

The vegetation of Asante Sana Private Game Reserve and surrounds, Sneeu-berg Centre of Floristic Endemism (Eastern Cape Province, South Africa)

V. Ralph CLARK¹ & Joao D. VIDAL

¹Afromontane Research Unit & Department of Geography, University of the Free State: QwaQwa Campus, Phuthaditjhaba, 9866, Free State, South Africa.

*Corresponding author: e-mail: vincentralph.clark@gmail.com; ClarkVR@ufs.ac.za

Abstract

Asante Sana Private Game Reserve – c.11,000 Ha in the Sneeu-berg massif, Eastern Cape Province of South Africa – has been the focus of intensive biodiversity research in the past 15 years. Extensive botanical exploration from 2005 to 2017 has resulted in a flora of 575 species – 48% of the total Sneeu-berg flora – and the discovery of six new Sneeu-berg endemics, two of which are near-endemic to Asante Sana itself. The vegetation of Asante Sana comprises four Biomes, in which there are six recognised Vegetation Units; an additional six putative Vegetation Units are indicated. The montane components comprise part of the Sneeu-berg Centre of Floristic Endemism, and seven of the 24 Sneeu-berg endemics and 12 of the 27 ‘Cape Midlands Centre’ endemics have been recorded at Asante Sana. Although a detailed assessment of non-native species has not been done (only 20 species are recorded), *Nassella trichotoma* is clearly a major problematic species in the montane areas, while *Schinus molle* and *Echinopsis schickendantzii* are major problems in the lowland areas. A comprehensive phytosociological and non-native species assessment of Asante Sana would be valuable for better understanding the vegetation for academic interest and management purposes.

Keywords

Asante Sana; endemics; invasive species; plant diversity; Sneeu-berg; Vegetation Units

1. Introduction

The Sneeu-berg (Afrikaans for “Snow Mountains”) forms a discrete component of southern Africa’s eastern Great Escarpment (CLARK et al. 2011; FIGURE 1A). The first complete floristic treatment of the Sneeu-berg was provided by CLARK et al. (2009), who concluded a flora of 1195 plant taxa from the six Biomes that meet in the Sneeu-berg. In addition, 33 endemic plant taxa were listed for the Sneeu-berg (CLARK et al. 2009); however, new data since then has revised this to about 25 species – a result of improved ‘biodiversity accounting’ along the southern component of the Great Escarpment (CLARK 2010) – with former endemics now known to be shared with adjacent mountain ranges, and new ones having come to light as well (CLARK et al. 2019). This new data will necessitate a revision of CLARK et al.’s (2009) Sneeu-berg Centre of Floristic Endemism, to accommodate a more holistic understanding of patterns of endemism in the region, viz. the ‘Cape Midlands Escarpment Centre’ (CLARK et al. in prep).

Prior to the work of CLARK et al. (2009), the Sneeu-berg was a very poorly-known mountain range from a floristic perspective, with most detailed botanical fieldwork having been done in the later 1800s. Asante Sana Private Game Reserve (hereafter referred to as ‘Asante Sana’) provided the initial access for modern botanical research in the current millennium, and many of the novel plant taxa found in the Sneeu-berg since 2005 were first collected at Asante Sana. It is therefore fitting that a publication is devoted to the vegetation and flora of Asante Sana, to complement the lepidopterist discoveries detailed in this Memoir.

2. Location and characteristics

Asante Sana (FIGURE 1B), c.11,000 Ha, is located in the eastern Sneeu-berg, i.e. on that arm of the Sneeu-berg that runs east-west from Somerset East/Cradock to Graaff-Reinet; Asante Sana is centred on the old hamlet of Petersburg. The eastern Sneeu-berg includes the Boschberg, Groot Bruintjieshoogde, the montane components of Mountain Zebra National Park, and the prominent Nardousberg – the second highest peak in

the Sneeuberg (2429 m), and one of the highest points in southern Africa outside of the Maloti–Drakensberg. Asante Sana comprises a broad, upper valley basin (the upper reaches of the Melkriver, “Milk River”) flanked on the north and west by the high ground (up to 2300 m) of the Sneeuberg massif, and to the east and south by slightly lower elevation spurs (up to 1800 m) off the main Sneeuberg. A narrow valley leads the Melkriver out of this upper basin.

3. Material and methods

The first author undertook extensive botanical fieldwork at Asante Sana from 2005 to 2016, and this account is based largely on that experience. No particular sampling protocol was followed other than to explore the mountainous components of the property as much as possible, and to collect a herbarium voucher specimen of each plant species encountered. Because biodiversity data management in South Africa uses the quarter degree grid system as a reference, and because three grids meet at Asante Sana, repeat species sampling took place in many instances – i.e. the same species was collected from different grids; similarly, because of the volume of collections from Asante Sana, the same species were often collected multiple times due to uncertainty of having collected it before or not, or to get a better sample range of particular species of interest. As a result, the first author has become very familiar with the montane components of the flora, but less so with the lower elevation components.

Some 1206 herbarium specimens have been collected at Asante Sana. The majority of the material was identified using the reference library and collections in the Selmar Schonland Herbarium (GRA), Albany Museum, Grahamstown (South Africa), with duplicates (or originals, if duplicates not available) of taxonomically-complex species sent to specialists worldwide for expert identification. Most specimens were deposited in GRA, except for material donated in exchange for reliable identifications, as well as duplicates of some material. In 2015–2016, the Asante Sana material was digitised (through the creation of a Botanical Research and Herbarium Management Software (BRAHMS) database and the high-resolution imaging of the specimens) as part of a data mobilisation project by the Great Escarpment Biodiversity Research Programme (Rhodes University), with funding from the Foundational Biodiversity Information Programme (southern African National Biodiversity Institute).

Details on how data for the Sneeuberg as a whole were collected are provided by CLARK et al. (2009), and methods details on the description of new species discovered at Asante Sana are detailed in those publications (see 5. Endemics).

This review on the vegetation of Asante Sana has been organised using MUCINA & RUTHERFORD’S (2006) Biomes and associated Vegetation Units. We discuss local vegetation complexities under each Biome, except for Azonal, where we have included Azonal Vegetation Units embedded within a Biome under that Biome. Names used follow the African Plant Database (2019).

4. The plant species diversity and vegetation of Asante Sana

The Asante Sana flora currently comprises 575 species, or 48% of the total Sneeuberg flora. Asante Sana itself hosts four of the six Biomes represented in the Sneeuberg: Albany Thicket, Azonal, Grassland and Nama–Karoo (MUCINA & RUTHERFORD 2006); Forest and Savanna are absent, occurring further east on the south-facing scarp of the Boschberg and on the pediplain below the Boschberg, respectively. We discuss the local characteristics of the vegetation at Asante Sana per Biome present, except that we include relevant Azonal components under Grassland and Nama–Karoo, as Azonal components are embedded within these two Biomes.

Albany Thicket Biome:

Camdeboo Escarpment Thicket

Typical Albany Thicket Biome vegetation at Asante Sana occurs on the north-facing slopes of the southern rim of the basin, and is classified by MUCINA & RUTHERFORD (2006) as Camdeboo Escarpment Thicket (FIGURE 1c, PLATE 1A). Historically, this Camdeboo Escarpment Thicket would have been dominated by *Portulacaria afra* Jacq., but this matrix species has been missing for decades following intense overgrazing by goats prior to its current private protected status (ACOCKS 1998, PALMER 1990); the original vegetation structure can be inferred from the still-intact Camdeboo Escarpment Thicket on the ‘Mount Camdeboo’ property immediately west

of Asante Sana, with a clear fence-line contrast. Other typical species comprising Camdeboo Escarpment Thicket at Asante Sana are *Vachellia karroo* (Hayne) Banfi & Galasso (= *Acacia karroo* Hayne), *Boscia oleoides* (Burch. ex DC.) Tölken, *Carissa bispinosa* (L.) Desf. ex Brenan (= *C. haematocarpa* (Eckl.) A.DC.), *Ehretia rigida* (Thunb.) Druce subsp. *rigida*, *Euclea crispa* (Thunb.) Gürke subsp. *crispa*, *Grewia robusta* Burch., *Gymnosporia buxifolia* (L.) Szyszyl, *G. linearis* (L.f.) Loes. subsp. *linearis*, *Pappea capensis* Eckl. and Zeyh., *Searsia* spp., and scattered *Aloe ferox* Mill.

Wild Olive (*Olea europaea* subsp. *africana*) Bushveld

The riparian and adjacent areas on the lower- to medium-elevation (900–1600 m) south-, east- and west-facing slopes of the Asante Sana basin are dominated by an extensive, closed woodland dominated by old *Olea europaea* subsp. *africana* (Mill.) P.S.Green groves and mixed species thickets (FIGURE 1c, PLATE 1b). We have placed it here under Albany Thicket, although, it might need to be described as a novel transitional Vegetation Unit that incorporates elements of Forest, Savanna and Thicket Biomes – it has been referred to by others as “temperate thicket” (COWLING et al. 2005) and “incipient forest” (VAN DER WALT 1980). This Vegetation Unit is a common component of the southern flanks of the high Sneeuberg, from Buffelshoek Pass (below the Groot Bruintjieshoogde) in the east, west to the Kamdebooberge (behind Aberdeen), and has not been documented phytosociologically.

While *O. europaea* subsp. *africana* (Mill.) P.S.Green is the characteristic species, there is a relatively rich species mix, and other typical woody species include *Vachellia karroo* (Hayne) Banfi & Galasso, *Celtis africana* Burm.f., *Dodonaea viscosa* var. *angustifolia* (L.f.) Benth., *Euclea crispa* (Thunb.) Gürke subsp. *crispa*, *Grewia robusta* Burch., *Gymnosporia buxifolia* (L.) Szyszyl., *Heteromorpha arborescens* (Spreng.) Cham. & Schldl. var. *arborescens*, *Kiggelera africana* L., *Maytenus acuminata* (L.f.) Loes. var. *acuminata*, *Myroxylon aethiopicum* (Thunb.) Loes. subsp. *aethiopicum*, *Osyris lanceolata* Hochst. & Steud., *Pittosporum viridiflorum* Sims, *Rhamnus prinoides* L'Hér., *Searsia krebsiana* (C.Presl ex Engl.) Moffett, *S. lancea* (L.f.) F.A.Barkley, *S. pallens* (Eckl. & Zeyh.) Moffett, *S. pyroides* (Burch.) Moffett and *S. rehmanniana* var. *glabrata* (Sond.) Moffett. The climbers *Clematis brachiata* Thunb. and *Rubia petiolaris* DC. are quite common, as is the hemi-parasite *Viscum hoolei* (Wiens) Polhill & Wiens. The dominant understory grass is *Stipa dregeana* Steud. var. *dregeana*. Woodland peripheries at higher elevations host colonies of *Melianthus comosus* Vahl and *Myrsine africana* L., the latter where rocky.

Dry Woody Cliff Communities

The vegetation of the warmer (north-, west- and east-facing) cliffs at medium elevations (1300–1600 m; PLATE 1c; not represented in FIGURE 1c) have not been formally documented, but casual observation indicates that they are typically characterised by a mix of woody species that typically include *Buddleja glomerata* H.L.Wendl. and *Cussonia paniculata* Eckl. & Zeyh. subsp. *paniculata*, while the succulent species *Aloe striatula* Haw. var. *striatula* is common, as are colonies of the geophyte *Haemanthus humilis* Jacq. subsp. *humilis* (among the rocks and underneath shrubs).

Grassland Biome:

Of the Biomes represented at Asante Sana, Grassland is perhaps the most interesting (from a floristics perspective), as this is where the species unique to the Sneeuberg occur, and is the Biome in which all the novel species discovered at Asante Sana occur. If one includes all the embedded variants (i.e. grassland, fynbos, montane shrubland, ‘renosterveld’, south-facing cliff communities, wetlands and rocky plateau communities; Plate 1d–m) it is also the largest Biome at Asante Sana (Figure 1c).

Karoo Escarpment Grassland

Asante Sana’s ‘pure’ grassland falls under MUCINA & RUTHERFORD’s (2006) Karoo Escarpment Grassland Vegetation Unit: a sub-arid grassland that dominates the higher elevations (>1600 m) of the Sneeuberg (CLARK et al. 2009; PLATE 1d), with outliers in the adjacent Nuweveldberge, Stormberg and Great Winterberg–Amatholes (MUCINA & RUTHERFORD 2006). At Asante Sana, *Tenaxia disticha* (Nees) N.P.Barker & H.P.Linder is the dominant grass species, and – although this is a naturally occurring species in the Sneeuberg – overgrazing in the past may have increased this low-palatability species at the expense of other possibly, historically (co-)dominant grasses species (BOARDMAN et al. 2003, MEADOWS & WATKEYS 1999). For instance, *Themeda triandra* Forssk. is a dual-dominant species in many parts of the Sneeuberg where overgrazing has not taken place, but there may be other drivers such as aspect and substrate (CLARK et al. 2009).

Other common grass species at Asante Sana in the montane grasslands are *Ehrharta calycina* J.E.Sm.,

Melica decumbens Thunb., *Merxmüllera macowanii* (Stapf) Conert (the dominant species in summit wetlands), *Karroochloa purpurea* (L.f.) Conert and Tuerpe, *Tetrachne dregei* Nees (possibly a former co-dominant species; CLARK et al. 2009), *Helictotrichon longifolium* (Nees) Schweick. and *H. turgidulum* (Stapf) Schweick. An interesting species occurring on damp turf soils on the highest plateaux is *Ehrharta longigluma* C.E.Hubb. – this species was previously believed to be endemic to VAN WYK & SMITH'S (2001) Drakensberg Alpine Centre of Floristic Endemism (CARBUTT & EDWARDS 2006), but is now fairly well-known across the Sneeuberg, the first extra-Drakensberg locality recorded being Asante Sana (CLARK et al. 2009).

Forbs, ferns, geophytes, herbs, low shrubs and succulents are well-represented in the montane grasslands at Asante Sana. There are too many species to mention specifically, this likely being the richest floral component of Asante Sana, but typical species encountered in these grasslands are *Alchemilla capensis* Thunb., *Alectra capensis* Thunb., *Anthospermum monticola* Puff., *Asparagus denudatus* (Kunth) Baker, *Berkheya buphthalmoides* (DC.) Schltr., *Chasmatophyllum musculinum* (Haw.) Dinter & Schwantes (succulent), *Cheilanthes hirta* Sw., *Chrysocoma ciliata* L., *Clusia monticola* S.Moore var. *monticola*, *Cotyledon orbiculata* L. var. *orbiculata*, *Craterocapsa montana* (A.DC.) Hilliard & B.L.Burt, *Cyrtanthus macowanii* Baker, *Delosperma lootbergense* Lavis, *Diascia capsularis* Benth., *Dierama robustum* N.E.Br., *Euclea coriacea* A.DC., *Euphorbia clavarioides* Boiss. var. *clavarioides*, *E. epicyparissias* E. Mey. ex Boiss., *Gazania krebsiana* Less. subsp. *krebsiana*, *Geranium harveyi* Briq., *Helichrysum albo-brunneum* S.Moore, *H. aureum* (Houtt.) Merr. var. *aureum*, *H. montanum* DC., *H. odoratissimum* (L.) Sweet, *H. scitulum* Hilliard & B.L.Burt, *Hermannia coccocarpa* (Eckl. & Zeyh.) Kuntze, *Indigofera Meyeriana* Eckl. & Zeyh., *Kniphofia stricta* Codd, *K. triangularis* Kunth subsp. *triangularis*, *Lotononis laxa* Eckl. & Zeyh., *Moraea spathulata* (L.f.) Klatt, *Ornithogalum graminifolium* Thunb., *Othonna carnosae* Less. var. *carnosae*, *Oxalis depressa* Eckl. & Zeyh., *Pellaea calomelanos* (Sw.) Link var. *calomelanos*, *Pharnaceum detonsum* Fenzl, *Polygala sphenoptera* Fresen., *Rubus ludwigii* Eckl. & Zeyh. subsp. *ludwigii*, *Scabiosa columbaria* L., *Sebaea macrophylla* Gilg, *Selago dolosa* Hilliard, *Senecio erubescens* var. *crepidifolius* DC., *S. inaequidens* DC. and *Wahlenbergia undulata* (L.f.) A.DC.

While typical grassland dominates the plateaux, there is a shrubby-grassland that dominates the upper slopes of the Escarpment (PLATE 1E). This usually occurs between the lower woody communities (Wild Olive Bushveld) and higher elevation grasslands. This shrubland can become quite dense and only thins out from occasional fires. *Euryops* is usually the dominant shrub genus represented, with *Euryops galpinii* Bolus and *E. trilobus* Harv. being the typical species, but also with a strong presence of *Helichrysum splendidum* (Thunb.) Less. and *Melolobium* species such as *M. adenodes* Eckl. & Zeyh. and *M. microphyllum* (L.f.) Eckl. & Zeyh. Unique to Suurkloof at Asante Sana there is also a lower elevation dense shrubland, dominated by the 2,5 m- tall shrub *Otholobium macradenium* (Harv.) C.H.Stirt., and which replaces *Olea europaea* subsp. *africana* (Mill.) P.S.Green woodland after fire; in Waterkloof, this effect is seen with *Searsia dregeana* (Sond.) Moffett, which forms very dense communities and also colonises *O. europaea* subsp. *africana* woodland after fire. The shrub *Dicerotheramnus rhinocerotis* (L.f.) Koekemoer is also very common at Asante Sana, and forms extensive local communities between ca. 1300–1800 m (PLATE 1F). This is typical throughout the Sneeuberg, and CLARK et al. (2009) suggests that there might be an undescribed 'Renosterveld' vegetation unit present; if true, this would be the eastern-most Renosterveld Vegetation Unit in South Africa, under the Fynbos Biome (MUCINA & RUTHERFORD 2006).

Drakensberg–Amathole Afromontane Fynbos

Of potentially particular interest to Lepidopterists, and embedded in the montane grassland at the highest elevations (>2000 m) at Asante Sana, are fynbos (macchia) elements that are possibly perhaps best placed under MUCINA & RUTHERFORD'S (2006) Drakensberg–Amathole Afromontane Fynbos; if accepted as true, this would be a westerly range extension of this Vegetation Unit. It includes what VAN DER WALT (1980) terms "arid fynbos" and NORDENSTAM (1969) "false macchia", although it can be divided into "more arid" communities (summit plateaux; Plate 1g) and less arid communities (on moist southern slopes and cliffs; Plate 1h).

The plateaux communities at Asante Sana are dominated by *Cliffortia ramosissima* Schltr., *Erica leucopelta* Tausch, *Euryops candollei* Harv., *E. exsudans* B.Nord. & V.R.Clark, *Ischyrolepis distracta* (Mast.) H.P.Linder, *Muraltia alticola* Schltr., *M. alopecuroides* (L.) DC., *Passerina montana* Thoday and *Thesium gnidiaceum* A.DC. and occur on the highest elevations on northern edge of the property (i.e. on the highest plateaux of the Sneeuberg between Suurkloof and Waterkloof).

The cliff communities are found in places along the south-facing cliffs below this summit plateaux, and are most notably well-developed on the southern slopes of the Nardousberg ridge-line (2200–2400 m). These communities can include the previously-mentioned species, but usually include 'softer' species such

as *Cliffortia eriocephalina* Cham., *Erica caespitosa* Hilliard & B.L.Burt and *E. woodii* Bolus var. *woodii*. *Ischyrolepis distracta* (Mast.) H.P.Linder – one of the Restionaceae – is an interesting species which occurs on the summit plateaux, in dwarf form, and in a more robust form in cliffs (some of the cliffs above Waterkloof are almost entirely dominated by this species). Most interestingly, this fynbos community hosts what appears to be an isolated population of *Erica reenensis* Zahlbr., otherwise only known from the far northern Maloti–Drakensberg, with another population also relatively recently discovered on the Great Winterberg peak (CLARK et al. 2014), 136 km to the east of the Nardousberg.

South-facing Cliff Communities

The communities that have capitalised on the cool, moist south-facing cliffs and cliff-bases at high elevation (1800–2400 m; PLATE 1) at Asante Sana are the most interesting, from the authors' perspectives: this is because this habitat provides a refugium for species not otherwise capable of surviving the prevailing conditions on either the summit plateaux or lower elevation slopes and plains. What is unique to this habitat is that snow and ice remain much longer here than elsewhere at Asante Sana, and moisture availability is generally much more consistent through the year.

Given the jointed and rugged nature of the massive dolerite cliffs on the northern side of the basin, rising from 1600–2000 m, a large number of species are hosted within and on the cliffs. The most typical are *Albuca tenuifolia* Baker, *Asplenium adiantum-nigrum* L. var. *adiantum-nigrum*, *A. cordatum* (Thunb.) Sw., *A. trichomanes* subsp. *quadri-valens* D.E.Mey., *Crassula exilis* subsp. *cooperi* (Regal) Tölken, *C. lanceolata* (Eckl. & Zeyh.) Endl. ex Walp. subsp. *lanceolata*, *C. pellucida* subsp. *brachypetala* (Drège ex Harv.) Tölken, *C. setulosa* Harv. var. *setulosa*, *Cystopteris fragilis* (L.) Bernh., *Disperis macowanii* H.Bolus, *Ficinia compasbergensis* Drège, *Helichrysum sessile* DC., *Polypodium vulgare* L., *Scirpus falsus* C.B.Clarke, *Selago bolusii* Rolfe, *Senecio tanacetopsis* Hilliard, *Troglophyton capillaceum* (Thunb.) Hilliard & B.L.Burt subsp. *diffusum* (DC.) and *Zaluzianskya ovata* (Benth.) Walp.

Cliff-bases host the most diverse cliff-associated communities, and herbaceous species are the most common growth form in these cliff communities. Cliff-bases are often dominated by colonies of *Myosotis sylvatica* Ehrh. ex Hoffm. (supposedly naturalised; SKEAD 2009) and *Ranunculus multifidus* Forssk.: these two species often forming a joint 'alpine show' of blue and yellow in summer. Other colourful species are *Anchusa capensis* Thunb., *Cineraria aspera* Thunb., *C. erodioides* DC., *C. geraniifolia* DC., *C. lobata* L'Hér., *Cysticapnos pruinosa* (Bernh.) Lidén, *Geranium brycei* N.E.Br., and *Nerine angustifolia* (Baker) Baker. One of the more recently described Cape Midlands endemics – *Conium hilliburtorum* Magee & V.R.Clark – is the only true cliff-base specialist in the Cape Midlands endemic guild (MAGEE & CLARK 2017), and is known exclusively from this habitat. One of the most enigmatic species at Asante Sana is *Guthriea capensis* H.Bolus, and recently shown to be one of the few exclusively lizard-pollinated species in Africa (COZIEN et al. 2019); it only grows in this cliff habitat. Other typical herbs include *Galium thunbergianum* var. *hirsutum* (Sond.) Verdc., *Geum capense* Thunb., *Lobelia preslii* A.DC., *Pelargonium ranunculophyllum* (Eckl. & Zeyh.) Baker and *Stachys grandifolia* E.Mey. ex Benth. Ferns are typically represented by *Cheilanthes quadripinnata* (Forssk.) Kuhn, *Mohria nudiuscula* J.P.Roux and *Polystichum monticola* N.C.Anthony & Schelpe. *Brachypodium bolusii* Stapf is the dominant cliff-associated grass species, but the occasional *Festuca caprina* Nees and *F. scabra* Vahl colony is also present. *Pentaschistis airoides* subsp. *jugorum* (Stapf) H.P.Linder is typical among crevices and cliff-bases, right up to the highest peaks.

Shrubs are variable in presence and abundance, but typically can include *Erica woodii* Bolus and *Searsia divaricata* (Eckl. & Zeyh.) Moffett. *Euryops proteoides* B.Nord. & V.R.Clark is a robust species (up to three metres) that is only known from the Nardousberg and immediate surroundings, and was first encountered at Asante Sana; it is almost exclusively only found in the vicinity of cliffs, but also occasionally occurs along summit watercourses (e.g. in upper Waterkloof). *Polemannia grossulariifolia* Eckl. & Zeyh. is occasional in cliff communities, but is most prevalent in the extensive, boulder-scrub slopes that flank the main Nardousberg ridge-line.

Drakensberg Wetlands

On west- and south-facing slopes at Asante Sana there is more water availability due to the higher elevations of the higher Sneeu-berg above. As a result, these rocky watercourses at medium to higher elevations (1600–1800 m; PLATE 1j) are dominated by montane shrubby species such as *Buddleja salviifolia* (L.) Lam., *Gomphostigma virgatum* (L.f.) Baill., *Leucosidea sericea* Eckl. & Zeyh., *Psoralea margaretflorea* C.H.Stirton & V.R.Clark (incorrectly listed as *P. glabra* E.Mey. in CLARK et al. 2009), the grass *Miscanthus capensis* (Nees) Anderss., and herbs such as *Geranium cafferum* Eckl. & Zeyh., *Pelargonium zonale* (L.) L'Hér. and

Phygelius capensis E.Mey. ex Benth. Rocky overhangs and damp crevices support ferns such as *Adiantum capillus-veneris* L., *A. poiretii* Wikstr., *Blechnum australe* L. subsp. *australe* and *Pteris cretica* L. Rock pools host colonies of *Ranunculus rionii* Lagger (incorrectly listed as *R. aquatilis* L. by CLARK et al. 2009). These watercourse probably fit into MUCINA & RUTHERFORD'S (2006) Drakensberg Wetlands Vegetation Unit.

Eastern Temperate Freshwater Wetlands

Above 1800 m, watercourses are usually dominated by the large, spiky tussock grass *Merxmuellera macowanii* (Stapf) Conert (PLATE 1K), and extensive communities of this species occur on the Sneeuwberg summit plateaux. Floristic surveys of these wetlands indicate that they are low in species diversity (CONNOR et al. 2011). Where the vegetation is not dominated by *Merxmuellera macowanii* (Stapf) Conert (PLATE 1L), streams and wetlands on the Sneeuwberg summit have a rich flora that includes *Alchemilla elongata* Eckl. and Zeyh. var. *elongata*, *Berula erecta* subsp. *thunbergii* (DC.) B.L.Burt, *Conium fontanum* Hilliard and B.L.Burt, *Cotula microglossa* (DC.) O.Hoffm. & Kuntze ex Kuntze, *Crassula natans* Thunb. var. *natans*, *Epilobium capense* Buch. ex Hochst, *Gunnera perpensa* L., *Haplocarpha nervosa* (Thunb.) Beauverd, *Limosella* spp., *Lobelia dregeana* (C.Presl) A.DC., *L. flaccida* (C.Presl) A.DC. subsp. *flaccida*, *L. thermalis* Thunb., *Mentha longifolia* subsp. *capensis* (Thunb.) Briq., *Ornithogalum capillare* J.M.Wood & M.S.Evans, *Ranunculus meyeri* Harv., *Rumex* spp., *Senecio polyodon* DC., *Trifolium africanum* Ser. var. *africanum*, *Veronica anagallis-aquatica* L., and numerous Cyperaceae in the genera *Carex*, *Cyperus*, *Isolepis* and *Kyllinga*. Such wetlands could likely be included under MUCINA & RUTHERFORD'S (2006) Eastern Temperate Freshwater Wetlands Vegetation Unit.

Plateau Rock Communities

On exposed rocky outcrops and barren, rocky plateaux at the high elevations (1800–2100 m), typical alpine growth forms occur, the most distinctive being colonies of the compact, 50 cm-tall, dome-shaped *Ruschia complanata* L.Bolus/*R. putterillii* (L.Bolus) L.Bolus (it is not quite clear which species of these two it is, or if both are present); when in flower, these domes make for spectacular pink cushions (PLATE 1M). Such communities are also characterised by very small twiggy shrubs such as *Pentzia tortuosa* (DC.) Fenzl ex Harv., and by the cushion-species *Anacampteros rufescens* (Haw.) Sweet, *Crassula corallina* Thunb. subsp. *corallina*, *Othonna carnososa* Less. var. *carnososa*, and *Stomatium duthiae* L.Bolus, and the shrubby succulents *Bulbine abyssinica* A.Rich., *Crassula dependens* Bolus, *C. sarcocaulis* Eckl. & Zeyh. subsp. *sarcocaulis*, *Euphorbia caterviflora* N.E.Br. and *Ruschia hamata* (L.Bolus) Schwantes. The geophytes *Androcymbium striatum* A.Rich. and *Eriospermum corymbosum* Baker are typical.

Nama–Karoo:

Eastern Lower Karoo

The Nama–Karoo Biome dominates the basin floor of Asante Sana, in the form of MUCINA & RUTHERFORD'S (2006) Eastern Lower Karoo vegetation type (PLATE 1N₀), and is an exclave of the Camdeboo Plains vegetation that is characteristic of the Great Karoo south of the Sneeuwberg. Eastern Lower Karoo comprises sparse, low bushes and succulents up to 50 cm tall, typically dominated by common and widespread species such as *Aizoon* spp., *Aptosimum procumbens* (Lehm.) Steud., *Blepharis capensis* (L.f.) Pers., *Delosperma* spp., *Eriocephalus* spp., *Euphorbia ferox* Marloth, *Galenia* spp., *Lycium* spp., *Pentzia* spp., *Pteronia* spp. *Rhigozum obovatum* Burch., *Ruschia* spp., *Sarcocaulon camdeboense* Moffett, *Trichodiadema* sp. and various Molluginaceae in the genera *Hypertelis* E.Mey. ex Fenz, *Limeum* L. and *Mollugo* L. (LOW & REBELO 1998).

On the Nama–Karoo plains in the basin floor, *Vachellia karroo* (Hayne) Banfi & Galasso trees dominate the episodic watercourses (PLATE 1O), as is typical of arid riparian zones in the Great Karoo region. This vegetation is described by MUCINA & RUTHERFORD (2006) as the Southern Karoo Riviere Vegetation Unit.

5. Endemics

Seven (29%) of the 24 strict Sneeuwberg endemics have been recorded at Asante Sana, and 12 (44%) of the 27 regional endemics from the proposed 'Cape Midlands Centre' (i.e. with the Sneeuwberg, Great Winterberg–Amatholes and Stormberg as sub-centres, Clark et al. in prep.). This provides a total of 19 (37%) endemics at Asante Sana out of 51 local and regional mountain endemics, and emphasizes the conservation importance of Asante Sana.

While there are no species exclusively confined to Asante Sana, there are two that could be considered near-endemic: *Euryops proteoides* B.Nord. & V.R.Clark (NORDENSTAM et al. 2009; PLATE 2B) is only known from Asante Sana and the properties immediately to the west that also border the Narsousberg, and one property immediately adjacent to Asante Sana in the east. Similarly, but even more restricted, *Indigofera asantasanensis* Schrire & V.R.Clark (= *I.* sp. 2 in CLARK et al. 2009; PLATE 2G) is found on Asante Sana and on the immediately adjacent property to the east (CLARK et al. 2015). Asante Sana is the locality where both of these species were first discovered, and in total six novel species were first encountered at Asante Sana, the other four being *Conium hilliburttorum* Magee & V.R.Clark (= *C.* sp. 4 in CLARK et al. 2009; PLATE 2D), *Euryops exsudans* B.Nord & V.R.Clark (PLATE 2C), *Psoralea margaretiflora* C.H.Stirton & V.R.Clark (PLATE 2A), and *Senecio stella-purpurea* V.R.Clark, J.D.Vidal & N.P.Barker (PLATE 2F) (NORDENSTAM et al. 2009, STIRTON et al. 2011, CLARK et al. 2015, 2019, MAGEE & CLARK 2017; *Senecio stella-purpurea* is incorrectly listed as *S. arenarius* L. in CLARK et al. 2009). There is one species also first discovered at Asante Sana that is still to be published, viz. *Hermannia sneeuwbergensis* Gwynne-Evans & V.R.Clark MS (= *H.* sp. 1 in CLARK et al. 2009; Plate 2e). *Hesperantha helmei* Goldblatt & J.C.Manning was discovered in 2005 on the Nardousberg summit, the only other known locality being the Toorberg summit in the western Sneeuwberg (CLARCK et al. 2009).

Other notable collections and discoveries at Asante Sana are *Albuca tenuifolia* Baker, where it was first collected and recognised as this species, as it was not known from a type specimen (MARTÍNEZ-AZORÍN et al. 2011). There is an unconfirmed record of the far-eastern Sneeuwberg endemic *Dierama grandiflorum* G.J.Lewis from Asante Sana, a species otherwise only known from the Swaershoek Pass and Boschberg. A "lost" species, thought to be present in the Nardousberg area, is *Cliffortia bolusii* Diels ex C.Whitehouse – only known from its type specimen (WHITEHOUSE & FELLINGHAM 2007), it has not yet been rediscovered, despite a very comprehensive survey of Asante Sana and adjacent properties.

6. Non-native and invasive species

Non-native species are found throughout Asante Sana. These range from species that have been planted in gardens that have not naturalised, through naturalised species that behave as ruderals, to fully invasive species that invade natural (undisturbed) habitats. As a comprehensive survey of non-native species has not been undertaken on Asante Sana (only 20 species are formally recorded at present), there is currently no comprehensive data on how these are distributed. As a result, these notes here are largely based on incidental observations; we do not discuss planted species that have not naturalised, and focus on naturalised and invasive species.

Hypothetically, as the lower elevations (i.e. Eastern Lower Karoo and Southern Karoo Riviere) of Asante Sana are the most transformed through human activities, it also likely has the highest prevalence of non-native species – both in terms of diversity, richness and population sizes. This seems to be true for both naturalised and invasive species.

Eastern Lower Karoo has been heavily invaded in places by the South American cactus *Echinopsis schickendantzii* F.A.C.Weber. It is under a form of biological control by African Elephant *Loxodonta africana* through heavy browsing and resultant damage, but still remains a potentially serious problem, and probably covers several hundred hectares in total on Asante Sana. Southern Karoo Riviere has been invaded by the reed-like *Arundo donax* L., and locally by the trees *Ailanthus altissima* Swingle, *Populus x canescens* (Aiton) Sm. and (more extensively) *Schinus molle* L.. *Salix babylonica* L. var. *babylonica* has been extensively planted at Asante Sana, but it is not obviously invasive here, compared to other, wetter regions of South Africa, e.g. the Highveld. Ruderal species are common in the lower elevation areas, and include *Datura* spp., *Xanthium spinosum* L., *Nicotiana glauca* Graham, and various Chenopodiaceae.

In the montane grassland, the species of most concern is the grass *Nassella trichotoma* (Nees) Hack. ex Arechav. (PLATE 3). This is the most problematic high elevation species in the Sneeuwberg, and threatens the economic viability of properties and species diversity (WELLS & DE BEER 1987). The Asante Sana near-endemic *I. asantasanensis* is listed as Vulnerable (VU D2) due to the presence of large *N. trichotoma* (Nees) Hack. ex Arechav. invasions in its distribution range (CLARK et al. 2015), including on the eastern side of Asante Sana. *Urtica dioica* L. is a common naturalised species along south-facing cliff-bases, where the introduced grasses *Bromus catharticus* Vahl and *Vulpia bromoides* (L.) S.F.Gray also occur. *Opuntia ficus-indica* (L.) Mill. is common in drier cliffs, but is very local and is under an effective biocontrol agent.

Conclusion

Botanically, Asante Sana might be one of the better-studied properties in the Sneeu Berg – at least in terms of montane plant diversity – given botanical research that took place there over the space of 12 years. It is a remarkable property in having been the discovery locality of six new plant species in this time, two of which can be considered near-endemic to Asante Sana itself. It is likely that future fieldwork in areas of Asante Sana that are still less well-explored might reveal additional interesting species. In terms of better understanding the total vegetation of Asante Sana, we recommended a formal phytosociological survey of Asante Sana, and a comprehensive survey of non-native species (with a management plan for invasive species as per the South African Alien and Invasive Species Regulations 2014).

Acknowledgements

Richard and Kitty VILJOEN are thanked for the many years of generous access to Asante Sana. Wolfram MEY is thanked for the invitation to prepare this dedicated contribution on the vegetation of Asante Sana and for covering publication costs.

VRC's fieldwork at Asante Sana comprised part of a Rhodes University PhD (2005–2009), supported by a freestanding South African Biosystematics Initiative grant (2006–2009), Buk'Indalo Consultancy cc, and a Dudley D'Ewes Scholarship from the Cape Tercentenary Foundation; two scarce skills post-doctoral fellowships to VRC (from Rhodes University and the NRF, respectively; 2014–2016) further supported ad hoc field work. The PhD was also supported under a National Research Foundation (NRF, grant GUN 2069059) and National Geographic Society (USA) Committee for Research and Exploration Grant (8521-08) to Nigel Barker under his Great Escarpment Biodiversity Research Programme.

Collecting permits were authorised by the Eastern Cape Department of Environmental Affairs. VRC would like to thank Nigel BARKER for mentorship and supervision during the tenure of the PhD that fieldwork at Asante Sana formed a part. Gareth COOMBS, Ivan CRAUSE, Nico DEVOS, Robert McKENZIE, Tlou MOHOLWA, Syd RAMDHANI and Peter WESTON for invaluable assistance and camaraderie in the field. The Curator of the Selmar Schonland Herbarium (GRA), Tony DOLD, is thanked for access to the herbarium library and collections; numerous taxonomists are thanked for their expertise in assisting with identifications (detailed in CLARK et al. 2009). VRC contributed the text and photographs; cartography and textual comment was provided by JDV (with support through a University of the Free State post-doctoral fellowship).

References

- ACOCKS, J.P.H. (1988): Veld Types of South Africa. Memoirs of the Botanical Survey of South Africa No. 57. Botanical Research Institute, Pretoria, 146 pp.
- African Plant Database (version 3.4.0). Conservatoire et Jardin botaniques de la Ville de Genève and South African National Biodiversity Institute, Pretoria. Retrieved November 2019, from <http://www.ville-ge.ch/musinfo/bd/cjb/africa/>.
- BOARDMAN, J., PARSON, A.J., HOLLAND, R., HOLMES, P.J. & WASHINGTON, R. (2003): Development of badlands and gullies in the Sneeu Berg, Great Karoo, South Africa. – *Catena* **50**: 165–184.
- CARBUTT, C. & EDWARDS, T.J. (2006): The endemic and near-endemic angiosperms of the Drakensberg Alpine Centre. – southern African Journal of Botany **72**: 105–132.
- CLARK, V.R. (2010): The phytogeography of the Sneeu Berg, Nuweveldberge and Roggeveldberge (Great Escarpment): Assessing migration routes and endemism. Unpublished PhD Thesis, Rhodes University, Grahamstown, 337 pp.
- CLARK, V.R., BARKER, N.P. & MUCINA, L. (2009): The Sneeu Berg: A new centre of floristic endemism on the Great Escarpment, South Africa. – southern African Journal of Botany **75**: 196–238
- CLARK, V.R., BARKER, N.P. & MUCINA, L. (2011): The Great Escarpment of southern Africa: a new frontier for biodiversity exploration. – *Biodiversity and Conservation* **20**: 2543–2561.
- CLARK, V.R., DOLD, A.P., McMASTER, C., MCGREGOR, G., BREDEKAMP, C. & BARKER, N.P. (2014): Rich Sister, Poor Cousin: Plant Diversity and Endemism in the Great Winterberg–Amatholes (Great Escarpment, Eastern Cape, South Africa). – southern African Journal of Botany **92**: 159–174.
- CLARK, V.R., SCHIRRE, B.D. & BARKER, N.P. (2015): Two new species of *Indigofera* L. (Leguminosae) from the Sneeu Berg Centre of Floristic Endemism, Great Escarpment (Eastern and Western Cape, South Africa). – *PhytoKeys* **48**: 29–41.
- CLARK, V.R., VIDAL JR., J.D. & BARKER, N.P. (2019): A new, localised species of radiate *Senecio* (Asteraceae: Senecioneae) from the Sneeu Berg massif, South Africa. – *Phytotaxa* **406**: 180–190.
- CLARK, V.R., VIDAL JR., J.D. & BARKER, N.P. (in prep.): The Cape Midlands Escarpment Centre of Floristic Endemism.
- COWLING, R.M., PROCHE, S.M. & VLOK, J.H.J. (2005): On the origin of southern African subtropical thicket vegetation. – southern African Journal of Botany **71**: 1–23.
- CONNOR, A.L., DANIELS, R.J., JANKS, M.R., CLARK, V.R. & BARKER, N.P. (2011): The distribution, floristics, and palaeoecology of *Merxmüllera macowanii* montane wetlands in the Sneeu Berg. – southern African Journal of Botany **77**: 570–571.
- COZIEN, R.J., VAN DER NIET, T., JOHNSON, S.D. & STEENHUISEN, S.-L. (2019): Saurian surprise: lizards pollinate South Africa's enigmatic hidden flower. – *Ecology* **100**: e02670.
- ESTER, K.J., MILTON, S.J. & DEAN, W.R.J. (2006): Karoo Veld, Ecology and Management. – Briza Publications, Pretoria, X+214 pp.
- LOW, A.B. & REBELO, A.G. (Eds.) (1998): Vegetation of South Africa, Lesotho and Swaziland. Department of Environmental Affairs and Tourism, Pretoria, pp.

- MAGEE, A. & CLARK, V.R. (2017): Mzansi's Mountain Hemlocks: The identities of Hilliard & Burt's *Conium* species 3 & 4 (Apiaceae), and a revised key for the genus. – southern African Journal of Botany **108**: 243-247.
- MARTÍNEZ-AZORÍN, M., CLARK, V.R., CRESPO, M.B., DOLD, A.P. & BARKER, N.P. (2011): The rediscovery of *Albica tenuifolia* Baker, an orophilous species from the eastern Great Escarpment in South Africa. – Nordic Journal of Botany **29**: 465–470.
- MEADOWS, M.E. & WATKEYS, M.K. (1999): Palaeoenvironments. In: DEAN, W.R.J. & MILTON, S.J. (Eds.), *The Karoo: ecological patterns and processes*. Cambridge University Press, Cambridge, pp. 27–41.
- NORDENSTAM, B., CLARK, V.R., DEVOS, N. & BARKER, N. (2009): Two new species of *Euryops* (Asteraceae: Senecioneae) from the Sneeuberg, Eastern Cape Province, South Africa. – southern African Journal of Botany **75**: 145-152.
- PALMER, A.R. (1990): A qualitative model of vegetation history in the eastern Cape midlands, South Africa. – Journal of Biogeography **17**: 35-46.
- SKEAD, C.J. (2009): *Historical Plant Incidence in Southern Africa: A Collection of Early Travel Records in Southern Africa. Strelitzia 24*. southern African National Biodiversity Institute, Kirstenbosch, 378 pp.
- VAN DER WALT, P.T. (1980): A phytosociological reconnaissance of the Mountain Zebra National Park. – Koedoe **23**: 1-32.
- VAN WYK, A.E. & SMITH, G.F. (2001): *Regions of floristic endemism in southern Africa*. – Umdaus Press, Hatfield, South Africa, VIII + 199 pp.
- WELLS, M.J. & DE BEER, H. (1987): *Nassella tussock. Farming in South Africa: Weeds A.21/1987*. Department of Agriculture & Water Supply, Pretoria, 3 pp.
- WHITEHOUSE, C.M. & FELLINGHAM, A.C. (2007): New species and notes on the genus *Cliffortia* (Rosaceae). *Bothalia* **37**: 9-22.

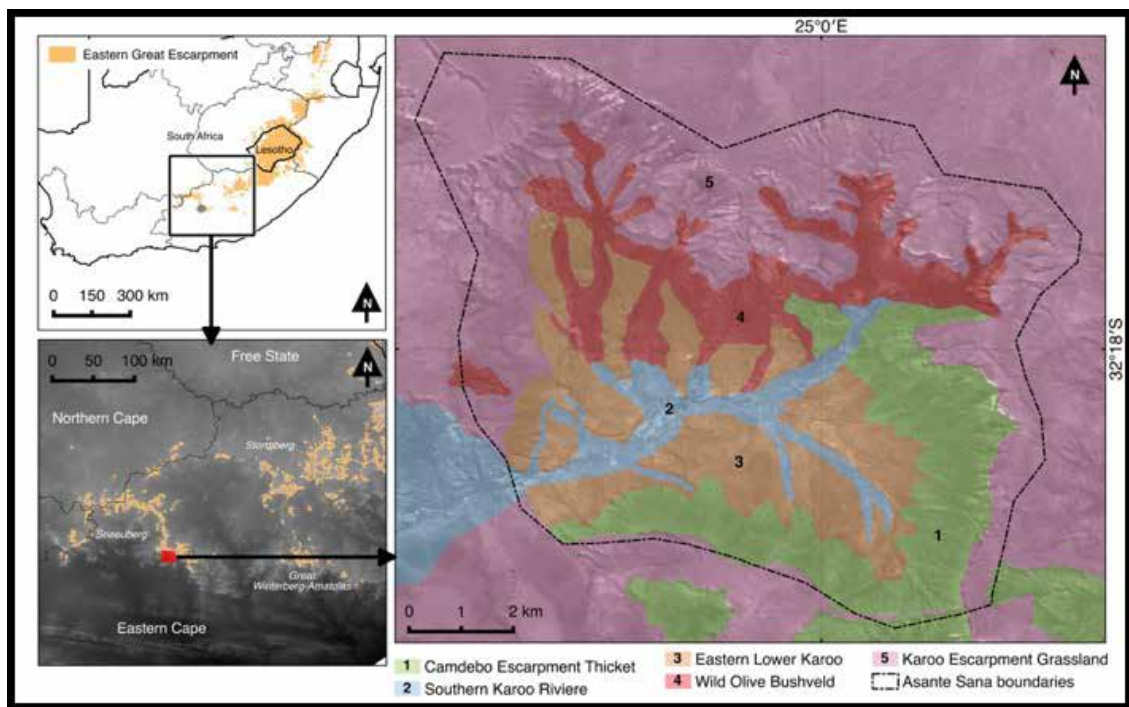


Figure 1: Asante Sana Private Game Reserve: (A) Location relative to the eastern Great Escarpment in southern Africa; (B) Location in the Sneeuberg massif; and (C) Dominant vegetation types.

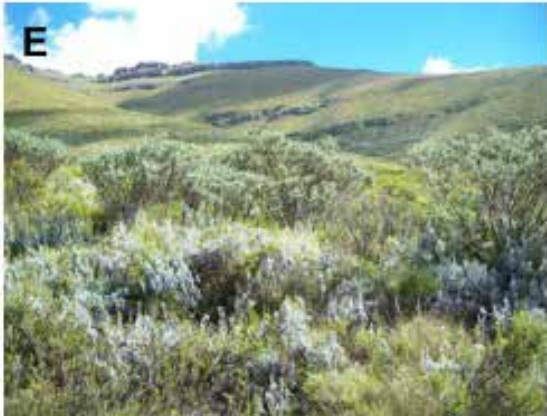


Plate 1: Vegetation Units of Asante Sana Private Game Reserve: (A) Camdeboo Escarpment Thicket; (B) Wild Olive Bushveld (viewed from Suurkloof); (C) Dry Woody Cliff Communities (as seen here in Suurkloof); (D) Karoo Escarpment Grassland (c.2200 m); (E) Montane Shrubland (upper Suurkloof, c.1700 m); (F) Sneeuberg 'Renosterveld' (here above Glen Avon, c.1500 m).



Plate 1 (cont.): (G) Drakensberg–Amathole Afromontane Fynbos: drier summit plateau (c.2100 m); (H) Drakensberg–Amathole Afromontane Fynbos: moister southern slopes (Nardousberg ridge, c.2300 m); (I) South-facing Cliff Communities (c.2000 m); (J) Drakensberg Wetlands (Suurkloof, c.1600 m); (K) Eastern Freshwater Temperate Wetlands: dominated by the large tussock grass *Merxmuellera macowanii* (Stapf) Conert (above Waterkloof, c.2100); (L) Eastern Freshwater Temperate Wetlands: without *Merxmuellera macowanii* (Stapf) Conert (photograph taken c.4.5 km north-east of Suurkloof, on an adjacent property)..



Plate 1 (cont.): (M) Plateau Rock Communities, here represented by a cushion of *Ruschia complanata* L. Bolus (Blinkberg, c.6 km north-east of Asante Sana, c.1800 m); (N) Eastern Lower Karoo (c.700–900 m); (O) Eastern Lower Karoo showing Southern Karoo Riviere along the watercourses. All photographs by V.R. CLARK.



Plate 2: New plant species first discovered at Asante Sana Private Game Reserve: (A) *Psoralea margaretiflora* C.H.Stirton & V.R.Clark; (B) *Euryops proteoides* B.Nord. & V.R.Clark; (C) *Euryops exsudans* B.Nord & V.R.Clark; (D) *Conium hillburttorum* Magee & V.R.Clark; (E) *Hermannia sneeuwbergensis* Gwynne-Evans & V.R.Clark MS; (F) *Senecio stella-purpurea* V.R.Clark, J.D.Vidal & N.P.Barker; (G) *Indigofera asantasanensis* Schrire & V.R.Clark. All photographs by V.R. CLARK.



Plate 3: *Nassella trichotoma* (Nees) Hack. ex Arechav. invasion in the eastern parts of Asante Sana Private Game Reserve, c.1700 m (foreground and middleground). *Nassella trichotoma* presents the greatest threat to native biodiversity and wildlife/livestock carrying capacity in the higher elevations of the Sneeuberg.