) and *Dietes bicolor* (Rare), which occurred in more than 10 % of the sampled gardens. The occurrence of the remaining 16 species was lower (Table 6).

Useful plants

The utilization of plants as food, natural healing remedies, construction material and for other benefits is as

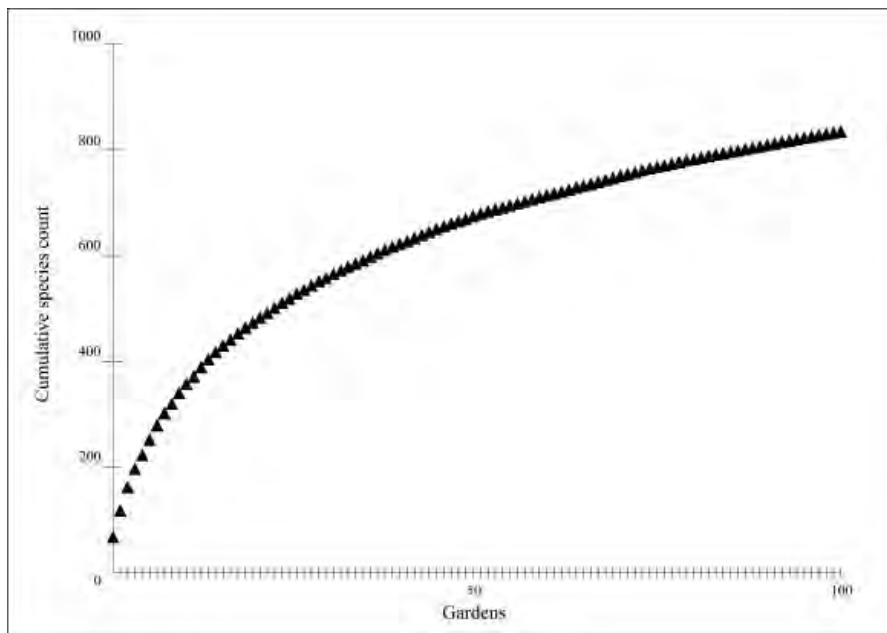


FIGURE 2.—Species accumulation curve for 100 domestic gardens in TCM.

TABLE 5.—South African endemic species recorded from domestic gardens of TCM

Species	Origin	% plots	Species	Origin	% plots
<i>Tulbaghia violacea</i>	C	30	<i>Anisodonteia elegans</i>	C	2
<i>Portulaca grandiflora</i>	C	27	<i>Crassula capitella</i>	C	2
<i>Sida spinosa</i>	N	27	<i>Crassula tetragona</i>	C	2
<i>Tulbaghia simmleri</i>	C	22	<i>Cussonia paniculata</i>	C	2
<i>Crassula ovata</i>	C	19	<i>Encephalartos natalensis</i>	C	2
<i>Euryops chrysanthemoides</i>	C	16	<i>Felicia amelloides</i>	C	2
<i>Strelitzia alba</i>	C	12	<i>Haworthia cymbiformis</i>	C	2
<i>Aptenia cordifolia</i>	C	11	<i>Lampranthus glaucus</i>	C	2
<i>Cyperus textilis</i>	C	11	<i>Nemesia strumosa</i>	C	2
<i>Dietes bicolor</i>	C	11	<i>Podocarpus henkelii</i>	C	2
<i>Lampranthus roseus</i>	C	10	<i>Podranea ricasoliana</i>	C	2
<i>Ledebouria socialis</i>	C	10	<i>Aloe brevifolia</i>	C	1
<i>Chondropetalum tectorum</i>	C	9	<i>Aloe tenuior</i>	C	1
<i>Strelitzia reginae</i>	C	9	<i>Carpobrotus edulis</i>	C	1
<i>Dimorphotheca ecklonis</i>	C	8	<i>Crassula multicava</i>	C	1
<i>Pelargonium peltatum</i>	C	8	<i>Cyrtanthus elatus</i>	C	1
<i>Agapanthus africanus</i>	C	7	<i>Encephalartos horridus</i>	C	1
<i>Haworthia fasciata</i>	C	7	<i>Geranium incanum</i>	C	1
<i>Dietes grandiflora</i>	C	5	<i>Haemanthus albiflos</i>	C	1
<i>Gasteria bicolor</i>	C	5	<i>Haworthia reinwardtii</i>	C	1
<i>Gnaphalium nelsonii</i>	N	5	<i>Lampranthus glaucoides</i>	C	1
<i>Ornithogalum thyrsoides</i>	C	5	<i>Melanthus elongatus</i>	C	1
<i>Zantedeschia pentlandii</i>	C	5	<i>Oxalis lanata</i>	C	1
<i>Lampranthus blandus</i>	C	4	<i>Pelargonium reniforme</i>	C	1
<i>Begonia homonyma</i>	C	3	<i>Plectranthus saccatus</i>	C	1
<i>Coleonema pulchellum</i>	C	3	<i>Scabiosa africana</i>	C	1
<i>Ehretia rigida</i>	N	3	<i>Senecio articulatus</i>	C	1
<i>Lampranthus aureus</i>	C	3	<i>Senecio rowleyanus</i>	C	1
<i>Ocimum serratum</i>	C	3	<i>Senecio scaposus</i>	C	1
<i>Plectranthus hilliardiae</i>	C	3	<i>Ursinia chrysanthemoides</i>	C	1
<i>Aloe striatula</i>	C	2			

C, cultivated; N, natural.

TABLE 6.—Red Data species recorded in domestic gardens of TCM (Raimondo *et al.* 2009)

Species	National status	No. plots
<i>Begonia homonyma</i>	EN	3
<i>Lampranthus aureus</i>	EN	3
<i>Encephalartos horridus</i>	EN	1
<i>Encephalartos lebomboensis</i>	EN	1
<i>Clivia miniata</i>	VU	27
<i>Crinum moorei</i>	VU	5
<i>Zantedeschia pentlandii</i>	VU	5
<i>Lampranthus glaucus</i>	VU	2
<i>Haworthia fasciata</i>	NT	7
<i>Encephalartos natalensis</i>	NT	2
<i>Nemesia strumosa</i>	NT	2
<i>Dietes bicolor</i>	Rare	11
<i>Freylinia tropica</i>	Rare	2
<i>Crinum bulbispermum</i>	Declining	6
<i>Eucomis autumnalis</i>	Declining	6
<i>Crinum macowanii</i>	Declining	2
<i>Hypoxis hemerocallidea</i>	Declining	2
<i>Acacia erioloba</i>	Declining	1

EN, Endangered; NT, Near Threatened; VU, Vulnerable.

old as humanity itself and an important part of South Africa's cultural heritage (Van Wyk *et al.* 1997; Van Wyk & Gericke 2000). The majority of plant species (61 %) was cultivated in domestic gardens solely for orna-

mental purposes (Figure 3). Frequent species in this group included *Rosa chinensis* and *Agapanthus praecox*. The second largest group was the weeds (16 %), with *Cynodon dactylon* and *Euphorbia prostrata* as frequent species. A further 9 % of the species were classified as food plants on account of their edible leaves, tubers, fruits or seeds. Medicinal plants accounted for 7 % of all the species, while 5 % were regarded as shade trees. Hedges and windbreaks did not make a considerable contribution in terms of species richness.

Origin of indigenous-cultivated species

Most of the species found in the domestic gardens of the TCM do not occur naturally in South Africa (72.2 % of the garden flora). The remaining 27.8 % of the recorded garden flora consisted of 232 native and indigenous-cultivated species (Germishuizen *et al.* 2006). The number of indigenous species in each of six geographical groups in South Africa is shown in Figure 4. Widespread species, that have fewer specific environmental preferences, contributed greatly towards the cultivated garden flora, with 122 species recorded from more than eight of the 13 regions specified in Germishuizen *et al.* (2006). Thereafter, most of the cultivated species (69) were contributed by the flora of the Eastern Cape and KwaZulu-Natal (southeastern provinces). The other four regions all made smaller contributions to the domestic garden flora of the TCM (Figure 4).

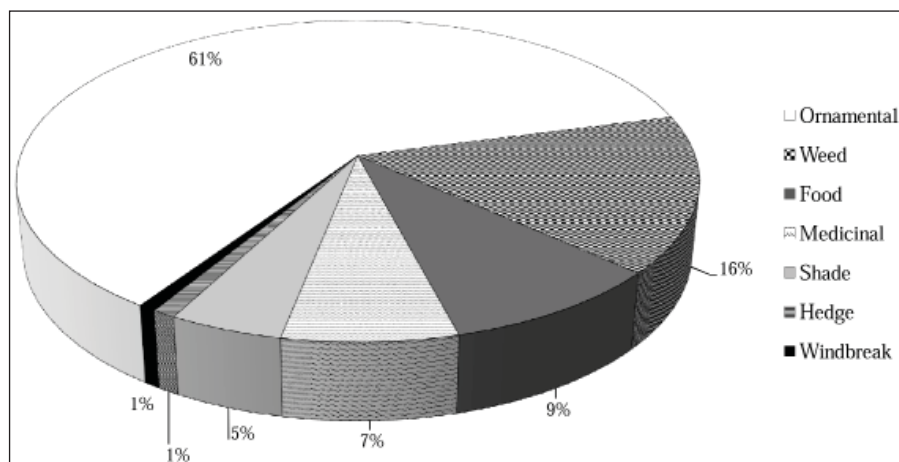


FIGURE 3.—Contribution of urban flora towards seven useful plant categories of domestic gardens in TCM.

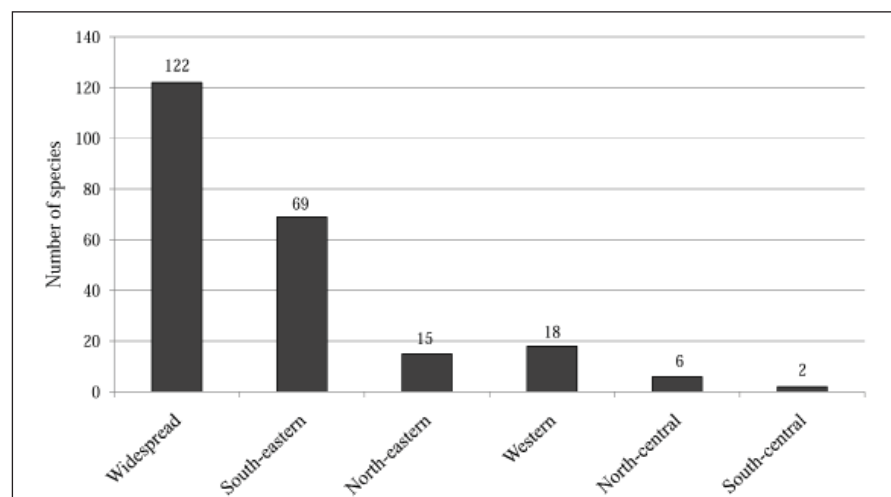


FIGURE 4.—Main geographical origin of indigenous-cultivated species that were recorded for domestic gardens in TCM. S Central (Free State, Lesotho); N Central (North-West Province, Limpopo, Botswana); Western (Western Cape, Northern Cape, Namibia); N Eastern (Mpumalanga, Gauteng, Swaziland), S Eastern (KwaZulu-Natal, Eastern Cape); Widespread, defined as occurring naturally in eight or more of regions.

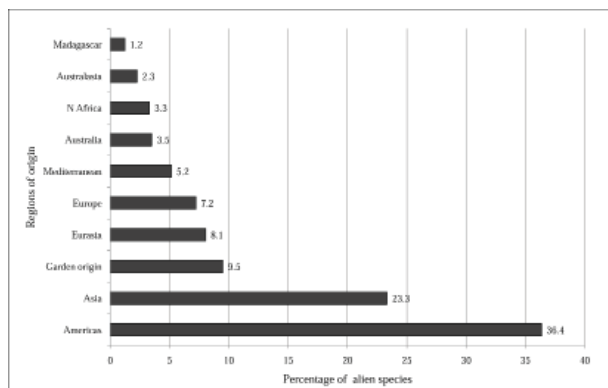


FIGURE 5.—Ten regions of origin of alien cultivated and naturalized alien species recorded for domestic gardens in TCM.

TABLE 7.—Three most frequent invasive species recorded for each declared category of invasiveness and proposed invaders. No. species recorded for each category in brackets

Category 1: declared weeds (32)	No. occurrences
<i>Canna × generalis</i>	43
<i>Araujia sericifera</i>	23
<i>Nerium oleander</i>	17
Category 2: declared invaders (12)	
<i>Pennisetum clandestinum</i>	99
<i>Cynodon dactylon</i>	84
<i>Robinia pseudoacacia</i>	15
Category 3: declared invaders (36)	
<i>Ligustrum lucidum</i>	63
<i>Ipomoea purpurea</i>	35
<i>Nephrolepis exaltata</i>	32
Proposed invaders (8)	
<i>Celtis sinensis</i>	38
<i>Celtis australis</i>	9
<i>Duranta erecta</i>	5

Category 1: prohibited in South Africa, must be eradicated where possible; Category 2: planting only allowed under controlled conditions in demarcated areas, trading only with permits; Category 3: no further plantings and no trade allowed (Henderson 2001).

Origin of naturalized and cultivated alien species

No information was available regarding the origin of 65 of the naturalized and cultivated alien species and 31 species originated from more than one region. The remaining 484 naturalized and cultivated alien species could be grouped according to regions of common origin (Figure 5). More than a third (36.4 %) of the alien horticultural plant species found in the domestic gardens of the TCM was originally introduced from the Americas (North, Central and/or South America). Asia was the second largest contributor to the alien horticultural flora, as 23.3 % of the species originate from there. Hybrids that originated in gardens also made a significant contribution of 9.5 %.

Invasive species

Apart from the substantial utilization, maintenance and conservation of biodiversity found in gardens, there are some unforeseen consequences, such as the occurrence of invasive alien species. In the domestic gardens of the TCM, 88 declared invader and weed species were

found (Table 7) (Henderson 2001). There were 32 Category 1 declared weeds, which comprise the most severe type of invasive species. *Canna × generalis* formed part of this group and it occurred in 43 % of gardens. *Pennisetum clandestinum* and *Cynodon dactylon*, which have shown the highest occurrences of all, were some of the species classified as Category 2 declared invaders. Category 3 declared invaders had the highest number of species (36) and included, amongst others, *Ligustrum lucidum* in more than 60 % of the surveyed gardens. *Celtis sinensis* (38 %), from the list of proposed invaders, was found to be the most frequent species in this category.

Growth forms

The majority of species found in the domestic gardens of the TCM were forbs (341) (Figure 6). *Euphorbia prostrata* and *Guilleminea densa* were the most frequent herbaceous species occurring respectively in 79 % and 72 % of sample plots. The second most frequent growth form was shrubs (173 species) with frequent species such as *Rosa chinensis* and *Ficus carica*, followed by trees (131 species), of which the most frequent representative was the popular hedge species *Ligustrum lucidum*. *Prunus persica* was found to be the second most frequent tree species, as it is commonly cultivated for its edible fruit. Succulents, geophytes and graminoids were all represented by a lower, but relatively similar number of species with ferns being the smallest represented group.

Total species diversity

The total number of species and the numbers of indigenous and alien species of different land use types were compared (Figure 7). Two distinct floristic differences are evident between domestic gardens and the other land use types. The first is the substantially higher total number of species (or gamma diversity) of domestic gardens when compared to the other land use types. The other difference is the inverted relationship of indigenous and alien species in domestic gardens when compared to the other land use types. Domestic gardens contained almost twice as many alien as indigenous species.

DISCUSSION

Most frequent taxa

Urban areas are characterized as heterogeneous and highly dynamic environments (Rebele 1994), a phenomenon that is also observed within domestic gardens of residential areas (Mathieu *et al.* 2007). The gamma diversity of plant species encountered in the 100 sampled domestic gardens of the TCM (835 species) is in accordance with results from other studies, e.g. 973 species in Lauris, France, from 120 gardens (Marco *et al.* 2008) and 1 166 species in Sheffield, United Kingdom, from 61 gardens (Smith *et al.* 2006). However, the fact that 235 species were recorded only once is indicative of the high species turnover between gardens, and is consistent with the gardens of Sheffield (Thompson *et al.* 2003). The lack of saturation of the species accumulation curve is also in accordance with results from other domestic garden studies (Smith *et al.* 2006) and indi-

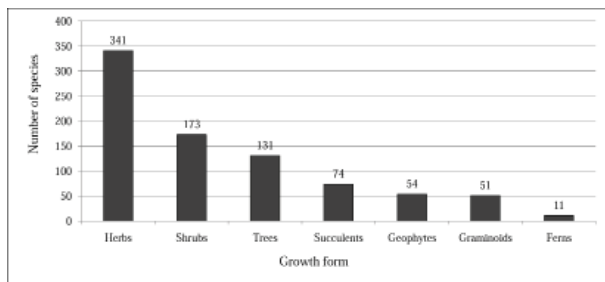


FIGURE 6.—Dominant growth forms of flora in domestic gardens of TCM.

cates that the number of plant species would continue to increase if more sample sites were included in the survey. According to Smith *et al.* (2006), the theoretical limit for the garden species pool is set by the number of species available in the horticultural trade.

All the most frequent garden genera are well represented in the South African natural flora, except for *Prunus* and *Tradescantia* (Germishuizen *et al.* 2006). Many species from the most frequent genera, such as *Solanum*, *Aloe* and *Salvia*, are popular ornamental species or declared weeds, which may explain to a certain extent the frequent occurrence of these genera in gardens. Despite a high number of species from these genera being alien to South Africa (44 %), none of the most frequent genera belong to alien families. This means that the alien species have a close affinity with South African indigenous species at family level (Germishuizen *et al.* 2006). Of the 20 most frequent species, most were naturalized weeds rather than cultivated species. These naturalized species may originally have been horticultural subjects that escaped from gardens into the natural surroundings (Hodkinson & Thompson 1997; Siebert *et al.* 2010). Species belonging to alien plant families are cultivated mostly for their high ornamental value, e.g. *Cordyline australis*, *Abelia* $\times$ *grandiflora*, *Aspidistra elatior* and *Nandina domestica*.

Endemic and endangered species

Endemic and endangered species represent only a small portion of the garden flora, but, however small the contribution of a few gardens may be towards the protection of such species, its collective effort across an entire urban ecosystem and also globally holds tremendous potential (Savard *et al.* 2000; Gaston *et al.* 2005). However, the cultivation of these species takes place for their utilitarian value and not necessarily with conservation in mind. As perceptions of what is considered useful can change over time, these plant species of conservation concern may be replaced with something new. The presence of these rare and endangered species in domestic gardens highlights the role that such land use types can fulfil in the conservation of indigenous biodiversity, albeit a somewhat vulnerable niche. Through interaction of gardens with other types of greenspace in close vicinity within the urban environment, better support of biodiversity is possible—a concept described by Colding (2007) as ‘ecological land-use complementation’. This means that more indigenous species can be supported in terms of nutrition, space and water resources by the combined patches of the entire urban green infrastructure, which stresses the importance of proper planning of urban development. Furthermore, the conservation resources that already exist can be utilized better in protecting not only endangered, but also abundant indigenous species (Hamilton 1999).

Useful plants

Despite the high proportion of species originating from Asia and the Americas, the culture of gardening in Potchefstroom is predominantly European (Cilliers 2010), which has influenced local cultures across socioeconomic classes (Lubbe *et al.* 2010), resulting in the high frequency of ornamental plant species in most gardens of the city. Inhabitants of Ganyesa, a small, rural village in the North-West Province, also cultivate many ornamental species—an indication that even poorer, more traditional communities regard aesthetics as important (Cilliers 2010). Weeds, the second largest group (Figure

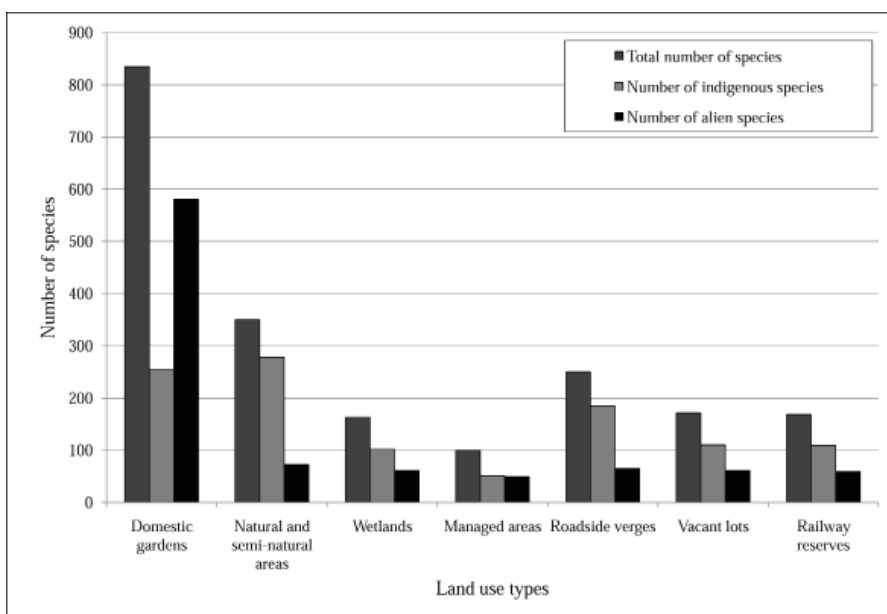


FIGURE 7.—Comparison of total species, indigenous species (including native species) and alien species (including naturalized species) for land use types of TCM (gamma diversity).

3), are not favoured by gardeners because of their occurrence in unwanted locations (Henderson 2001). However, these plants are almost always present in gardens and contribute towards the ecological environment within the garden. Food plants did not contribute as significantly to the diversity of the total flora (9 %) of the TCM gardens as would be expected. For instance, in Ganyesa almost 28 % of plant species were classified as food plants (Cilliers 2010). Molebatsi *et al.* (2010) have shown that the Batswana communities in the rural areas harboured a greater number of useful, indigenous species in their home gardens. This is an indication of the dependence of poorer communities on utility gardens for their livelihoods. The other categories (medicinal, shade, hedge and windbreak species) all made very small contributions to the diversity of the garden flora. Some of the species that are cultivated locally as hedges, however, occurred in many gardens (*Ligustrum lucidum*, 63 %; *Rosa banksiae*, 19 %), indicating that a low percentage in a plant use category (Figure 3) may underestimate the importance of its constituent species.

Species distribution

Species that are widespread throughout and occur naturally in South Africa (native and indigenous-cultivated species) were most common in gardens, such as the tree *Acacia karroo*, and grasses *Cynodon dactylon* and *Eragrostis lehmanniana*. Species originating from the southeastern provinces were also commonly cultivated, for example *Chlorophytum comosum*, *Tulbaghia violacea* and *Clivia miniata*. Van Jaarsveld (2001) argued that species from the Eastern Cape are especially well suited for gardening almost anywhere in the world, because they are extremely tolerant to disturbance, wide temperature ranges and can endure both drought and excessively wet conditions. Fewer species from the other regions of South Africa (for example fynbos species) are found in gardens, as they may not always be as tolerant of the dynamic and ever-changing conditions in gardens. The fact that indigenous species play an important role in cultivation practices is partly ascribed to nurseries promoting such plantings in gardens. All three of the major nurseries in Potchefstroom keep 20–30 % of indigenous stock for cultivation and recommend these above alien horticultural species (J. du Toit 2010; A. Grobler 2010; I. Scheepers 2010 pers. comm.). In many cases, however, customers purchase the more colourful or hardy alien horticultural species, of which there is normally a greater variety available.

Plant species from similar climates are adapted to specific environmental conditions, such as temperature ranges and frost resistance, and should thus be able to survive such conditions elsewhere. Commonalities between the climate of the country of origin of cultivated alien species and the South African Highveld climate could be the reason why the Americas and Asia were the largest contributors to the alien horticultural flora of the TCM, indicating that plant species from these regions may be best suited for the local climatic conditions, and even harder than most indigenous species. Apart from hardiness and suitability for cultivation, these cultivated alien species also share another important characteristic—ornamental or food value—that

makes them popular for cultivation. The garden hybrids also made a substantial contribution to the garden flora, suggesting that these taxa are already adapted to the environmental conditions in domestic gardens.

Invasive species

South Africa is regarded as a country threatened by invasive alien plants, with 1 226 alien taxa occurring within its borders (Richardson *et al.* 2005). Many of these alien species possess the potential to escape from cultivation in gardens to form self-sustaining natural populations (Sullivan *et al.* 2005). This may have detrimental effects on the survival and existence of indigenous vegetation and biodiversity (Pimentel *et al.* 2000; Richardson & Van Wilgen 2004). The high number of alien invasive species found in domestic gardens of the TCM confirmed that this problem has its origin in ecosystems created by man where sources of alien invasive species are maintained. Most of the invasive species found in domestic gardens either were cultivated extensively in the past, although they may not be commercially available anymore, e.g. *Ligustrum lucidum*, or are still cultivated and available today (*Canna × generalis*, *Celtis sinensis* and *Pennisetum clandestinum*). The fact that these species are still cultivated could be an indication that they may become even more problematic in the future and that more cultivated species have the potential to spread into the natural environment (Aronson *et al.* 2007). However, due to the low occurrence of most of the cultivated invasive species in gardens it is less likely that these species will spread outside of cultivation. This information on the presence and abundance of invasive species in domestic gardens can be incorporated into preventative measures and eradication plans in the future.

Species diversity

The higher gamma diversity of domestic gardens when compared to other land use types is further proof of the heterogeneous nature of urban areas and gardens. In the Phoenix, Arizona metropolis, Hope *et al.* (2003) found that the city had much higher gamma diversity than the surrounding desert as a result of the introduced alien vegetation that has replaced the indigenous species. The high gamma diversity of urban domestic gardens is the result of the diverse species pool that gardeners can choose from for cultivation purposes in a variety of habitat types. Plant diversity is generally viewed as an indication and determinant of overall biodiversity, influencing all related biota (Matson *et al.* 1997) and the green spaces in urban areas are thus of critical importance for all that is living in these environments.

More alien than indigenous species are cultivated in domestic gardens because cultivation practices promote the planting of hardy and aesthetic alien species that can be imported from all over the world (Thompson *et al.* 2003; Kühn *et al.* 2004), simultaneously contributing to high species diversity. Gardens are continually supplied with nutrients and water, thus diminishing the constraints of survival associated with natural areas and thereby increasing the number of species that can exist in a limited environment (Hope *et al.* 2003; Niinemets & Peñuelas 2008). Species that would otherwise not sur-

vive in local habitats and climates are thus able to survive.

CONCLUSION

The data presented here is a snapshot of the entire garden flora of a southern African city—a moment in time of a very dynamic and complex system. Nevertheless, it provides a broad picture of the state of the garden flora. As there is very little such descriptive data available, especially for developing countries, this paper contributes to the pool of knowledge necessary to understand urban biodiversity, and urban ecosystems as a whole, more effectively.

Domestic gardens contribute to the plant diversity of the urban ecosystem, which forms the basis of the provision of several ecosystem goods and services. Furthermore, gardens have enormous potential to maintain indigenous diversity and threatened species, albeit on a small scale, in every garden. On the other hand, with the majority of species cultivated in gardens being alien, it holds the potential to produce even more invasive species that could harm our natural ecosystems and indigenous vegetation. Considering both the benefits of garden vegetation and the possible threat that it poses to our natural heritage, much more knowledge on the ecological functioning of gardens is necessary to fully understand their features and allow cities to manage the natural environment sensibly and optimize its potential for sustainability.

REFERENCES

- ALBERTI, M. 2005. The effects of urban patterns on ecosystem function. *International Regional Science Review* 28: 168–192.
- ALUKA. 2010. *African plants*. <http://www.aluka.org/page/content/plants.jsp> (accessed 3 Feb. 2010).
- ARONSON, M.F.J., HANDEL, S.N. & CLEMANTS, S.E. 2007. Fruit type, life form and origin determine the success of woody plant invaders in an urban landscape. *Biological Invasions* 9: 465–475.
- BESTER, S.P., STEYN, H.M. & KOEKEMOER, M. 2008. National plant collecting programme: is it worth the trouble? Progress on collection in Tankwa Karoo and Namaqua National Parks. *South African Journal of Botany* 74: 385.
- BOLUND, P. & HUNHAMMAR, S. 1999. Ecosystem services in urban areas. *Ecological Economics* 29: 293–301.
- CILLIERS, S.S. 1998. *Phytosociological studies of urban open spaces in Potchefstroom, North West Province, South Africa*. Ph.D. thesis, PU for CHE, Potchefstroom.
- CILLIERS, S.S. 2010. Social aspects of urban biodiversity: overview. In N. Müller, P. Werner & J. Kelcey, *Urban biodiversity and design—implementing the convention on biological diversity in towns and cities*: 81–100. Wiley-Blackwell Publishing, Oxford.
- CLARKE, K.R. & GORLEY, R.N. 2001. PRIMER v5: User manual/tutorial. Primere Publishers, Plymouth.
- COLDING, J. 2007. 'Ecological land-use complementation' for building resilience in ecosystems. *Landscape and Urban Planning* 81: 46–55.
- ENVIRONMENTAL SYSTEMS RESEARCH INSTITUTE (ESRI). 2006. ArcView 9.2. www.esri.com. Redlands, USA.
- GASTON, K.J., WARREN, P.H., THOMPSON, K. & SMITH, R.M. 2005. Urban domestic gardens (IV): the extent of the resource and its associated features. *Biodiversity and Conservation* 14: 3327–3349.
- GERMISHUIZEN, G., MEYER, N.L., STEENKAMP, Y. & KEITH, M. (eds). 2006. *A checklist of South African plants*. Southern African Botanical Diversity Network Report No. 41. SABONET, Pretoria.
- GLEN, H.F. 2002. *Cultivated plants of southern Africa*. Jacana, Johannesburg.
- GODEFROID, S. & KOEDAM, N. 2007. Urban plant species patterns are highly driven by density and function of built-up areas. *Landscape Ecology* 22: 1227–1239.
- HAMILTON, H.R. 1999. The case for abundant species management. *Human Dimensions of Wildlife* 4: 74–85.
- HAWAIIAN ECOSYSTEMS AT RISK. 2010. Hawaiian Ecosystems at Risk Project. <http://www.hear.org/> (accessed 3 Feb. 2010).
- HENDERSON, L. 2001. *Alien weeds and invasive plants*. Agricultural Research Council, Pretoria.
- HODKINSON, D.J. & THOMPSON, K. 1997. Plant dispersal: the role of man. *Journal of Applied Ecology* 34: 1484–1496.
- HOPE, D., GRIES, C., CASAGRANDE, D., REDMAN, C.L., GRIMM, N.B. & MARTIN, C. 2006. Drivers of spatial variation in plant diversity across the central Arizona-Phoenix system. *Society and Natural Resources* 19: 101–116.
- HOPE, D., GRIES, C., ZHU, W., FAGAN, W.F., REDMAN, C.L., GRIMM, N.B., NELSON, A.L., MARTIN, C. & KINZIG, A. 2003. Socio-economics drive urban plant diversity. *Proceedings of the National Academy of Sciences* 100: 8788–8792.
- ISAACSON, R.T. 2004. *The Anderson Horticultural Library's source list of plants and seeds: a completely revised listing of 2000–2003 catalogues*, edn 6. Anderson Horticultural Library, Chanhassen, USA.
- JHA, S. & BAWA, K.S. 2006. Population growth, human development, and deforestation in biodiversity hotspots. *Conservation Biology* 20: 906–912.
- JOFFE, P. 2007. *Skeppende tuinmaak met inheemse plante: 'n Suid-Afrikaanse gids*. Briza, Pretoria.
- KÜHN, I., BRANDL, R. & KLOTZ, S. 2004. The flora of German cities is naturally species rich. *Evolutionary Ecology Research* 6: 749–764.
- LUBBE, C.S., SIEBERT, S.J. & CILLIERS, S.S. 2010. Political legacy of South Africa affects the plant diversity patterns of urban domestic gardens along a socio-economic gradient. *Scientific Research and Essays*, 5: 2900–2910.
- MACAULAY, D., BUCHANAN, N., BURTON, R. & MURPHY, M. 2009. *RHS plant finder 2009–2010*. Dorling Kindersley, London.
- MANGOLD, S., MOMBERG, M. & NEWBERY, R. 2002. Biodiversity and conservation. In S. Mangold & M. Kalule-Sabiti, *North West Province State of the Environment Report*: 1–106. Department of Environmental Affairs and Tourism, Mafikeng.
- MARCO, A., DUTOIT, T., DESCHAMPS-COTTIN, M., MAUFFREY, J., VENNETIER, M. & BERTAUDIÈRE-MONTES, V. 2008. Gardens in urbanizing rural areas reveal an unexpected floral diversity related to housing density. *Comptes Rendus Biologies* 331: 452–465.
- MATHIEU, R., FREEMAN, C. & ARYAL, J. 2007. Mapping private gardens in urban areas using object-oriented techniques and very high-resolution satellite imagery. *Landscape and Urban Planning* 81: 179–192.
- MATSON, P.A., PARTON, W.J., POWER, A.G. & SWIFT, M.J. 1997. Agricultural intensification and ecosystem properties. *Science* 277: 504–509.
- MCKINNEY, M.L. 2008. Effects of urbanization on species richness: a review of plants and animals. *Urban Ecosystems* 11: 161–176.
- MILLENNIUM ECOSYSTEM ASSESSMENT. 2003. Ecosystems and human well-being: a framework for assessment. Island Press, Washington DC.
- MOLEBATSI, L.Y., SIEBERT, S.J., CILLIERS, S.S., LUBBE, C.S. & DAVOREN, E. 2010. The Tswana tshimo: a home garden system of useful plants with a particular layout and function. *African Journal of Agricultural Research* 5: 2952–2963.
- MUCINA, L. & RUTHERFORD, M.C. (eds). 2006. The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia* 19. South African National Biodiversity Institute, Pretoria.
- NIINEMETS, Ü. & PEÑUELAS, J. 2008. Gardening and urban landscaping: significant players in global change. *Trends in Plant Science* 13: 60–65.
- PICKETT, S.T.A., CADENASSO, M.L., GROVE, J.M., NILON, C.H., POUYAT, R.V., ZIPPERER, W.C. & COSTANZA, R. 2001. Urban ecological systems: linking terrestrial ecological, physical and socio-economic components of metropolitan areas. *Annual Review of Ecology and Systematics* 32: 127–157.
- PIENAAR, K. 1994. *The ultimate southern African gardening book*. Southern Book Publishers, Pretoria.
- PIENAAR, K. 2000. *The South African what flower is that?* Struik, Cape Town.

- PIMENTEL, D., LACH, L., ZUNIGA, R. & MORRISON, D. 2000. Environmental and economic costs of nonindigenous species in the United States. *BioScience* 50: 53–65.
- RAIMONDO, D., VON STADEN, L., FODEN, W., VICTOR, J.E., HELME, N.A., TURNER, R.C., KAMUNDI, D.A. & MANYAMA, P.A. 2009. Red List of South African plants 2009. *Strelitzia* 25. South African National Biodiversity Institute, Pretoria.
- REBELE, F. 1994. Urban ecology and special features of urban ecosystems. *Global Ecology and Biogeography Letters* 4: 173–187.
- RICHARDSON, D.M., ROUGET, M., RALSTON, S.J., COWLING, R.M., VAN RENSBURG, B.J. & THUILLER, W. 2005. Species richness of alien plants in South Africa: environmental correlates and the relationship with indigenous plant species richness. *Ecoscience* 12: 391–402.
- RICHARDSON, D.M. & VAN WILGEN, B.W. 2004. Invasive alien plants in South Africa: how well do we understand the ecological impacts? *South African Journal of Science* 100: 45–52.
- SAVARD, J.L., CLERGEAU, P. & MENNECHEZ, G. 2000. Biodiversity concepts and urban ecosystems. *Landscape and Urban Planning* 48: 131–142.
- SIEBERT, S.J., ZOBOLO, A.M. & DOWE, J.L. 2010. *Livistona chinensis*: a first record of a naturalized palm in South Africa. *Bothalia* 40: 55–57.
- SMITH, G.F. & VAN WYK, B-E. 2008. *Guide to garden succulents*. Briza Publications, Pretoria.
- SMITH, R.M., THOMPSON, K., HODGSON, J.G., WARREN, P.H. & GASTON, K.J. 2006. Urban domestic gardens IX: composition and richness of the vascular plant flora, and implications for native biodiversity. *Biological Conservation* 129: 312–322.
- SNYMAN, H. 2009. Top 20 SA plant families. H.Snyman@sanbi.org.za (accessed 4 Dec. 2009).
- SOUTH AFRICA. 1983. Conservation of Agricultural Resources Act of 1983. Government Printer, Pretoria.
- SULLIVAN, J.J., TIMMINS, S.M. & WILLIAMS, P.A. 2005. Movement of exotic plants into coastal native forests from gardens in northern New Zealand. *New Zealand Journal of Ecology* 29: 1–10.
- THOMPSON, K., AUSTIN, K.C., SMITH, R.M., WARREN, P.H., ANGOLD, P.G. & GASTON, K.J. 2003. Urban domestic gardens I: putting small-scale plant diversity in context. *Journal of Vegetation Science* 14: 71–78.
- UNITED STATES DEPARTMENT OF AGRICULTURE (USDA). 2009. *Plants database*. <http://www.plants.usda.gov/> (accessed 3 Feb. 2010).
- VAN JAARSVELD, E. 2001. Shaped by suffering. *Veld & Flora* 87: 16–19.
- VAN WYK, B.-E. & GERICKE, N. 2000. *People's plants: a guide to useful plants of southern Africa*. Briza Publications, Pretoria.
- WILLIAMS, J.W., SEABLOOM, E.W., SLAYBACK, D., STOMS, D.M. & VIERS, J.H. 2005. Anthropogenic impacts upon plant species richness and net primary productivity in California. *Ecology Letters* 8: 127–137.
- WORKWELL. 2004. *Potchefstroom socio-economic survey*. WorkWell research unit for people, policy and performance, Potchefstroom.
- WU, J., JENERETTE, G.D. & DAVID, J. 2003. Linking land-use change with ecosystem processes: a hierarchical patch dynamic model. In S. Guhathakurta, *Integrated land use and environmental models*: 99–119. Springer, Berlin.

Miscellaneous notes

TRIBUTE TO BEVERLEY MOMBERG, TECHNICAL EDITOR IN THE PUBLICATIONS SECTION OF THE SOUTH AFRICAN NATIONAL BIODIVERSITY INSTITUTE

Over the past nearly 30 years, Mrs Beverley Momberg—or Bev, as everyone calls her—has been involved in the Publications Section of the South African National Biodiversity Institute (SANBI), particularly as technical editor of *Bothalia* and also other scientific series. She will be retiring from this position on 31 October 2011. This issue of *Bothalia* is therefore the final one to which she will be applying her technical editing skills as a tenured staff member. During her career at SANBI, Beverley tirelessly worked on improving texts submitted for publication in a range of SANBI's scientific, technical, semi-scientific and popular series.

Beverley Ann Momberg (née Paola) was born on 10 October 1946 in Pretoria. She attended the Loreto Convent, Hillcrest, Pretoria, matriculating in 1963. She then went on to the University of Pretoria where she completed a B.Sc. degree in 1967, majoring in Entomology and Zoology. After she completed her undergraduate studies, she took a job in Johannesburg in the field of medical research with the identification of disease vectors as one of her responsibilities.

After her marriage in 1969, the next eleven years were spent at home rearing two sons and a daughter. When the youngest child was ready for school, she took a job in Pretoria in 1980, working with Dr Bernard de Winter, the then Director of the Botanical Research Institute (BRI), one of the forerunners of SANBI, assisting with arrangements for the 10th AETFAT Congress that was held in Pretoria in January 1982, and of which Dr De Winter was the Secretary-General. After the Congress, she worked with Dr Donald Killick, at the time Deputy Director and editor of the BRI's scientific publications, in producing the AETFAT Congress Proceedings that eventually appeared in volume 14 of *Bothalia* in 1983. Most of Bev's career of 31 years, in first the BRI, later the National Botanical Institute, currently SANBI, has therefore been spent in the technical editing of scientific publications. During this time she worked with the several scientific editors of the follow-

ing: *Bothalia*, *Memoirs of the Botanical Survey of South Africa*, *Flora of southern Africa*, *Strelitzia* and *SANBI Biodiversity Series*, namely Dr Killick, Dr Otto A. Leistner (Smith 1998) and Mr Gerrit Germishuizen (Smith 2011), which allowed her to further develop her love of, and natural capabilities in, the written and spoken word, which was fostered in her while attending school at the Loreto Convent. She was responsible for every stage in the production of *Bothalia* for the last 24 years.

Authors who submitted texts to, and saw them published in a range of SANBI's publication series, owe a debt of gratitude to Beverley for having competently polished and delivered their written effusions to the world. Many people—not only authors—make the publication of a book or journal a reality. It may not be common practice to acknowledge the work of technical editors, but in the case of Beverley Momberg it is more than appropriate.

In many respects, the end of the first and beginning of the second decades of the 21st Century is ringing in changes for components of SANBI's suite of scientific and other publications. With the retirement of Beverley and, a year ago, Gerrit Germishuizen (Smith 2011), an era of high-quality, in-house science publishing has come to an end.

REFERENCES

- SMITH, G.F. 1998. New editor for *Bothalia*. *Bothalia* 28: 113–115.
SMITH, G.F. 2011. Tribute to Gerrit Germishuizen, editor of *Bothalia*. *Bothalia* 41: 229.

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OBITUARY

FRANZ SEBASTIAN MÜLLER (1913–2010)

On 22 May 2010, Dr Franz Sebastian Müller (Figure 1) passed away in Pretoria at the grand old age of 97, following medical treatment for mild bladder cancer. His passing went almost unnoticed in botanical circles, although he was one of South Africa's pioneers in the field of plant cytogenetic research. This is perhaps not surprising as he left the field of botany in 1946, shortly after obtaining a Doctor Scientiae (D.Sc.) degree in botany from the University of Pretoria. He then went on to the University of Cape Town to study medicine, and eventually carved out a successful career stretching over 40 years in private medical practice, hospital administration, and provincial health services. Franz's second name has sometimes in error been spelled with two 'a's [Sebastiaan] and at other times with a 'z' replacing the second 's' [Sebaztian], and his surname with a 'u', rather than a 'ü', mainly because in years gone by, standard typewriters did not easily type a 'ü', but correctly, his name was Franz Sebastian Müller.

Franz Sebastian Müller was born on 16 February 1913 in Heilbron, a small town in the Free State Province (then the Orange Free State) of South Africa, the oldest child of Edward Julius Frances Müller and Anna Margaretha Müller (née Swart). As a child he moved with his parents first to Petrus Steyn and later to Frankfort in the Free State. He attended school there and eventually wrote the final matriculation examination in 1930. Interestingly, he initially failed matric because he misread the time that the German examination started. He therefore had to rewrite, and passed the German examination in February 1931. After having completed secondary school, Franz initially did not have sufficient resources to enter university and worked in Frankfort for two years, one year of which was spent working for a law firm in the town.

He eventually managed to afford university tuition and, starting in February 1933, registered for a B.Sc. degree at the then Potchefstroom University for Christian Higher Education (PUCHE) in Potchefstroom, now the Potchefstroom campus of the North-West University. During his first year, as part of the informal initiation process for new and first-year students, he was the 'slave' allocated to senior student Hennie Bredell, who was then reading for a Master of Science (M.Sc.) degree. Although not mentioned in Gunn & Codd (1981), Bredell apparently later worked at the National Herbarium in Pretoria for a short while. While engaged in his undergraduate studies, Müller had more than a passing interest in geology and indicated, at the end of his second study year, that he considered relocating to the then University of the Orange Free State, where this discipline was taught for degree purposes. However, the PUCHE had no intention of allowing Müller, a very promising student, to depart from their campus in Potchefstroom. To retain him, they rather started lectures in geology and, at the beginning of 1935, a course in this

discipline, which resulted in the establishment of the Department of Geology. Müller took botany, geology and zoology as his major final-year subjects, and completed his degree in the first class. Throughout his undergraduate study years at the PUCHE he was awarded merit bursaries for academic achievement, and in 1935 he completed his B.Sc. studies. He was then awarded one of 10 national bursaries available to students who excelled in their undergraduate studies. The bursary, with a value of £80.00, enabled Franz to enroll for a master's degree in botany at the PUCHE in 1935.

For his Masters study, Franz worked on the genus *Sporobolus* R.Br. (Poaceae), on which he conducted systematic studies with emphasis on leaf anatomy. He worked under the tutelage of Prof. A.P. [Antonie Petrus Gerhardus] Goossens, who at the time was attached to the PUCHE. Prof. Goossens is perhaps best known for his Afrikaans text books on botanical terminology (Goossens 1950 and several later editions) and the taxonomy of the southern African flora (Goossens 1963). An M.Sc. degree was awarded to Müller in 1936. During his Masters studies he also did relief teaching in biology (Muller 2005).

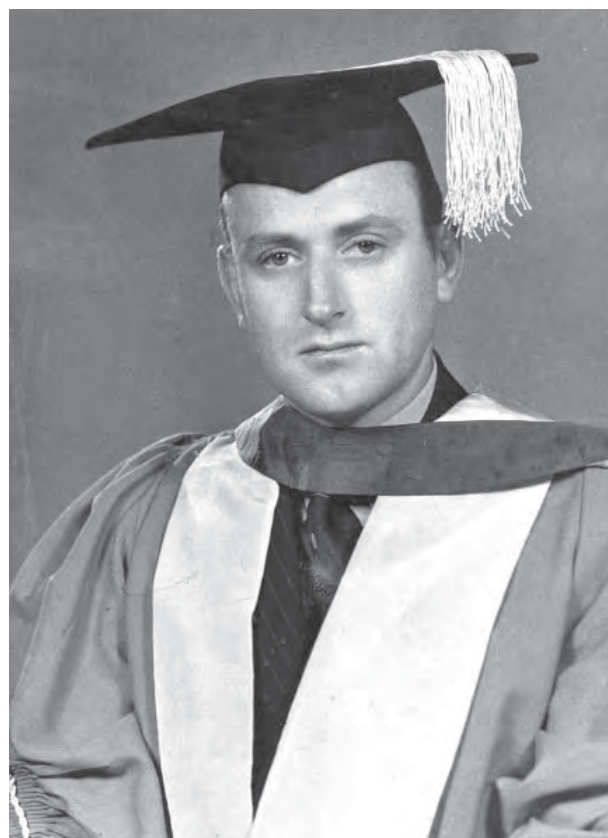


FIGURE 1.—Franz Sebastian Müller (1913–2010) photographed in 1942 at the time of his D.Sc. graduation ceremony at the University of Pretoria.

Based on his academic achievements, Müller was thereafter awarded a Von Humboldt Stipendium by the Deutscher Austausch Dienst, and on 1 March 1937 he departed for Europe on board the steamboat *S.S. Usaramo*, with the intention of doing a doctorate in plant sciences in Germany (Figure 2). However, the looming Second World War resulted in his immediate return to South Africa in April 1937, a few years before hostilities broke out between Nazi Germany and the Allies, on whose side South Africa joined the war effort. On his return to South Africa he obtained work as a clerk of the court in Frankfort. The money he saved during his eight-month employment in Frankfort enabled him to return to the PUCHE where he registered for a diploma in education. After he completed the diploma he took a job as science and accountancy teacher at the secondary school in Zeerust, and from there accepted a similar position at a school in Durban, Natal, now KwaZulu-Natal. However, when he arrived at the school in Durban, he was informed that he would have to teach English to primary school learners, and he immediately turned down the appointment and returned to Frankfort. Some time after his return to South Africa, following his abortive journey to Germany, he realised with dismay that the research he conducted towards his Masters thesis had been published by his supervisor, Prof. Goossens (Goossens 1938). Müller's name was relegated to the terse acknowledgement for '...his willing assistance in carrying out most of the anatomical researches'.

During the course of 1939, while teaching at the Hoërskool Zeerust, he registered for a D.Sc. degree at the University of Pretoria. Müller initially started this doctoral research at the PUCHE at the time that he was registered there for a Teaching Diploma, but was informed by the Registrar of the University that it would not be possible to be registered simultaneously for two academic qualifications. Müller then contacted Prof. B. Elbrecht who was attached to the Department of Botany of the University of Pretoria and informed him that he would like to work on the cytology of the African flagship plant genus, *Aloe* L., for his D.Sc. dissertation. (It should be noted that at that time, the University awarded D.Sc. degrees and not Ph.D. degrees) At the time, the Head of the Department of Botany was Prof. Hans

(H.G.W.J.) Schweickerdt, who is credited as the founder of modern plant systematics at the University of Pretoria (Rourke 1999). Müller's research proposal was accepted and he started collecting material of aloes on the *koppies* around Zeerust and further afield in South Africa. At the time, one of the few books available on aloes (and other monocot groups) was *Flora capensis*, volume VI, Haemodoraceae to Liliaceae (Figure 3). Dr I.B. Pole Evans, an early director of what is now part of the South African National Biodiversity Institute, also had more than a passing interest in the genus, and he collected aloes from various parts of South Africa for cultivation in the garden at the National Herbarium, which at the time was situated just below the Union Buildings in Pretoria. Müller eventually also obtained living material for his cytological work from this garden. The doyen of aloe research at the time was Dr G.W. Reynolds and Müller credits him as having been very supportive of his research, for example through providing research material from his garden. When Müller graduated, Reynolds had projection slides made of some of Müller's chromosome plates for use during lectures, and donated these to Müller.

In August 1940, Müller was contacted by Dr E.P. Phillips, then Chief of the Division of Botany and Plant Pathology in Pretoria, who offered him an appointment in the Department of Agriculture in Pretoria. He resigned his post as teacher in Zeerust and accepted the job offer. While working in the Department, he continued with his doctoral research and it was in the laboratories at the Prinshof Agricultural Research Station, not far from Pretoria's central business district, that he refined the cytogenetic methodologies required to study the chromosomes of *Aloe* species. This work was mostly conducted after hours as his day job was to carry out genetic research on agricultural crops. Here he met and collaborated with fellow geneticist, Dr Leslie [L.E.W.] Codd, who was later to become Director of the Botanical Research Institute (BRI), now also part of the South African National Biodiversity Institute. A search in the Pretoria, National Herbarium (PRE) Computerised Information System (PRECIS) for specimens collected by F.S. Müller, did not yield any results. However, in the 1940s, Dr Codd jointly collected several specimens



FIGURE 2.—On 1 March 1937 Franz S. Müller departed for Germany aboard the *S.S. Usaramo* to conduct his doctoral studies in Germany.

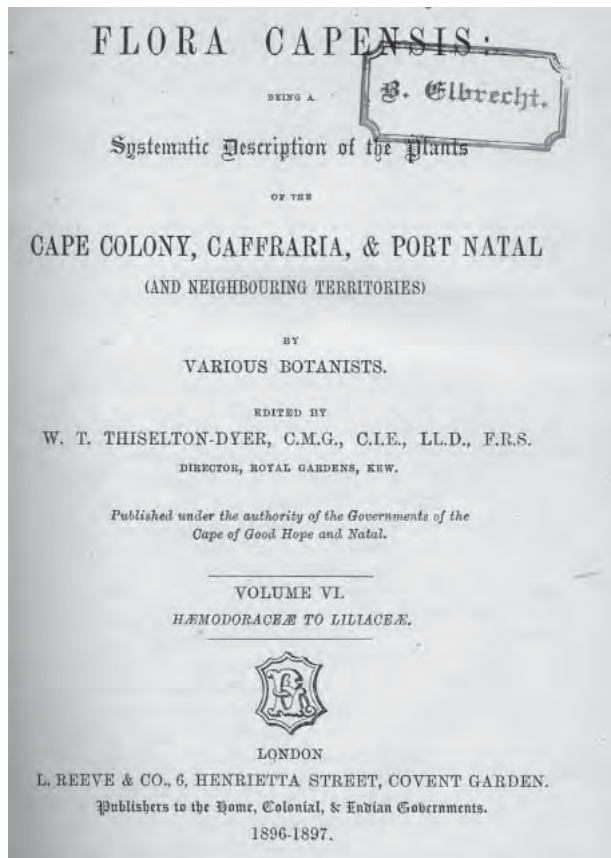


FIGURE 3.—*Flora capensis*, volume VI, Haemodoraceae to Liliaceae, was one of the few books available on *Aloe* (and other monocot groups for that matter) when Franz S. Müller started his work on the cytology of the genus. This copy belonged to and was signed by Müller's D.Sc. supervisor, Prof. B. Elbrecht, at the University of Pretoria, and it is likely that Müller consulted this work.

with an 'F. Muller' and an 'S. Muller' in northern South Africa, the Western Cape and Swaziland. Some of these specimens are of grasses, but none are of aloes. Both these Mullers could well have been F.S. Müller, given that he often accompanied Dr Codd on trips to agricultural research facilities in what was then the Eastern Transvaal [Mpumalanga] and Natal [KwaZulu-Natal] (Müller 2005). However, no specimens collected by Müller could be traced in the H.G.W.J. Schweickerdt Herbarium of the Department of Plant Science of the University of Pretoria.

Four years before Müller's D.Sc. dissertation was published by the University of Pretoria (Müller 1945), the first Afrikaans book on aloes appeared under the authorship of Barend Hermanus (Ben) Groenewald (Groenewald 1941). It was also the first book on the genus published in South Africa, indeed in Africa (Anonymous 2010). In the 1930s and 1940s Groenewald described several new taxa in *Aloe* and had a special interest in the spotted aloes (Verdoorn 1966; Glen *et al.* 1995). Groenewald completed his undergraduate studies at the University of Pretoria, obtaining a B.Sc. in Natural Sciences in 1932. His book on aloes was intended as fulfilling part of the degree requirements for a M.Sc. degree at the University of Pretoria, also under the tutelage of Prof. Elbrecht, a degree that he obtained in 1942, in the same year that Müller obtained his D.Sc. (Figure 1). Significantly, as far as we could ascertain, Müller

does not mention, nor anywhere references, the work of Groenewald in his dissertation (Müller 1945). Müller must have been aware of Groenewald's work, which contained a significant section on the cytology of some representatives of the genus *Aloe*, and it remains a mystery as to why it was not cited. Similarly, Groenewald (1941) does not refer to the cytological work of Müller, which he in turn must have been aware of when he did his research in the same University Department, and under the same supervisor. Nevertheless, it is possible that both were working some distance away from the University and, with little contact with their supervisor, they may well have been unaware of the other's work. In the present age of instant connectivity to virtually any place, or anyone, around the world, through the global electronic ether, such a situation is difficult to fathom.

At the time that Groenewald and Müller conducted their work on the chromosomes of the aloes in South Africa, Prof. Dr Flávio P. de Resende (1907–1967), also a well-known student of the genus in the 1940s, independently conducted his pioneering cytological research on these plants and their relatives, especially haworthias (see for example Resende 1943 and Riley & Majumdar 1979 for references). Resende was a Professor of botany at the University of Lisbon from 1943 to 1967 and Director of this University's Botanical Garden (Smith & Figueiredo 2011).

Resulting from his cytological work on *Aloe*, Müller drew attention to the variation encountered in the chromosome numbers of the morphologically similar-looking *Aloe ciliaris* Haw. and *A. ciliaris* var. *tidmarshii* Schönland. He found that *A. ciliaris* was a hexaploid ($2n = 42$), whereas var. *tidmarshii* was a normal diploid ($2n = 14$). This prompted him to raise *A. tidmarshii* to the rank of species, as *A. tidmarshii* (Schönland) F.S.Müll. Confirmation of the existence of an intermediate tetraploid ($2n = 28$) resulted in the reinstatement of *A. tidmarshii* as a variety, and the establishment of *A. ciliaris* var. *redacta* S.Carter (Brandham & Carter 1990). This classification is widely followed today. Interestingly, Resende (1938) recorded a pentaploid ($2n = 35$), informally referred to as 'forma gigas', in the *A. ciliaris* complex. Müller was, however, unable to obtain fertilization from deliberate crosses he attempted between *A. ciliaris* and *A. tidmarshii*. Well-known botanical artist, Ms Cythna Letty, did a painting of *A. tidmarshii*, and a reproduction appeared in Müller's dissertation.

After completing his botanical studies, Müller applied for a position at the Division of Botany and Plant Pathology of the Department of Agriculture and Forestry, now also part of the South African National Biodiversity Institute. Possibly as a result of lingering anti-German sentiments in South Africa, Müller was not appointed to the Division of Botany. Convinced that he had been rejected in favour of a candidate with less qualifications but whose appointment was politically correct, Müller became disillusioned with the lack of progress in his career as a research botanist. He then registered for medicine at the University of Cape Town and completed the degree MBChB in 1949, so realizing a long-held dream to enter the field of medical practice.

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REFERENCES

- ANONYMOUS. 2010. Overlooked by history? Barend Hermanus Groenewald (Ben) 21-6 [??]-1905 to 24-9-1976. *Aloe* 47: 57–59.
- BRANDHAM, P.E. & CARTER, S. 1990. A revision of the *Aloe tidmarshii* / *A. ciliaris* complex in South Africa. *Kew Bulletin* 45: 637–645.
- GLEN, H.F., SMITH, G.F. & HARDY, D.S. 1995. Asphodelaceae/Aloaceae. Typification of *Aloe* species described by B.H. Groenewald. *Bothalia* 25: 97–99.
- GOOSSENS, A.P. 1938. A study of the South African species of *Sporobolus* R.Br. with special reference to leaf anatomy. *Transactions of the Royal Society of South Africa* 26: 173–223.
- GOOSSENS, A.P. 1950. *Lys van terme in die plantkunde. Engels-Afrikaans*. Fakulteit Natuurwetenskap en Tegniek. Saamgestel in opdrag van die Suid-Afrikaanse Akademie vir Wetenskap en Kuns. Die Suid-Afrikaanse Akademie vir Wetenskap en Kuns, Pretoria.
- GOOSSENS, A. 1963. *Taksonomie van die angiosperms*. Pro Regepers, Potchefstroom.
- GROENEWALD, B.H. 1941. *Die aalwyne van Suid-Afrika, Suidwes-Afrika, Portugees Oos-Afrika, Swaziland, Basoetoeland, en 'n spesiale ondersoek van die klassifikasie, chromosome and areale van die Aloe Maculatae*. Nasionale Pers, Bloemfontein.
- GUNN, M. & CODD, L.E. 1981. *Botanical exploration of southern Africa*. Balkema, Cape Town.
- MU[Ü]LLER, F.S. [Sebastian]. 2005. *Outobiografie van Franz Sebastian Mu[ü]ller vanaf 1913 tot 2005*. Unpublished, typed manuscript, in Afrikaans, covering the first 92 years of the life of F.S. Müller, Pretoria.
- RESENDE, F. 1938. Gigas—Formen mit geringerer Chromosomenzahl als die Stammarten. *Berichte der Deutschen Botanischen Gesellschaft* 56: 533–542.
- RESENDE, F. 1943. Suculentas africanas III. Contribuição para o estudo da morfologia, da fisiologia da floração e da geno-sistemática das Aloineae. *Memórias da Sociedade Broteriana* vol. II: 5–119.
- RILEY, H.P. & MAJUMDAR, S.K. 1979. *The Aloineae. A biosystematic survey*. The University Press of Kentucky, Lexington.
- ROURKE, J.P. 1999. Plant systematics in South Africa: a brief historical overview, 1753–1953. *Transactions of the Royal Society of South Africa* 54: 179–190.
- SMITH, G.F. & FIGUEIREDO, E. 2011. Provenance of the material on which the name *Aloe mendesii* Reynolds (Asphodelaceae), a cliff-dwelling species from Angola, is based. *Bradleya* 29: in press.
- VERDOORN, I.C. 1966. Hedendaagse plantkundiges en plantversamelaars. 1. Frederick Ziervogel van der Merwe. *Bothalia* 8 (Bylaag No. 1): 59, 60.

SELECTED PUBLICATIONS OF FRANZ SEBASTIAN MÜLLER

- MULLER, F.S. [Sebastian] 1936. 'n Sistematiese studie van die Suid-Afrikaanse materiaal van die geslag *Sporobolus* R.Br. met spesiale verwysing na die anatomie van die blare. M.Sc. thesis, Potchefstroomse Universiteit vir Christelike Hoër Onderwys, Potchefstroom [now the Potchefstroom campus of the North-West University].
- MÜLLER, F.S. [Sebastian] 1945. 'n Chromosoomstudie van 'n aantal spesies van die genus *Aloe* Linn., met spesiale verwysing na die morfologie en betekenis van die somatiese chromosome. Publikasies van die Universiteit van Pretoria. Reeks II: Natuurwetenskappe No. 8. Universiteit van Pretoria, Pretoria. [Submitted in partial fulfillment of the requirements for the D.Sc. degree in the Faculty of Mathematical and Natural Sciences of the University of Pretoria.]
- 1998. *Child abuse. An educational and medical approach to important issues and associated problems*. A comprehensive scholarly, absorbed treatise and sound common sense guide. Published by the author, Pretoria.

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