

Bothalia

A JOURNAL OF BOTANICAL RESEARCH

Vol. 37,1

May 2007

TECHNICAL PUBLICATIONS OF THE SOUTH AFRICAN NATIONAL BIODIVERSITY INSTITUTE PRETORIA

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A JOURNAL OF BOTANICAL RESEARCH

Volume 37,1

Scientific Editor: G. Germishuizen
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SOUTH AFRICAN

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2 Cussonia Avenue, Brummeria, Pretoria
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ISSN 0006 8241

May 2007

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Notes on new and misunderstood taxa of *Cyrtanthus* (Amaryllidaceae: Cyrtantheae) from the Western Cape, Eastern Cape and KwaZulu-Natal, South Africa

D.A. SNIJMAN*

Keywords: Amaryllidaceae, Cyrtantheae, *Cyrtanthus*, new species, subspecies, South Africa, taxonomy

ABSTRACT

Cyrtanthus aureolinus Snijman is a new, rare species of fire lily, which is localized in a vlei on the northern slopes of the Groot Swartberg, Western Cape. The upright or slightly spreading, yellow to cream-coloured flowers and the perigone tube which gradually widens to the throat suggest that it is closely related to the Western Cape endemic, *C. ochroleucus* (Herb.) Burch. ex Steud., and *C. mackenii* Hook.f., a variable species from southern KwaZulu-Natal and Eastern Cape. The species differs mainly by the shape, size and position of the tepals and the length of the filaments. *Cyrtanthus mackenii* var. *cooperi* (Baker) R.A.Dyer is raised to subspecies rank as *C. mackenii* subsp. *cooperi* (Baker) Snijman. Its hysteranthous leaf habit and grassland habitat differ from the riverine habitat of the evergreen *C. mackenii* subsp. *mackenii*. Described in detail are *C. aureolinus*, *C. ochroleucus*, and *C. mackenii*.

INTRODUCTION

Found in southern and East Africa, *Cyrtanthus* Aiton, comprising about 55 species, is one of the largest genera in the family Amaryllidaceae. Throughout its distribution, *Cyrtanthus* has species adapted to cope with fire and because of this specialization they are commonly known as fire lilies.

In the Cape Floristic Region, some of the first plants to flower in response to summer fires and sufficient moisture are species of *Cyrtanthus* which characteristically produce their inflorescences in advance of the leaves. In the heat of summer, however, their flowering is often fleeting, hence many populations of *Cyrtanthus* in the Cape Fold Mountains are infrequently seen or probably yet to be recorded. This became evident after a wild fire burnt a large tract of arid fynbos on the dry northern slopes of the Groot Swartberg, east of Oudtshoorn, Western Cape, in December 2004. Two to three weeks later, a large population of *Cyrtanthus* appeared in a blackened seepage zone on the lower slopes and the stand of yellow flowers promptly attracted attention from local nature conservationists and botanists. Field and morphological studies of the newly discovered population in relation to other species of *Cyrtanthus* with tubular, yellow flowers have confirmed that the plants are distinct from all the currently known species of the genus and they are described here as a new species, *C. aureolinus*.

Due to the discovery of *C. aureolinus*, its putative close allies, *C. ochroleucus* (Herb.) Burch. ex Steud. and *C. mackenii* Hook.f., were examined in detail. The morphological variability within and among populations of the two varieties of *C. mackenii* was re-assessed in relation to phenology and habitat. Consequently, the rank of *C. mackenii* var. *cooperi* (Baker) R.A.Dyer is raised to that of subspecies as *C. mackenii* subsp. *cooperi* (Baker)

Snijman. To accommodate the taxonomic changes and new data, *C. mackenii* and *C. ochroleucus* are described and mapped in full.

***Cyrtanthus aureolinus* Snijman, sp. nov.**, floribus tubularibus et aureis ad *C. ochroleucum* (Herb.) Burch. ex Steud. et *C. mackenum* Hook.f. accedens, differt filamentis exterioris 5 mm longis et filamentis interioris 7 mm longis, staminibus perigonio exserto, et florifero tante post ignem.

TYPE.—Western Cape, 3322 (Oudtshoorn): Swartberg Mountains, N side of mountain on property directly W of Meiringspoort and abutting Swartberg Nature Reserve, (–BC), 14-1-2005, J.H.J. Vlok & A.L. Schutte 505 (NBG, holo.; PRE).

Semi-evergreen, bulbous geophyte, 220–300 mm tall when flowering. *Bulb* solitary, hypogeal, ovoid, up to 30–45 × 25–30 mm, narrowed to a slender neck 40–60 × 8–15 mm; outer tunics brown and papery; inner tunics cream-coloured and fleshy. *Leaves* developing sequentially, either absent or 2 or 3 newly emerging at flowering, finally up to 4, strap-shaped, up to 300 × 5–9 mm, suberect to recurved, ± channelled, glabrous; abaxial surface with 3 or 4 prominent median veins, not keeled; margin smooth. *Inflorescence* 4–10-flowered, solitary or occasionally 2 per bulb; scape erect, up to 250 mm long, 5–8 mm diam. at base, tapering distally up to 4–6 mm at apex, round to slightly compressed in t/s, green with a reddish blush towards base, hollow; spathe valves 2, outer sheathing inner at base, lanceolate, exceeding the pedicels, up to 45–65 × 7–9 mm (at base), membranous, suberect and flushed ox-blood red when fresh, later turning brown and reflexing; bracteoles several, linear, up to 15 mm long; pedicels suberect to slightly spreading, up to 40 × 1.5 mm at anthesis, lengthening up to 50 mm and becoming more rigid when fruiting, green to pale brown. *Flowers* erect to spreading slightly above the horizontal, opening sequentially, sulphur-yellow, sometimes with 6 diffuse green median bands from perigone base to tepal tips, firm, unscented, apparently without nectar; perigone tube dilated gradually to throat, straight or slightly

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MS. received: 2006-08-17.

curved distally, 29–40 mm long, ± 3 mm diam. at base, widening gradually to 6–8 mm diam. at throat; tepals narrowly ovate, slightly spreading, neither reflexed nor rolled back, 12–15 $\times$ 5–7 mm, subacute at apex; outer tepals sometimes slightly narrower than inner, shortly mucronate. *Stamens* biseriate, regular, attached slightly below and in perigone throat, both whorls shortly exserted; outer filaments ± 5 mm long, attached ± 1 mm lower than inner; inner filaments ± 7 mm long; anthers dorsifixed, ± 4.5 mm long before dehiscing, yellow; pollen yellow. *Ovary* ellipsoidal, somewhat 3-angled, $\pm 5 \times 2$ mm, green; ovules axile, ± 25 per locule; style usually pressed against upper tepals, as long as or slightly longer than perigone, reaching up to 40 mm; stigmatic branches 3, spreading, slender, $\pm 2.0 \times 0.5$ mm, truncate, shortly papillate towards apex. *Capsule* ovoidal, $\pm 15 \times 8$ mm. *Seeds* unknown. Plate 1.

Phenology and pollination: the first flowers appear two to three weeks after summer fires. Individual flowers fade after a few days, but a many-flowered inflorescence may remain attractive for approximately one week. The response of individual plants is also staggered, so the entire flowering period lasts approximately three weeks. Although most individuals produce at least one leaf while flowering, the full complement of leaves is present only later in the season. Thereafter the plants remain evergreen until burnt by another fire.

Cyrtanthus aureolinus shows the typical fire lily response of not flowering in the seasons between fires. Observations in the early morning indicate that the flowers are visited by honeybees which alight on the tepals but do not enter the perigone tube. In the absence of nectar, pollen appears to be their only floral reward.

Diagnostic features: in its floral characters, particularly the form, position and colour of the flowers, *Cyrtanthus aureolinus* resembles *C. ochroleucus* from the Langeberg, Western Cape, and to a lesser degree the Eastern Cape and KwaZulu-Natal species, *C. mackenii*. All three species have somewhat tubular flowers with $\pm$ equally long perigone tubes that widen gradually from the base to the throat and have small tepal lobes. Although the flowers of *C. mackenii* and *C. ochroleucus* vary in colour from yellow to cream-coloured or rarely white, they resemble the clear yellow flowers of *C. aureolinus* in being upright to somewhat spreading, and are seldom horizontally spreading.

Despite their many similarities, these species can be distinguished florally mainly by the shape, size and position of the tepals, and by the length of the filaments (Table 1). The narrowly ovate to oblong tepals in *Cyrtanthus aureolinus* and *C. ochroleucus* are more than twice as long as broad and slightly spreading, unlike those of *C. mackenii* which are ovate, less than twice as

TABLE 1.—Morphological characters that distinguish *Cyrtanthus mackenii*, *C. aureolinus*, and *C. ochroleucus*

	<i>C. mackenii</i> subsp. <i>mackenii</i>	<i>C. mackenii</i> subsp. <i>cooperi</i>	<i>C. aureolinus</i>	<i>C. ochroleucus</i>
Bulb habit	forming offsets	solitary	solitary	solitary
Leaf width	7–18 mm	7–11 mm	5–9 mm	± 3 mm
Leafing phenology	synanthous	mostly hysteranthous	emerging at flowering after fire, otherwise evergreen	mostly hysteranthous
Pedicle length at anthesis	up to 27 mm	up to 30 mm	up to 40 mm	up to 12 mm
Flower(s)				
position:	suberect to nodding	suberect to spreading horizontally	suberect to spreading above horizontal plane	suberect to slightly spreading
per inflorescence	3–6(–8)	3–8(9)	4–10	2–6
periodicity per inflorescence	simultaneous	simultaneous	sequential	simultaneous
colour	clear yellow, cream-coloured or white	dull yellow or cream-coloured, tinged pink	bright yellow, plain or tinged green	dull yellow or cream-coloured, tinged pink or green
scent	sweet	spicy and bittersweet	unscented	dull and bittersweet
Perigone				
tube length	36–45 mm	25–47 mm	29–40 mm	33–50 mm
throat diam.	6–8 mm	4.0–5.5 mm	6–8 mm	5–6 mm
Tepal				
shape	ovate	ovate	narrowly ovate	narrowly ovate to oblong
length $\times$ width	5–10 $\times$ 3.5–5.0 mm	3.5–6.0 $\times$ 2.5–4.0 mm	12–15 $\times$ 5–7 mm	7–11 $\times$ 3–4 mm
position	patent to rolled back	slightly recurved to rolled back	slightly spreading	slightly spreading
Filament				
length: outer and inner	± 1 & ± 1 mm	± 1 & ± 1 mm	± 5 & ± 7 mm	± 2 & ± 4 mm
insertion on perigone: outer and inner	3–4 mm below throat and in or up to 2 mm below throat	5 mm below throat and 2 mm below throat	± 1 mm below throat and in throat	± 3 mm below throat and in throat
Flowering phenology	Jun.–Sep.(–Nov.), without fire	(late Jul.)Aug.–Sep.(–Nov.), not strictly fire dependent	Jan., strictly after fire	Oct.–Dec., not strictly fire dependent
Habitat	stream banks in coastal forest	grassland	permanent seepage in fynbos	dry flats or N slopes in fynbos
Distribution	S KwaZulu-Natal, E Cape	S KwaZulu-Natal, E Cape	W Cape, N slopes Groot Swartberg	W Cape, Langeberg, Albertinia plain

long as broad and patent or rolled back at anthesis. The filaments, however, are most diagnostic. In *C. aureolinus* both the outer and inner whorls of filaments (5 and 7 mm long respectively) extend beyond the perigone throat. Those of *C. ochroleucus* are slightly shorter (± 2 and ± 4 mm respectively) and only the inner filaments extend beyond the throat. In contrast, both the outer and inner filaments in *C. mackenii* are very short (± 1 and ± 1 mm respectively) and the stamens remain included in the perigone throat or within the upper part of the tube.

If the features of the tepals and stamens that characterize the species are also significant for determining affinities, then *Cyrtanthus aureolinus* is closest to *C. ochroleucus*. The perigone throat of *C. aureolinus*, however, is wider than that of *C. ochroleucus* and its leaves are broad and smooth, unlike the narrow leaves of *C. ochroleucus* which are minutely papillate on the margin and midvein. Both species are found in the fynbos of the Western Cape where they occupy different habitats and display dissimilar flowering habits.

Distribution and habitat: *Cyrtanthus aureolinus* is confined to damp habitats on the northern foothills of the Groot Swartberg, west of Meiringspoort (Figure 1). The only known population, covering an area of $\pm 15 \times 40$ m in size, is found in a permanent seepage zone in arid fynbos, where sandstone-derived soils meet a band of loam-rich soils at ± 800 m. In winter the area is waterlogged but it remains sufficiently wet in summer to support a population of the clicking stream frog, *Strongylopus grayii* (Smith). In periods between fires (of ± 18 –40 years) the seepage zone is dominated by large clumps of restioids which form dense, fibrous tussocks at their base. Most individuals of *C. aureolinus* grow between these clumps, but in the wetter parts of the vlei, they are found on the raised tussocks. They are absent from the wettest parts of the site.

Other specimen examined

WESTERN CAPE.—3322 (Oudtshoorn): Farm Wilgermond, northern slopes of Groot Swartberg, W of Meiringspoort, ± 800 m, (–BC), 19-1-2005, Snijman 1980 (K, NBG, PRE).

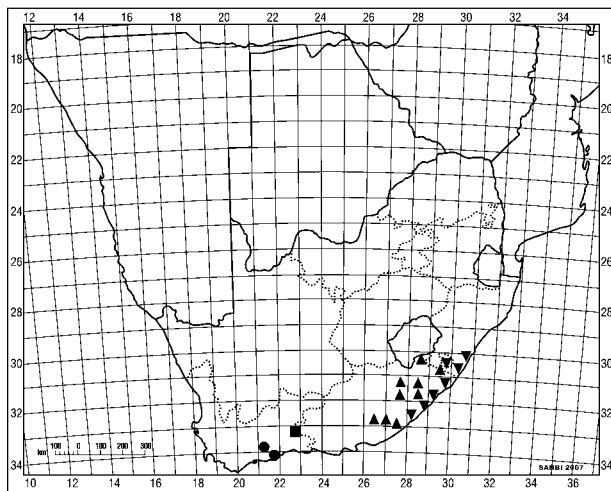


FIGURE 1.—Distribution of *Cyrtanthus ochroleucus*, ●; and *C. aureolinus*, ■, in Western Cape Province; and *C. mackenii* subsp. *mackenii*, ▼; and *C. mackenii* subsp. *cooperi*, ▲, in KwaZulu-Natal and Eastern Cape Province.

Re-assessment of *Cyrtanthus mackenii* and *C. ochroleucus*

The discovery of *Cyrtanthus aureolinus*, which is putatively most closely related to *C. ochroleucus*, makes it necessary to focus attention on the questionable identity of a group of hysteroanthous-leaved plants from the grasslands of the Eastern Cape, northeast of King William's Town—a problem raised by Reid & Dyer (1984) and to some extent by Turrill (1960). Reid & Dyer (1984) pointed out that these populations are found in the same area as *C. mackenii* var. *cooperi*, but remarked that the plants might possibly represent outliers of *C. ochroleucus*, a species originally collected by William Burchell whose travels in the Cape never extended northeast of the Great Fish River (McKay 1943). The inconsistent naming of these particular plants is reflected in Batten & Bokelmann (1966: 31, t. 25, fig. 4) who referred to the plants from near King William's Town as *Cyrtanthus* sp., and those from near East London as *C. ochroleucus* (t. 24, fig. 1). In contrast, Manning (2001: 74, fig. 1 & 81, fig. 4) referred to both as *C. mackenii*.

In an attempt to resolve the relationships of the Eastern Cape plants to *Cyrtanthus mackenii* and *C. ochroleucus*, all the South African herbarium material (BOL, GRA, NBG, NH, PRE, SAM) belonging to this complex was studied together with the types of *C. ochroleucus*, *C. mackenii* var. *mackenii* and *C. mackenii* var. *cooperi*.

The types of *Cyrtanthus mackenii* var. *cooperi*—Cooper 1806 (K, NH, PRE) collected in British Kaffraria, the eastern part of today's Eastern Cape Province—all lack leaves which strongly suggests that the leaves are hysteroanthous. Furthermore, the pressed inflorescences (on the sheets at K and PRE) closely resemble those of the hysteroanthous-leaved plants from the Eastern Cape referred to by Reid & Dyer (1984) with regard to flower number, perigone tube length, size of the perigone throat (4 mm wide), and shape and size of the tepals (ovate and 4×3.5 mm). This close similarity is in contrast to the more distant likeness found between *C. ochroleucus* and the hysteroanthous-leaved Eastern Cape plants which are in question. Despite their shared hysteroanthous-leaved state, they differ in leaf width (± 3 vs 7–11 mm); tepal shape (narrowly ovate to oblong vs ovate); tepal size (7–11 $\times$ 3–4 vs 3.5–6.0 $\times$ 2.5–4.0 mm); and flowering time (Oct.–Dec. vs Aug.–Oct.). Moreover, no intermediates between the two elements are known and their distribution ranges are disjunct, separated by a gap of ± 750 km.

Based on the above comparison, the resemblance of the hysteroanthous-leaved plants from the Eastern Cape to the type of *Cyrtanthus mackenii* var. *cooperi* is considered to be sufficiently close to warrant their inclusion in *C. mackenii* var. *cooperi*. This is in agreement with Baker's (1896) circumscription of the taxon which he originally named *C. lutescens* var. *cooperi* Baker.

Following the inclusion here of the Eastern Cape's populations of hysteroanthous-leaved plants into *Cyrtanthus mackenii* var. *cooperi*, is the need to re-assess the classification of *C. mackenii* into two varieties which

Dyer (1939) and Reid & Dyer (1984) distinguished primarily by the possession of yellow to cream-coloured rather than white flowers. To do so, this comparison has incorporated field data on flowering and leafing phenologies and habitat which are often missing from herbarium records.

The descriptions of *Cyrtanthus mackenii* (Dyer 1939; Turrill 1960; Reid & Dyer 1984) mention that the species reproduces vegetatively from bulblets. Field data, however, indicate that this habit is confined to the typical variety and leads to the formation of large clumps of bulbs with several shiny, evergreen leaves. Furthermore, the flowers of *C. mackenii* var. *mackenii* are sweetly scented, the perigone has a fairly broad throat (6–8 mm wide), and the tepals (5–10 × 3.5–5.0 mm) are ovate and vary from patent to rolled back at anthesis. Distributed from near Port Shepstone in southern KwaZulu-Natal southwards along the Eastern Cape coast, the plants grow most often on the shaded banks of permanent streams, in patches of remnant forest which seldom or never burn. They flower mainly in winter, from June to September, or rarely as late as November.

In contrast, *Cyrtanthus mackenii* var. *cooperi* is deciduous and has solitary bulbs that produce two to five glaucous leaves each season. The flowers have a strong spicy scent with a 4.0–5.5 mm wide perigone throat, and short, ovate tepals (3.5–6.0 × 2.5–4.0 mm) that are slightly recurved to rolled back at anthesis. Populations belonging to this taxon are plentiful in seasonally damp places in open, rolling grassland but occasional plants can be found in drier situations. They have been recorded from the Midlands of southern KwaZulu-Natal, near Kokstad, through to King William's Town, Eastern Cape, and close to East London where they approach the coast. Although the plants do not depend on fire to flower, they are known to flower most prolifically in the spring (August to October) following winter fires. With few exceptions, the bulbs produce new leaves slightly later in the season.

Despite the subtle nature of the floral features that separate these taxa, they may play a role in attracting a slightly different range of pollinators. This, together with the slightly asynchronous flowering times and their discrete habitats, may impose some level of reproductive isolation upon the taxa. It is apparent, nevertheless, that these morphological, phenological and habitat differences reflect a level of discontinuity that warrants more than varietal delimitation, especially as the populations of the two taxa occupy different, albeit partially sympatric, geographical ranges, namely the coast versus the Midlands of southern KwaZulu-Natal and the Eastern Cape. The only places where populations of the two taxa co-occur are where patches of forest extend inland into the temperate grasslands along major river courses. This interpretation, consequently, excludes the coastal, evergreen plants with yellow flowers that Dyer (1939) and Reid & Dyer (1984) previously considered to belong to *C. mackenii* var. *cooperi*.

Based on the above conclusions, *C. mackenii* var. *cooperi* is elevated to subspecies rank, *C. mackenii* subsp. *cooperi*. The full descriptions of *C. mackenii* and *C. ochroleucus* are given below.

***Cyrtanthus mackenii* Hook.f.** in The Gardener's Chronicle and Agricultural Gazette: 641 (1869); Baker: 57 (1888); Baker: 225 (1896). Type: Natal [KwaZulu-Natal], P.C. Sutherland s.n. in Herb. Hookerianum, July 1864 (K000366180, lecto.; designated here, image only seen).

Bulbous geophyte, 180–530 mm tall when flowering. *Bulb* hypogeal, up to 20–50 × 15–35 mm, narrowed to a neck 10–80 × 7.5–15.0 mm; outer tunics brown and papery; inner tunics cream-coloured and fleshy. *Leaves* narrowly lanceolate, up to 400 × 7–18 mm, suberect to recurved, slightly channelled, glabrous; abaxial surface with 3 prominent median veins. *Inflorescence* 3–8(9)-flowered; scape erect to curved, up to 450 × 5–8 mm diam. at base, tapering distally up to 3–5 mm at apex, round to slightly compressed in t/s, hollow; spathe valves 2, outer sheathing inner at base, lanceolate, shortly exceeding pedicels, up to 25–60 × 4–8 mm (at base), membranous, suberect and flushed pinkish when fresh, later reflexing and turning brown; bracteoles several, linear, up to 20 mm long; pedicels suberect to slightly spreading, up to 27 × ± 1.5 mm at anthesis, lengthening up to 30 mm and becoming more rigid when fruiting. *Flowers* opening ± simultaneously, white to yellow often suffused with apricot-pink; nectar unknown; perigone tube dilated gradually to throat, slightly to distinctly curved; tepals ovate, outer shortly mucronate. *Stamens* biseriate, regular; filaments ± 1 mm long; anthers dorsifixed, 2.0–2.5 mm long before dehiscing, yellow; pollen yellow. *Ovary* ellipsoidal, somewhat 3-angled, 4–5 × 3 mm; ovules axile, ± 25 per locule; style usually pressed against upper tepals, as long as or rarely slightly longer than perigone tube, reaching up to ± 45 mm; stigmatic branches 3, spreading, slender, ± 1 mm long, truncate, shortly papillate towards apex. *Capsule* ovoidal, 10–20 × 7–10 mm. *Seeds* 5 × 3 mm, winged, dark shiny brown.

subsp. *mackenii*

Dyer: 79 (1939); Reid & Dyer: 16 (1984).

C. mackenii var. *cooperi* (Baker) R.A.Dyer, pro parte, excluding the type of this taxon: 79 (1939); Reid & R.A.Dyer, pro parte, excluding the type of this taxon: 17 (1984).

Illustrations: Phillips: t. 33 (1921); Turrill: t. 368 (1960); Batten & Bokelmann: t. 24, fig. 6 [as *C. mackenii* var. *cooperi* (Baker) R.A. Dyer] (1966); Manning: 75, fig. 1 top right (2001).

Evergreen, often semi-aquatic bulbous geophyte. *Bulbs* clumped, forming numerous offsets. *Leaves* present at flowering, 4 or 5, shiny green; margin smooth. *Inflorescence* solitary per bulb; scape green often with a reddish blush towards base; pedicels green. *Flowers* 3–6(–8), suberect to slightly nodding, clear yellow, cream-coloured or white, sweetly scented; perigone tube 36–45 mm long, ± 2 mm diam. at base, widening gradually to 6–8 mm diam. at throat; tepals ovate, patent to rolled back, 5–10 × 3.5–5.0 mm, obtuse at apex; outer tepals as wide as inner. *Stamens* included in perigone throat and upper part of perigone tube; outer filaments attached 3–4 mm below throat; inner filaments attached in perigone throat, rarely up to 2 mm below throat. *Ovary* green.

Phenology: flowering starts in June and usually lasts until September, but can extend into early November. The leaves are evergreen.

Diagnostic features: the plants, commonly known as Ifafa lilies, are clump-forming and produce several leaves which persist throughout the year. The usually sweet-smelling flowers have ovate tepals that are patent to rolled back at anthesis and the stamens are characteristically included in the fairly broad perigone throat (Table 1). Populations of white-flowered plants are fairly localized and have been recorded from the Port Shepstone District in KwaZulu-Natal near the mouths of the Umzimkulu and Umtamvuna Rivers, and in the Eastern Cape near the Great Kei River mouth. Elsewhere in the distribution range, populations occasionally have cream-coloured flowers, but most often the flowers are yellow.

Distribution and habitat: *Cyrtanthus mackenii* subsp. *mackenii* is distributed along the Indian Ocean coastal belt from Port Shepstone southwards to Port Edward, KwaZulu-Natal, and from Port St Johns to just south of the Great Kei River, Eastern Cape. Scattered populations have also been recorded a short distance inland along the banks of large rivers (Figure 2). The plants favour partially shaded habitats, amongst rocks on the edge of watercourses in remnant patches of Scarp Forest and Southern Mistbelt Forest (*sensu* Mucina *et al.* 2005).

Specimens examined

KWAZULU-NATAL.—2930 (Pietermaritzburg): Malvern, (–DD), 22-7-1951, *Kent s.n.* (NH40424). 3029 (Kokstad): Umzimkulu, (–BD), Aug. 1967, *Gardner s.n.* (NH57299). 3030 (Port Shepstone): Isipingo, (–BB), Jun. 1882, *Wood 1336* (K, NH); Ifafa, (–BC), Feb. 1885, *Knox 2103* (PRE), Aug. 1916, *Lansdell s.n.* (NH16127); Natal coast, Ifafa Dist., (–BC), May 1883, *Tyson 2103* (BOL, K, SAM); The Valleys, (–CB), 8-7-1952, *Martin 936* (NBG), 3-10-1937, *Mogg 13945* (PRE); Oribi Gorge, (–CB), 16-8-1980, *Schrire 1850* (NH); Umzimkulwana River, (–CB), July 1916, *Thode 2515* (NH); Umtamvuna Nature Reserve, (–CC), 31-7-1982, *Abbott 170* (PRE), 11-7-1977, *Nicholson 1784* (PRE), 15-6-1969, *Strey 8745* (PRE), 15-7-1975, *Van Wyk 1669* (PRE), 14-7-1976, *Venter 1004* (PRE), 18-7-1995, *Victor 1381* (PRE). Inexact locality: Natal, *Gerrard s.n.* (K000366179).

EASTERN CAPE.—3129 (Port St Johns): Mbotyi, on river banks, 50 ft [15 m], (–BC), 9-9-1961, *Batten s.n.* (NBG60489); Mbotyi, on river banks, 100 ft [30 m], (–BC), 10-9-1962, *Batten s.n.* (NBG66279); Mbotyi, on river banks, 200 ft [60 m], (–BC), 12-8-1963, *Batten s.n.* (NBG69947); Magwa Estates, (–BC), 7-9-1979, *Germishuizen 1193* (PRE); Ntsubane Forest Station, Fraser's Falls, (–BC), 24-8-1976, *Venter & Vorster 101* (PRE); 2 km from forestry station on road to [van bosbou stasie op pad na] Mbotyi, (–BC), 12-7-1976, *Venter 886* (PRE); Coffee Bay, (–CC), Oct. 1919, *Tyson s.n.* (PRE TM20573); ± 2.5 km from Umzimvubu bridge at Port St Johns, (–DA), 20-8-1998, *Abbott 7296* (NBG). 3228 (Butterworth): Tsolorha, Bashee River, (–BA), *Van Jaarsveld 16903* (NBG); Cwebe Forest, (–BB), 14-9-1998, *Winter s.n.* (NBG179726); between Qora and Mazeppa Bay, (–BC), *Winter 513* (NBG); Dwesa Nature Reserve, (–BD), *Winter 496* (NBG); Kei River mouth, margins of streams, (–CB), Aug. 1889, *Flanagan 300* (BOL, PRE, SAM); banks of Kei River, 200 ft [60 m], (–CB), July 1894, *Flanagan 2335* (BOL, NBG); Kentani Dist., (–CB), July 1911, *Pegler 28* (PRE); Nyutura, (–CB), 12-7-1966, *Strey 6641* (NH, PRE), 12-7-1966, *Ward 5724* (PRE); half mile [0.8 km] E of Nenga Post Office (–CC), 17-7-1955, *Codd 9275* (PRE); Farm Hill and Dale, near Haga Haga, in stream bed and banks, 60 m, (–CC), 8-8-2001, *McMaster s.n.* (NBG177935); near Haga Haga, (–CC), *McMaster s.n.* (NBG182889).

subsp. *cooperi* (Baker) Snijman, stat. et comb. nov.

C. mackenii var. *cooperi* (Baker) R.A.Dyer, syn. nov.: 79 (1939). *C. lutescens* var. *cooperi* Baker, Handbook of the Amaryllideae: 58 (1888); Baker: 225 (1896). Type: British Kaffraria [Eastern Cape], 1860, *T.Cooper 1806* (K000400308, lecto.; [designated by Reid & Dyer: 17 (1984)], image only seen; NH!, PRE!).

C. lutescens sensu Hook.f.: 89: t. 5374 (1863), non Herb.: 129. t. 33, fig. 14 (1837) [= *C. ochroleucus* (Herb.) Burch. ex Steud.]

Illustrations: Batten & Bokelmann: t. 24, fig. 1, [as *C. ochroleucus* (Herb.) Burch. ex Steud.]; t. 25, fig. 4 [as *C. sp.*] (1966); Manning: 75, fig. 1 top left & 81, fig. 4 (2001).

Deciduous, bulbous geophyte, 180–530 mm tall when flowering. *Bulb* solitary. *Leaves* developing sequentially, absent at flowering, rarely 1 or 2 emerging at end of flowering period, finally up to 5, green or glaucous; margin smooth or minutely rough. *Inflorescence* solitary or occasionally 2 per bulb; scape glaucous with a pinkish blush. *Flowers* 3–8(9), suberect to spreading horizontally, cream-coloured to dull yellow, often suffused with apricot-pink on tube; scent spicy, usually bittersweet; perigone tube 25–47 × ± 2 mm diam. at base, widening gradually up to 4.0–5.5 mm diam. at throat; tepals ovate, slightly recurved to rolled back, 3.5–6.0 × 2.5–4.0 mm; outer tepals slightly narrower than inner, with somewhat subacute and shortly mucronate tips; inner tepals with round tips. *Stamens* included in upper part of perigone tube and throat, outer attached ± 5 mm below throat, inner attached ± 2 mm below throat. *Ovary* green or pinkish grey.

Phenology: the flowering period which often follows winter fires starts at the end of July at low altitudes (30 m) and peaks in September, but a few individuals continue flowering until November at high altitudes (1800 m). The plants flower in the seasons between fires so are not true fire lilies. The leaves are absent during the main flowering period in September and begin to emerge from scattered individuals in October. Leafing continues throughout summer until the onset of the dry season when the bulbs become dormant over winter.

Diagnostic features: the plants are solitary and deciduous, and the leaves mostly reach maturity after flowering. The perigone tube has a relatively narrow throat with small, ovate tepals (Table 1). The flowers are most often dull yellow but in populations from around Maclear, Umtata, Stutterheim, and King William's Town, the perigone tube is pinkish cream to apricot. Often the flowers have a spicy scent.

Distribution and habitat: populations of *Cyrtanthus mackenii* subsp. *cooperi* are usually concentrated in seasonally damp places in open grassland where they are most prolific, but occasional individuals are also found in dry grassland. The distribution extends through the Sub-Escarpment Grassland Bioregion in East Griqualand and the Transkei (*sensu* Mucina *et al.* 2005), below the Amathole Mountains around King William's Town and Stutterheim and to grassy flats in the vicinity of East London. In the northern parts of the range, populations are found at altitudes of up to 1400 m but in the south they reach the coast (Figure 2).

Specimens examined

KWAZULU-NATAL.—3028 (Matatiele): between Swartberg and Matatiele, (–BD), 29-9-1962, *Strey 4315* (PRE). 3029 (Kokstad): Farm Thornham, Kokstad, (–CB), 10-10-1972, *Coleman 633* (NH); Kokstad golf course, (–CB), Oct. 1966, *Germishuizen 100* (PRE); Kokstad, (–CB), Sep. 1940, *Sister Mildred 267* (NBG); circa Kokstad, (–CB), Oct. 1883, *Tyson 1550* (BOL); Harding, 3000 ft [914 m], (–DB), Sep. 1928, *Oliver 19* (NH).

EASTERN CAPE.—3127 (Lady Frere): Elliot, (–BD), 30-9-1935, Reynolds s.n. (PRE37783), 5-10-1935, Reynolds s.n. (BOL22397); 12 miles [19 km] N of Cala, (–BD), 16-10-1953, Theron s.n. (PRE37793); 3 km on road to McLeantown, (–DA), 30-9-1976, Stirton 6289 (PRE); 10 miles [16 km] S of Cala Pass on road to Engcobo, (–DB), Sep. 1940, Reynolds 3605 (PRE). 3128 (Umtata): near Ugie, (–AA), 6-10-2001, Adendorff s.n. (NBG); Maclear commonage, 1 470 m, (–AB), 30-8-1993, Bester 715 (NH); Maclear commonage, 1 380 m, (–AB), 13-10-1993, Bester 1201 (NH); 1 mile [1.6 km] W of Maclear railway station, (–AB), Reynolds 3033 (PRE); Farm Borva, $\pm$ 12 km SSE of Xuxa drift siding, 1 410 m, (–AC), 1-9-1993, Bester 754 (PRE), 755 (NH); Tsolo Agricultural College, 900 m, (–BD), 9-10-1990, Cloete 508 (NH); Bazeia, in low moist places, 2000 ft [609 m], (–CB), Bauer 242 (GRA); Umtata, 2500 ft [625 m], (–DB), 1-9-1962, Bokelmann s.n. (NBG62902); Umtata, (–DB), 13-9-1997, Singh & Baijnath 243 (NH, PRE). 3226 (Fort Beaufort): Katberg, 6000 ft [1 829 m], (–BC), Nov. 1926, Dyer 760 (GRA, PRE); Katberg, no date, H.Hutton s.n. (K000400306). 3227 (Stutterheim): Stutterheim Div., Dohne Research Station, (–CB), 21-8-1942, Acocks 9022 (PRE); Stutterheim Dist., towards Kologha, 880 m, (–CB), 28-9-1997, McMaster 30 (NBG); Stutterheim Dist., adjacent to Van Rensburgdorp, 860 m, (–CB), 28-9-1997, McMaster 31 (NBG); grassy valley above Komgha, 4000 ft [1 218 m], (–DB), Sep. 1889, Flanagan 294 (BOL, GRA, PRE); Berlin, King William's Town Dist., (–DC), 14-9-1954, Marais 445 (GRA); Gonubie, grassy flats, (–DD), 20-5-1961, Batten s.n. (NBG60457). 3327 (Peddie): Buffalo Pass, East London, (–BB), 7-1-1945, Barker 3520 (NBG); East London, 20–100 ft [61–30 m], (–BB), 10-9-1962, Batten s.n. (NBG62903); 1 mile [1.6 km] from Bonza Bay, (–DD), 20-7-1955, Comins 1255 (PRE). Inexact locality: British Kaffraria, Cooper 3225 (K000400310), C.Hutton s.n. (K000400310).

Cyrtanthus ochroleucus (Herb.) Burch. ex Steud., Nomenclator botanicus 1,4 (edn 2): 475 (1840). *Monella ochroleuca* Herb.: 29 (1821). Type: [Western Cape] Riversdale Div., on or near the Langebergen, W.J.Burchell 7144 (K, lecto.; here designated, image only seen).

C. lutescens Herb. var. *lutescens*: 129, t. 33, fig. 14 (1837), nom. superfl.

Deciduous, bulbous geophyte, 130–360 mm tall when flowering. *Bulb* hypogeal, ovoidal, 30–40 $\times$ 30–35 mm, narrowed to a short neck up to 10 $\times$ 7–10 mm; outer tunics brown and papery; inner tunics cream-coloured and fleshy. *Leaves* developing sequentially, either absent or 1 newly emerging at flowering, 2 or more, linear, at least 100 $\times$ up to 3 mm, suberect; abaxial surface with a prominent median vein, keeled; margin and midvein minutely papillate. *Inflorescence* 2–6-flowered, solitary per bulb; scape erect, up to 320 $\times$ 5 mm (at base), tapering distally up to $\pm$ 3 mm at apex, round to slightly compressed in t/s, dull green, hollow; spathe valves 2, outer sheathing inner at base, lanceolate, exceeding pedicels, up to 25 $\times$ $\pm$ 3.5 mm (at base), membranous, suberect and pinkish when fresh, later reflexing and turning brown; bracteoles several, linear, up to 15 mm long; pedicels suberect to slightly spreading, dull green, up to 12 $\times$ $\pm$ 1.5 mm at anthesis, lengthening up to 15 mm and becoming more rigid when fruiting. *Flowers* erect to slightly spreading, opening $\pm$ simultaneously, cream-coloured to dull yellow, suffused with pink or green on perigone tube sometimes extending to tepals, with a bitter-sweet scent; nectar unknown; perigone tube dilated gradually to throat, slightly curved, 33–50 mm long, $\pm$ 2 mm diam. at base, widening gradually up to 5–6 mm diam. at throat; tepals narrowly ovate to oblong, slightly spreading, neither reflexed nor rolled back, 7–11 $\times$ 3–4 mm, outer tepals $\pm$ as wide as inner tepals, shortly mucronate at apex; inner tepals obtuse. *Stamens* biseriate, regular; outer stamens included; inner stamens shortly exserted; outer filaments $\pm$ 2 mm long, attached

$\pm$ 3 mm below perigone throat; inner filaments $\pm$ 4 mm long, attached in perigone throat; anthers dorsifixed, 2 mm long before dehiscing, dark yellow; pollen yellow. *Ovary* ellipsoidal, $\pm$ 5 $\times$ 3 mm, dull green; ovules axile, $\pm$ 25 per locule; style usually pressed against upper tepal, slightly shorter than perigone, reaching up to 47 mm; stigmatic branches 3, short, spreading, slender, $\pm$ 1 mm long, truncate, shortly papillate towards apex. *Capsule* unknown.

Phenology: the plants flower from October to December, mostly in advance of the leaves, but in a few individuals one newly emerging leaf may be present. After flowering, the leafing habit remains poorly known.

Diagnostic features: *Cyrtanthus ochroleucus* is distinguished by its hysteranthous leaves which are narrow ($\pm$ 3 mm wide) and minutely papillate on the margin and midvein, by the suberect tubular flowers which are cream-coloured to dull yellow, and by the short ($\pm$ 2 mm) outer filaments and longer ($\pm$ 4 mm) inner filaments so that only the inner stamens are exserted from the perigone throat. The similarities and differences between *C. ochroleucus* and its close allies, *C. aureolinus* and *C. mackenii*, are summarized in Table 1.

Distribution and habitat: this species is only known from fynbos on the lower northern slopes of the Langeberg, and on the Albertinia coastal plain, Western Cape (Figure 2). Populations have been found in stony or sandy habitats and, although the bulbs flower after fire, they also flower in the intervals between fires. The plants grow singly and are scattered in open patches.

Nomenclatural note: Herbert (1821) based his original description of *Monella ochroleuca* Burch. (the basonym of *C. ochroleucus*) on the herbarium collections of Burchell, but he failed to cite any particular specimen. The original diagnosis of *M. ochroleuca* states that it is allied to *M. odora* (Ker Gawl.) Burch. (based on *C. odorus* Ker Gawl.) but that it is distinguished by having yellow-white flowers. *Cyrtanthus odorus* itself is a distinctive species which is characterized by hysteranthous leaves, suberect, tubular flowers with small tepals and, in contrast to *C. ochroleucus*, has dark red flowers.

Herbert (1837) later adopted the name *C. lutescens* for *M. ochroleuca*, which he explicitly referred to as a synonym, and he cited Burchell 7144 as the only preserved specimen. There can be little doubt that the diagnosis of *M. ochroleuca* clearly distinguishes it from other taxa and that the name is validly published. Thus *C. lutescens* is considered to be nomenclaturally superfluous and is illegitimate. The lectotype of *C. ochroleucus* that has been designated here is Burchell 7144 (K) which consists of leafless, flowering bulbs with narrowly tubular flowers that appear to be held upright.

Specimens examined

WESTERN CAPE.—3321 (Ladismith): Garcia's Pass, (–CC), Oct. 1904, H.Bolus s.n. (BOL111388, PRE); Langeberg above Corente River, (–CC), Nov. 1908, Muir 191 (PRE); Corente River Farm, Riversdale Dist., (–CC), Nov. 1908, Muir 5379 (PRE); Oudenbosch at foot of Langeberg, stony slope recently burned, (–CC), 16-12-1979, Oliver 7550 (NBG, PRE); Langeberg, NE of Garcia's Pass, W

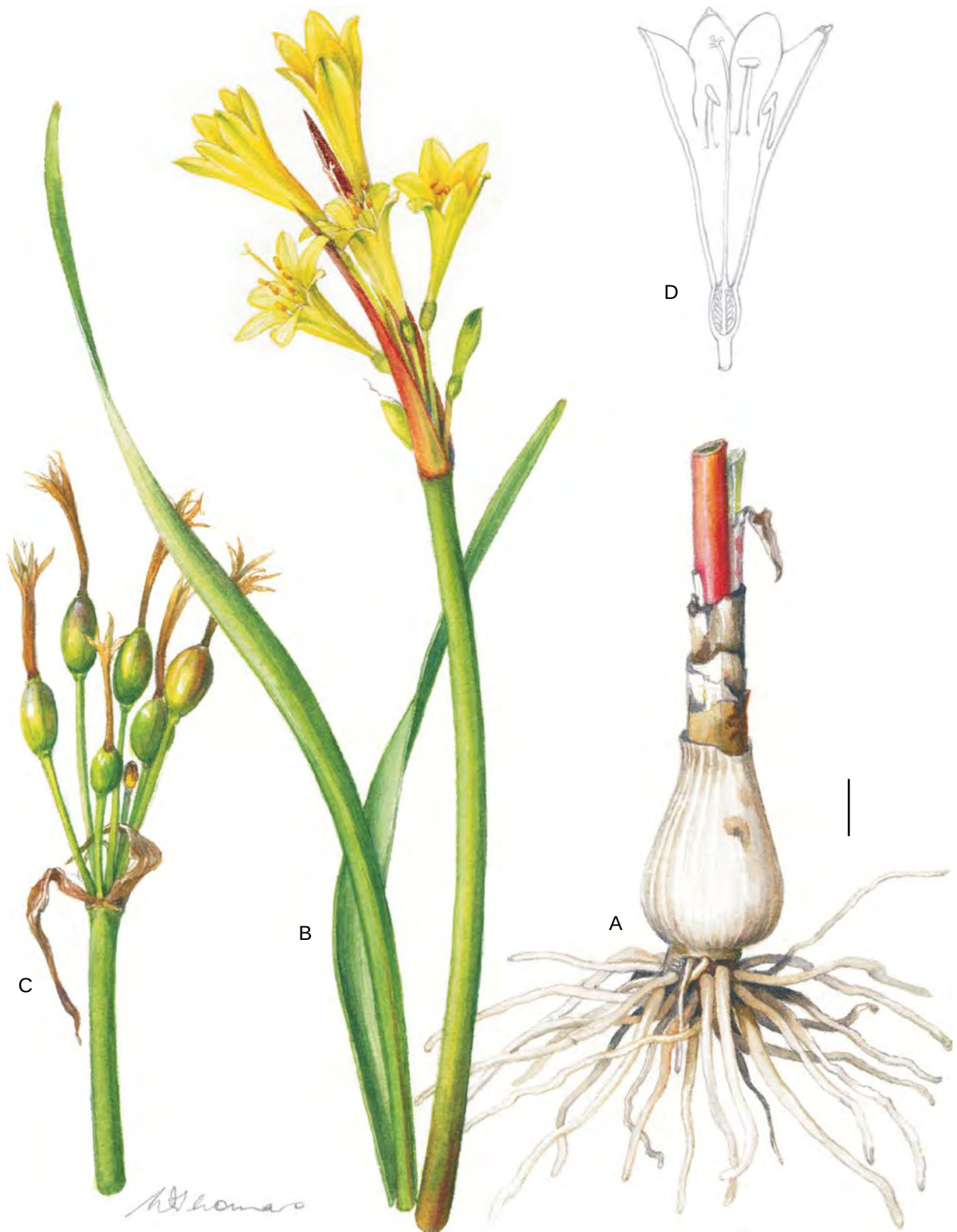


PLATE 1.—*Cyrtanthus aureolinus*, Snijman 1980. A, bulb; B, leaves and inflorescence; C, young infructescence; D, half flower laid open. Scale bar: A–C, 10 mm; D, 15 mm. Artist: Vicki Thomas.

of Welgemoed, in old fire break, 2150 ft [655 m], (–CD), 13-12-1984, *Oliver* 8639 (NBG, PRE); Langeberg at Bergfontein, 350 m, (–DC), 14-12-1979, *Oliver* 7529 (NBG). 3421 (Riversdale): Farm Vogelstruis, in coastal fynbos, (–BC), *Horstmann s.n.* (NBG167767).

ACKNOWLEDGEMENTS

I would like to thank William Pulles and Colin Paterson-Jones for assistance in the field; Leon and Tilla Nell and Jan and Anne Lise Vlok for their observations on *C. aureolinus*; Cameron and Rhoda McMaster and Jaco Adendorff for their field data on *C. mackenii*; and Vicki Thomas for the illustration of *C. aureolinus*. The Western Cape Nature Conservation Board granted a permit to collect specimens, and K, PRE and NH kindly made their collections available for this study.

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New species and notes on the genus *Cliffortia* (Rosaceae)

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Keywords: Cape Floristic Region, *Cliffortia* L., endemic, new combinations, new species, Rosaceae

ABSTRACT

Seven new species of *Cliffortia* L. endemic to the Cape Floristic Region (CFR) are described, *C. anthospermoides*, *C. cruciata*, *C. ferricola*, *C. gracillima*, *C. perpendicularis*, *C. sparsa* and *C. weimarckii*. A further species from the Graaff-Reinet area, described by Weimarck but not formally named, is here given the name *C. bolusii*. New varieties *C. cuneata* var. *cylindrica* and *C. filifolia* var. *arenaria* are also described, and *C. gracilis* Harv. is recombined as *C. dentata* var. *gracilis*. *Cliffortia discolor* Weim. and *C. hermaphroditica* Weim. are reduced to synonyms of *C. odorata* L.f. and *C. juniperina* L.f. respectively. There are now 132 species recognized in *Cliffortia*, 124 of which are found in the CFR and 109 endemic to the region.

INTRODUCTION

Cliffortia L. is one of the ten largest genera in the Cape Floristic Region (CFR) (Goldblatt & Manning 2000). In Fellingham's (2000) enumeration of the species in the CFR, 111 described species were recognized. Five other species had been described that occurred exclusively outside the CFR (Oliver & Fellingham 1994; Whitehouse 2004a), including one, *C. nitidula* (Engl.) R.E.Fr. & T.C.E.Fr. (incorporating *C. aequatorialis* R.E.Fr. & T.C.E.Fr.), found as far as Kenya (Graham 1960). Since then, eleven more species have been described (Fellingham 2003; Whitehouse 2004a, b).

In this paper, eight more species are described, as well as new varieties of *Cliffortia cuneata* Dryand. and *C. filifolia* L.f. One species, *C. gracilis* Harv., is considered to be a variety of *C. dentata* Willd., while a further two species, *C. discolor* Weim. and *C. hermaphroditica* Weim., are reduced to synonymy of more widespread species. Seven of the new species are endemic to the CFR, but the eighth species is only known from the Nardouwsberg on the Great Escarpment east of Graaff-Reinet. This brings the total number of species in the genus *Cliffortia* to 132.

The following species were listed as endemic to the CFR by Fellingham (2000), but have collections from outside the region: *Cliffortia amplexistipula* Schltr. (Namaqualand, Fellingham 1993), *C. erectisepala* Weim. (Grahamstown, Whitehouse 2004a), *C. eriocephalina* Cham. (Graaff-Reinet, see *C. bolusii* Diels ex C.Whitehouse below, and Amatole Mtns, Phillipson 1987), *C. graminea* L.f. (Grahamstown, Weimarck 1934), *C. ilicifolia* L. (Grahamstown, Weimarck 1934), *C. montana* Weim. (see *C. bolusii* below and Graaff-Reinet, Weimarck 1934) and *C. ruscifolia* L. (Namaqualand, Weimarck 1934). The presence of *C. juniperina* L.f. north of Nieuwoudtville is doubtful, whereas *C. repens* Schltr. is regarded now as being found only outside the CFR (Whitehouse 2004a). Therefore, the total number

of species found within the CFR is 124, of which 109 are endemic to the area.

1. *Cliffortia anthospermoides* Fellingham, sp. nov., *C. ramosissimae* Schltr. affinis, sed internodiis brevibus, brachyblastis imbricatis, staminibus 9–12 notabilis.

TYPE.—Western Cape, 3419 (Caledon): Caledon District, Walker Bay area, Grootbos Private Nature Reserve, slight northern slope, 150 m, (–CB), 31 Aug. 1996, Fellingham 1691 (BOL, holo.!, K!, NBG!, PRE!).

C. sp. 2 sensu Fellingham: 614 (2000).

Medium, erect shrub, up to 1 m high, monoecious but with alternating male and female phases; young branches reddish with indumentum of long white hair, turning greyish brown, becoming glabrous, hair bases remaining as pustules, bark splitting and peeling, ageing to a smooth glabrous reddish brown surface with persistent patent, woody sheaths of fallen leaves with central nerves prominent, giving appearance of thorny petioles; internodes $\pm$ 10 mm long, shorter than leaves, giving plant a leafy appearance. Leaves trifoliate; leaflets 5.5–7.0 $\times$ 0.9–1.0 mm, straight to falcate to twisted giving an untidy appearance; margins scabrid to minutely denticulate; lamina bright green, glabrous adaxially, with occasional long hairs on margin and abaxially; sheath 1–2 mm long below central leaflet, diminishing distally, glabrous except for a few long cilia on margins, 3-nerved, medially herbaceous, laterally pinky white membranous; stipules represented by the membranous edges of sheaths forming rectangular 'wings'. Flowers solitary, ebracteate, in axils of vegetative leaves separated by long internodes. Male flowers: bracteoles ovate-lanceolate, 2.2 $\times$ 1.5 mm, glabrous, scarious, whitish; pedicel and receptacle 1 mm long, glabrous; sepals 3(or 4), linear-lanceolate, 3.7–4.3 $\times$ 2.6–3.0 mm, green with occasional maroon longitudinal lines, prominently mucronate even in bud, adaxially with obvious locking mechanism consisting of subapical tuft of crisped papillae; stamens (9)10–12; filaments 5 mm long, maroon, glabrous; anthers 0.7–0.8 mm long, maroon-red with white connective. Female flowers: bracteoles ovate-lanceolate, 3.4–3.6 $\times$ 2.0–2.3 mm, membranous, translucent, sheathing fruit, inner bracteole with apical one fifth part reflexed, outer with a tuft of retrorse hair at base; pedicel absent up to 0.6 mm long in fruit, glabrous; sepals 3, broadly elliptic, 1.9–2.0

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MS. received: 2006-01-18.

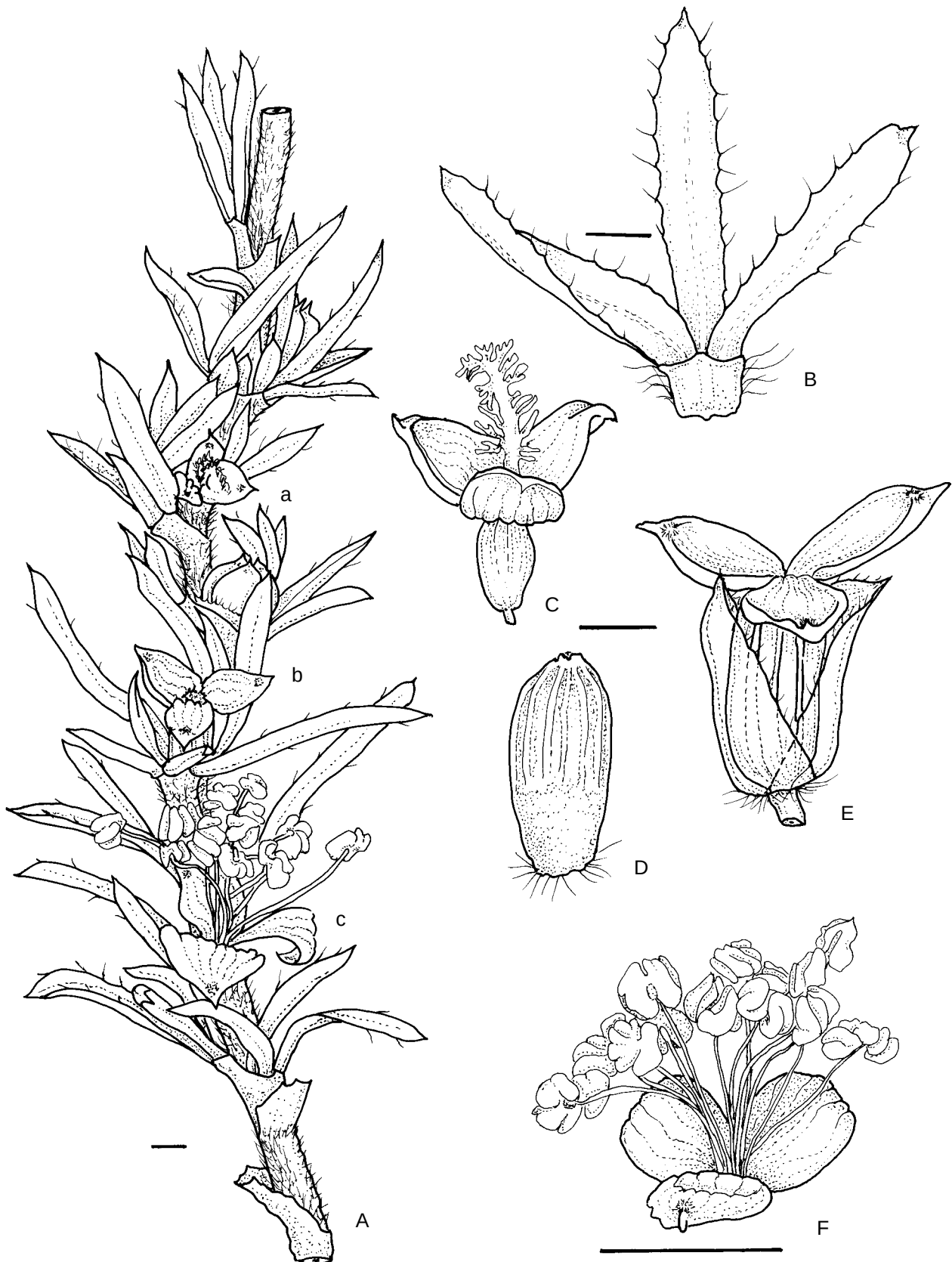


FIGURE 1.—*Cliffortia anthospermoides*. A, branch: Aa, female flower in situ; Ab, fruit in situ; Ac, male flower in situ. B, leaf; C, female flower; D, fruit; E, fruit with sepals and bracts in situ; F, male flower; A, D, E, Fellingham 1545; B, C, Fellingham 1529; F, Fellingham 1634. Scale bars: A–E, 1 mm; F, 3 mm. Artist: A.C. Fellingham.

× 1.5–1.6 mm, spreading, mucronate, glabrous but for papillate locking mechanism ventrally near apex, fugacious; immature receptacle ellipsoid, 1.5 mm × 0.8 mm, pale green with occasional longitudinal reddish lines; style solitary, 0.2–0.3 mm, pale green, glabrous; stigma 1.8–2.2 mm long, deep maroon-red, fimbriate. *Achene* ellipsoid, 1.9–2.1 × 1.5–1.6 mm, apex with small indentation containing staminodes and ridged by remains of fallen sepals, apical two thirds with ± 12 low longitudinal ridges, green, tinged with maroon where exposed to sun, lower third smooth, base concave with central pedicel scar surrounded by a ring of stiff hairs. Figure 1.

Diagnostic characters and affinities: at first sight, this species can be mistaken for a member of the genus *Anthospermum* (Rubiaceae). However, on closer examination the alternate arrangement of shoots becomes evident. Morphologically it appears closest to *Cliffortia ramosissima* Schltr. but the habit of that species is lower and spreading, not upright as in *C. anthospermoides*. Furthermore, the leaves of *C. anthospermoides* are larger and more tightly packed on the stems and the species generally has more stamens in the male flowers: 9–12, as opposed to *C. ramosissima*, which has fewer than nine. The distributions of the two species do not overlap.

Superficially the flowers appear to be borne singly in the axils of normal vegetative leaves, particularly those at the top of shoots. On closer inspection of the implantation sites of these flowers, however, the presence of a growth point next to each flower has been noted. Furthermore, the axils of leaves lower down on the vegetative shoots contained well-developed short shoots, bearing the bracts of a lower (fallen) flower as well as a second developing flower above them. From the size of the empty bracts it can be deduced that these subtended a female flower, whereas the second flower was male. Axils in the intermediate zone contained fruits in the lower bracts with very young male flowers above, whereas the axils in the tops of the shoots contained young male flowers. From the emerging pattern of male and female flower sites, it can be deduced that the first flowers of the season to appear on any particular plant, would be female. As a result of their diminutive size and obscure arrangement, these would go unnoticed except for the showy red styles. The shedding of the styles completely obscures the female phase, whereas the male phase which follows is patently obvious by its showy stamens, thus leading a casual observer to the erroneous conclusion that the plant is a male specimen of a dioecious species.

Habitat: fynbos on brown, sandy soil on slight slopes; altitude 50–250 m.

Distribution: only known from the Gansbaai area, Caledon District (Figure 2).

Conservation status: four populations are known. The population at Woest Arabie has been ± destroyed by road widening, the one at Danger Point is under threat of development and the one at Wortelgat has been severely invaded by *Acacia cyclops*; only the population in the Grootbos Nature Reserve is protected.

Etymology: an early Elsie Esterhuysen collection was annotated by her as having ‘the aspect of *Anthospermum*

aethiopicum’; an apt description as the tightly packed leaves obscure the alternate arrangement of the leaves which would distinguish it from an *Anthospermum*.

2. *Cliffortia cruciata* C.Whitehouse, sp. nov., *C. ramosissima* Schltr. primo aspectu similis, sed nullis petiolis, sepalis quatuor, costis acheniorum manifeste quatuor differt.

TYPE.—Western Cape, 3319 (Worcester): Worcester District, Jonaskop, Wildepaardeberg, just below sandy plateau, 900 m, (–DC), 15 Sept. 2000, Whitehouse 137 (BOL, holo.!, K!, MO!, NBG!, Z!).

Low, erect shrub, up to 0.3 m high, killed by fire; densely divaricately branched, forming brachyblasts; young stems 0.6–0.9 mm wide, tinged reddish, hairy; stem hairs adpressed upwards, 0.2–0.4 mm long. *Leaves* trifoliate; leaflets linear, 2.7–3.7 × 0.4–0.6 mm, base noticeably swollen and bulbous, apex 0.1–0.2 mm long, margins rounded but slightly grooved, entire and smooth; lamina chartaceous, 0.3–0.5 mm thick, slightly curved upwards and towards stem, green with two paler stripes on each side, glabrous; sheath 0.7–1.0 mm long, abaxially glabrous, adaxially hairy; stipules 0.3–0.8 mm long, free, margins smooth; petiole absent. *Flowers* solitary at base of undifferentiated leaves; bracteoles hairy on keel, margins ciliate; sepals 4, glabrous. *Male flowers:* bracteoles 1.2–1.5 mm long; pedicel and receptacle 0.5–0.8 mm long; sepals broadly ovate, 3.4–4.4 × 1.3–2.2 mm, acute to acuminate at apex, tips not completely separating at anthesis; stamens 6 or 7; filaments 1.2–2.0 mm long, red; anthers brownish red. *Female flowers:* bracteoles 1.3–1.7 mm long, shorter than immature receptacle; sepals 0.8–1.2 × 0.2–0.4 mm, erect; carpel 1; stigma 1.4–2.6 mm long, red to pinkish, feathery, hidden within leaves; immature receptacle 1.3–2.7 × 0.6–1.1 mm, glabrous, clearly ribbed. *Achene* broadly ellipsoid, 3.8–4.7 × 1.7–2.0 mm, medium brown, glabrous; ribs 4, rounded, ± 0.6 mm wide, slightly tuberculate. *Flowering time:* around September. Figure 3.

Diagnostic characters and affinities: closely allied to *Cliffortia subsetacea* (Eckl. & Zeyh.) Diels ex Bolus & Wolley Dod, but this is only clearly discernible by examination of the achenes, which are very similar except that the ribs on *C. cruciata* are not curved. In general appearance the species looks more similar to *C. ramosissima* with its short, but comparatively broad and flat, very slightly curved leaves. Apart from the achene, the two species can be easily separated because *C. cruciata* lacks any evidence of a petiole and the flowers have four sepals and four prominently ribbed achenes.

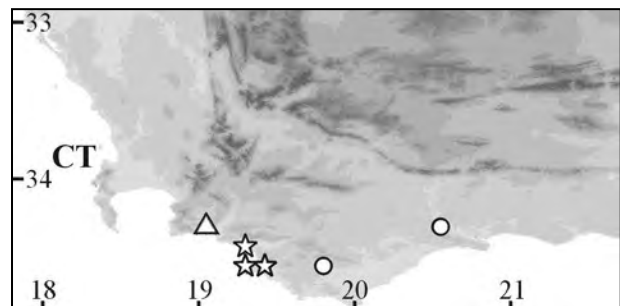


FIGURE 2.—Known distribution of *Cliffortia anthospermoides*, ☆; *C. ferricola*, Δ; and *C. perpendicularis*, ○, in South Africa.



FIGURE 3.—*Cliffortia cruciata*. A, branch with achenes, $\times 2$; B, branch with female flowers, $\times 4$; C, achene, $\times 10$.

Habitat: fynbos in full sun, on well-drained soils on deep sandy plateau; acid sands from Table Mountain Series; altitude 900–1 000 m.

Distribution: a very narrow endemic restricted to the sandy plateau of the Wildepaardeberg on the northern slopes of Jonaskop in the Riviersonderend Mtns (Figure 4).

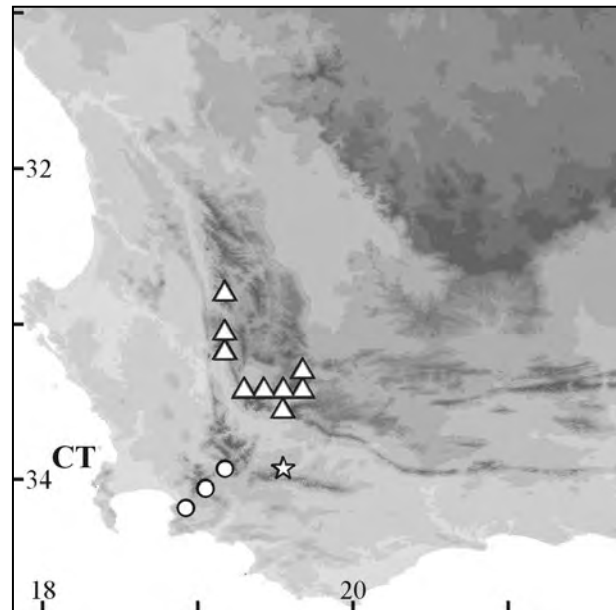


FIGURE 4.—Known distribution of *Cliffortia cruciata*, ☆; *C. sparsa*, ○; and *C. weimarckii*, Δ, in South Africa.

Conservation status: very narrow endemic, only known from a very particular habitat on a single mountain, although relatively inaccessible, it could be threatened by over-frequent fires.

Etymology: *cruciata*, Latin for crosswise, referring to the shape that the four prominent ribs of the achene make when viewed in cross section.

3. *Cliffortia ferricola* C.Whitehouse, sp. nov., ex affinitate *C. ruscifoliae* L. et specierum affinium, sed foliis saepissime profunde bilobis vel trilobis distinguenda.

TYPE.—Western Cape, 3419 (Caledon): Caledon District Kogelberg, S slopes of Mt Horeb, Kleinmond-Highlands road, 200 m, (–AC), 27 Sept. 2000, *Whitehouse 145* (BOL, holo.!, NBG!).

C. versiformis C.Whitehouse (2003), manuscript name.

Medium, erect shrub, up to 1.5 m high, resprouting after fire and spreading clonally; densely divaricately branched, forming brachyblasts; young stems 1.2–1.7 mm wide, tinged reddish, hairy; stem hairs adpressed upwards, 0.2–0.7 mm long. *Leaves* usually unifoliate and deeply toothed, but occasionally bifoliate or trifoliate; leaflets broadly ovate to lanceolate, 5.3–10.0 $\times$ 1.7–3.5 mm, apex sharply acuminate to pungent, 0.7–1.5 mm long, margins turned upwards to rounded, smooth and entire or more frequently with 2 teeth becoming deeply 3-lobed, lobes 0.6–4.9 mm long, straight; lamina 4–7-veined from base, cartilaginous, 0.3–0.4 mm thick, midrib prominent abaxially against lamina, curved downwards and away from stem, glabrous adaxially, hairy abaxially on very young growth but soon becoming glabrous, hairs 0.3–0.7 mm long; sheath 1.0–1.8 mm long, abaxially glabrous, adaxially scattered adpressed hairs; stipules 0.7–1.3 mm long, free, margins smooth to ciliate; petiole absent. *Flowers* solitary in axil of undifferentiated leaves; bracteoles hairy on keel with margins ciliate or not; sepals 3, hairy abaxially. *Male*

flowers: bracteoles 4.0–4.6 mm long; pedicel and receptacle 1.1–1.4 mm long; sepals broadly ovate, 6.4–6.8 × 2.2–3.0 mm, acute to acuminate at apex; stamens 9 or 10; filaments 8.8–10.1 mm long, red; anthers brownish red. *Female flowers*: bracteoles 3.1–4.4 mm long, longer than immature receptacle; sepals ovate, 3.2–4.1 × 0.8–1.3 mm, recurved; carpel 1; stigma 6.7–8.7 mm long, red, feathery, prominent above leaves; immature receptacle 2.4–2.9 × 0.9–1.2 mm, glabrous, clearly ribbed. *Achene* narrowly ellipsoid and slightly curved, 3.5–4.8 × 1.2–1.5 mm, medium to dark brown, glabrous; ribs 9–13, rounded to acute, 0.1–0.2 mm wide; elaiosome swollen around base. *Flowering time*: September–February, possibly sporadically all year. Figure 5.

Diagnostic characters and affinities: *Cliffortia ferricola* is clearly closely related to the very common and widespread *C. ruscifolia*, but has smaller leaflets, which are often deeply divided, sometimes almost into two or three leaflets. The habit is also characteristic, often forming erect, strongly ascending stems so that the plants are narrowly columnar. Plants are more frequently monoecious than *C. ruscifolia*.

Habitat: well-drained, clayish soil of ferricretes from shale bands of Table Mountain Series or from Bokkeveld Series, in full sun; altitude 150–250 m.



FIGURE 5.—*Cliffortia ferricola*. A, branch with female flowers, × 2; B, leaf, × 4; C, female flower, × 4; D, achene, × 6.

Distribution: restricted to ferricretes in the Bot River Valley between Houwhoek, Kleinmond and Hermanus (Figure 2).

Conservation status: known from only a few localities in a small area, one of which is near a highway junction and under threat of development.

Etymology: *ferricola*, Latin for dweller on iron, referring to the habitat of this species on ferricrete-derived soils. The name was suggested by Nick Helme, who has found this species in several localities around the Bot River growing on ferricrete.

4. *Cliffortia dentata* Willd., Species plantarum 2, edn 4: 842 (1806); DC.: 596 (1825); Harv.: 299 (1862); Weim.: 20, fig. 1A–F (1934); Levyns: 445 (1950); Fellingham: 612 (2000). Type: Cape of Good Hope, without further information (B-W, holo.).

Low, sprawling or trailing, semi-herbaceous shrub up to 0.7 m high, killed by fire; densely divaricately branched, only forming long branches; young stems 0.3–0.7 mm wide, hairy; stem hairs adpressed downwards, 0.2–1.1 mm long. *Leaves* trifoliate; leaflets obovate, 4.2–10.3 × 2.3–6.4 mm, apex acute to rounded, up to 0.4 mm long, margins flat except for apices which are sometimes recurved, with up to 5 lobes or teeth; outer leaflets often narrower than middle one and sometimes untoothed; lamina herbaceous, midrib slightly prominent abaxially against lamina, curved upwards and towards stem, glabrous; sheath 0.4–0.9 mm long, abaxially hairy, adaxially with a fringe of long straight hairs; stipules 1.9–4.0 mm long, partially joined on reverse side of stem, margins ciliate; petiole absent. *Flowers* solitary in axil of undifferentiated leaves; bracteoles glabrous on keel, margins ciliate; sepals 4, glabrous. *Male flowers*: bracteoles 1.6–2.3 mm long; pedicel and receptacle glabrous; sepals broadly ovate, 3.5–3.8 × 1.5–2.0 mm, with long attenuate apices; stamens 8; filaments 4.0–4.3 mm long, red; anthers brownish red. *Female flowers*: bracteoles 1.5–3.4 mm long, longer than immature receptacle; sepals ovate, 1.2–2.2 × 0.5–0.9 mm, strongly recurved; carpels 2; stigma 2.1–2.6 mm long, greenish white, feathery; immature receptacle 0.9–1.1 × 0.7–1.0 mm, glabrous, smooth. *Achene* slightly flattened, 2.2–2.8 × 1.0–1.2 mm, pale brown, glabrous, unribbed but with a central groove dividing two carpels. *Flowering time*: April–October, possibly as late as December.

4a. var. *dentata*

Middle leaflet 4.2–8.5 × 2.9–6.1 mm; outer leaflets, 4.3–10.3 × 2.3–5.1 mm; all leaflets 3–5-lobed or toothed, middle lobe 0.6–1.5 × 0.9–2 mm.

Habitat: shady slopes in gulleys and on damp south-facing cliffs on well-drained soils from Table Mountain Series; altitude 300–1 450 m.

Distribution: found between Wemmershoek Mtns in the north to the Helderberg and Hottentots Holland Mtns in the south, with an outlying population on the Cape Peninsula, where it is only known from the eastern slopes of the saddle between Table Mtn and Devil's Peak (Figure 6).

Conservation status: an uncommon species but its localities are well conserved and inaccessible; however, being a seeding species, too frequent fires on Devil's Peak could threaten the Cape Peninsula population.

Etymology: *dentata*, Latin for toothed, referring to the apices of the leaves that can appear like the teeth of a saw.

4b. var. **gracilis** (Harv.) C.Whitehouse, comb. et stat. nov. Type: Western Cape, 3319 (Worcester): Worcester District, Du Toit's Kloof, 610–915 m, (–CA), 1839, *Drège 145b* (K, holo.!; B†, L, S, W).

C. gracilis Harv. in *Flora capensis* 2: 299 (1862); Weim.: 22 (1934) pro parte; Fellingham: 612 (2000) pro parte.

Middle leaflet 4.5–8.4 × 4.1–6.1 mm; outer leaflets 4.7–9.5 × 3.0–6.4 mm, untoothed; middle leaflet 3(–5)-lobed or toothed, middle lobe 0.6–1 × 0.6–1.2 mm.

Diagnostic characters and affinities: *Cliffortia gracilis* was considered a distinct species by Weimarck. However, the populations in the Langeberg have consistently smaller leaves and are considerably disjunct from the Du Toit's Kloof population (the type locality). In terms of size of the leaves and flowers, the Du Toit's Kloof population falls within the range of variation shown by *C. dentata*, and only differ on the degree of dentation at the apex. Furthermore, the discovery of a population of the latter species from the Wemmershoek Mtns (*C. Whitehouse 14*), a mere 10 km or so from Du Toit's Kloof, means that the geographical distance between the populations is much smaller than previously thought. Therefore, *C. gracilis* is here reduced to varietal status and a new name, *C. gracillima* C.Whitehouse, given to the Langeberg populations.

Cliffortia dentata and *C. gracillima* form a pair of closely related species which create decumbent trailing mats on shady rocky slopes. The trifoliate, glabrous leaves, along with the general habit, distinguish this group from any other *Cliffortia*. Var. *gracilis* can be distinguished from the typical variety by the middle leaflet, which is often only 3-lobed, with the middle lobe being much narrower than the outer two, and untoothed outer leaflets.

Habitat: shady slopes in gulleys and on damp south-facing cliffs on well-drained soils from Table Mountain Series; altitude 600–1 700 m.

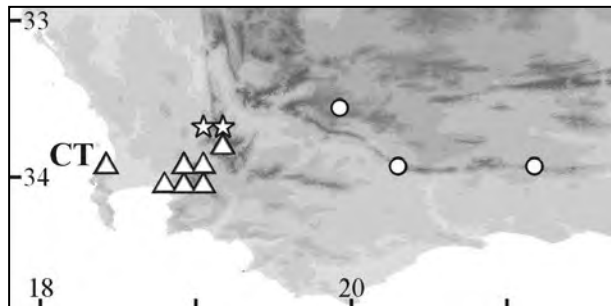


FIGURE 6.—Known distribution of *Cliffortia dentata* var. *dentata*, Δ; *C. dentata* var. *gracilis*, ☆; and *C. gracillima*, ○, in South Africa.

Distribution: only known from Molenaarsberg and Upper Wellington Sneekop to the north of Du Toit's Kloof (Figure 6).

Conservation status: only known from a small inaccessible area to the north of Du Toit's Kloof, but it could be threatened by over-frequent fires as it probably only survives as seed.

Etymology: *gracilis*, Latin for thin, slender, referring to the stems that are too weak to hold the plant upright and trail over the rocks.

5. **Cliffortia gracillima** C.Whitehouse, sp. nov., a *C. dentata* Willd. var. *gracili* (Harv.) C.Whitehouse foliis minoribus differt.

TYPE.—Western Cape, 3321 (Ladismith): Riversdale District, Garcia's Pass, 395 m, (–CC), Oct. 1904, *Bolus 11271* (BOL, holo.!; PRE!).

C. dentata sensu Muir: 56 (1929), non Willd.

C. gracilis sensu Weim.: 22 (1934) pro parte; Fellingham: 612 (2000) pro parte.

Illustration: Weim.: fig. 1G–L (1934).

Low, sprawling or trailing, semi-herbaceous shrub up to 0.3 m high, probably killed by fire; densely divaricately branched, only forming long branches; young stems 0.2–0.6 mm wide, hairy; stem hairs adpressed downwards, 0.2–0.8 mm long. Leaves trifoliate; middle leaflet obovate, 3.1–5.4 × 2.2–4.6 mm, apex acute to mucronate, up to 0.4 mm long, margins flat except for apices which are sometimes recurved, entire or up to 3-lobed, middle lobe much smaller and narrower than outer two, 0.4–0.9 × 0.3–1.4 mm, outer leaflets elliptic to obovate, 3.7–6.1 × 1.6–3.1 mm, almost always entire; lamina herbaceous, up to 0.1 mm thick, midrib slightly prominent abaxially against lamina, curved upwards and towards stem, glabrous; sheath 0.2–0.6 mm long, abaxially hairy, adaxially with a fringe of long straight hairs; stipules 1.6–3.1 mm long, partially joined on reverse side of stem, margins ciliate; petiole absent. Flowers solitary at base of undifferentiated leaves; bracteoles glabrous on keel, margins ciliate; sepals 4, glabrous. Male flowers: pedicel and receptacle glabrous; sepals broadly ovate with long attenuate apices; filaments red; anthers brownish red. Female flowers: bracteoles 1.7–3.2 mm long, longer than immature receptacle; sepals ovate, strongly recurved; carpels 2; stigma 2.6–3.2 mm long. Achene slightly flattened, 2.2–3.8 × 0.9–1.5 mm, pale brown, glabrous, unribbed but with a central groove dividing two carpels. Flowering time: July–October. Figure 7.

Diagnostic characters and affinities: previously included as part of *C. gracilis*, which is now regarded as a variety of *C. dentata*. It differs from that species by its much smaller leaves, as well as having a clear disjunction in distribution and therefore occurs in areas where summer rainfall is more common.

Habitat: shady areas in gulleys on well-drained soils from Table Mountain Series; altitude 250–1 400 m.

Distribution: known from a few localities in the Langeberg from Leeurivierberg to Garcia's Pass, with an

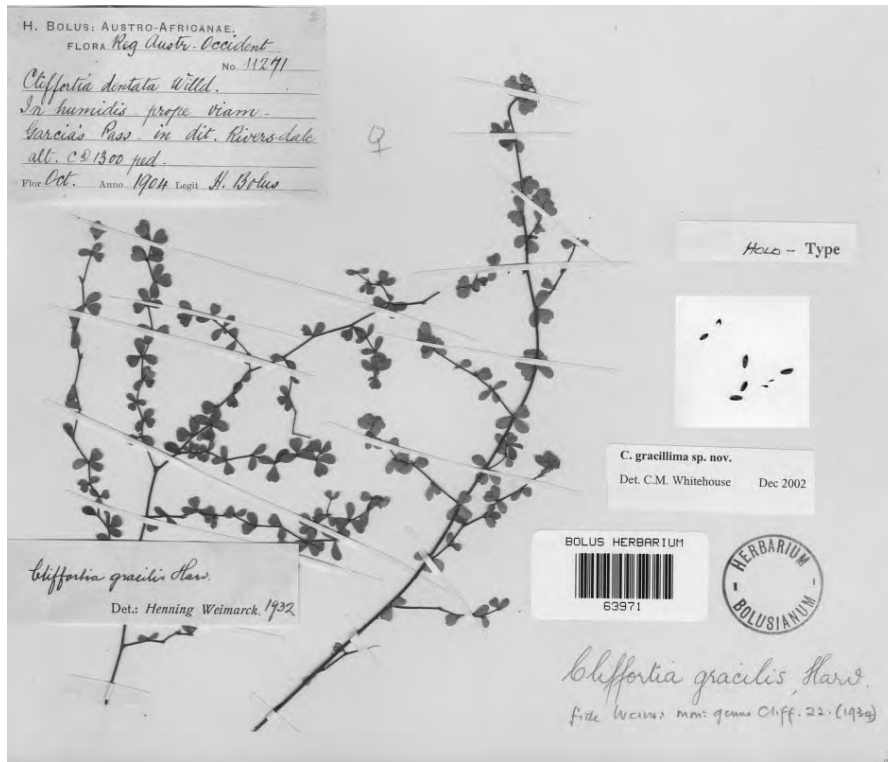


FIGURE 7.—Type specimen of *Cliffortia gracillima*.

outlying population on the Waboomsberg near Montagu (Figure 6).

Conservation status: only known from four localities but areas in between are poorly explored and it is possible that more populations occur, it grows in inaccessible areas but might be threatened by too frequent fires.

Etymology: *gracillima*, Latin for very thin and slender, referring to the stems and allusion to its previous inclusion within *C. gracilis*, from which it is much smaller in all its parts.

6. ***Cliffortia perpendicularis* C.Whitehouse, sp. nov.**, ex affinitate *C. falcatae* L.f. et *C. ramosissimae* Schltr., sed ab utraque forma ramificationis distincta.

TYPE.—Western Cape, 3419 (Caledon): Bredasdorp District, Elim, Geelkop Nature Reserve, W slope of hill, 120 m, (–DB), 3 Sept. 2001, C. & A. Whitehouse 259 (BOL, holo.!, K!, NBG!).

Sprawling shrub up to 0.5 m high but often semi-prostrate, killed by fire; divaricately branched and forming brachyblasts that spread at right angles to main stem, but few long branches developing; young stems 0.9–1.6 mm wide, tinged reddish, hairy; stem hairs spreading or adpressed upwards, 0.2–0.5 mm long. *Leaves* trifoliate; leaflets oblong to linear, outer ones sickle-shaped, 3.5–7.5 × 0.7–1.1 mm, apex sharply acuminate, 0.3–0.6 mm long, margins flat, entire and smooth; lamina chartaceous, 0.2–0.5 mm thick, curved upwards and towards stem, green but with two paler stripes on either side of midrib abaxially, glabrous; sheath 1.1–2.0 mm long, abaxially glabrous, adaxially glabrous except for fringe of hairs at apex; stipules 0.8–1.5 mm long, free, margins ciliate; petiole present, 0.6–1.4 mm long. *Flowers* solitary at base of undifferentiated leaves; bracteoles short-hairy on keel, margins ciliate; sepals 3, glabrous. *Male*

flowers unknown. *Female flowers*: bracteoles 2.7–3.8 mm long, longer than immature receptacle; sepals oblong to linear, 3.5–4.5 × 0.5–1.0 mm, spreading; carpel 1; stigma 2.5–4.9 mm long, red, feathery, hidden amongst incurved leaves; immature receptacle 1.1–1.8 × 0.7–1.2 mm, sparsely and very short-hairy. *Achene* ellipsoid to cylindrical, 3.5–4.6 × 1.8–2.6 mm, medium brown but sometimes appearing greyish on account of being covered by membranous layer, glabrous or sparsely and very



FIGURE 8.—*Cliffortia perpendicularis*. A, branch, × 1; B, leaf, × 4.

short-hairy, irregularly acutely ribbed beneath membranous layer. *Flowering time*: September. Figure 8.

Diagnostic characters and affinities: the leaves of this species appear most similar to *Cliffortia arcuata* Weim., but that species is only found on the mountains surrounding the Little Karoo. Related species that occur in the vicinity of *C. perpendicularis* include *C. ramosissima* and *C. falcata* L.f. The leaves are generally longer and more curved than *C. ramosissima* and more sharply pointed than *C. falcata*. However, the most distinctive feature about *C. perpendicularis* is the very sparse branching (excluding the brachyblasts). It has a spindly, lax habit, so much so that often only a couple of long branches exist and the main stem is unable to bear the weight of the plant, resulting in its sprawling amongst the surrounding vegetation. This is in contrast to *C. arcuata* and *C. falcata*, which have erect ascending branches, and *C. ramosissima* which has an intricate divaricate branching pattern. The distinctive branching pattern is accentuated by the brachyblasts, which appear to project from the stem at right angles.

The species is possibly of hybrid origin. In both the localities where it has been found, *C. falcata* and *C. ramosissima* are found growing within a few kilometres. However, seed is clearly viable, as the species occurs frequently in the habitats even though the plants are killed by fire; specific status is considered the most appropriate treatment for this taxon. Male flowers have not yet been found, so it is presumed that most of the reproduction by seed is apomictic and therefore asexual.

The three populations of this species appear $\pm$ identical despite the contrasting soil types (gritty acid sands from Table Mountain sandstone on the Potberg and clayish silcretes and ferricretes over Bokkeveld shales near Elim) and they both share the unusual sprawling habit that is diagnostic for this species. Population level studies of the species would be needed to determine if they share a common ancestry or represent a case of two cryptic apomictic species derived from hybridization.

Habitat: fynbos in full sun on acid sands from Table Mountain Series or clayish soil of Bokkeveld Series; altitude 100–300 m.

Distribution: known only from three localities: two populations close to Elim and one on Potberg (Figure 2).

Conservation status: a poorly known species and only known from three very small areas, one that is threatened by agriculture and quarrying, while the others are in danger of invasion by alien vegetation.

Etymology: *perpendicularis*, Latin for at right angles, referring to the way the branches and brachyblasts appear to join the stem at right angles to it.

7. *Cliffortia sparsa* C.Whitehouse, sp. nov., planta inter *C. atratam* Weim. et *C. sericeam* Eckl. & Zeyh. aliquam intermedia sed foliis sparse pubescentibus dignoscenda.

TYPE.—Western Cape, 3419 (Caledon): Caledon District, Hottentots Holland Nature Reserve, around Nuweberg Forest Station, 560 m, (–AA), 25 Oct. 2001, Whitehouse 283 (BOL!; NBG!).

C. pterocarpa sensu Weim.: 62, fig. 16K (1934) pro parte, non (Harv.) Weim. sensu stricto.

Medium, erect shrub up to 1.2 m high, killed by fire; densely divaricately branched, forming brachyblasts; young stems 0.7–1.0 mm wide, sometimes tinged reddish, hairy; stem hairs adpressed upwards, 0.3–0.6 mm long. *Leaves* trifoliate; leaflets linear to needle-shaped, 6.0–10.1 $\times$ 0.6–1.1 mm, apex acute to sharply acuminate, 0.2–0.4 mm long, margins flat, entire and smooth; lamina chartaceous, 0.2–0.5 mm thick, midrib prominent abaxially, $\pm$ straight to curved downwards and away from stem, sparsely hairy adaxially and abaxially, hairs 0.1–0.6 mm long; sheath 1.2–2.1 mm long, abaxially glabrous, adaxially glabrous except for fringe of hairs at apex; stipules 1.1–2.5 mm long, free, margins smooth to serrulate; petiole absent. *Flowers* solitary in axil of undifferentiated leaves; bracteoles hairy on keel, margins serrate to very shortly ciliate; sepals 3, hairy abaxially. *Male flowers*: bracteoles 3–4 mm long; pedicel and receptacle 0.6–0.8 mm long; sepals broadly ovate, 4.8–6.0 $\times$ 1.9–2.5 mm, acute to acuminate at apex; stamens 10 or 11; filaments 6.4–7.8 mm long, red or greenish white; anthers yellow. *Female flowers*: bracteoles 2.6–4.2 mm long, longer than immature receptacle; sepals ovate, 2.2–4.1 $\times$ 0.9–1.5 mm, recurved; carpel 1; stigma 2.9–5.0 mm long, red to pinkish white, feathery, promi-



FIGURE 9.—*Cliffortia sparsa*. A, branch with achenes, $\times$ 2; B, leaf, $\times$ 4; C, achene, $\times$ 12.

nent above leaves; immature receptacle $1.7\text{--}2.0 \times 0.8\text{--}1.0$ mm, glabrous, clearly ribbed. *Achene* ellipsoid, $3.5\text{--}4.1 \times 1.1\text{--}1.5$ mm, sometimes slightly curved, medium to dark brown, glabrous; ribs 9–12, acute, $0.1\text{--}0.3$ mm wide; elaiosome swollen around base. *Flowering time*: mainly August–November, once in May. Figure 9.

Diagnostic characters and affinities: specimens of this species have in the past generally been attributed to the poorly delimited species, *Cliffortia pterocarpa*. Molecular evidence suggests, however, that this species may be of hybrid origin between *C. atrata* Weim. and *C. cristata* Weim. or *C. sericea* Eckl. & Zeyh. of section *Inflexae* (Whitehouse 2003). In many respects it is intermediate between the two putative parents, having achenes and needle-shaped leaves most similar to *C. atrata*, but having the hairs of section *Inflexae*. However, it is common where it occurs and being a reseeders is clearly able to reproduce, even if only apomictically, by seed. Male and female flowers have been found and further introgression with parent species is likely and would explain the many intermediate forms that are found.

Habitat: well-drained clayish soil from shale bands of Table Mountain Series in full sun; altitude 250–800 m.

Distribution: common along the lower slopes of the mountains from Sir Lowry's Pass to Franschoek Pass (Figure 4).

Conservation status: widespread and common through its range, often occurring in disturbed areas.

Etymology: *sparsa*, Latin for sparse, referring to the hairs on the leaves, which although appearing glabrous are in fact covered with short, sparse hairs.

8. *Cliffortia weimarckii* C.Whitehouse, sp. nov., *C. eriocephalinae* Cham. similis sed foliis longioribus angustioribus rigidioribus, apicibus acutis differt.

TYPE.—Western Cape, 3319 (Worcester): Worcester District, Matroosberg, Spekrivierskloof, stony E slopes

above Ski Hut, 1950 m, (–BC), 27 Jan. 2001, *Whitehouse 187* (BOL, holo.!; NBG!).

Erect shrub up to 0.9 m high, resprouting after fire and spreading clonally; densely divaricately branched, forming brachyblasts; young stems $1.1\text{--}1.5$ mm wide, usually tinged reddish, densely hairy; stem hairs spreading, $0.9\text{--}1.5$ mm long. *Leaves* trifoliate; leaflets narrowly oblong to needle-shaped, $6.2\text{--}13.4 \times 0.8\text{--}1.2$ mm, base contracted abruptly to form a pseudopetiolule, apex acute to acuminate, $0.1\text{--}0.2$ mm long, margins inrolled abaxially, entire; lamina chartaceous to rigid, $0.1\text{--}0.3$ mm thick, midrib prominent abaxially against lamina, $\pm$ straight or curved upwards and towards stem, densely greyish hairy adaxially, hairs $0.4\text{--}1.7$ mm long, densely whitish hairy abaxially, hairs $0.2\text{--}0.4$ mm long, sheath $2.7\text{--}3.1$ mm long, abaxially hairy, adaxially densely hairy; stipules $0.2\text{--}0.4$ mm long, free, margins ciliate; petiole absent. *Flowers* solitary at base of undifferentiated leaves; bracteoles hairy; sepals 3, densely hairy abaxially. *Male flowers*: bracteoles $3.6\text{--}4.0$ mm long; pedicel and receptacle $0.9\text{--}1.3$ mm long; sepals broadly ovate, $5.0\text{--}5.8 \times 1.8\text{--}2.3$ mm, acute to acuminate at apex; stamens 9–11; filaments $4.6\text{--}5.7$ mm long, red; anthers brownish red. *Female flowers*: bracteoles $2.8\text{--}4.8$ mm long, longer than immature receptacle; sepals linear, $1.5\text{--}2.9 \times 0.2\text{--}0.5$ mm, erect; carpel 1; stigma $4.1\text{--}6.5$ mm long, red, feathery, prominent above leaves; immature receptacle $1.6\text{--}2.2 \times 0.7\text{--}0.9$ mm, glabrous, clearly ribbed. *Achene* ellipsoid, $3.2\text{--}3.7 \times 1.1\text{--}1.4$ mm, pale greyish brown, glabrous; ribs 11–15, rounded to acute, less than 0.1 mm wide. *Flowering time*: January, although probably in the neighbouring months as well. Figure 10.

Diagnostic characters and affinities: this species is very similar in many respects to *Cliffortia eriocephalina* but differs on account of its longer, narrower, stiffer and pointed leaves. The leaves are similar in form to the unrelated lowland species, *C. stricta*, but are much more hairy and grey in appearance. *C. eriocephalina* and *C. weimarckii* grow sympatrically in some places such as Matroosberg, where they can be easily distinguished. However, some specimens from the Baviaansberg (Stokoe 4537, Esterhuysen 29806) and Cederberg Langberg (Bond 1383) have leaves of intermediate length, and without field observations on the populations, they are only tentatively attributed to this species.

Weimarck annotated some collections of this species indicating that he thought they were a new species. It therefore seems most appropriate to name this species in his honour, especially considering his immense contribution to our current understanding of the genus.

Habitat: high altitude mountain fynbos on well-drained acid sands from Table Mountain Series in full sun; altitude 1200–2250 m.

Distribution: Hex River Mtns and the highest peaks of the Koue Bokkeveld and Groot Winterhoek Mtns, possibly also Baviaansberg and Cederberg Langberg (see note above, Figure 4).

Conservation status: populations are scattered as it is restricted to such high altitudes, however it is therefore also not threatened, especially as it is a resprouter.

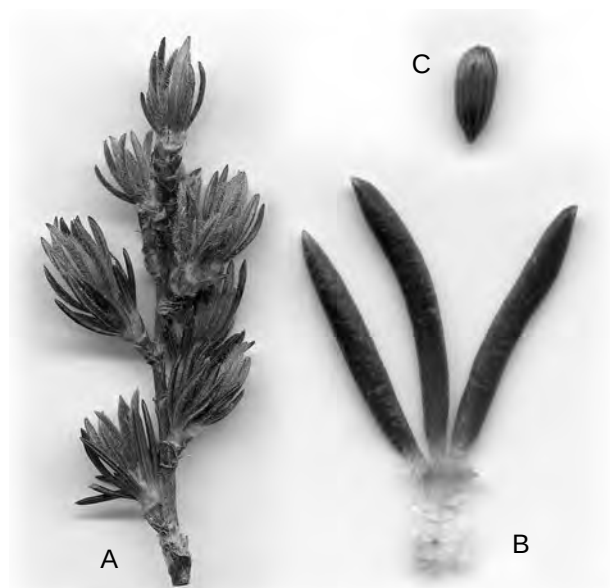


FIGURE 10.—*Cliffortia weimarckii*. A, branch, $\times 1$; B, leaf, $\times 4$; C, achene, $\times 4$.

Etymology: *weimarckii* is named after Henning Weimarck who wrote the first full monograph of *Cliffortia*.

9. *Cliffortia cuneata* Dryand. in Aiton, Hortus kewensis, edn 1, 3: 413 (1789); DC.: 595 (1825); Weim.: 129, fig. 37A–F (1934); Fellingham: 609 (2000). Lectotype, designated by Weimarck (1934): Western Cape, 3418 (Simonstown): False Bay, *Robertson s.n.* (BM, holo!).

Medium to tall, erect shrub, up to 3 m high, killed by fire; densely divaricately branched, forming long branches and brachyblast when flowering; young stems 1.0–2.5 mm wide, glabrous or slightly hairy but quickly becoming glabrous; stem hairs adpressed upwards, 0.1–0.4 mm long. *Leaves* unifoliate; wedge-shaped to oblong, 13–41 × 4.9–13.9 mm, margins flat, only toothed at apex with 2–6 broad straight teeth, 0.6–2.9 mm long; lamina 3–7-veined from base, chartaceous, 0.1–0.6 mm thick, midrib very prominent abaxially, curved upwards and towards stem, slightly glaucous, glabrous; sheath 0.8–2.3 mm long, abaxially glabrous, adaxially hairy or glabrous except for fringe at apex; stipules 0.2–1.6 mm long, free, margins smooth; petiole absent. *Flowers* solitary at base of undifferentiated leaves but often clustered together; bracteoles hairy or glabrous on keel, margins smooth; sepals 3, glabrous. *Male flowers:* bracteoles 6.2–8.5 mm long; pedicel and receptacle 1.2–2.1 mm long; sepals broadly ovate, 6.6–10.3 × 4.0–5.9 mm, acute to acuminate at apex; stamens 27–36; filaments 11–14 mm long, red; anthers yellow. *Female flowers:* bracteoles 3.8–10.5 mm long, longer than immature receptacle; sepals ovate to obovate, 3.7–5.9 × 1.4–2.9 mm, erect; carpel 1; stigma 6.5–11.0 mm long, greenish white, feathery, prominent at base of the leaves; immature receptacle 1.9–5.2 × 1.2–2.9 mm, glabrous, smooth. *Achene* cylindrical to almost globose, 4.5–6.8 × 1.5–3.8 mm, medium to dark brown, glabrous; ribs 6 or 12–14, rounded, 0.1–0.8 mm wide.

Diagnostic characters and affinities: the reverse, long, almost triangular glaucous leaves, toothed only at the truncate apex, are very distinctive on this medium-sized species. This character is not only diagnostic but emphasizes the isolated position that this species holds within the genus as it has no close relatives.

However, while the typical form of the species has large, almost globose, achenes with numerous ribs, the achenes from the populations around Arieskraal are smaller, more cylindrical in shape, with only six low ribs. Furthermore, the leaves appear to be consistently



FIGURE 11.—*Cliffortia cuneata* var. *cylindrica*: A, branch with achenes, × 2; B, achene, × 4. *C. cuneata* var. *cuneata*: C, achene, × 4.

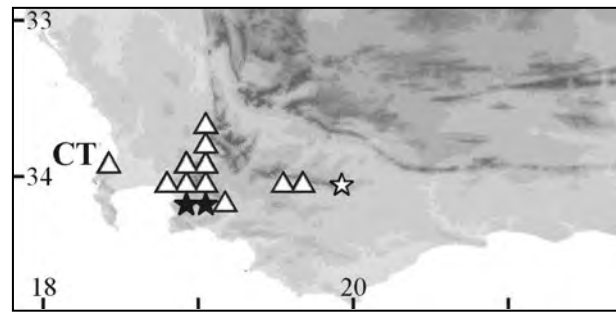


FIGURE 12.—Known distribution of *Cliffortia cuneata* var. *cuneata*, Δ; and *C. cuneata* var. *cylindrica*, ☆; *C. cuneata* var. *cuneata* and var. *cylindrica*, ★, in South Africa.

smaller, although still within the variation shown by the large-achened form of the species. This form is described here as a new variety.

The fruit is so distinct that specific rank was considered. However, as the number of specimens examined is still low, male flowers are unknown and a population near Riviersonderend was of questionable status, varietal rank was considered most appropriate for the present.

Etymology: *cuneata*, Latin for wedge-shaped or inversely triangular, referring to the distinctive shape of the leaves.

9a. var. *cuneata*

Leaves 16–41 × 5.4–13.9 mm, margins toothed at apex with 2–6 broad straight teeth, 0.9–2.9 mm long; lamina 3–7-veined from base. *Male flowers* as above. *Female flowers:* bracteoles 8.2–10.5 mm long; sepals ovate to obovate, 4.2–5.9 × 1.7–2.9 mm; immature receptacle 3.0–5.2 × 2.0–2.9 mm. *Achene* broadly ovoid to almost globose, 6.2–6.8 × 2.9–3.8 mm; ribs 12–14, rounded, 0.3–0.8 mm wide. *Flowering time:* June–December. Figure 11C.

Habitat: low slopes in fynbos on well-drained clayish shale soils in full sun; altitude 0–950 m.

Distribution: found on lower slopes between the Paarl side of Du Toit's Kloof, Helderberg and Houw Hoek, with an outlying population in Boesmanskloof in the Riviersonderend Mtns (Figure 12).

Conservation status: widespread but scattered localities of quite extensive populations, several within nature reserves; threats come from too frequent fires and invasive alien vegetation.

9b. var. *cylindrica* C.Whitehouse, var. nov., a var. *cuneata* acheniis subcylindricis sexcostatis differt.

TYPE.—Western Cape, 3418 (Simonstown): Caledon District, Arieskraal, south-facing slopes on Bokkeveld shale above Arieskraal Dam, 215 m, (–BB), 29 Nov. 2000, Whitehouse 166 (BOL!; NBG!).

Leaves 13–23 × 4.9–7.5 mm, margins toothed at apex with 4 broad, straight teeth, 0.6–1.6 mm long; lamina 3–5-veined from base. *Male flowers* unknown. *Female flowers:* bracteoles 3.8–6.0 mm long; sepals narrowly ovate to linear, 3.7–4.1 × 1.4–2.0 mm; immature receptacle 1.9–3.4 × 1.2–1.4 mm. *Achene* cylindrical, 4.5–

5.0 × 1.5–1.7 mm; ribs 6, rounded, 0.1–0.3 mm wide. *Flowering time*: October–November. Figure 11A, B.

Habitat: fynbos on south-facing shale slopes of the Bokkeveld Series; altitude 250–400 m.

Distribution: only known from Arieskraal in the Kogelberg area, but possibly present near Riviersonderend (see note above, Figure 12).

Conservation status: known from only one or two very small populations in a very confined area much of which has already been converted to orchards because it grows on relatively fertile shale; the only population that the first author has seen is on a slope too steep to be used.

Etymology: *cylindrica*, Latin for cylindrical, referring to the shape of the ± straight-sided achenes in contrast with the typical variety, which are broadly ovate.

10. *Cliffortia filifolia* L.f., Supplementum plantarum: 430 (1782); DC.: 596 (1825); Weim.: 68, fig. 17J–N (1934); Levyns: 447 (1950); Fellingham: 615 (2000). Type: Western Cape, 3318 (Cape Town): Cape Peninsula, Table Mtn, E slopes, (–CD), *Thunberg s.n.* (LINNf, holo.; CP, LD, UPS-THUNB).

Low, often sprawling, shrub, up to 1 m high, killed by fire; densely divaricately branched, forming closely overlapping brachyblasts; young stems 0.5–1.0 mm wide, sometimes tinged reddish, glabrous. *Leaves* trifoliate; leaflets needle-shaped, 5.8–17.0 × 0.3–0.8 mm, apex sharply acuminate, 0.2–0.9 mm long, margins rounded, minutely serrulate to scabrid; lamina chartaceous, 0.2–0.4 mm thick, with two pale stripes on either side of midrib, glabrous; sheath 1.3–3.0 mm long, abaxially glabrous, adaxially glabrous except occasionally for a few hairs at apex; stipules 0.7–3.1 mm long, free, margins smooth to serrulate; petiole 0.2–2.0 mm long. *Flowers* solitary in axil of undifferentiated leaves; bracteoles gla-

brous on keel, margins smooth to serrate; sepals 3, glabrous. *Male flowers*: bracteoles 2.4–4.3 mm long; pedicel and receptacle 0.4–0.7 mm long, glabrous; sepals broadly ovate, 3.2–5.2 × 1.2–1.8 mm, acute to acuminate at apex; stamens 5 or 6; filaments 3.4–5.2 mm long, red; anthers yellow. *Female flowers*: bracteoles 2.5–4.4 mm long, longer than immature receptacle; sepals narrowly ovate to linear, 1.7–2.7 × 0.4–1.0 mm, erect to spreading; carpel 1; stigma 1.6–2.5 mm long, greenish white, feathery, hidden at base of leaves; immature receptacle 0.8–1.2 × 0.4–0.7 mm, glabrous, smooth. *Achene* ellipsoid to cylindrical, 2.8–5.2 × 1.2–1.7 mm, greyish to medium brown, covered by membranous layer, glabrous, obscurely ribbed; ribs 6–9, rounded, up to 0.1 mm wide.

Habitat: in the west it is found on shale bands of Table Mountain Series, but east of Cape Agulhas it is restricted to dune slacks; altitude 0–1 100 m.

Distribution: widespread though scattered from Piketberg to Knysna.

Conservation status: widespread though scattered, but no serious threats except possibly var. *arenaria*, which grows in areas subject to development.

Etymology: *filifolia*, Latin for thread-leaved, referring to the fine, needle-like leaves.

10a. var. *filifolia*

C. leptophylla Eckl. & Zeyh.: 270 (1836). Type: Western Cape, 3319 (Worcester): Caledon District, Houwhoek Mtn, near Knofflookskraal, (–AA), July, *Ecklon & Zeyher 1752* (B†, CP, G-DEL, K!, L, PRE, UPS, S, W, Z).

Young stems 0.6–1.0 mm wide. *Leaflets* 6.1–17.0 × 0.4–0.8 mm, apex 0.2–0.9 mm long; lamina 0.2–0.4 mm thick, curved upwards and towards stem; sheath 1.3–3.0 mm long; stipules 0.7–3.1 mm long; petiole 0.2–2.0 mm long. *Female flowers*: bracteoles 2.5–4.4 mm long; sepals 1.7–2.7 × 0.4–1.0 mm, erect to spreading; carpel 1; stigma 1.6–2.5 mm long, greenish white, feathery,

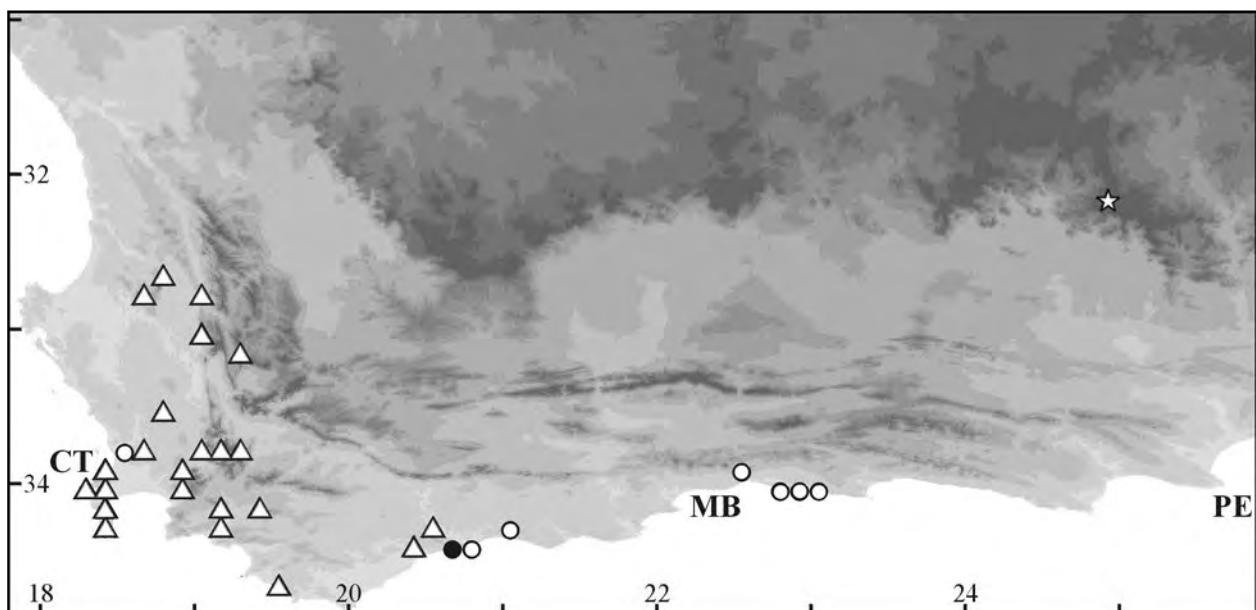


FIGURE 13.—Known distribution of *Cliffortia filifolia* var. *filifolia*, Δ; and *C. filifolia* var. *arenaria*, ○; *C. filifolia* var. *arenaria* and var. *filifolia*, ●; and *C. bolusii*, ☆, in South Africa.



FIGURE 14.—*Cliffortia filifolia* var. *arenaria*. A, branch with achenes, $\times 2$; B, leaf, $\times 3$; C, achene, $\times 10$.

hidden at base of leaves; immature receptacle $0.8\text{--}1.2 \times 0.4\text{--}0.7$ mm. Achene $2.8\text{--}4.4 \times 1.2\text{--}1.6$ mm. Flowering time: May–September.

Habitat: well-drained soils on shale bands of Table Mountain Series rocks in full sun; altitude 0–1 100 m.

Distribution: common but scattered on the lower slopes of mountains from Piketberg in the north to Caledon Swartberg in the south, including the Cape Peninsula, with an outlying population on the Potberg in De Hoop Nature Reserve (Figure 13).

10b. var. ***arenaria*** C.Whitehouse, var. nov., a varietate typica foliis plerumque brevioribus saepe deorsum curvatis differt.

TYPE.—Western Cape, 3422 (Mossel Bay): George District, sand dunes E of Wilderness, (–BA), 3 Dec. 1951, Esterhuysen 19336 (BOL!; NBG!, PRE!).

Young stems $0.5\text{--}0.6$ mm wide. Leaflets $5.8\text{--}6.6 \times 0.3\text{--}0.6$ mm, apex $0.1\text{--}0.3$ mm long; lamina $0.2\text{--}0.3$ mm thick, often curved downwards and away from stem; sheath $0.6\text{--}1.1$ mm long; stipules $0.7\text{--}1.0$ mm long; petiole $0.3\text{--}0.5$ mm long. Female flowers: bracteoles $2.5\text{--}2.8$ mm long; sepals $2.3\text{--}2.5 \times 0.6\text{--}0.8$ mm. Achene $4.7\text{--}5.2 \times 1.6\text{--}1.7$ mm. Flowering time: March to August. Figure 14.

Diagnostic characters and affinities: *Cliffortia filifolia* is relatively distinctive amongst the numerous needle-leaved species of *Cliffortia*. The presence of a short petiole along with the fine leaflets is diagnostic. However, within *C. filifolia*, there appear to be two distinct ecotypes. The western variety, var. *filifolia*, has longer leaflets, which curve upwards towards the stem. This variety generally occurs on clayish soils derived from sandstones of the Table Mountain Series. The eastern variety described here, var. *arenaria*, is distinguished by its shorter leaflets, which often curve in directions away from the stem. It is almost entirely restricted to sandy coastal areas, especially dune slacks. In the southern Overberg [3419, Caledon District, Waterford Farm, (–DA), Whitehouse 222] and Cape Flats [3318, Cape Town, Penhill, (–DC), Helme 1594], the distinction between the two varieties and their habitats is less clear, otherwise species status might have been considered more appropriate.

Habitat: wind-blown sand of dune slacks in full sun; altitude 0–250 m.

Distribution: coastal areas from De Hoop Nature Reserve as far as Knysna, with a possible record from the sandplains of the Cape Flats (Figure 13).

Etymology: *arenaria*, Latin meaning growing on sand, referring to the fact that it is found growing in dune slacks.

11. ***Cliffortia bolusii*** Diels ex C.Whitehouse, sp. nov., a congeneribus stipulis nullis foliis oblongis $3\text{--}7$ mm longis planis apicibus rotundatis distinguatur.

TYPE.—Eastern Cape, 3224 (Graaff-Reinet): Graaff-Reinet District, Nardouwsberg, (–BB), Apr. 1873, Bolus 2630 (BOL, holo.; B†).

C. sp. 1 sensu Weim.: 158 (1934).

Illustration: Weim.: fig. 47A (1934).

Shrub, densely divaricately branched, forming brachyblasts; young stems hairy; stem hairs spreading to curled. Leaves trifoliate; leaflets elliptic to oblong, $3\text{--}7 \times 0.6\text{--}0.8$ mm, apex mucronate to rounded, margins flat, entire and smooth; lamina chartaceous, straight to curved downwards and away from stem, hairy adaxially and abaxially; sheath $1.5\text{--}3.0$ mm long, abaxially hairy, adaxially glabrous except for fringe of hairs at apex; stipules absent; petiole absent. Flowers unknown but solitary bracteoles found at base of undifferentiated leaves; bracteoles hairy. Figure 15.

Diagnostic characters and affinities: the species has no clear affinities. The leaves bear a resemblance to a trifoliate version of *Cliffortia dichotoma* Fellingham, but are more rounded at the apex. Apart from its isolated geographic locality there is no further reason to suggest that it belongs to section *Arborea*. A solitary hairy bracteole was found in a leaf axil, but this does not reveal any significant systematic information about the species.

Weimarck refrained from naming this species until more information was available, although he realised that it was distinctive both taxonomically and biogeo-

graphically. Seventy years on from his monograph, no further collections have been made, but the trifoliate leaves, lacking stipules, with flat oblong leaflets, are diagnostic. Furthermore, it is important to recognize the taxon formally to encourage further searches for the species and to ensure that it is included in conservation assessments for the area.

Habitat: unknown, although the mountain is generally montane grassland with rocky outcrops and dolerite cliffs; altitude 1 700–1 800 m (but see note below).

Distribution: known only from a single collection made on the Nardouwsberg near Graaff-Reinet (Figure 13).

Conservation status: not been collected since it was first collected in 1873, though the Nardouwsberg is a large mountain and it may still exist on some rocky outcrops. The Nardouwsberg is subject to grazing and burning, making the chance of this species surviving away from the protection of rocks unlikely.

Etymology: *bolusii* is named after Harry Bolus, founder of the Bolus Herbarium at the University of Cape Town and the only person to have ever collected this species.

A very poorly known species with only a single surviving fragment remaining of a collection made over 100 years ago. Unfortunately Bolus's notes describing his collecting trip to the Nardouwsberg were lost in a shipwreck, as probably were further specimens account-

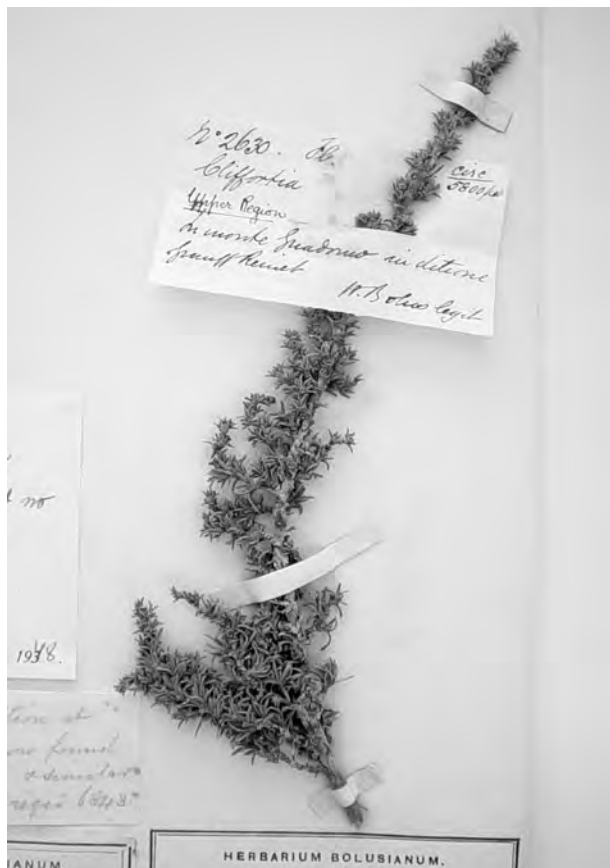


FIGURE 15.—Type specimen of *Cliffortia bolusii*.

ing for the paucity of the remaining fragment at BOL. (The other specimen seen by Weimarck was at B and is presumably now destroyed.) More accurate information on where he collected is therefore unavailable. A cursory search of the mountain did not reveal this species, but three other species were found: *Cliffortia eriocephalina*, *C. montana* and *C. ramosissima*.

The name *bolusii* is written on the herbarium sheet at BOL and attributed to Diels, though he never published it. Although the altitude is given as 5800 ft (± 1770 m), this is also the altitude given for Bolus's specimen of *C. eriocephalina* (Bolus 851) from the same locality. However, on the recent trip to the Nardouwsberg, *C. eriocephalina* was only seen just below the summit, an altitude of ± 2300 m.

12. **Cliffortia odorata** L.f., Supplementum plantarum: 431 (1782); Weim.: 152, fig. 45A–E (1934); Levyns: 450 (1950); Fellingham: 610 (2000).

TYPE.—South Africa, without precise locality, 'Cape of Good Hope', *Thunberg s.n.* (LINNf, holo.; CP, UPS-THUNB).

C. discolor Weim.: 202, fig. 16d–f (1948); Fellingham: 609 (2000), syn. nov. Type: Western Cape, 3318 (Cape Town): Cape Peninsula, Table Mtn, 1000 m, (–CD), Nov. 1884, *Marloth* 360 (PRE, holo.).

Cliffortia discolor was described by Weimarck based on a specimen from Table Mtn with very dense white hairs on the underside of the leaves. However, field observations of this well-explored locality reveal a continuous range of variation typical of *C. odorata*. Specimens of *C. odorata* at higher altitudes are often more densely hairy, especially beneath, and have smaller, rounder leaves. This is probably a result of increased exposure and as no further specimens have ever been attributed to *C. discolor*, the name is here reduced to synonymy of *C. odorata*.

13. **Cliffortia juniperina** L.f., Supplementum plantarum: 430 (1782); Weim.: 57, fig. 14A–E (1934); Fellingham: 615 (2000). Type: South Africa, without precise locality, *Sparrman* s.n. (LINNf, holo.)

C. hermaphroditica Weim.: 172, fig. 2a–c, t. 4 (1948); Fellingham: 612 (2000), syn. nov. Type: Western Cape, 3318 (Cape Town): Stellenbosch District, Jonkershoek, (–DD), 4 Nov. 1943, *Compton 15332* (NBG, holo.).

The identification of *Cliffortia hermaphroditica* is difficult as the specimen of *Compton 15332* supposedly deposited at NBG has not been found. Two other specimens of the same collection have been seen at BOL and PRE and both belong to a form of *C. juniperina* with close acute ribs. Weimarck placed the BOL specimen in his concept of *C. juniperina* var. *pilosula* on account of its hairy stems. The photograph in Weimarck l.c., t. 4 (1948) does nothing to suggest that the type was anything other than a slightly abnormal specimen of *C. juniperina*. Certainly the type locality has been very well collected and nothing else similar has been found, indicating further that it was an atypical form, possibly of hybrid origin, that arose once and has since disappeared.

ACKNOWLEDGEMENTS

The first author wishes to thank the Leverhulme Trust, who funded this research with a Study Abroad Studentship, along with assistance from the University of Cape Town through a J.W. Jagger International Scholarship and the Smuts Memorial Fellowship. The project was supported by Prof. H.P. Linder, formerly of the Bolus Herbarium, now in Zurich, Switzerland, with much valuable encouragement by Prof. T.A.J. Hedderson. The curators of BM, BOL, GRA, K, NBG, NU and PRE are thanked for permission to examine their collections or for sending loans.

SPECIMENS EXAMINED

Acoccks 16102 (9a) BOL, K; 21529, 22531 (10b) K, PRE; 22426 (10a) K, PRE. *Acoccks & Hafstrom* 568 (10a) PRE. *Andreae s.n.* (4a) BOL; 1154 (8) NBG, PRE.

Barker 4583 (10a) NBG; 5950 (9a) NBG. *Bean, Vlok & Viviers* 2096 (5) NBG, PRE. *Berg STE19824* (4a) NBG. *Beyers* 214 (9a) NBG, PRE. *A. Bolus* 1545 (4a) BOL. *F. & L. Bolus* 13310 (10a) BOL. *H. Bolus* 2630 (11) BOL; 4017 (10a) BOL, K; 6994 (9a) BOL, NBG, PRE; 7987 (4a) BOL, K; 11271 (5) BOL, PRE. *Bond* 727 (9a) NBG. *Bosenberg & Rutherford* 337 (1) NBG. *Boucher* 1749 (9b) NBG. *Boucher & Shepherd* 4359 (10a) NBG. *Boucher & Stindt* 5282 (10a) NBG. *Bousse s.n.* (9a) BM. *Burchell* 5583 (10b) K; 7816 (9a) K. *Burgers* 1947 (10a) NBG, PRE. *Burke s.n.* (10a) K. *Buys* 64 (9a) NBG.

Compton 6408, 8151, 9219, 16534 (7) NBG; 8359, 15301, 18324 (9a) NBG; 15828 (10b) BOL, NBG; 16471 (9b) NBG; 17090 (10a) NBG; 17451, 18546 (4a) NBG; 20120 (4b) NBG. *Cowling* 178 (10b) GRA.

De Villiers s.n. (9a) NBG. *Drège s.n.* (9a) K; *s.n.* (4b) K; *a* (9a) BM. *Dryfhout* 1557 (9a) NBG. *Duthie* 957 (9a) BOL.

Ecklon 1751, 1752 (10a) K. *Esterhuysen s.n.*, 1993, 11968, 33622, 33625 (4a) BOL; *s.n.*, 1992 (9a) BOL; 121 (4a) PRE; 2647 (4a) BOL, K, NBG, PRE; 8312 (8) BOL, K, PRE; 9296, 9368, 9920, 13782, 14183, 14280, 14722, 14832, 14891, 14946, 27575, 27688, 27772, 28090 (8) BOL; 10100, 15242 (4a) BOL, PRE; 11636, 11857, 11947, 14501, 16185, 31353 (10a) BOL; 11658 (10a) BOL, PRE; 12813 (4b) BOL; 14062 (4b) BOL, K; 14499, 15325 (10a) BOL, NBG; 14647 (4a) BOL, NBG; 15745 (10a) BOL, NBG, PRE; 19336 (10b) BOL, NBG, PRE; 27765 (5) BOL; 29401 (10b) BOL; 30602 (1) BOL, K, NBG, PRE.

Fellingham 655 (10a) NBG, PRE; 1056 (10a) NBG; 1529 (1) BOL, K, NBG, PRE; 1530, 1545, 1546, 1582, 1613, 1626, 1634, 1635 (1) BOL, NBG, PRE; 1551, 1597, 1601 (1) NBG; 1623 (1) NBG, PRE; 1695 (1) BOL, NBG. *Froembling s.n.* (4a) NBG; *s.n.* (10a) NBG.

Galpin 4002 (5) BOL, PRE. *Gamble* 22232 (10a) K. *Garside* 1025 (9a) K. *Gillett* 712, 1802 (9a) NBG. *Goulimis s.n.* (10a) BOL. *Guthrie* 35 (10a) BOL; 2348 (9a) NBG.

Haynes 692 (4a) K, NBG, PRE; 1148 (9a) NBG, PRE. *Helme* 1594 (10b) NBG; 2939 (3) NBG; 3970 (1) NBG; 3973 (6) NBG. *Herb. Goodenough s.n.* (9a) K. *Hort. Kew s.n.* (9a) BM. *Hubbard* 176, 396 (9a) NBG. *Humbert* 9436, 9663 (10a) PRE.

Keet STE13379 (10b) NBG; 725 (10b) GRA, PRE. *Kerfoot* 5412 (9a) NBG; 5705 (4a) PRE; 6021 (4a) K, NBG, PRE.

Leighton 460 (10a) BOL; 792 (9b) BOL. *Levy* 2707 (5) BOL; 3364, 3919, 7284, 8500, 11406 (9a) BOL; 5322 (10a) BOL; 5329 (10a) BOL, PRE; 7890, 9155, 10262, 10313, 10345 (10b) BOL.

Maguire 1067 (7) NBG. *Marloth* 2250 (8) PRE; 4241 (8) NBG; 4341 (4a) PRE. *McDonald* 651 (4a) K, NBG, PRE. *Morley* 8 (10b) NBG, PRE.

O'Callaghan, Fellingham & Van Wyk 105 (10b) NBG, PRE.

Page s.n. (10a) BOL, GRA. *Palmer* 78 (10a) NBG. *Pappe* 11 (9a) BM. *Parker* 3489 (4a) BOL, K, NBG; 3616, 4281 (9a) BOL, K, NBG. *Penfold* 32 (10a) NBG. *Pillans s.n.*, 8422 (9a) BOL; 7570 (10a) BOL. *Prior s.n.* (4a) K, PRE; *s.n.* (9a) K; *s.n.* (10a) K, PRE.

Robertson s.n. (9a) BM. *Rodin* 3266 (9a) BOL, K, PRE. *Rogers* 29245 (9a) BOL, K, PRE. *Runnalls* 587 (9a) NBG, PRE; 587a (9a) NBG. *Rycroft* 3209, 3284, 3318 (9a) NBG.

Schlechter 798 (9a) BOL; 2203 (5) K, NBG, PRE; 7558 (9a) BM, K, NBG, PRE. *Schoeman s.n.* (9a) NBG. *Sieber* 508 (10a) K. *Stauffer* 5022 (10a) K, NBG, PRE. *Stokoe SAM59213* (4a) NBG, PRE; *SAM61481* (9a) PRE; 8619 (9a) BOL, PRE; 8835 (8) BOL.

Taylor 6365 (10a) NBG, PRE; 6370 (10a) K, NBG, PRE; 6529 (10a) BOL, K, NBG, PRE; 6851 (10a) BOL, NBG, PRE; 6905 (9a) NBG, PRE. *Thode* 6174 (4a) NBG; 9181 (4a) NBG. *Thompson* 176 (3) NBG, PRE; 994 (4a) K, NBG, PRE.

Van der Merwe 844 (9a) NBG, PRE. *Van Jaarsveld & Sardien* 7686 (9b) NBG. *Van Rensburg* 469 (9a) NBG; *SKF2033* (9a) K, PRE. *Van Wyk* 1911 (10b) NBG, PRE.

Wallich s.n. (10a) K. *Werdermann & Oberdieck* 367, 743 (9a) K, PRE. *C. Whitehouse* 14 (4a) BOL, K, NBG; 21 (9a) BOL, NBG; 34 (4a) BOL, NBG; 54, 111 (10a) BOL, NBG; 98 (5) BOL, NBG; 119 (6) BOL; 137 (2) BOL, K, MO, NBG, Z; 145 (3) BOL, NBG; 151 (9a) BOL; 166, 282 (9b) BOL, NBG; 187 (8) BOL, NBG; 219 (1) BOL, K, NBG, Z; 222 (10a) BOL; 283 (7) BOL, NBG. *C. & A. Whitehouse* 149 (9a) BOL, K, NBG; 215 (10a) BOL; 245 (9a) BOL, NBG; 257 (6) BOL, NBG; 259 (6) BOL, K, NBG; 304 (10a) BOL, NBG; 318 (10b) BOL, NBG; 329 (3) BOL, NBG; 331 (7) BOL. *Wilms* 3182 (4a) K. *Wolley Dod* 1072 (10a) K; 2637 (4a) BOL, K. *Wright s.n.* (10a) K.

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Notes on African plants

Various Authors

APOCYNACEAE

A NEW SPECIES OF *HUERNIA* (ASCLEPIADOIDEAE–CEROPEGIEAE) FROM SOUTHERN ANGOLA

The genus *Huernia* R.Br. consists of 64 species according to Leach (1988). However, further research has suggested that 49 species is a better estimate (Bruyns 2005). The present new species then brings the number of species in *Huernia* to 50. *Huernia* is widely distributed in sub-Saharan Africa and six species also occur in the Arabian Peninsula, where the former South Yemen is the northeastern limit of its distribution. In Angola, *Huernia* is represented by *H. oculata* N.E.Br., *H. similis* N.E.Br., *H. urceolata* L.C.Leach, *H. verekeri* Stent and *H. volkartii* Peitsch. ex Werderm. & Peitsch. Of these, only *H. similis* is endemic to Angola, whereas *H. oculata* and *H. urceolata* are found in both Angola and Namibia and *H. verekeri* and *H. volkartii* are more widely distributed in southern Africa. The new species described here is also an Angolan endemic and is of very local occurrence on the margin of the Namib Desert near Namibe (Figure 1).

***Huernia lopanthera* Bruyns, sp. nov., nullo dubio** *H. kennedyana* Lavranos proxima, praecipue differt caulibus gracilioribus, corolla intus uniformiter rubra-brunnea cum papillis brevioribus, tubo corollae brevioris et lobis coronae exterioris interiorisque brevioribus.

TYPE.—Angola, NE of Namibe, Jan. 2006, Bruyns 10410 (BOL, holo.; K, iso.).

Dwarf succulent, up to 300 mm diam., forming dense mats of tightly packed stems, not rhizomatous. Stems 10–40 × 6–12 mm, decumbent, shortly ellipsoidal, grey-green; tubercles 1–3 mm long, conical, laterally flattened, acute, joined into 6 or 7 low ridges along stem to give it a tessellate appearance. Inflorescence of 1–3 flowers developing in gradual succession, arising at middle of or in lower half of stem on short peduncle (< 5 mm long), with fine filiform bracts 1 mm long; pedicel 7–10 × 1 mm, ascending, holding flower facing horizontally or slightly downwards; sepals 3–4 mm long, 1 mm broad at base, acuminate. Corolla 3–4 × 22–27 mm, shallowly plate-like to flat, scentless; outside obscurely papillate, pale brownish green, with 3 raised longitudinal veins running down lobes; inside uniformly deep red-brown becoming finely speckled with white towards centre, with many pale yellow papillae from middle of lobes to around corona, papillae up to 0.5 mm long and widely spaced on lobes becoming much shorter and densely crowded around corona; tube absent to very shallow (1–2 mm deep); lobes 5–7 × 7–10 mm, spreading, deltate, acuminate, with raised pale yellow papillate margin. Corona 2.5 × 3 mm, sessile on corolla; outer lobes 0.5 × 1–1.5 mm, spreading onto surface of corolla, ± rectangular to slightly notched in centre, pale yellow faintly suffused with red; inner lobes 1.5 mm long, deep yellow,

adpressed to anthers in lower half then rising slightly to meet in centre, slightly dorsiventrally flattened, sometimes with swollen gibbosity at base, sometimes with slightly clavate, finely bristly apex. Follicles and seed unknown. Figure 2.

The new species differs from all others in Angola by its 6- or 7-angled, shortly ellipsoidal stems and the nearly flat flowers. Vegetatively, *Huernia lopanthera* is most similar to *H. kennedyana* Lavranos, *H. longii* Pillans and *H. pillansii* N.E.Br. from the southern edges of the Great Karoo in South Africa, on account of the tessellate stems with more than five angles. In *H. longii* and *H. pillansii* the corolla has a cupular tube and the lobes are much longer than broad, whereas in *H. kennedyana* the flowers are relatively flat with a shallow tube and the corolla lobes are roughly as long as broad. Consequently, among these three species, *H. lopanthera* is most similar to *H. kennedyana*. In *H. kennedyana* the stems are almost spherical and, at 10–25 mm thick, are mostly much thicker than those of *H. lopanthera*. The flower in *H. kennedyana* is brilliantly transversely striped with red-brown to maroon on a cream-coloured

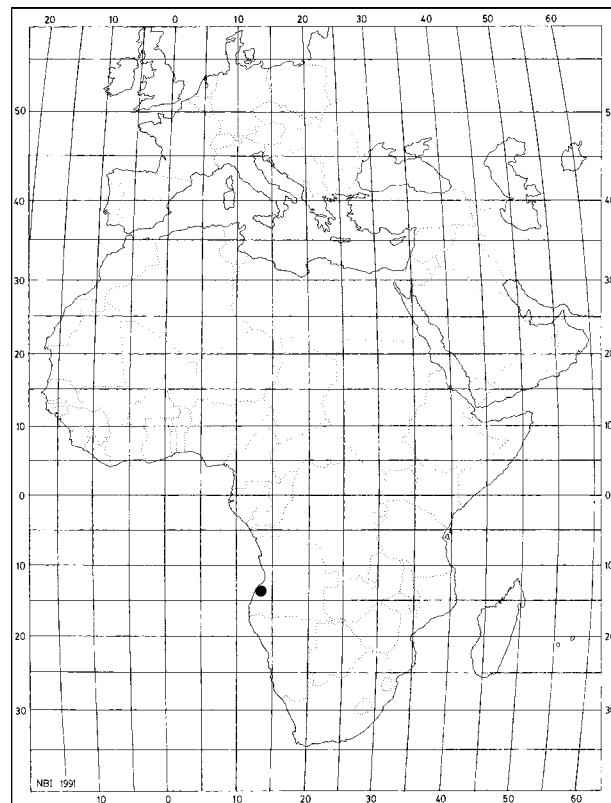


FIGURE 1.—Known distribution of *Huernia lopanthera*.

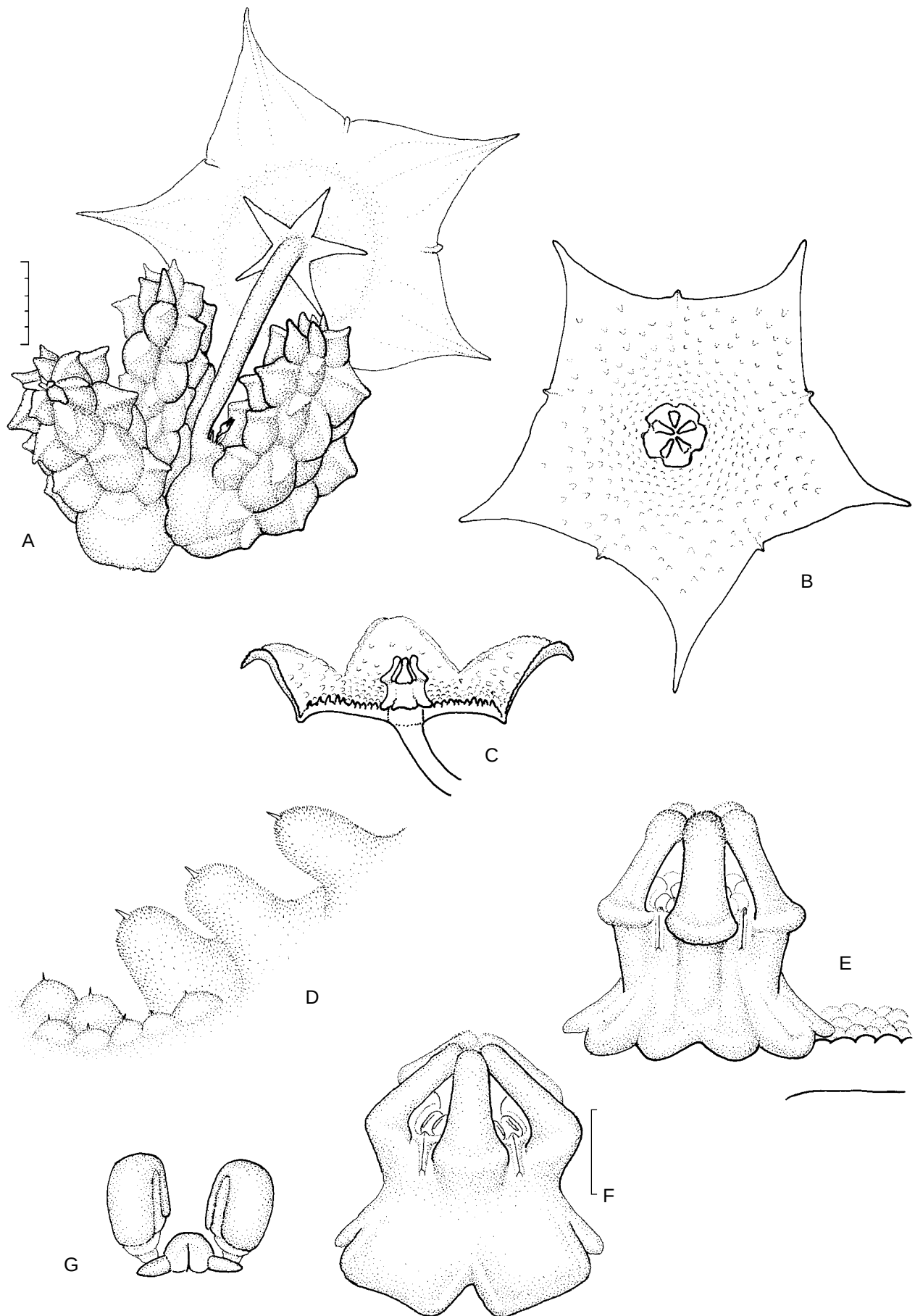


FIGURE 2.—*Huernia lopanthera*, Bruyns 10410. A, portion of plant; B, face view of flower; C, side view of dissected flower; D, papillae inside flower, larger ones from middle of lobes, smaller from around corona; E, F, side views of gynostegium; G, pollinarium. Scale bars (at A): A–C, 5 mm; (at F): D–G; D, 0.5 mm; E, F, 1 mm; G, 0.25 mm. Artist: P.V. Bruyns.

to dull yellow background (as opposed to uniformly deep red-brown in *H. lopanthera*), the corolla tube is 5–6 mm long (to 2 mm long in the new species, but often absent, as in Figure 1C) and the inner surface of the corolla has relatively long papillae, that reach a maximum length of 3 mm (contrasting with a maximum of 0.5 mm in the new species).

Although it has been stated (Leach 1969, 1974, 1988; Meve 1997: 42) that the corona in all species of *Huernia* is sessile on the base of the corolla tube, there are some species for which this is not the case (Bruyns 2005: 132). In those species of *Huernia* where the gynostegium is indeed sessile, the outer corona lobes can be pressed to the base of the corolla tube and may even be partly fused to it. The other extreme is presented by *H. kennedyana*, where the gynostegium possesses a short stipe (i.e. is not sessile) so that the outer corona is somewhat raised above the surface of the corolla tube. In this respect *H. lopanthera* differs from *H. kennedyana* in that it does not have a stipe beneath the gynostegium and the outer corona lobes touch the surface of the corolla, though they are not fused to it.

It has also been stated (Meve 1997: 43) that the gynostegium in *Huernia* is distinctive for the small tubercle on the outer corona projecting towards the base of the guide-rails. This structure is formed by the somewhat raised and projecting lip of the orifice below the guide-rails (Bruyns 2005: 133). Again this feature is actually variably present in *Huernia* (Bruyns 2005: 69, 133) and, while it is found in *H. kennedyana*, it is absent in *H. lopanthera*. In *H. kennedyana* the inner corona lobes are connivent in the centre and then diverge above this, whereas in *H. lopanthera* the inner corona lobes touch in the centre but do not rise above that and do not diverge again. The presence of a swollen gibbosity at their base

is surprisingly variable (as is seen in Figure 1E, F, drawn from different plants of the same collection) and the inner corona lobes are also sometimes swollen and finely papillate at their tips.

Plants of this new species form dense mats of very short stems filling crevices between rocks in gently sloping terrain. They occur amongst a sparse and very low vegetation, much of which is not higher than 300 mm. This vegetation contains a remarkable number of succulents. These include various members of the Portulacaceae, *Euphorbia carunculifera* L.C.Leach, *E. indurescens* L.C.Leach and *E. subsalsa* Hiern, one species each of *Kalanchoe* Adanson and *Kleinia* Miller, as well as a wide selection of Apocynaceae, including *Adenium obesum* (Forssk.) Roem. & Schultes, *Fockea angustifolia* K.Schum., *Hoodia currorii* (Hook.) Decne., *H. mossamedensis* L.C.Leach, *Huernia oculata* Hook.f., *Sarcostemma viminale* (L.) R.Br., *Stapelia kwebensis* N.E.Br. and *Tavaresia angolensis* Welw.

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 MS. received: 2006-06-30.

BORAGINACEAE

LECTOTYPIFICATION OF THE BASIONYM, *ECHIMUM GLAUCOPHYLLUM*

Buek (1837) based his combination *Lobostemon glaucophyllum* (Jacq.) H.Buek on *Echium glaucophyllum* Jacq. Although not directly referring to Jacquin, Buek did so indirectly by citing '*E. glaucophyllum* Pers.' referring to the use of the name by Persoon (1805) who cites Jacquin's original publication. Buek also included as a synonym, *E. laevigatum* Lam., a superfluous and illegitimate name for *E. glaucophyllum*. The species in question was described in Jacquin's *Collectanea* (1789a).

Jacquin (1789b) simultaneously and subsequently compiled *Icones plantarum rariorum*, the publication dates of which are multifarious (Schubert 1945). The illustration of *E. glaucophyllum* appeared in vol. 2, fascicle 3 in 1789 and the accompanying text was issued with the appearance of fascicle 16 (Jacquin 1795). Many of the Jacquin names published in *Collectanea* have been typified by illustrations in his *Icones plantarum rariorum*. Jacquin based many new names on specimens collected from plants cultivated in botanical gardens such as Schönbrunn (D'Arcy 1970). However, there is a Boos specimen at W (here chosen as lectotype) which appears

to be one of a few associated with Jacquin that was collected and dried in the field. Franz Boos (1753–1832), later to become Director of the mentioned garden, probably collected the specimen while accompanying the official Austrian expedition to Mauritius (Neilreich 1855). Boos arrived at the Cape in May 1786 and remained there for nine months before proceeding to Mauritius in February 1787. He called at the Cape again in the summer of January 1788 on his return to Europe, and arrived back in Vienna in July (Garside 1942; Gunn & Codd 1981).

Garside (1942: 211, 212) based his statements regarding the collection dates of the *Oxalis* specimens of Boos & Scholl, on the analysis by Salter, who had an unrivalled field knowledge of this genus in South Africa. Salter assumed that the *Oxalis* specimens were collected during Boos' first expedition from May to July, 1786.

In the protologue, Jacquin mentions '*Ad Promontorium bonae Spei creicit; sub dio apud nos floret Julio, hyemem agens in hybernaculo*', i.e. 'growing near the

Cape of Good Hope, blossoms in July when growing outside, kept in hibernation' (under cover) in the winter. 'Julio' could mean the month of collection in the Cape. We interpret the protologue as referring to a plant cultivated in the Schönbrunn garden which subsequently flowered in July.

The herbarium sheet *Boos s.n. sub W0001202* consists of two separate specimens, the one on the left numbered '2' and the one on the right numbered '1'. On the accompanying label is written in an unidentified hand '1. Cap. B. Sp. Boos.' and '2. Hort. Schönbr.' and on the reverse similarly, in an unidentified hand '1. Cap. B. Spei. Boos.' and '2. Hort. Bot. Schönbr.' Specimen '1' was therefore collected in the field by Boos and specimen '2' was sampled from a plant cultivated later in the Schönbrunn garden—the one mentioned in the protologue as flowering in July. Accordingly, we choose the specimen on the right ('1') as lectotype.

Echium glaucophyllum Jacq., *Collectanea*: 325, 326. (1789) $\equiv$ ***Lobostemon glaucophyllus*** (Jacq.) H.Buek, *Linnaea* 11: 139 (1837). Lectotype designated here: without locality, *Boos s.n. sub W0001202* (W!).

This lectotypification maintains application of the name *Lobostemon glaucophyllus* which is currently considered the correct name (Buys 2002).

ACKNOWLEDGEMENTS

We thank the curator of the Natural History Museum, Vienna (W) for allowing access to the designated type

specimen and John McNeill and Bruno Wallnöfer for commenting on the manuscript.

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MS. received: 2006-05-31.

ASPHODELACEAE

TRACHYANDRA ARENICOLA AND T. MONTANA, TWO NEW SPECIES FROM SOUTH AFRICA

INTRODUCTION

Trachyandra Kunth is a genus of ± 50 species distributed throughout sub-Saharan Africa. It is centred in the southern African winter rainfall region, with three or four species extending into tropical Africa, one as far north as Ethiopia (Smith & Van Wyk 1998). *Trachyandra* is distinguished from other genera of Asphodelaceae by its soft-textured leaves and short-lived, white or pinkish flowers with a deciduous perianth and $\pm$ scabrid filaments (Obermeyer 1962). The seeds appear to be highly characteristic, developing distinctive idioblasts containing bundles of needle-like crystals. These are visible as small, raised excrescences in the tissue of the enveloping funicular sarcotesta, which is a family characteristic of Asphodelaceae.

Three sections are currently recognized within the genus (Obermeyer 1962). In sections *Liriothamnus* and *Glandulifera* the first leaves of each growth cycle are not reduced to membranous sheaths and thus grade into the

foliage leaves, the roots are slender and wiry, and the filaments are monomorphic. Species in section *Glandulifera* are invariably sparsely or densely glandular-pubescent and those in section *Liriothamnus* either glabrous or pubescent but not glandular. Section *Trachyandra* is readily distinguished from the other sections by having the first leaves of each growth cycle reduced to sheathing membranous or papery cataphylls that surround the base of the annual shoots, by its $\pm$ swollen or tuberous roots, and by often having dimorphic filaments. It is the largest section of the genus, comprising around half of the species, most of which are endemic to the winter rainfall parts of the Western Cape and Northern Cape.

Just over 30 species are endemic or near-endemic (Obermeyer 1962; Manning & Klopper 2006). Two species have been described since the last revision of the South African members of the genus (Obermeyer 1962), both from the winter rainfall parts of the Western Cape and Northern Cape (Manning 1990; Perry 1990).

Another two species are described here. *Trachyandra montana* was recently discovered on the middle and upper slopes of Jonaskop, the highest peak in the western part of the Riviersonderend Mountain range in the southwestern Cape. *Trachyandra arenicola*, from the arid west coast of Namaqualand and adjacent Western Cape, was first collected in 1925–1926 and later in 1945 but confused with other species in the genus (Obermeyer 1962). Several recent gatherings made over the past few decades, however, provide ample evidence of its distinctness.

***Trachyandra montana* J.C.Manning & Goldblatt,**
sp. nov.

Geophyta decidua, 100–200 mm alta, radicibus gracilibus tuberibus fusiformibus distalibus ferentibus, foliis 1 vel 2 ligulatis firmis scabridis 5–10 mm latis, inflorescentibus simplice pedunculis dense pubescentibus, floribus albis nervo medio aurantiacis, tepalis ad basem medioque pubescentibus, ovario sparse scabrido ovulis 6 in quoque loculo, capsulis dense pubescentibus erectis 6–7 × 4–5 mm.

TYPE.—Western Cape, 3319 (Worcester): Riviersonderend Mtns, Jonaskop, along road to summit at 1 200 m, (–DC), 18 October 2005, J. Manning 2995 (NBG, holo.; MO, iso.).

Deciduous geophyte, 100–200 mm high. *Rhizome* short, horizontal; roots slender, lanate, reddish brown, developing tubers ± 100 mm from base, tubers 30–40 × 5–8 mm. *Cataphylls* surrounding shoots as well as leaf and scape bases, papery, brown, 5–10 mm long. *Leaves* (1)2, linear-lanceolate, 200–300 × 5–10 mm, plane, firm-textured, somewhat twisted and flexuous, striate with raised, thickened veins, scabrid along veins, bright green flushed pink towards base. *Inflorescence* a simple raceme; peduncle flexed 20–40 mm from base then inclined to erect, terete, 1.5–2.0 mm diam. at base, densely pubescent with short, straggling hairs; raceme lax, few- to many-flowered, 40–80 mm long; bracts ovate-acuminate, membranous, pubescent at base and along margins and midrib; pedicels 8–10 mm long, suberect in bud but arcuate-spreading at anthesis, becoming erect in fruit and ultimately ± 10 mm long, pubescent. *Flowers* rotate, white with orange midribs, immaculate, opening in afternoon, fragrance unknown; tepals pubescent at base and along abaxial midrib, outer elliptical, 10–12 × 2.0–2.5 mm, inner obovate, 10–12 × 4–5 mm. *Stamens* suberect; filaments filiform, tapering below, white, retrorsely scabrid in upper two thirds, outer ± 7 mm long, inner ± 6 mm long; anthers yellow, ± 2 mm long. *Ovary* ovoid, ± 2 mm long, sparsely scabrid, green, with 6 ovules per locule; style erect, filiform, ± 6.5 mm long, white. *Capsule* subglobose, 6–7 × 4–5 mm, densely retrorsely scabridulous. *Seeds* tetrahedral, verrucose, black, ± 3 mm diam. *Flowering time*: October and November. Figure 3.

Distribution and habitat: so far known only from the middle slopes of Jonaskop at the western end of the Riviersonderend Mountains (Figure 4), *Trachyandra montana* is not uncommon on the drier, north-facing

slopes, occurring in stony sandstone in more open, rocky ground and along the roadside.

Diagnosis and relationships: the papery cataphylls and fleshy roots place *Trachyandra montana* in section *Trachyandra*, where it is closely allied to *T. hirsutiflora* (Adamson) Oberm., another southwestern Cape endemic. Both are characterized by apomorphic, unbranched, cylindrical inflorescences with densely hairy scapes lacking sterile bracts, firm-textured and striate, scabrid leaves, and pubescent capsules. *Trachyandra montana* is distinguished by its distinctive roots, which are initially slender and only develop fusiform tubers some distance along their length, by its two (or rarely just one) plane leaves 5–10 mm wide, surrounded at the base with chestnut brown cataphylls, its rather lax and inclined inflorescence, and its relatively small capsules 6–7 mm long. *Trachyandra hirsutiflora*, in contrast, has roots that taper from a swollen base, (2)3–5 linear-canaliculate leaves (1)2–5(–8) mm in diameter surrounded at the base by translucent cataphylls, typically a dense, stiffly erect inflorescence, and characteristically large capsules (8–)10–15 mm long. *Trachyandra hirsutiflora* ranges through the coastal mountains of the southwestern Cape, from the Piketberg to the Potberg (Figure 4), but has not been recorded from further inland on the Riviersonderend Mountain range. It favours sandy, often seasonally moist flats rather than the drier, rockier situations in which *T. montana* occurs, and flowers especially freely, sometimes prolifically, after fire.

Other material examined

WESTERN CAPE.—3319 (Worcester): Riviersonderend Mtns, Jonaskop, along road to summit at 1 200 m, (–DC), 10 January 2006 (fruiting), J. Manning 2996 (NBG, MO).

***Trachyandra arenicola* J.C.Manning & Goldblatt,**
sp. nov.

TYPE.—Northern Cape, 2917 (Springbok): flats below Anenous Pass, along road to Eksteenfontein, Farm Grasvlakte, deep red sands, (–DC), 28 July 2006, J. Manning 3026 (NBG, holo.; K, MO, iso.).

Geophyta decidua, (100–)200–500 mm alta, radicibus pluribus leviter incrassatis decrescentibusque, foliis 150–200(–500) × 5–10(–30) mm, marginibus scabridulis retrorsis, ad basem cataphyllis papyraceis, inflorescentia erecta ramis 1 vel 2, laxe multifloris, pedunculo glabro vel pubescente, floribus albis maculo flavo ad basem tepalis, loculis ovulis 10–14 eodem, capsulis erectis 10–14 mm longis.

Deciduous geophyte, (100–)200–500 mm high. *Rhizome* short, vertical; roots several, slightly swollen and tapering, lanate, current season's complement without lateral rootlets, whitish, 5–6 mm diam. at base, previous season's complement developing feeder rootlets, brownish. *Cataphylls* ± 10 mm long, surrounding shoots as well as leaf and scape bases, papery, translucent greyish brown. *Leaves* (2–)4–12, lanceolate-falcate, 150–200(–500) × 5–10(–30) mm, plane, soft-textured and succulent, retrorsely scabridulous on margins, withered and twisted at tips at flowering time, glaucous

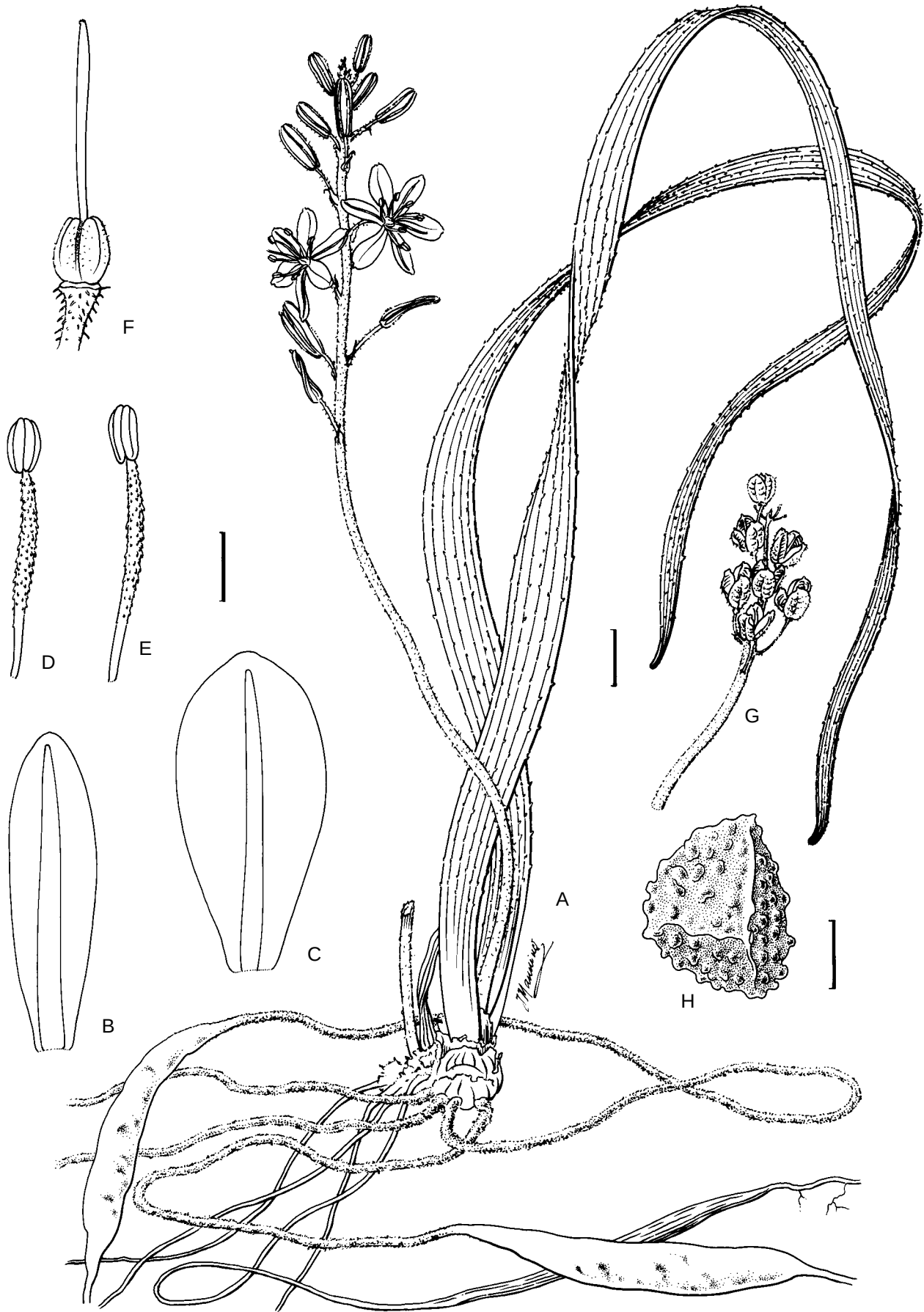


FIGURE 3.—*Trachyandra montana*, Manning 1995, 1996. A, whole plant; B–F, floral details: B, outer tepal; C, inner tepal; D, outer stamen; E, inner stamen; F, gynoecium. G, infructescence; H, seed. Scale bars: A, G, 10 mm; B–F, H, 2 mm. Artist: John Manning.

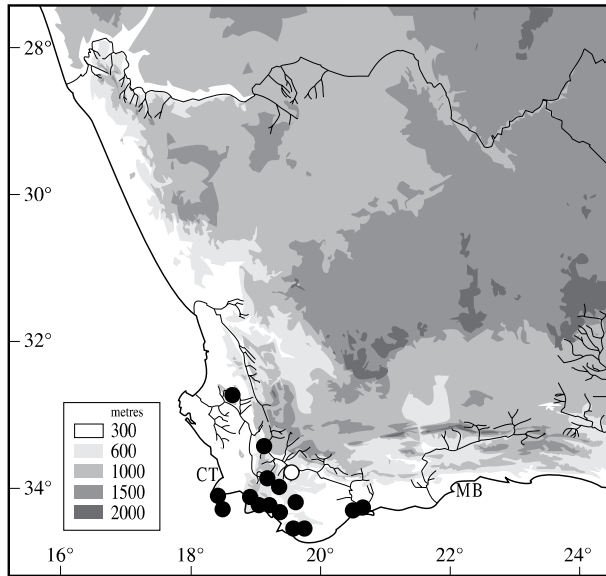


FIGURE 4.—Known distribution of *Trachyandra montana*, ○; and *T. hirsutiflora*, ●.

or dull green. *Inflorescence*: peduncle erect, sometimes becoming deflexed with age and in fruit, 3–7 mm diam. at base, green or flushed reddish, glabrous or pubescent with soft, straggling hairs; raceme, compound, lax, with one or two suberect branches, the lower sometimes with an additional accessory branch, usually several (up to 6) inflorescences per plant, many-flowered, 100–200(–600) mm long; bracts ovate-acuminate, 7–9 mm long, membranous, glabrous or pubescent along midrib, ciliate along margins in upper half; pedicels (10–)12–19 mm long, erect in bud but arcuate-spreading at anthesis, glabrous, sparsely retrorse-scabridulous, strigose, or pubescent with spreading hairs, becoming sinuate- or spreading-erect in fruit but not elongating further. *Flowers* rotate, white or flushed pink on reverse with greenish or greyish midribs, tepals each with greenish or bright yellow spot near base, opening $\pm$ 13:00 and withering $\pm$ 18:00, sweetly scented; tepals fused below for 1 mm, glabrous or pubescent adaxially at base and on midrib, outer oblanceolate, 10–13 $\times$ 2.3–3.0 mm, inner obovate, 10–13 $\times$ 3–4 mm, somewhat clawed in lower 3 mm and papillate-ciliolate along margins of claw. *Stamens* suberect; filaments filiform, tapering below, white or flushed pinkish in lower half, retrorsely scabrid or scabridulous except in uppermost 0.5–1.0 mm, outer 7–8 mm long, inner 8–9 mm long; anthers yellow, $\pm$ 1.8 mm long at anthesis. *Ovary* ellipsoid, $\pm$ 2 mm long, glabrous, green or greyish, with 10–14 ovules per locule; style erect, filiform, white, 10–11 mm long. *Capsule* ellipsoid, 10–12 $\times$ 4–5 mm, glabrous. *Seeds* tetrahedral, $\pm$ 2 mm diam., sparsely verrucose, pale reddish brown. *Flowering time*: mainly July and August, extending into September under favourable conditions. Figure 5.

Distribution and ecology: *Trachyandra arenicola* is scattered along the edge of the Namaqualand coastal plain wherever suitable areas of deep, sandy soils occur. Populations have been recorded from the Anenous Flats at the southern fringe of the Richtersveld in the north, as far south as Wallekraal in Northern Cape, and then much farther to the south around Klawer and Graafwater in

Western Cape (Figure 6). Plants are locally common on sandy flats or in duneveld, sometimes numbering hundreds of individuals. Like most species in the genus, the flowers open in the afternoon and wither the same evening. They are pleasantly scented.

Diagnosis and relationships: in its relatively robust stature, lanceolate leaves, and sparsely branched inflorescence, *Trachyandra arenicola* most closely resembles *T. ciliata* (L.f.) Kunth and *T. falcata* (L.f.) Kunth in section *Trachyandra*. The bracts in the immature inflorescences of these three species are closely imbricate, and the young racemes of *T. ciliata* and *T. falcata* were vividly likened to ears of corn by Obermeyer (1962). These characteristic young inflorescences make the latter two species useful as a vegetable under the Afrikaans vernacular name *veldkool*. On the basis of these several features it seems likely that the three species are immediately related.

Trachyandra arenicola is distinguished from *T. falcata* by its more slender stature, laxer inflorescences with $\pm$ concolorous bracts, and especially by lacking the amplexicaul peduncular bract diagnostic of *T. falcata*. The latter is an altogether more robust species with a dense inflorescence, characteristically with the outer half of the bracts suffused dark brown. In addition, the roots of *T. falcata* are far more numerous, slender, and not swollen. The two species are ecologically distinct, with *T. falcata* favouring stony, often granitic slopes, and *T. arenicola* restricted to sandy flats. From *T. ciliata* it is immediately separable by its erect, not trailing or creeping inflorescences (although the older inflorescences tend to topple over and become decumbent in fruit), its erect, not pendent fruits, and by the shorter bracts, 7–9 mm long vs 10–16 mm. *Trachyandra ciliata*, like *T. arenicola*, is also commonly encountered on sandy coastal flats but is much more widely distributed, extending from southern Namibia through the coastal areas of Western Cape as far east as Bathurst in the Eastern Cape (Figure 6).

All three species may be variously pubescent or $\pm$ glabrous, with both forms co-occurring in certain localities. In *Trachyandra arenicola* the variation in vestiture is geographical. Populations from Namaqualand in Northern Cape are glabrous apart from the sparsely scabridulous pedicels, whereas those from the south, around Klawer and Graafwater, are densely pubescent on the peduncles and pedicels, and the tepals are also partially pubescent. The capsules in the southern populations tend also to be slightly more broadly ellipsoid. Early collections from the southern populations were identified as *T. falcata* by Obermeyer (1962), and a single, incomplete collection from Namaqualand she assigned to *T. ciliata*.

Other material examined

NORTHERN CAPE.—2917 (Springbok): Anenous Flats, Farm Grasvlakte, red sands, (–DC), 6 October 1991, J. Manning 1032 (NBG); 23 August 1992, P. Goldblatt & J. Manning 9287 (MO, NBG). 3017 (Hondeklipbaai): Farm Avontuur, 15 km inland from Hondeklipbaai, deep, loose sand, (–AD), 29 August 1990, P.A. Bean & M. Viviers 2558 (BOL); 1 km from Wallekraal, red sand flats, (–BC), without date, P.L. Perry 3869 (NBG); 1.5 km along Wallekraal road

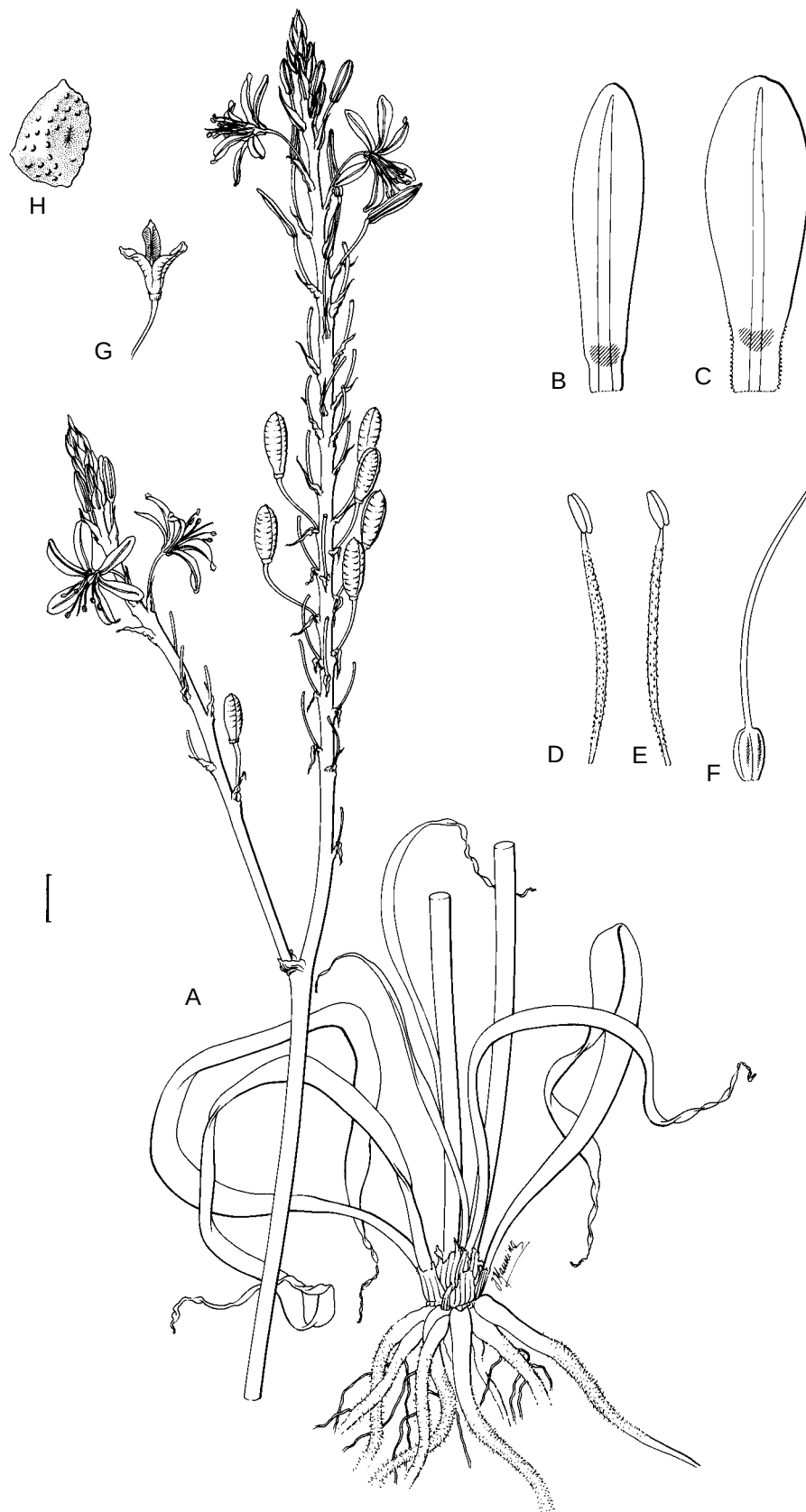


FIGURE 5.—*Trachyandra arenicola*, Manning 3026. A, whole plant; B–G, floral details: B, outer tepal; C, inner tepal; D, outer stamen; E, inner stamen; F, gynoecium; G, capsule; H, seed. Scale bar: A, G, 10 mm; B–F, 2 mm; H, 1 mm. Artist: John Manning.

to Spoegrivier, red sands, (–BC), 6 October 1991, *J. Manning* 1039; Farm Hardekoppie, northwest of Kotzesrust, consolidated sand, (–DC), 180 m, 29 September 1987, *C. Reid* 1299 (BOL, PRE); 10.5 km west of Kotzesrust, sandy slope, (–DD), 28 August 2001, *P. Goldblatt & L. Porter* 11778 (MO, NBG). Without precise locality: Namaqualand, 1925–6, *G. Meyer* s.n. (NBG).

WESTERN CAPE.—3118 (Vanhynsdorp): ± 50 km west of N7 highway between Clanwilliam and Vanhynsdorp, 6.5 km north of turnoff to Klawer, sandveld, (–DA), 7 August 1985, *K. Steiner* 906 (NBG); 20 km SSE of Klawer, Sandkraal, (–DC), without date, *P.L. Perry* 3580 (NBG); Klawer, (–DC), 2 September 1945, *W.F. Barker* 3638 (NBG).

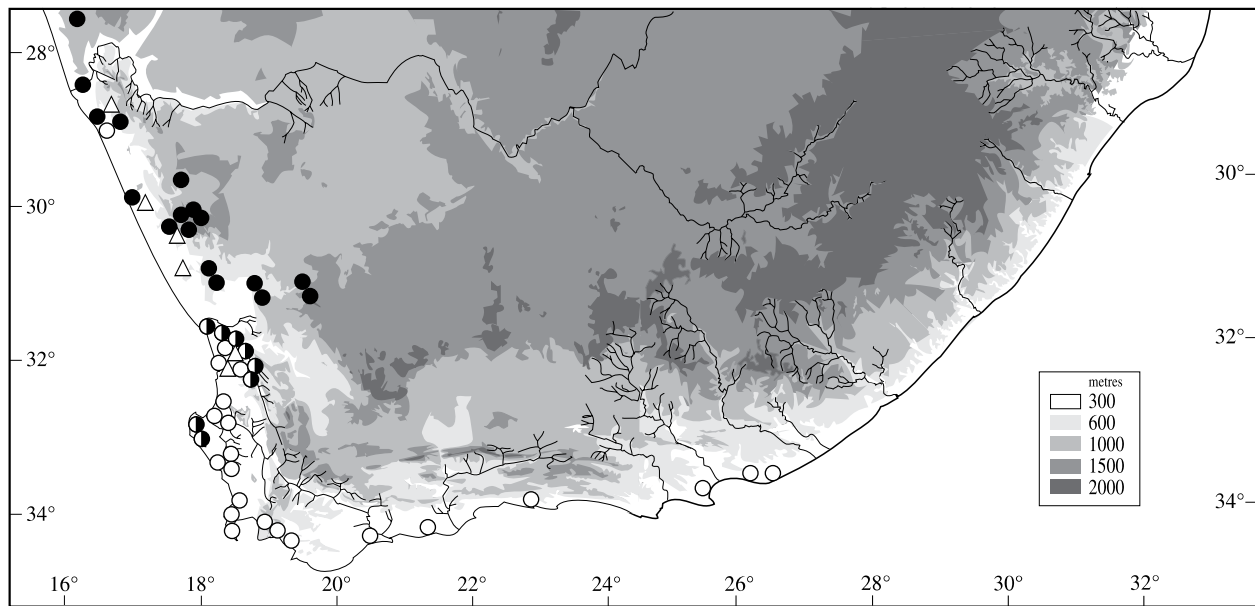


FIGURE 6.—Known distribution of *Trachyandra arenicola*, $\triangle$; *T. ciliata*, $\circ$; and *T. falcata*, $\bullet$.

ACKNOWLEDGEMENTS

Material was gathered with permits from Western and Northern Cape Nature Conservation.

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MS. received: 2006-05-29.

HYACINTHACEAE

A NEW PYROPHYTIC *LACHENALIA* SPECIES (MASSONIEAE) FROM WESTERN CAPE, SOUTH AFRICA

The new species described here forms part of a series of papers towards a revision of the genus (Duncan 1993, 1996, 1997, 1998; Duncan & Edwards 2002, 2006).

Lachenalia lutzeyeri G.D.Duncan, sp. nov.

Bulbus globosus penitus praesens, folia 1 vel 2 anguste lanceolata marginibus cartilagineis, pedunculus rigidus, flores oblongo-campanulati nutantes flavo-cremei gibbis viridibus vel brunneis, stamina bene exserta filamentis leniter declinatis, semina globosa strophiole inflato medio-terminali. *L. youngii* Baker affinis, sed ab specie nova bulbis non profundis foliis linearibus marginibus non cartilagineis pedunculo non rigido floribus staminibus breve exsertis filamentis rectis differt.

TYPE.—Western Cape, 3419 (Caledon): Witkransberg area of Grootbos Private Nature Reserve, northwest

of Gansbaai, on southwest-facing mountain slope in Table Mountain Sandstone, (–CB), November 2004, *H. Lutzeyer* s.n. (NBG, holo.!; PRE, iso.).

Deciduous, winter-growing geophyte, 200–420 mm high. *Bulb* solitary, deep-seated, globose, 20–25 mm diam., white with membranous, dark brown outer tunics; roots numerous, mainly contractile, a few fibrous. *Leaves* 1 or 2, narrowly lanceolate, 85–290 × 4–13 mm, prostrate, spreading or suberect, deeply canaliculate or sometimes conduplicate, yellowish green or pale to deep maroon, adaxial surface plain or with large dark green, brown or maroon flattened pustules, margins cartilaginous, flat or undulate; clasping leaf base white, subterranean, up to 85 mm long, or with short aerial portion up to 15 mm long. *Inflorescence* an erect or suberect, many-flowered, moderately dense raceme 50–120 mm long, with a sterile apex up to 10 mm long; peduncle

rigid, erect or suberect, 120–200 mm long, green and unmarked, or yellowish green and heavily marked with minute maroon speckles or small to large maroon blotches; rachis green, 50–120 mm long; pedicels suberect during flowering, ascending in fruit, green, 3–4 mm long; bracts ovate in lower half of inflorescence, becoming lanceolate in upper half, 1–2 × 0.5–2.0 mm, translucent white. *Flowers* oblong-campanulate, nodding at anthesis, yellowish cream with dark green or brown gibbosities, with a moderately strong, soapy-sweet scent, fading to dull maroon and ascending in fruit; perianth tube cup-shaped, pale yellowish cream, 2–3 mm long; outer tepals ovate, 5–6 × 3–4 mm, inner tepals obovate, 6–7 × 4–5 mm, protruding very slightly beyond outer tepals, translucent white with a yellowish green median keel and a dark green or brown marking near

apex. *Stamens* exserted 5–6 mm beyond perianth; filaments weakly declinate, white, 9–10 mm long; anthers maroon prior to anthesis; pollen yellow at anthesis. *Ovary* obovoid, 2 × 3 mm, bright green; style straight, 9 mm long, white. *Capsule* obovoid, 6–7 × 6–7 mm. *Seed* globose, 1.1–1.2 × 1.2–1.3 mm, shiny black, with a terminal, inflated, black strophiole 0.8–0.9 mm long. *Flowering time*: early to late November, rarely to late January, with a peak in mid-November. Figures 7, 8.

Etymology: *Lachenalia lutzeyeri* is named for Heiner Lutzeyer of Grootbos Private Nature Reserve near Gansbaai, who discovered this species and made the first collection of plants, in recognition of the wonderful contribution that he has made to nature conservation in this part of the southern Cape.

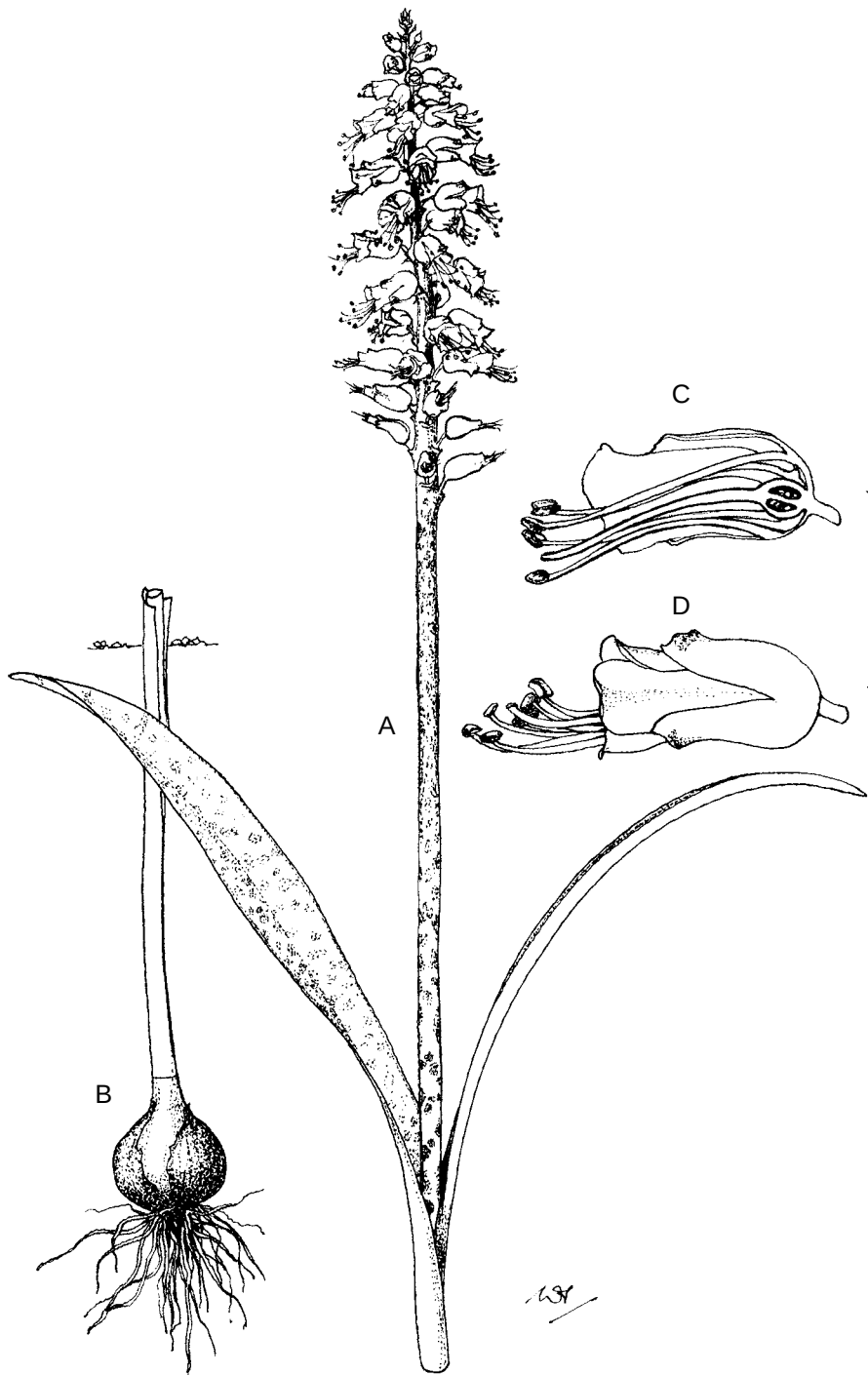


FIGURE 7.—*Lachenalia lutzeyeri*, Duncan 511 (NBG): A, inflorescence, peduncle and leaves; B, bulb and clasp leaf base; C, l/s flower; D, single flower. A, B, × 0.8. Scale bar: C, D, 10 mm. Artist: Vicki Thomas.

History: *Lachenalia lutzeyeri* is only known from the type material, first collected by Heiner Lutzeyer (Figure 8B) in early November 2004, following an extensive wild fire that burnt over the Witkransberg area of Grootbos Private Nature Reserve, northwest of Gansbaai, in late March 2004. Large numbers of plants were seen in flower in November 2004 but during the corresponding period in November and December 2005, the number of flowering plants had decreased drastically to just a few individuals. A single flowering specimen was collected on 15 November 2005 for illustration. In February 2006, the *L. lutzeyeri* type population was burnt again as a result of a devastating fire that raged across most of the Grootbos Private Nature Reserve and resulted in the appearance of large numbers of flowering individuals in November of that year.

Diagnostic features and affinities: *Lachenalia lutzeyeri* is recognized by a moderately dense raceme of oblong-campanulate, nodding, yellowish cream flowers with olive green or dark brown gibbosities and well-exserted stamens with weakly declinate, white filaments. The inflorescence is borne on a rigid peduncle and the inner tepals protrude 1–2 mm beyond the outer tepals. The pedicels become ascending and the capsules become suberect at fruiting, and the globose, shiny black seeds have a terminal, inflated, medium-long strophiole 0.8–0.9 mm long. The plants occur as solitary individuals within small to large groups, and have deep-seated, globose bulbs that produce one or two narrowly lanceolate, prostrate, spreading or suberect, deeply canaliculate or sometimes conduplicate leaves with flat or undulate, cartilaginous margins (Figures 7, 8).

Lachenalia lutzeyeri appears to be most closely allied to *L. youngii* Baker, another late-flowering species that

occurs much further east from Mossel Bay in the southern part of the Western Cape to Humansdorp in the southwestern part of the Eastern Cape. *L. youngii* has similar oblong-campanulate, nodding flowers produced on suberect white pedicels and is also a member of the group of species having globose shiny black seeds with a medium-long (0.5–0.9 mm), terminal, inflated strophiole. *L. youngii* differs mainly in having linear leaves without cartilaginous margins, a non-rigid peduncle, shortly exserted, straight stamens, purplish pink, unscented flowers, and its shallow-seated bulbs are offset-forming and not dependent on fire for flowering to occur.

Distribution and habitat: *Lachenalia lutzeyeri* is presently only known from the type locality on the Witkransberg in the Grootbos Private Nature Reserve, northwest of Gansbaai in the southern part of the Western Cape (Figure 9). Possible reasons for it having remained undetected until very recently are that flowering is extremely erratic, due to its dependence on the occurrence of summer or early autumn fires, coupled with its very late flowering period and the slim chance of it being recognized as a distinct taxon due to its superficial similarity to other members of the genus. It may well be recorded in other parts of the southern Cape in due course. In *Lachenalia*, flowering performance is greatly enhanced in a number of species in the spring and early summer season immediately following late summer or early autumn fires, such as in *L. orchidoides* (L.) Aiton and *L. peersii* Marloth ex W.F.Barker. However, *L. lutzeyeri* is remarkable in being one of only three members of this genus known to be entirely dependent on the effects of fire for flowering to occur. Until recently, two other pyrophytes endemic to montane fynbos of the southern Cape, *L. montana* Schltr. ex W.F.Barker and *L. sargeantii* W.F.Barker were the only



FIGURE 8.—A, *Lachenalia lutzeyeri* flowering in habitat, Grootbos Private Nature Reserve; B, Heiner Lutzeyer with a flowering specimen of *Lachenalia lutzeyeri*, 15 November 2005. Scale bar: A, 10 mm.

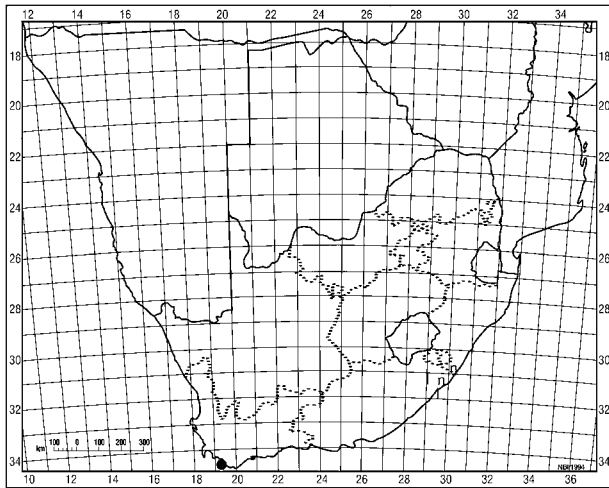


FIGURE 9.—Distribution of *Lachenalia lutzeyeri*.

other species known to flower solely in the wake of wild fires (Duncan 1988). An example of erratic flowering in one of these pyrophytic taxa was observed recently in *L. sargeantii*. It was discovered in full bloom in November 1970 after a summer burn near Bredasdorp; only a few individuals flowered there the following year, and it was only seen in flower again 33 years later, in a new locality in the southern Cape (Duncan & Edwards 2005; Duncan *et al.* 2005). The typical phenological pattern displayed by these three fire-dependent species is seen as lush vegetative growth produced in the winter season immediately following summer or autumn fires, followed by prolific flowering in early summer, and dormancy from midsummer to midautumn. During the second winter season following a burn, most of the bulbs remain completely dormant, with an extremely small number of individuals (or sometimes none at all) producing leaves in winter, and flowers in early summer. The bulbs of these three species all flower at $\pm$ the same time of year, and are deep-seated, especially those of *L. lutzeyeri* that can be buried up to 85 mm deep. All three species produce relatively few fibrous roots, but numerous contractile roots assist in pulling the bulbs deeply into the soil. Deep-seated bulbs may be an adaptive strategy to escape damage from severe fires. Rigid peduncles in *Lachenalia* are only known in these three species.

At the type locality, *Lachenalia lutzeyeri* occurs in a large colony, but as solitary individuals; no plants seen appear to multiply by offset formation. They grow in full sun in open aspects or between Table Mountain Sandstone boulders, on a moderate slope with a south-westerly aspect, at an altitude of 390 m. Following

a recent severe fire that burnt over most of Grootbos Private Nature Reserve in February 2006, large numbers of *L. lutzeyeri* have been observed growing in a range of aspects in addition to the southwesterly aspect of individuals at the type locality, especially on southern and northern slopes. Companion plants of *L. lutzeyeri* include *Mimetes cucullatus* (Proteaceae) and various genera of the family Restionaceae.

Paratype material examined

WESTERN CAPE.—3419 (Caledon): Witkransberg in Grootbos Private Nature Reserve, northwest of Gansbaai, on southwest-facing mountain slope in Table Mountain Sandstone, (–CB), 15-11-2005, Duncan 511 (NBG).

ACKNOWLEDGEMENTS

We extend our thanks to Mr Heiner Lutzeyer for bringing this new taxon to our attention, Ms Vicki Thomas for executing the line drawing, and Dr E.G.H. Oliver for translating the diagnosis into Latin.

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MS. received: 2006-06-06.

FABACEAE

ASPALATHUS THERESAE, A NEW SPECIES FROM WESTERN CAPE, SOUTH AFRICA

INTRODUCTION

Aspalathus L., comprising 278 species, is the largest genus endemic to South Africa (Dahlgren 1988). The distribution of the genus lies mainly in the Cape Floristic

Region (CFR), where about 98% of the species occur, and it is the second largest genus in the CFR (Goldblatt & Manning 2002). Important contributions to the taxonomy of *Aspalathus* were published in a series of publications in the 1960s by Dahlgren (1960, 1961, 1963, 1965,

1967, 1968). Since then a single species was described in the mid 1980s (Dahlgren 1984), but since the treatment for the *Flora of southern Africa* (Dahlgren 1988) no new species has been described.

During a field trip in 1997 in the Riviersonderend Mountains, Western Cape, with colleagues Ted and Inge Oliver and John Manning, I collected various legume plants. Numerous attempts to identify an *Aspalathus* species failed. The specimen displays a combination of characters unique in the genus which justify its recognition as a distinct species following the species concept applied by Dahlgren (1960, 1963). He recognized species when the individuals of one or more populations are morphologically distinct from those of other species by a marked discontinuity in several characters. The distribution of the species may or may not overlap with other closely related species (Dahlgren 1960, 1963). This species meets these criteria and it is accordingly described here.

Aspalathus theresae C.N.Cupido, sp. nov., *A. aspalathoides* (L.) Rothm. affinis a qua differt carina rostrata, stylo sigmoideo, vexillo ovato-circulari, alis lunatis, ovulis 4.

TYPE.—Western Cape, 3419 (Caledon): Riviersonderend, Riviersonderend Mtns, Olifantsdoorn, northern head, 1 280 m, (–BB), 7 November 1997, C.N. Cupido 29 (NBG, holo.; PRE). Figure 10.

Erect, branched shrub up to 700 mm high; branches densely leafy, villous or woolly. *Leaves* trifoliolate; leaflets flat, oblong or narrowly elliptic, acute, 5.5–9.0 × 1.5–2.8 mm, coriaceous, green, with long villous hairs on abaxial surface, adaxial surface glabrous. *Inflorescence* a terminal head of 5–20 flowers, subtended by uppermost leaves; pedicel 0.5–3.0 mm long, covered with long villous hairs; bracts unifoliolate, linear, 5.8–8.1 mm long, covered with long villous hairs; bracteoles unifoliolate, similar to bracts, 5.5–5.8 mm long, covered with long villous hairs. *Calyx* campanulate, sericeous; lobes triangular, upper lobes distinctly broader than remaining lobes, 2.2–3.6 mm long. *Corolla* yellow; standard blade ovate-circular, 6.7–9.0 × 6.8–8.0 mm, sericeous on back, apex emarginate, base cordate, claw 3.0–3.4 mm long; wing blade lunate, 6.1–8.0 × 3.1–4.3 mm, sericeous on most of lower parts, with several rows of minute folds, claw ± 2.9 mm long; keel blade rostrate, 6.5–8.1 × 3.5–4.7 mm, upper margin slightly concave, sericeous on lower parts, prominent pouch present, claw 2.8–4.0 mm long. *Stamens* monadelphous; filaments united basally for three quarters, forming a split sheath; anthers 5 short, dorsifixed; 4 long, basifixed; 1 intermediate in size and attachment. *Pistil* sessile, ovary and style base sericeous; ovules 4; style sigmoid, stigma capitate. *Pod* obliquely ovate, rostrate, 5.5–6.0 × 3.2–3.5 mm, one-seeded. *Flowering time*: November. Figure 11.

Conservation status: known from a single small population on the Riviersonderend Mountains and is not under threat. It must be considered as Vulnerable [D2, World Conservation Union (IUCN) 2001].

Diagnostic features and affinities: no phylogeny for *Aspalathus* exists to provide evidence for relationships within the genus. However, Dahlgren (1988) established



FIGURE 10.—Holotype of *Aspalathus theresae*.

informal groups to give recognition to morphological similarities between supposedly related species. The placement of *A. theresae* is uncertain, but a combination of several characters can be used to suggest possible affinity. The flat, trifoliolate leaves and capitate inflorescence place *A. theresae* in the group Cephalanthae, one of 34 groups recognized by Dahlgren (1988). The name Cephalanthae is derived from the capitate inflorescence characteristic of species in this group. Species in other groups, particularly in the Sericeae may have these characters. Within the Cephalanthae, *A. theresae* superficially resembles *A. aspalathoides* (L.) Rothm. The two species are similar in general appearance, the number of flowers in the inflorescence and the cordate shape of the standard base. *A. theresae* differs from it in having a rostrate keel, sigmoid style, ovate-circular standard, lunate wing blades and four ovules. In contrast, the keel in *A. aspalathoides* is obtuse, the style upcurved, the standard elliptic, the wings oblong and the ovules two. In addition to the differences in morphological features, *A. aspalathoides* is not known from the Riviersonderend Mountains. It occurs mainly on coastal mountains from the Cape Peninsula to Bredasdorp, as well as along the Langeberg Mountain range in Swellendam, Riversdale and Montagu, Rooiberg Mountains south of Ladismith and Keurkloof northwest of Barrydale. Within the Cephalanthae, the rostrate keel and sigmoid style are unique to *A. theresae*. A rostrate keel and sigmoid style are characteristic of the groups Rostratae and

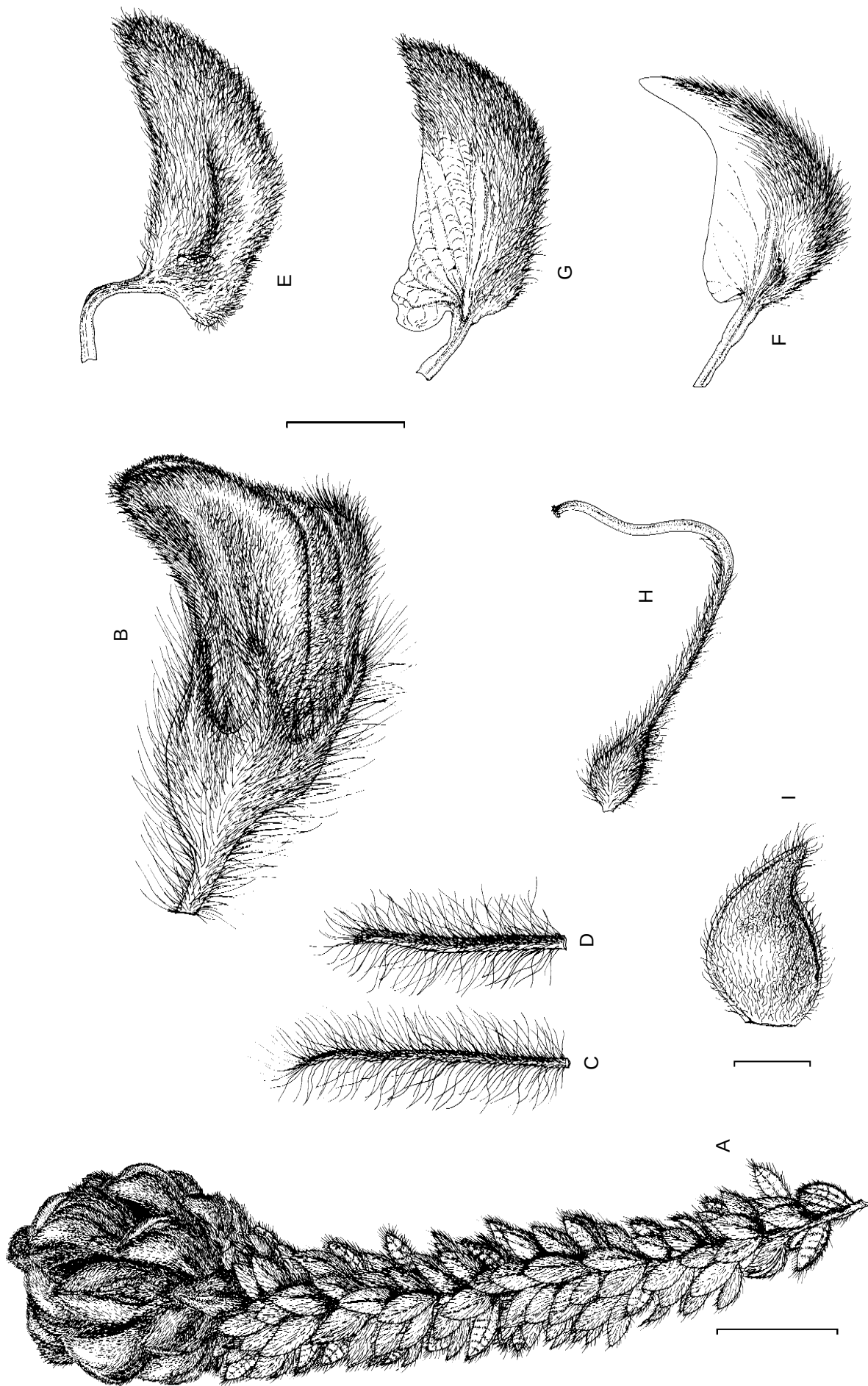


FIGURE 11.—*Aspalathus theresae*, Cupido 29. A, flowering branch; B, flower; C, bract; D, bracteole. E–G, petal; E, standard (folded); F, keel; G, wing. H, pistil; I, pod. Scale bars: A, 10 mm; B–H, 3 mm; I, 2 mm. Artist: T.L. Nowell.

Crotalariaiiformes, but in these groups the inflorescences are unifloral and situated on reduced lateral shoots or in terminal groups of two to four flowers. The leaves are also described as subterete or somewhat angular or flat (Dahlgren 1988). In the Carnosae, *A. theresae* shares the rostrate keel, sigmoid style and capitate inflorescence with the Cape Peninsula endemic species, *A. capitata* L. However, this species differs from *A. theresae* in having clusters of linear-pinoid leaves, elliptic to narrowly obovate bracts, longer pedicels and two ovules.

Distribution and habitat: *Aspalathus theresae* is only known from a single collection from the northern head of Olifantsdoorn in the Riviersonderend Mountains (Figure 12). It grows in sand on an exposed rocky Table Mountain Sandstone slope at an altitude of 1 280 m.

Etymology: the specific epithet is derived from my mother's forename, Theresa, in acknowledgement of her love for plants, which she also instilled in me.

ACKNOWLEDGEMENTS

I wish to thank Ferozah Conrad for the Latin translation and Dr John Manning for valuable comments on the final draft of the manuscript. Deshni Pillay assisted with determining the conservation status and Tracey Nowell is thanked for the line drawings.

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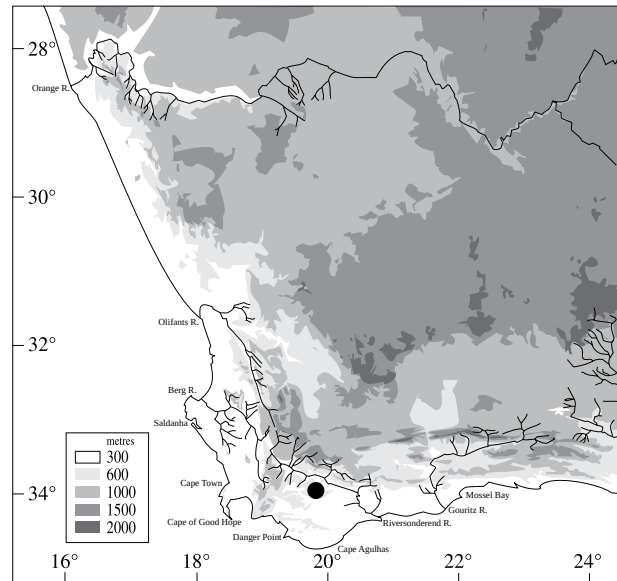


FIGURE 12.—Known distribution of *Aspalathus theresae*.

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LAMIACEAE

RABDOSIELLA LEEMANNII, A NEW SPECIES FROM THE LIMPOPO PROVINCE OF SOUTH AFRICA

***Rabdosiella leemannii* N.Hahn**, sp. nov., affinis *R. calycinae* sed ab illa habito perenne fruticoso, foliis minoribus, angustioribusque, ellipticis vel trullatis, (57–) 59–66(–70) × (25–) 27–36(–38) mm, perianthio maiore (6.9–) 7.0–9.4(–9.7) mm, tubo (3.6–) 3.7–4.9(–5.2) × 2.9–3.1 mm mediante differt.

TYPE.—Limpopo, 2329 (Polokwane) [Pietersburg]: Soutpansberg, Lejuma, 23°01'22.584"S, 29°25'57.180"E, 1 638 m, (–AB), 13-04-2005, in flower, *N. Hahn 2086* (ZPB, holo.; PRE!, PRU!, iso.).

Phanerophyte, single or multi-stemmed shrub up to 2 m tall, usually not exceeding 1.5 m. *Seedlings* with distinctly succulent roots. *Main stem* up to 50 mm diam., showing multiple year rings, not ribbed in fresh mate-

rial; young stems pubescent, pale brown. *Bark* grey to grey-brown, glabrous. *Leaves* decussate, rarely ternate; lamina shortly petiolate; petiole (1.1–) 1.9–3.4(–4.0) mm; blade ovate to elliptic to trullate, size of mature leaf, (57–) 59–66(–70) × (25–) 27–36(–38) mm, upper surface pale green, strigose, lower surface grey, tomentose; main veins 5–8, venation reticulate; margins crenate to dentate, teeth 10–15 per side. *Inflorescence* a terminal thyrse, 50–100 mm long. *Flowers* in pedunculate dichasia, 20 mm long; peduncles 2–4 mm; pedicel (3.6–) 3.7–4.9(–5.2) mm long. *Calyx* equally 5-toothed, tubular, 2.2–4.9(–5.2) mm long in flowering stage extending to 1 × 6 mm in fruiting stage, green, glandular hairy, lobes 5, (1.1–) 1.2–1.4 mm long, tinged purple at apex, at fruiting (4.0–) 4.2–5.0(–5.1) mm long. *Corolla* (6.9–) 7.0–9.4(–9.7) mm long; tube (3.6–) 3.7–4.9(–5.2) × 2.9–3.1 mm,



FIGURE 13.—*Radosiella leemannii*. A, flowering branch, $\times 1$; B, infructescence, $\times 1$; C, persistent calyx encasing nutlet, $\times 5$; D, nutlet, $\times 15$; E, habitat, much reduced. Artist: G. Condy.

FIGURE 14.—Holotype of *Rabdosiella leemannii*.

white-hairy; upper lobe (1.3–)1.4–1.9(–2.0) mm, inside tinged purple-pink, outside densely glandular hairy; lower lobe navicular, (3.2–)3.1–4.3(–4.5) mm, white on outside, tinged purple-pink on inside. *Stamens* antrorse, 5.4–7.5 mm long, attached to tube. *Style* antrorse, shorter than stamens, 5.4–7.2 mm long, bifid. *Fruit* a small, brown, rounded nutlet, 0.9 × 0.7 mm. Figures 13, 14.

The genus *Rabdosiella* Codd was described in 1984 with two species, the widespread grassland suffrutex, *R. calycina* (Benth.) Codd from South Africa, and *R. ternifolia* (D. Don) Codd from India, Burma, Thailand and China. *Rabdosiella leemannii* represents the third South African species, and clearly belongs to *Rabdosiella*. *Rabdosiella* can be distinguished from *Plectranthus* L. Hér. by its woody growth, ternate leaves and leaf-like bracts, as well as its distinctly 10-nerved calyx (bearing subequal teeth) becoming erect with maturity. Although the delimitation of the genus *Plectranthus* is not clear, it is at present best to uphold *Rabdosiella* as a separate genus until a thorough multidisciplinary investigation of *Plectranthus* and its relatives can be undertaken.

Rabdosiella leemannii is a distinct species and differs from *R. calycina* in several features such as its habitat, habit and the vegetative and floral features (Table 1). It is distinguished by its erect, shrubby nature (Figure 15), woody stems, smaller leaves and flowers. The leaves of *R. leemannii* are only rarely ternate, smaller, narrower (ovate to elliptic or trullate), never becoming broadly ovate as those found in *R. calycina*. The leaves of *R.*

calycina are often ternate. The inflorescences and flowers are also considerably smaller than those of *R. calycina*. *R. leemannii* is endemic to the Soutpansberg and Blouberg Afromontane mist-belt open bushland (Figure 16) above 1 400 m, where it forms perennial shrubs with woody stems reaching 50 mm in diameter at the base and displaying up to 10 clearly defined year rings. The habitat consists of Soutpansberg Summit Sourveld and a mosaic of the latter and Soutpansberg Mountain Bushveld (Mucina *et al.* 2005). Hahn (2002) has pointed out the importance of mist precipitation on the endemic flora of the Soutpansberg. In times of drought, mist precipitation is the only source of moisture available in this habitat. However, total precipitation can almost be doubled if mist precipitation is added to rainfall. On herbarium sheets its habitat is occasionally stated as grassland—this is an error as the ‘grassy component’ is in fact the sedge, *Coleochloa setifera* (Ridl.) Gilly. The habitat of *R. leemannii* is quite sheltered from fire with a maximum period of five years. In the absence of fire, *R. leemannii* forms single-stemmed shrubs, however, plants exposed to fire do resprout forming multi-stemmed shrubs. *Rabdosiella calycina* is clearly a herbaceous suffrutex, annually burnt. It is commonly associated with grassland of the eastern escarpment of South Africa occurring as far north as the Soutpansberg.

Both *Rabdosiella leemannii* and *R. calycina* have been cultivated at the Kirstenbosch National Botanical Gardens (E.J. van Jaarsveld pers. comm.). In spite of being cultivated under similar conditions, each retained their characteristic growth form. Seed of *R. leemannii* germinates readily within three weeks, immediately forming distinctly fleshy roots.

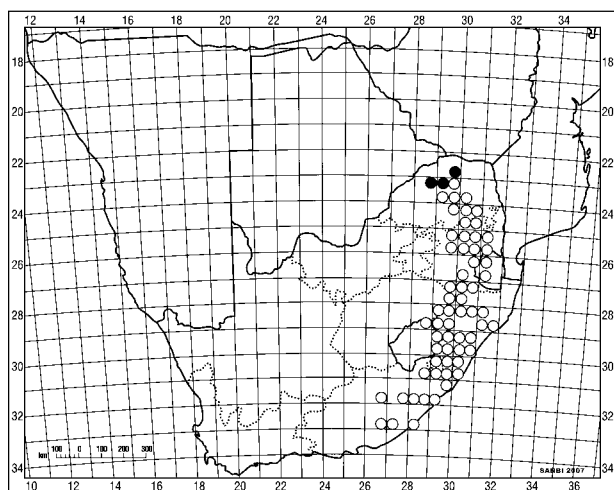


FIGURE 15.—Plant from which type specimens were collected.

TABLE 1.—Comparison of selected characters of *Rabdosiella leemannii* and *R. calycina*

	<i>R. leemannii</i>	<i>R. calycina</i>
Lithology	quartzite	usually basalt or dolerite
Soil	sand	clay
Habitat	open mountain mist-belt among rocks	grassland
Growth form	phanerophyte	hemicryptophyte or suffrutex
Above-ground stems	perennial	annul
Stems	branching	not branching
Leaf		
shape	ovate-elliptic to trullate	ovate to broadly ovate
colour	grey green	green
Inflorescence length	50–100 mm	100–300 mm

The species is named after the great uncle of the first author, Albert Conrad Leemann (misspelt Leeman in Gunn & Codd 1981), who in 1933 was the first to collect a specimen while on an excursion to the Blouberg. His findings were published in *Vegetationsbilder* (Leemann 1935). In this article he made mention of the wholesale destruction of the environment at the foot of the mountain. He stressed the importance of conserving mountains such as the Blouberg which act as refugia of undisturbed

FIGURE 16.—Distribution of *Rabdosiella leemannii*, ●, and *R. calycina*, O, in South Africa.

habitat. These refugia are of immense importance to our understanding of vegetation changes caused by man.

ACKNOWLEDGEMENTS

A special word of thanks to Ernst van Jaarsveld for his invaluable comments whilst writing this article and sharing his knowledge on the cultivation of *Rabdosiella leemannii*. We would also like to thank the South African National Biodiversity Institute for allowing us access to their herbarium and Mr John Lavranos for the Latin diagnosis.

Other specimens examined

LIMPOPO.—2229 (Waterpoort): Soutpansberg, Farm Wellington, northern side of farm, 1 400 m, (–DC), 25-03-1994, *Rossouw 208* (PRE); northern slopes of Hanglip near summit, (–DD), 02-04-1957, *Meeuse 10164* (PRE); Farm Buckworth (Dr Bird's farm), southern slope north of Bird's cottage near summit, (–DD), 12-05-1957, *Meeuse 10243* (PRE). 2328 (Baltimore): Blouberg, mountain grassland, aspect south, shrub, 23°04'37.922"S, 28°59'10.506"E, 1 990 m, (–BB), 11-05-1999, *Hahn 1574* (ZPB); in kloof leading to beacon, 5 600 ft [1 847 m], 29-04-1954, (–BB), *Codd 8759* (PRE); alt. 6 000 ft [1 968 m], (–BB), 10-03-1933, *Leemann 118* (PRE); kloof near top, 4 ft [1.3 m], (–BB), 26-06-1961, *Strey & Schlieben 8517* (PRE); kloof below beacon, (–BB), 26-4-1961, *Van der Schijff 5416* (PRE). 2329 (Polokwane): Soutpansberg, Farm Lejuma, Mt Lejuma, 23°01'22.584"S, 29°25'57.180"E, 1 636 m, 22-05-1982, (–AB), *Venter 7855* (PRE); Lejuma south of Mt Lejuma, (–AB), 23-05-1982, *Venter 8754* (PRE).

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MS. received: 2006-01-31.

BURSERACEAE

COMMIPHORA KUNENEANA, A NEW SPECIES FROM THE KAOKOVELD, NAMIBIA

Commiphora kuneneana Swanepoel, a new species from the Kaokoveld Centre of Endemism (Van Wyk & Smith 2001), is described. During field work for the Namibian Tree Atlas project in the Kunene River Valley and Sesfontein areas, the author encountered *Commiphora* trees with morphological features that were characteristic of both *C. saxicola* Engl. and *C. crenato-serrata* Engl. (Van der Walt 1974, 1986). Similar plants were subsequently found to be widespread in the west-

ern Kaokoveld and are here proposed as representing a distinct new species.

A study of the *Commiphora* holdings in PRE and WIND revealed several collections of the new species, all filed under either *C. saxicola* or *C. crenato-serrata*. In the *Flora of southern Africa* treatment of *Commiphora*, one of these specimens (*De Winter & Leistner 5876*) is mentioned as a possible new species, *C. crassifoliolata*

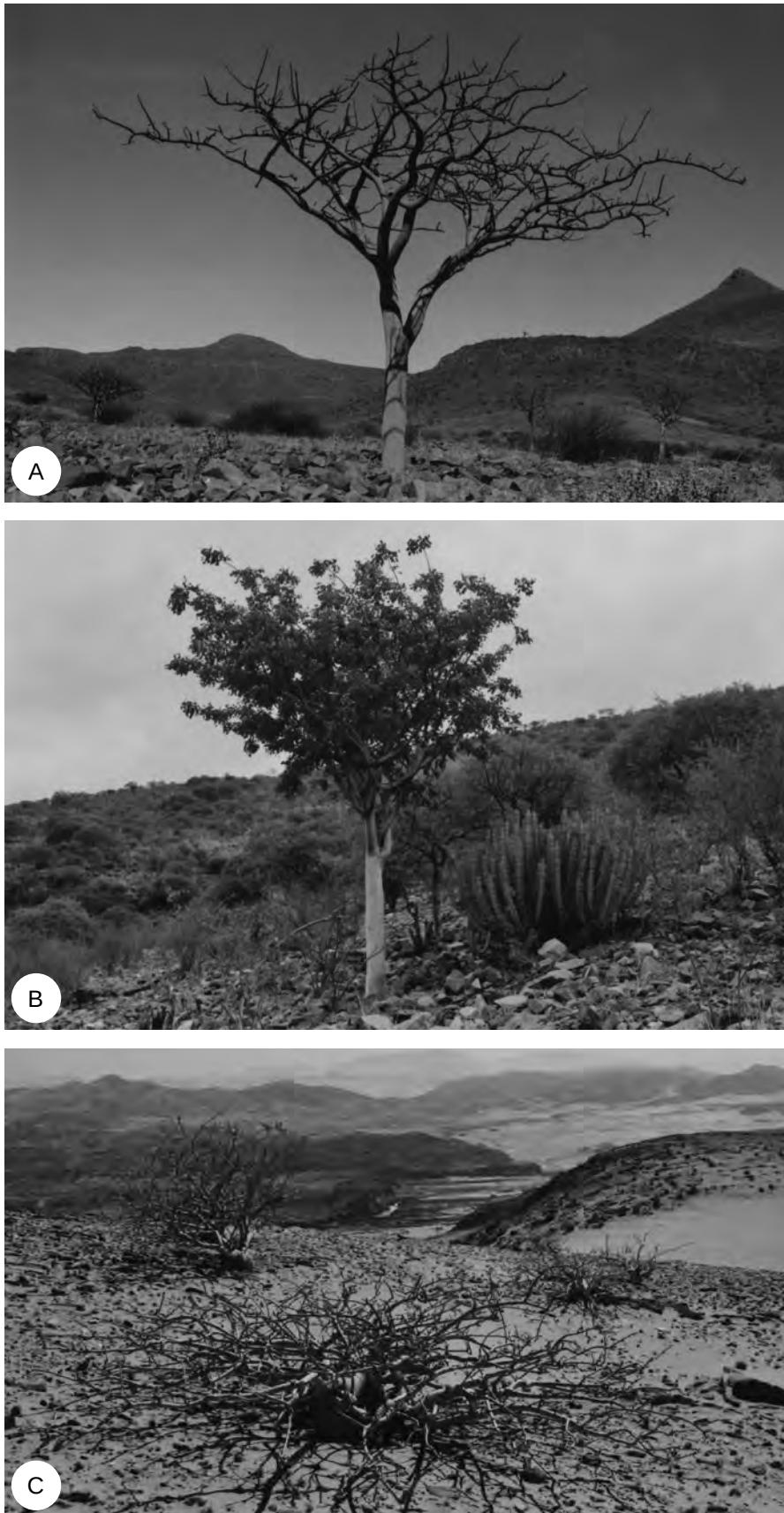


FIGURE 17.—*Commiphora kuneneana*. A, tree, 6 m tall, without leaves and with flattened crown; B, tree, 5 m tall, in leaf; C, shrub-like trees.

Mendes *nom. prov.* (Van der Walt 1986: 34). Herbarium specimens of *C. kuneneana* can be mistaken for *C. saxicola* and *C. crenato-serrata* due to similarities in leaf morphology. In habit, however, *C. kuneneana* differs conspicuously from *C. saxicola* over most of its range,

in that it is a tree, with a distinct, erect trunk (Figure 17A, B). In the field, when without fruit, *C. kuneneana* can also be confused with *C. crenato-serrata* because of its similarities in habit, bark, exudate and leaves. Apart from morphological differences, the three taxa also have

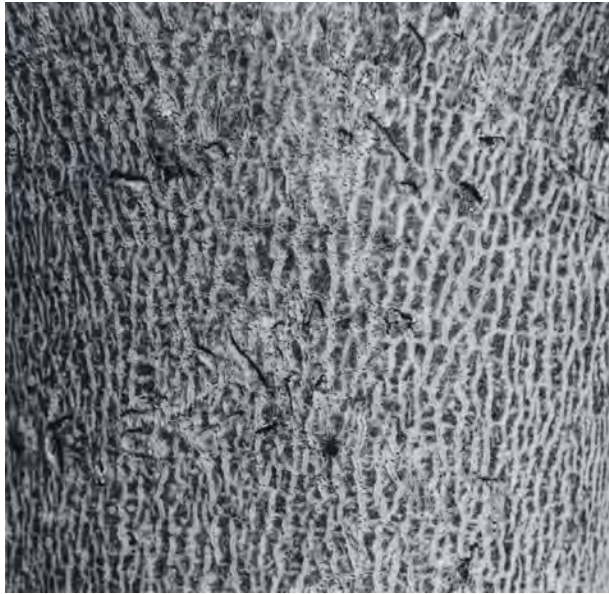


FIGURE 18.—*Commiphora kuneneana*. Bark.

different distribution ranges: *C. kuneneana* has a more northerly distribution than *C. saxicola* and a more westerly distribution than *C. crenato-serrata*. However, in the northwestern parts of its range in Namibia, in the Otjihipa Mountains, *C. kuneneana* is sympatric with *C. crenato-serrata*.

Diagnostic morphological characters to differentiate between *C. kuneneana*, *C. saxicola* and *C. crenato-serrata* are presented. Apart from examining the herbarium collections of the three species in PRE and WIND, live material from numerous populations in Namibia were studied in the field. Morphological characters in the following description were all determined from mature leaves, fresh flowering material and ripe fruit.

***Commiphora kuneneana* Swanepoel, sp. nov.**, *C. saxicolae* Engl. simillima cortice laevi non deglubenti, foliis pinnatis, laminis viridibus pilis longis glandularibusque, saepe subconduplicatis, foliolis sub-orbicularibus, ovatis, obovatis vel ellipticis; inflorescentiis saepe thyrsoides, pedunculo glanduloso-piloso, floribus perigynis, disco intus 8-plicato, lobis apice bifidis non hypanthio adnato, pseudo-arillo cupulare, putamen 25–60% tegenti, brachiis commissuralibus 2(0) brevibus, lobis facialibus 2(1). A *C. saxicola* statura plerumque arboris, caule proprio, recto, cylindrico, erecto, foliis plerumque duplo maioribus, lamina saepe plana, plerumque maiori, saepe ovata vel lanceolata, raro rhombea, petiolo saepe cum fasciculis vascularibus medullaribus, petiolulis saepe longioribus, inflorescentiis saepe paniculoso-thyrsoideis, pedunculo plerumque longiori (usque ad 400 mm), antheris plerumque longioribus (usque ad 2.1 mm), pseudo-arillo semper rubro, differt.

TYPE.—Namibia, 1713 (Swartbooisdrif): 3 km WSW of Epupa Falls on main road to Okangwati, 690 m, (–AA), 14-01-2006, *Swanepoel 211*, (WIND, holo.!; PRE, iso.!).

Illustrations: Van der Walt: t. 31, as *C. saxicola* (1974: 19). Steyn: 69, top left; 70, bottom left as *C. saxicola* (2003). Steyn: 53, top left & right; 54, centre & right as *C. crenato-serrata* (2003).

Dioecious tree without spines, up to 8 m tall, usually infundibular in shape, crown rounded or ± flat-topped. *Trunk* single, occasionally multi-stemmed, cylindrical, ± straight, erect, 0.8–3.5 m long, up to 400 mm in diam., rarely a shrub-like tree branching from just above ground level (Figure 17C). *Bark* pale grey, reddish grey, cream-coloured or pale yellowish, smooth, not peeling, with minute, shallow, longitudinal fissures (Figure 18). *Branches and branchlets* with scattered small lenticels, obtuse, glabrous, youngest ones with glandular hairs and with long flexuous branched hairs at apex, yellowish, dark or reddish brown or grey to reddish grey; branchlets short, scarred. *Exudate* milky, glutinous, not squirting when branches or branchlets damaged or cut, aromatic, producing a soft, caramel-brown or hard olive-green or pale yellow transparent resin.

Leaves imparipinnate (Figure 19), rarely paripinnate or intermediate, (2)3–6(–9)-jugate, rarely trifoliate, up to 280 mm long, grouped closely together at end of branches and branchlets, spirally on shoots, green; leaflets with scattered, short glandular hairs on both sides, especially on and along midrib, long glandular and long flexuous hairs, some branched, also usually present, otherwise glabrous; *lamina* flat or subconduplicate, shape varies considerably, even on same tree and same leaf; terminal leaflets elliptic to broadly elliptic, ovate, rarely broadly lanceolate, rhombic or suborbicular (15–)23–38(–68) × (10–)18–28(–42) mm; lateral leaflets narrowly ovate to broadly ovate, elliptic to broadly elliptic, lanceolate to broadly lanceolate, rarely obovate or suborbicular, (12–)19–36(–64) × (6–)18–36(–45) mm; *apex* acute, acuminate or obtuse but with minute tip usually acute, base cuneate, truncate or obtuse and in lateral leaflets also cordate, base often abruptly attenuate onto petiole, often oblique and then asymmetric with one side abruptly attenuate onto petiole; *margin* crenate-serrate, occasionally dentate near apex, 5–26 teeth per side, usually entire near base, rarely almost entire; *midrib* green or yellowish green, conspicuous and prominent abaxially; *petiole* with scattered, short glandular hairs, usually with long glandular and long flexuous simple or branched hairs, otherwise glabrous, (7–)27–56(–72) mm long, pentagonal, ovate or triangular in t/s with (8–)10–13(14) vascular bundles, some petioles with additional one or two medullary vascular bundles lacking xylem element, occasionally shallowly sulcate adaxially, sectional dimensions (0.9–)1.2–1.8(–2.2) × (1.2–)1.5–1.9(–2.4) mm; *rachis and petiolules* with short glandular hairs, often with few additional long flexuous hairs, some branched; petiolule on terminal leaflets up to 35 mm long, on lateral leaflets up to 23 mm long or leaflets rarely subsessile.

Inflorescence thyrsoid or paniculose-thyrsoide (Figure 20A), with short glandular hairs, often with additional long, simple or branched hairs near apex; peduncle up to 400 mm long, at apex of branches and on dwarf lateral branchlets. *Flowers* subsessile or pedicellate, unisexual,

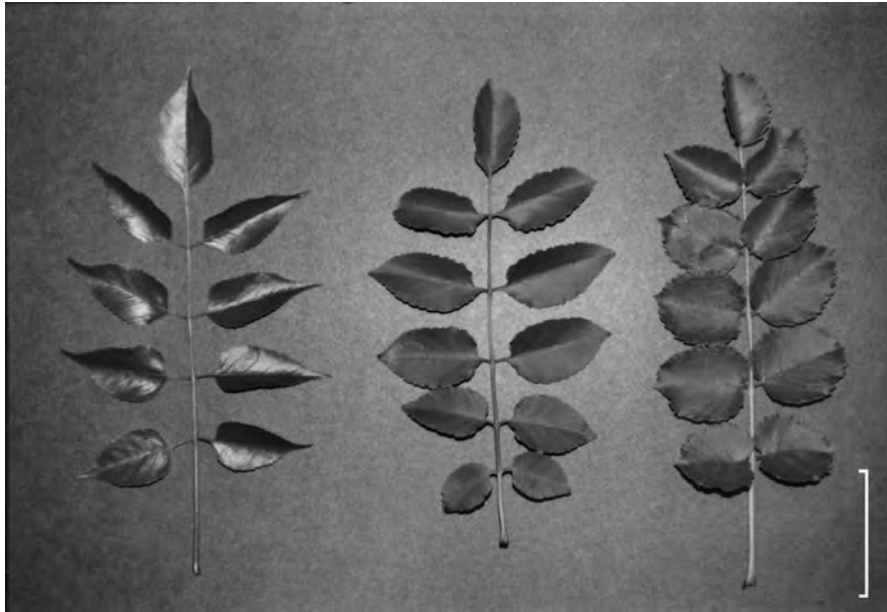


FIGURE 19.—*Commiphora kuneneana*. Leaves. Scale bar: 20 mm.

perigynous, precocious or flowering with leaves. *Bracts* linear-triangular, up to 4 mm long, bracteoles narrowly triangular or narrowly elliptic, up to 1.5 mm long, apex acute, with glandular hairs abaxially and on margin, often with long simple or branched hairs. *Calyx* green, yellowish green or greenish red, with glandular hairs, lobes triangular or triangular-ovate, apex acute. *Petals* greenish yellow, often reddish along centre, glabrous or with short glandular hairs abaxially over apical part, recurved towards apex but minute tip inflexed. *Disc* cylindrical with 4(5) distinct lobes, adnate to hypanthium but distal part of lobes free. *Male flowers* 2.5–5.4 mm long; pedicel up to 1.3 mm long, with glandular hairs, often with few long hairs; calyx 1.3–1.9 mm long, calyx lobes 4(5), 0.2–0.7 mm long; petals 4(5), oblanceolate to broadly oblanceolate or narrowly elliptic, 2.7–5.2 × 1.2–1.8 mm; disc fleshy, inside of disc 8-folded, often with maroon markings, lobes bifid at apex; stamens 8(10), 4(5) long stamens with filaments 1.0–2.8 mm long, inserted on top of disc lobes, 4(5) short ones with filaments 0.4–1.7 mm long, inserted on margin of disc between lobes; anthers on long stamens 0.7–2.1 mm long, anthers on short stamens 0.6–1.6 mm long; filaments subterete, on long stamens slightly flattened and broadened over lower part; gynoecium rudimentary (Figure 20B–E). *Female flowers* 2.8–3.3 mm long; pedicel up to 0.9 mm long, with glandular hairs, often with few long hairs; calyx 1.1–1.4 mm long, lobes 0.3–0.6 mm long; petals broadly oblanceolate or narrowly elliptic, 2.5–3.5 × 1.0–1.3 mm; disc not very fleshy, lobes bifid at apex; staminodes 8, 4 long and 4 short; ovary half inferior, glabrous or with few short glandular hairs; style from ± short to ± long, sutures grooved; stigma obscurely 4-lobed; pistil 2.3–3.0 × 0.6–0.8 mm (Figure 20F–I).

Fruit a drupe, ellipsoid, oblong-ellipsoid or ovoid, 10–17 × 5–9 × 5–9 mm, often slightly constricted midway between base and apex, often slightly apiculate (Figure 20J); pericarp 2-valved, suture rectilinear or rarely slightly curved towards sterile locule; exocarp glabrous or with scattered, short, glandular hairs,

non-glutinous, reddish green in ripe fruit; mesocarp not very fleshy; putamen 5.7–10.7 × 3.5–6.1 × 3.1–4.4 mm, flattened, asymmetrical-ellipsoid, oblongoid or oblong-ellipsoid, with one fertile and one sterile locule, smooth or slightly rugose (Figure 20K–N); fertile locule in sutural view asymmetrically convex towards apex, rarely convex or rectilinear and tapering to base and apex, apex often bent over to sterile locule, convex in apical view; sterile locule dorsally ridged, variable in sutural view, convex near base and rectilinear to concave towards apex, rectilinear and tapering to base and apex, or slightly humped near base and apex, ± triangular in apical view; suture rectilinear but convex towards sterile locule at apex, rarely rectilinear; angle between locules at apex 50°–105°; pseudo-aril red, fleshy, cupular, covering 25%–60% of the locules equally, with 2(0) very short commissural arms up to 1.8 mm long and 2(1) facial lobes; lobes convex or triangular: on fertile locule, 0.3–1.4(–2.6) mm long, usually convex, rarely drawn out into a long fragmented arm, almost reaching apex, often undeveloped and completely absent; on sterile locule, 0.5–2.0 mm long, usually triangular and larger; apical pits small or absent. *Flowering time*: August to January.

Diagnostic characters and affinities: *Commiphora kuneneana* is probably most closely related to *C. saxicola*, the species with which it has hitherto most often been confused, and also to *C. crenato-serrata*. Salient diagnostic morphological characters to differentiate between the three species are supplied in Table 2.

The shrub-like tree form of *Commiphora kuneneana* was only observed in the far western parts of its range, in the extremely arid area bordering the Namib Desert. In this area it is not unusual to find both tree and shrub-like forms growing side by side. *Commiphora saxicola* is only rarely a small tree up to 4 m tall with the trunk and main stem flexuous, semiterete, up to 2.4 m long, often with thinner lateral branches at the base and an irregular crown.

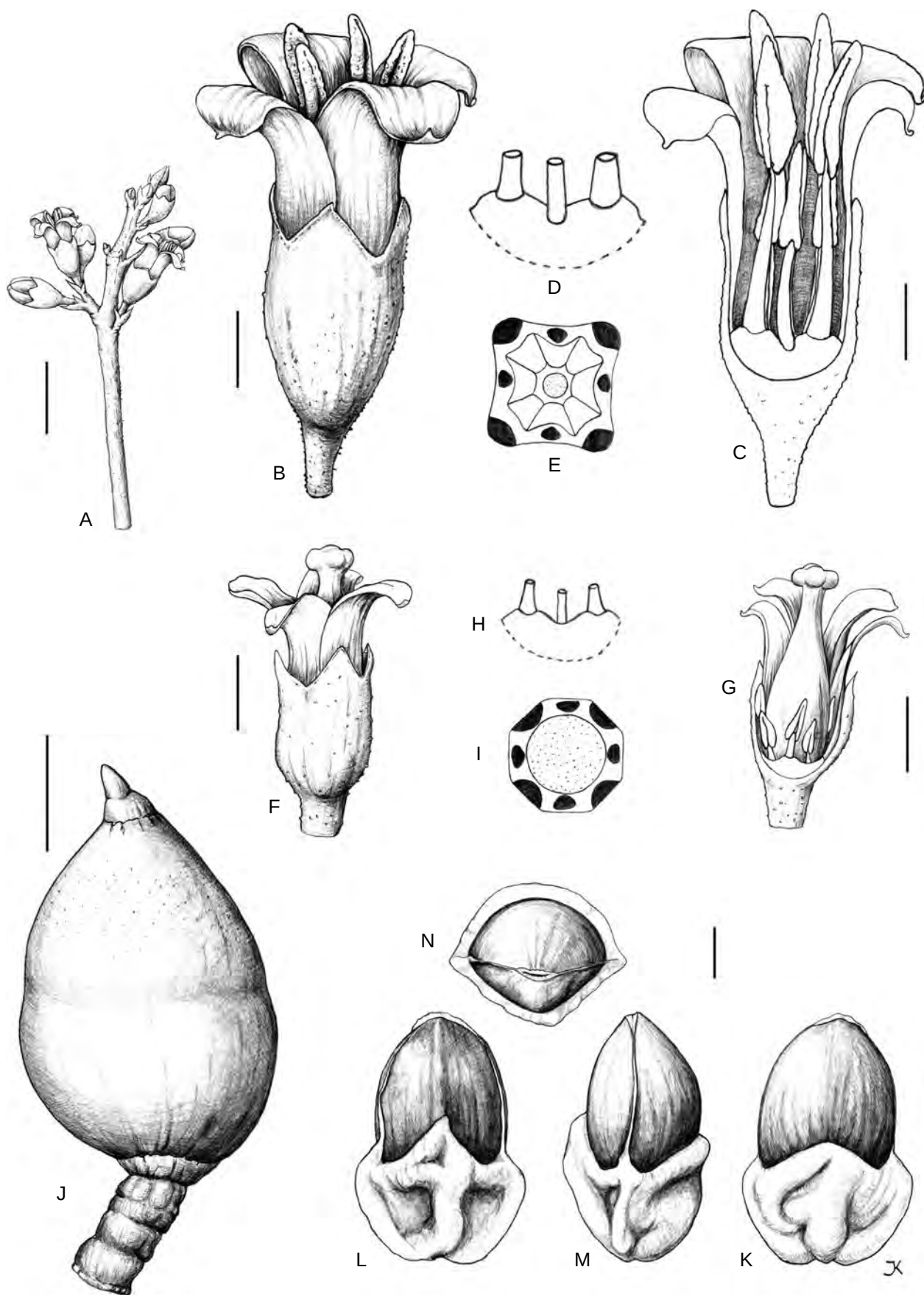


FIGURE 20.—*Commiphora kuneneana*. A, male inflorescence. B–E, male flower: C, calyx and corolla partly removed; D, disc as seen from inside; E, disc as seen from above to depict position of stamens (black) and rudimentary ovary (circle). F–I, female flower: G, calyx and corolla partly removed; H, disc as seen from inside; I, disc as seen from above to depict position of stamens (black). J, fruit. K–N, putamen with pseudo-aril: K, side with fertile locule; L, side with sterile locule; M, lateral view, fertile locule right, sterile locule left; N, apical view. A–E, Swanepoel 218; F–N, Swanepoel 211. Scale bars: A, 5 mm; B, C, F, G: 1 mm; J, 3 mm; K–N, 2 mm. Artist: Julia Kreiss.

TABLE 2.—Salient morphological differences between *Commiphora kuneneana*, *C. saxicola* and *C. crenato-serrata*

Character	States	<i>C. kuneneana</i>	<i>C. saxicola</i>	<i>C. crenato-serrata</i>
Habit	Tree, straight trunk	Usually	Rarely	Always
	Shrub-like tree, low-growing	Rarely	Usually	Never
Height	Length (m)	Up to 8	0.2–2.5	Up to 8
Leaves	Jugate (leaflet pairs)	(1–)3–6(–9)	(2)3 or 4(–6)	(3–)5 or 6(–8)
	Length (mm)	Up to 280	Up to 130	Up to 460
Lamina shape terminal leaflets	Elliptic or ovate	Usually	Never	Never
	Suborbicular	Rarely	Usually	Never
	Obovate	Never	Rarely	Never
	Lanceolate	Rarely	Never	Always
	Reniform	Never	Rarely	Never
	Rhombic	Rarely	Never	Never
lateral leaflets	Ovate	Often	Rarely	Never
	Lanceolate	Often	Never	Always
	Obovate	Rarely	Rarely	Never
	Suborbicular	Rarely	Often	Never
	Elliptic	Rarely	Rarely	Never
	Oblate	Never	Often	Never
	Reniform	Never	Rarely	Never
Lamina		flat or subconduplicate	subconduplicate or conduplicate	
terminal leaflets	Size (mm)	15–68 × 10–42	3–21 × 3–26	50–130 × 20–65
lateral leaflets	Size (mm)	12–64 × 6–45	4–17 × 4–21	30–130 × 10–70
base	Shape	Truncate, obtuse, cuneate or cordate	Truncate, cuneate or rarely cordate	Truncate
apex	Shape	Acute, acuminate or obtuse; minute tip acute	Emarginate or truncate; rarely acute tip	Acuminate
margin	Shape	Crenate-serrate, occasionally dentate near apex, rarely almost entire	Entire near base, crenate-serrate or serrate in centre, dentate apically	Crenate-serrate
teeth on margin	No. per side	5–26	3–12, coarse	15–44
Petiole				
dimensions in t/s	Size (mm)	0.9–2.2 × 1.2–2.4	0.6–1.5 × 0.6–1.5	1.2–2.7 × 1.2–2.4
vascular bundles	No. of	8–14	5–11	11–17
medullary vascular bundles	Present	Often	Never	Always
length	(mm)	7–72	3–30	25–90
Petiolules				
terminal leaflets	Length (mm)	Up to 35	Up to 22	4–45
lateral leaflets	Length (mm)	Up to 23	Up to 5	3–26
leaflets	Subsessile	Rarely	Often	Never
Inflorescence type				
	Thyrsoïd	Often	Often	Always
	Paniculose-thyrsoïd	Often	Never	Never
	Racemose	Never	Often	Never
peduncle	Length (mm)	Up to 400 mm	Up to 130 mm	Up to 320 mm
trichomes	Glandular hairs	Always	Always	Often
	Long hairs	Often	Never	Often
Flowers				
male flowers	Length (mm)	2.5–5.4	3.3–4.2	5.0–7.1
	Pedicellate	Often	Rarely	Often
female flowers	Length (mm)	2.8–3.3	3.1–3.3	3.3–5.3
	Pedicellate	Often	Rarely	Often
Pedicel				
male flowers	Length (mm)	Up to 1.3	Up to 0.5	Up to 1.1
female flowers	Length (mm)	Up to 0.9	Up to 0.2	Up to 0.3
trichomes	Glandular hairs	Always	Always	Never
	Long hairs	Often	Never	Rarely
Calyx				
indumentum	Glandular hairs	Always	Always	Often
	Long hairs	Never	Never	Often
	Glabrous	Never	Never	Often

TABLE 2.—Salient morphological differences between *Commiphora kuneneana*, *C. saxicola* and *C. crenato-serrata* (cont.)

Character	States	<i>C. kuneneana</i>	<i>C. saxicola</i>	<i>C. crenato-serrata</i>
Calyx lobes				
male flowers	Length (mm)	0.2–0.7	0.4–0.8	0.5–1.2
female flowers	Length (mm)	0.3–0.6	0.7–0.8	0.6–1.2
Petals				
shape	Oblanceolate	Often	Often	Usually
	Narrowly elliptic	Often	Often	Never
	Cultrate	Never	Never	Rarely
indumentum	Glandular hairs	Often	Always	Often
	Glabrous	Often	Never	Often
male flowers	Length (mm)	2.7–5.2 × 1.2–1.8	2.9–4.1 × 0.9–1.4	4.3–5.1 × 0.9–1.5
female flowers	Length (mm)	2.5–3.5 × 1.0–1.3	2.1–2.4 × 1.1–1.3	2.9–4.0 × 1.0–1.4
Filaments				
long stamens	Length (mm)	1.0–2.8	1.3–2.2	3.0–3.5
short stamens	Length (mm)	0.4–1.7	0.7–1.2	1.5–2.2
Anthers				
long stamens	Length (mm)	0.7–2.1	0.8–1.1	0.9–1.1
short stamens	Length (mm)	0.6–1.6	0.8–1.0	0.7–0.9
difference in size	Differs	Often	Usually	Always
	Length (mm)	0.2–0.7	0.1–0.2	0.1–0.3
Pistil (length × diam. of ovary)	Size (mm)	2.3–3.0 × 0.6–0.8	1.7–1.9 × 0.7–0.9	2.6–3.2 × 1.0–1.2
Fruit				
shape	Oblong-ellipsoid	Often	Often	Never
	Ovoid	Rarely	Never	Often
	Obovoid	Never	Often	Often
	Obovate-ellipsoid, subglobose or oblongoid	Never	Often	Never
	Slightly constricted mid-way	Often	Rarely	Never
	Slightly apiculate	Often	Rarely	Never
	Strongly apiculate	Never	Never	Always
dimensions	Length × wide side × narrow side (mm)	10–17 × 5–9 × 5–9	8–15 × 6–9 × 5–9	13–20 × 8–13 × 8–13
Putamen				
shape	Oblongoid	Often	Often	Never
	Ovoid	Never	Often	Often
	Obovoid	Never	Often	Never
	Subglobose	Never	Often	Never
apex	Angle between locules (degrees)	50–105	60–130	55–95
dimensions	Length × wide side × narrow side (mm)	5.7–10.7 × 3.5–6.1 × 3.1–4.4	5.2–10.0 × 3.8–5.7 × 2.9–4.7	6.6–9.6 × 4.6–7.2 × 3.3–5.3
fertile locule				
sutural view	Asymmetrically convex towards apex	Usually	Always	Rarely
	Convex	Rarely	Never	Usually
	Rectilinear, tapering to base and apex	Rarely	Never	Never
apex	Bent over to sterile locule	Often	Never	Never
sterile locule, apical view	Convex	Never	Never	Often
Pseudo-aril				
extent	Proportion of putamen covered (%)	25–60	25–60	20–45
colour	Red	Always	Often	Often
	Orange	Never	Often	Often

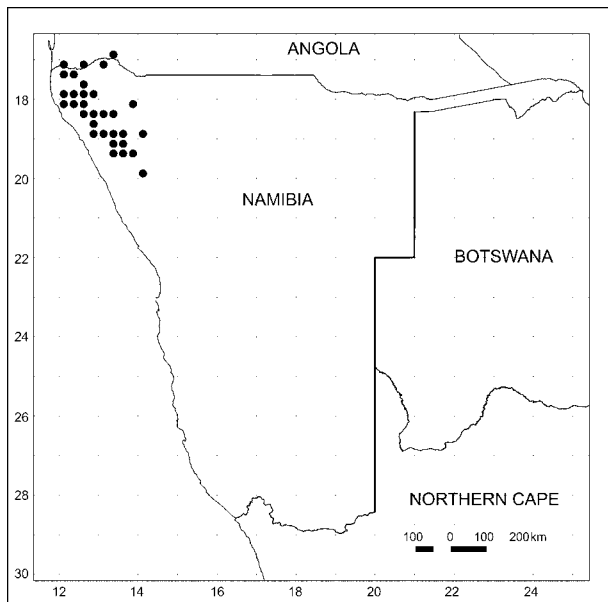


FIGURE 21.—Known distribution of *Commiphora kuneneana*.

It is often difficult to determine a specimen's true identity using morphological characters alone. However, a comparative anatomical study of petioles all over the ranges of the two species revealed that specimens with more than 11 vascular bundles and/or medullary vascular bundles in addition, are restricted to the area north of $\pm 20^\circ\text{S}$. Hence it is concluded that *C. kuneneana* occurs as far south as $\pm 20^\circ\text{S}$ and *C. saxicola* to the south of $\pm 20^\circ\text{S}$. Although no evidence was found during the present study, the two taxa may be sympatric in the area.

In plants of *Commiphora kuneneana* from the Kunene River Valley and Otjihipa Mountains, the lamina of the leaflets tends to be lanceolate more often, the leaf apices to be acuminate and the petiolules to be longer than elsewhere in its range in Namibia. In these areas the fruit is also consistently constricted midway between base and apex. In the absence of fruiting material, confusion with *C. crenato-serrata* is likely in these areas, due to similarities in lamina shape, habit and habitat preferences. Leaves of *C. crenato-serrata*, however, usually are larger, up to 460 mm long, the lamina is also usually larger, 30–130 $\times$ 10–70 mm long, always lanceolate in shape and the margin has up to 44 teeth per side. The petiole has 11–17 vascular bundles and 1–6 medullary vascular bundles, the latter including xylem, are always present (Van der Walt & Van der Schijff 1973). The leaves and lamina of *C. kuneneana* usually are smaller, variable in shape and the margin usually has fewer teeth per side. Furthermore, the petiole in *C. kuneneana* usually has fewer vascular bundles and only some petioles have medullary vascular bundles (lacking the xylem element). The fruit, when apiculate, is only slightly so. Inflorescences of *C. crenato-serrata* are always thyrsoid, the flowers usually larger and the fruit is strongly apiculate and not constricted between the base and apex.

Etymology: the specific epithet refers to the Kunene Region, named after the Kunene River in northwestern Namibia where the new species is found. As English and Afrikaans vernacular names, I propose 'Kunene cork-

wood' and 'Kunene-kanniedood', respectively. The local Ovahimba people in the Epupa area use the name *omu-whanga* for *C. kuneneana*. However, in the Otjitanda area, where *C. kuneneana* is absent, the same name is used for *C. crenato-serrata*. As with many other species of *Commiphora*, the trunk is damaged by a hacking-knife and the sap so obtained is used as a thirst quencher by both the local people and domestic animals.

Distribution: *Commiphora kuneneana* is only known from the Kaokoveld Centre of Endemism in north-western Namibia. It occurs from the Kunene River southwards to $\pm 20^\circ\text{S}$, the area between Palmwag and Sesfontein (Figure 21). It almost certainly also occurs in the adjacent parts of southern Angola, as it was collected at several localities on the Namibian side of the Kunene River Valley. It ranges from common to rare, often growing amongst other species of *Commiphora*, such as *C. anacardiifolia*, *C. crenato-serrata*, *C. discolor*, *C. glaucescens*, *C. kaokoensis*, *C. steynii*, *C. tenuipetiolata*, *C. virgata* and *C. wildii*. *C. kuneneana* is most abundant in the Kunene River Valley to the west of Epupa Falls and in the mountainous areas between Sesfontein and Purros. It is rare to the east of Epupa in the Kunene River Valley.

Habitat and ecology: *Commiphora kuneneana* occurs in the Kaokoveld, including the pro-Namib and the Escarpment area. It is found 35–180 km from the coast at altitudes of 200–1 800 m, where the mean annual rainfall is 50–250 mm (Mendelsohn *et al.* 2002). It is not very habitat specific and is found on mountain slopes, plateaus, valley floors and in drainage lines on sandy flats and rocky areas. It does not appear to be limited to any specific geological formation or substrate. *C. kuneneana* is not threatened as it occurs in remote, unpopulated areas mostly within the limits of conservancies.

Other specimens examined

Basson Bas 1-12-2001 WIND.

Craven 3061, 3068, 3164 WIND. Curtis 417, 559 WIND. Curtis, Aronson, Le Flo'h & Le Flo'h Cur1662a, b WIND.

De Winter & Leistner 5670, 5876 PRE, WIND.

Giess 8921 PRE, WIND; 9401 WIND.

Hearn 176 WIND.

Merxmüller & Giess 1430 PRE, WIND. Müller & Loutit 2196 WIND.

Steyn 24 WIND. Sullivan 39 WIND. Swanepoel 2A, B, 3A, B, 4A, 191–210 WIND; 211 PRE, WIND; 212–220, 223 WIND.

Tinley 1615 WIND.

Van der Walt 243 PRE, WIND. Viljoen 306, 452 WIND.

Ward, Ward & Seely 10455 WIND.

ACKNOWLEDGEMENTS

I would like to thank Prof. A.E. van Wyk, University of Pretoria, for advice and support, Dr H.F. Glen, SANBI, for translating the diagnosis into Latin, Ms Hester Steyn, SANBI, for preparing the distribution map and Ms Julia Kreiss for the line drawings. The curator and staff of the National Herbarium of Namibia are thanked for their assistance during visits to the herbarium. The National Herbarium of Namibia and the South African National Biodiversity Institute are also thanked for the use of information from their databases: SPMNDB, Flora DB and PRECIS. The curator, National Herbarium, Pretoria, is thanked for access to their collec-

tions; the assistance of Dr C.L. Bredenkamp and Ms M. Jordaan during visits to the herbarium is acknowledged with thanks. Ms V. Papworth from the National History Museum, London, is thanked for images of Angolan material and Mr B. Olivier for flowering material. Mr K. Verwey of Otjinhungwa is thanked for logistical support during visits to the Marienfluss. The University of Pretoria is thanked for financial support. I am especially grateful to my wife Hannelie for assistance and support during field trips.

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MS. received: 2006-05-05.

APOCYNACEAE

TRANSFER OF *SCHIZOGLOSSUM UMBELLULIFERUM* TO *STENOSTELMA*, AND ITS NEOTYPIFICATION (ASCLEPIADOIDEAE)

Rudolf Schlechter originally described *Schizoglossum umbelluliferum* in 1895 after a collecting trip to South Africa. The specimen (*Schlechter* 3687) on which he based his description was collected between 28 October and 15 November 1893 (Gunn & Codd 1981) on the plains below the Magaliesberg, a range of mountains near Pretoria, South Africa.

Schlechter's placing of this species in the genus *Schizoglossum* E.Mey. was based on habit and floral characteristics. As circumscribed at that time in the protologue, he mentioned the affinities between *S. umbelluliferum* and *S. orbiculare* Schltr. Brown (1907) agreed with Schlechter's generic placement and indicated that, in his opinion, *S. umbelluliferum* might be conspecific not only with *S. orbiculare* but also with *S. crassipes* S.Moore. However, he did not see Schlechter's type specimens, and his opinion was based only on the descriptions of *S. umbelluliferum* and *S. orbiculare*. Unfortunately, Schlechter's type specimens, previously housed at the Berlin Herbarium (B), could not be traced and were probably destroyed during the bombing of this herbarium during the Second World War (Nicholas 1992). According to Schlechter (1895), he had collected only one specimen each of *S. umbelluliferum* and *S. orbiculare*, and it is thus doubtful that any other Schlechter specimens of these species will be found in any other herbaria.

Some living plants precisely fitting Schlechter's description of *Schizoglossum umbelluliferum* were recently rediscovered by the senior author in two subpopulations at the foot of the Magaliesberg. This discovery has enabled a re-assessment of the generic position, neotypification and re-circumscription of this species.

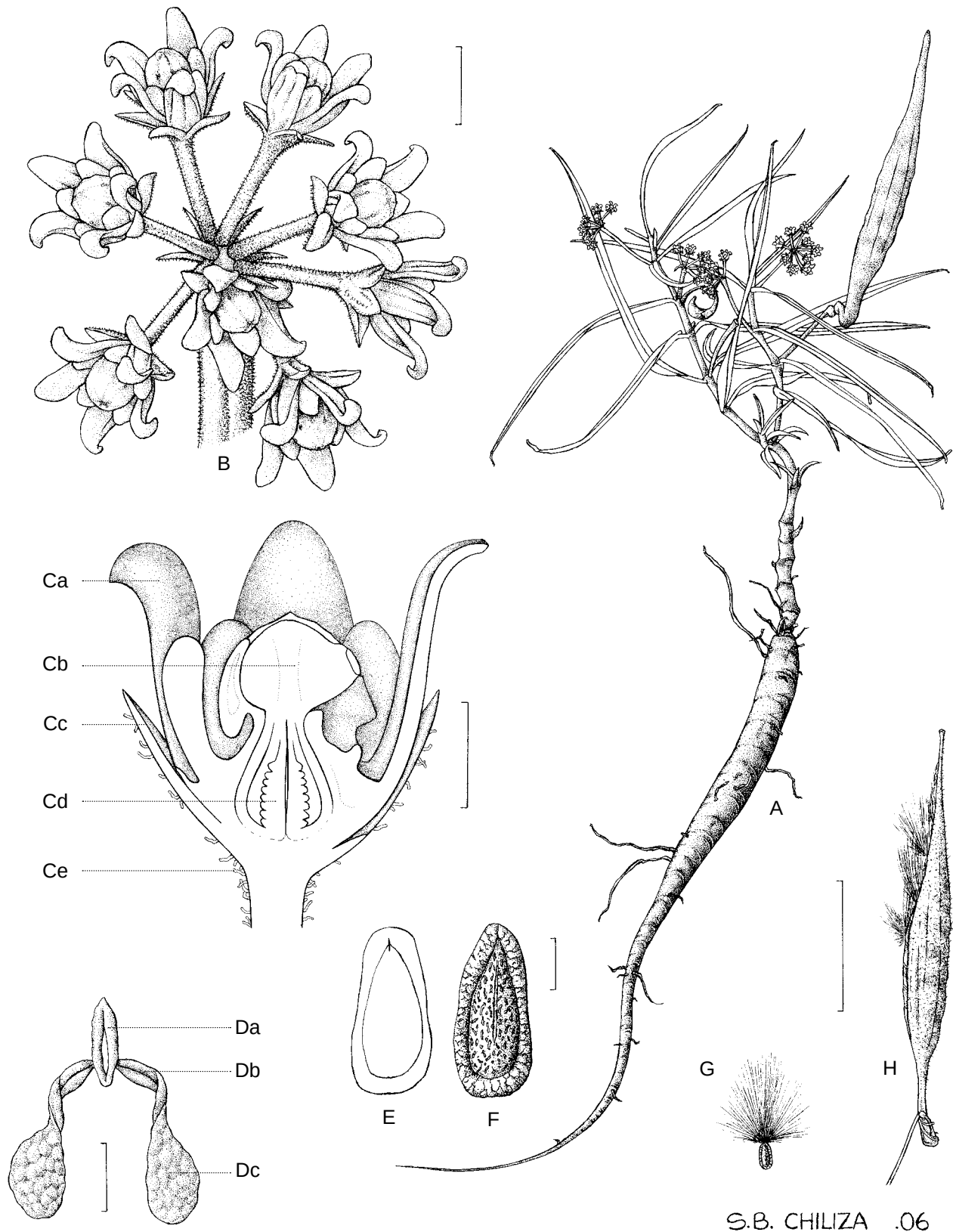
TAXONOMY

Stenostelma Schltr. is currently represented in southern Africa by two taxa, namely *S. capense* Schltr. and *S. cor-*

niculatum (E.Mey.) Bullock (Victor *et al.* 2003). Kupicha (1984), during her study of the genus *Schizoglossum*, suggested an expanded concept for *Stenostelma* and argued for the inclusion of a number of *Schizoglossum* species, including *S. umbelluliferum*. However, she never published these new combinations. Nicholas (1999) agreed with Kupicha and expressed the intention to enlarge the current circumscription of *Stenostelma* to also include three species previously placed in *Xysmalobium* R.Br. These transfers have not yet been effectively or validly published but would bring the number of species under *Stenostelma* to ten.

The proposed transfer of *Schizoglossum umbelluliferum* to the genus *Stenostelma* is based on a number of correlated characteristics which may be considered synapomorphies for the genus, namely: a fleshy, tough and fibrous napiform tuber; globose or subglobose inflorescences; greenish yellow to cream-coloured flowers; corolla lobes that are divided almost to the base, usually with a terminal oblique notch; corona lobes free, erect, somewhat fleshy, sometimes with an inverted v-shaped indentation with thickened edges, below the apex on the inner surface and a gibbous or keeled outer surface; anther flaps that usually fully cover the style head; barrel-shaped (constricted below and above) style head (in longitudinal section); triangular anther wings with a medial or sub-terminal notch in profile from the side; gynostegial head conical-shaped in outline; apical attachment of the translator arms to the pear-shaped pollinia; and erect follicles, narrowly fusiform (not inflated), smooth or with $\pm$ six, slight longitudinal ridges.

Stenostelma umbelluliferum can be easily distinguished from the other southern African species currently recognized in this genus in that it has the smallest plants (38–200 mm tall above ground) and has globose, slightly dorsiventrally flattened corona lobes with no extended horns, teeth or other processes.



S.B. CHILIZA .06

FIGURE 22.—*Stenostelma umbelluliferum*. A, habit with inflorescences, leaves, follicle and tuber; B, inflorescence. C, 1/5 flower: Ca, corolla lobe; Cb, style head; Cc, calyx; Cd, carpel; Ce, hairs. D, pollinarium: Da, corpusculum; Db, translator-arm; Dc, pollinium. E–G, seed: E, dorsal view; F, ventral view; G, with coma. H, dehiscent follicle. A, B, *Chiliza & Bester 2*; C–H, *Bester 5251*. Scale bars: A, G, H, 25 mm; B, 2.2 mm; C, 1 mm; D, 125 µm; E, F, 1.3 mm. Artist: Sibonelo Chiliza.

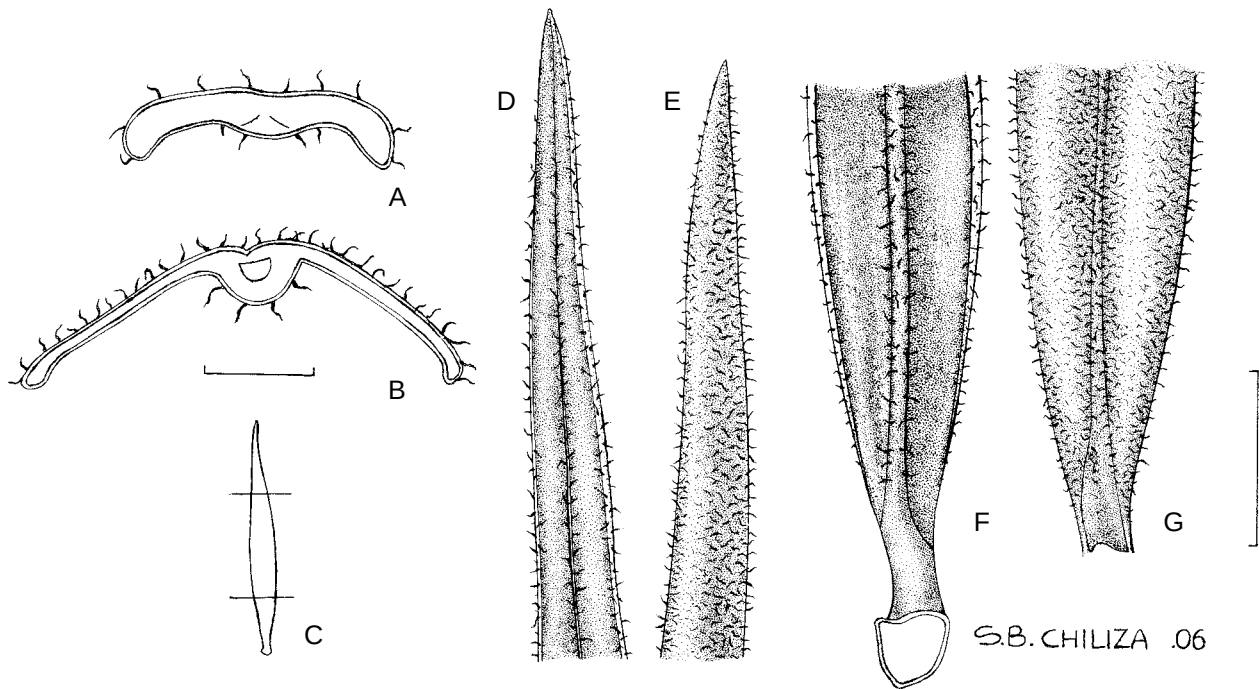


FIGURE 23.—*Stenostelma umbelluliferum*, Bester 5251. A–C, c/s lamina showing revolute margins: A, basal portion; B, apical portion; C, position of sections. D–G, leaf: D, E, tip, abaxial and adaxial view; F, G, base, abaxial and adaxial view. Scale bars: A, B, 0.5 mm; D–G, 2.3 mm. Artist: Sibonelo Chiliza.

***Stenostelma umbelluliferum* (Schltr.) S.P.Bester & Nicholas, comb. nov.**

Schizoglossum umbelluliferum Schltr., in Botanische Jahrbücher 20,5, Beibl. 51: 24 (1895). Type: Farm Doornpoort, Pretoria, Gauteng, South Africa, 25°38'36" S, 28°15'01" E, 1 222 m, 16 September 2004, S.P. Bester 5251 (PRE, neo. selected here; K, MO, B, Z, iso.).

Perennial geophytic herb with milky latex; aerial parts annual, 38–200 × 40–300 mm. *Tuber* fleshy, napiiform, broadest above middle, 50–100(–140) × 4–18 mm, pale cream-coloured, outer layer fibrous (Figure 22). *Underground stem* arising from tuber crown, 30–110 mm long, containing numerous adventitious points, usually unbranched; internodes 22–25 mm long. *Aerial stems* arising from apex of underground stem, 1–6-branched from soil level with further secondary branching, erect-spreading to decumbent from base; internodes 3–12 mm long, densely foliate. *Leaves* opposite, simple, erect to spreading-erect, 9–16 per branch; lamina narrowly linear to triangularly linear, up to 90 × 5 mm, acute, base attenuate to cuneate, usually narrowing into a very short petiole, nearly glabrous, green to tinged purple above, becoming dark pink to maroon with age, paler green towards main vein, paler beneath, margins revolute especially distinct in younger leaves; main vein prominent, abaxially concave, smooth to scabrid, adaxially convex, glabrous to puberulous to scabrid, secondary veins abaxially paler (Figure 23). *Inflorescence* umbellate, axillary, alternate, up to 22 umbels per plant, up to 7 per branch, (1–)3–28 flowers per umbel; peduncles 5–30 mm long, pubescent, deflexed at apex after flowering; pedicels 2–18 mm long, drooping after flowering, puberulous, hairs flat, multicellular; bracts linear to narrowly lanceolate, up to 1.5 × 0.24 mm. *Flowers* 5-merous. *Calyx* free, erect to spreading-erect; lobes lanceolate, 0.8–1.5 × 0.45–0.65 mm, half as long as corolla, acute, dark green, outside glabrous, inside glabrous to puberulous. *Corolla* ± divided to base, erect to spreading-erect; lobes oblong-

lanceolate, obliquely notched, 1.8–0.24 × 0.10–0.12 mm, convex in basal half and concave in apical half, revolute, pinkish inside, greenish outside, both sides darkening to maroon as they mature; apex rounded to obtuse, both sides glabrous. *Staminal corona* arising at base of staminal column; lobes free, erect, ovate to, oblong-ligulate, 0.5–0.8 × 0.4–0.6 mm, obtuse to acute, basally ovoid, keeled on sides, inner surface flat, outer surface bulged, much shorter than staminal column, green. *Staminal column* cylindrical or barrel-shaped, 0.7–1.1 mm high. *Stamens*: anther wings triangular, broadest at base or middle, 0.2 × 0.1 mm; anther appendages ovate to broadly ovate, 0.35–0.4 × 0.2–0.3 mm, apex obtuse to acute, erect-inflexed over conical style apex. *Pollinaria* solitary, pendulous in each anther sac, obliquely pear-shaped. *Ovaries* 2, subinferior, many-ovuled, glabrous; styles fused into a stylar column, terete, style head orbicular to conical-orbicular, exceeding anthers; translators from lateral surface of style head inverted y-shaped, 60–140 × 40 µm, caudicles filiform, widely diverging, apically fused to corpusculum, corpusculum oblong-narrowly-ovoid to oblong-ovoid, subacute. *Follicles* up to 4 per branch, usually 1(2) per umbel, narrowly fusiform, noninflated, ± equally tapering at both ends, tips slightly broader, obtuse, up to 85 × 8 mm, minutely papillate or puberulous, green striped with cream to green, maturing to darker green turning to pinkish then maroon, or sometimes green to glaucous with darker lateral striations, usually longer than 70 mm at maturity, fruiting stalk swirled and then upturned. *Seeds* 25–45 per follicle, broadly ovate, 3.0–3.5(–4.0) × 1.4–1.6 mm, dorsiventrally flattened, bifacial, minutely rugulose to favariate, above slightly convex, beneath slightly concave, margin up to 0.3 mm broad, ridges very dark brown, with light brown wing on outside of darker centre; coma up to 22 mm long. *Flowering time*: August–May, peaking October–January. *Fruiting time*: September–May.

Distribution and ecology: endemic in South Africa (North-West, Gauteng, KwaZulu-Natal and Free State) (Figure 24). Found at 1 115–1 280 m in savanna of Mixed Bushveld (Acocks 1988) on deep black turf soils mainly associated with or in the vicinity of drainage lines, in fully exposed situations as well as in light shade (mainly of species of *Acacia sensu lato*). Depth of the tuber below the soil surface varies greatly. The neck of the deepest seated tuber was found at 20 cm below the soil surface.

Material examined

NORTH-WEST.—2527 (Rustenburg): west of settlement of Sonop, (–DA), 25°39'20"S, 27°38'12"E, 31 January 2006, *Bester 6451* (PRE); ± 10 km east of Brits, (–DB), 25°37'47"S, 27°55'5"E, 2 February 2006, *Bester 6470* (PRE).

GAUTENG.—2528 (Pretoria): Annlin/Sinoville, drainage line running E-W just south of Wonderboom Airport, (–CA), 25°40'0" S, 28°12'38" E, 24 October 2004, *Bester 5255* (PRE, with stem tuber and follicle).

FREE STATE.—2627 (Potchefstroom): Sasolburg Dist., Uitkomst Farm 413, 5–6 km directly west of Sasolburg on west-facing hill on banks of Rietspruit, (–DD), 26°48'20" S, 27°44'47" E, 10 October 1996, *Kroon 12084* (PRE, with flowers and follicles).

KWAZULU-NATAL.—2730 (Vryheid): Golugola Plain, Bloedrivier Station, near station, (–DC), 17 September 1945, *Acocks 11774* (PRE, with flowers).

A specimen of Acocks (*Acocks 11774*) named as *Schizoglossum* sp. and another identified as *S. eustegioides* (*Kroon 12084*) belong to the current taxon and was re-named accordingly. Although initially thought to be

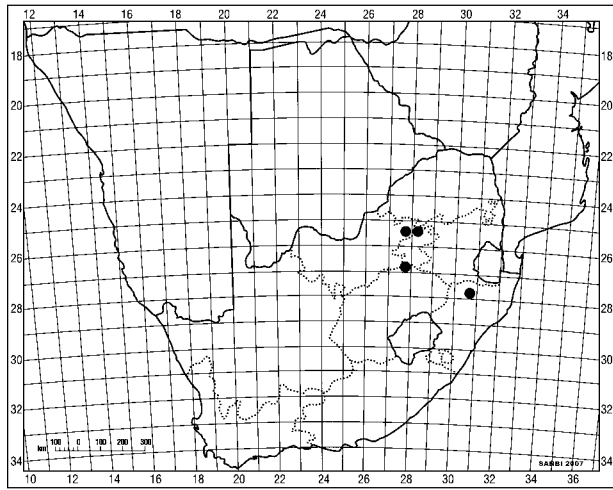


FIGURE 24.—Known distribution of *Stenostelma umbelluliferum* in South Africa.

restricted in distribution, an extensive search for more populations, sponsored by the Gauteng Department of Agriculture, Conservation and Environment (GDACE), has lead to the discovery of additional populations east and west of Brits. A herbarium sheet originating from the Free State was also found at PRE. Given the present known distribution of this species and the fact that the Magaliesberg populations fall mainly within a developing, high-density residential area, its conservation status has, after some debate, been classified as Near Threatened (J.E. Victor & M. Phab 2006 pers. comm.).

ACKNOWLEDGEMENTS

We are grateful to Dr O.A. Leistner who kindly translated the original Latin and German descriptions. The South African National Biodiversity Institute, University of KwaZulu-Natal and Gauteng Department of Agriculture Conservation and Environment are thanked for making resources available for this study. Dr H.F. Glen is thanked for nomenclatural advice.

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MS. received: 2006-06-15.

LEGUMINOSAE

VIGNA VERDCOURTII (PAPILIONOIDEAE), A NEW SPECIES FROM EASTERN AFRICA

The genus *Vigna* Savi (Papilionoideae) is an important group which includes several domesticated species, five in Asia and two in Africa, the African ones being the cowpea, *Vigna unguiculata* (L.) Walp., and the Bambara groundnut, *Vigna subterranea* (L.) Verdc. Major advances in the knowledge of the genus are the works of Verdcourt (1970) and Maréchal *et al.* (1978).

Since 1978, various phylogenetic works, especially Thulin *et al.* (2004), indicate a much smaller genus *Vigna*, reduced to 50–60 species. Apart from the Asian species of subgenus *Ceratotropis*, and despite several changes made in the nomenclature (Pasquet 2001), most of the African taxa had already been described by 1978. Six new species were described after 1978 (Mithen &

Kibblewhite 1989; Pasquet & Maréchal 1989; Pienaar 1991, 1993; Du Puy & Labat 2002); however, some of them are controversial (including *Vigna benuensis* Pasquet & Maréchal) and will probably not survive the phylogenetic test of DNA sequence analysis.

During the preparation of the account of *Vigna* for *Flora zambesiaca* (Pasquet 2001), a few specimens were difficult to identify. These specimens were close to *V. oblongifolia* A.Rich. and pubescent forms of *V. luteola* (Jacq.) Benth. (= *V. fischeri* Harms), but they were char-



FIGURE 25.—*Vigna verdcourtii*. A, flowering and fruiting branches; B, seedling from accession X3080, National Botanic Garden of Belgium, Meise; C, seed. A, Paget-Wilkes 926 (EA); B, C, Robson & Angus 407 (K). Scale bars: A, B, 10 mm; C, 1 mm. Artist: Nicholas Muema, East African Herbarium, Nairobi, Kenya.

acterized by standard dimensions longer than wide, an unusual character in *Vigna*, and only encountered in two unrelated species, i.e. *V. schimperi* Baker from subgenus *Haydonia* (R. Wilczek) Verdc. and *V. owahuensis* Vogel from subgenus *Vigna* in the Hawaiian archipelago.

Later, from one matK sequence (Feleke 2007), it appeared that these specimens clearly belonged to a fairly rare new species within subgenus *Vigna*, known at present from only thirteen specimens.

***Vigna verdcourtii* Pasquet, sp. nov.**, (Sect. *Vigna*—Papilionoideae), floribus flavis 12.5–18.0 mm longis, *V. schimperi* Baker similis sed exino grani pollinis reticulato atque ovario ovula 7–10 gerenti differt; formis pubescentibus *V. luteolae* (Jacq.) Benth. similis sed vexillo longiore quam latiore differt.

Vigna fischeri sensu Thulin in Opera Botanica 68: 172 (1989), non Harms.

TYPE.—Ethiopia, Kaffa, Amero, 2 250 m, 1 December 1960, Mooney 8745 (K, holo.; ETH, FT, S, iso.).

Twining herb. Rootstock unknown. Stems covered with spreading ferruginous hairs. Stipules triangular-lanceolate, 5–6 × 1.5 mm, slightly bilobed at base, multinerved; lobes rounded, 1.5 mm long. Leaves trifoliate; terminal leaflets lanceolate, rarely ovate, 35–77 × 13–30 mm, acute and mucronulate at apex, rounded-subcordate

at base, sometimes slightly hastate, sparsely to densely soft-pubescent on both surfaces; petiole 15–45 mm long; rhachis 5–15 mm long. Inflorescence axillary, 2–16-flowered; peduncles 10–160 × 0.8–2 mm, not winged; rhachis 8–17 mm long, 1–8-noded; internode 1–3 mm long. Flowers 12.5–18 × 10–14 mm, yellow with purple marks; pedicel 1–4 mm long, very slightly expanding during fruiting. Bracteole oblong or lanceolate, 3–6 × 0.5–1.5 mm, 1-nerved. Calyx pubescent; tube 3 mm long; lobes 1.5 mm long, the lower twice as long, the upper pair joined to form acute or bifid lip. Standard longer than wide, obovate, usually 14–16 × 10–13 mm, with two small oblique appendages. Keel slightly twisted toward right or not twisted (seen from rhachis top), whitish with a short purple beak. Alternate anthers without a pair of glands at base. Pollen exine reticulate. Ovary 7–10-ovuled. Pod black, slightly compressed, curved or almost straight, 45–48 × 4.0–4.5 mm, slightly constricted between seeds, covered with ferruginous and white bristly hairs, with a short curved beak. Seed 3–4 × 2.5 mm, 1.5 mm thick, black; hilum 1.5 mm long, eccentric, with a conspicuous fork-shaped eccentric aril. Figures 25, 26.

Diagnostic features and affinities: *Vigna verdcourtii* is sister to the mainly yellow-flowered group which includes *V. lanceolata* Benth., *V. pseudovenulosa* (Maréchal, Mascherpa & Stainier) Pasquet & Maesen, *V. subterranea* (L.) Verdc., *V. filicaulis* Hepper, *V. multinervis* Hutch. & Dalziel, *V. heterophylla* A. Rich., *V. pubigera* Baker, *V. oblongifolia* var. *oblongifolia*, *V. luteola*, *V.*

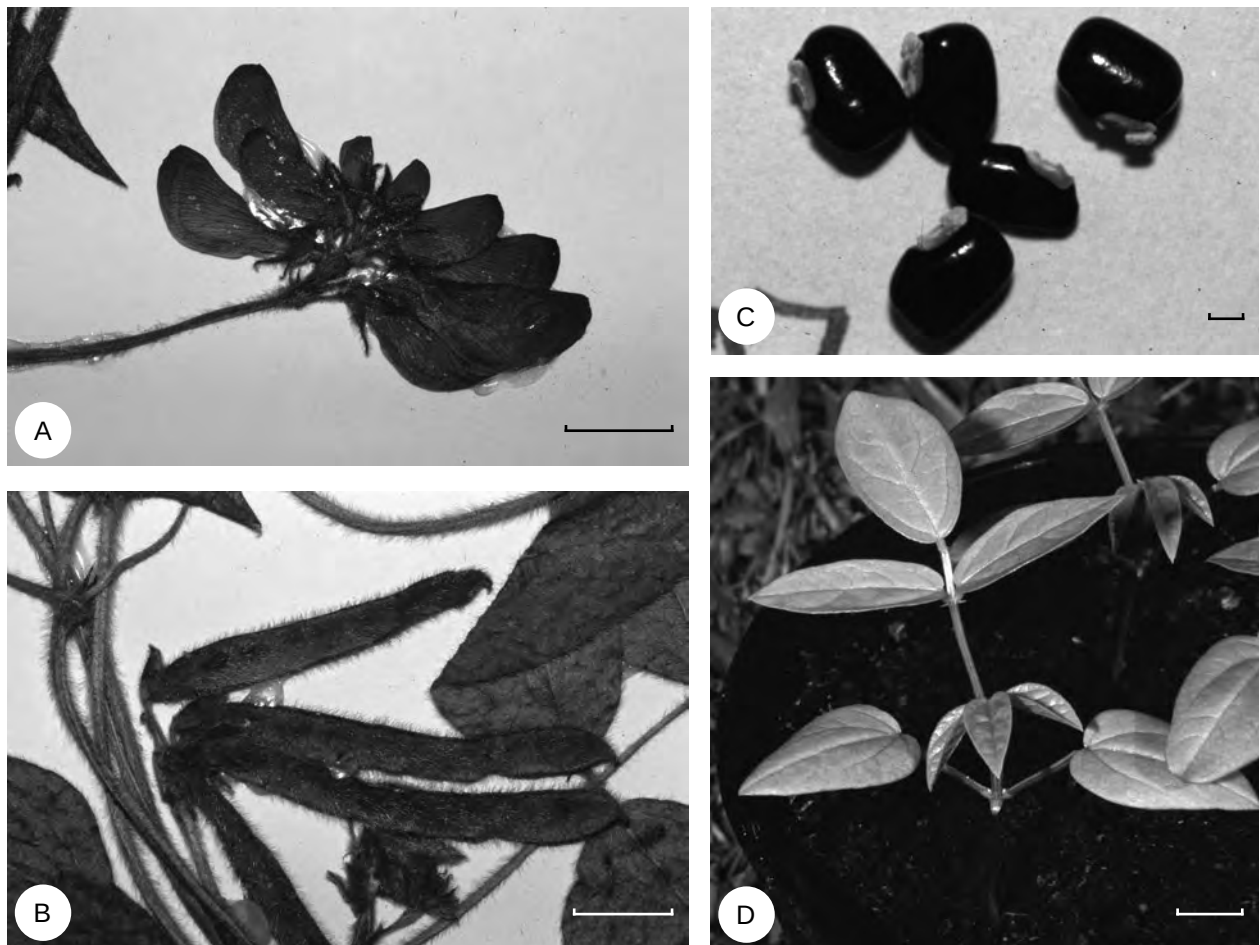


FIGURE 26.—*Vigna verdcourtii*. A, flower; B, pods; C, seeds; D, seedlings from accession X3080, National Botanic Garden of Belgium, Meise, A. B, Luke 7032 (EA); C, Robson & Angus 407 (K). Scale bars: A,B,D, 10 mm; C, 1 mm.

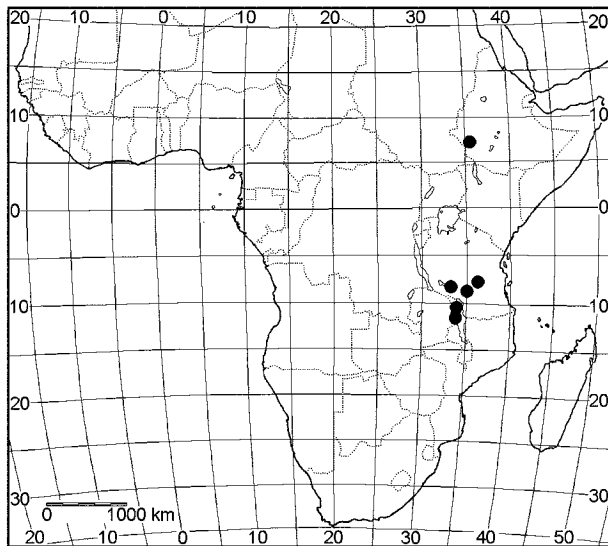


FIGURE 27.—Known distribution of *Vigna verdcourtii*.

marina (Burm.) Merr., *V. oblongifolia* var. *parviflora* (Baker) Verdc., and *V. owahuensis* (Feleke 2007).

The general plant morphology is very similar to both that of *Vigna oblongifolia* var. *oblongifolia* (especially the pubescence, the number of ovules, and the pod and seed morphology), and to that of the pubescent forms of *V. luteola* (= *V. fischeri*) due to the leaf shape and the flower size (Figure 25). Previously, Mooney 8745 was identified as *V. fischeri* by Thulin (1983, 1989), and Robson & Angus 407 as *V. oblongifolia* by the author (Pasquet 2001). Most of the specimens were labelled *V. fischeri*, one *V. luteola*, and one *V. oblongifolia*.

The contracted inflorescence and the standard being longer than wide (Figure 26) suggest *Vigna schimperi*, but the *V. verdcourtii* pollen exine is not smooth, the stipule is produced below the point of insertion, and the ovule number (7–10) is much lower than that of *V. schimperi* (13–20).

Distribution and ecology: *Vigna verdcourtii* appears to be restricted to the mountainous areas of tropical East Africa (Figure 27) occurring at 1 500–2 300 m. This is higher than the *V. luteola* altitudinal range, and similar to that of *V. schimperi*. However, the ecology is more related to that of the *V. luteola* group: streambanks, forest edges, fallows and cleared land in forest areas. In fact, this exactly matches pubescent forms of *V. luteola*.

The number of specimens available is small, but it highlights a surprising feature of its distribution. The taxon is found between latitude 8°N and 12°S, but it has never been collected between 6°N and 6°S (Figure 27), notably in Kenya and northern Tanzania, which have been intensively surveyed in the past and where pubescent forms of *V. luteola* are encountered. This may be due to a photoperiod sensitivity which could prevent the plant from flowering when day length is not variable enough. The area of occurrence of *V. verdcourtii* is fully included within that of *V. schimperi*, which extends from

13°N to 12°S, with numerous collections from Kenya and northern Tanzania.

Other material examined

TANZANIA.—Iringa Prov., Mufindi, 6500' [1 980 m], 15 October 1931, Davies 29 (EA); Udzungwa Mountain NP, Ruipa River, 1 650 m, 6 October 2000, Luke, Bytebier, Butynski, Ehardt, Perkins & Kimaro 7032 (EA, K); Mufindi, ± 6200' [1 900 m], 25 July 1969, Paget-Wilkes 549 (EA); Mufindi, Lugeme, ± 6200' [1 900 m], 18 September 1971, Paget-Wilkes 926 (EA, K); Mufindi, Nymalala, ± 6200' [1 900 m], 17 September 1971, Paget-Wilkes 937 (EA, K); Mufindi Dist., Livalonge Tea Estate, [± 1 700 m], 27 August 1971, Perdue & Kibuwa 11269 (EA, K); Rungwe Dist., Ngozi Poroto Mtns, 2 100 m, 17 October 1956, Richards 6537 (K); Mbeya Dist., Kikondo, 2 250 m, 20 October 1956, Richards 6654 (K); Nyassa Hochland, Station Kyimbila, 1913, Stolz 2157 (C, HBG, L, LD, S, U).

MALAWI.—Chikangawa, ± 1 800 m, 9 July 1952, Jackson 956 (BR, K); edge of rainforest path leaving Nyika, 7300' [2 225 m], 7 July 1971, Pawek 5033 (K).

ZAMBIA.—Nyika Plateau, below Rest House on path to N Rukuru waterfall, 2 150 m, 27 October 1958, Robson & Angus 407 (BM, K, PRE).

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MS. received: 2006-08-25.

ASTERACEAE

A KEY TO *DICOMA* TAXA (DICOMEAE) IN SOUTHERN AFRICA

Recent molecular phylogenetic studies of the family Asteraceae suggest that the genus *Dicoma* Cass. belongs to the tribe Dicomeae, closely related to the tribe Cardueae (Panero & Funk 2002). Harvey (1865) revised the southern African species of *Dicoma*. In 1923, Wilson revised the whole genus including seventeen southern African species. Since the publication of Wilson's monograph, many new species have been described, and some taxonomic changes have been made to the genus. Ortiz (2000) made a phylogenetic analysis of *Dicoma* and related genera. Following this analysis he reinstated the

genus *Macleodium*, which was first described by Cassini (1825). The species that previously belonged to sections *Macleodium* (Cass.) DC. and *Pterocoma* DC. of *Dicoma* (as they were delimited by De Candolle in 1838 and Harvey in 1865) were transferred to the genus *Macleodium* (Ortiz 2001). Netnou (2001) revised the genus *Dicoma* in southern Africa and during the course of this study, various herbaria were visited. Due to large numbers of incorrectly identified and unidentified species of this genus in some herbaria, it became apparent that a key to the species of *Dicoma* in southern Africa is much needed.

Key to southern African taxa of *Dicoma* Cass.

- 1a Heads radiate; rays neuter; disc floret pappus isomorphic of barbellate bristles; rigid shrublets:
 - 2a Leaves many, bright green, narrowly obovate or oblong-spathulate; midrib inconspicuous; heads cylindrical in shape; involucre bracts often reddish, gland-dotted *D. fruticosa* Compton
 - 2b Leaves few, dull grey-green, upper ones minute, basal ones often absent from herbarium specimens, if present broader than upper ones; midrib conspicuous at least on abaxial surface; heads obconic or campanulate; involucre bracts not gland-dotted:
 - 3a Heads distinctly obconic, cuneate at base; involucre bracts in (5)6(7) rows; pappus 9–11 mm long; leaves linear-elliptic *D. obconica* S.Ortiz & Pulgar
 - 3b Heads campanulate to subglobose, rounded at base; involucre bracts in 7 or 8(9) rows; pappus < 9 mm long; leaves oblanceolate to spathulate *D. picta* (Thunb.) Druce
- 1b Heads discoid or disciform; disc floret pappus isomorphic or dimorphic; shrubs, prostrate or erect herbs:
 - 4a Heads discoid; disc floret pappus dimorphic or isomorphic; plants erect or prostrate:
 - 5a Pappus dimorphic, outer rows of barbellate bristles, innermost row of membranous scales becoming barbellate toward apex:
 - 6a Erect annual herb, leaves discolorous, linear, narrowly elliptic or spathulate, margins serrate, base attenuate; involucre bracts purplish, spiny; inner pappus of membranous scales with barbellate tips *D. tomentosa* Cass.
 - 6b Prostrate perennial herb; leaves concolorous, elliptic or obovate, margins entire, distinctly petiolate; involucre bracts straw-coloured, not spiny; inner pappus with lower half scale-like, apex barbellate *D. cuneneensis* Wild
 - 5b Pappus isomorphic, of barbellate bristles, inner row not of membranous scales:
 - 7a Shrubs; leaves spatulate or broadly elliptic to suborbicular, both surfaces greyish white-felted:
 - 8a Leaves broadly elliptic to suborbicular, (10–)15–25 × (4–)7–10 mm; heads with 2(–5) subtending leaves; heads 13–16 mm long *D. kurumanii* S.Ortiz & Netnou
 - 8b Leaves spatulate, 8–12(–15) × 4–6(–8) mm; heads covered with at least 20 subtending leaves; heads less than 12 mm long *D. nachtigallii* O.Hoffm.
 - 7b Herbs or shrubs; leaves linear, elliptic, oblanceolate or ovate, upper surface tomentose, glabrous or subglabrous, lower surface greyish white-felted:
 - 9a Leaves linear, several times longer than wide:
 - 10a Shrub; leaves (5–)20–25 × 2–4 mm, upper surface dull greyish green, tomentose; involucre bracts erect with aristate apices, often sericeous on either side of midvein *D. dinteri* S.Moore
 - 10b Erect or prostrate herbs; leaves often longer than 30 mm:
 - 11a Plants erect:
 - 12a Heads solitary; leaves flexuous, upper surface glabrous to glabrescent, often with yellowish glands; heads broadly obconic, 30–32 mm wide; involucre bracts ovate-deltate, glabrous *D. swazilandica* S.Ortiz, Rodr.Oubiña & Pulgar
 - 12b Heads solitary or 3–5 corymbosely arranged at end of branches; leaves not flexuous, upper surface greenish black, gland-pitted; heads subcylindric to campanulate, relatively small, less than 30 mm wide; involucre bracts lanceolate, glabrescent *D. anomala* Sond. subsp. *gerrardii* (Harv. ex F.C.Wilson) S.Ortiz & Rodr.Oubiña
 - 11b Plants prostrate:
 - 13a Heads broadly campanulate; involucre bracts finely araneose-lanate or glabrescent, margins scarious, tips often recurved; leaves not fascicled, upper surface gland-pitted, greenish black *D. anomala* Sond. subsp. *anomala* (narrow-leaved form)
 - 13b Heads subcylindric; involucre bracts glabrous, ± entirely scarious, often not recurved; leaves often fascicled, upper surface dull greyish green with black glands *D. prostrata* Schweick.
 - 9b Leaves elliptic, lanceolate, oblanceolate, ovate or obovate:
 - 14a Prostrate herbs; leaves lanceolate to elliptic; heads sessile up to 40 mm wide; pappus of fine barbellate bristles, 10 mm or more long *D. anomala* Sond. subsp. *anomala* (broad-leaved form)
 - 14b Erect herbs or subshrubs; leaves oblanceolate, obovate or narrowly ovate; heads pedunculate, up to 25 mm wide; pappus ciliate, if barbellate up to 7 mm long:
 - 15a Bushy herbs or subshrubs; leaves oblanceolate to obovate, often fascicled on axils, lower ones usually larger, upper surface bright green, glabrous at maturity, conspicuously gland-dotted; heads up to 25 mm wide; involucre bracts glabrous, outer often recurved, with sharp pointed apices; pappus ciliate up to 9 mm long *D. galpinii* F.C.Wilson
 - 15b Shrubs; leaves lanceolate or narrowly ovate, not fascicled, upper surface of leaves gland-dotted, visible through tomentose indumentum; heads up to 20 mm wide; outer involucre bracts pilose, often recurved, apices acuminate-pungent; pappus barbellate, up to 7 mm long *D. montana* Schweick.
 - 4b Heads disciform; disc floret pappus dimorphic; prostrate herbs:
 - 16a Disc florets distinctly shorter than pappus; base of inner row of pappus broad, membranous with undulate margins, upper part ciliate:
 - 17a Leaves concolorous, elliptic, up to 20 mm wide, distinctly petiolate, margins serrulate; disc floret pappus 7–12 mm long *D. schinzii* O.Hoffm.
 - 17b Leaves discolorous, oblong-lanceolate, up to 15 mm wide, subsessile, margins subtentire; disc floret pappus 21–24(–30) mm long *D. macrocephala* DC.
 - 16b Disc florets ± equal to pappus; base of inner pappus of disc florets with basal part scale-like, upper part barbellate:

- 18a Leaves discolorous, ovate to orbicular; inner pappus of disc florets with basal part scale-like for more than $\frac{1}{2}$ length, tip barbelate *D. arenaria* Bremek.
 18b Leaves concolorous, narrowly oblong-lanceolate; inner pappus of disc florets with basal part scale-like for $\frac{1}{3}$ length, tip plumose *D. capensis* Less.

ACKNOWLEDGEMENTS

This key is part of an M.Sc. thesis submitted to the Rand Afrikaans University, now the University of Johannesburg. We would like to thank the curators of the following herbaria: BOL, GRA, J, NBG, NH, PRE, PRU and UNIN for making their collections available for this study. Financial assistance from the South African National Biodiversity Institute, National Research Foundation and University of Johannesburg is acknowledged. Prof. A.E. van Wyk and Dr H.F. Glen are thanked for their valuable comments on the thesis. We would also like to thank the staff of the National Herbarium, especially Drs Elizabeth Retief, Elsie Steyn, Sarie Perold, and Marinda Koekemoer, and Priscilla Burgoyne, Anne-Lise Fourie, Paul Herman, Estelle Potgieter and Sandra Turck for their assistance and support.

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A reconnaissance survey of the woody flora and vegetation of the Catapú logging concession, Cheringoma District, Mozambique

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Keywords: Catapú, checklist, Cheringoma, ecology, flora, Mozambique, Sena, vegetation, vernacular names

ABSTRACT

A checklist of the trees, shrubs and lianes of Catapú, Cheringoma District, Mozambique, is presented. Floristically the study area falls within the Swahilian/Maputaland Regional Transition Zone. In total, 238 woody species and infraspecific taxa have been recorded, representing 59 families and 167 genera. Most species (64%) occur both to the north and south of the study area, 26% have their core distribution in the Swahilian Regional Centre of Endemism, 4% have a more southerly distribution, 14 are endemic to the Swahilian/Maputaland Regional Transition Zone and two near-endemic, extending into the Zambezi Regional Centre of Endemism only along the Zambezi River Valley as far west as Kariba. The checklist includes the Sena names for 191 species, 77 of which are recorded for the first time. Comparisons of the Catapú checklist are made with other checklists.

INTRODUCTION

According to a preliminary checklist of vascular plants, the flora of Mozambique comprises 3 932 indigenous plant taxa and of these 177 are endemic (Da Silva *et al.* 2004). The primary purpose of the study was to establish what trees, shrubs and woody lianes occur on the Catapú logging concession area. Floristically, White (1983) recognized the zone occupying the East African coastal belt, $\pm$ 50–200 km wide, from southern Somalia in the north to the mouth of the Limpopo River in the south as the Zanzibar-Inhambane Regional Mosaic. Subsequently this phytochorion was split into two smaller floristic regions by Clarke (1998), namely: 1, the Swahilian Regional Centre of Endemism along the Kenyan, Tanzanian and northern Mozambique coasts and marginally extending into southern Somalia; and 2, the Swahilian/Maputaland Regional Transition Zone extending along the Mozambique coast and into southern Malawi and eastern Zimbabwe between the Swahilian Regional Centre of Endemism and White's (1983) Maputaland-Pondoland Regional Mosaic. The study area falls within the Swahilian/Maputaland Regional Transition Zone.

Wild & Barbosa (1967) broadly classified the vegetation of the concession area as Dry Deciduous Lowland Forest (vegetation type 6), Mosaic of Low Altitude Dry (Mixed) Forest and Miombo (vegetation type 10) and Discontinuous Dry Savanna Woodland-Tree Savanna and 'Tandos' Grassland (Gorongosa Lowland) (vegetation type 45) along the lower altitude river valleys. The Wild & Barbosa (1967) map also indicates the presence of Open Deciduous Tree Savanna (Lowland) with *Acacia nigrescens* dominant (vegetation type 52) but this has not been seen either in or near the study area. White (1983)

mapped the region as North Zambezi Undifferentiated Woodland and Wooded Grassland (mapping unit 29c), which seem to better describe the floristically rich vegetation of the study area. In the east, Catapú borders White's Zanzibar-Inhambane East African Coastal Mosaic (mapping unit 16a). Outliers of one of the forest types, Zanzibar-Inhambane Undifferentiated Forest, occur on Catapú.

Although some plant exploration was undertaken in the Sofala Province of Mozambique between 1940 and 1980, notably by Müller & Pope (1973 pers. comm.) and Tinley (1977), that part of Mozambique was still remote, and collecting of herbarium material was largely confined to areas adjacent to roads. In those days, Catapú was well away from the main road which went between Inhambitanga and Marromeu. During the civil war in Mozambique (1975–1994), botanical collecting came to a halt and has only taken place sporadically since then (Da Silva *et al.* 2004). Hitherto, most of the botanical inventories undertaken in Mozambique have been conducted mainly in the south of the country; the central and northern parts have been less well documented (Izidine & Bandeira 2002). The paucity of biodiversity data for central and northern Mozambique has also been highlighted by Schipper & Burgess (2004).

The checklist focuses on the woody plants and lianes and is ongoing. To describe the intricate mosaic of vegetation types in the study area, we have adopted a narrative style which we hope will be useful for workers on the ground and as a basis for possible quantitative surveys in future. The common Sena (= Cisena, Chisena) names—the principal vernacular of the region—are presented, many for the first time. We also comment on the impacts of logging on the vegetation and the need for measures to ensure sustainability and the conservation of an ecosystem rich in plant diversity.

STUDY AREA

Catapú, the logging concession of TCT-Dalman Furniture, Lda., is located 30–40 km south of the Zambezi River and on the northwestern side of the Inhambitanga Village in the district of Cheringoma, Sofala

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MS. received: 2005-09-13.

Province, central Mozambique (Figure 1) at $\pm S18^{\circ}00'05''$ and $E35^{\circ}08'13''$, an area covering 24 821 ha. The GPS reading at the sawmill is $S18^{\circ}02'41''$; $E35^{\circ}12'24''$. The main road, the EN-1, traverses the concession where it $\pm$ follows the watershed between the Zangue and Tissadze Rivers. Field work started in 2000 and results up to July 2006 are reported. Hitherto the survey has been concentrated within the firebreak around the sawmill area, west of the EN-1 along the roads known as Via Pungue and Via Santove and around the pans.

In the west, Catapú is bordered by the Zangue River and flood plain, up which the Zambezi River floods back during the wet season. The eastern boundary extends from the EN-1 road/railway junction at Gangala in the north along the obsolete Dondo-Caia railway line to the Inhamitanga Village. The northern boundary is in the form of a 'V' with Via Zangue 2 on the western arm and the EN-1 on the eastern arm. The southern boundary is the Inhamitanga road to the EN-1 at Chapa and then the EN-1 to the Zangue River bridge. The Tissadze River flows from south to north $\pm$ bisecting the eastern half of the concession and the Chirimadzi River, which is more a series of pans than a river with the woody vegetation margin more clearly defined than the waterway, goes from south to north in the northern third.

The altitude at the Catapú turn-off from the EN-1 is 200 m a.s.l. but drops from ± 100 to 50 m along the river valleys. Soils are sand with outbreaks of sandstone and

calcareous conglomerates and black cotton or turf soils around the vleis and in the river floodplains. The sands are underlain by sublittoral sands which accumulate water, enabling them to support very tall trees. A bore-hole was drilled and a sample collected every 3 m to a depth of 51 m. Every sample was sand except for the first 3 m in which there was some gravel. Mean annual rainfall ranges from 700–1 400 mm, although for the last four years it has barely exceeded 500 mm during the rainy season (November to March). There are many pans in the forest/thicket/woodland mosaic, grass-covered depressions of half a hectare or more which fill with water during the rains. As a result of below-average rainfall, none of these pans has held any water for the last four or five years. During the other seven months (April to October) an average of 126 mm has been recorded.

Vegetation of Catapú comprises a mosaic of mainly dry lowland forest, dry deciduous thicket and woodland. In the Chirimadzi Valley in the northern area of the concession, the vegetation is sparsely wooded grassland. There is an area of miombo woodland on the southeast boundary of the concession and open undifferentiated woodland in the southwestern section.

METHODS AND TERMINOLOGY

Recognizing the rich plant diversity at Catapú, a survey of the woody species was started. Specimens have

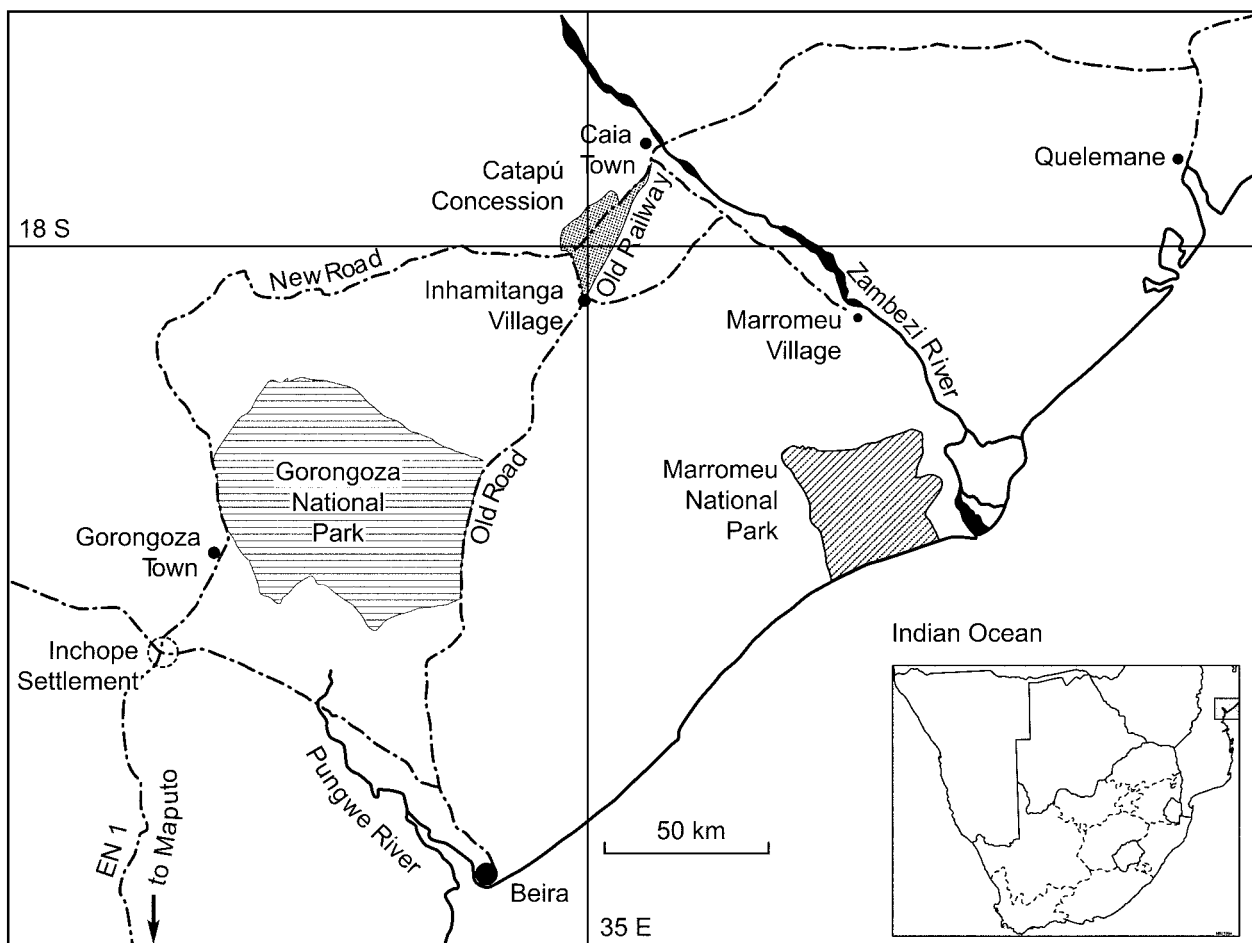


FIGURE 1.—Map showing the location of the study area in central Mozambique. Roads: — · — · —.

been collected and voucher specimens prepared which are housed in the recently established field herbarium to be known as the Cheringoma Herbarium (proposed acronym CHER). Any species not identified in the field were taken for identification to the National Herbaria in Harare (SRGH) and Pretoria (PRE). Regional Floras, e.g. *Flore de Moçambique* (1969–), *Flora zambesiaca* (1960–) and *Flora of tropical East Africa* (1952–) have also been used to assist in identification. The scientific names of the plants are based mainly on Coates Palgrave (2002) and Kloppe *et al.* (2006).

Sena names on the list, (Appendix 1, column 4), were checked against species in the field to confirm identification. Aware that the use of plant vernacular names is essentially a spoken language, they have been spelt phonetically. The names were checked against De Koning (1993) where a very broad view was taken of the spelling and the regions in which the names were recorded.

Plants recorded at Catapú were assessed phyto-geographically. The checklist of the study area was compared with the preliminary checklist of vascular plants of Mozambique (Da Silva *et al.* 2004) and also with checklists compiled during two recent vegetation and plant surveys in nearby areas, one of the Cabora Bassa shoreline (Timberlake 2002) and the other the Zambezi Delta wetland plant survey (Müller *et al.* 2000). It was also compared with the checklists of two South African forests, Richards Bay forest and the Maputaland forest complex (Geldenhuys 1992) as well as with a mid-Zambezi Valley dry forest biodiversity survey (Hoare *et al.* 2002). The Red Data List, Mozambique (Izidine & Bandeira 2002) was checked for species occurring in the study area.

Very simplified, the following definitions are used for the different broad vegetation types:

Forest has a canopy whose crowns interlock at 10 m or more in height (Hoare *et al.* 2002). A forest is rich in species, but due to the availability of soil moisture, it changes rapidly in composition and physiognomy over quite short distances and is difficult to classify (White 1983). Dry deciduous forest is characteristically found on deep sands which absorb all the incident rainfall or receive lateral seepage water and remain moist throughout the greater part of the dry season (White 1983). Understorey species remain evergreen throughout the year in dry semi-deciduous forest and are deciduous for more than one month in dry deciduous forest (Chapman & White 1970).

Thicket has a canopy between 3–7 m tall formed by the interlocking branches of small trees and multi-stemmed shrubs. The presence of emergent trees over 10 m tall protruding above the canopy or shrub layer is often a feature of thickets (Chapman & White 1970).

Woodland comprises open stands of trees at least 5 m tall, crowns covering at least 20% of the surface, sometimes in lateral contact but crowns not interlocking; grass cover is usually present (Chapman & White 1970).

Zambezian undifferentiated woodland is defined by the absence of miombo and mopane dominants rather than by its own floristic composition. It is composed of

many more tree species than either miombo or mopane woodland. Although the dominants of miombo woodland are normally absent from undifferentiated woodland some of their associated species are frequently present (White 1983).

Miombo is a colloquial term used to describe those central, southern and eastern African woodlands dominated by members of *Brachystegia*, *Julbernardia* and/or *Isoberlinia*, three closely related genera from the legume family, Fabaceae, subfamily Caesalpinioideae (Campbell *et al.* 1996). It generally occurs on geologically old, nutrient-poor soils in the uni-modular rainfall zone. The shrub layer is variable in density and composition. Ground cover varies from a dense coarse grass growth to a sparse cover of herbs and grasses (Campbell *et al.* 1996).

RESULTS

Floristic analysis

A total of 238 woody species and infraspecific taxa (referred to collectively as species) recorded during the survey are listed in Appendix 1. These represent 59 families and 167 genera. Fabaceae is the largest family, with eight genera and eight species in Caesalpinioideae, seven genera and 20 species in Mimosoideae and 11 genera and 17 species in Papilionoideae, making a total of 26 genera and 45 species, followed by Rubiaceae with 12 genera and 14 species. None of the other families has more than 10 species.

We recorded 191 Sena names (Appendix 1, column 4) for species in the study area of which 77 names are not included in De Koning (1993). The names published in De Koning (1993) are marked with an asterisk, those not marked are names not previously published.

Appendix 1, column 5, presents the phyto-geographical distribution of the species in the study area. With the symbol 'T', there are 152 species (64.5%) common to both the East African coastal flora and the southern African flora (FSA) region (Germishuizen & Meyer 2003). With the symbol 'N' denoting those from the north there are 61 species (25.5%) extending southwards from the East African coastal flora. With the symbol 'S' there are 10 (5%) species extending northwards from the southern African flora (FSA) region. There are 14 species (5.6%) with the symbol 'E', which are endemic to the Swahilian/Maputaland Regional Transition Zone. They are: *Acacia torrei*, *Catunaregam swynnertonii*, *Cola mossambicensis*, *Combretum kirkii*, *Cordia stuhlmannii*, *Erythrina livingstoniana*, *Glyphaea tomentosa*, *Hibiscus mossambicensis*, *Millettia mossambicensis*, *Monodora stenopetala*, *Ochna angustata*, *Pavetta klotzschiana*, *Tricalysia jasminiflora* and *Vangueria esculenta*. *Ziziphus mauritiana*, included in the checklist is an alien, marked with a (+). *Tamarindus indica* is treated as indigenous (Coates Palgrave 2002). There are 40 species in common with the Maputaland-Pondoland Regional Mosaic as shown in Appendix 1, column 6.

Comparison with Da Silva *et al.* (2004) Appendix 1, column 7, shows that of the 240 species on the Catapú

checklist, 38 species can be added as occurring in Sofala Province and an additional 22 as occurring both in Sofala Province and in Mozambique. New records of particular interest are *Dovyalis xanthocarpa*, a new record for Mozambique; new for Sofala and south of the Zambezi River include *Cordia torrei*, *Grewia forbesii*, *Zanthoxylum holtzianum*, also interesting is *Combretum kirkii*, with a very limited distribution along the Zambezi Valley; *Elaeodendron transvaalense* has not previously been recorded as far north as this (R. Archer pers. comm.).

The Zambezi Delta survey (Müller *et al.* 2000) included six days spent at Coutada 11, GPS reading S18°33'11", E36°06'02", a hunting concession not very far from Catapú. It was anticipated that many of the woody species at Catapú would appear on that list of plants recorded for the forest and woodland columns in the survey. But Appendix 1, column 8, shows 86 species in common. Lake Cabora Bassa is situated on the Zambezi River in Tete Province upstream from the study area. The result of the comparison with that shoreline survey (Appendix 1, column 9) shows that 152 species on the Catapú checklist were recorded. Of the Catapú checklist, 59 species appeared on both the previously mentioned lists and 60 species did not occur on either list. Although 162 species (68%) of the plants on the Catapú checklist occur in the FSA region, only 40 species (17%) occur in the Maputland/Pondoland Regional Mosaic (Appendix 1, column 6).

In the mid-Zambezi Valley dry forest biodiversity survey (Hoare *et al.* 2002), no checklist was presented, but a list of 36 species considered to be indicator species of dry forest was given. Of those, 20 species occur in the study area, *Kirkia acuminata* and *Schinziophyton rautanenii* are infrequent and found mainly in woodland and the shrubs *Citropsis daweani* and *Zanthoxylum leprieurii* are only occasional. *Cleistochlamys kirkii* and *Monodora junodii* are classified as shrubs, the former described as being tall trees in the description of the vegetation to follow and the latter is distinctly a tree of 3 to 4 m tall. *Xylothea tettensis* is plentiful in the study area. *Xylia torreana* is considered an indicator of dry forest and thicket and is very much a constituent of the forest vegetation in the study area.

Conservation status

Eleven species on the Catapú checklist have been included in the Red Data List for Mozambique (Izidine & Bandeira 2002). Only three are considered vulnerable: *Acacia torrei* VU D2, *Cola mossambicensis* VU A1a and *Sterculia appendiculata* VU A1ad. Izidine & Bandeira (2002) comment that regeneration in *Sterculia appendiculata* is difficult. In the study area, however, this species coppices very readily. On the edge of Via Pungue where the roots were disturbed by a bulldozer when the road was being constructed, there has been a proliferation of saplings growing from root shoots, some now $\pm$ 4 m tall. *Azelia quanzensis* is given a Threatened status in Mozambique by Bandeira *et al.* (1994), Lower-Risk Near Threatened (Izidine & Bandeira 2002), and as Vulnerable (Da Silva *et al.* 2004), citing that large quan-

ties are being cut for timber, charcoal and fuel wood production.

Two species, *Acacia adenocalyx* and *Amblygonocarpus andongensis* are incorrectly listed as Mozambique endemics and rated VU D2 in Da Silva *et al.* (2004) but not included in Izidine & Bandeira (2002). *Acacia adenocalyx* is not an endemic to Mozambique, as it also occurs in Kenya and Tanzania (Ross 1979) and in the study area it is widespread and invasive. *Amblygonocarpus andongensis* has a wide distribution, occurring as far afield as Namibia, Botswana, Zambia and in the savanna regions of tropical Africa (Brenan 1970). It is also fairly widespread in Mozambique.

Vegetation types

The study area comprises a mosaic of three vegetation types: dry deciduous forest, dry deciduous thicket and woodland. Areas of lowland deciduous forest, with the canopy usually $\pm$ 20 m high, but varying from 12 to 25 m and not always continuous, are very patchy but there are good examples along the road known as Via Pungue, in the area west of the EN-1 and just south of Mashamba Grande and an area east of the EN-1 just north of Chapa. Nearly all the canopy species are deciduous but there is considerable variation from species to species and from year to year. The dominant trees emergent above the canopy are *Adansonia digitata*, *Berchemia discolor*, *Bivinia jalbertii*, *Bombax rhodognaphalon*, *Milicia excelsa*, *Millettia stuhlmannii*, *Morus mesozygia* and *Sterculia appendiculata*. Reaching and forming the canopy at 12 to 25 m are *Azelia quanzensis*, *Balanites maughamii*, *Celtis mildbraedii*, *Cordyla africana*, *Fernandoa magnifica*, *Terminalia sambesiaca* and *Xylia torreana*. Many of the *Terminalia sambesiaca* have died except for some along the EN-1 highway. *Sterculia appendiculata* occurs in dense and open forest.

Below the canopy but reaching up towards it in the sparse understorey, are numerous *Drypetes reticulata*. Also frequent are *Millettia mossambicensis* and *Strychnos usambarensis*. In addition, *Hunteria zeylanica*, *Strychnos henningsii* and *S. potatorum* are found. There is a fairly continuous canopy and very sparse undergrowth with very few to no ferns, herbs or grasses. Some of the understorey shrubs are *Chazaliella abrupta*, *Citropsis daweani*, *Drypetes arguta*, *Hibiscus mossambicensis*, *Lasciodiscus pervillei*, *Sclerochiton kirkii* and *Zanthoxylum leprieurii*.

Lianes in the study area include *Abrus precatorius*, *Acacia adenocalyx*, *Adenia gummifera*, *Artabotrys brachypetalus*, *Cissus cucumerifolia*, *C. integrifolia*, *C. quadrangularis* and *C. rotundifolia*, *Combretum kirkii*, *C. microphyllum*, *C. padoides*, *Dalbergia arbutifolia*, *Dalbergia fischeri*, *Entada wahlbergii*, *Grewia caffra*, *Hugonia busseana*, *Landolphia kirkii*, *Loeseneriella crenata*, *Opilia celtidifolia*, *Reissantia buechananii*, *R. indica*, *Strophanthus kombe*, *S. petersianus*, *Synaptolepis alternifolia*, *S. kirkii* and *Tiliacora funifera*.

In 1994 there was a devastating fire through parts of the forest. *Acacia adenocalyx* proliferated and totally

overran large areas. Stands were so thick that nothing was able to grow underneath and it also climbed over and smothered surviving trees. This has been cleared in places and one of the pioneer species that regenerated in the cleared areas was *Fernandoa magnifica*. Lianes and climbers also seem to have proliferated as a result of fire damage and in the area known as Mashamba Experimental, a 30 m tall *Gyrocarpus americanus* has fallen, apparently having been pulled down by their weight. In the same section, *Cordia stuhlmannii* and *C. torrei* occur. They seem to have survived the fire or managed to regenerate successfully. Perhaps the latter, as *Cordia torrei* has also been observed along the edge of the road on the EN-1.

Continuing west along Via Pungue, the forest thins towards Mpiá Pan and the vegetation becomes open wooded grassland. The scattered trees include remarkably tall *Boscia salicifolia*, *Cleistochlamys kirkii*, *Combretum adenogonium*, *Dalbergia melanoxylon*, *Philenoptera violacea*, *Piliostigma thonningii*, *Sclerocarya birrea* and *Vitex payos*. Some of the smaller species are *Rourea orientalis*, *Senna petersiana* and *Xylothea tectensis*.

Vegetation east of the EN-1 along the road known as Via Entrada, is very difficult to classify as it is an intricate mosaic of forest, thicket and woodland. The canopy varies in height considerably and it is probably best described as dry thicket with some emergent trees over 10 m high. The taller trees are *Azelia quanzensis*, *Albizia harveyi*, *Balanites maughamii*, *Berchemia discolor*, *Blighia unijugata*, *Boscia salicifolia*, *Hymenocardia ulmoides*, *Millettia stuhlmannii*, *Monodora junodii* var. *macrantha*, *Monodora stenopetala*, *Pteleopsis myrtifolia*, *Strychnos madagascariensis* and *Warneckea sansibaricum*. Other trees are *Carpolobia goetzei*, *Gardenia ternifolia*, *Millettia mossambicensis*, *M. usaramensis* and *Rothmannia fischeri*. Some of the shrubs are *Allophylus rubifolius*, *Bauhinia tomentosa*, *Coffea racemosa*, *Cordia pilosissima*, *Dovyalis xanthocarpa*, *Friesodielsia obovata*, *Indigofera ormocarpoides*, *Rourea orientalis* and *Tricalysia jasminiflora*.

East of the Tissadze River along Via Lavu there is a very different picture. In this area there is very much a mosaic of forest, thicket and undifferentiated woodland. There is a canopy of ± 3 to 4 m with tall emergent trees well over 10 m high, such as *Bombax rhodognaphalon*, *Newtonia hildebrandtii* and *Diospyros mespiliformis*, of which, although few and far between, there is no indication of previous logging; *Adansonia digitata*, very tall and slender, is one of the emergents that also occurs in forest. *Millettia stuhlmannii* is easily identified with characteristic grey-green bark and *Sterculia africana* also has a distinctive bark. Forest species forming the lower canopy are *Dalbergia boehmii*, *Lecaniodiscus fraxinifolius* with characteristic pale bark (can also become very tall), *Drypetes reticulata*, *Strychnos madagascariensis* and *Trichilia capitata*. On the termite mounds are *Lecaniodiscus fraxinifolius*, *Spirostachys africana*, *Tamarindus indica* and the occasional *Lannea schweinfurthii*.

Usually considered woodland species, and contributing to the thicket canopy are *Albizia anthelmintica*, *Combretum adenogonium*, *C. hereroense*, *Terminalia sericea*, *Drypetes mossambicensis*, *Schrebera trichoclada*, *Sclerocarya birrea* (which becomes very tall in semi-closed forest but in the open remains far more squat) and *Strychnos madagascariensis*. *Spirostachys africana* occurs in clumps, sometimes forming pure stands of its own little forest, as does *Cleistochlamys kirkii*. Tall *Acacia nigrescens*, *Crossopteryx febrifuga* and *Kigelia africana* are found on the fringes and in open forest, as are *Acacia robusta* subsp. *usambarensis*, which appear to be dying around the pans, possibly as a result of past dry years. *Combretum imberbe* also occurs around the pans and on the heavier soils.

In the more scrubby forest/woodland mosaic *Diospyros loureiriana* and *D. senensis* are found. *Balanites maughamii* occurs in deep forest and in scrub forest. Sometimes in the woodland areas there is a tall grass cover and at others, shrubs, which include *Dovyalis hispidula*, *Friesodielsia obovata*, *Grewia forbesii*, *G. inaequilatera*, *G. lepidopetala*, *Holarrhena pubescens*, *Hoslundia opposita* (an up to 2 m shrub in the study area), *Margaritaria discoidea*, *Markhamia obtusifolia*, *M. zanzibarica*, *Ozoroa obovata* subsp. *obovata* and *Phyllanthus ovalifolius*.

Sporadically there is an almost park-like opening in the forest/thicket with a grass cover and very tall woodland trees up to 10 m high and very few shrubs. Trees recorded in those areas include *Acacia nigrescens*, *A. robusta* subsp. *usambarensis*, *Boscia salicifolia*, *Combretum hereroense*, *Dalbergia melanoxylon*, *Philenoptera violacea* and *Terminalia sericea*.

North from the Catapú turn-off along the EN1 as the road drops down to Tissadze and Chirimadzi River Valleys, where the altitude is ± 50 –100 m, the trees gradually become less forest and more woodland species. The river valley is open grassland with solitary trees or clumps of trees and bushes including *Acacia robusta* subsp. *usambarensis*, *A. polyacantha*, *A. xanthophloea*, *Combretum imberbe*, *Ficus sycomorus*, *Hyphaene coriacea* and *Xanthocercis zambesiaca*, all indicative of a high water table.

On the Zangue terrace along Via Santove grows the little known Mozambique endemic, *Acacia torrei* on black soils, and three palm species, *Borassus aethiopum*, *Hyphaene coriacea* and *Phoenix reclinata*. Other species are: *Acacia galpinii*, *A. polyacantha*, *A. sieberiana* var. *sieberiana*, *Albizia versicolor*, *Croton megalobotrys*, *Grewia sulcata*, *Margaritaria discoidea*, *Pluchea dio-scordis* and *Sclerocarya birrea*.

The area of miombo woodland next to the Tissadze River bridge on the Inhamitanga road is obviously situated on nutrient-poor soils. The trees are widely spaced, there is a poor grass cover and few shrubs. The woody vegetation seems to be mainly concentrated on termittaria, adjacent to small pans or along the bank of the Tissadze River. These include large *Cleistochlamys kirkii*, *Dovyalis hispidula*, *Flueggea virosa*, *Strychnos*

potatorum, a large *Tamarindus indica* (covered with a *Dalbergia arbutifolia*), *Trichilia capitata* and *Ziziphus mucronata*. Of the Miombo species only *Brachystegia spiciformis* was recorded. There is no continuous canopy and other trees scattered around are *Acacia nilotica*, *A. robusta* subsp. *usambarensis*, *Diospyros loureiriana*, *Philenoptera violacea*, *Schrebera trichoclada* and *Vangueria infausta*. Close to the river bank next to a huge *Sclerocarya birrea* is an 8 m tall *Brackenridgea zanguebarica*.

Logging and conservation

Millettia stuhlmannii known in the timber trade as *panga-panga*, *jambiri* and partridge-wood, *Afzelia quanzensis* (*chamfuta/chanfuta*), *Cordyla africana* (*mutondo*) and other hardwoods have been logged extensively throughout Mozambique for the last 100 years and continue to be today. Almost all logging has taken place on a non-renewable basis (pers. obs.). Judged from the height of many isolated very tall trees, particularly solitary baobabs, *Adansonia digitata*, and *Sterculia appendiculata*, trees that are not exploited for their wood, it is suggested that forest was more prevalent in central Mozambique in the past than is now apparent. Furthermore, those that remain are frequently being replaced by rural settlement and cultivation (pers. obs.; Izidine & Bandeira 2002; Schipper & Burgess 2004), with the result that much of the extensive forest that once covered especially the coastal areas of Mozambique, has disappeared.

Although Catapú is a timber concession, only certain species are felled. The three targeted species have the ability to coppice and silvicultural follow-up operations are now conducted on all stumps that have been logged. There is also an active programme of re-planting of *Millettia*, *Cordyla* and *Afzelia*. The seedlings are raised in a small nursery adjacent to the sawmill and currently some 10 000 seedlings are planted out into the logged areas each year in early summer with the first rains. This represents roughly four times the number of trees that are felled in the concession each year. The growth of the seedlings, those which have escaped the attention of the porcupines, in some places has been remarkable. For instance, of 34 plants propagated in ground seedbeds in Nov. 1997, dug up and replanted in the field in Oct. 1998, 20 survived and measurements taken in October 2005 show an average height of 4.15 m with an average trunk diameter of 140 mm. Obviously the average of 126 mm of rain which falls in the dry season enables the deep sands to remain moist throughout the greater part of the year.

A conservation/sensitive forest area of $\pm 4\ 000$ hectares within the firebreak around the sawmill and residential area has been established. This includes many different vegetation communities and has now been protected from fire for six years. Although woodland and miombo vegetation types in the study area tolerate burning and are even dependent on it for maintaining their structure, this area of forest has clearly not evolved with fire as a natural factor. Such intolerance to fire is also seen in Sand (Licuáti) Forest on the coastal plains of

Maputaland in southern Mozambique. Currently fire is increasingly introduced into forest patches with the slash and burn agricultural activities of an expanding human population.

DISCUSSION

Checklists of plants have an important role beyond the call for simple inventories of species. They serve as foundations for the enumeration of flora and vegetation in given areas. This paper also serves to demonstrate the diversity of woody species and vegetation types within a small area. Comparisons of the Catapú checklist with checklists of the surveys in nearby regions, confirm the convergence of several floristic and vegetation elements resulting in the richness and unique composition of the vegetation at Catapú.

When a plant has a name it has an identity, and the inclusion of vernacular names in a checklist has the potential to increase communication during field work. The trees at Catapú have been numbered and tagged, their exact position recorded and voucher specimens prepared. This has resulted in a living reference collection, cross-referenced to herbarium specimens, available on site, an important contribution to any future botanical study or field work in the area.

The present survey shows that 181 species recorded in the study area at Catapú were also recorded by one or other of the two available Zambezi River Valley vegetation surveys. A total of 60 species on the Catapú list were not included in either of the Zambezi River Valley vegetation surveys. Furthermore, this checklist is essentially a list of woody species and is an ongoing exercise but when ferns, herbs, geophytes and grasses are taken into account, the diversity will prove considerable.

There is a so-called forest reserve, the Inhamitanga Forest Reserve, a 2 km wide belt (1 km on either side of the road) on the Inhamitanga-Chupanga road, which starts at Inhamitanga Village on the southeastern boundary of Catapú, where the railway line and road meet, and runs for ± 10 km. Although it is marked on most of the 1: 250 000 maps of the area, very few people know of its existence and there is no formal protection of the reserve. It falls within Coutada 12, the hunting concession on the Catapú eastern boundary, so no timber concessions or simple cutting licenses can be issued in the area. The damage to the reserve so far has been very limited but like all Mozambique's forests they face the constant threat to slash and burn settlement, the risk of fire damage and of fuel-wood collection.

Not included in the checklist are at least another 10 or more tree species known to occur in the area but not yet found on Catapú. Hence the importance of this study which it is hoped can be extended to cover the rest of the Cheringoma area, including the Inhamitanga Forest Reserve and adjacent hunting concessions where the vegetation is probably protected to some extent, particularly against the ravages of extensive slash and burn settlement. An increased conservation initiative in this

area is urgently required, together with further biological studies. It is essential to know what is there before measures can be taken to save it.

We believe there is a very strong case for the whole Cheringoma area to be declared an Important Plant Area (Smith 2004) as it fulfills the following criteria; the site contains restricted range species (narrow endemics), has a botanical diversity with a high number of species and is a regionally threatened habitat. The area forms part of the Southern Zanzibar-Inhambane Coastal Forest Mosaic, an ecoregion of which the conservation status is 'critical' (Schipper & Burgess 2004). Furthermore, the Cheringoma area also falls within the Coastal Forests of Eastern Africa Hotspot (Burgess *et al.* 2004), one of 34 such regions identified as Earth's biologically richest and most endangered terrestrial ecoregions.

ACKNOWLEDGEMENTS

TCT-Dalman Furniture, Lda. is thanked for the opportunity to conduct this study and for providing support and generous hospitality during visits made to Catapú. Mario Jose Inacio has been an invaluable guide. He knows the trees by the local vernacular names in Sena and their numbers in English. Antonio Luis Domingos helped with the phonetic spelling of the Sena names.

Mr R.B. Drummond is thanked for all his help with the identification of difficult specimens. John Burrows and the Mpumalanga Plant Specialist Group visited Catapú and their help with identification is acknowledged with grateful thanks. The staff at SANBI in Pretoria, including those of the Mary Gunn Library, are always most helpful and are sincerely thanked. The Head of the Institute of the National Herbarium and Botanic Garden in Harare, Zimbabwe, is thanked for allowing the use of the library and herbarium.

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APPENDIX 1.—A checklist of woody species at Catapú

1 Taxon	2 Voucher No.	3 Growth form†	4 Sena name	5 Distr.	6 Gel.	7 DaS	8 Mul.	9 Tim.
Acanthaceae								
<i>Ruspolia hypocrateriformis</i> (Vahl) Milne-Redh. var. <i>australis</i> Milne-Redh.	<i>Cher58</i>	ST		N	0	NM	0	0
<i>Sclerochiton kirkii</i> (T.Anderson) C.B.Clarke	<i>Cher99, 100</i>	ST		N	0	NS	0	0
Anacardiaceae								
<i>Lannea schweinfurthii</i> (Engl.) Engl. var. <i>stuhlman-</i> <i>nii</i> (Engl.) Kokwaro	<i>M78</i>	T	N'tchilussua*	T	0	1	1	1
<i>Ozoroa obovata</i> (Oliv.) R.Fern. & A.Fern. var. <i>obovata</i>	<i>Cher33</i>	T	Nkhataussalu*	T	1	1	1	0
<i>Sclerocarya birrea</i> (A.Rich.) Hochst. subsp. <i>caffra</i> (Sond.) Kokwaro	<i>M119</i>	T	N'fula*	T	2	1	1	1
Annonaceae								
<i>Annona senegalensis</i> Pers. subsp. <i>senegalensis</i>	<i>Cher56</i>	T	Mulembe*	T	2	NS	1	0
<i>Artabotrys brachypetalus</i> Benth.	<i>M106</i>	LS	Nfazi*	T	0	NS	1	1
<i>Cleistochlamys kirkii</i> (Benth.) Oliv.	<i>Cher35</i>	T	Nhongolo*	T	0	1	1	1
<i>Friesodielsia obovata</i> (Benth.) Verdc.	<i>M85</i>	ST	N'tsinga*	N	0	1	0	1
<i>Monodora junodii</i> Engl. & Diels var. <i>macrantha</i> <i>J.Paiva</i>	<i>Cher5</i>	T		T	0	T	1	1
<i>Monodora stenopetala</i> Oliv.	<i>Cher76</i>	T	Nsiwi*	E	0	1	0	1
<i>Uvaria lucida</i> Benth. subsp. <i>virens</i> (N.E.Br.) Verdc.	<i>M103</i>	LS	Nunde	T	0	1	0	0
Apiaceae								
<i>Steganotaenia araliacea</i> Hochst. var. <i>araliacea</i>	<i>M143</i>	T	N'dhudhu-nhanga*	T	0	1	0	1
Apocynaceae								
<i>Diplorhynchus condylocarpon</i> (Müll.Arg.) Pichon	<i>JAW2</i>	T	Nhanthomole*	T	0	1	1	1
<i>Holarrhena pubescens</i> (Buch.-Ham.) Wall. ex <i>G.Don.</i>	<i>Cher36</i>	TS	Khumba yaa ndzo	T	0	1	0	1
<i>Hunteria zeylanica</i> (Retz.) Gardner ex Thwaites var. <i>africana</i> (K.Schum.) Pichon	<i>Cher28, 37</i>	TS	N'dhudhu-nhanga de floresta*	N	0	1	0	0
<i>Landolphia kirkii</i> T-Dyer ex Hook.f.	<i>Cher38</i>	LS	Mamungu*	T	1	NS	1	0
<i>Strophanthus kombe</i> Oliv.	<i>Cher39</i>	LS	Tribadeila	T	0	1	0	1
<i>Strophanthus petersianus</i> Klotzsch	<i>Cher40</i>	LS		T	0	1	0	1
<i>Tabernaemontana elegans</i> Stapf	<i>M65, 71</i>	T	N'caucau*	T	1	1	1	0
Arecaceae								
<i>Borassus aethiopum</i> Mart.	<i>s.n.</i>	P	N'dhikhua	T	0	NM	1	0
<i>Hyphaene coriacea</i> Gaertn.	<i>M161</i>	P	N'tcheu	T	0	NM	1	0
<i>Phoenix reclinata</i> Jacq.	<i>s.n.</i>	P	N'tchiendo	S	1	NM	1	0
Asteraceae								
<i>Pluchea dioscoridis</i> (L.) DC.	<i>Cher50</i>	T	N'dvuvu*	T	0	1	1	1
<i>Vernonia colorata</i> (Willd.) Drake subsp. <i>colorata</i>	<i>M174</i>	ST		T	0	1	1	0

Column 1: taxon, author name

Column 2: voucher no., collectors' abbreviations: Cher, Cheringoma herbarium accession no.; DP, David Peta; JAW, James White; M, Meg Coates Palgrave; MJJ, Mario Jose Inacio; qg, quick guide no.

Column 3: growth form: T, tree; S, shrub over 2 m; L, liane; P, herbaceous perennial.

Column 4: Sena name, * published in De Koning (1993).

Column 5: Distr., phytogeographical distribution: N, northerly distribution, occurring mainly north of the study area; S, southerly distribution, occurring mainly south of the study area; T, distribution transitional, occurring both north and south of the study area; E, species endemic to the Swahilian/Maputaland Regional Transition Zone; *Ziziphus mauritiana*, marked +, an alien, is included in the list. *Tamarindus indica* is considered to be indigenous for the area (Coates Palgrave 2002).

Column 6: Gel., Geldenhuys (1992): 0, absent; 1, present.

Column 7: DaS, Da Silva *et al.* (2004): 1, present; NS, absent or not recorded for Sofala; NM, absent or not recorded for Mozambique.Column 8: Mul., Müller *et al.* (2000): 1, present; 0, absent.

Column 9: Tim., Timberlake (2002): 1, present; 0, absent.

APPENDIX 1.—A checklist of woody species at Catapú (cont.)

1 Taxon	2 Voucher No.	3 Growth form†	4 Sena name	5 Distr.	6 Gel.	7 DaS	8 Mul.	9 Tim.
Balanitaceae								
<i>Balanites maughamii</i> <i>Sprague</i> subsp. <i>maughamii</i>	<i>M83</i>	T	N'soconondo	T	2	1	0	1
Bignoniaceae								
<i>Fernandoa magnifica</i> <i>Seem.</i>	<i>M121</i>	T	N'culue	N	0	1	0	0
<i>Kigelia africana</i> (<i>Lam.</i>) <i>Benth.</i>	<i>M139</i>	T	N'vunguti*	T	0	1	1	1
<i>Markhamia obtusifolia</i> (<i>Baker</i>) <i>Sprague</i>	<i>M76</i>	T	N'cluvu Nhuvuruvu N'sevu*	N	0	1	1	1
<i>Markhamia zanzibarica</i> (<i>Bojer ex DC.</i>) <i>K.Schum.</i>	<i>M140</i>	T	Muanambeu Tsueua*	T	0	1	1	1
<i>Stereospermum kunthianum</i> <i>Cham.</i>	<i>MJ16</i>	T	Nhacavunguti	N	0	1	0	1
Bombacaceae								
<i>Adansonia digitata</i> <i>L.</i>	<i>CherM142</i>	T	Himbondeiro Mulambe*	T	0	1	0	1
<i>Bombax rhodognaphalon</i> <i>K.Schum. ex Engl.</i>	<i>M104</i>	T	N'ghuza*	N	0	1	0	1
Boraginaceae								
<i>Cordia goetzei</i> <i>Gürke</i>	<i>MJ13</i>	T	Tchiothamafumu	N	0	NM	1	1
<i>Cordia pilosissima</i> <i>Baker</i>	<i>M113</i>	ST	Mamina a n'gombe	N	0	NS	0	1
<i>Cordia stuhlmannii</i> <i>Gürke</i>	<i>Cher55, 90</i>	T		E	0	NM	0	0
<i>Cordia torrei</i> <i>Martins</i>	<i>Cher61, 66</i>	T	Mamina a n'gombe	N	0	NM	0	0
<i>Ehretia amoena</i> <i>Klotzsch</i>	<i>Cher84</i>	T	Ncanacana	T	0	1	0	1
Burseraceae								
<i>Commiphora edulis</i> (<i>Klotzsch</i>) <i>Engl.</i> subsp. <i>edulis</i>	<i>Cher41</i>	T		T	0	1	0	1
<i>Commiphora zanzibarica</i> (<i>Baill.</i>) <i>Engl.</i>	<i>Cher42</i>	T	Tchinthiko*	T	1	1	0	1
Capparaceae								
<i>Boscia mossambicensis</i> <i>Klotzsch</i>	<i>M221</i>	T		T	0	1	0	1
<i>Boscia salicifolia</i> <i>Oliv.</i>	<i>M134</i>	T	Nhenze*	N	0	1	1	1
<i>Capparis erythrocarpos</i> <i>Isert</i> var. <i>rosea</i> (<i>Klotzsch</i>) <i>DeWolf</i>	<i>Cher93</i>	S	M'phatchocolo	N	0	NS	1	1
<i>Cladostemon kirkii</i> (<i>Oliv.</i>) <i>Pax & Gilg</i>	<i>M148</i>	ST	Ndico za mabhongue	T	0	1	0	1
<i>Maerua angolensis</i> <i>DC.</i>	<i>Cher44</i>	T	Tchidzyambuzi	T	0	1	0	1
<i>Thilachium africanum</i> <i>Lour.</i>	<i>Cher17</i>	ST	Tchikhala-nherere	T	0	1	0	1
Celastraceae								
<i>Elaeodendron transvaalense</i> (<i>Burt</i> <i>Davy</i>) <i>R.H.Archer</i>	<i>Cher 94</i>	T		S	0	NS	0	0
<i>Gymnosporia putterlickioides</i> <i>Loes.</i>	<i>Cher45</i>	T		T	0	NS	0	0
<i>Gymnosporia senegalensis</i> (<i>Lam.</i>) <i>Loes.</i>	<i>Cher46</i>	ST	N'tamba ntsato*	T	2	1	1	1
<i>Loeseneriella crenata</i> (<i>Klotzsch</i>) <i>N.Hallé</i> [= <i>Hippocratea crenata</i> (<i>Klotzsch</i>) <i>K.Schum. & Loes.</i>]	<i>Cher49</i>	SL		T	0	1	0	1

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Celastraceae (cont.)								
<i>Reissantia buchananii</i> (Loes.) N.Hallé [= <i>Hippocratea buchananii</i> Loes.]	<i>Cher47</i>	SL	Ntutu	N	0	1	0	0
<i>Reissantia indica</i> (Willd.) N.Hallé var. <i>orientalis</i> N.Hallé & Mathew [= <i>Hippocratea indica</i> Willd.]	<i>Cher48</i>	SL		T	0	NS	1	0
Celtidaceae								
<i>Celtis mildbraedii</i> Engl.	<i>Cher51</i>	T	Mpepe	T	0	1	0	0
Clusiaceae								
<i>Garcinia livingstonei</i> T.Anderson	<i>M90</i>	T	M'pimbi*	T	1	1	1	1
Combretaceae								
<i>Combretum adenogonium</i> Steud. ex A.Rich.	<i>M114</i>	T	N'fiti*	N	0	1	0	1
<i>Combretum apiculatum</i> Sond. subsp. <i>apiculatum</i>	<i>M110</i>	T	Cagolo*	T	0	1	0	1
<i>Combretum hereroense</i> Schinz	<i>M93</i>	T	Sindza nchuere*	T	0	1	0	1
<i>Combretum imberbe</i> Wawra	<i>M99</i>	T	Nangali*	T	0	1	1	1
<i>Combretum kirkii</i> M.A.Lawson	<i>Cher53</i>	L		E	0	NS	0	1
<i>Combretum microphyllum</i> Klotzsch	<i>Cher95</i>	L	Nhacaluelue	T	0	1	0	1
<i>Combretum mossambicense</i> (Klotzsch) Engl.	<i>Cher153</i>	SL	N'cotamo*	T	0	1	0	1
<i>Combretum padoides</i> Engl. & Diels	<i>Cher54</i>	ST		T	0	NS	0	1
<i>Combretum pisoniiflorum</i> (Klotzsch) Engl.	<i>M508</i>	L		N	0	1	0	1
<i>Pteleopsis myrtifolia</i> (M.A.Lawson) Engl. & Diels	<i>Cher108</i>	T	Ngolozzi*	T	0	1	1	1
<i>Terminalia sambesiaca</i> Engl. & Diels	<i>Cher109</i>	T	N'culungu*	N	0	1	0	1
<i>Terminalia sericea</i> Burch. ex DC.	<i>M77</i>	T	N'ghodhoni*	T	0	1	0	1
Connaraceae								
<i>Rourea orientalis</i> Baill.	<i>Cher18, 87</i>	S	Nhantsanga	N	0	1	1	0
Convolvulaceae								
<i>Ipomoea verbascoidea</i> Choisy		LS		T	0	1	0	0
Dichapetalaceae								
<i>Tapura fischeri</i> Engl.	<i>Cher2, 110</i>	T	Nhaussanga	T	1	1	1	1
Ebenaceae								
<i>Diospyros loureiriana</i> G.Don subsp. <i>loureiriana</i>	<i>Cher77</i>	TS	Nhandhima*	T	0	1	1	0
<i>Diospyros mespiliformis</i> Hochst. ex A.DC.	<i>M141</i>	T	N'fuma*	T	0	1	1	1
<i>Diospyros senensis</i> Klotzsch	<i>M80</i>	T	Gogoda ya n'thika* Tombo n'thika	N	0	1	1	1
<i>Diospyros squarrosa</i> Klotzsch	<i>JAW1</i>	T	Nhacatsicana	N	0	1	0	1
<i>Euclea schimperii</i> (A.DC.) Dandy	<i>qq215</i>	ST	Nhandema	T	1	NS	1	1
Erythroxylaceae								
<i>Erythroxylum emarginatum</i> Thonn.	<i>Cher83</i>	ST		T	2	1	1	0

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Euphorbiaceae								
<i>Acalypha chirindica</i> S.Moore	<i>Cher59</i>	ST		N	0	NS	0	0
<i>Alchornea laxiflora</i> (Benth.) Pax & K.Hoffm.	<i>Cher19</i>	ST	M'bebe	T	0	1	1	1
<i>Croton megalobotrys</i> Müll.Arg.	<i>Cher89</i>	T		T	0	1	0	1
<i>Erythrococca menyharthii</i> (Pax) Prain	<i>Cher75</i>	ST		T	0	1	0	0
<i>Excoecaria bussei</i> (Pax) Pax	<i>M122</i>	T	Nthavu ya mphonda	T	0	1	0	1
<i>Mildbraedia carpinifolia</i> (Pax) Hutch.	<i>Cher595</i>	T	N'tundunkhadzi	N	0	1	0	0
<i>Schinziophyton rautanenii</i> (Schinz) Radcl.-Sm.	<i>M151</i>	T	N'gomo*	N	0	1	0	0
<i>Spirostachys africana</i> Sond.	<i>M88</i>	T	N'cuniti*	T	1	1	0	0
<i>Suregada zanzibariensis</i> Baill.	<i>Cher155</i>	T	Nsinjamachue*	T	1	1	1	0
Fabaceae: Caesalpinioideae								
<i>Afzelia quanzensis</i> Welw.	<i>M94, 132</i>	T	N'socossa*	T	0	1	1	1
<i>Bauhinia tomentosa</i> L.	<i>Cher73</i>	ST		T	1	1	0	1
<i>Brachystegia spiciformis</i> Benth.	<i>s.n.</i>	T	Missassa* N'sassa*	T	0	1	1	1
<i>Burkea africana</i> Hook.	<i>Cher43</i>	T	N'cimbe*	T	0	1	0	1
<i>Cassia afrodistula</i> Brenan var. <i>patentipila</i> Brenan	<i>M109</i>	TS	Mulumanhyama* Murumanhyama*	T	0	NM	0	0
<i>Piliostigma thonningii</i> (Schumach.) Milne-Redh.	<i>M95</i>	T	N'sekesse*	T	0	1	1	1
<i>Senna petersiana</i> (Bolle) Lock	<i>M73</i>	ST	M'bhuembakhoe*	T	0	1	0	1
<i>Tamarindus indica</i> L.	<i>M91, 102</i>	T	M'bhwemba*	T	0	1	0	1
Fabaceae: Mimosoideae								
<i>Acacia adenocalyx</i> Brenan & Exell	<i>Cher126</i>	SL	Linghato	N	0	NS	0	0
<i>Acacia burkei</i> Benth.	<i>Cher125</i>	T		S	0	1	0	0
<i>Acacia galpinii</i> Burtt Davy	<i>M153</i>	T	N'sheni*	T	0	1	0	1
<i>Acacia nigrescens</i> Oliv.	<i>M115</i>	T	Ncunghu	T	0	1	0	1
<i>Acacia nilotica</i> (L.) Willd. ex Delile subsp. <i>kraussiana</i> (Benth.) Brenan	<i>M191</i>	T	Nhacasadze N'tchissio*	T	0	1	1	1
<i>Acacia polyacantha</i> Willd. subsp. <i>campylacantha</i> (Hochst. ex A.Rich.) Brenan	<i>M166</i>	T	N'ghowe*	T	0	1	1	1
<i>Acacia robusta</i> Burch. subsp. <i>usambarensis</i> (Taub.) Brenan	<i>M64</i>	T	Nsadzi*	T	0	1	0	0
<i>Acacia sieberiana</i> DC. var. <i>sieberiana</i>	<i>Cher124;</i> <i>M147, 163</i>	T	N'ghunga*	N	0	1	0	1
<i>Acacia torrei</i> Brenan	<i>Cher60</i>	SG		E	0	NM	0	0
<i>Acacia xanthophloea</i> Benth.	<i>M152</i>	T	Njerenjere	T	0	NS	1	1
<i>Albizia anthelmintica</i> (A.Rich.) Brongn.	<i>M96</i>	T	N'zanga	T	0	1	0	1
<i>Albizia glaberrima</i> (Schumach. & Thonn.) Benth. var. <i>glabrescens</i> (Oliv.) Brenan	<i>Cher123</i>	T	N'ghedhan'khanga*	N	0	1	0	1
<i>Albizia harveyi</i> E.Fourn.	<i>Cher121</i>	T	N'solola*	T	0	1	0	1
<i>Albizia versicolor</i> Welw. ex Oliv.	<i>M162</i>	T	Tangatanga*	T	0	1	1	1
<i>Albizia zimmermannii</i> Harms	<i>Cher122</i>	T		N	0	1	0	0

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Fabaceae: Mimosoideae (cont.)								
<i>Amblygonocarpus andongensis</i> (Welw. ex Oliv.) <i>Exell & Torre</i>	<i>M155</i>	T	M'bhawawanga*	T	0	NS	0	0
<i>Dichrostachys cinerea</i> (L.) Wight & Arn.	<i>Cher69</i>	ST	Mphangala* Chitsangala*	T	2	1	1	1
<i>Entada wahlbergii</i> Harv.	<i>Cher91</i>	L	Tripadela	T	0	NM	0	0
<i>Newtonia hildebrandtii</i> (Vatke) Torre var. <i>hildebrandtii</i>	<i>M89</i>	T	N'ghuyugyu* N'guiugiu*	T	0	1	0	1
<i>Xylia torreana</i> Brenan	<i>Cher120</i>	T	N'calala*	S	0	1	0	1
Fabaceae: Papilionoideae								
<i>Abrus precatorius</i> L. subsp. <i>africanus</i> Verdc.	<i>M187</i>	L	N'minimini*	T	1	1	1	1
<i>Cordyla africana</i> Lour.	<i>M156</i>	T	N'tondo*	T	1	NM	0	1
<i>Craibia zimmermannii</i> (Harms) Dunn	<i>M217</i>	T		T	2	1	0	0
<i>Dalbergia arbutifolia</i> Baker subsp. <i>arbutifolia</i>	<i>Cher130</i>	L	N'tsinda	N	0	1	0	1
<i>Dalbergia boehmii</i> Taub. subsp. <i>boehmii</i>	<i>Cher131</i>	T		N	0	1	0	1
<i>Dalbergia fischeri</i> Taub.	<i>Cher82</i>	L		N	0	1	0	1
<i>Dalbergia melanoxylon</i> Guill. & Perr.	<i>M74</i>	T	M'phingwe* Pau-preto	T	0	1	0	1
<i>Erythrina livingstoniana</i> Baker	<i>Cher132</i>	T	Chinungu N'angalan'goma	E	0	1	1	1
<i>Indigofera ormocarpoides</i> Baker	<i>M160</i>	ST	Nhacamphete*	T	0	NS	0	1
<i>Millettia mossambicensis</i> J.B.Gillett	<i>Cher133</i>	T	N'sangala	E	0	1	0	0
<i>Millettia stuhlmannii</i> Taub.	<i>Cher136</i>	T	M'pangiri* Panga-panga*	T	0	1	1	0
<i>Millettia usaramensis</i> Taub. subsp. <i>australis</i> J.B.Gillett	<i>Cher135</i>	T	Nsangala dzinza	N	O	1	1	O
<i>Philenoptera bussei</i> (Harms) Schrire	<i>M127</i>	T		N	0	1	0	1
<i>Philenoptera violacea</i> (Klotze) Schrire	<i>M116</i>	T	M'phacassa*	T	0	1	1	1
<i>Pterocarpus angolensis</i> DC.	<i>M150</i>	T	Umbila*	T	0	1	1	1
<i>Xanthocercis zambesiaca</i> (Baker) Dumaz-le-Grand	<i>Cher81</i>	T		T	0	1	0	1
<i>Xeroderris stuhlmannii</i> (Taub.) Mendonça & <i>E.P.Sousa</i>	<i>M117</i>	T	Mulonde*	T	0	1	1	1
Flacourtiaceae								
<i>Bivinia jalbertii</i> Tul.	<i>Cher103</i>	T		N	0	1	0	0
<i>Casearia gladiiformis</i> Mast.	<i>Cher11</i>	T	Nhamauira	T	0	1	0	0
<i>Dovyalis hispidula</i> Wild	<i>Cher112</i>	ST	Nhacitje N'tudza* N'tutu Nyacsinge	N	0	1	0	0
<i>Dovyalis xanthocarpa</i> Bullock	<i>M130</i>	ST		N	0	NM	0	0
<i>Flacourtia indica</i> (Burm.f.) Merr.	<i>M70</i>	T	N'tchumbutchumbu* N'tudza*	T	0	1	0	1
<i>Oncoba spinosa</i> Forssk.	<i>MJI132</i>	T		T	0	1	0	0

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Hernandaceae								
<i>Gyrocarpus americanus</i> Jacq. subsp. <i>africanus</i> Kubitzki	<i>Cher65</i>	T		T	0	NS	0	1
Kiggelariaceae								
<i>Xylothea tettensis</i> (Klotzsch) Gilg var. <i>macrophylla</i> (Klotzsch) Wild	<i>Cher113</i>	TS	Ncanacana Nchenamadzi*	N	0	1	1	1
Kirkiaceae								
<i>Kirkia acuminata</i> Oliv.	<i>Cher165</i>	T	N'tun'gundua	T	0	1	0	1
Lamiaceae								
<i>Clerodendrum eriophyllum</i> Gürke	<i>Cher71</i>	TS		N	0	1	0	0
<i>Hoslundia opposita</i> Vahl	<i>JAW3</i>	S	Tsuimbatsuiru*	T	0	1	1	0
<i>Premna senensis</i> Klotzsch	<i>MJI60</i>	ST	Tsuimbatsuiru	N	0	NS	0	0
<i>Vitex ferruginea</i> Schumach. & Thonn.	<i>Cher114</i>	T		T	0	NS	0	1
<i>Vitex payos</i> (Lour.) Merr.	<i>M63</i>	T		N	0	NS	1	1
<i>Vitex petersiana</i> Klotzsch	<i>Cher74</i>	ST		N	0	NS	1	1
Linaceae								
<i>Hugonia busseana</i> Engl.	<i>Cher115</i>	SL	Gonadzololo	N	0	1	1	1
Malvaceae								
<i>Hibiscus mossambicensis</i> Gonc.	<i>M169</i>	ST		E	0	1	0	0
Melastomataceae								
<i>Warneckea sansibaricum</i> (Taub.) Jacq.-Fél.	<i>M201</i>	T	Nhacateme	N	0	1	1	0
Meliaceae								
<i>Khaya anthotheca</i> (Welw.) C.DC.	<i>MJI5</i>	T	M'bhausa*	N	0	1	0	0
<i>Trichilia capitata</i> Klotzsch	<i>Cher67, 116, 118</i>	T	N'ghonamadziwa	N	0	1	0	1
<i>Trichilia emetica</i> Vahl subsp. <i>emetica</i>	<i>qg142</i>	T	N'sikiri*	T	2	1	1	1
<i>Turraea nilotica</i> Kotschy & Peyr.	<i>Cher117</i>	T	Ncanacana	T	0	1	0	1
Menispermaceae								
<i>Tiliacora funifera</i> (Miers) Oliv.	<i>Cher152; M195</i>	L		T	0	1	1	1
Moraceae								
<i>Ficus bussei</i> Warb. ex Mildbr. & Burret	<i>MJI8</i>	T	N'towe*	N	0	1	0	1
<i>Ficus ingens</i> (Miq.) Miq.	<i>M118</i>	T	N'towe*	T	1	NS	0	0
<i>Ficus stuhlmannii</i> Warb.	<i>Cher128</i>	T	N'towe*	T	0	1	0	0
<i>Ficus sycomorus</i> L. subsp. <i>sycomorus</i>	<i>M159</i>	T	N'savu	T	0	1	1	1
<i>Ficus tremula</i> Warb. subsp. <i>tremula</i>	<i>Cher127</i>	T	N'thowe*	T	0	1	0	0

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Moraceae (cont.)								
<i>Maclura africana</i> (Bureau) Corner	M120	SL	N'dhowa*	T	0	1	1	1
<i>Milicia excelsa</i> (Welw.) C.C.Berg	DP1	T	N'ghunda*	T	0	NS	0	0
<i>Morus mesozygia</i> Stapf ex A.Chev.	Cher129	T	N'codzi	T	1	1	0	0
Ochnaceae								
<i>Brackenridgea zanguebarica</i> Oliv.	Cher86	T	Ncana-ncana*	T	0	1	0	1
<i>Ochna angustata</i> N.Robson	M510	ST		E	0	1	0	0
Oleaceae								
<i>Ximenia americana</i> L. var. <i>microphylla</i> Welw. ex Oliv.	M204	ST		S	1	1	0	1
<i>Ximenia caffra</i> Sond. var. <i>natalensis</i> Sond.	M98	T	Ntenguene* Ntenguere*	T	2	1	0	1
Oleaceae								
<i>Jasminum stenolobum</i> Rolfe	Cher157	L		T	0	1	0	1
<i>Schrebera trichoclada</i> Welw.	M145		N'combego	T	0	1	0	1
Opiliaceae								
<i>Opilia amentacea</i> Roxb. [= <i>Opilia celtidifolia</i> (Guill. & Perr.) Endl. ex Walp.]	M194, 199			S	0	NS	0	0
Passifloraceae								
<i>Adenia gummiifera</i> (Harv.) Harms	M157		Mole*	T	0	NS	0	1
Phyllanthaceae								
<i>Antidesma venosum</i> E.Mey. ex Tul.	M124	T	Mungalamunhu* N'tchiviri Nthangalamunhu*	T	2	1	1	1
<i>Bridelia cathartica</i> G.Bertol. subsp. <i>melanthesoides</i> (Baill.) J.Léonard	Cher21	ST		T	2	NS	1	1
<i>Cleistanthus schlechteri</i> (Pax) Hutch.	M112	T	N'cua*	T	1	NS	1	0
<i>Flueggea virosa</i> (Roxb. ex Willd.) Voigt subsp. <i>virosa</i>	M75	ST	N'sossoto*	T	0	NS	1	1
<i>Hymenocardia ulmoides</i> Oliv.	Cher2	T	Nchinkhue*	T	0	NS	0	0
<i>Margaritaria discoidea</i> (Baill.) G.L.Webster var. <i>triplosphaera</i> Radcl.-Sm.	Cher72	T	Ncalassi Ntsanzayadziua	N	0	NS	0	0
<i>Phyllanthus ovalifolius</i> Forssk.	Cher97	ST		N	0	NS	1	0
<i>Phyllanthus reticulatus</i> Poir.	M62	ST		T	1	1	1	1
<i>Pseudolachnostylis maprouneifolia</i> Pax	M125	T	N'toto*	T	0	1	0	1
<i>Uapaca</i> sp. cf. <i>U. nitida</i> & <i>U. sansibarica</i>	M172	T		-	-	-	-	-
Polygalaceae								
<i>Carpolobia goetzei</i> Gürke	Cher92	T	N'tenja*	N	0	1	1	0
<i>Securidaca longepedunculata</i> Fresen.	Cher70; M158	T	M'pupu*	T	0	1	0	1

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Putranjivaceae (cont.)								
<i>Drypetes arguta</i> (Müll.Arg.) Hutch.	<i>Cher22</i>			T	2	1	0	0
<i>Drypetes mossambicensis</i> Hutch.	<i>Cher23</i>			T	0	1	0	1
<i>Drypetes reticulata</i> Pax	<i>Cher3, 24, 25</i>		N'thassica	T	0	1	0	0
Rhamnaceae								
<i>Berchemia discolor</i> (Klotzsch) Hemsl.	<i>M138</i>	T	N'tatcha*	T	1	1	1	1
<i>Lasciodiscus pervillei</i> Baill. subsp. <i>pervillei</i>	<i>Cher15, 62</i>	ST		T	0	NS	0	0
<i>Ziziphus abyssinica</i> Hochst. ex A.Rich.	<i>M61</i>	T	N'tsao-tsanga*	N	0	NS	0	0
<i>Ziziphus mauritiana</i> Lam.	<i>M66</i>	T	N'sao*	+	0	1	0	1
<i>Ziziphus mucronata</i> Willd.	<i>M111</i>	T	N'tchatchane*	T	1	1	1	1
<i>Ziziphus pubescens</i> Oliv.	<i>Cher88</i>	T	N'suinga mamina	T	0	1	0	1
Rhizophoraceae								
<i>Cassipourea euryoides</i> Alston	<i>s.n.</i>	T		T	0	1	0	0
Rubiaceae								
<i>Afrocanthium racemosum</i> (S.Moore) Lantz var. <i>racemosum</i>	<i>Cher137</i>	T		N	0	NM	0	0
<i>Catunaregam swynnertonii</i> (S.Moore) Bridson	<i>Cher64</i>	T	Nyacapumba	E	0	NS	1	1
<i>Chazaliella abrupta</i> (Hiern) E.M.A.Petit & Verdc. var. <i>abrupta</i>	<i>Cher20, 98</i>	S		N	0	NM	1	1
<i>Coffea racemosa</i> Lour.	<i>Cher16, 148</i>	ST		S	1	1	1	0
<i>Crossopteryx febrifuga</i> (Afzel. ex G.Don) Benth.	<i>M72</i>	T	Fititonga	T	0	1	1	1
<i>Gardenia ternifolia</i> Schumach. & Thonn. subsp. <i>jovis-tonantis</i> (Welw.) Verdc. var. <i>goetzei</i> (Stapf & Hutch.) Verdc.	<i>Cher139</i>	T		T	0	1	0	1
<i>Heinsia crinata</i> (Afzel.) G.Taylor subsp. <i>parviflora</i> (K.Schum. & K.Krause) Verdc.	<i>Cher96, 140</i>	ST	N'tanha	T	0	1	0	0
<i>Oxyanthus latifolius</i> Sond.	<i>Cher141</i>	ST	Nghona-alendo	T	0	NS	1	0
<i>Pavetta klotzschiana</i> K.Schum.	<i>Cher142</i>	ST		E	0	NS	1	1
<i>Rothmannia fischeri</i> (K.Schum.) Bullock subsp. <i>moramballae</i> (Hiern) Bridson	<i>M131</i>	T		T	0	NS	0	1
<i>Tricalysia jasminiflora</i> (Klotzsch) Benth. & Hook.f. ex Hiern var. <i>jasminiflora</i>	<i>Cher143</i>	ST	Tchidyakamba	E	0	1	1	0
<i>Tricalysia junodii</i> (Schinz) Brenan	<i>MJI95</i>	ST		S	0	NS	0	1
<i>Vangueria esculenta</i> S.Moore	<i>Cher4</i>	T	N'zuiro	E	0	1	0	0
<i>Vangueria infausta</i> Burch. subsp. <i>infausta</i>	<i>Cher85</i>	T	N'zuiro*	T	2	1	1	1
Rutaceae								
<i>Citropsis daweani</i> Swingle & M.Kellerm.	<i>Cher145</i>	ST		N	0	1	0	1
<i>Vepris lanceolata</i> (Lam.) G.Don	<i>Cher146</i>	ST	Nhatchetche	S	2	1	0	0
<i>Zanthoxylum holtzianum</i> (Engl.) P.G.Waterman	<i>M108</i>	T		N	0	NM	0	0
<i>Zanthoxylum leprieurii</i> Guill. & Perr.	<i>Cher119</i>	ST		T	0	1	0	1

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Salvadoraceae								
<i>Salvadora persica</i> L. var. <i>persica</i>	<i>M222</i>	ST		T	0	NS	0	1
Sapindaceae								
<i>Allophylus rubifolius</i> (Hochst. ex A.Rich.) Engl.	<i>JAW2; M67</i>	ST	Nhamatubhu*	T	0	1	1	1
<i>Blighia unijugata</i> Baker	<i>M66A</i>	T		T	1	1	1	0
<i>Deinbollia xanthocarpa</i> (Klotzsch) Radlk.	<i>Cher144</i>	SG?	N'tsikiribhanda*	T	0	1	1	1
<i>Lecaniodiscus fraxinifolius</i> Baker subsp. <i>scassel-latii</i> (Chiov.) Friis	<i>M128</i>	T	Mutarara* N'talala*	T	0	1	0	1
Sapotaceae								
<i>Inhambanella henriquesii</i> (Engl. & Warb.) Dubard	<i>Cher30, 148</i>	T	M'piao*	T	1	1	1	0
<i>Manilkara mochisia</i> (Baker) Dubard	<i>Cher147</i>	T	N'gambu* N'gambu-n'gambu	T	0	1	0	1
<i>Mimusops obtusifolia</i> Lam.	<i>Cher31, 149</i>	T	N'salazi*	T	0	1	0	0
Solanaceae								
<i>Solanum aculeastrum</i> Dunal	<i>Cher29</i>	T		T	0	NM	0	0
Sterculiaceae								
<i>Cola mossambicensis</i> Wild	<i>Cher150</i>	T		E	0	1	0	0
<i>Dombeya rotundifolia</i> (Hochst.) Planch. var. <i>rotundifolia</i>	<i>M97</i>	T		T	1	1	0	1
<i>Dombeya shupangae</i> K.Schum.	<i>Cher101</i>	T		N	0	1	0	0
<i>Sterculia africana</i> (Lour.) Fiori var. <i>africana</i>	<i>M133</i>	T	N'ghoza*	N	0	1	0	1
<i>Sterculia appendiculata</i> K.Schum.	<i>Cher151; M144</i>	T	N'djale*	N	0	1	1	1
Strychnaceae								
<i>Strychnos henningsii</i> Gilg	<i>Cher6, 28</i>	T		T	1	1	0	0
<i>Strychnos madagascariensis</i> Poir.	<i>Cher106</i>	T	N'teme	T	2	NS	0	1
<i>Strychnos potatorum</i> L.f.	<i>M82</i>	T	N'tupa*	T	0	1	0	1
<i>Strychnos spinosa</i> Lam.	<i>Cher104</i>	T	N'tengulengu*	T	2	1	1	1
<i>Strychnos usambarensis</i> Gilg	<i>Cher107; M129</i>	T	N'tchapata	S	0	1	0	1
Thymelaeaceae								
<i>Synaptolepis alternifolia</i> Oliv.	<i>M189</i>	LS		N	0	NS	1	0
<i>Synaptolepis kirkii</i> Oliv.	<i>Cher159; M190</i>	L		T	0	NS	1	0
Tiliaceae								
<i>Glyphaea tomentosa</i> Mast.	<i>Cher14</i>	T	N'calangua* Ncalangue-ntherere*	E	0	1	0	0
<i>Grewia caffra</i> Meisn.	<i>Cher7</i>	SL		T	0	1	1	0

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Tiliaceae (cont.)								
<i>Grewia forbesii</i> Harv. ex Mast.	<i>Cher9</i>	ST	N'tsunzwa	N	0	NS	0	1
<i>Grewia inaequilatera</i> Garcke	<i>Cher8</i>	ST	Thenzua	T	0	1	0	1
<i>Grewia lepidopetala</i> Garcke	<i>Cher11</i>	ST	Nhacathenzua	N	0	NS	0	1
<i>Grewia micrantha</i> Bojer	<i>Cher109</i>	T	N'tongolo*	T	0	1	0	1
<i>Grewia microcarpa</i> K.Schum.	<i>Cher12, 13, 154</i>	T	N'tsunzwa	N	0	1	0	1
<i>Grewia sulcata</i> Mast.	<i>Cher102</i>	ST	N'tsunzwa*	T	0	1	1	1
Violaceae								
<i>Rinorea elliptica</i> (Oliv.) Kuntze	<i>Cher27, 32</i>	T		N	0	1	0	0
Vitaceae								
<i>Cissus cornifolia</i> (Baker) Planch.	<i>s.n.</i>	S		T	0	1	0	1
<i>Cissus integrifolia</i> (Baker) Planch.	<i>M107</i>	L	N'tamba*	T	0	1	1	1

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The concept of 'Musa-pelo' and the medicinal use of shrubby legumes (Fabaceae) in Lesotho

A. MOTEETEE*† and B-E. VAN WYK*

Keywords: adaptogen, bitter tonic, Fabaceae, immune stimulant, sedative, traditional medicine

ABSTRACT

In the Kingdom of Lesotho, 20 plant species are commonly known as 'Musa-pelo'. The term literally means 'the one who brings back or turns around the heart'. 'Musa-pelo' is traditionally used as a sedative and is given as a first aid treatment to bereaved people who are under severe psychological duress or stress. Of the 20 species known as 'Musa-pelo', 17 belong to nine genera of the Fabaceae (*Argyrolobium*, *Crotalaria*, *Indigofera*, *Lessertia*, *Lotononis*, *Melolobium*, *Sutherlandia*, *Tephrosia* and *Trifolium*). The three remaining species namely *Cleome monophylla*, *Heliophila carnosa* and *Cysticapnos pruinosa*, belong to the families Capparaceae, Brassicaceae and Fumariaceae, respectively. In this paper, the concept of 'Musa-pelo' in traditional medicine is explored.

INTRODUCTION

The concept of 'Musa-pelo' is an important part of traditional medicine in Lesotho. 'Musa-pelo' and its cultural significance is described and explained here for the first time in a scientific context. Watt & Breyer-Brandwijk (1962) did not discuss 'Musa-pelo' in their comprehensive review of medicinal plants of southern and eastern Africa. The aim of this paper is to present and discuss the identity and uses of 20 plant species that are known as 'Musa-pelo' or that have been reported in the literature as 'Musa-pelo'.

METHODS

The study was based mainly on a literature survey and observations made by the first author on traditional practices at home and in the community; the first author has also used some of these remedies. Some traditional healers were consulted with regards to the use of *Cleome monophylla* as 'Musa-pelo'—the plant was shown to them in the field.

DISCUSSION

The concept of 'Musa-pelo'

'Musa-pelo' is used to treat fits, circulation problems, stress-related ailments and chronic illnesses (Maliehe 1997). As a traditional healer, Eric Maliehe (pers. comm.) pointed out: 'for ages and ages the Basotho have been using 'Musa-pelo' for trauma because trauma is considered to affect the heart first'. The term 'Musa-pelo' literally means 'one who brings back or turns around the heart' and according to him, it means 'bringing back health to the heart'. It is a term given to several plant species traditionally used to cure or ease a 'sore heart' or dropsy of the heart (Phillips 1917; Jacot Guillarmod 1971). In the first author's own experience, 'Musa-pelo' is administered as a sedative to bereaved people who are

under severe psychological duress or stress. It is given to recently widowed women for spasms and heart disease. Most of the traditional uses point to possible sedative and/or stress-relieving activity for the plants involved.

Plants known to be used as 'Musa-pelo'

Detailed information on the Sesotho names and the traditional uses (where known) of the 20 species known to be 'Musa-pelo' plants are given in Appendix 1. Authorities for the scientific names are included in Appendix 1 and will not be given elsewhere. In all, 20 plant species, including 17 belonging to the family Fabaceae are called 'Musa-pelo'. These include two species of *Argyrolobium*, one of *Crotalaria*, four of *Indigofera*, two of *Lessertia* and one of *Sutherlandia*. Three other species *Cleome monophylla* (Capparaceae), *Cysticapnos pruinosa* (Fumariaceae) and *Heliophila carnosa* (Brassicaceae), have also been listed as 'Musa-pelo'. *Heliophila carnosa* is used for auscultation (Phillips 1917); and is also known in Sesotho as *Semameloa*, meaning 'the small one who listens'. *Cysticapnos pruinosa* is used as a 'charm to comfort and drug the sorrowing' (Jacot Guillarmod 1971). Phillips (1971) recorded 'Musa-pelo' as a Sesotho name for *Cleome monophylla*, but did not provide any details of its usage. After consultation with several traditional healers in Lesotho regarding the use of *C. monophylla*, none of them could confirm that it is used as 'Musa-pelo'.

To distinguish between the 20 species with one common name, variations to the name are applied either to describe a striking feature of the plants, their size or their habitat. For example, *Melolobium alpinum* is 'Musa-pelo-o-moholo-oo-thaba' (the big mountain 'Musa-pelo') because it is indeed an alpine species. To differentiate *Crotalaria distans*, flower colour is added to the name, i.e. 'Musa-pelo-o-mosehlanya' (the yellowish 'Musa-pelo'). *Lotononis sericophylla* is characterized by whitish hairs and is known as 'Musa-pelo-o-mosoeu' (the white 'Musa-pelo').

Members of the Fabaceae are well known as rich sources of nitrogen compounds. Some of the species in Appendix 1 have been investigated (summarized in Harborne 1994): *Argyrolobium lotoides* and *Melolobium*

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MS. received: 2006-08-31.

alpinum contain quinolizidine alkaloids (anagryne, cytisine, leontidine and camoensine), *Lotononis sericophylla* is a source of pyrrolizidine alkaloids (integerrimine and senecionine), *Crotalaria distans* has amino acids (2,4-diaminobutanoid acid and N- γ -glutamyltyrosine), and *Trifolium* contains flavonoids (maackiain, medicarpin and vestiol). Of special interest is the closely related *Sutherlandia* and *Lessertia*, both of which contain high levels of free amino acids and canavanine (a non-protein amino acid) in the leaves (Van Wyk & Wink 2004).

Possible mode of action of 'Musa-pelo

Sedatives are drugs which depress the central nervous system. Many plants, including those of 'Musa-pelo, are also used traditionally as sedatives. The traditional use of *Sutherlandia* species to relieve anxiety and stress is believed to be due to the presence of the amino acid gamma-aminobutyric acid (GABA), a known inhibitory neurotransmitter with mood-elevating properties (Van Wyk & Gericke 2000). It is interesting to note that Smith & Myburgh (2004) have presented evidence that *Sutherlandia* alters the corticosterone response in stressed rats.

Adaptogens are described as agents or biological substances (of plant origin) that help to increase the body's resistance to stress, whether physical, chemical or biological (Schulz *et al.* 2001). For a plant to be adaptogenic, it 'must be innocuous and cause minimal disorders in the physiological functions of an organism, it must have nonspecific action, and it usually has a normalizing action irrespective of the direction of the pathological state' (Brekhman & Dardymov 1969). Some very well-known adaptogenic plants include *Panax ginseng* (Asian ginseng), *P. quinquefolium* (American ginseng), *Eleutherococcus senticosus* (Siberian ginseng), *Rhodiola rosea* (roseroot) and *Withania somnifera* (often called Indian ginseng) (Van Wyk & Wink 2004).

Immune stimulants are substances that help increase the activity of the body's immune system but without any antigenic action against specific pathogens, whether viral or bacterial (Schulz *et al.* 2001). They are therefore similar to adaptogens in that their action is nonspecific and could be multifocal. Two well-known immune stimulant herbs are *Echinacea* spp. (coneflower) and *Viscum album* (mistletoe).

Digestive bitters (amara) are tonic herbs with a bitter taste thought to stimulate the taste buds and promote (as a reflex via the vagus nerve) the secretion of saliva, gastric juices and bile (Van Wyk & Wink 2004). The bitterness can be due to a number of chemical constituents including volatile oils, alkaloids and sesquiterpene lactones. Surprisingly, bitters also act on the cardiovascular system, decreasing the heart rate and cardiac stroke volume (Schulz *et al.* 2001). Some commonly used bitter herbs include *Gentiana lutea* (gentian), which occurs in mountains of central and southern Europe, *Centaurium erythraea* (century), primarily distributed in the Mediterranean and *Artemisia absinthium* (wormwood), native to temperate regions of Europe, Asia and northern Africa.

CONCLUSIONS

It appears to be no coincidence that of the 20 plants used as 'Musa-pelo, 17 plant species are from the Fabaceae, a family known for its rich diversity of nitrogen compounds (Harborne 1994)—alkaloids, phenolic amines, amino acids, nonprotein amino acids and other constituents known to act on the central nervous system. The chemical composition of most 'Musa-pelo plants and their pharmacological activities (such as possible corticomimetic and neuromodulatory effects), are not yet known, and this opens up a new area of investigation. It should be pointed out, however, that some plants belonging to certain listed genera (*Argyrobium*, *Crotalaria*, *Indigofera* and *Lotononis*) have been reported to have indications of toxic potential (Hutchings *et al.* 1996), therefore, it is advisable that these remedies should not be taken without proper knowledge of required dosages. It is possible that 'Musa-pelo plants have undiscovered compounds inducing adaptogenic, bitter (amarum) or neuroreceptor responses which are, individually or collectively, responsible for the sedative or mood-enhancing effects reported for these plants. Altogether there are 20 species listed as 'Musa-pelo plants, however there is no evidence that *Cleome monophylla* is used as 'Musa-pelo and should perhaps be excluded from the list.

ACKNOWLEDGEMENT

The University of Johannesburg is thanked for financial assistance.

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APPENDIX 1.—Medicinal plants commonly known in Sesotho as '*Musa-pelo*'. Note: the word '*Musa-pelo*' means 'the one who brings back the heart (*pelo*)' and since it is the base name for the Sesotho names of all these species, its meaning will not be repeated in the table. References are given in brackets, details at end of table

Taxon	Sesotho Name	Meaning	Uses
Brassicaceae			
<i>Heliophila carnosa</i> (Thunb.) Steud.	' <i>Musa-pelo-oa-mangope/semameloana</i> (1, 2, 6)	' <i>Musa-pelo</i> of the dongas/ the small one who listens.	Unspecified parts used for auscultation to locate pain in chest complaints (1, 2, 6).
Capparaceae			
<i>Cleome monophylla</i> L.	' <i>Musa-pelo-o-monyenyane</i> (2)	The small (<i>monyenyane</i> ; from adjective <i>nyane</i>) ' <i>Musa-pelo</i> .	Details not provided (2).
Fabaceae			
<i>Argyrolobium collinum</i> Eckl. & Zeyh.	' <i>Musa-pelo-oa-matlapa</i> (2)	' <i>Musa-pelo</i> of the flat stones (<i>matlapa</i>).	Details not provided (2).
<i>A. lotoides</i> Harv.	' <i>Musa-pelo-o-monyenyane</i> (2)	The small (<i>monyenyane</i> ; from adjective <i>nyane</i>) ' <i>Musa-pelo</i> .	Details not provided (2).
<i>Crotalaria distans</i> Benth.	' <i>Musa-pelo-o-mosehlanyana</i> (2)	The yellowish (<i>mosehlanyana</i> ; from adjective <i>tšehla</i>) ' <i>Musa-pelo</i> .	Details not provided (2).
<i>Indigofera dimidiata</i> Vogel ex Walp.	' <i>Musa-pelo-oa-thaba</i> (1, 2, 4)	The mountain (<i>thaba</i>) ' <i>Musa-pelo</i> .	Roots used to treat fever and neuralgia and as a sedative (1, 2, 4).
<i>I. hedyantha</i> Eckl. & Zeyh.	' <i>Musa-pelo-oa-mafika</i> (2, 4)	' <i>Musa-pelo</i> of the rocks.	Same as above.
<i>I. tristis</i> E.Mey.	' <i>Musa-pelo-o-monyenyane</i> (1, 2, 4)	The small (<i>monyenyane</i> ; from adjective <i>nyane</i>) ' <i>Musa-pelo</i> .	Same as above.
<i>I. zeyheri</i> Spreng. ex Eckl. & Zeyh.	' <i>Musa-pelo-o-monyenyane</i> (1, 2, 4)	Same as above.	Same as above.
<i>Lessertia depressa</i> Harv.	' <i>Musa-pelo</i> (1, 2, 4)		Infusion of above-ground parts used for heart palpitations and as sedative (4).
<i>L. perennans</i> (Jacq.) DC.	' <i>Musa-pelo-oa-liliba</i> (1, 2, 4)	' <i>Musa-pelo</i> of the springs (<i>liliba</i>).	Infusion of above-ground parts used for dropsy of heart (1, 4).
<i>L. stricta</i> L.Bolus	' <i>Musa-pelo-oa-matlapa-o-moholo</i> (1, 2, 4)	The big (<i>moholo</i> ; from adjective <i>kholo</i>) ' <i>Musa-pelo</i> of the flat stones.	Decoction 'drunk every day by a person who has passed through some affliction until he is better' (1). Decoction of leaves and stems used for heart palpitations and as sedative (4).
<i>Lotononis laxa</i> Eckl. & Zeyh.	' <i>Musa-pelo-oa-matlapa-o-monyenyane</i> (2, 4)	The small (<i>monyenyane</i>) ' <i>Musa-pelo</i> of the flat stones.	Details not provided (2).
<i>L. sericophylla</i> Benth.	' <i>Musa-pelo-o-mosoeu</i> (1, 4)	The white (<i>mosoeu</i> ; from adjective <i>tšoeu</i>) ' <i>Musa-pelo</i> .	Details not provided (2).
<i>Melolobium alpinum</i> Eckl. & Zeyh.	' <i>Musa-pelo-o-moholo-oa-thaba</i> (1, 2)	The big (<i>moholo</i> ; from adjective ' <i>kholo</i> ') mountain (<i>thaba</i>) ' <i>Musa-pelo</i> .	Leaves used as a sedative (1, 4).
<i>Sutherlandia montana</i> E.Phillips & R.A.Dyer	' <i>Musa-pelo</i> (1, 2, 4)/ ' <i>Musa-pelo-oa-nōka</i> (6)	' <i>Musa-pelo</i> of the river (<i>nōka</i>).	Infusion of leaves used for dropsy of heart (1) and as sedative (4).
<i>Tephrosia capensis</i> (Jacq.) Pers.	' <i>Musa-pelo</i> (1, 2, 4)		Decoction of roots used to ease heart palpitations (1, 2, 4). Pulverized, dried roots sniffed for headaches (5).
<i>Trifolium africanum</i> Ser.	' <i>Musa-pelo</i> (1, 4)		Whole plant is infused or chewed raw for sore throat or heart trouble and as a sedative (1, 2, 3, 4, 6). Used as diuretic and sweating agent (2). Used as cure for cancer and for cleansing blood (3).
<i>T. burchellianum</i> Ser.	' <i>Musa-pelo</i> (1, 3, 4, 6)		Same as above.
Fumariaceae			
<i>Cysticapnos pruinosa</i> (Bernh.) Lidén	' <i>Musa-pelo-oa-nōka</i> (1)	' <i>Musa-pelo</i> of the river (<i>nōka</i>).	Used as a charm to comfort and drug the sorrowing (1).

1, Jacot Guillarmod (1971); 2, Phillips (1917); 3, Maliehe (1997); 4, Own experience of first author; 5, Hutchings & Van Staden (1994); 6, Schmitz (1982). Author abbreviations according to Brummitt & Powell (1992).

Can anthropogenic variables be used as threat proxies for South African plant richness?

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Keywords: endemic species, human population density, land transformation, setting conservation priorities

ABSTRACT

Human demographic and socio-economic measures (anthropogenic variables) reflect the detrimental impact of humans on plant diversity globally. The Pretoria (PRE) Computerised Information System (PRECIS) of the South African National Biodiversity Institute (SANBI), provided three sets of South African plant richness data, overall (OPR), endemic (EPR), and threatened (TPR), to investigate the relationships between richness and six anthropogenic variables. Spearman's Rank order correlations, Kruskal Wallis Analysis of Variance (ANOVA) and Generalized Linear Models (GLZ) were used. Although all three plant richness measures were correlated with anthropogenic variables, individual anthropogenic variables contributed a small fraction to the explained variation in richness. Differences in spatial and temporal scaling of the datasets, or the response to another causal mechanism, may have contributed to this low explained variation. Because more variation was accounted for in OPR than EPR or TPR, OPR is a more suitable surrogate measure of plant biodiversity when investigating the anthropogenic variables used here. Average human density (HD), infrastructure (degree of urbanization and road cover) (LRU) and percentage land area transformed and degraded (LTD) were identified as useful surrogates of human impacts on OPR. LTD may be a more inclusive human impact measure when conducting analyses of human impacts using OPR. LTD includes the effects of urban expansion, road networks and other land transformation impacts, such as agriculture.

INTRODUCTION

Human actions threaten biological diversity at a global scale. The sources of threat include taxon-specific threats such as exploitation, introduced taxa and various forms of ecosystem degradation, including land transformation and pollution (World Resources Institute 2000). Strong evidence indicates correlations between rates of habitat and species disappearance with human demography patterns, such as population density and population growth, and human activities (James 1994; Ceballos & Ehrlich 2002; Harcourt & Parks 2003; Luck *et al.* 2003). As a result, conservation planners have been urged to integrate biological, socio-economic and human demographic data in their assessments to effectively determine real world conservation priorities (Cincotta *et al.* 2000; Brooks & Thompson 2001).

Human demographic and socio-economic data are often current and easily available (Harcourt & Parks 2003), and may constitute useful surrogate measures of the proximate threats to certain life forms and taxa. A number of human-related variables are correlated with plant richness measures around the world, both at regional and global scales. These include human demographic parameters (e.g. population density, human population growth rate change, poverty and affluence, urbanization), land transformation, land fragmentation and fuel wood consumption (Macdonald 1991; Kerr & Currie 1995; Cincotta *et al.* 2000; Ceballos & Ehrlich 2002; Liu *et al.* 2003).

Of these parameters, human population density has been considered a reasonably good indicator of threat of the risk of species extinction (Thompson & Jones 1999; Harcourt & Parks 2003). Plant population declines are

mostly concentrated in areas with either high human densities or high human impact, such as agriculture (Burgess *et al.* 2002; Ceballos & Ehrlich 2002; Araújo 2003). In turn, rapid and continuing population growth, and the associated human impact on the environment, is ever increasing (Cincotta *et al.* 2000; World Resources Institute 2000; Liu *et al.* 2003), necessitating urgent investigation into the relationship between plant richness and human population increase.

Sub-Saharan countries have some of the highest population growth rates in the world (United Nations Development Programme 2001). This, tied with high human population densities, clearly translates into considerable landscape transformation (James 1994; McKinney 2001). Most of Africa's dense human settlements, intensive agricultural activities and habitat fragmentation are concentrated in areas of high animal and plant endemism (Balmford *et al.* 2001; Harcourt *et al.* 2001; Burgess *et al.* 2002; Chown *et al.* 2003).

A strong association between population growth and environmental degradation exists that is mediated, in part, through income. For example, it has been demonstrated that as human populations grow, agricultural productivity declines, and this in turn raises rural poverty (Ukpolo 1994). Poverty stricken people are forced to rely heavily on surrounding resources for survival, placing increased pressure on vegetation and plant and animal species in the region (Lucas & Syngé 1981; James 1994). Struggling populations in rural areas may then move to the cities (Ukpolo 1994; World Resources Institute 2000) resulting in, for example, urban sprawl that generally involves complete transformation of relatively large areas (Macdonald 1991; Cincotta *et al.* 2000; Liu *et al.* 2003).

On the other end of the income scale, higher per capita income may also lead to environmental degradation (Naidoo & Adamowicz 2001). Areas with a high Gross National Product (GNP) correspond to areas with a high

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proportion of threatened plants in various countries (Kerr & Currie 1995; Naidoo & Adamowicz 2001). High GNP usually fuels excessive land conversion and resource exploitation, increasing the number of threatened plant and vertebrate taxa (Naidoo & Adamowicz 2001). In many cases, this association between humans and environmental degradation, and humans and species threat, is mutually reinforced by additional anthropogenic measures such as household dynamics, urbanization, technology and political instability (World Resources Institute 2000; Liu *et al.* 2003). In this sense, the combined forces of human population pressure apply tremendous stress to ecological systems in Africa and other underdeveloped areas (Ukpolo 1994).

Environmental degradation extends beyond the effects of human population growth. Land use and land-cover changes are important elements of the larger problem of global environmental change. Land use impact and the loss of species can often be directly related to the percentage area under urbanization, transformation or fragmentation (Wood *et al.* 1994; Pfab & Victor 2002). Theobald (2003) found that areas with more than 15% infrastructure development coverage could be deemed highly fragmented and thus impacting negatively on biodiversity, resulting in species loss (Santos *et al.* 2002; Tschamtker *et al.* 2002). Correspondingly, roads have been claimed to have a disproportionate effect on biotic diversity (Macdonald 1991; Reyers 2004). Reyers *et al.* (2001) illustrated that road construction and maintenance significantly altered surrounding natural habitat and landscapes. In addition, other forms of landscape transformation and degradation such as areas utilized for agriculture and plantations may lower species richness. Although the effect of high human population density on species richness may be observable through increased road infrastructure and urban expansion, agriculturally degraded or transformed landscapes are likely to occur in lower human density areas, confounding the relationship between land transformation and human population density. As a result, land-cover changes may also impact species richness patterns.

Identifying and managing threatening processes, threatened areas and taxa at risk of extinction at national scales, in essence, requires interpreting the impacts of human activities on biodiversity at smaller spatial extents (Brooks & Thompson 2001; Gärdenfors *et al.* 2001; Chown *et al.* 2003; Liu *et al.* 2003). Incorporating human demographic and socio-economic variables into conservation priority setting procedures will allow more informed conservation decisions to be made (Hannah *et al.* 1994; Sisk *et al.* 1994). An understanding of the relationships between these variables and plant richness at national scales is essential to determining the suitability of such data as surrogate measures to assist in understanding the proximate and ultimate threats to plant taxa (Kerr & Currie 1995; Brooks & Thompson 2001). However, ascertaining the relationships between biodiversity and human impacts are not as straightforward as originally believed. The effects of, and threat posed by, human demographic and socio-economic activities on taxon richness at national scale remain unclear because of the complexity and multiplicity of human activities, as mentioned above.

The impacts of human activities on biodiversity may also vary between richness measures (Van Rensburg *et al.* 2002). For example, human impacts may be greater, and therefore more apparent, for threatened and endemic plant taxa than for total species richness. Higher taxon richness has been successfully used as a biodiversity surrogate in prioritizing areas of conservation importance at both national and continental scales (Fjeldsø 1997; Balmford *et al.* 2001; Harcourt & Parks 2003; Rouget *et al.* 2004). But conservation strategies based solely on overall plant richness are often of limited use (Jetz & Rahbek 2002). The large proportion of endemic taxa in southern Africa has been attributed to the diverse ecological conditions, as well as the product of high speciation within a large number of endemic genera (Cowling & Hilton-Taylor 1994). It is essential to include an analysis of threatened and range restricted taxa when classifying areas of conservation priority (Rouget *et al.* 2004).

In South Africa, the Western Cape has been favoured by human settlement for the past 350 years, leading to substantial land transformation through agricultural and urban development, and alien plant encroachment (Deacon 1992; Rebelo 1992a; Richardson *et al.* 1996). Subsequently, much of the remainder of southern Africa has also undergone extensive land transformation over the past 100 years (Macdonald 1991; Van Rensburg *et al.* 2004). People have been attracted to the interior where mineral and fossil fuel resources abound (Deacon 1992). This has resulted in a multi-faceted combination of human demands and inherent threats across the southern African landscape (Reyers *et al.* 2001; Neke & Du Plessis 2004).

Previous work investigating human impacts in South Africa has focused on the relationships of taxon (or species) richness and human variables for South Africa's birds and, recently, frogs (Van Rensburg *et al.* 2002; Chown *et al.* 2003; Van Rensburg *et al.* 2004; Evans *et al.* 2006). Their results show that avian species richness and human density were positively correlated, apparently as both responded positively to increasing levels of primary productivity (Van Rensburg *et al.* 2002; Chown *et al.* 2003; Van Rensburg *et al.* 2004). Here, we investigate the relationships between three plant richness measures that include all endemic and threatened South African plant taxa and six human demographic and socio-economic variables, to better understand potential and realistic anthropogenic threats to South African plants.

METHODS

Plant distributions of all South African taxa were extracted from the Pretoria National Herbarium (PRE) Computerised Information System (PRECIS) for 1 936 quarter degree squares (QDS) of South Africa. Richness maps were collated for three sets of plant groups. First, overall plant richness (OPR) was collated for South Africa at QDS level. Secondly, a list of 'endemic' taxa believed to occur only in South Africa, were extracted from the PRECIS database as well as Germishuizen *et al.* (2006) to produce a richness map for South African endemic taxa. Finally, a measure of threatened plant richness per QDS was calculated based on

a list of threatened taxa, which was extracted from the Threatened Species Programme's database of December 2003 (Threatened Species Programme unpublished data). This list of threatened species as used here (preliminary 2003 Red List of South African plants) is currently in the process of being re-assessed according to the IUCN (2001) Red List Categories & Criteria, by the Threatened Species Programme of the South African National Biodiversity Institute (SANBI). On release, this SANBI Red List will supersede the current 2003 list used. All taxa listed either by Hilton-Taylor (1996) as Endangered (E), or Vulnerable (V) or by IUCN (2001) categories Critically Endangered (CR), Endangered (EN) or Vulnerable (VU), were classified as Threatened.

Taxon richness counts across South Africa's QDSs were square root-transformed following Rebelo & Tansley (1993). Endemic and threatened taxon richness per QDS were also square root-transformed and corrected for total plant richness by dividing by total plant richness in that QDS (following Rebelo & Tansley 1993) yielding standardized endemic plant richness (EPR) and standardized threatened plant richness (TPR) at a QDS scale across South Africa.

South African anthropogenic data

Six human and socio-economic variables (anthropogenic variables from here on) were extracted from various data sources at a national scale in South Africa. These include: 1, human population density; 2, human population growth rate change; 3, a poverty index; 4, an affluence measure; 5, infrastructure; and 6, the degree of land transformation and degradation. Human population density, human population change, poverty, and affluence data were derived from magisterial district data (Central Statistical Service 1995, 1998), whereas all land-cover and transformation data were collated from the National Land-Cover (NLC) database (Fairbanks & Thompson 1996; Fairbanks *et al.* 2000). To standardize the scale of this data with the plant distributional data, data were converted to a spatial scale at the QDS level ($25 \times 25 \text{ km}^2$) using ESRI ArcView GIS 3.2.

The 1996 South African population census data (Central Statistical Service 1998) were used to estimate the weighted average population density per QDS (human density—HD). Human density was denoted as the average number of people/ km^2 within each QDS. The average percentage increase or decrease of human population per QDS (human growth rate change—HC) over the period 1996 to 2001 (Central Statistical Service 1998; Rouget *et al.* 2004) was used as a direct proxy for the impact of human population growth on the environment.

A poverty index (economic poverty—EP) was estimated as the proportion of people per municipality earning less than R200 per month (Central Statistical Service 1998). The United Nations Development Programme South Africa (2003) report indicated that people earning less than R354 per month could be regarded as earning below the poverty line. The census data uses broad categories of which 'less than R200/month' together with the 'no income' category are regarded as earning below

the poverty level. This allowed the computation of a weighted average of the proportion of people per QDS earning less than R200/month.

A measure of economic affluence (EA) defined as the weighted average Gross Geographic Product (GGP) per capita income per QDS, was based on GGP obtained for all South African magisterial districts (Central Statistical Service 1995). GGP represents 'the remuneration received by the production factors—land, labour capital and entrepreneurship for their participation in production within a defined area' (Central Statistical Service 1995). The Central Statistical Service (1995) provides 1994 estimates of GGP and remuneration of employees by magisterial district in South African Rand (R). Fine-scale spatial Gross National Product (GNP) data for South Africa were not available, forcing the use of GGP data, which represents the finest-scale data available for South Africa and was incorporated in the current analysis rather than GNP data used by other authors (Kerr & Currie 1995; Naidoo & Adamowicz 2001).

To obtain a measure to investigate the effects of urbanization and related development (e.g. industry) on plant richness in South Africa, infrastructure coverage (in the form of the percentage of a QDS covered by road and urbanized areas) was estimated (land-cover, roads and urban, LRU). Infrastructure data were extracted from the NLC database (Fairbanks & Thompson 1996). The extent of the urban area was extracted from all types of 'urban/built-up land' land-cover type (= land-cover type 24–30; Fairbanks & Thompson 1996) in the NLC database. A buffered road network for South Africa was obtained from Reyers *et al.* (2001) representing various buffered road types in South Africa.

The extent of land transformation (land-cover, transformed and degraded (LTD) was obtained from the NLC database, by calculating and summing the percentage of each land-cover class in each QDS, based on the six transformed land-cover classes identified by Fairbanks & Thompson (1996) and Fairbanks *et al.* (2000). These classes were based on seasonally standardized Landsat TM satellite imagery captured primarily during 1994–1995 and included anthropogenic effects such as forest plantations, artificial water bodies, urban/built-up areas, cultivated lands, degraded land as well as mines/quarries. LTD may be a more inclusive human impact measure than HD or LRU alone (when available), as it includes the effects of human population density on urban expansion, road networks and the effects of other forms of land transformation that occur in lower human density areas but that may significantly affect species richness (e.g. agricultural, industrial and other land transformations, such as plantations).

The values of the weighted average anthropogenic variables calculated for each QDS across South Africa (Table 1) conform reasonably well to human statistics presented by the Development Bank of South Africa (DBSA) (2000). This suggests that the rescaled (to weighted average values for each QDS across South Africa) human demographic variables used here do not noticeably differ from the provincial scale data issued by DBSA.

TABLE 1.—No. approximate total plant taxa, no. endemic and threatened plant taxa for South Africa and for the nine respective provinces. All national and provincial taxa counts are approximate counts (rounded off) obtained from PRECIS (see Germishuizen *et al.* 2006 for up to date counts)

Area	Plant taxa	Endemic taxa in area	Endemic taxa to area	Threatened taxa in area	Threatened and endemic in area	HD	HC	EP	EA	LRU	LTD
Eastern Cape	7 000	2 800	750	259	234	33.51	5.5	68.7	R 406 × 10 ⁶	6.61	21.2
Free State	2 900	320	25	36	24	26.98	7.68	67.7	R 625 × 10 ⁶	7.78	28.7
Gauteng	2 700	220	20	39	19	301.7	19.88	51.8	R 6 558 × 10 ⁶	18.70	41.6
KwaZulu-Natal	6 400	1 350	400	198	151	83.95	12.49	71.6	R 1 126 × 10 ⁶	6.14	34.3
Limpopo	4 500	480	130	101	58	40.89	13.53	56.8	R 891 × 10 ⁶	4.79	24.1
Mpumalanga	5 000	640	250	108	62	43.97	18.23	57.2	R 483 × 10 ⁶	7.12	29.3
North-West	2 500	180	10	29	13	32.86	6.57	69.6	R 1 083 × 10 ⁶	5.84	29.1
Northern Cape	5 100	1 900	650	337	282	2.97	−6.15	57.5	R 307 × 10 ⁶	3.77	2.6
Western Cape	11 800	7 900	5 550	1 093	1 060	24.07	12.46	49.9	R 1 287 × 10 ⁶	5.79	23.4
South Africa	22 800	11 200	11 200	1 880	1 464	33.76	6.57	61.1	R 1 099 × 10 ⁶	6.13	20.4

Endemic taxa in area: approximate no. South African endemic taxa occurring in particular region.

Endemic taxa to area: approximation of taxa endemic to area, reported to occur only in area.

Threatened and endemic taxa: no. threatened taxa [Critically Endangered (CR), Endangered (EN), Vulnerable (VU) (IUCN 2001), Endangered (E), and Vulnerable (V) pre-1994 criteria] based on preliminary 2003 Red List (Threatened Species Programme 2003 unpubl. data).

Information on average anthropogenic variables for each of areas calculated for all provincial quarter-degree squares (QDS), with abbreviations as follows: HD, human density (people/km²); HC, human growth rate change (% increase/decrease of people); EP, economic poverty (proportion of people earning < R200/month); EA, economic affluence [Rands (GGP) per capita × 10⁶]; LRU, land use roads and urbanization (% area under urban or road); LTD, land-cover transformed and degraded (% area transformed or degraded).

Statistical analysis

All three measures of richness (OPR, EPR and TPR) and the six anthropogenic variables (HD, HC, EP, EA, LRU, LTD) were log-transformed for statistical analyses. Kruskal Wallis Analysis of Variance (ANOVA) by Ranks and Spearman's *R* Rank order correlations (Zar 1996) were used to test for statistical differences and correlations, respectively, between measures.

Generalized Linear Models (GLZ; McCullagh & Nelder 1989) were used to assess the relationship between OPR and EPR, and between OPR and TPR, as well as between each of the three measures of plant richness and each anthropogenic variable independently. Anthropogenic variables were not included simultaneously in the analysis because of high correlations between some variables (which may lead to collinearity in the model), the substantial differences in the manner in which the variables were measured and subsequently rescaled, and because we wanted to examine the contribution of each variable to explained deviance in each richness variable independently, to assess its potential as a surrogate measure of anthropogenic impact. Because the measures of plant richness were in the form of counts, a Poisson distribution with a logarithmic link function was used in the GLZs (Maggini *et al.* 2002). A goodness-of-fit test (a deviance statistic), which yields the proportion of deviance explained (similar to an *R*² value) by the variable in the GLZ (McCullagh & Nelder 1989) was used to determine which anthropogenic variable contributed the most to explained deviance in the richness variable used. All statistical analyses were based on analytical subroutines in STATISTICA version 6.1 (StatSoft 2001).

RESULTS

Based on the 2003 data extracted from the PRECIS data set, ± 11 200 of the 22 000 recognized South African plant taxa are endemic to South Africa. The

preliminary 2003 Red List regarded about 1 900 taxa as threatened with extinction (Threatened). The Western Cape and Eastern Cape proved to have the highest number of plant taxa, endemic as well as threatened (Table 1; Figure 1), mainly in the Cape Floristic Region.

Considering the anthropogenic measures, Gauteng displayed the highest human variables except for economic poverty (EP) and economic affluence (EA—GGP/capita). KwaZulu-Natal, was highlighted as the province with the highest proportion of poverty (EP), and Northern Cape highlighted with the highest average GGP/capita (EA), mainly the result of lower human population density and large GGP contributors (mining and quarrying, data not shown) in the province (Table 1). Excluding 'per capita' from the GGP measure, Gauteng Province was the largest contributor to South Africa's economy.

Human densities (HD) and high human growth rate change (HC) were evident mostly in the large metropolitan areas such as City of Cape Town, eThekweni Municipality (city of Durban) and municipalities in Gauteng Province (Figure 2A, B). EP in turn was higher in areas in the North-West, Eastern Cape and northeastern KwaZulu-Natal. EA (affluence/capita) was high in areas with low human density, e.g. Northern Cape (Figure 2C, D). Gauteng Province yielded QDSs with the highest levels of urbanization and road coverage, with Western Cape, Eastern Cape (Transkei), North-West and Free State yielding areas of high transformation and/or degradation (Figure 2E, F).

Relationships between species richness measures

Overall plant richness (OPR), endemic plant richness (EPR) and threatened plant richness (TPR) were all significantly different from one another across South Africa (Kruskal Wallis $H_{3, 7752} = 4070$; $P < 0.001$). Nonetheless,

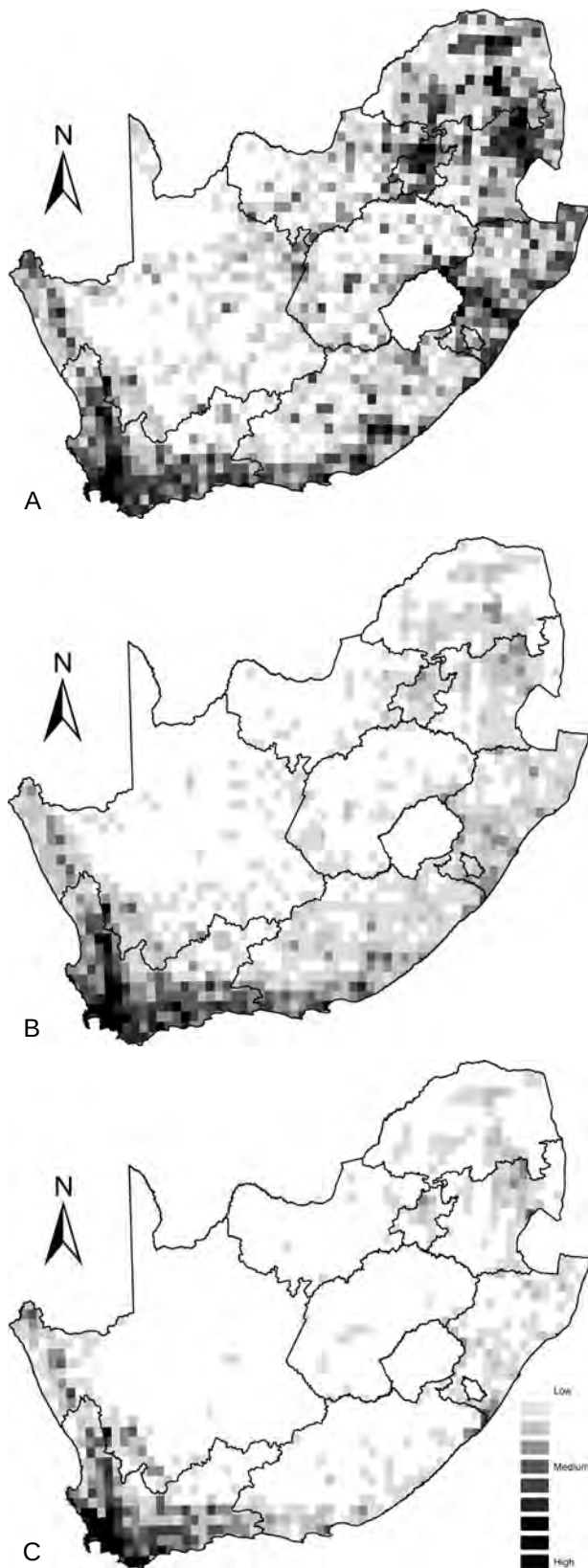


FIGURE 1.—Patterns of plant richness across South Africa, based on distribution data from Pretoria National Herbarium Computerised Information System (PRECIS) presented at quarter-degree square (QDS, 25 × 25 km). A, overall plant richness (OPR); B, endemic plant richness (EPR); C, threatened plant richness (TPR). Darker shades represent higher plant richness for each QDS. Threatened plant richness was based on the preliminary 2003 Red List of South African plants. Note: this map should not be used for provincial conservation purposes until our results are verified by the updated Red List (shortly to be released by SANBI).

EPR was strongly significantly correlated with OPR (Spearman $R = 0.807$; $n = 1936$; $P < 0.05$), with EPR (dependant variable) contributing to 63% (Pearson $X^2 = 3468.52$; d.f. = 1935; $P < 0.001$) of the total deviance in OPR. OPR and TPR were also strongly correlated, but not as strongly as the relationship between OPR and EPR (Spearman $R = 0.679$; $n = 1936$; $P < 0.05$), with the regression model explaining 61% (Pearson $X^2 = 724.76$; d.f. = 1935; $P < 0.01$) of the total deviance. The strong correlation and percentage deviance explained for overall plant richness with both EPR and TPR indicates, not surprisingly, that endemic and threatened South African taxa are relatively strongly dependent on total taxon richness. Despite this strong link between richness measures, $\pm 40\%$ of the variation in overall plant richness remains unaccounted for when including either endemic or threatened taxa. We felt it prudent to investigate the relationships between each plant richness variable and the six anthropogenic variables, given that the richness measures varied significantly from one another across QDSs and because human impacts on endemic and threatened taxa may differ from overall plant richness.

Relationships between human demographic and socio-economic variables

The anthropogenic variables were all strongly significantly different from one another (Kruskal Wallis $H_{5, 11601} = 7307.40$; $P < 0.001$). All variables were positively correlated with one another except for the measure of affluence (EA—GGP/capita), which was negatively correlated with all anthropogenic variables calculated within the current study (Table 2). The poverty index (EP) and human growth rate change (HC) were the only two variables that were not significantly correlated with each other. Human density (HD) was strongly positively correlated with all variables, except EA (Table 2), suggesting that this variable may be the single, most inclusive anthropogenic variable to include in investigations of human impacts on flora. Human density was particularly strongly correlated with both land transformation (LTD) and roads and urbanization (LRU).

The effects of anthropogenic variables on species richness measures

Statistical analysis indicated varying relationships between OPR and the six anthropogenic variables. Plant richness (OPR) was positively correlated with human density (HD), human population growth rate change (HC), land-cover roads and urban (LRU) and land-cover transformed and degraded (LTD). Economic poverty (EP) and economic affluence (EA) were negatively correlated with plant richness, indicating that the effect of these variables on OPR was inverse to the effect of the remaining anthropogenic variables (Table 3). Although HD and LTD were strongly correlated (Table 2), LTD was able to contribute 2% more than HD to explained deviance in OPR (Table 3). No single anthropogenic variable accounted for more than 10.10% deviance explained in OPR (Table 3). Therefore, the observed effect of individual anthropogenic variables on OPR was small, but significant.

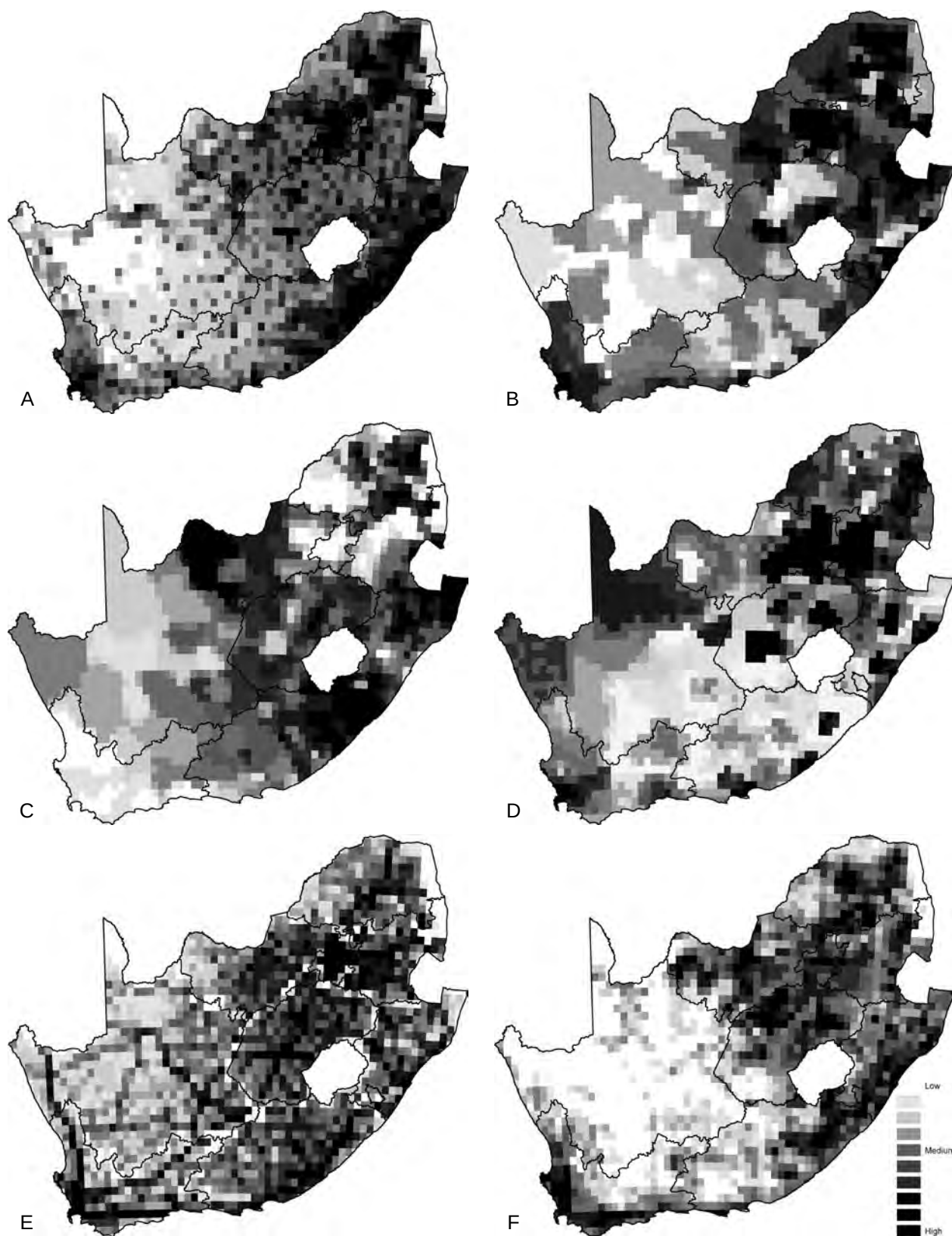


FIGURE 2.—Spatial representation per QDS across South Africa. A, human population density (HD); B, human growth rate change (HC); C, economic poverty (EP); D, measure of economic affluence (EA) denoted as the weighted average GGP/capita (EA); E, infrastructure of land-cover road and urban areas (LRU); and F, degree of land-cover transformed and degraded (LTD). Darker shades represent higher impacts.

Endemic plant richness (EPR) and the anthropogenic variables were all weakly correlated with one another (Table 3). Only the poverty (EP) variable, which was weakly negatively correlated with EPR, explained a significant proportion of the deviance (10.50%) in EPR (Table 3). Other than EP, the anthropogenic variables

used here do not appear to contribute sufficiently to understanding the effects of human impacts on endemic plant species.

Threatened plant richness (TPR) and the human variables were all weakly significantly correlated (Table 3).

TABLE 2.—Spearman Rank order correlation (*R*-values) for the six anthropogenic measures

	HD	HC	EP	EA	LRU
HD	1.00				
HC	0.54	1.00			
EP	0.34	0.003 ^{ns}	1.00		
EA	−0.86	−0.37	−0.48	1.00	
LRU	0.57	0.26	0.10	−0.49	1.00
LTD	0.73	0.54	0.25	−0.59	0.42

Values in bold: statistical significance of $P < 0.05$; ns, not significantly correlated; HD, human density; HC, human growth rate change; EP, economic poverty; EA, economic affluence; LRU, percentage land-cover under roads and/or urban; LTD, percentage land-cover transformed and degraded.

Poverty (EP) and economic affluence (EA) were again negatively correlated with the plant richness variable (TPR). Only these variables contributed significantly to explained deviance in TPR, although the contribution was minimal (Table 3).

DISCUSSION

Strong evidence links rates of habitat and species loss with human demographic patterns (Cincotta *et al.* 2000; Ceballos & Ehrlich 2002; Luck *et al.* 2003). Given South Africa's low economic growth during the past decade (2.7%), increased population size (2.2% per annum) and increasing demand on urbanized areas (DBSA 2000; Statistics South Africa 2002; Chown *et al.* 2003), anthropogenic effects on species should be readily apparent. None of the anthropogenic variables measured here contributed more than 10% towards explaining variation in any of the three species richness measures used. Nonetheless, the contribution of single, anthropogenic variables on overall species richness was both significant and observable. It is important to remember that anthropogenic variables entered in combination, may contribute substantially more than individual variables. This analysis is, however, beyond the scope of the current paper.

Various studies have found a significant, albeit weak, relationship between human population size, human population growth, poverty, per capita income, urbaniza-

tion and species per country (Ehrlich & Holden 1971; Kerr & Currie 1995; Cincotta *et al.* 2000). Balmford *et al.* (2001) reported a marked congruence of high species richness and human population density across the African continent. Chown *et al.* (2003) state that a strong significant relationship exists between South African birds and human population density ($R^2 = 0.67$) at a quarter-degree scale that is driven, in part, by available energy (Evans *et al.* 2006). Moreover, strong evidence supports remarkably strong correlations between plant richness and potential evapotranspiration, annual precipitation, as well as geographic variation in plant taxonomic richness (Rutherford & Westfall 1986; Currie & Paquin 1987; O'Brien *et al.* 1998, 2000; Van Rensburg *et al.* 2002). Yet none of the human predictors under consideration here had any such strong relationship with any of the richness variables, even though weak significant correlation was present.

The discrepancy between temporal scales of the data may have contributed to the weak relationships that were detected between richness and anthropogenic variables in this study. The time scale of the plant richness distribution data range from specimens collected in the early 1700s until the present time. Most collections occurred in and prior to 1970 with only 7% of all the specimen collections occurring since 1990 (PRECIS unpublished data). Furthermore, plant distribution data are rarely representative and accurate, and in most cases old and out of date (Rebelo 1992a, b; Freitag & Van Jaarsveld 1997; Maddock & Du Plessis 1999; Maddock & Samways 2000; Rouget *et al.* 2004). Conversely, the human and socio-economic variable data used in the current study generally date from 1994 to present.

Other than time scale differences in data collection, another major factor influencing statistical results and analysis could be the different spatial scales of the biotic and anthropogenic databases. Most of the anthropogenic data were measured at magisterial district scale and consequently were transformed by up- or down-scaling to QDS scale and converted to weighted averages. A QDS is often too large to reflect finer-scale topographical and vegetation differences and will most likely not reflect many of the finer interactions between human predictors and plant richness measures (Rebelo & Tansley 1993; Van Rensburg *et al.* 2004). However, this effect

TABLE 3.—Spearman Rank (*R* values) and *P* value, as well as Generalized Linear Model with Poisson error distribution and Log Link function (McCullagh & Nelder 1989) parameters for relationships between overall plant richness (OPR), endemic plant richness (EPR) and threatened plant richness (TPR) with each anthropogenic variable

	OPR Spearman <i>R</i> value	OPR Explained Deviance	OPR Pearson χ^2	EPR Spearman <i>R</i> value	EPR Explained Deviance	EPR Pearson χ^2	TPR Spearman <i>R</i> value	TPR Explained Deviance	TPR Pearson χ^2
HD	0.488**	6.67**	770999.68	0.040**	0.28 ^{ns}	525.64	0.145**	0.00 ^{ns}	5507.44
HC	0.421**	10.10**	733711.85	−0.063**	0.26 ^{ns}	525.66	0.195**	0.28 ^{ns}	5501.54
EP	−0.071**	3.40**	795575.84	−0.175**	10.50**	423.59	−0.217**	7.27*	5494.70
EA	−0.399**	0.93**	9814042.08	−0.120**	0.26 ^{ns}	526.04	−0.112**	0.05***	5438.64
LRU	0.264**	9.69**	743557.77	0.128**	0.31 ^{ns}	526.78	0.062**	0.00 ^{ns}	5537.99
LTD	0.343**	8.17**	746962.96	0.038 ^{ns}	0.57 ^{ns}	522.37	0.142**	0.34 ^{ns}	5586.00

HD, human density; HC, human growth rate change; EP, economic poverty; EA, economic affluence; LRU, percentage land-cover under roads and/or urban; LTD, percentage land-cover transformed and degraded.

Statistical significance: ***, $P < 0.001$; **, $P < 0.01$; *, $P < 0.05$; ns, not statistically significant.

is unlikely to be substantial as the summarized statistics for each province, using the data rescaled to QDS (see Table 1), are remarkably similar to the results of the Development Bank of South Africa issued at provincial scale (DBSA 2000). Notwithstanding these temporal and spatial scaling issues, all the databases are still useful to investigate the presence of broader spatial scale relationships and trends, albeit if finer scale interactions may be weakened.

Finally, other more important causal mechanisms may dominate plant richness patterns, e.g. climatic variables, topographic variables and β -diversity (Bailey *et al.* 2002). Indeed, Evans *et al.* (2006) suggest that available energy may be driving the observed patterns in bird species richness and human population change.

Even though conservationists are urged to include human variables when setting conservation priorities, human population variables are imperfect indicators of risk to biodiversity (Thompson & Jones 1999; Cincotta *et al.* 2000). Indeed, the results of this study show that the strength of the relationships between human variables were weak, albeit significant, and the strength of the relationship did not improve when endemic or threatened taxa were used in the analyses instead of overall plant species richness (OPR).

Thompson & Jones (1999) found that human population density accounted for almost 35% of the variability in rare and threatened plant loss in a study conducted in Britain. Our study shows that human population density did explain a significant proportion of the variation in OPR but that its contribution to explained variation in endemic (EPR) or threatened (TPR) plant species richness was not significant. Therefore, although there is a strong link between the three richness measures used here, OPR appears to be the most suited richness surrogate when using the anthropogenic variables included in this study. Nonetheless, it remains important to consider how human impacts may affect endemic and threatened plant richness patterns. This study shows that the only suitable anthropogenic variable to use for EPR and TPR is economic poverty. This was the only anthropogenic measure to show a significant relationship with these richness measures. In addition, TPR data used here are based on preliminary 2003 data, which will be superseded by the Red List due in 2007 (Threatened Species Programme, SANBI). This will allow for more up-to-date richness data, as well as updated threat data and subsequent threat analysis. The results from the present study should be verified when the updated SANBI Red List becomes available.

Although clear evidence for different measures of human impact affecting plant extinction have been highlighted, it is difficult to assign a risk value to the impacts of these measures (Kerr & Currie 1995; Czech & Krausman 1997; Chertow 2001; Ceballos & Ehrlich 2002). Anthropogenic activities form a complex web of threats that is influenced by various socio-economic and political factors, e.g. national policies, economic conditions and a host of other factors varying among nations (Macdonald 1991; Kerr & Currie 1995; DBSA 2000; McKinney 2001; O'Neill *et al.* 2001; Liu *et al.* 2003). Testing certain human threat predictors (as used in the

current study) should not be taken to mean that other anthropogenic variables are insignificant, as many additional human predictors are also extremely important at local scales (Macdonald 1991; Rouget *et al.* 2004).

For the current study, human population density (HD), land-cover that is transformed and degraded (LTD) and land-cover roads and urban areas (LRU), appear to be useful measures of anthropogenic impacts on OPR. The pooled strength of the relationship between these variables and OPR may not increase as HD is strongly correlated with LTD and LRU. LTD is, however, a more inclusive human impact measure than HD or LRU when conducting analyses of human impacts using OPR. The analyses show that slightly more variation in OPR is explained by this variable than for HD. Also, the effects of large human populations on urban expansion and road networks are included in HD and LRU. However, other forms of land transformation that occur in lower human density areas that may significantly affect species richness, such as, areas under agricultural or industrial use or plantations, are not included in HD and LRU. These impacts are included in LTD. Plant population decreases are concentrated in areas with high human densities or high human impact, such as agricultural areas (Burgess *et al.* 2002; Ceballos & Ehrlich 2002; Araújo 2003), also suggesting that the use of LTD may yield more information on human impacts than HD and LRU alone. It has been shown that human density is clearly a proximate threat, whereas agriculture, urbanization, land transformation, and roads are ultimate threats (Thompson & Jones 1999). Further analysis is required to ascertain whether other human measures are proximate or ultimate threats.

The differing anthropogenic threats should be assessed individually for each province prior to any risk assessment. Plant richness and endemism are not evenly distributed across South Africa, and most of these endemic taxa are confined to the predominantly winter rainfall Fynbos and Succulent Karoo Biomes (Cowling & Hilton-Taylor 1994; Figure 1A, B). Also, as shown here, anthropogenic variables vary substantially between provinces. For example, Gauteng is an important economic region in terms of business and industrial development, mining and agriculture, and is undergoing rapid expansion of urban areas, constituting the most serious threat to plant populations in this province (Phab & Victor 2002).

It is self-evident of the conservation movement today, that conservation targets are set by incorporating a wide variety of suitable data, ranging from taxa/species information, land types and habitat types (Pressey *et al.* 2003; Rouget *et al.* 2004). Using anthropogenic variables to improve conservation priority, setting procedures for plants is somewhat confounded by the low correlation between anthropogenic and richness variables found in the current study. Studies that do use anthropogenic variables as threat predictors for taxa should not be taken up haphazardly (Cincotta *et al.* 2000). To further assist in identifying South African plant taxa threatened by human activity, additional research is clearly required. Analysis of different human and socio-economic variables may well yield substantially different results. Undertaking a more detailed study on the effects of cli-

mate, water energy dynamics, and topography on various species richness measures (not only woody tree and shrub richness; see O'Brien *et al.* 1998), could perhaps provide insight into processes driving species distribution, and subsequently assist in identifying threats to these species. Furthermore, it would perhaps be more relevant to investigate human threats and its impact on broader units (e.g. vegetation type, habitat units) for which the QDS data is adequately suited. The analysis performed here provides insight into the relationships (or lack thereof) between human and socio-economic variables as used in the current study, and provides conservation planners with a better understanding of potential anthropogenic variables that could be regarded as threat proxies for plant taxa.

ACKNOWLEDGEMENTS

This work would not have been possible without the assistance of the Royal Norwegian Embassy (NORAD), via the Department of Environment Affairs and Tourism (DEAT). We would like to thank Statistics South Africa for data and the South African National Biodiversity Institute for use of data from the National Herbarium (PRE) Computerised Information System (PRECIS). H. Snyman, J. Victor, W. Foden and D. Pillay are thanked for their assistance with data acquisition and review of the manuscript. We thank the reviewers for comments on the earlier version of the manuscript.

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Threatened Limestone Fynbos plant communities of Andrew's Field and Tsaba-Tsaba Nature Reserve, Western Cape

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Keywords: conservation area, endemic plants, Limestone Fynbos, phytosociology, plant communities, TWINSpan, Western Cape

ABSTRACT

The vegetation of inland plains and hills of the Andrew's Field and Tsaba-Tsaba Nature Reserve, Bredasdorp District, Western Cape was classified using TWINSpan and Braun-Blanquet procedures. The resulting four plant communities and nine subcommunities were described and interpreted ecologically. The vegetation was sampled using 97 randomly stratified plots. The floristic composition, Braun-Blanquet cover-abundance of each species, and various environmental variables were recorded in each sample plot. The relationship between the vegetation units and the associated environmental gradients was confirmed by ordination, using the DECORANA computer program, applied to the floristic data set. The conservation priority of each vegetation unit was determined by taking the occurrence of Red Data List species, limestone endemic species and Cape Floristic Region endemic species into consideration. The distribution of the plant communities can mainly be ascribed to differences in the clay/sand content of the soil and the degree of exposure of the vegetation to the dominating winds (southeastern and northwestern) of the area.

INTRODUCTION

The Andrew's Field and Tsaba-Tsaba Nature Reserve is situated in the Bredasdorp/Riversdale Centre of Endemism (Cowling 1992). This centre refers to a well-defined group of plants confined to the limestones of the Bredasdorp Formation (Moll *et al.* 1984) and associated colluvial deposits (Heydenrych 1994). Limestone Fynbos is one of the most threatened vegetation types in the Cape Floristic Region (Hilton-Taylor & Le Roux 1989). Factors threatening Limestone Fynbos vegetation include alien plants (considered to be the biggest threat to the natural environment), land clearing, resort development, incorrect fire management and over-harvesting of flowers (Heydenrych 1994).

Cowling *et al.* (1988) and Rebelo *et al.* (1991) indicated that very little is known about the vegetation ecology of Limestone Fynbos. Both these authors attempted vegetation classifications based on a combination of structural characters (Campbell 1986) and dominant species. Vegetation classification and description using total floristics were avoided due to the highly variable floristic structure and the very high number of species in Fynbos communities (Cowling *et al.* 1988). Detailed vegetation studies based on total floristics are therefore very limited or do not exist at all in Limestone Fynbos. Furthermore, 21% of all Limestone Fynbos species are not conserved in state-owned nature reserves (Heydenrych 1994). The conservation importance of Limestone Fynbos, which dominates the inland plains and hills, makes the effective management of the area all the more important, and justifies a detailed vegetation study based on total floristics.

STUDY AREA

Location

The study area is situated in the Bredasdorp District, Western Cape, between Struisbaai North in the south

and the De Mond State Forest in the north (Figure 1). The area is bordered in the west by the Bredasdorp/Struisbaai road, and in the south by the sea. According to the geographical division of Heydon & Tinley (1980), the study area is situated on the south coast, which is a transitional zone, between tropical and temperate waters. Offshore is the major retroflex area of Agulhas Current waters, recurving eastwards and landwards (Heydon & Tinley 1980).

The study area is ± 979 ha in extent and consists of Andrew's Field (± 129 ha) and Tsaba-Tsaba Nature Reserve (± 850 ha), which are adjacent areas on the same farm (Portion 7 and the remainder of Portion 8 of the Farm Zoetendalsvlei No. 280). Approximately two thirds of the study area consists of inland plains and hills of Limestone Fynbos; the rest of the area consists of coastal thickets. According to Low & Rebelo (1998), two veld types occur on the inland plains and hills: Limestone Fynbos and South- and Southwest Coast Renosterveld, whereas Mustard *et al.* (1997) also mentions Dune Asteraceous Fynbos for this coastal area. According to Mucina *et al.* (2005), the area consists of Overberg Dune Strandveld and De Hoop Limestone Fynbos.

Geology

Two formations of the Bredasdorp Group namely the Strandveld Formation and the Waenhuiskrans Formation are found in the study area. The Bredasdorp Group is described by Malan *et al.* (1994) as Cenozoic sediments of marine and marine related origin, stretching up to 22 km inland from the current coastline. The rocks are discordantly laid down on marine-paved rocks of the Table Mountain, Bokkeveld and Uitenhage Groups (Malan *et al.* 1994).

The Strandveld Formation, found along the coast, consists of white to pale grey dune sands with a high percentage of shell fragments. Partial cementing of sands with a high calcium carbonate content took place. The lithology of this formation can be described as white dune sand with finely divided shell and alluvial stones (Malan *et al.* 1994).

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MS. received 2005-08-19.

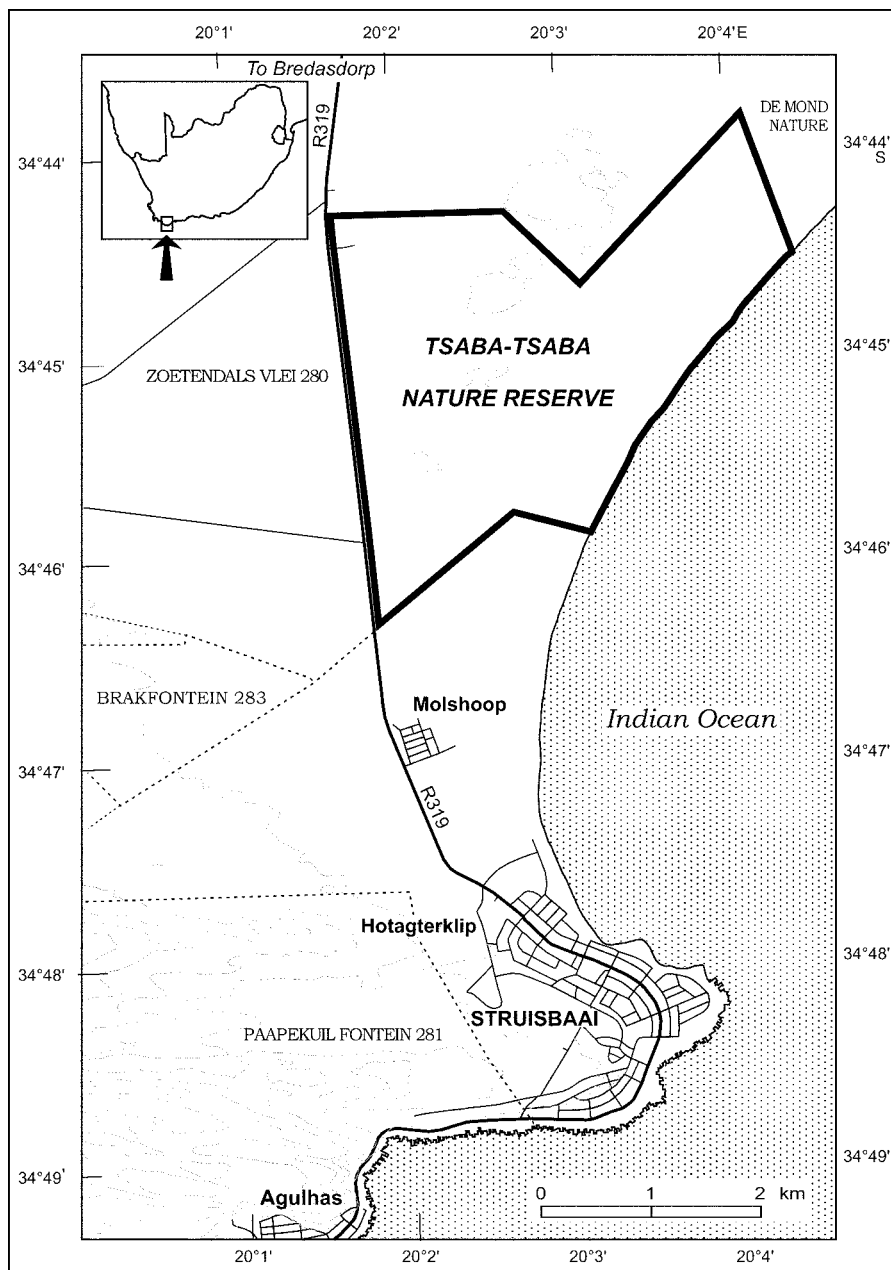


FIGURE 1.—The location of the study area.

The Waenhuiskrans Formation forms outcrops next to the current coastline. The Waenhuiskrans stratotype is 12.4 m deep, overlain with 1 m thick calcretes locally, and consists of medium granulated cross-layered calcarenite with well-rounded quartz and a few glauconite grains. Large-scale aeolic cross layers are characteristic of the unit. The lithology of this formation can be described as partially calcified dune sand (Malan *et al.* 1994).

A small portion of the study area's mother material consists of sedimentary rocks (pale grey to pale red sandy soil), underlain by the Waenhuiskrans Formation (partly calcified dune sand with calcrete lenses) (Malan *et al.* 1994).

Physiography

The study area is situated on the Agulhas Plain, which is a coastal lowland. Most of the study area falls below the 10 m contour with a ridge running roughly north-

south reaching an altitude of 31 m in places (Jeffery 1996). The area mostly consists of gradual, sloped limestone hills and flat to gradual, sloped plains.

Soil

The soil is shallow and sandy, overlying limestone, or deeper and sandy, overlying clay, silt and gravel. Four different soil forms have been distinguished in the area. Coega (Orthic A on hard bank carbonate horizon), family Marydale (lime containing A-horizon); Immerpan (Melanic A on hard bank carbonate horizon), family Kalkpan (lime containing A-horizon); Brandvlei (Orthic A on soft carbonate horizon), family Kolke (signs of wetness in the carbonate horizon); and Namib (Orthic A on regic sand), family Beachwood (containing lime within 1 500 mm from the soil surface) (MacVicar 1991).

The Coega soil form is found on the limestone hills and shallow-soil limestone plain. The Immerpan soil form is found on the deeper soil of a proteoid-dominated

limestone plain. The Brandvlei soil form is found in the marsh area, as well as on the renosterveld plain, whereas the Namib soil form is found on the dune plain and the deep sand found on proteoid-dominated foothills and plains.

Climate

The main factors affecting the climate are the contrasting sea surface temperatures of the two major ocean currents and the inshore circulation (Tinley 1985). The south coast has a warm temperate climate with all seasons and bimodal equinoctial rainfall (Strydom 1992).

The study area is situated in the Southern Overberg, which is a transition between the winter rainfall region and the nonseasonal rainfall region in the east (Mustard *et al.* 1997). According to Heydorn & Tinley (1980) the study area is situated in a low rainfall region, on an arid inland tongue reaching the coast. The low rainfall regime appears to be due to the occurrence of cold inshore waters, which inhibit shoreline rains. The average annual precipitation of the area is 444 mm. Precipitation mostly takes place in the form of rain, but also occurs in the form of fog. The maximum precipitation is in June, and the minimum precipitation during February and December. A climate diagram (Figure 2) was compiled from data obtained from the Agulhas Weather Station.

The average annual minimum and maximum temperatures for the area are 6°C and 13.3°C, respectively. The maximum and minimum temperatures for the area were 36.1°C in February and 3.9°C in June respectively.

The wind along the south coast is bi-directional; southeasterly winds alternate with northwesterly and southwesterly winds (Heydorn & Tinley 1980).

METHODS

Relevés were compiled in 97 plots, placed in a stratified random way in relatively homogeneous areas, representative of particular plant communities. A plot size of 10 × 10 m was used, which is considered as large enough to ensure that all species of regular occurrence in the stand are present in the sample plot (Rebello *et al.* 1991). Sample plots were placed to ensure that each plot adequately represented the structure of the particular vegetation (Werger 1974). A list of plant species found in each sample plot was compiled. The cover-abundance of each species in the sample plot was assessed, using the Braun-Blanquet cover-abundance scale (Mueller-Dombois & Ellenberg 1974; Werger 1974), with the modification proposed by Barkman *et al.* (1964) and Westhoff & Van der Maarel (1978). Vegetation structure, based on height and plant cover classes, is described according to the structural classification of Edwards (1983).

The Edwards (1983) height classification is as follows:

Height class	Shrubs	Grasses and herbs
High	2–5 m	> 2 m
Tall	1–2 m	1–2 m
Short	0.5–1.0 m	0.5–1.0 m
Low	< 0.5 m	< 0.5 m

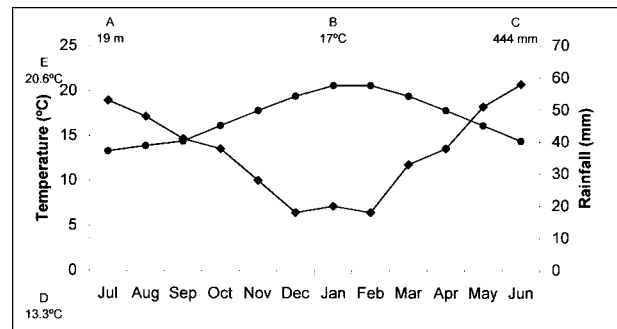


FIGURE 2.—A climate diagram for Andrew's Field and Tsaba-Tsaba Nature Reserve. A, altitude; B, mean annual temperature; C, mean annual rainfall; D, mean daily minimum (coldest month); E, mean daily maximum (hottest month).

The following habitat characteristics were recorded in each sample plot: altitude, topographical position, geomorphology, exposure to sun and wind, slope angle, slope direction, geology, soil, percentage rock cover and biotic influence.

All data were incorporated into a vegetation database created in TURBOVEG (Hennekens & Schaminee 2001). To obtain a first approximation of the plant communities of the area, relevés were extracted from TURBOVEG into MEGATAB (Hennekens 1996) and then classified using the TWINSpan algorithm (Hill 1979) contained within MEGATAB. These results were then refined by application of the classical Braun-Blanquet methodology (Behr & Bredenkamp 1988), using MEGATAB as the table editor. The results obtained from the classification are presented in a phytosociological table (Appendix 1). Plant names conform to Germishuizen & Meyer (2003).

RESULTS

Classification

Six main habitat types are found in the study area, namely wetlands, limestone hills, shallow limestone plains, deep-soil limestone plains, undulating dune plains with neutral sands and Renosterveld.

The plant communities are classified as follows:

1. *Phragmites australis*–*Juncus kraussii* Tall to High Closed Reed Wetland Community
2. *Chondropetalum microcarpum*–*Metalasia pungens* Low Closed Ericoid and Restioid Fynbos Community
 - 2.1 *Adromischus caryophyllaceus*–*Chondropetalum microcarpum* Low Closed Limestone Fynbos Subcommunity
 - 2.2 *Passerina corymbosa*–*Chondropetalum microcarpum* Low to Short Closed Fynbos Subcommunity
 - 2.3 *Empodium gloriosum*–*Chondropetalum microcarpum* Low to Short Closed Limestone Fynbos Subcommunity
 - 2.4 *Eriocephalus kingesii*–*Chondropetalum microcarpum* Low to Short Closed Fynbos Subcommunity
3. *Leucadendron meridianum*–*Protea obtusifolia* Low to High Limestone Fynbos Community
 - 3.1 *Amphithalea alba*–*Leucadendron meridianum* Tall Closed Limestone Fynbos Subcommunity
 - 3.2 *Erica abietina*–*Leucadendron meridianum* Tall Closed Limestone Fynbos Subcommunity
 - 3.3 *Ehrharta calycina*–*Leucadendron meridianum* Low to Short Limestone Fynbos Subcommunity

- 3.4 *Metalasia muricata*–*Leucadendron meridianum* Tall Closed Limestone Fynbos Subcommunity
 3.5 *Protea susannae*–*Leucadendron coniferum* High Closed Fynbos Subcommunity
 4. *Oedera uniflora*–*Elytropappus rhinocerotis* Low Closed Renosterveld Community

A diagrammatic presentation of the hierarchical classification and associated environmental interpretation of the plant communities is given in Figure 3. The community numbers in Figure 3 correspond with the plant community numbers used in the text.

The distribution of the communities is shown in a vegetation map (Figure 4).

Description of the communities

1. *Phragmites australis*–*Juncus kraussii* Tall to High Closed Reed Wetland Community

Species per relevé: 4.

Diagnostic species: the reed *Phragmites australis*, the rush *Juncus kraussii* as well as the shrub *Plecotachys serpyllifolia* (Species Group A, Appendix 1).

Dominant plants: *Phragmites australis* and *Juncus kraussii*.

Structure: high, closed grass *Phragmites australis* in the wetland, with high *Phragmites australis*, tall *Juncus kraussii* and some short shrubs in the area surrounding the dam. The surrounding marshy area contains tall, closed *Juncus kraussii*, with some short shrubs in between.

The community is situated near the corner of the northern and western borders of the Reserve. It is found in the flat wetland/marsh area close to a dam, at an altitude of 3 m. Small, irregular, white-grey limestone stones, originating from the Waenhuiskrans Formation of the Bredasdorp Group, and orange-brown ferricrete pebbles associated with Table Mountain Rocks (Malan *et al.* 1994), cover 10% of the soil surface. Soils are of the Coega Form.

2. *Chondropetalum microcarpum*–*Metalasia pungens* Low Closed Ericoid and Restioid Fynbos Community

Diagnostic species: the shrubby *Metalasia pungens*, *Indigofera meyeriana*, *Acmadenia obtusata*, *Agathosma collina*, *Muraltia satureoides* var. *satureoides*, the forb *Lobelia setacea*, the restio *Calopsis viminea*, and the grasses *Cymbopogon pospischilii* and *Setaria sphacelata* var. *sphacelata* (Species Group B, Appendix 1).

Dominant plants: the restios *Ischyrolepis eleocharis* and *Chondropetalum microcarpum* (Species Group N).

Prominent species: the shrubs *Metalasia pungens*, *Acmadenia obtusata*, *Agathosma collina* (Species Group B), *Diosma guthriei* (Species Group C), *Disparago anomala*, *Phyllica ericoides* (Species Group M), *Morella quercifolia* (Species Group N), *Passerina paleacea* (Species Group P) and *Passerina galpinii* (Species Group Q), and the grass *Stipagrostis zeyheri* subsp. *sericans* (Species Group M).

Structure: varies from predominantly low, closed ericoid and asteraceous shrubs, with low restioids in abundance and with short shrubs sparsely scattered in the area.

This widespread and diverse community, consisting of four subcommunities, is found at the western and northern borders of Tsaba-Tsaba Nature Reserve and also in a mosaic of scattered patches in the central parts of the study area. It occurs at an altitude of 3–23 m, at a gradient of 0°–45°, on various habitat types, including the shallow-soil limestone plains, undulating dune plains, sandy footslopes and southerly slopes of limestone hills.

Small, irregular, white-grey pebbles, stones and rocks from the Waenhuiskrans Formation cover 0–40% on the limestone plains and 2–60% on the limestone hills. Small limestone pebbles originating from the Strandveld Formation cover 0–5% on the dune plains.

Soils are of the Coega and Brandvlei Forms on the limestone plain, the Namib Form on the dune plain and the Coega and Immerpan Forms on the limestone hills.

This restio-dominated fynbos community is floristically different from the Restioid Fynbos recognized by Cowing *et al.* (1988) or Rebelo *et al.* (1991). It should, however, be mentioned that Rebelo *et al.* (1991) combined structural and floristic characters in their analysis, and only dominant species were surveyed. This may account for some of the floristic differences between the plant communities from the current study and those from the Riversdale Plain. Many floristically different plant communities are, however, expected to be found in Restioid Fynbos from the limestone areas, as four subcommunities are recognized in this study:

- 2.1 *Adromischus caryophyllaceus*–*Chondropetalum microcarpum* Low Closed Limestone Fynbos Subcommunity

Species per relevé: 28.

Diagnostic species: the shrubby *Diosma guthriei*, the succulent forb *Adromischus caryophyllaceus* and the sedge *Ficinia truncata* (Species Group C, Appendix 1).

Dominant plants: the shrubs *Metalasia pungens* and *Acmadenia obtusata*, (Species Group B), and the restios *Ischyrolepis eleocharis* and *Chondropetalum microcarpum* (Species Group N).

Prominent species: the shrubs *Disparago anomala*, *Phyllica ericoides* (Species Group M) and *Passerina galpinii* (Species Group Q) and the grass *Stipagrostis zeyheri* subsp. *sericans* (Species Group M).

Structure: low, closed ericoid and asteraceous shrubs, with low restioids in abundance; short shrubs are also sparsely distributed.

The subcommunity is found scattered throughout the study area and is situated at an altitude of 3–10 m on a gradient of 0°–8°, on the shallow-soil limestone plain, where pebbles, stones and rocks cover 0–30% of the soil. Soils are of the Coega and Brandvlei Forms.

- 2.2 *Passerina corymbosa*–*Chondropetalum microcarpum* Low to Short Closed Fynbos Subcommunity

Species per relevé: 35.

Diagnostic species: the shrubby *Passerina corymbosa* and *Agathosma dielsiana* and the restio *Ischyrolepis triflora* (Species Group D, Appendix 1).

Dominant plants: the shrubs *Metalasia pungens*, *Acmadenia obtusata* (Species Group B), *Agathosma collina* (Species Group B), *Morella quercifolia*

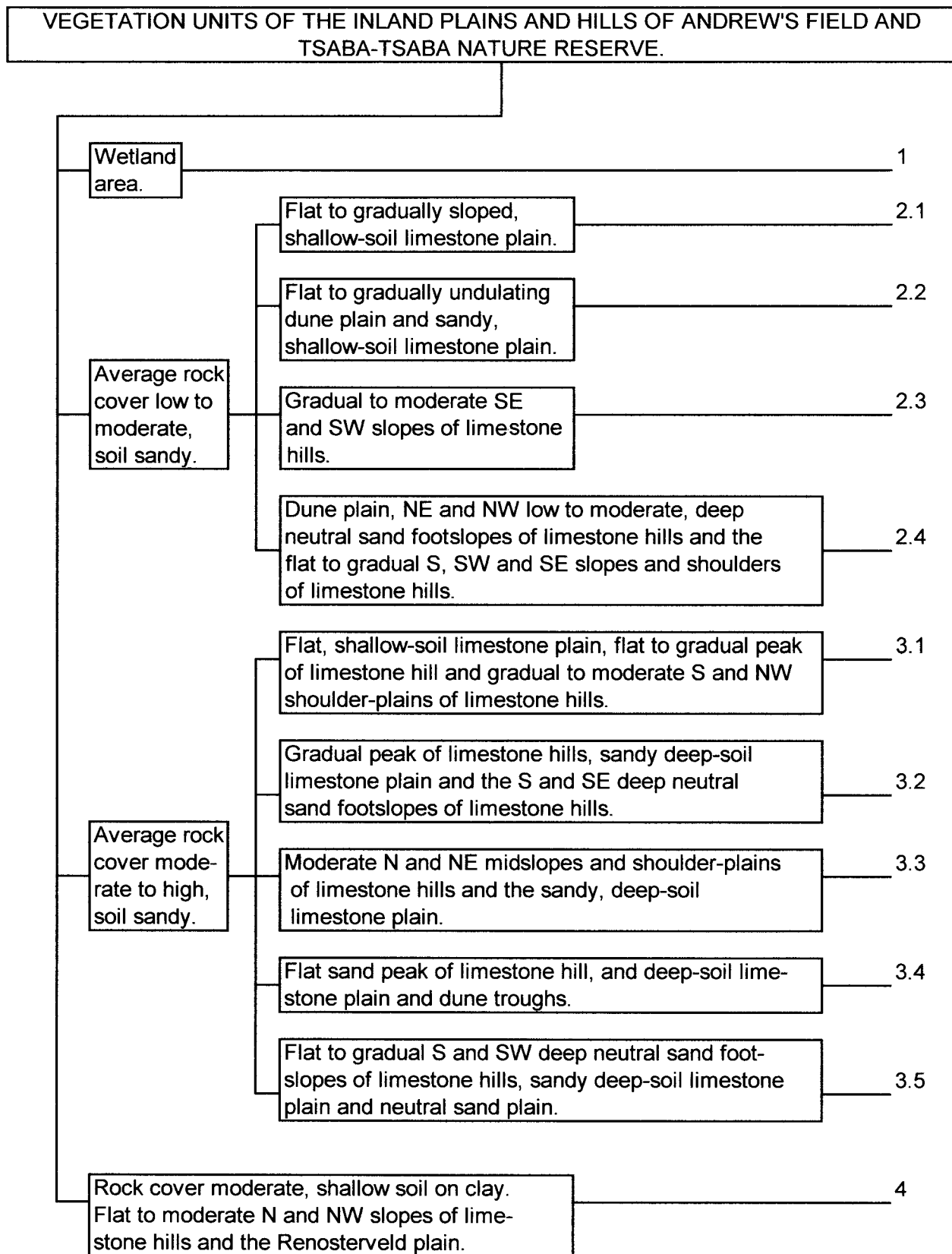


FIGURE 3.—The hierarchical classification and associated environmental characteristics of plant communities of the inland plains and hills.

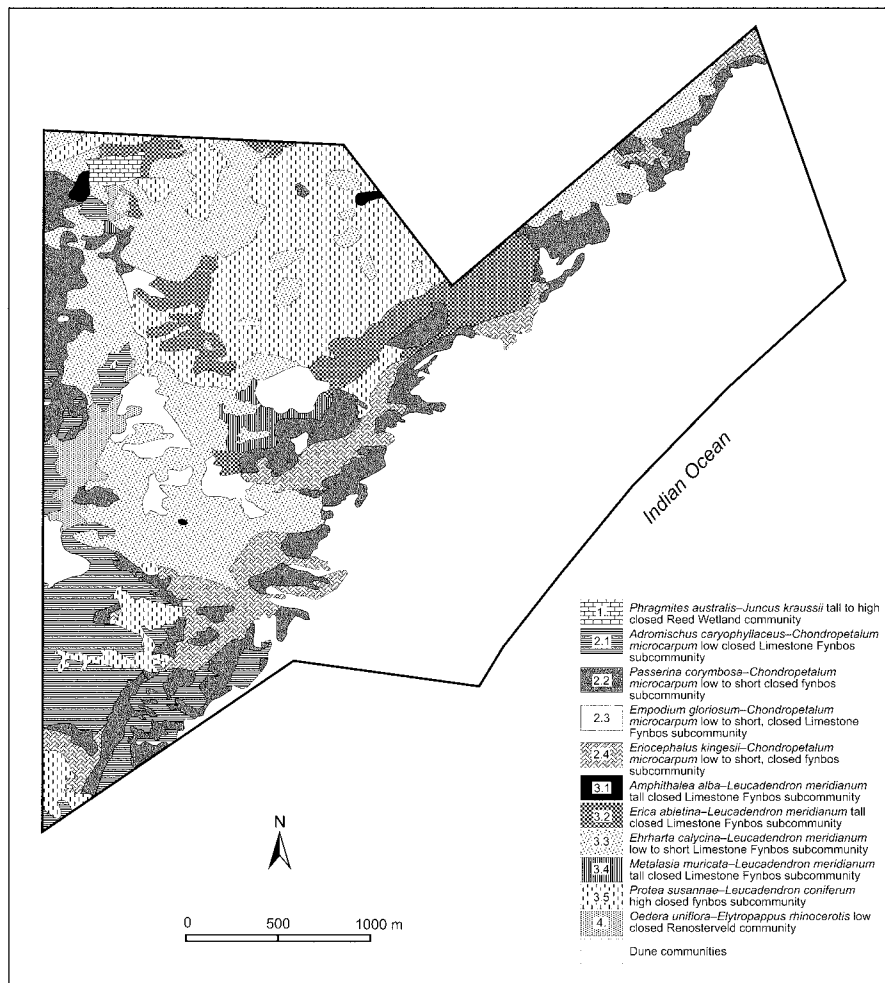


FIGURE 4.—Vegetation map of the Andrew's Field and Tsaba-Tsaba Nature Reserve.

(Species Group N) and *Passerina paleacea* (Species Group P), and the restios *Ischyrolepis eleocharis* and *Chondropetalum microcarpum* (Species Group N).

Prominent species: the shrubs *Phylica ericoides*, *Disparago anomala*, (Species Group M), *Otholobium bracteolatum* (Species Group P) and *Passerina galpinii* (Species Group Q), the restio *Thamnochortus insignis* (Species Group Q) and the grass *Stipagrostis zeyheri* subsp. *sericans* (Species Group M).

Structure: mostly low to short, closed ericoid and asteraceous shrubs; taller shrubs scattered throughout the area; some tall and short restios in abundance.

The subcommunity is found scattered over the entire study area at an altitude of 0–12 m, at a gradient of 0°–26°, on the dune plains where pebbles cover 0–5% and the sandy, shallow-soil limestone plains with pebbles covering 7–40%. Soils are of the Namib Form on the dune plains and the Brandvlei Form on the limestone plain.

2.3 *Empodium gloriosum*–*Chondropetalum microcarpum* Low to Short Closed Limestone Fynbos Subcommunity

Species per relevé: 26.

Diagnostic species: the forb *Empodium gloriosum*. (Species Group E, Appendix 1). Although this species group is poorly defined, with low constancy of the diagnostic species, the subcommunity is further confirmed by

the presence of Species Group B and absence of Species Groups C, D, and E.

Dominant plants: the shrub *Phylica ericoides* (Species Group M) and restioids *Ischyrolepis eleocharis* and *Chondropetalum microcarpum* (Species Group N).

Prominent species: the shrubs *Disparago anomala* (Species Group M), *Passerina paleacea* (Species Group P) the restoid *Thamnochortus insignis* (Species Group Q) and the grass *Stipagrostis zeyheri* subsp. *sericans* (Species Group M).

Structure: mostly low to short, closed ericoid and asteraceous shrubs; some taller shrubs scattered throughout the area; some tall and short restios in abundance.

This subcommunity is situated near the western border and in the eastern middle part of the Reserve. It occurs at an altitude of 3–23 m, at a gradient of 0°–45°, on the southeastern- and southwestern-facing slopes of limestone hills. Pebbles, stones and small rocks cover 2–60% of the soil. Soils are of the Coega and Immerpan Forms.

2.4 *Erioccephalus kingesii*–*Chondropetalum microcarpum* Low to Short Closed Fynbos Subcommunity

Species per relevé: 22.

Diagnostic species: the shrub *Erioccephalus kingesii* (Species Group F, Appendix 1).

Dominant plants: the shrubs *Acmadenia obtusata* and *Agathosma collina* (Species Group B), *Phylica ericoides* (Species Group M), *Passerina paleacea* (Species Group P),

the restios *Ischyrolepis eleocharis* and *Chondropetalum microcarpum* (Species Group N).

Prominent species: the shrubs *Metalasia pungens* (Species Group B), *Disparago anomala* (Species Group M), *Morella quercifolia* (Species Group N) and *Passerina galpinii* (Species Group Q), the restios *Calopsis viminea* (Species Group B) and *Thamnochortus insignis* (Species Group Q) and the grass *Stipagrostis zeyheri* subsp. *sericans* (Species Group M).

Structure: mostly low to short, closed ericoid and asteraceous shrubs; taller shrubs scattered throughout the area with tall and short restios in abundance.

The subcommunity occurs scattered over the entire study area on footslopes and slopes of limestone hills and on dune plains at an altitude of 3–21 m, with gradients of 0°–16°. Pebbles cover 1–35% of the soil. Soils are of the Namib Form on the dune plain and Immerpan and Coega Forms on the limestone hills.

3. *Leucadendron meridianum*–*Protea obtusifolia* Low to High Limestone Fynbos Community

Diagnostic species: the shrub *Helichrysum patulum* and the trees *Leucadendron meridianum* and *Protea obtusifolia* (Species Group G, Appendix 1).

Dominant plants: the shrubs *Rhus glauca*, *Euclea racemosa* and the restio *Thamnochortus insignis* (Species Group Q).

Prominent species: the shrubs/trees *Amphithalea alba*, *Leucospermum truncatum*, *Erica longifolia*, *E. propinqua*, *Stoebe cinerea* and *Aspalathus globulosa* (Species Group I), *Protea susannae* (Species Group L), *Metalasia muricata* (Species Group N), *Passerina paleacea* (Species Group P), and *Passerina galpinii* (Species Group Q), the forbs *Dimorphotheca nudicaulis* (Species Group I), *Dorotheanthus bellidiformis*, *Gladiolus gracilis*, *Dianthus albens* (Species Group J), the grass *Eragrostis sarmentosa* (Species Group K) and the restios *Ischyrolepis eleocharis* and *Chondropetalum microcarpum* (Species Group N).

Structure: a mixture of low, open ericoid-dominated fynbos shrubland, with scattered groups of tall to high, closed proteoid-dominated shrubs. High restios are found in the community, usually more abundant in the closed proteoid-dominated shrubland areas of the community. Low restios are also found quite abundantly throughout the community.

The community occurs from the corner formed by the northern and western borders of the Reserve up to the middle of the study area, running along the western border, and on the eastern section of the northern border, at an altitude of 1–31 m, at a gradient of 0°–16°, on the shallow and deep soils of the limestone plains, along the limestone hills, on the northern and northeastern midslopes of limestone ridges, on the deep sands of footslopes as well as in the dune troughs between dunes.

Large, irregularly shaped, white-grey rocks, with some smaller stones and pebbles, as well as rock sheets, cover 3–65% of the soil on the ridge. Small, irregular white-grey pebbles and stones cover 0–7% of the limestone plains. The sand in the dune troughs have no rocks. The limestone originated from the Waenhuiskrans

Formation of the Bredasdorp Group. Soils are of the Brandvlei Form on the shallow-soil limestone plain, the Immerpan Form on the deep-soil limestone plain, the Immerpan and Coega Forms on the limestone hills, and the Namib Form in the dune through areas.

The tall-, high-, short-, and low shrub strata have an average canopy cover of 21%, 16%, 11% and 11% respectively, and an average height of 2.5 m, 1.5 m, 0.75 m and 0.4 m respectively. The forb stratum has an average canopy cover of 4% and an average height of 0.3 m. The high-, tall-, short-, and low restioid strata have an average canopy cover of 0.5%, 6%, 2%, and 14% respectively, and an average height of 2.5 m, 1.5 m, 0.75 m and 0.4 m respectively. The sedge stratum has an average canopy cover of 0.7% and an average height of 0.15 m. The short- and low grass strata have an average canopy cover of 1% and 3% respectively, and an average height of 0.5 m and 0.3 m respectively. Rebelo *et al.* (1991) emphasized the conspicuous high cover of proteoids and restioids in this type of vegetation.

Similar communities were described from the Riversdale Plain by Cowling *et al.* (1988) and Rebelo *et al.* (1991) as *Leucadendron meridianum*/*Protea obtusifolia* Mesic Proteoid Fynbos.

Five subcommunities could be distinguished. The diagnostic species groups of particularly subcommunities 3.2, 3.3 and 3.4 are rather weakly defined, though TWINSPAN delimited these subcommunities on the basis of total floristic composition, and the diagnostic species, though present with rather low constancy, are to a large extent restricted to the particular subcommunity.

3.1 *Amphithalea alba*–*Leucadendron meridianum* Tall Closed Limestone Fynbos Subcommunity

Species per relevé: 42.

Diagnostic species: the shrubs *Amphithalea alba*, *Leucospermum truncatum*, *Oedera capensis* and *Erica spectabilis* (Species Group I, Appendix 1).

Dominant plants: the shrubs *Leucadendron meridianum* and *Protea obtusifolia* (Species Group G) and the restios *Ischyrolepis eleocharis* and *Chondropetalum microcarpum* (Species Group N).

Prominent species: the shrubs *Helichrysum patulum* (Species Group G), *Metalasia calcicola* (Species Group H), *Phyllica ericoides* (Species Group M), *Disparago anomala* (Species Group M), *Rhus glauca* and *Euclea racemosa* (Species Group Q).

Structure: low, open ericoid-dominated fynbos shrubland, with scattered groups of tall, closed proteoid-dominated shrubs.

The subcommunity is situated near the corner of the northern and western border of the Reserve, adjacent to the marsh area. The subcommunity is also found at the northwestern inland border, as well as near the middle of the western border of the Reserve, at an altitude of 3–31 m, at a gradient of 0°–16°, on shallow-soil limestone plains and along the limestone hill summit.

Large irregularly shaped, white-grey rocks, smaller stones and pebbles cover 3–5% of the soil on the limestone hills, while pebbles are present on the limestone

plain. The limestone originated from the Waenhuiskrans Formation of the Bredasdorp Group. Soils are of the Brandvlei Form on the limestone plain and the Coega and Immerpan Forms on the limestone hills.

3.2 *Erica abietina*–*Leucadendron meridianum* Tall Closed Limestone Fynbos Subcommunity

Species per relevé: 34.

Diagnostic species: the shrubs *Erica abietina* var. *abietina*, *Heterolepis peduncularis* and *Stoebe cinerea* (Species Group J, Appendix 1).

Dominant plants: the shrubs *Leucadendron meridianum* and *Protea obtusifolia* (Species Group G) and the restioids *Ischyrolepis eleocharis* and *Chondropetalum microcarpum* (Species Group N).

Prominent species: the shrubs *Helichrysum patulum* (Species Group G), *Metalasia calcicola* (Species Group H), *Phyllica ericoides*, *Disparago anomala* (Species Group M), *Metalasia muricata* (Species Group N, Appendix 1), *Passerina paleacea* (Species Group P), *Rhus glauca* and *Euclea racemosa* (Species Group Q) and the restio *Thamnochortus insignis* (Species Group Q).

Structure: tall, closed, proteoid-dominated shrubland fynbos.

The subcommunity is found along the northern border of the Reserve, near the marsh area and at the northwestern border, as well as near the middle of the Reserve, at an altitude of 3–31 m, at a gradient of 0°–16°, on the summit of limestone hills, deep soils of the limestone plains and the deep sand on the footslopes of the limestone hills. Small, irregular, white-grey pebbles and stones on the limestone plains, and large, irregular, white-grey rocks, with some pebbles and stones, as well as sheets of rock on the limestone hills cover 0–65% of the soil. Soils are of the Immerpan Form on the limestone plains, the Immerpan and Coega Forms on the limestone hills, and the Namib Form in the sand area.

3.3 *Ehrharta calycina*–*Leucadendron meridianum* Low to Short Limestone Fynbos Subcommunity

Species per relevé: 33.

Diagnostic species: the shrub *Cassine peragua* and the grasses *Ehrharta calycina*, *Bromus diandrus* and *Eragrostis sarmentosa* (Species Group K, Appendix 1).

Dominant plants: the shrubs *Rhus glauca*, *Euclea racemosa* (Species Group Q) and *Passerina paleacea* (Species Group P), and the restio *Thamnochortus insignis* (Species Group Q).

Prominent species: the shrubs *Leucadendron meridianum*, *Protea obtusifolia* (Species Group G), *Helichrysum patulum* (Species Group G), *Metalasia muricata*, *Morella quercifolia* (Species Group N), *Otholobium bracteolatum* (Species Group P) and *Passerina galpinii* (Species Group Q) and the restios *Ischyrolepis eleocharis* and *Chondropetalum microcarpum* (Species Group N) and the grass *Stipagrostis zeyheri* subsp. *sericans* (Species Group M).

Structure: low to short, open ericoid-dominated fynbos shrubland, with groups of tall to high, closed proteoid-dominated shrubs; high and low restios are abundant.

The subcommunity occurs in patches from the middle section of the northern border to the central part of the Reserve; it also occurs in the centre of the whole of the study area, near the western and northern borders, at an altitude of 3–21 m, at a gradient of 0°–16° on the northern and northeastern midslopes and upper slopes of limestone hills and also on the sandy, deep-soil limestone plain. Irregular white-grey limestone pebbles, stones and small rocks and rock sheets cover 1–10 % of the soil on the limestone plain. Large, irregular, white-grey rocks, with pebbles, stones and rock sheets, cover up to 60% on the limestone hills. Soils are of the Immerpan Form on the limestone plain, and the Immerpan and Coega Forms on the limestone hills.

3.4 *Metalasia muricata*–*Leucadendron meridianum* Tall Closed Limestone Fynbos Subcommunity

Species per relevé: 13.

Diagnostic species: Species Group G and the absence of Species Groups H–L (Appendix 1).

Dominant plants: the shrub *Metalasia muricata* and the restio *Chondropetalum microcarpum* (Species Group N).

Prominent species: the shrubs *Leucadendron meridianum*, *Protea obtusifolia*, *Helichrysum patulum* (Species Group G) and *Passerina paleacea* (Species Group P).

Structure: tall, closed, proteoid-dominated shrubland.

The subcommunity is found in patches near the central part of the whole study area and in patches near the southeastern border of the Reserve, at an altitude of 1–14 m, at a gradient of 0°–8°, on the sandy summits of limestone hills, and on the deep-soil limestone plain and on dune troughs. Small, irregular, white-grey pebbles and stones cover 3% of the soil on the limestone hill, but no rocks occur on the limestone plain and in the dune troughs. Soils are of the Namib Form in the dune area, the Immerpan Form on the limestone plain, and the Immerpan and Coega Forms on the limestone hills.

The absence of the widespread species of Species Group M is a further diagnostic feature. An obvious explanation for the lack of diagnostic species is the very low species richness of this subcommunity. The species present in this subcommunity are from Species Group G (diagnostic species of the *Leucadendron meridianum*–*Protea obtusifolia* low to high Limestone Fynbos community), and other widespread species (Species Groups N, P and Q).

3.5 *Protea susannae*–*Leucadendron coniferum* High Closed Fynbos Subcommunity

Species per relevé: 24.

Diagnostic and dominant species: the trees *Protea susannae* and *Leucadendron coniferum* (Species Group L, Appendix 1).

Dominant plants: the trees *Protea susannae* and *Leucadendron coniferum* (Species Group L, Appendix 1).

Prominent species: the shrubs *Helichrysum patulum* (Species Group G) and *Passerina paleacea* (Species Group P) and the restios *Ischyrolepis eleocharis* and *Chondropetalum microcarpum* (Species Group N).

Structure: high, closed, proteoid-dominated shrubland.

The subcommunity is situated in patches along the northern border of the Reserve, adjacent to the marsh area, in the corner of the northern and inland northwest-

ern border and in patches near the centre of the whole study area, at an altitude of 3–25 m, at a gradient of 3°–8°, on the southern and southwestern deep sands on the footslopes of limestone hills and on the deep-soil limestone plain. There are no rocks in this subcommunity. Soils are of the Namib Form on the sand areas and the Immerpan Form on the deep-soil limestone plain.

A further characteristic feature of this subcommunity is the absence of the widespread species of Species Groups M and N.

Rebelo *et al.* (1991) also identified a community with *Protea sussanae* from the Riverdale Plain, while Cowling *et al.* (1988) described a *Protea sussanae*/*Leucadendron coniferum* Mesic Proteoid Fynbos from the Agulhas Plain.

4. *Oedera uniflora*–*Elytropappus rhinocerotis* Low Closed Renosterveld Community

Species per relevé: 25.

Diagnostic and dominant species: the shrubs *Elytropappus rhinocerotis*, *Oedera uniflora* and *Euchaetis meridionalis*, the grass *Andropogon appendiculatus* and the forbs *Berkheya coriacea* and *Tritonia deusta* (Species Group O, Appendix 1).

Prominent species: the shrubs *Passerina galpinii* and *Helichrysum teretifolium* (Species Group Q).

Structure: low, closed renosterveld shrubland.

The community is found in patches near the middle of the western border of the study area, as well as adjacent to the wetland area, at an altitude of 3–18 m, at a gradient of 0°–13°, on the northern and northwestern slopes of limestone hills, and on the Renosterveld plain. Small, irregular, white-grey pebbles and stones cover 1–10%.

The tree stratum has an average canopy cover of 6% and an average height of 2.5 m. The high shrub stratum has an average canopy cover of 6% and an average height of 1.5 m, while the medium shrub stratum has an average canopy cover of 7%, and an average height of 0.75 m and the low shrub stratum has an average canopy cover of 32% and an average height of 0.4 m. The high, medium and low restio strata have an average canopy cover of 2%, 0.6% and 4% respectively, and an average height of 1.5 m, 0.75 m, and 0.20 m respectively. The medium grass stratum has an average canopy cover of 17% and an average height of 0.6 m while the low grass stratum has an average canopy cover of 2% and an average height of 0.25 m. The sedges have an average canopy cover of 0.5% and an average height of 0.10 m. The forb stratum has an average canopy cover of 3% and an average height of 0.15 m.

The absence of widespread Limestone Fynbos species listed in Species Groups M, N and P (Appendix 1) is a feature of this Renosterveld community. This community is considered to be rare and threatened by encroachment from alien *Acacia* species (Zietsman & Bredenkamp 2006). A similar community was recognized by Cowling *et al.* (1988) from the Agulhas Plain west of the study area and Rebelo *et al.* (1991) from the Riversdale Plain, east of the study area.

DISCUSSION

A large variety of plant species grouped into various plant communities occur on the Reserve. This study indicated that a total floristic approach can be successfully applied in the species-rich Limestone Fynbos communities. It is also shown that floristically derived plant communities can be mapped at the scale of nature reserves, and that this can be applied in conservation management plans. It is, however, recognized that a total floristic approach for regional studies remains difficult within the Limestone Fynbos area (Van der Merwe 1977; Cowling *et al.* 1988; Rebelo *et al.* 1991). The use of TWINSpan and the application of Braun-Blanquet procedures for refinement were successful to delimit the communities and classify them in a hierarchical system. Four plant communities, with nine subcommunities, were identified. The plant communities could all be related to specific environmental conditions and are therefore floristically and ecologically distinguishable and interpretable. These plant communities are interpreted as separate ecosystems (Bredenkamp & Brown 2001), they therefore represent different management units, and can be incorporated in a veld management program.

The communities are well defined by diagnostic species, though diagnostic species for the subcommunities often have low constancy values. However, these subcommunities are retained because they were delimited by TWINSpan, based on total floristic composition, and the diagnostic species are largely restricted to the particular subcommunities.

CONSERVATION

All the plant communities of the inland plains and hills are considered to have a high conservation value. Community 1, the *Phragmites australis*–*Juncus kraussii* tall to high closed Reed Wetland is a sensitive wetland system that could easily be disturbed and should therefore be protected (Doust & Doust 1995; Van Wyk *et al.* 2000). The conservation of wetlands is furthermore enforced by law (Environment Conservation Act, 1989: Act No. 73 of 1989 and National Water Act, 1998: Act No. 36 of 1998).

Among the terrestrial plant communities identified in the study area, nine species encountered are listed in the *Red Data List of southern African plants* (Hilton-Taylor 1996) and a further four are listed in the later *Southern African plant Red Data List* (Golding 2002), giving a total of 13 Red Data plant species. Furthermore, 23 limestone endemic species were present. From a PRECIS list (SANBI 2006), 38 from 238 species collected from the 3420CC grid, were Red Data species. The Agulhas plain, on which the study area is situated, is considered, from a botanical viewpoint, as an area of high irreplaceability and high vulnerability, being rich coastal lowland with remnant patches of coastal renosterveld and lowland fynbos, which are considered among the highest priorities for conservation in South Africa and globally (Schwegler 2003).

Heydenrych (1994) listed 110 plant species endemic to limestone outcrops. The Agulhas Plain Centre, one

of the six phytogeographic centres of the Cape flora, contains a total of 1 374 species (Goldblatt & Manning 2000). Of the 285 species recorded during the plant surveys in the Reserve, 138 species are endemic to the Cape, giving a figure of 48% endemism for the study area.

It can clearly be seen that the study area is one of exceptional species richness and conservation importance. Communities 2, 3 (Limestone Fynbos) and 4 (Renosterveld) should be protected due to the endemic and Red Data plant species present. Furthermore, large areas of renosterveld have been destroyed, mainly because of agricultural land clearing (Low & Rebelo 1998).

CONCLUSIONS

Andrew's Field and Tsaba-Tsaba Nature Reserve are of great conservation significance. This area comprises an important part of a unique natural floral heritage found at the southern tip of Africa, with several endemic and Red Data species, and it should be protected and conserved to maintain its biodiversity for future generations.

The resulting classification could provide a useful tool, not only for the management of the plant communities of Andrew's Field and Tsaba-Tsaba Nature Reserve, but also for similar vegetation areas, e.g. the Agulhas National Park, found in the surrounding region.

ACKNOWLEDGEMENT

Mrs F. Siebert is thanked for her assistance during data processing.

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APPENDIX 1.—Phytosociological table of inland plains and hills of Andrew's Field and Tsaba-Tsaba Nature Reserve (cont.)

[illegible]

Miscellaneous notes

AMARYLLIDACEAE

CHROMOSOME STUDIES ON AFRICAN PLANTS. 20. KARYOTYPES OF SOME *CYRTANTHUS* SPECIES

INTRODUCTION

The genus *Cyrtanthus* Aiton (Amaryllidaceae) is endemic to sub-Saharan Africa. The centre of distribution is the southeastern Cape with smaller centres in other parts of the Western and Eastern Cape, Gauteng, Mpumalanga and KwaZulu-Natal Provinces (Du Plessis & Duncan 1989; Meerow & Snijman 1998; Snijman & Archer 2003). *Cyrtanthus* is the largest amaryllid genus in southern Africa and currently consists of 56 species, one subspecies and seven varieties (Snijman & Archer 2003, 2006).

There are two major trends characterizing amaryllidaceous karyotype evolution (Meerow 1995). Certain gen-

era, e.g., *Crinum* L. and *Hippeastrum* Herb., show great karyotypic stability, with a low frequency of polyploidy. Similar chromosome morphology among the species of these genera is characteristic. Their polyploids have a tendency to be autopolyploid in origin. A genus may also exhibit great variation in both chromosome number and morphology, e.g. *Hymenocallis* Salisb. and *Lycoris* Herb. Both allopolyploidy and Robertsonian changes have been implicated as important factors in speciation in such genera.

Chromosomes in *Cyrtanthus* are large, as in the rest of the Amaryllidaceae (Wilsenach 1963). The genus has base numbers of $x = 6, 8$ and 11 (Meerow 1995). Most *Cyrtanthus* species studied (Figures 1, 2) have a somatic

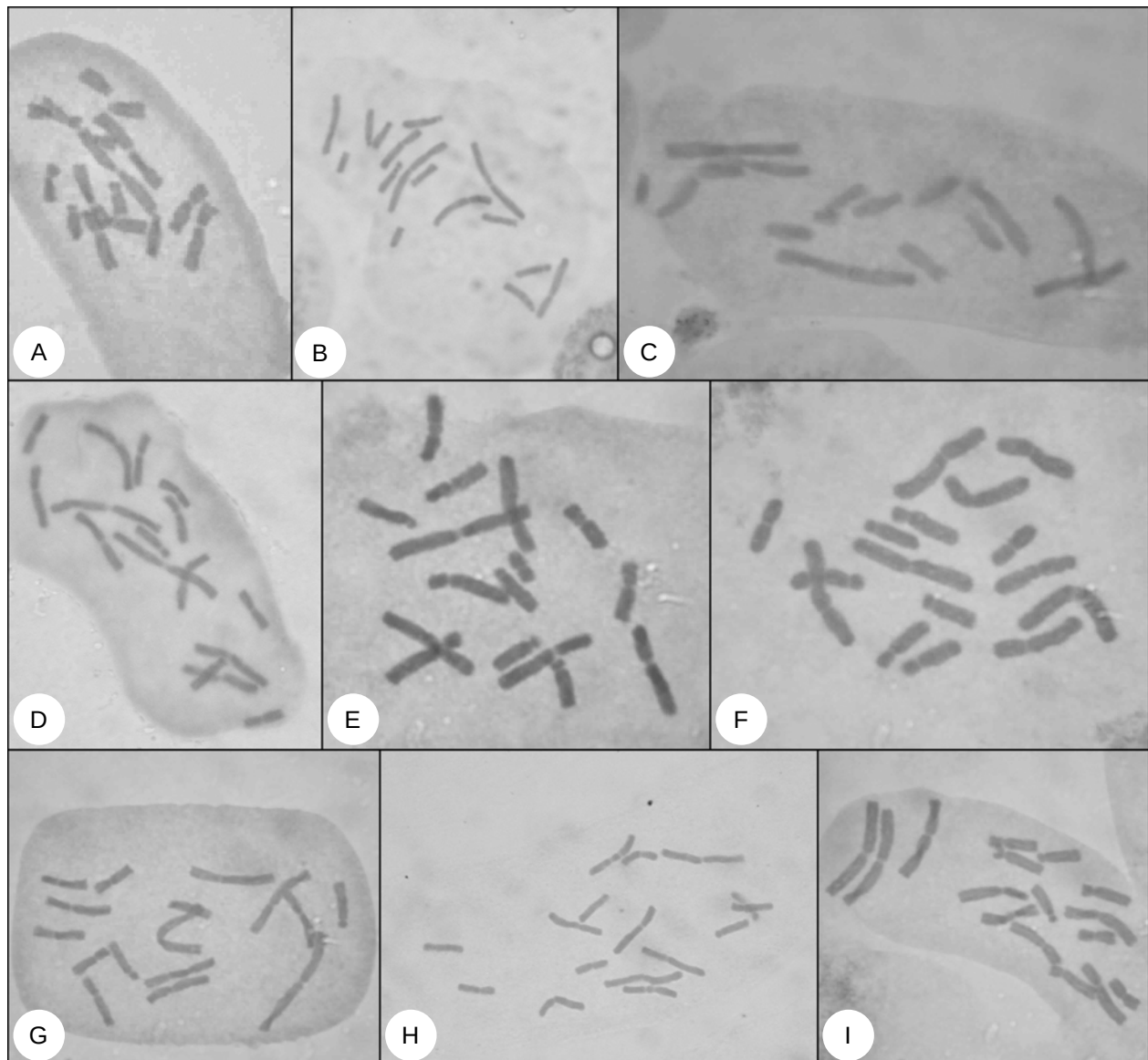


FIGURE 1.—Mitotic chromosomes in various *Cyrtanthus* species with $2n = 16$. A, *C. bicolor*, Spies 7185; B, *C. brachyscyphus*, Spies 7186; C, *C. breviflorus*, Spies 7189; D, *C. elatus*, Spies 7193; E, *C. epiphyticus*, Spies 7200; F, *C. eucallus*, Spies 7262; G, *C. falcatus*, Spies 7208; H, *C. herrei*, Spies 7267; I, *C. loddigesianus*, Spies 7203.

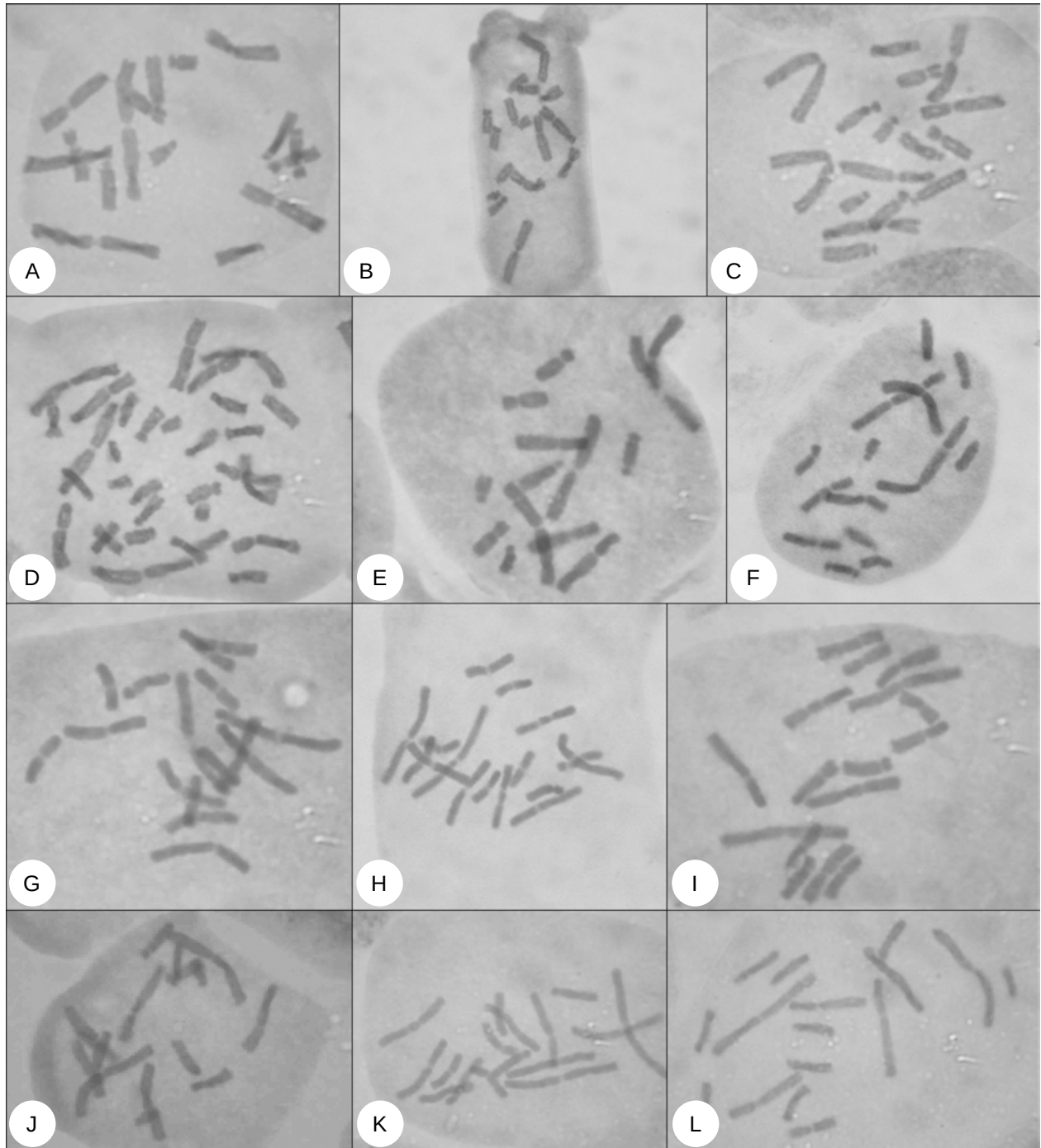


FIGURE 2.—Mitotic chromosomes in various *Cyrtanthus* species. A, *C. mackenii* var. *cooperi*, Spies 7211; B, C, *C. mackenii* var. *mackenii* (diploid); D, tetraploid, Spies 7268, 7274, 7370; E, F, *C. macowanii*, Spies 7201; G, H, *C. montanus*, Spies 7275; I, *C. obliquus*, Spies 7276; J, *C. obrienii*, Spies 7376; K, *C. sanguineus*, Spies 7216; L, *C. tuckii* var. *viridilobus*, Spies 7377.

chromosome number of $2n = 16$ (Taylor 1925; Gouws 1949; Tjio & Levan 1950; Flory 1955; Ising 1962, 1966, 1970; Wilsenach 1963; Bose 1965; Nandi 1973; Venkateswarlu & Lakshmi 1976; Lakshmi 1980) or $2n = 32$ (Ising 1966), but $2n = 14$ and 22 were recorded by Bose (1965) and Satô (1938, 1942), respectively for *C. obliquus*, and Mookerjee (1955) and Bose (1965) recorded $2n = 18$ for *C. sanguineus*. Variations in karyotypes have been described (Wilsenach 1963; Ising 1966).

The aim of this study was to determine the chromosome numbers of more species and to compare their karyotypes.

MATERIALS AND METHODS

Bulbs were collected in the field and grown in greenhouses at ARC-Roodeplaat, Pretoria. Herbarium specimens are stored in the Geo Potts Herbarium (BLFU), Bloemfontein (Appendix 1).

Root tips were collected between 08:00 and 10:00 in glass bottles filled with tap water (4°C) and refrigerated for 24 hours. Subsequent to the cold pre-treatment, the water was replaced with Pienaar's fixative (Pienaar 1955). The root tips were macerated in 1N HCl for 7 minutes at 60°C and stained with 2% propionic-carmin,

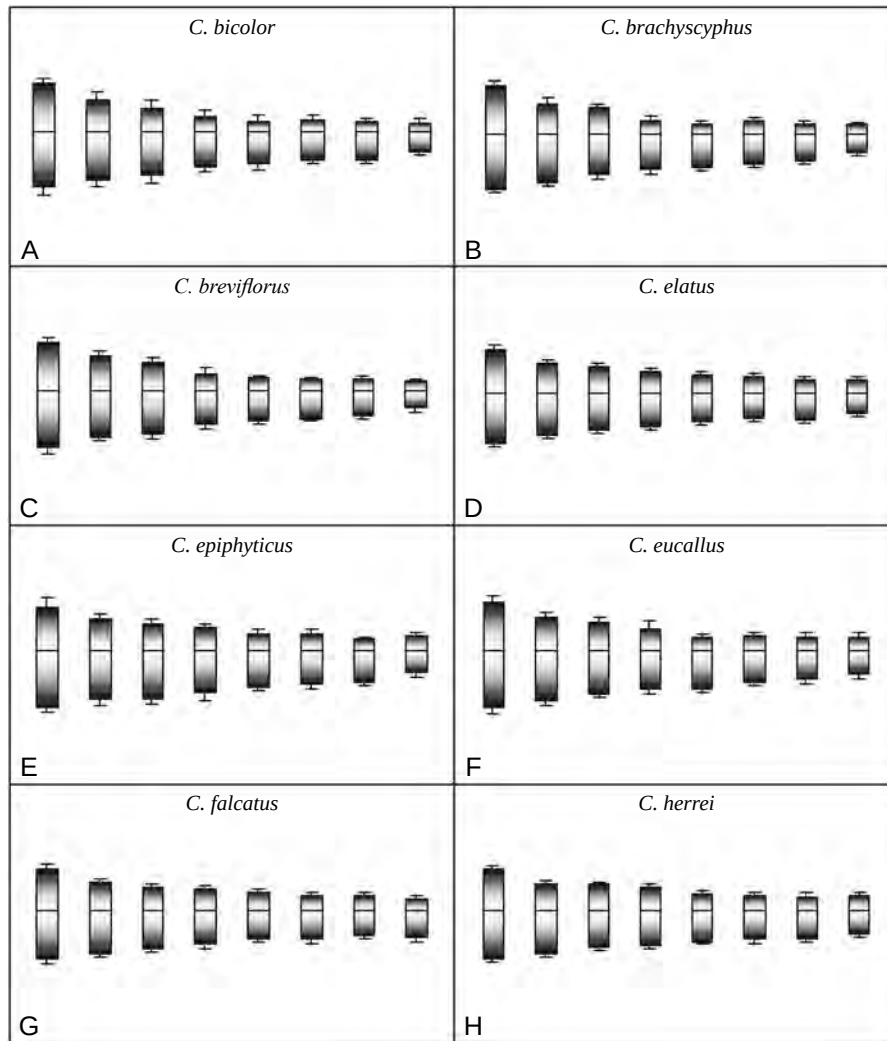


FIGURE 3.—Ideograms of some *Cyrtanthus* species. A, *C. bicolor*; B, *C. brachyscyphus*; C, *C. breviflorus*; D, *C. elatus*; E, *C. epiphyticus*; F, *C. eucallus*; G, *C. falcatus*; H, *C. herrei*.

to which a trace of ferric-acetate was added. Permanent slides were analysed under a Nikon Microphot FXA microscope, chromosome counts were made and cells with well-spread chromosomes were photographed with a Cool Pix digital camera.

All chromosomes in a minimum of 20 well-spread metaphase cells were measured to determine the karyotypes. The following parameters were used for each metaphase plate: 1, chromosome length of each individual chromosome (CL); 2, length of the short arm (p); 3, total chromosome length (TCL); 4, relative chromosome length (CL_x/TCL); 5, relative short arm length (p_x/TCL). The arithmetic averages of the relative chromosome lengths and relative short arm lengths were used to draw the ideograms and to indicate the standard deviation from the mean for each chromosome pair.

RESULTS AND DISCUSSION

Sixty-two specimens, representing 19 species were studied. A somatic chromosome number of $2n = 2x = 16$ was observed in all specimens (Figures 1, 2), except two *C. mackenii* var. *mackenii* specimens, Spies 7274 (Figure 2D) and 7372, which were both tetraploid with $2n = 4x = 32$ (Appendix 1). This is the first report on

a natural occurring tetraploid in *C. mackenii* and these somatic chromosome numbers indicate a basic chromosome number of $x = 8$ (Figures 1, 2).

Reported chromosome numbers for *Cyrtanthus* indicate $2n = 22$ as the previous highest somatic chromosome number (Satô 1938, 1942). This report further supports the chromosome numbers observed by Taylor (1925), Gouws (1949), Tjio & Levan (1950), Flory (1955), Ising (1962, 1966, 1970), Wilsenach (1963), Bose (1965), Nandi (1973), Venkateswarlu & Lakshmi (1976) and Laksmi (1980). The apparent different basic chromosome numbers described in the literature, such as $x = 6$ and 11 in *Cyrtanthus*, are most probably the results of incorrect identifications or incorrect interpretation of metaphase plates. In the Satô report (1938), the material was embedded in paraffin and cut in cross sections. This method does not enable researchers to examine single layers of large cells in their totality and thus may result in miscounts of chromosomes (Darling & La Cour 1942). No vouchers were cited in this report and therefore they cannot be consulted for accuracy of chromosome accounts. The Bose report (1965) is also a miscount, given ample evidence from recent counts that *C. sanguineus* has $2n = 16$. Ising (1970) already commented on this issue, concluding that the secondary constrictions occurring sometimes, could also be a reason

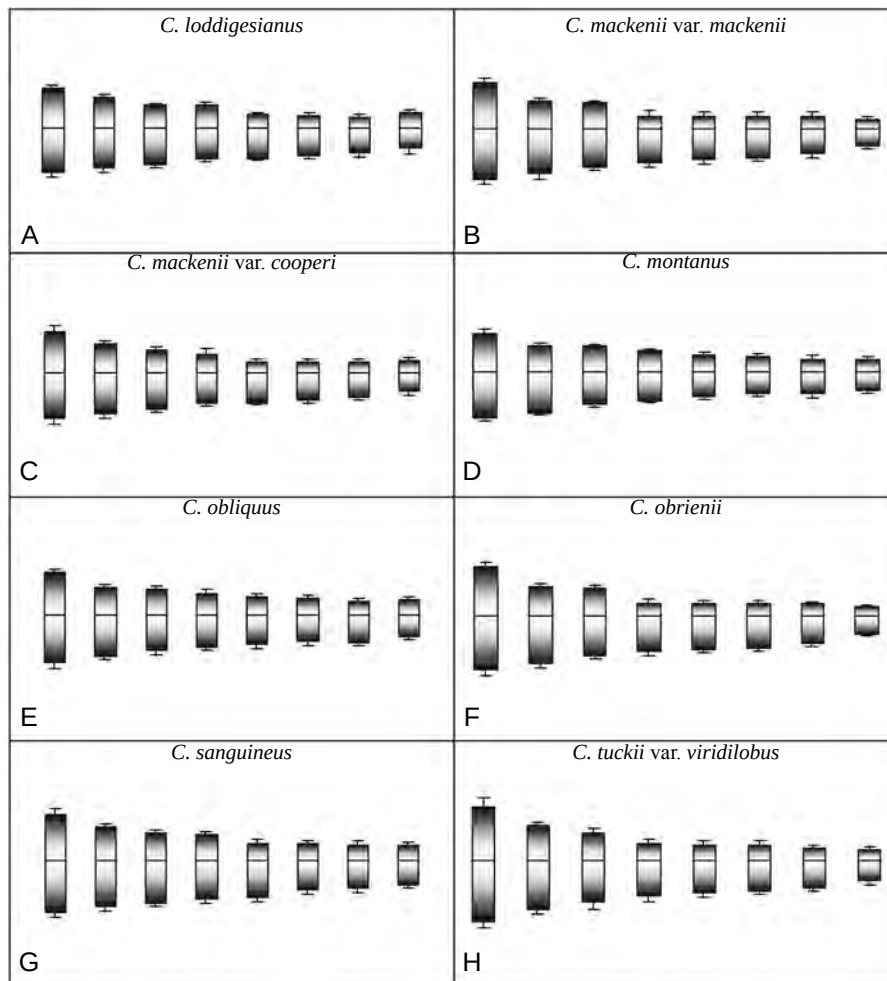


FIGURE 4.—Ideograms of some *Cyrtanthus* species. A, *C. loddigesianus*; B, *C. mackenii* var. *mackenii*; C, *C. mackenii* var. *cooperi*; D, *C. montanus*; E, *C. obliquus*; F, *C. obrienii*; G, *C. sanguineus*; H, *C. tuckii* var. *viridilobus*.

for incorrect counts. The real base number is $x = 8$, as supported by this study. In this study, the somatic chromosome number of $2n = 32$ indicates a doubling of the somatic chromosome number of $2n = 16$.

Previous studies indicated that ideograms vary among the different *Cyrtanthus* species and may be used in the identification of certain species (Ising 1970). This variability is not supported by this study. Chromosome contraction varies greatly between different chromosomes and in a single root tip, different ideograms can be obtained from different cells, varying slightly depending upon the time the cell entered mitosis. The ideograms of 16 diploid taxa are shown in Figures 3 and 4. Each taxon has eight meta- to submetacentric chromosomes, arranged in the ideograms from the longest to the shortest. There is a significant difference in length between the longest and shortest chromosomes in each of these taxa. However, when a large number of metaphase cells are measured, and the average length of a chromosome pair in all cells are used, the variation in ideograms is minimal and cannot be used for identification purposes.

This study clearly indicated that *Cyrtanthus* has a chromosome complement of $2n = 2x = 16$. Although ideograms provided additional information, they proved to be relatively unreliable for identification purposes.

ACKNOWLEDGEMENTS

The University of the Free State and the Roodeplaat Vegetable and Ornamental Plant Institute of the Agricultural Research Council are thanked for financial assistance during this study. The latter Institute and Johan Wentzel are also thanked for collecting and providing the bulbs used in this study.

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MS. received: 2006-05-29.

APPENDIX 1.—Specimens of *Cyrtanthus* taxa studied with their voucher numbers, localities or author and somatic chromosome numbers

Taxon	Voucher	Locality/author	2n	Figure
<i>C. angustifolius</i> (L.f.) Aiton		Flory 1955.	16	
<i>C. bicolor</i> R.A.Dyer	Spies 7185	Locality unknown, grown from seeds.	16	1A; 3A
<i>C. brachyscyphus</i> Baker (= <i>C. parviflorus</i> Baker)	Spies 7186	KWAZULU-NATAL.—2930 (Pietermaritzburg): near Durban, (–DD).	16	1B; 3B
	Spies 7187, 7204, 7272	Localities unknown, grown from seeds.	16	
		Taylor 1925; Ising 1962, 1966, 1970; Wilsenach 1963.	16	
<i>C. breviflorus</i> Harv. (= <i>Anoiganthus breviflorus</i> (Harv.) Baker.; <i>A. luteus</i> (Baker) Baker; <i>C. luteus</i> Baker)	Spies 7188	GAUTENG.—2528 (Pretoria): near Bronkhorstspuit, (–DC).	16	
	Spies 7189	MPUMALANGA.—2529(Witbank): near Witbank, (–CC).	16	1C; 3C
	Spies 7278, 7366	Localities unknown, grown from seeds.	16	
		Ising 1970.	16	
		Ising 1970.	32	
<i>C. carneus</i> Lindl.		Wilsenach 1963.	16	
<i>C. clavatus</i> (L'Hér.) R.A.Dyer		Ising 1970.	16	
<i>C. contractus</i> N.E.Br.	Spies 7190	MPUMALANGA.—2730 (Vryheid): on Farm Bergplaas, Piet Retief District, (–BB).	16	
		Wilsenach 1963; Ising 1970.	16	
<i>C. elatus</i> (Jacq.) Traub (= <i>Valotta speciosa</i> T.Durand & Schinz)	Spies 7194	MPUMALANGA.—2530 (Lydenburg): near Nelspruit, (–BD).	16	
	Spies 7193	WESTERN CAPE.—3322 (Oudtshoorn): near Ruitersbos, (–CC).	16	1D; 3D
	Spies 7197	WESTERN CAPE.—3421 (Riversdale): near Stilbaai, (–AD).	16	
	Spies 7192, 7195, 7202	WESTERN CAPE.—3322 (Oudtshoorn): near George, (–CD).	16	
	Spies 7196, 7198, 7367	Localities unknown, grown from seeds.	16	
		Ising 1970.	16	
<i>C. epiphyticus</i> J.M.Wood	Spies 7200	EASTERN CAPE.—3128 (Umtata): near Maclear, (–AB).	16	1E; 3E
	Spies 7368	Locality unknown, grown from seeds.	16	
		Ising 1970.	16	
<i>C. erubescens</i> Killick		Wilsenach 1963; Ising 1970.	16	
<i>C. eucallus</i> R.A.Dyer	Spies 7218	MPUMALANGA.—2530 (Lydenburg): near Nelspruit, (–BD).	16	
	Spies 7262	Locality unknown, grown from seeds.	16	1F; 3F
		Ising 1970.	16	
<i>C. falcatus</i> R.A.Dyer	Spies 7208, 7263, 7264	Localities unknown, grown from seeds.	16	1G; 3G
		Flory 1955; Ising 1962; Wilsenach 1963.	16	
<i>C. flanaganii</i> Baker		Ising 1970.	16	
<i>C. galpinii</i> Baker	Spies 7265	KWAZULU-NATAL.—2731 (Louwsburg): near Pongola, (–BC).	16	
		Wilsenach 1963.	16	
<i>C. helictus</i> Lehm.		Wilsenach 1963.	16	
<i>C. herrei</i> (F.M.Leight.) R.A.Dyer (= <i>Cryptostephanus herrei</i> F.M.Leight.)	Spies 7194, 7267	Localities unknown, grown from seeds.	16	1H; 3H
		Wilsenach 1963; Ising 1970.	16	

APPENDIX 1.—Specimens of *Cyrtanthus* taxa studied with their voucher numbers, localities or author and somatic chromosome numbers (cont.)

Taxon	Voucher	Locality/author	2n	Figure
<i>C. huttonii</i> Baker		Wilsenach 1963; Ising 1970.	16	
<i>C. loddigesianus</i> (Herb.) R.A.Dyer (= <i>C. affinis</i> R.A.Dyer)	<i>Spies 7203</i>	EASTERN CAPE.—3325 (Port Elizabeth): near Port Elizabeth, (–DC).	16	11; 4A
<i>C. mackenii</i> Hook.f. var. <i>cooperi</i> (Baker) R.A.Dyer	<i>Spies 7273</i>	KWAZULU-NATAL.—2930 (Pietermaritzburg): near Durban, (–DD).	16	
	<i>Spies 7211, 7373</i>	Localities unknown, grown from seeds.	16	2A; 4C
		Ising 1966.	16	
<i>C. mackenii</i> Hook.f. var. <i>mackenii</i>	<i>Spies 7270</i>	NAMIBIA.—1917 (Tsumeb): near Otavi, (–CB).	16	
	<i>Spies 7269</i>	KWAZULU-NATAL.—2930 (Pietermaritzburg): near Durban, (–DD).	16	
	<i>Spies 7268, 7271, 7272, 7369, 7370, 7371, 7374</i>	Localities unknown, grown from seeds.	16	2B, C; 4B
		Flory 1955; Ising 1962, 1966; Wilsenach 1963; Bose 1965; Nandi 1973; Venkateswarlu & Lakshmi 1976; Lakshmi 1980.	16	
	<i>Spies 7274, 7372</i>	Localities unknown, grown from seeds.	32	2D
<i>C. macowanii</i> Baker	<i>Spies 7201</i>	MPUMALANGA.—2530 (Lydenburg): near Nelspruit, (–BD).	16	2E, F
<i>C. montanus</i> R.A.Dyer	<i>Spies 7209, 7275, 7375</i>	Localities unknown, grown from seeds.	16	2G, H; 4D
<i>C. obliquus</i> (L.f.) Aiton	<i>Spies 7276, 7277, 7278</i>	Localities unknown, grown from seeds.	16	2I; 4E
		Bose 1965.	14	
		Ising 1962; Wilsenach 1963.	16	
		Satō 1938, 1942.	22	
<i>C. obrienii</i> Baker	<i>Spies 7193, 7215, 7279, 7376</i>	Localities unknown, grown from seeds.	16	2J; 4F
		Flory 1955; Ising 1970.	16	
<i>C. ochroleucus</i> (Herb.) Burch. ex Steud. (= <i>C. lutescens</i> Herb.)		Tjio & Levan 1950; Flory 1955; Ising 1962; Wilsenach 1963.	16	
<i>C. rotundilobus</i> N.E.Br.		Ising 1970.	16	
<i>C. sanguineus</i> (Lindl.) Walp.	<i>Spies 7281</i>	KWAZULU-NATAL.—2930 (Pietermaritzburg): near Durban, (–DD).	16	
	<i>Spies 7216, 7280, 7282</i>	Localities unknown, grown from seeds.	16	2K; 4G
		Flory 1955; Ising 1962; Wilsenach 1963; Bose 1965; Nandi 1973.	16	
		Mookerjee 1955; Bose 1965.	18	
<i>C. smithiae</i> Watt ex Harv.		Wilsenach 1963.	16	
<i>C. staadensis</i> Schönland		Ising 1970.	16	
<i>C. stenanthus</i> Baker		Ising 1970.	16	
<i>C. stenanthus</i> Baker var. <i>stenanthus</i>	<i>Spies 7283</i>	Locality unknown, grown from seeds.	16	
<i>C. thorncroftii</i> C.H.Wright		Wilsenach 1963.	16	
<i>C. tuckii</i> Baker var. <i>transvaalensis</i> I.Verd.		Gouws 1949.	16	
<i>C. tuckii</i> Baker var. <i>tuckii</i>		Ising 1970.	16	
<i>C. tuckii</i> Baker var. <i>viridilobus</i> I.Verd.	<i>Spies 7377</i>	Locality unknown, grown from seeds.	16	2L; 4H

The handling of the proposal to conserve the name *Acacia* at the 17th International Botanical Congress—an attempt at minority rule

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Keywords: *Acacia*, conservation, International Botanical Congress, International Code of Botanical Nomenclature, nomenclature, Nomenclature Section, *Racosperma* C.Mart., *Senegalia* Raf., *Vachellia* W.F.Wight & Arn.

ABSTRACT

The handling of controversial Proposal 1584 to conserve the name *Acacia* with a conserved type for the Australian acacias during the Nomenclature Section meeting at the 17th International Botanical Congress (Vienna) in 2005 is reviewed. Through a simple majority vote, this Section adopted rules requiring a 60% majority of votes to approve any proposal to modify the International Code of Botanical Nomenclature and a simple majority to approve all other motions; motions not receiving the required majority were to be rejected. However, for the motion addressing Proposal 1584, 45.1% voted to conserve the type of the name *Acacia* for Australian acacias, and 54.9% voted to retain the current African type for the name *Acacia*. Even though this motion failed to get a 60% majority either way as required by the Section's own rules, Section officials have concluded that the name *Acacia* is to be conserved for Australian acacias. Treating a motion as approved, even though it received only minority support, also violates the fundamental principle of standard parliamentary procedure—the right of the majority to approve proposals. For *Acacia* to be formally conserved, the Nomenclature Section needed to approve a motion addressing Proposal 1584 with a majority vote, and this never happened in Vienna. Recommendations are made on how this process might be improved.

Introduction

The Nomenclature Section of the 17th International Botanical Congress met during July of 2005. Division III, Provision 1 of the International Code of Botanical Nomenclature (Code) states that the Code 'may be modified only by action of a plenary session of an International Botanical Congress on a resolution moved by the Nomenclature Section of that Congress' (McNeill *et al.* 2006: 117). The Section at Vienna acted on numerous proposals to amend the Code, including proposals to conserve and reject names, and the decisions made by the Section have been incorporated into the latest printed version of the Code (McNeill *et al.* 2006).

One of the proposals that the Section addressed was Proposal 1584 (Orchard & Maslin 2003) to conserve the name *Acacia* Mill. with a conserved type. This proposal was made so as to maintain the name *Acacia* for the bulk of Australian species that would otherwise have to go by the name *Racosperma* C.Mart. under a pending new taxonomy (Pedley 2003).

Unlike proposals to amend the rules of the Code, proposals to conserve or reject names are usually first reviewed by two committees, the relevant nomenclature committee (Committee for Spermatophyta in the case of Proposal 1584) and the General Committee, before a decision is taken by the Nomenclature Section (Articles 14.12, 56.2 in McNeill *et al.* 2006: 31, 99). Proposal 1584 was met with strong resistance but did receive positive recommendations from the Committee for Spermatophyta and General Committee, although the vote was divided in both committees. This set the stage for action on Proposal 1584 by the Nomenclature Section and Congress. At the Nomenclature Section meeting, when the motion dealing with Proposal 1584 was put up for a vote, Section officials required that 60%

of the votes cast on this matter be opposed to Proposal 1584 in order for that proposal to be rejected. The vote on this motion received only 45.1% to conserve the name *Acacia* for Australian acacias.

Despite the minority support of 45.1% for Proposal 1584 by the Nomenclature Section, Section officials treat Proposal 1584 as having been approved, leading Rijkcevorsel (2006) to ask, 'Is it possible that the Nomenclature Section made a decision to modify the Code, i.e. to include the name *Acacia* with a conserved type by voting 54.9% against?' In order to address Rijkcevorsel's question, a detailed examination of the history of the process of the conservation and rejection of names is provided. A review is also provided on what occurred at the Nomenclature Section meeting in Vienna. Given that the Section at Vienna, through voting, adopted rules of procedure that required a 60% majority vote for any motion to pass, an answer of 'no' is given to Rijkcevorsel's query.

Review of procedure for conservation of names

Prior to the Paris Congress of 1954, proposals to conserve names, like proposals to amend the rules of the International Code of Botanical Nomenclature, were presented directly to the Nomenclature Section. For example, at the Stockholm Congress of 1950, over 39 sets of 250+ individual proposals to conserve names of families or genera were made by over two dozen botanists (Lanjouw 1950). This led Acting Rapporteur Lanjouw (1950: 221) to note that all these proposals could not be individually dealt with at the Nomenclature Section meeting, and he recommended they be handled by various special (nomenclature) committees.

While there was general agreement by the Nomenclature Section with Lanjouw's suggestion, there was considerable discussion regarding what the relative authorities should be among the special (nomenclature) committees, General Committee and Nomenclature Sec-

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MS. received: 2006-10-07.

tion. A relevant portion of this discussion is given below (Lanjouw 1953: 538, 539):

'DR ROGERS asked what was the power of the Special Committee[s] with regard to *nomina conservanda proposita*.
 PROF. MERRILL said they had power to conserve.
 PROF. LANJOUW thought they would refer to the General Committee.
 DR SPRAGUE said in the last Congress these committees had been given power and they had worked in some cases exceedingly well, especially where the committee had an energetic secretary. He suggested power be given to the committee and then it should secure the sanction of the General Committee for conservation.
 PROF. BAEHNI asked how we were to know what names were conserved.
 PROF. LANJOUW asked if he meant between Congresses.
 PROF. BAEHNI: Yes.
 PROF. LANJOUW: By means of our new association [International Association for Plant Taxonomy] we will publish new lists as soon as they are available.
 DR BLAKE inquired whether the list of *nomina generica conservanda* would be published in a preliminary way so that the names would be subject to criticism before final adoption.
 DR RAMSBOTTOM replied that the names would be accepted informally in the interim, the list to be tentative until formally approved by the next Congress.
 DR ROGERS said he agreed to that.
 PROF. MERRILL put the motion before the meeting that *Committees have power to select names for conservation* but the list will be tentative until the next Congress. [Italics in original.]

This was *carried* by a large majority. [Italics in original.]

The current procedure for the conservation and rejection of names has remained largely unchanged since its establishment with the founding of the International Association for Plant Taxonomy in 1950 and the addition of Division III to the Code at the Paris Congress of 1954. The following overview is from Rickett & Smith (1958: 151; see also Figure 1):

'[C]onservation can be effected only by action of a plenary session of an International Botanical Congress, as specified in Division III, Provision I of the Code....
 (1) the author sends his proposal to the rapporteur, and it is published in *Taxon*;
 (2) by this publication the proposal is brought to the attention of the General Committee;
 (3) the proposal, with advance agreement by the General Committee, is automatically referred to the appropriate study committee;
 (4) after study of the case, this special [nomenclature] committee publishes its report in *Taxon*;
 (5) the General Committee studies this report and any collateral information sent to it, reaches a decision on each proposal by mail ballot, and prepares a recommendation for the next International Congress;
 (6) the next Congress at a plenary session affirms or rejects the recommendation of the General Committee;
 (7) the *nomen conservandum propositum*, if all decisions up to this point are affirmative, is listed in the next edition of the Code and becomes a part of that document.'

My only quibble with Rickett & Smith's overview is that (6) actually involves two steps: first the Nomenclature Section approves or rejects the proposal to conserve or reject, taking into consideration the committees' recommendations, and then a plenary session ratifies (or not) the Nomenclature Section's decision. To summarize, the committees recommend, the Nomenclature Section decides and the International Botanical Congress, through a plenary session, ratifies. The new printed edition of the Code that incorporates the decisions taken by the previous Nomenclature Section is also subject to approval by the next Nomenclature Section (see Greuter *et al.* 2000: 15). Under the current Code (McNeill *et al.* 2006), besides the conservation of

names of families and genera, it is also possible to conserve the names of species and reject names at any rank.

Proposals to conserve or reject names are clearly proposals to amend the Code, since conserved or rejected names must appear in one of the Code's Appendices (II, III, IV, V); hence Rickett & Smith's (1958) citation of Division III, Provision I of the Code that governs the procedure for its modification. Stafleu & Lanjouw (1954: 8): 'Dr Lanjouw explained that at present the Appendices are parts of the Code and that some of them even contain rules'.

Currently, the nomenclature committees (Committees for Vascular Plants*, Bryophyta, Fungi, Algae, Fossil Plants) and the General Committee operate under a procedure whereby it takes a three-fifths (60%) majority to either recommend acceptance or rejection of a proposal (Nicolson 1996). Proposals that fail to receive a 60% vote either way remain unresolved. Previously, committees have operated under rules requiring a simple majority (Voss 1979: 179) or a two-thirds majority (Greuter *et al.* 1989: 215) to recommend acceptance of a proposal, and proposals that were not approved were automatically considered as rejected. Recently, proposals to conserve or reject names have not been included in the synopses of proposals prepared by the rapporteurs (Greuter & McNeill 1993; Greuter & Hawksworth 1999; McNeill & Turland 2005), although they were included in the past (Stafleu & Voss 1969; Voss & Greuter 1981; Greuter & McNeill 1987).

The Nomenclature Sections' voting majority required to approve proposals to amend the Code has varied from Congress to Congress, with a simple majority (Lanjouw 1953: 488, 489; 1959: 29), two-thirds majority (Stafleu 1954: 192) and three-fifths majority (Stafleu 1966: 8) being used. The Nomenclature Section at Seattle in 1969 required a 60% majority to approve proposals to amend the articles (rules) of the Code and a simple majority to approve proposals to amend other portions of the Code (Stafleu & Voss 1972: 4, 5). Nomenclature Sections since Leningrad in 1975 have required a 60% majority for all proposals to modify the Code; in the case of competing proposals, a vote of 60% has been required to authorize the change, and a simple majority to choose between the competing proposals (Voss 1979: 132; Greuter & Voss 1982: 9; Greuter *et al.* 1989: 14; 1994b: 12; 2000: 14, 15; McNeill *et al.* 2005: 1058).

Occasionally there has been debate at Nomenclature Sections regarding what type of majority vote (e.g. simple, three-fifths, two-thirds) was required to approve a proposal to amend the Code. During the Section meeting at Leningrad in 1975, Greuter moved for a 60% majority for proposals to amend the Code (Voss 1979: 132), but at Yokohama in 1993 (Greuter *et al.* 1994b: 12), he moved for a simple majority; Brummitt objected both times, in Leningrad (Voss 1979: 132) arguing for a simple majority, stating 'a 59% vs 41% vote would be frustrating', but in Tokyo (Greuter *et al.* 1994b: 12) defending the 60% majority, noting that the 60% requirement

*Prior to the Vienna Congress there was not a Committee for Vascular Plants but rather separate committees for Spermatophyta and Pteridophyta.

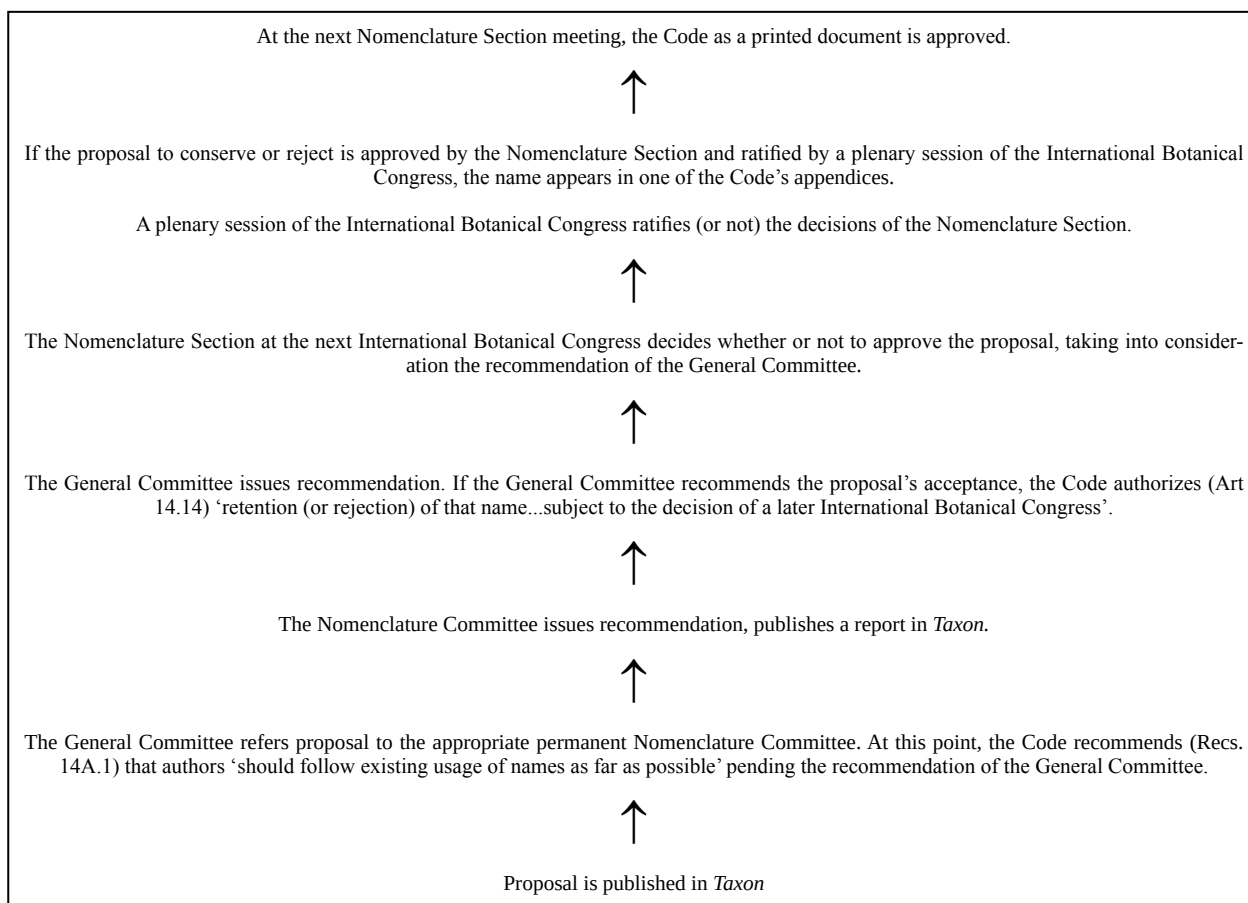


FIGURE 1.—Steps a proposal to conserve or reject a name must go through under the current procedure authorized by the International Code of Botanical Nomenclature (McNeill *et al.* 2006) and administered by the International Association for Plant Taxonomy.

'has always been applied in these sessions and that it had worked very well'.

The primary justification for the 60% requirement to approve any proposal to amend the Code is to ensure that changes to it are generally accepted (Greuter *et al.* 2000: 14). The 60% requirement is similar to the procedure in Robert *et al.* (2000), which recommends a two-thirds majority to amend existing rules. Sturgis (2001: 132), however, suggests that requiring greater (e.g. three-fifths, two-thirds) than a simple majority is unwise because of the 'power it gives to a minority' to reject proposals thereby overriding 'the majority's wishes.' Neither Robert *et al.* (2000) nor Sturgis (2001) permits the approval of a motion when it receives a minority vote.

Actions on proposals to conserve or reject names by Nomenclature Sections: Paris Congress (1954)—St Louis Congress (1999)

Since the establishment of the current nomenclature committee structure in 1950, proposals to conserve or reject names have always been subject to the approval of the Nomenclature Section. At earlier Nomenclature Section meetings, proposals to conserve names were presented as proposals to amend the relevant appendices in the Code where the entries would appear if approved (Rousseau *et al.* 1960: 30–33; Stafleu 1966: 61–65; Voss 1979: 173) or as a batch of *nomina conservanda proposita* (Stafleu & Voss 1972: 125). At the Section meeting

at Sydney in 1981, proposals to conserve or reject were addressed when the General Committee reported; two votes were taken, one accepting the General Committee report and a second 'to accept the proposals to conserve and reject names as approved by the General Committee' (Greuter & Voss 1982: 105). At the Nomenclature Section meetings at Berlin in 1987, Yokohama in 1993 and St Louis in 1999, a single vote was taken approving the General Report and the proposals to conserve and reject as recommended by the General Committee (Greuter *et al.* 1989: 215; 1994b: 252, 253; 2000: 237, 238).

The changes in how proposals to conserve or reject names have been presented to Nomenclature Sections (i.e. proposals to amend appendices, *nomina conservanda proposita*, General Committee reports) should not be taken as evidence that the Section's authority on this matter has declined, while that of the committees has expanded. The full authority given to the Nomenclature Section and the International Botanical Congress to modify the Code under Division III, Provision 1 has not changed since it was introduced with the Paris Code in 1956 (Lanjouw *et al.* 1956).

While there has always been considerable debate by Nomenclature Sections regarding proposals to amend the rules of the Code, there has seldom been discussion on the proposals to conserve or reject individual names (see Greuter *et al.* 1989: 215, 216 for an example involving the conservation of the name *Lycopersicon esculentum* Mill.), and these proposals have always been approved

by the Section. There has also never been any serious discussion of decisions taken by Nomenclature Section meetings during any of the plenary sessions responsible for ratifying the proposals passed at the Section meetings, although a question was raised at the plenary session at Vienna regarding the proposal to conserve the name *Acacia* with a conserved type. The plenary sessions have always ratified the decisions of the Nomenclature Sections through a single resolution.

Actions on proposals to conserve or reject names at Vienna (2005)

Orchard & Maslin (2003) proposed (Proposal 1584) to conserve the name *Acacia* Mill., replacing the name's current type, *A. scorpioides* (L.) W.F.Wight (= *A. nilotica* (L.) Delile), with *A. penninervis* Sieber ex DC. The aim of the proposal is to preserve the name *Acacia* for the vast majority of species known from Australia ($\pm 1\,000$ spp.) that would otherwise have to go by the name *Racosperma* C.Mart. under a proposed new classification (e.g. Pedley 2003). Under the new classification, and provided the proposal was accepted, the generic names of many African and American species traditionally in *Acacia* would change to *Vachellia* W.F.Wight & Arn., whereas other species would change to *Senegalia* Raf., regardless of the proposal's acceptance.

The proposal was reviewed by the Committee for Spermatophyta, with many submissions by both those in favour and those opposed, and it was approved by a 9-6 (60%) vote in early 2004 (Brummitt 2004). (For the sake of transparency, I mention that at the time I was a member of this committee and I voted to reject this proposal, although, working in a floristic region with no species of *Acacia*, I did not have a strong opinion on the case.) This proposal was strongly supported by the committee's Secretary, Richard Brummitt (Smith *et al.* 2006), who along with Tony Orchard, one of the authors of Proposal 1584, subsequently posted dozens of letters from Australian citizens in support of Proposal 1584 on several notice boards outside the lecture hall in Vienna where the Section meetings were taking place; correspondence submitted to the Committee for Spermatophyta from opponents of Proposal 1584, such as letters signed by twelve legume taxonomists and 24 African botanists, was not posted. Prior to the Vienna Congress there was much debate within the botanical community with articles for (Maslin 2004a, b; Maslin & Orchard 2004; Orchard & Maslin 2005) and against (Walker & Simpson 2003; Pedley 2004; Luckow *et al.* 2005) the proposal being published.

The General Committee had still not issued its recommendation on Proposal 1584 when the Nomenclature Section convened in July 2005, over one year after the Committee for Spermatophyta had made its recommendation. During the Section meeting, the General Committee finally voted to approve the recommendation of the Committee for Spermatophyta by a vote of 14-6-2 (63.6%; percentage figure assumes three positions on the General Committee were vacant or had been eliminated at the time of the vote, since the Nomenclature Section at St. Louis elected 25 members to serve; see Nicolson

1999). In the 1 July 2006 General Committee circular to members, the Secretary of the General Committee, Fred Barrie, concluded 'the best approach for the GC would be to approve this report, thus providing the foundation for the inevitable debate in Vienna'. This advice may have influenced committee members to cast a positive vote, even though debate on Proposal 1584 could have occurred at the Nomenclature Section meeting in Vienna regardless of the outcome of the General Committee's vote (Smith *et al.* 2006).

Action on the General Committee's recommendations occurred on the last day of the Nomenclature Section meeting (16 July). After the nomenclature committees' reports were received, the General Committee reported. Instead of a single report, the Section received two reports from the General Committee. The first covered all recommendations, except the one for Proposal 1584 to conserve the name *Acacia* with a conserved type. This first report, and therefore the recommendations regarding proposals to conserve or reject contained therein, was approved by a show of hands vote. The Nomenclature Section then received a second report from the General Committee that contained only one recommendation, that to approve Proposal 1584. Section officials stated that there would have to be a 60% vote in order to reject any recommendation made by the General Committee.

There is some confusion on the wording of the motion regarding the General Committee report on *Acacia*. The official report (McNeill *et al.* 2005: 1059) indicates that it was a vote on a motion from the floor to *reject* the report, whereas the unedited transcript (copy of the relevant portion provided by John McNeill) states that the vote was on a motion to *adopt* the report (and therefore the recommendation on Proposal 1584). Regardless of the wording of the motion, the Nomenclature Section, after a lengthy and reasoned debate, took a card vote with 203 (45.1%) in favour of adopting the General Committee's recommendation on Proposal 1584 and 247 (54.9%) voted for rejecting the recommendation. Therefore, the General Committee's recommendation on Proposal 1584 received only minority support from the Section.

Article 14.14—the justification for the procedure used for Proposal 1584 at Vienna

Article 14.14 of the Code is central to those who defend the procedure used at Vienna for Proposal 1584. The essential language of this article dates back to a proposal (Ramsbottom *et al.* 1929: 11; Hall 1926) to the 5th International Botanical Congress at Cambridge in 1930. Despite Rapporteur Briquet's (1930: 14) initial negative reaction to the proposal ['Le rapporteur éprouve un sentiment de malaise à voir consacrer par un article spécial (20bis) des Règles un régime de nomenclature provisoire.'], it was passed at the Cambridge Congress (Briquet 1931) and appeared in the Cambridge Code (Briquet 1935) as Article 22: 'When a name proposed for conservation has been provisionally approved by the Executive Committee [a precursor to the General Committee], botanists are authorized to retain it pending the decision of the next International Botanical Congress'.

Rickett & Smith's (1958) successful proposal to amend this language—deleting the word 'provisionally' and adding the phrase 'after study by the Committee for the taxonomic group concerned'—did not change its meaning but simply clarified that the rule did not take effect until after the General Committee approved the recommendation of the special [nomenclature] committee rather than when the proposal was first published in *Taxon*. Starting with the Sydney Code (Voss *et al.* 1983), language was added to cover the rejection of names, giving Article 14.14 its current language (McNeill *et al.* 2006: 31, 32): 'When a proposal for the conservation of a name, or its rejection under Article 56, has been approved by the General Committee after study by the Committee for the taxonomic group concerned, retention (or rejection) of that name is authorized subject to the decision of a later International Botanical Congress'.

Prior to the Tokyo Code (Greuter *et al.* 1994a), Article 14.14 was used as justification for provisionally listing in the Code, names recommended by the General Committee for conservation or rejection but not ratified by an International Botanical Congress, with a statement that such names were subject to a decision by a later Congress. In the Seattle (Stafleu *et al.* 1972), Leningrad (Stafleu *et al.* 1978), Sydney (Voss *et al.* 1983) and Berlin Codes (Greuter *et al.* 1988), names approved by the General Committee but not acted on by the Nomenclature Section or International Botanical Congress were asterisked, indicating 'conservation approved by the General Committee; use authorized under Article 15 [currently Article 14.14] pending final decision by the next Congress'. Earlier Codes (Lanjouw *et al.* 1956, 1966) also listed provisional entries that still required action by a later International Botanical Congress.

The justification for the 60% vote to reject the General Committee's recommendation to conserve the name *Acacia* Mill. with a conserved type was, that once the General Committee recommended the name *Acacia* for conservation, it had *de facto nomen conservandum* status under Article 14.14 (McNeill 2006; Stafleu 1964: 6). Therefore, opposition to the General Committee's recommendation was viewed as analogous to a proposal to amend the Code since the name *Acacia* could appear as a provisional entry in a future printed edition of the Code if no action were taken at a Congress (McNeill 2006).

Was the procedure used at Vienna appropriate?

The intent of Article 14.14 was not to give primary authority of conservation/rejection of names to the General Committee, as the previously cited discussion from the Nomenclature Section at Stockholm in 1950 (Lanjouw 1953: 538, 539) makes clear. The intent was simply to prevent the possible creation of 'superfluous names' (Ramsbottom *et al.* 1929: 38) by giving authors guidance during the interim period when a General Committee recommends a proposal for approval and action at the next Congress (there was a 20 year interval between the Cambridge Congress of 1930 and the preceding Brussels Congress in 1910 where the Ramsbottom *et al.* proposal was passed). For example,

if the General Committee recommended conservation of a name shortly after a Congress had adjourned, Article 14.14 would allow users to retain this name until the next Congress.

However, in the case of Proposal 1584, the interim period between the General Committee finalizing its recommendation and the vote of the Nomenclature Section was not years but a mere few days! The continent of Africa did not suddenly abandon the name *Acacia* and adopt the names *Vachellia* and *Senegalia* during those few days.

More importantly, such provisionally conserved names have *de facto* conserved status but not *de jure* conserved status. It is obvious that not everything in the printed book that goes by the name International Code of Botanical Nomenclature is part of the *de jure* Code as approved by the Nomenclature Section and Congress (Rijckevorsel 2006). Examples of such items include tables of contents, prefaces, and indices. Likewise, things can be part of the *de jure* Code although they do not appear in the printed version of the Code, such as what appears on the errata slip accompanying some printed copies of the Tokyo Code (Greuter *et al.* 1994a). Furthermore, even when a new version of the Code is published, it itself is provisional until it is approved by a subsequent Nomenclature Section and International Botanical Congress (e.g. Greuter *et al.* 2000: 15; McNeill *et al.* 2005: 1058). Ramsbottom, the lead author of the proposal (Ramsbottom *et al.* 1929) that resulted in the basic language now in Article 14.14, was very clear that names recommended for conservation by the General Committee were to be 'accepted informally in the interim, the list to be tentative until formally approved by the next Congress' (Lanjouw 1953: 539).

Most critically, the procedure used when voting on the General Committee recommendation on Proposal 1584 at the Nomenclature Section meeting in Vienna violated the most fundamental principle of parliamentary procedure—the right of the majority to approve decisions, as noted in the following passage from Sturgis (2001: 130): 'The most fundamental rule governing voting is that at least a majority vote is required to take an action. ... Jefferson said, "Until a majority has spoken, nothing has changed". It is obvious that to permit fewer than a majority to decide for any group would subject the many to the rule of the few, and this would be contrary to the most basic democratic principle. Democratic peoples universally accept decisions by majority vote'.

While it is standard parliamentary practice (Robert *et al.* 2000) to permit in some cases a supermajority vote to approve a motion (such as the rule adopted by the Nomenclature Section in Vienna to require a 60% vote to amend the Code) and therefore permit a minority vote to result in the rejection of a proposal, it is against standard parliamentary practice (Robert *et al.* 2000; Sturgis 2001; Sylvester 2004) to allow a motion to be considered approved when the motion receives only minority support, such as the motion to approve the General Committee's recommendation on Proposal 1584. Declaring a proposal approved when the vote on it registered a majority disapproving, also belies basic common sense.

The procedural switcheroo—forcing the 60% requirement on those opposed to changing the Code—used for the General Committee's recommendations on proposals to conserve or reject names, also created much confusion at the Nomenclature Section meeting. This confusion is not surprising when one considers that, like all preceding Nomenclature Section meetings, the Section at Vienna required a positive majority or supermajority to *approve* all motions. However, when the General Committee's recommendation on Proposal 1584 was up for a vote, they were told the vote would require 60% to *reject*. What was the Section being asked to reject? A proposal from the floor not to accept the General Committee's recommendation on Proposal 1584? Or the General Committee recommendation itself? These two different interpretations would require different votes from supporters and opponents of Proposal 1584. Nothing perhaps exemplifies this confusion better than the fact that the official report (McNeill *et al.* 2005: 1059) and the unedited official transcript give different interpretations as to what was meant by a 'yes' vote, the official report indicating that it was to support a motion from the floor to reject the General Committee's recommendation on Proposal 1584 (the vote being reported as 247:203, 54.9%) and the official transcript indicating a 'yes' vote supported adoption of the recommendation (the vote here being reported as 203:247).

Further evidence of confusion at the Nomenclature Section meeting at Vienna was that when the vote on Proposal 1584 was being readied 'Africa' and 'Australia' were written on the whiteboard with '60%' written next to Australia seemingly indicating that 60% would have to vote to move the type to the name of the Australian *A. penninervis*. The '60%' was later erased and written next to 'Africa'. Robert *et al.* (2000: 100): 'It is preferable to avoid a motion containing a negative statement even in cases where it would have meaning, since members may become confused as to the effect of voting for or against such a motion. ... In this connection, it should be noted that voting down a motion or resolution that would express a particular opinion is not the same as adopting a motion expressing the opposite opinion, since—if the motion is voted down—no opinion has been expressed'. Such procedures may have been especially confusing for those at the Section meeting whose first language was not English. (Requests to officials of the Nomenclature Section to receive a copy of the audio recording of the proceedings of the Nomenclature Section meeting so as to better understand the precise wording of the motion concerning *Acacia* were not honoured.)

It is also important to remember that, unlike the nomenclature committees which rarely meet, the Nomenclature Section meeting is the only time botanists truly deliberate on the Code (Robert *et al.* 2000: xx): '[T]he opportunity for simultaneous aural communication among all participants is central to the deliberative character of a meeting... [A]lthough e-mail or faxes may provide a suitable substitute for postal mail (the primary methods of communication used by the nomenclature committees)... they are not suited for the conduct of the deliberative process....' Furthermore, the Nomenclature Section meeting is more likely to better represent all users of plant names due to its openness and, therefore,

greater number of participants. All of this argues for the vote of the Nomenclature Section to prevail when it conflicts with the vote of the General Committee. No exceptions.

Was there a valid outcome at Vienna on Proposal 1584?

There are no bylaws or standing rules that govern the procedure to be used at a Nomenclature Section meeting, Division III, Provision I of the Code stating merely that the Code can be modified 'only by action of a plenary session of an International Botanical Congress on a resolution moved by the Nomenclature Section of that Congress'. Therefore, each Nomenclature Section is free to establish its own rules of procedure.

On the first day, the Nomenclature Section at Vienna, like all Sections since the Leningrad Congress in 1975, approved through a simple majority vote, rules requiring a three-fifths (60%) majority to pass any proposal to amend the Code and a simple majority to pass any other motion; motions not receiving the required majority were to be rejected. The Section never voted to suspend these rules, nor was a rule permitting a motion to be carried with less than a majority vote, ever voted on and approved (such a rule would be highly unorthodox with respect to standard parliamentary practice).

The statement from the Nomenclature Section officials that the vote on the General Committee recommendation on *Acacia* would not require a majority vote for approval was in direct conflict with the rules of procedure the Section had previously established and was therefore operating under invalid circumstances—Sturgis (2001: 130): 'Any requirements permitting decisions by less than a majority vote...are not valid unless they are included in the law, the rules of parliamentary law, or the bylaws' (italics in original). Robert *et al.* (2000: 332): '[M]otions are out of order if they conflict with a motion that has been adopted by the society and has neither been rescinded, nor reconsidered and rejected after adoption. Such conflicting motions, if adopted, are null and void unless adopted by the vote required to rescind or amend the motion previously adopted'.

Therefore, in no way can the vote on the General Committee's recommendation on Proposal 1584 be taken as an approval of that recommendation, since the motion received only minority (45.1%) support. Nothing done at the plenary session (held on 23 July 2005) resolved this matter, since it simply approved the decisions taken by the Nomenclature Section (Stuessy 2006: 246).

Some will say that the arguments in this paper have come too late and that the time to object was at the Nomenclature Section meeting. However, most botanists are not experts on parliamentary procedure, and should not be expected to have an objection 'at the ready' when something like the unusual procedure used for Proposal 1584 occurs. Furthermore, Section officials never indicated that they were establishing a new procedure by requiring only a 40% positive vote to approve the General Committee recommendation on *Acacia*, but rather simply presented this approach as though it were

established procedure (Rijckevorsel 2006). And it is never too late to point out that the procedure used for the motion on the General Committee recommendation on *Acacia* was invalid.

Conclusions

The procedure used at the Nomenclature Section meeting at Vienna on the General Committee recommendation on *Acacia* was not only inappropriate, unprecedented, and confusing, but conflicted with the Section's established rules of procedure (Rijckevorsel 2006). Therefore, the vote by the Section on the General Committee's recommendation on Proposal 1584 cannot be taken as an approval of the proposal. Indeed, based on the Section's established rules of procedure, the vote on the General Committee's recommendation on Proposal 1584 resulted in its rejection. Nonetheless, *Acacia* is now listed in the Vienna Code in Appendix III as a conserved name with a conserved type (McNeill *et al.* 2006: 286).

This matter can be raised again at the 18th International Botanical Congress at Melbourne in 2011 when the printed version of the Vienna Code comes up for ratification. Such challenges to the printed version of the Code, while rare, are not unprecedented (Stafleu 1966: 6).

Such a challenge to what occurred at Vienna is needed because of the unfortunate precedent this case will set if not challenged. Up until the *Acacia* entry in the Vienna Code, nothing substantive or nonprovisional had ever been added to or deleted from the Code without obtaining approval from a Nomenclature Section through a majority vote. This is a history that spans over 100 years.

To quote from Greuter & McNeill (1994: xiv): '... plant nomenclature is not governed by a bureaucracy of committees but, in an open and democratic manner, by the community of its users represented by the enrolled members of International Botanical Congresses. The user-driven process by which plant nomenclature is regulated is of utmost importance for a Code, which, having no 'teeth' in the way of penalties for infringements, entirely depends on user consensus for its universal application and implementation'.

However, if committee recommendations are allowed to be treated as approved even though a majority of the votes cast at the Nomenclature Section meeting was opposed to them, has not plant nomenclature indeed become a bureaucracy of committees? Incredibly, some who opposed Proposal 1584 were further told that even if the Section had rejected the General Committee's recommendation on *Acacia* this 'still would not necessarily have resulted in its absence from the Vienna Code, in which it could have been included with an asterisk, pending further discussion at the 2011 International Botanical Congress' (Smith *et al.* 2006: 224, 225). Apparently, this bureaucracy of committees also ignores Section decisions that are not to its liking.

The primary reason for Nomenclature Sections requiring a 60% supermajority to amend the Code is to ensure

that there is widespread acceptance of these changes (Greuter *et al.* 2000: 14). Treating motions as approved even though they fail to get majority support is a recipe for the opposite.

It has been argued that the special procedure used for the *Acacia* case was because 'overturning a decision of the General Committee is clearly a momentous step and, like an amendment to the Code, is not to be taken lightly' (McNeill 2006). However, until the *Acacia* debacle, there had never been serious opposition by a Nomenclature Section to a recommendation by the General Committee, clear evidence that Section members do not take it lightly. The precedent set in opposing this General Committee recommendation does not justify the precedent-setting procedure used for handling this recommendation, because there was a long history of requiring majority votes to approve General Committee recommendations on proposals to conserve or reject names. While a proposal's controversial status may justify it being handled differently with respect to a separate consideration and a longer debate, it does not justify a change in the voting requirement.

It should also be lost on no one that much of the opposition to the proposal to conserve *Acacia* largely came from parts of the world, Africa and South America, that are under-represented in plant taxonomy in general and in plant nomenclature specifically. For example, of the nine officers of the Nomenclature Section at Vienna (McNeill *et al.* 2005: 1058), five were from Europe, three from North America, one from Australia and none from Africa or South America. At the end of the Nomenclature Section meeting at the 16th International Botanical Congress at St. Louis, C. Kabuye from Kenya noted (Greuter *et al.* 2000: 239), 'Several African botanists would have been interested in being present at the sessions, to learn more about nomenclature through discussion and debate, but they could not afford to come on their own'. Nonetheless, some complained about all of the proxy institutional votes from Africa and South America that were carried to Vienna, even though this was wholly within the rules, and, at best, probably served only to counteract the lack of individual voting members at the Section from these areas.

Looking to the future, I propose the following recommendations that might improve this process:

Recommendations for future Nomenclature Sections

1. *Nomenclature Sections should determine what the voting procedure will be regarding the approval of General Committee recommendations to conserve or reject names. All recommendations of the General Committee should be subject to the same vote requirement—a straight up or down vote to approve; all proposals not receiving a majority vote should be rejected.*

Based on the published proceedings, the Nomenclature Section at the Seattle Congress in 1969 (Stafleu & Voss 1972: 4, 5) is apparently the only recent (post 1950) Section to adopt a voting procedure that made a clear distinction between the rules of the Code and the other portions of the Code, requiring a 60% majority to

amend the rules and a simple majority for proposals to amend portions other than the articles (Rolla Tryon at the Edinburgh Congress unsuccessfully proposed that this procedure be included in the Code; see Stafleu 1966: 8). Subsequent Sections have not been clear as to what the procedure was when voting on General Committee recommendations—was a 60% or simple majority required? In the absence of an explicit rule for voting on these recommendations, I argue that the procedure used for amending the Code would apply, since such proposals, when approved, effect changes to the Code. Therefore, the proposals to conserve or reject names at the Nomenclature Section meeting (presented as General Committee recommendations) at Vienna should have been subject to a 60% vote to approve since they would effect changes to the Code.

The second sentence of this recommendation prevents the voting inconsistency and confusion that occurred at the Nomenclature Section meeting in Vienna regarding Proposal 1584. It also ensures that majority rule prevails.

2. A specific recommendation/proposal within a package of recommendations/proposals must be considered separately, if one person in the assembly so moves.

Robert *et al.* (2000: 265) and Sturgis (2001: 96–100) state that when ‘a series of independent resolutions relating to completely different subjects is offered by a single main motion...any resolution in the series must be taken up and voted on separately at the request of a single member’. This allows efficiency when there is no disagreement, and debate when there is. If a General Committee recommendation rejects a proposal to conserve or reject a name, the original proposal is rejected and the name should not appear in the Code. If a General Committee recommendation to conserve or reject is rejected by the Section, this action does not approve the original proposal (Robert *et al.* 2000: 100). A separate motion would have to be made on the original proposal and it would be subject to approval by the Section.

3. Rules for voting and membership for the General Committee should be re-evaluated.

Currently, all members can vote on all proposals before the General Committee. All Secretaries of the nomenclature committees (committees for Algae, Bryophyta, Fossil Plants, Fungi, and Vascular Plants) are also *ex-officio* members of the General Committee. In addition, some ad hoc members of the General Committee are also members of a nomenclature committee. These dual members, therefore, can vote twice on the same proposal. Procedures should be enacted preventing double voting by these members. The purpose of the General Committee is to evaluate the recommendations made by the nomenclature committees, and this should be done with as much independence as possible. This double voting is tantamount to a judge simultaneously sitting on a lower court and a supreme court and ruling twice on the same case, and it conveys an image that the General Committee, at least in part, is simply a rubber stamp of the nomenclature committees. Perhaps those who are already members of a nomenclature committee should not serve on the General Committee. Secretaries of the other committees need to be members

to explain specific cases before the General Committee, but perhaps they should not vote on cases in which they have already voted as a member of the other committee.

It is up to the General Committee to determine how it will evaluate the nomenclature committee recommendations. For example, should the General Committee consider the merits of the case or should it limit its evaluation to technical aspects, such as making sure a nomenclature committee interpreted the rules of the Code correctly? However, members of the General Committee should never vote to recommend a proposal simply so it can be sent to the Nomenclature Section for action. The Nomenclature Section is omnipotent with respect to the Code and is free to consider any topic with or without the General Committee’s recommendation.

4. After the General Committee receives recommendations on proposals to conserve or reject names by a nomenclature committee, the General Committee should act on these recommendations within a reasonable time frame. General Committee recommendations should be published in advance of the Nomenclature Section meeting.

Stafleu (1964: 6) suggested that the General Committee should act within three months of publication of the nomenclature committee recommendation. This seems like a reasonable time frame. A General Committee report needs to be published before the Congress (no such report was published prior to the Vienna Congress), so it is clear which proposals will be up for approval at the Nomenclature Section meeting. While it may be impossible to publish the recommendations made on all proposals, ‘last minute’ General Committee recommendations that go unpublished prior to the Nomenclature Section meeting in which they are acted on, should be kept to a minimum.

5. Consideration should be given to expanding the content in Division III of the Code to clarify the charge and relative roles of the General Committee and the nomenclature committees that report to it.

While the Code spells out the charge of the Editorial Committee, it says little regarding the roles of the nomenclature committees. Language should be added here explaining the general roles of these committees. Any language would have to be as general as possible, so as not to hamstring future congresses’ ability to assign these committees with new duties.

Acknowledgements

The following are thanked for reviewing drafts of the manuscript: M. Alford, M. Luckow, L. Pedley, C. Rushworth, B. Schrire, P. van Rijkvorsel, G. Smith, A. van Wyk and three anonymous reviewers. B. Momberg and G. Germishuizen are thanked for assistance with editing the manuscript. J. McNeill is thanked for his extensive discussions with me on this matter even though we disagree. Parliamentarians, N. Sylvester and L. Wynn, are thanked for providing valuable assistance regarding procedure and reviewing the manuscript.

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OBITUARY

ELSIE ELIZABETH ESTERHUYSEN (1912–2006)

On Tuesday, 9th June 2006, some 200 persons gathered in the conference room at the Kirstenbosch Research Centre of the South African National Biodiversity Institute in the Kirstenbosch National Botanical Garden, Cape Town, to pay homage to and celebrate the life of the late Elsie Esterhuysen. The memorial gathering was hosted and conducted by her nephew, Allan Lighton and his wife, Megan (née Esterhuysen), and comprised three speeches of tribute from the botanical fraternity and one from the Mountain Club of South Africa on her mountaineering prowess, followed by refreshments, with many personal reminiscences among those attending. The following are the contributions from the three botanists outlining her life and work and paying tribute to her wonderful contributions to botany, with personal reminiscences and anecdotes.

John Rourke

‘Today we are here to celebrate the life of a legend, for Elsie was a legend, certainly within the local botanical community (Figure 1). She was born 94 years ago in Observatory, Cape Town, on 11 April 1912. Elsie attended the Wynberg Girls High School and after matriculating, proceeded to the University of Cape Town where she graduated with an M.A. degree in botany in 1933, the subject of her thesis being the anatomy of the resurrection plant, *Myrothamnus flabellifolius* Welw. But anatomy and physiology held little attraction for her—right from those early days it was clear that field work was to be her abiding interest. After a brief period of employment as a clerk in the Education Department, her

chance came with the award of the Solly Scholarship at Kirstenbosch in 1935. There she made a detailed study of the fynbos regeneration after the felling of a 50 year-old plantation of *Pinus pinaster* at the northern end of the Kirstenbosch estate—a mere few hundred metres from where we are gathered this afternoon. The results of this study form the basis of the few research papers she ever published.

Elsie had long wanted to join Dr I.B. Pole Evans’ Botanical Survey group in the Department of Agriculture, but the Pretoria bureaucrats turned her down merely because she was a woman. In those days the very prospect of a female doing botanical survey work in the remoter parts of the South African bush was unthinkable! One of her classmates at university, John Acocks, was accepted by Pole Evans and went on to produce his famous *Veld Types of South Africa*. With the Great Depression at its peak, jobs were hard to come by and so in 1936 Elsie gratefully accepted a position as assistant to the redoubtable Maria Wilman, Director of the McGregor Museum, Kimberley, who was then undertaking a survey of the flora of Griqualand West. Miss Wilman insisted that Elsie should learn to drive in order to reach the more distant parts of the survey area. All went well until one day Elsie stalled the car on a level crossing. Despite the fact that there was no belching locomotive thundering down the line towards her, this incident proved to be a life-altering experience for her. She never drove again! Instead she took to pedal power and the bicycle, perfecting her cycling technique on a variety of models over the years. Who will ever forget the spectacle of Elsie’s



FIGURE 1A–C.—Elsie Esterhuysen (dates unknown; photographs courtesy of Bolus Herbarium).

daily homeward journey from the Bolus Herbarium on her trusty bike, head forwards, hair streaming behind her, careering down the viciously steep Stanley Road at breakneck speed, then whipping into Lovers Walk, followed immediately by another swooping twist into Grotto Road—all with the panache of a Tour de France professional—before coming to a heart-stopping halt in Main Road, Rondebosch.

After two years in Kimberley, Elsie returned to Cape Town in 1938. It was here that her real career began when she joined the Bolus Herbarium (Figure 2) under another formidable woman, Dr Louisa Bolus. Her former professors, Robert Adamson and Harold Compton, knowing of her interest in mountaineering, suggested that she explore and document the high-altitude flora of the Cape Mountains as herbarium records from such areas were at that stage sparse or even lacking completely. This idea appealed immensely to Elsie and became the focus of her life's work for the next 60 years, during which time she amassed over 37 000 herbarium collections. What makes this achievement even more remarkable is that having no transport of her own, she relied entirely on Mountain Club friends to provide lifts to the various sites she investigated, be they in the Western Cape mountains or the KwaZulu-Natal (KZN) Drakensberg.

It's an astonishing fact that for the first 18 years of her employment she received no proper salary and was



FIGURE 2.—Elsie Esterhuysen, taken in the Bolus Herbarium in 1962 (photograph by J.P. Jessop).

paid out of petty cash at a rate not much better than a labourer. When Prof. Ted Schelpe arrived as curator of the Bolus Herbarium in 1956, he had to do battle with the bureaucrats in the University of Cape Town's administrative office to get a permanent establishment post created for her. It was the first time she had any financial security. Such was the extent of her loyalty and dedication.

She did not collect randomly; Elsie was above all an intelligent collector, seeking range extensions, local variants, or even new species, filling voids in the Bolus Herbarium's records, often returning months later to collect seeds or fruits that were of diagnostic importance. To do this effectively pre-supposed an encyclopedic knowledge of the published literature on the Cape flora and this she possessed to a remarkable degree. Despite being responsible for this avalanche of botanical discoveries, sustained over several decades, Elsie could not be persuaded to publish the results of her work under her own name. Instead she delighted in helping others; indeed Elsie seemed to take vicarious pleasure in seeing her own discoveries written up in a host of monographs by several generations of young taxonomists. Was it laziness, a fear of criticism or modesty that caused this curious reluctance to publish? Knowing Elsie, I feel sure it was her innate modesty. Always self deprecating, one of her favourite comments was 'I'm only filling in gaps'.

As postgraduate botany students at the University of Cape Town working in the Bolus Herbarium during the 1960s, many of us had the privilege of engaging in regular lunch-time discussions with her on a great many aspects of the Cape flora, while eating our sandwiches perched on the rather decrepit old sofa that graced the tearoom of the Bolus Herbarium. Though never part of the formal teaching staff, her influence was incalculable. But it was not only local botanists whom she helped. Eminent specialists from abroad all beat a path to her door to seek her expertise and assistance in the field—from Switzerland, Sweden, Denmark, Germany and the USA, among others. It was a well-known fact internationally that if you were coming to South Africa to work on the taxonomy of any plant group in the Cape flora, the first person you had to see was Elsie Esterhuysen.

Although she published very little herself, the South African Association of Botanists recognized the huge contribution she had made in assisting others by awarding her their Senior Medal in 1987. Her old university also acknowledged her achievements. On the occasion of the University of Cape Town's conferment of an honorary Master of Science degree on Elsie in 1989 (Figure 3), the university orator referred to her as a 'botanical hunter gatherer'. The metaphor was very apt. Like a hunter gatherer, she was in perfect harmony with nature, never being wasteful, never taking more than was needed at the time, never defacing or contaminating the environment. She had a deep and profound respect for nature. It was almost like a religion to her.

Elsie was a person of huge warmth and generosity. She cared deeply for the oppressed, the downtrodden and the underdog. Tramps and vagrants who knocked at her door were often sent away in astonishment with a fist



FIGURE 3.—Elsie Esterhuysen with the Chancellor of the University of Cape Town, Harry Oppenheimer, after her graduation in 1989 (photograph courtesy of Bolus Herbarium).

full of cash in their hands (but sadly, in her late eighties, she was attacked by one of them when he became greedy). We all know how frugal she was. Who else could survive for days in the mountains on half a raw cabbage, a few carrots, some powdered milk and weak tea? But on occasions she could let her hair down. I well remember offering to get her a drink at a book launch held at Kirstenbosch. A double brandy and ginger ale was requested and consumed with gusto! She was one of the most broad-minded and tolerant people I have ever met, yet there was one human folly of which she was extremely intolerant and that was smoking. Cigarette smoke was anathema to Elsie. How she coped with the chain-smoking of her boss I do not know. There was a memorable incident when an eminent but chain-smoking professor of biochemistry from Berlin ignored her pleas to desist from smoking on a field trip. Elsie calmly reached up, tore the cigarette from his lips, hurled it to the ground and crushed it underfoot! Needless to say, he did not light up again in her presence.

Today Elsie's botanical legacy lies within the folders of the Bolus Herbarium—a superb botanical archive, some of it already cited in major taxonomic publications by a host of local and international specialists. But many of her collections remain to be worked on like a huge untapped data base waiting to be sifted through and mined by future botanists in decades to come. And so Elsie's name will live on as later generations examine and dissect the specimens she gathered over a lifetime of prodigious activity. They will marvel at her achievements rather as we today marvel at the work of 18th and 19th century explorers such as Thunberg and Burchell. Elsie was unique in the truest sense of that overworked word. We will not see her like again.'

Peter Linder, Zurich, Switzerland (read by E.G.H. Oliver)

'When I first started working in the Bolus Herbarium in 1973, as an undergraduate student wanting to know

the names of the plants on the Piketberg, it was a curious place. There was a wonderful chaos of specimens, stacked on every available surface. On two floors was a superb library of the most magnificent books. Down in the tearoom was Ted Schelpe, twirling his moustache and smoking endless Mills cigarettes, a source of many ideas and inspiration. Tony Hall was in an office on the top floor, from where he organized a large number of conservation initiatives. Elsie was on the middle floor, and she was what I thought a botanist was supposed to be. She was in the mountains every weekend, and came back with big black plastic bags full of plants, that she sorted and passed to Gert Syster to press. She was the one person who could put names on plants that defeated my attempts. And she had little time for academic niceties—for her the important things were plants in the mountains, their welfare, their relationships. She was immersed in plants and mountains.

However, I only started to know her somewhat better when I worked on restios—although she knew the orchids, these were not a particular theme to her. But the restios had fascinated her since before the war. After Pillans had died (in 1964), she had taken on the mantle of the restio specialist. The really close collaboration only started after I had left for Kew as South African Botanical Liaison Officer—we had an intense correspondence about the species limits and the new generic limits I was proposing. When I left she had said that she does not write letters—well, I have a huge pile of her correspondence: detailed comments about each species, discussions about the best Latin for the diagnoses, discussions about the characters for the genera and the groupings that would be best to use. Her letters were a delight and a constant inspiration for me. She had built up a formidable knowledge about each species, knew its ranges, knew when it flowered. She would wait, sometimes for many years, until a mountain club trip took her back to where they occurred to collect seed, to extend the distribution ranges, to document the flowering times. Whereas Ted Schelpe taught me how to write descrip-

tions and deal with nomenclature, Elsie taught me that each species has an essence, a character—that it liked some habitats but not others and that it flowered at a particular time. She was curious about the plants, not because they informed her about some theory or other, but she was interested in the plants themselves—she cared about them.

Elsie lived in a suburban house in Rondebosch, on a bleached and leached sandy soil. For many years she let most of the house, and lived in the servant's quarters. But the garden at the back was hers, and her cats'. It was full of remarkable bulbs that she had brought back from all over the Cape, and was delightfully overgrown. It was a pleasure to sit in the shade in the unmowed lawn, amongst a remarkable collection of species, drinking tea and talking about mountains and plants. Rumour had it that she also bathed in a tub in the back garden.

She also went to the mountains in the same way—not to climb them *per se*, but to be in them. She did not need clothing and equipment to keep nature out. She was simply at home in nature. The only natural element that she could not relax in was the sun.

The older of us probably all still remember Elsie in her working bay in the Bolus, immediately to the left on the first floor. She had a large table laden with specimens, comments on fading paper written in a fast, almost abbreviated handwriting, and tattered paper-covered revisions and books lying about. Under her table was a wooden footrest, in the tearoom her unusually low chair. She talked about her cats, and had a dry sense of humour. When Schelpe tested a prospective Ph.D. student by asking her what the differences between Selaginellaceae and Scrophulariaceae were, and then gleefully explained when the poor student did not know, Elsie remarked *sotto voce* that she, also, did not know what the difference was. Then there was the poor Austrian botanist that could not keep up with her in the mountains, when, after all, he came from the Alps. Or when I was rather nervous scrambling over an exposed cliff at the top of Ferny Gully and she said—well, you do have children to worry about.

I asked her once how she worked; my curiosity was aroused when I started a revision of *Pentaschistis* and found all specimens neatly identified in the herbarium, complete with the new species sorted out correctly at the end of the genus. She told me that she would collect all plants that she could not identify. This way she found genera in which the species taxonomy was inadequate. Then she would focus on a genus for several years, curating the old collections and attempting to name her new collections. When she found what she thought might be new species, she would start searching for more localities, in this way mapping the distribution ranges, flowering times, and ecology of each new species. By the time she was finished, the taxonomy was sorted out, the new species well documented, and all mounted and laid in the herbarium. In the case of the restios this even meant that there were little capsules with seeds, carefully collected in the field. It was left for the 'academics' to write the descriptions and the keys. This was the situation in Restionaceae and *Pentaschistis*, and

I would love to know whether it was also the situation in other genera, such as *Agathosma* and *Phyllica*. And was she intrigued, or amused, by the antics of the academics? Or did she simply prefer fieldwork to writing, and fighting with reviewers?

She was, however, at times concerned about the recognition that she got for her work. She felt that the importance of her work was not always recognized by the University authorities. It was therefore really good that Hugh Amore took the initiative to convince the University to grant her an M.Sc. *honoris causa*. Hugh was at the time the Registrar of the University, a difficult and demanding task, he had enough to worry about. So much more to his honour, and to the fame of Elsie, that he took it upon himself to organize and co-ordinate this degree (see additions at end).

Several people had an important influence on Elsie. I do not know where her love for the plants came from—her origins were always a mystery to me. I never heard her talk Afrikaans, yet Esterhuysen is a good Afrikaans surname. Her focus on the montane plants was apparently started by a comment from Adamson, who wanted her to document the mountain summit floras. And the late interest in lowland floras I suspect came from Richard Cowling. Elsie once commented to me that she should have concentrated more on the lowland flora, as it was much more threatened than the montane flora.

And how many people did Elsie influence? That is hard to know. She had a subtle, but very powerful, influ-



FIGURE 4.—Elsie Esterhuysen and Prof. Peter Linder after the graduation in 1989 (photograph G. Scott, courtesy of Bolus Herbarium).

ence on me (Figure 4). And I suspect that many of her fellow mountaineers, and also many of the botanists that passed through the Bolus, were deeply affected by this tiny, remarkable woman, who was so much at one with nature.'

Ted Oliver

'We are here this afternoon for a very special purpose—to pay tribute to an extraordinary person who in some way, small or large, came into our lives. Death, memorial services, funerals are usually solemn occasions filled with sadness, sometimes tears. But don't let us go that route here. Let us rather celebrate a wonderful life that has finally come to an end. Yes, it is sad that we have lost Elsie, but then at 94 she did live well beyond her three score years and ten. In the end, through loss of memory, she was a burden unto herself and her death was indeed a happy release for her on 31 May 2006.

I first got to know Elsie in 1958, and like Peter, as an undergraduate wanting to know something about the Cape flora. At that time I also met her because she lived in a flat above a double garage along the road from my family home in Rondebosch (the house of Brian and Joan Quail of the Mountain Club). Just behind our house was a large residence for old people, The Abbotsleigh, where Elsie's mother had moved in. And so Elsie often came past our house to visit her mom.

In the Bolus Herbarium I was keen to learn about ericas which I had seen on our family holidays near Betty's Bay—who better than Elsie to help me. She had concentrated on *Erica* collecting at the insistence of Mrs Bolus who had helped her uncle Harry Bolus write them up

for *Flora capensis* (1896–1905). She was very generous with her encouragement and guidance for this youngster who was now encroaching on her territory, but never once relayed any thoughts of this to me. Thanks very much Elsie.

The first of Elsie's few publications was the description of a new species, *Erica viscidiflora* in 1936, and then *E. cremnophila* in 1940 with Capt. Salter. Then came Dr Hans Dulfer, in Vienna, with his revision of *Erica* in the early 1960s. Elsie sent him a few batches of some of her problem material to show him some of the difficulties in the genus, whereupon he promptly thanked her, and described them all as new species. This put the wind up Elsie's sails and she decided to send no more material and promptly wrote a paper on her views on certain species just before his revision came out. This was her only major publication as sole author. Two things must have galled her (from the grunts one picked up)—Dulfer put the holotypes of her material in Vienna and he sank her *E. viscidiflora*! One felt from her veiled comments that this must have stifled any further ideas of publications. Little did she know that her *viscidiflora* is a good species that my late wife and I have reinstated. Later, of course, through Peter's research, she was encouraged to publish in his papers (Esterhuysen in Linder 1985, 1990) all her new species of Restionaceae that she had so assiduously been collecting over the years—some 47 species.

We have heard that Elsie concentrated her efforts on collecting, but not only in the Cape Florsitic Region (CFR), she did much in the KZN Drakensberg mainly on the annual July camps of the Mountain Club (Figure 5). One of her early mentors was Dr Henri Georges Fourcade with whom she worked and collected for his



FIGURE 5.—Elsie Esterhuysen at the Mountain Club's Drakensberg July Camp of 1987 where she is being made 'a free woman' on receiving the Freedom of July Camps from the chairman of the local branch, Dr Graham Smith (photograph by B. Cooke).



FIGURE 6.—Elsie Esterhuysen with Ted Oliver and the type plants of *Erica atrovinosa* in the Hex River Mtns in 1964; she discovered it in 1942 (photograph M.F. Thompson).

work on the flora of the Knysna/Uniondale area. As a collector she was certainly the most prolific for the CFR and ranks among the top three in South Africa with Compton and Acocks, all with just short of 40 000 collections.

But how did she manage this? John has mentioned her lack of enthusiasm for cars, although she did once much later say that if Mrs Bolus in her late 80s still drove her tiny black Austin, perhaps she should take up driving again! So how did she get to all those remote places. The answer—the Mountain Club as John mentioned. Because the MCSA members did not roam around the flats, this is why I suspect she tackled them only later in life as Peter mentioned. She joined the club in 1935!

But her mode of transport was the bicycle (we have her latest model here today). She rode to UCT up that dreadful steep road every day for a lifetime, come sunshine or rain, heat or cold. Now one knows why she was so fit and could outstrip any poor unsuspecting younger botanist in the mountains! Every day she would come up and park her bicycle behind the Bolus Herbarium building and then often jump through the window in the preparation section rather than walk all the way around to the front door. One day I happened to be looking out of the window and saw Elsie leaping onto her bicycle to go home, and lo and behold, a bit further down the University Ave between the Physics Dept and the Science Lecture Theatre, she actually fell off it in front of a group of students! The next day she told me she had never been so embarrassed.

Peter noted her quiet presence in the corner of the tea-room on that extraordinarily low chair. There she would sit with her oversized enamelled mug full to the brim with skimmed milk and a touch of tea. One hardly saw her with anything else, perhaps an orange or an apple, even on trips into the mountains. It is amazing how she managed to climb so many mountains and live so long on powdered skim milk. But she did have one serious health problem—her very thin skin which was always

getting scratched and infected in older life.

Conversation at tea time was very varied with only the occasional comment from Elsie who spent most of the time endlessly stirring and sipping her milky tea. But things changed for her when something political was mentioned (yes Elsie was quite a liberal) or if someone mentioned the word CAT. Elsie loved her cats—sometimes too much. She was known to buy choice meat for the cats rather than herself; and to give up her bed and sleep on the floor rather than disturb the sleeping cats on her bed at bedtime!

I had wonderful trips with Elsie in those early days (Figures 6, 7) and later in the 1980s with Dolf Schumann—Hex River Mountains, Kogelberg and Swartberg. She always slept apart from us, never on a mattress, preferring to make a nice nest out of restios and slangbos, or, in the Drakensberg, lots of grass (Figure 8). Peter



FIGURE 7.—Elsie Esterhuysen with the orchid, *Disa longicornu*, on Table Mountain (date unknown, photograph by M. Burger).



FIGURE 8.—Elsie Esterhuysen in the Drakensberg with a load of grass bedding for the night in July 1982 (photograph courtesy of Bolus Herbarium)

has alluded to her behaviour in nature—with mumbled apologies she was not averse to shedding everything and hopping into a little stream to cool off! One of her greatest experiences was coming along with Dolf Schumann and myself in 1990 from Cape Town on a helicopter trip which Dolf organized to photograph the rare *Erica alfredii* in the Riviersonderend Mountains. On the return flight I persuaded the pilot to go low along a very devious route through the mountains via Jonaskop, Kaaimansgat, Goudini Sneeuksop and Victoria Peak. She was amazed at seeing from the air all those mountains that she knew personally on the ground.

I shall cherish the moments I had with Elsie in the herbarium and in the mountains, I am only sorry that I was away from the Bolus working at Kew, Pretoria and Stellenbosch. Elsie was not a religious person but she must definitely have communed with God and nature in her own way in her countless days and nights in the mountains.

Let us give thanks for Elsie's life—for her great contribution to the study of our unique flora, through her superb collections that will last for as long as man continues to study plants from the Cape, and, hopefully, maintain herbaria. She will be remembered in two genera and about 56 species with *Erica* having three of them (Table 1).

When any of you next go up into the mountains, know that Elsie's spirit will be around somewhere in her paradise. Perhaps you will feel her presence in those large restiad clumps.

Thank you Elsie—you were a great person, mentor and friend.'

Note added in the preparation of this obituary

Elsie's parents were Johannes Petrus le Roux Esterhuysen (Afrikaans speaking) and her mother, Florence Ethel Larkin (English speaking)—hence her mother tongue. Her father attended Victoria College, Stellenbosch, where he studied law and then worked in the master's office of the Supreme Court in Cape Town. He was transferred from Cape Town to Windhoek where Elsie visited her parents by train during holidays. He retired early due to Florence not liking the Windhoek climate, and bought a smallholding at De Hoek, outside Joubertina in the southern Cape, where his son, Cyril, was the local attorney. Elsie visited the family there during her early botanical years at the Bolus Herbarium, hence her contact and friendship with Dr Fourcade who lived across the Tzitzikama Mountains at Witelsbosch.

A newspaper cutting found among her personal effects after her death showed a side of Elsie that none of us knew existed. It was from the local Kimberley newspaper (undated) and reported on a *Reading on life and works of Franz Schubert* at a meeting of the Kimberley Philharmonic Society. The lecture was given by Miss E. Esterhuysen. It was preceded by another describing Burchell's travels in South Africa during Schubert's time and was followed by 'a delightful short programme of the composer's music played as piano solos by Miss Esterhuysen'.

Elsie was also an accomplished artist as evidenced by the few charming watercolours of flowers that were among her effects. She illustrated with black and white line drawings the species of *Erica* which she described with Salter.

Elsie celebrated her 80th birthday by climbing the 2 000 m high Sneeuksop in the Cederberg Wilderness area with friends from the Mountain Club.

Also in her effects was a handwritten letter to the principal of the university about her honorary degree and this shows something of her character:

'Dear Prof Saunders,

Thank you for your kind letter of 9th Jan. I accept the award of the honorary degree and appreciate the honour.

I wonder, though, whether the staff of the Botany Dept were consulted. If the matter were not confidential I should like to consult them myself because it does not seem to me that my work warrants the hon. degree. I hope Council were not misled into supposing that the discovery of undescribed species was a great achievement because it wasn't. Apart from that I worked as a technician keeping the herbarium in order and up to date.

Yours sincerely

Elsie Esterhuysen'

TABLE 1.—Plants named after Elsie Esterhuysen. Accepted names in roman type and synonyms in italics

Direct names	
Bryophyta	Linaceae
<i>Lophocolea esterhuysenii</i> (ae) S.W.Arnell (1963) [= <i>L. bewsii</i> (Sim) Grolle]	<i>Linum esterhuyseniae</i> C.M.Rogers (1982)
<i>Plagiochila esterhuysenii</i> (ae) S.W.Arnell (1963) [= <i>P. squamulosa</i> Mitt. var. <i>crispulo-caudata</i> (Gottsche) Vander Berghen]	Lobeliaceae
	<i>Lobelia esterhuyseniae</i> E.Wimm. (1968) [= <i>L. comptonii</i> E.Wimm (1968)]
Pteridophyta	Mesembryanthemaceae
<i>Dryopteris esterhuyseniae</i> Schelpe & N.C.Anthony (1982) [= <i>Dryopteris dracomontana</i> Schelpe & N.C.Anthony]	<i>Aridaria esterhuyseniae</i> L.Bolus (1939) [= <i>A. noctiflora</i> (L.) Schwantes var. <i>straminea</i> (Haw.) Gerbaulet (1996)]
	<i>Delosperma esterhuyseniae</i> L.Bolus (1959)
	<i>Erepsia esterhuyseniae</i> L.Bolus (1939)
	<i>Esterhuysenia</i> L.Bolus (1967)
	<i>Gibbaeum esterhuyseniae</i> L.Bolus (1958)
	<i>Lampranthus esterhuyseniae</i> L.Bolus (1958)
	<i>Ruschia esterhuyseniae</i> L.Bolus (1950)
Apiaceae	Orchidaceae
<i>Chamarea esterhuyseniae</i> B.L.Burt (1991)	<i>Disa esterhuyseniae</i> Schelpe ex H.P.Linder (1981)
Asphodelaceae	
<i>Bulbine esterhuyseniae</i> Baijnath (1987)	Polygalaceae
<i>Trachyandra esterhuysenae</i> Oberm. (1962)	Muraltia
	<i>elsiae</i> Paiva (1981)
Asteraceae	<i>esterhuyseniae</i> Levyns (1949), in obs., sine descr. lat. (IK)
<i>Anderbergia elsia</i> B.Nord. (1996)	Proteaceae
<i>Athanasia elsia</i> Källersjö (1991)	<i>Paranomus esterhuyseniae</i> Levyns (1970)
<i>Chrysocoma esterhuyseniae</i> Ehr.Bayer (1981)	
<i>Corymbium elsia</i> Weitz (1989)	Restionaceae
<i>Felicia esterhuyseniae</i> Grau (1973)	<i>Askidiosperma esterhuyseniae</i> (Pillans) H.P.Linder (1985) [= <i>Chondropetalum esterhuyseniae</i> Pillans (1945)]
<i>Hydroidea elsia</i> (Hilliard) P.O.Karis (1990) [= <i>Atrichantha elsia</i> Hilliard (1981)]	<i>Calopsis esterhuyseniae</i> (Pillans) H.P.Linder (1985) [= <i>Leptocarpus esterhuyseniae</i> Pillans (1945)]
<i>Troglophyton elsia</i> Hilliard (1983)	<i>Elegia esterhuyseniae</i> Pillans (1945)
	<i>Ischyrolepis esterhuyseniae</i> (Pillans) H.P.Linder (1985) [= <i>Restio esterhuyseniae</i> Pillans (1945)]
Brassicaceae	<i>Ceratocaryum fimbriatum</i> (Kunth) H.P.Linder [= <i>Willdenowia esterhuyseniae</i> Pillans (1945)]
<i>Heliophila esterhuyseniae</i> Marais (1966)	
Bruniaceae	Rosaceae
<i>Lonchostoma esterhuyseniae</i> Strid (1968)	<i>Cliffortia esterhuyseniae</i> Weim. (1948)
<i>Tittmannia esterhuyseniae</i> Powrie (1969)	
Chenopodiaceae	Rubiaceae
<i>Salsola esterhuyseniae</i> Botsch. (1973)	<i>Anthospermum esterhuysenianum</i> Puff (1986)
Cyperaceae	
<i>Ficinia esterhuyseniae</i> Muasya (2005)	Rutaceae
Droseraceae	<i>Agathosma esterhuyseniae</i> Pillans (1950)
<i>Drosera esterhuyseniae</i> (T.M.Salter) P.Debbert (1992) [= <i>D. curviscapa</i> T.M.Salter var. <i>esterhuyseniae</i> T.M.Salter (1939)], [<i>D. aliciae</i> Raym.-Hamet]	Euchaetis
	<i>elsiae</i> I.Williams (1979)
Ericaceae	<i>esterhuyseniae</i> I.Williams (1979)
<i>Erica</i>	Scrophulariaceae
<i>elsiana</i> (E.G.H.Oliv.) E.G.H.Oliv. (1987) [= <i>Philippia elsiana</i> E.G.H.Oliv. (1984)]	<i>Diascia esterhuyseniae</i> K.E.Steiner (1999)
<i>esterhuyseniae</i> Compton (1941)	Selago
<i>estiana</i> E.G.H. Oliv. (1987) [= <i>Philippia esterhuyseniae</i> E.G.H.Oliv. (1984)]	<i>elsiae</i> Hilliard (1999)
	<i>esterhuyseniae</i> Hilliard (1998)
Fabaceae	<i>Trieneae elsia</i> Hilliard (1989)
<i>Amphithalea esterhuyseniae</i> (Granby) A.L.Schutte (1998) [= <i>Coelidium esterhuyseniae</i> R.Granby (1980)]	Thymelaeaceae
<i>Aspalathus esterhuyseniae</i> R.Dahlgren (1960)	<i>Passerina esterhuyseniae</i> Bredenk. & A.E.van Wyk (2003)
<i>Lotononis esterhuyseniana</i> B-E.van Wyk (1990)	
Hyacinthaceae	Names in allusion
<i>Elsiea</i> F.M.Leight. (1944) see Bothalia 12: 323 [= <i>Ornithogalum paludosum</i> Baker (1874)]	Asteraceae
<i>Lachenalia esterhuyseniae</i> W.F.Barker (1978)	<i>Monticapra</i> (Karis) Koekemoer (2001). [= <i>Disparago</i> section <i>Monticapra</i> Karis (1993)]; <i>mons, montis</i> , a mountain, and <i>capra</i> , a she-goat; hence like a mountain she-goat (see below)
<i>Ornithogalum esterhuyseniae</i> Oberm. (1978)	
Iridaceae	Ericaceae
Geissorhiza	<i>Erica oreotragus</i> E.G.H.Oliv. & I.M.Oliv. (2001) [= <i>E. esterhuyseniae</i> Compton var. <i>trimera</i> Compton (1941)]; <i>Oreotragus oreotragus</i> , the klipspringer antelope; referring to Elsie's adept way of hopping around the mountains like a free klipspringer in search of choice plants! (see above)
<i>elsiae</i> Goldblatt (1985)	
<i>esterhuyseniae</i> Goldblatt (1985)	Scrophulariaceae
<i>Hesperantha elsia</i> Goldblatt (1984)	<i>Trieneae</i> Hilliard (1989): <i>Tri-eeneae</i> , three e's for E.E. Esterhuysen (<i>Trieneae elsia</i>).
<i>Ixia esterhuyseniae</i> M.P.de Vos (1988)	
<i>Moraea elsia</i> Goldblatt (1976)	
<i>Romulea atrandra</i> G.J.Lewis var. <i>esterhuyseniae</i> M.P.de Vos (1972)	
<i>Watsonia elsia</i> Goldblatt (1989)	

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Book Review

CHECK-LIST DES PLANTES VASCULAIRES DU GABON/
CHECKLIST OF GABONESE VASCULAR PLANTS (*Scripta Botanica
Belgica* 35) by M.S.M. SOSEF, J.J. WIERINGA, C.C.H. JONGKIND,
G. ACHOUDONG, Y. AZIZET ISSEMBÉ, D. BEDIGIAN, R.G.
VAN DEN BERG, F.J. BRETELIER, M. CHEEK, J. DEGREEF,
R.B. FADEN, P. GOLDBLATT, L.J.G. VAN DER MAESEN, L.
NGOK BANAK, R. NIANGADOUMA, T. NZABI, B. NZIENGUI,
Z.S. ROGERS, T. STÉVART, J.L.C.H. VAN VALKENBURG, G.
WALTERS & J.J.F.E. DE WILDE. 2006. *National Botanic Gardens
of Belgium, Meise*. Pp. 438. Soft cover: ISBN 90-72619-69-2; ISSN
0779-2387, price € 53.00.

More information is available on: <http://www.br.fgov.be>

Without up-to-date information on biodiversity, no area can be properly managed or conserved. Therefore, the compilation of a species inventory or checklist should be the first step towards conservation. However, despite this obvious value, very few countries maintain complete checklists of their biodiversity, especially in Africa. Less than half of the sub-Saharan African countries have country-level checklists or inventories of their plants, most of them produced more than ten years ago. Gabon is one of the few African countries that can boast a recent vascular plant checklist. It is the result of years of botanical exploration and research in Gabon. The publication was made possible by the collaborative effort of eight institutions and 22 authors.

The bilingual (French and English) introduction is very concise (ten pages and nine figures), but provides valuable information about the checklist and the Plants of Gabon Project. It briefly introduces the reader to Gabon, a relatively small country on the equatorial west coast of Africa. The country has an extremely rich flora and its lowland rainforests (covering around 80% of the country) are claimed to be amongst the richest in Africa. Owing to the selective nature of logging in Gabon, which concentrates on one near-endemic but a common pioneer species that regenerates rapidly, the Gabonese forests have escaped the immense destruction of rainforests typically found in other tropical parts of Africa and the world. The country also has a network of 13 National Parks, covering 10% of the country's surface. The importance of inventories or checklists in the management and conservation of these parks is highlighted. Furthermore, the general introduction is well illustrated with three maps showing the main rivers, regions and altitude zones, the main vegetation types and the network of National Parks of the country. The first map and the National Parks map, as well as a further map showing the provinces of Gabon, are repeated on the inside back cover of the publication, facilitating easy referencing.

The rest of the introductory chapter is divided into sections dealing with checklist preparation, plant collecting in Gabon and analyses of the data. The methods used to create and hone the specimen-based database from which the checklist was extracted, as well as those used to improve the resulting draft checklist, are briefly explained under the first subheading. The database contains over 65 000 specimen records for the more than 4 700 vascular plants known in the country, as well as over 800 literature references associated with the Gabonese flora. Most (98%) of these specimen records include accurate map references. Images and other additional data are currently being added to the database.

The database is available online at <http://herbaria.plants.ox.ac.uk/bol/home>. This Plants of Gabon website is very informative and useful. It provides relevant information on the specimens in the database. In addition, maps can be produced and, as mentioned above, images will become available. The website also links to various other important taxonomic and biodiversity databases (including IPNI, TROPICOS, GBIF and others) where queries are run automatically on the taxon selected in the Gabonese database. Another important online database on Africa's flora to which the Plants of Gabon database should link is the African Flowering Plants Database of the African Plant Checklist and Database Project (<http://www.ville-ge.ch/cjb/bd/africa>). The reason why it is not linked might simply be that the African Flowering Plants Database website was not yet fully functional when the Plants of Gabon website was launched.

The database is undoubtedly the most comprehensive of its type for Gabon. Nevertheless, the claim by the authors that it is unique in Africa, is not quite true. The information contained in the Plants of

Gabon database is very similar to that in the PRECIS database, kept by the South African National Biodiversity Institute (SANBI) for the *Flora of southern Africa (FSA)* region. The website and the accuracy of the Plants of Gabon data do make the database exceptional in Africa. However, SANBI is in the process of developing a web interface for PRECIS, but, being a much larger database (containing data on 24 000 taxa linked to around 900 000 specimens and almost 30 000 literature references), the process of quality control and enhancing the PRECIS data for online availability takes much longer.

Under the Plant collecting in Gabon subheading, the most important collectors and collecting efforts in Gabon are briefly mentioned. The authors are apparently preparing a full account on all botanists that collected in Gabon, which will be published elsewhere.

The section of the introductory chapter dealing with the analyses of the data is again subdivided into various subsections. It offers valuable information about the Gabonese flora and the state of botanical knowledge in the country. According to these analyses, the number of collections from Gabon (around 72 000 herbarium specimens in total) reveals that the country is still regarded as under-collected or poorly known, with a mere 0.24 plant specimens per km². For a botanical country checklist to be of an acceptable level, a minimum of one specimen per km² is required. This is also reflected by the fact that almost every botanical expedition to Gabon reveals novel taxa that have not yet been recorded for the country or that are entirely new to science. Fortunately the analysis on collecting history indicates that collecting activities in Gabon have increased substantially over the past 30 years and are still increasing. This is very well illustrated with a histogram showing the number of plant collections per decade from 1846–1849 up to 2004. A map of the number of plant collections per quarter-degree square demonstrates the distribution of collecting efforts in Gabon. This map clearly shows a few areas that are botanically well known or fairly well known. Not surprisingly, the region with the most specimens is that around the capital, Libreville. Also very obvious on this map is the fact that most areas in Gabon have very few collections, whereas others have never been included in plant collecting surveys at all. An interesting analysis is that of collecting throughout the seasons. This was done to determine whether certain species could have been overlooked, since most collecting took place outside their flowering or fruiting season. The accompanying histogram, illustrating the number of collections per month of the year, shows that collecting is fairly evenly distributed throughout the year. The least specimens were collected from June to August, which coincides with the dry season when less flowering material is available, and which is also the holiday season. The greatest number of specimens were collected in November, but the authors have no concrete explanation for this phenomenon.

Since no exhaustive search for type collections was performed during this project, the figure of 1 318 type specimens indicated in the database is lower than the actual number of types based on Gabonese material. The total number of taxa, as well as species, genera and families currently listed for Gabon is presented in a very useful table. This table not only shows the total number, but also the separate numbers for the classes Lycopsidea, Pteropsida, Pinopsida and Magnoliopsida. The checklist currently contains 4 710 species of vascular plants in Gabon, including 82 introduced species. This number will fluctuate with new records and new species being discovered in the country, as well as with advances in taxonomic knowledge and improved identification of specimens. The authors estimate the total number of species present in Gabon to be between 7 000 and 7 500. The map illustrating the recorded species richness across Gabon per quarter-degree square, shows great similarity to the previous map indicating number of plant collections. This is not unexpected, since information on species density is largely dependent on the number of collections, even more so in an area that has not yet been thoroughly explored.

There are 508 strict endemics (10.8% endemism) in Gabon and a further 97 near-endemics. This figure will also fluctuate with new records and expanded knowledge. The map showing the distribution of endemic and near-endemic taxa in Gabon clearly shows the regions richest in endemics. This map also shows similarities to the previous maps indicating number of collections and species density. These endemic-rich areas are of the utmost importance in conservation efforts and it is good to see that some, although not all, are currently included in Gabon's National Parks network.

Under the last subheading, the number of collections per species is discussed. As can be seen from the accompanying histogram, over half of the species are known from only one to five specimens. This further highlights the fact that Gabon is severely under-collected and that the discovery of many more species can be expected as collecting is expanded in future.

The introductory chapter is concluded by a list of all the literature cited.

On the first two pages of the 404-page checklist, the format is explained in detail. The checklist records taxa in the following sequence: Lycopsidea, Pteropsida, Pinopsida and Magnoliopsida. Under each class, families are listed alphabetically, and then genera and species also alphabetically under each family. The most important synonyms of an accepted name are listed. The endemic, near-endemic or introduced status of relevant taxa is indicated. Cultivated taxa are not included in the checklist. At least one abbreviated literature reference is provided. This usually contains a good description of the taxon, or otherwise it is a publication that was used to verify the correctness of the name. An abbreviated list of Gabonese provinces in which the listed specimens were collected is given. The map on the inside back cover showing the provinces of Gabon also appears on the second page of this chapter, where the details of the checklist are explained. The altitudinal range of the taxon in Gabon is indicated, as well as any available notes relat-

ing to nomenclature, distribution or natural occurrence of the taxon. Each taxon account concludes with an alphabetical listing of specimens according to collector's name and number. Other information provided for each specimen includes the acronym of the herbarium or herbaria where duplicates of the specimen can be found, the name of the most recent identifier and the year of identification, if available. Type specimens and doubtful identifications are also indicated.

A reference chapter follows, providing the full version of the references abbreviated in the checklist. The publication ends with an index to genera, which facilitates the location of genera in the checklist.

The authors and institutions involved are congratulated on this production of the Plants of Gabon Project. As the authors of the publication anticipated, this checklist, as well as the database, will undoubtedly contribute to the continued conservation and wise utilization of Gabon's immense botanical wealth. More checklists of this quality and similar online databases are urgently needed to improve our knowledge, understanding and ability to manage and conserve Africa's unique flora.

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