South African Journal of Botany 92 (2014) 159–174

Contents lists available at ScienceDirect

South African Journal of Botany

journal homepage: www.elsevier.com/locate/sajb

Rich sister, poor cousin: Plant diversity and endemism in the Great Winterberg–Amatholes (Great Escarpment, Eastern Cape, South Africa)

V.R. Clark [a,*], A.P. Dold [b], C. McMaster [c], G. McGregor [d], C. Bredenkamp [e], N.P. Barker [a]

[a] Great Escarpment Biodiversity Programme, Department of Botany, Rhodes University Grahamstown, 6140, South Africa
[b] Selmar Schonland Herbarium, Department of Botany, Rhodes University, Grahamstown 6140, South Africa
[c] African Bulbs, P.O. Box 26, Napier 7270, South Africa
[d] Department of Geography, Rhodes University, Grahamstown 6140, South Africa
[e] National Herbarium, South African National Biodiversity Institute, Private Bag X101, Pretoria 0001, South Africa

ARTICLE INFO

Article history:
Received 20 June 2013
Received in revised form 3 January 2014
Accepted 4 January 2014
Available online 12 March 2014

Edited by RM Cowling

Keywords:
Afromontane
Amatholes
Amatolas
Cape Midlands Escarpment
Drakensberg Alpine Centre
Eastern Cape
Endemism
Floristics
Great Escarpment
Great Winterberg
Phytogeography
Sneeuberg
Stormberg

ABSTRACT

The Great Winterberg–Amatholes (GWA) is part of the Great Escarpment in southern Africa and 'sister' to the Sneeuberg and Stormberg ranges in the Eastern Cape. It comprises a historically well-sampled Amathole Component, and a poorly known Great Winterberg Component. Accordingly, overall plant diversity and endemism have been unknown. Here we define the boundaries of the GWA as an orographic entity and present a comprehensive list of taxa compiled from existing collection records supplemented by intensive fieldwork. With a flora of 1877 taxa, the GWA is surprisingly richer than the adjacent and larger Sneeuberg, but predictably poorer than the very much larger Drakensberg Alpine Centre (DAC). With 1.9% floristic endemism, the GWA could marginally qualify as a new centre of floristic endemism (complimentary to the adjacent Sneeuberg Centre), but formal recognition as a discrete Centre should await comprehensive floristic comparison with the adjacent, poorly studied Stormberg. Due to restricted distributions and pressure from commercial forestry, almost half of the 35 endemics have conservation listings as Rare or stronger, with one Presumed Extinct and three Endangered. Five endemics are still only known from their type specimens. Intensive fieldwork and accurate collation of available data is thus shown as essential for accurate biodiversity assessment and conservation planning in South Africa's montane regions.

1. Introduction

The Great Escarpment in the Eastern Cape Province, South Africa, has remained one of South Africa's least researched montane areas (Clark et al., 2011c), with available data collections often dating to the 1800s. Despite evidence of local montane endemism and complex phytogeographical affinities, very little floristic data has been available for detailed comparisons and conservation planning in this ecologically important region (Bester, 1998; Van Wyk and Smith, 2001). While broad-scale vegetation mapping and phytosociological surveys in the Eastern Cape have been very effective and informative in recent decades (Acocks, 1988; Palmer, 1988, 1990, 1991; Hoare and Bredenkamp, 1999, 2001; Low and Rebelo, 1998; Mucina and Rutherford, 2006, etc.), rigorous biodiversity inventory based on intensive fieldwork is essential as a complementary, fine-scale assessment of biodiversity.

The Cape Midlands in the Eastern Cape Province are bounded by three sets of mountains – the Sneeuberg, Stormberg and Great Winterberg–Amatholes (GWA; we have adopted 'Amathole' over 'Amatola' here) – that form part of the Great Escarpment in southern African (Clark et al., 2009, 2011c; Fig. 1B). Of the three, the Sneeuberg is now the most well documented floristically (Clark et al., 2009, 2011a; Nordenstam et al., 2009; Martínez-Azorín et al., 2011; Stirton et al., 2011), the GWA moderately well so, and the Stormberg the most poorly. This study addresses data deficiencies in the GWA.

The GWA is some 130 km long by 70 km wide, covering 7382 km^2, located between 32°00′–32°45′S and 25°50′–27°40′E (Fig. 1A–C; Plates 1–2; the study area delimitation method is provided in the Online Supplementary Material (OSM): Section 1). The highest altitude reached is 2367 m (Great Winterberg peak). The towns of Bedford, Adelaide, Fort Beaufort, Alice and Stutterheim occur along the southern edge at the foot of the Escarpment, with Tarkastad, Sada/Whittlesea and Cathcart along the northern edge. The GWA is divided into two roughly equal-sized parts (the Great Winterberg and Amathole Components) by

* Corresponding author. Tel.: +27 46 603 8111; fax: +27 46 603 7350.
E-mail address: vincentralph.clark@gmail.com (V.R. Clark).

0254-6299/$ – see front matter © 2014 SAAB. Published by Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.sajb.2014.01.008

the Hackney and Readsdale valleys, these being deep incisions into the GWA from the north and south, leaving a narrow montane bridge east of Devil's Bellows Nek on the R351 (near the Katberg Pass). We have termed this the 'Readsdale Constriction' (Fig. 1A).

Although William Burchell passed through the Sneeuberg in 1812–1813 (McKay, 1943) he did not visit the GWA, nor did Thunberg (Phillipson, 1987). The earliest botanical records from the GWA are thus those of C.F. Ecklon & C.L.P. Zeyher (collected from 1831–1832), 18 years after Burchell's Sneeuberg visit. Since then, the Amathole Component has been relatively well collected, with a large number of specimens lodged in the Selmar Schonland Herbarium (GRA), University of Fort Hare (UFH) and National Herbarium (PRE; Phillipson, 1987; a complete list of known collectors to the GWA is provided in the OSM: Section 2). From the mid-1950s to the 1980s, regular student excursions to the Hogsback area were organised by A.R.A. Noel, A. Jacot Guillarmod and R.A. Lubke (specimens in GRA). Phillipson (1987) indicates that by 1986 ca. 3000 specimens had been collected in the Amatholes. Although the Great Winterberg Component received more attention in the latter 1800s than the Amathole Component – through the efforts of *inter alia* J.F. Drège, E.E. Galpin and P. MacOwan – it has been largely neglected since then. This collecting bias since the early 1900s may be due to the Amathole Component's proximity to the larger population centres (e.g. King Williams Town and East London), the University of Fort Hare (in Alice, near its southern base), and the Dohne Agricultural Research Station. Road access onto the Amathole Component is also better than onto the Great Winterberg, particularly with the steady deterioration of the Katberg Pass in recent years (now only accessible by 4 × 4).

The main objectives of this paper are:

(1) To provide a comprehensive plant checklist for the GWA that will serve as a baseline reference for taxonomic, floristic, phylogenetic and ecological research and conservation in these mountains.
(2) To determine the level of floristic endemism in the GWA, particularly in relation to the Sneeuberg and Drakensberg Alpine Centres (DAC) of Floristic Endemism.
(3) To provide a comprehensive overview of the endemic and near-endemic taxa occurring in the GWA.

2. Methods

2.1. Compilation of the plant checklist

The following method was used to compile the plant checklist for the GWA:

(1) The starting point for a complete GWA checklist (Pteridophytes, Gymnosperms and Angiosperms) was Phillipson's (1987) list of 1192 taxa (the 23 'sp.' and 'spp.' being excluded) for his 900 km^2 portion of the Amathole Component (Fig. 1A). This was then augmented by a list of taxa obtained from the National Herbarium's Computerised Information System (PRECIS; Arnold and Steyn, 2005), creating a draft checklist.
(2) Extensive fieldwork was undertaken by VRC (et al.) from 2009–2011 in the Great Winterberg Component, totalling 2181 specimens (Table S1). These collections represent among the most recent and comprehensive field data for the Great Winterberg Component. The fieldwork systematically sampled all vegetation types in order to get representation across the broad climatic and altitudinal spectra. Particular topographic features of focus were the highest peaks, the extensive plateau wetlands, cliff-lines, and gorges. Specimens were identified in GRA. For some groups (Aizoaceae, *Alchemilla*, Apiaceae, Brassicaceae, *Cineraria*, *Cliffortia*, Cyperaceae, *Erica*, *Euryops*, Fabaceae, *Hermannia*, *Kniphofia*, *Lycium*, Orchidaceae, petaloid monocotyledons, Polygalaceae, Pteridophytes, Restionaceae) assistance from taxonomists was obtained (see Acknowledgements). The majority of the specimens are lodged in GRA, with duplicates sent primarily to the Bolus Herbarium (BOL), Compton Herbarium (NBG), Missouri Botanical Garden (MO), PRE and Swedish Museum of Natural History (S).
(3) Detailed fieldwork had been done in the Mpofu area in 2006 by CB, with members of the Botanical Society of South Africa and Mpofu Nature Reserve staff (specimens referenced to Bredenkamp CL and Mpupa L, Middelberg G, Steenkamp LP, and Van Stadon D in OSM: Appendix A). This resulted in 298 specimens from this poorly sampled lower to mid-altitude section of the Great Winterberg Component. The specimens were identified by staff at PRE, where they are also lodged.
(4) CM has been undertaking photographic botanical exploration of the GWA – particularly the lesser known inland parts of the Amathole plateau – for many years, resulting in the discovery of several local endemics and numerous important range extensions (Goldblatt, 2003; Dold, 2006; McMaster, 2007, etc.).
(5) APD has undertaken numerous exploratory trips to the GWA, notably the Katberg and the farm 'Glen Etive', and the inland margins of the GWA nearer Whittlesea/Sada.
(6) Additional collection records were obtained from H.P. Linder (Katberg Orchidaceae) and N.A. Helme (Great Winterberg, Finella Gorge and the Elandsberg).
(7) Available literature in GRA (notably taxonomic revisions) was perused for endemics and possible GWA records. Everard and Hardy's (1993) detailed forest work in the GWA was used to supplement forest taxa.
(8) Additional locality information for taxa with ambiguous localities was obtained using the African Plants Database (2013) and JSTOR's Global Plants (jstor.org/global-plants), as these sites provide the original taxonomic treatments/description citations of many poorly known taxa.
(9) Taxa on the plant checklist which could not been referenced through any of the above means (being mostly specimens from PRECIS) were checked against the locality descriptions of voucher specimens in GRA, and either assigned a voucher reference or deleted if their occurrence in the GWA could not be confirmed. A side benefit of the exercise was that many historical vouchers from early GWA botanical pioneers (notably E.E. Galpin, T.R. Sim, R. Story, etc.), which had not been included in Phillipson (1987), were added. Consequently, reliable data from two herbaria (i.e. GRA and UFH, which was Phillipson's, 1987, primary source) is reflected in the final plant checklist.
(10) Problematic specimens and taxa excluded from Appendix A are detailed in the OSM: Section 3.

As it would have been possible in Appendix A to reference many of the taxa from several sources (e.g. new vouchers, historical vouchers, photographs, literature citations etc.), the following referencing priority was employed: (1) VRC specimens, (2) CB (Mpofu) specimens, (3) Phillipson (1987), (4) other literature, (5) GRA specimens and other records such as those of APD, H.P. Linder and N.A. Helme, (6) and lastly, CM records (as these are mostly photographic; simply referenced as 'CM, pers. rec.'). Names were standardised according to Roux (2001) for Pteridophytes, and the African Plant Database (2013) for the remainder, with the exception of *Searsia* (which follows Moffett, 2007) and *Restio* (which follows Linder and Hardy, 2010).

2.2. Endemism

The plant taxa endemic to the GWA were determined from botanical revisions and publications available in GRA and on the internet (notably SANBI, 2012, the African Plants Database, 2013, and JSTOR's Global

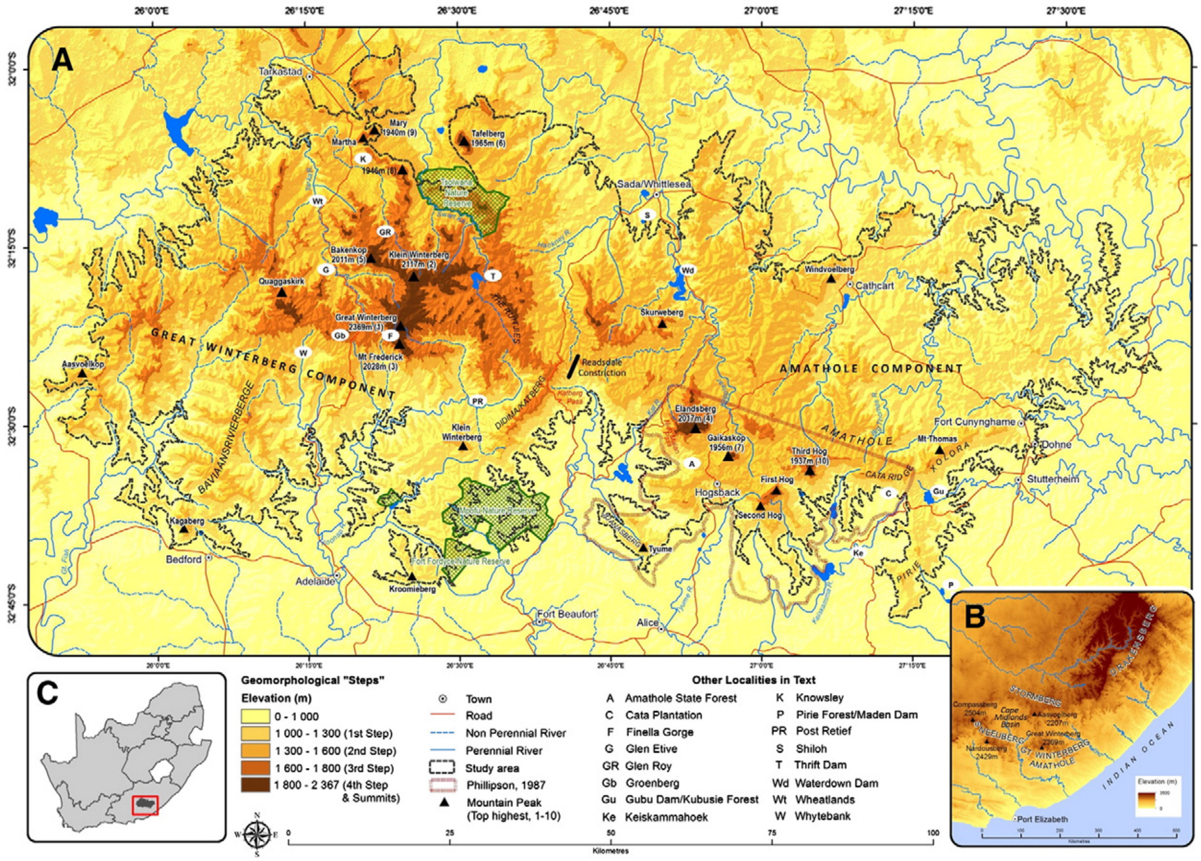

Fig. 1. The Great Winterberg–Amatholes: (A) Orographic delimitation, topography and localities mentioned in the text (note that Geomorphological "Steps" refers to the area between the southern edge of the study area and the main peaks, although the same elevation intervals have been used throughout); (B) Regional context; (C) South African context.

Plants), as well as from communications with several taxonomists. A review of the endemics was compiled, being the first comprehensive treatment of GWA endemics (Table 3). Percentage endemism was calculated against the total indigenous flora.

2.3. Floristic comparisons

The Sneeuberg is particularly suitable for comparison with the GWA given its close proximity (ca. ten kilometres to the west of the GWA). These sister mountain ranges are also similar in geology, latitude and altitude, although the Sneeuberg is overall drier (ca. 700 mm per annum) and larger (14,000 km^2; Clark et al., 2009, 2011d). The DAC – being that portion of the main Drakensberg escarpment above 1800 m (Van Wyk and Smith, 2001; Carbutt and Edwards, 2004, 2006) – is the second-closest montane system on the Great Escarpment with a comprehensive and reliable account of endemism and diversity with which to compare the GWA, although there are large differences in area (40,000 km^2) and substrate (mostly basalt).

Floristic comparisons were made at family, genus, species and endemic diversity levels. Appendix A was used for the GWA, and an updated version of Clark et al.'s (2009) Appendix A was used for the Sneeuberg (OSM: Appendix B). The DAC's family, genus and taxon diversity were determined by deleting the Bryophytes from Carbutt and Edwards's (2004) Table 2 (as the GWA and Sneeuberg floras do not include these), and adding the 166 naturalised aliens noted by them in the same paper (as their Table 2 only represents indigenous diversity). DAC endemic diversity was calculated by subtracting the 14 range extensions now known from the Sneeuberg and GWA (updated from Clark et al., 2009, and Table S5A) from Carbutt and Edwards's (2006) total endemic angiosperms, and adding the nine endemic Pteridophytes listed by Roux (2001). The number of DAC near-endemics in the GWA was calculated by taking Carbutt and Edwards's (2006) total of 595 near-endemic angiosperms, adding the 14 former DAC endemics (and one taxon not mentioned by them but confined to the DAC and GWA; Table S5E), giving a total of 608 taxa.

To place the GWA in the larger Great Escarpment context, basic species–area and endemic–area analyses (Cowling and Hilton-Taylor, 1994; Rosenzweig, 1995) were done using sections of the eastern Great Escarpment for which fairly reliable and comprehensive data exists: the 'Amatolas', Sneeuberg and DAC (as described above), the Wolkberg (from Cowling and Hilton-Taylor, 1994), the Mpumalanga–Limpopo Escarpment (from Van Wyk and Smith, 2001), and the Manica Highlands (Zimbabwe–Mozambique borderland; from unpublished data and Van Wyk and Smith, 2001).

3. Description of the vegetation cover

(To make the text less cumbersome, plant author names are only included for taxa not listed in Appendices A and B. A parallel, detailed account of local topographic features, geology and geomorphology, climate, hydrology, faunal value, land-use and historical value, and environmental challenges, are provided in the OSM: Sections 4–11).

3.1. Major vegetation types

Phillipson (1987) considers the 'Amatolas' (and this is true for the entire GWA) to be of special botanical interest due to its location in a region where six major African phytochoria – the Indian Ocean Coastal

Plate 1. The vegetation of the Great Winterberg–Amatholes (GWA) — Part 1: (A) Amathole Montane Grassland on the Kroomieberg (1130 m; part of the 1st Step), with Southern Mistbelt Forest on the south-facing slopes and along streams; (B) Karoo Escarpment Grassland on the Klein Winterberg (2100 m; part of the 4th Step), with Tafelberg (1965 m; a typical dolerite-capped inselberg) in the central background; (C) Amathole Mistbelt Grassland on the summit of the endemic-rich Didima Range/Katberg (1750 m; part of the 3rd Step; Mr G. Keevey in photograph); (D) Tarkastad Montane Shrubland on the drier, western slopes (1000 m) above the Great Fish River valley (note the regular strata of the Beaufort Series sediments, with dolerite forming the irregular summits of the hills); (E) Extensive *Thamnocalamus tessellatus* (Berg Bamboo) stands (up to three metres tall) below the western cliffs of the Great Winterberg peak (at 2200 m; part of the 4th Step; note the typical columnar dolerite which characterises many peaks in the Cape Midlands Escarpment); (F) Woody *Cliffortia paucistaminea* var. *paucistaminea* fynbos on the summit of the Kagaberg (1300 m; part of the 1st Step). Photographs: V.R. Clark.

Belt, Sudano–Zambezian Region, Karoo–Namib Region, Cape Region, and the Afromontane Region – meet. From Mucina and Rutherford (2006) it is evident that five biomes with 14 vegetation units are present, and one Azonal vegetation unit (Fig. 2; Table 1). Grassland is by far the dominant biome (82.1%), followed by Albany Thicket (7.4%), Savanna (6.4%), Forest (3%) and Nama-Karoo (0.7%).

3.1.1. Grassland

Seven of the GWA's vegetation units fall into this biome (Table 1). Amathole Montane and Mistbelt Grasslands (together with Drakensberg–Amathole Afromontane Fynbos — see below) form part of White's (1983) Afromontane and Afroalpine Shrubland vegetation type and Acocks's (1988) Dohne Sourveld. Amathole Mistbelt Grassland above 1800 m forms part of Killick's (1978) Afro-alpine region (Phillipson, 1987), and has been detailed by Cook (sine anno) for the highest peaks in the Amathole Component.

Covering 41.8% of the GWA, Amathole Montane Grassland is the most extensive grassland vegetation unit (Plate 1A). It is roughly synonymous with Hoare and Bredenkamp's (1999) *Eragrostio curvulae–Themedetum triandrae* group. It dominates the majority of the GWA on the 1st–3rd Steps and hosts the most number of GWA endemics (Mucina and Rutherford, 2006). As a vegetation unit it is 'near-endemic', occurring mostly in the GWA (69.9%), with a small outlier on the Boschberg (behind Somerset East) in the Sneeuberg, and a lower altitude extension extending eastwards from the GWA towards Komgha (Mucina and Rutherford, 2006).

Karoo Escarpment Grassland (Plate 1B) dominates the drier inland plateau and north-facing upland slopes of the GWA, particularly in the north-west, and covers some 21.7% of the GWA. This vegetation unit is typical of the mountains that encircle the Cape Midlands basin (Mucina and Rutherford, 2006). The GWA hosts 19.1% of its total extent, and many of the endemics shared between the Sneeuberg, GWA and Stormberg occur in this vegetation unit.

Although Amathole Mistbelt Grassland (Plate 1C) only covers 2.1% of the GWA, it is wholly confined ('endemic') to the GWA and is restricted to the higher, windward ridges and peaks (3rd–4th Steps). It is roughly synonymous with Hoare and Bredenkamp's (1999) *Themedo triandrae–Helichrysum aurei* (Amatholes) and *Andropogono appendiculati–Festucetum scabrae* (Great Winterberg) groups. It hosts several GWA endemics.

The remaining four grassland vegetation units occur mostly outside the GWA (Table 1). Tsomo Grassland and Queenstown Thornveld (part of Acocks's, 1988, False Thornveld and Invasion of Grassveld by *Acacia karroo* vegetation types) are typically lower-altitude vegetation units characterising the lower montane slopes and plains between the GWA and Stormberg. They vary from open grassland to *A. karroo* thornveld, and have been much abused through overgrazing. Tsomo Grassland (in particular) is consequently typically dominated by *Euryops floribundus* shrubs (Mucina and Rutherford, 2006). Tsomo Grassland extends into the GWA up the Thorn and Big Thomas River valleys in the Cathcart area, and Queenstown Thornveld up the Hackney River valley. Tarkastad Montane Shrubland is the typical vegetation of the drier inselbergs north and north-west of the GWA, but also occurs as a narrow band on the western and north-central edges of the GWA (Plate 1D). It is characterised by species such as *A. karroo*, *Aloe ferox*, *Diospyros austro-africana*, *Ehretia rigida* and *Searsia pallens* in arid montane grassland. Bedford Dry Grassland is extremely marginal in the south, and does not warrant further consideration.

Worthy of separate note, and almost exclusive in the GWA to Amathole Montane and Mistbelt Grasslands, are dense stands of the bamboo *Thamnocalamus tessellatus*, and Mucina and Rutherford's (2006) Drakensberg–Amathole Afromontane Fynbos. *T. tessellatus* (endemic to the GWA, Stormberg and DAC; Stapf, 1909; Childs, 1971; Soderstrom and Ellis, 1982) is restricted to the higher peaks above 1900 m, forms dense stands in fire-protected areas, and reaches heights of 2–3 m (Plate 1E). Drakensberg–Amathole Afromontane Fynbos, included by Mucina and Rutherford (2006) in their Grassland Biome, occurs as azonal communities in the GWA (Acocks, 1988; Hoare and Bredenkamp, 1999). Two types of fynbos can be recognised with altitude:

(1) On the 1st (and possibly 2nd) Steps, woody and shrubby species such as *Anthospermum monticola*, *Cliffortia linearifolia* and *C. paucistaminea* var. *paucistaminea* dominate where fire has been excluded. This fynbos completely replaces grassland with a 1–1.5 m tall dense, woody component comprised of relatively few species, and can be a precursor to *Leucosidea sericea* thicket and (possibly) ultimately forest (Story, 1952a, b; Childs, 1971; Phillipson, 1987; Acocks, 1988; Downing et al., 1998). Excellent examples occur on the Kagaberg and Kroomieberg (Plate 1F).

(2) On the 3rd–4th Steps, fynbos is characterised by a varied and rich mix of softer species such as *Cliffortia eriocephalina*, *Clutia impedita*, *Erica* sp. aff. *reenensis*, *E. woodii*, *Muraltia alopecuroides*, *M. alticola*, *Phylica galpinii*, *P. paniculata*, and Restionaceae such as *Restio distracta*, *R. schoenoides* and *R. sejunctus* (Cook, sine anno; Plate 2A). This fynbos appears to be a stable and non-replacing climax vegetation type restricted to high altitude screes, moist upland slopes, and rocky summits (Childs, 1971; Phillipson, 1987; Cook, sine anno). The 2nd Step does not host much fynbos, mostly due to the gently undulating landscape with few rocky outcrops to act as fire refugia, and land management practices that favour grassland (i.e. intensive grazing or regular fire).

3.1.2. Albany Thicket

Valleys of river systems that have incised into the southern sections of the GWA are dominated by Eastern Cape Escarpment Thicket and Great Fish Thicket of the Albany Thicket Biome (Acocks's, 1988, Valley Bushveld). Everard and Hardy (1993) indicate thicket in the GWA totals 462.8 km^2, less than our 541 km^2 — this discrepancy perhaps arises from the intergrading of Forest and Thicket and the resultant vegetation ambiguity.

Eastern Cape Escarpment Thicket is typical of the steep slopes and dissected side-valleys of the southern, lower scarp slopes (Plate 2B), 17% of this vegetation unit occurring in the GWA. It replaces Southern Mistbelt Forest on drier aspects, and intergrades with it seamlessly, particularly west of the Katberg. Lower and north-facing slopes are composed of a dense, 3–4 m tall compact thicket with a 1.2–2 m sub-canopy gap, with a variety of groundcovers at ground level. On moister, mid-slopes trees become larger (5–10 m), with a sparse understory and a ground cover of mostly leaf-litter. On the upper slopes and crest the vegetation once again becomes short and compact. Species composition varies tremendously, with the following broad cross-section of woody taxa: *A. karroo*, *Azima tetracantha*, *Ehretia rigida* subsp. *rigida*, *Euphorbia tetragona*, *E. triangularis*, *Grewia occidentalis* var. *occidentalis*, *Gymnosporia buxifolia*, *G. polyacantha*, *Maytenus undata*, *Ochna serrulata*, *Olea europaea* subsp. *africana*, *Ptaeroxylon obliquum*, *Scolopia zeyheri*, *Scutia myrtina* and *Searsia lucida* forma *lucida*. Climbers are abundant: *Behnia reticulata*, *Capparis sepiaria* var. *citrifolia*, *C. tomentosa*, *Cynanchum ellipticum*, *Jasminum angulare*, *J. multipartitum*, *Rhoicissus digitata*, *R. tridentata* and *Secamone alpini*. At lower altitudes, succulent, geophytic and shrubby Nama-Karoo elements are common.

Great Fish Thicket is a drier, lower altitude version of Eastern Cape Escarpment Thicket, typically dominated by *E. tetragona* and *E. triangularis*. Somewhat marginal (only covering 4.4% of the GWA), it is not a typical montane thicket type, but has made use of the deep Baviaansrivier and associated valleys in the south-west to penetrate the Escarpment.

3.1.3. Savanna biome

The Savanna biome is represented by Eastern Valley Bushveld and Bhisho Thornveld, both of which are marginal to the GWA (Table 1). Eastern Valley Bushveld (part of Acocks's, 1988, Valley Bushveld) is typical of riparian ravines in the region, and is represented in the lower reaches of the Thomas River in the north-east of the GWA. Bhisho Thornveld – a form of *A. karroo* woodland similar to Queenstown Thornveld (and also part of Acocks's, 1988, False Thornveld and Invasion of Grassveld by *A. karroo* vegetation types) – occurs on the dissected plateau above Eastern Valley Bushveld in the north-east of the GWA, and on the fragmented mid-altitude plateaux (1st Step) in the Katberg Valley–Nico Malan Pass–Tyume area.

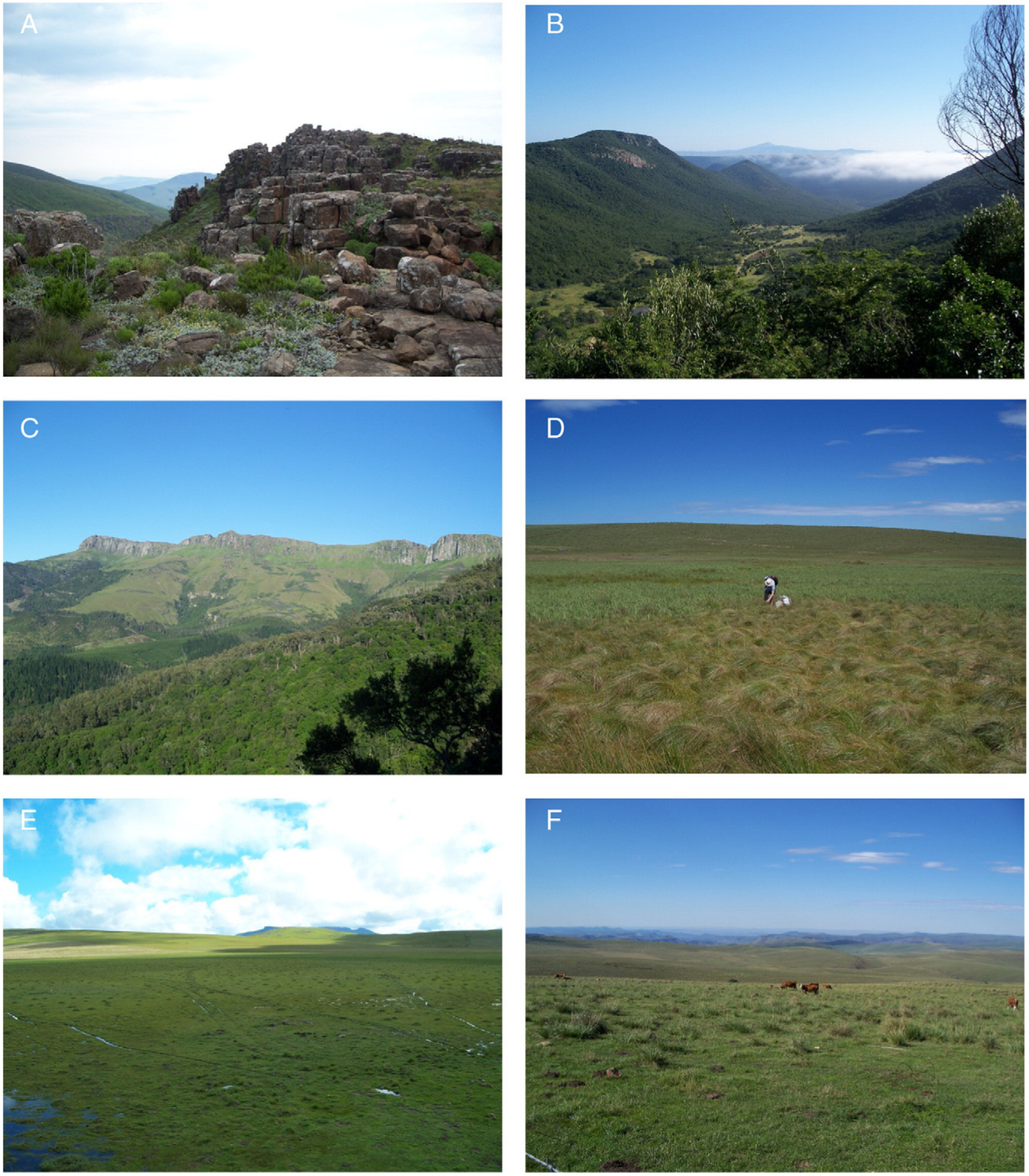

Plate 2. The vegetation of the Great Winterberg–Amatholes (GWA) — Part 2: (A) Herbaceous fynbos on the summit of the Didima Range/Katberg (1720 m; part of the 3rd Step); (B) Dense and largely impenetrable Eastern Cape Escarpment Thicket in the dissected region north of the Kroomieberg (1100 m; part of the 1st Step; the Great Winterberg peak, 2367 m and part of the 4th Step, in the central distance); (C) Extensive Southern Mistbelt Forest on the lower slopes of the Didima Range/Katberg (bottom and right), with some riparian/gulley patches on the midslopes (centre), and commercial forestry pines (centre and bottom left); (D) An example of the extensive eastern temperate freshwater wetlands in the GWA, here on the rolling upland plateau south of Quaggaskirk (1700 m; part of the 3rd Step; VRC in photograph); (E) The Ruitjies (1730 m; part of the 3rd Step) — an extensive and almost featureless rolling plateau with valleys dominated by permanent wetlands and seasonally flooded grassland (note the Great Winterberg peak in the background); (F) A view from the 3rd Step (here the Quaggaskirk ridge at 1925 m, foreground) southwards over the 2nd Step (mid-ground) and 1st Step (dissected plateaus in the distance). Photographs: V.R. Clark (A–C, E, F), V. Van der Merwe (D).

3.1.4. Forest

The first note on the GWA's forests was Sim's (1907) inclusion of the Amathole forests in his Cape Colony forests overview. These forests fall into Mucina and Rutherford's (2006) Southern Mistbelt Forest vegetation unit (part of White's, 1983, Undifferentiated Afromontane Forest), with the GWA hosting 20% of this vegetation unit. Although only covering 3% of the GWA, they are of great ecological and faunal biodiversity value (OSM: Section 9). Forest occurs patchily on the south-facing scarps between the base of the Escarpment and the 3rd Step (Plates 1A, 2C), with patch size varying from 3 to 4990 Ha (Everard and Hardy, 1993; Geldenhuys and Rathogwa, 1997). Everard and Hardy (1993) indicate there are some 221 individual forest patches totalling 405.5 km^2; this

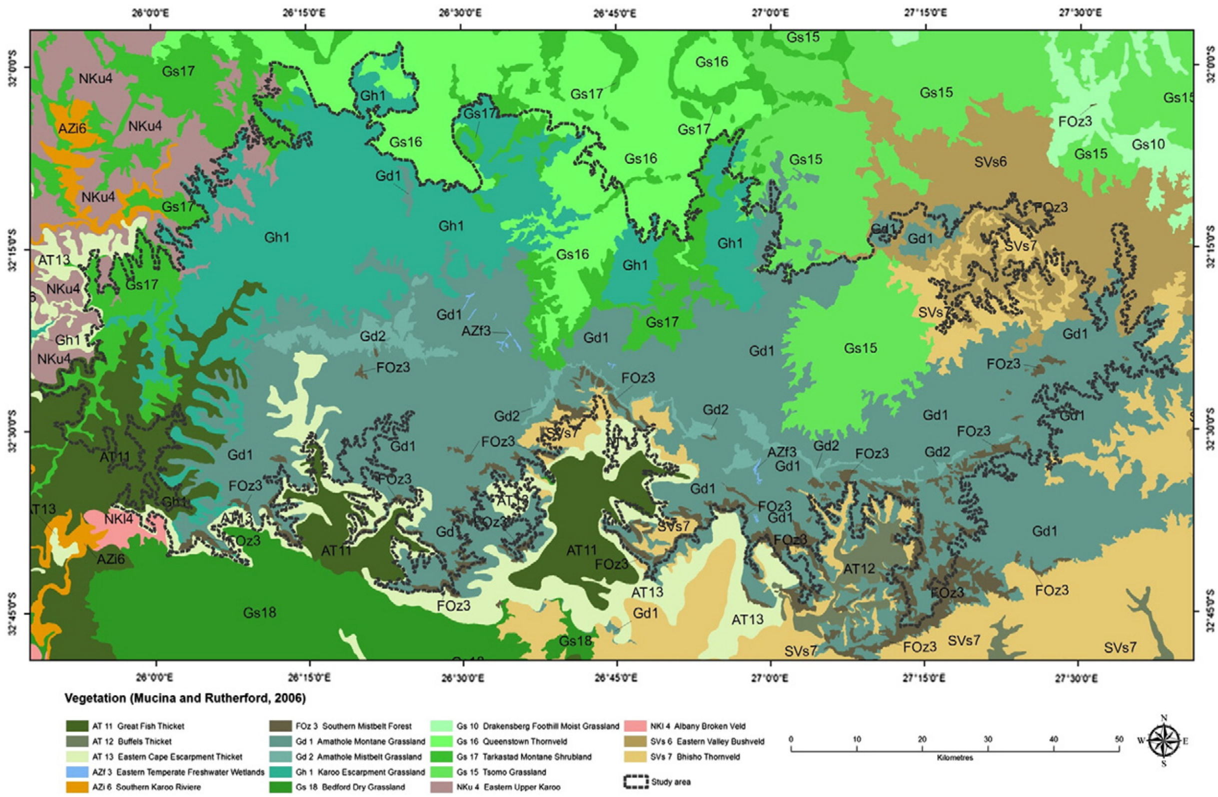

Fig. 2. Vegetation units in the Great Winterberg–Amatholes (from Mucina and Rutherford, 2006).

is roughly twice the coverage calculated by us (219.6 km^2) and is because many of the larger forest sections (e.g. Pirie Forest) extend beyond the lower altitude limits used by us to define the GWA.

Overall, forests are structurally better developed and more species rich in the Amathole Component (Phillipson, 1987), while in the Great Winterberg Component they are very fragmented, less species rich, and have a lower canopy height. Forest intergrades extensively with Eastern Cape Escarpment Thicket at lower altitudes due to variations in aspect and moisture availability, particularly in the Great Winterberg Component between Mpofu Nature Reserve and the Kagaberg. In a detailed floristic survey of the Amathole Component's forests, Everard and Hardy (1993) recorded 233 forest taxa. Acocks (1988) considered these ‘Dohne’ forests to be richer (notably with more climbers) than those further north along the Great Escarpment. Species compositions vary tremendously between forests fragments, but Everard and Hardy (1993) list certain ‘common denominators’ that occur throughout, including *Diospyros whyteana*, *Elaeodendron croceum*, *Harpephyllum caffrum*, *Scolopia mundii* and *Trichocladus ellipticus* subsp. *ellipticus*. From our observations, other characteristic trees include *Afrocarpus falcatus*, *Calodendrum capense*, *Celtis africana*, *Chionanthus foveolatus*, *Clausena anisata* var. *anisata*, *Cussonia spicata*, *Mystroxylon aethiopicum* subsp. *aethiopicum*, *Ochna natalitia*, *Olea capensis* subsp. *macrocarpa*, *Podocarpus latifolius*, *Searsia chirindensis*, *S. dentata*, *Trimeria trinervis* and *Zanthoxylum capense*. Typical forest floor and understory taxa are *Asparagus setaceus*, *Behnia reticulata*, *Chlorophytum comosum*, *Cyperus albostriatus*, *Dietes iridioides* and *Streptocarpus rexii* (Everard and Hardy, 1993). There is a rich fern flora, especially in the Amathole Component, typical taxa including *Adiantum poiretii*, *A. aethiopicum* subsp. *aethiopicum*, *A. stoloniferum* and *Cyathea capensis* var. *capensis*.

Table 1
Biomes and vegetation units in the Great Winterberg–Amatholes (GWA) (data from Mucina and Rutherford, 2006; figures in parentheses indicate rankings in order of decreasing magnitude).

Biome	% of GWA	Vegetation Unit	Area in GWA (km^2)	% of GWA	Proportion occurring in GWA (%)
Albany Thicket	7.4 (2)	Eastern Cape Escarpment Thicket	219.4	3.0 (8)	17.0 (5)
	(=541.0 km^2)	Great Fish Thicket	321.6	4.4 (5)	4.8 (9)
Azonal	0.1 (6)	Eastern Temperate Freshwater Wetlands	5.2	0.1 (11)	0.9 (12)
Forest	3.0 (4)	Southern Mistbelt Forest	219.6	3.0 (8)	20.0 (3)
Grassland	82.1 (1)	Amathole Mistbelt Grassland	158.2	2.1 (9)	100.0 (1)
	(=6303.9 km^2)	Amathole Montane Grassland	3086.9	41.8 (1)	69.9 (2)
		Bedford Dry Grassland	0.5	0 (12)	0 (14)
		Karoo Escarpment Grassland	1601.2	21.7 (2)	19.1 (4)
		Queenstown Thornveld	283.5	3.8 (6)	7.9 (7)
		Tarkastad Montane Shrubland	547.5	7.4 (3)	12.9 (6)
		Tsomo Grassland	406.5	5.5 (4)	6.6 (8)
Nama-Karoo	0.7 (5)	Albany Broken Veld	1.1	0 (12)	0.1 (13)
	(=55.1 km^2)	Eastern Upper Karoo	54.0	0.7 (10)	0.1 (13)
Savanna	6.4 (3)	Bhisho Thornveld	253.9	3.4 (7)	3.2 (10)
	(=477.0 km^2)	Eastern Valley Bushveld	223.1	3.0 (8)	2.2 (11)

3.1.5. Nama-Karoo

Nama-Karoo is represented by small incursions of Albany Broken Veld and Eastern Upper Karoo in the north-west. Being marginal it is not considered further.

3.1.6. Eastern temperate freshwater wetlands

Although only covering 0.1% of the GWA, extensive seasonal and perennial wetland systems occur on the larger plateau sections of the 1st–3rd Steps. It is possible many have not yet been mapped into Mucina and Rutherford's (2006) *Vegetation of South Africa* database. These systems vary from large (ca. 50 Ha) perennial valley head systems dominated by *Carex zuluensis* (Plate 2D), to seasonal wetlands/ flooded grasslands dominated by a mix of species such as *Sporobolus fimbriatus*, *Fingerhuthia sesleriiformis* and *Pennisetum sphacelatum* (Plate 2E). Although some of these systems have been partly inundated by farm dams, there are extensive intact systems on The Ruitjies, forming the headwaters of the Swart Kei. Apart from a few 'wetland specials' such as *Nerine angustifolia* and *Wurmbea elatior*, plant biodiversity is not high or particularly special, but the ecological value of these wetlands cannot be over-emphasised (Critical Ecosystem Partnership Fund, 2010).

3.2. Palaeohistory

Palaeo-ecological reconstruction from 12,500 BP until recent times, based on pollen preservation in two large wetlands near the Elandsberg, suggests that the current vegetation assemblage has remained much the same over most of that time (Meadows and Meadows, 1988). Meadows and Meadows (1988) postulate that, immediately prior to this, drier karroid elements dominated in response to the Last Glacial Maximum (LGM), and that forest was either absent or confined to very small areas. Montane forest is consistently represented in the pollen record from ca. 8000 BP, but does not appear to have expanded much beyond existing current patches (Meadows and Meadows, 1988; Meadows and Linder, 1993). This contradicts Acocks's (1988) view that the current Afromontane grassland is an anthropogenically-exacerbated replacement of an original contiguous forest cover.

4. Plant diversity in the GWA

4.1. Composition

The GWA flora comprises 1877 taxa, representing 155 families and 660 genera (Table 2; Fig. 3A; Appendix A). Dicotyledons dominate the flora at family, genus and species levels, followed by lower representation of Monocotyledons and Pteridophytes, and very few Gymnosperms. The flora is predominantly indigenous (1750 taxa or 93.2%) with 127 taxa (6.8%) being naturalised or invasive aliens. Of the indigenous taxa, 35 taxa (1.9%) are strict endemics (Table 3). This checklist is considered reliable and representative, whilst recognising that continued work – particularly of the inland plateau and isolated adjacent inselbergs – will continue to add new records.

4.2. Comparison with Phillipson's (1987) 'Amatolas'

An absolute numerical comparison with Phillipson's (1987) 'Amatolas' list is difficult given the large number of taxonomic changes since 1987, but based on a simple comparison of totals our flora exceeds Phillipson's (1987) by 23 families (many from the fragmentation of Liliaceae), 128 genera and 685 taxa. Phillipson's (1987) list comprises 63.5% of our total, while only covering 12% of the GWA.

4.3. Comparison with the floras of the Sneeuberg and DAC

GWA floral diversity is higher than the Sneeuberg's, and very much lower than the DAC's (Fig. 3A). As species diversity generally increases with area (Rosenzweig, 1995), it is surprising that the GWA – at half the size of the Sneeuberg – has 412 more taxa. Clark et al. (2011d) consider this to be the effect of climate filtering westwards through decreasing rainfall, given that other factors between the two mountain blocks are similar (geology, alien species number, collecting intensity, altitudinal range) and they are separated by only a narrow interval. Climate filtering is reflected in Orchidaceae being the fourth largest family in the GWA, with 84 taxa, compared to Sneeuberg's eight taxa (Fig. S3A, B); the higher ranking of Iridaceae in GWA than in Sneeuberg; the presence of two succulent-dominant families (Aizoaceae and Crassulaceae) in Sneeuberg's top ten families; and the widespread presence of well-developed Afromontane forest on the GWA, whereas only scattered, poorer versions exist on the Sneeuberg.

The much smaller flora compared to the larger DAC fits the pattern of increased diversity with increased area (Rosenzweig, 1995). A comparison with the total Drakensberg (i.e. the DAC plus the Drakensberg below 1800 m — i.e. Cowling and Hilton-Taylor's, 1994, Eastern Mountain Region) would probably increase this difference further. However, despite the large difference in taxa, Clark et al. (2011d) noted that the GWA (based on a data set of 1498 indigenous taxa for the GWA) was floristically more similar to the DAC than to the Sneeuberg. This emphasises climate filtering as more important (in this region) to diversity than physical proximity. Similarly, Cook (sine anno) indicates that 61% of a sample of 116 taxa from above 1800 m in the Amathole Component belongs either to the DAC or CFR. This supports Galley et al.'s (2007) CFR–DAC link, and Weimarck's (1941) south-east connection from the CFR onto the Great Escarpment (Clark et al., 2011d). How these taxa then spanned the intervening 200 km between the GWA and DAC is still to be tested — possibilities are north via the Stormberg (quite probable) or north-east via the Transkei sub-Escarpment (also quite probable). The presence of many CFR and DAC taxa on the GWA (compared to the Sneeuberg) is likely due to its overall higher and more consistent rainfall pattern (Phillipson, 1987), supporting both summer and winter rainfall taxa, and again supporting climate filtering as the primary role-player in local biodiversity assemblages.

Asteraceae, Poaceae and Fabaceae are the top three families represented in the GWA (Fig. S3A). This pattern is the same for the Sneeuberg and DAC (Fig. S3B, C). At 14% of the total GWA flora, Asteraceae is by far the largest family represented, exceeding the next largest family – Poaceae – by 7%; this is similar in both the Sneeuberg and DAC, with an 8% and 6% difference respectively. There is close similarity in GWA and DAC family dominance, the only difference in the top ten being Euphorbiaceae in the GWA and Asphodelaceae in the DAC. Interestingly, Orchidaceae ranks higher in the top ten GWA families than in the DAC, where it is superseded by Scrophulariaceae, suggesting that the latter better tolerates the higher altitude conditions of the DAC.

4.4. Comparisons along the eastern Great Escarpment

Fig. 3B indicates that not only is the GWA of 'below average' species diversity for its areal extent on the eastern Great Escarpment (i.e. the Sneeuberg to Manica Highlands), but also that area is not a good predictor of species diversity or endemism for this 1500 km-stretch of Great Escarpment. The Afromontane region has often been described as 'archipelago-like' (White, 1983), suggesting that the strong species-area relationship typical of island groups (Rosenzweig, 1995) may apply to the Afromontane region. While this would need to be tested for the entire Afromontane region, the initial results in Fig. 3B suggest that other parameters – such as topographical heterogeneity, rainfall range, annual frost days/minimum temperature, potential evapotranspiration, altitude and geological substrate (Cowling et al., 1997; Cowling and Lombard, 2002; Thuiller et al., 2006) – may be more important, and should be tested further (Van Wyk and Smith, 2001).

Table 2
The main components of the Great Winterberg–Amatholes flora.

Main plant divisions	Families		Genera		Taxa	
	No.	%	No.	%	No.	%
Pteridophytes	19	12.3	39	5.9	89	4.7
Gymnosperms	4	2.6	5	0.8	10	0.5
Monocotyledons	26	16.8	162	24.5	536	28.6
Dicotyledons	106	68.4	454	68.8	1242	66.2
Total:	**155**	**100**	**660**	**100**	**1877**	**100**
Endemic, alien, indigenous representation						
Endemic	0	0	0	0	35	1.9
Alien	7[a]	4.5	64[a]	9.7	127	6.8
Non-endemic indigenous	148[b]	95.5	596[b]	90.3	1715	91.4
Total:	**155**	**100**	**660**	–	**1877**	**100**

[a] Only those with no indigenous taxa.
[b] Include those with some alien taxa.

5. Endemism in the GWA

5.1. Strict GWA endemics

There are no families or genera endemic to the GWA (or Sneeuberg), compared to five genera in the DAC (Carbutt and Edwards, 2006). While the GWA is richer in the actual number of endemics than the Sneeuberg (by ten), floristic endemism is the same (1.9% of their native floras). Both have much lower floristic endemism than the DAC, which at 12.6% is proportionally ten-times richer, and both are ‘below average’ for endemism on the eastern Great Escarpment (Fig. 3C).

GWA endemism is biased towards the Amathole Component, which has 11 local endemics compared to the Great Winterberg Component's seven (Table 3). The remaining 17 bridge the ‘Readsdale Constriction’, with a notable presence on the Katberg. This Amathole–Katberg bias largely mirrors areas of higher mean annual precipitation (Fig. S1), but a purely climatic explanation does not take into account drier northern slope specialist taxa such as *Heliophila brassicifolia* and *Nerine filamentosa*. Another reason may be that the Amathole Component (particularly the scarp) has been historically much better sampled, and continued work in the Great Winterberg Component may reveal hitherto undetected taxa.

There is unequal representation of families among endemics in the GWA, Sneeuberg and DAC, with similarities stopping at Asteraceae being the dominant family in all three (Fig. S4A–C). This is probably due to the randomness inherent in speciation events. It is surprising however that there are no endemic *Kniphofia* (Asphodelaceae) in the GWA, a genus characterised by local endemism in the Afromontane region (Ramdhani et al., 2008). It is possible that unbroken genetic connectivity between GWA *Kniphofia* populations and the moist east Coast and Transkei sub-Escarpment has prevented genetic drift, compared to climatic isolation in the Sneeuberg (with its endemic *Kniphofia acraea*) and high altitude and/or basaltic edaphic isolation in the DAC (with its five endemics; Carbutt and Edwards, 2006; Clark et al., 2009). The closest is three DAC-near endemic species (*K. caulescens*, *K. fibrosa* and *K. northiae*) in the GWA, *K. caulescens* also occurring locally in the Sneeuberg.

With one species already Presumed Extinct (*Alepidea multisecta*), three Endangered (*Aspidoglossum uncinatum*, *Cineraria vagans* and *Cyrtanthus suaveolens*; Plate 4E), and almost half listed in risk categories

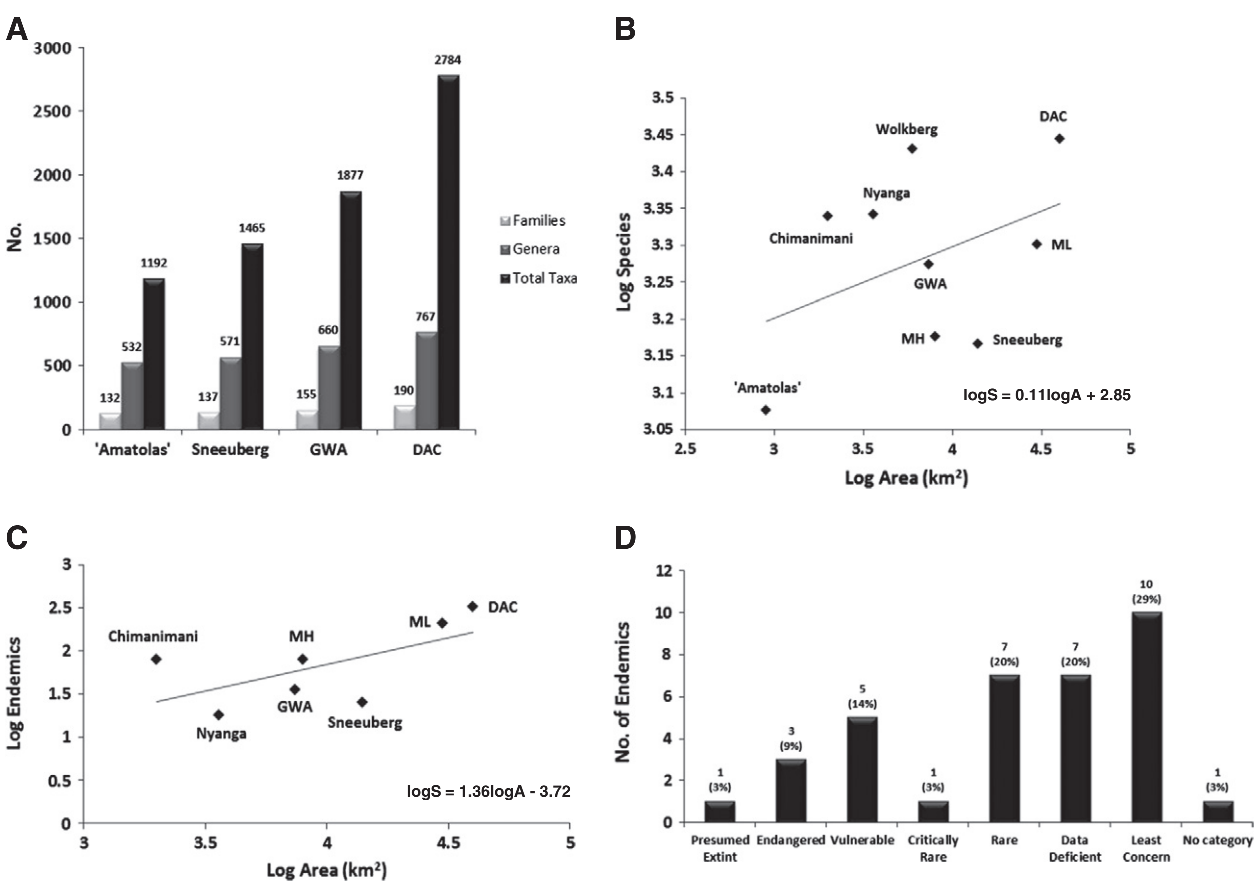

Fig. 3. Great Winterberg–Amatholes (GWA) floristic comparisons and endemic conservation statuses: (A) Family, genus and taxon comparisons for Phillipson's (1987) ‘Amatolas’, GWA, Sneeuberg and Drakensberg Alpine Centre (DAC); (B)–(C) Species-area and endemic-area relationships along the eastern Great Escarpment (MH = Manica Highlands, ML = Mpumulanga–Limpopo Escarpment); (D) Conservation status distribution among the 35 GWA endemics.

Table 3
Plant taxa endemic to the Great Winterberg–Amatholes (GWA) (vegetation units as per Mucina and Rutherford, 2006; Red Data statuses as per SANBI, 2012; herbaria abbreviations: B = Botanic Garden & Botanical Museum Berlin-Dahlem; BOL = -Bolus Herbarium, University of Cape Town; GRA = Selmar Schonland Herbarium, Albany Museum; LD = Lund University Botanical Museum; K = Royal Botanical Gardens, Kew; MO = Missouri Botanical Gardens; NBG = Compton Herbarium, Kirstenbosch Botanical Garden; NYBG = William & Lynda Steere Herbarium, Botanical Garden of New York; P = Paris Museum of Natural History; PRE = National Herbarium, Pretoria; S = Swedish Museum of Natural History).

Taxon	Notes and references
Alepidea multisecta B.L. Burtt	Amathole Component endemic, only known from the type collected on Gaika's Kop (Grant AL, Blenkiron M.-E. 3071, 1940 m, December 1926, BOL). Amathole Mistbelt Grassland. Presumed Extinct due to afforestation of the type specimen's habitat and failure to rediscover the species. SANBI (2012).
Arrowsmithia styphelioides DC.	GWA endemic. Common from 1200 to 2000 m in Amathole Mistbelt and Amathole Montane Grasslands. Least Concern. Van Wyk and Smith (2001).
Aspalathus katbergensis (Dahlg.) Dahlg.	GWA endemic, from the Katberg eastwards, 1200–1400 m. Unconfirmed on the Boschberg by Clark et al. (2011a). Amathole Montane Grassland. Vulnerable due to afforestation and overgrazing. Dahlgren (1988).
Aspidoglossum uncinatum (N.E.Br.) Kupicha	GWA endemic, from the Katberg to Stutterheim. Endangered due to afforestation threats. SANBI (2012).
Brachystelma cathcartense R.A. Dyer.	Amathole Component endemic, only known from one population near Cathcart. Vulnerable. Craib (1993); Dold and Cumming (2002); Dold (2006). Plate 3I.
Cineraria vagans Hilliard	GWA endemic, known from the Katberg Pass, the Elandsberg, and the Nico Malan Pass. According to Hilliard and Burtt (1988b) occurs on the Sneeuberg and GWA, but Cron et al. (2006) consider it endemic to the GWA. Amathole Mistbelt Grassland. Endangered.
Ceropegia macmasteri A.P. Dold	Amathole Component endemic. Only known from one population near Cathcart. Vulnerable. Dold (2006). Plate 4K.
Crassula sediflora var. *amatolica* (Schonland) Tölken	Amathole Component endemic, only known from the type collected at Cata Ridge (Dyer RA 356, 1820 m, December 1925, LD, PRE). Although much of the area has been afforested, the habitat described on the label ('grass and rocks near swampy stream') suggests that it might still exist given the required riparian zone protection in forestry legislation. Amathole Mistbelt Grassland. Data Deficient. Tölken (1977).
Cyrtanthus suaveolens Schonland	Amathole Component endemic, known from Mount Thomas to Stutterheim. Amathole Mistbelt Grassland. Endangered due to threats from afforestation. Schonland (1914); CM (pers. data). Plate 4E.
Delosperma alpinum (N.E. Br.) S.A. Hammer & A.P. Dold	GWA endemic, from the Katberg, Hogsback and Cata Ridge. Occurs at high altitude on dolerite scree. Amathole Mistbelt Grassland. Rare. Brown (1927); Bolus (1927); Hammer and Dold (2002). Plate 3C.
Delosperma katbergense L. Bolus	GWA endemic, from the Katberg to Hogsback. Occurs in sandstone crevices at 1200–1700 m. Amathole Mistbelt Grassland. Rare. Bolus (1927); Hartmann (2002).
Erica amatolensis E.G.H. Oliv.	GWA endemic, from the Katberg to Stutterheim, 1000–1600 m. Forest margin, grassland. Amathole Montane Grassland. Least Concern. Oliver (1994).
Euphorbia ovata (E. Mey. ex Klotzsch & Garcke) Boiss.	Great Winterberg Component endemic, only known from the Katberg. Several specimens exist: two specimens at K without collector or locality details (but with a note on each by N.E. Brown stating they are duplicates of Drège JF 3561 from E. Meyer's Herbarium; dated 1822 and not 1832); Drège JF 3561, 'Kalberg' (=Katberg — the 't' here in De Candolle, 1862, is fainter than others), November 1832, P; Drège JF s.n., no locality or date, P; Drège JF s.n., no locality or date (but with a note based on De Candolle, 1862, that it is probably a duplicate of Drège JF 3561), MO; Drège JF s.n., 1840, NYBG; Ecklon CF, Zeyher CLP s.n. or 12.3 (perhaps wrongly attributed to them; Drège, 1847, is quoted for detailed habitat data), S. Originally described by E. Meyer in Drège (1843), detailed by Klotzsch (1860), De Candolle (1862) and Brown et al. (1925). From the S specimen, quoting Drège: 'Katberg, above woods, in grassy plateaux, stony areas, and in swamps'; from Brown et al. (1925), quoting label on Drège JF 3561: collected 'on a mountain between the Kat and Klipplaat Rivers' at 1200–1500 m (which is not strictly the Katberg — actually more Mount Misery–Elandsberg direction). Not Red Data listed, but should be Data Deficient.
Euryops ciliatus B. Nord.	Amathole Component endemic. Abundant on the Elandsberg. Occurs on damp dolerite slopes/cliffs above 1550 m. Amathole Mistbelt Grassland. Rare. Nordenstam (1969), Helme, pers. comm.. Plate 3D.
Euryops dyeri Hutch.	GWA endemic. Occasional in rocky montane grassland above 1650 m. Amathole Mistbelt and Amathole Montane Grasslands. Rare. Nordenstam (1969). Plate 3G.
Geranium amatolicum Hilliard & B.L. Burtt	GWA endemic. Common. Amathole Mistbelt and Amathole Montane Grasslands. Least Concern. Hilliard and Burtt (1985).

Geranium contortum Eckl. & Zeyh.	GWA endemic. Common. Amathole Mistbelt and Amathole Montane Grasslands. Least Concern. Hilliard and Burtt (1985).
Geranium discolor Hilliard & B.L. Burtt	According to Hilliard and Burtt (1985), a GWA endemic. According to SANBI (2012), possibly also occurs on the Stormberg. Common. Amathole Mistbelt and Amathole Montane Grasslands. Least Concern.
Geranium grandistipulatum Hilliard & B.L. Burtt	GWA endemic. Common. Amathole Mistbelt and Amathole Montane Grasslands. Least Concern. Hilliard and Burtt (1985). Plate 3H.
Helichrysum isolepis Bolus	Great Winterberg Component endemic, occurring on the Great Winterberg and Katberg. Occurs in stony montane grassland. Amathole Mistbelt and Amathole Montane Grasslands. Rare. Hilliard (1983).
Helichrysum montis-cati Hilliard	GWA endemic, known from Katberg Pass, Cata Forest Reserve and the 'Amatola mountains'. Vulnerable. Hilliard (1983).
Heliophila brassicifolia Eckl. & Zeyh.	Amathole Component endemic, between 1500 and 1700 m. The type (Ecklon CF, Zeyher CLP 28093, NBG) indicates that it was collected at 'Silo in Tambukiland'. As other Ecklon & Zeyher specimens combine Tambukiland and the Klipplaatrivier, it is probable that 'Silo' is Shiloh, and the plants were collected on the drier inland edge of the GWA. Data Deficient.
Heliophila katbergensis Marais	Great Winterberg Component endemic, only known from the type collected on the Katberg summit (Hutchinson J 1614, November 1928, PRE). No further data, Amathole Mistbelt Grassland. Data Deficient. Marais (1970).
Hesperantha stenosiphon Goldblatt	GWA endemic, from the Katberg eastwards. Originally collected in the Cathcart area, our collection is a range extension onto the Katberg, where locally common (Clark VR, Keevey G 192, Katberg Pass, March 2011; Clark VR, Keevey G 220, Katberg, March 2011; both in GRA; dets J. Manning, by photograph). Amathole Mistbelt Grassland, and cliffs in Southern Mistbelt Forest. Least Concern. Goldblatt (2003). Plate 3F.
Hypoxis sagittata Nel	Described by Nel (1914) from a specimen collected 'between the Kat and Klipplaat rivers' (Drège JF 3515, November 1832, B), possibly the Katberg, as this is the same label locality for the type of *Euphorbia ovata* (see above). The area described is actually more in the Mount Misery–Elandsberg direction, but we consider this a Great Winterberg Component endemic (Katberg) until further information is available. Nel (1914) refers to it as an Ecklon specimen. In her recent treatment of *Hypoxis*, Singh (2009) considers it to be insufficiently known due to a paucity of specimens, and does not address it further; it is only mentioned in passing by Wiland-Szymanska (2001). A tetra-petaloid *Hypoxis* collected on the Katberg summit (see *Hypoxis tetramera* in Table S5D) in December 2010 (Clark VR, Daniels RJ 493, GRA) was identified from the photographs as *H. tetramera* (det. Y. Singh). Examination of the voucher might indicate it to be *H. sagittata*, and the two species may even be conspecific. Interestingly enough, SANBI (2012) considers it to be Least Concern with a stable population!
Lotononis alpina (Eckl. & Zeyh.) B.-E. Van Wyk subsp. *alpina*	Great Winterberg Component endemic. A poorly known taxon. There is a recent collection from Finella Gorge (Helme NA 7718, 1620 m, February 2013, NBG). Amathole Mistbelt Grassland. Data Deficient. Van Wyk (1991); Helme, pers. comm. Plate 3E.
Lotononis harveyi B.-E. Van Wyk	Great Winterberg Component endemic, only known from the type collected on the 'Winterberg' (Barber FW 43, K). Data Deficient. Van Wyk (1991).
Lotononis trichodes (E. Mey.) B.-E. Van Wyk	Great Winterberg Component endemic, occurring on the Great Winterberg and Katberg. Vulnerable. Van Wyk (1991).
Macowania revoluta Oliv.	Amathole Component endemic, collected originally by P. MacOwan (MacOwan P 2013, Kaffrarian mountains near King Williams Town, December 186, K; duplicate in NYBG states Pirie Mountains, 1060 m; duplicate in P indicates mountains above Buffelsrivier). According to SANBI (2012), not collected since before 1949. Habitat uncertain, but as the Buffelsrivier rises in Pirie Main Forest, it should be looked for on the forest edge and grassland above this. Data Deficient. Smith (1927).
Moraea reticulata Goldblatt	GWA endemic. Common in Amathole Mistbelt and Amathole Montane Grasslands. Least Concern. Goldblatt and Anderson (1986). Plate 3A.
Muraltia rara Levyns	Amathole Component endemic, only known from the type specimen collected at Keiskammahoek (Story R 3664, 1830 m, 1948, BOL). Data Deficient. Levyns (1954).
Nerine filamentosa W.F. Barker	Amathole Component endemic, restricted to dry habitats in the Cathcart area. Least Concern. Saunders (1997); McMaster (sine anno). Plate 4A.
Phylica galpinii Pillans	GWA endemic, from the Katberg to Hogsback. Occurs on rock sheets on mountain summits. Amathole Mistbelt Grassland. Rare. Pillans (1942). Plate 3B.
Schizoglossum amatolicum Hilliard	Amathole Component endemic, on the Elandsberg and Gaika's Kop. Amathole Mistbelt Grassland. Critically Rare. Hilliard and Burtt (1988b); McMaster (2010). Plate 4D.
Watsonia amatolae Goldblatt	GWA endemic, from the Katberg to Dohne. Wet mountain grassland. Amathole Mistbelt Grassland. Rare. Goldblatt (1989). Plate 4C.

from Rare upwards (Fig. 3D), the future of thE GWA's endemic taxa is of concern. In almost all cases the biggest threat is commercial forestry (and associated feral alien vegetation) in upland grasslands. Of the seven Data Deficient endemics, five (*Crassula sediflora* var. *amatolica*, *Heliophila brassicifolia*, *Heliophila katbergensis*, *Lotononis harveyi* and *Muraltia rara*) are only known from their type specimens. The most important localities for these long-lost endemics are the Katberg, Cata Ridge/Pirie mountains, and the Klipplaat/Shiloh area, but efforts to relocate them have either been unsuccessful or not attempted. Two species (*Lotononis alpina* subsp. *alpina* and *Macowania revoluta*; Plate 3E) are only known from a few specimens. *Euphorbia ovata* is not listed in any Red Data category, but should be Data Deficient given its paucity of data. The ten Least Concern endemics occur across the GWA or have large populations: the exception is *Hypoxis sagittata*, which should be classified as Data Deficient given the almost complete absence of data since its original collection by JF Drège in 1832. Overall, the future of the GWA's endemics is much more precarious than that of the Sneeuberg's — the reasons being

Plate 3. A selection of plant taxa endemic and near-endemic to the Great Winterberg–Amatholes (GWA) — Part 1: (A) *Moraea reticulata*, a common upland endemic throughout the GWA; (B) *Phylica galpinii*, endemic to rock sheets at higher altitudes from the Katberg to Hogsback; (C) The high altitude scree-endemic *Delosperma alpinum* is known from only three sites between the Katberg and Cata Ridge; (D) *Euryops ciliatus* is a locally abundant endemic confined to the Amathole Component, here photographed on the Elandsberg; (E) *Lotononis alpina* subsp. *alpina* is a poorly known shrub endemic to the Great Winterberg Component; (F) Showy *Hesperantha stenosiphon* occurs in the Cathcart area and on the Katberg; (G) Decumbent *Euryops dyeri* is an uncommon, cushion-forming endemic; (H) *Geranium grandistipulatum* is one of four beautiful and common *Geranium* endemics; (I) *Brachystelma cathcartensis* is only known from one population near Cathcart. Photographs: C. McMaster (A, F, I), N.A. Helme (B, D, E), A.P. Dold (C, G), V.R. Clark (H).

Plate 4. A selection of plant taxa endemic and near-endemic to the Great Winterberg–Amatholes (GWA) — Part 2: (A) The beautiful *Nerine filamentosa* is endemic to the drier inland part of the Amathole Component; (B) Like *Brachystelma cathcartensis*, *Ceropegia macmasteri* is also only known from one population near Cathcart; (C) *Watsonia amatolae* occurs in wet mountain grassland from the Katberg to Dohne; (D) The Critically Rare *Schizoglossum amatolicum* is only known from two sites in the Amathole Component; (E) The Endangered *Cyrtanthus suaveolens*, threatened by commercial forestry, is only found between Mount Thomas and Stutterheim; (F) The spectacular *Delosperma dyeri* is rare in the Amathole Component, common on The Ruitjies, and also occurs as an isolated population on the Nardousberg (Sneeuberg); (G) *Jamesbrittenia crassicaulis* is a common Cape Midlands Escarpment endemic shared by the GWA, Sneeuberg and Stormberg. Photographs: C. McMaster (A–E), V.R. Clark (F, G).

the comparative remoteness and inaccessibility of the Sneeuberg, and that it is much less suitable for commercial forestry. There are also no high altitude statutory conservation areas in the GWA, compared to at least one (the Mountain Zebra National Park) in the Sneeuberg.

5.2. Potentially undescribed endemics

Phillipson (1987) notes the probability of undescribed taxa in the GWA, and lists potentially new taxa in *Cliffortia*, *Cineraria*, *Conium*, *Crassula*, *Fuirena*, *Helichrysum*, *Nidorella* ('*Nidorella amatolensis*', proposed but unpublished by Phillipson, based on MacOwan P 1166 from the Kagaberg, GRA), *Passerina*, *Pentzia*, *Stoebe* and *Watsonia*. Unfortunately, specimens have probably not reached relevant taxonomists. Recent fieldwork has also indicated several potentially undescribed taxa that require further investigation (none of these have been included in Appendix A).

5.3. Near-endemics

The GWA shares several near-endemics with adjacent sections of the Great Escarpment, most notably the Sneeuberg and Stormberg, as well as several with the DAC.

5.3.1. GWA–Sneeuberg endemics

Following Clark et al.'s (2009) treatment of the Sneeuberg flora, three Sneeuberg endemics have since been discovered on the GWA (*Bergeranthus nanus*, *Erica* sp. aff. *reenensis* and *Hermannia sneeuwbergensis*) and one GWA endemic on the Sneeuberg (*Encephalartos cycadifolius*) (Table S5A). The number of shared endemics between these two mountain ranges has thus risen from Clark et al.'s (2009) original six to ten. In the Sneeuberg, the Boschberg and Nardousberg are the principle localities for these shared endemics, the former hosting five and the latter three. Two taxa are worth specific mention: a localised population of *Delosperma dyeri* occurs on the Nardousberg summit at ca. 2400 m, but is common and widespread on The Ruitjies in the GWA at ca. 1700 m; it also occurs in the Amathole Component, where it is less common (Dold and Hammer, 2001; Plate 4F). *Erica* sp. aff. *reenensis* was only known from the Nardousberg (and adjacent high ground), but now also from the western side of the Great Winterberg peak, being confined to scree and cliff-lines above 1900 m. It still awaits taxonomic treatment, and is allied to the northern DAC endemic *Erica reenensis* Zahlbr. (Oliver, pers. comm.). Overall, the presence of Sneeuberg 'endemics' on the GWA is not surprising, considering the biogeographical negligibility of the Great Fish River Interval (Clark et al., 2011d). It is likely that other Sneeuberg endemics may still be encountered on the GWA.

5.3.2. GWA–Stormberg endemics

The GWA shares three endemics with the Stormberg (Table S5B). Because the Stormberg is still floristically poorly documented, the number of shared endemics is likely to increase with further fieldwork there. The numerous high altitude (>1800 m) inselbergs situated between the GWA and Stormberg (which also still require exploration) and may also host some of these endemics.

5.3.3. GWA–Sneeuberg–Stormberg (Cape Midlands Escarpment) endemics

Six endemics are shared between the GWA, Sneeuberg and Stormberg (Table S5C). Two (*Crassula exilis* subsp. *cooperi* and *Jamesbrittenia crassicaulis*; Plate 4G) are new records onto the GWA, both common in Karoo Escarpment Grassland on the drier inland plateau. Five taxa currently only known from the Sneeuberg and Stormberg (*Aspalathus acicularis* subsp. *planifolia*, *Euryops trilobus*, *Huernia piersii*, *Selago bolusii* and *S. retropilosa*) may also still be discovered on the GWA, likely also in Karoo Escarpment Grassland.

It is worth noting here that there are several taxa centred on the Cape Midlands Escarpment but which also have records westwards onto the Nuweveldberge. One of these, *Ficinia compasbergensis*, was originally considered a Sneeuberg endemic but was later collected on the Nuweveldberge (Clark et al., 2009, 2011b). It has since been found in the GWA (where it is abundant on Martha and the Aasvoëlberg), and the Stormberg (VRC, unpubl. data). Other such southern Great Escarpment taxa that may still be encountered on the GWA are *Helichrysum tysonii*, *Lessertia sneeuwbergensis* (recently found on the Stormberg; VRC, unpubl. data) and *Ruschia complanata*.

5.3.4. GWA–Drakensberg Alpine Centre endemics

Nine taxa defined by Carbutt and Edwards (2006) as being DAC endemics have been recorded on the GWA (Table S5D). Three of these were previously listed by Phillipson (1987), while *Thesium congestum* was originally described from the GWA by Dyer (1933). Four (*Agrostis subulifolia*, *Hypoxis tetramera*, *Manulea dregei* and *Pentzia tortuosa*) are range extensions based on recent fieldwork.

Of the 608 DAC near-endemics (21.8% of the DAC flora), 200 occur in the GWA (Tables S5D, E, S6). The number of DAC near-endemics in the GWA comprises 10.7% of the flora, slightly more than Sneeuberg's 8.1% (119 taxa).

5.3.5. GWA–other endemics

Numerous taxa (not totalled; the most notable are detailed in Table S5F) are shared between the GWA and the adjacent Albany lowlands, the Transkei sub-Escarpment, and the moist eastern seaboard (particularly Eastern London and Pondoland). These near-endemics represent biogeographical connections primarily to the south, north-east and east. It is possible that more detailed floristic research on the Transkei sub-Escarpment and floristic comparisons with the Wild Coast may shed more light on these connections. It is worth noting that several 'Great Kei Catchment' endemics (e.g. *Erythrina acanthocarpa* E. Mey., *Greyia flanaganii* Bolus and *Umtiza listeriana* Sim) occur adjacent to the GWA, but apparently not on it.

5.4. The GWA as a potential centre of floristic endemism

Based on endemism of 2.8% (with 33 endemic taxa), Clark et al. (2009) described the Sneeuberg as a new centre of floristic endemism on the Great Escarpment. While at the time this was within the percentage 'ball-park' for recognised centres of endemism in southern Africa (Van Wyk and Smith, 2001), a growing list of taxa, and the 'loss' of several endemics to the Nuweveldberge, GWA and Stormberg, has whittled endemism down to 1.9%. Because of a much higher floral total – despite having more endemics – floristic endemism in the GWA is also 1.9%. While not high by global standards, and certainly at the lower end of the scale in southern Africa, 1.9% is marginally 'significant' (with these percentages being a convenient means of highlighting biodiversity value rather than an expression of evolutionary history). While it may be justifiable to describe a GWA Centre of Floristic Endemism – complementary to the Sneeuberg Centre, and strongly supported by its faunal endemism (OSM: Section 9.1) and Van Rooy's (2000) Amatholes Centre of Moss Diversity – it is preferable to wait until detailed floristic work on the Stormberg has been completed. This will reduce the chance of 'losing' GWA endemics to the Stormberg, or to the intervening inselbergs. It will also then be possible to critically test if Nordenstam's (1969) original 'Sneeuwbergen Centre' (based on *Euryops*, and comprising the Sneeuberg, Stormberg and GWA as the 'Cape Midlands Centre') should be resurrected with three sub-centres, or if two new Centres (GWA and Stormberg) should be created complimentary to the Sneeuberg Centre. The inclusion of these local montane endemics in systematic studies will assist in determining their origins and the evolutionary value of these local montane nodes of endemism (Linder, 2001).

6. Notable range extensions

Apart from the range extensions of DAC endemics onto the GWA, five other notable range extensions are recorded for the GWA (Table S5G). The most unusual are *Cliffortia setifolia*, *Pelargonium petroselinifolium* and *Lachenalia aurioliae*, all from the Cape Floristic Region. In the remaining two, *Brachystelma campanulatum* is a local Albany-centred species, and *Nemesia rupicola* is an eastern Great Escarpment and associated Highveld species. These range extensions highlight local floristic complexity in the Cape Midlands Escarpment and the value of fieldwork for obtaining accurate species distribution data in South Africa.

7. Notably 'missing' taxa

There are several taxa whose absence from the GWA is surprising. These include *Ehrharta longigluma* (DAC and Sneeuberg), *Euryops annae* (Nuweveldberge, Sneeuberg, Stormberg, DAC), *Guthriea capensis* (Sneeuberg, DAC), *Hordeum capense* (widespread montane), *Indigastrum argyraeum* (Sneeuberg), *Ruschia hamata* (Nuweveldberge, Sneeuberg, Stormberg, DAC), *Searsia bolusii*, *S. montana*, and better *Melolobium* species representation. It is possible that these will be added in due course, as the GWA provides suitable habitat for these and several other surprisingly unrecorded taxa. It is possible however that there is a (if perhaps minor) biogeographical signal present: the GWA is also 'bypassed' by the Berg Adder *Bitis atropos*, which occurs on the eastern Sneeuberg, Stormberg and DAC (Kelly, pers. comm.).

8. Conclusion

With 1877 taxa the GWA is unexpectedly richer in diversity than its larger and overall higher, neighbouring Sneeuberg 'sister'. This is due to climate filtering westwards of the GWA, also being evident in the GWA itself, with rainfall decreasing substantially from east to west. Compared to the more distant DAC, the GWA is a 'poor cousin' in both diversity and endemism — easily attributed to the former being much more massive in altitude range and area. Despite these differences, floristically the GWA is closer to the DAC than to the Sneeuberg, due to more similar climatic regimes. At 1.9% the GWA has the same proportion endemism as the Sneeuberg, but with ten more endemics, totalling 35. This suggests that the 'Dragon's strength' diminishes westwards onto the Cape Midlands Escarpment with decreasing rainfall, as a tail of smaller local nodes of endemism. While a GWA Centre of Floristic Endemism could be considered, it is prudent to wait until comprehensive results on the third Cape Midlands 'sister' (the Stormberg) are available. The seven GWA endemics listed as Data Deficient (and five still only known from their types) highlight the poorly explored status of these Eastern Cape mountains — this despite the GWA being a popular tourist area and close to major centres. Pressure from commercial forestry and feral alien vegetation is motivation for the improved sustainable stewardship of this popular orographic entity — particularly in view of the one Presumed Exinct and three Endangered endemics, and the valuable ecological services provided by the GWA.

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.sajb.2014.01.008.

Acknowledgements

Private landowners are thanked for their kind permissions to collect specimens on their properties and for their generous hospitality and assistance: Dave Brotherton, Roger and Paula Bryant, Chris Bush, Norman Emsley, Brad Emsley, Jerry and Angie Hattingh, Rodney and Angela King, Guy and Mandy Levy, Henk and Martie Linde, Dave and Judy Morgan, Gary and Anne Pagel, Malcolm Phillips, Allan Porter, Dave and Barbara Scott, and Jim and Jeanette Streaton. The willing help of numerous people in the field is much appreciated: Ryan Daniels, Matt Janks, Garreth Keevey, Chris Kelly, Tlou Moholwa, Götz Neef, Charl Pienaar and Vincent Van der Merwe. Accurate identifications of many specimens would not have been possible without the kind and patient assistance of Ihsan Al-Shehbaz, Clare Archer, Kevin Balkwill, Dirk Bellstedt, Pieter Bester, Stephen Boatwright, Estelle Brink, Priscilla Burgoyne, John and Sandie Burrows, Graham Duncan, Lyn Fish, Berit Gehrke, Glynis Goodman-Cron, Dave Gwynne-Evans, Peter Goldblatt, Peter Linder, Anthony Magee, John Manning, Bettie Marais, Mario Martínez-Azorín, Robert McKenzie, Rodney Moffett, Muasya Muthuma, Bertil Nordenstam, Ted Oliver, Craig Peter, Syd Ramdhani, Brian Schrire, Dee Snijman, Charlie Stirton, Andor Venter and Christopher Whitehouse. The Eastern Cape Parks and the Botanical Society are thanked for permissions to collect in the Mpofu Nature Reserve. This paper was constructed by VRC during two Rhodes University Post-doctoral Fellowships, a Research Assistantship in the Department of Botany, and a Swiss Federal Scholarship at the Institut für Systematische Botanik, Universität Zürich; the Department and Institute are thanked for the logistical and technical assistance. Bertil Nordenstam kindly provided information on the endemic *Euryops*. Nick Helme kindly provided field data and photographs of several GWA endemic and near-endemic taxa. The following organisations are thanked for research sponsorships: National Research Foundation (Grant GUN 2069059 to NPB) and a freestanding SABI grant, National Geographic Society Committee for Research and Exploration (Grant 8521-08), Buk'Indalo Consultancy cc, the Cape Tercentenary Foundation and Rhodes University. The South African Weather Service (South African Department of Environmental Affairs and Tourism) is thanked for the rainfall data, supplied free of charge. Dave Morgan kindly provided rainfall data for the Farm Whytebank. The Eastern Cape Department of Economic Affairs, Environment & Tourism is thanked and acknowledged for the relevant collecting and export permits during the study period. Peter Linder kindly commented on earlier versions of the manuscript.

References

Acocks, J.P.H., 1988. Veld types of South Africa, 3rd ed. Memoirs of the Botanical Survey of South Africa, 28. Government Printer, Pretoria.

African Plants Database, 2013. Conservatoire et Jardin botaniques de la Ville de Genève and South African National Biodiversity Institute, Pretoria. (http://www.ville-ge.ch/musinfo/bd/cjb/africa/index.php?langue=an. Accessed 2012–2013.).

Arnold, T.H., Steyn, H.M., 2005. PRECIS.pc. National Herbarium, Pretoria (PRE) computerised information system. Specimen Database User Guide.

Bester, S.P., 1998. Vegetation and Flora of the Southern Drakensberg Escarpment and Adjacent Areas. (MSc Thesis) University of Pretoria, Pretoria.

Bolus, H.M.L., 1927. Novitates africanae. Annals of the Bolus Herbarium 4, 98–99.

Brown, N.E., 1927. *Mesembryanthemum* and some genera recently separated from it. Gardeners' Chronicle 81, 12.

Brown, N.E., Hutchinson, J., Prain, D., 1925. Flora Capensis, vol. 5, Part 2. Reeve, London, p. 216.

Carbutt, C., Edwards, T.J., 2004. The flora of the Drakensberg Alpine Centre. Edinburgh Journal of Botany 60, 581–607.

Carbutt, C., Edwards, T.J., 2006. The endemic and near-endemic angiosperms of the Drakensberg Alpine Centre. South African Journal of Botany 72, 105–132.

Childs, N.T., 1971. The Geography of the Bedford, Adelaide, Fort Beaufort, Stockenstroom and Victoria East Magisterial Districts. (MA Thesis) Rhodes University, Grahamstown.

Clark, V.R., Barker, N.P., Mucina, L., 2009. The Sneeuberg: a new centre of endemism on the Great Escarpment, South Africa. South African Journal of Botany 75, 196–238.

Clark, V.R., Barker, N.P., Mucina, L., 2011a. The Boschberg (Somerset East, Eastern Cape) — a floristic cross-roads of the southern Great Escarpment. South African Journal of Botany 77, 94–104.

Clark, V.R., Barker, N.P., Mucina, L., 2011b. A phytogeographic assessment of the Nuweveldberge, South Africa. South African Journal of Botany 77, 147–159.

Clark, V.R., Barker, N.P., Mucina, L., 2011c. The Great Escarpment of southern Africa — a new frontier for biodiversity exploration. Biodiversity and Conservation 20, 2543–2561.

Clark, V.R., Barker, N.P., Mucina, L., 2011d. Taking the scenic route — the southern Great Escarpment (South Africa) as part of the Cape to Cairo floristic highway. Plant Ecology and Diversity 4, 313–328.

Cook, A., sine anno. The phytogeography of the Amatole Mountains, Eastern Province. Department of Botany, Rhodes University.

Cowling, R.M., Hilton-Taylor, C., 1994. Patterns of plant diversity and endemism in southern Africa: an overview. In: Huntley, B.J. (Ed.), Botanical Diversity in Southern Africa. Proceedings of a Conference on the Conservation and Utilization of Southern African Botanical Diversity, Cape Town, September 1993. Strelitzia 1. National Botanical Institute, Pretoria, pp. 31–52.

Cowling, R.M., Lombard, A.T., 2002. Heterogeneity, speciation/extinction history and climate: explaining regional plant diversity patterns in the Cape Floristic Region. Diversity and Distributions 8, 163–179.

Cowling, R.M., Richardson, D.M., Schulze, R.E., Hoffman, M.T., Midgley, J.J., Hilton-Taylor, C., 1997. Species diversity at the regional scale. In: Cowling, R.M., Richardson, D.M., Pierce, S.M. (Eds.), Vegetation of Southern Africa. Cambridge University, Cambridge, pp. 447–467.

Craib, C., 1993. Field studies and cultivation of some *Brachystelma* species in the eastern Cape, Natal, the eastern Free State (including Qua Qua), and the Transvaal. Excelsa 16, 11–23.

Ecosystem Partnership Fund, Critical, 2010. Ecosystem Profile. Maputaland–Pondoland–Albany Biodiversity Hotspot. Conservation International Southern African Hotspots Programme. South African National Biodiversity Institute.

Cron, G.V., Balkwill, K., Knox, E.B., 2006. A revision of the genus *Cineraria* (Asteraceae, Senecioneae). Kew Bulletin 61, 449–535.

Dahlgren, R., 1988. Flora of Southern Africa. Fabaceae, Part 3, Papilionoideae, Fascicle 6, Crotalarieae (*Aspalathus*), vol. 16. Botanical Research Institute, Department of Agriculture and Water Supply.

De Candolle, A.P., 1862. Prodromus Systematis Universalis Regni Vegetabilis. Pars XV. (−1866) Sistens Euphorbiaceas, Masson, Paris.

Dold, A.P., 2006. *Ceropegia macmasteri* (Apocynaceae–Asclepiadoideae–Ceropegieae), a new species from Eastern Cape, South Africa. South Africa Journal of Botany 72, 144–146.

Dold, T., Cumming, D., 2002. Notes on the species of *Brachystelma* R.Br. occurring in the Eastern Cape province of South Africa. Asklepios 84, 4–9.

Dold, T., Hammer, S., 2001. Dyer's *Delosperma* rediscovered. Cactus and Succulent Journal 73, 73–75.

Downing, B.H., Robinson, E.R., Trollope, W.S.W., Morris, J.W., 1998. The effect of macchia eradication techniques on the botanical composition of grasses in Döhne Sourveld of the Amatholes Mountains. Proceedings of the Grassland Society of Southern Africa, 13, pp. 111–115.

Drège, J.F., 1843. Zwei Pflanzengeographische Documente. In: Meyer, E. (Ed.), Flora, oder, Allgemeine botanische Zeitung. Besondere Beigabe zur Flora, 2, pp. 1–16 (reprint issued in 1844, Leipzig).

Drège, J.F., 1847. Standörter-Verzeichniss der von C.L. Zeyher in Südafrika gesammelten Pflanzen. Linnaea 19, 584–591.

Dyer, R.A., 1933. Notes on the flora of Southern Africa: IV. Miscellaneous new species. Bulletin of Miscellaneous Information (Royal Gardens, Kew) 459–462.

Everard, D.A., Hardy, S.D., 1993. Composition, structure and dynamics of the Amatole forests. Report FOR-DEA 810. Division of Forest Science and TechnologyCSIR, Pretoria.

Galley, C., Bytebier, B., Bellstedt, D.U., Linder, H.P., 2007. The Cape element in the Afrotemperate flora: from Cape to Cairo? Proceedings of the Royal Society B 274, 535–543.

Geldenhuys, C.J., Rathogwa, N.R., 1997. Growth and mortality patterns over stands and species in four Amatola forest growth study sites: report on 1996 measurements. Report ENV/P/C 97006. Division of Forest Science and TechnologyCSIR, Pretoria.

Goldblatt, P., 1989. The genus *Watsonia*. Annals of the Kirstenbosch Botanical Gardens 19, 1–148.

Goldblatt, P., 2003. A synoptic review of the African genus *Hesperantha* (Iridaceae: Crocoideae). Annals of the Missouri Botanical Garden 90, 390–443.

Goldblatt, P., Anderson, F., 1986. The *Moraeas* of Southern Africa. Annals of the Kirstenbosch Botanic Gardens 14, 1–224.

Hammer, S.A., Dold, A.P., 2002. *Ectotropis* N.E.Br. — lost, found and fragile. Haseltonia 9, 35–40.

Hartmann, H.E.K. (Ed.), 2002. Illustrated Handbook of Succulent Plants: Aizoaceae A–E. Springer, Berlin.

Helme, N.A., Personal Communication. List of specimens collected in the Great Winterberg area, January 2013.

Hilliard, O.M., 1983. Flora of Southern Africa. Asteraceae, Part 7, Inuleae, Fascicle 2, Gnaphaliinae (1st Part), vol. 33. Department of Agriculture, Botanical Research Institute.

Hilliard, O.M., Burtt, B.L., 1985. A revision of *Geranium* in Africa south of the Limpopo. Notes from the Edinburgh Royal Botanic Garden 42, 171–225.

Hilliard, O.M., Burtt, B.L., 1988. Notes on some plants of southern African chiefly from Natal. Notes from the Edinburgh Royal Botanic Garden 45, 179–223.

Hoare, D.B., Bredenkamp, G., 1999. Grassland communities of the Amatola/Winterberg mountain region of the Eastern Cape, South Africa. South African Journal of Botany 65, 75–82.

Hoare, D.B., Bredenkamp, G.J., 2001. Syntaxonomy and environmental gradients of the grasslands of the Stormberg/Drakensberg mountain region of the Eastern Cape, South Africa. South African Journal of Botany 67, 595–608.

Kelly, C., Personal Communication. Rhodes University at the time of consultation. *Bitis*.

Killick, D.J.B., 1978. The Afro-alpine region. In: Werger, M.J.A. (Ed.), Biogeography and Ecology of Southern Africa. Dr. W. Junk, The Hague, pp. 515–560.

Klotzsch, J.F., 1860. Linné's natürliche Pflanzenklasse *Tricoccae* des Berliner Herbarium's im Allgemeinen und die natürliche Ordnung Euphorbiacea insbesondere. Abhandlungen der Königlich Akademie der Wissenschaften zu Berlin 1859. Königlichen Akademie der Wissenschaften, Berlin, p. 97.

Levyns, M.R., 1954. The genus *Muraltia*. Journal of South African Botany Supplementary 11, 1–247.

Linder, H.P., 2001. On Areas of Endemism, with an Example from the African Restionaceae. Systematic Biology 50, 892–912.

Linder, H.P., Hardy, C.R., 2010. A generic classification of the Restioneae (Restionaceae), southern Africa. Bothalia 40, 1–35.

Low, A.B., Rebelo, A.G. (Eds.), 1998. Vegetation of South Africa, Lesotho and Swaziland, 2nd ed. Department of Environmental Affairs and Tourism, Pretoria.

Marais, W., 1970. Cruciferae. In: Codd, L.E., De Winter, B., Killick, D.J.B. (Eds.), Flora of Southern Africa, vol. 13. Department of Agricultural Technical Services, Republic of South Africa, pp. 1–118.

Martínez-Azorín, M., Clark, V.R., Crespo, M.B., Dold, A.P., Barker, N.P., 2011. The rediscovery of *Albuca tenuifolia* Baker, an orophilous species from the eastern Great Escarpment in South Africa. Nordic Journal of Botany 29, 465–470.

McKay, H.M., 1943. Sketch maps of Burchell's trek. Journal of South African Botany 9, 27–78.

McMaster, C., sine anno. *Nerine* Notes — *Nerines* of the Eastern Cape http://www.africanbulbs.com/page24.html. Accessed 26/03/2012.

McMaster, C., 2007. *Disa lugens*. New discoveries in the Eastern Cape extend the known range of this wonderful orchid. Veld and Flora 147–149 (September 2007).

McMaster, C., 2010. A rare Amatola milkweed: CREW. Veld and Flora 96, 65.

Meadows, M.E., Linder, H.P., 1993. A palaeoecological perspective on the origin of afromontane grasslands. Journal of Biogeography 20, 345–355.

Meadows, M.E., Meadows, K.F., 1988. Late Quaternary vegetation history of the Winterberg Mountains, Eastern Cape, South Africa. South African Journal of Science 84, 253–259.

Moffett, R.O., 2007. Name changes in the Old World *Rhus* and recognition of *Searsia* (Anacardiaceae). Bothalia 37, 165–175.

Mucina, L., Rutherford, M.C. (Eds.), 2006. The Vegetation of South Africa, Lesotho and Swaziland. Strelitzia, vol. 19. South African National Biodiversity Institute, Pretoria.

Nel, G.C., 1914. Die afrikanischen Arten der Amaryllidaceae-Hypoxideae. In: Engler, A., Beiträge zur Flora von Afrika: 43. Botanischer Jahrbücher 51, 287–340.

Nordenstam, B., 1969. Phytogeography of the genus *Euryops* (Compositae). A contribution to the phytogeography of southern Africa. Opera Botanica 23, 7–77.

Nordenstam, B., Clark, V.R., Devos, N., Barker, N.P., 2009. Two new species of *Euryops* Cass. (Asteraceae: Senecioneae) from the Sneeuberg, Eastern Cape Province, South Africa. South African Journal of Botany 75, 145–152.

Oliver, E.G.H., Personal Communication. Department of Botany and Zoology, University of Stellenbosch. *Erica*.

Oliver, E.G.H., 1994. Studies in the Ericoideae (Ericaceae). XV. The generic relationship between *Erica* and *Ericinella*. Bothalia 24, 121–126.

Palmer, A.R., 1988. Vegetation Ecology of the Camdebo and Sneeuberg Regions of the Karoo Biome, South Africa. (PhD Thesis) Department of Plant Sciences, Rhodes University, Grahamstown.

Palmer, A.R., 1990. A qualitative model of vegetation history in the eastern Cape midlands, South Africa. Journal of Biogeography 17, 35–46.

Palmer, A.R., 1991. A syntaxonomic and synecological account of the vegetation of the eastern Cape midlands. South African Journal of Botany 57, 76–94.

Phillipson, P.B., 1987. A checklist of the vascular plants of the Amatola mountains, eastern Cape province/Ciskei. Bothalia 17, 237–256.

Pillans, N.S., 1942. The genus *Phylica*, Linn. The Journal of South African Botany 8, 1–164.

Ramdhani, S., Barker, N.P., Baijnath, H., 2008. Exploring the Afromontane centre of endemism: *Kniphofia* Moench (Asphodelaceae) as a floristic indicator. Journal of Biogeography 35, 2258–2273.

Rosenzweig, M.L., 1995. Species Diversity in Space and Time. Cambridge University, Cambridge.

Roux, J.P., 2001. Conspectus of southern African Pteridophyta. SABONET Report No. 13SABONET, Pretoria.

Saunders, R., 1997. Nerines in South Africa. Herbertia 52 (88–89), 186–187.

Schonland, S., 1914. On some new and some little known South African plants. Records of the Albany Museum 3, 52–64.

Sim, T.R., 1907. The Forests and Forest Flora of the Colony of the Cape of Good Hope. Taylor & Henderson, Aberdeen.

Singh, Y., 2009. Systematics of *Hypoxis* (Hypoxidaceae) in southern Africa. PhD Thesis University of Pretoria.

Smith, C.A., 1927. The genus *Macowania*, Oliv. Bothalia 2, 348–350.

Soderstrom, T.R., Ellis, R.P., 1982. Taxonomic status of the endemic South African bamboo, *Thamnocalamus tessellatus*. Bothalia 14, 53–67.

South African National Biodiversity Institute (SANBI), 2012. Threatened Species Programme. http://redlist.sanbi.org/ (Accessed 2012–2013).

Stapf, O., 1909. The South African bamboo (*Arundinaria tessellata*, Munro). Bulletin of Miscellaneous Information (Royal Gardens, Kew) 59–61.

Stirton, C.H., Clark, V.R., Barker, N.P., Muasya, A.M., 2011. *Psoralea margaretiflora* (Psoraleeae, Fabaceae): a new species from the Sneeuberg Centre of Floristic Endemism, Eastern Cape, South Africa. Phytokeys 5, 31–38.

Story, R., 1952a. A botanical survey of the Keiskammahoek District. Botanical Survey Memoir No. 27Department of Agriculture, Division of Botany.

Story, R., 1952b. A botanical survey of the Keiskammahoek District. In: Mountain, E.D. (Ed.), The Natural History of the Keiskammahoek District. Keiskammahoek Rural Survey, vol. 1. Shuter and Shooter, Pietermaritzburg, pp. 42–54.

Thuiller, W., Midgley, G.F., Rouget, M., Cowling, R.M., 2006. Predicting patterns of plant species richness in megadiverse South Africa. Ecography 29, 733–744.

Tölken, H.R., 1977. A revision of the genus *Crassula* in Southern Africa. Parts 1 and 2. Contributions from the Bolus Herbarium Number 8University of Cape Town, Rondebosch.

Van Rooy, J., 2000. Diversity and phytogeography of the Moss Flora of Southern Africa. Part 1 Text. (PhD Thesis) University of Pretoria, Pretoria.

Van Wyk, B.-E., 1991. A synopsis of the genus *Lotononis* (Fabaceae: Crotalarieae). Contributions from the Bolus Herbarium, Nos. 14–19University of Cape Town, Rondebosch.

Van Wyk, A.E., Smith, G.F., 2001. Regions of Floristic Endemism in Southern Africa. Umdaus Press, Hatfield.

Weimarck, H., 1941. Phytogeographical Groups, Centres and Intervals within the Cape Flora. Lund, Leipzig.

White, F., 1983. The vegetation of Africa. Unesco, Paris (Accompanied by The Unesco/AETFAT/Unesco Vegetation Map of Africa).

Wiland-Szymanska, J., 2001. The genus *Hypoxis* (Hypoxidaceae) in Central Africa. Annals of the Missouri Botanical Garden 88, 302–350.