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Vegetation on the ultramafic soils of the Sekhukhuneland Centre of Endemism

by

Stefan John Siebert

Submitted in partial fulfilment of the requirements of the degree

Philosophiae Doctor

in the Faculty of Natural and Agricultural Sciences

Department of Botany

University of Pretoria

Pretoria

promoters:

Prof. Dr A.E. van Wyk
Prof. Dr G.J. Bredenkamp

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"The primary tactic in conservation must be to locate the world's hot spots and to protect the entire environment they contain"

E.O. Wilson (1992)

"Ecology is the scientific study of the interactions that determine the distribution and abundance of organisms in nature"

C.J. Krebs (1978)

I live to honour God, and I present this thesis to Him, who thought it well to provide me with opportunities that I am certainly not worthy of.

ABSTRACT

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A floristic-ecological account of the vegetation of the Sekhukhuneland Centre of Plant Endemism (SCPE) is given. This is the first comprehensive botanical study undertaken in this floristically poorly known region. A brief review of the physical environment, namely topography, geology, soils and climate, as well as the vegetation and flora, is presented.

Data from 415 sample plots were subjected to phytosociological classification using TWINSPAN and refined with table-sorting procedures based on the Braun-Blanquet approach. The analysis revealed six major vegetation types consisting of 82 syntaxa, interpreted as *Fuirena pubescens–Schoenoplectus corymbosus* Wetland Vegetation, *Themeda triandra–Senecio microglossus* Cool Moist Grasslands, *Hippobromus pauciflorus–Rhoicissus tridentata* Rock Outcrop Vegetation, *Combretum hereroense–Grewia vernicosa* Open Mountain Bushveld, *Kirkia wilmsii–Terminalia prunioides* Closed Mountain Bushveld and *Acacia tortilis–Dichrostachys cinerea* Arid Northern Bushveld. Plant communities of each major vegetation type are described and diagnostic and rare/threatened species highlighted.

Thirteen rock types of the SCPE were analysed to evaluate the chemical relationships with serpentinite. Maize seedlings were grown in ultramafic soils of the SCPE and showed

symptoms of nickel and chromium toxicity. Plant material of indigenous species and soil samples were sampled along 13 points of a catena in the SCPE and analysed with recognised analytical methods to determine the levels of 33 elements. Nine SCPE endemics, three SCPE near-endemics, and eight common species were analysed. None of the plant taxa were hyperaccumulators of chromium or nickel, but seven species accumulated more than 1000 mg/kg of iron and aluminium. The accumulators were mostly common species and included one SCPE endemic form and one SCPE near-endemic. Three of the hyperaccumulators belong to the Asteraceae.

The threat status of 80 plant species of the SCPE was assessed using IUCN categories and 26 met these criteria. A first division of the SCPE into subcentres is presented to aid future conservation strategies. The SCPE endemic, near-endemic and disjunct plant taxa are listed, as well as those species shared with other centres or floristic regions. Major threats to the plant diversity of Sekhukhuneland are considered and a probable conservation solution presented. A checklist is given of the approximately 2000 plant taxa of the 4000 km^2 of the SCPE and arranged according to family, with genera and species listed alphabetically within the families. This analysis supports the recognition of the region as an important Centre of Plant Endemism and Diversity requiring conservation attention.

Keywords: biodiversity, Centre of Plant Endemism, chromium, conservation, endemism, grassland, heavy metals, hyperaccumulation, Mpumalanga, Northern Province, phytosociology, platinum, Red Data List, Rustenburg Layered Suite, savanna, Sekhukhuneland, TWINSPAN, ultramafic rocks.

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LIST OF ABBREVIATIONS

CBD	=	Convention on Biological Diversity
GIS	=	Geographical Information System
PRE	=	National Herbarium, Pretoria
PRECIS	=	Pretoria National Herbarium Computerised Information System
PRU	=	H.G.W.J. Schweickerdt Herbarium, University of Pretoria
QDG	=	Quarter Degree Grid
RLS	=	Rustenburg Layered Suite
SCPE	=	Sekhukhuneland Centre of Plant Endemism

SUMMARY

Vegetation on the ultramafic soils of the Sekhukhuneland Centre of Endemism

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The vegetation types of South Africa, and especially those associated with Centres of Endemism, are under increasing human pressure. Habitat loss as a result of open cast mining, mine dumps, population growth, overgrazing, trampling and alien species invasions, is the greatest threat to the Sekhukhuneland Centre of Plant Endemism (SCPE). A floristic-ecological account of the threatened vegetation of the SCPE is given. This is the first comprehensive botanical study undertaken in this floristically poorly known region situated west of the northeastern Drakensberg Escarpment, between 24°15' and 25°30'S latitude, 29°30' and 30°30'E longitude. A brief review of the physical environment, namely topography, geology, soils and climate, as well as the vegetation and flora, are given.

A detailed account is given of the vegetation types of the SCPE. Phytosociological data from 415 sample plots were subjected to phytosociological classification using TWINSPAN and refined with table-sorting procedures based on the Braun-Blanquet floristic-sociological approach. The vegetation classification revealed six major vegetation types consisting of 82 syntaxa, interpreted as *Fuirena pubescens–Schoenoplectus corymbosus* Wetland Vegetation, *Themeda triandra–Senecio microglossus* Cool Moist Grasslands, *Hippobromus pauciflorus–Rhoicissus tridentata* Rock Outcrop Vegetation, *Combretum hereroense–Grewia vernicosa* Open Mountain Bushveld, *Kirkia wilmsii–Terminalia prunioides* Closed

Mountain Bushveld and *Acacia tortilis–Dichrostachys cinerea* Arid Northern Bushveld. Plant communities of each major vegetation type are described and the diagnostic species highlighted, with the occurrence of rare and threatened plant species indicated.

Maize seedlings that were grown in ultramafic soils of the SCPE showed typical symptoms of nickel and chromium toxicity. To further investigate heavy metal accumulation, 20 indigenous plant species were sampled along 13 points of an ultramafic catena. Plant material and soil samples were analysed with recognised analytical methods to determine the concentrations of 33 elements. Thirteen rock types of the SCPE were analysed to highlight the chemical relationship between the rocks of the study area and serpentinite. Nine SCPE endemics, three SCPE near-endemics, and eight common species were analysed. None of the plant taxa were hyperaccumulators of chromium or nickel, but seven indigenous species accumulated more than 1000 mg/kg of iron and aluminium. The accumulators of high heavy metal concentrations were mostly common species. Accummulators included one SCPE endemic form and one SCPE near-endemic. Three of the hyperaccumulators belong to the Asteraceae.

Eighty plant species of the SCPE were assessed according to the IUCN categories of threat and 26 met the criteria. A first division of the SCPE into sub-centres is presented to aid future conservation actions. The endemic plant species are listed, as well as the near-endemic and disjunct taxa that are shared with other centres or floristic regions. A checklist is given of the approximately 2000 plant taxa that occur in the 4000 km^2 of the SCPE and are arranged by family, with the genera and species listed alphabetically within. Major threats to the plant diversity of Sekhukhuneland are considered and a probable conservation solution presented. The available data supports the recognition of the region as an important Centre of Plant Endemism and Diversity requiring conservation attention.

OPSOMMING

Plantegroei op die ultramafiese grond van die Sekhukhuneland Sentrum van Endemisme

deur

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Die plantegroeitipes van Suid-Afrika, en veral die wat geassosieer is met Sentrums van Endemisme, is onder toenemende druk as gevolg van ontwikkeling. Habitat verlies as gevolg van oopgroef mynbou, mynhope, bevolkingsgroei, oorbeweiding, vertrapping en indringerplante, is die grootste bedreiging vir die Sekhukhuneland Sentrum van Plant Endemisme (SSPE). 'n Floristies-ekologiese ondersoek van the bedreigde plantegroei van die SSPE word aangebied. Dit is die eerste indiepte botaniese studie wat onderneem is in hierdie floristies onbekende gebied wat geleë is aan die westekant van die noordoostelike Drakensberg Eskarpement tussen 24°15' en 25°30'S breedtegraad, en 29°30' en 30°30'O lengtegraad. 'n Kort oorsig van die fisiese omgewing, naamlik die topografie, geologie, grond en klimaat, asook die plantegroei en flora, word aangebied.

'n Gedetaileerde ondersoek handelend oor die plantgemeenskappe van die SSPE word voorgelê. Fitososiologiese data wat in 415 plotte ingesamel was, was onderwerp aan fitososiologiese klassifikasie met behulp van TWINSPAN. Die resultate was verfyn met tabelsorterings tegnieke wat gebaseer is op die Braun-Blanquet floristies-sosiologiese benadering. Die plantegroei klassifikasie het ses hoof plantegroeitipes onderskei wat bestaan uit 82 syntaksa, geinterpreteer as die *Fuirena pubescens–Schoenoplectus corymbosus*

Vleiland Plantegroei, *Themeda triandra–Senecio microglossus* Koel Vogtige Grasveld, *Hippobromus pauciflorus–Rhoicissus tridentata* Rots Dagsoom Plantegroei, *Combretum hereroense–Grewia vernicosa* Oop Berg Bosveld, *Kirkia wilmsii–Terminalia prunioides* Geslote Berg Bosveld and *Acacia tortilis–Dichrostachys cinerea* Ariede Noordelike Bosveld. Plantgemeenskappe van elke hoof plantegroeitipe is beskryf en die diagnostiese spesies beklemtoon. Die teenwoordigheid van skaars en bedreigde spesies is aangedui.

Mielie saailinge is aangeplant in ultramafiese grond van die SSPE en het tipiese simptome van nikkel en kroom vergiftiging getoon. Om swaar metaal akkumulering verder te ondersoek, is 20 inheemse plantspesies versamel langs 13 punte van 'n ultramafiese katena. Plantmateriaal en grondmonsters was geanaliseer met erkende analitiese metodes om die konsentrasies van 33 elemente te bepaal. Dertien rots tipes van die SSPE was ook geanaliseer om the chemiese verband tussen die gesteentes van die studiegebied en serpentyn uit te wys. Plantmateriaal van nege SSPE endemiese, drie SSPE naby endemiese, en agt algemene spesies was geanaliseer. Nie een van die plant taksa was hiperakkumuleerders van kroom of nikkel nie, maar sewe inheemse spesies het meer as 1000 mg/kg van yster en aluminium geakkumuleer. Die akkumuleerders van hoë swaar metaal konsentrasies was meestal algemene spesies. Die akkumuleerders sluit een SSPE endemiese form en een SSPE naby endemiese spesie in. Drie van die hiperakkumuleerders is van die Asteraceae.

Tagtig plantspesies van die SSPE was geëvalueer op grond van die IUCN kategorieë van bedreiging en 26 spesies het hieraan voldoen. Vir die eerste keer is die SSPE opgedeel in subsentrums om toekomstige bewaringsaksies te ondersteun. Die endemiese plantspesies word gelys, asook die naby endemiese en disjunk taksa wat gedeel word met ander sentrums of floristiese gebiede. 'n Spesielys is opgestel van die ongeveer 2000 plant taksa wat in die 4000 km^2 van die SSPE voorkom. Die lys is alfabeties gerangskik volgens familie, met die genusse en spesies alfabeties gerangskik daarbinne. Aspekte wat die plant diversiteit van Sekhukhuneland bedreig is oorweeg en 'n moontlike oplossing vir bewaring word voorgestel. Die beskikbare data ondersteun die erkenning van die studiegebied as 'n Sentrum van Endemisme en Diversiteit wat dringend aandag benodig as 'n belangrike bewaringsgebied.

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CURRICULUM VITAE

Stefan John Siebert was born on 27 September 1974 in Empangeni, KwaZulu-Natal. He attended Mandini Primary School and later King Edward High School in Matatiele, KwaZulu-Natal, where he matriculated in 1992.

In 1993 he joined the South African Defence Force, where he became an officer and obtained the rank of second lieutenant at 4 Artillery Regiment in Potchefstroom.

In 1994 he enrolled at the University of Pretoria, and was awarded his B.Sc. degree in 1996, with Botany and Zoology as majors.

He registered for an Honours degree in Botany at the University of Pretoria in 1997 and specialised in taxonomy and ecology. He obtained this degree *cum laude* and recieved the H.G.W.J. Schweickerdt Medal for Botany at the Honours level.

In 1998 he registered for a Master of Science degree in Botany at the same university, specialising in the plant diversity of the ultramafic rocks of Sekhukhuneland. He completed his research dissertation that same year and was awarded the degree *cum laude*.

From 1999 to 2001 he pursued and completed a Doctor of Philosophy Degree with the title: *Vegetation on the ultramafic soils of the Sekhukhuneland Centre of Endemism*. His botanical work in the Sekhukhuneland Centre culminated in ten presentations in South Africa, one in the United States of America and one in Australia. Four articles have been submitted and accepted by scientific journals, and six articles are in preparation. Various articles have also been prepared and submitted to popular journals.

He is currently employed as the Regional Coordinator of the Southern African Botanical Diversity Network (SABONET) at the National Botanical Institute of South Africa (2001-2002).

CHAPTER 1

INTRODUCTION

1.1 Background

On 5 June 1992, at the United Nations Conference on Environment and Development (the Rio 'Earth Summit'), the Convention on Biological Diversity [CBD] was opened for signature (Davis *et al.* 1994). The CBD was inspired by the world community's growing commitment to sustainable development. It represents a dramatic step forward in the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of benefits arising from the use of genetic resources.

What is biological diversity? Biological diversity, or **biodiversity**, is the sum of all species of animals, plants, fungi and micro-organisms, as well as the gene pool, evolutionary history and potential value of each species (Low & Rebelo 1996; Garcia *et al.* 2001). Biodiversity is an integral part of ecosystems, ecological processes and landscapes, which is much appreciated (e.g. Kruger National Park) and needed (e.g. Maputaland) by a country's people.

Plant species are fundamental independent building blocks of biodiversity to which people can easily relate in terms of various values. It forms a most obvious biological unit that is of substantial use to people and thus forms the unit that is the most significant part of biological research. The importance of plant diversity may be summarised as follows: humans and most other animals are almost totally dependent on plants, directly or indirectly, as a source of energy through their ability to sequester carbon from the atmosphere and to capture the sun's energy via photosynthesis (Salisbury & Ross 1992). Humans are currently using tens of thousands of species of higher plants, and several hundred lower plants, for a wide range of purposes. To conserve and utilise this plant life sustainably, it is important to know what is being used and what should be conserved.

In recent years there has been much interest in documenting biodiversity (Stork 1993; Blackmore 1996; Cresswell & Bridgewater 2000). A lot of focus has been placed on the development of strategies to monitor biodiversity in developing countries by training and making use of parataxonomists (Huntley *et al.* 1998; Basset *et al.* 2000; Danielsen *et al.* 2000). Such strategies became necessary where the achievements of initiatives to strengthen biodiversity conservation in developing countries became difficult to assess because most of these countries have no system for monitoring biodiversity. Furthermore the need for georeferenced specimen-label databases (botanical collections) has become increasingly important as tools for conservation actions (Soberón *et al.* 2000; Ter Steege *et al.* 2000; Siebert & Willis 2000), which in turn, are an output of the strategies to monitor biodiversity.

Before biodiversity can be monitored, an inventory listing the natural resources, namely species, ecosystems and environmental factors, of a region is needed. Such an inventory will aid future monitoring strategies and management plans of large natural areas. Knowledge of a region's plant diversity forms the basis for understanding and managing its plant resources and environment. Concern for the survival of plant species has driven conservation policies and actions for many centuries. One of the main problems facing plant conservation in southern Africa, is the lack of sound information on which to base conservation strategies. Traditional botanical conservation systems have evolved around species that are of practical use (e.g. food, fodder, timber, medicine, etc.). However, governmental conservation policies have focussed on species that are charismatic and/or of scientific interest (e.g. *Welwitschia mirabilis*, succulents, forest trees, etc.). The conservation of rare species that are threatened or endangered has also become a major concern of late shared by governments, conservation organisations and individuals. Although these approaches differ, it is the concern for the survival of plant species that has been the driving force in conservation.

Conservation issues are even more critical in areas that are prone to rapid development. This is often the case in mining areas where the economic value of the underground layers are more important than the above ground value of the biodiversity. South-central Africa, that is South Africa, Zimbabwe, Botswana, Zaire and Zambia, are some of the richest areas for heavy metals (especially copper, cobalt, chromium, nickel, platinum and uranium) in the world (Brooks & Malaisse 1985; Coetzee 1985; Nriagu & Nieboer 1988). Poor economic growth, large populations and poverty have driven southern African governments to opt for the more popular and sought-after underground reserves of heavy metals as a much needed income. This has placed the associated biodiversity of these areas under threat.

1.2 Sekhukhuneland Centre of Plant Endemism

Inadequate definitions and inconsistent use of phytogeographic terms have led to confusion in southern African phytogeography (Van Rooy 2000). Due to this problem, and for the purpose of this study, a centre of endemism is demarcated as an area with a high concentration of taxa with limited geographic distributions (endemics). A centre of endemism is therefore defined as a concentration of taxa (usually at species level) in the geographic distribution area of an endemic element, which in this case is the Flora of Sekhukhuneland.

It is important to note that, in the broad sense of the term, Sekhukhuneland is a hot-spot. Hot-spots are geographic areas where centres of diversity and centres of endemism overlap and are threatened by habitat modification and transformation (Myers 1990). On a larger scale Sekhukhuneland is part of the hot-spot associated with the northeastern Drakensberg Escarpment (Matthews 1991, Siebert 1998), which broadly relates to Croizat's "Barberton Node" (Croizat 1965), and includes, among others, the Barberton and Wolkberg Centres of Plant Endemism.

The Sekhukhuneland Centre of Plant Endemism [SCPE] is a phytogeographic (floristic) region (group of quarter degree grids of similar floristic composition) within a larger region. Due to the occurrence of a phytogeographic (floristic) element (group of taxa—endemics—of similar geographic distribution) it was classified as a centre of endemism (Van Wyk & Van Wyk 1997; Siebert 1998).

The criteria which were adopted to select the study area as a Centre of Plant Endemism was based on the characteristics described by Davis *et al.* (1994) for Centres of Plant Diversity:

- The area is evidently species-rich, even though the number of species present may not be accurately known (Siebert 2000);
- The area is known to contain a large number of species endemic to it (Siebert 1998);
- The site contains an important genepool of plants of value to humans or that are potentially useful (Kritzinger 1992; Crookes *et al.* 2000);
- The site contains a diverse range of habitat types (Siebert *et al.* 2002a);
- The site contains a significant proportion of species adapted to special edaphic conditions (Siebert *et al.* 2001);
- The site is threatened or under imminent threat of large-scale devastation (Siebert *et al.* 2002b).

In view of the current focus on global biodiversity, it is not surprising that the identification of centres of plant diversity and endemism has become a matter of great urgency and importance (Myers 1988; Wilson 1992). The international Convention on Biological Diversity has focused renewed attention on the rapid global loss and degradation of natural ecosystems (Convention on Biological Diversity 1994). Recently the World Conservation Union (IUCN) and World Wide Fund for Nature (WWF) recognised approximately 235 Centres of Plant Diversity worldwide which are of primary importance for the conservation of plant diversity (Davis *et al.* 1994). These centres are endemic-rich botanical sites of global conservation significance. No fewer than 14 of the 84 centres in Africa are located in southern Africa. However, many other centres of local importance have not yet been explored or investigated in great detail. The Sekhukhuneland Centre of Plant Endemism (Van Wyk & Van Wyk 1997; Siebert 1998) is such an area. It is a poorly studied, serpentine-related, floristic region located in the Northern Province and Mpumalanga on the ultramafic rocks of the Rustenburg Layered Suite of the Bushveld (Igneous) Complex (Siebert 1998). The SCPE lies directly adjacent and to the west of the

Wolkberg Centre of Endemism (Matthews *et al.* 1993), a local focus of endemism within the Afromontane Region. The Afromontane Region is one of the 84 sites (Site A*f*67) in Africa that has been identified as a Centre of Plant Diversity and Endemism (Davis *et al.* 1994)—the southern parts which are known as the Drakensberg Regional Mountain System.

1.3 Rationale and motivation

Southern Africa has the richest temperate flora in the world (Arnold & De Wet 1993). For a predominantly warm-temperate, semi-arid region, southern Africa is exceptionally rich in vascular plants. Southern Africa, defined as the region south of the Cunene-Zambesi Rivers, comprises over 30 000 species of flowering plants and ferns, including the whole of one of the world's six floristic kingdoms (the Cape Floristic Region or Fynbos Biome). The region also includes (Huntley *et al.* 1998):

- Seventeen of the centres of plant diversity identified by the IUCN/WWF;
- Arid and semi-arid ecosystems (with half of the world's known succulents);
- Coastal, marine and freshwater ecosystems (RAMSAR and World Heritage Sites);
- Forest ecosystems (most under some threat);
- Mountain ecosystems (e.g. Richtersveld, Drakensberg and Maluti Mountains).

South Africa plays host to an enormous diversity of plants which comprises almost 10% of the world's known flowering plants (Davis *et al.* 1994). According to Arnold & De Wet (1993), the approximately 24 000 infrageneric taxa of South Africa is the highest number of native vascular plant species recorded for any country in Africa. In the world only Brazil, Colombia, China and Borneo have more native vascular plant species than South Africa. According to Davis *et al.* (1994), South Africa carries the most endemics (> 16 000 species) in Africa, resulting in a species endemism of approximately 70%. This percentage compares well with endemism rates on islands like Madagascar. Only a few regions have a higher percentage endemism than South Africa.

The above-mentioned statistics concerning southern Africa, and in particular South Africa's rich and unique plant diversity, justifies the attention it receives in numerous scientific works concerning floristics (Cowling & Hilton-Taylor 1994; Davis *et al.* 1994; Myers *et al.* 2000; Van Wyk & Smith 2001). However, despite this great botanical diversity, the flora of the region has not been inventoried, monitored and evaluated to its full potential. In addition many plant species are threatened with extinction, mainly through agricultural, mining, industry and urban activities. The 2001 IUCN Red Data List of Threatened Plants lists more than 4 300 plant species as threatened in southern Africa (Golding 2001a).

Sekhukhuneland is a region within southern Africa which boasts a rich temperate flora on a relatively small land area. For instance, in South Africa the province of KwaZulu-Natal has an estimated 5 000 indigenous species in an area of approximately 91 000 km^2. The Sekhukhuneland Centre of Plant Endemism is about 20 times smaller (4 000 km^2) and has approximately 2 000 indigenous species. This figure is extraordinary if compared with islands in the world, namely New Zealand has 2 000 species on 268 000 km^2 and Hawaii has 2 000 indigenous species on 16 600 km^2. However, when the percentage endemism is compared it is obvious that speciation in Sekhukhuneland has been much restricted as open niches were filled by plant species from surrounding areas. The percentage endemism for New Zealand is 80%, Hawaii 95% and Sekhukhuneland about 4%. Considering that a restricted area is compared with complete biogeographical zones, a more significant figure can be obtained for the SCPE if all endemic species of the South Africa, which occur in the study area, are considered. In this case it will mean that 28% of the species in the SCPE are endemic to South Africa.

According to the Pretoria National Herbarium Computerised Information System [PRECIS] (data obtained on 11/03/1997), approximately 3 000 of the infrageneric taxa recorded for southern Africa occur along the eastern Bushveld Complex (Siebert 1998). Furthermore, it is estimated that 520 of these 3 000 species are endemic to the northern provinces of South Africa. Of these 520 endemics, it was determined that approximately 50 specific/infraspecific taxa are specifically endemic to the ultramafic substrates of Sekhukhuneland (Siebert 1998).

An overview of this region's stormy history explains why, to date, not much was known about the area's flora and vegetation. The Sekhukhuneland of today cannot stand apart from a changing Africa. In the twentieth century, Sekhukhuneland was included into the Lebowa homeland during the apartheid era in South Africa. During this time very little research took place regarding the sustainable development and conservation of the environment. The political and social instability in the area resulted in all research being focused on social aspects and hence, the flora, which form such an integral part of the peoples lives and heritage, has been neglected. Presently, heavy demands on natural resources imposed by the rapidly growing mining industry and a burgeoning human population, calls for the wise future use and management of the SCPE's plant diversity. People are depleting the available natural plant resources as they struggle to deal with their poverty and already large parts of Sekhukhuneland, which were known to be tree or thicket covered, are now laid bare (Kritzinger 1992).

One of the main problems facing plant conservation in Sekhukhuneland is the lack of sound information on which to base conservation strategies. A baseline inventory of ecological data became essential to supply authorities with the necessary information required to designate areas for the most appropriate forms of land-uses, and to formulate management plans for the protection and sustainable use of the region's native plant resources. Hence, the primary motivation for this study stemmed from the urgent need to highlight those areas of prime botanical importance that is prone to rapid loss and degradation of natural ecosystems due to unplanned and uncontrolled development. An adequate database of natural features is essential for effective land-use management and implementation (Kent & Ballard 1988; Bedward *et al.* 1992; Rhoads & Thompson 1992).

Until the beginning of 1998 no in depth research concerning the floristic uniqueness of the area has formally been documented. Sekhukhuneland should henceforth be recognised for its endemic flora and heavy metal soils. Broad hypotheses were formulated to test for uniqueness in the plant diversity of the Sekhukhuneland Centre of Plant Endemism:

Hypothesis 1. *The Sekhukhuneland Centre of Plant Endemism is characterised by plant communities specific to its heterogeneous environmental factors.*

Hypothesis 2. *The Sekhukhuneland Centre of Plant Endemism exhibits a specific relationship between certain plant species and heavy metal soils.*
Hypothesis 3. *The Sekhukhuneland Centre of Plant Endemism has a rich plant diversity, including endemic, near-endemic and threatened plant taxa.*

The hypotheses were used to formulate a *wider objective* that fits into the national vision for South Africa, an *immediate objective* that is in accordance with the missions of both national and provincial nature conservation agencies, and specific *objectives of the thesis* to test the hypotheses and to contribute to vegetation science:

Wider Objective
To contribute towards sustainable human development in the Sekhukhuneland region through the effective conservation and utilisation of plant diversity resources and their associated habitats.

Immediate Objective
To develop a detailed knowledge base of the plant species diversity and habitat within the plant communities of the Sekhukhuneland Centre of Plant Endemism, adequate to monitor and evaluate future activities for conservation, sustainable use and rehabilitation of botanical diversity, in the face of specific developmental challenges in the region and in response to the Convention on Biological Diversity.

Objectives of the thesis
The overall objectives of this vegetation study of the SCPE, as discussed in this thesis, is to document and:

- Describe the plant communities and associated habitats (Chapter 5-9)
- Investigate the plant-soil relationships on heavy metal substrates (Chapter 10)
- Assess the plant diversity, plant endemism and threatened plant taxa (Chapter 11)

1.4 Principle aims

- To classify the vegetation of the study area and formally describe the plant communities;
- To identify endemic, rare and threatened plant species, and to incorporate such taxa in sections dealing with conservation and vegetation;
- To comment on the distribution of endemic/near-endemic taxa, in particular plant communities and environmental conditions;
- To investigate the most important environmental factors that might have an influence on vegetation and floristic diversity of the study area;
- To investigate the habitat diversity with specific emphasis on habitats containing taxa of conservation value;
- To comment on the floristic status of the area and to identify biogeographical patterns and floristic affinities between plant communities;
- To identify the boundaries of the Sekhukhuneland Centre of Plant Diversity and Endemism;
- To produce various maps of the floristic and environmental factors of the study area;
- To investigate and assess the major threats to the region;
- To produce a detailed first inventory of plant species in the study area, supported by voucher specimens deposited in the H.G.W.J. Schweickerdt Herbarium;
- To emphasize the potential impact of mining and residential development on the floristic diversity of the study area, and to make recommendations concerning sensitive plant species and floristic areas that should be conserved;
- To propose management guidelines and strategies for the wise utilisation of resources, and the conservation of floristic diversity in the study area.

1.5 Layout of thesis

The layout of this thesis can be divided into three main parts, namely phytosociology (Chapters 4-9), plant-soil associations (Chapter 10) and floristic analyses (Chapter 11). Each of these chapters was prepared from baseline data of scientific papers that have and will be submitted to scientific journals for possible publication. In addition, a general introduction (Chapter 1), the study area in a broad sense (Chapter 2) and detailed methods (Chapter 3) was presented, with additional information on these topics given under *Background* in Chapters 4 to 9, and under *Introduction* in Chapters 10 and 11. An abstract is also provided for Chapters 4 (covering Chapters 4 to 9), Chapter 10 and Chapter 11. All the discussions of the scientific papers presented as Chapters 4 to 11 are brought together as Chapter 12. This major discussion focuses on relevant issues with regards to the main hypotheses and principle aims of this thesis. Appendices present a graphical account of the element concentrations in the rocks, soils and plants of the study area, as well as a checklist of the plant species recorded for the Centre of Endemism.

CHAPTER 2

STUDY AREA

2.1 History

Sekhukhuneland was named after the Pedi chief Sekhukhune I (Raper 1987), who succeeded the previous chief of the Pedi, Sekwati, who died in September 1861 (Monnig 1967; Smith 1967). The Pedi are the people who historically lived on, and around, the Leolo Mountains of Sekhukhuneland (Pollock *et al.* 1963). According to Monnig (1967), the Pedi settled in Sekhukhuneland in approximately 1650. Very little is known of their history between 1650 and 1800, but the first definite date established in the history of the Pedi, was the day of the solar eclipse, the day Thulare died in 1824 (Quin 1959).

Chief Thulare is recalled as the greatest and most loved of all the Pedi rulers (Monnig 1967). He managed to build a mighty nation and thus entered upon the most prosperous period of Pedi history. After Thulare's death, the powerful Pedi Empire came to a fall as a result of disruptions and arguments between his sons (Monnig 1967). At the same time the Matebele raided Pedi territory and killed Thulare's sons, except for two (Monnig 1967). One of the sons, Sekwati, gathered what he could of the Pedi and fled, leaving behind a country devastated by the Matebele, who had completely denuded the country of all stock and grain.

Fortunately, Sekwati returned after an absence of four years, restoring the Pedi kingdom (Monnig 1967). Chief Sekwati was a very diplomatic leader with great military skills (Smith 1967). He managed to resist attacks from both the Swazi and the Zulu, which made him a popular leader (Monnig 1967). According to Otto (1934), Sekwati established peace with the Europeans and both parties recognised the Steelpoort River as the boundary between the Pedi country, and the Republic of the Transvaal. This peace negotiation provided the Pedi protection against the Swazi, which resulted in the development of a very powerful Pedi tribe at the beginning of 1860 (Otto 1934).

After Sekwati's death, Sekhukhune stole the chieftainship from his brother Mampuru and thus inherited a powerful nation from his father (Otto 1934; Monnig 1967; Smith 1967). Chief Sekhukhune I strengthened his nation with rifles and accepted warriors from other nations (Otto 1934; Quin 1959). Soon Chief Sekhukhune's warriors started harassing smaller tribes and European farmers living near the borders of Sekhukhuneland (Quin 1959; Monnig 1967). In these areas Europeans and tribesman battled for residual highlands which stand free from disease amidst the hot lowlands. Bush cover and rough terrain in the lowlands also restricted movement by horse and wagon and made such environments inaccessible (Pollock *et al.* 1963). Thus, the Europeans and smaller tribes sought their guns to protect their land from the Pedi.

The harassment of the European farmers and smaller tribes, as well as the persecution of black Christians, led to the first Sekhukhune war in 1872 (Otto 1934; Quin 1959). The European farmers drove the Pedi back into their own country and tried to upset Sekhukhune's rule, but failed. The second war was initiated by the British Empire after their annexation of the Transvaal (Quin 1959; Smith 1967). Chief Sekhukhune indicated that he resented British authority and commenced raiding the country. British and Swazi forces defeated him in 1879 (Otto 1934; Smith 1967).

The Transvaal was retroceded to the European farmers in 1881 (Quin 1959). The Pedi, like the other tribal groups in the Transvaal, received certain rights to land during the Pretoria Convention (Pollock *et al.* 1963). It was hoped that some security from encroachment would bring the wars of the defiant Sekhukhune of the Leolo Mountains to an end. However, when the final boundary fixing came about, the Sekhukhune tribal land was not big enough to achieve anything more than 'reserve' status (Pollock *et al.* 1963). Thus, the area, though a local borderland big enough to merit the name of Sekhukhuneland, did not give rise to international or provincial boundaries as happened in the British Protectorates, such as Swaziland and Lesotho. In later years, Sekhukhuneland became part of the former Lebowa, which was given to the Pedi as a homeland during the apartheid era. This remained until the establishment of a full democracy in South Africa (1994).

2.2 Locality

The Sekhukhuneland floristic region is located to the west of the northeastern Drakensberg Escarpment in the Republic of South Africa (Figure 1). For the purpose of this study, the name 'Sekhukhuneland', is not used to describe the demarcated area on the map of the Magisterial Districts and Provinces (1994) of South Africa, but rather to indicate the much wider Sekhukhuneland Centre of Plant Endemism. The SCPE lies within, and across, the political borders of the Sekhukhuneland Magisterial District in the Republic of South Africa, because political boundaries, usually, have little to do with environmental and biotic tendencies. It stretches from the Northern Province into Mpumalanga, and include towns such as Roossenekal, Schoonoord, Steelpoort, Sekhukhune, Burgersfort and Mecklenburg (Figure 1).

The study area is situated between 24°15' and 25°30' S latitude, 29°30' and 30°30' E longitude. It is located to the west of the northeastern Drakensberg Escarpment where it encompasses approximately 4 000 km^2. The layers of the Rustenburg Layered Suite of the eastern Bushveld Complex (Kent 1980; Visser *et al.* 1989) underlie the core area of the SCPE; it is bordered by Highveld Escarpment to the south, Strydpoort Mountains to the north, the Steenkampsberg and Drakensberg to the east, and the Springbok Flats to the west. The study area incorporates 12 quarter degree grids [QDGs] as defined by Siebert (1998)[1], with every quarter degree grid covering about 675 km^2 (Edwards & Leistner 1971). The study area (Figure 1) lies within the following QDGs:

Grid	Quarter Degree
2429	BC; BD; DB; DD
2529	BB; BD
2430	AC; CA; CB; CC; CD
2530	AA

The chosen QDGs exhibit certain characteristics which are absent from the adjacent ones. These characteristics are:

- The surface area is covered by a substantial percentage of ultramafic rock;
- The vegetation is predominantly Bushveld;
- The topography is mountainous;
- The area is situated in the rain shadow of the northeastern Drakensberg Escarpment;
- The winter months are relatively frost-free.

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[1]**Note**

Ultramafic rocks also occur in adjacent QDG 2529AD, 2529BC and 2529DB, but these are not part of the study, primarily due to the higher frost intensity in 2529BC and 2529DB (also not bushveld) and the locality of 2529AD, which is wedged in between other geological substratcs outside the rain shadow of the Drakensberg Escarpment.

The included, 2430CD, is characterised by all, except one, of the necessary requirements. The absence of the most important requirement, ultramafic substrates, renders it inappropriate as a QDG of the SCPE. However, this QDG is wedged between the Bushveld of the study area and the grassland-covered mountains of the Drakensberg and the Steenkampsberg. Thus, it is included so that its bushveld affinity with ultramafic substrates may be investigated.

2.3 Physical environment

A literature survey was conducted to obtain existing information on the physical environment (topography, geology, soils and climate) of the SCPE (Erasmus 1985; Chief Director of Surveys and Mapping 1988; Visser *et al.* 1989; McVicar *et al.* 1991; Weather Bureau 1998). The information and maps (Figures 2 to 5) provided will hopefully assist environmental consultants, conservationists and researchers when conducting critical surveys of the vegetation of the region.

The physical environment comprises a complex of ecological factors that determine the vegetation of a region (Rattray 1963):

- *Physiographic factors* which are determined by the topographic features (aspect and slope), exposure, altitude, relief, ground water and geodynamic processes (erosion);
- *Edaphic facors* which include soil structure, texture, depth, mineral composition, moisture availability, pH and aeration;
- *Climatic factors* which include rainfall, light, temperature, humidity, wind and evaporation;
- *Biotic factors* which are living organisms such as humans, large herbivores, invasive plants and fire.

2.3.1 Topography

The study area is known for its concentric belts of rocky ridges and mountains, and its traversing broad, heavily eroded valleys (Figure 2). Physiographically the study area can be described as a mountainous area that consists of rugged hills with flat to undulating valleys. The topography of the SCPE is very heterogeneous and complex, a product of tectonic forces and magma surges 2 000 million years ago (Coetzee 1985), upon which the climate and erosive agents have promoted geomorphologic change (Marlow 1976).

The study area lies to the west of the north-south orientated northeastern Drakensberg Escarpment that curves slightly westwards in its northern parts. Thaba Sekhukhune to the west of the Steelpoort River, the Strydpoort Mountains to the north of the Olifants River, the Steenkampsberg to the south and the Drakensberg to the west, isolates the study area from the Lowveld. It brings about what can be called a 'lowveld' enclave on the Highveld. As a whole the study area falls in the rain shadow of the northeastern escarpment with a resultant relatively low rainfall for an area located in the eastern part of southern Africa.

The Leolo Mountains and the Steelpoort River Valley are the most prominent topographic features in the SCPE, with either one or both of these features represented in seven of the 12 QDGs. From the Steelpoort River Valley, which lies at about 700 m above sea level [asl] (one of the lowest points), the Leolo Mountains rise to 1 932 m asl (the highest point) (Chief Director of Surveys and Mapping 1988). In the central area it has a topographical height asl variation of approximately 1 000 m over a distance of approximately 5 km.

The Leolo Mountains run from north to south through the centre of the study area; almost connecting the Strydpoort Mountains with the Thaba Sekhukhune Escarpment. Several small mountain ranges occur in the study area—of these the Thaba Sekhukhune Escarpment is the most diagnostic topographic feature. Other prominent mountains of the region include Tauteshoogte (1 789 m), Hoofstadkop (1 747 m), Morone (1 520 m), Morole (1 403 m) and Phepane (1 436 m).

There are numerous valleys, from the Steelpoort River and Olifants River Valleys and the valleys of their tributaries, to the areas between the various mountain ranges such as the Leolo and Drakensberg ranges. These broad, flat valleys can be up to 60 km long and several in width. In general, the study area falls within the drainage basin of the Olifants River. The east-flowing Olifants River and its tributaries sculptured the topography of Sekhukhuneland over millions of years. Its headwaters captured a major west-flowing river after it had broken through the Great Escarpment during two major upliftments of the subcontinent, which occurred in the Miocene and late Pliocene (Partridge & Maud 1987). Several rivers drain the basin, and flow through valleys averaging 750 m asl. The largest rivers feeding into the Olifants River are the Steelpoort, Lepellane, Moopetsi, Motse, Dwars and Klip.

2.3.2 Geology

The lithology of South Africa can be divided into basic and acidic rocks. The difference between the two lies in the mineral content of the rock. Ultrabasic (ultramafic) rocks contain, for example, MgO, FeO and CaO, and acidic rocks contain mineral oxides such as SiO_2, K_2O and Na_2O (Krauskopf 1967). Basic rocks are usually referred to as basalt. The Bushveld Igneous Complex can be described as basaltic, because it contains relatively high concentrations of Mg, Ca, Fe, Al, and Cr compared to other rocks. Ultramafic rocks are not the result of weathering and subsequent sedimentation, but are products of the earth's mantle. These rocks are relatively 'new' and have only recently been exposed to weathering. They are therefore not a normal inclination and are termed 'anomalous'.

Granite and shale are acidic rocks. Granite is known for its low mineral content and shale is formed from sediments derived from weathered rocks. These rocks are therefore not rich in heavy metals and are known as 'normal' rocks. Sediments derived from weathered rocks, such as shale, cover about 70% of the world's surface lithology (Krauskopf 1967). Ultramafic rocks rich in heavy metals cover only a small portion of the earth's surface.

In contrast to most parts of the world, ultramafic rocks are plentiful in southern Africa (Kent 1980; Roberts and Proctor 1992). Most of the world's economically exploitable deposits of heavy metals are located in the ultramafic rocks of South Africa, more specifically in the Rustenburg Layered Suite [RLS] of the Bushveld Complex (Coetzee 1985; Schürmann *et al.* 1998). Concentric belts of pyroxenite, norite and anorthosite of the eastern RLS commences near Stoffberg in the Mpumalanga province on the lower slopes of the Highveld Escarpment, continues northwards, crosses the Steelpoort River into the Northern Province and then stretches northwards as far as the foothills of the Strydpoort Mountains, a total distance of approximately 170 km. It has an average width of 30 km and is wedged between the Transvaal Sequence to the east and the Lebowa Granite Suite to the west (Visser *et al.* 1989). Some of the largest quantities of chromium and platinum in the world are present in the Critical Zone of the suite (Schurmann *et al.* 1998; Viljoen & Schurmann 1998). Chromium has been mined extensively in the past (Brabers 1970), but platinum even more so at present, due to very high market prices (Cawthorn 1999).

Since surface outcrops of ultramafic rocks of the RLS largely defines the area of the SCPE, the geology is important and discussed in some detail (Figure 3). The Bushveld Complex was formed during the Precambrian together with the Phalaborwa, Kunene and Losberg Complexes, the Vredefort Granophyre and the Uitloop Granites, which represents the greatest mineral deposit event that has ever occurred on earth (Coetzee 1985). Before the formation of the Bushveld Complex, sedimentary rocks of the Transvaal Sequence covered the interior of what are today the northern Provinces of South Africa (age: 2 000 to 2 300 million years). Approximately 1 950 million years ago a series of magma surges resulted in the emplacement of lava into the interior of the Transvaal Sequence as a result of alternating stress and pressure conditions (Visser *et al.* 1989). When the lava crystallised it gave rise to different layers (Schürmann *et al.* 1998). The tremendous weight of the congealed lava on the surface of the Transvaal Sequence resulted in its collapse. Layers of the Bushveld Complex and Transvaal Sequence were broken and exposed to the surface where it was weathered to its present state over millions of years.

Sekhukhuneland is known for its concentric belts (layers) of norite, which gave rise, among others, to the Leolo Mountains. The concentric belts in the SCPE, as they are visible today, are the exposed broken layers in their weathered state. This characteristic igneous layering of the Complex, is the product of crystallisation differentiation during successive surges of magma (Visser *et al.* 1989). The Provisional Tectonic Map of the Bushveld Complex (Hunter 1975) clearly distinguishes between three exposed layers of the RLS. The three main groups of saucers (primary layers) that were crystallised are the Upper Zone, the Main Zone and the Lower Zone (Kent 1980).

The RLS forms the outer limit of the Bushveld Complex, because it was deposited as the first (bottom) layers during the magma outflow (Keyser 1998; Schürmann *et al.* 1998). Its characteristic igneous layering is the product of crystallisation differentiation during successive surges of magma (Visser *et al.* 1989). The formation of the layers was dependent on the density of the minerals concerned (Kent 1980). When the lava reached the surface, the heavier metals sunk to the bottom where they crystallised first. The first layer that crystallised was the Lower Zone and is characterised by norite, bronzitite, dunite and serpentinised harzburgite as secondary layers. These layers contain main mineral components made up of elements such as Mg, Ni and Cr. The second saucer-shaped layer that crystallised was the Main Zone. It is characterised by four predominant secondary layers namely, norite, anorthosite, pyroxenite and gabbro. These layers are characterised by mineral components rich in Ca, Al, Ti and V. The Upper Zone is characterised by two main secondary layers, namely ferrogabbro and ferrodiorite, and to a lesser degree, magnetite. The main elements within the mineral components of these layers are Fe, Na, V and Ti. The crystallisation of chromites occurred between the Lower and Upper Zones and is referred to as the Critical Zone. The Critical Zone's secondary layers are mostly pyroxenite, norite, anorthosite, dunite and harzburgite. The main component of these layers contains rich quantities of Cr, Pt and Fe. Each of the layers can be further divided into secondary layers.

The secondary layers are distinguished from surrounding layers according to their main mineral component. The main mineral component consists of certain characteristic elements, e.g. olivine contains Mg and Ni and plagioclase contains Ca and Fe.

2.3.3 Soils

The predominant inclination of soils on earth is one of low heavy metal concentrations. However, high concentrations of different heavy metals occur in metalliferous or serpentiniferous soils derived from ultramafic rocks (Kent 1980). The most naturally occurring ultramafic soils in Africa are those produced by outcrops of metal-bearing ores of copper, aluminium, nickel and iron (Wild 1978).

The heavy metal soils of the RLS are derived from gangue minerals such as norite, anorthosite, pyroxenite, gabbro, feldspar and rarely, magnetite (Coetzee 1985). These gangues are basaltic rocks and are the intermediate form between serpentine and granite (Wild 1978). Basalt shows the highest concentration of selected elements when it is compared with granite and shale, and even the earth's crust (Krauskopf 1967). Granite gives rise to 'normal' soils and serpentine gives rise to 'toxic' serpentiniferous soils. Basalt contains higher concentrations of heavy metals than granite (Krauskopf 1967) and less than serpentine, and produces intermediate metalliferous soils (Wild 1978). Relatively high concentrations of heavy metals in the soils of Sekhukhuneland are therefore a consequence of its ultramafic origin.

The soils of South Africa consist of a very complex mixture of various types, and there are few cases where a single uniform type occurs over any large area (Figure 4). Mother material from which soils developed in Sekhukhuneland, are characterised by great variations in types, locality and abundance of elements (Hunter 1975; Marlow 1976). The RLS holds some of the highest concentrations of heavy metals, such as Cr, Al, V and Ti, in the world (Coetzee 1985; Schürmann *et al.* 1998). The abundance of the elements varies from one area to another (see Chapter 5) and therefore the type of heavy metal soil occurring in a specific region is a result of the specific exposed layer of the RLS.

Ultramafic soils are considerably different from 'normal' soils in that they are rich in chromium, cobalt, iron, nickel and deficient in the nutrients calcium, molybdenum, nitrogen, phosphorous and potassium (Brooks 1987). The soils of the study area are typical for ultramafic areas, for they conform to the element composition and certain areas have a high Mg/Ca ratio > 1 (Johnston & Proctor 1981). However, certain areas of the SCPE have a low Mg/Ca ratio < 1, a phenomenon is presumably caused by a reduction in the binding strength of Mg due to topsoil acidification and subsequent Mg leaching (Roberts & Rodenkirchen 1995). This explanation holds for the RLS, as soils of these strata have a variable pH (6-8) (Loock *et al.* 1982).

Physiography and climate, together with the underlying rock, determine the nature of the soils that are formed (Rattray 1963). Soil types of the SCPE are characterised by clays. Ultramafic soils of the SCPE are mainly red or black montmorillonitic clays (Werger & Coetzee 1978). These soils are vertic to melanic A-horizons and are rich in smectite clay minerals and ions such as Ca, K, Na, and especially Mg (McVicar *et al.* 1991). The soils are generally dark-coloured and occur in both upland and bottomland positions (Land Type Survey Staff 1987; 1988; 1989). Prominent soils of this type identified for the SCPE are Arcadia, Bonheim, Mayo, Milkwood and Steendal forms. Soils with ortic A-horizons and one of the following B-horizons, namely yellow apedale, red apedale, red structured, pedocutanic, neocutanic or lithocutanic, are also common in the SCPE. These include the following forms, namely Clovelly, Hutton, Shortlands, Valsrivier, Swartland, Oakleaf, Mispah and Glenrosa.

Groups of soil types develop under similar conditions and four basic soil groups are distinguished for the study area (Mönnig 1967). Most of the area consists of **ferruginous lateritic** soils, with broad intrusions of **turf** in certain areas. Towards the extreme east and south there are smaller intrusions of **mist-belt** soils. Large areas of the SCPE are characterised by **low altitude** soils below the footslopes of mountains.

- Ferruginous lateritic soils include grey lateritic, brown/dark brown ferruginous and deep red sandy-loam soils. It originates from both sediments and igneous rocks, and this, together with climate and natural drainage, determined the chemical and physical qualities of the soil. Where the internal drainage is poor, the soil is stony and shallow ("Lesikihledi") with a solid lateritic base.

• Turf soils ("Seloko") consist of black and red clay types, of which the black is usually found in dry areas with inadequate drainage. These soils have a heavy, coarse texture and tend to crack to considerable depths. The top-soils slake to form a fine, granulated layer. These soils tend to retain moisture.

• The mist-belt soils developed in high altitude areas of high temperature and rainfall, which accelerated the soil forming process. This results in its formation on practically all the geological formations of the study area. These soil layers vary from red to yellow and have a clayish texture with a structure that gives an adequate internal drainage. These soils are also intensely cultivated.

• Low altitude soils have better internal drainage. Gravel and stone tend to disappear and a deep soil with a sandy-loam to clay texture ("Mehlabane") results. The soils of low altitudes consist of many types, most of which can be fairly shallow. In these areas highly eroded basic igneous rock formations such as norite predominate. The soils are deep red to brown loam or clay soils of an excellent structure.

According to the Soil Degradation Index of Hoffman & Ashwell (2000a), the southern part of the SCPE that lies within the Mpumalanga Province is rated to have *light* soil degradation. The northern part of the study area that falls within the Northern Province has *severe* soil degradation as measured with the SDI (Hoffman & Ashwell 2000b). This index is based on soil erosion and overgrazing.

2.3.4 Climate

The study area lies in the summer rainfall region and the average annual rainfall for the SCPE is 578 mm (South African Weather Bureau 1998), but the rainfall pattern is strongly influenced by the local topography (Siebert 1998) and varies from as little as 400 mm in some of the valleys, to an estimated 700 mm on the Leolo Mountains and in the extreme south (Mapochs Gronde) (Siebert 1998). Perhaps the most outstanding climatic feature of the central and northern parts of SCPE is that it lies in the rainshadow of the northeastern Drakensberg Escarpment.

Sekhukhuneland receives nearly half its rain (48%) between December and February (summer), an average total of 283 mm for these three months (Erasmus 1985). The peak month is January with an average monthly rainfall of 100–120 mm for the mountain bushveld areas and 140–600 mm for the temperate grassland areas. Throughout the country May to August are generally dry. In the marginal months of April and September there is a general average rainfall of 20 mm per month. Spring rains that contribute 28% of the total rainfall in a single year usually precede the summer rains, but can stay away.

The rainfall gradient extends from southeast to northwest (Siebert 1998). The western part of the study area receives less rain on average than the eastern parts. There is a gradual increase in rainfall from west to east, with a sharp increase in the east, on the border with the Drakensberg foothills. Fluctuations can be attributed to altitude. The northern parts of the study area are also drier than the south. The north-central part of the SCPE is the driest, with the average annual rainfall for the study area increasing towards the Steenkampsberg that form the border in the south and the Strydpoort Mountains that form the northern extremity.

The whole study area has a fairly drawn-out warm summer, with a short mild winter. January is generally the warmest month and July the coolest. Extreme temperatures for the study area range from -4.5°C to 38°C. The daily average is approximately 18.5°C (Weather Bureau 1998). Taking the mountain bushveld and grassland areas respectively, the average minimum temperatures in January are 18°C and 14°C, and the average maximum temperatures 32°C and 26°C. The average minimum temperatures for July are 6°C and 2°C, and the average maximum temperatures 24°C and 20°C respectively. Temperatures vary at different localities within the study area, also correlating strongly with physiographic regions, being higher in low-lying valleys and lower on high-lying plateaus (Buckle 1996). However, minimum temperatures of below freezing point are rare, even in the high-lying areas.

The northern and western parts of the study area are on average warmer than the south and east. The northern and western parts have average daily temperatures of 28.3°C maximum and 7.2°C minimum. These temperatures compare well with those associated elsewhere with Mixed Bushveld (Van Rooyen & Bredenkamp 1996). Average daily temperatures of the southern and eastern regions are more temperate and below those expected for Mixed Bushveld.

Temperature data also exhibit a set climatic pattern like that described for rainfall. Valleys have a subtropical climate with no frost in winter, whereas in the mountains the conditions become more temperate with frost in winter as altitude increases towards the Steenkampsberg. On the whole the study area is frost-free.

Lower rainfall in the western and northern parts of the SCPE correlates with the warmer temperatures in these parts (Siebert 1998). Climatically the SCPE comprises an arid (karroid), subtropical (lowveld) enclave surrounded by mountains that are temperate (frost in winter) and much wetter (particularly towards the east and south (Van Wyk & Smith 2001). The SCPE can be divided into climatic regions (Figure 5). This includes the Bushveld areas with a dry, warm desert climate and a summer rainfall which is similar to the Central-Western United States of America and the southern Russian Steppes (Mönnig 1967) and can be divided into two climatic regions namely the (1) northern, moderately dry (350–450mm/annum) and warm (21–22°C daily average) arid bushveld and the (2) central region, intermediate, typically Mixed Bushveld rainfall (450–600mm/annum) and temperature averages (20°C). The third (3) climatic region is the southern region, which is moderately wet (600–850mm/annum) and cool (18–19°C daily average), and can be described as a temperate, cooler escarpment zone with a typical Highveld climate that comprises dry winters and good summer rainfall (Mönnig 1967).

2.4 Vegetation and flora

The most important works on the vegetation of South Africa are those by Pole Evans (1936), Adamson (1938), Acocks (1953), Werger (1978), White (1983), Rutherford & Westfall (1986), Low & Rebelo (1996) and Cowling *et al.* (1997).

Rutherford & Westfall (1986) and Low & Rebelo (1996) identified eight biomes in South Africa in accordance with dominance or co-dominance of plant life forms. The SCPE falls predominantly within the Savanna Biome and to a lesser extent includes an ecotone with the Grassland and elements of the Forest Biomes. Savanna is a tropical plant assemblage where the herbaceous stratum is continuous and prominent, interrupted to a greater or lesser extent by fire tolerant trees and shrubs (Lamotte 1985).

The Savanna Biome covers the greater part of the Northern Province and the northern parts of North-West Province. The area comprises mostly undulating to flat plains, at an altitude of 700 to 1 100 m above sea level (Van Rooyen & Bredenkamp 1996). Savanna is characterised by a grassy ground layer and a distinct upper layer of woody plants. When the vegetation has an upper layer near the ground, the vegetation may be referred to as Shrubveld, where it is dense it is referred to as Woodland, and the intermediate stages are locally known as Bushveld (Rutherford & Westfall 1986). Fire and grazing is known to determine the structure of the Savanna Biome.

The vegetation maps by Acocks (1953) and Low & Rebelo (1996) are used as references for this study. The vegetation map of Acocks (1953) is the older version of the two (approximately 40 years) and is based on Veld Types. The map of Low & Rebelo (1996) is based on Vegetation Types.

Acocks (1953) classifies the study area as three Veld Types, which includes the Mixed Bushveld (18), Sourish Mixed Bushveld (19) and North-Eastern Sandy Highveld (57). According to this vegetation map, Sekhukhuneland is bordered by the North-Eastern Mountain Sourveld (8), Springbok Flats Turf Thornveld (12), Bankenveld (61) and to a lesser degree, the Lowveld Sour Bushveld (9).

According to the vegetation map of Low & Rebelo (1996), the QDGs of the SCPE are classified as one vegetation type, namely the Mixed Bushveld (18) Vegetation Type. On this vegetation map, Moist Sandy Highveld Grassland (38), North-Eastern Mountain Grassland (43), and to lesser degree by Clay Thorn Bushveld (14) and Afromontane Forest (2) borders the SCPE.

The larger part of the SCPE was classified as Mixed Bushveld by both vegetation maps and hence will be treated as such. The Mixed Bushveld covers an area of 642 600 km^2, of which approximately 3 500 km^2 (0.5%) occurs in Sekhukhuneland. The Mixed Bushveld is one of 25 Vegetation Types recently defined for the Savanna Biome (Low & Rebelo 1996).

The Mixed Bushveld represents a great variety of plant communities, with many variations and transitions. The vegetation varies from a dense, short bushveld to a relative open tree savanna. On shallow soils *Combretum apiculatum* dominates the vegetation type. Other trees and shrubs include *Acacia caffra, Dichrostachys cinerea, Lannea discolor, Sclerocarya birrea* and various *Grewia* species. Here the grazing is sweet, and the herbaceous layer is dominated by grasses such as *Digitaria eriantha, Schmidtia pappophoroides, Anthephora pubescens, Stipagrostis uniplumis* and various *Aristida* and *Eragrostis* species. On deeper, and more sandy soils, *Terminalia sericea* becomes dominant, with *Ochna pulchra, Grewia flava, Peltophorum africanum* and *Burkea africana* often prominent woody species, while *Eragrostis pallens* and *Perotis patens* are characteristically present in the scanty grass sward.

According to a survey done by Kritzinger (1992), the vegetation of Maandagshoek in Sekhukhuneland differs from typical Mixed Bushveld and varies from open shrubland to dense bushveld. On shallow soil, covered with chalky gravel, *Eragrostis lehmanniana* dominates the vegetation, with species such as *Diospyros lycioides* var. *guerkei* and *Heteropogon contortus* proving prominent. On the clay soils the sweet veld include species such as *Fingerhuthia africana, Dichrostachys cinerea, Combretum hereroensis* and *Hippobromus pauciformis*. Rocky soils are characterised by *Eragrostis rigidior, Psiadia punctuata, Dichrostachys cinerea* and *Sclerocarya birrea* occur. On the rocky dry hills *Aristida transvaalensis* becomes dominant, with species such as *Catha transvaalensis, Acacia caffra* and *Elephantorrhiza praetermissa* appearing diagnostic. Other prominent species of the region include *Croton gratissimus, Vitex obovata* subsp. *wilmsii, Enteropogon macrostachys* and *Rhoicissus sekhukhuniensis*. Certain heavily eroded areas (vegetation anomalies, though not serpentine) are very sparsely vegetated with distinctive flora, including *Rhus keetii, Euclea linearis, Polygala* sp. nov. and *Pterothrix spinescens*.

Cole (1986) classifies the bushveld of the SCPE as part of the *Savanna Parklands and associated low Savanna Woodlands* that are typical for South Africa. The whole study area is savanna, with mixtures of grassland, but with bushveld predominating. The greater part of the study area can be described as a sweet bushveld. It has a thick, rich covering of various types of palatable graminoids, notably *Heteropogon contortus*, *Setaria sphacelata*, *Themeda triandra* and *Tristachya leucothrix*.

The bushveld in Sekhukhuneland is mainly a dense vegetation type and is characterised by deciduous trees, particularly *Combretum apiculatum* and *C. molle*, and other trees such as *Terminalia prunioides*, *Kirkia wilmsii*, *Euclea crispa* and various *Acacia* species (Mönnig 1967). The grass cover is thick with many herbaceous herbs.

The southern part of the study area lies in Mpumalanga and is classified as having *insignificant* veld degradation on the Veld Degradation Index (VDI) of Hoffman & Ashwell (2000a). However, the northern part of the SCPE that lies within the Northern Province is rated to have *severe* veld degradation, with the Schoonoord District being one of the top twenty districts in South Africa that requires priority attention in terms of land degradation (Hoffman & Ashwell 2000b).

Approximately 15% of the land area in the Northern Province and Mpumalanga has been invaded by alien plant species (Hoffman & Ashwell 2000a; 2000b). Invasive plants are a serious problem in the provinces where the study area is located and has influenced the current floristic composition of many systems.

2.4.1 Floristic history

The flora of the SCPE is mainly of Zambezian extraction, with Afromontane elements, especially at higher altitudes. According to the floristic map of White (1983), which indicates the main phytochoria of Africa and Madagascar, Sekhukhuneland is located within the Sudano-Zambezian Region, or more precisely its Zambezian Domain (Zambezian Regional Centre of Endemism), on the border between the former and the Afromontane Archipelago-like Regional Centre of Endemism. The archipelago is spread over southern

Africa, mainly along the eastern escarpment, but also in the south, reaching the Indian Ocean coast (Werger & Coetzee 1978).

The Zambezian Regional Centre of Endemism covers virtually the entire high plateau of southern Africa and comprises vast stretches of woodland, savanna and grassland vegetation with occasional dry forests and thickets, and patches of swampy vegetation (Werger & Coetzee 1978). Over large parts of the enormous area covered by the Zambezian Regional Centre of Endemism, the rich flora only gradually changes, possibly as a result of the lack of strong relief and other contrasting physiographic factors (Werger & Coetzee 1978). The Zambezian phytochorion probably has the richest and most diversified flora in Africa (White 1983) and stretches across ten countries. It emphasises how important it is to gather data on diversity and endemism by means of floristic provinces and not by political subdivisions.

On this larger scale, the Mixed Bushveld Vegetation Type of Rebelo & Low (1996) would be classified as part of the '*South Zambezian undifferentiated woodland and scrub woodland*' in the Zambezian Domain of the Zambezian Regional Centre of Endemism (White 1983). In structure and floristic composition it is intermediate between '*North Zambezian undifferentiated woodland*' and '*Tongaland-Pondoland semi-evergreen bushland and thicket*'. Half of the recorded species in the '*South Zambezian undifferentiated woodland and scrub woodland*' are widespread in the Zambezian Domain (White 1983). The remainder are more or less confined to the southern fringes of the Zambezian Domain, which are mostly situated in South Africa, and include the SCPE.

The southern fringes are recognised by certain taxa which characterise the southern element, for example (White 1983): *Acacia caffra*, *Aloe arborescens*, *Grewia flava*, *Kirkia wilmsii*, *Protea caffra*, *Ptaeroxylon obliquum*, *Rhus leptodictya*, *Schotia brachypetala* and *Spirostachys africana* (White 1983). Many of these are shrubs or small bushy trees. Some are deciduous and others are evergreen. All the above-mentioned diagnostic species are present in the SCPE.

Although the vegetation of the study area is mainly of Zambezian extraction, Afromontane links are to be expected as the region abuts on the northeastern Drakensberg Escarpment with a mainly Afromontane flora (Wolkberg Centre). The vegetation of the Afromontane Archipelago-like Regional Centre of Endemism mainly consists of dense forests, but also contains grasslands and savannas (White 1978). The most extensive vegetation type existing today in the Afromontane is fire-maintained grassland (White 1978). The change from Afromontane to Zambezian is particularly noticeable when one descends from the high-lying, wetter, more temperate Steenkampsberg to the low-lying, much drier, subtropical Roossenekal-Steelpoort area. Thus, many taxa of the SCPE are shared between the Zambezian Regional Centre of Endemism and the Afromontane Archipelago-like Regional Centre of Endemism (Siebert 1998).

White (1983) also mentions the Zambezian flora on heavy metal soils, but only recognises such phenomena outside the boundaries of South Africa. Toxic amounts of heavy metals in the soil break the uniformity of the prevailing woodlands in the Zambezian Domain with areas with very sparse vegetation. The less heavily contaminated soils support an open bushland or wooded grassland. This is also characteristic in the SCPE, however the species composition differs.

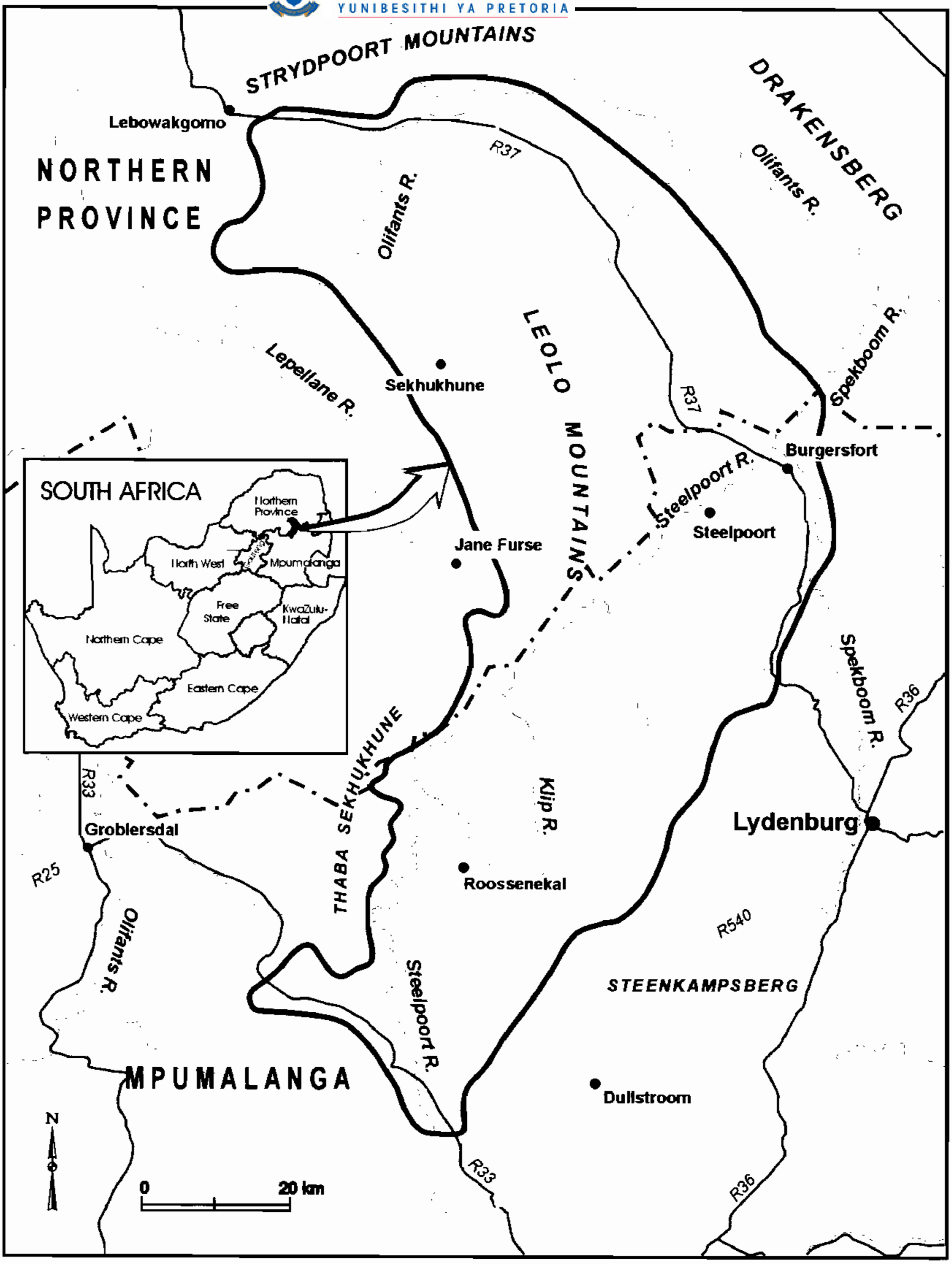

Figure 1 Location of the Sekhukhuneland Centre of Plant Endemism in the Northern Province and Mpumalanga, South Africa (based on Van Wyk & Van Wyk (1997), Siebert (1998) and Van Wyk & Smith (2001)).

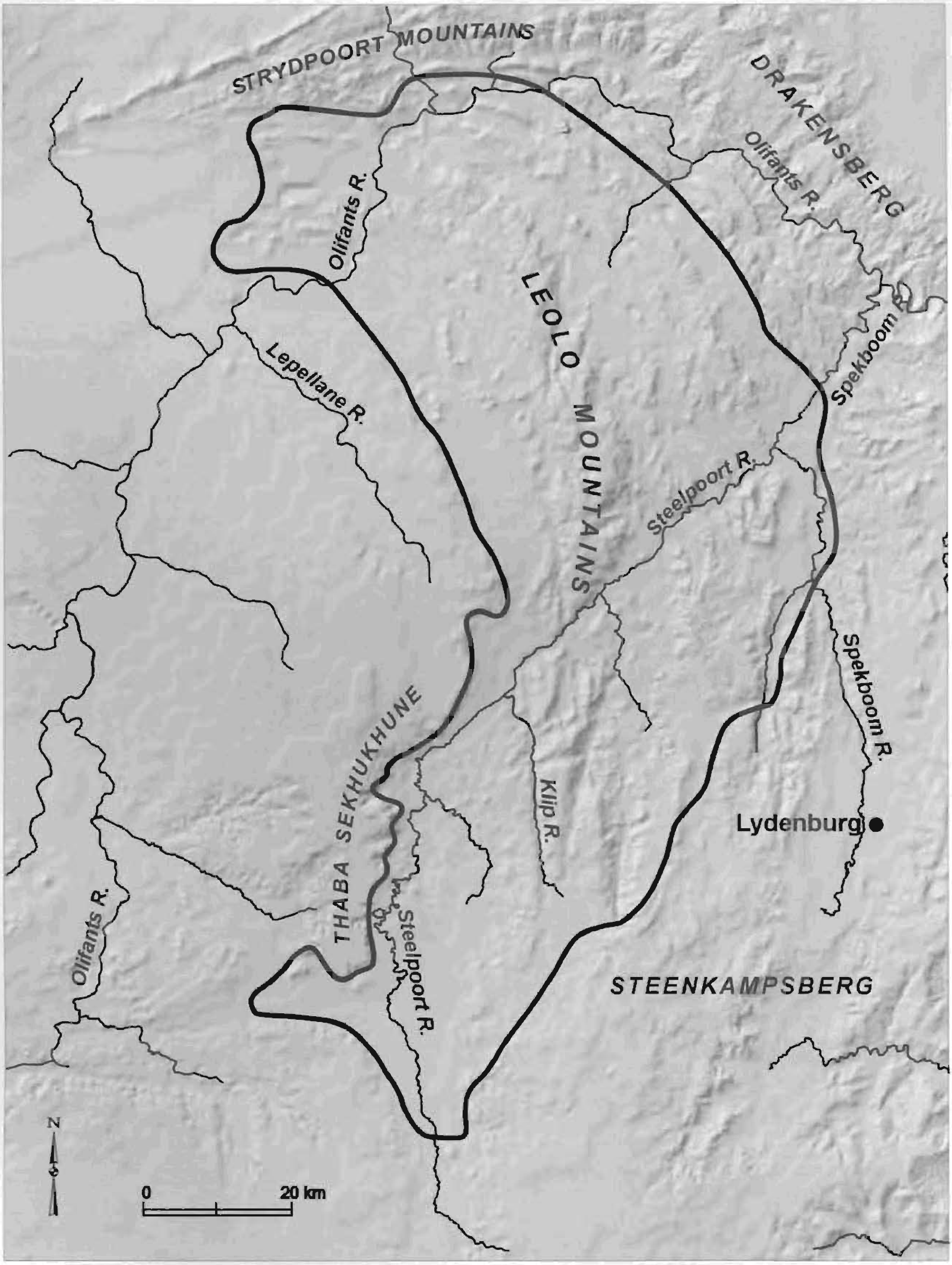

Figure 2 Topography of the Sekhukhuneland Centre of Plant Endemism (based on Van Wyk & Smith (2001)).

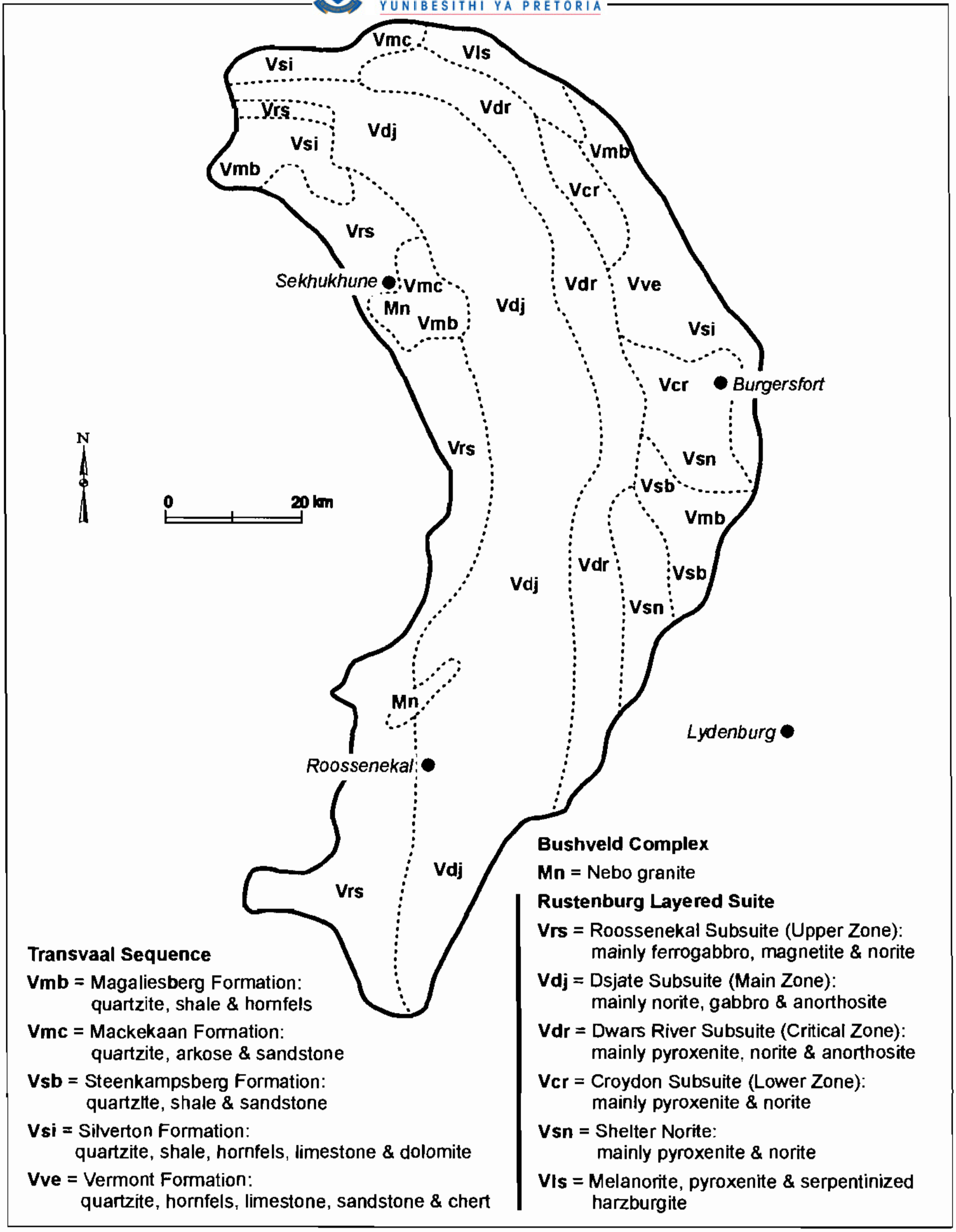

Figure 3 Major geological substrates of the Sekhukhuneland Centre of Plant Endemism (based on Marlow (1976), Kent (1980), Visser *et al.* (1989) and Keyser (1998)).

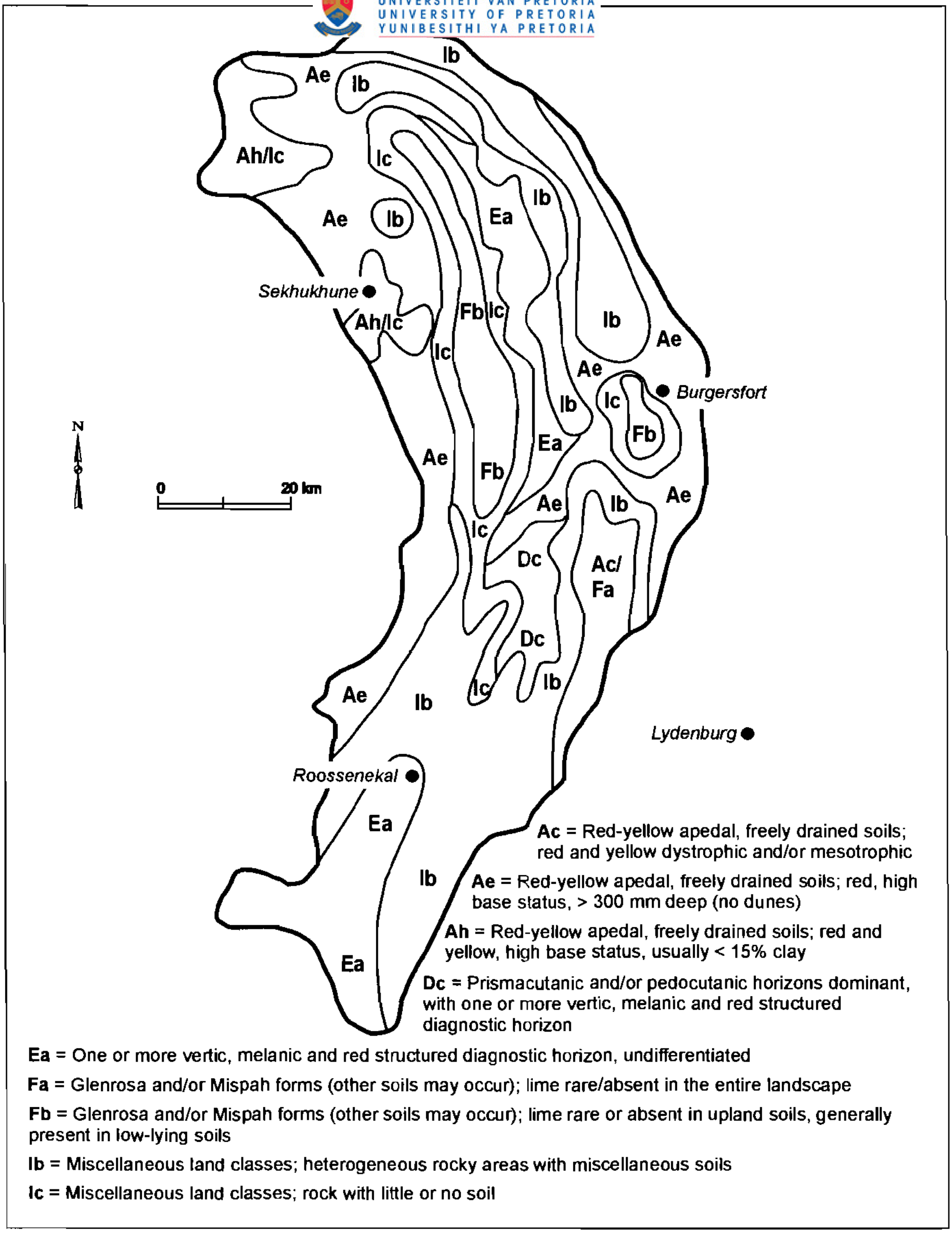

Figure 4 Major soil patterns of the Sekhukhuneland Centre of Plant Endemism (based on McVicar *et al.* (1991) and Land Type Survey Staff (1987, 1988, 1989)).

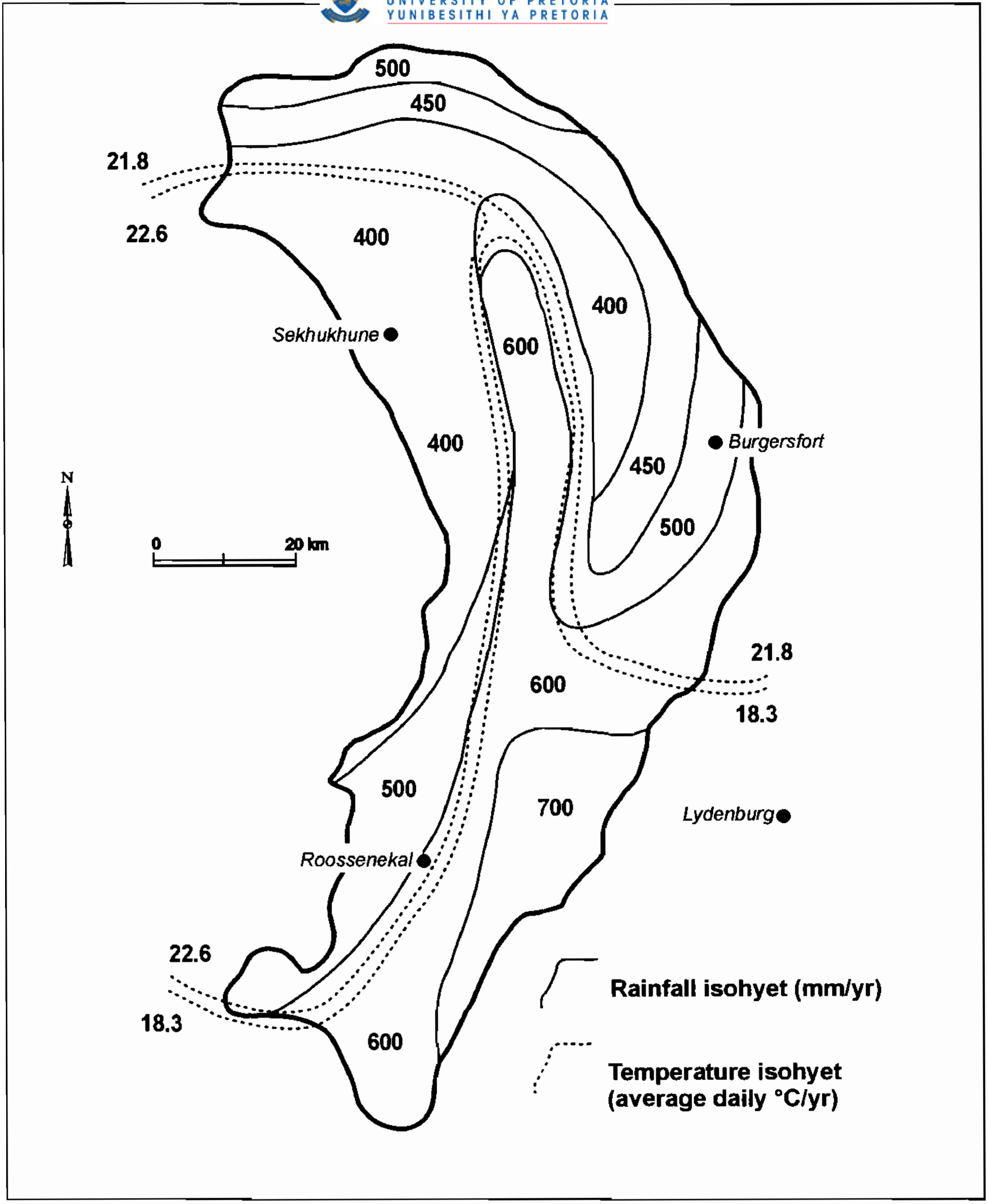

Figure 5 Major climatic patterns of the Sekhukhuneland Centre of Plant Endemism (based on Erasmus (1985), Siebert (1998) and Weather Bureau (1998)).

CHAPTER 3

METHODS

3.1 Phytosociological assessment

Experimental research in ecology is difficult to carry out, especially at the more complex levels of communities, ecosystems and landscapes. Most studies at these levels, such as the work presented in Chapter 4, are descriptive. The sets of data being analysed are large; they are gathered during field surveys. The analytical techniques used are determined by the objectives of the project; the results are influenced by what is sampled and the way it was carried out (Jongman *et al.* 1995).

Quantitative approaches or numerical techniques have been used extensively in plant ecology and phytogeography. Examples of quantitative approaches at the fine-scale vascular plant community or phytosociological level in southern Africa include studies by Coetzee *et al.* (1995), Richards *et al.* (1995), Brown *et al.* (1996), Van Wyk *et al.* (1996), Witkowski & O'Connor (1996), Smit *et al.* (1997), Sullivan & Konstant (1997), Cilliers & Bredenkamp (1998), Kirkwood & Midgley (1999), Matthews *et al.* (1999), Lechmere-Oertel & Cowling (2000) and Van Wyk *et al.* (2000).

The non-statistical Braun-Blanquet method, as described by Mueller-Dombois & Ellenberg (1974), Werger (1974) and Westhoff & Van der Maarel (1982), was used to classify the vegetation of the SCPE into homogeneous physiognomic-physiographic units. In an analytical phase the environmental, floristic and structural data are collected in the field. The data are then classified in the synthetic phase, to deliver the delineation of plant communities on the basis of their floristic and structural differences.

The current study has moved away from the methodology and technique and focussed more on the ecological application. This deductive approach uses phytosociology as a tool rather than an end in itself.

3.1.1 Analytical phase

The analytical phase was conducted over two growing seasons in 1999 and 2000, from mid-December to mid-April. Initial reconnaissance surveys were done on several occasions prior to December 1999 to become familiar with the patterns in the climate, geology, topography and vegetation of the area. Voucher specimens of conspicuous plants were collected throughout the study period and were identified by the candidate and staff of the H.G.W.J. Schweickerdt Herbarium [PRU], University of Pretoria and the National Herbarium [PRE], Pretoria.

The study area was stratified into relatively homogeneous physiographic-physiognomic units by recognising and mapping possible uniform vegetation units from aerial photographs (1:25 000) and further assisted with geological maps (1:50 000). This enabled a sound stratification of the study area for efficient sampling of the representative vegetation types. Stratification was also based on terrain type and aspect. Sample plots were placed in such a way that the habitat was as uniform as possible within each vegetation stand. Homogeneity is difficult to test statistically, therefore it was assessed visually and care was taken not to place plots in ecotonal zones.

Subjective stratified sampling (partially random) was used to allocate sample plots to physiographic-physiognomic units. The number of sample plots per unit depended on the unit size. This ensured that no over or under sampling occurred in such a large area of 4 000 km^2. In the field the sample plots were placed randomly within each homogeneous physiographic-physiognomic unit. The number of plots for the study area depended entirely upon the scale of the survey and subsequently it was decided to use a minimum of five relevés per homogeneous vegetation unit (Hin 2000).

Plot size was standardised at 400 m^2 (20 x 20 m) for both the savanna, grassland and forest areas to counter the bias of different scale (Jonsson & Moen 1998). This large plot size was chosen due to the large scale of the survey and the heterogeneity of the SCPE vegetation. A large plot size ensures that a more representative model of the SCPE is investigated during the short time given for the study. Plots were shaped as to conditions to enhance homogeneity. Where the pre-determined position of the sample plot did not meet the requirements mentioned above, or fell on structures such as roads, the plots were moved to more suitable areas. It must be noted that phenological changes over the year influenced the species cover and consequently the data of the relevés (Fischer 2000).

In the Braun-Blanquet method a complete species list of vascular plants is normally compiled for each stand to derive a comprehensive floristic description. This requirement cannot always be met in semi-arid areas with unpredictable rainfall, and because multiple visits to a sample plot is not possible due to the limited time available and the extend of the study area. Therefore an attempt was made to compile as complete a species list as was possible in the time available. Plant species names follow Retief & Herman (1997). Soil forms are in accordance with MacVicar *et al.* (1991).

A Global Positioning System (GPS) reading in longitude and latitude, as well as a terrain description, were taken at each sample plot to facilitate future location of the specific vegetation unit. Habitat factors were also recorded and included the following: terrain type (Land Type Survey Staff 1987; 1988; 1989), aspect, slope, topography, geology (Visser *et al.* 1989), soil type (MacVicar *et al.* 1991), geomorphology, gradient, percentage rock cover, rock size and degree of erosion where applicable.

In each sample plot all species were recorded and a cover-abundance value was estimated with the Braun-Blanquet cover-abundance scale (Mueller-Dombois & Ellenberg 1974), namely **r**: rare; +: <1% cover; **1**: <5% cover; **2a**: 5-12% cover; **2b**: 12-25% cover; **3**: 25-50% cover; **4**: 50-75% cover; **5**: >75% cover. The vegetation structure at each relevé was described according to a system of structural classification (Edwards 1983). All relevé data are stored in the TURBOVEG database (Hennekens 1996a) managed by the Department of Botany, University of Pretoria (Mucina *et al.* 2000).

Endemic, near-endemic and Red Data List species/infraspecific taxa of the SCPE were determined from relevant literature (Hilton-Taylor 1996; Siebert 1998), fieldwork and herbarium surveys. The following symbols are used: **$** = endemic to the SCPE; # = near-endemic to the SCPE; **E** = Endangered; **V** = Vulnerable; **R** = Rare; **I** = Indeterminate; **K** = Insufficiently Known; **N** = not threatened in northern provinces of South Africa (threatened in one or more of the other provinces). New IUCN categories are still in the process of being applied or updated for most of these and other taxa (Golding 1999) and will be discussed elsewhere in this thesis.

3.1.2 Synthetic phase

A data set of 415 relevés, containing a total of 1010 taxa, was entered into a vegetation database created in TURBOVEG (Hennekens 1996a). Two unpublished phytosociological data sets were available and included as part of the 415 relevés, namely nine from a survey in the Maandagshoek region (Kritzinger 1992), and 44 from a study of the Potlake Nature Reserve by M.M. Matthee during 1978.

As a first approximation the data was analysed with Two Way INdicator SPecies ANalysis (TWINSPAN) procedures (Hill 1979a) and based on the procedure developed by Bredenkamp & Bezuidenhout (1995) for large data sets. TWINSPAN is a divisive, hierarchical classification technique which detects overall patterns of differences in biological data. Although the reliability of the TWINSPAN approach has been questioned under certain conditions (Van Groenewoud 1992; Van der Maarel 1996), it was chosen for its proven combination of effectiveness, robustness and relative objectivity, as well as its availability and speed (Gauch & Whittaker 1981; Myklestad & Birks 1993).

To reduce distortion of data in the numerical data set, cut levels were adjusted in MEGATAB (Hennekens 1996b) to alter the default definition of pseudospecies, which insured less overweighing of dominants. A synoptic table was constructed to represent the major groups defined by the TWINSPAN classification (Table 1). Refinement of the synoptic table was done with Braun-Blanquet procedures according to the steps proposed by Behr & Bredenkamp (1988). A first step of an objective multivariate classification identified several vegetation types/major groups. The synoptic table contained species in each of the identified major groups on constancy values of a 20% ordinal scale (I–V). Only species with a minimum constancy value of 20% (II), in any given major group, were included in the table.

This result was then used to subdivide the data set into five phytosociological tables, each representing one of the major vegetation types of the Sekhukhuneland study area (Siebert *et al.* 2002a). Each of these was again subjected to TWINSPAN. The resultant classification was further refined by using Braun Blanquet procedures in the MEGATAB computer programme (Hennekens 1996b). The groups obtained from this data set were subsequently described and classified in Chapters 5 to 9.

The ordination algorithm DEtrended CORrespondence ANAlysis (DECORANA) (Hill 1979b) was applied to determine gradients in vegetation and the relationship between these plant communities and the physical environment. Results are depicted on a scatter diagram. The ordinations are presented for the plant communities of each of the major vegetation types.

Plant communities were named binomially according to the recommendations of Barkman *et al.* (1986). The first scientific name is that of a diagnostic plant species within the specific community. The second scientific name is that of a dominant species. Diagnostic and dominant species follow the definitions of Werger (1974). An applicable physiognomic term is added to the community name in certain circumstances.

To facilitate the identification of areas of high conservation potential, the alpha diversities of the different plant communities were calculated. The alpha diversity (plant species richness) is defined as the number of species per unit area within a homogeneous community or the total number of species per community (Whittaker 1977). A 400 m^2 sample plot was taken as the unit area within a homogeneous community.

3.2 Plant and soil analyses

Analytical techniques to determine element concentrations in plants and soils have been used extensively in studies of ultramafic substrates and its associated vegetation. Examples of analytical approaches at the fine-scale level of heavy metal accumulation, speciation and mine rehabilitation in southern Africa include studies by Wild (1974a), Brooks & Yang

(1984), Morrey *et al.* (1989), Hughes & Noble (1991), Roberts & Proctor (1992), Anderson *et al.* (1995) and Balkwill & Burlin (1995).

As a result of a limited research budget and the high costs associated with mineral/metal analysis, soil and plant sampling was restricted to a few samples along a transect of a catena on the Critical Zone, in the undisturbed, under-utilised areas south of the Steelpoort River. In addition, it was thought appropriate to only include a fixed set of heavy metals as part of the element spectrum investigated in both the plant and soil analyses of the SCPE. Aluminium was selected, as it is the most common metal in the world's soils; it is a problem on 30–40% of the world's arable lands where acid soil releases aluminium ions into the ground water (Barinaga 1997). Chromium and nickel was chosen because the Critical Zone has the highest concentrations of Cr and Ni in the world (Schurmann *et al.* 1998) and these metals are typical for serpentines (Brooks 1987). Other parts of the SCPE is mined extensively for Fe, Mn and V, and because the ultramafic flora of Sekhukhuneland occurs on all four layers of the Rustenburg Layered Suite, it was decided to include these metals in the analysis.

3.2.1 Pot experiment

Topsoil and subsoil samples were collected from a chromium outcrop near Tweefontein, Kennedy's Vale, Sekhukhuneland. Twenty-five samples were taken 500 mm deep in close proximity to established stands of sparse natural vegetation. Material was collected from the three dominant grass species All the samples were mixed to make up one soil mixture. The soil mixture was stored at room temperature in sealed bottles for 6 months.

Approximately 500 g of the soil mixture was weighed and placed in each of the 27 (9 x 3 sets) numbered containers and placed in a greenhouse at the beginning of spring 1999. A control soil of quartzite sand was also weighed into 27 (9 x 3 sets) numbered containers in the same greenhouse. A commercial fertilizer P:K:N (3:2:3), equivalent to a rate of application of 600 kg/ha (1g per pot) was placed in the centre of each container below the surface. Maize seeds of the variety SNK 2340 (Vryburg), pre-treated with molybdenum, were planted in the containers at a depth of 10 mm to straddle the fertilizer band. Seeds were germinated and grown with rainwater. Plants were thinned to the required numbers per container after 7 days. Even sized plants were selected for the experiment. The commercial fertilizer was re-applied every two weeks.

Different experimental layouts and procedures were used. Three different layouts were followed with regard to the number of plants left per container after thinning. The layouts had 2, 4 or 8 plants per container. Three different procedures were also followed with regards to harvesting. One pot of each layout was harvested after 2, 3 and 4 weeks respectively. On harvesting days the roots and leaves of plants were measured and then separately placed in well-marked paper bags. The harvested material was then dried in a drying oven for seven days. After drying, the dry mass was determined for both the roots and leaves. The dry material of plants grown in the chromium outcrop soils was milled and then analysed (see 3.2.3 Sample preparation and analyses) for a selected few elements, namely N, P, S, Mg, Ca, Ni and Cr.

The three most abundant grass species from the sites where the soil samples were taken were also sampled. These species were prepared and analysed according to the method in 3.2.3 Plant analyses. The element levels in these grasses were used as a control, as they belong to the same family as maize, namely the Poaceae.

3.2.2 Soil analyses

Rock samples

Rock samples were collected from 12 rock outcrops in randomly selected sites in the SCPE where vegetation anomalies occurred. A control rock sample of "true" serpentine was also collected from the Barberton Greenstone Belt in Mpumalanga. All the rocks were analysed and their metal and element concentrations determined. The area where the rocks were most strongly related to serpentine was chosen for a transect study.

Soil samples

Soil samples were collected along a transect of a catena near Tweefontein, Kennedy's Vale, Sekhukhuneland. The mother material from this catena is of ultramafic origin. This site was proclaimed for Cr mining in 1999 and has subsequently been mined.

The catena was divided into 13 topographic positions (see 10.3.2 Results and discussion; Figure 24). Topsoil and subsoil samples were taken 500 mm deep in the rooting area of plant species that were in proximity to established stands of sparsely distributed natural vegetation anomalies (the collection of soil samples was used as an indication for the collection of plant material). Five soil samples were taken for each topographic position, close to the stems of the plant species that were sampled for analysis. Soil samples were stored in sealed bottles at room temperature for 6 months.

Sample preparation for both rock and soil analysis

Samples were dried and grinded to <75 µm in a Tungsten Carbide milling vessel. Quartz crucibles were boiled in 1:1 HCL for 30 minutes in a glass beaker on a hot plate in a fume cupboard. Afterwards the crucibles were rinsed with distilled water and dried in a furnace at 1 000°C for a 30 minutes and left to cool in a desiccator.

The cool, empty crucible was weighed on an analytical balance and its weight recorded to the fifth decimal place. Powder of the sample (2 g) was added and the weight recorded. The crucible with the sample was dried at 110°C for a minimum of four hours to determine the amount of hygroscopic water in the sample. After the crucible was cooled in the desiccator, the sample was reweighed and the weight recorded. The sample was then ashed at a temperature of 950°C for four hours. After cooling in the desiccator, the sample was once again reweighed and the weight recorded. The Loss On Ignition (LOI) value is the sum of all changes that occur in a sample at a temperature of 950°C, expressed as a weight percentage of the original sample weight.

Fused beads were prepared following the standard method used in the XRD & XRF laboratory of the University of Pretoria (adapted from Bennett & Oliver 1992). A bead was prepared by adding 1 g pre-roasted sample to 6 g Lithium Tetra Borate ($Li_2B_4O_7$) flux and mixing by rolling it in a polytop covered with Mylar foil and a lid. Three drops of 250 g/l LiBr solution was added to a cleaned 5% Au/Pt crucible. The mixture was fused at 1 050°C in a muffle furnace with occasional swirling every 5 minutes. When no undissolved residue remained, it was poured into a pre-heated Pt/Au mould.in the furnace. The casting disk was then removed from the furnace and placed on a refractory brick to cool. When the fused beads (glass disks) cooled down, they were removed from the casting dishes by tipping them upside down on paper.

Pellets were prepared using an adaptation of the method described by Watson (1996). Using 16–20 ml, the grinded powdered samples were bound with 10–15 drops of a saturated movial solution. Everything was transferred into a plastic bag and rubbed thoroughly between the palms to distribute the movial binder evenly throughout the sample. Samples were then transferred into an Al cup and pressed into a pellet under 8 tons/in^2 for two minutes. The pellet was then removed from the press and dried at 110°C for 30 minutes.

Sample analysis

Rock and soil samples were analysed with X-Ray Fluorescence at the Department of Geology, University of Pretoria. The apparatus used was the ARL 9400XP+ Wavelength Dispersive X-Ray Fluorescence (XRF) Spectrometer. The XRF Spectrometer calculates the concentrations of the elements and a printout is obtained with all the results. The following method was followed:

I. Major element analysis was executed on fused beads, following the standard method used in the XRD & XRF laboratory of the University of Pretoria (adapted from Bennett & Oliver 1992). The bottom surface of a fused bead (glass disk) was analysed.

II. Trace elements were analysed on pressed pellets, using an adaption of the method described by Watson (1996). Samples pressed into pellet under 8 tons/in^2 were analysed.

III. XRF Spectrometer was calibrated with certified reference materials. NBSGSC Fundamental Parameter Programme was used for matrix correction of major elements as well as Cl, Co, Cr, V, Ba, Sc and S. The Rh Compton peak ratio method was used for the other trace elements. Analyses were executed using the wide confidence limit program. The wide confidence limit program (QUANTAS) functions by executing a scan over the total wavelength span of the spectrometer using different crystal/wavelength combinations. The overlap and background corrected peaks were quantified after application of the NBSGSC program for matrix correction.

There are two very different types of analysis that are used for the determination of chromium: (1) total chromium (with consideration to its oxidation state) and (2) chromium (VI) (Kimborough *et al.* 1999). Chromium (III) can be inferred from the difference between the two analyses. The analysis for total chromium is less complex and controversial than the analysis for chromium (VI). Since exchangeable levels of Cr are normally very low (Kimbrough *et al.* 1999), only total Cr was determined for the soil and plant material.

IV. Soil pH was measured in 1:2.5 soil:distilled water suspensions. The mixtures were left for one hour and measured with a pH metre at 25°C.

3.2.3 Plant analyses

Plant material collection

Plant material was collected along a transect of a catena in the study area near Tweefontein, Kennedy's Vale, Sekhukhuneland. Plant material samples were taken as roots, stems and leaves within established stands of natural vegetation. Certain criteria were followed for the selection of plant species:

- More than five specimens were available for collection;
- It is dominant in the plant community/vegetation anomaly;
- It is a SCPE endemic, near-endemic, form of a common species or disjunct locality.

Voucher specimens were prepared for each taxon sampled and are housed in the H.G.W.J. Schweickerdt Herbarium (PRU), University of Pretoria. Collectors numbers are given in square brackets. This is followed by the reason why the specific species was cosen. Plant material of the following plant species were collected:

Monocotyledons

Poaceae

Diheteropogon amplectens (Nees) Clayton [*Siebert 671*]; dominant in community

Heteropogon contortus (L.) Roem. & Schult. [*Siebert 600*]; dominant in community

Stipagrostis hirtigluma (Trin. & Rupr.) De Winter subsp. *patula* (Hack.) De Winter [*Siebert 597*]; disjunct locality

Dicotyledons

Acanthaceae

Petalidium oblongifolium C.B. Clarke [*Siebert 598*]; near-endemic species

Anacardiaceae

Rhus batophylla Codd [*Siebert 936*]; endemic species

Rhus keetii Schönland [*Siebert 931*]; near-endemic species

Asteraceae

Berkheya insignis (Harv.) Thell. [*Siebert 942*]; endemic form

Brachylaena ilicifolia (Lam.) E. Phillips & Schweick. [*Siebert 613*]; endemic form

Dicoma gerrardii Harv. ex F.C. Wilson [*Siebert 929*]; dominant in community

Pterothrix spinescens DC. [*Siebert 928*]; disjunct locality

Celastraceae

Catha transvaalensis Codd [*Siebert 604*]; endemic species

Combretaceae

Terminalia prunioides G. Lawson [*Siebert 605*]; dominant in community

Convolvulaceae

Ipomoea bathycolpos Hallier f. var. *sinuatodentata* Hallier f. [*Siebert 617*]; endemic infraspecific taxon

Ebenaceae

Euclea sp. nov. (*E. sekhukhuniensis* Siebert, Retief & Van Wyk) [*Siebert 937*]; endemic

Euclea linearis Zeyh. ex Hiern [*Siebert 938*]; endemic form

Lamiaceae

Leucas capensis (Benth.) Engl. [*Siebert 596*]; endemic form

Orthosiphon fruticosus Codd [*Siebert 615*]; endemic species

Tinnea rhodesiana S. Moore [*Siebert 614*]; dominant in community

Polygalaceae

Polygala sp. nov. (*P. sekhukhuniensis* Siebert, Retief & Van Wyk) [*Siebert 602*]; endemic species

Schrophulariaceae

Jamesbrittenia aurantiaca (Burch.) Hilliard [*Siebert 930*]; dominant in community

Plant material was collected along the broader topographic positions of the catena (10.3.2 Results and discussion; Figure 24), namely chromium outcrops (I–M), the associated hill slope (E–I) and the eroded areas (A–E) in the valley below the slope. This collection method was followed because plant species follow the broader topographic trends. Plant material of succulents was not sampled, as Wild (1975) found that amongst endemics of Zimbabwean ultramafics, succulent species characteristically accumulate less heavy metals than non-succulent species. Monocotyledons growing on ultramafic soils often also have lower concentrations of metal ions in their tissue, largely because of preferential accumulations of elements in roots which are readily shed when the metal content becomes to high (Ernst 1972). It was therefore thought best to concentrate all effort and expenses on non-succulent dicotyledons to ensure optimum results.

The dried plant material was stored in paper bags at room temperature for 6 months. Before analysing the plant material it was milled to a fine powder. Plant material was analysed at the Institute for Soil, Climate and Water in Pretoria.

Sample preparation and analysis

I. Method for N (nitrogen) determination (Bellomonte *et al.* 1987).

The dried and milled sample was used directly for N determination on a Carlo Erba NA 1500 C/N/S Analyser (Dumas Method). A few milligrams of the sample was weighed into a tin container and ignited at high temperature in oxygen (on a chrome oxide catalyst). The gasses produced passed through silvered cobalt oxide, a column of copper (reducing the oxides of nitrogen to nitrogen gas and removing the excess O_2) and water vapour, and CO_2 traps. Gasses are then separated by gas chromatography using a helium carrier gas and detected by a thermal conductivity detector. The instrument was calibrated against a pure organic compound of known composition, in this case an ethyl ester of 4-Aminobenzoic acid, which contains 8,48% N.

II. Methods for the digestion and determination of Ca (calcium), Mg (magnesium), P (phosphorous), S (sulphur), Fe (iron), Mn (manganese) and Al (aluminium).

Sample digestion (Zasoski & Burau 1977): 1g of a sample was digested with 7 ml HNO_3 (concentrated nitric acid) and 3 ml $HClO_4$ (perchloric acid) at a temperature of 200°C and brought to volume in a 100 ml volumetric flask.

Ca, Mg, Fe and Mn (Antanasopoulos undated): The solution was analysed with Flame Atomic Absorption Spectrophotometry (AAS) for Fe and Mn, using an Air-Acetylene Flame with wavelengths of 248.3 nm and 279.5 nm for Fe and Mn respectively. An aliquot of the solution was diluted for determination of Ca and Mg by AAS in a Nitrous Oxide-Acetylene Flame, using a wavelength of 422.7 nm for Ca and 285.2 nm for Mg.

P and Al (Anonymous 1972; Hambleton 1990; A.O.A.C. 1990): Other aliquots were used for the colourimetric determination of P and Al, using automated flow systems. The P method uses the reaction of the phosphate with ammonium molybdovanadate and measurement of the absorption of the coloured complex at 420 nm. The Aluminon reagent method was used for Al (Jayman & Sivasubramaniam 1974; Bertsch *et al.* 1981).

S (Ogner & Haugen 1977; Van Vliet 1999): A final aliquot was used for the determination of S (in the form of SO_4^{-2}) by precipitation of barium sulphate, suspension of the precipitate in polyvinyl chloride and measurement of the turbidity.

III. Methods for the digestion and determination of Cr (chromium), Ni (nickel) and V (vanadium).

Sample digestion (Chao-Yong & Schulte 1985): 15 ml HNO_3 (concentrated nitric acid) was added to a 0.5 g sample and heated to 120°C. After addition of 30% H_2O_2 (10 drops) and a few ml distilled water, the samples were digested at this temperature for another 20 minutes, before cooling and bringing to volume in a 100ml volumetric flask.

Cr, Ni and V: These 3 elements are simultaneously determined by ICP-MS (Inductively Coupled Plasma-Mass Spectrometry). The isotopes used were V 51, Cr 52 and Ni 60. An internal standard (Indium - In) is used to increase the accuracy (added by diluting the digest solution with indium nitrate to 10 ppb. The procedures are based on the standard operating concentrations and nutrient levels were once again determined by adding the totals of the applicable elements for each.

The third group of scatter diagrams relates element levels of the soil to that in the plant material. These diagrams aim to determine whether there is an association between the plant species and the soils on which they grow. This association is expressed as a function of the spatial distribution of plots along a two-dimensional plane (Figure 30). Figures used for the metal concentrations and nutrient levels were also determined by adding the totals of the applicable elements for each.

Plots of Cr and Ni concentrations of plant material against levels in the soil defined the fourth group of scatter diagrams (Figure 31). These are simple graphs indicating at what critical soil concentrations indigenous plant species accumulated these elements at maximum levels.

3.3 Floristic evaluation

Existing data on the distribution of plant taxa were obtained from PRECIS (National Herbarium (PRE) Computerised Information System) (Prentice & Arnold 1997). Distribution patterns of endemic plant taxa were projected by a Geographical Information System [GIS], Idrisi for Windows 32® (Clark Labs 1999). This information was verified and supplemented by a study of herbarium specimens in the National Herbarium (PRE), Pretoria, the H.G.W.J. Schweickerdt Herbarium (PRU), University of Pretoria, and botanical literature.

Extensive fieldwork was conducted over two years in spring and summer, and approximately 2 000 herbarium specimens were collected in the SCPE. The collections are housed in recognised herbaria of South Africa, namely the C.E. Moss Herbarium, University of the Witwatersrand (J), National Museum Herbarium, Bloemfontein (NMB), H.G.W.J. Schweickerdt Herbarium, University of Pretoria (PRU), and the National Herbarium, Pretoria (PRE). More details on the composition of the checklist are supplied in Appendix 5.

Quantitative criteria were used to place a species in a particular Red List category using the guidelines set by the IUCN-Species Survival Commission (IUCN 1994). In most cases decisions were based on fieldwork observations and recorded locality, ecological and population data. Extent of occurrence was calculated for each species (Siebert 1998) using the IDRISI for Windows Geographic Information System package. Data were not analysed using RAMAS® Red List, a software package developed by a software development company, Applied Biomathematics (this software implements the IUCN Red List criteria for classifying species into one of the three categories of threat, or a Low Risk category; if insufficient data is available to arrive at a conclusion it is classified as Data Deficient).

CHAPTER 4

PHYTOSOCIOLOGICAL STUDY

Abstract

A detailed account is given of the vegetation types of the Sekhukhuneland Centre of Plant Endemism. Phytosociological data from 415 sample plots were subjected to phytosociological classification using TWINSPAN. The resulting classification was further refined with table-sorting procedures based on the Braun-Blanquet floristic-sociological approach of vegetation classification. The analysis revealed six major vegetation types (Siebert et al. *2002a) consisting of 82 syntaxa, interpreted as the* Acacia tortilis-Dichrostachys cinerea *Arid Northern Bushveld, the* Kirkia wilmsii-Terminalia prunioides *Closed Mountain Bushveld, the* Combretum hereroense-Grewia vernicosa *Open Mountain Bushveld, the* Hippobromus pauciflorus-Rhoicissus tridentata *Rock Outcrop Vegetation, the* Themeda triandra-Senecio microglossus *Cool Moist Grasslands and the* Fuirena pubescens-Schoenoplectus corymbosus *Wetland Vegetation. Plant communities of each major vegetation type are described and the diagnostic species highlighted. The occurrence of rare and threatened plant species in each plant community is indicated.*

4.1 Introduction

The Sekhukhuneland Centre of Plant Endemism has a remarkably rich diversity of plant communities that are a direct result of the diversity of its substrates (geology and soils), climate (rainfall, temperature and fire patterns), topography (aspect, slope and height above sea level), floristic history (sub-tropical bushveld and afromontane ecotone) and human influence (agriculture, settlements, over-grazing and mining). These conspicuous plant communities constitute the various vegetation types of the centre, providing shelter and food for a myriad of organisms by means of tight, integrated local ecosystems. In addition these plant communities are of immense practical value to man and support the livelihoods of many of the rural people in Sekhukhuneland, both commercial and subsistence farmers (Crooks *et al.* 2000).

During the past few decades conservation management has moved in the direction of environmental management—the influence of human activities as they affect the quality of mankind's physical environment, especially air, water and terrestrial features (Sewell 1975). Emphasis is not on strictly policed, protected areas primarily for large mammals, but on sustainable resource use, maintenance of ecological processes, and genetic diversity (Cunningham 1989).

Savannas can be described as a tropical vegetation type co-dominated by woody plants and grasses. It is the dominant vegetation of Africa, occupying 54% of southern Africa (Scholes 1997). The Savanna region is species-rich and 43% of the species are endemic to the subcontinent. This vegetation type is also home to many large mammal species (Cowling & Olivier 1992). The central Savanna is an important location of biological diversity in the region and according to Rebelo (1997), 9.96% of the Savanna Biome is conserved in South Africa. Furthermore, small land areas of only 7% in Mpumalanga and 2% in the Northern Province has been set aside for conservation (Hoffman & Ashwell 2000a; 2000b).

Many informal settlements exist in the central Savanna. These people rely on the savanna to supply grazing, fuel wood and timber. The SCPE lies in the savanna of the Northern Province and Mpumalanga. Approximately 46% of Mpumalanga and 58% of the Northern Province land areas is used for grazing (Hoffman & Ashwell 2000a; 2000b). A further 30% and 22% of the land area respectively, is used for agriculture (Hoffman & Ashwell 2000a; 2000b). The area contributes considerably to the formal economy of the region through its livestock, ecotourism and mining industries. Fast growing human populations in South Africa is making increasing demands on the natural resources and this will encourage expansion of agriculture and industry into marginal and often sensitive areas. It is thus essential to have the necessary ecological knowledge of an area to assist in planning development, management and conservation to prevent future environmental deterioration.

Existing ecological knowledge of the vegetation types of the central Savanna of South Africa is scanty (Cole 1986; Winterbach 1998) and confined to farms or nature reserves of local significance. Even less studied is the savanna of ultramafic substrates (norite, anorthosite and pyroxenite) of the region (Siebert 1998). The first step to identify broader vegetation types of the region, which also covered the ultramafic substrates of the western Bushveld Complex, was taken by Van der Meulen (1979).

This chapter deals with the analysis of ecological data to investigate the interrelationships between plant communities and their environment (synecology). It also draws on other disciplines such as climatology, physical geography and pedology. This chapter provides an invaluable identification and classification reference to 82 of the common plant communities in the SCPE region, both indigenous and anthropogenic. A principal aim of the classifications presented in this chapter, is to define and describe the characteristics of the SCPE communities. This will assist scientists, conservationists and land-use planners when future projects are conducted in the centre. It is anticipated that the work presented will contribute to a more sustainable and less destructive development of the natural environment of the region. Sound environmental development is a state of mind and is something that can be achieved if basic data, such as this thesis, are actively drawn on during planning and management of natural resources.

The vegetation discussed here is largely confined to the norite and pyroxenite hills of Sekhukhuneland. These substrates are intermediate between serpentine and granite—to quote Wild (1965) page 51, paragraph 4, on his view of the vegetation on such substrates: "These intermediate characteristics of pyroxenite and norite soils, together with their *variability*, render an exact study of their vegetation more difficult than in the case of serpentine and so no attempt has been made to analyse their flora in detail here ..."

The heterogeneity of the vegetation on norites and pyroxenites was also recognised by Acocks (1953) who described the Steelpoort area in Sekhukhuneland as a distinct variation of Mixed Bushveld. The fact that he did not give it a distinguishing name at the time indicates the lack of knowledge that surrounds this vegetation type. This chapter is therefore an attempt towards classifying the heterogeneous vegetation of the Sekhukhuneland Centre of Plant Endemism.

4.2 Major vegetation types

Major vegetation types of the SCPE can be divided into three continuous regions, namely Arid Bushveld, Mountain Bushveld and Grassland (Figure 6). These floristic regions are based on the broad distribution of major vegetation types. This floristic classification is hierarchical and dependent on scale, with smaller areas accommodated within successively larger ones (Maclaughlin 1992).

The first TWINSPAN division separated the azonal Wetland Vegetation from the other vegetation types. The second division separated the Arid Northern Bushveld from the moister southern and central vegetation types. A further division divided the vegetation into Cool Moist Grassland and woodland/thicket vegetation types. A fourth division divided the bushveld into Rock Outcrop Vegetation, with afromontane elements, and mountain bushveld. Final division of the central mountain bushveld resulted in two types, namely Open Mountain Bushveld and Closed Mountain Bushveld (Figure 33; Chapter 12).

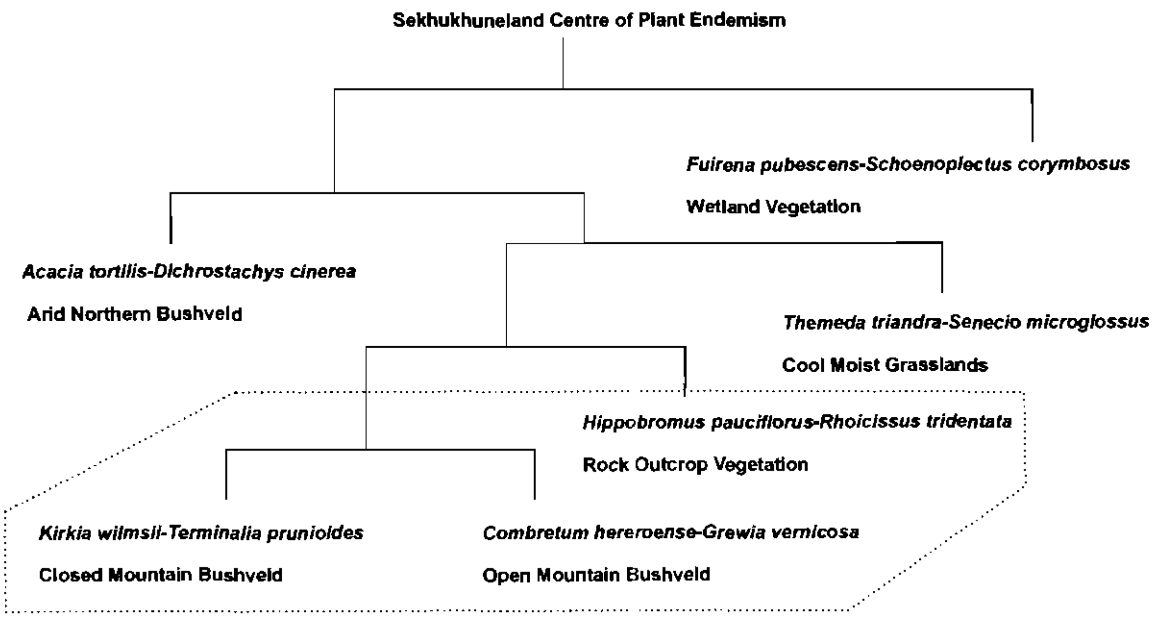

Figure 33 Dendrogram depicting the TWINSPAN division of the six major vegetation types of the Sekhukhuneland Centre of Plant Endemism (Dotted lines demarcate the vegetation types that are part of the proposed *Kirkia wilmsii-Acacia caffra* Alliance on clay soils).

The most diagnostic species for each major vegetation type were distinguished, and based on the distribution of the plant species within the SCPE in general; the most prominent character and differential species were used for the classification of the groups. However, this remains provisional, for the vegetation of Sekhukhuneland is a complex system due to its heterogeneous habitats. It is difficult to predict the most prominent differential species, for significant variation in species composition arises in any given place and time. No two plant communities are identical in size, species composition or structure in the SCPE.

Endemic, near-endemic and Red Data List species/infraspecific taxa are given for each of the major vegetation types. Fifty-two endemic and 52 (of approximately 70) near-endemic species/infraspecific taxa (Siebert 1998) were recorded during the study. Thirty-seven taxa were identified as Red Data List taxa (Hilton-Taylor 1996), namely one Endangered, two Vulnerable, eight Rare, one Indeterminate, 15 Insufficiently Known and 10 threatened in other provinces/countries of southern Africa (not threatened in northern Provinces).

The floristic composition of the six major vegetation types is given in the synoptic table (Table 1). A discussion of the major groups follows below:

A. *Fuirena pubescens-Schoenoplectus corymbosus* Wetland Vegetation (Chapter 5)[1]

This wetland vegetation is found throughout the region, on stream banks in the valleys, seepage areas on the mountain slopes and wetlands on the mountain plateaus. It is usually associated with vertic black clay soils that are saturated with water during the spring, summer and autumn seasons.

A floristic affinity exists with the *Themeda triandra-Senecio microglossus* Cool Moist Grassland. It is also an extension of the wetlands on the Steenkampsberg (Bloem 1988). This vegetation type is found throughout the Centre in all the floristic regions (Figure 6), especially in the grassland. It has, however, not been investigated thoroughly during this study.

[1]For the purpose of describing the syntaxa, this major vegetation type is discussed with the grassland communities in Chapter 5.

This vegetation type is not bound by climate, geology, soils or topography, but is only dependent on a permanent water supply for the largest part of the year. Hence, many of the taxa in this major group are widespread throughout the northern provinces of South Africa.

Fuirena pubescens and *Schoenoplectus corymbosus* are the indicator species separating this azonal vegetation type from the zonal. Diagnostic species for this group are presented in species group R (Table 1).

Salix mucronata is the diagnostic woody species for the group. Herbs are plentiful, with *Artemisia afra*, *Conyza scabrida* and *Chironia purpurascens* the diagnostic forbs and *Fimbristylis ferruginea*, *Fuirena pubescens* and *Schoenoplectus corymbosus* the diagnostic sedges. Frequently occurring, diagnostic taxa of the Poaceae include *Andropogon eucomis*, *Imperata cylindrica*, *Miscanthus junceus* and *Phragmites australis*, and other dominant graminoids are *Cymbopogon validus* and *Hyparrhenia filipendula*.

This vegetation type has the lowest number of taxa of conservation value (Table 2). However, this is a northeastern Drakensberg Escarpment wetland system, which means that it should receive conservation priority (Bloem 1988; Burgoyne 1995). An endemic form of *Acacia karroo*, a near-endemic which is Insufficiently Known in the Red Data List, *Nuxia gracilis*, and a Red Data List taxon not threatened in the northern provinces, *Eucomis autumnalis* subsp. *clavata*, occur in this vegetation type (Table 2).

B. *Themeda triandra-Senecio microglossus* Cool Moist Grasslands (Chapter 5)

This grassland is restricted to the higher altitude undulating hills of the southern region, and to a lesser degree, the high altitude plateau of the Leolo Mountains in the central region. It occurs on shallow clay soils underlain by norite and exhibits the highest floristic diversity in the region.

The vegetation is dense grassland, with scattered woody species. A floristic link exists with the grasslands of the Steenkampsberg (Burgoyne 1995). This major group is predominant in the Grassland floristic region (Figure 6).

High altitudes (Figure 2), temperate climates with high rainfall and frost (Figure 5), and seasonal fire gives rise to grasslands in the SCPE. This vegetation type follows the 600 mm and 18°C isohyet, and is maintained, not created, by the seasonal fires (Van Oudtshoorn 1999) that occur in different areas of Sekhukhuneland annually.

The most important indicator species for the division between the bushveld and the grassland are *Diheteropogon amplectens* and *Senecio microglossus*. Diagnostic taxa for this group are presented in species group L (Table 1).

Diagnostic woody species in this region include the tree, *Protea caffra* and the suffrutex, *Elephantorrhiza elephantina*. The invasive alien tree, *Acacia dealbata*, is a problem in this vegetation type. Many prominent forbs occur frequently in this major group and include the diagnostic *Acalypha punctata*, *Clerodendrum triphyllum* and *Thesium gracilentum*, and the abundant *Berkheya insignis*, *Gnidia caffra*, *Hypoxis rigidula*, *Senecio latifolius* and *S. microglossus*. This vegetation type is characterised by the dominance of graminoids, which include prominent, conspicuous grasses such as *Brachiaria serrata*, *Diheteropogon amplectens*, *Elionurus muticus*, *Setaria sphacelata*, *Themeda triandra* and *Tristachya leucothrix*.

The highest number of Red Data List taxa, namely 15, occurs in this vegetation type (Table 2). Of these taxa two are Rare, seven are Insufficiently Known (highest number for the study area), one is Indeterminate and five are threatened elsewhere in southern Africa (Table 2). This major group also has the highest number of taxa with conservation importance restricted to a vegetation type in the study area (15), and includes taxa such as the endemic *Zantedeschia jucunda* and the Rare *Eucomis montana* (Table 2).

C. *Hippobromus pauciflorus–Rhoicissus tridentata* Rock Outcrop Vegetation (Chapter 6)

The communities of the *Hippobromus pauciflorus–Rhoicissus tridentata* Rock Outcrop Vegetation are scattered as bush clumps, or stages of it, throughout the study area, but are more frequent in the southern region. It prefers sheltered habitats of rock outcrops, classified as rocky outcrops, -ridges, -flats and -refugia. On a macro scale, the vegetation of rocky outcrops is dependent on topography (Figure 2). However, this vegetation type, although not diverse, is very specialised and a direct consequence of specific environmental conditions (Bredenkamp & Deutschlander 1995).

The vegetation type can be found within all the floristic regions of the Centre, but to a lesser degree in the Mixed Bushveld floristic region (Figure 6). These broad-leaved closed woodlands or open shrublands of rock outcrops have a strong floristic link with afromontane vegetation. Two patches of afromontane forests, both from the Leolo Mountains, are included in this group. The forest tree layer is mostly 5 m, but heights of up to 10 m have also been recorded. These afromontane forests of the SCPE are undersampled and are provisionally grouped here until further research can provide more information that will probably lift the forest communities out of this major vegetation type into its own.

The indicator species that delimitate this vegetation type are *Celtis africana* and *Aloe arborescens*. Diagnostic species of this Rock Outcrop Vegetation type are listed in species group G (Table 1).

Prominent tree/shrub species, representative of all four types of rock habitats are the diagnostic *Maytenus undata* and the woody *Acacia ataxacantha*, *Aloe castanea*, *Combretum molle*, *Cussonia transvaalensis*, *Hippobromus pauciflorus* and *Rhoicissus tridentata*. The most abundant forbs include the diagnostic taxa *Cyphostemma woodii*, *Gerbera jamesonii*, *Orthosiphon labiatus* and *Tetradenia brevispicata*. *Xerophyta retinervis* is also prominent in the group. Dominant grasses are the diagnostic *Aristida transvaalensis* and abundant *Cymbopogon excavatus*.

This vegetation type has the status as the major group with the highest number of SCPE near-endemic taxa (Table 2). The second highest number of Red Data List taxa is also present, including one of the two Indeterminate taxa recorded for the study area, *Aloe reitzii* var. *reitzii* (Table 2). Fifteen taxa of conservation importance, the second highest number for the SCPE, are restricted to this group, of which *Adenia wilmsii*, *Euphorbia sekhukhuniensis* and *Tulbaghia coddii* are of conservation priority (Table 2).

D. *Combretum hereroense–Grewia vernicosa* Open Mountain Bushveld (Chapter 7)

This sparse open bushveld has a patchy distribution throughout the whole study area. It occurs on anomalous soils that contain high concentrations of heavy metals (Al, Cr, Fe, Ni, Pt, Ti and V) and high levels of Mg and Ca (see Chapter 10). These soils have a weak structure and high erosion potential.

This sparse bushveld, with a scattered grass sward, gives way to the *Acacia tortilis-Dichrostachys cinerea* Arid Northern Bushveld (a deciduous microphyllous thornveld) in the north and *Kirkia wilmsii–Terminalia prunioides* Closed Mountain Bushveld (a deciduous broad-leaved savanna) in the central parts where the soils are 'normal'. To a lesser extent it also occurs as patches in the *Themeda triandra–Senecio microglossus* Cool Moist Grasslands. Thus an extensive mosaic is formed. It is, however, more predominant in the Mountain Bushveld floristic region (Figure 6).

The existence of this vegetation type can primarily be ascribed to geology (Figure 3) and soils (Figure 4). Aridity, induced by freely drained or vertic soils, and metalliferous soils, produced by specific layers of the Rustenburg Layered Suite, have created harsh environments. These open niches have been filled by a specific group of plant species, which are common in other major groups as well. This vegetation type can be described as an anomaly, for the species composition and predominantly stunted structure is very distinctive and different from the surrounding vegetation.

Combretum hereroense and *Loudetia simplex* were identified as the indicator species that separate this vegetation type from the other bushveld types. Diagnostic plant species for this vegetation type are listed in species group D (Table 1).

Small trees/shrubs, which are diagnostic, are *Brachylaena ilicifolia* and *Ozoroa sphaerocarpa*, prominent and abundant woody species include *Combretum hereroense*, *Grewia vernicosa*, *Tinnea rhodesiana* and *Vitex obovata* subsp. *wilmsii*. Forbs such as the diagnostic *Euphorbia enormis* and *Orthosiphon fruticosus*, and prominent *Commelina africana*, *Kyphocarpa angustifolia* and *Phyllanthus glaucophyllus* are occurs frequently.

Enneapogon scoparius, *Heteropogon contortus* and *Themeda triandra* are the dominant grasses of the vegetation type.

This is the major vegetation type with the most SCPE endemics recorded within its plant communities (Table 2). Together with the Rock Outcrop Vegetation it is host to four Rare taxa. The only Endangered taxon in the study area, *Euphorbia barnardii*, occurs in this vegetation type (Table 2).

E. *Kirkia wilmsii–Terminalia prunioides* Closed Mountain Bushveld (Chapter 8)

This bushveld vegetation type occurs predominantly in the central parts of the SCPE, on clay soils of mountain slopes that are underlain by norite and pyroxenite. The topography is predominantly and typically an undulating landscape. It is the dominant group of the Mountain Bushveld floristic region (Figure 6).

The grass layer of this woodland is well developed and the tree layer varies between 2–5 m. A mosaic is formed with the *Acacia tortilis–Dichrostachys cinerea* Arid Northern Bushveld on clays of the dry valleys and the *Combretum hereroense–Grewia vernicosa* Open Mountain Bushveld on anomalous soils of mountain foot slopes and valleys.

This major group is a product of the regions topography (Figure 2), soils (Figure 4) and climate (Figure 5). The relatively drier, warmer climate facilitated the development of bushveld instead of grassland on the hills. An undulating topography separates this bushveld group from the lowland microphyllous thornveld of the Springbok Flats along the western border of the SCPE. Soil patterns were responsible for the division between Closed Mountain Bushveld on 'normal' soils and Open Mountain Bushveld on 'toxic' soils.

The indicator species for this vegetation type are *Dichrostachys cinerea* and *Panicum deustum*. These species are the most important taxa in the group's separation from the other related major groups. Plant species of diagnostic value in this vegetation type are listed in species group B (Table 1).

The *Kirkia wilmsii–Terminalia prunioides* Closed Mountain Bushveld is characterised by the diagnostic trees *Acacia nigrescens* and *Commiphora mollis*, and the dominant trees/shrubs *Acacia senegal* var. *leiorachis*, *Combretum apiculatum*, *Kirkia wilmsii* and *Terminalia prunioides*. Conspicuous dominant forbs are the diagnostic *Clerodendrum ternatum*, and the prominent *Barleria saxatilis*, *Psiadia punctulata* and *Sanseviera hyacinthoides*. Prominent, abundant grass species include *Aristida canescens*, *Enneapogon scoparius*, *Heteropogon contortus* and *Panicum deustum*.

This major group has the second highest number of SCPE endemics and SCPE near-endemics (Table 2). Ten Red Data List taxa were also recorded, with three taxa categorised as Rare, of which two are endemic to the SCPE (Table 2). Fourteen taxa of conservation importance are restricted to this group, of which the endemic, *Ledebouria dolomiticola*, and two undescribed species are examples (Table 2).

F. *Acacia tortilis–Dichrostachys cinerea* Arid Northern Bushveld (Chapter 9)

This vegetation type occurs mostly in the moderately arid and warmer northern part of the study area. It is usually restricted to the deep, clayey alluvium soils of the Olifants and Steelpoort River valleys in the Mixed Bushveld floristic region of the SCPE (Figure 6). It also occurs in the dry river valleys between the mountains of the central parts of the SCPE, where it forms a mosaic with the *Kirkia wilmsii–Terminalia prunioides* Closed Mountain Bushveld.

This bushveld is characteristically a sparse thornveld with an open grassy layer. The tree layer usually reaches a height of approximately 3 m. A floristic relationship exists with the vegetation of the Pietersburg Plateau (Bredenkamp & Van Vuuren 1977).

This major vegetation type is climatically induced, more specifically by rainfall, for it is restricted to the region with a maximum average annual rainfall of 400 mm (Figure 5). The geology of this region is very heterogeneous (Figure 3) and the soils extremely diverse (Figure 4), and are responsible for heterogeneity within communities.

The diagnostic graminoids *Eragrostis barbinodis* and *Tragus berteronianus* are the most important indicator species at the division level separating this bushveld vegetation type from the moister *Kirkia wilmsii–Terminalia prunioides* and the *Combretum hereroense-Grewia vernicosa* Mountain Bushveld types. All diagnostic species of this group are given in species group A (Table 1).

Acacia tortilis, *Boscia foetida* and *Dichrostachys cinerea* are the most abundant and prominent dominant tree species of the group. The most frequent occurring diagnostic forbs are *Becium filamentosum*, *Felicia clavipilosa*, *Gisekia africana*, *Hermannia odorata* and *Melhania rehmannii*. Prominent graminoids of the vegetation type include *Aristida congesta*, *Enneapogon cenchroides*, *E. scoparius* and *Urochloa mossambicensis*.

One Rare taxon, *Boscia foetida* subsp. *minima*, and the only recorded Vulnerable taxon for the study area, *Plinthus rehmannii*, occur in this vegetation type (Table 2). Five taxa of conservation value are restricted to this vegetation type and include the succulent SCPE near-endemic, *Huernia stapelioides* (Table 2). This major group has the lowest number of taxa with conservation value of all the zonal vegetation types.

4.3 Hierarchical classification

A hierarchical classification of all the syntaxa identified within the six major vegetation types is presented to give a clearer overview of the results. Each syntaxon is also linked to the page number on which it is discussed as part of relevant groups.

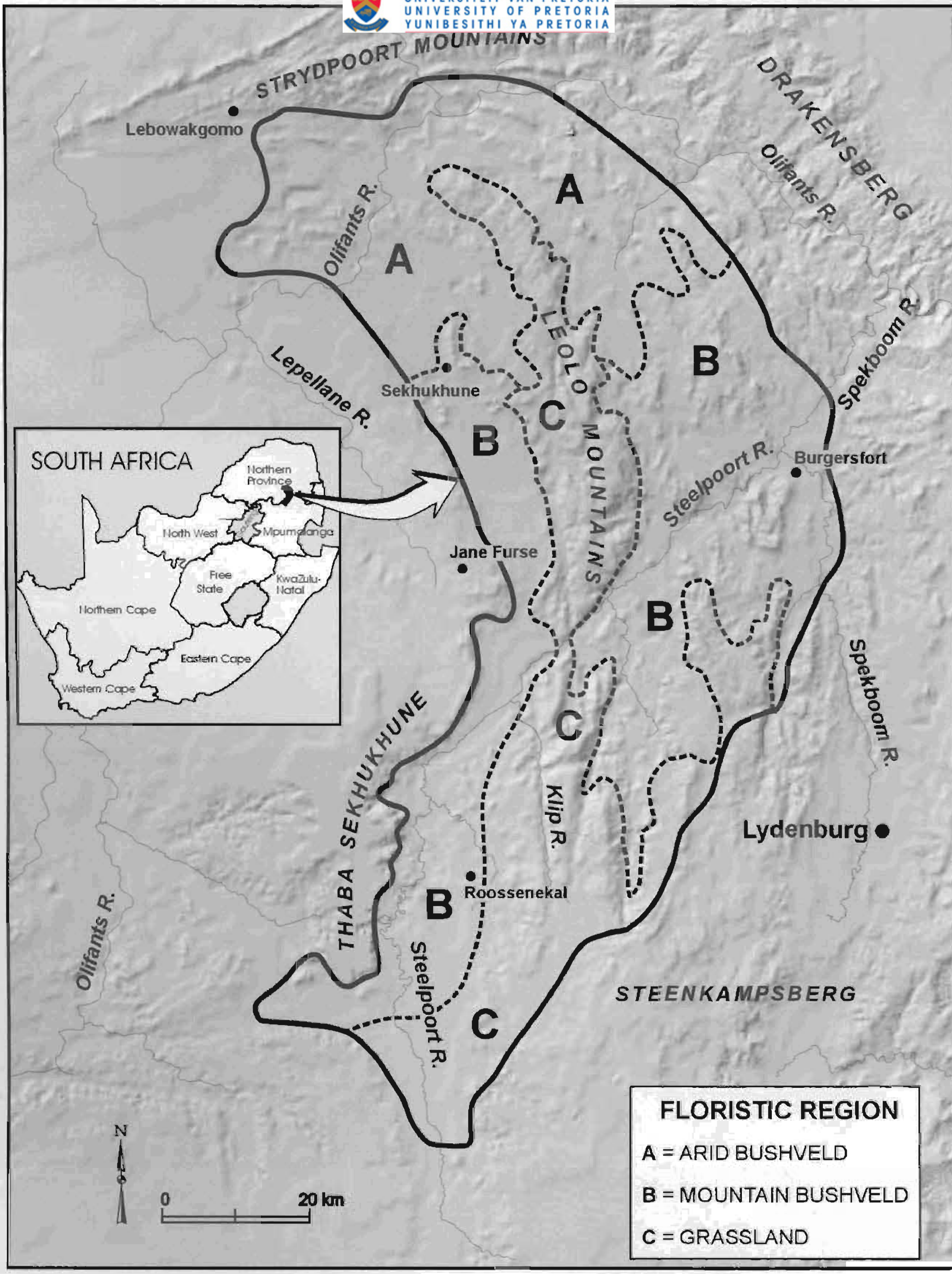

Figure 6 Major floristic regions identified for the Sekhukhuneland Centre of Plant Endemism. (Mountain Bushveld comprises Open and Closed Mountain Bushveld; Rocky Outcrop and Wetland Vegetation is scattered throughout the study area).

Table 1 Synoptic table of the major vegetation types of the Sekhukhuneland Centre of Plant Endemism.

MAJOR GROUP	1	2	3	4	5	6
NUMBER OF RELEVES	47	103	91	100	57	17
SPECIES GROUP A						
Diagnostic for the *Acacia tortilis-Dichrostachys cinerea*						
Eragrostis barbinodis	V	.	.	.	.	.
Tragus berteronianus	IV	.	.	.	.	.
Becium filamentosum	III	.	.	.	.	.
Felicia clavipilosa	III	I	I	.	.	.
Gisekia africana	III	.	I	.	.	.
Hermannia odorata	III	.	.	.	.	.
Melhania rehmannii	III	I	.	.	.	.
Phyllanthus maderaspatensis	III	.	.	.	.	.
Urochloa mosambicensis	III	.	.	I	.	.
Acacia mellifera	II	.	.	.	.	.
Aristida scabrivalvis	II	.	.	I	.	.
Blepharis integrifolia	II	.	.	.	.	.
Hermannia modesta	II	.	.	.	.	.
Hibiscus praeteritus	II	.	.	.	.	.
Indigastrum costatum	II	.	.	.	.	.
Ptaeroxylon obliquum	II	.	.	.	.	.
Solanum coccineum	II	.	.	.	.	.
Acacia grandicornuta	II	I	.	.	.	.
Albizia anthelmintica	II	I	I	.	.	.
Cenchrus ciliaris	II	I	I	.	.	.
Corchorus asplenifolius	II	.	I	.	I	.
Indigofera enormis	II	I	I	.	.	.
Ptycholobium contortum	II	I	.	.	.	.
Schmidtia pappophoroides	II	I	.	.	.	.
Sporobolus ioclados	II	I	I	I	.	.
SPECIES GROUP B						
Diagnostic for the *Kirkia wilmsii-Terminalia prunioides*						
Clerodendrum ternatum	.	III	I	.	.	.
Commiphora mollis	.	III	I	.	.	.
SPECIES GROUP B (cont.)						
Acacia nigrescens	.	II	I	.	.	.
Acacia nilotica	I	II	I	.	.	.
Aristida meridionalis	.	II	I	.	.	.
Aristida rhiniochloa	.	II	I	I	.	.
Barleria lancifolia	.	II	I	.	.	.
Carissa bispinosa	.	II	I	I	.	.
Commiphora africana	.	II	I	I	.	.
Cryptolepis oblongifolium	.	II	.	I	.	.
Dolichos trilobus	.	II	I	I	.	.
Euclea divinorum	.	II	I	.	.	.
Flueggea virosa	.	II	I	I	.	.
Grewia flavescens	I	II	I	.	I	.
Indigofera lydenburgensis	.	II	I	.	.	.
Ochna inermis	.	II	I	I	.	.
Ocimum canum	.	II	I	.	.	.
Rhynchosia minima	I	II	I	I	.	.
Sansevieria hyacinthoides	I	II	I	I	.	.
Sida dregei	I	II	I	I	.	.
Sporobolus fimbriatus	.	II	.	I	I	.
Sporobolus stapfianus	.	II	I	I	I	.
Sterculia rogersii	I	II	I	.	.	.
Urginea epigea	.	II	I	.	.	.
Ximenia americana	I	II	I	.	.	.
SPECIES GROUP C						
Acacia tortilis	IV	II	I	I	I	.
Seddera suffruticosa	IV	II	I	.	.	.
Enneapogon cenchroides	III	II	I	.	.	.
Lantana rugosa	III	II	I	I	.	.
Monechma divaricatum	III	II	I	.	.	.
Boscia albitrunca	II	III	I	.	.	.

Table 1 continued.

MAJOR GROUP NUMBER OF RELEVES	1 47	2 103	3 91	4 100	5 57	6 17
SPECIES GROUP C (cont.)						
Grewia flava	II	III	I	.	.	.
Boscia foetida	II	II	.	.	.	.
Cadaba termitaria	II	II	.	.	I	.
Commiphora pyracanthoides	II	II	.	I	.	.
Croton menyhartii	II	II	I	.	.	.
Digitaria eriantha	II	II	I	.	I	.
Ehretia rigida	II	II	I	I	.	.
Eragrostis rigidior	II	II	I	.	.	.
Rhus engleri	II	II	I	.	.	.
SPECIES GROUP D						
Diagnostic for the *Combretum hereroense-Grewia vernicosa*						
Brachylaena ilicifolia	.	I	III	.	.	.
Orthosiphon fruticosus	.	I	III	I	.	.
Ozoroa sphaerocarpa	.	I	III	I	.	.
Andropogon chinensis	.	I	II	.	I	.
Argyrolobium wilmsii	.	.	II	.	.	.
Bolusanthus speciosus	.	I	II	.	.	.
Cassine aethiopica	.	I	II	I	.	.
Catha edulis	.	.	II	I	.	.
Crabbea angustifolia	.	I	II	I	.	.
Elaeodendron transvaalensis	.	I	II	I	I	.
Euclea linearis	.	I	II	.	I	.
Euclea sp. (*S 934*)	.	.	II	.	.	.
Euphorbia enormis	.	.	II	.	.	.
Euphorbia schinzii	.	I	II	I	.	.
Indigofera nebrowniana	.	I	II	.	.	.
Ipomoea bathycolpos var. *sinuatodentata*	.	.	II	.	I	.
Jamesbrittenia atropurpurea	.	.	II	.	.	.
Laggera decurrens	.	.	II	.	.	.
Ledebouria marginata	.	I	II	.	I	.

MAJOR GROUP NUMBER OF RELEVES	1 47	2 103	3 91	4 100	5 57	6 17
SPECIES GROUP D (cont.)						
Ormocarpum kirkii	.	I	II	.	.	.
Polygala sp. (*S 449*)	I	.	II	.	I	.
Rhus batophylla	.	I	II	.	.	.
Rhus keetii	.	.	II	.	I	.
Tarchonanthus camphoratus	.	I	II	.	.	.
SPECIES GROUP E						
Terminalia prunioides	.	IV	II	.	.	.
Psiadia punctulata	I	III	III	I	.	.
Acacia senegal var. *leiorachis*	I	III	II	.	.	.
Aristida canescens	I	III	II	I	I	I
Barleria saxatilis	I	III	II	.	.	.
Combretum apiculatum	.	III	II	.	.	.
Combretum hereroense	I	II	IV	I	I	.
Grewia vernicosa	I	II	IV	.	.	.
Tinnea rhodesiana	.	II	IV	.	.	.
Phyllanthus glaucophyllus	I	II	III	.	I	.
Aloe burgersfortensis	.	II	II	.	.	.
Chaetacanthus costatus	.	II	II	I	.	.
Dalechampia galpinii	.	II	II	I	I	.
Decorsea galpinii	.	II	II	.	.	.
Eragrostis lehmanniana	.	II	II	I	.	.
Fingerhuthia africana	I	II	II	.	.	.
Jatropha latifolia	.	II	II	I	.	.
Justicia protracta	.	II	II	I	.	.
Sclerocarya birrea	.	II	II	I	.	.
Waltheria indica	I	II	II	.	.	.
SPECIES GROUP F						
Dichrostachys cinerea	IV	IV	II	.	I	.
Enneapogon scoparius	III	IV	III	.	.	.

Table 1 continued.

MAJOR GROUP	1	2	3	4	5	6
NUMBER OF RELEVES	47	103	91	100	57	17
SPECIES GROUP F (cont.)						
Evolvulus alsinoides	III	II	II	.	.	.
Leucas capensia	III	II	II	.	.	.
Kyphocarpa anguatifolia	II	III	III	.	I	.
Aptosimum lineare	II	II	II	.	.	.
Balanites maughamii	II	II	II	.	.	.
Blepharis subvolubilis	II	II	II	.	.	.
Corbichonia decumbens	II	II	II	I	.	.
Geigeria ornativa	II	II	II	.	.	.
Petalidium oblongifolium	II	II	II	.	I	.
SPECIES GROUP G						
Diagnostic for the *Hippobromus pauciflorus-Rhoicissus tridentata*						
Aristida transvaalensis	.	I	I	III	I	.
Cyphostemma woodii	.	I	.	III	.	.
Gerbera jamesonii	.	I	I	III	I	.
Maytenus undata	.	.	.	III	I	.
Allophylus africanus	.	.	.	II	.	.
Apodytes dimidiata	.	.	.	II	I	.
Asparagus intricatus	.	.	I	II	.	.
Berchemia zeyheri	.	I	I	II	.	.
Clematis brachiata	.	I	.	II	.	.
Crassula sarcocaulis	.	.	I	II	I	.
Cyphia elata	.	.	I	II	.	.
Diospyros whyteana	.	.	.	II	.	.
Dovyalis zeyheri	.	I	.	II	.	.
Drimiopsis maxima	.	.	.	II	I	.
Grewia occidentalis	.	.	.	II	.	.
Halleria lucida	.	.	.	II	I	.
Olea capensis	.	.	.	II	.	.
Olinia emarginata	.	.	.	II	I	.
Orthosiphon labiatus	.	.	.	II	.	.

MAJOR GROUP	1	2	3	4	5	6
NUMBER OF RELEVES	47	103	91	100	57	17
SPECIES GROUP G (cont.)						
Ruellia stenophylla	.	.	I	II	.	.
Scolopia zeyheri	.	.	I	II	I	.
Tetradenia brevispicata	.	.	.	II	.	.
Vangueria infausta	.	.	I	II	.	.
Zantedeschia pentlandii	.	.	.	II	I	.
Zanthoxylum thorncroftii	.	I	.	II	.	.
SPECIES GROUP H						
Diospyros lycioides subsp. *nitens*	.	.	III	II	.	.
Acacia ataxacantha	.	.	II	III	.	.
Combretum molle	.	I	II	III	.	.
Cymbopogon excavatus	.	I	II	III	I	.
Xerophyta retinervis	.	I	II	III	I	.
Catha transvaalensis	.	I	II	II	.	.
Mimusops zeyheri	.	.	II	II	.	.
Pavetta zeyheri	.	.	II	II	.	.
Sphedamnocarpus pruriens	.	I	II	II	I	.
Thesium burkei	.	I	II	II	I	.
SPECIES GROUP I						
Kirkia wilmsii	.	IV	III	II	I	.
Panicum deustum	.	IV	II	III	I	.
Asparagus buchananii	.	III	II	II	.	.
Elephantorrhiza praetermissa	.	II	III	II	I	.
Hippobromus pauciflorus	.	II	II	IV	.	.
Ziziphus mucronata	I	II	II	III	I	.
Aloe cryptopoda	.	II	II	II	.	.
Croton gratissimus	I	II	II	II	.	.
Dombeya rotundifolia	.	II	II	II	.	.
Jasminum multipartitum	.	II	II	II	.	.
Kleinia stapeliiformis	.	II	II	II	.	.

Table 1 continued.

MAJOR GROUP	1	2	3	4	5	6
NUMBER OF RELEVES	47	103	91	100	57	17
SPECIES GROUP I (cont.)						
Setaria lindenbergiana	.	II	II	II	.	.
Triaspis glaucophylla	.	II	II	II	I	.
SPECIES GROUP J						
Aloe marlothii	.	II	I	II	.	.
Celtis africana	.	II	I	II	.	.
Clerodendrum glabrum	.	II	.	II	.	.
Diospyros lycioides subsp. *lycioides*	I	II	I	II	.	.
Euphorbia ingens	.	II	.	II	.	.
Grewia monticola	.	II	I	II	.	.
Maytenus heterophylla	I	II	I	II	I	.
Opuntia ficus-indica	I	II	.	II	.	.
Pappea capensis	.	II	.	II	.	.
Peltophorum africanum	.	II	I	II	.	.
Stylochiton natalensis	.	II	I	II	.	.
SPECIES GROUP K						
Kleinia longiflora	IV	II	II	II	.	.
Sarcostemma viminale	II	III	II	III	I	.
Dodonaea angustifolia	II	II	II	II	.	.
Kalanchoe paniculata	II	II	II	II	.	.
Mundulea sericea	II	II	II	II	I	.
Rhus gueinzii	II	II	II	II	.	.
Schotia brachypetala	II	II	II	II	.	.
Solanum panduriforme	II	I	I	I	.	.
SPECIES GROUP L						
Diagnostic for the *Themeda triandra-Senecio microglossus*						
Acalypha punctata	.	.	.	I	III	.
Clerodendrum triphyllum	.	.	.	.	III	.
Thesium gracilentum	.	.	.	.	III	.
SPECIES GROUP L (cont.)						
Athrixia elata	.	.	.	.	II	.
Callilepis leptophylla	.	.	.	.	II	.
Cephalaria zeyheriana	.	.	.	.	II	.
Dicoma zeyheri	.	.	.	.	II	.
Elephantorrhiza elephantina	.	.	.	.	II	.
Eragrostis superba	.	I	I	I	II	.
Gnidia capitata	.	.	I	.	II	.
Hermannia antonii	.	.	.	.	II	.
Melhania randii	.	.	.	.	II	.
Phyllanthus parvulus	I	.	I	I	II	.
Polygala uncinata	I	I	I	.	II	.
Protea caffra	.	.	.	.	II	.
Rhoicissus sp. (*S 48*)	.	.	.	I	II	.
Rhus wilmsii	.	.	I	I	II	.
Rhynchosia sordida	.	.	.	.	II	.
Scilla natalensis	.	.	I	I	II	.
Striga asiatica	.	I	.	.	II	.
Striga bilabiata	.	.	I	.	II	.
Tetraselago wilmsii	.	.	.	I	II	.
Trachypogon apicatus	.	.	I	I	II	.
Tristachya rehmannii	I	.	I	I	II	.
Vernonia oligocephala	.	.	.	.	II	.
SPECIES GROUP M						
Hypoxis rigidula	.	.	I	II	V	.
Aloe greatheadii	.	I	I	II	III	.
Eragrostis nindensis	I	I	I	II	III	I
Ledebouria revoluta	.	I	I	II	III	.
Convolvulus sagittatus	.	.	.	II	II	.
Eragrostis pseudosclerantha	.	I	I	II	II	.
Eragrostis racemosa	I	I	.	II	II	.

Table 1 continued.

MAJOR GROUP	1	2	3	4	5	6
NUMBER OF RELEVES	47	103	91	100	57	17
SPECIES GROUP M (cont.)						
Jasminum quinatum	.	.	.	II	II	.
Lopholaena coriifolia	.	.	I	II	II	.
Melinis repens	I	I	.	II	II	.
Cyphostemma sp. A (*W 13389*)	.	.	I	II	II	.
Pearsonia sessilifolia	.	.	.	II	II	.
Senecio macrocephalus	.	.	.	II	II	.
SPECIES GROUP N						
Vitex obovata subsp. *wilmsii*	.	I	IV	III	IV	.
Euclea crispa	.	I	III	III	II	.
Rhoicissus tridentata	.	I	II	IV	II	.
Cussonia transvaalensis	.	I	II	III	II	.
Senecio latifolius	.	.	II	II	IV	.
Rhynchosia spectabilis	.	.	II	II	III	.
Setaria sphacelata	.	I	II	II	III	.
Acacia caffra	.	I	II	II	II	.
Eragrostis chloromelas	.	I	II	II	II	.
Tristachya leucothrix	.	.	II	II	II	I
SPECIES GROUP O						
Diheteropogon amplectens	.	I	II	I	IV	.
Berkheya insignis	.	.	II	I	III	.
Brachiaria serrata	I	I	II	I	III	.
Elionurus muticus	.	I	II	.	III	.
Gnidia caffra	.	I	II	I	III	.
Dicoma gerrardii	.	I	II	.	II	.
Jamesbrittenia macrantha	.	.	II	.	II	.
Loudetia simplex	.	.	II	.	II	.
Rhynchosia komatiensis	.	.	II	.	II	.
Rhynchosia totta	I	I	II	I	II	.
Thesium multiramulosum	.	I	II	.	II	.

MAJOR GROUP	1	2	3	4	5	6
NUMBER OF RELEVES	47	103	91	100	57	17
SPECIES GROUP P						
Commelina africana	I	III	IV	III	II	.
Themeda triandra	I	II	IV	II	V	.
Aloe castanea	I	II	II	III	II	.
Pellaea calomelanos	.	II	II	III	II	.
Indigofera hilaris	.	II	II	II	III	.
Raphionacme galpinii	.	II	II	II	III	.
Andropogon schirensis	.	II	II	II	II	.
Melhania prostrata	.	II	II	II	II	.
Melinis nerviglumis	.	II	II	II	II	.
Tephrosia purpurea	.	II	II	II	II	.
SPECIES GROUP Q						
Aristida congesta	V	II	II	II	II	.
Aristida adscensionis	III	II	II	II	II	.
Panicum maximum	III	II	II	II	II	.
Asparagus suaveolens	II	II	II	II	II	.
Cynodon dactylon	II	II	II	II	II	.
Kedrostis foetidissima	II	II	II	II	II	.
Pollichia campestris	II	II	II	II	II	.
Polygala hottentotta	II	II	II	II	II	.
Ruellia patula	II	II	II	II	II	.
Seddera capensis	II	II	II	II	II	.
Vernonia fastigiata	II	II	II	II	II	.
SPECIES GROUP R						
Diagnostic for the *Fuirena pubescens-Schoenoplectus corymbosus*						
Fuirena pubescens	.	I	.	.	.	V
Andropogon eucomus	.	I	.	.	.	IV
Artemisia afra	.	.	.	.	.	IV
Schoenoplectus corymbosus	.	.	.	.	.	IV
Chironia purpurascens	.	.	.	.	.	III

Table 1 continued.

MAJOR GROUP	1	2	3	4	5	6
NUMBER OF RELEVES	47	103	91	100	57	17
SPECIES GROUP R (cont.)						
Cliffortia nitidula	.	.	.	.	.	III
Conyza scabrida	.	.	.	.	.	III
Fimbristylis ferruginea	.	.	.	.	.	III
Imperata cylindrica	.	.	.	.	.	III
Miscanthus junceus	.	.	.	.	.	III
Phragmites australis	.	.	.	.	.	III
Plantago lanceolata	.	.	.	.	.	III
Pulicaria scabra	.	.	.	.	.	III
Schoenus nigricans	.	.	.	.	.	III
Typha capensis	.	.	.	.	.	III
Verbena brasiliensis	.	.	.	.	.	III
Berula erecta	.	.	.	.	.	II
Dittrichia graveolens	.	.	.	.	.	II
Eucomis autumnalis var. *clavata*	.	.	.	.	I	II
Gomphostigma virgatum	.	.	.	.	.	II
Hypoxis argentea	.	.	.	.	.	II
Ischaemum fasciculatum	.	I	.	.	.	II
Kyllinga alba	.	.	.	.	.	II
Mariscus congestus	.	.	.	.	.	II
Verbena bonariensis	.	.	.	.	.	II
SPECIES GROUP S						
Senecio microglossus	.	.	.	I	IV	III
Cymbopogon validus	.	I	.	I	II	V
Hyparrhenia filipendula	.	I	I	I	II	IV
Aristida bipartita	.	I	I	.	II	III
Lippia javanica	.	I	.	I	II	III
Lippia rehmannii	.	.	.	.	II	III
Chlorophytum fasciculatum	.	.	.	.	II	II
Hyparrhenia hirta	.	.	I	.	II	II
Pearsonia obovata	.	.	.	.	II	II
Scabiosa columbaria	.	.	I	.	II	II
Senecio inornatus	.	.	.	.	II	II
Senecio lygodes	.	.	.	.	II	II
Sporobolus centrifugus	.	.	.	.	II	II
SPECIES GROUP T						
Heteropogon contortus	II	III	III	II	II	III
Rhus leptodictya	II	II	II	III	II	III
Eragrostis curvula	II	II	II	II	III	II
Acacia karroo	II	II	II	II	II	III
Eragrostis capensis	II	II	II	II	II	II
Ipomoea obscura	II	II	II	II	II	II

Table 2 Endemic, near-endemic and Red Data List taxa recorded for each of the major vegetation types.

Species	Fam	G I	G II	G T	R I	R II	R III	R IV	R T	O I	O II	O T	C I	C II	C T	A I	A T	Status
Acacia karroo [form] (*P4*)	FABA	e	e	e	-	-	-	-	-	-	-	-	-	-	-	-	-	e
Acacia sp. nov. (*H p.c.*)	FABA	-	-	-	-	-	-	-	-	-	-	-	-	e	e	-	-	e
Adenia wilmsii	PASS	-	-	-	K n	-	-	-	K n	-	-	-	-	-	-	-	-	K n
Albuca sp. nov. (*S856*)	LILI	-	-	-	-	-	-	-	-	-	-	-	-	e	e	-	-	e
Aloe burgersfortensis	LILI	-	-	-	-	-	-	-	-	-	e	e	e	e	e	-	-	e
Aloe castanea	ASPH	n	-	n	n	n	n	-	n	n	n	n	n	n	n	n	n	n
Aloe pretoriensis	ASPH	-	-	-	n	n	n	-	n	-	-	-	-	-	-	-	-	n
Aloe reitzii var. *reitzii*	ASPH	-	-	-	-	I n	I n	-	I n	-	-	-	-	-	-	-	-	I n
Aloe sp. nov. (*S 1419*)	LILI	-	-	-	-	-	-	-	-	-	-	-	-	e	e	e	e	e
Aneilema longirrhizum	COMM	n	-	n	-	-	-	-	-	-	-	-	-	-	-	-	-	n
Argyrolobium wilmsii	FABA	n	-	n	-	-	-	-	-	n	-	n	-	-	-	-	-	n
Asclepias sp. nov. (*K110*)	ASCL	e	-	e	-	-	-	-	-	-	e	e	-	-	-	-	-	e
Asparagus clareae	ASPA	-	-	-	-	-	-	-	-	-	-	-	K n	K n	K n	-	-	K n
Asparagus intricatus [form] (*W&S1501*)	ASPA	-	-	-	e	e	-	-	e	e	-	e	e	-	e	-	-	e
Asparagus sekukuniensis	ASPA	-	-	-	K e	-	-	-	K e	K e	-	K e	K e	-	K e	-	-	K e
Bauhinia tomentosa [form] (*S444*)	FABA	-	-	-	-	-	-	-	-	e	-	e	e	-	e	-	-	e
Berkheya densifolia	ASTE	n	-	n	-	-	-	-	-	-	-	-	-	-	-	-	-	n
Berkheya insignis [form] (*S257*)	ASTE	e	-	e	-	e	-	-	e	e	e	e	-	-	-	-	-	e
Boscia albitrunca subsp. *macrophylla*	CAPP	-	-	-	-	-	-	-	-	-	-	-	n	-	n	-	-	n
Boscia foetida subsp. *minima*	CAPP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	R	R
Brachylaena ilicifolia [form] (*S613*)	ASTE	-	-	-	-	-	-	-	-	e	e	e	e	e	e	-	-	e
Callilepis leptophylla	ASTE	N	-	N	-	-	-	-	-	-	-	-	-	-	-	-	-	N
Catha transvaalensis	CELA	-	-	-	-	e	-	-	e	e	e	e	e	e	e	-	-	e
Chlorophytum cyperaceum	LILI	-	-	-	-	n	-	-	n	-	-	-	-	-	-	-	-	n
Clerodendrum suffruticosum [form] (*S1565*)	VERB	-	-	-	e	-	-	-	e	-	-	-	-	-	-	-	-	e
Combretum petrophilum	COMB	-	-	-	-	-	-	-	-	R n	-	R n	-	R n	R n	-	-	R n
Cyphia transvaalensis	LOBE	-	-	-	-	-	-	-	-	-	-	-	n	-	n	-	-	n
Cyphostemma sp. nov. A (*W13389*)	VITA	e	-	e	e	e	-	-	e	e	-	e	-	-	-	-	-	e
Cyphostemma sp. nov. B (*S1383*)	VITA	-	-	-	e	e	-	e	e	-	-	-	e	-	e	-	-	e
Cyphostemma sp. nov. C (*D4142*)	VITA	e	-	e	-	-	-	-	-	-	-	-	-	-	-	-	-	e
Dicliptera fruticosa	ACAN	-	-	-	-	-	-	-	-	-	-	-	n	n	n	-	-	n
Disa rhodantha	ORCH	-	K	K	-	-	-	-	-	-	-	-	-	-	-	-	-	K

Table 2 continued.

Species	Fam	G I	G II	G T	R I	R II	R III	R IV	R T	O I	O II	O T	C I	C II	C T	A I	A T	Status
Dombeya autumnalis	STER	-	-	-	-	-	-	-	-	-	-	-	-	-	-	n	n	n
Dyschoriste perrotteti	ACAN	-	-	-	n	n	-	-	n	-	-	-	-	-	-	-	-	n
Elephantorrhiza praetermissa	FABA	Ke	-	Ke	-	Ke	Ke	-	Ke	Ke	Ke	Ke	Ke	Ke	Ke	-	-	Ke
Euclea crispa [form] (*W&S13205*)	EBEN	e	-	e	-	e	-	-	e	e	e	e	-	-	-	-	-	e
Euclea linearis [form] (*S937*)	EBEN	n	-	n	-	-	-	-	-	-	n	n	n	n	n	-	-	n
Euclea sp. nov. (*W&S1686*)	EBEN	-	-	-	-	-	-	-	-	e	e	e	-	-	-	-	-	e
Eucomis autumnalis subsp. clavata	LILI	N	N	N	-	-	-	-	-	-	-	-	-	-	-	-	-	N
Eucomis montana	LILI	R	-	R	-	R	-	-	R	-	-	-	-	-	-	-	-	R
Euphorbia barnardii	EUPH	-	-	-	-	-	-	-	-	-	Ee	Ee	-	-	-	-	-	Ee
Euphorbia enormis	EUPH	-	-	-	-	-	-	-	-	-	n	n	-	-	-	-	-	n
Euphorbia lydenburgensis	EUPH	-	-	-	-	n	-	-	n	-	-	-	n	-	n	-	-	n
Euphorbia sekhukhuniensis	EUPH	-	-	-	Re	-	-	-	Re	-	-	-	-	-	-	-	-	Re
Euphorbia sp. nov. (*W13194*)	EUPH	-	-	-	-	-	-	-	-	e	e	e	-	e	e	-	-	e
Gnidia caffra [form] (*W&S12975*)	THYM	e	-	e	-	e	-	-	e	e	e	e	e	-	e	-	-	e
Gossypium herbaceum	MALV	-	-	-	-	-	-	-	-	-	-	-	N	-	N	N	N	N
Grewia vernicosa	TILI	-	-	-	-	-	-	-	-	n	n	n	n	n	n	n	n	n
Gymnosporia sp. nov. A (*W&S13351*)	CELA	-	-	-	-	-	-	n	n	-	-	-	-	-	-	-	-	n
Gymnosporia sp. nov. B (*S458*)	CELA	-	-	-	-	e	-	e	e	e	e	e	-	e	e	-	-	e
Helichrysum albilanatum	ASTE	n	-	n	-	n	-	-	n	-	-	-	-	-	-	-	-	n
Helichrysum uninervium	ASTE	n	-	n	-	-	-	-	-	-	n	n	-	-	-	-	-	n
Hemizygia sp. nov. (*S615*)	LAMI	e	-	e	-	-	-	-	-	-	e	e	-	-	-	-	-	e
Hermannia antonii	STER	n	-	n	-	-	-	-	-	-	-	-	-	-	-	-	-	n
Heurnia insigniflora	ASCL	-	-	-	n	-	n	-	n	-	-	-	-	-	-	-	-	n
Heurnia stapelioides	ASCL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	n	n	n
Hibiscus barnardii	MALV	-	-	-	-	-	-	-	-	Re	-	Re	-	Re	Re	-	-	Re
Indigofera lydenburgensis	FABA	-	-	-	-	-	-	-	-	n	-	n	n	n	n	-	-	n
Ipomoea bathycolpos var. sinuatodentata	CONV	e	-	e	-	-	-	-	-	e	e	e	-	-	-	-	-	e
Jamesbrittenia silenoides	SCHR	N	-	N	-	-	-	-	-	-	-	-	-	-	-	-	-	N
Jamesbrittenia macrantha	SCHR	Ke	-	Ke	-	-	-	-	-	Ke	Ke	Ke	-	-	-	-	-	Ke
Jamesbrittenia sp. nov. (*W13026*)	SCHR	-	-	-	-	-	-	-	-	-	e	e	-	-	-	-	-	e
Jasminum quinatum	OLEA	n	-	n	-	n	-	-	n	-	-	-	-	-	-	-	-	n
Jatropha latifolia var. *latifolia*	EUPH	-	-	-	-	n	-	-	n	n	n	n	n	-	n	-	-	n
Kleinia longiflora [form] (*W&S13239*)	ASTE	-	-	-	-	e	-	e	e	-	-	-	e	e	e	-	-	e

Table 2 continued.

Species	Fam	G I	G II	G T	R I	R II	R III	R IV	R T	O I	O II	O T	C I	C II	C T	A I	A T	Status
Kleinia stapeliiformis	ASTE	-	-	-	n	n	-	-	n	-	n	n	-	n	n	-	-	n
Ledebouria dolomiticola	HYAC	-	-	-	-	-	-	-	-	-	-	-	e	-	e	-	-	e
Leucas capensis [form] (*W&S13007*)	LAMI	-	-	-	-	-	-	-	-	e	e	e	e	e	e	e	e	e
Lotononis wilmsii	FABA	-	-	-	-	n	-	-	n	-	-	-	-	-	-	-	-	n
Melhania randii [form] (*S46*)	STER	K e	-	K e	-	-	-	-	-	-	-	-	-	-	-	-	-	K e
Mosdenia leptostachys	POAC	-	-	-	-	-	-	-	-	-	-	-	K	-	K	-	-	K
Nuxia gracilis	LOGA	-	K n	K n	-	-	-	-	-	-	K n	K n	-	-	-	-	-	K n
Orthosiphon fruticosus	LAMI	-	-	-	-	e	-	-	e	e	e	e	e	e	e	-	-	e
Orthosiphon tubiformis	LAMI	-	-	-	-	-	-	-	-	-	-	-	-	n	n	-	-	n
Ozoroa albicans	ANAC	-	-	-	-	-	-	-	-	K n	-	K n	-	-	-	-	-	K n
Pachycarpus transvaalensis	ASCL	-	-	-	-	n	-	-	n	-	-	-	-	-	-	-	-	n
Pachypodium saundersii	APOC	-	-	-	-	-	-	-	-	-	-	-	-	N	N	-	-	N
Pavetta zeyheri [form] (*S22*)	RUBI	-	-	-	N e	N e	-	-	N e	N e	N e	N e	-	-	-	-	-	N e
Pegolettia lanceolata	ASTE	n	-	n	-	-	-	-	-	-	-	-	-	-	-	-	-	n
Pegolettia senegalensis	ASTE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
Petalidium oblongifolium	ANAC	-	-	-	-	-	-	-	-	n	n	n	n	n	n	n	n	n
Phyllanthus sp. nov. (*S470*)	EUPH	-	-	-	-	-	-	-	-	-	-	-	e	e	e	e	e	e
Plectranthus venterii	LAMI	-	-	-	e	-	-	-	e	-	-	-	-	e	e	-	-	e
Plectranthus xerophilus	LAMI	-	-	-	-	n	-	-	n	n	-	n	n	-	n	-	-	n
Plinthus rehmannii	AIZO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	V n	V n	V n
Polygala sp. nov. (*W&S13311*)	POLY	e	-	e	-	-	-	-	-	-	e	e	-	-	-	e	e	e
Premna mooiensis [form] (*W&S13004*)	VERB	-	-	-	e	-	-	-	e	-	-	-	-	e	e	-	-	e
Protea caffra [form] (*S1382*)	PROT	e	-	e	-	-	-	-	-	-	-	-	-	-	-	-	-	e
Rhoicissus sekhukhuniensis	VITA	-	-	-	e	-	-	-	e	-	-	-	e	e	e	-	-	e
Rhoicissus sp. nov. (*S48*)	VITA	e	-	e	-	e	-	-	e	-	-	-	-	-	-	-	-	e
Rhus batophylla	ANAC	-	-	-	-	-	-	-	-	-	R e	R e	R e	-	R e	-	-	R e
Rhus engleri	ANAC	-	-	-	-	-	-	-	-	-	n	n	n	n	n	n	n	n
Rhus keetii	ANAC	n	-	n	-	-	-	-	-	n	n	n	-	-	-	-	-	n
Rhus rogersii	ANAC	N	-	N	-	N	N	-	N	-	-	-	-	-	-	-	-	N
Rhus sekhukhuniensis	ANAC	-	-	-	-	R e	-	-	R e	R e	R e	R e	-	-	-	-	-	R e
Rhus tumulicola var. *meeuseana* f. *pumila*	ANAC	n	-	n	-	n	n	-	n	-	-	-	-	-	-	-	-	n
Rhus wilmsii	ANAC	K n	-	K n	-	K n	K n	-	K n	-	K n	K n	-	-	-	-	-	K n
Rhynchosia nitens	FABA	K	-	K	-	-	-	-	-	-	-	-	-	-	-	-	-	K

Table 2 continued.

Species	Fam	G I	G II	G T	R I	R II	R III	R IV	R T	O I	O II	O T	C I	C II	C T	A I	A T	Status
Rhynchosia spectabilis	FABA	-	-	-	n	n	n	-	**n**	-	-	-	-	-	-	-	-	n
Schizoglossum sp. nov. (*S628*)	ASCL	e	-	**e**	-	-	-	-	-	-	-	-	-	-	-	-	-	e
Scilla natalensis	LILI	N	-	**N**	-	N	N	-	**N**	N	-	**N**	-	-	-	-	-	N
Solanum incanum [form] (*W&S13013*)	SOLA	-	-	-	e	-	-	e	**e**	e	-	**e**	e	-	**e**	-	-	e
Stapelia gigantea	ASCL	-	-	-	-	-	-	-	-	-	-	-	N	-	**N**	-	-	N
Stylochaeton sp. nov. A (*S1845*)	ARAC	-	-	-	-	-	-	-	-	e	-	**e**	e	-	**e**	-	-	e
Stylochaeton sp. nov. B (*S672*)	ARAC	-	-	-	e	-	-	-	**e**	-	-	-	-	-	-	-	-	e
Thesium multiramulosum	SANT	n	-	**n**	-	-	-	-	-	-	-	-	-	-	-	-	-	n
Thesium gracilentum	SANT	K	-	**K**	-	-	-	-	-	-	-	-	-	-	-	-	-	K
Tragia sp. nov. (*S1573*)	EUPH	-	-	-	-	-	-	-	-	-	e	**e**	-	e	**e**	-	-	e
Triaspis glaucophylla	MALP	n	-	**n**	-	n	n	-	**n**	n	n	**n**	n	-	**n**	-	-	n
Tristachya biseriata	POAC	K	-	**K**	-	-	-	-	-	-	-	-	-	-	-	-	-	K
Tulbaghia coddii	LILI	-	-	-	-	K n	K n	-	**K n**	-	-	-	-	-	-	-	-	Kn
Tulbaghia sp. nov. (*S1304*)	LILI	-	e	**e**	-	-	-	-	-	-	-	-	-	-	-	-	-	e
Vitex obovata subsp. *wilmsii*	VERB	n	-	**n**	n	n	n	n	**n**	n	n	**n**	n	n	**n**	-	-	n
Xerophyta retinervis [form] (*W13208*)	VELL	e	-	**e**	-	e	e	-	**e**	e	e	**e**	e	-	**e**	-	-	e
Zantedeschia jucunda	ARAC	I e	-	**I e**	-	-	-	-	-	-	-	-	-	-	-	-	-	I e
Zantedeschia pentlandii	ARAC	R n	-	**R n**	-	R n	R n	-	**Rn**	-	-	-	-	-	-	-	-	R n
SCPE Endemics (e)		18	2	**19**	12	15	2	4	**23**	23	24	**31**	19	18	**28**	4	**4**	**52**
SCPE Near-endemics (n)		17	1	**18**	8	20	11	3	**24**	12	15	**20**	15	16	**22**	7	**7**	**52**
Total Floristic Elements		35	3	**37**	20	35	13	7	**47**	35	39	**51**	34	34	**50**	11	**11**	**104**
Endangered (E)		0	0	**0**	0	0	0	0	**0**	0	1	**1**	0	0	**0**	0	**0**	**1**
Vulnerable (V)		0	0	**0**	0	0	0	0	**0**	0	0	**0**	0	0	**0**	1	**1**	**1**
Rare (R)		2	0	**2**	1	3	1	0	**4**	3	2	**4**	1	2	**3**	1	**1**	**8**
Indeterminate (I)		1	0	**1**	0	1	1	0	**1**	0	0	**0**	0	0	**0**	0	**0**	**2**
Insufficiently Known (K)		7	2	**9**	3	3	3	0	**5**	4	4	**6**	4	2	**4**	0	**0**	**15**
Threatened in other regions of s. Afr. (N)		5	1	**5**	1	3	2	0	**3**	2	1	**2**	2	1	**3**	2	**2**	**10**
Total Red Data List Taxa		15	3	**17**	5	10	7	0	**13**	9	8	**13**	7	5	**10**	4	**4**	**37**
TOTAL		44	5	**47**	20	38	15	7	**50**	36	39	**52**	37	35	**54**	14	**14**	**121**
Restricted to the vegetation type		15	2	**19**	3	3	0	2	**15**	1	4	**5**	5	7	**14**	5	**5**	**51**

D = G Dednam; P = PP Swartz; S = SJ Siebert; W = AE van Wyk
sp. nov. = possibly an undescribed species

CHAPTER 5

GRASSLAND AND WETLAND VEGETATION

5.1 Background

Several phytosociological studies have been conducted on grasslands along the northeastern escarpment of the Northern Province and Mpumalanga (e.g. Bloem 1988; Deall *et al.* 1989; Matthews *et al.* 1992a, 1992b; Burgoyne *et al.* 2000). However, the vegetation of some areas remained to be investigated and described, both on reconnaissance level and in more detail. An area, for which very limited information on the grasslands vegetation exists, is the undulating norite hills in the Roossenekal-Tonteldoos region. This area is located in the southern portion of the SCPE (Van Wyk & Van Wyk 1997; Van Wyk & Smith 2001), and comprises the Roossenekal Subcentre of Endemism (Siebert 1998). The Roossenekal Subcentre is known for its many plant endemics, the distributions of which correlate with the diversity in geological substrate in the region (Siebert 1998; Siebert *et al.* 2001).

Various grassland and wetland vegetation types, which show a floristic affinity and relationships with the Roossenekal Subcentre (Siebert 1998), have previously been described from the adjacent Steenkampsberg (Bloem 1988; Burgoyne 1995), Witbank Nature Reserve (Smit *et al.* 1997), and the Great Dyke of Zimbabwe (Werger *et al.* 1978). Acocks (1953) mapped the vegetation of the Roossenekal Subcentre as two veld types, namely North-eastern Sandy Highveld (57) and Bankenveld (61). The grassland area forms an ecotone between the Mixed Bushveld (18) and the North-eastern Sandy Highveld (57) Veld Types (Acocks 1953), but it is probably more representative of Bankenveld (61), than any of the aforementioned. A broad scale classification of the same region's vegetation was given by Low & Rebelo (1996), who recognises three vegetation types in the study area, namely Mixed Bushveld (18), Moist Sandy Highveld Grassland (38) and North-eastern Mountain Grassland (43). These veld/vegetation types are closely associated with seasonal fires (Edwards 1984).

Only Acocks (1953) accurately mapped the high-altitude outcrops of norite (Leolo Mountains) in the northern region of the SCPE as grassland, namely North-eastern Sandy Highveld (57). Geologically and floristically the Leolo Subcentre is similar to the Roossenekal Subcentre, and is treated as part of the study area covered in this chapter (Siebert 1998). However, the vegetation classification of the entire Sekhukhuneland Centre needs further attention as comparatively little is known about its plant communities, floristic diversity and the relationship between distribution patterns of plants and the clayey soils derived from the ultramafic norite.

In a broad overview of the vegetation types of the SCPE, Siebert *et al.* (2002a) recognised six major vegetation units. The vegetation units described in this paper covers the *Themeda triandra–Senecio microglossus* Cool Moist Grassland and the *Fuirena pubescens–Schoenoplectus corymbosus* Wetland Vegetation, the two major vegetation types of the relatively moist Roossenekal and Leolo Subcentres.

The grasslands and wetlands of the SCPE are situated in northern Mpumalanga between latitude 25°00'00"–25°20'00" S and longitude 29°50'00"–30°05'00" E (southern part of the SCPE) and latitude 24°30'00"–24°50'00" S and longitude 30°00'00"–30°05'00" E (Leolo Mountains) (Figure 7). The area covers approximately 1 500 km^2 and comprises a homogeneous geology (Visser *et al.* 1989), with a heterogeneous physiography (Land Type Survey Staff 1987). The area dealt with here lies on the Upper and Main Zones of the Rustenburg Layered Suite and is mainly underlain by concentric belts of norite, and to a lesser degree outcrops of ferrogabbro (Visser *et al.* 1989). This norite stratum extends north-south and rises to form the Leolo Mountains (1 700 m asl). The lower reaches of the mountainous areas are characterised by many small outcrops of magnetite.

The valleys have a subtropical climate with little or no frost in winter, whereas in the mountains conditions become more temperate with increasing altitude. Average annual precipitation is about 700 mm (South African Weather Bureau 1998). Local rainfall patterns are strongly influenced by the area's topography and altitude (Siebert 1998), varying from 721 mm in the east, to 607 mm per annum in the west; 710 mm in the south, to 702 mm in the north (Erasmus 1985). Daily average temperature ranges from a minimum of 2.8°C in winter to a maximum of 25.9°C in summer, with an average annual temperature of 16.2°C (South African Weather Bureau 1998). In this region of undulating rocky hills, the vegetation is characterised by scattered woodlands in sheltered habitats along foot slopes and in valleys. Grassland, with scattered bush clumps, cover the exposed plateaus, hill slopes and valleys. The difference in altitude between the two most extreme locations is approximately 500 m (1 700 m asl on the Leolo Mountains to 1 200 m asl where the Klip River cuts through the hills near Roossenekal).

5.2 Classification

The analysis resulted in the identification of 17 plant communities, ordered as eight associations, 11 sub-associations and four variants (Table 3a & 3b). These units were subsequently hierarchically classified. Since the area covered by these communities lies in the climatically uniform moist and cool southern region of the SCPE (Siebert 1998), no major macro-climatic variation plays a role in local differentiation of the plant communities. The major plant communities relate to soil character, rockiness and terrain type, with aspect and slope also playing minor roles. Communities were not always distinctive in the field. This might be attributed to the homogeneity of grassland physiognomy and the heterogeneity of the environmental factors, which resulted in a complex mosaic distribution pattern of habitats and associated vegetation.

The hierarchical classification of the vegetation reinforces the correlation between habitat and plant communities (Figure 8a & 8b). The distribution of the SCPE endemic/near-endemic and Red Data List plant taxa among various plant communities is listed in Table 4. A summary of selected floristic and habitat attributes for each plant community is supplied in Table 5.

The *Themeda triandra–Senecio microglossus* Cool Moist Grassland (Siebert *et al.* 2002a) is interpreted as belonging to the proposed *Tristachya leucothrix*-*Trachypogon spicatus* Class (Du Preez & Bredenkamp 1991). The *Fuirena pubescens–Schoenoplectus corymbosus* Wetlands Vegetation (Siebert *et al.* 2002a) is interpreted as part of the *Miscanthus junceus–Schoenoplectus corymbosus* plant community described by Bloem

(1988) and proposed here as an alliance. The grassland and wetland plant communities of the Roossenekal Subcentre are classified as follows:

I. *Tristachya leucothrix–Trachypogon spicatus* class of moist mountain slopes and plateaus

(*Themeda triandra–Senecio microglossus* Cool Moist Grassland (Siebert *et al.* 2002a))

1. *Helichryso splendidii–Tristachyetum leucothricis*
2. *Zantedeschio pentlandii–Aloetum castaneae*
3. *Brachiario serratae–Melhanietum randii*
    - 3.1 *Brachiario serratae–Melhanietum randii helichrysetosum rugulosii*
        - 3.1.1 *Digitaria eriantha* variant
        - 3.1.2 *Alloteropsis semialata* variant
    - 3.2 *Brachiario serratae–Melhanietum randii argyrolobietosum transvaalense*
        - 3.2.1 *Koeleria capensis* variant
        - 3.2.2 *Berkheya seminivea* variant
    - 3.3 *Brachiario serratae–Melhanietum randii gnidietosum capitatae*
    - 3.4 *Brachiario serratae–Melhanietum randii setarietosum nigrirostis*
4. *Elionuro muticusae–Trachypogonetum spicati*
    - 4.1 *Elionuro muticusae–Trachypogonetum spicati bewsietosum biflorae*
    - 4.2 *Elionuro muticusae–Trachypogonetum spicati acacietosum tortilis*
5. *Jamesbrittenio macranthae–Loudetietum simplicis*
    - 5.1 *Jamesbrittenio macranthae–Loudetietum simplicis combretetosum hereroense*
    - 5.2 *Jamesbrittenio macranthae–Loudetietum simplicis eucleetosum linearis*

II. *Miscanthus junceus–Schoenoplectus corymbosus* community of streams and seepage areas

(*Fuirena pubescens–Schoenoplectus corymbosus* Wetlands (Siebert *et al.* 2002a))

6. *Fuireno pubescentis–Schoenetum nigricantis*
    - 6.1 *Fuireno pubescentis–Schoenetum nigricantis triraphietosum andropogonoidis*
    - 6.2 *Fuireno pubescentis–Schoenetum nigricantis pycnostachetosum reticulatae*
    - 6.3 *Fuireno pubescentis–Schoenetum nigricantis bulbostylietosum hispidulae*
7. *Andropogono eucomis–Fimbristyletum ferrugineae*
8. *Limosello maioris–Ranunculetum meyeri*

5.3 Description

The *Themeda triandra–Senecio microglossus* Cool Moist Grassland and scattered *Cymbopogon validus–Fuirena pubescens* Wetland Vegetation are predominantly restricted to the valleys, slopes and plateaus of undulating norite hills (Siebert *et al.* 2002a). Surface rocks are common and abundant in many of the communities, with soil clay percentages varying from 25% to more than 50%. The vegetation can be classified into herbland and grassland (Edwards 1983). An important feature of the region is the fact that the mountain and hill ranges have a north-south orientation; therefore the grassland communities are mostly restricted to east and west aspects, crests and valleys. Grasslands have been a long-standing component of the Afromontane vegetation mosaic (Meadows & Linder 1989; Matthews *et al.* 1993), and are therefore seen as primary vegetation. Plant communities of the grasslands and wetlands recognised in the SCPE are classified and desribed as follows:

I. *Tristachya leucothrix–Trachypogon spicatus* class (Du Preez & Bredenkamp 1991)
1. *Helichryso splendidii–Tristachyetum leucothricis* ass. nova hoc loco
Nomenclatural type: relevé 408 (holotypus)

Environmental data. Vegetation representing this association occurs at medium altitudes and forms a transition from low to high altitude grassland (1 700 m above sea level). It lies in a rather moist region (> 700 mm/annum), mostly restricted to the summit of the Leolo Mountains on norite. The habitat is a gentle undulating plateau (1–5°) with a general eastern or western aspect (Table 5). The dominant soil type is the Mayo form, a melanic A-horizon over a lithocutanic B-horizon. Average rock size varies from 300–500 mm in diameter and covers 15–20% of the soil surface.

Diagnostic and dominant/prominent taxa. In the SCPE this undersampled association is characterised by species group A (Table 3a). *Euryops brevipapposus, Helichrysum splendidum* and *Vernonia myriantha* are the most prominent diagnostic species of this syntaxon. Other diagnostic species include the shrub *Buddleja saligna* and the herbaceous *Lotononis foliosa* and *Xerophyta viscosa*. There are no diagnostic grasses, but dominant species include *Eragrostis capensis, E. curvula* and *Tristachya leucothrix*. A prominent forb is *Pentanisia prunelloides*, while the shrub *Protea caffra* (endemic form) is conspicuously present.

Notes on floristic diversity. This grassland community is unique for the SCPE and only a slight floristic affinity exist with other grasslands types of the SCPE in species groups M and X (Table 3a). The average number of species per relevé is 30, and the total number of species recorded for the association is 40 (two relevés) (Table 5). Four plant taxa of conservation significance occur in this association (Table 4), namely the endemic forms of *Euclea crispa* and *Protea caffra*, the endemic *Zantedeschia jucunda* that is classified as Indeterminate in the Red Data List (also restricted to the association) and *Jamesbrittenia silenoides*, a taxon assessed as Vulnerable in KwaZulu-Natal.

2. *Zantedeschio pentlandii–Aloetum castaneae* ass. nova hoc loco
Nomenclatural type: relevé 100 (holotypus)

Environmental data. The vegetation is a short shrubland on rocky flats; areas where bedrock is exposed at ground level. The plant community is associated with exposed rock outcrops of norite, a rock type mined extensively as dimension stone in the region. It is situated on gentle slopes (0–5°) and with a very high surface rock cover percentage of 50–70% (Table 5). Solid exposed rock sheets can cover areas of 25 m^2. The dominant soil type is the Mispah form, indicating very shallow soils over hard rocks, often restricted to crevices. The habitat is situated on the midslopes, scarps and crests of undulating hills.

Diagnostic and dominant/prominent taxa. Characteristic species are represented by species group B (Table 3a). Diagnostic trees/shrubs of the association include *Apodytes dimidiata*, *Canthium suberosum*, *Halleria lucida* and *Olinia emarginata*. Diagnostic forbs are *Thesium burkei*, the succulents *Crassula sarcocaulis* and *Aloe pretoriensis*, and the geophytes *Boophane disticha* and *Zantedeschia pentlandii*. *Aristida junciformis* and *Cymbopogon excavatus* are the diagnostic grasses of this association. Prominent plants are the succulent *Aloe castanea*, the shrubby *Rhoicissisus tridentata* and the grasses *Eragrostis pseudosclerantha*, *Themeda triandra* and *Tristachya leucothrix*.

Notes on floristic diversity. This association exhibits a typical floristic relationship with other grasslands of the SCPE (Table 3a). The average number of species encountered per sample plot is 36, with a total of 105 species recorded for the association (five relevés) (Table 5). Sixteen taxa of conservation significance are present in the association (Table 4), six are SCPE endemics, six are SCPE near-endemics and seven are Red Data List taxa. This association has a high number of plant taxa with conservation status in the southern region of the SCPE. The association also has a high number of five taxa with conservation status restricted to it, such as *Asclepias* sp. (*Siebert 27*) (endemic), *Eucomis montana* (Rare), and *Zantedeschia pentlandii* (endemic, Rare).

3. *Brachiario serratae–Melhanietum randii* ass. nova hoc loco
Nomenclatural type: relevé 321 (holotypus)

Environmental data. The vegetation comprises short, dense and very diverse grassland associated with plateaus or terraces on rocky undulating hills. The association is found on all aspects, on gentle to moderate slopes (5–15°) of footslopes, midslopes, scarps and crests (Table 5). Soils are characterised by a melanic A-horizon underlain by hard rock (Milkwood form) or a soft carbonate horizon (Steendal form). The soil surface is covered by 15–75% of rock with a diameter of 0.1–1 m (Table 5).

Diagnostic and dominant/prominent taxa. Characteristic species of the association are represented by species group C (Table 3a). The dominant diagnostic forbs are *Callilepis leptophylla*, *Dicoma zeyheri*, *Gnidia capitata*, *Melhania randii* and *Vernonia oligocephala*. Woody species typical of the association include the geoxylic suffrutices *Elephantorrhiza elephantina* and *Rhus wilmsii*, and the small trees *Acacia caffra*, *Protea caffra* and *Vitex obovata* subsp. *wilmsii*. Other prominent forbs include *Clerodendrum triphyllum*, *Senecio latifolius* and *Tephrosia purpurea*. Prominent grasses for the association are *Andropogon chinensis*, *Brachiaria serrata*, *Setaria sphacelata*, *Themeda triandra*, *Trachypogon spicatus* and *Tristachya leucothrix*.

Notes on floristic diversity. The average number of species encountered per sample plot in this association is 48, with the total number of plant species being a minimum of 119 taxa

(29 relevés) (Table 5). There are 23 plant taxa of conservation value in the association, of which six are restricted to it. These include taxa such as the near-endemics, *Argyrolobium wilmsii* and *Pachycarpus transvaalensis* (Table 4). Red Data List taxa include *Callilepis leptophylla* (status is Rare in KwaZulu-Natal), *Mehania randii* (status is Insufficiently Known in the northern provinces) and *Scilla natalensis* (status is Vulnerable in the Free State and KwaZulu-Natal). This association harbours the highest number of plant taxa with conservation status in the southern region of the SCPE and, together with plant community 2, the highest number of Red Data List taxa.

3.1 *Brachiario serratae Melhanietum randii helichrysetosum rugulosii* sub-ass. nova hoc loco

Nomenclatural type: relevé 321 (holotypus)

Environmental data. In the Roossenekal Subcentre this sub-association represents short rocky grassland communities on clay soils such as Mayo and Milkwood forms. This grassland vegetation occurs on midslopes, scarps and crests of undulating norite hills. It occurs on slopes of 3–9° on all aspects. Rocks cover 20–50% of the soil surface and are an average size of 0,15–1 m in diameter (Table 5).

Diagnostic and dominant/prominent taxa. Species group F contains the diagnostic species for this sub-association, with the taxa *Helichrysum rugulosum*, *Pimpinella caffra* and *Tephrosia elongata* (Table 3a). Other characteristic species include the forbs *Acalypha punctata*, *Leonotis ocymifolia* and *Senecio lygodes*, as well as the grasses *Panicum natalense* and *Tristachya biseriata*. Trees that are prominent are *Euclea crispa* and *Vitex obovata* subsp. *wilmsii*. Predominant grasses are *Themeda triandra* and *Tristachya leucothrix*.

Notes on floristic diversity. A strong floristic affinity exists with all the sub-associations of the association (Table 3a). The average number of species encountered per sample plot in this sub-association is 49, with the total number of plant species being a minimum of 130 taxa (14 relevés) (Table 5). Two plant taxa of conservation value are restricted to the sub-association (Table 4).

3.1.1. *Digitaria eriantha* variant

Environmental data. The variant is rocky grassland on shallow clay soils of moderately slope hill scarps and crests (Table 5). Average rock size is 600 mm in diameter and covers 25% soil surface (Table 5).

Diagnostic and dominant/prominent taxa. Diagnostic taxa include the forbs *Agapanthus inapertus, Berkheya densifolia, Cyanotis speciosa, Indigofera hedyantha, Monsonia attenuata* and *Tephrosia longipes* and the grass *Digitaria eriantha* (species group D; Table 3a). Other frequently occurring grasses are *Andropogon schirensis, Brachiaria serrata* and *Setaria sphacelata*.

Floristic diversity. A strong floristic similarity exist with plant community 3.2.1, probably due to the similarity in their rock size and cover (species group H; Table 3a & Table 5). Five SCPE endemics, five near-endemics and seven Red Data List taxa are found in this variant (Table 4). Of the 112 taxa recorded for the variant (seven relevés), only 15 are of conservation value (one is restricted to it). The average number of species encountered per sample plot is 47 (Table 5).

3.1.2. *Alloteropsis semialata* variant

Environmental data. This variant represents rocky grasslands on shallow clay soils occurring on relatively steep midslopes of hills. Rock cover of the surface is 35%, with rocks averaging 350 mm in diameter (Table 5).

Diagnostic and dominant/prominent taxa. Berkheya onopordifolia, Helichrysum albilanatum, H. nudifolium and the succulent *Kalanchoe rotundifolia*, are the diagnostic forbs, with *Alloteropsis semialata* and *Sporobolus pectinatus* the diagnostic grasses species (species group E; Table 3a). Dominant dwarf shrubs are *Clutia pulchella* and *Rhus discolor*.

Floristic diversity. The community shares a floristic identity within various species groups (Table 3a). Five SCPE endemics, and seven near-endemics and seven Red Data List taxa are found in this variant (Table 4). It has 17 taxa of conservation value, the highest number for this paper, with only one taxon restricted to it. The average number of species recorded per sample plot is 51 (richest plant diversity of all the study area's grassland communities), with a total number of 130 plant taxa (seven relevés) (Table 5).

3.2 *Brachiario serratae–Melhanietum randii argyrolobietosum transvaalense* sub-ass. nova hoc loco

Nomenclatural type: relevé 8 (holotypus)

Environmental data. This is relatively tall rocky grassland of midslopes and crests of undulating norite hills. The sub-association occurs on soils of the Milkwood and Steendal forms. It lies on relatively steep sloped areas (3–15°). Rock cover of the surface is between 25–75%, with rock diameter between 100–950 mm (Table 5).

Diagnostic and dominant/prominent taxa. Diagnostic species for this vegetation type is *Berkheya seminivea* and *Drimiopsis atropurpurea*. This sub-association is characterised by group G (Table 3a). Prominent taxa that occur in this vegetation unit are the forbs *Acalypha punctata*, *Argyrolobium transvaalense*, *Barleria ovata*, *Pachycarpus transvaalensis*, *Rhynchosia spectabilis*, *Tephrosia purpurea* and *Vernonia natalensis*. Important grasses for this vegetation type are *Brachiaria serrata*, *Diheteropogon amplectens*, *Setaria sphacelata* and *Themeda triandra*. Prominent woody species include the geoxylic suffrutices *Elephantorrhiza elephantina* and *Rhus discolor*.

Notes on floristic diversity. The community exhibits a strong floristic affinity with all the grasslands of the study area (Table 3a). The average number of species encountered per sample plot in this sub-association is 49, with the total number of plant species being a minimum of 119 taxa (nine relevés) (Table 5). No plant taxa of conservation value are restricted to it (Table 4).

3.2.1 *Koeleria capensis* variant

Environmental data. This variant of relatively tall rocky mountain grassland on east-west aspects of steep midslopes and crests occurs on shallow clay soils. It is covered by approximately 30% rock, with a relatively large rock diameter (on average 650 mm) (Table 5).

Diagnostic and dominant/prominent taxa. No diagnostic species occur in this variant. Character species include the prominent forbs *Crabbea hirsuta* and *Ipomoea obscura*, and prominent grasses are *Eulalia villosa* and *Koeleria capensis* (species group G; Table 3a). Other dominant plants include the geoxylic suffrutex *Rhus discolor* and the small tree *Euclea crispa*. Grass cover is dense and species rich.

Floristic diversity. A strong floristic similarity is shared with plant community 3.1.1, probably due to similarity in rock size and cover (species group H; Table 3a & Table 5). Of the 14 taxa of conservation value in this variant, five are SCPE endemics, six near-endemics and five Red Data List taxa (Table 4). The average number of species encountered per sample plot is 48, with a total of 119 plant species (6 relevés), the second richest plant diversity in the study area's grasslands (Table 5).

3.2.2. *Berkheya seminivea* Variant

Environmental data. This variant represents rocky grassland communities on shallow clays of moderate midslopes and crests that are situated on east-west aspects (Table 5). Average rock size is 200 mm and cover 40% of the soil surface (Table 5).

Diagnostic and dominant/prominent taxa. There are no diagnostic species, but characteristic species for this variant include the forbs *Berkheya seminivea, Drimiopsis atropurpurea, Helichrysum cephaloideum* and *Thesium magalismontanum* the most frequent (species group G; Table 3a). Other important taxa are *Andropogon schirensis, Argyrolobium transvaalense, Eragrostis chloromelas* and *Rhynchosia spectabilis*.

Floristic diversity. This variant is floristically typical of its association, but is characterised by the absence of the sister variant's diagnostic species (species group G & H; Table 3a). Of its 13 taxa of conservation value, five are SCPE endemics, four near-endemics and six Red Data List taxa (Table 4). The average number of species encountered per sample plot is 50, with the total being 95 taxa (three relevés) (Table 5).

3.3 *Brachiario serratae- Melhanietum randii gnidietosum capitatae* sub-ass. nova hoc loco
Nomenclatural type: relevé 86 (holotypus)

Environmental data. In the Roossenekal Subcentre this sub-association represents rocky grassland communities on black clay soils. The habitat is found on footslopes and midslopes of undulating norite hills. The gentle slopes vary from 5–9°, with an east-west aspect the norm. Soils characteristic of these slopes is the Milkwood form. Rock cover percentage vary from 35–40% and rock size from 400–750 mm in diameter.

Diagnostic and dominant/prominent taxa. Species group J contains the characteristic species for this sub-association, with prominent forbs such *Becium obovatum*, *Convolvulus sagittatus*, *Gerbera ambigua* and *Vernonia galpinii* (Table 3a). The forbs *Senecio microglossus* and *S. latifolius*, and the grasses *Themeda triandra* and *Tristachya leucothrix* are the most dominant in this sub-association. Other important taxa are the woody species *Elephantorrhiza elephantina* and *Euclea crispa*, succulents *Aloe castanea* and *A. greatheadii*, and grass species such as *Eragrostis superba*, *Setaria sphacelata*, *Sorghum bicolor* and *Tristachya rehmannii*.

Notes on floristic diversity. A strong floristic affinity exists with certain plant communities of the association (species group J), but excludes species from plant communities 3.1.1 and 3.4 (Table 3a). The average number of species encountered per sample plot in this sub-association is 46, with the total number of plant species being 109 (six relevés) (Table 5). Although 16 taxa with conservation value occur in this sub-association (Table 4), namely six SCPE endemics, six near-endemics and six Red Data List taxa, no plant taxa with conservation value are restricted to it.

3.4 *Brachiario serratae–Melhanietum randii setarietosum nigrirostis* sub-ass. nova hoc loco

Nomenclatural type: relevé 64 (holotypus)

Environmental data. The sub-association is moist rocky mountain grassland on black turf soils. It lies on the lower part of gentle sloped footslopes (3–5°). It is found predominantly on soils of the Arcadia form. Approximately 15–30% of the soil surface is covered by rocks, with a relatively small average size of 100–250 mm in diameter (Table 5).

Diagnostic and dominant/prominent taxa. Diagnostic species are represented by species group L (Table 3a). Diagnostic forbs are *Lotononis adpressa* and *Scleria dieterlenii*, and the grass *Setaria nigrirostis*. No tree species are diagnostic, but *Protea caffra* is extremely prominent in this sub-association. Other important forbs are *Bulbostylis contexta*, *Lotononis macrosepala* and *Pegolettia lanceolata*. *Berkheya insignis*, *Hermannia antonii*, *Hypoxis rigidula*, *Melhania randii*, *Senecio microglossus* and *Thesium gracilentum* are prominent forbs. Prominent grasses of the sub-association are *Elionurus muticus* and *Eragrostis nindensis*. Grasses found frequently are *Brachiaria serrata*, *Diheteropogon amplectens*, *Themeda triandra*, *Trachypogon spicatus* and *Tristachya leucothrix*.

Notes on floristic diversity. The sub-association shows its strong floristic affinity within association 3 in species groups C and M (Table 3a). More detailed future studies could suggest its upgrading to the level of association. The average number of species encountered per sample plot in this sub-association is 44, with 77 plant species the total number (four relevés) (Table 5). Thirteen taxa with conservation value occur in this sub-association (Table 4), namely five SCPE endemics, five SCPE near-endemics and five Red Data List taxa. No plant taxa with conservation value are restricted to it.

4. *Elionuro muticusae–Trachypogonetum spicati* ass. nova hoc loco

Nomenclatural type: relevé 112 (holotypus)

Environmental data. This rocky mountain grassland on deep black turf soils (500–750 mm) lies on moderate sloped lower footslopes and valley bottoms (5–15°) of the SCPE. It is found predominantly on vertic Arcadia and Steendal soil forms. Approximately 10–40% of the soil surface is covered by rocks, with an average size of 100–150 mm in diameter (Table 5).

Diagnostic and dominant/prominent taxa. Diagnostic species are presented in species groups N (Table 3a). The diagnostic species for this association are characterised by the small trees *Rhamnus prinoides* and *Rhus rogersii*, the grasses *Brachiaria eruciformis* and *Setaria incrassata*, and the forbs *Indigofera evansiana*, *Kohautia caespitose* and *Striga elegans*. Forbs are abundant in the vegetation unit and prominent species include *Albuca setosa*, *Berkheya onopordifolia*, *Felicia muricata*, *Helichrysum albilanatum*, *H. nudifolium*, *Justicia anagalloides*, *Kalanchoe rotundifolia* and *Rubia horrida*. Prominent grasses of the association are *Alloteropsis semialata* and *Sporobolus pectinatus*, and dominant grasses such as *Brachiaria serrata*, *Eragrostis chloromelas*, *Heteropogon contortus* and *Panicum natalense*.

Notes on floristic diversity. The average number of species encountered per sample plot in this association is 44, with the total number of plant species being a minimum of 84 taxa (12 relevés) (Table 5). There are 12 plant taxa of conservation value in the association (Table 4), of which two are restricted to it, including *Rhus rogersii*, a shrub assessed as Insufficiently Known in the Red Data List for Swaziland.

4.1 *Elionuro muticusae–Trachypogonetum spicati bewsietosum biflorae* sub-ass. nova hoc loco

Nomenclatural type: relevé 42 (holotypus)

Environmental data. The vegetation is moist, cool mountain grassland on turf soils. It lies on gentle sloped footslopes (3–5°), restricted to deep Steendal soils. Approximately 20–

25% of the soil surface is covered by rocks, with an average diameter of 50–150 mm (Table 4).

Diagnostic and dominant/prominent taxa. Diagnostic species are represented by species group O (Table 3a). Only one woody species, the shrubby *Rhus tumulicola* var. *meeuseana*, is diagnostic of the sub-association, with *Acacia karroo* being a dominant and extremely common tree. *Argyrolobium amplexicaule*, *Conyza podocephala*, *Helichrysum* spp., *Rhynchosia albissima* and *Senecio* spp. are the diagnostic forbs. *Bewsia biflora* is the only diagnostic grass. Other prominent forbs include *Pearsonia grandifolia*, *Senecio microglossus* and *Striga elegans*. Dominant grasses include *Brachiaria eruciformis*, *Brachiaria serrata*, *Diheteropogon amplectens*, *Elionurus muticus* and *Themeda triandra*.

Notes on floristic diversity. A floristic link with plant community 4.2 in species group N, indicates the relationship between these two sub-associations on turf (Table 3a), although the environmental data differs to a great extend. The average number of species encountered per sample plot is 46. The total number for this sub-association being 84 (four relevés) (Table 5). One plant taxon with conservation value, the near-endemic *Rhus tumulicola* var. *meeuseana*, is restricted to it. Ten taxa with conservation value occur in this sub-association and comprise five SCPE endemics, three near-endemics and two Red Data List taxa (Table 4)

4.2 *Elionuro muticusae–Trachypogonetum spicati acacietosum tortilis* sub-ass. nova hoc loco

Nomenclatural type: relevé 78 (holotypus)

Environmental data. In the Roossenekal Subcentre this sub-association represents wooded grassland communities on black turf soils. These units occur in valley bottoms between undulating norite hills. The gentle slope varies from 1–3° and east or west aspects are predominant. Soil characteristic of these slopes is the Arcadia form. Rock cover percentage vary from 5–10% and average rock diameter is relatively small from 50–100 mm (Table 5).

Diagnostic and dominant/prominent taxa. Species group P contains the diagnostic species for this association (Table 3a). Two trees are diagnostic for the association, namely *Acacia tortilis* and *Dichrostachys cinerea*. These taxa are often dominant in the *Panico maximi–Acacietea tortilis* class (Winterbach *et al.* 2000), a class representing microphyllus savanna in the central Bushveld of South Africa. Diagnostic grasses for the sub-association are *Digitaria sanguinalis*, *Panicum deustum*, *P. maximum* and *Sporobolus fimbriatus*. The association is dominated by forbs such as *Chrysanthemoides monilifera*, *Indigastrum burkeanum*, *Jasminum quinatum* and *Kyphocarpa angustifolia*. Other prominent taxa include the woody species *Rhamnus prinoides* and *Acacia karroo*, the herbaceous species *Asparagus suaveolens*, *Berkheya insignis*, *Gnidia caffra* and *Senecio microglossus*, and the grasses *Cymbopogon validus*, *Diheteropogon amplectens*, *Elionurus muticus*, *Hyparrhenia filipendula*, *Loudetia simplex*, *Setaria sphacelata* and *Themeda triandra*.

Notes on floristic diversity. A floristic link exists with the more herbaceous plant community 4.1, in species group N (Table 3a), but a difference in vegetation structure is apparent. The average number of species encountered per sample plot is 41 (Table 5). The total number of plant species for this sub-association is 65 (four relevés). No plant taxa with conservation value are restricted to the community, although four SCPE endemics, three SCPE near-endemics and two Red Data List taxa were recorded.

5. *Jamesbrittenio macranthae–Loudetietum simplicis* ass. nova hoc loco
Nomenclatural type: relevé 47 (holotypus)

Environmental data. The vegetation is wooded grassland. It occurs on red clay and white loam soils of predominantly the Mispah form. It lies on moderate footslopes of 5–9° on all aspects of undulating hills. Approximately 20–70% of the soil surface is covered by large rocks, with an average size of 100–400 mm in diameter (Table 5).

Diagnostic and dominant/prominent taxa. Character species are represented by species group S (Table 3a). Herbs are diagnostic of this community, namely *Helichrysum uninervium*, *Jamesbrittenia macrantha*, *Lotononis wilmsii*, *Polygala hottentotta* and *Rhynchosia komatiensis*. *Elephantorrhiza praetermissa* is the characteristic woody species and *Aristida adscensionis* and *Melinis repens* the characteristic grasses. Prominent forbs are *Dicoma anomala, Gnidia caffra, Melhania prostrata* and *Thesium multiramulosum*. Grasses of importance include *Aristida congesta, Diheteropogon amplectens, Elionurus muticus, Eragrostis nindensis, Loudetia simplex, Themeda triandra* and *Tristachya leucothrix*. *Protea caffra* and *Vitex obovata* subsp. *wilmsii* are prominent trees and *Rhus wilmsii* a prominent geoxylic suffrutex of the association.

Notes on floristic diversity. The average number of species encountered per sample plot is 36, with the total number of plant species being a minimum of 72 taxa (nine relevés) (Table 5). There are 16 taxa of conservation value occurring in the association (Table 4). The association has the highest number of taxa with conservation status restricted to it (seven), and include plant species such as the near-endemics *Helichrysum uninervium* and *Lotononis wilmsii*, and the endemic and Red Data listed *Jamesbrittenia macrantha*.

5.1 *Jamesbrittenio macranthae–Loudetietum simplicis combretetosum hereroense* sub-ass. nova hoc loco
Nomenclatural type: relevé 47 (holotypus)

Environmental data. The vegetation is a wooded grassland of rocky footslopes with clay soils. It lies on moderate slopes of 7–9° on north-south aspects of rocky ridges of magnetite. Soils are predominantly the Mispah form. Approximately 60–70% of the soil surface is covered by large rocks, with an average diameter of 100–400 mm (Table 5).

Diagnostic and dominant/prominent taxa. The diagnostic species are represented by species group T (Table 3a), and include one tree species, *Combretum hereroense*. The forbs *Aneilema longirrhizum, Chamaecrista comosa, Hemizygia petrensis, Ledebouria marginata, Lotononis calycina, Phyllanthus incurvus* and *Triumfetta sonderi* are diagnostic. The most important dominant grasses include *Loudetia simplex, Themeda triandra, Tristachya leucothrix* and *T. rehmannii*. Other dominant taxa include *Protea caffra, Rhus wilmsii* and *Senecio microglossus*.

Notes on floristic diversity. The sub-association shows a floristic affinity with the grasslands of the Roossenekal Subcentre in species groups V and W (Table 3a). A specific link with the grasslands of the study area, which includes its sister sub-association, is indicated in species group X. The average number of species encountered per sample plot is 39, with the total number for this sub-association being 70 (four relevés) (Table 5). Six SCPE endemics, six near-endemics and three Red Data List taxa are found in this sub-association (Table 4). Of its 12 taxa of conservation value, only the near-endemic *Aneilema longirrhizum* is restricted to it.

5.2 *Jamesbrittenio macranthae–Loudetietum simplicis eucleetosum linearis* sub-ass. nova hoc loco

Nomenclatural type: relevé 106 (holotypus)

Environmental data. This association represents wooded rocky grassland on whitish loam soils. It is restricted to exposed norite surfaces. It lies on moderately sloped footslopes of 5–7° on all aspects. Soils are predominantly the Mispah form. Approximately 20–70% of the soil surface is covered by large rocks with an average diameter of 100–200 mm (Table 5).

Diagnostic and dominant/prominent taxa. Species group U (Table 3a) represents the diagnostic species of the sub-association. The diagnostic grass species of the sub-association is *Andropogon chinensis*. Six forbs are diagnostic, namely *Indigofera tristoides, Ipomoea bathycolpos* var. *sinuatodentata, Jamesbrittenia burkeana, Phyllanthus glaucophyllus, Polygala* sp. nov. (*Siebert 449*) and *Seddera capensis*. *Euclea linearis* is the diagnostic woody species of the sub-association. Dominant plants in the community are the forbs *Dicoma anomala* and *Helichrysum uninervium*, and grasses *Aristida adscensionis, Diheteropogon amplectens* and *Elionurus muticus*. *Protea caffra*, *Rhus wilmsii* and *Vitex obovata* subsp. *wilmsii* are dominant woody species.

Notes on floristic diversity. A slight floristic affinity exists between this sub-association and plant communities 4.2 and 5.1 in species group V (Table 3a). The average number of species encountered per sample plot is 33, with the total number for this sub-association being 72 (five relevés) (Table 5). It is one of the syntaxa with the highest numbers of SCPE endemics and SCPE near-endemics. It also has three Red Data List taxa (Table 4). Of its 15 taxa of conservation value, four taxa, namely the SCPE near-endemics *Rhus keetii* and *Euclea linearis* (form), and the SCPE endemics *Ipomoea bathycolpos* var. *sinuatodentata* and *Polygala* sp. nov. (*Siebert 449*), are restricted to it. This number is the second highest for any community in the Roossenekal area.

II. *Miscanthus junceus–Schoenoplectus corymbosus* community (Bloem 1988)

6. *Fuireno pubescentis–Schoenetum nigricantis* ass. nova hoc loco

Nomenclatural type: relevé 73 (holotypus)

Environmental data. Within the Roossenekal and Leolo Subcentres, this association represents hygrophilous vegetation of mountain streams and seepage areas. The association occurs on wet sites where rocks of approximately 150 mm diameter cover approximately 25% of the soil surface. These areas have gentle slopes (3°) and the soils are typically clay on solid rock, with a sandy alluvial layer on the surface.

Diagnostic and dominant/prominent taxa. Species group AA (Table 3b) contains the diagnostic species. Dense stands of the diagnostic sedge *Schoenus nigricans* and the diagnostic grass *Hyparrhenia tamba* dominate the vegetation. Other diagnostic forbs are *Chironia purpurascens*, *Equisetum ramosissimum* and *Hypoxis argentea*. Sedges such as *Fuirena pubescens* and *Schoenoplectus corymbosus* are also prominent, while *Andropogon eucomis*, *Cymbopogon validus*, *Hyparrhenia filipendula* and *Imperata cylindrica* are prominent grasses. *Acacia karroo* and *Rhus leptodictya* are the woody species that may occur in the association.

Notes on floristic diversity. A strong floristic affinity with the wetland community 7 is indicated in species group AI and some relationships exist with the grasslands (species group Y) (Table 3b). The azonal wetland vegetation is not as rich in plant diversity as the grasslands. The average number of species encountered per sample plot is only 27, with the total number of plant species being a minimum of 52 taxa (11 relevés) (Table 5). There are, however, four taxa of conservation value that occur in this association (Table 4), and two taxa with conservation status restricted to it, namely the Red Data listed orchid *Disa rhodantha* (Insufficiently Known), and the near-endemic shrub, *Nuxia gracilis*.

6.1 *Fuireno pubescentis–Schoenetum nigricantis triraphietosum andropogonoidis* sub-ass. nova hoc loco
Nomenclatural type: relevé 73 (holotypus)

Environmental data. This sub-association represents sparsely wooded moist herbland and grassland along mountain streams in rocky areas lying on gentle to moderate midslopes (5–7°). The average rock size varies between 350–750 mm in diameter and covers 35–45% of the soil surface.

Diagnostic and dominant/prominent taxa. Species group AB (Table 3b) contains the diagnostic species for this sub-association, which include the woody species *Acacia karroo*, *Nuxia gracilis* and *Rhus leptodictya*. Diagnostic forbs are the fern *Adiantum capillus-veneris*, and the sedges *Coleochloa setifera*, *Dittrichia graveolens* and *Juncus punctorius*. *Triraphis andropogonoides* is a diagnostic grass. Prominent forbs are the sedges *Fuirena pubescens*, *Schoenoplectus corymbosus* and *Schoenus nigricans*. *Andropogon eucomis*, *Aristida bipartita* and *Cymbopogon validus* are the most dominant grasses.

Notes on floristic diversity. A notable relationship exists with plant community 6.2 in species group AC (Table 3b). The average number of species encountered per sample plot is 28, with the total number for this sub-association being 51 (four relevés) (Table 5). The association has three taxa of conservation value, comprising one SCPE endemic, one SCPE near-endemic and two Red Data List taxa (Table 4).

6.2 *Fuireno pubescentis–Schoenetum nigricantis pycnostachetosum reticulatae* sub-ass. nova hoc loco

Nomenclatural type: relevé 23 (holotypus)

Environmental data. This sub-association of dense moist reed-beds along permanent mountain streams occur on gentle midslopes and footslopes of 1–3°. Approximately 5–15% of the soil surface is covered by small rocks, with an average size of 50–150 mm in diameter (Table 5).

Diagnostic and dominant/prominent taxa. Characteristic species are represented by species group AC and AG (Table 3b). No woody or grass species are diagnostic of this community. Characteristic forb species include the sedges *Cyperus sexangularis* and *Kyllinga erecta*, and the forb *Berula erecta*. Dominant grass species are *Miscanthus junceus* and *Phragmites australis*, the forbs *Pycnostachys reticulata* and *Senecio gerrardii*, and the sedges *Fuirena pubescens*, *Schoenoplectus corymbosus* and *Schoenus nigricans*. *Andropogon eucomis*, *Cymbopogon validus* and *Hyparrhenia filipendula* are prominent grasses.

Notes on floristic diversity. A floristic affinity exists with the adjacent grassland plant community 3.4 (species group L) (Table 3a), and with the wetland plant community 7 (species group AG) (Table 3b). The average number of species encountered per sample plot is 27, with the total number for this sub-association being 42 (three relevés) (Table 5). Only two taxa of conservation value, namely Red Data List taxa, are found in this sub-association (Table 4).

6.3 *Fuireno pubescentis–Schoenetum nigricantis bulbostylietosum hispidulae* sub-ass. nova hoc loco

Nomenclatural type: relevé 34 (holotypus)

Environmental data. This sub-association of sparsely wooded herbland and grassland occur in moist valley bottoms or on mountain crests, usually in seepage areas along streams. It is associated with gentle slopes of 1–3°. Approximately 10–20% of the soil surface is covered by scattered stones of an average diameter of 50–100 mm (Table 5).

Diagnostic and dominant/prominent taxa. Diagnostic species are presented in species group AD (Table 3b), including the forbs, *Alepidea amatymbica* and *Bulbostylis hispidula*, and the grasses, *Bothriochloa insculpta* and *Microchloa caffra*. The woody *Rhus leptodictya* is a prominent species. Predominant forbs include *Artemisia afra* and *Cliffortia nitidula*, and the sedges *Mariscus congestus* and *Schoenus nigricans*. *Andropogon eucomis*, *Cymbopogon validus*, *Hyparrhenia filipendula*, *Ischaemum fasciculatum* and *Miscanthus junceus* are the dominant grasses.

Notes on floristic diversity. A strong floristic affinity exists with the grassland community 4.1 (species group O), but a distinct affinity also exists with the wetland plant community 7 in species group AH (Table 3b). In this sub-association the sedges are less prominent and should be seen as a moist grassland-wetland ecotone. The average number of species encountered per sample plot is 25, with 52 taxa the total number for this sub-association (four relevés) (Table 5). The sub-association has four taxa of conservation value that comprises one SCPE endemic, one SCPE near-endemic and three Red Data List taxa (Table 4).

7. *Andropogono eucomis–Fimbristyletum ferrugineae* ass. nova hoc loco
Nomenclatural type: relevé 192 (holotypus)

Environmental data. This association represents wooded herbland and grassland along larger rivers in valleys, such as the Steelpoort River. The vegetation covers the zone directly adjacent to streams, on permanently moist soils. The area has a gentle slope of 1–3° and approximately 20–30% of the soil surface is covered by stones with an average diameter of 150–200 mm (Table 5).

Diagnostic and dominant/prominent taxa. Diagnostic species are represented by species group AF (Table 3b). The vegetation unit is dominated by diagnostic forbs, which include the prominent weedy aliens *Conyza bonariensis* and *Flaveria bidentis*, the sedges

Cyperus marginatus, *Mariscus rehmannianus*, *M. sumatrensis*, and the forb *Polygonum meisnerianum*. The presence of weeds is the result of disturbance caused by annual floods, often supplemented by trampling by domestic animals, notably cattle and goats. *Salix mucronata* is the diagnostic woody species and *Eragrostis gummiflua* the diagnostic grass. Hygrophilous grasses and sedges such as *Miscanthus junceus* and *Schoenoplectus corymbosus* are dominant. *Acacia karroo* and *Rhus leptodictya* are common small trees of the association. *Andropogon eucomis, Cymbopogon validus, Hemarthria altissima, Hyparrhenia hirta* and *Imperata cylindrica* are dominant grasses of the association.

Notes on floristic diversity. A strong floristic affinity exist with the wetland plant community 6 (species group AI) and a weaker affinity with the grasslands (species group Y) (Table 3b). The average number of species encountered per sample plot is 27, with the total number of plant species being 52 taxa (four relevés) (Table 5). This association has the lowest number of taxa with a conservation status (Table 4) and include the Red Data List taxon *Eucomis autumnalis* subsp. *clavata*, which is classified as Rare in the Free State and Vulnerable in KwaZulu-Natal, and the SCPE endemic form of *Acacia karroo*.

8. *Limosello maioris–Ranunculetum meyeri* ass. nova hoc loco
Nomenclatural type: relevé 410 (holotypus)

Environmental data. This rare association represents dense herbland of moist seepage areas, only recorded on the summit plateaus of the Leolo Mountains. It is usually associated with black clay soils. A short, dense cover of non-grassy forbs dominates the vegetation. It lies on gentle slopes of 1–3° and approximately 10% of the soil surface is covered by small stones with an average diameter of 50 mm (Table 5).

Diagnostic and dominant/prominent taxa. Diagnostic species are represented by species group AJ (Table 3b). The most predominant diagnostic taxa of the association are the small forbs *Anagallis huttonii*, *Limosella maior*, *Ranunculus meyeri* and *R. multifidus*. *Sporobolus centrifugus* is the diagnostic grass. *Schoenoplectus corymbosus* is a dominant sedge in the association.

Notes on floristic diversity. A very slight floristic affinity exists with the other wetland plant communities of the area (species group AK) and also with the grasslands of the study area (species group Y) (Table 3b). The average number of species encountered per sample plot is 20, with the total number of plant species being 24 taxa (two relevés) (Table 5). Together with plant community 7, this association has the lowest number of taxa with a conservation status, namely two. These include the Red Data List species *Eucomis autumnalis* subsp. *clavata*, and the undescribed SCPE endemic *Tulbaghia* sp. nov. (*Siebert 1304*), which may comprise a new genus of the Alliaceae.

5.4 Vegetation key

A dichotomous vegetation key is presented to facilitate identification of the various syntaxa found in the study area (Table 6). The definitions are broad indications of the syntaxa and should be seen as a guideline, rather than precise descriptions. A diagnostic characteristic of the vegetation or habitat is given, followed by the most diagnostic and conspicuous species of a particular syntaxon. The first species listed is restricted to the specific syntaxon only, and the second is dominant in the syntaxon, but may occur in other syntaxa. Where one species is given, no species were restricted to the particular syntaxon only.

5.5 Ordination

A scatter diagram displaying the distribution of the relevés along the second and third ordination axes is presented for both grassland and wetlands in Figure 8a (eigen values: axis 2 = 0.471; axis 3 = 0.325) and Figure 8b (eigen values: axis 2 = 0.458; axis 3 = 0.256) respectively. Vegetation units are represented as clusters, their distribution on the scatter diagram corresponding with certain physical environmental conditions. The gradient described by the first axis in both instances, is related to drainage and hence, soil moisture. In the grasslands the communties with the highest available soil moisture are situated at the left of the diagram (Figure 8a), but communities of the wetlands with poor drainage on waterlogged soils are to the right (Figure 8b). In addition, communities of the grasslands on clay soils of steep slopes are situated to the left of the diagram and communities on gravel soils of steep slopes to the right (Figure 8a). The clay soils have the highest moisture availability, although the run-off is high. Grassland communities of turf soils on moderate slopes are positioned in the centre of the diagram, because these soils have a high soil moisture percentage, which is unavailable due to retention by the soil particles. The gradient shown by the second ordination axis for communities of wetlands is that of topographic position (Figure 8b). Here, the water systems of mountain slopes with a faster run-off are placed to the top of the scatter diagram. Perennial seepage systems of plateaus are centred in the middle of the diagram, and communities of permanent, slow flowing rivers are located at the bottom.

The gradient along the first axis of Figure 8a is also an indication of the species diversity in the grasslands, with the species diversity at the left of the diagram being higher than that of the communities at the right. This phenomenon can be attributed to the heterogeneous environment experienced by most *Brachiario serratae–Melhanietum randii* rocky grassland communities.

The gradients that have been identified correlate closely with each other and have a strong influence on the vegetation. The three most dominant and conspicuous taxa of each growth form (trees/shrubs/suffrutices, forbs/sedges and grasses) are given for each of the eight major vegetation types depicted in the scatter diagram (Table 7).

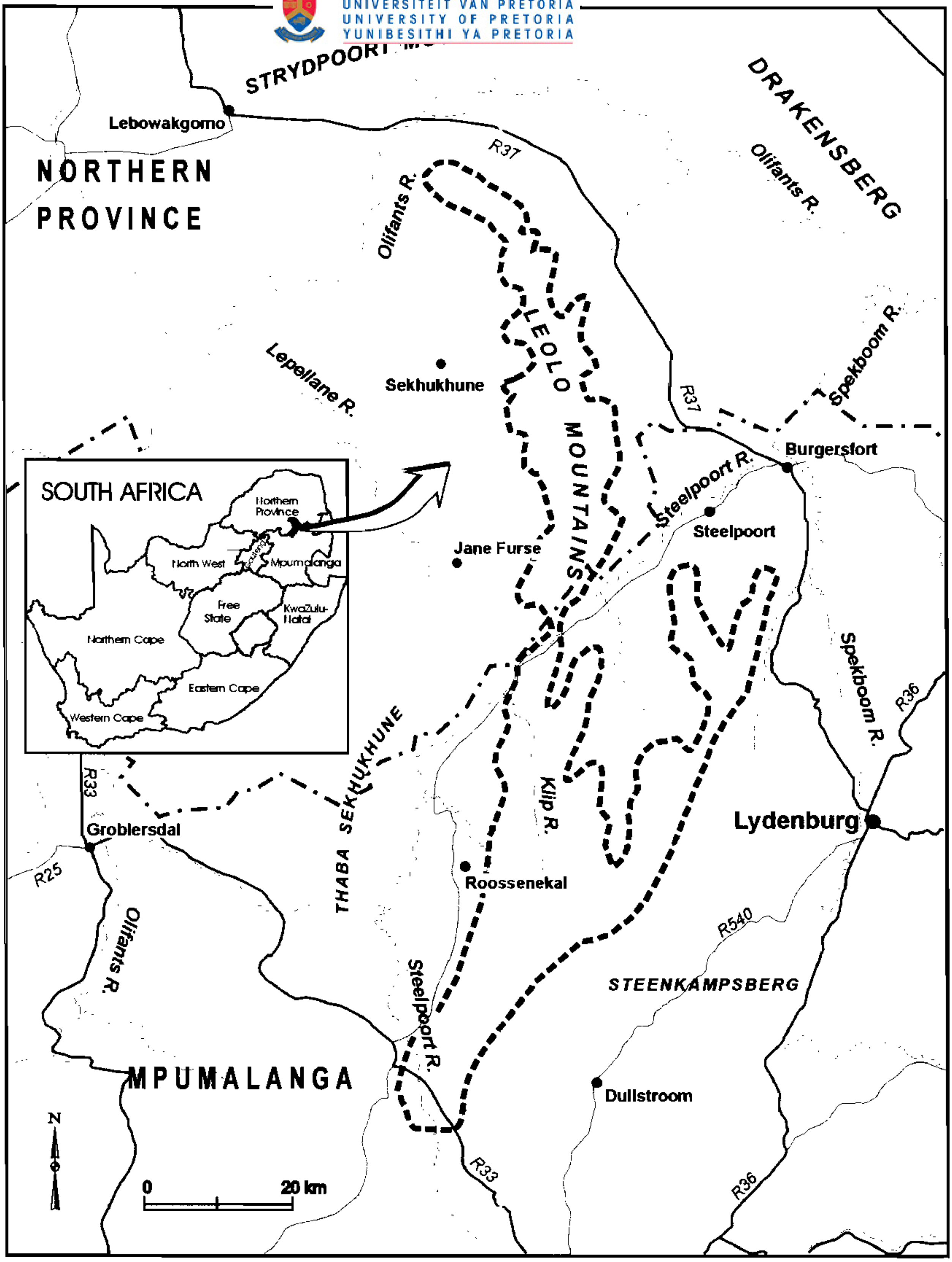

Figure 7 Location of the Grassland and Wetland Vegetation of the Sekhukhuneland Centre of Plant Endemism in the Northern Province and Mpumalanga, South Africa.

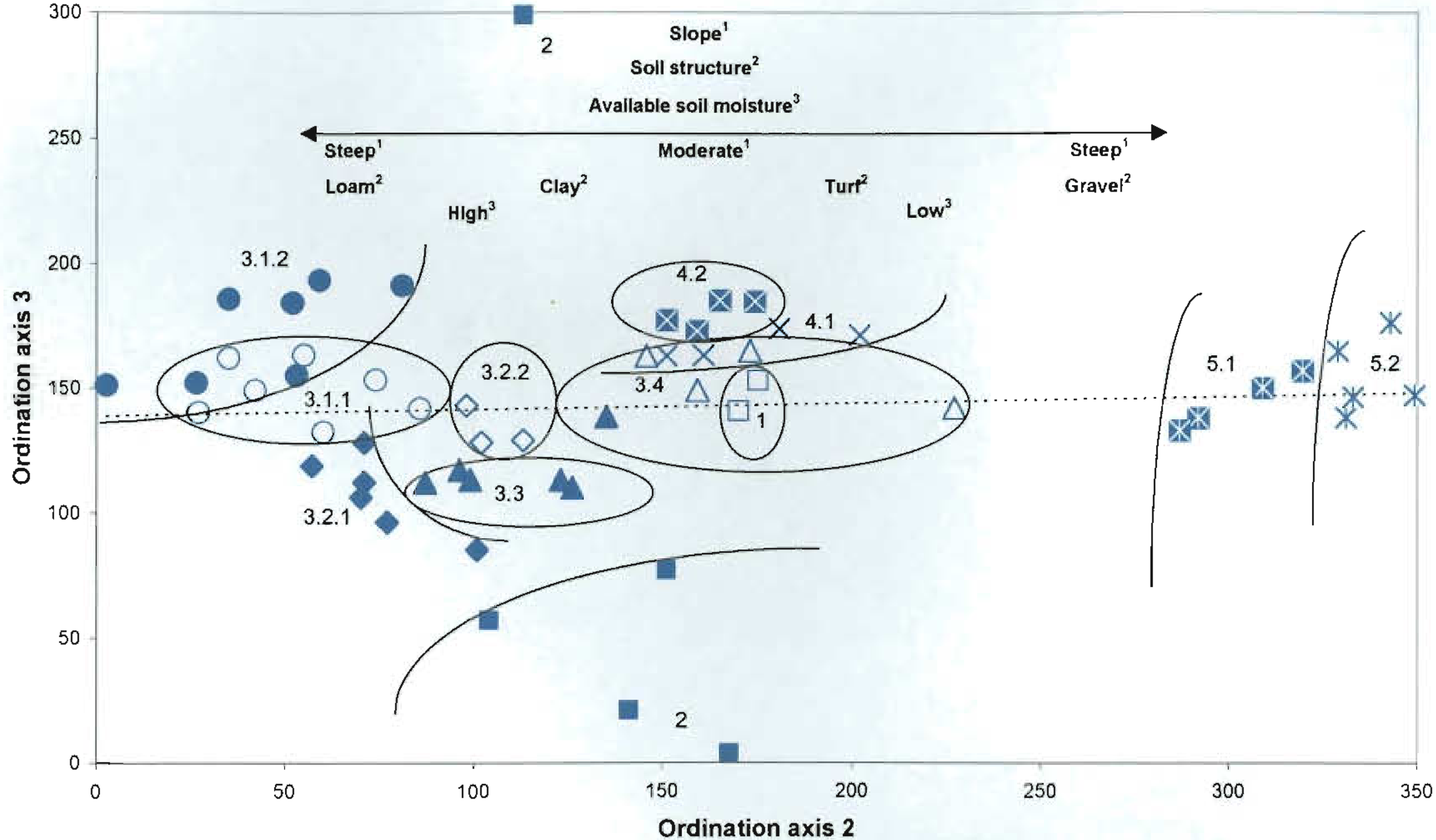

Figure 8a Relative positions of all the releves along the second and third axis of the ordination of the Grassland Vegetation of the Sekhukhuneland Centre of Plant Endemism. Numbers correspond with the plant communities in Table 3a.

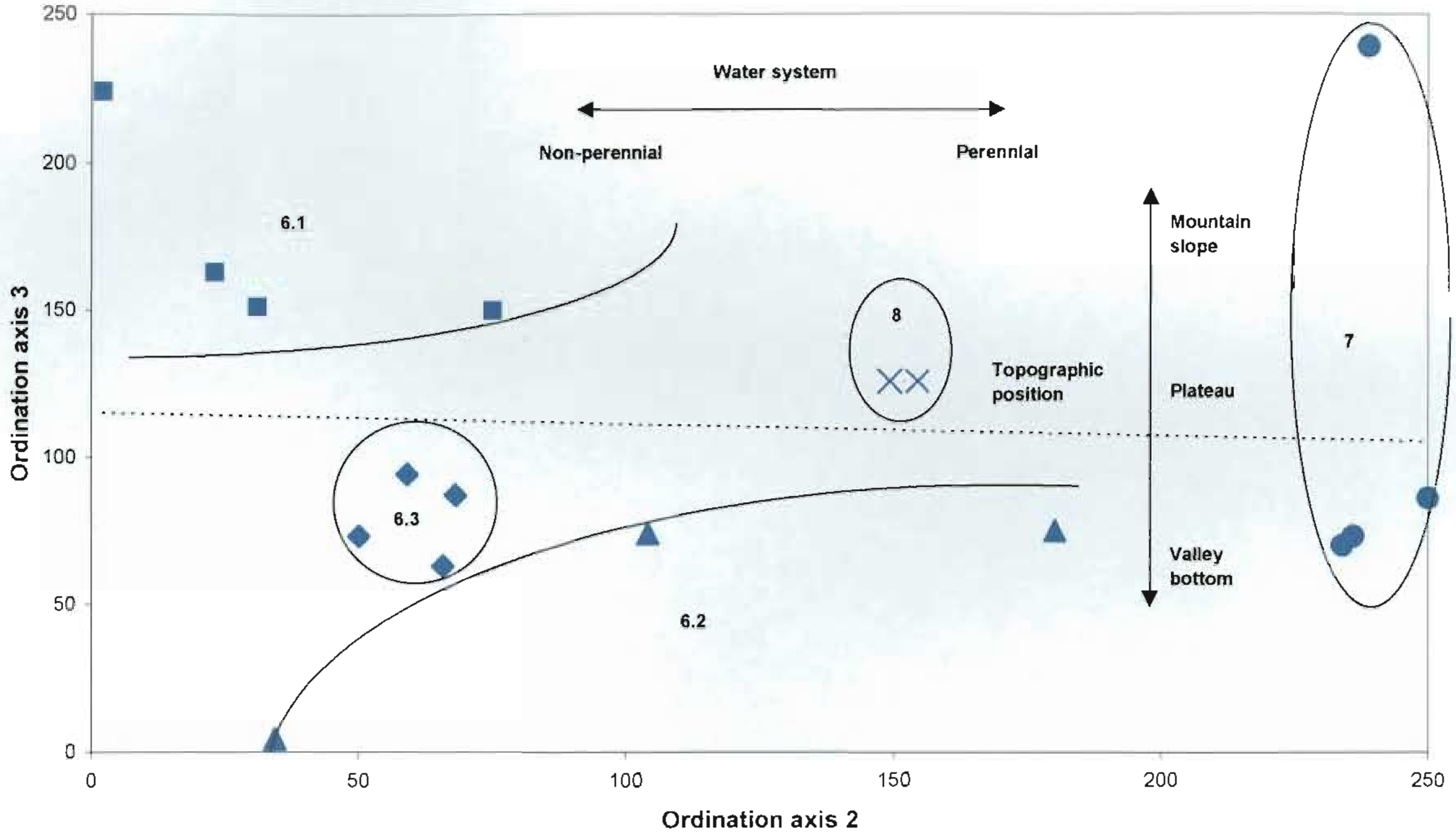

Figure 8b Relative positions of all the releves along the second and third axis of the ordination of the Wetland Vegetation of the Sekhukhuneland Centre of Plant Endemism. Numbers correspond with the plant communities in Table 3b.

Table 3a A phytosociological table of the Cool Moist Grasslands of the Sekhukhuneland Centre of Plant Endemism.

Relevé	408	409	2	3	92	100	312	25	26	31	94	276	277	314	52	53	316	318	321	319	323	8	10	28	89	101	109	56	63	90	6	9	13	14	21	68	57	61	95	64	42	48	104	111	77	78	110	112	33	43	44	47	37	49	65	106	289
Association	1		2					3	.						3	.						3	.					3	.		3	.					3	.			4				4	.			5				5	.			
Sub-association								1	.						1	.						2	.					2	.		3						4				1				2				1				2				
Variant								1							2							1						2																													
Species group A																																																									
Euryops brevipapposus	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Helichrysum splendidum	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lotononis foliosa	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Vernonia myriantha	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Xerophyta viscosa	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hirpicium bechuanense	+	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Manulea parviflora	+	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Buddleja saligna	R	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Jamesbrittenia silenoides	R	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Androcymbium melanthioides	R	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Geranium wakkerstroomianum	R	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species group B																																																									
Cymbopogon excavatus	.	.	+	+	.	A	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Zantedeschia pentlandii	.	.	+	+	R	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Crassula sarcocaulis	.	.	+	+	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Canthium suberosum	.	.	+	R	+	+	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Thesium burkei	.	.	R	R	R	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Halleria lucida	.	.	+	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Boophane disticha	.	.	R	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Apodytes dimidiata	.	.	R	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aloe pretoriensis	.	.	.	+	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Olinia emarginata	.	.	.	R	1	+	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aristida junciformis	.	.	.	R	+	+	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species group C																																																									
Vernonia oligocephala	.	R	.	.	.	.	.	1	.	+	.	+	.	+	.	1	+	+	+	.	R	+	R	+	1	+	.	R	+	.	R	.	+	1	+	+	+	1	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Melhania randii	.	.	.	.	R	R	.	+	+	1	1	.	1	1	.	.	+	.	1	.	R	1	.	+	.	R	+	.	R	1	R	.	R	+	.	1	+	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Clerodendrum triphyllum	.	.	.	R	.	.	R	+	+	.	1	+	.	+	+	R	1	.	1	+	+	+	+	1	+	1	.	+	+	+	+	1	+	1	R	.	+	R	R	R	.	.	.	.	.	.	.	.	.	R	.	R	R	.	.	R	.
Rhynchosia sordida	.	.	.	.	.	.	.	+	R	+	.		.	.	.	R	.	R	.	.	.	+	.	+	.	+	R	.	.	+		+	.	+	R	.		R	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dicoma zeyheri	.	.	.	.	.	.	.	R	.	+	.	+	+	R	R		.	+	+	.	1	.	+	.	+	+	R	.	R	+	.	.	+	.	R	+	.	+	+	+	.	.	R	.	.	.	R	.	.	.	.	.	.	.	.	.	.
Gnidia capitata	.	.	.	R	.	.	.	R	.	+	+	+	+	.	+	.	R	+	+	+	.	1	+	+	.		R	R		.	+	+	+	+	+	+	R	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Callilepis leptophylla	.	.	.	.	R	.	.	.	+	.	+	+	.	.	+	.	1	.	+	.	+	+	1	+			+	R	.	+	+	+	1	+	.	R	R	+	1	+	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Phyllanthus parvulus	.	.	.	.	.	.	.	.	R	+	.	+	.	R	R	+	.	+	+	.	+	R		R	R		R	R	R	.	R	+	.	R	.	.	.	R	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dierama mossii	.	.	.	.	.	.	.	.	R	R	.	.	.	.	R	.	.	.	R	.	+	.	.	R	.		.	.	+	.	.	R	.		.	R	R	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.
Hypoxis hemerocallidea	.	.	R	.	.	.	.	.	R	.	+		.	+	1	R	.	.	.	R	.	+	.	.	R		+	+	.	R	.	.	R	.	+	.	+	R	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.
Species group D																																																									
Berkheya densifolia	.	.	.	.	.	.	.	+	R	.	.	.	+	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cyanotis speciosa	.	.	.	.	.	.	.	+	R	.	+	+	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Digitaria eriantha	.	.	.	.	.	.	.	+	.	1	1	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Agapanthus inapertus	.	.	.	.	.	.	.	+	.	+	.	+	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Euphorbia clavarioides	.	.	.	.	.	.	.	+	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Indigofera hedyantha	.	.	.	.	.	.	.	R	R	.	+	.	+	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tephrosia longipes	.	.	.	.	.	.	.	R	.	+	+	R	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Monsonia attenuata	.	.	.	.	.	.	.	.	R	R	.	R	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Schistostephium heptalobum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	R	.	R	+	.	+	.	.	.	.	.	R	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Alloteropsis semialata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	1	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Helichrysum nudifolium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	R	R	.	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rhynchosia hirta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	R	R	.	+	R	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Clutia pulchella	R	R	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Albuca setosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	R	+	R	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Fadogia muricata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	+	.	+	R	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Kalanchoe rotundifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	R	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Berkheya onopordifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	R	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sporobolus pectinatus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	R	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Helichrysum albilanatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	+	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Helichrysum rugulosum	.	.	.	.	.	.	.	1	+	.	.	+	+	1	R	.	1	+	1	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pimpinella caffra	.	.	.	.	.	.	.	1	.	+	+		+	.	R	+	+	.	+	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Senecio coronatus	.	.	.	.	.	.	.	+	R	.	R	.	+	R	R	R	.	.	+	.	R	.	.	.	.	.	R	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tephrosia elongata	.	.	.	.	.	.	.	+	.	R	.	+	.	R	.	+	.	.	R	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Table 3a continued.

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	8	9	2	3	2	0	2	5	8	1	4	6	7	4	2	3	6	8	1	9	3	8	0	8	8	1	9	6	3	0	6	9	3	4	1	8	7	1	5	4	2	8	4	1	7	8	0	2	3	3	4	7	7	9	5	6	8
Association	1		2					3	.						3	.						3	.					3	.		3	.					3	.			4	.			4	.			5	.			6	.			
Sub-association								1	.						1	.						2	.					2	.		3						4				1				2				1				2				
Variant								1							2							1						2																													
Species group F cont.																																																									
Tristachya biseriata	.	.	.	.	.	.	+	R	.	.	+	.	+	+	.	+	.	+	+	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acalypha angustata	.	.	.	.	.	.	.	.	R	+	+	.	+	.	1	+	R	+	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.
Panicum natalense	.	.	.	.	.	.	.	.	R	+	.	1	.	+	+	1	+	1	.	R	R	.	.	.	R	.	.	R	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Leonotis ocymifolia	.	.	.	.	.	.	.	.	R	.	+	.	.	+	.	+	.	R	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Berkheya seminivea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	R	.	.	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Drimiopsis atropurpurea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	R	R	.	.	R	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Helichrysum cephaloideum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	R	.	+	+	+	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pachycarpus transvaalensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	R	.	.	+	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Thesium magalismontanum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	+	+	.	.	R	.	+	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Helichrysum pilosellum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	R	.	.	+	.	+	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pearsonia obovata	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	R	.	.	+	+	+	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Eulalia villosa	.	.	.	.	.	.	.	1	+	+	.	R	+	.	.	.	.	.	R	.	.	+	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ipomoea obscura	.	.	.	.	.	.	.	R	.	+	R	.	.	R	.	.	.	.	.	.	.	+	+	.	R	.	R	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Crabbea hirsuta	.	.	.	.	.	.	.	+	.	+	R	.	R	R	.	.	.	.	.	.	.	R	.	R	.	R	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.
Koeleria capensis	.	.	.	.	.	.	.	.	1	+	.	R	.	.	.	.	.	.	.	.	.	.	+	+	1	.	R	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Eragrostis chloromelas	.	.	.	.	.	.	.	1	.	1	A	R	.	.	1	1	1	1	+	R	.	.	1	R	.	+	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Thunbergia atriplicifolia	.	.	.	.	.	.	.	+	.	+	.	+	R	.	.	R	+	.	.	R	+	R	.	+	.	+	.	R	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Haplocarpha scaposa	.	.	.	.	.	.	.	R	+	.	.	R	.	.	.	+	.	R	+	.	+	R	.	+	.	.	+	R	R	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Helichrysum setosum	.	.	.	.	.	.	.	.	R	R	.	+	.	+	+	.	.	+	.	.	+	.	R	.	+	+	.	+	.	R	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Schistostephium crataegifolium	.	.	.	.	.	.	.	.	R	.	+	.	+	A	R	.	1	.	.	R	+	R	R	.	R	.	+	1	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Vernonia natalensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	+	.	1	+	.	1	+	.	R	1	+	.	+	R	.	R	R	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Argyrolobium transvaalense	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	R	.	1	1	.	+	+	.	R	.	+	1	A	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Vernonia galpinii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	R	+	R	.	.	+	+	R	.	R	.	+	R	+	.	.	+	R	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Becium obovatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	R	.	+	R	.	+	.	R	.	R	.	.	+	.	.	+	.	+	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Convolvulus sagittatus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	R	.	R	+	R	.	+	.	.	R	.	R	R	R	.	.	R	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Barleria ovata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	+	.	.	+	R	.	.	R	.	+	.	R	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gerbera ambigua	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	+	.	+	.	.	.	R	.	+	+	.	+	+	+	R	.	R	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ipomoea crassipes	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	+	R	.	+	.	+	R	.	R	+	+	.	R	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species group K																																																									
Aloe castanea	.	.	+	1	.	+	.	R	+	+	.	R	R	.	R	.	.	+	.	+	.	.	R	.	+	.	R	R	.	R	.	+	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Kedrostis foetidissima	.	.	+	+	.	R	.	R	.	.	R	+	.	.	.	R	.	+	.	.	.	+	R	.	+	.	.	.	+	.	.	.	R	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eragrostis racemosa	.	.	+	.	R	.	.	.	+	.	+	1	1	.	B	.	R	+	+	.	.	1	+	1	.	R	.	R	.	.	R	+	.	1	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ledebouria revoluta	.	.	R	+	.	R	+	+	+	+	.	R	.	+	.	R	R	.	.	+	R	.	+	R	.	.	R	.	R	R	R	R	+	+	+	.	.	.	.	R	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cyphostemma sp. A (AW 13389)	.	.	R	.	.	.	R	R	.	R	.	.	R	.	R	.	R	.	.	R	.	.	.	R	.	R	.	.	R	R	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Alepidea setifera	.	.	.	+	1	.	+	.	R	.	.	R	.	R	.	.	+	+	1	.	+	R	.	R	.	.	+	1	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tetraselago wilmsii	.	.	.	+	+	.	+	R	+	1	+	+	R	1	.	R	.	1	.	+	1	.	+	.	+	R	+	R	.	R	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pellaea calomelanos	.	.	.	.	R	.	R	R	+	R	.	.	R	.	.	+	.	+	R	.	R	+	+	.	+	+	.	.	R	.	.	+	+	+	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Setaria nigrirostris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pegolettia lanceolata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	R	.	R	.	.	+	+	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Scleria dieterlenii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	B	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bulbostylis contexta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.
Lotononis macrosepala	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	R	+	.	R	R	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.
Mentha longifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	+	.	+	.	+	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Lotononis adpressa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Pentanisia prunelloides	+	+	.	R	R	.	.	R	.	.	R	+	+	.	.	+	R	.	R	+	.	+	.	R	.	+	.	+	.	+	+	.	R	.	R	R	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Senecio latifolius	R	R	1	+	+	+	+	1	+	+	.	+	1	+	.	+	.	1	+	+	1	+	+	+	1	1	+	+	+	.	1	1	+	+	+	A	.	+	R	+	.	.	R	.	.	.	R	.	.	.	.	+	.	.	.	.	.
Polygala uncinata	+	.	R	.	.	R	.	+	.	R	R	.	R	.	+	.	.	+	+	.	R	R	+	.	+	+	.	+	.	.	+	R	.	.	R	.	+	1	.	+	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tephrosia purpurea	.	R	+	+	.	R	R	+	+	+	.	.	R	R	R	.	R	+	.	+	.	.	+	+	+	1	R	R	+	1	+	.	+	+	.	+	+	.	+	+	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.
Acalypha punctata	.	R	+	.	.	+	+	+	+	1	+	.	.	+	+	.	+	.	1	.	+	1	+	+	1	1	.	+	+	+	.	+	+	+	+	1	R	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.
Eragrostis pseudosclerantha	.	.	+	1	.	R	.	.	.	R	.	.	.	.	.	R	.	.	.	.	R	+	.	.	.	.	R	.	R	.	R	.	.	.	R	.	R	.	.	R	.	R	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Scilla natalensis	.	.	+	.	.	.	+	.	+	.	+	.	.	.	+	.	.	+	.	+	+	.	+	.	.	.	.	.	+	.	+	.	.	.	+	+	+	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Andropogon schirensis	.	.	.	R	R	.	1	1	R	1	+	1	.	1	.	1	1	1	1	.	1	+	1	.	+	.	R	.	1	+	.	R	R	1	+	.	.	R	+	.	.	R	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.

Table 3a continued.

Relevé	408	409	2	3	92	100	312	25	26	31	94	276	277	314	52	53	316	318	321	318	323	8	10	28	89	101	109	58	63	90	6	9	13	14	21	66	57	61	65	64	42	48	104	111	77	78	110	112	33	43	44	47	37	48	65	108	288
Association	1		2					3	.						3	.						3	.					3	.		3						3	.			4	.			4				5	.			5	.			
Sub-association								1	.						1	.						2	.					2	.		3						4				1				2				1				2				
Variant								1							2							1						2																													
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Brachiaria eruciformis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	R	.	.	.	R	.	R	.	+	.	.	+	+	.	+	+	.	+	+	.	.	.	.	.	.	.	.	.
Indigofera evansiana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	+	.	+	R	+	.	.	.	.	.	.	.	.	.	.	.
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Kohautia caespitosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	R	.	R	.	R	.	R	.	.	.	.	.	R	.	.	.	.
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Rhamnus prinoides	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	1	+	1	.	.	.	.	.	.	.	.	.	.
Setaria incrassata	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	R	+	+	.	.	.	.	.	.	.	.	.
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Bewsia biflora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	A	+	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Pearsonia grandifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	R	.	+	1	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Senecio erubescens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rhynchosia albissima	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.
Helichrysum harveyanum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	R	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Senecio venosus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	R	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
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Helichrysum oreophilum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	R	.	.	.	.	.	.	.	.	.	.	.	.	.
Argyrolobium amplexicaule	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Conyza podocephala	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Rhus tumulicola var. *meeuseana*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.
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Acacia tortilis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	1	.	.	.	.	.	.	.	.	.
Dichrostachys cinerea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.
Digitaria sanguinalis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	+	.	R	.	.	.	.	.	.	.	.	.
Jasminum quinatum	.	.	.	.	R	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	+	.	+	.	.	.	.	.	.	.	.	.
Kyphocarpa angustifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	+	.	R	.	.	.	.	.	.	.	.	.
Chrysanthemoides monilifera	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	+	R	.	.	.	.	.	.	.	.	.
Sporobolus fimbriatus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	R	.	.	.	.	.	.	.	.	.	.
Indigastrum burkeanum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	R	.	.	R	+	R	.	.	.	.	.	.	.	.	.
Panicum deustum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	R	+	.	.	.	.	.	.	.	.	.
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Pollichia campestris	.	.	.	.	.	.	.	.	.	.	R	.	.	.	+	.	R	.	+	+	.	.	.	+	+	.	R	R	.	+	R	.	.	R	.	+	+	R	+	R	.	+	R	+	.	R	R	R	.	.	.	.	.	.	.	.	.
Senecio sellus	.	.	.	.	.	.	.	.	.	.	.	.	.	R	+	.	.	+	R	.	R	.	+	.	R	+	.	.	+	.	.	+	+	.	R	.	R	.	R	.	+	.	1	.	.	R	.	.	.	.	.	.	.	.	.	.	.
Rhoicissus sp. (*SS 48*)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	R	+	+	+	.	1	+	R	.	+	+	1	1	.	+	+	+	1	+	+	.	R	.	+	R	.	+	.	.	.	R	.	.	.	.	.	.	.	.	.	.
Sorghum bicolor	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	+	.	.	.	+	.	.	+	.	.	R	.	.	+	+	+	+	.	.	.	.	R	+	.	R	.	R	1	.	+	.	.	.	.	.	.	.	.	.
Asparagus suaveolens	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	R	.	+	+	+	.	.	+	1	+	.	+	+	+	+	.	.	+	.	.	1	R	.	.	+	+	+	+	+	.	.	.	.	.	.	.	.	.
Senecio lygodes	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	+	.	R	.	.	R	.	R	.	+	.	.	.	.	R	+	.	R	.	.	+	+	.	.	+	.	+	.	.	.	.	.	.	.	.	.
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Setaria sphacelata	.	.	.	R	.	.	.	1	1	A	.	1	.	+	.	1	+	.	+	.	1	+	A	+	1	+	1	R	.	+	A	+	+	R	A	+	1	+	R	.	R	+	+	.	1	1	1	A	.	.	R	.	.	.	.	.	.
Thesium gracilentum	.	.	.	.	.	.	.	+	R	+	R	R	+	R	+	R	.	+	.	+	R	R	.	+	.	R	.	R	R	R	.	R	.	.	R	R	R	+	+	+	R	+	R	R	.	.	R	+	.	.	.	.	.	.	.	.	.
Sphenostylis angustifolia	.	.	.	.	.	R	.	+	R	+	.	+	.	R	.	R	+	.	+	+	.	R	+	R	.	.	R	R	+	.	R	.	R	+	.	R	.	R	.	R	+	.	.	R	.	.	.	R	.	.	.	.	.	.	.	.	.
Sebaea grandis	R	.	.	.	.	.	.	+	.	+	.	R	.	+	R	.	+	.	+	R	.	.	+	+	R	+	.	R	.	.	.	+	.	.	R	+	R	.	R	.	+	.	R	.	.	.	R	.	.	.	.	.	.	.	.	.	.
Rhynchosia spectabilis	.	.	.	.	R	R	.	+	.	+	.	R	R	.	+	+	.	R	+	+	+	R	.	R	1	1	1	1	1	R	1	.	1	R	+	R	.	.	R	R	.	R	+	+	+	+	+	.	.	.	.	.	.	.	.	.	.
Elephantorrhiza elephantina	.	.	R	.	.	.	.	R	1	+	+	.	+	.	+	.	R	.	1	.	R	1	.	+	.	.	+	.	+	+	+	+	+	R	+	.	R	+	+	+	.	R	.	+	.	R	.	.	.	.	.	.	.	R	.	.	.
Trachypogon spicatus	.	.	.	.	.	.	R	R	.	R	1	+	.	+	+	.	R	1	+	.	+	+	.	.	R	.	+	.	+	.	.	+	+	.	R	+	A	+	.	R	+	.	1	+	.	+	1	A	.	.	.	.	.	.	.	.	.
Cephalaria zeyheriana	.	.	.	.	.	.	.	.	+	.	+	.	R	1	R	.	.	+	+	.	.	+	+	.	+	+	+	.	.	+	.	+	.	+	.	+	+	.	1	+	1	.	+	.	.	+	.	+	.	.	.	.	.	.	.	.	.
Gnidia variabilis	.	.	.	.	.	.	.	.	R	.	+	R	.	.	.	.	+	.	.	R	.	.	.	R	.	.	.	+	.	.	R	.	+	.	.	.	.	R	.	.	.	+	.	R	+	.	R	.	.	.	.	.	.	.	.	.	.
Species group S																																																									
Jamesbrittenia macrantha	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	A	R	+	+	1	+	+	+	+
Rhynchosia komatiensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	.	+	.	R	+	A	+
Helichrysum uninervium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	R	+	1	1	1	1	.
Melinis repens	.	.	+	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	.	+	1	+	.
Aristida adscensionis	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	1	1	1	+	R	1
Polygala hottentotta	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	R	R	.	R	R	R	+	.
Lotononis wilmsii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	R	.	R	.	+	.	R
Elephantorrhiza praetermissa	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	+	.	.	.	+	R
Species group T																																																									
Combretum hereroense	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	+	+	.	.	.	.	.
Hemizygia petrensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.	.	.	.
Chamaecrista comosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	R	R	.	.	.	.	.
Lotononis calycina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	R	.	.	.	.	.
Phyllanthus incurvus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	+	R	.	.	.	.	.	.

Table 3a continued.

Relevé	408 409	2 3 92 100 312	25 26 31 94 276 277 314	52 53 316 318 321 319 323	8 10 28 88 101 109	56 83 90	8 9 13 14 21 86	57 61 95 64	42 48 104 111	77 78 110 112	33 43 44 47	37 49 66 106 268
Association	1	2	3	3	3	3	3	3	4	4	5	5
Sub-association			1	1	2	2	3	4	1	2	1	2
Variant			1	2	1	2						
Species group T cont.												
Ledebouria marginata	. .	. . . . .	. . . .	. . . .	. . . . . .	. . .	. . . . . .	. . . .	. . . .	. . . .	R + . R	. . . . .
Triumfetta sonderi	. .	. . . . .	. . . .	+	. . . . . .	. . .	. . . . . .	. . . .	. . . .	. . . .	R + . +	. . . . .
Aneilema longirhizum	. .	. . . . .	. . . .	. . . .	. . . . . .	. . .	. . . . . .	. . . .	. . . .	. . . .	. + R R	. . . . .
Species group U												
Seddera capensis	. .	. . . . .	. . . .	. . . .	. . . . . .	. . .	. . . . . .	. . . .	. . . .	. . . .	. . . .	1 . + R .
Andropogon chinensis	. .	. . . . .	. . . .	. . . .	. . . . . .	. . .	. . . . . .	. . . .	. . . .	. . . .	. . . .	+ 1 + 1 R
Polygala sp. (*SS 449*)	. .	. . . . .	. . . .	. . . .	. . . . . .	. . .	. . . . . .	. . . .	. . . .	. . . .	. . . .	+ R R + .
Indigofera tristoides	. .	. . . . .	. . . .	. . . .	. . . . . .	. . .	. . . . . .	. . . .	. . + .	. . . .	. . . .	+ R . + R
Euclea linearis	. .	. . . . .	. . . .	. . . .	. . . . . .	. . .	. . . . . .	. . . .	. . . .	. . . .	. . . .	R 1 + 1 R
Jamesbrittenia burkeana	. .	. . . . .	. . . .	. . . .	. . . . . .	. . .	. . . . . .	. . . .	. . . .	. . . .	. . . .	. + R + .
Phyllanthus glaucophyllus	. .	. . . . .	. . . .	. . . .	. . . . . .	. . .	. . . . . .	. . . .	. . . .	. . . .	. . . .	. R . . +
Ipomoea bathycolpos	. .	. . . . .	. . . .	. . . .	. . . . . .	. . .	. . . . . .	. . . .	. . . .	. . . .	. . . .	. . R . +
Species group V												
Melhania prostrata	. .	. . . . .	. . . .	. . . .	. . . . . .	. . .	. . . R . .	. . . .	. . . .	+ . + R	1 + 1 1	. + . R R
Thesium multiramulosum	. .	. . . . .	. . . .	. . . .	. . . . . .	. . .	. . . . . .	. . . .	. . . .	R + . R	R + + +	1 + + . R
Aristida congesta	. .	. . R . .	. . . .	. . . .	. . . . . .	. . .	. . . . . .	. . . .	. . . .	. + + .	1 R + R	+ . + R .
Species group W												
Pearsonia aristata	. .	. . . . .	. . . .	. . . .	. . . . . R	. . .	+ + . + . R	. R . +	. R . .	. R + .	R . . R	+ . + . R
Dicoma anomala	. .	. . . . .	. . . .	. . . .	. . . . . .	. . .	+ . R + . R	R . . +	+ . 1 +	+ . R +	. + + .	1 + + 1 1
Indigofera egens	. .	. . . . .	. . . .	. . . .	. . . . . .	. . .	+ . R . R .	. + . +	+ 1 + .	. R . R	R . . R	+ . R R .
Polygala amatymbica	. .	. . . . .	. . . .	. . . .	. . . . . .	. . .	+ . . R . R	. R R .	. . R .	R . . R	R . + .	. R . + .
Abildgaardia ovata	. .	. . . . .	. R	. . . .	R . . . . R	. . .	R . . R + .	R . R .	+ . . R	R . R .	+ . + .	R . . R .
Loudetia simplex	. .	. . . . .	. . . .	. . . .	. . . . . .	. . .	. + . R 1 .	R . + .	B . + 1	+ 1 + A	1 + + A	R 1 . 1 +
Anthospermum rigidum	. .	. . . . .	. . . .	R . . . . . +	. . . . . .	. . .	. R R . . +	. R . +	. R + .	. R . R	. + 1 +	. R 1 + .
Hermannia antonii	. .	. . . . .	. . . .	. . . . + . .	. . . . . .	. . .	. R . + . +	+ + . B	. . + R	R . R .	. + + +	. + + . +
Helichrysum gerberifolium	. .	. . . . .	. . . .	. . . .	. . . . . .	. . .	. R . R 1 .	+ . R +	+ + . R	. R . +	. + + .	+ . + + .
Species group X												
Tristachya leucothrix	1 1	1 A 1 + .	B 3 . 1 . R R	R + + 1 1 R 1	1 3 B . R A	1 . B	B 1 B B 1 A	A 1 . A	. + R .	. + R .	R 1 + +	. + + . R
Protea caffra	+ +	R . . R .	. R . + + . 1	R . . + . + +	. R . R . +	+ + .	. R . R . .	1 + + +	. R . R	. . . R	. 1 1 .	+ + 1 R .
Eragrostis nindensis	+ R	. R R . +	+ . R . . R .	. B . . R . +	R . R . R .	+ A .	R . + . + +	+ 1 A 1	R . + .	+ . + .	R 1 + .	+ + + . R
Commelina africana	R .	+ + . . +	A + + R + . .	R . + . . + .	R . + . . .	+ + +	R . R 1 . .	+ + . R	. . R .	R . . .	. R . R	R . . . +
Cyanotis pachyrrhiza	R .	R . . . R	. R . R . . .	R . R	. R . . . +	+ . R	R . + . R .	+ . R .	R . . +	. . R .	R . R +	. . . . .
Themeda triandra	. R	1 A 1 1 .	+ A 1 B 1 1 1	+ 1 1 + 1 . 1	A 1 1 1 B .	1 . B	A A A A 3 1	1 + 3 1	1 + B 3	A B B 3	B . R +	. 1 + . +
Euclea crispa	. R	+ + + . .	. . R . + . +	+ 1 + . . . R	. R . . . 1	. R .	+ . R . + +	. R . .	R . . R	. R R +	. R . .	. . + . R
Brachiaria serrata	. R	+ . . . +	A 1 1 . 1 1 1	. + R 1 1 1 +	1 . 1 1 R 1	+ + .	1 . R 1 1 +	1 1 + R	. 1 1 1	+ + . 1	+ + . 1	. . . . .
Gnidia caffra	. R	. . . R .	. + . R . + +	R R . R . + R	. + R . . R	+ . +	R . + . 1 R	+ R + R	R + + R	+ + + +	. + R +	+ R + + .
Diheteropogon amplectens	. .	1 1 . . 1	A + . . R 1 .	. R . + 1 . R	+ + + 1 + A	A 1 A	1 1 . + + 1	B + 1 3	+ + 1 A	1 + 1 B	+ . 1 A	+ 1 A B A
Rhoicissus tridentata	. .	1 + + + .	+ R 1 + + . 1	. . R . . R .	. R + + . +	. . R	. R . R . .	. R . .	. R . +	R . + .	. R . R	. + R + .
Hypoxis rigidula	. .	+ + + + .	+ + + 1 + + 1	R . . 1 1 + .	+ 1 + + + +	+ 1 1	+ 1 + + + 1	+ 1 + 1	. R R +	+ + + +	+ . R .	. . R + .
Vitex obovata subsp. *wilmsii*	. .	+ + . . R	R R + R . + .	. + R . R . .	+ R R R . +	R R .	. R R R R R	. R R R	. R . R	+ . R R	+ R . +	. + + . .
Raphionacme galpinii	. .	+ R + + R	+ R . R . . R	. R . . + R .	R . + R + .	R R R	+ R R . . +	R . + .	. . R .	. R . .	R . + R	R . . + +
Rhus wilmsii	. .	+ . + . R	. + . + + . .	1 + . . 1 . R	R . . . . +	. R +	. . R . . +	. . . +	R . R .	. . . R	+ + 1 .	+ + + A +
Acacia caffra	. .	R + . R .	+ . + ...	. + ... +	. . + + . +	. R .	+ . R . R .	. . R .	R R . .	. 1 . +	R . . +	R . . + .
Aloe greatheadii	. .	R + + R .	+ . R . + . +	R . R . . . +	+ + . . + R	. + .	+ + + + . +	. R R .	+ . R .	. + . +	. R . +	. . . . .
Athrixia elata	. .	R . R . .	R . R . R . .	. R . . R + +	. . + . . +	. + .	. . . R . +	. . R .	+ . + +	+ + R +	. R . .	. + + + .
Ruellia patula	. .	. R + . R	. + . . R R .	. + . + + R .	+ . + + R .	+ . +	. + + + . R	. + . R	. R . .	. R . R	+ + . .	. . . . .
Striga bilabiata	. .	. R . R .	R R + + . . R	R . R . . . R	R . + . . R	. R .	R + + . + R	R + . .	. . + .	R . + .	. R + R	. . . . .
Rhynchosia totta	. .	. R . . .	. + . . R . R	R . . + . . +	R . R . + .	+ . R	. + . R . .	R . . .	R + . .	. + . +	+ . . R	. R . + R
Tristachya rehmannii	. .	. . + 1 .	. R R + . . R	+ R . . . R .	. R + . . +	+ . .	1 + 1 R R .	R + . R	R . . R	. R . .	R + R A	R + . R .
Indigofera hilaris	. .	. . . + R	R . . 1 . R .	. + + R . . R	. + + + + +	+ + 1	. + . + + +	R + + +	R R . .	R . . R	+ + . .	R + R . .
Eragrostis superba	. .	. . . . .	R . + . R . .	. R . R . . .	. + . + . .	. R +	+ + R 1 + +	. + R +	. . + R	R . R .	R . + .	1 R + . .
Berkheya insignis	. .	. . . . .	R . . + . + +	. . 1 . . + .	R + . . . +	+ + .	. + + . + +	+ 1 1 +	1 1 . +	+ + + 1	1 . + .	R . + + +
Elionurus muticus	. .	. . . . .	. + R . R 1 .	+ . + . R . +	+ . . R + .	+ + +	1 . 1 . + .	A A . 1	B 1 1 1	+ 1 A A	. + 1 A	R . 1 1 +
Species group shared with Table 3b												
Species group Y												
Eragrostis capensis	1 1	+	. . . .	. . . .	. . + . . .	. R .	. . . . . R	. . . .	. . . .	. . R .	. . . .	R R + . .
Eragrostis curvula	1 1	. . . . .	. + + + 1 1 .	+ + . . . 1 .	. + ...	+ . .	1 . + . . .	. . . .	1 . + .	1 1 . +	. . R .	. R . . .
Hyparrhenia hirta	R R	. R . . .	R	. . 1 A 1 R +	. R . . A .	. . .	. . . . . .	. . . .	. . . .	. . R .	. . . .	. . . . .
Senecio microglossus	. R	. . . R .	1 . . . . . +	. . + R + . .	1 A . 1 + A	1 1 .	1 1 B + . A	1 1 1 1	A 1 + A	+ 1 A A	1 1 1 .	+ . + R .
Aristida bipartita	. R	. . . . .	. R	. . R	. . . . . R	. . R	. . R . . .	. R . .	. R . +	R . + +	. . . .	. . . R .
Heteropogon contortus	. .	1 . . + +	1 . + A + 1 1	1 1 + 1 + . +	. + . + . +	. + .	. . . R . .	. . . .	. . R .	. . . .	. . . .	. . . . .
Cymbopogon validus	. .	. . + 1 .	. . . R . . .	R	. . . . R .	. . .	+ . . . 1 .	. . . R	+ 1 R +	+ + 1 1	. . . .	. . . . .
Hyparrhenia filipendula	. .	. . R . .	. R	. R	. . R . . .	R . .	+ . + . . .	. . . .	+ . 1 +	1 1 1 1	. . . .	. . . R .
Scabiosa columbaria	. R	. . . . R	. . . . . R .	. R . . . R .	R . . . + .	+ . +	R . R . R +	R + . .	. 1 . +	. + + .	. . . .	. . . . .
Lippia rehmannii	R .	. . R . .	. . R	. . . .	. . . . R .	. . .	. . R R R R	. R . .	+ . + .	. . . .	. R . .	. . . . .
Acacia karroo	. .	R	. . . .	. . . . R . .	. . . . . .	. . .	+ . . . + .	. . . .	. 1 + +	1 1 1 1	. . . .	. . . . .
Eucomis autumnalis	. .	. R . . .	. . . . R . .	. . . R . . .	. . . . . .	. . R	. . . . R .	. R . .	. . . .	. . . .	. . . .	. . . . .
Chlorophytum fasciculatum	. R	. R . . .	. . . . . R .	. . . . . R .	. R	R . .	. . . R . .	. . . .	R R R R	. . . .	. . . R	. . . . .

Table 3b A phytosociological table of the Wetland Vegetation of the Sekhukhuneland Centre of Plant Endemism.

Relevé				3			1				2	1	1	1	2	4	4
		1	7	2	2	2	0	3	3	6	7	4	8	9	8	1	1
	5	1	3	2	2	3	2	4	6	6	5	1	1	2	1	0	5
Association	6	.			6	.		6	.			7				8	
Sub-association	1				2			3									
Species group AA																	
Schoenus nigricans	A	A	1	+	3	A	.	1	1	A	R	.	.	.	.	.	.
Chironia purpurascens	+	+	.	+	+	+	+	+	+	+	.	.	.	.	.	.	.
Hypoxis argentea	R	R	.	.	.	R	R	R	R	.	.	.	.	.	.	.	.
Hyparrhenia tamba	.	+	R	1	.	R	.	1	.	+	.	.	.	.	.	.	.
Equisetum ramosissimum	.	.	+	+	.		R	.	.	+	R	.	.	.	.	.	.
Species group AB																	
Triraphis andropogonoides	A	1	A	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Juncus punctorius	A	1	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.
Dittrichia graveolens	+	1	+	R	.	.	.	.	.	.	.	.	R	.	.	.	.
Nuxia gracilis	+	+	1	.	.	.	.	.	.	R	.	.	.	.	.	.	.
Adiantum capillus-veneris	R	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Coleochloa setifera	.	R	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Species group AC																	
Cyperus sexangularis	1	+	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.
Kyllinga erecta	+	.	+	R	+	+	.	.	.	.	.	.	.	.	.	.	.
Berula erecta	.	+	R	+	+	R	+	.	.	.	.	.	.	.	.	.	.
Species group AD																	
Bulbostylis hispidula	.	.	.	.	.	.	.	A	1	+	.	.	.	.	.	.	.
Alepidea amatymbica	.	.	.	.	.	.	.	+	+	R	.	.	.	.	.	.	.
Bothriochloa insculpta	.	.	.	.	.	.	.	+	+	.	+	.	.	.	.	.	.
Microchloa caffra	.	.	.	.	.	.	.	+	.	.	R	.	.	.	.	.	.
Species group AE																	
Pycnostachys reticulata	.	.	.	.	1	1	1	.	+	R	.	.	.	.	.	.	.
Mariscus congestus	.	.	.	.	1	+	+	+	+	A	.	.	.	.	.	.	.
Leonotis leonurus	.	.	.	.	+	.	R	+	.	.	+	.	.	.	.	.	.
Lippia javanica	.	.	.	.	R	+	.	R	+	R	+	R	.	.	.	.	.
Senecio gerrardii	.	.	.	.	.	1	1	1	.	.	+	.	.	.	.	.	.
Monopsis decipiens	.	.	.	.	.	+	R	.	.	R	+	.	.	.	.	.	.
Pteris buchananii	.	.	.	.	.	+	.	.	R	.	+	.	.	.	.	.	.
Species group AF																	
Polygonum meisnerianum	.	.	.	.	.	.	.	.	.	.	.	1	.	R	.	.	.
Mariscus sumatrensis	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.
Conyza bonariensis	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.
Cyperus marginatus	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.
Flaveria bidentis	.	.	.	.	.	.	.	.	.	.	.	R	.	R	.	.	.
Mariscus rehmannianus	.	.	.	.	.	.	.	.	.	.	.	.	1	1	R	.	.
Salix mucronata	.	.	.	.	.	.	.	.	.	.	.		+	+	1	.	.
Eragrostis gummiflua	.	.	.	.	.	.	.	.	.	.	.	.	R	1	+	.	.
Species group AG																	
Phragmites australis	.	.	.	.	1	1	3	.	.	.	.	A	3	1	3	.	.
Fimbristylis ferruginea	R	.	.	.	+	+	.	.	.	R	.	+	1	+	.	.	.
Helichrysum cooperi	.	.	.	.	+	R	+	.	.	.	.	.	R	.	R	.	.
Cyperus sphaerospermus	.	.	.	.	R	.	+	.	.	.	.	1	+	.	+	.	.
Gomphocarpus fruticosus	.	.	.	.	R		1	.	.	.	.	+	.	R	.	.	.
Senecio gregatus	.	.	.	.	.	R	+	.	.	.	.	.	.	+	R	.	.
Table 3b continued																	
Species group AH																	
Ischaemum fasciculatum	.	.	.	.	.	R	.	+	+	R	.	R	+	.	.	.	.
Kyllinga alba	.	.	.	.	.	.	.	R	.	+	+	R	+	+	R	.	.
Hemarthria altissima	.	.	.	.	.	.	.	.	+	.	R	.	+	.	+	.	.
Species group AI																	
Andropogon eucomus	1		1	+	.	1	+	1	+	+	1	1	R	+	1	.	.
Fuirena pubescens	A	1	+	+	+	1	3	B	A	A	1	.	+	R	1	.	.
Artemisia afra	1	+	+	.	.	+	+	+	+	+	+	.	.	+	1	.	.
Cliffortia nitidula	1	1	.	+	.	R		1	+	R	1	R	+	.	+	.	.
Verbena brasiliensis	+	R	.	+	.	+	+	R	.	.	+	1	+	.	.	.	.
Miscanthus junceus	+	.	.	+	A	A	.	.	R	1	1	1	+	.	1	.	.
Pulicaria scabra	+	.	.	R	.	.	R	+	.	+	.	R	+	.	+	.	.
Imperata cylindrica	.	+	+	.	+	.	+	.	+	.	+	.	+	+	+	.	.
Rhus leptodictya	.	R	+	.	R	.	.	.	R	+	.	R	+	+	R	.	.
Plantago lanceolata	.	R	R	.	+	.	R	+	+	.	+	+	.	.	R	.	.
Verbena bonariensis	.	.	+	+	+	R	.	.	R	R	+	R	.	.	+	.	.
Typha capensis	.	.	R	+	R	+	1	.	1	.	+	.	R	1	.	.	.
Species group AJ																	
Ranunculus meyeri	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
Anagallis huttonii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+
Limosella maior	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+
Ranunculus multifidus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+
Sporobolus centrifugus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+
Species group AK																	
Schoenoplectus corymbosus	+	A	+	+	1	B	A	R	+		+	+	R	1	+	+	+
Gomphostigma virgatum	+	+	.	+	.	R	.	R	.	+	.	.	1	.	+	R	.
Species goup shared with Table 3a																	
Species group Y																	
Eragrostis capensis	.	.	.	R	.	.	.	+	.	.	.	.	+	.	.	R	.
Eragrostis curvula	R	.	R	.	R	.	.	R	.	.	.	.	.	.	.	.	.
Hyparrhenia hirta	.	.	R	.	R	.	.	.	.	.	.	.	+	1	.	.	.
Senecio microglossus	1	+	+	.	+	.	+	.	.	+	.	R	.	.	.	R	.
Aristida bipartita	+	+	1	R	.	R	.	.	.	R	.	R	.	R	R	.	.
Heteropogon contortus	R	R	R	.	.	.	.	.	.	R	.	+	.	.	R	.	R
Cymbopogon validus	1	B	+	+	A	1	1	1	+	.	1	+	+	+	+	.	.
Hyparrhenia filipendula	R	R	.	1	+	+	+	1	+	+	1	+	.	.	R	R	.
Scabiosa columbaria	+	.	.	.	.	.	.	+	+	R	.	.	.	+	.	.	.
Lippia rehmannii		.	R	+	.	R	+	.	+	.	.	.	+	+	.	.	R
Acacia karroo	R	+	.	+		.	.	.	.	+	.	.	+	.	R	.	.
Eucomis autumnalis	.	R	.	.	.	R	.	.	.	R	R	.	R	.	R	.	R
Chlorophytum fasciculatum	+	+	R	.	.	.	.	.	.	.	.	.	.	.	.	.	R

Table 4 Sekhukhuneland Centre endemic/near-endemic and Red Data List plant taxa of the Grassland and Wetland Vegetation.

Taxon	Family	Syntaxa																
		I												II				
		1	2	3.1.1	3.1.2	3.2.1	3.2.2	3.3	3.4	4.1	4.2	5.1	5.2	6.1	6.2	6.3	7	8
Acacia karroo [form] (*P4*)	FABA	.	.	.	.	.	.	$+	.	$1	$1	.	.	$+	.	$r	$r	.
Aloe castanea	ASPH	.	#1	#+	#r	#r	.	#+	.	.	.	.	.	.	.	.	.	.
Aneilema longirrhizum	COMM	.	.	.	.	.	.	.	.	.	.	#+	.	.	.	.	.	.
Argyrolobium wilmsii	FABA	.	.	.	#r	#r	#r	.	.	.	.	.	.	.	.	.	.	.
Asclepias sp. nov. (*S27*)	ASCL	.	$r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Berkheya densifolia	ASTE	.	.	#r	.	.	.	.	.	.	.	.	.	.	.	.	.	.
B. insignis [form] (*S257*)	ASTE	.	.	$+	$+	$+	$+	$+	$1	$1	$1	$+	$+	.	.	.	.	.
Callilepis leptophylla	ASTE	.	.	N+	N+	N+	N+	N+	N+	.	.	.	.	.	.	.	.	.
Cyphostemma sp. nov. A (*W13389*)	VITA	.	$r	$r	$r	$r	.	$r	.	.	.	.	.	.	.	.	.	.
Disa rhodantha	ORCH	.	.	.	.	.	.	.	.	.	.	.	.	.	Kr	Kr	.	.
Elephantorrhiza praetermissa	FABA	.	K$r	.	.	.	.	.	.	.	.	K$r	K$r	.	.	.	.	.
Euclea crispa [form] (*W&S13205*)	EBEN	$r	$+	$r	$+	$r	$r	$+	$+	$r	$r	$r	$r	.	.	.	.	.
E. linearis [form] (*S937*)	EBEN	.	.	.	.	.	.	.	.	.	.	.	#1	.	.	.	.	.
Eucomis autumnalis subsp. *clavata*	LILI	.	.	Nr	Nr	.	Nr	.	.	.	.	.	.	Nr	Nr	Nr	Nr	Nr
E. montana	LILI	.	Rr	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gnidia caffra [form] (*W12975*)	TILI	.	.	$+	$r	$r	$+	$+	$+	$+	$+	$+	$+	.	.	.	.	.
Helichrysum albilanatum	ASTE	.	.	.	#1	.	.	.	.	.	.	.	.	.	.	.	.	.
H. uninervium	ASTE	.	.	.	.	.	.	.	.	.	.	#1	#1	.	.	.	.	.
Hermannia antonii	STER	.	.	.	#r	.	.	#+	#1	#r	.	#r	#r	.	.	.	.	.
Ipomoea bathycolpos var. *sinuatodentata*	CONV	.	.	.	.	.	.	.	.	.	.	.	$r	.	.	.	.	.
Jamesbrittenia macrantha	SCHR	.	.	.	.	.	.	.	.	.	.	K$1	K$1	.	.	.	.	.
J. silenoides	SCHR	Nr	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Jasminum quinatum	OLEA	.	#r	.	.	.	.	.	.	.	#+	.	.	.	.	.	.	.
Melhania randii	STER	.	.	K#1	K#1	K#1	K#1	K#1	K#1	.	.	.	.	.	.	.	.	.

Table 4 continued.

Taxon	Family	Syntaxa																
		1	2	3.1.1	3.1.2	3.2.1	3.2.2	3.3	3.4	4.1	4.2	5.1	5.2	6.1	6.2	6.3	7	8
Nuxia gracilis	LOGA	.	.	.	.	.	.	.	.	.	.	.	.	K#1	.	K#+	.	.
Pegolettia lanceolata	ASTE	.	.	.	.	#r	.	#+	#r	.	.	.	.	.	.	.	.	.
Polygala sp. nov. (*S449*)	POLY	.	.	.	.	.	.	.	.	.	.	.	$1	.	.	.	.	.
Protea caffra [form] (*S1382*)	PROT	$+	.	$1	$+	$r	$+	.	$1	.	.	$1	$1	.	.	.	.	.
Rhoicissus sp. nov. (*S48*)	VITA	.	.	.	$+	$+	$1	$1	$r	$r	.	.	.	.	.	.	.	.
Rhus keetii	ANAC	.	.	.	.	.	.	.	.	.	.	.	#r	.	.	.	.	.
R. rogersii	ANAC	.	.	.	.	.	.	.	.	Nr	Nr	.	.	.	.	.	.	.
R. tumulicola var. *meeuseana*	ANAC	.	.	.	.	.	.	.	.	#r	.	.	.	.	.	.	.	.
R. wilmsii	ANAC	.	K#+	K#+	K#+	K#r	K#r	K#r	K#r	.	.	K#1	K#1	.	.	.	.	.
Rhynchosia nitens	FABA	.	Kr	.	.	.	.	Kr	.	.	.	.	.	.	.	.	.	.
Schizoglossum sp. nov. (*S628*)	ASCL	.	$r	$r	.	.	$r	.	.	.	.	.	.	.	.	.	.	.
Scilla natalensis	LILI	.	Nr	Nr	N+	Nr	Nr	N+	N+	.	.	.	.	.	.	.	.	.
Thesium gracilentum	SANT	.	.	K+	K+	Kr	Kr	Kr	K+	K+	K+	.	.	.	.	.	.	.
T. multiramulosum	SANT	.	.	.	.	.	.	.	.	.	#+	#+	#+	.	.	.	.	.
Triaspis glaucophylla	MALP	.	#+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tristachya biseriata	POAC	.	Kr	K+	K+	.	.	.	.	.	.	.	.	.	.	.	.	.
Tulbaghia sp. nov. (*S1304*)	LILI	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	$r
Vitex obovata subsp. *wilmsii*	VERB	.	#+	#+	#+	#+	#+	#+	#+	#+	#+	#+	#+	.	.	.	.	.
Xerophyta retinervis [form] (*W13208*)	VELL	.	$r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Zantedeschia jucunda	ARAC	I$+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Z. pentlandii	ARAC	.	R#+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Table 4 continued.

Taxon	Family	Syntaxa																
		1	2	3.1.1	3.1.2	3.2.1	3.2.2	3.3	3.4	4.1	4.2	5.1	5.2	6.1	6.2	6.3	7	8
SCPE endemics		3	6	6	6	6	6	6	5	5	4	6	8	1	0	1	1	1
SCPE near-endemics		0	6	5	7	6	4	6	5	3	3	6	7	1	0	1	0	0
Red Data List		2	7	7	7	5	6	6	5	2	2	3	3	2	2	3	1	1
Restricted to syntaxon		2	5	1	1	0	0	0	0	1	0	1	4	0	0	0	0	1
Restricted to association		2	5	6						2		7		2			0	1
Total for syntaxon		4	16	16	18	15	14	16	13	10	9	12	15	3	2	4	2	2
Total for association		4	16	23						12		16		4			2	2

Endemism: $ = endemic, # = near-endemic; **Red Data List:** I = Indeterminate, K = Insufficiently Known, R = Rare, N = Not threatened in the northern provinces of South Africa, but in other areas of southern Africa; **Abundance in communities:** 1 = abundant, + = frequent, r = rare, . = absent; **Collectors:** P = Swartz, S = Siebert, W = Van Wyk; **Bold** blocks represent community/syntaxon specific taxa.

Table 5 Environmental factors and selected attributes associated with different plant communities of the Grassland and Wetland Vegetation.

Factors/attributes	Syntaxa																
	I												II				
	1	2	3.1.1	3.1.2	3.2.1	3.2.2	3.3	3.4	4.1	4.2	5.1	5.2	6.1	6.2	6.3	7	8
Number of relevés	2	5	7	7	6	3	6	4	4	4	4	5	4	3	4	4	2
Total number of species	40	105	112	130	119	95	109	77	84	65	70	72	51	42	52	52	24
Average number of species per relevé	30	36	47	51	48	50	46	44	46	41	39	33	28	27	25	27	20
Number of endemics/ near-endemics	2	11	10	12	11	9	11	9	7	6	11	14	2	0	2	1	1
Number of Red Data List taxa	2	7	7	7	5	6	6	5	2	2	3	3	2	2	3	1	1
Topographic position*	C	C	CS	M	CM	CM	MF	F	F	V	F	F	M	M	CV	V	C
Slope (°)	1–3	1–5	5–9	3–7	3–15	5–15	5–9	3–5	3–5	1–3	7–9	5–7	5–7	0–1	0–1	3–5	0–1
Aspect	E	ESW	NESW	NESW	EW	EW	EW	EW	EW	EW	NS	NESW	-	-	-	-	-
Predominant soil type**	My	Ms	My	Mw	Mw/Sd	Mw/Sd	Mw	Ar	Sn	Ar	Ms	Ms	-	-	-	-	-
Rock cover percentage (%)	15–20	50–70	20–40	25–50	25–50	25–75	35–40	15–30	20–25	5–10	60–70	20–70	35–45	5–15	10–20	20–30	5–10
Average rock size (mm)	300–500	> 1000	200–950	150–450	450–950	100–250	400–750	100–250	50–150	50–150	100–400	100–200	350–750	50–100	50–100	150–200	10–50

* C = crest; S = scarp; M = midslope; F = footslope; V = valley

** Ms = Mispah; Ar = Arcadia; Sn = Steendal; My = Mayo; Mw = Milkwood; Sd = Shortlands

Table 6 A key to the syntaxa of the Grassland and Wetland Vegetation of the undulating norite hills of the Sekhukhuneland Centre of Plant Endemism.

Leads/description	Go to/syntaxon
1a Grassland (*Tristachya leucothrix* & *Senecio microglossus*)	2
b Wetland (*Schoenoplectus corymbosus* & *Cymbopogon validus*)	13
2a Mispah soils on footslopes (*Jamesbrittenia macrantha* & *Dicoma anomala*)	3
b Other soils and terrain types (*Tristachya leucothrix*)	4
3a Gentle sloped (*Euclea linearis* & *Loudetia simplex*)	5.2 *Jamesbrittenio macranthae–Loudetietum simplicis eucleetosum linearis*
b Larger rock size and cover (*Combretum hereroense* & *Brachiaria serrata*)	5.1 *Jamesbrittenio macranthae–Loudetietum simplicis combretetosum hereroense*
4a Higher altitudes (*Helichrysum splendidum* & *Pentanisia prunelloides*)	1. *Helichryso splendidi–Tristachyetum leucothricis*
b Lower altitudes (*Acacia caffra*)	5
5a Larger rock size and cover (*Zantedeschia pentlandii* & *Aloe castanea*)	2. *Zantedeschio pentlandii–Aloetum castaneae*
b No Mispah soils; low rock cover (*Trachypogon spicatus*)	6
6a Vertic A-horizon (*Rhamnus prinoides* & *Setaria sphacelata*)	7
b Melanic A-horizon (*Rhynchosia spectabilis* & *Protea caffra*)	8
7a Lower rock cover percentage (*Acacia tortilis* & *Hyparrhenia filipendula*)	4.2 *Elionuro muticusae–Trachypogonetum spicati acacietosum tortilis*
b Steeper slope (*Pearsonia grandifolia* & *Senecio microglossus*)	9
8a All aspects (*Helichrysum rugulosum* & *Clerodendrum triphyllum*)	10
b East-west aspects (*Vernonia oligocephala*)	11
9a Steendal soils (*Bewsia biflora* & *Tephrosia purpurea*)	4.1 *Elionuro muticusae–Trachypogonetum spicati bewsietosum biflorae*
b Arcadia soils (*Setaria nigrirostris* & *Callilepis leptophylla*)	3.4 *Brachiario serratae–Melhanietum randii setarietosum nigrirostis*
10a Milkwood soils, midslopes (*Alloteropsis semialata* & *Hyparrhenia hirta*)	3.1.2 *Brachiario serratae–Melhanietum randii helichrysetosum rugulosii*, *Alloteropsis semialata* variant
b Mayo soils, scarps and crests (*Digitaria eriantha* & *Tetraselago wilmsii*)	3.1.1 *Brachiario serratae–Melhanietum randii helichrysetosum rugulosii*, *Digitaria eriantha* variant
11a Footslopes/midslopes (*Vernonia galpinii*)	3.3 *Brachiario serratae–Melhanietum randii gnidietosum capitatae*
b Midslopes/crests (*Berkheya seminivea*)	12
12a Higher rock cover (*Argyrolobium transvaalense*)	3.2.2 *Brachiario serratae–Melhanietum randii argyrolobietosum transvaalense*, *Berkheya seminivea* variant
b Larger rock size (*Koeleria capensis*)	3.2.1 *Brachiario serratae–Melhanietum randii argyrolobietosum transvaalense*, *Koeleria capensis* variant

Table 6 continued.

Leads/description	**Go to/syntaxon**
13a High altitude seepage (*Ranunculus meyeri* & *Schoenoplectus corymbosus*)	8. *Limosella maioris–Ranunculetum meyeri*
b Streams/rivers (*Fuirena pubescens* & *Schoenoplectus corymbosus*)	**14**
14a Valley rivers (*Mariscus rehmannianus* & *Andropogon eucomis*)	7. *Andropogono eucomis–Fimbristyletum ferrugineae*
b Mountain streams (*Schoenus nigricans* & *Miscanthus junceus*)	**15**
15a Rocky streams (*Cyperus sexangularis* & *Hyparrhenia tamba*)	**16**
b Stream seepage (*Bulbostylis hispidula* & *Chironia purpurascens*)	6.3 *Fuireno pubescentis–Schoenetum nigricantis bulbostylietum hispidulae*
16a Level slope (*Cyperus sexangularis* & *Berula erecta*)	6.2 *Fuireno pubescentis–Schoenetum nigricantis pycnostachetosum reticulatae*
b Steeper slope, more rocky (*Triraphis andropogonoides* & *Kyllinga erecta*)	6.1 *Fuireno pubescentis–Schoenetum nigricantis triraphietosum andropogonoidis*

Table 7 The three most dominant and conspicuous plant taxa of each of the major vegetation types of the Grassland and Wetland Vegetation depicted in the DECORANA scatter diagram.

Major vegetation type	Trees/shrubs/suffrutecis	Forbs/sedges	Grasses
1. *Helichryso splendidii–Tristachyetum leucothricis*	*Buddleja saligna*	*Euryops brevipapposus*	*Eragrostis capensis*
(*Helichrysum splendidum–Tristachya leucothrix*)	*Clutia pulchella*	***Helichrysum splendidum***	*Eragrostis curvula*
	Protea caffra (form)	*Pentanisia prunelloides*	***Tristachya leucothrix***
2. *Zantedeschio pentlandii–Aloetum castaneae*	*Apodytes dimidiata*	***Aloe castanea***	*Aristida junciformis*
(*Zantedeschia pentlandii–Aloe castanea*)	*Canthium suberosum*	*Crassula sarcocaulis*	*Cymbopogon excavatus*
	Halleria lucida	***Zantedeschia pentlandii***	*Eragrostis pseudosclerantha*
3. *Brachiario serratae–Melhanietum randii*	*Elephantorrhixa elephantina*	*Clerodendrum triphyllum*	*Andropogn chinensis*
(*Brachiaria serrata–Melhania randii*)	*Protea caffra* (form)	***Melhania randii***	***Brachiaria serrata***
	Rhus wilmsii	*Vernonia oligocephala*	*Tristachya leucothrix*
4. *Elionuro muticusae–Trachypogonetum spicati*	*Rhamnus prinoides*	*Berkheya insignis*	***Elionurus muticus***
(*Elionurus muticus–Trachypogon spicatus*)	*Rhus rogersii*	*Cephalaria zeyheriana*	*Setaria sphacelata*
	Vitex obovata	*Gnidia caffra*	***Trachypogon spicaus***
5. *Jamesbrittenio macranthae–Loudetietum simplicis*	*Elephantorrhiza praetermissa*	*Helichrysum uninervium*	*Aristida adscensionis*
(*Jamesbrittenia macrantha–Loudetia simplex*)	*Protea caffra* (form)	***Jamesbrittenia macrantha***	***Loudetia simplex***
	Vitex obovata	*Thesium multiramulosum*	*Melinis repens*
6. *Fuireno pubescentis–Schoenetum nigricantis*	*Acacia karroo*	***Fuirena pubescens***	*Hyparrhenia filipendula*
(*Fuirena pubescens–Schoenus nigricans*)	*Nuxia gracilis*	***Schoenus nigricans***	*Hyparrhenia tamba*
	Rhus leptodictya	*Typha capensis*	*Jmperata cylindrical*
7. *Andropogono eucomis–Fimbristyletum ferrugineae*	*Acacia karroo*	*Cyperus sphaerospermus*	***Andropogon eucomis***
(*Andropogon eucomis–Fimbristylis ferruginea*)	*Rhus leptodictya*	***Fimbristylis ferruginea***	*Eragrostis gummiflua*
	Salix mucronata	*Mariscus rehmannianus*	*Phragmites australis*
8. *Limosello maioris–Ranunculetum meyeri*		***Limosella maior***	*Eragrostis capensis*
(*Limosella maior–Ranunculus meyeri*)		***Ranunculus meyeri***	*Heteropogon contortus*
		Ranunculus multifidus	*Sporobolus centrifugus*

CHAPTER 6

ROCK OUTCROP VEGETATION

6.1 Background

Although several phytosociological studies have been conducted on vegetation types of the northeastern Drakensberg Escarpment and adjacent areas of the Northern Province and Mpumalanga (Deall 1985; Bloem 1988; Matthews 1991; Burgoyne 1995), the rock habitat of the SCPE (Van Wyk & Van Wyk 1997; Van Wyk & Smith 2000) is a vegetation type that has never been studied in detail. The area where the rocky outcrops occur covers approximately 8 000 km^2 and is characterised by considerable diversity in geology (Kent 1980) and physiography (Land Type Survey Staff 1987). In South Africa rock outcrop communities received very little attention from botanists and environmentalists (Bredenkamp & Deutschlander 1995), probably due to their low agricultural potential. Ultramafic rock outcrops are floristically noteworthy and has high conservation significance (Meirelles *et al.* 1999), in that many endemics with distributions correlated with the geological substrate occur here (Madulid & Agoo 1995).

Various vegetation types have been recognised on the rock outcrops of the northeastern Drakensberg Escarpment (Matthews *et al.* 1991; Matthews *et al.* 1992b), an area adjacent to the SCPE to which it shows a definite floristic affinity (Siebert 1998). The areas where the rocky outcrops of the SCPE occur were mapped as three major veld types by Acocks (1953), namely Mixed Bushveld (18), Sourish Mixed Bushveld (19) and North-Eastern Sandy Highveld (57). A more generalised classification of the same region's vegetation is given by Low & Rebelo (1996), who recognises one broad vegetation type for the area under focus, namely Mixed Bushveld (18).

The vegetation described here only includes those plant communities of rock habitats, identified as the *Hippobromus pauciflorus-Rhoicissus tridentata* Rock Outcrop Vegetation by Siebert *et al.* (2002a). Major bushveld and grassland communities of the SCPE are discussed elsewhere.

The vegetation of the SCPE can be broadly described as undulating mountain bushveld that is bordered by a moist grassland in the south and an arid bushveld in the north. In this region of undulating hills and mountains, a predominant characteristic feature is the scattered rocky outcrops, often with large boulders. The *Hippobromus pauciflorus-Rhoicissus tridentata* vegetation of rocky habitats forms a mosaic distribution with the other major vegetation types (Siebert *et al.* 2002a). Thirty-four of the Sekhukhuneland endemics/near-endemics occur in the rocky outcrop vegetation types (Siebert 1998).

Four types of rock habitats are recognized for the region, namely, rocky (1) outcrops, (2) ridges, (3) flats and (4) refugia. Rocky outcrops are defined as hills of large boulders stacked upon one another. Rocky ridges are defined as exposed reefs and scattered groups of rocks and boulders on the sides of mountains/hills. Rocky flats are defined as rock beds exposed at ground level. Rocky refugia are defined as extremely rocky areas scattered with boulders around caves, in kloofs and below cliffs.

Temperatures for the areas with rocky habitats range from -4.5°C to 38°C, with a daily average of 18.5°C (South African Weather Bureau 1998). The northern and western parts of the study area (Figure 9) are on average warmer than the southern and eastern parts (Siebert 1998). The northern parts of the region exhibit average daily temperatures of 28.3°C maximum and 7.2°C minimum.

6.2 Classification

The analysis resulted in the identification of 17 plant communities (Table 8) that were subsequently hierarchically classified into 17 associations (Barkman *et al.* 1986). Four major plant communities are recognised on the grounds of the physical environment and are presented as hypothetical alliances, with all 17 of the associations classified under them. No macro-climatic or geological variation plays a role in local differentiation of the plant communities. Plant communities relate to soil type, rockiness and terrain type, with aspect and slope also of importance. Communities are distinctive and easily distinguishable in the field. This might be attributed to the uniformity of the environmental factors for each of the major communities, causing a distinct distribution pattern of habitats and associated vegetation.

The hierarchical classification of the vegetation reinforces the correlation between habitat and plant communities (Figure 10). The distribution of Sekhukhuneland Centre endemic/near-endemic and Red Data List taxa among various plant communities is listed in Table 9. A summary of selected community attributes is supplied in Table 10. Plant communities of the *Hippobromus pauciflorus–Rhoicissus tridentata* Rock Outcrop major vegetation type recognised in the SCPE are classified as follows:

I. *Rhoicissus sekhukhuniensis–Ficus abutilifolia* community of rocky outcrops

1. *Vepro reflexae–Mimusopetum zeyheri*
2. *Commiphoro marlothii–Crotonetum gratissimi*

II. *Cymbopogon excavatus–Pavetta* sp. nov. community of rocky ridges

3. *Grewio monticolae–Elephantorrhizetum praetermissae*
4. *Melino nerviglumis–Cathetum edulis*
5. *Heteropogono contorti–Apodytetum dimidiatae*
6. *Gerbero jamesonii–Kirkietum wilmsii*
7. *Brachiario serratae–Viticetum wilmsii*
8. *Cymbopogono excavati–Brachylaenetum rotundatae*
9. *Aloo pretoriensis–Xerophytetum retinervis*
10. *Tephrosio purpureae–Rhoicissetum tridentatae*
11. *Cymbopogono validi–Rhamnetum prinoidis*
12. *Enteropogono macrostachys–Hippobrometum pauciflorii*

III. *Aristida transvaalensis–Crassula sarcocaulis* community of rocky flats

13. *Munduleo sericeae–Euphorbietum cooperi*
14. *Crassulo sarcocaulis–Aristidietum transvaalensis*

IV. *Panicum deustum–Celtis africana* community of rocky refugia

15. *Clauseno anisatae–Diospyretum whyteanae*

16. *Fico sur–Combretetum erythrophyllii*

17. *Andrachno ovalis–Allophylletum transvaalensis*

6.3 Description

The *Hippobromus pauciflorus-Rhoicissus tridentata* Rock Outcrops are predominantly restricted to the slopes and plateaus of undulating ultramafic hills. Surface rocks are predominant and abundant in the habitats, with rock percentage varying from 25% on the rocky flats to more than 50% in the rocky refugia. The vegetation can structurally be classified into forest/woodland (rocky refugia), thicket (rocky outcrops and ridges) and herbland (rocky flats) (Edwards 1983). Rocky habitats constitute an important feature which is an unique island that differs significantly from surrounding areas (Madulid & Agoo 1995).

I. *Ficus abutilifolia-Rhoicissus sekhukhuniensis* community of rocky outcrops

Environmental data. The vegetation of the alliance is a thicket on ultramafic outcrops. The alliance is found on all aspects of sloped (1–3°) rock intrusions on midslopes, scarps and occasionally in valleys (Table 10). Soil forms are shallow and rocky. The soil surface is covered by 60–90% of rock with a large average diameter of 2.5–8 m (Table 10).

Diagnostic and dominant/prominent taxa. Diagnostic species are represented by species group D (Table 8) and include the trees *Ficus abutilifolia*, *Homalium dentatum*, *Pouzolzia mixta* and *Vepris reflexa* and the herbaceous shrubby climbers *Asparagus buchananii*, *A. intricatus* and *Rhoicissus sekhukhuniensis*. Prominent trees of the association are *Croton gratissimus* and *Maytenus undata*, the dominant grass is *Panicum deustum* and frequent occurring herbaceous taxa include the forb *Commelina africana*, the fern *Pellaea calomelanos* and the succulent *Sarcostemma viminale*.

Notes on floristic diversity. Floristic links with the rest of the data set are visible in species groups AA and AH (Table 8). The weak links supports the recognition of the alliance. The average number of species encountered per sample plot for this alliance is 29, with the total number of plant species being a minimum of 91 taxa (13 relevés) (Table 10). There are 14 plant taxa of conservation value, eight are SCPE endemics, six are SCPE near-endemics and one is a Red Data List taxon (Table 9). Of these taxa, five are restricted to the alliance in the SCPE.

1. *Vepro reflexae–Mimusopetum zeyheri* ass. nova hoc loco
Nomenclatural type: relevé 190 (holotypus)

Environmental data. The vegetation representing this association is a sparse tall thicket on the banks of seasonal streams and rivers. It is mostly found along watercourses that flow towards the Steelpoort River Valley from the mountains. The habitat is a rocky outcrop with gentle sloped sides (1–3°) (Table 10). The dominant soil type is the Bonheim form, a melanic A-horizon underlain with a pedocutanic B. Average rock size varies from 5.5 to 7 m in diameter and covers 70–80% of the soil surface.

Diagnostic and dominant/prominent taxa. In the SCPE this association is characterised by species group A (Table 8). *Heteropyxis natalensis*, *Mimusops zeyheri* and *Pittosporum viridiflorum* is the diagnostic woody species. Other diagnostic species include the climbers *Abrus laevigatus*, *Rhoicissus tomentosa* and *Secamone filiformis*. There are no diagnostic grasses. Other dominant woody species include *Ficus abutifolia* and *Vepris reflexa*. Prominent grass species include *Cymbopogon validus* and *Panicum deustum*. Prominent forbs are *Orthosiphon labiatus* and *Ruellia patula*.

Notes on floristic diversity. This rock outcrop community is not typical for the SCPE and only a slight floristic affinity exist with other rock habitats of the Centre in species groups K, U and AA (Table 8). The average number of species per relevé is 31, and the total number of species recorded for the association is 46 (three relevés) (Table 10). Five plant taxa of conservation value occur in this association (Table 9), namely one SCPE endemic, *Rhoicissus sekhukhuniensis*, and four SCPE near-endemics.

2. *Commiphoro marlothii–Crotonetum gratissimi* ass. nova hoc loco
Nomenclatural type: relevé 195 (holotypus)

Environmental data. The vegetation is a sparse short thicket on rocky outcrops in the Steelpoort River Valley. The plant community is associated with exposed norite or pyroxenite outcrops with gently sloped sides (0–1°) on midslopes and scarps of the hills. Surface rock cover percentage is 60–90%, with the stacked exposed boulders reaching diameters between 2.5 and 8 m (Table 10). The dominant soil type is the Mispah form, indicating very shallow soils over rock.

Diagnostic and dominant/prominent taxa. Diagnostic species are represented by species group B (Table 8). Diagnostic trees/shrubs of the association include *Commiphora marlothii*, *Euphorbia sekukuniensis*, *Nuxia congesta*, *Premna mooiensis* and *Steganotaenia araliacea*. Diagnostic woody forbs are *Abutilon pycnodon*, *Ruttya ovata* and *Turraea obtusifolia*, and the succulents *Cyphostemma sulcatum* and *Tetradenia brevispicata*. *Stylochiton* sp. nov. (*Siebert 1332*) is an undescribed taxon; it is a neo-endemic of the SCPE. *Andropogon schirensis*, *Cymbopogon excavatus*, *Eragrostis nindensis* and *Panicum deustum* are the dominant grasses in this association. Other prominent plants are the woody species *Barleria rotundifolia*, *Combretum molle*, *Croton gratissimus* and *Maytenus undata*.

Notes on floristic diversity. This plant community exhibits a slight floristic link with the rocky ridges of the Centre in species groups K, P, U and AA (Table 8). The average number of species encountered per sample plot is 27, with the total number for this association being 91 (10 relevés) (Table 10). Twelve taxa with conservation status are present in the association (Table 9), eight are SCPE endemics, the highest number for any plant community in the Rocky Outcrop vegetation, four are SCPE near-endemics and one a Red Data List taxon, *Euphorbia sekukuniensis*. Of all the rock habitats, this association has the highest number of plant taxa with a conservation status restricted to it (four).

II. *Pavetta* sp. nov. –*Cymbopogon excavatus* community of rocky ridges

Environmental data. In the SCPE this alliance is characterised by open to closed moist bushclumps on rocky ridges with predominantly shallow black and red clay soil forms. This vegetation occurs on midslopes and scarps of undulating ultramafic hills. It occurs on varying slopes of 1–15° on all aspects. Rocks can cover 45–80% of the soil surface and are an average diameter of 1–5 m (Table 10).

Diagnostic and dominant/prominent taxa. Species group U contain the diagnostic species for this alliance, which are characterised by the trees *Acacia caffra*, *Olinia emarginata* and *Scolopia zeyheri*, the shrubs *Elephantorrhiza praetermissa* and *Pavetta* sp. nov., the forbs *Ruellia patula* and *R. stenophylla*, and the grass *Cymbopogon excavatus* (Table 8). Other prominent species of the alliance include the trees *Combretum molle*, *Cussonia transvaalensis*, *Euclea crispa* and *Hippobromus pauciflorus*, and the ground layer is dominated by the grasses *Themeda triandra* and *Setaria sphacelata*.

Notes on floristic diversity. This alliance is dominant and floristic relationships exist with the other alliances, hence indicating that it forms the basis for the plant communities of rocky habitats (Table 8). The average number of species encountered per sample plot in this alliance is approximately 35, with the total number of plant species being a minimum of 110 taxa (62 relevés) (Table 10). Twenty-eight taxa of conservation value are part of the alliance, of which 14 are restricted to it (Table 9).

3. *Grewio monticolae–Elephantorrhizetum praetermissae* ass. nova hoc loco
Nomenclatural type: relevé 130 (holotypus)

Environmental data. This association represents bush clumps on warm north and northeast aspects of hills with norite and pyroxenite rocky ridges. It occurs on midslopes and scarps on red clay soils of the Glenrosa and Mispah forms. It covers gentle to moderate sloped areas (3–7°). Rock cover on the surface is 70–90%, with rocks reaching an average size of 2–4.5 m in diameter (Table 9).

Diagnostic and dominant/prominent taxa. Diagnostic species are presented in species group E (Table 8). Diagnostic herbaceous taxa include forbs such as the herbs *Aspilia mossambicensis* and *Orthosiphon fruticosus* and the succulent *Kleinia stapeliiformis*. Diagnostic grasses are *Aristida rhiniochloa* and *Sporobolus stapfianus*. The diagnostic woody species are *Englerophytum magalismontanum* and *Grewia monticola*. Other important dominant taxa are shrubs, namely *Elephantorrhiza praetermissa, Hippobromus pauciflorus, Pavetta* sp. nov. and *Xerophyta retinervis* (form). Grasses such as *Aristida transvaalensis, Panicum deustum* and *Themeda triandra* are the dominant grasses.

Notes on floristic diversity. This associations is strongly linked with the other associations of the alliance. The average number of species encountered per sample plot is 30, with a total number of 89 plant taxa (nine relevés) (Table 10). Four SCPE endemics, seven near-endemics and one Red Data List taxon are found in this association (Table 9). None of the 11 taxa of conservation value are restricted to it.

4. *Melino nerviglumis–Cathetum edulis* ass. nova hoc loco
Nomenclatural type: relevé 41 (holotypus)

Environmental data. This association represents dry bush clumps on northern aspects of norite (sometimes pyroxenite) hills. It occurs on red and black clay soils of the Mayo and Milkwood forms on midslopes and scarps. It lies on moderately sloped areas (5–15°). Rock cover on the surface is 45–50%, with rocks reaching an average size of 0.5–1 m in diameter (Table 10).

Diagnostic and dominant/prominent taxa. Diagnostic species are presented in species group F (Table 8). Diagnostic herbaceous taxa include the forbs *Commelina erecta, Helichrysum intricatum, Hypoestes aristata* and *Sanseviera hyacinthoides*. *Aristida canescens* and *Eragrostis heteromera* are the diagnostic grasses. It is predominantly characterised by trees, which include the diagnostic taxa *Acacia robusta, Catha edulis, Euphorbia ingens, Ficus craterostoma, Schrebera alata* and *Sclerocarya birrea*. Other important dominant taxa are trees such as *Acacia ataxacantha, Hippobromus pauciflorus* and *Ziziphus mucronata*, and grasses such as *Panicum deustum*, *Setaria sphacelata* and *Themeda triandra*.

Notes on floristic diversity. The association has a strong grassland-savanna affinity in species group H with association 5 (Table 8), which is to be expected because of the vegetation type's abundance on rocky outcrops in the grasslands of the Roossenekal Subcentre. The average number of species encountered per sample plot is 46, together with association 5 the highest number recorded per relevé for any of the vegetation units of rocky habitats. It has a total number of 105 plant taxa (eight relevés) (Table 10). Four SCPE endemics, of which two are Red Data List taxa namely *Elephantorrhiza praetermissa* and *Zantedeschia pentlandii*, and five near-endemics are found in this association (Table 9).

5. *Heteropogono contorti–Apodytetum dimidiatae* ass. nova hoc loco
Nomenclatural type: relevé 81 (holotypus)

Environmental data. This association represents moister bush clumps of rocky ridges restricted to southern aspects. It prefers midslopes and scarps of norite hills with a gentle to moderate slope (3–15°). It occurs on black clay soils of the Mayo and Milkwood forms. Approximately 45–60% of the soil surface is covered by rocks, with an average size of 0.5–1 m in diameter (Table 10).

Diagnostic and dominant/prominent taxa. Diagnostic species are represented by species group G (Table 8). The diagnostic species found in this association are predominantly woody ones, namely *Buddleja auriculata*, *B. salviifolia*, *Diospyros lycioides* subsp. *nitens*, *Jasminum quinatum*, *Rhus rigida* and *Triaspis glaucophylla*. The only diagnostic forb is *Pupalia lappacea*. Other conspicuous woody species are *Apodytes dimidiata*, *Combretum molle*, *Hippobromus pauciflorus* and *Rhoicissus tridentata*. Dominant grasses include *Heteropogon contortus*, *Panicum deustum*, *Setaria sphacelata* and *Themeda triandra*.

Notes on floristic diversity. Species group H (Table 8) shows a strong floristic resemblance to plant community 4 (Table 10) due to their similar geographical distribution.

The average number of species encountered per sample plot is 46, together with association 4 the highest average number recorded per relevé in the data set. The total number of plant species for this association is 110 (seven relevés), the richest diversity of species recorded for any rock habitat association (Table 10). Of the 10 taxa of conservation value in this association, three are SCPE endemics, six SCPE near-endemics and of these three are Red Data List taxa (Table 9). Three of these taxa are restricted to the association, namely *Berkheya insignis* (endemic form), *Eucomis montana* (Rare (R) in the Red Data List) and *Gnidia caffra* (endemic form).

6. *Gerbero jamesonii–Kirkietum wilmsii* ass. nova hoc loco
Nomenclatural type: relevé 20 (holotypus)

Environmental data. An association dominated by a dense herbaceous cover on ridges that are situated on midslopes and scarps of norite hills. It occurs on red clay soils of the Mispah form, with the soil surface covered by 70–80% rock, of a relatively large average size of 4–7 m in diameter (Table 10). Slope of the habitat is usually 1–3°.

Diagnostic and dominant/prominent taxa. Diagnostic species are represented by species group I (Table 8). Diagnostic herbs, such as the fern *Cheilanthes hirta,* the succulents *Aloe aculeata, Kalanchoe rotundifolia, Plectranthus xerophilus* and *Sanseviera aethiopica,* and the forbs, *Gloriosa superba* and *Tripteris auriculata,* dominate the community. Two undescribed *Cyphostemma* species are also diagnostic. *Sporobolus ioclados* and *Trachypogon spicatus* are the diagnostic grasses. Dominant woody species are trees *Barleria rotundifolia, Catha transvaalensis, Croton gratisiimus, Kirkia wilmsii* and the small shrub *Chrysanthemoides monilifera.* Conspicuous grasses include *Andropogon schirensis* and *Eragrostis nindensis.*

Notes on floristic diversity. Two noteworthy floristic relationships exist with other associations, namely with association 2 in species group C and a unique combination of associations in species group AG (Table 8). The average number of species encountered per sample plot is 39, with the total number for the association being 103 (seven relevés) (Table 10). Six SCPE endemics, six near-endemics and four Red Data List taxa (most for any association) are found in this association (Table 9). Of its 13 taxa of conservation value, one of three associations sharing this highest number, three near-endemics are restricted to the association, namely *Aloe reitzii* var. *reitzii* (Indeterminate (I) in Red Data List), *Chlorophytum cyperaceum* and *Plectranthus xerophilus*.

7. *Brachiario serratae–Viticetum wilmsii* ass. nova hoc loco
Nomenclatural type: relevé 71 (holotypus)

Environmental data. This association is a dry bush clump of any aspect, situated on exposed norite and magnetite ridges, on midslopes and scarps of hills. It occurs on red and black clay soils of the Mispah form (ortic A-horizon) and Milkwood form (melanic A-horizon) underlain by hard rock. The soil surface is covered by 50–60% rock, of an average size of 2.5–3 m in diameter (Table 10). Slope of the habitat is usually 3–7°.

Diagnostic and dominant/prominent taxa. Diagnostic species are represented by species group L (Table 8). The dominant diagnostic species are forbs such as *Rhynchosia spectabilis*, *Ruellia cordata* and *Pearsonia aristata*, the succulent *Aloe verecunda*, the sedge *Bulbostylis burchellii*, and the grasses *Aristida junciformis*, *Brachiaria serrata* and *Tristachya rehmannii*. Prominent woody species are *Apodytes dimidiata*, *Catha transvaalensis*, *Olea capensis* subsp. *enermis* and *Vitex obovata* subsp. *wilmsii*. Important conspicuous taxa include *Aloe castanea* and *Sphedamnocarpus pruriens*.

Notes on floristic diversity. The community has a marked floristic grassland affinity in species group Y with associations 13 and 14 (Table 8). The average number of species encountered per sample plot is 40, with the total number for this association being relatively high at 109 species (seven relevés) (Table 10). Five SCPE endemics, eight SCPE near-endemics, together with association 8 the highest number for the rocky habitats, and three Red Data List taxa were recorded (Table 9). It has 13 taxa of conservation value, which are the highest number recorded in three vegetation units. One SCPE near-endemic, *Lotononis wilmsii*, is restricted to the association.

8. *Cymbopogono excavati–Brachylaenetum rotundatae* ass. nova hoc loco
Nomenclatural type: relevé 51 (holotypus)

Environmental data. This association represents bush clumps on all aspects of hills with norite and ferrogabbro rocky ridges. It usually occurs at higher altitudes than the other associations, and is found on midslopes and scarps on red clay soils of the Mayo and Mispah forms. It lies on gently sloped areas (1–5°). Rock cover on the surface is 60–80%, with rocks reaching an average size of 3–5 m in diameter (Table 9).

Diagnostic and dominant/prominent taxa. Diagnostic species are presented in species group M (Table 8). Diagnostic herbaceous taxa include the forbs *Pachycarpus transvaalensis*, *Pearsonia sessilifolia*, *Rhynchosia hirta*, *Senecio oxyriifolius* and *Solanum supinum*. Diagnostic woody species are the tree *Brachylaena rotundata*, the shrub *Grewia villosa* and the bushy *Felicia filifolia*. The diagnostic grass is *Diheteropogon amplectens*. Other important dominant taxa are trees such as *Catha transvaalensis*, *Olea capensis* subsp. *enermis* and *Ziziphus mucronata*, and grasses such as *Cymbopogon validus*, *Heteropogon contortus* and *Themeda triandra*.

Notes on floristic diversity. No prominent floristic links are evident. The average number of species encountered per sample plot is 34, with a high total number of 109 plant taxa (seven relevés) (Table 10). Five SCPE endemics, eight near-endemics, together with association 7 the highest number for any of the vegetation units, and three Red Data List taxa, are found in this association (Table 9). There are 13 taxa of conservation value, this is the highest number for in the data set and is equalled by associations 6 and 7. One taxon is restricted to it, namely the near-endemic *Pachycarpus transvaalensis*.

9. *Aloo pretoriensis–Xerophytetum retinervis* ass. nova hoc loco
Nomenclatural type: relevé 136 (holotypus)

Environmental data. This association is an open, sparse bush clump of norite and pyroxenite ridges, on midslopes and scarps of hills. It occurs on black and red clay soils of the Glenrosa and Mispah forms against cool south and southeast aspects. The soil surface is covered by 60–80% rock, which is of an average size of 2.5–3.5 m in diameter (Table 10). Slope of the habitat is usually 1–5°.

Diagnostic and dominant/prominent taxa. Diagnostic species are represented by species group O (Table 8). The community is dominated by diagnostic forbs such as *Convolvulus sagittatus*, *Dalechampia galpinii*, *Gnidia variabilis*, *Jatropha latifolia* var. *latifolia* and *Justicia protracta*. The diagnostic shrub is *Gymnosporia glaucophylla* and the diagnostic succulent is *Aloe pretoriensis*. Dominant woody species include the shrubs *Hippobromus pauciflorus*, *Pavetta* sp. nov. and *Vitex obovata* subsp. *wilmsii*. Important conspicuous grasses include *Aristida transvaalensis*, *Cymbopogon excavatus* and *Themeda triandra*.

Notes on floristic diversity. The community has several floristic relationships with the rest of the data set. The average number of species encountered per sample plot is 33, with 89 species the total number for this association (six relevés) (Table 10). Of the 12 taxa of conservation value, no taxa are restricted to it. Six SCPE endemics and six SCPE near-endemics, of which two Red Data List taxa, were recorded (Table 9).

10. *Tephrosio purpureae–Rhoicissetum tridentatae* ass. nova hoc loco
Nomenclatural type: relevé 320 (holotypus)

Environmental data. This is a vegetation type typical of rocky ridges in the southern region of the SCPE. It is a bush clump plant community of moist grassland on midslopes and scarps of undulating norite or pyroxenite hills. The habitat is rather a level slope of 1–3°, restricted to south and west aspects. Soils are typical red and black clays of the Mayo and Milkwood forms. Average rock size is 1–3.5 m in diameter and cover 50–70% of the soil surface (Table 10).

Diagnostic and dominant/prominent taxa. Species group Q (Table 8) contains the characteristic species for this association, with the diagnostic grassland forb species *Dioscorea sylvatica*, *Helichrysum albilanatum*, *Rhynchosia minima*, *Tephrosia purpurea* and *Zornia linearis*. Other diagnostic taxa are the grasses *Digitaria argyrograpta*, *Eragrostis curvula* and *Hyparrhenia filipendula*, and the trees *Canthium mundianum*, *Rhus sekhukhuniensis* and *Rhus discolor* (suffrutex). Other dominant taxa of the association include the trees/shrubs *Hippobromus pauciflorus*, *Olea capensis* subsp. *enermis* and *Rhoicissus tridentata*, and the grass *Cymbopogon excavatus*.

Notes on floristic diversity. This association's floristic relationships are typical for the alliance (Table 8). The average number of species encountered per sample plot is 34, with the total number of plant species for this association being 75 (three relevés) (Table 10). A high number of taxa of conservation value are found in this association (12), and of these six are SCPE endemics, six SCPE near-endemics and three Red Data List taxa (Table 9). Two taxa with conservation status are restricted to the association, namely the near-endemic *Helichrysum albilanatum* and the Rare (R) endemic *Rhus sekhukhuniensis*.

11. *Cymbopogono validi–Rhamnetum prinoidis* ass. nova hoc loco
Nomenclatural type: relevé 4 (holotypus)

Environmental data. The association is a moist riverbank thicket of rocky mountain streams in the valleys between undulating norite and pyroxenite hills. It lies on a gentle slope of 1–3°. Soils are characteristically a moist humus-rich sandy loam on a rocky substrate. Approximately 60–70% of the soil surface is covered by rocks, with an average size of 3.5–5.5 m in diameter (Table 10).

Diagnostic and dominant/prominent taxa. Diagnostic species are represented by species group R (Table 8). Diagnostic tree species are prominent, namely *Cassinopsis ilicifolia*, *Leucosidea sericea* and *Rhamnus prinoides*. Diagnostic forbs are *Freesia laxa*, *Kalanchoe paniculata* and *Thunbergia atriplicifolia*. *Scleria dieterlenii* is the diagnostic sedge and *Sporobolus fimbriatus* the diagnostic grass. Other important trees are *Chionanthus foveolatus* and *Olinia emarginata*. *Aristida transvaalensis*, *Cymbopogon validus*, *Eragrostis racemosa* and *Panicum deustum* are the dominant grasses.

Notes on floristic diversity. The association follows the floristic affinities of the alliance, but is characterised by the absence of species in group Z (Table 8). The average number of species encountered per sample plot in this association is 34, with the total number of plant species being 64 taxa (five relevés) (Table 10). Four taxa occur in this association, namely two SCPE endemics and two SCPE near-endemics (Table 9). No plant taxa with conservation value are restricted to it.

12. *Enteropogono macrostachys–Hippobrometum pauciflorii* ass. nova hoc loco
Nomenclatural type: relevé 334 (holotypus)

Environmental data. This vegetation type is a degraded bush clump of cool south and east slopes of norite hills. It covers moderately sloped midslopes and scarps (3–9°). The community is restricted to sandy loam soils. Approximately 20–40% of the soil surface is covered by rocks, with an average diameter of >500 mm (Table 9).

Diagnostic and dominant/prominent taxa. Diagnostic species are represented by species group T (Table 8). Only one non-grassy species, the shrubby *Psiadia punctulata,* is diagnostic of the association. *Cynodon dactylon, Enteropogon macrostachys, Eragrostis lehmanniana* and *Panicum coloratum* are the diagnostic grasses. Prominent trees of the association are *Acacia caffra, Euclea crispa, Hippobromus pauciflorus* and *Rhoicissus tridentata.*

Notes on floristic diversity. No clear-cut floristic links exist with other plant communities of rocky ridges, but it is characterised by the absence of species in group Z (Table 8). Over utilization of veld is indicated by species groups U, AA and AH (Table 8). The average number of species encountered per sample plot is 20 and the total number for this association being 35 (three relevés) (Table 10). These numbers are the lowest recorded for this study of rocky habitats. None of the five plant taxa with conservation value are restricted to it and comprise three SCPE endemics, two near-endemics and one Red Data List taxon (Table 9).

III. *Crassula sarcocaulis-Aristida transvaalensis* community of rocky flats

Environmental data. Alliance of rocky flats on footslopes, midslopes and scarps of predominantly norite hills and to a lesser extent pyroxenite hills. The habitat occurs on all aspects and is gently to moderately sloped (1–9°). Approximately 60–90% of the soil surface is covered by rocks with a relatively large average diameter of >10 m (Table 10). Soils are sandy and humus-rich.

Diagnostic and dominant/prominent taxa. Diagnostic species are represented by species group X (Table 8). The vegetation unit is dominated by forbs, with the most predominant diagnostic taxa including *Crassula swaziensis*, *Craterostigma wilmsii*, *Oldenlandia herbacea* and *Pearsonia cajanifolia*. The diagnostic grasses are *Aristida adscensionis*, *Eragrostis capensis*, *E. pseudosclerantha* and *Melinis repens*. Other pominent plant taxa of the association include the fern *Pellaea calomelanos*, the shrubby *Xerophyta retinervis*, the succulents *Aloe castanea* and *Crassula sarcocaulis*, and the grasses *Aristida transvaalensis* and *Eragrostis racemosa*.

Notes on floristic diversity. A strong floristic affinity exists with the alliance of rocky ridges, which is confirmed by species group Z (Table 8). The average number of species encountered per sample plot is 29, with the total number of plant species being a minimum of 75 taxa (14 relevés) (Table 10). This alliance has 10 plant taxa with conservation value, of which two are SCPE endemics, seven SCPE near-endemics and four Red Data List taxa. No taxa are restricted to the alliance.

13. *Munduleo sericeae–Euphorbietum cooperi* ass. nova hoc loco
Nomenclatural type: relevé 30 (holotypus)

Environmental data. The habitat is shrubby and grassy rocky flats of the Roossenekal Subcentre. It occurs on north, south and west aspects of footslopes, midslopes and scarps of undulating norite hills. It lies on gentle slopes (1–3°) and is found predominantly on moist, humus-rich sandy soils. Approximately 20–80% of the soil surface is covered by rocks, with an average size of >10 m in diameter (Table 10).

Diagnostic and dominant/prominent taxa. Characteristic species are presented in species group V (Table 8). There are diagnostic herbaceous species for this association, namely the fern *Cheilanthes involuta*, the geophyte *Stylochiton natalense*, and the forbs *Dioscorea dregeana* and *Orthosiphon amabilis*. Diagnostic trees/shrubs include a short-stemmed form of the succulent *Euphorbia cooperi* and *Vangueria infausta*. *Aristida scabrivalvis* and *Microchloa caffra* are the diagnostic grasses. The succulent *Crassula swaziensis* and woody *Myrothamnus flabellifolia* are dominant forbs of the association. Prominent shrubs are *Euclea crispa*, *Mundulea sericea* and *Rhoicissus tridentata*. *Aristida transvaalensis*, *Eragrostis pseudosclerantha*, *E. racemosa* and *Heteropogon contortus* are frequent occurring grasses.

Notes on floristic diversity. A strong floristic relationship exists with association 14 in species group X, and with the other associations in species groups Z and AA (Table 8). The average number of species encountered per sample plot in this association is 30, with the total number of plant species being 66 taxa (six relevés) (Table 10). None of the seven plant taxa of conservation value, namely two SCPE endemics, four near-endemics and three Red Data List taxa are restricted to the association (Table 9).

14. *Crassulo sarcocaulis–Aristidietum transvaalensis* ass. nova hoc loco
Nomenclatural type: relevé 58 (holotypus)

Environmental data. This is a grassy rocky flat of humus-rich sandy soils. It covers moderately sloped footslopes of 3–9° on all aspects of undulating norite and pyroxenite hills. The habitat occurs on footslopes, midslopes and scarps. Approximately 60–90% of the soil surface is covered by large rocks, with an average size of >10 m in diameter (Table 10).

Diagnostic and dominant/prominent taxa. Diagnostic species are represented by species group W (Table 8). Herbs are diagnostic of this community, namely the fern *Cheilanthes eckloniana* and fern-ally *Selaginella dregei*, the forbs *Kedrostis foetidissima*, *Thesium burkei* and *Xerophyta villosa*, and the succulents *Crassula alba*, *Euphorbia schinzii*, *Kalanchoe luciae* and *Kleinia longiflora*. *Rhus wilmsii* is a diagnostic woody suffrutex. Other taxa of importance are the grasses *Aristida transvaalensis* and *Melinis* *nerviglumis*. The succulents *Aloe castanea* and *Crassula sarcocaulis* are conspicuous members of the association.

Notes on floristic diversity. Floristically the association is strongly related to association 13 in species group X and shows a strong link with association 7 in species group Y (Table 8). The average number of species encountered per sample plot is 27, with the total number of plant species being 75 taxa (eight relevés) (Table 10). There are 10 taxa of conservation value occurring in the association, namely two SCPE endemics, seven near-endemics and four Red Data List taxa (Table 9) that are the highest number of Red Data taxa recorded for an association.

IV. *Celtis africana-Panicum deustum* community of rocky refugia

Environmental data. In the SCPE this alliance represents dense woodlands or thickets of rocky refugia. It is a rare vegetation type and can be found on southerly aspects of valleys, and mountain footslopes, midslopes and crests. The habitat is characterised by large norite boulders of minimum 2 m high and the average rock diameter approximately 0.5–2.5 m, while covering approximately 10–70% of the soil surface. It is characterised by gentle to moderate slopes (1–7°). Soil types are characterised as a red or black clay base on unconsolidated material and include the Mayo (lithocutanic B-horizon) and the Oakleaf (neocutanic B-horizon) forms.

Diagnostic and dominant/prominent taxa. Species group AF (Table 8) contains the diagnostic species for this alliance in the SCPE, which are the trees *Calodendrum capense* and *Celtis africana*, the shrubs *Diospyros whyteana* and *Ehretia whyteana*, and the succulent *Aloe arborescens*. Other prominent plant taxa include the woody species *Acacia ataxacantha*, *Allophyllus africanus*, *Halleria lucida*, *Hippobromus pauciflorus* and *Ziziphus mucronata*. *Panicum deustum* is the dominant grass of the alliance.

Notes on floristic diversity. A strong floristic affinities exist with associations 4, 5 and 6 in species group AG (Table 8), which shows its relationship with the SCPE. The average number of species encountered per sample plot is 36, with the total number of plant species being a minimum of 68 taxa (11 relevés) (Table 10). There are four taxa of conservation value associated with the alliance, namely one SCPE endemic and three SCPE near-endemics (Table 9). Of these taxa two are restricted to the alliance.

15. *Clauseno anisatae–Diospyretum whyteanae* ass. nova hoc loco
Nomenclatural type: relevé 67 (holotypus)

Environmental data. In the Roossenekal Subcentre this association represents wooded rocky refugia, sometimes associated with boulders around caves, boulders in kloofs and below cliffs, or stonewalls of old kraals. It is a vegetation unit on red clay soils of the Mayo and Oakleaf forms. These units occur on footslopes and midslopes of undulating norite hills. The gentle slopes vary from 3–7° and east-south-west aspects are predominant. Rock cover percentage vary from 10–40% and average rock diameter is 1–1.5 m (Table 10).

Diagnostic and dominant/prominent taxa. Species group AB contains the diagnostic species for this association (Table 8). Trees are diagnostic of the association, namely the succulent *Aloe marlothii*, *Clausena anisata*, *Clerodendrum glabrum*, *C. myricoides*, *Ficus thonningi* and *Obetia tenax*. A few diagnostic forbs are *Abutilon austro-africanum*, *Cyathula cylindrica*, *Hermannia floribunda* and *Scadoxus puniceus*. Diagnostic grasses include *Brachiaria brizantha*, *Digitaria sanguinalis*, *Setaria verticillata* and *Urochloa mossambicensis*. Other important dominant taxa include the woody species *Acacia ataxacantha*, *Allophyllus transvaalensis*, *Celtis africana* and *Diospyros whyteana*, the forb *Pavonia burchellii*, and the grasses *Panicum deustum* and *P. maximum*.

Notes on floristic diversity. A floristic link exist with association 16 in species group AD and association 17 in species group AF (Table 8). The average number of species encountered per sample plot is a high 41 (Table 10). The total number of plant species for this association is 68 (six relevés). One taxon of conservation value occurs in this association, namely an undescribed endemic *Cyphostemma* species (*Siebert 1383*).

16. *Fico sur–Combretetum erythrophyllii* ass. nova hoc loco
Nomenclatural type: relevé 182 (holotypus)

Environmental data. This vegetation type is woodlands next to rivers in the valleys between mountains. The habitat lies between norite outcrops on black and red clay soils derived from alluvium. It lies on gentle slopes of 3–5°. Soils are predominantly the Mayo and Oakleaf forms. Approximately 20–70% of the soil surface is covered by rocks, with an average diameter of 0.5–2.5 m (Table 10).

Diagnostic and dominant/prominent taxa. The diagnostic species are represented by species group AC (Table 8), and include the woody species, *Acacia galpinii*, *Combretum erythrophyllum*, *Ficus sur*, *Flueggea virosa*, *Melia azedarach* (naturalised alien) and *Spirostachys africana*. The diagnostic forbs are *Achyranthes aspera*, *Barleria obtusa*, and the climbers *Cardiospermum corindum* and *Secamone acutifolia*. *Celtis africana* and *Schotia brachypetala* are other prominent trees of the association. Important dominant grasses include *Panicum deustum* and *P. maximum*.

Notes on floristic diversity. The association shows a strong floristic link exist with association 15 in species group AD, and a specific afromontane link with association 17 in species group AF (Table 8). The average number of species encountered per sample plot is 33, with the total number for this association being 64 (three relevés) (Table 10). It has one taxon of conservation value, namely one near-endemic (Table 9).

17. *Andrachno ovalis–Allophylletum transvaalensis* ass. nova hoc loco
Nomenclatural type: relevé 406 (holotypus)

Environmental data. This is an association of relict Afromontane Forests on the crest of the Leolo Mountains. It is associated with norite substrates and boulders of 2–6m high. The habitat has a southerly aspect and a gentle slope of 1–3°. Approximately 20–40% of the soil surface is covered by rocks with an average diameter of 500–750 mm (Table 10). Soil is black clay of the Oakleaf form.

Diagnostic and dominant/prominent taxa. Diagnostic species are represented by species group AE (Table 8). The vegetation unit is dominated by diagnostic woody species, namely *Andrachne ovalis*, *Gymnosporia* sp. nov. A, *Ilex mitis*, *Kiggelaria africana*, *Prunus africana* and *Senna occidentalis*. Diagnostic forbs include *Polygala virgata*, *Senecio tamoides*, *Solanum aculeastrum* and *Urtica lobulata*. Other conspicuous taxa are the tree *Halleria lucida*, the climber *Clematis brachiata* and the grass *Panicum deustum*.

Notes on floristic diversity. Strong floristic affinities exist with associations 15 and 16 (species group AF) in species groups AF and AG (Table 8). However, this is not a true rock outcrop vegetation type, but due to the undersampling of these forests (2 releves), it was group here. Only two species depauperated forests were incountered. The average number of species encountered per sample plot is 35, with the total number of plant species numbering 65 taxa (two relevés) (Table 10). This association has two taxa with a conservation status, namely the near-endemics *Gymnosporia* sp. nov. A (*Van Wyk & Siebert 13351*) and *Nemesia zimbabwensis* (Table 9). Both these taxa are restricted to the association. Its relict status gives the community special conservation significance as a plant community (perhaps the rarest in the SCPE).

6.4 Vegetation key

A vegetation key is presented to aid with the identification of the various plant communities (Table 11). The definitions are broad indications of typical groups and should be seen as a guideline. A diagnostic characteristic of the vegetation or habitat is given, followed by the most diagnostic and visual species of a group. The first species is restricted to the specific group only, and the second is dominant in the group, but also occurs in other groups. Where one species is given, no species was restricted to the group only.

6.5 Ordination

On a larger scale the rocky outcrop vegetation is characterised as naturally sparsely vegetated due to the relatively high surface cover of rock, with many taxa typical for this habitat in the northern provinces of South Africa. When compared with other habitats of the

SCPE, the environmental factors for this major vegetation group is relatively homogeneous. A combination of factors such as terrain type (slope), soil texture (clay/sand content) and rockiness (rock size and rock cover), affects the species composition of these plant communities. The ordination indicated the gradients which are mainly caused by rockiness.

The scatter diagram displays the distribution of relevés along the first and second ordination axes (Figure 10). The vegetation units are represented as groups, their distribution on the scatter diagram corresponding with certain physical environmental conditions. The rockiness, slope and soil texture determines a definite gradient that is depicted by both the first (eigen value = 0.669) and second axis (eigen value = 0.456). Rockiness, slope and soil texture determines the moisture retention and drainage of the habitat. The gradient on the x-axis expresses rock cover as a percentage of the soil surface, with the left of the scatter diagram representing rocky flats with its continuous layers of rock at the soil surface and the right depicting the large boulders with large areas of open soil between them which are typical for rocky refugia. On the y-axis, the gradient indicates higher moisture availability over the long term at the top of the graph, because clayey soils on moderate slopes with large areas covered with rock remain moist over a longer period. Steep slopes with sandy soils and low rock cover dry out quickly and are at the bottom of the diagram. The first axis also exhibits a gradient with deep soils at the right and shallow soils at the left.

All these gradients correlate closely with each other and have a strong influence on the vegetation structure and species composition. The three most dominant and conspicuous taxa of each growth form (trees/shrubs/suffrutices, forbs/sedges and grasses) are given for each of the eight major vegetation types depicted in the scatter diagram (Table 12).

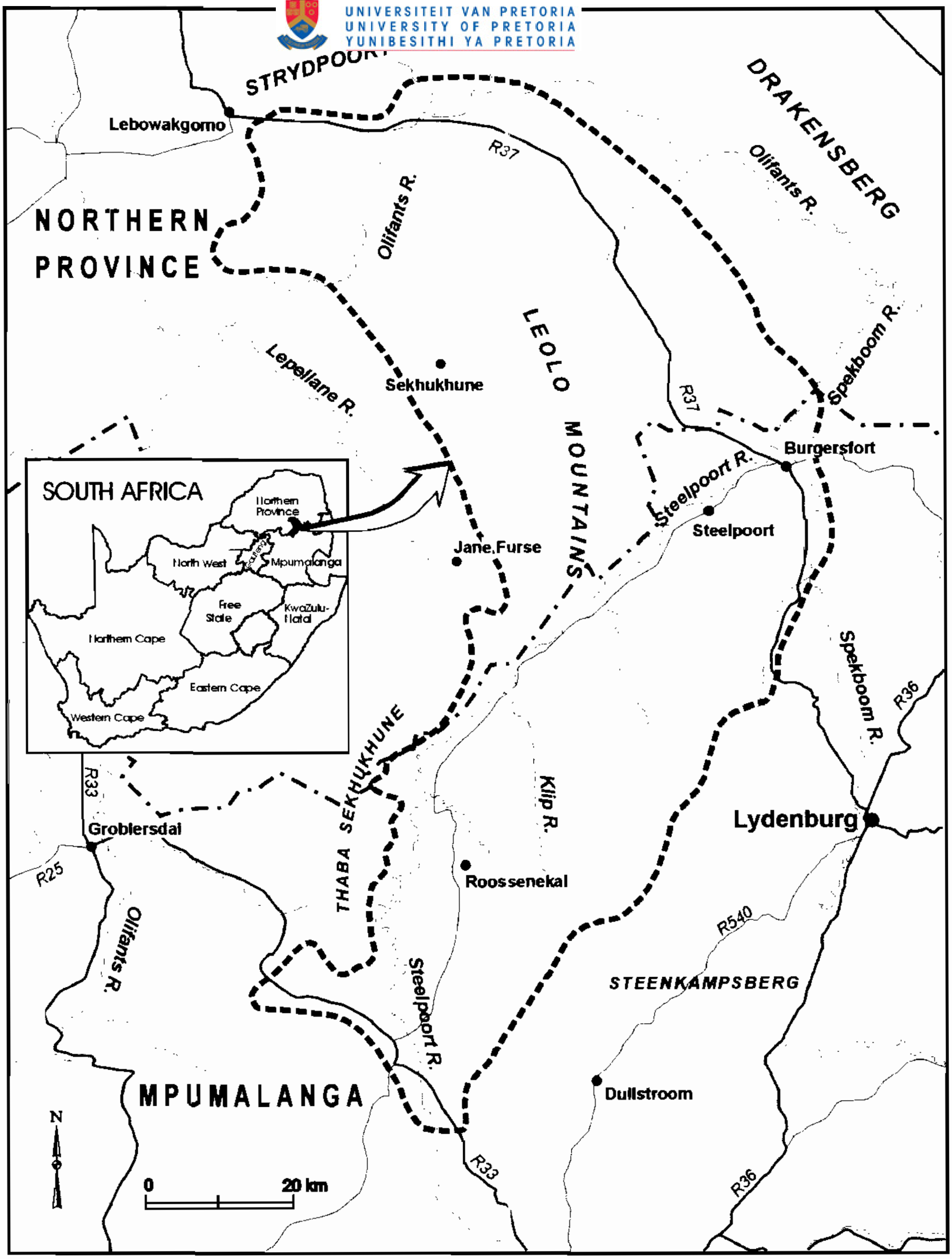

Figure 9 Extend of occurrence of the Rock Outcrop Vegetation of the Sekhukhuneland Centre of Plant Endemism in the Northern Province and Mpumalanga, South Africa.

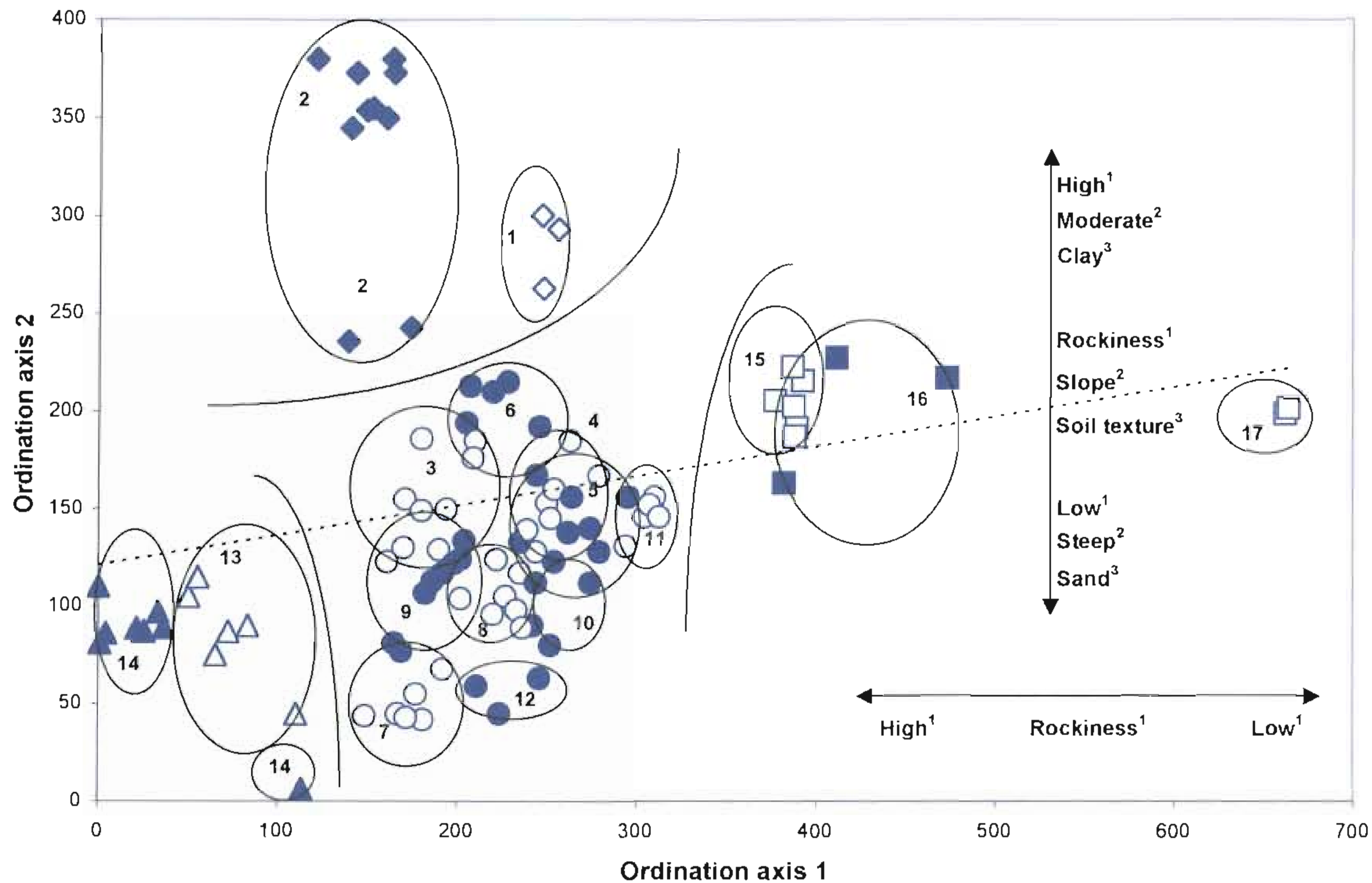

Figure 10 Relative positions of all the releves along the first and second axis of the ordination of the Rocky Outcrop Vegetation of the Sekhukhuneland Centre of Plant Endemism. Numbers correspond with the plant communities in Table 8.

Table 8 A phytosociological table of the Rock Outcrop Vegetation of the Sekhukhuneland Centre of Plant Endemism.

Relevé number	125 190 215	122 123 195 195 222 243 245 266 269 401	139 130 139 153 224 230 241 242 247	10 17 27 38 59 40 41 33	90 91 92 44 45 98 513	18 19 20 50 295 296 317	7 15 24 71 98 105 108	45 51 55 59 60 82 93	51 107 138 224 240 245	315 320 324	4 12 74 75 76	334 339 339	1 29 30 32 35 68	58 97 91 97 98 134 244 278	87 89 70 79 88 103	72 182 227	408 407
Alliance	I		II										III		IV		
Association	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Species group A																	
Mimusops zeyheri	+ 1 +	R	+	+ R			+		+ R			R +					
Heteropyxis natalensis	+ +								+								
Rhoicissus tomentosa	+ +	R															
Secamone filiformis	R + R		R														
Pittosporum viridiflorum	R +						+										
Abrus laevigatus	R R																
Species group B																	
Commiphora marlothii		1 1 + 1 + 1 1 1 +															
Nuxia congesta		+ 1 1 R + + + 1 +															
Ruttya ovata		+ + + + + + +															
Abutilon pycnodon		+ + R 1 + +															
Turraea obtusifolia		+ R R + 1 R 1						R									
Euphorbia sekukuniensis		+ R 1 1 R															
Premna mooiensis		+ + + + +															
Tetradenia brevispicata		R + + R + 1 R + +															
Steganotaenia araliacea		R + R + + + +				R +											
Stylochiton sp. (SS 1331)		R + R R +															
Cyphostemma sulcatum		+ + R R															
Species group C																	
Barleria rotundifolia		+ + 1 1 + + +				+ + 1 +		R R									
Eragrostis nindensis		+ 1 + A + 1		+ R		1 1 + + 1	+	+ +									
Andropogon schirensis		1 + + + +				+ + 1				R			+	R			
Species group D																	
Ficus abutilifolia	1 + +	+ 1 + R + + R +															
Rhoicissus sekhukhuniensis	1 + +	+ + 1 + 1 + +															
Pouzolzia mixta	1 +	R + + + 1 R	R R R														
Vepris reflexa	+ 1 +	+ + + + R + 1															
Homalium dentatum	+ + 1	+ + + 1 +															
Asparagus buchananii	+ R	R R R + +						R			R R R						
Asparagus intricatus	R R +	R + R R R R	R R R														
Species group E																	
Aspilia mossambicensis			1 R + +				+										
Orthosiphon fruticosus			+ R + 1						R	R							
Grewia monticola		R R R	R 1 R + + +							R							
Englerophytum magalismontanum			+ + +														
Aristida rhiniochloa			R + +														
Sporobolus stapfianus			+ + R R R						R								
Kleinia stapeliiformis	R		+ + R					R		R							
Species group F																	
Catha edulis				1 R + 1 + + +					+								
Sclerocarya birrea				+ + + + 1								R					
Acacia robusta				+ R R + 1													
Euphorbia ingens				R + R R + +			R	+	R						R R +		
Schrebera alata				R R R R													
Helichrysum africanum				R R R R													
Sansevieria hyacinthoides				+ + + +													
Eragrostis heteromera				R + + + +	R												
Commelina erecta				R + R +				R					R				
Hypoestes aristata				R R R +												+	R
Aristida canescens				1 1 +	R	R							+		+		
Ficus craterostoma				+ 1 + +	R	R		R							R R	+ R	

Table 8 continued.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Relevé number	125 190 215	122 123 185 195 222 243 245 286 288 401	129 130 138 153 224 230 231 242 247	16 17 27 38 39 40 41 83	80 81 82 84 85 96 313	18 19 20 50 295 296 317	7 15 24 71 99 105 108	45 51 55 59 60 62 93	54 107 136 225 240 246	315 320 324	4 12 74 75 76	334 338 339	1 29 30 32 35 68	58 87 81 87 98 134 244 278	67 69 70 79 88 103	72 182 227	406 407
Alliance	I		II										III		IV		
Association	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Species group G																	
Diospyros lycioides subsp. *nitens*			+ R R		+ 1 + 1 +			+ R		R							
Buddleja auriculata					+ R + + +		R R	R		R							R R
Triaspis glaucophylla			R	R	+ R + 1 R		R R						R	R R			
Jasminum quinatum				R	+ R + +		R			R							
Buddleja salviifolia					R 1 R + R +	R	R										R
Rhus rigida					R + + + +			+			+					R	
Pupalia lappacea					+ R + +					R							
Species group H																	
Crabbea angustifolia				R + R + +	R R R												
Lantana rugosa				R + + R + R	+ R +												
Nidorella resedifolia				R + + + R	R + R												
Chlorophytum bowkeri				R R + +	+ R +		R +										
Tricholaena monachne				R + +	+ R R					R							
Setaria lindenbergiana				+ + + +	+ + +										R R		
Peltophorum africanum	R			+ + R	- + +			R +			R					R R	
Heteromorpha trifoliata				R + R	R + + R			+ R	R	R				R R			
Species group I																	
Cheilanthes hirta					R + R	+ + R R		+									
Sansevieria aethiopica						R + + + R											
Kalanchoe rotundifolia				R		R + + R		R									
Cyphostemma sp. B (*SS 1353*)		R		R		R R R R			R						R R		
Trachypogon spicatus					+	R + + +											
Aloe aculeata						R R + 1 R		+									
Plectranthus xerophilus						R + +											
Tripteris auriculata						R R +											
Cyphostemma sp. A (*AW 13380*)		R				R R R R R +	R R	R R		R							
Sporobolus ioclados						R R R + +											
Gloriosa superba						R R R											
Chrysanthemoides monilifera						R + 1											
Species group J																	
Eragrostis chloromelas				1 + + 1 R	R + + + +	[illegible]				R							
Dombeya rotundifolia				+ + R + + + + +	R + 1 R	R + +			R R						R R		
Tetradenia riparia			R + +	+ + R + +	R + 1 + +	1 + 1 + +				R							
Cussonia paniculata				+ R + +	+ +	R + +		R + R		R							
Grewia occidentalis				+ + R +	+ +	+ + + + + +		+									
Seemannaralia gerrardii				R +	R +	+ + R R		R									
Commelina benghalensis				R R R R R	+ R +	R R R	R R				R R						
Orthosiphon labiatus	+ +			R + R R	1 R	+ 1 +		R					R + R R +				
Ficus ingens		R	R	+ +	+ R +	R +	R	R									
Species group K																	
Croton gratissimus	1 +	+ 1 1 1 1 1 1 R +	+ + 1 R R +	+ + 1 1 +	R R	+ + 1 1 +		+ R				R					
Kirkia wilmsii	+ R	R R + +	R + R + + R R +	R R R + +		A + A + 1			R R		R R			R			
Aloe cryptopoda	R	R + + + +	+ + + + + + +	+ R +	+ + +	R + + R			+	R							
Species group L																	
Ruellia cordata							1 + R				+ +						
Tenaris rubella							R + R R							R			
Acalypha punctata					R		R R 1 +							+			
Aloe verecunda			R				R R +			R							
Bulbostylis burchellii							R + R										
Pearsonia aristata							R 1 1 +				R R						
Brachiaria serrata							1 1 + +		+ R					+			
Scilla nervosa							+ R + R										
Rhynchosia spectabilis		R R					+ + + R R	+	R +	R				R			
Lotononis wilmsii							+ + R										
Pentanisia prunelloides							+ R + R										

Table 8 continued.

Relevé number	125, 190, 215	122, 123, 185, 195, 222, 243, 245, 286, 289, 401	129, 130, 138, 153, 224, 230, 241, 242, 247	16, 17, 27, 38, 39, 40, 41, 83	80, 81, 2, 84, 85, 96, 313	18, 19, 20, 50, 295, 296, 317	7, 15, 24, 71, 98, 105, 108	45, 51, 55, 59, 60, 82, 93	54, 107, 136, 225, 240, 246	315, 320, 324	4, 12, 74, 75, 76	334, 338, 339	1, 29, 30, 32, 35, 68	58, 87, 91, 97, 98, 134, 244, 278	87, 89, 70, 79, 88, 103	72, 182, 227	406, 407
Alliance	I	I	II	II	II	II	II	II	II	II	II	II	III	III	IV	IV	IV
Association	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Species group L cont.																	
Aristida junciformis							R + R	R	R								
Tristachya rehmannii							1 + 1 R		R					+			
Species group M																	
Brachylaena rotundata	R +	R	+ R					1 R 1 + 1									
Pearsonia sessilifolia								+ R + R +									
Grewia villosa				R				R + R							R		
Senecio oxyriifolius					R	R		R 1 +		R							
Diheteropogon amplectens			R				R	+ 1 +									
Pachycarpus transvaalensis								+ R R									
Rhynchosia hirta								R + R									
Solanum supinum								R + 1									
Felicia filifolia								+ R 1						+			
Species group N																	
Apodytes dimidiata	R R		R +	+ + R +	R + + 1 1 1 R	+ + + + +	+ R + + +	+ + +									
Myrsine africana				R R	+ + R	R + R R	R	+ R +		+							R R
Greyia radlkoferi				R 1 +	+ R 1 +	R R	R 1 +	R + 1	R	+ 1							
Gerbera jamesonii	R	R + R	+	+ R	R R + 1 R	+ + + 1 R	+ R R	+ + + + +	+		R R			R	R R		
Canthium suberosum			R	R +	+ 1 +	R + R	R R +	+ R + + +	R +	R							
Rhus zeyheri				R R R	R + R	R R R	R R R R	R + R + R		R				R			
Zantedeschia pentlandii				R R +	R +	+ R + + 1 +	+ + R + +	R + R +	R	+			R	R			
Species group O																	
Dalechampia galpinii			R	R					+ R R +								
Aloe pretoriensis		+	+					R +	R 1 + + R 1					R + +			
Justicia protracta			R R						R + + R								
Gnidia variabilis									R R								
Convolvulus sagittatus			R R				R	R	R + R +								
Gymnosporia glaucophylla	R								R + R							R	
Jatropha latifolia			R R						R R R R								
Species group P																	
Asparagus laricinus		R	R R + R R R R R R	R + R	R + R R	+ R R R	R R R R	R R R	R R R R								
Themeda triandra		+ R	A 3 + A R R	1 1 1 + R A	1 A B 1 1 1	A 1 A + +	+ + 1 1 1 +	R + A 1 1	A + 1 R	+ R	+	+	R +	R			
Combretum molle		+ + +	+ R R R + +	+ 1 + 1 + +	1 1 1 1 +	+ 1 + +	R	R +	+ R R + 1			+ +					
Cussonia transvaalensis		+ R	R	+ + + + + +	+ + + + + 1	+ + + 1	+ + + +	R + R + + + R	+ + 1 + + +	+ +					R +		
Species group Q																	
Tephrosia purpurea			+				R R			+ + +			R	+			
Eragrostis curvula		R						R	R	+ +			R				
Zornia linearis										+ R							
Digitaria argyrograpta					R					+ +							
Rhynchosia minima					R					R R R							
Rhus discolor										R R							
Helichrysum albilanatum										R R							
Canthium mundianum										+ +							
Rhus sekhukhuniensis										+ R							
Hyparrhenia filipendula										+ +							
Dioscorea sylvatica										R R							
Species group R																	
Sporobolus fimbriatus											1 + 1 +					+	
Scleria dieterlenii											1 1						
Rhamnus prinoides					R						1 + 1 +					+	+
Freesia laxa											+ + + + R						
Leucosidea sericea											+ + +					+	+
Kalanchoe paniculata											R + +						
Cassinopsis ilicifolia	R										+ +						R
Thunbergia atriplicifolia											+ +						

Table 8 continued.

Relevé number	125, 290, 115	122, 123, 185, 195, 222, 243, 245, 286, 289, 401	129, 130, 138, 153, 224, 230, 231, 242, 247	16, 17, 27, 38, 39, 40, 41, 83	80, 81, 82, 84, 85, 96, 313	18, 19, 20, 50, 295, 296, 317	7, 15, 24, 71, 99, 105, 108	45, 51, 55, 59, 60, 62, 93	54, 107, 136, 225, 240, 246	315, 320, 324	4, 12, 74, 75, 76	334, 338, 339	1, 29, 30, 32, 35, 68	58, 87, 91, 97, 98, 134, 244, 278	67, 69, 70, 79, 88, 103	72, 182, 227	408, 407
Alliance	I	I				II	II	II	II	II	II	II	III	III	IV	IV	
Association	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Species group S																	
Catha transvaalensis						1 1 + +	1 1 1 + 1 1	+ 1 1 + +	+ R	+ R	1 + R	+					
Olea capensis			+ R	R R		R + + + 1	A 1 + 1 1	+ 1 + 1 +	+ + +	1 1	+ + +						
Oxalis semiloba						R + + +	R +	R 1 +	R R	R	+ 1					R	
Chionanthus foveolatus						R R	+ 1	R	R +	R	+ R 1 +						
Cymbopogon validus	+				+	R +	1 1	+ 1 1 1 A	+	A	1 1 1 B					+	
Species group T																	
Enteropogon macrostachys												1 A +					
Cynodon dactylon												1 1 +					
Eragrostis lehmanniana												1 + +					
Panicum coloratum												R + R					
Psiadia punctulata												+ +					
Species group U																	
Elephantorrhiza praetermissa			1 A R + 1 + +	+ R	1 1 +	R R	1 +	R	R + 1	+ +		+	R R	R			
Cymbopogon excavatus		+ R + +	1 1 1 + 1	R 1 + + R +	1 1 1	+ R + 1 + R 1	+ + + A 1	1 1 + 1 I +	1 + + 1	1 1	+ +	R R	R +	+			
Ruellia patula	R R	+	+ 1 +	+ + +	R + +	R R	+ + + R +	+ 1	+	1 R	+ + + +	+		+			
Acacia caffra	+	+	R R R +	R R + R + +	+ R +	+ R +	+ + +	R	1 + +	R	+ + + +	1 +	R R			R	
Olinia emarginata	+ R		+ + +	+ R	+ R +	+ + +	+ + R	+	R +	R +	+ 1 +						
Pavetta zeyheri		R	1 + 1 1 + +	R +	+ + + + +	+ +	+ + +	R	1 + 1 R 1	+ +	R	+ R					
Scolopia zeyheri				+ + 1 +	+ + +	R R	+ + + +	+ + 1 + R	+ + + R		+ R +						
Ruellia stenophylla		R		R 1 +	+ + 1 R +	+ +	+ R R	R	+	+ + +	+ R + +	+		+			
Species group V																	
Euphorbia cooperi						+ + +	R	+					1 + + + +				
Cheilanthes involuta				R R			+		+				+ 1 R				
Stylochiton natalensis		R R	+			R		R	+				R 1 R + R	R			
Microchloa caffra													R R + +				
Vangueria infausta		+	R				+	R		R		R	R + + +				
Aristida scabrivalvis													+ + + R	+			
Orthosiphon amabilis				R	R			R					R + R R +				
Dioscorea dregeana				R R									R + R				
Species group W																	
Xerophyta villosa													+	1 + + + 1 1			
Crassula alba							R				R			1 R + + R			
Selaginella dregei						+								+ + R + +			
Kleinia longiflora					R		R	+	+ +	+				+ + + +			
Thesium burkei			R		R	R	R R			R				R R R R			
Euphorbia schinzii														R R R R			
Rhus wilmsii							R +	1						R + 1 R			
Ceterach cordatum														R R + +			
Kalanchoe lanceolata		+	+			+		+ R +	+				+	R + + +			
Kedrostis foetidissima			R			R R	R R		R					R R + R			
Cheilanthes eckloniana		R												1 1 R R			
Species group X																	
Eragrostis pseudosclerantha				+ R	+								1 + 1 + +	1 + + +			
Craterostigma wilmsii													+ + 1	R R + + +			
Crassula swaziensis													+ + + + 1	1 + + R + +			
Myrothamnus flabellifolia													+ R + + A	+ 1 +			
Aristida adscensionis		+ +											+ +	1 + + 1			
Eragrostis capensis					R			+			R R		+ +	+ 1 + R			
Melinis repens							+ +	+	+		R +		R R R + 1 R	R R R R R R			
Scilla natalensis						R							R +	+ R R			
Oldenlandia herbacea													+ + 1	+ R + + +			
Cyphia alata			R			R R R		R	R				R R R	R R R R			
Pearsonia cajanifolia													R R +	+ R +			

Table 8 continued.

Relevé number	125, 190, 215	122, 123, 185, 195, 222, 243, 245, 286, 289, 401	129, 130, 158, 153, 224, 230, 231, 242, 247	16, 17, 27, 38, 39, 40, 41, 83	80, 81, 82, 84, 95, 96, 313	18, 19, 20, 50, 295, 296, 317	7, 15, 24, 71, 99, 105, 108	45, 51, 55, 59, 60, 62, 93	54, 107, 136, 225, 240, 246	315, 320, 324	4, 12, 74, 75, 76	334, 338, 339	1, 29, 30, 32, 35, 88	58, 87, 91, 97, 98, 134, 244, 278	67, 9, 70, 79, 88, 103	72, 182, 227	406, 407
Alliance	I		II										III		IV		
Association	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Species group Y																	
Ledebouria revoluta		R				R	R R R + + +	+					+ R +	+ + + R R + +			
Hypoxis rigidula				R R +	+	+	+ + + +	+					+ +	R +			
Crassula sarcocaulis							R + R +	+ R			R	R	+ + + +	+ + + + + 1 1			
Lopholaena coriifolia						R +	R R + R			R			+ R R +	+ R R R R + + +			
Species group Z																	
Xerophyta retinervis			1 + + + + 1 + 1	R R R		R	+ + +	1 + +	+ + + + + +				+ R + + + R	+ + R R + + + +			
Sphedamnocarpus pruriens			+ R R + + R	R + R	+ R		1 1 1	+	1 R + + R R	+			+ +	+ + R			
Mundulea sericea			+ + R +	R + R			+ +	R	+ +	+			+ + + + +	+ + R +			
Raphionacme galpinii			R + R R R R	R R R	R R	R R R R R	R R R R R	R	R R R R				+ R R	R R R R R R R			
Tristachya leucothrix			+	+ +		R R	+ A	1 + +	1 +	+			+ 1 +	+			
Senecio latifolius			+ +	R R +	+ R + + + 1	R + +	R + R R R + +	R + +	+ R + + +	+ + R			1 R R R	R 1 R			
Melinis nerviglumis		+ +	R +	1 + + R + +		+ +	+ + + 1	+ 1	1 1 A	R			+ +	A + + A + 1			
Setaria sphacelata			+	B 1 + 1 A 1 1	A 1 1 A 1 +	R R	+ 1 + 1 1	+	+ 1	1			+ R R R R	+			
Species group AA																	
Aristida transvaalensis	+	+ +	1 1 1 1 1 +	R R	R	+ 1	+ 1 +	1 + 1 +	+ 1 +	R	+ 1 B R	+ R	1 A + 1	1 1 A + A + 1 1		+	
Pellaea calomelanos	R R	R + +	+ R R + R + R + +	R +	+ R R	R R + R	+ R R	+ +	+ R R	R	R R		R + + R R	+ + R + + R R			
Aloe castanea	R	R	+ +	R R + + R	R + R R	+ + 1 + + 1 1	1 + + 1 + +	+ 1 + + +	1 1 R	R	+ R R R	R	1 R 1 +	R + + + + R R +			
Commelina africana	R R	R + R + R	+ + + + R + R	+ A R R +	R R R R	+ R +	+ R	+ + R +	1 1 R +	1	+ R R R		+ R + R R	R R			
Vitex obovata subsp. *wilmsii*	R		+ +	R R R R + R R	R + R + + +	R R R	A + 1 + A = +	R + + 1 +	+ + 1 +		1 R R	R R	1 R + R	R R R		R	
Eragrostis racemosa	R	R	R R	R + R	+ R +	R + +	R R	R +	R R	R	1 + +	+	+ + 1 1 + A	+ + + +			
Heteropogon contortus		R R 1	+ 1	+ +	1 1 1 1	+ R +	- R	+ B R +	+ +	1	+ + +	A R +	1 + + 1 +	R R			
Cyphostemma woodii		+ R +	R + + R R	R R R + R	R R R R R R	+ R + R R	R R	R R R + R	R R	R R	R R R R		R R R R	R R			
Species group AB																	
Clausena anisata					+ R +										A + 1 + + +		
Urochloa mosambicensis															1 R + +		
Cyathula cylindrica															+ 1 1 R 1		
Obetia tenax		+													+ 1 R +		
Abutilon austro-africanum															+ + R + +		
Clerodendrum myricoides															+ + R + +		
Setaria verticillata															+ + R R R		
Clerodendrum glabrum				+ + +	+ + 1 +										+ R 1 1 1		
Ficus thonningii															+ R R R +		
Hermannia floribunda															+ + +		
Aloe marlothii		+	+			+ +							+ R		R 1 R +		
Plectranthus laxiflorus															R R + +		
Senecio macrocephalus															R R R + R		
Scadoxus puniceus							R								R + +		
Schkuhria pinnata			R										+		R R + R R		
Brachiaria brizantha															+ R +		
Digitaria sanguinalis															R 1 + R		
Species group AC																	
Ficus sur	+ +										+				R R	1 A +	
Combretum erythrophyllum	+ +										+ + +				1 1 +	
Acacia galpinii																+ 1 R	
Spirostachys africana																+ 1 R	
Berleria obtusa																+ 1	
Secamone acutifolia																R + +	R
Melia azedarach																R + R	
Cardiospermum corindum																R +	
Achyranthes aspera										R R						1 +	
Flueggea virosa																+ 1	
Species group AD																	
Pavonia burchellii					R										+ 1 R + R R	+ R	
Lippia javanica				R R R R	R										R R + + R	+ + R	
Tagetes minuta															R A R +	+	

Table 8 continued.

Relevé number	126 190 215	122 123 186 1?5 222 241 245 205 289 401	126 130 118 153 224 230 231 242 247	16 17 27 38 39 45 41 53	80 81 82 84 85 96 313	18 19 20 50 295 298 317	7 15 24 71 99 105 108	45 51 55 58 60 62 63	54 107 138 223 240 246	315 320 324	4 12 74 15 75	354 358 359	1 39 30 32 35 88	58 87 81 97 98 134 244 275	87 69 70 70 88 103	72 192 227	406 407
Alliance		I					II							III		IV	
Association	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Species group AD cont.																	
Pavetta gardeniifolia															+ R +	R +	
Panicum maximum										1					+ + 1 1	1 1	
Schotia brachypetala				+ R	R							A			R + R	R 1	
Species group AE																	
Andrachne ovalis																	+ 1
Allophylus transvaalensis																R	+ +
Carissa bispinosa																R	+ +
Ilex mitis																	+ +
Kiggelaria africana																	+ +
Gymnosporia mossambicensis																	+ +
Prunus africana																	+ +
Senna occidentalis																	+ +
Senecio tamoides																	+ R
Polygala virgata																	R +
Solanum aculeastrum																	R +
Urtica lobulata																	R +
Species group AF																	
Diospyros whyteana	+ +			R	R	R R		+			R +				1 + + 1 + +	R	+ +
Aloe arborescens								+							+ 1 + R +	P	+ +
Celtis africana						+					+				+ + 1 + + 1	+ + 1	+ +
Ehretia rigida			R	+	+										+ R + R	+ +	R
Calodendrum capense															1 + +	R	+ +
Species group AG																	
Maytenus heterophylla		+	+	+ + + +	1 R +	R 1 + + R	R	+ + +	R		R		R	+	+	+ +	R +
Drimiopsis maxima			+	+ + + R +	R + + R + +	R + + + R	+ +	+				R		+	+ + R R +	R	+
Allophylus africanus				+ + + +	+ + + + + +	+ + + + +	+					R	R		A 1 + 1 + 1	R	R
Halleria lucida				+	1 1	+ 1		+ R		+ +	R		R		R R	R	+ +
Diospyros lycioides subsp. *lycioides*				+ + + 1 +	+ +	+ + +						R		R	+ + + + 1	R	
Dovyalis zeyheri				R + + +	+ + + +						R		R		+ R R + R	R	R
Species group AH																	
Panicum deustum	1 1 1	1 R 1 1 1 A 1 1	A A 1 1 1 + 1 1	1 1 1 1 + 1 1 1	1 1 1 + 1 1	1 A 1 +	1	1 A +	A	R	1 + 1 1		R +	P P	+ + P 1 A R	+ A A	A 1
Maytenus undata	+ 1 +	+ + + + + + 1 +	+ + + R + +	+ + + R R	R R + + +	+ + +	+ + +	+ + + +	+ +	+	R + +	R		R	R R R	R	R R
Sarcostemma viminale	+	R + R R 1	+ R	+ 1 +	R +	R + +	1 + R	+ + R +	R R	R	R R R		R +	R R + R +	R +		
Pappea capensis	+ + +	R +	R + R R R R R	R R R	R	+ 1	R	+ +	R 1 R		R + R	R	R		R + R R		
Euclea crispa	+ + 1		+	+ R 1 1 + + +	+ + + + R 1 +	R + R	1 + P 1 + +	+ + 1 +	+ + +	1 1 1	+ R +	+ 1 +	+ R R R + R	+ +	+ 1 +	+	
Hippobromus pauciflorus	R R 1	R + + 1	R + R + + 1 1 +	1 1 1 1 + + 1 +	1 1 + + 1 + +	1 + 1 1 R	1 1 1 + + 1 +	1 + R	+ 1 1 1 R 1	+	R R + R 1	1 B 1		R	+ 1 1	R +	R
Acacia ataxacantha	+		+ + +	1 A + + 1 1 + R	+ + + R R +	P	+ + + + + R	R	R + +		R + + +		R	R	1 1 + 1 R 1	P	
Berkheya zeyheri	+ R		+ R R	+ + R	+ + R		+ R R		R R + R		R R			R	R	R P	
Clematis brachiata	+	+		+ + + +	+ + R R +	+	R			+ 1	R				R R 1	R	+ +
Ziziphus mucronata	R	R	+ R R +	+ + 1 1 1 1 R	+ R +	1 1 R R	+ 1 1 R + + +	1 + 1 1 +	R	+			R	R R	+ + + + R	R +	
Cassine aethiopica	+		R +			R			R	+		R	R	R		+ R	
Zanthoxylum thorncroftii	R	R	+ + + + +	+ 1 1 +	R	1	+ +	+ + +	+	R	R	R	R		+ 1 + +	+	
Rhus leptodictya	R	+ R	+ + + +	+ R R R + +	1 + + P +	R	+ R R + +	R 1 R	+ R +	+	R + + R		+ R R R	R R	R R R R +	+	
Rhoicissus tridentata		R R R	+ 1 + + 1 1	+ + + +	+ 1 + 1 1 +	+ + + + +	1 + 1 R 1 + 1	+ + + 1	+ + + + + +	1 A A	R R	1 + R	+ R + R R	1 R	A + R 1 R	R	

Table 9 Sekhukhuneland Centre endemic/near-endemic and Red Data List plant taxa of the Rock Outcrop Vegetation.

Taxon	Family	Syntaxa																
		I		II										III		IV		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Aloe castanea	ASPH	#r	#r	#+	#+	#r	#1	#1	#1	#+	#r	#r	#r	#1	#+	.	.	.
A. pretoriensis	ASPH	.	#r	#r	.	.	.	.	#+	#1	.	.	.	.	#+	.	.	.
A. reitzii var. *reitzii*	ASPH	.	.	.	.	.	I#r	.	.	.	.	.	.	.	.	.	.	.
Asparagus intricatus [form] (*W&S1501*)	LILI	$+	$+	$r	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Berkheya insignis [form] (*S257*)	ASTE	.	.	.	.	$r	.	.	.	.	.	.	.	.	.	.	.	.
Catha transvaalensis	CELA	.	.	.	.	.	$1	$1	$1	$r	$r	$+	$r	.	.	.	.	.
Chlorophytum cyperaceum	LILI	.	.	.	.	.	#r	.	.	.	.	.	.	.	.	.	.	.
Cyphostemma sp. nov. A (*W13389*)	VITA	.	$r	.	.	.	$+	$r	$r	.	$r	.	.	.	.	.	.	.
C. sp. nov. B (*S1383*)	VITA	.	$r	.	$r	.	$+	.	.	$r	.	.	.	.	.	$r	.	.
Elephantorrhiza praetermissa	FABA	.	.	K$1	K$r	K$+	K$r	K$+	K$r	K$+	K$+	.	K$r	K$r	K$r	.	.	.
Eucomis montana	LILI	.	.	.	.	Rr	.	.	.	.	.	.	.	.	.	.	.	.
Euphorbia sekukuniensis	EUPH	.	R$1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gnidia caffra [form] (*W12975*)	TILI	.	.	.	.	$+	.	.	.	.	.	.	.	.	.	.	.	.
Gymnosporia sp. nov. A (*W&S13351*)	CELA	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	#+
Helichrysum albilanatum	ASTE	.	.	.	.	.	.	.	.	.	#r	.	.	.	.	.	.	.
Jasminum quinatum	OLEA	.	.	.	#r	#+	.	#r	.	.	#r	.	.	.	.	.	.	.
Jatropha latifolia var. *latifolia*	EUPH	.	.	#r	.	.	.	.	.	#+	.	.	.	.	.	.	.	.
Kleinia stapeliiformis	ASTE	#r	.	#+	.	.	.	.	#r	.	#r	.	.	.	.	.	.	.
Lotononis wilmsii	FABA	.	.	.	.	.	.	#+	.	.	.	.	.	.	.	.	.	.
Nemesia zimbabwensis	SCHR	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	#r
Orthosiphon fruticosus	LAMI	.	.	$+	.	.	.	.	.	$r	$r	.	.	.	.	.	.	.
Pachycarpus transvaalensis	ASCL	.	.	.	.	.	.	.	#+	.	.	.	.	.	.	.	.	.
Pavetta sp. nov. (*S22*)	RUBI	.	$r	$1	$r	$+	$r	$+	$r	$1	$+	$r	$r	.	.	.	.	.
Plectranthus venteri	LAMI	.	$+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Table 9 continued.

Taxon	Family	Syntaxa																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
P. xerophilus	LAMI	.	.	.	.	.	**#+**	.	.	.	.	.	.	.	.	.	.	.
Premna mooiensis [form] (*W&S13004*)	VERB	.	**$1**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rhoicissus sekhukhuniensis	VITA	$1	$1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rhus sekhukhuniensis	ANAC	.	.	.	.	.	.	.	.	.	**R$r**	.	.	.	.	.	.	.
R. wilmsii	ANAC	.	.	.	.	.	.	K#+	K#+	.	.	.	.	.	K#1	.	.	.
Rhynchosia spectabilis	FABA	.	#r	.	.	.	.	#+	#r	#r	#r	.	.	.	#r	.	.	.
Scilla natalensis	LILI	.	.	.	.	.	Nr	.	.	.	.	.	.	Nr	N+	.	.	.
Stylochaeton sp. (*S1332*)	ARAC	.	**$+**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Triaspis glaucophylla	MALP	.	.	#r	#r	#1	.	#r	.	.	.	.	.	#r	#r	.	.	.
Vitex obovata subsp. *wilmsii*	VERB	#r	.	#+	#+	#+	#r	#1	#1	#1	.	#+	#r	#+	#r	.	#r	.
Xerophyta retinervis [form] (*W13208*)	VELL	.	.	$1	$r	.	$r	$+	$+	$1	.	.	.	$+	$+	.	.	.
Zantedeschia pentlandii	ARAC	.	.	.	R#+	R#r	R#1	R#+	R#+	R#r	R#r	.	.	R#r	R#r	.	.	.
SCPE endemics		2	9	5	4	4	6	5	5	6	6	2	3	2	2	1	0	0
SCPE near-endemics		3	3	6	5	5	6	8	8	6	6	2	2	4	7	0	1	2
Red Data List		0	1	1	2	3	4	3	3	2	3	0	1	3	4	0	0	0
Restricted to association		0	4	0	0	3	3	1	1	0	2	0	0	0	0	0	0	2
Total for association		5	12	11	9	10	13	13	13	12	12	4	5	7	10	1	1	2

Endemism: $ = endemic, # = near-endemic; **Red Data List:** I = Indeterminate, K = Insufficiently Known, R = Rare, N = Not threatened in the northern provinces of South Africa, but in other areas of southern Africa; **Abundance in communities:** 1 = abundant, + = frequent, r = rare, . = absent; **Collectors:** S = Siebert, W = Van Wyk; **Bold blocks** represent community/syntaxon specific taxa.

Table 10 Environmental factors and selected attributes associated with the different plant communities of the Rock Outcrop Vegetation.

Factors/attributes	**Syntaxa**																
	I		II										III		IV		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Number of relevés	3	10	9	8	7	7	7	7	6	3	5	3	6	8	6	3	2
Total number of species	46	91	89	105	110	103	109	109	89	75	64	35	66	75	68	64	65
Average number of species per relevé	31	27	30	46	46	39	40	34	33	34	34	20	30	27	41	33	35
Number of endemics/ near-endemics	5	12	11	9	9	12	13	13	12	12	4	5	6	9	1	1	2
Number of Red Data List taxa	0	1	1	2	3	4	3	3	2	3	0	1	3	4	0	0	0
Geology*	H	N/P	N/P	N	N	N	M/N	F/N	N/P	N/P	H	N	N	N/P	N	A/N	N
Topographic position**	M/S	M/S	M/S	M/S	M/S	M/S	M/S	M/S	M/S	M/S	M/F	M/S	F/M/S	F/M/S	F/M	V	C
Slope (°)	1-3	0-1	3-7	5-15	3-15	1-3	3-7	1-5	1-5	1-3	1-3	3-9	1-3	3-9	3-7	3-5	1-3
Aspect	-	-	NE	N	S	-	NESW	NESW	SE	SW	-	SE	NSW	NESW	ESW	-	S
Predominant soil type***	Bo	Ms	Gs[1]/ Ms	My[1]/ Mw	My[1]/ Mw	Ms	Ms/ Mw	Ms[1]/ My	Gs/ Ms	Mw/ My	Sand	Sand	Sand	Sand	My[1]/ Oa	My[1]/ Oa	Oa

Table 10 continued.

Factors/attributes	Syntaxa																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Rock cover percentage (%)	70-80	60-90	70-90	45-50	45-60	70-80	50-60	60-80	60-80	50-70	60-70	20-40	70-80	60-90	10-40	20-70	20-40
Average rock size (mm)	5500-7000	2500-8000	2000-4500	500-1000	500-1000	4000-7000	2500-3000	3000-5000	2500-3500	1000-3500	3500-5500	> 500	> 10000	> 10000	1000-1500	500-1500	500-750

* A = alluvium; F = ferrogabbro; H = harzburgite; M = magnetite; N = norite; P = pyroxenite

** C = crest; S = scarp; M = midslope; F = footslope; V = valley

*** Bo = Bonheim; Gs = Glenrosa; Ms = Mispah; My = Mayo; Mw = Milkwood; Oa = Oakleaf (X[1] Dominant soil type)

Table 11 A key to the syntaxa of the Rock Outcrop Vegetation of the rocky hills of the Sekhukhuneland Centre of Plant Endemism.

Leads/description	Go to/syntaxon
1a Tall, moist woodland (*Celtis africana* & *Panicum deustum*)	**2**
b Short woodland, herbland and grassland (*Aloe castanea* & *Euclea crispa*)	**3**
2a Mountain crest (*Andrachne ovalis* & *Diospyros whyteana*)	17. *Andrachno ovalis–Allophylletum transvaalensis*
b Mountain slope and valley (*Pavonia burchellii* & *Ziziphus mucronata*)	**4**
3a Average rock size > 9 m (*Oldenlandia herbacea* & *Xerophyta retinervis*)	**5**
b Average rock size > 9 m (*Hippobromus pauciflorus*)	**6**
4a Valley (*Combretum erythrophyllum* & *Cassine aethiopica*)	16. *Fico sur–Combretetum erythrophyllii*
b Mountain slope (*Clausena anisata* & *Allophylus africanus*)	15. *Clauseno anisotae–Diospyretum whyteanae*
5a Slope 3-9° (*Xerophyta villosa* & *Melinis nerviglumis*)	14. *Crassulo sarcocaulis–Aristidietum transvaalensis*
b Slope 1-3° (*Euphorbia cooperi* & *Mundulea sericea*)	13. *Munduleo sericeae–Euphorbietum cooperi*
6a Open woodland or grassland (*Pavetta* sp. nov. & *Cymbopogon excavatus*)	**7**
b Closed woodland (*Ficus abutifolia* & *Croton gratissimus*)	**8**
7a Developed soils (*Combretum molle* & *Senecio latifolius*)	**9**
b Sand (*Heteropogon contortus*)	**10**
8a Mispah soil (*Commiphora marlothii* & *Barleria rotundifolia*)	2. *Commiphoro marlothii–Crotonetum gratissimi*
b Bonheim soil (*Mimusops zeyheri* & *Olinia emarginata*)	1. *Vepro reflexae–Mimusopetum zeyheri*
9a Glenrosa soil (*Xerophyta retinervis*)	**11**
b Other lithosols (*Apodytes dimidiata* & *Setaria sphacelata*)	**12**
10a Rock cover 20–40% (*Enteropogon macrostachys* & *Rhoicissus tridentata*)	12. *Enteropogono macrostachys–Hippobrometum pauciflori*
b Rock cover 60-70% (*Rhamnus prinoides* & *Cymbopogon validus*)	11. *Cymbopogono validi–Rhamnetum prinoidis*
11a South-easterly aspects (*Aloe pretoriensis* & *Cussonia transvaalensis*)	9. *Aloo pretoriensis–Xerophytetum retinervis*
b North-easterly aspects (*Grewia monticola* & *Elephantorrhiza praetermissa*)	3. *Grewio monticolae–Elephantorrhizetum praetermissae*
12a Variety of rock substrates (*Catha transvaalensis*)	**13**
b Restricted to norite (*Dombeya rotundifolia* & *Diospyros lycioides*)	**14**

Table 11 continued.

Leads/description	Go to/syntaxon
13a All aspects (*Scolopia zeyheri*)	**15**
b Southerly aspects (*Canthium mundianum* & *Ruellia stenophylla*)	10. *Tephrosio purpureae–Rhoicissetum tridentatae*
14a Slope 3-15° (*Setaria lindenbergiana* & *Rhus leptodictya*)	**16**
b Slope 1-3° (*Sanseviera aethiopica* & *Zantedeschia pentlandii*)	6. *Gerbero jamesonii–Kirkietum wilmsii*
15a Also on ferrogabbro (*Brachylaena rotundata* & *Gerbera jamesonii*)	8. *Cymbopogono excavati–Brachylaenetum rotundatae*
b Also on magnetite (*Brachiaria serrata* & *Ledebouria revoluta*)	7. *Brachiario serratae–Viticetum wilmsii*
16a Southerly aspect (*Buddleja auriculata* & *Halleria lucida*)	5. *Heteropogono contorti–Apodytetum dimidiatae*
b Northerly aspect (*Catha edulis* & *Melinis nerviglumis*)	4. *Melino nerviglumis–Cathetum edulis*

Table 12 The three most dominant and conspicuous plant taxa of each of the major vegetation types of the Rocky Outcrop Vegetation depicted in the DECORANA scatter diagram.

Major vegetation type	Trees/shrubs	Forbs/sedges	Grasses
I. *Rhoicissus sekhukhuniensis–Ficus abutilifolia*	*Croton gratissimus*	*Abutilon pycnodon*	*Andropogon schirensis*
	Ficus abutilifolia	***Rhoicissus sekhukhuniensis***	*Eragrostis nindensis*
	Vepris reflexa	*Sarcostemma viminale*	*Panicum deustum*
II. *Cymbopogon excavatus–Pavetta* sp. nov	*Hippobromus pauciflorus*	*Cyphostemma woodii*	***Cymbopogon excavatus***
	***Pavetta* sp. nov.**	*Rhoicissus tridentata*	*Panicum deustum*
	Vitex obovata subsp. *wilmsii*	*Senecio latifolius*	*Themeda triandra*
III. *Aristida transvaalensis–Crassula sarcocaulis*	*Aloe castanea*	***Crassula sarcocaulis***	***Aristida transvaalensis***
	Euclea crispa	*Crassula swaziensis*	*Eragrostis pseudosclerantha*
	Xerophyta retinervis	*Myrothamnus flabellifolia*	*Melinis nerviglumis*
IV. *Panicum deustum–Celtis africana*	*Allophylus africanus*	*Aloe arborescens*	***Panicum deustum***
	Celtis africana	*Lippia javanica*	*Panicum maximum*
	Diospyros whyteana	*Pavonia burchellii*	*Urochloa mosambicensis*

CHAPTER 7

OPEN MOUNTAIN BUSHVELD

7.1 Background

Although a number of phytosociological studies have been conducted on the bushveld (the local term equivalent to savanna) of ultramafic substrates in southern Africa (Werger *et al.* 1978; Van der Meulen 1979; Breebaart & Deutschlander 1997), several vegetation types on this type of substrate still remain poorly investigated. An example is the Mountain Bushveld identified by Siebert *et al.* (2002a) on the norite, pyroxenite and anorthosite hills and mountains of the SCPE (Van Wyk & Van Wyk 1997; Van Wyk & Smith 2001). Ultramafic mountains and hills are floristically noteworthy in that they harbour many endemics with distributions associated with this particular geological substrate (Iturralde 1995; Madulid & Agoo 1995; Siebert *et al.* 2001).

In many instances the distinction between two different plant communities in the SCPE is so pronounced, that a mere visual observation is all that is needed to observe the geological boundaries. Even when the underlying rocks are relatively similar, differences in vegetation can be observed. It has been noted that the most toxic ultramafic soils are the ones with the most depauperated vegetation types (Wild 1974). One of the most comprehensive surveys of vegetation in a single ultramafic region was conducted by Jaffré (1980) on the serpentine flora of New Caledonia. This series of papers on the vegetation of the 4 000 km^2 of ultramafic rock of the eastern Rustenburg Layered Suite is probably the most extensive in recent time.

Various vegetation types have been recognised on the adjacent dry dolomitic hills and mountains of the northeastern Drakensberg Escarpment (Matthews 1991; Matthews *et al.* 1992), an area adjacent to the SCPE with which it shows a definite floristic affinity (Siebert 1998). Acocks (1953) mapped the bushveld in the SCPE as three major veld types, namely

Mixed Bushveld (18), Sourish Mixed Bushveld (19) and North-Eastern Sandy Highveld (57). A more generalised classification of the same region's vegetation is given by Low & Rebelo (1996), who recognises only one major vegetation type, namely Mixed Bushveld (18). Only the plant communities of the *Combretum hereroense*–*Grewia vernicosa* Open Mountain Bushveld (Siebert *et al.* 2002a) are described in this chapter.

The area dealt with (Figure 11) is characterised by considerable diversity in geology (Kent 1980) and physiography (Land Type Survey Staff 1987; 1988; 1989), with the vegetation broadly described as undulating mountain bushveld, bordered by a Northeastern Sandy Highveld Grassland-mountain bushveld ecotone in the south and a mountain bushveld-Mixed Bushveld ecotone in the north. Most of the undulating hills and mountains of the region are predominantly covered by bushveld. The *Combretum hereroense*–*Grewia vernicosa* bushveld vegetation type is intermingled with the other major vegetation types of the SCPE, due to the heterogeneity in the environmental factors of the region (Siebert *et al.* (2002a). Fourty seven of the Sekhukhuneland endemics/near-endemics occur in this vegetation type (Siebert 1998).

Landform patterns exhibit complex behaviour (Werner 1999) and play an important role in the development of the local flora (White 1981; Siebert 1998). Two major physiographic entities are characteristic of the area of focus, namely, (1) mountain slopes and (2) valleys. Mountain slopes are defined as the scarps, midslopes and upper footslopes of undulating hills and mountains. Valleys are defined as the low-lying valleybottoms and lower footslopes between the hills and mountains, which are usually traversed by a stream, river or drainage channel.

The average annual rainfall is 578 mm (South African Weather Bureau 1998), but the rainfall pattern is strongly influenced by the local topography (Siebert 1998). Rainfall varies from as little as 400 mm in some of the valleys, to an estimated 550 mm on the lower slopes of the Leolo Mountains (Erasmus 1985). Temperatures for the study area range from 0°C to 38°C, with a daily average of 20°C (Weather Bureau 1998). The northern and western parts of the study area are on average warmer than the southern and eastern parts (Siebert 1998) and exhibit average daily temperatures of 28.3°C maximum and 7.2°C minimum.

7.2 Classification

The final TWINSPAN division of the main table (415 relevés) separated the *Kirkia wilmsii–Terminalia prunioides* Closed Mountain Bushveld from the *Combretum hereroense–Grewia vernicosa* Open Mountain Bushveld (Siebert *et al.* 2002a). This was a marginal division, with both bushveld vegetation types sharing the majority of their species and occurring in the same terrain types on mountain/hill slopes and in valleys. An eigenvalue of 0.39 (n = 194) was obtained at the division level, which indicates a suitable gradient between the two vegetation types for an accurate TWINSPAN. Ten significant preferential species were used for the division of the two vegetation types and are listed in Table 13, together with five non-preferential ones.

Analysis of the *Combretum hereroense–Grewia vernicosa* Open Mountain Bushveld resulted in the identification of 20 plant communities, which are grouped as eight associations and 18 sub-associations (Table 14). These were subsequently hierarchically classified. Two major groups are recognised on the grounds of the physical environment, namely mountain slopes or valleys. Hence, macro-climatic and/or geological variation plays a role in the development of the Open Mountain Bushveld, but terrain type (topography) is responsible for local differentiation of the plant communities. The major plant communities relate to soil character and slope, which are determined by the terrain type. Associations are distinctive and easily distinguishable in the field. This might be attributed to the uniformity of the environmental factors for each of the six major vgetation groups that ceated a distinct distribution pattern of habitats and associated vegetation.

The hierarchical classification of the vegetation reinforces the correlation between habitat and plant communities (Figure 12). The distribution of Sekhukhuneland Centre endemic/near-endemic and Red Data List taxa among various plant communities is listed in Table 15. A summary of selected community attributes is supplied in Table 16.

Plant communities of the *Combretum hereroense–Grewia vernicosa* Open Mountain Bushveld recognised in the Centre are classified as follows:

I. *Enneapogon scoparius–Combretum molle* community of mountain slopes

1. *Enteropogono macrostachyo–Sclerocaryetum birreae*
   - 1.1 *Enteropogono macrostachyo–Sclerocaryetum birreae asparagetosum sekukuniensis*
   - 1.2 *Enteropogono macrostachyo–Sclerocaryetum birreae grewietosum vernicosae*
2. *Enneapogono scoparii–Acacietum leiorachis*
   - 2.1 *Enneapogono scoparii–Acacietum leiorachis chloretosum virgatae*
   - 2.2 *Enneapogono scoparii–Acacietum leiorachis grewietosum flavescentis*
   - 2.3 *Enneapogono scoparii–Acacietum leiorachis brachylaenetosum ilicifoliae*
   - 2.4 *Enneapogono scoparii–Acacietum leiorachis commiphoretosum mollis*
3. *Phyllantho glaucophyllae–Brachylaenetum ilicifoli*
   - 3.1 *Phyllantho glaucophyllae–Brachylaenetum ilicifoli setarietosum sphacelatae*
   - 3.2 *Phyllantho glaucophyllae–Brachylaenetum ilicifoli brachiarietosum serratae*
4. *Tristachyo leucothricis–Cussonietum transvaalensis*
   - 4.1 *Tristachyo leucothricis–Cussonietum transvaalensis myrothamnetosum flabellifolius*
   - 4.2 *Tristachyo leucothricis–Cussonietum transvaalensis melinetosum nerviglumis*
   - 4.3 *Tristachyo leucothricis–Cussonietum transvaalensis argylobietosum wilmsii*
   - 4.4 *Tristachyo leucothricis–Cussonietum transvaalensis combretetosum zeyheri*

II. *Loudetia simplex–Combretum hereroense* community of valleys

5. *Eragrosti lehmannianae–Hippobrometum pauciflori*
   - 5.1 *Eragrostio lehmannianae–Hippobrometum pauciflori rhoetosum batophyllae*
   - 5.2 *Eragrosti lehmannianae–Hippobrometum pauciflori sorgetosum bicoloris*
   - 5.3 *Eragrosti lehmannianae–Hippobrometum pauciflori elionuretosum mutici*
6. *Aristido rhiniochloo–Gnidietum polycephalae*
7. *Loudetio simplicis–Eucleetum linearis*
   - 7.1 *Loudetio simplicis–Eucleetum linearis diheteropogonetosum amplectentis*
   - 7.2 *Loudetio simplicis–Eucleetum linearis heteropogonetosum contorti*
   - 7.3 *Loudetio simplicis–Eucleetum linearis andropogonetosum chinensis*
8. *Petalidio oblongifolii–Raphionacmetum procumbentis*

7.3 Description

The *Combretum hereroense–Grewia vernicosa* Open Mountain Bushveld is predominantly restricted to the warm slopes and valleys of undulating ultramafic hills and mountains. Surface rocks are predominant and abundant in the various habitats, with average rock size varying between 200 and 1 000 mm (20–70% surface cover) on the slopes of hills and between 100 and 400 mm (10–50% surface cover) in the valleys. The vegetation can be classified into broad-leaved woodlands (Edwards 1983). A noteworthy feature of this bushveld type is the fact that it constitutes a unique habitat or "island" which differs significantly from the surrounding habitats regarding microhabitat and vegetation.

I. *Enneapogon scoparius–Combretum molle* community of mountain slopes

Environmental data. The vegetation is an open broad-leaved bushveld of mountain slopes. The alliance is found on all aspects, but predominantly southern aspects. It occurs on steep slopes (3–18°) on mainly midslopes, but also to a lesser degree on scarps, crests and footslopes (Table 16). Soil is shallow and constitutes rocky Mispah and Glenrosa forms. The soil surface is covered by 20–70% of rock with an average diameter of 0.3–1 m (Table 16).

Diagnostic and dominant/prominent taxa. Diagnostic species are represented by species group S (Table 14) and include the trees *Combretum apiculatum*, *C. molle*, *Dombeya rotundifolia*, *Kirkia wilmsii* and *Ozoroa spahaerocarpa* and the shrubby climbers *Acacia ataxacantha* and *Asparagus laricinus*. Diagnostic grasses include *Enneapogon scoparius*, *Eragrostis chloromelas* and *Panicum maximum*. Diagnostic herbaceous taxa include the forbs *Justicia protracta*, *Thesium burkei* and *Tephrosia purpurea*. *Pellaea calomelanos* is the diagnostic fern and *Aloe castanea* the diagnostic succulent.

Notes on floristic diversity. Floristic links with the other alliance is visible in species groups W, AC, AF, AG and AH (Table 14). The weak links supports the recognition of the alliance. The average number of species encountered per sample plot for this alliance is 38, with the total number of plant species being a minimum of 130 taxa (55 relevés) (Table 16).

There are 35 plant taxa of conservation value, 21 are SCPE endemics, 12 are SCPE near-endemics and eight are Red Data List taxa (Table 15). Of these taxa, 11 are restricted to this alliance in the SCPE.

1. *Enteropogono macrostachyo–Sclerocaryetum birreae* ass. nova hoc loco
Nomenclatural type: relevé 413 (holotypus)

Environmental data. The vegetation representing this association is sparse short woodland on the lower slopes and foothills of the north-south trending Leolo Mountains. It is mostly found on the east and west aspects of the mountain range. The habitat is rocky with moderate slopes (3–7°) (Table 16). The dominant soil type is the Glenrosa form, an ortic A-horizon over a lithocutanic B. Average rock size varies from 200 to 750 mm in diameter and covers 10 to 70% of the soil surface.

Diagnostic and dominant/prominent taxa. Characteristic species are represented by species group A (Table 14). *Sclerocarya birrea* is the diagnostic tree of the association, *Hibiscus coddii* and *Stylochaeton natalensis* the diagnostic forbs, and *Enteropogon macrostachys* the diagnostis grass. Other dominant woody species include *Croton gratissimus*, *Dichrostachys cinerea* and *Grewia vernicosa*. *Heteropogon contortus* and *Themeda triandra* are the most dominant grasses and *Hibiscus coddii* the most conspicuous forb.

Notes on floristic diversity. This bushveld community is scarce in the SCPE and only a slight floristic affinity exist with other slope bushveld communities of the SCPE in species groups G and S (Table 14). Twelve taxa with conservation status are present in the association (Table 15), the lowest number recorded for an association in this paper. Nine are SCPE endemics and three are SCPE near-endemics, of which three are Red Data List taxa. Three of these plant taxa are restricted to the association. The average number of species encountered per sample plot is 31, with the total number for this association being a minimum of 64 plant taxa (six relevés) (Table 16).

1.1 *Enteropogono macrostachyo–Sclerocaryetum birreae asparagetosum sekukuniensis* sub-ass. nova hoc loco

Nomenclatural type: relevé 413 (holotypus)

Environmental data. The vegetation is sparse woodland on the western midslopes of the Leolo Mountains and its foothills. This association characterises exposed ferrogabbro with moderately sloped sides of 7° (Table 16). The surface rock cover percentage is relatively high, namely 60–70%, with the exposed rocks reaching average diameters for the study area, which is 500–750 mm in diameter (Table 16). The dominant soil type is the Glenrosa form.

Diagnostic and dominant/prominent taxa. In the SCPE this association is characterised by species group B (Table 14). *Combretum petrophilum, Croton menyhartii* and *Pavetta eylesii* are the diagnostic woody species of this syntaxon. Diagnostic forb species include *Asparagus intricatus, A. sekukuniensis, Boerhavia erecta* and *Hermannia floribunda*. The diagnostic grasses are *Botriochloa insculpta* and *Digitaria eriantha*. *Enteropogon macrostachys, Eragrostis chloromelas* and *Heteropogon contortus* are the most prominent grasses. *Corchorus asplenifolius, Evolvulus alsinoides* and *Tephrosia purpurea* are the dominant forbs. Other prominent plants are the woody species *Grewia vernicosa, Dichrostachys cinerea* and *Sclerocarya birrea*, and the suffrutex *Gymnosporia* sp. B (*Van Wyk 13052*).

Notes on floristic diversity. This plant community exhibits a strong floristic link with the slopes of Thaba Sekhukhune (sub-association 2.1) and the slopes of the Schurinksberg (sub-association 2.2) in species group G (Table 14). Eight plant taxa of conservation value occur in this sub-association (Table 15), namely five SCPE endemics and three SCPE near-endemics, of which three are Red Data List taxa. Three plant taxa of conservation value are restricted to this sub-association, namely an endemic form of *Asparagus intricatus*, the SCPE endemic *Asparagus sekukuniensis* (Insufficiently Known on the Red List) and the SCPE near-endemic *Combretum petrophilum* (Rare on the Red List). This is the highest number of taxa with conservation value restricted to a sub-association in this paper. The average number of species per relevé is 40, and the total number of species recorded for the association is 45 (two relevés) (Table 16).

1.2 *Enteropogono macrostachyo–Sclerocaryetum birreae grewietosum vernicosae* sub-ass. nova hoc loco
Nomenclatural type: relevé 337 (holotypus)

Environmental data. The vegetation is short open woodland on the northern and eastern midslopes and foothills of the Leolo Mountains. It is associated with predominantly exposed pyroxenite and norite (to the west of the study area it becomes ferrogabbro). The sub-association is found on gentle to moderate slopes (3–7°) (Table 16). Soils are predominantly of the Glenrosa form (in certain communities the Steendal form (melanic A-horizon over a soft carbonat horizon) intersperse with the lithosols). The soil surface is covered by 10–40% of rock with a diameter of 200–500 mm (Table 16).

Diagnostic and dominant/prominent taxa. Characteristic species of the association are represented by species group C (Table 14). Woody species diagnostic of the association include *Diospyros lycioides* subsp. *sericea*, *Rhigozum obovatum*, *Rhus gueinzii*, *Vangueria infausta*, the semi-succulent shrub *Senecio barbertonicus* and the woody climber *Rhoicissus tomentosus*. The diagnostic grasses are *Aristida transvaalensis*, *Sporobolus ioclados* and *S. nitens*. *Hemizygia albiflora* is the diagnostic forb. Other prominent trees of the sub-association are *Combretum hereroense*, *Croton gratissimus*, *Euclea crispa*, *Grewia vernicosa* and *Sclerocarya birrea*. Dominant grasses are *Eragrostis lehmanniana*, *Heteropogon contortus* and *Themeda triandra*. *Psiadia punctulata* is the most conspicuous forb of the sub-association.

Notes on floristic diversity. A notable floristic link exists with sub-associations 2.1 and 2.2, in species group G (Table 14). There are six plant taxa of conservation value in the association, the lowest number of all the sub-associations. Four taxa are SCPE endemics, two are SCPE near-endemics (both figures are of the lowest for the paper) and one is a Red Data List taxon (Table 15). None are restricted to the sub-association. The average number of species encountered per sample plot in this association is 27, with the total number of plant species being 64 taxa (4 relevés) (Table 16).

2. *Enneapogono scoparii–Acacietum leiorachis* ass. nova hoc loco
Nomenclatural type: relevé 249 (holotypus)

Environmental data. In the SCPE this association occurs as tall, dry woodland stands on mountain slopes running into the Steelpoort River Valley. The habitat of the association is heterogeneous with no two communities exhibiting the same environmental factors. It occurs on relatively steep slopes on all aspects of various geological substrates. Rock cover and average rock size vary considerably, namely 20–75% of the soil surface and a relatively large diameter of 0.4–1.5 m, respectively (Table 16).

Diagnostic and dominant/prominent taxa. Species group D contains the diagnostic species for this association, which are characterised by the tree *Acacia senegal* var. *leiorachis*, the shrub *Grewia flava*, and the grass *Aristida meridionalis* (Table 14). Other prominent species of the sub–association include the trees/shrubs *Brachylaena ilicifolia*, *Kirkia wilmsii*, *Tinnea rhodesiana* and *Triaspis glaucophylla*, the forbs *Asparagus laricinus*, *Commelina africana* and *Thesium burkei*, the succulent *Aloe cryptopoda*, and the grasses *Panicum maximum* and *Themeda triandra*.

Notes on floristic diversity. A strong floristic affinity exists with associations 3 and 4 in species groups R and S (Table 14), and a slight link exists with the valley vegetation in species groups W and AC. Twenty-one taxa of conservation value are part of the association, of which one is restricted to it (Table 15). There are 13 SCPE endemics, seven near-endemics and two Red Data List species. The average number of species encountered per sample plot in this sub-association is 39, with the total number of plant species being a minimum of 122 taxa (20 relevés) (Table 16).

2.1 *Enneapogono scoparii–Acacietum leiorachis chloretosum virgatae* sub-ass. nova hoc loco

Nomenclatural type: relevé 291 (holotypus)

Environmental data. This sub-association is tall, open woodland of the peripheral hills running along the western borders of the Centre. It occurs on the midslopes of the Thaba Sekhukhune and its associated foothills on northern and eastern aspects. The substrate is granofire and ferrogabbro, which give rise to Glenrosa form soils. The soil surface is covered by 30–40% rock, of an average size of 500–600 mm in diameter (Table 16). Slope of the habitat is moderately steep, usually 7–9°.

Diagnostic and dominant/prominent taxa. Diagnostic species are represented by species group E (Table 14). Diagnostic herbs include *Indigofera holubii*, *Justicia odora* and *Vigna unguiculata*. *Acacia nigrescens*, *Bridelia mollis*, *Grewia monticola*, *Maytenus senegalensis*, *Peltophorum africanum* and *Strychnos madagascariensis* are the diagnostis woody species. *Aristida bipartita*, *Chloris virgata*, *Eragrostis rigidior* and *Pogonarthria squarrosa* are the diagnostic grasses. The sub-association is dominated by small trees/shrubs of which *Acacia ataxacantha*, *Combretum apiculatum*, *C. molle*, *Dombeya rotundifolia*, *Kirkia wilmsii*, *Tinnea rhodesiana* and *Triaspis glaucophylla*, are the most dominant. Conspicuous succulents are *Aloe castanea* and *A. marlothii*. Dominant grasses include *Aristida canescens*, *Diheteropogon amplectens*, *Enneapogon scoparius*, *Sporobolus stapfianus* and *Themeda triandra*.

Notes on floristic diversity. It is doubtful whether this sub-association belongs with either association 1 or 2. This sub-association was included into association 2 on grounds of TWINSPAN. The community has a floristic identity with association 1 in species group G, and association 2 in species group D (Table 14). It is, however, excluded from association 2 in species groups R and S. Six taxa are of conservation significance—together with sub-association 1.2 the lowest number recorded for the paper. Three SCPE endemics, three near-endemics (both of the lowest numbers for the paper) and one Red Data List taxon, *Rhus sekhukhuniensis*, are found in this sub-association (Table 15). No taxa with conservation status are restricted to it. The average number of species encountered per sample plot is 36, with the total number for this variant being 55 (four relevés) (Table 16).

2.2 *Enneapogono scoparii–Acacietum leiorachis grewietosum flavescentis* sub-ass. nova hoc loco

Nomenclatural type: relevé 271 (holotypus)

Environmental data. This sub-association represents tall, open woodland with a well developed grass layer, of northern, southern and western aspects. The habitat is mostly restricted to pyroxenite, anorthosite and magnetite hills, where the grasslands of the Leolo and Roossenekal Subcentres meet the bushveld of the Steelpoort Subcentre (Siebert *et al.* 2002a). It occurs on midslopes and scarps, on ortic A-horizon and lithocutanic B-horizon soils of the Glenrosa and Mispah forms, as well as patches of pedocutanic soils types. It lies on gently sloped areas (3–5°). Rock cover on the surface is 20–30%, with rocks reaching a medium size of 0.4–1 m in diameter (Table 16).

Diagnostic and dominant/prominent taxa. No diagnostic species occur in this sub-association; it is characterised by the absence of the diagnostic species presented for sub-association 2.1 in species group F (Table 14). Dominant herbaceous taxa include the forbs *Barleria saxatilis*, *Leucas capensis*, *Monechma divaricatum*, *Orthosiphon fruticosus* and *Petalidium oblongifolium*. Dominant woody taxa include *Acacia senegal* var. *leiorachis*, *Brachylaena ilicifolia*, *Grewia flavescens*, *Jasminum multipartitum* and *Terminalia prunoides*. Dominant grasses are *Aristida canescens*, *Enneapogon scoparius*, *Sporobolus stapfianus* and *Themeda triandra*.

Notes on floristic diversity. The association has a grassland affinity with the Roossenekal Subcentre that is not obvious in Table 14. Species group G (Table 14) shows the relationship with association 1. Six SCPE endemics and six near-endemics were recorded in this sub-association (Table 15). Of its 12 taxa of conservation value, only one, a form of *Bauhinia tomentosa*, is restricted to it. This is the only sub-association in the study area with no Red Data List taxa present. The average number of species encountered per sample plot is 34. It has a total number of 78 plant taxa (four relevés) (Table 16).

2.3 *Enneapogono scoparii–Acacietum leiorachis brachylaenetosum ilicifoliae* sub-ass. nova hoc loco

Nomenclatural type: relevé 156 (holotypus)

Environmental data. This sub-association represents shorter open woodlands of hill slopes in the Steelpoort River Valley where it is restricted to southern aspects. It prefers midslopes and scarps of norite, pyroxenite and anorthosite hills with a moderate to steep slope (5–12°). It occurs on lithosols of the Mispah and Glenrosa forms. Approximately 35–60% of the soil surface is covered by rocks, with a medium size of 0.4–1 m in diameter (Table 16).

Diagnostic and dominant/prominent taxa. Characteristic species are represented by species group H (Table 14). The diagnostic species found in this variant are predominantly herbaceous, namely *Dolichos trilobus*, *Dyschoriste fischeri*, *Euryops transvaalensis*, *Felicia clavipilosa*, *Indigofera lydenburgensis* and the undescribed taxon, *Stylochaeton* sp. (*Siebert 1332*). The only diagnostic woody species is *Berchemia zeyheri*. Other conspicuous woody species are *Acacia senegal* var. *leiorachis*, *Brachylaena ilicifolia*, *Diospyros lycioides* subsp. *nitens*, *Dombeya rotundifolia*, *Grewia flava*, *Ormocarpum kirkii*, *Tarchonanthus camphoratus* and *Vitex obovata* subsp. *wilmsii*. Dominant grasses include *Aristida congesta*, *Enneapogon scoparius*, *Eragrostis curvula*, *Panicum deustum*, *P. maximum* and *Themeda triandra*.

Notes on floristic diversity. Floristic affinities for the sub-association are the same as for the association. However, in addition, it shows a floristic affinity with associations 4 and 5 in species group W (Table 14). Eleven SCPE endemics, seven SCPE near-endemics and one Red Data List species, *Elephantorrhiza praetermissa*, are found in this sub-association (Table 15). Of its 18 taxa of conservation value, not one is restricted to the sub-association. The average number of species encountered per sample plot is 42, which is the highest average in this paper (Table 16). It also has the second highest total number of plant taxa of all the sub-associations, namely 122 (six relevés) (Table 16).

2.4 *Enneapogono scoparii–Acacietum leiorachis commiphoretosum mollis* sub-ass. nova hoc loco

Nomenclatural type: relevé 249 (holotypus)

Environmental data. This vegetation type is tall woodland, dominated by herbs, and associated with scarps on all aspects of exposed norite, pyroxenite and anorthosite hills in the Steelpoort River Valley. The sub-association occurs on soils of the Mispah form. It lies on relatively steep sloped areas (9–15°). Rock cover of the surface is high, between 45 and 75%, with a relatively large average rock diameter between 0.5–1.5 m (Table 16).

Diagnostic and dominant/prominent taxa. Diagnostic species for this sub-association are listed in species group I (Table 14). Diagnostic trees/shrubs are *Commiphora mollis* and *Sterculia rogersii*, and diagnostic forbs are *Clerodendrum ternatum* and *Ipomoea magnusiana*. No diagnostic grasses occur. Prominent small trees/shrubs for this vegetation unit are *Acacia senegal* var. *leiorachis*, *Combretum apiculatum*, *Elephantorrhiza praetermissa*, *Jasminum multipartitum*, *Kirkia wilmsii* and *Terminalia prunoides*. *Enneapogon scoparius*, *Heteropogon contortus*, *Panicum deustum* and *Themeda triandra* dominate the grass layer. The herbaceous layer is prominent and includes species such as *Asparagus laricinus*, *Chaetacanthus costatus*, *Commelina africana*, *Jatropha latifolia*, *Justicia protracta*, *Psiadia punctulata* and *Xerophyta retinervis*.

Notes on floristic diversity. Floristic affinities for the sub-association are the same as for the association. However, in addition, it shows a floristic affinity with associations 4 and 5 in species group W (Table 14). Fifteen plant taxa with conservation value are part of this sub-association, of which eight are SCPE endemics, seven are SCPE near-endemics and one is a Red Data List taxon (Table 15). No taxa with conservation value are restricted to the sub-association. The average number of species encountered per sample plot is 40, with the total number of plant species being 99 (six relevés) (Table 16).

3. *Phyllantho glaucophyllae–Brachylaenetum ilicifoli* ass. nova hoc loco

Nomenclatural type: relevé 175 (holotypus)

Environmental data. This is typical intra-zonal short woodland on exposed rocks of norite, pyroxenite and anorthosite. This vegetation anomaly occurs on midslopes and crests of undulating hills. The habitat has a rather variable slope of 7–12°, restricted to mostly southern aspects. Soils are typical of the Glenrosa form. Average rock diameter is 0.1–1.5 m and it covers 30–70% of the soil surface (Table 16).

Diagnostic and dominant/prominent taxa. Species group J, K and Q (Table 14) contains the characteristic species for this association, with no species shared exclusively between the sub-associations. Therefore the diagnostic species will be listed under each of the sub-associations. Dominant taxa of the association include the trees/shrubs *Brachylaena ilicifolia*, *Diospyros lycioides* subsp. *nitens*, *Elephantorrhiza praetermissa*, *Euclea* sp. (*Siebert 934*), *Rhus keettii*, *Tinnea rhodesiana* and *Vitex obovata* subsp. *wilmsii*. Dominant forbs are also frequent and include *Asparagus suaveolens*, *Berkheya insignis* (form), *Gnidia caffra* (form), *Orthosiphon fruticosus* and *Phyllanthus glaucophylla*. *Pellaea calomelanos* is a common fern in the association. Abundant grasses are *Brachiaria serrata*, *Setaria sphacelata*, *Tristachya leucothrix*, and especially *Heteropogon contortus* and *Themeda triandra*.

Notes on floristic diversity. This association is floristically related to both associations 2 and 4 in species groups D and Q (Table 14). It is debateable whether these associations exist, and it is speculated that they represent ecotones between the *Enneapogono scoparii–Acacietum leiorachis* and *Tristachyo leucothricis–Cussonietum transvaalensis*. Of the 20 taxa of conservation value in this association, 13 are SCPE endemics and seven SCPE near-endemics, of which two are Red Data List taxa (Table 15). The Red Data List taxa, *Elephantorrhiza praetermissa* and *Jamesbrittenia macrantha*, are present in both sub-associations. No taxa of conservation value are restricted to the association only. The average number of species encountered per sample plot is 36. The total number of plant species for this association is a minimum of 71 (12 relevés) (Table 16).

3.1 *Phyllantho glaucophyllae–Brachylaenetum ilicifoli setarietosum sphacelatae* sub-ass. nova hoc loco

Nomenclatural type: relevé 171 (holotypus)

Environmental data. This is woodland with a well-developed grass layer on midslopes of southern aspects. It occurs on hills of pyroxenite, norite and anorthosite. Soils are of the Glenrosa form (ortic A-horizon) and are underlain by rock. The soil surface is amply covered by 40–70% rock, of a relatively large average size of 0.5–1.5 m in diameter (Table 16). Slope of the habitat is usually steep and average 7–12°.

Diagnostic and dominant/prominent taxa. Diagnostic species are represented by species group J (Table 14). The community is characterised by diagnostic species, such as the forb *Barleria lancifolia*, the succulent *Aloe verecunda*, and the grasses *Hyparrhenia hirta* and *Setaria lindenbergiana*. Dominant woody species are *Brachylaena ilicifolia*, *Combretum apiculatum*, *Hippobromus pauciflorus*, *Tarchonanthus camphoratus* and *Vitex obovata* subsp. *wilmsii*. *Themeda triandra* and *Setaria sphacelata* are the most dominant grasses, with other conspicuous grasses including *Brachiaria serrata*, *Heteropogon contortus* and *Tristachya leucothrix*. Prominent forbs are *Barleria saxatilis*, *Justicia protracta*, *Leucas capensis*, *Orthosiphon fruticosus* and *Phyllanthus glaucophylla*.

Notes on floristic diversity. The community has a floristic affinity with associations 2 and 4 (Table 14). Ten SCPE endemics, six near-endemics and two Red Data List taxa are found in this sub-association (Table 15). Altogether it has 16 taxa of conservation value of which none are restricted to the sub-association. The average number of species encountered per sample plot is 40, with the total number for this variant being 71 (four relevés) (Table 16).

3.2 *Phyllantho glaucophyllae–Brachylaenetum ilicifoli brachiarietosum serratae* sub-ass. nova hoc loco

Nomenclatural type: relevé 124 (holotypus)

Environmental data. This sub-association represents short woodlands on the crests or midslopes of pyroxenite, norite and anorthosite hills. It usually occurs on soils of the Glenrosa form. The habitat lies on relatively level sloped areas. Rock cover on the surface is 30–40%, with rocks reaching an average size of 100–300 mm in diameter (Table 16).

Diagnostic and dominant/prominent taxa. Diagnostic species are presented in species group K (Table 14). Diagnostic herbaceous taxa include forbs such as *Helichrysum harveyanum*, *Hermannia boraginiflora*, *Thesium magalismontanum*, and the fern-ally, *Selaginella dregei*. The tree, *Acacia caffra*, is the diagnostic woody species. No diagnostic grasses occur. Other important dominant taxa are small trees/shrubs such as *Brachylaena ilicifolia*, *Elephantorrhiza praetermissa*, *Grewia vernicosa*, *Tinnea rhodesiana* and *Vitex obovata* subsp. *wilmsii*, and the suffrutex *Euclea* sp. (*Siebert 934*). Grasses such as *Brachiaria serrata*, *Enneapogon scoparius*, *Heteropogon contortus*, *Themeda triandra* and *Tristachya leucothrix* are the most dominant in the sub-association. *Berkheya insignis*, *Justicia protracta*, *Kyphocarpa angustifolia*, *Phyllanthus glaucophylla*, *Rhynchosia spectabilis* and *Tephrosia purpurea* are the prominent forbs.

Notes on floristic diversity. This sub-association has a floristic link with association 4 (Table 14). Eleven SCPE endemics, six near-endemics and two Red Data List taxa are found in this sub-association (Table 15). There are 17 taxa of conservation value in this sub-association, with none of these restricted to it. The average number of species encountered per sample plot is 35, with a total number of 60 plant taxa (five relevés) (Table 16).

4. *Tristachyo leucothricis–Cussonietum transvaalensis* ass. nova hoc loco

Nomenclatural type: relevé 169 (holotypus)

Environmental data. This association represents open tall woodlands on cool, predominantly southernly aspects of ferrogabbro, norite, pyroxenite and anorthosite hills. It occurs on midslopes and scarps on clay lithosols of the Glenrosa and Mispah forms. It lies on relatively steep sloped areas (5–18°). Rock cover on the surface is average, between 25–60%, with rocks reaching a large average size of 0.5–1.5 m in diameter (Table 16).

Diagnostic and dominant/prominent taxa. Diagnostic species are presented in species group L (Table 14). Diagnostic herbaceous taxa include forbs such as *Gerbera ambigua* and *Senecio scitus*. Diagnostic woody species are the trees *Cussonia transvaalensis* and *Faurea saligna*, and the suffrutex *Gymnosporia* sp. nov. B (*Van Wyk 13052*). Other important dominant taxa are small trees/shrubs, namely *Acacia ataxacantha*, *Catha edulis*, *Diospyros lycioides* subsp. *nitens*, *Elephantorrhiza praetermissa*, *Rhoicissus tridentata* and *Vitex obovata* subsp. *wilmsii*. Grasses dominate the association, especially *Heteropogon contortus*, *Setaria sphacelata*, *Themeda triandra* and *Tristachya leucothrix*. Prominent forbs are *Berkheya insignis*, *Orthosiphon fruticosus*, *Rhynchosia spectabilis*, *Senecio latifolius* and the fern *Pellaea calomelanos*.

Notes on floristic diversity. The association has a strong link with association 3 in species group R and associations 2 and 5 in species group W (Table 14). Thirty taxa of conservation value are part of this association, the highest number recorded for any of the associations and sub-associations in the study area. Eighteen SCPE endemics, 11 SCPE near-endemics and six Red Data List taxa are found in this association (Table 15). Of its 30 taxa of conservation value, four taxa are restricted to it. The average number of species encountered per sample plot is 41, with a minimum total number of 130 plant taxa (17 relevés) (Table 16).

4.1 *Tristachyo leucothricis–Cussonietum transvaalensis myrothamnetosum flabellifolius* sub-ass. nova hoc loco

Nomenclatural type: relevé 237 (holotypus)

Environmental data. In the SCPE this sub-association represents a wooded herbland on Glenrosa form soils. The habitat is found on midslopes and crests of undulating pyroxenite, norite and anorthosite hills (Table 16). Slope has an inclination to be level, but can be up to

5°. Southernly aspects are the norm. Rock cover percentage is average and varies from 25–60% and rock size between 300–500 mm in diameter (Table 16).

Diagnostic and dominant/prominent taxa. Species group M contains the characteristic species for this sub-association (Table 14), with diagnostic species including herbaceous taxa, namely the grass *Eragrostis pseudosclerantha*, the forbs *Myrothamnus flabellifolius*, *Oldenlandia herbacea* and *Xerophyta villosa*, and the fern *Ceterach cordatum*. Other prominent taxa include the grasses *Eliomurus muticus*, *Enneapogon scoparius* and *Heteropogon scoparius*, the forbs *Jamesbrittenia macrantha*, *Orthosiphon fruticosus* and *Senecio latifolius*, the succulents *Aloe cryptopoda* and *Euphorbia schinzii*, and the woody species *Elephantorrhiza praetermissa*, *Ozoroa sphaerocarpa*, *Rhus keetii* and *Vitex obovata* subsp. *wilmsii*.

Notes on floristic diversity. This sub-association follows the floristic link of the association (Table 14). Ten SCPE endemics, five near-endemics and two Red Data List taxa are present in this sub-association (Table 15). There are 15 taxa of conservation value in this sub-association, with none of these restricted to it. The average number of species encountered per sample plot is 32, with a total number of 63 plant taxa (three relevés) (Table 16).

4.2 *Tristachyo leucothricis–Cussonietum transvaalensis melinetosum nerviglumis* sub-ass. nova hoc loco

Nomenclatural type: relevé 208 (holotypus)

Environmental data. This sub-association is open, sparse woodland of ferrogabbro and pyroxenite hills, on midslopes and scarps of southern aspects. It occurs on red clay soils of the Glenrosa and Mispah forms. The soil surface is covered by 30–60% rock, which is of a large average size of 0.5–1 m in diameter (Table 16). Slope of the habitat is usually steep, between 7–15°.

Diagnostic and dominant/prominent taxa. Diagnostic species are represented by species group N (Table 14). The community is characterised by diagnostic forbs such as

Barleria wilmsiana, *Drimiopsis atropurpurea*, *Plectranthus xerophilus* and *Schistostephium heptalobum*. *Melinis nerviglumis* is the diagnostic grass. No diagnostic woody species occur. Dominant woody species are the shrubs *Elephantorrhiza praetermissa*, *Pavetta* sp. nov. and *Rhoicissus tridentata*, and the small trees *Acacia ataxacantha*, *Faurea saligna* and *Vitex obovata* subsp. *wilmsii*. Important conspicuous grasses include *Andropogon schirensis*, *Diheteropogon amplectens*, *Heteropogon contortus*, *Tristachya leucothrix* and *Themeda triandra*. Abundant forbs in the sub-association are *Commelina africana*, *Senecio latifolius*, *Sphedamnocarpus pruriens* and the fern *Pellaea calomelanos*.

Notes on floristic diversity. The sub-association shows the same floristic relationships as the association (Table 14). This plant community has the highest conservation value of all the sub-associations in the study area. The highest number of SCPE endemics, namely 15, the highest number of SCPE near-endemics, namely 10, and the highest number of Red Data List taxa, namely five, are found in this sub-association (Table 15). Of its 25 taxa of conservation value, the highest recorded for the sub-associations, one taxon, the near-endemic *Plectranthus xerophilus*, is restricted to it. The average number of species encountered per sample plot is 42, together with sub-association 2.3 the highest average recorded in this study (Table 16). The total number of plant taxa recorded for this sub-association is 130 (six relevés) (Table 16), also the highest recorded in the study area..

4.3 *Tristachyo leucothricis–Cussonietum transvaalensis argylobietosum wilmsii* sub-ass. nova hoc loco

Nomenclatural type: relevé 169 (holotypus)

Environmental data. The sub-association is short woodland with a well developed grass layer on the scarps of undulating norite, pyroxenite and anorthosite hills. It lies on south-facing steep slopes of 7–18°. Soils are characteristically a red clay soil of the Mispah form. Approximately 40–60% of the soil surface is covered by rocks, with a large average size of 0.5–1 m in diameter (Table 16).

Diagnostic and dominant/prominent taxa. No diagnostic species represent this sub-association. However, species group O contains the characteristic species of the community, with the sub-association being recognised due to the absence of the taxa in species group N (Table 14). Important trees/shrubs of the association are *Cussonia transvaalensis*, *Diospyros lycioides* subsp. *nitens*, *Elephantorrhiza praetermissa*, *Pavetta* sp. nov., *Rhoicissus tridentata*, *Tarchonanthus camphoratus* and *Vitex obovata* subsp. *wilmsii*. Prominent forbs are *Argyrolobium wilmsii*, *Berkheya insignis*, *Orthosiphon fruticosus* and the fern *Pellaea calomelanos*. *Enneapogon scoparius*, *Heteropogon contortus*, *Setaria sphacelata*, *Themeda triandra* and *Tristachya leucothrix* are the most abundant grasses.

Notes on floristic diversity. The sub-association shows the same floristic relationships as the association. It has a strong floristic link with sub-association 4.1 in species group O (Table 14). Twenty-three taxa of conservation value occur in this sub-asociation, the second highest number in the study area (Table 15). These are 14 SCPE endemics, second highest for the study, eight SCPE near-endemics and four Red Data List taxa, also the second highest number for the study (Table 15). One plant taxon with conservation value is restricted to it, namely *Scilla natalensis*, a species classified as Vulnerable in the Free State and KwaZulu-Natal. The average number of species encountered per sample plot in this sub-association is 41, with the total number of plant species being 96 taxa (seven relevés) (Table 16).

4.4 *Tristachyo leucothricis–Cussonietum transvaalensis combretetosum zeyheri* sub-ass. nova hoc loco
Nomenclatural type: relevé 235 (holotypus)

Environmental data. This vegetation type is tall open woodland of cool south and east slopes of pyroxenite hills. It lies on moderately sloped midslopes and scarps (5–9°). The community is restricted to soils of the Glenrosa form. Approximately 30–45% of the soil surface is covered by rocks, with a large average diameter of 0.5–1.5 m (Table 16).

Diagnostic and dominant/prominent taxa. Diagnostic species are represented by species group P (Table 14). Only one grass species, *Setaria incrassata*, is diagnostic of the sub-association. *Nidorella hottentotica* and *Solanum panduriforme* are the diagnostic forbs, and *Combretum zeyheri* and *Elaeodendron transvaalensis* the diagnostic trees. Prominent trees of the sub-association are *Combretum apiculatum*, *C. molle*, *Cussonia transvaalensis*, *Diospyros lycioides* subsp. *nitens*, *Dombeya rotundifolia* and *Vitex obovata* subsp. *wilmsii*. Dominant herbaceous taxa include the forbs *Asparagus suaveolens*, *Rhynchosia spectabilis* and *Senecio latifolius*, and the grasses *Heteropogon contortus*, *Themeda triandra* and *Tristachya leucothrix*.

Notes on floristic diversity. The sub-association shows the same floristic relationships as the association. Sixteen plant taxa with conservation value occur in this sub-association and comprise ten SCPE endemics, six SCPE near-endemics and two Red Data List taxa (Table 15). No plant taxon with conservation value is restricted to it. The average number of species encountered per sample plot is 41 and the total number of plant species for this sub-association is 95 (four relevés) (Table 16).

II. *Loudetia simplex–Combretum hereroense* community of valleys

Environmental data. In the SCPE this alliance is characterised by open bushveld anomalies on undulating footslopes and valleys, which forms an extensive mosaic with the typical vegetation of such areas, namely microphyllous thornveld. It is restricted to deep sandy to loam soils. It occurs on varying slopes of 1–5° on all aspects. Rocks can cover 30–65% of the soil surface and are an average diameter of 100–400 mm (Table 16).

Diagnostic and dominant/prominent taxa. Species group AE contains the diagnostic species for this alliance, which includes the tree *Bolusanthus speciosus*, the grasses *Andropogon chinensis*, *Aristida adscensionis*, *Elionurus muticus* and *Loudetia simplex* and forbs such as *Aloe burgersfortensis*, *Dicoma gerrardii* and *Rhynchosia komatiensis* (Table 14). Other prominent species of the alliance include the shrubs *Combretum hereroense*, *Rhus keetii* and *Tinnea rhodesiana*, with the ground layer dominated by the grasses *Diheteropogon amplectens* and *Heteropogon contortus*.

Notes on floristic diversity. This alliance shows several floristic relationships with the other alliance, hence indicating that it forms part of the Open Mountain Bushveld (Table 14). The average number of species encountered per sample plot in this alliance is approximately 32, with the total number of plant species being a minimum of 98 taxa (36 relevés) (Table 16). Thirty-seven taxa of conservation value are part of the alliance, comprising 21 SCPE endemics, 16 SCPE near-endemics and seven Red Data List taxa, of which 13 are restricted to it (Table 15).

5. *Eragrosti lehmannianae–Hippobrometum pauciflori* ass. nova hoc loco
Nomenclatural type: relevé 133 (holotypus)

Environmental data. Association on alluvium and scattered patches of exposed pyroxenite of valleys and footslopes. This vegetation type is characteristic of the large river valleys of the SCPE. It occurs predominantly as scattered thickets in dongas or eroded areas. Soils are sandy (Hutton form) or have a pedocutanic B-horizon (Bonheim and Valsrivier form). The habitat occurs on all aspects and is gently sloped (1–3°). Approximately 10–50(–80)% of the soil surface is covered by stones with a relatively large average diameter of 100–350 mm (Table 16).

Diagnostic and dominant/prominent taxa. Diagnostic species are represented in species group T (Table 14). The vegetation unit is dominated by trees and shrubs, with diagnostic woody species including *Acacia karroo*, *Mimusops zeyheri* and *Schotia brachypetala*. *Eragrostis lehmanniana* is the only diagnostic grass. No forbs are diagnostic of the association. Prominent plant taxa of the association include the forbs *Polygala hottentotta* and *Psiadia punctulata*, the grasses *Brachiaria serrata*, *Diheteropogon amplectens*, *Loudetia simplex* and *Panicum deustum*, and the woody species *Cassine aethiopica*, *Combretum hereroense*, *Hippobromus pauciflorus* and *Tinnea rhodesiana*.

Notes on floristic diversity. A strong floristic affinity exists with the mountain bushveld of the region in species group W (Table 14), due to the suitable microhabitats created by the dongas. This association has 24 plant taxa with conservation value, the third highest of all the associations. Of these 15 are SCPE endemics, nine SCPE near-endemics and two are

Red Data List taxa (Table 15). One taxon is restricted to the association. The average number of species encountered per sample plot is 26, with the total number of plant species being a minimum of 60 taxa (11 relevés) (Table 16).

5.1 *Eragrostio lehmannianae–Hippobrometum pauciflori rhoetosum batophyllae* sub-ass. nova hoc loco

Nomenclatural type: relevé 252 (holotypus)

Environmental data. The vegetation type is a scattered thicket on the slopes of dongas in the large valleys to the east of the Leolo Mountains. It occurs on no specific aspect and these are gently sloped (1–3°). It is found predominantly on deep (> 1 000 mm) soils of the Bonheim and Valsrivier forms. A low rock cover of approximately 10–20% characterise the soil surface, with an average size of 100–150 mm in diameter (Table 16).

Diagnostic and dominant/prominent taxa. Characteristic species are presented in species group U (Table 14). There are no diagnostic herbaceous species for this sub-association. *Catha transvaalensis*, *Dodonaea angustifolia*, *Olea europaea* and *Rhus batophylla* are the diagnostic trees/shrubs. *Bolusanthus speciosus*, *Brachylaena ilicifolia*, *Combretum hereroense* and *Hippobromus pauciflorus* are the dominant trees, *Psiadia punctulata* and *Rhynchosia komatiensis* the prominent forbs, and *Andropogon chinensis*, *Aristida adscensionis*, *Diheteropogon amplectens*, *Eragrostis lehmanniana* and *Panicum deustum* the most abundant grasses.

Notes on floristic diversity. Floristic relationships are the same as for the association. There are ten plant taxa of conservation value in this sub-association (Table 15), namely eight SCPE endemics, two SCPE near-endemics (together with sub-association 1.2 the lowest number recorded in the study) and one Red Data List taxon, *Rhus batophylla*. None of these taxa are restricted to the sub-association. The average number of species encountered per sample plot in this sub-association is 25, with the total number of plant species being 37 taxa (five relevés) (Table 16). Both these values are the second lowest numbers recorded during the study.

5.2 *Eragrosti lehmannianae–Hippobrometum pauciflori sorgetosum bicoloris* sub-ass. nova hoc loco

Nomenclatural type: relevé 137 (holotypus)

Environmental data. This is scattered thicket of eroded sandy and clay soils. It lies in gently sloped valleys of 1–3° on all aspects. The substrate is alluvium and soils are predominantly of the Hutton and Bonheim forms. Approximately 10–50% of the soil surface is covered by large rocks, with a diameter of 100–250 mm (Table 16).

Diagnostic and dominant/prominent taxa. Diagnostic species are represented by species group V (Table 14). Small trees/shrubs are diagnostic of this community, namely *Acacia tortilis*, *Carissa bispinosa*, *Euclea divinorum*, *Rhus engleri* and *Ximenia americana*. No diagnostic herbs occur, but *Panicum natalense* and *Sorghum bicolour* are the diagnostic grasses. Other taxa of importance are the grasses *Brachiaria serrata*, *Diheteropogon amplectens*, *Heteropogon contortus*, *Loudetia simplex*, *Panicum deustum* and *Themeda triandra*. The conspicuous forbs are the succulent *Aloe burgersfortensis*, and the herbaceous *Dicoma gerrardii*, *Petalidium oblongifolium* and *Psiadia punctulata*. Most abundant small trees/shrubs are *Balanites maughamii*, *Bolusanthus speciosus*, *Combretum hereroense* and *Terminalia prunoides*.

Notes on floristic diversity. Floristic relationships are the same as for the association. There are 19 taxa of conservation value in this sub-association, namely 11 SCPE endemics, eight SCPE near-endemics and one Red Data List taxon (Table 15). One taxon with conservation value, namely the near-endemic *Rhus engleri* (common on the adjacent Springbok Flats) is restricted to it. The average number of species encountered per sample plot is 16, with the total number of plant species being 20 taxa (three relevés) (Table 16). Both these values are the lowest recorded for this major vegetation type.

5.3 *Eragrosti lehmannianae–Hippobrometum pauciflori elionuretosum mutici* sub-ass. nova hoc loco

Nomenclatural type: relevé 332 (holotypus)

Environmental data. In the SCPE this sub-association represents dense, tall thicket. It is common on southerly and westerly aspects of footslopes merging into valleys. The habitat is characterised by erosion on alluvium and exposed layers of pyroxenite rock. Average rock diameter is approximately 100–350 mm, covering a high percentage (40–80%) of soil surface (Table 16). It is characterised by gentle slopes (1–3°). Soil types are characterised as a red apedale B-horizon under an ortic A-horizon, and is classified as the Hutton form (Table 16).

Diagnostic and dominant/prominent taxa. There are no diagnostic species for this sub-association. The community is recognised on grounds of the absence of species from species groups U and V (Table 14), which are diagnostic for the other two sub-associations of the association. Prominent plant taxa include the woody species *Acacia karroo*, *Combretum hereroense*, *Euclea crispa*, *Grewia vernicosa* and *Tinnea rhodesiana*. Conspicuous forbs are *Commelina africana*, *Dicoma gerrardii* and *Indigofera hilaris*. *Aristida congesta*, *Brachiaria serrata*, *Elionurus muticus*, *Heteropogon contortus*, *Loudetia simplex* and *Panicum deustum* are the most abundant grasses.

Notes on floristic diversity. Floristic relationships are the same as for the association. There are 11 taxa with conservation value occurring in the association, namely seven SCPE endemics, four SCPE near-endemic and one Red Data List taxon (Table 15). The average number of species encountered per sample plot is 39, with the total number of plant species being 60 taxa (three relevés) (Table 16).

6. *Aristido rhiniochloo–Gnidietum polycephalae* ass. nova hoc loco

Nomenclatural type: relevé 387 (holotypus)

Environmental data. This association represents disturbed valley thornveld. It is associated with the areas between rural settlements and the associated abandoned fields. It is a vegetation unit on predominantly red Hutton soils clay soils, which are interspersed with areas of the Bonheim form. This community occurs in large river valleys that are heavily disturbed by agriculture, mining and rural settlement. The slope is more or less level (1°). Rock cover percentage varies from 30 to 40% and average rock diameter is from 50–150 mm (Table 16).

Diagnostic and dominant/prominent taxa. Species group X contains the diagnostic species for this association (Table 14). Trees are diagnostic of the sub-association, namely the succulents *Agave sisalana* (an alien) and *Euphorbia tirucalli*, and the small tree/shrubs *Acacia nilotica*, *Nuxia gracilis* and *Rhus sekhukhuniensis*. Diagnostic forbs include *Chascanum hederaceum*, *Geigeria burkei*, *Gnidia polycephala* and *Pechuel-Loeschea leubnitzia*. *Aristida rhiniochloa*, *Eragrostis capensis*, *Stipagrostis hirtigluma* var. *patula* and *Urochloa panicoides* are the diagnostic grasses. Other important dominant taxa include the woody species *Bolusanthus speciosus*, *Combretum hereroense*, *Euclea crispa*, *Grewia vernicosa*, *Rhus keetii* and the suffrutex *Euclea* sp. (*Siebert 934*). Prominent forbs are the succulent *Aloe cryptopoda*, and the herbaceous *Dicoma gerrardii*, *Jamesbrittenia* sp. (*Van Wyk 13026*), *Ledebouria marginata* and *Polygala* sp. (*Siebert 449*).

Notes on floristic diversity. A floristic link exists with association 7 in species group AB and other associations in species groups AF and AG (Table 14). There are 21 taxa with conservation value occurring in this association, namely 12 SCPE endemics, nine SCPE near-endemics and four Red Data List taxa (Table 15). Of these three are restricted to it, namely the Endangered endemic *Euphorbia barnardii*, and the disjunct near-endemics *Gnidia polycephala* and *Nuxia gracilis* (Insufficiently Known Red Data List species). The average number of species encountered per sample plot is 35, and the total number of plant species for this association is 98 (four relevés) (Table 16).

7. *Loudetio simplicis–Eucleetum linearis* ass. nova hoc loco
Nomenclatural type: relevé 218 (holotypus)

Environmental data. This vegetation type is open shrublands in the valleys between mountains. The habitat is predominantly underlain by alluvium, as well as by norite, pyroxenite and magnetite. It lies on gentle slopes of 1–5°, on all aspects. Soils are predominantly the Valsrivier form, but are interspersed with patches of either the Bonheim or Mispah forms. Soil surface cover by rock is average for the study area, 10–65%, with a diameter averaging between 100–500 mm (Table 16).

Diagnostic and dominant/prominent taxa. The diagnostic species are represented by species group Y (Table 14), with the woody species, *Euclea linearis*, dominating the association. The following forbs are diagnostic, *Evolvulus alsinoides*, *Giegeria ornativa*, *Helichrysum uninervium*, *Jamesbrittenia burkeana*, *Kohautia caespitosa*, *Pterothrix spinescens* and *Seddera capensis*. There are no diagnostic grasses. *Rhus keetii*, *Tinnea rhodesiana* and *Vitex obovata* subsp. *wilmsii* are other prominent shrubs of the association. Important dominant grasses include *Andropogn chinensis*, *Aristida canescens*, *Diheteropogon amplectens*, *Loudetia simplex* and *Themeda triandra*. Common forbs are *Dicoma gerrardii*, *Indigofera hilaris* and *Rhynchosia komatiensis*.

Notes on floristic diversity. The association shows a slight floristic link with association 6 in species group AB (Table 14). This association has the second highest number of taxa with conservation status, namely 26. Of these 15 are SCPE endemics, 11 SCPE near-endemics and four Red Data List taxa (Table 15). Three taxa of conservation value are restricted to the association, specifically the near-endemic *Helichrysum uninervium* and the biogeographically significant disjunct *Pterothrix spinescens*. The average number of species encountered per sample plot is 35, with the total number for this association being a minimum of 85 plant taxa (17 relevés) (Table 16).

7.1 *Loudetio simplicis–Eucleetum linearis diheteropogonetosum amplectentis* sub-ass. nova hoc loco

Nomenclatural type: relevé 146 (holotypus)

Environmental data. This sub-association is an open shrubland on all aspects of footslopes and valleys in the Steelpoort River Valley. It is associated with alluvium on norite and pyroxenite substrates. The habitat is relatively level, although undulating, with a gentle slope of 1–3°. Approximately 10–40% of the soil surface is covered by rocks with an average diameter of 100–300 mm (Table 16). A sandy layer intersperse with the Bonheim and Valsrivier soil forms.

Diagnostic and dominant/prominent taxa. Diagnostic species are represented by species group Z (Table 14). The vegetation unit is dominated by diagnostic herbaceous species, namely the succulents *Euphorbia enormis* and *Fockea angustifolia*, and the forbs *Anthospermum rigidum*, *Blepharis saxatilis*, *Cleome angustifolia*, *Crabbea angustifolia* and *Laggera decurrens*. Other conspicuous taxa are the small trees/shrubs *Combretum hereroense*, *Euclea linearis*, *Rhus keetii* and *Tinnea rhodesiana*, the forbs *Berkheya insignis*, *Blepharis subvolubilis*, *Dicoma gerrardii*, *Evolvulus alsinoides* and *Petalidium oblongifolium*, and the grasses *Andropogon chinensis*, *Aristida canescens*, *Diheteropogon amplectens*, *Loudetia simplex* and *Themeda triandra*.

Notes on floristic diversity. Floristic affinities are the same as for the association. This sub-association has, together with sub-association 4.3 the second highest number of taxa with a conservation status, namely 23. This comprises 13 SCPE endemics, 10 SCPE near-endemics and three Red Data List taxa (Table 15). None of these taxa are restricted to the sub-association. The average number of species encountered per sample plot is 37, with the total number of plant species being 85 (nine relevés) (Table 16).

7.2 *Loudetio simplicis–Eucleetum linearis heteropogonetosum contorti* sub-ass. nova hoc loco

Nomenclatural type: relevé 218 (holotypus)

Environmental data. In the SCPE this sub-association is an open shrubland of undulating, eroded surfaces of footslopes and valleys. The habitat is characterised by alluvium and patches of exposed norite and magnetite rocks, hence the occurrence of the soil forms Valsrivier (pedocutanic B-horizon) and Mispah (hard rock). It occurs on all aspects and gentle slopes of 1–5°. Rock cover and average size are an average 50–65% of the soil surface and 200–400 mm in diameter, respectively (Table 16).

Diagnostic and dominant/prominent taxa. Species group AA contains the diagnostic species for this sub-association, which are characterised by the suffrutex *Rhus wilmsii* (Table 14). Diagnostic herbaceous taxa include the sedge *Bulbostylis burchellii*, and the forbs *Corchorus asplenifolius*, *Lotononis calycina*, *L. wilmsii* and *Striga elegans*. Other prominent species of the sub-association include the shrubs *Combretum hereroense*, *Grewia vernicosa* and *Tinnea rhodesiana*, the forbs *Dicoma gerrardii* and *Senecio latifolius*, and the grasses *Aristida canescens*, *Diheteropogon amplectens*, *Loudetia simplex* and *Themeda triandra*.

Notes on floristic diversity. Floristic affinities are the same as for the association. Twenty-one taxa of conservation value are part of this sub-association, of which one, *Rhus wilmsii*, the SCPE near-endemic, Insufficiently Known Red Data List taxon, is restricted to it. Of these 13 are SCPE endemics, eight are SCPE near-endemics and three are Red Data List taxa (Table 15). The average number of species encountered per sample plot in this sub-association is 30, with the total number of plant species being 73 taxa (four relevés) (Table 16).

7.3 *Loudetio simplicis–Eucleetum linearis andropogonetosum chinensis* sub-ass. nova hoc loco

Nomenclatural type: relevé 307 (holotypus)

Environmental data. This sub-association represents open shrublands, of undulating landscapes on footslopes and valleys, dominated by a well-developed grass layer. Mostly restricted to freely drained soils on mostly westerly and southerly aspects, it prefers alluvium substrates characterised by patches of norite and pyroxenite (with no soils) exposed by natural erosion. Slopes are gentle (1–3°). It occurs on soils of the Valsrivier form. Rocks cover approximately 30–50% of the soil surface, with a diameter averaging 300–500 mm (Table 16).

Diagnostic and dominant/prominent taxa. There are no diagnostic species for the sub-association. The diagnostic species for the association are the characteristic species for this sub-association in the SCPE. Conspicuous forbs of the sub-association are *Dicoma* *gerrardii*, *Geigeria ornativa* and *Seddera capensis*. Dominant woody species include *Euclea linearis*, *Tinnea rhodesiana* and *Vitex obovata* subsp. *wilmsii*. The sub-association is dominated by the following grasses, *Andropogon chinensis*, *Aristida adscensionis*, *A. canescens*, *Elionurus muticus*, *Fingerhuthia africana*, *Loudetia simplex* and *Themeda triandra*.

Notes on floristic diversity. Floristic affinities are the same as for the association. Of the 19 taxa of conservation value in this sub-association, 11 are SCPE endemics, eight are SCPE near-endemics and three are Red Data List taxa (Table 15). Of these none are restricted to the sub-association. The average number of species encountered per sample plot is 34 and the total number of plant species for this sub-association is 85 (four relevés) (Table 16).

8. *Petalidio oblongifolii–Raphionacmetum procumbentis* ass. nova hoc loco
Nomenclatural type: relevé 284 (holotypus)

Environmental data. The habitat is a scattered open shrubland of magnetite and ferrogabbro outcrops on midslopes, footslopes and valleys. The community is usually encountered as patches amidst any of the communities discussed in this paper. It prefers southerly aspects, which are moderately sloped (1–7°), and is found predominantly on deep shallow soils of the Mispah and Glenrosa forms. A rock cover is average and approximately 30–50% of the soil surface, with a medium to small average size of 250–500 mm in diameter (Table 16).

Diagnostic and dominant/prominent taxa. Characteristic species are presented in species group AD (Table 14). The diagnostic herbaceous species for this association are *Chlorophytum polyphyllum*, *Clerodendrum louwalbertsii*, *Gerbera jamesonii*, *Indigofera enormis*, *Ipomoea obscura*, *Kleinia longiflora*, *Limeum pterocarpum*, *Phyllanthus parvulus*, *Raphionacme procumbens* and *Ruellia cordata*. *Eragrostis superba* is the only dignostic grass. There are no diagnostic woody species. *Euclea crispa*, *Combretum hereroense* and *Grewia vernicosa* are the dominant small trees/shrubs, *Berkheya insignis*, *Petalidium oblongifolium*, *Phyllanthus glaucophylla* and *Rhynchosia komatiensis* the prominent forbs, and *Diheteropogon amplectens* and *Themeda triandra* the most abundant grasses.

Notes on floristic diversity. Floristic relationships exist between this association and all the others of the study area and this is evident in species groups AF to AL (Table 14). There are 19 plant taxa of conservation value in the association (Table 15), namely 11 SCPE endemics and eight SCPE near-endemics, of which one is a Red Data List taxon. None of these taxa are restricted to the sub-association. The average number of species encountered per sample plot in this association is 36, with the total number of plant species being 84 taxa (four relevés) (Table 16).

7.4 Vegetation key

A vegetation key is presented to facilitate plant community identification (Table 17). The definitions are broad indications of typical groups and should be seen as a guideline. A diagnostic characteristic of the vegetation or habitat is given, followed by the most diagnostic and visual species of a group. The first species is restricted to the specific group only, and the second is dominant in the group, but also occurs in other groups. Where one species is given, no species was restricted to the group only.

7.5 Ordination

On a larger scale the Open Mountain Bushveld is characterised by a naturally tree-depauperated flora, dominated by a low diversity of small trees/shrubs and many taxa not typical for the region. On a smaller scale an extremely heterogeneous environment determines the plant communities within the Open Mountain Bushveld. A combination of many factors such as terrain type (valley or slope), soil structure (eroded areas or soil forms), heavy metal soils (anomalies) or anthropogenically altered areas (fields or mine dumps), affects the species composition of these plant communities. The ordination indicated the gradients caused by the soil structure.

The scatter diagram displays the distribution of relevés along the first and second ordination axes (Figure 12). The vegetation units are represented as groups, their distribution on the scatter diagram corresponding with certain physical environmental conditions. The terrain type, and consequently soil character, determines a definite gradient that is depicted by both the first (eigen value = 0.518) and second axis (eigen value = 0.453). Soil character influences the moisture availability and drainage. The gradient on the x-axis expresses moisture availability over the short term, where water can filter deep into the soils on the right (Hutton, Bonheim and Valsrivier) after precipitation. On the y-axis, the gradient indicates higher moisture availibity over the long term at the bottom of the graph, because carbonate horizons (Steendal) absorb water and apedale horizons (Hutton and Bonheim) dry out quickly. Unlike the other soils, Valsrivier soils can retain water and make it available over a longer period, hence explaining its position at the bottom right of the diagram. The scatter diagram also indicates the slope gradient (undulating to level) on the first axis, which links with the soil type and structure. Both the first and second axis also exhibits a gradient with deep soils at the top or right and shallow soils at the bottom or left.

All these gradients correlate closely with each other and have a strong influence on the vegetation structure and species composition. The three most dominant and conspicuous taxa of each growth form (trees/shrubs/suffrutices, forbs/sedges and grasses) are given for each of the eight major vegetation types depicted in the scatter diagram (Table 18).

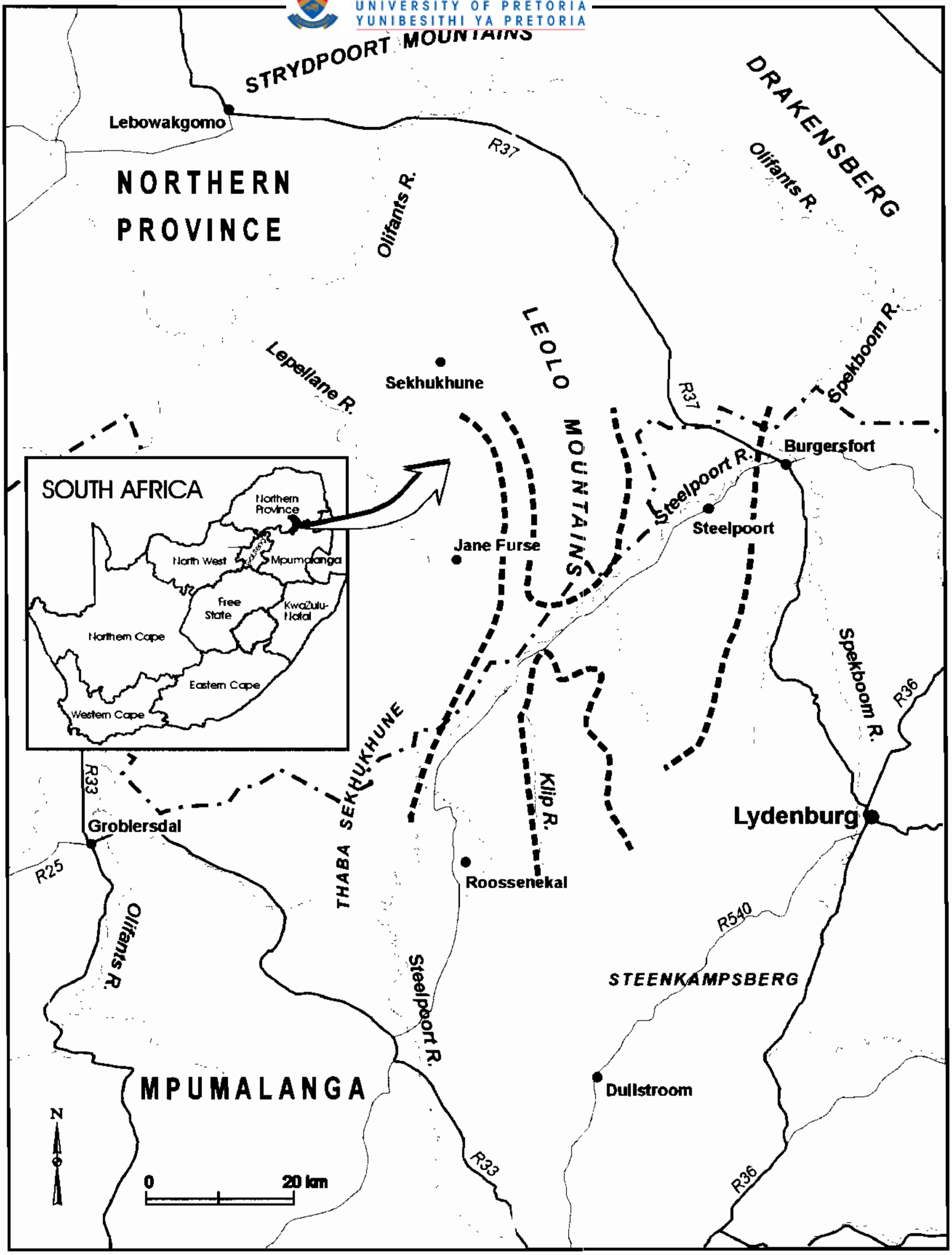

Figure 11 Extend of occurrence of the Open Mountain Bushveld of the Sekhukhuneland Centre of Plant Endemism in the Northern Province and Mpumalanga, South Africa.

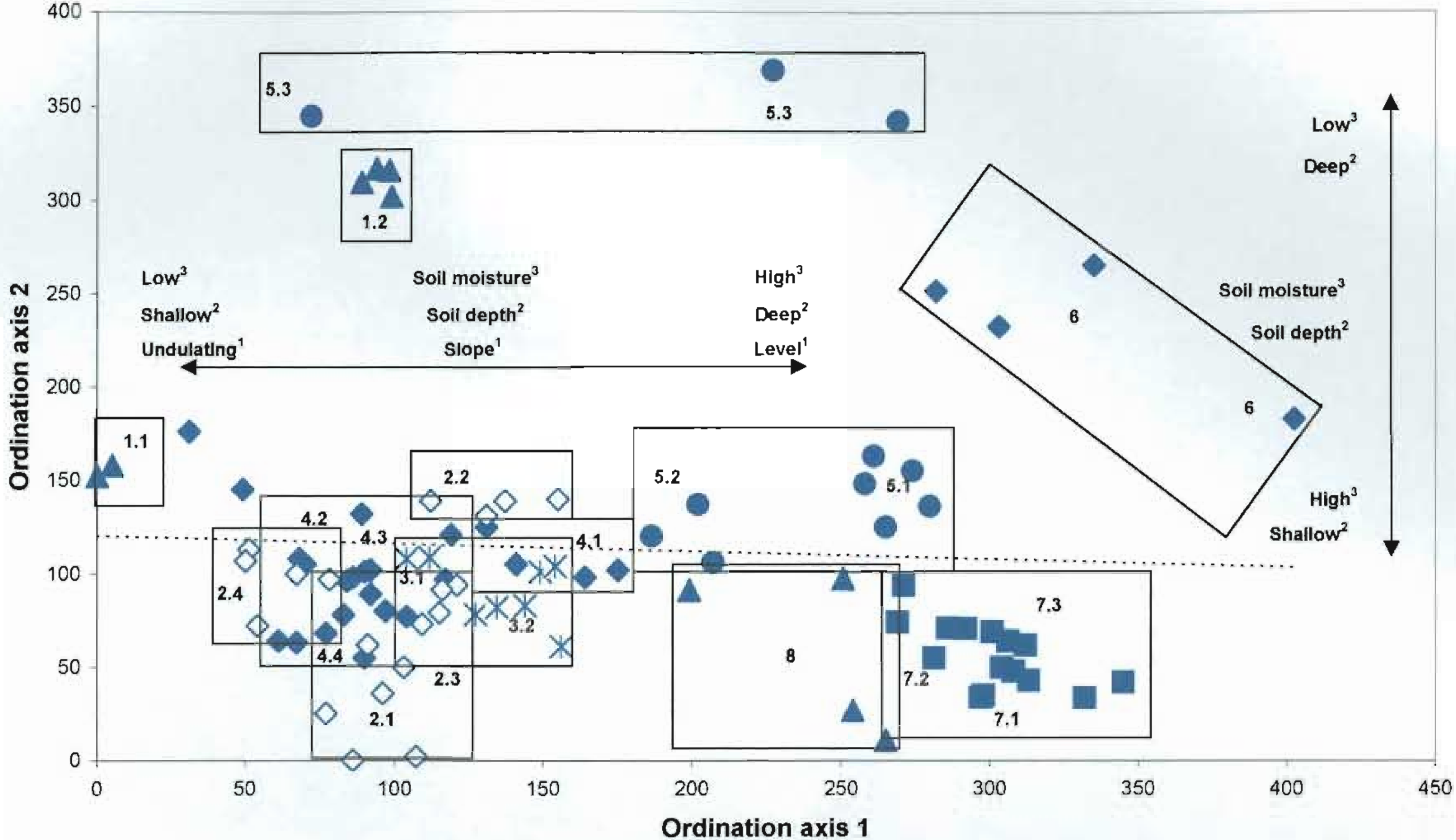

Figure 12 Relative positions of all the releves along the first and second axis of the ordination of the Open Mountain Bushveld of the Sekhukhuneland Centre of Plant Endemism. Numbers correspond with the plant communities in Table 14.

Table 13 Preferential species for each of the Open and Closed Mountain Bushveld types (figures represent the number of relevés (n) in which a species was recorded).

Species	Open Bushveld (n = 91)	Closed Bushveld (n = 103)	Difference
Preferentials for Open Mountain Bushveld			
Vitex obovata subsp. *wilmsii*	67	4	63
Tinnea rhodesiana	55	12	43
Brachylaena ilicifolia	44	4	40
Euclea crispa (form)	40	3	37
Themeda triandra	70	35	35
Preferentials for Closed Mountain Bushveld			
Panicum deustum	24	73	49
Dichrostachys cinerea	14	56	42
Terminalia prunioides	24	58	34
Boscia albitrunca	6	36	30
Grewia flava	4	34	30
Non-preferentials for Mountain Bushveld			
Heteropagon contortus	50	50	0
Indigofera hilaris	22	23	1
Jasminum multipartitum	19	18	1
Corbichonia decumbens	20	23	3
Petalidium oblongifolium	21	27	6

Table 14 A phytosociological table of the Open Mountain Bushveld of the Sekhukhuneland Centre of Plant Endemism.

Relevè number	413 414	210 333 336 337	291 297 302 303	255 257 269 271	152 156 174 188 204 216	128 160 162 233 249 259	139 171 184 283	124 175 196 205 265	207 237 239	46 135 208 219 234 238	164 167 169 203 248 260 282	209 226 235 399	166 173 252 272 279	132 133 137	331 332 335	387 388 397 403	127 144 146 183 183 199 200 261 266	218 221 285 310	251 254 301 307	142 214 284 287
Alliance	I												II							
Association	1	1	2	2	2	2	3	3	4	4	4	4	5	5	5	6	7	7	7	8
Sub-association	1	2	1	2	3	4	1	2	1	2	3	4	1	2	3		1	2	3	
Species group A																				
Enteropogon macrostachys	1 1	+ 1 R .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Sclerocarya birrea	+ +	. A R 1	. . . .	. . . .	. . . . . .	R . . R + .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	+ . . .	. . . .	. . . .	. . . .	. . . .
Hibiscus coddii	+ .	. R . +	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Stylochaeton natalensis	R +	R . + .	. . R .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. R . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Species group B																				
Asparagus sekukuniensis	1 +	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Bothriochloa insculpta	+ +	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Digitaria eriantha	+ +	. . . .	. . . .	. . . .	. . . . . .	. . . R . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Croton menyhartii	1 .	. . . .	. . . .	. . . R	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Pavetta eylesii	+ R	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Asparagus intricatus	R +	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Boerhavia erecta	R +	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Hermannia floribunda	R +	. . . .	. . . .	. . . .	. . . + . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Combretum petrophilum	R R	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Species group C																				
Senecio barbertonicus	. .	A . R .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Rhigozum obovatum	. .	+ R . R	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Sporobolus nitens	. .	+ . + .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Sporobolus ioclados	. .	+ . . R	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Aristida transvaalensis	. .	. + A .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. + .	. 1	. . . .	. . . .	. . . . .	. . .	. . B	. . + .	. . . .	. . . .	. . . .	. . . .
Cynodon dactylon	. .	. + R 1	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	+ + .	. + + .	. . . .	. . . .	. . . .	. . . .
Diospyros lycioides ssp. *sericea*	. .	. + R 1	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	R . . 1	. . . . .	. . .	1 . .	1 . . .	. . . .	. . . .	. . . .	. . . .
Rhus gueinzii	. .	. + . R	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	+ . . .	. . . .	. . . .	. . . .	. . . .
Hemizygia albiflora	. .	. R + .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Vangueria infausta	. .	. . + +	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	R . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Rhoicissus tomentosa	. .	. . R +	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Species group D																				
Acacia senegal var. *leiorachis*	. .	+ . . .	+ R + .	1 1 + +	+ R + . + .	. 1 + . + +	. . . .	. . . . .	. . .	. . . . . .	. . . R . . .	. . . .	. . . . .	. 1 +	. . .	. . . .	. . . .	. . . .	. . . .	. . + .
Grewia flava	. .	. . . .	R . . +	. + . +	. + . + 1 .	R . . + + .	R . R .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Leucas capensis	. .	+ . . .	R . . R	R + . +	R + + + + +	. R R R . .	+ . + +	. . . . .	. . .	. . . . . R	. . . .	. . . .	. . . R .	R . .	. . .	. . . .	. . . R . . R . .	. . . .	. . . .	. . . .
Aristida meridionalis	. .	. . . .	. + + R	. + + .	+ . . R + .	+ . R + . +	. + . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Jasminum multipartitum	. .	R . . .	. + + .	+ . 1 +	R R + . R R	. 1 1 + . .	1 1 + R	. . . . .	. . .	. . . . . R	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . + .
Barleria saxatilis	. .	. . . .	. R . .	+ . 1 +	1 + + . . .	. + R . + +	. 1 + +	R	. . +	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	+ . . .	. . . .	. . . .	. . + .	. . . .
Kedrostis foetidissima	R .	. . . .	. . R .	. + R .	. . + . R .	+ . R . R R	R R + .	. R . . .	R . .	. . . . . .	. . . .	. . . +	. . . . .	. . .	. . .	. . . .	. . . .	R . . .	. . . .	. . R R
Species group E																				
Chloris virgata	. .	. . . .	1 1 + 1	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. + R .	. . . .	. . . .	. . . .	. . . .
Eragrostis rigidior	. .	. . . .	1 + . +	. . . .	. . . . . .	. . . + . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Grewia monticola	. .	. . . .	+ + + +	. . . .	. . . R + .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . + . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Vigna unguiculata	. .	. . . .	+ R . +	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Maytenus senegalensis	. .	. . . .	+ . + +	. . . .	. . . R . .	. . . R . .	. . . .	. . . . .	. . .	+ . . . . +	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Bridelia mollis	. .	. . . .	+ . + +	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Acacia nigrescens	. .	+ . . .	+ . + R	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. + .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .

Table 14 continued.

Relevé number	413 414	210 313 336 337	291 297 302 303	255 257 268 271	152 156 174 186 204 216	128 160 162 233 249 259	139 171 264 283	124 175 196 205 265	207 237 239	46 135 208 219 234 238	164 167 169 203 248 260 282	209 226 235 398	186 173 252 272 279	132 133 137	331 332 335	387 388 397 403	127 144 146 163 193 199 200 261 266	218 225 286 310	251 254 301 307	142 214 284 287
Alliance	I												II							
Association	1	1	2	2	2	2	3	3	4	4	4	4	5	5	5	6	7	7	7	8
Sub-association	1	2	1	2	3	4	1	2	1	2	3	4	1	2	3		1	2	3	
Species group E cont.																				
Peltophorum africanum	. .	. . . .	+ . . +	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	R	. . . .	. . . .	R R . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Justicia odora	. .	R . . .	R + A +	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. + .	. . .	. . . .	. . . .	. . . .	. . . .	+ . . .
Aristida bipartita	. .	. . . .	R R . R	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . . R	. . . .	+ . . .	. R . .
Pogonarthria squarrosa	. .	. . . .	. + + .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Indigofera holubii	. .	. . . .	. R + .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Strychnos madagascariensis	. .	R . . .	. + . R	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Species group F																				
Sporobolus stapfianus	. .	. . . .	+ 1 . .	. . + 1	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Waltheria indica	. .	R . . .	R + R +	+ . R R	. . . . . .	. R R . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . R	. . . .	. . R R	. . . +
Commiphora africana	. .	. . . .	R . . +	. R R .	. . . . . .	R R	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Monechma divaricatum	. .	. . . .	. R + .	. R + +	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Aloe marlothii	. .	. . . .	. + . 1	+ . . +	. . . . . R	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	+ . . . + . .	. . . R	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Species group G																				
Dichrostachys cinerea	R +	+ + . +	+ . . +	+ . . 1	. . . . . .	. . R . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	R 1 +	. R .	. + . .	. . . .	. . . .	. . . .	. . . .
Grewia flavescens	R .	+ . R 1	. . R .	+ + 1 1	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	R	. . . .	. . . .	. . . . .	. . R	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Croton gratissimus	. +	. R 1 1	. R . .	+ . + R	. . . . . .	. . . . R R	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	+ + R	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Species group H																				
Felicia clavipilosa	. .	. . . .	. . . .	. . . R	+ + . R + .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Berchemia zeyheri	. .	. . . .	. . . .	. . . .	+ + . R . +	. . R . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . R R	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Euryops transvaalensis	. .	. . . .	. . . .	. . . .	R + R . R .	. . . . . .	. . . .	+	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Dolichos trilobus	. .	. . . .	R . . R	. . . .	R + . . + R	. . . R . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Dyschoriste fischeri	. .	. . . .	. . . .	. . . .	R R . R . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Stylochaeton sp. (SS 1332)	R .	. . . .	. . . .	. . . .	. R R . R R	. . . R . .	. . . .	. . . . .	. . .	. . . R . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Indigofera lydenburgensis	. .	. . . .	. . . .	. . . .	. . R + . R	R . . . . R	. . . .	. . . . .	. . .	. . . . . .	. . . R . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Species group I																				
Commiphora mollis	. .	. . . .	. . . .	. . . .	. . . . . .	+ . . 1 1 1	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Sterculia rogersii	. .	. . . .	. . . .	. . . .	. . . . . .	+ . R . + 1	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Clerodendrum ternatum	. .	. . . .	. . R .	. . . .	. . . . . .	. + R + + .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Ipomoea magnusiana	. .	. . . .	. . . .	. . . .	. . . R . .	. R + . R .	. . . .	. . . . .	. . .	. . . . . .	. . . R . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Species group J																				
Hyparrhenia hirta	. .	. . . .	. . . .	. . . .	. . + . . .	. . . . . .	1 + + .	. . . R .	. . +	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . . . A . . .	. . . .	. . . .	. . . .
Barleria lancifolia	. .	. . . .	. . . .	. . . .	. . + . . .	+	R + R .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Aloe verecunda	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	R + . R	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Setaria lindenbergiana	. .	. . . .	. . . .	. . . .	. . . . R .	. . . . . .	. + . +	. . . . .	. . .	. . . . . .	. . . .	. R . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Species group K																				
Selaginella dregei	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	+ + . + R	. R .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Acacia caffra	. .	. . R .	. . . .	. . . .	. . . . . .	. . . R . .	+ . . .	R + R + .	. R .	. . . . . .	. . . .	. . . .	. R R . .	. . .	. + R	R . . .	. . . .	R + . .	. . . .	. . . .
Thesium magalismontanum	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	R R + R +	. . R	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. R . .	. . . .	. . . .
Hermannia boraginiflora	. .	. . . .	. . . .	. . R .	. . . . . .	+	. . . .	+ . + . R	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Helichrysum harveyanum	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	R R R . .	. . .	. . R . R .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .

Table 14 continued.

Relevé number	413 414	210 333 338 337	291 297 302 303	255 257 269 271	152 156 174 188 204 216	128 160 162 233 249 259	139 171 284 283	124 175 196 205 265	207 237 239	46 135 208 218 234 238	164 167 169 203 248 260 282	209 226 235 399	166 173 252 272 279	132 133 137	331 332 335	387 388 397 403	127 144 146 163 183 188 200 261 268	218 228 285 310	251 254 301 307	142 214 284 287
Alliance	I												II							
Association	1	1	2	2	2	2	3	3	4	4	4	4	5	5	5	6	7	7	7	8
Sub-association	1	2	1	2	3	4	1	2	1	2	3	4	1	2	3		1	2	3	
Species group L																				
Gerbera ambigua	. .	. . . .	. . . .	. . . .	. . . + . R	. . . . . .	. . . .	. . . . .	R R .	+ . + R + .	R . . + + R .	. R . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Senecio scitus	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. + R	+ R	. R . R . . R	. R . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Faurea saligna	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. R .	+ 1 + + .	. + + . + + .	+ . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Gymnosporia sp. (AW 13052)	R +	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . R	. . R . + R	. + R . . . R	R . R .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Cussonia transvaalensis	. .	. . . .	1 . . .	. . . .	. . . . + +	. . . . . .	. . + .	. . . . .	. . +	. R + + + +	+ + + + + + +	+ + + +	. . . R .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Species group M																				
Xerophyta villosa	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	+ 1 .	+	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Myrothamnus flabellifolius	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	+ + R	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Ceterach cordatum	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	R + R	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Eragrostis pseudosclerantha	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. + R	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Oldenlandia herbacea	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. + R	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Species group N																				
Melinis nerviglumis	. .	. . . .	R . + R	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	+ + R + R .	. . . .	. + . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Plectranthus xerophilus	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	R R + R + .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Barleria wilmsiana	. .	. . . .	. . . .	. . . .	. . . . R .	. . . . . .	. . . .	. . . . .	. . .	. R . + + R	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Drimiopsis atropurpurea	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . + . R R	. . . .	. . R .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Schistostephium heptalobum	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . R + R .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Species group O																				
Andropogon schirensis	. .	. . . .	. . . .	. . + .	. . + . . .	. . . . . +	. . . .	. . . . .	. . .	+ + . . + .	. . + + . R .	. . . .	. . . . .	R + .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Ruellia stenophylla	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. R R . .	. . .	+ R . . R +	R + + . R . R	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Sphedamnocarpus pruriens	. .	. . . .	. . . .	. . . .	. . . . . .	. R	. . . .	. . . . .	. R R	+ . + + R .	. R + + R . R	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Argyrolobium wilmsii	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. R R + + .	+ . 1 R + 1 .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Thamnosma africana	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. R . 1 . +	R . . . + + .	. . . .	. . . . .	. . .	. . .	. + . .	. . . .	. . . .	. . . .	. . . .
Pavetta zeyheri	. .	. . . .	. . . .	. . . .	. . . . + .	R	. . + .	. . . . .	. . .	. . + + + +	R + + . + + +	R . . .	. . . . .	R R .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Ozoroa albicans	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . R . . +	. . . . . R +	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Pearsonia aristata	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	R . .	. . . R + .	. . + . R . +	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Species group P																				
Nidorella hottentotica	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	+ . + .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Combretum zeyheri	. .	. . . 1	. . . .	. . . .	. . . . . .	. . . R . .	R . . .	. . . . .	. . .	. . . . . .	+	R 1 + +	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Elaeodendron transvaalensis	R R	. . . .	. . . .	. . . .	. . . . . +	. R	. . . .	. . . . .	. . .	. . . . . .	R	R + + .	. . . . .	+ . .	. . .	. . . .	. . . .	R R . .	. . . .	. . . .
Solanum panduriforme	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	R	. + . 1	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Setaria incrassata	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . R . .	. . . .	. . + R	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Species group Q																				
Catha edulis	. .	. . . .	. . . .	. . . .	. . R . . .	. . . . . .	+ + + .	. R R . .	. R .	. + . 1 . +	+ 1 . + . . R	+ + . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Setaria sphacelata	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	+ . 1 1	. + R + .	R . .	A + . . R +	1 1 1 . + 1 1	+ + . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . + .	R . + .
Tristachya leucothrix	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. + + .	1 1 . R +	. R .	1 . 1 + + .	. 1 1 1 1 1 +	1 A 1 .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Rhynchosia spectabilis	. .	+ . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . R +	+ + . + +	. . R	+ . + R 1 R	. + R . R + +	+ + 1 R	. . . . .	. . .	. . .	+ . . .	. . . .	+ + . .	. . . .	. . . .
Jamesbrittenia macrantha	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . R .	. . R + .	+ . +	. R R . . .	. + . R + . .	R + . R	. . . . .	. . .	. . .	. . . .	. . . . . . R . .	. . + +	. . + +	. . . .
Species group R																				
Diospyros lycioides ssp. *nitens*	. .	. . . .	. . . .	1 . . .	1 + + + 1 .	+	1 + + +	+ + 1 + .	1 . 1	. . + + 1 1	. + + + 1 + +	1 1 1 .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Orthosiphon fruticosus	. .	1 . . .	. . . .	+ . 1 +	+ + + . . +	. + ...	+ + . +	R . . + .	+ . +	. . + . + +	1 A 1 . 1 + .	+ R + .	. . . . .	. . .	. . .	R . . .	. . . .	. . . .	. . . .	. . + .
Asparagus suaveolens	+ .	. . . .	. . . .	+ . R .	. . R . . .	+ . . . . B	R R R .	R R R R R	. R +	. . + R . .	. R R . R + +	. + + +	. . . . .	. . .	. . .	R . . .	. . . .	+ + . .	. . . .	. . . .

Table 14 continued.

Relevé number	4 4	2 3 3 3	2 2 3 3	2 2 2 2	1 1 1 1 2 2	1 1 1 2 2 2	1 1 2 2	1 1 1 2 2	2 2 2	1 2 2 2 2	1 1 1 2 2 2 2	2 2 2 3	1 1 2 2 2	1 1 1	3 3 3	3 3 3 4	1 1 1 1 1 1 2 2 2	2 2 2 3	2 2 3 3	1 2 2 2
	1 1	1 3 3 3	9 9 0 0	5 5 6 7	5 5 7 8 0 1	2 6 6 3 4 5	3 7 6 8	2 7 8 0 6	0 3 3	4 3 0 1 3 3	6 6 6 0 4 6 8	0 2 3 9	6 7 5 7 7	3 3 3	3 3 3	8 8 9 0	2 4 4 6 8 9 0 6 6	1 2 8 1	5 5 0 0	4 1 6 8
	3 4	0 3 6 7	1 7 2 3	5 7 8 1	2 6 4 6 4 6	8 0 2 3 9 9	9 1 4 3	4 5 6 5 5	7 7 9	6 5 8 9 4 6	4 7 8 3 8 0 2	9 6 5 9	6 3 2 2 9	2 3 7	1 2 5	7 8 7 3	7 4 6 3 3 9 0 1 6	8 1 5 0	1 4 1 7	2 4 4 7
Alliance	I												II							
Association	1 .	1 .	2	2 .	2 .	2 .	3	3 .	4 .	4 .	4 .	4 .	5 .	5 .	5 .	6	7 .	7 .	7 .	8
Sub-association	1	2	1	2	3	4	1	2	1	2	3	4	1	2	3		1	2	3	
Species group R cont																				
Tarchonanthus camphoratus	. .	. . . .	. . . .	+ . . .	+ + + . 1 .	. . . . . .	+ + + +	. . . . .	. . .	. . . . . +	+ 1 + + . + +	. . . R	. . . . .	. . .	. . .	. . . .	. . . . . . R . .	. . . .	. + . .	. . . .
Decorsea galpinii	. .	. . . .	. . . .	. + + .	R . . . . R	. . + R R R	. . R +	. . . . .	R . R	. . . . . R	. + . R . . .	R + R .	. . . . .	. . .	. . .	. . . .	. . . . R	. . . .	. . . .	. . . .
Jatropha latifolia	. .	. . . .	. . . .	. R + .	. . . . R +	R . R R + +	. . R .	. . . . .	. . R	. . R R R R	. . . R R R R	R . R .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . R R
Ziziphus mucronata	. .	. . . .	. . . .	. . + +	. + . . + .	. . . + + +	. + . +	. . . . .	. . .	+	R	R . + .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Dalechampia galpinii	. .	. . . .	. . . .	. . + R	. . . . R R	. . . . R R	R R R .	. . . . .	. . .	. . . . . .	. . . .	. + + .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Xerophyta retinervis	. .	. . . .	. . . .	. . . .	+ . + . . .	1 + . + + +	. . . .	+ R + + .	1 . R	. R + R . .	+ + + + 1 + +	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	+ + . .	. . . .	. . . .
Cymbopogon excavatus	. .	. . . .	. . . .	. . . .	. + . . + .	. . . . R .	. R . .	. . . . .	. 1 .	. . + . . +	. . . .	+ . R .	. . . . .	. + .	. . .	. . . .	. . . .	. . . .	. . R R	. . . .
Mundulea sericea	. .	. . . .	. . . .	. . . .	. R . + . .	R . . . R .	. . . .	. . R . .	R + R	. + . R . .	. R . . R R R	. . . +	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Chaetacanthus costatus	. .	. . . .	. . . .	. . . .	. . R R . +	1 + 1 + . +	. . + .	. . R . R	. . .	. . R R R +	. . R	. R . .	. . . . .	. . .	. . .	. . . .	. R R . R	. . . .	. . . .	. . . .
Species group S																				
Tephrosia purpurea	+ R	. . . .	+ + + +	. + . .	. . . . + .	. . + . . .	. . + .	. + + + +	. . .	+ . . . . +	. . + . . . +	. + . .	. . . . .	. . .	. . .	. + . .	. . . .	. . . .	. . . R	. . . .
Eragrostis chloromelas	+ R	. . . .	. . R +	R . . +	1 . . + . .	. R . . . +	. . R .	. . + R .	. . .	. . . + . .	+ . . + . + .	. . + R	. . . . .	. . .	. . .	. . . .	. + ...	. . . .	. . . .	. . . .
Combretum molle	+ .	R . . +	+ 1 + +	. . . .	. . R 1 + .	. . . . . .	+ R . .	R + . R +	. . R	. . R + . +	R . . + . . .	+ + R +	. . . . .	. . .	. . .	. . . .	. . . .	R R . .	. . . .	. . . .
Ozoroa sphaerocarpa	R .	. . R +	. + + .	. R . .	. . R . . R	. . . R . .	R . R R	R . . R .	R R R	+	R R R . . R R	R R R .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. R R R
Enneapogon scoparius	. +	+ . + .	1 1 1 1	1 1 1 1	A A . . + 1	+ + + A 1 1	. . . .	. A A . +	A . R	. . . . . .	+ 1 . + + . .	. . R R	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Aloe castanea	. +	R . + .	1 + + 1	. B . .	 1	+	. . . .	. . . . .	R . .	. R + R + .	. . . .	. . R .	. . . . .	. . .	. . .	R . . .	. . . .	. . . .	. . . .	. . . .
Ormocarpum kirkii	. +	. + . .	. + + +	. . . .	+ + + . 1 .	. . . . . .	+ R . .	. + . . R	. . .	+	+ . . 1 R . .	R + + .	. . . . .	. . .	. . .	. . . .	. . . .	R R . .	. . . .	. . . .
Pellaea calomelanos	. R	. R . .	R R R R	. . . .	. R	+ R + . R +	+ R R R	R + + . R	R + .	R + + + R .	+ + R . + + .	R . + R	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Justicia protracta	. R	. . . .	R + . +	+ . + .	. + ...	A + + . + +	. + + +	+ + R + .	. . .	. . . . . .	+ . . . . + +	. R + .	. . . . .	. . .	. . .	. . . .	. . . .	. R . R	. . . .	R . . .
Panicum maximum	. .	+ . R .	. R R +	. . . R	+ + . + . +	. . + + . .	R . . .	. . . . .	. . .	. . . . . .	. + ...	. . . +	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Dombeya rotundifolia	. .	. + + .	+ + + R	. . . .	+ + + + 1 .	. . . + . .	. . . .	. . . . .	. . .	. . . R R .	. . . R . . .	+ . . +	. . . . .	. . .	. . .	R . . .	. . . .	. . . .	. . . .	. . . .
Combretum apiculatum	. .	. . R R	1 + + 1	. . . .	. . 1 . . R	1 + + + + .	1 1 + +	. . . . .	. . .	1	. . . .	R + 1 .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Acacia ataxacantha	. .	. . . .	+ + + +	. . R .	. . R . . R	. . . . R R	+ + . .	. . . . .	. . .	. . 1 1 1 .	+ + + . 1 R .	+ + R .	. . . . .	. . .	. . .	. . R .	. . . .	. . . .	. . . .	. . . .
Asparagus laricinus	. .	. . . .	R R R R	. . R .	R R + R . +	R R + . + R	. . . R	. . . . .	. . .	. . R . . R	R . . . R R +	. . . .	. . . . .	. . R	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Thesium burkei	. .	. . . .	R R . R	R . R .	R	R R R R . .	. . R R	. . . . .	. . .	+ . R R R +	R	. R R .	. . . . .	R R .	. . .	. . . .	. . . .	. . . .	. . . .	. . R .
Kirkia wilmsii	. .	. . . .	1 + 1 1	+ . . R	+ R R R . R	R R . 1 1 A	R . . R	. . . R .	. R .	. R . . R R	. . R R + R R	. . . +	. . . . .	R R .	. . .	. . . .	. . . .	. . . .	. . . R	. . + .
Species group T																				
Schotia brachypetala	. .	R R . +	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . R . +	. . +	. + .	. . . .	. . . .	. . . .	. . . .	. . . .
Eragrostis lehmanniana	. .	. 1 + +	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . +	1 + + 1 +	R + .	B + R	. . . .	. . . .	. . . .	. . . .	. . . .
Acacia karroo	. .	. 1 . +	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	+ . R R R	. + .	. 1 R	+ . R .	R	. . . .	. . . .	. R . .
Mimusops zeyheri	. .	. R . +	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . +	. . . .	. . . +	R . R + .	. . .	+ . .	R . . .	. . . .	. . . .	. . . .	. . . .
Species group U																				
Dodonaea angustifolia	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	R	. . . .	. . . .	+ 1 1 . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Rhus batophylla	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	+ + 1 + 1	. R .	. . .	. . . 1	. . R R	. . . .	. R . .	. . . .
Catha transvaalensis	. .	. . . .	. . . .	. . . .	. . . R . .	. . . . . .	. . . .	. . . . .	. . .	R	. . . + . . .	. . . .	+ R + . +	R . .	. . R	. . . .	. . . .	. . . .	. . . .	. . + .
Olea europaea	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	+ . + R R	R . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Species group V																				
Sorghum bicolor	. .	+ . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	+ A 1	. . .	R . . .	. . . . . + + . .	. . . .	. . . .	. . . .
Panicum natalense	. .	1 . . .	. . . .	+ . R .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	+ 1 1	. . .	R . . .	. . . .	. . . .	. . . .	. . . .
Ximenia americana	. .	. . . .	. . . .	. . . .	. . . . . +	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	+ . +	. . .	+ . . .	. . . .	. . . .	. . . .	. . . .
Euclea divinorum	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	+ . R	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Acacia tortilis	R .	+ . . .	. . . .	+ . R .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	R + +	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Carissa bispinosa	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	R R +	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Rhus engleri	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	R . R	. . .	. . . .	. . . .	. . . .	. . . .	. . . .

Table 14 continued.

Relevé number	413 414	210 313 336 337	281 297 302 303	255 257 269 271	152 156 174 188 204 216	128 160 162 233 249 259	138 171 284 283	124 175 196 205 265	207 237 239	46 135 208 219 234 238	164 167 189 203 248 260 262	209 226 235 399	186 173 252 272 279	132 133 137	331 332 355	387 388 397 403	127 144 146 163 193 199 200 281 266	218 221 285 310	251 254 301 307	142 214 264 287
Alliance	I												II							
Association	1	1	2	2	2	2	3	3	4	4	4	4	5	5	5	6	7	7	7	8
Sub-association	1	2	1	2	3	4	1	2	1	2	3	4	1	2	3		1	2	3	
Species group W																				
Panicum deustum	. .	. . . .	. . . .	. . + .	A 1 . A 1 +	1 1 1 R 1 R	. . + .	. . . . .	. . .	. . . + . R	. . + 1 . . .	. . . .	+ + + + .	. + +	+ . +	. . . .	. . . .	. . . .	. . . .	. . . .
Psiadia punctulata	R .	+ + . R	. . . .	. R + .	1 1 + R 1 .	. 1 . + + .	+ . + +	. . . . .	. . .	R + R . . +	+ . . 1 . + .	. + . +	R R + . +	R 1 +	R R R	. . . .	. . . .	. . . .	. . . .	. . . .
Hippobromus pauciflorus	. .	. R . +	. . . .	+ . . +	. 1 + . 1 .	+ . . . + .	1 + + +	. . . . .	. . .	. . 1 . + +	. 1 + ...	1 . + .	1 + + 1 +	+ . +	. + R	. . . .	. . . .	. . . .	. . . .	. . + .
Balanites maughamii	. .	+ . . .	. . . .	. . . .	. 1 + . . R	. R R . . R	. 1 . R	. . . . .	. . .	. R . . R .	. . . R . . .	. . R R	+ R . + .	. + +	R . .	. . . .	. . . .	. . . .	. . . .	. . . .
Indigofera nebrowniana	. .	. . . .	. . . .	. . . .	. R R . R .	. . . . . .	R R R .	. . . . .	. . .	. . . . . R	. . . .	. . . .	R R + . +	R R .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Rhoicissus tridentata	. .	. . . R	. . . .	. . . .	. . + + + +	. . . + + .	. . + +	. . . . .	. . R	+ . 1 + + +	+ + + + + + +	+ + . .	. R R R R	. . .	. + .	. . . .	. . . .	. . . .	. . . .	. . . .
Cassine aethiopica	. .	R . . .	. . . .	. . . .	. . . . . .	R . R . . R	R . . .	. . . . .	. . .	+ . . R . .	+	R + + .	+ R + R .	R R R	. . R	. . . .	. . . .	. . . .	. . . .	. . . .
Species group X																				
Aristida rhiniochloa	. .	. . . .	. . . .	. . . 1	. . . . . .	. . . + . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	A + R .	. . . .	. . . .	. . . .	. . . .
Euphorbia tirucalli	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . +	. . .	1 R + +	. . . .	. . . .	. . . .	. . . .
Gnidia polycephala	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	R + + 1	. . . .	. . . .	. . . .	. . . .
Agave sisalana	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	1 . + R	. . . .	. . . .	. . . .	. . . .
Rhus sekhukhuniensis	. .	. . . .	+ . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . + . . .	. . . .	. . . .	. . . . .	. . .	. . .	+ + R .	. . . .	. . . .	. . . .	. . . .
Urochloa panicoides	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	+ R + .	. . . .	. . . .	. . . .	. . . .
Stipagrostis hirtigluma	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . . .
Nuxia gracilis	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	R R . +	. . . .	. . . .	. . . .	. . . .
Acacia nilotica	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . +	. . .	+ . . +	. . . .	. . . .	. . . .	. . . .
Eragrostis capensis	. .	. . . .	. . . .	. R . .	. . . . . R	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	+ . . R	. . . .	. . . .	. . . .	. . . .
Chascanum hederaceum	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	R . . +	. . . .	. . . .	. . . .	. . . .
Geigeria burkei	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. 1 + .	. . . .	. . . .	. . . .	. . . .
Pechuel-Loeschea leubnitzie	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. + + +	. . . .	. . . .	. . . .	. . . .
Species group Y																				
Euclea linearis	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	+ . .	. . .	+ . . .	B A 1 1 A 1 A 1 +	+ . . R	+ 1 1 1	. . . .
Evolvulus alsinoides	+ +	. . . .	. . . .	. . + .	. . . . . .	. . R . . .	. . . .	+ . . + .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	+ R . 1 R . . + +	+ R R .	. + . .	. . . .
Helichrysum uninervium	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	+ . R . . R . . +	. . . .	+ R . .	. . . .
Kohautia caespitosa	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . R .	+ . . R + . . . R	. . . +	R . + +	. . . .
Geigeria ornativa	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . + . . + + . +	+ . R .	+ + + +	R . . .
Jamesbrittenia burkeana	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . R . R + R . +	. . . .	+ . . .	. . . .
Pterothrix spinescens	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . . R . . R +	. . . .	+ R . .	. . . .
Seddera capensis	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . . . . + . +	. R . .	+ . 1 +	. . + .
Species group Z																				
Euphorbia enormis	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	R + + . R . . + .	. . . .	. . . .	R . . .
Crabbea angustifolia	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . R	. . . . . .	. R	. . . .	. . . . .	. . .	. . .	. + . .	R + R . R R + + R	R . . .	. . . R	. R . .
Fockea angustifolia	. .	. . . .	. . . .	. R . .	. . . . . .	. R	. . . .	R	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	R + . . + . . R R	. . . .	. . . R	. . R .
Cleome angustifolia	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. + . 1 . . + + .	. . . +	. . R .	. . . .
Blepharis saxatilis	. .	+ . . .	. . . .	. . . .	. . . . . R	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . + R . 1 1 . R	. . . .	. . . .	+ . . .
Anthospermum rigidum	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	R	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . + . R . . R +	. . . .	R . . .	. . . .
Laggera decurrens	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . R	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . R + . . + . .	. . . R	. R . .	+ . . .
Species group AA																				
Lotononis wilmsii	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	+ + . R	. . . .	. . . .
Bulbostylis burchellii	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	+ R + .	. . . .	. . . .
Lotononis calycina	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	+ . R .	. . . .	. . . .
Corchorus asplenifolius	R R	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	R . . .	. . . . .	. . .	. . .	. . . .	. R R	R + . +	R . . .	. . . .

Table 14 continued.

Relevé number	413 414	210 233 336 337	291 297 302 303	255 257 269 271	152 156 174 188 204 216	126 180 182 233 249 259	139 171 264 283	124 175 198 205 265	207 237 239	46 135 208 219 234 238	164 167 169 203 248 260 262	209 226 235 399	168 173 252 272 279	132 133 137	331 332 335	387 388 397 403	127 144 146 163 193 199 200 261 266	218 221 285 310	251 254 301 307	142 214 282 287
Alliance	I												II							
Association	1	1	2	2	2	2	3	3	4	4	4	4	5	5	5	6	7	7	7	8
Sub-association	1	2	1	2	3	4	1	2	1	2	3	4	1	2	3		1	2	3	
Species group AA cont.																				
Rhus wilmsii	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	R + R .	. . . .	. . . .
Striga elegans	. .	. R . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. R	. . . .	. R . .	. . . . .	. . .	. . .	R . . .	. . . .	R . R +	. R . .	. . . .
Species group AB																				
Fingerhuthia africana	. .	. R R .	. . . .	. + . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . +	A . + +	. . . + . + + . .	. + . +	. R A 1	. . . .
Jamesbrittenia sp. (AW 13026)	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. R R . .	. . .	. . .	. + + .	. + . + R . R . +	+ R . .	+ R . +	. . . .
Species group AC																				
Aristida canescens	. .	. . . .	1 + . .	. 1 . R	. R + . . .	. . R . . +	. . . .	. R . . .	. . .	. + . . . 1	. . + . + . .	. . . .	. . . . .	. + .	. . R	. . 1 .	1 + . + 1 + . + .	1 . 1 +	1 . 1 1	. R . .
Kyphocarpa angustifolia	. .	. . . .	+ + . R	. R R .	. . . . . .	. R R . . .	. . . .	+ + + + +	+ . .	. . . R . .	. . . . + R .	. . . R	. . . . .	. . .	. R .	. R . .	. + + . R + + + +	+ + R .	. . R +	. . . .
Rhus leptodictya	. .	R . . .	+ . + +	R . R +	. . . . . +	. . . . + .	. + . +	R . . R .	. R .	R . . R . .	+ + R . . + R	. . . .	R R . R .	R . R	. . .	. . . .	R + . R . . R . .	R R . R	. . + .	. . . .
Melhania prostrata	. .	. . . .	+ . + +	. + . .	. . . + R .	. . R . . .	. R . .	. . R . .	. R .	. . . . . .	. . . 1 . . +	. . R .	. . . . R	. + R	. R .	. . . R	. R . + + + . + +	. . . .	. . + +	. . . .
Brachylaena ilicifolia	. .	. . . .	. . R .	+ R R .	+ A 1 R 1 1	. A . . R .	+ + + +	+ + + + +	. . +	. . R . R +	. R . + . . .	. . . .	. + + + +	+ . +	. . .	R . R .	+ + + + . + R R +	. + R .	. . + +	. . . .
Aloe cryptopoda	. .	. . . .	. . . +	+ . . +	. . . + + .	+ + . + . +	. . + +	. . . . R	+ + +	. . . . . .	. . + . . . +	+ . . R	R	R . +	+ . .	+ + . +	. . . + ...	. . R R	. + . .	. . . .
Senecio latifolius	. .	. . . .	. . . .	. . + .	+ . R . . .	. + . R . .	R . . .	R + + + .	+ . +	+ . + + + .	R R R R + + .	+ + + .	. R . . .	. R .	. R +	. . . R	+ . . . + . + . .	+ + . +	. . . R	. . . .
Species group AD																				
Indigofera enormis	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	1 . + .
Kleinia longiflora	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. + ...	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	+ R R .
Raphionacme procumbens	R .	. . . .	. . . .	. R . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	R	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	R R + +
Eragrostis superba	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	R . . .	. . . .	R . + .
Ipomoea obscura	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . R . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. + . R
Phyllanthus parvulus	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	+	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. + + .
Gerbera jamesonii	. .	R . . .	. . . .	. . . .	. . . . . R	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	R . . . . R .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. + R .
Limeum pterocarpum	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	R . . R
Clerodendrum louwalbertsii	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . . + . +	R . + .	. . . . .	. . .	. . .	. . . .	R	R . . .	. . . .	. . + +
Chlorophytum polyphyllum	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . .	. . . .	. . . .	. . + .	. . . .	. . + +
Ruellia cordata	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	R . R .	. . . . .	. . .	. . .	. . . .	. . . .	. . . .	. . . .	. . R R
Species group AE																				
Aristida adscensionis	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. + ...	. . . .	. . . .	A 1 1 A +	R . .	. . +	A . . .	+ . . . . . . + .	+ . . +	+ 1 1 1	+ . . .
Rhynchosia komatiensis	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	1 + + + +	. R .	. R .	R . . .	+ + + + 1 . . + +	+ . . +	R + + +	. R + +
Loudetia simplex	. .	. . . .	. . . .	. . . .	. . + . . .	. . . . . .	1 1 . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	1 . . 1 .	R 1 1	+ + .	. . . +	A A A B A + + 1 1	1 R . 1	1 1 . A	. . . 1
Polygala hottentotta	. .	. . . .	. R R .	. . . .	. . R . . .	. . . . . .	R . . .	. . . . .	. . .	. . R . . R	. . . .	. . . .	R . + + R	. R R	R . R	R . R .	. . + R . . . R R	. R . .	R R + R	. R R .
Bolusanthus speciosus	. .	+ . . .	. . . .	. . . .	. + . . . +	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	R . + .	. + . + +	+ + +	. . .	+ + . .	. + R + R + R . .	. R . .	. . R +	. R + .
Andropogon chinensis	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. + . + +	R . .	+ . .	. . R +	A . 1 1 . . 1 1 1	. . R 1	+ + A A	+ . . .
Elionurus muticus	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . R	. . . . .	+ . +	. . . . . .	. . . .	. . . .	. R R . .	. . .	. + +	. R . +	. . + . . + . + +	. . . .	. + + 1	. . R 1
Indigofera hilaris	. .	. . . .	. . . .	. . . .	. . . . . +	. . . . . .	. . . .	+ R R + .	. . .	. . . . . .	. . . .	. . . .	. . R . .	R . +	. . R	. . . .	. + R + R 1 . + R	. + R .	R + + +	. R + .
Dicoma gerrardii	. .	R . . .	. . . .	. . . .	. . . . . .	. . . . R .	. . . .	. R + . .	. . +	. . . . . .	. . R	. . . .	. . . . R	+ . .	. + +	+ 1 + A	+ + + + + + 1 + +	+ + + .	+ + 1 +	. 1 . +
Aloe burgersfortensis	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	R R .	+ + .	+ R . .	. R R . R . . + R	. . . .	. . . .	+ . R .
Ledebouria marginata	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. R .	. . .	+ . + .	. + + + + . . R +	. . + +	. R + +	. . R +
Kleinia stapeliiformis	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . +	. . .	. . R .	. + ... R .	. R . +	. . . .	R . . R
Thesium multiramulosum	. .	. . . .	. . . .	. . . +	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . R	R . .	. . R .	. + R . + + R + R	R . R .	R . + +	R . . +
Polygala sp. (SS 449)	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . .	. . . . .	. . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	R . R	+ 1 + +	R . . + ...	R . + .	+ + . +	R + . .
Species group AF																				
Brachiaria serrata	. .	. . . .	. . . .	. . . .	. . 1 . . .	. . . . . .	R A . .	1 A + . .	. + R	+	. . . . . + .	. . . .	. . + . .	. + +	+ . +	. . . .	+ . . . . . R R .	. . . .	. . 1 +	. . + +
Berkheya insignis	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	+ . . +	+ + . + +	+ . .	. . + . + .	+ + + + + R .	R . + .	R + . . +	R . .	. . R	. R R .	+ + + + + 1 1 . .	1 + . .	. . + .	. 1 + +

Table 14 continued.

Relevé number	413 414	210 313 336 337	291 297 302 303	255 257 269 271	152 156 174 188 204 216	128 160 162 233 249 259	139 171 284 283	124 175 198 205 265	207 237 239	46 135 208 219 234 238	164 167 169 203 248 268 282	209 226 235 399	166 173 252 272 279	132 133 137	331 332 335	387 388 397 403	127 144 146 163 193 199 200 261 266	218 221 285 310	251 254 301 307	142 214 284 287
Alliance	I												II							
Association	1	1	2	2	2	2	3	3	4	4	4	4	5	5	5	6	7	7	7	8
Sub-association	1	2	1	2	3	4	1	2	1	2	3	4	1	2	3		1	2	3	
Species group AF cont.																				
Rhus keetii	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	R R R .	+ . . + .	+ . +	. . . . . R	. . . . + . R	R . . .	. . . . .	. R .	. . .	+ + . .	1 + + + 1 + . . 1	+ . + .	1 . . .	. + . R
Gnidia caffra	. .	. . . .	. . . .	. . . .	. . + . . .	. + ...	R + . .	R + . R +	R . +	. . . R + .	. R + R R + +	R . . .	. . . . .	. . R	. R .	. . . .	R . . + + R + R R	+ . . .	+ + . .	. R . .
Euphorbia schinzii	. .	. . . .	. . . .	. + . .	. . . . . .	. . . . . .	. R + .	+ . . R .	+ + +	. R	R	. R . R	. . . R .	. . .	. . .	. . . R	. + R . R	. . R +	R + . .	+ . . R
Diheteropogon amplectens	. .	. . . .	. + + .	. . . .	. . . . . .	. . . . . .	. . R R	. . . . .	. . .	1 1 + . + .	. + 1	. . R .	. 1 1 A 1	+ + .	. R .	. . R .	A A + + 1 1 A 1 +	1 . A +	. + + 1	A 1 1 +
Ipomoea bathycolpos	. .	. . . .	. . . .	. . . .	. . . . . .	. . . . . .	. . . R	. . . R R	. . R	. . . R . R	. . . R . . .	R . . .	R	. . R	R . .	. . . .	. . . R	. R R R	. . . .	+ R R R
Species group AG																				
Terminalia prunioides	. .	. . . .	. . . .	1 + 1 1	. + . . + +	+ + + . + R	. . + .	. . R . .	. . .	R . . . . R	. . . .	. . . .	. . . . .	R 1 1	. . .	. R + .	R . . . . 1 + . .	R . . .	. 1 . .	R . + .
Petalidium oblongifolium	. .	. . . .	. . . .	. 1 . +	. . + . R .	R + R R . .	. R . R	. . . R .	. R R	. . R R R .	. . . .	. . . .	. . . . .	R 1 1	. . R	. + R .	1 1 1 + A + + 1 +	. R + .	R . . .	1 + A 1
Aristida congesta	. .	. . . .	. . . .	. + . .	+ + + . . .	. . . R R .	. + R .	. R . R .	. . .	. . . R R .	. . . .	. . . .	. . . . .	. R .	+ + .	1 + . A	R . R R	. . . +	. . R +	R + . .
Eragrostis curvula	. .	. . . .	. . + .	. . R .	. 1 + . + .	. . + . R .	. A . +	. . R R .	. R .	R . . R . .	. . . .	. . + .	. . . . .	. R .	. R .	. . R R	. R . . R . . R .	. . + .	R . . R	+ . . +
Corbichonia decumbens	. .	. . . .	. . . .	. . . .	R . . R . .	+ R R + . +	. . . .	. . R . R	. . .	. . . . . .	. . . .	. R . .	. . . . .	. . .	. . R	. . + .	. R R R + R R R R	. . R .	. . R R	. . . R
Raphionacme galpinii	. .	. . . .	. . . .	. . . .	R . . . . R	R R R . R R	. . . R	. . . . .	. R R	. R + . . +	. . . R . . R	. . . .	. . . . .	. . R	. . .	. . . R	. R . . R . . R R	. . . R	. . . .	+ . R +
Euclea sp. (*SS 934*)	. .	. . . .	. . . .	. . . .	. + + . . .	. R	+ + R .	1 + . + 1	1 . +	. R . . R .	. . . . . . R	+ . + .	. . . . .	R . .	. . .	+ . . +	. . . . . R R . .	+ + + .	+ . R .	. 1 . R
Species group AH																				
Grewia vernicosa	1 1	1 1 + +	+ + + +	1 . A .	. . . . + +	. . . R R R	. . + +	1 R + + +	+ . .	. . . . . +	. . . . R R +	. . . +	. . . . .	R R +	+ + R	1 1 . +	+ . + . . + + . .	1 1 . .	. . . +	+ + + +
Heteropogon contortus	+ +	+ 3 3 3	. . . .	. 1 . .	. . . . 1 1	A A 1 1 + 1	. . 1 A	1 1 1 1 A	+ . 1	. . . B A 1	+ A 1 . A A 1	1 . 1 B	. . . . .	1 1 A	1 A B	+ . + +	. . + + ...	+ . A .	. . . +	. + A .
Blepharis subvolubilis	+ +	+ . . .	. . . .	. + + .	+ . + . . .	. + ...	R + + .	+	+ . .	. . . . . .	. . . .	. . . .	. . . . .	. . .	. . R	. . . .	+ 1 + . + . . + +	. . . +	. . + .	. 1 . .
Vitex obovata ssp. *wilmsii*	R R	. + . +	. . . .	R . . +	+ 1 1 + 1 1	+ . + . . .	A 1 + 1	+ + + + +	1 R +	+ . 1 + 1 1	+ 1 + 1 + + +	. 1 + .	R R + + +	R . .	. + +	+ + . .	+ . + + . + + + +	. + R +	+ + + +	. + + 1
Themeda triandra	R R	B . 1 .	1 1 . 1	A . 1 +	B A 1 A 1 B	B + B + 1 1	B 1 1 A	A 1 + 1 1	R . 1	A 1 A 1 1 .	B A A + + A B	1 1 1 .	. . . . .	+ A A	. . +	+ . . .	1 + + 1 + + + . +	1 A A	. 1 B 1	A 1 1 .
Phyllanthus glaucophylla	R R	. . . .	. . . .	R . R +	R . + . . .	+ R + . R R	R + + +	+ + + + +	+ . +	. . . . . .	R R + ...	. + . .	R R . . .	. . .	. . .	. . . .	. + + + + + . + +	. . . .	. . . .	. 1 . +
Euclea crispa	. .	1 + + +	1 . . .	+ . R +	. + . . + +	. . . . . .	. . + +	. . . . .	. . .	. . . . . .	. + 1 . . + .	. . . +	R . R R R	. . .	+ 1 +	1 + . .	. . . . . R R R R	+ R . +	R R R +	. 1 + R
Combretum hereroense	. .	1 R + +	. . . .	+ . . +	. . . . R R	. + ...	. . . .	+	+ . .	. . . . . R	. . . .	R + 1 .	+ + + 1 +	R + +	+ 1 .	+ + +	1 + + 1 + 1 1 + 1	1 + + .	. . . +	+ + + .
Elephantorrhiza praetermissa	. .	. R R .	. . . .	. . . .	+ R + . R .	1 + + + + R	. + + R	+ + 1 + 1	1 R +	+ R + + + 1	+ 1 + 1 1 R +	. 1 R R	. . . . .	. . .	. . 1	. . . .	. + . . + . . R +	+ + . .	. . 1 1	. . + .
Triaspis glaucophylla	. .	. . . .	1 + 1 1	1 . . +	+ 1 R . R +	R 1 1 R R R	+ R . .	. . R . .	. . .	. . . . . R	. . . R + R R	. + + .	. . . . .	. R +	. + .	. . . .	. R . . + . . R .	. . . +	. . 1 R	. R + R
Tinnea rhodesiana	. .	. . . .	+ + 1 +	. R . R	+ + R R .	. + + R . .	+ R + +	1 1 1 + 1	. . +	R	. R + 1 R R		+ R + +	+ R R	+ +	R +	1 + 1 1 + + + +	. + + +	+ R + 1	+ R
Commelina africana	. .	. . . .	+ + 1 R	. . R .	R + R R . +	R + R + R R	+ R . R	R R + R R	R + R	. R + + R +	R R R R R + R	+ R R .	. . . . .	. . R	. + +	. . . .	. + . + + R R R R	. + . .	. . + +	R R R R

Table 15 Sekhukhuneland Centre endemic/near-endemic and Red Data List plant taxa of the Open Mountain Bushveld.

Taxon	Family	Syntaxa																			
		I											II								
		1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	4.1	4.2	4.3	4.4	5.1	5.2	5.3	6	7.1	7.2	7.3	8
Aloe burgersfortensis	LILI	.	.	.	.	.	.	.	.	.	.	.	.	.	$r	$+	$r	$+	.	.	$r
Aloe castanea	LILI	.	.	#1	#r	#r	#r	.	.	#r	#+	.	#r	.	.	.	#r	.	.	.	.
Argyrolobium wilmsii	FABA	.	.	.	.	.	.	.	.	.	#+	#1	.	.	.	.	.	.	.	.	.
Asparagus intricatus [form] (*W&S1501*)	ASPA	$+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Asparagus sekukuniensis	ASPA	K$1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bauhinia tomentosa [form] (*S444*)	FABA	.	.	.	$r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Berkheya insignis [form] (*S257*)	ASTE	.	.	.	.	.	.	$+	$1	$+	$+	$1	$+	$+	$r	$r	$r	$1	$1	$+	$1
Brachylaena ilicifolia [form] (*W&S13244*)	ASTE	.	.	$r	$+	$1	$r	$+	$+	$r	$r	$r	.	$+	$+	.	$r	$1	$+	$+	.
Catha transvaalensis	CELA	.	.	.	.	$r	.	.	.	.	$r	$r	.	$+	$r	$r	.	.	.	.	$r
Combretum petrophilum	COMB	R#r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Elephantorrhiza praetermissa	FABA	.	K$r	.	.	K$+	K$1	K$+	K$1	K$1	K$1	K$1	K$+	.	.	K$r	.	K$+	K$+	K$1	K$r
Euclea crispa [form] (*W&S13205*)	EBEN	.	$1	$r	$+	$+	.	$+	.	.	.	$+	$r	$r	$1	.	$+	$r	$r	$+	$1
Euclea linearis	EBEN	.	.	.	.	.	.	.	.	.	.	.	.	.	#r	.	#r	#1	#r	#1	.
Euclea sp. nov. (*S934*)	EBEN	.	.	.	.	$+	$r	$+	$1	$+	$r	$r	$+	.	$r	.	$+	$r	$+	$r	$+
Euphorbia barnardii	EUPH	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	E$+	.	.	.	.
Euphorbia enormis	EUPH	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	#+	.	.	#r
Euphorbia sp. nov. (*W13194*)	EUPH	.	.	.	$r	.	.	.	$+	$+	$r	.	.	.	.	.	.	$+	$+	$r	$r
Gnidia caffra [form] (*W12975*)	THYM	.	.	.	.	$r	$r	$r	$+	$r	$r	$+	$r	.	$r	$r	.	$+	$r	$+	$r
Gnidia polycephala	THYM	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	#1	.	.	.	.
Grewia vernicosa	TILI	#1	#1	#+	#+	#r	#r	#r	#+	#r	#r	#r	#r	.	#r	#+	#1	#+	#1	#r	#+
Gymnosporia sp. nov. B (*W13052*)	CELA	$+	.	.	.	.	.	.	.	.	.	$r	$r	$r	.	.	.	.	.	.	.

Table 15 continued.

Taxon	Family	Syntaxa 1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	4.1	4.2	4.3	4.4	5.1	5.2	5.3	6	7.1	7.2	7.3	8
Helichrysum uninervium	ASTE	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	#+	.	#r	.
Hibiscus barnardii	MALV	R$r	.	.	.	.	.	.	.	.	R$r	.	.	.	.	.	.	.	.	.	.
Indigofera lydenburgensis	FABA	.	.	.	.	#r	#r	.	.	.	.	#r	.	.	.	.	.	.	.	.	.
Ipomoea bathycolpos var. *sinuatodentata*	CONV	.	.	.	.	.	.	$r	$r	$r	$r	$r	$r	$r	$r	$r	.	$r	$r	.	$+
Jamesbrittenia macrantha	SCHR	.	.	.	.	.	.	K$r	K$r	K$+	K$r	K$+	K$r	.	.	.	.	K$r	K$+	K$+	.
Jamesbrittenia sp. nov. (*W13026*)	SCHR	.	.	.	.	.	.	.	.	.	.	.	.	$r	.	.	$+	$+	$r	$+	.
Jatropha latifolia var. *latifolia*	EUPH	.	.	.	#r	#r	#r	#+	#r	.	#r	#r	#r	#r	.	.	.	.	.	.	#r
Kleinia stapeliiformis	ASTE	.	.	.	.	.	.	.	.	.	.	.	.	.	#r	.	#r	#r	#+	.	#r
Leucas capensis [form] (*W&S13007*)	LAMI	.	$r	.	$+	$+	.	.	$+	.	.	$r	.	.	$r	.	$r	.	$r	.	.
Nuxia gracilis	LOGA	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	K#+	.	.	.	.
Orthosiphon fruticosus	LAMI	.	$r	.	$1	$+	$r	$+	$r	$+	$+	$1	$+	.	.	.	$r	.	.	.	$r
Ozoroa albicans	ANAC	.	.	.	.	.	.	.	.	.	K#r	K#r	.	.	.	.	.	.	.	.	.
Pavetta sp. nov. (*S22*)	RUBI	.	.	.	.	$r	$r	$r	.	.	$+	$+	$r	.	$r	.	.	.	.	.	.
Petalidium oblongifolium	ANAC	.	.	.	#+	#r	#r	#r	#r	#r	#r	.	.	.	#1	#r	#r	#1	#r	#r	#1
Plectranthus xerophilus	LAMI	.	.	.	.	.	.	.	.	.	#r	.	.	.	.	.	.	.	.	.	.
Polygala sp. nov. (*S449*)	POLY	.	.	.	.	.	.	.	.	.	.	.	.	.	.	$r	$1	$r	$r	$+	$r
Pterothrix spinescens	ASTE	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	#+	.	#r	.
Rhus batophylla	ANAC	.	.	.	.	.	.	.	.	.	.	.	.	R$1	R$r	.	R$r	R$r	.	R$r	.
Rhus engleri	ANAC	.	.	.	.	.	.	.	.	.	.	.	.	.	#r	.	.	.	.	.	.
Rhus keetii	ANAC	.	.	.	.	.	.	#r	#+	#+	#r	#r	#r	.	#r	.	#+	#1	#+	#+	#r
Rhus sekhukhuniensis	ANAC	.	.	R$r	.	.	.	.	.	.	R$r	.	.	.	.	.	R$+	.	.	.	.
Rhus wilmsii	ANAC	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	K#+	.	.
Scilla natalensis	LILI	.	.	.	.	.	.	.	.	.	.	Nr	.	.	.	.	.	.	.	.	.
Stylochaeton sp. nov. (*S1332*)	ARAC	$r	.	.	.	$+	$r	.	.	.	$r	.	.	.	.	.	.	.	.	.	.
Triaspis glaucophylla	MALP	.	.	#1	#+	#+	#+	#r	#r	.	#r	#r	#+	.	#+	#r	.	#r	#r	#r	#r

Table 15 continued.

Taxon	Family	1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	4.1	4.2	4.3	4.4	5.1	5.2	5.3	6	7.1	7.2	7.3	8
Vitex obovata subsp. *wilmsii*	VERB	#r	#+	.	#r	#1	#+	#1	#1	#+	#1	#1	#+	#+	#r	#+	#+	#1	#r	#+	#+
Xerophyta retinervis [form] (*W13208*)	VELL	.	.	.	.	$+	$1	.	$+	$+	$r	$1	.	.	.	.	.	.	$+	.	.
SCPE endemics		5	4	3	6	11	8	10	11	10	15	14	10	8	11	7	12	13	13	11	11
SCPE near-endemics		3	2	3	6	7	7	6	6	5	10	8	6	2	8	4	9	10	8	8	8
Red Data List		3	1	1	0	1	1	2	2	2	5	4	2	1	1	1	4	3	3	3	1
Restricted to syntaxon		3	0	0	1	0	0	0	0	0	1	1	0	0	1	0	3	0	1	0	0
Restricted to association		3		1				0		4				1			3	3			0
Total for syntaxon		8	6	6	12	18	15	16	17	15	25	23	16	10	19	11	21	23	21	19	19
Total for association		12		21				19		30				24			21	26			19

Endemism: $ = endemic, # = near-endemic; **Red Data List:** I = Indeterminate, K = Insufficiently Known, R = Rare, N = Not threatened in the northern provinces of South Africa, but in other areas of southern Africa; **Abundance in communities:** 1 = abundant, + = frequent, r = rare, . = absent; **Collectors:** S = Siebert, W = Van Wyk; **Bold** blocks represent community/syntaxon specific taxa.

Table 16 Environmental factors and selected attributes associated with the different plant communities of the Open Mountain Bushveld.

Factors/attributes	**Syntaxa**																			
	I												II							
	1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	4.1	4.2	4.3	4.4	5.1	5.2	5.3	6	7.1	7.2	7.3	8
Number of relevés	2	4	4	4	6	6	4	5	3	6	7	4	5	3	3	4	9	4	4	4
Total number of species	45	64	55	78	122	99	71	60	63	130	96	95	37	20	60	98	85	73	85	84
Average number of species per relevé	40	27	36	34	42	40	40	35	32	42	41	41	25	16	39	35	37	30	34	36
Number of endemics/ near-endemics	8	6	6	12	18	15	16	17	15	25	23	16	10	19	11	21	23	21	19	19
Number of Red Data List taxa	3	1	1	0	1	1	2	2	2	5	4	2	1	1	1	4	3	3	3	1
Geology*	F	P/N	G/F	P/M/ A	P/N/ A	P/N/ A	P/N/ A	P/N/ A	P/N/ A	F/P	P/N/ A	P	Q	Q	Q/P	Q	Q/P/ N	Q/P/ M	Q/P/ N	Q/F/ M
Topographic position**	M	M/F	M	M/F	M/S	S	M	M/C	M/S	M/S	S	M/S	V	V	F	V	F/V	F/V	F/V	M/F/ V
Slope (°)	7	3-7	7-9	3-5	5-12	9-15	7-12	-	-/5	7-15	7-18	5-9	1-3	1-3	1-3	1	1-3	1-5	1-3	1-7
Aspect	W	N/E	N/E	N/S/ W	S	N/E/ S/W	S	-	-/S	S	S	S/E	-	N/E/ S/W	S/W	N/S/ W	N/E/ S/W	N/W/ S	W/S	W/S
Predominant soil type***	Gs	Gs[1]/ Sn	Gs	Gs[1]/ Hu	Gs[1]/ Ms	Ms	Gs	Gs	Gs	Ms[1]/ Gs	Ms	Gs	Va[1]/ Bo	Bo[1]/ Hu	Hu	Hu[1]/ Bo	Va[1]/ Bo	Va[1]/ Ms	Va	Ms[1]/ Gs

Table 16 continued.

Factors/attributes	Syntaxa																			
	1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	4.1	4.2	4.3	4.4	5.1	5.2	5.3	6	7.1	7.2	7.3	8
Rock cover percentage (%)	60-70	10-40	30-40	20-30	35-60	45-75	40-70	30-40	25-60	30-60	40-60	30-45	10-20	10-50	40-80	30-40	10-40	50-65	40-50	30-50
Average rock size (mm)	500-750	200-500	500-1000	400-1000	400-1000	500-1500	500-1500	100-300	300-500	500-1000	500-1000	500-1500	100-150	100-250	100-350	50-150	100-300	200-400	300-500	250-500

* A = anorthosite; F = ferrogabbro; G = granofire; M = magnetite; N = norite; P = pyroxenite; Q = Alluvium

** C = crest; S = scarp; M = midslope; F = footslope; V = valley

*** Bo = Bonheim; Gs = Glenrosa; Hu = Hutton; Ms = Mispah; Sn = Steendal; Va = Valsrivier (X[1] Dominant soil type)

Table 17 A key to the syntaxa of the Open Mountain Bushveld of the hills and valleys of the Sekhukhuneland Centre of Plant Endemism.

Leads/description	Go to/syntaxon
1a Slope bushveld (*Ozoroa sphaerocapa* & *Themeda triandra*)	2
b Valley bushveld (*Bolusanthus speciosus* & *Diheteropogon amplectens*)	3
2a Southern aspects (*Tristachya leucothrix* & *Elephantorrhiza praetermissa*)	4
b All aspects (*Acacia senegal* var. *leiorachis* & *Psiadia punctulata*)	5
3a Predominantly clay soils (*Geigeria ornativa* & *Loudetia simplex*)	6
b Predominantly loam soils (*Acacia karroo*)	7
4a Midslope and scarp (*Cussonia transvaalensis* & *Rhoicissus tridentata*)	8
b Midslope and crest (*Kirkia wilmsii*)	9
5a Maximum rock size < 1000mm (*Grewia flava* & *Enneapogon scoparius*)	10
b Maximum rock size < 750mm (*Enteropogon macrostachys* & *Blepharis subvolubilis*)	11
6a Lithosols predominant (*Raphionacme procumbens* & *Ozoroa sphaerocarpa*)	8. *Petalidio oblongifolii–Raphionacmetum procumbentis*
b Lithosols rare (*Euclea linearis* & *Aristida canescens*)	12
7a Disturbed, old fields (*Euphorbia tirucalli* & *Aristida congesta*)	6. *Aristido rhiniochloo–Gnidietum polycephalae*
b Disturbed, dongas (*Eragrostis lehmanniana* & *Hippobromus pauciflorus*)	13
8a Slope moderate (<9°) (*Jamesbrittemia macrantha*)	14
b Slope steep (<18°) (*Pavetta* sp. nov. & *Xerophyta retinervis*)	15
9a Rock size < 500mm (*Acacia caffra* & *Rhynchosia spectabilis*)	3.2 *Phyllantho glaucophyllae–Brachylaenetum ilicifoli brachiarietosum serratae*
b Rock size > 500mm (*Setaria lindenbergiana* & *Catha edulis*)	3.1 *Phyllantho glaucophyllae–Brachylaenetum ilicifoli setarietosum sphacelatae*
10a Pyroxenite and anorthosite (*Terminalia prunioides*)	16
b Ferrogabbro and granofire (*Chloris virgata* & *Aloe castanea*)	2.1 *Enneapogono scoparii–Acacietum leiorachis chloretosum virgatae*
11a Norite (*Diospyros lycioides* subsp. *sericea* & *Grewia vernicosa*)	1.2 *Enteropogono macrostachyo–Sclerocaryetum birreae grewietosum vernicosae*
b Ferrogabbro (*Croton menyhartii* & *Gymnosporia glaucophylla*)	1.1 *Enteropogono macrostachyo–Sclerocaryetum birreae asparagetosum sekukuniensis*
12a Rock cover > 40% (*Aristida adscensionis*)	17
b Rock cover < 40% (*Blepharis saxatilis* & *Petalidium oblongifolium*)	7.1 *Loudetio simplicis–Eucleetum linearis diheteropogonetosum amplectentis*
13a Rock cover percentage < 80% (*Heteropogon contortus*)	18
b Rock cover percentage < 20% (*Rhus batophylla* & *Rhynchosia komatiensis*)	5.1 *Eragrostio lehmannianae–Hippobrometum pauciflori rhoetosum batophyllae*

Table 17 continued.

Leads/description	Go to/syntaxon
14a Rock size > 500mm (*Combretum zeyheri & Combretum hereroense*)	4.4 *Tristachyo leucothricis–Cussonietum transvaalensis combretetosum zeyheri*
b Rock size < 500mm (*Myrothamnus flabellifolius & Mundulea sericea*)	4.1 *Tristachyo leucothricis–Cussonietum transvaalensis myrothamnetosum flabellifolius*
15a Ferrogabbro (*Tarchonanthus camphoratus*)	4.3 *Tristachyo leucothricis–Cussonietum transvaalensis argylobietosum wilmsii*
b Norite (*Melinis nerviglumis & Chaetacanthus costatus*)	4.2 *Tristachyo leucothricis–Cussonietum transvaalensis melinetosum nerviglumis*
16a Lithosols (*Panicum deustum*)	**19**
b Deeper soils (*Monechma divaricatum*)	2.2 *Enneapogono scoparii–Acacietum leiorachis grewietosum flavescentis*
17a Norite (*Elionurus muticus*)	7.3 *Loudetio simplicis–Eucleetum linearis andropogonetosum chinensis*
b Magnetite (*Rhus wilmsii & Senecio latifolius*)	7.2 *Loudetio simplicis–Eucleetum linearis heteropogonetosum contorti*
18a Footslopes (*Euclea crispa*)	5.3 *Eragrosti lehmannianae–Hippobrometum pauciflori elionuretosum mutici*
b Valleys (*Panicum natalense & Brachylaena ilicifolia*)	5.2 *Eragrosti lehmannianae–Hippobrometum pauciflori sorgetosum bicoloris*
19a All aspects (*Commiphora mollis & Juctícia protracta*)	2.4 *Enneapogono scoparii–Acacietum leiorachis commiphoretosum mollis*
b Southern aspects (*Berchemia zeyheri & Diospyros lycioides* subsp. *nitens*)	2.3 *Enneapogono scoparii–Acacietum leiorachis brachylaenetosum ilicifoliae*

Table 18 The three most dominant and conspicuous plant taxa of each of the major vegetation types of the Open Mountain Bushveld depicted in the DECORANA scatter diagram.

Major vegetation type	Trees/shrubs	Forbs/sedges	Grasses
1. *Enteropogono macrostachyo–Slerocaryetum birreae*	*Croton gratissimus*	*Asparagus sekukuniensis*	***Enteropogon macrostachys***
(*Enteropogon macrostachys–Sclerocarya birrea*)	*Grewia vernicosa*	*Hibiscus coddii*	*Heteropogon contortus*
	Sclerocarya birrea	*Stylochaeton natalensis*	*Themeda triandra*
2. *Enneapogono scoparii–Acacietum senegal*	***Acacia senegal* var. *leiorachis***	*Aloe cryptopoda*	*Aristida meridionalis*
(*Enneapogon scoparius–Acacia senegal* var. *leiorachis*)	*Brachylaena ilicifolia*	*Jasminum multipartitum*	***Enneapogon scoparius***
	Kirkia wilmsii	*Justicia protracta*	*Themeda triandra*
3. *Phyllantho glaucophyllae–Brachylaenetum ilicifoli*	***Brachylaena ilicifolia***	*Berkheya insignis*	*Heteropogon contortus*
(*Phyllanthus glaucophyllus–Brachylaena ilicifolia*)	*Diospyros lycioides* subsp. *nitens*	*Gnidia caffra*	*Themeda triandra*
	Vitex obovata subsp. *wilmsii*	***Phyllanthus glaucophylla***	*Tristachya leucothrix*
4. *Tristachyo leucothricis–Cussonietum transvaalensis*	***Cussonia transvaalensis***	*Orthosiphon fruticosus*	*Heteropogon contortus*
(*Tristachya leucothrix–Cussonia transvaalensis*)	*Elephantorrhiza praetermissa*	*Rhynchosia komatiensis*	*Themeda triandra*
	Vitex obovata subsp. *wilmsii*	*Rhynchosia spectabilis*	***Tristachya leucothrix***
5. *Eragrosti lehmannianae–Hippobrometum pauciflori*	*Combretum hereroense*	*Polygala hottentotta*	***Eragrostis lehmanniana***
(*Eragrostis lehmanniana–Hippobromus pauciflorus*)	***Hippobromus pauciflorus***	*Psiadia punctulata*	*Loudetia simplex*
	Tinnea rhodesiana	*Senecio latifolius*	*Panicum deustum*
6. *Aristido rhiniochloo–Gnidietum polycephalae*	*Combretum hereroense*	*Dicoma gerrardii*	*Aristida congesta*
(*Aristida rhiniochloo–Gnidia polycephala*)	*Euphorbia tirucalli*	***Gnidia polycephala***	***Aristida rhiniochloa***
	Grewia vernicosa	*Pechuel-Loeschea leubnitzia*	*Stipagrostis hirtigluma* var. *patula*
7. *Loudetio simplicis–Eucleetum linearis*	***Euclea linearis***	*Dicoma gerrardii*	*Diheteropogon amplectens*
(*Loudetia simplex–Euclea linearis*)	*Rhus keetii*	*Kyphocarpa angustifolia*	***Loudetia simplex***
	Vitex obovata subsp. *wilmsii*	*Rhynchosia komatiensis*	*Themeda triandra*
8. *Petalidio oblongifalii–Raphionacmetum procumbentis*	*Combretum hereroense*	*Berkheya insignis*	*Diheteropogon amplectens*
(*Petalidium oblongifolium–Raphionacme procumbens*)	*Grewia vernicosa*	***Petalidium oblongifolium***	*Heteropogon contortus*
	Vitex obovata subsp. *wilmsii*	***Raphionacme procumbens***	*Themeda triandra*

CHAPTER 8

CLOSED MOUNTAIN BUSHVELD

8.1 Background

Although a number of phytosociological studies have been conducted on the bushveld (the local term equivalent to savanna) of ultramafic substrates in southern Africa (Werger *et al.* 1978; Van der Meulen 1979; Breebaart & Deutschlander 1997), several vegetation types on this type of substrate still remain poorly investigated. An example is the Mountain Bushveld identified by Siebert *et al.* (2002a) on the norite, pyroxenite and anorthosite hills and mountains of the SCPE (Van Wyk & Van Wyk 1997; Van Wyk & Smith 2001). Ultramafic mountains and hills are floristically noteworthy in that they harbour many plant endemics with distributions associated with this particular geological substrate (Iturralde 1995; Madulid & Agoo 1995; Siebert *et al.* 2001).

Various vegetation types have been recognised on the dry dolomitic hills and mountains of the northeastern Drakensberg Escarpment (Matthews 1991; Matthews *et al.* 1992), an area adjacent to the SCPE with which it shows a definite floristic affinity (Siebert 1998). Acocks (1953) mapped the mountain bushveld in the SCPE as three major veld types, namely Mixed Bushveld (18), Sourish Mixed Bushveld (19) and North-Eastern Sandy Highveld (57). A more generalised classification of the same region's vegetation is given by Low & Rebelo (1996), who recognises only one major vegetation type, namely Mixed Bushveld (18). Plant communities of the *Kirkia wilmsii–Terminalia prunioides* Closed Mountain Bushveld (Siebert *et al.* 2002a) are described in this contribution.

The study area (Figure 13) is characterised by considerable diversity in geology (Kent 1980) and physiography (Land Type Survey Staff 1987; 1988; 1989). The vegetation of the SCPE can be broadly described as undulating mountain bushveld that is bordered by a Northeastern Sandy Highveld Grassland-mountain bushveld ecotone in the south and a mountain bushveld-Mixed Bushveld ecotone in the north. Most of the undulating hills and mountains of the region are predominantly covered by bushveld, described as the *Kirkia wilmsii–Terminalia prunioides* bushveld (Siebert *et al.* 2001a). Due to the heterogeneity of the environmental factors in the region, this major vegetation type is intermingled with several other major vegetation types (Siebert *et al.* 2001a). Fourty of the Sekhukhuneland endemics/near-endemics occur in this vegetation type (Siebert 1998).

Landform variation exhibits complex patterns (Werner 1999) and plays an important role in the development of the local flora (White 1981; Siebert 1998). Two major physiographic entities are characteristic of the study area, namely, (a) mountain slopes and (b) valleys. Mountain slopes are defined as the scarps, midslopes and footslopes of undulating hills and mountains. Valleys are defined as the low-lying valleybottoms and footslopes between the hills and mountains, which are usually traversed by a stream or river.

The average annual rainfall is 578 mm (South African Weather Bureau 1998), but the rainfall pattern is strongly influenced by the local topography (Siebert 1998). Rainfall varies from as little as 400 mm in some of the valleys due to rainshadows, to an estimated 600 mm on the summit of the Leolo Mountains (Erasmus 1985). Temperatures for the study area range from 0°C to 38°C, with a daily average of 20°C (Weather Bureau 1998). The northern and western parts of the study area are on average warmer than the southern and eastern parts (Siebert 1998). The northern parts of the region exhibit average daily temperatures of 28.3°C maximum and 7.2°C minimum.

8.2 Classification

Analysis of the *Kirkia wilmsii–Terminalia prunioides* Closed Mountain Bushveld resulted in the identification of 20 plant communities, which are grouped as five associations and 20 sub-associations (Table 19). These were subsequently hierarchically classified. The two major vegetation types are ecologically interpreted on the grounds of the physical environment, namely mountain slopes or valleys. Hence, macro-climatic and/or geological variation plays a role in local differentiation of the plant communities. The major plant communities relate to soil properties, rockiness and terrain type, with aspect and slope also important. Associations are distinctive and easily distinguishable in the field. This might be attributed to the uniformity of the environmental factors for each of the major groups, causing a distinct distribution pattern of habitats and associated vegetation.

Vegetation types of this area were identified and described as either slope bushveld, valley bushveld, disturbed veld or river thicket. Hence, the hierarchical classification of the vegetation reinforces the correlation between habitat and plant communities (Figure 14). The distribution of SCPE endemic/near-endemic and Red Data List taxa among various plant communities is listed in Table 20. A summary of selected community attributes is supplied in Table 21.

Plant communities of the *Kirkia wilmsii–Terminalia prunioides* Closed Mountain Bushveld recognised in the study area are classified as follows:

I. *Enneapogono scoparius–Kirkia wilmsii* community of mountain slopes

1. *Combreto apiculati–Kirkietum wilmsii*
    - 1.1 *Combreto apiculati–Kirkietum wilmsii clerodendretosum glabrae*
    - 1.2 *Combreto apiculati–Kirkietum wilmsii eustachetosum paspaloidis*
    - 1.3 *Combreto apiculati–Kirkietum wilmsii bridelietosum mollis*
    - 1.4 *Combreto apiculati–Kirkietum wilmsii chaetacanthetosum costatii*
    - 1.5 *Combreto apiculati–Kirkietum wilmsii hermannietosum boraginiflorae*
    - 1.6 *Combreto apiculati–Kirkietum wilmsii themedetosum triandrae*
    - 1.7 *Combreto apiculati–Kirkietum wilmsii nuxietosum congestae*
2. *Panico deustii–Dichrostachetum cinereae*
    - 2.1 *Panico deustii–Dichrostachetum cinereae sporoboletosum stapfianii*
    - 2.2 *Panico deustii–Dichrostachetum cinereae maeruetosum angolensis*
    - 2.3 *Panico deustii–Dichrostachetum cinereae melhanietosum prostratae*
    - 2.4 *Panico deustii–Dichrostachetum cinereae melhanietosum acuminatae*

II. *Eragrostis curvula–Combretum hereroense* community of valleys

3. *Fingerhuthio africanae–Boscietum foetidae*
    - 3.1 *Fingerhuthio africanae–Boscietum foetidae elaeodendretosum transvaalensis*
    - 3.2 *Fingerhuthio africanae–Boscietum foetidae aloetosum globuligemmae*

3.3 *Fingerhuthio africanae–Boscietum foetidae euphorbietosum ingentis*

3.4 *Fingerhuthio africanae–Boscietum foetidae sesamothamnetosum lugardii*

4. *Hippocrateo longipetiolatae–Euphorbietum tirucalli*

4.1 *Hippocrateo longipetiolatae–Euphorbietum tirucalli emilietosum transvaalensis*

4.2 *Hippocrateo longipetiolatae–Euphorbietum tirucalli aristidetosum transvaalensis*

4.3 *Hippocrateo longipetiolatae–Euphorbietum tirucalli bothriochloetosum insculptae*

5. *Celtido africanea–Combretetum erythrophyllii*

5.1 *Celtido africanea–Combretetum erythrophyllii acacietosum caffrae*

5.2 *Celtido africanea–Combretetum erythrophyllii acacietosum galpinii*

8.3 Description

The *Kirkia wilmsii–Terminalia prunioides* Closed Mountain Bushveld is predominantly restricted to the warm slopes and valleys of undulating ultramafic hills and mountains. Surface rocks are predominant and abundant in various habitats, with average rock size varying between 0.1 and 1 m (10–70% surface cover) on the slopes of hills and between 0.05 and 2 m (5–65% surface cover) in the valleys. The vegetation can be classified into broad-leaved mountain woodlands and microphyllous, disturbed valley thickets (Edwards 1983). An outstanding feature of this bushveld type is the fact that it constitutes a unique vegetation type that differs significantly from the surrounding and other bushveld types of southern Africa.

I. *Enneapogono scoparius–Kirkia wilmsii* community of mountain slopes

Environmental data. The vegetation is a closed broad-leaved bushveld of mountain slopes. The alliance is found predominantly on northern aspects. It occurs on moderate (3–5°) to steep slopes (5–15°), mainly on midlopes, but also to a lesser degree on either footslopes or scarps (Table 21). Soils are shallow and predominantly constitute rocky Glenrosa forms. The soil surface is covered by 15–65% of rock with an average diameter of 0.3–1 m (Table 21).

Diagnostic and dominant/prominent taxa. Diagnostic species are represented by species group R (Table 19) and include the tree *Acacia nigrescens*, the shrubby climber

Asparagus laricinus, perennial herb *Commelina africana*, and the grass *Enneapogon scoparius*. Dominant species include the trees *Acacia senegal* var. *leiorachis* and *Kirkia wilmsii*, the herbs *Psiadia punctulata* and *Barleria saxatilis*, and the grasses *Themeda triandra* and *Heteropogon contortus*.

Notes on floristic diversity. Floristic links with the other alliance is visible in species groups AA, AC, AJ and AQ (Table 19). Strong floristic links exist between the two alliances. The average number of species encountered per sample plot for this alliance is 38, with the total number of plant species being a minimum of 123 taxa (33 relevés) (Table 21). There are 29 plant taxa of conservation value, 15 are SCPE endemics, 14 are SCPE near-endemics and three are Red Data List taxa (Table 20). Of these taxa, 11 are restricted to this alliance in the SCPE.

1. *Combreto apiculati–Kirkietum wilmsii* ass. nova hoc loco
Nomenclatural type: relevé 165 (holotypus)

Environmental data. The vegetation representing this association is dense short woodland on the midslopes and scarps of the mountains and hills of the study area. It is mostly found on the northeastern aspects. It is restricted to the Steelpoort-Burgersfort region (Steelpoort Subcentre of Plant Diversity), with the orientation of hills and mountains in this area generally east-west, thus providing northern slopes facing into the Steelpoort River basin. The habitat is rocky with relatively steep slopes (5–15°) (Table 21). Average rock size varies from 0.3 to 1 m in diameter and covers 30–70% of the soil surface. The dominant soil type is the Glenrosa form, classified as an ortic A-horizon over a lithocutanic B-horizon.

Diagnostic and dominant/prominent taxa. Characteristic species are represented by species group A (Table 19). The association is characterised by diagnostic small trees/shrubs, namely *Acacia exuvialis*, *Combretum apiculatum*, *Grewia monticola*, *Triaspis glaucophylla* and the succulent tree *Aloe marlothii*. The fern *Pellaea calomelanos* is the only diagnostic herbaceous species. Other dominant woody species include *Acacia nigrescens*, *A. senegal* var. *leiorachis*, *Dichrostachys cinerea* and *Kirkia wilmsii*. *Enneapogon scoparius*, *Heteropogon contortus* and *Panicum deustum* are the most dominant grasses and *Asparagus laricinus*, *Corbichonia decumbens* and *Commelina africana* the most conspicuous forbs.

Notes on floristic diversity. This bushveld association is common in the SCPE and a floristic affinity exists with the other Closed Mountain Bushveld communities of the Centre in species groups AA, AC and AJ (Table 19). In this association the average number of plant species recorded per relevé is 38, and the minimum total number of species recorded for the association is 123 (33 relevés) (Table 21). Twenty plant taxa of conservation value occur in this association (Table 20), namely nine SCPE endemics and 11 SCPE near-endemic (the highests number recorded for any of the associations in the study), of which a high number of three plant species are Red Data List taxa. Five of these taxa are restricted to this association only, with the endemics *Stylochaeton* sp. nov. (*Siebert 1332*) and *Xerophyta retinervis* (tree-form) (*Van Wyk & Siebert 13208*), and the near-endemic *Jatropha latifolia* var. *latifolia* well represented in most of the sub-associations.

1.1 *Combreto apiculati–Kirkietum wilmsii clerodendretosum glabrae* sub-ass. nova hoc loco

Nomenclatural type: relevé 119 (holotypus)

Environmental data. The vegetation is dense woodland on the relatively shallow soils of slightly south facing midslopes on the northern aspect of the Schurinksberg. This sub-association is associated with exposed shale formations with moderately steep sloped sides of 9–12° (Table 21). The surface rock cover percentage is average for the association, namely 50–65%, with the exposed rocks averaging diameters of 500–800 mm in diameter (Table 21). The dominant soil type is the Glenrosa form.

Diagnostic and dominant/prominent taxa. In the SCPE this association is characterised by species group B (Table 19). *Clerodendrum glabrum*, *Dombeya rotundifolia*, *Ormocarpum kirkii* and *Rhus batophylla* are the diagnostic woody species of this syntaxon. Diagnostic herbaceous species include *Buttonia superba*, *Cucumis hirsutus*, *Plectranthus xerophilus* and the fern-ally, *Selaginella dregei*. There are no diagnostic grasses. *Enneapogon scoparius*, *Panicum deustum* and *P. maximum* are the most prominent grasses.

Achyranthes aspera, the succulent *Aloe castanea* and *Cryptolepis oblongifolium* are the dominant forbs. Other prominent plants are the woody species *Acacia exuvialis*, *Combretum apiculatum*, *Elephantorrhiza goetzei*, *Kirkia wilmsii* and *Triaspis glaucophylla*.

Notes on floristic diversity. This plant community is not a typical SCPE syntaxon, for its substrate is sedimentary in origin. However, it is included due to the strong floristic link that it exhibits with other sub-associations in species group G (Table 19), namely the slopes of Thaba Sekhukhune (sub-association 1.3) and the slopes of the Dwarsrivier Hills (sub-association 1.4). It also shows a relationship with association 5 in species group AP (Table 19). The average number of plant species encountered per sample plot is 30, with the total number for this association being 40 (three relevés) (Table 21). Four taxa with a conservation status are present in the association (Table 20), of which one is a SCPE endemic, three are SCPE near-endemics. The endemic, *Rhus batophylla*, is a Red Data List taxon and is restricted to the sub-association.

1.2 *Combreto apiculati–Kirkietum wilmsii eustachetosum paspaloidis* sub-ass. nova hoc loco

Nomenclatural type: relevé 116 (holotypus)

Environmental data. The vegetation is tall closed woodland on north-facing midslopes of the Schurinksberg. It is associated with predominantly exposed shale formations. The sub-association is found on relatively steep slopes (12–15°) (Table 21). Soils are predominantly of the Glenrosa form. The soil surface is covered by 40–60% of rock with a diameter of 450–600 mm (Table 21).

Diagnostic and dominant/prominent taxa. Characteristic species of the association are represented by species group C (Table 19). Woody species diagnostic of the association only include the semi-scandent *Rhoicissus tridentata*. Diagnostic herbaceous taxa are the geophyte *Boophane disticha*, the climbing Asclepiadaceae members *Ceropegia ampliata* and *Pergularia daemia*, and the forb *Lotononis pulchra*. The only diagnostic grass is *Eustachys paspaloides*. Prominent woody species of the sub-association are *Combretum* *apiculatum*, *Commiphora africana*, *C. mollis*, *Dichrostachys cinerea* and *Kirkia wilmsii*. Dominant grasses are *Digitaria eriantha*, *Enneapogon scoparius*, *Heteropogon contortus* and *Setaria lindenbergiana*. *Aspillia mossambicensis*, *Commelina africana* and *Urginia epigea* are the most conspicuous forbs of the sub-association.

Notes on floristic diversity. A notable floristic link exists with the rest of the association in species groups G and M, and with other associations in species groups AP (Table 19). The average number of plant species encountered per sample plot in this sub-association is 41, with the total number of plant species being 55 taxa (three relevés) (Table 21). There are four plant taxa of conservation value in the association that comprise two SCPE endemics and two SCPE near-endemics (Table 20).

1.3 *Combreto apiculati–Kirkietum wilmsii bridelietosum mollis* sub-ass. nova hoc loco
Nomenclatural type: relevé 300 (holotypus)

Environmental data. In the SCPE this association is tall dry woodland bush clumps on mountain slopes running into the Steelpoort River Valley, from Roossenekal in the south, to Steelpoort in the north. The habitat of the association is characterised by the igneous rocks ferrogabbro and granofire, covered by Glenrosa soils. However, these are not part of the Rustenburg Layered Suite, which result in different environmental (edaphic) factors than expected. It occurs on relatively steep slopes (7–12°) and on northern aspects. Rock cover and average rock diameter is average for the study area, namely 30–50% of the soil surface and a relatively large diameter of 500–750 mm, respectively (Table 21).

Diagnostic and dominant/prominent taxa. Species group E contains the diagnostic species for this association, which are characterised by the tree *Bridelia mollis*, the grass *Aristida bipartita*, and the forbs *Indigofera filipes*, *Justicia odora* and *Rhynchosia pauciflora* (Table 19). Other prominent species of the sub-association include the trees *Combretum apiculatum*, *Commiphora africana*, *C. glandulosa*, *Grewia monticola*, *Kirkia wilmsii* and *Pappea capensis*. Forbs such as *Barleria lancifolia*, *Clerodendrum ternatum* and *Melhania burchellii*, and grasses such as *Enneapogon scoparius* and *Heteropogon contortus* are dominant in the sub-association.

Notes on floristic diversity. A notable floristic link exists with the rest of the association in species groups M, and with other associations in species groups AA (Table 19). The average number of plant species encountered per sample plot in this sub-association is 34, with the total number of plant species recorded being 60 taxa (four relevés) (Table 21). Three taxa of conservation value are part of the sub-association, of which one is a SCPE endemic and two are near-endemics (Table 20).

1.4 *Combreto apiculati–Kirkietum wilmsii chaetacanthetosum costatii* sub-ass. nova hoc loco

Nomenclatural type: relevé 220 (holotypus)

Environmental data. This sub-association is tall, open woodland of the peripheral hills running adjacent to the norite massive of the SCPE, between it and the Schurinksberg. It is a true SCPE mountain bushveld community, for it is underlain by pure pyroxenite. It is associated with midslopes and scarps on northern aspects. The substrate is rock that gave rise to Glenrosa form soils. The soil surface is covered by 30–50% rock, of a larger average size of 0.4–1 m in diameter (Table 21). Slope of the habitat is moderately steep, usually 5–12°.

Diagnostic and dominant/prominent taxa. Diagnostic species are represented by species group F (Table 19). Diagnostic herbs include *Ipomoea obscura*, *Sphedamnocarpus pruriens* and *Sphenostylis angustifolia*. The tree, *Lannea discolor*, and the geoxylic suffrutex, *Tylosema fassoglense*, are both diagnostic woody species. *Sorghum bicolor* is the diagnostic grass. The sub-association is dominated by large trees/shrubs of which *Commiphora africana*, *Combretum apiculatum*, *Elephantorrhiza praetermissa*, *Grewia monticola*, *Kirkia wilmsii*, *Pappea capensis*, *Sterculia rogersii* and *Ziziphus mucronata* are the most frequent. Conspicuous forbs are *Chaetacanthus costatus*, *Clerodendrum ternatum* and *Jasminum multipartitum*. Dominant grasses include *Digitaria eriantha*, *Enneapogon scoparius* and *Heteropogon contortus*.

Notes on floristic diversity. A specific floristic link exists with certain groups in the association (species groups I and L) (Table 19). It is also the last of four sub-associations characterised by the trees *Pappea capensis* and *Ozoroa sphaerocarpa* in species group G (Table 19). One of the highest average numbers of species encountered per sample plot in this association and the study area, namely 45, was recorded for this sub-association. The total number of taxa recorded for this sub-association is 100 (five relevés) (Table 21). Four SCPE endemics, of which one is a Red Data List taxon, and six SCPE near-endemics are found in this sub-association (Table 20). Of its 10 taxa of conservation value, two taxa are restricted to this sub-association and the next three sub-associations (1.5, 1.6 & 1.7) of the association. The plant species concerned are the SCPE near-endemic *Jatropha latifolia* var. *latifolia* and the undescribed SCPE endemic *Stylochaeton* sp. nov. (*Siebert 1332*).

1.5 *Combreto apiculati–Kirkietum wilmsii hermannietosum boraginiflorae* sub-ass. nova hoc loco

Nomenclatural type: relevé 250 (holotypus)

Environmental data. This sub-association represents tall, closed woodland interspersed with patches of open shrubland and well-developed grass layer. It is restricted to northern aspects. The habitat is mostly restricted to large hills of gabbro, norite and anorthosite, but also occurs on ferrogabbro. It occurs on midslopes and scarps, on black and red soils of the Glenrosa form. It lies on moderate to steep sloped areas (5–15°). Rock cover on the surface is 35–55%, with rocks reaching relatively large medium size of 0.65–1 m in diameter (Table 21).

Diagnostic and dominant/prominent taxa. Diagnostic species occurring in this sub-association are listed in species group H (Table 19). It is characterised by the absence of the diagnostic tree and grass species. Diagnostic forbs include *Hermannia boraginiflora, H. glanduligera, Pentarrhinum insipidum* and *Tephrosia forbesii*. The small shrub *Mundulea sericea* is the only diagnostic woody species. Dominant herbaceous taxa include the forbs *Barleria saxatilis, Blepharis subvolubilis* and the semi-woody *Psiadia punctulata*. Prominent grasses are *Heteropogon contortus, Panicum deustum* and *Themeda triandra*. Dominant woody taxa include the shrubs *Elephantorrhiza praetermissa* and *Grewia* *vernicosa*, and the trees *Combretum apiculatum*, *Commiphora africana*, *C. mollis*, *Kirkia wilmsii* and *Terminalia prunoides*.

Notes on floristic diversity. A notable floristic link exists with the rest of the association in species groups L and M, and with other associations in species group U (Table 19). The average number of plant species encountered per sample plot is 39, with a total number of 84 plant taxa (five relevés) (Table 21). Four SCPE endemics and five SCPE near-endemics, of which the endemic *Elephantorrhiza praetermissa* is a Red Data List taxon, are found in this sub-association (Table 20). Of its nine taxa of conservation value, none are restricted to it.

1.6 *Combreto apiculati–Kirkietum wilmsii themedetosum triandrae* sub-ass. nova hoc loco
Nomenclatural type: relevé 191 (holotypus)

Environmental data. This sub-association represents shorter closed woodlands of hill slopes in the Steelpoort River Valley where it is restricted to northern aspects. It prefers midslopes and scarps of norite, pyroxenite and anorthosite hills with a moderate to steep slope (5–15°). It occurs on lithosols of the Mispah and Glenrosa forms. Approximately 35–60% of the soil surface is covered by rocks, with a medium size of 300–750 mm in diameter (Table 21).

Diagnostic and dominant/prominent taxa. Characteristic species are represented by species group J (Table 19). The diagnostic species found in this variant are predominantly herbaceous, namely *Rhynchosia crassifolia*, *R. totta*, *Solanum pseudocapsicum* (naturalised alien), *Thesium burkei* and *Tulbaghia ludwigiana*, and the succulent *Euphorbia schinzii*. *Cussonia transvaalensis*, *Karomia speciosa* and *Pavetta inandensis* are the diagnostic woody species. Other conspicuous woody species are *Acacia nigrescens*, *A. senegal* var. *leiorachis*, *Combretum apiculatum*, *Commiphora mollis*, *Elephantorrhiza praetermissa*, *Kirkia wilmsii*, *Ochna enermis* and *Terminalia prunioides*. *Aspilia mossambicensis*, *Clerodendrum ternatum*, *Commelina africana* and *Psiadia punctulata*. Dominant grasses include *Enneapogon scoparius*, *Eragrostis rigidior*, *Heteropogon contortus*, *Panicum deustum* and *Themeda triandra*.

Notes on floristic diversity. Floristic affinities shows a notable link with the rest of the association in species groups L and M, and with other associations in species groups U, AC and AJ (Table 19). The average number of plant species encountered per sample plot is 40 and the total number of plant species recorded for this sub-association is 123 (10 relevés), the highest total number of species recorded for the association (Table 21). Of the ten taxa of conservation value, four are SCPE endemics, six near-endemics and one of these is a Red Data List taxon (Table 20).

1.7 *Combreto apiculati–Kirkietum wilmsii nuxietosum congestae* sub-ass. nova hoc loco
Nomenclatural type: relevé 211 (holotypus)

Environmental data. This vegetation type is tall, closed woodland with patches of grassland on northern aspects of exposed norite, pyroxenite and anorthosite hills in the Steelpoort and Dwars River valleys. The sub-association occurs on soils of the Mispah form, which is an ortic A-horizon over solid rock. It lies on relatively steep sloped scarps (9°). Rock cover of the surface is high, between 50–70%, with a relatively large average rock diameter between 0.75–1.5 m (Table 21).

Diagnostic and dominant/prominent taxa. Diagnostic species for this sub-association are listed in species group K (Table 19). Diagnostic woody species are the shrubs *Acacia davyi*, *Barleria rotundifolia*, *Ficus abutifolia*, *Nuxia congesta* and *Rhoicissus sekhukhuniensis*. Diagnostic forbs include *Cyphia transvaalensis*, *Hermannia floribunda*, *Hibiscus calyphyllus*, *Ruttya ovata* and *Tetradenia brevispicata*. No diagnostic grasses occur. Prominent small trees in this vegetation unit are *Commiphora mollis*, *Croton gratissimus*, *Elephantorrhiza praetermissa*, *Grewia monticola*, *Kirkia wilmsii* and *Sterculia rogersii*. *Andropogon schirensis*, *Enneapogon scoparius*, *Eragrostis rigidior*, *Heteropogon contortus*, *Panicum deustum* and *Themeda triandra* dominate the grass layer. The herbaceous layer is sparse and rare; it does not warrant further treatment.

Notes on floristic diversity. Slight floristic affinities linked with the rest of the association in species groups L and M, and a weak connection with associations 2 to 5 (Table 19). The average number of plant species encountered per sample plot in this sub-association is 32, with the total number of plant species being 73 taxa (three relevés) (Table 21). Nine plant taxa with conservation value are part of the sub-association, and comprise four SCPE endemic and five SCPE near-endemics. It has one of the highest numbers of Red Data List taxa (two species) recorded for any of the sub-associations in the Closed Mountain Bushveld. The two species are the endemic *Elephantorrhiza praetermissa* and the near-endemic *Asparagus clareae*, both categorised as Insufficiently Known. One taxon, the near-endemic *Cyphia transvaalensis*, is restricted to it (Table 20).

2. *Panico deustii–Dichrostachetum cinereae* ass. nova hoc loco
Nomenclatural type: relevé 149 (holotypus)

Environmental data. This is typical anomalous tall woodland on deep soils of footslopes of mountains and hills in the Steelpoort River Valley. This is another vegetation type restricted to the Steelpoort Subcentre. It is an association of deep soils and therefore occurs on the footslopes below any geological substrate. It occurs on all aspects of hills and mountains. The habitat has a rather gentle slope of 3–5°, levelling towards the Steelpoort River. Soils are divers and dependent on the mother material. Typical soils include red loam such as the Bonheim, Hutton and Shortlands forms. Average rock size is 0.1–1 m in diameter and it covers 10–50% of the soil surface (Table 21).

Diagnostic and dominant/prominent taxa. Species group R and U (Table 19) contains the characteristic species for this association, with no species shared exclusively between the sub-associations of the association. Therefore the diagnostic species will be listed under each of the sub-associations. Dominant taxa of the association include the trees/shrubs *Acacia nigrescens*, *A. senegal* var. *leiorachis*, *A. tortilis*, *Dichrostachys cinerea*, *Kirkia wilmsii* and *Terminalia prunioides*. Dominant forbs are also frequent and include *Asparagus laricinus*, *Kyphocarpha angustifolia* and the succulent *Aloe castanea*. Grasses are abundant, namely *Andropogon schirensis*, *Aristida canescens*, *Enneapogon scoparius*, *Eragrostis curvula*, *Heteropogon contortus*, *Sporobolus ioclados* and *Themeda triandra*.

Notes on floristic diversity. This association is floristically related to, and forms the ecotone between associations 1 and 3 in species groups U, Z, AA, AC and AJ (Table 19).

In this association the minimum total number of species recorded for the association is 114 (23 relevés) and the average number of plant species recorded per relevé is 35 (Table 21). Of the 20 plant taxa of conservation value that occur in this association (Table 20), 11 are SCPE endemics (the highests number recorded for any of the associations in the Closed Mountain Bushveld) and nine are SCPE near-endemics, of which one *Elephantorrhiza praetermissa* is a Red Data List taxon. Two of these taxa are restricted to this association only.

2.1 *Panico deustii–Dichrostachetum cinereae sporoboletosum stapfianii* sub-ass. nova hoc loco

Nomenclatural type: relevé 155 (holotypus)

Environmental data. This is woodland with a well-developed shrub layer on midslopes and footslopes of hills of pyroxenite, norite and anorthosite. It occurs on all aspects on red loam soils of predominantly the Bonheim form (melanic A-horizon and underlain by a pedocutanic B). The soil surface is covered by 25–40% rock, of a relatively small average size of 200–400 mm in diameter (Table 21). Slope of the habitat is usually gently sloped and average 3–5°.

Diagnostic and dominant/prominent taxa. Diagnostic species are represented by species group N (Table 19). The community is characterised by diagnostic herbaceous species such as the forbs *Polygala uncinata* and *Raphionacme velutina*, the succulent *Fockea angustifolia*, and the grasses *Cenchrus ciliaris*, *Digitaria argyrograpta* and *Sporobolus stapfianus*. Diagnostic woody species include the shrubs *Bauhinia tomentosa* (form), *Rhigozum obovatum*, *Rhus gueinzii* and *Tinnea rhodesiana*. Dominant woody species are *Acacia senegal* var. *leiorachis*, *Boscia albitrunca*, *Croton menyhartii*, *Kirkia wilmsii* and *Terminalia prunioides*. *Andropogon schirensis*, *Aristida rhiniochloa*, *Enneapogon scoparius*, *Eragrostis curvula*, *Heteropogon contortus* and *Themeda triandra* are the most dominant grasses. Conspicuous small shrubs/forbs include *Asparagus laricinus*, *Barleria saxatilis*, *Indigofera hilaris*, *Monechma divaricatum*, *Petalidium oblongifolium* and *Psiadia punctulata*.

Notes on floristic diversity. The sub-association has the same floristic affinity as the association. However, a weak relationship does exist with sub-associations 3.1 and 3.2 in species group W, probably because all occur on Bonheim soils (Table 19). The average number of species encountered per sample plot is 39, with the total number for this variant being 114 (nine relevés), both values are the highest numbers recordeded for any sub-association in this association (Table 21). It has 12 plant taxa of conservation value, that is six SCPE endemics (one is a Red Data List taxon) and six near-endemics were recorded for this sub-association (Table 20).

2.2 *Panico deustii–Dichrostachetum cinereae maeruetosum angolensis* sub-ass. nova hoc loco

Nomenclatural type: relevé 149 (holotypus)

Environmental data. This sub-association represents tall, closed woodlands on the footslopes of pyroxenite and ferrogabbro hills. It usually occurs on red loam soils of the Hutton (ortic A-horizon on a red apedale B) and Shortlands (ortic A-horizon on a red structured B) forms. The habitat lies on relatively gently sloped areas (3–5°). Rock cover on the surface is 30–50%, with rocks reaching a relatively large average size of 0.5–1 m in diameter (Table 21).

Diagnostic and dominant/prominent taxa. Diagnostic species are presented in species group O (Table 19). Diagnostic herbaceous taxa include forbs such as *Chlorophytum bowkeri*, *Evolvulus alsinoides*, *Ledebouria dolomiticola* and *Orthosiphon fruticosus*. The tree, *Maerua angolensis*, is the diagnostic woody species and the grass, *Enteropogon macrostachys*, the diagnostic grass. Other important dominant taxa are small trees/shrubs such as *Acacia senegal* var. *leiorachis*, *Croton gratissimus*, *Dichrostachys cinerea*, *Grewia flavescens* and *Terminalia prunioides*. Prominent grasses such as *Aristida canescens*, *Enneapogon scoparius*, *Panicum deustum*, *Sporobolus ioclados* and *Themeda triandra* are the most abundant in the sub-association. *Barleria saxatilis*, *Kyphocarpha angustifolia* and *Sanseviera hyacinthoides* are the most dominant forbs.

Notes on floristic diversity. The sub-association shows the same floristic affinities as the association. In this sub-association the number of plant species encountered per sample plot averages 38, with a total number of 96 plant taxa (five relevés) (Table 21). Of the 12 taxa with conservation value, seven are SCPE endemics (the second highest for the study and the highest for the association) and five are near-endemics (Table 20). One endemic is a Red Data List taxon.

2.3 *Panico deustii–Dichrostachetum cinereae melhanietosum prostratae* sub-ass. nova hoc loco

Nomenclatural type: relevé 299 (holotypus)

Environmental data. In the SCPE this sub-association represents tall, closed woodland on red loam Hutton form soils. The habitat is found on footslopes of mountains with a granofire base. Slope is predominantly level, but can be 3–5° (Table 21). It occurs on all aspects. Rock cover percentage is below average and varies from 10 to 15% and rock size is relatively small between 100–150 mm in diameter (Table 21).

Diagnostic and dominant/prominent taxa. Species group P (Table 19) contains the characteristic species for this sub-association, with diagnostic species including herbaceous taxa, namely the grass *Diheteropogon amplectens*, and the forbs *Crabbea angustifolia*, *Jatropha zeyheri*, *Melhania prostrata* and *Ptycholobium plicatum*. *Bolusanthus speciosus* is the only diagnostic tree. Other prominent taxa include the grasses *Andropogon schirensis*, *Enneapogon scoparius*, *Eragrostis curvula*, *Heteropogon contortus*, *Panicum deustum* and *Themeda triandra*. The sub-association is dominated by trees and shrubs, with very few prominent herbs. Dominant trees include *Acacia senegal* var. *leiorachis*, *Combretum hereroense*, *Dichrostachys cinerea*, *Euclea divinorum*, *Grewia vernicosa* and *Kirkia wilmsii*.

Notes on floristic diversity. The sub-association shows the same floristic affinities as the association. The average number of plant species encountered per sample plot in this sub-association is 32, with the total number being 65 taxa (four relevés) (Table 21). Nine taxa with conservation value occur in this sub-association (Table 20), namely two SCPE endemics and seven near-endemics, which is the second highest number for the association and the highest for the sub-association. One Red Data List taxon was also recorded. No plant taxon with conservation value was restricted to it.

2.4 *Panico deustii–Dichrostachetum cinereae melhanietosum acuminatae* sub-ass. nova hoc loco

Nomenclatural type: relevé 117 (holotypus)

Environmental data. In the SCPE this sub-association is tall, closed woodland of footslopes, with a poorly developed grass layer. The habitat is characterised by bands of deep and shallow soils, usually associated with calcrete outcrops. It occurs on Glenrosa and Shortlands soil forms, hence the occurrence of deep (>300 mm) and shallow soils (<300 mm). It occurs on all aspects and gentle slopes of 3–5°. Rock cover and average size are an average 15–40% of the soil surface and 300–500 mm in diameter, respectively (Table 21).

Diagnostic and dominant/prominent taxa. Species group Q contains the diagnostic species for this sub-association, which are characterised by the trees *Mystroxylon aethiopicum* subsp. *schlechteri* and *Gardenia volkensii* (Table 19). Diagnostic herbaceous taxa include the forbs *Cyphostemma* sp. nov. (*Siebert 1383*), *Melhania acuminata*, *Pavonia senegalensis*, *Phyllanthus incurvus* and *Plectranthus neochilus*. Other prominent species of the sub-association include the trees/shrubs *Acacia tortilis*, *Dichrostachys cinerea*, *Grewia flavescens*, *Kirkia wilmsii* and *Terminalia prunioides*. Conspicuous forbs are *Asparagus laricinus*, *Sida dregei* and the succulent *Aloe castanea*. Prominent grasses are *Enneapogon cenchroides*, *Panicum deustum*, *P. maximum* and *Sporobolus ioclados*.

Notes on floristic diversity. Floristic affinities are the same as for the association. The average number of species encountered per sample plot in this sub-association is 29, with the total number of plant species numbered at 82 taxa (five relevés) (Table 21). Nine taxa of conservation value are part of the sub-association, of which five are SCPE endemics and four are SCPE near-endemics (Table 20). One taxon with conservation value, namely an endemic form of *Gnidia caffra* (*Van Wyk & Siebert 12975*), is restricted to the sub-association.

II. *Eragrostis curvula–Combretum hereroense* community of valleys

Environmental data. The vegetation is a closed broad-leaved bushveld of valleys. It occurs predominantly on level slopes (1–3°), only on footslopes and valleys. Soils are shallow (eg. Glenrosa form) on rocky exposures to deep (eg. Bonheim form) alluviums between the mountains. The soil surface is covered by 10–55% of rock with an average diameter of 0.1–2 m (Table 21).

Diagnostic and dominant/prominent taxa. No diagnostic species define this alliace (Table 2). However, certain species are dominant and include the trees *Combretum hereroense*, *Euclea divinorum* and *Rhus engleri*, the grasses *Aristida congesta*, *Eragrostis curvula*, *Heteropogon contortus* and *Panicum deustum*.

Notes on floristic diversity. Floristic links with the other alliances are visible in species groups U, Z, AA, AC, AJ, AN and AP (Table 19). Strong floristic links exist with certain groups in the other alliance. The average number of species encountered per sample plot for this alliance is 36, with the total number of plant species being a minimum of 131 taxa (47 relevés) (Table 21). There are 29 plant taxa of conservation value, 15 are SCPE endemics, 13 are SCPE near-endemics and five are Red Data List taxa (Table 20). Of these taxa, 11 are restricted to this alliance in the SCPE.

3. *Fingerhuthio africanae–Boscietum foetidae* ass. nova hoc loco
Nomenclatural type: relevé 202 (holotypus)

Environmental data. This association represents open tall woodlands on dry, warm, predominantly northernly aspects of mountains and hills. The mother material can be any of the following: ferrogabbro, norite, pyroxenite and anorthosite. It occurs on alluvium, which covers these substrates on footslopes and valleys. Relatively deep soils of the Bonheim, Hutton, Shortlands and Valsrivier forms are dominant, but are interspersed with Glenrosa lithosols. It lies on relatively level areas (1–3°). Rock cover on the surface is below average, between 10–40%, with rocks reaching a small average size of 100–400 mm in diameter (Table 21).

Diagnostic and dominant/prominent taxa. Diagnostic species are presented in species group S (Table 19). Diagnostic herbaceous taxa include succulent forbs, namely *Aloe burgersfortensis* and *Sarcostemma viminale*. *Boscia foetida* is the diagnostic woody species and *Fingerhuthia africana* the diagnostic grass. Other important dominant taxa are small trees/shrubs, namely *Boscia albitrunca*, *Combretum hereroense*, *Euclea divinorum* and *Terminalia prunioides*. Prominent forbs are *Asparagus suaveolens*, *Kyphocarpha angustifolia*, *Sanseviera hyacinthoides* and *Stylochaeton natalensis*. Grasses dominate the association and especially by *Aristida canescens*, *A. congesta*, *Eragrostis curvula*, *Panicum deustum* and *P. maximum*.

Notes on floristic diversity. The association has a strong link with associations 1 and 2 in species group AA and AC, associations 2 and 4 in species groups AJ, and associations 2 and 5 in species group AN (Table 19). The average number of species encountered per sample plot is 36, with a minimum total number of 131 plant taxa, which is the highests number recorded for any of the associations in the study area (25 relevés) (Table 21). Altogether 20 plant taxa of conservation value occur in this association and comprise nine SCPE endemics and 10 SCPE near-endemics (Table 20). Of the 20 taxa two are Red Data List taxa. Three taxa of conservation value are restricted to the association.

3.1 *Fingerhuthio africanae–Boscietum foetidae elaeodendretosum transvaalensis* sub-ass. nova hoc loco

Nomenclatural type: relevé 229 (holotypus)

Environmental data. This sub-association is tall, closed, but sparse woodland on pyroxenite and derived alluvium. It occurs on footslopes of hills and mountains, predominantly on westerly aspects. It occurs on red loam soils of the Bonheim (pedocutanic B), Hutton (red apedale B) and Shortlands (red structured B) forms. The soil surface is sparsely covered by 10–20% rock, which is of a small average size of 100–300 mm in diameter (Table 21). Slope of the habitat is usually level, between 1–3°.

Diagnostic and dominant/prominent taxa. Diagnostic species are represented by species group T (Table 19). The community is characterised by diagnostic forbs such as

Abutilon pycnodon, *Helichrysum rugulosum* and *Indigofera nebrowniana*. *Eragrostis capensis* is the diagnostic grass and *Catha transvaalensis* and *Elaeodendron transvaalensis* the diagnostic woody tree species. Dominant woody species are the trees *Acacia tortilis*, *Albizia anthelmintica*, *Croton gratissimus*, *Euclea divinorum*, *Rhus engleri* and *Terminalia prunioides*. *Aristida congesta*, *Eragrostis curvula*, *Heteropogon contortus*, *Panicum deustum* and *Themeda triandra* are the most important conspicuous grasses. Abundant forbs are frequent in the sub-association and include *Barleria saxatilis*, *Chaetacanthus costatus*, *Petalidium oblongifolium*, *Waltheria indica* and the succulent *Sarcostemma viminale*.

Notes on floristic diversity. The sub-association shows a similar floristic relationship as the association. However, it is doubtful whether this sub-association belongs with either association 2 or 3. This sub-association was included into association 3 on grounds of TWINSPAN classification. The community has a strong floristic identity in species group U with associations 1 and 2 (Table 19). It is, however, predominantly linked with sub-association 3.2 in species group W and with the rest of the association in species group Z and AN. It can therefore be seen as an ecotone between footslope and valley vegetation, as reflected by the occurrence of *Themeda triandra*. This sub-associations average number of plant species encountered per sample plot is 38, with the total number for this variant being 98 (six relevés) (Table 21). Four SCPE endemics and eight SCPE near-endemics were recorded, with the near-endemic figure the highest for the association and the whole study (Table 20). Of its 12 taxa of conservation value, no taxa are restricted to the sub-association.

3.2 *Fingerhuthio africanae–Boscietum foetidae aloetosum globuligemmae* sub-ass. nova hoc loco

Nomenclatural type: relevé 202 (holotypus)

Environmental data. The sub-association is low, dense woodland, with a well-developed herbaceous layer. It is associated with deep (> 1 m) soils in valleys. It occurs especially in the Steelpoort River Valley. Aspect is usually east or west due to the general southwest-northeast flow of the Steelpoort River. It lies on gentle slopes of 1–3°. Soils are characteristically a red loam with a pedocutanic B-horizon, such as the Bonheim (melanic A-horizon) and Valsrivier (ortic A-horizon) forms. Approximately 10–50% of the soil surface is covered by rocks, with a relatively small average size of 100–200 mm in diameter (Table 21).

Diagnostic and dominant/prominent taxa. Diagnostic species representing this sub-association are presented in species group V (Table 19). *Acacia luederitzii*, *Cadaba aphylla*, *C. natalensis* and *Ximenia caffra* are the diagnostic shrubs of the sub-association. *Eragrostis pseudosclerantha* and *Setaria incrassata* are the diagnostic grasses. The vegetation type is characterised by forbs and includes *Barleria prionitis*, *Chascanum pinnatifidum*, *Hibiscus micranthus*, *Indigofera enormis*, *Lotononis macrosepala*, *Pearsonia uniflora* and the succulent *Stapelia gigantea*. Important trees/shrubs of the association are *Acacia gerrardii*, *A. grandicornuta*, *A. nilotica*, *A. tortilis*, *Boscia albitrunca*, *Dichrostachys cinerea*, *Euclea divinorum*, *Grewia flava*, *Rhus engleri* and *Terminalia prunioides*. Prominent herbaceous taxa include are the succulents *Aloe burgersfortensis*, *A. globuligemma*, *Kleinia longiflora* and *Sanseviera hyacinthoides*. Abundant grasses are *Aristida canescens*, *Enneapogon cenchroides*, *Eragrostis curvula*, *E. lehmanniana*, *Fingerhuthia africana*, *Panicum deustum* and *Sporobolus fimbriatus*.

Notes on floristic diversity. The sub-association shows a strong floristic relationship with sub-associations 3.1 and 3.3 in species groups W and Y respectively. It has a strong floristic link with other sub-associations in species groups AA and AN (Table 19). The average number of plant species encountered per sample plot for this sub-association is 43, the highest for the association, with the total number of plant species being 131 taxa (8 relevés), the highest total for a sub-association in the association as well as the whole study (Table 21). Eleven taxa with conservation value occur in this sub-association, namely five SCPE endemics and six SCPE near-endemics (Table 20).

3.3 *Fingerhuthio africanae–Boscietum foetidae euphorbietosum ingentis* sub-ass. nova hoc loco

Nomenclatural type: relevé 306 (holotypus)

Environmental data. This vegetation type is tall closed woodland of predominantly dry northern, but also west and east aspects of mountain footslopes and valley. It lies on moderately sloped footslopes and valleys (1–3°). The community is restricted to ferrogabbro on footslopes and alluvium in the valleys. Thus the soils are of the Bonheim, Valsrivier and Glenrosa form. Rock cover is relatively low, with only 5–20% of the soil surface covered by rocks, with an average diameter of 50–400 mm (Table 21).

Diagnostic and dominant/prominent taxa. Diagnostic species are represented by species group X (Table 19). Only one grass species, *Eleusine coracana*, is diagnostic of the sub-association. *Indigofera circinnata* and *Ptycholobium contortum* are the diagnostic forbs, and *Ammocharis coranica* the diagnostic geophyte. *Erythrina lysistemon* is the diagnostic tree. Prominent trees of the sub-association are *Acacia nilotica*, *A. tortilis*, *Boscia albitrunca*, *Dichrostachys cinerea*, *Ehretia rigida*, *Euphorbia ingens* and *Rhus engleri*. Dominant herbaceous taxa include the succulent *Aloe greatheadii* and the geophyte *Urginea epigea*. The grasses *Eragrostis curvula*, *E. lehmanniana*, *Fingerhuthia africana*, *Panicum deustum*, *Schmidtia pappophoroides* and *Sporobolus fimbriatus*.

Notes on floristic diversity. The sub-association shows the same floristic relationships as the association. The average number of species encountered per sample plot is 29 and the total number recorded for this sub-association being 83 (six relevés) (Table 21). Four plant taxa with conservation value occur in this sub-association and comprise two SCPE endemics and two SCPE near-endemics (Table 20). These numbers are of the lowest recorded for any of the Closed Mountain Bushveld communities.

3.4 *Fingerhuthio africanae–Boscietum foetidae sesamothamnetosum lugardii* sub-ass. nova hoc loco

Nomenclatural type: relevé 311 (holotypus)

Environmental data. This sub-association represents dense shrublands, of undulating norite and anorthosite landscapes on footslopes. It is mostly restricted to Hutton soils interspersed with Glenrosa soils in the Burgersfort region. Easterly and northernly aspects are predominant. Slopes are gentle (3–5°). Rocks cover approximately 30–40% of the soil surface, with a diameter averaging between 400 and 500 mm (Table 21).

Diagnostic and dominant/prominent taxa. The diagnostic species for the sub-association are presented in species group AB (Table 19). The diagnostic species include the woody shrubs *Cadaba termitaria*, *Grewia bicolor*, *Maerua edulis*, *M. juncea*, *Triaspis hypericoides* var. *nelsonii*, and the succulent small tree *Sesamothamnus lugardii*. *Aristida adscensionis*, *Melinis repens*, *Pogonarthria squarrosa* and *Stipagrostis hirtigluma* var. *patula* are the diagnostic grasses. Diagnostic herbaceous taxa are common and include the succulents *Cissus quadrangularis*, *Euphorbia* sp. nov. (*Van Wyk 13194*), *Holubia saccata* and *Pterodiscus ngamicus*, the forbs *Cleome hirta*, *Decorsea schlechteri*, *Felicia mossamedensis*, *Indigofera heterotricha*, and the geophyte *Albuca* sp. nov. (*Siebert 856*). Other conspicuous forbs of the sub-association are *Justicia protracta*, *Stylochaeton natalensis* and the succulent *Aloe burgersfortensis*. Prominent woody species include *Boscia albitrunca*, *B. foetida* and *Grewia vernicosa*. The sub-association is characterised by the following grasses, *Aristida canescens*, *Eragrostis curvula*, *Fingerhuthia africana*, *Melinis nerviglumis* and *Panicum deustum*.

Notes on floristic diversity. Floristic affinities are the same as for the association. However, this plant ommunity can probably be upgraded to the level of association. It does not show any specific relationships with other sub-associations. It shows a strong floristic affinity with the Mopaneveld north of the Soutpanseberg (Du Plessis 2001). The average number of plant species encountered per sample plot is 33 and the total number of plant species for this sub-association is 55 (five relevés) (Table 21). Of the seven taxa of conservation value, three are SCPE endemics, three SCPE near-endemics and two Red

Data List taxa (Table 20). Three Red Data List taxa are also found. Three taxa with conservation priority are restricted to the sub-association, namely the two SCPE endemics *Albuca* sp. nov. (*Siebert 856*) and *Euphorbia* sp. nov. (*Van Wyk 13194*), the Red Data List taxon *Pachypodium saundersii* (Insufficiently Known for Swaziland). Species of biogeographic significance due to their disjunct distributions are *Polygala krumanina* (Karoo disjunct) and three Limpopo River Valley disjuncts, namely the small succulent trees *Sesamothamnus lugardii* and *Commiphora tenuipetiolata*, and herbaceous climber *Decorsea schlechteri*. The sub-association is similar to the *Sesamothamnus lugardii-Catophractes alexandri* Low Open Woodland (Visser *et al.* 1996).

4. *Hippocrateo longipetiolatae-Euphorbietum tirucalli* ass. nova hoc loco
Nomenclatural type: relevé 400 (holotypus)

Environmental data. Association of short, dense shrubland on alluvium, norite and anorthosite. It is restricted to midslopes, footslopes and valleys. This vegetation type is characteristic of the over-grazed areas between Burgersfort and Mecklenburg. Soils are of the Glenrosa, Mispah and Valsrivier forms, which are interspersed with black turf soils. The habitat occurs on all aspects and is gently to moderately sloped (1–7°). Approximately 45(10)-65 % of the soil surface is covered by stones with a relatively large average diameter of 0.5(0.1)-2 m (Table 21).

Diagnostic and dominant/prominent taxa. Diagnostic species are represented in species group AD (Table 19). The vegetation unit is dominated by diagnostic forbs, and includes *Dicoma tomentosa*, *Ledebouria marginata*, *Leucas capensis*, *Senna italica*, and the naturalised aliens *Catharanthus roseus* and *Schkuhria pinnata*. *Chloris virgata* is the only diagnostic grass. Diagnostic woody species are restricted to the scandent shrub *Hippocratea longipetiolata* and the succulent shrub *Euphorbia tirucalli*. Other prominent plant taxa of the association include the forbs *Abutilon guineense*, *Ocimum americanum* and the alien *Zinnia peruviana*, the grasses *Aristida congesta*, *A. rhiniochloa*, *Enneapogon cenchroides* and *Heteropogon contortus*, the shrub *Diospyros lycioides* subsp. *lycioides*, and the naturalised succulent tree aliens *Cereus peruvianus* and *Opuntia ficus-indica*.

Notes on floristic diversity. A strong floristic affinity exists with the valley bushveld of the region in species group AJ (Table 19), probably due to the similar habitats. However, the intense harvesting of firewood in this vegetation type is evident in species group AN, where the absence of woody species is distinct. The average number of species encountered per sample plot for this association is 40, which is the highest average recorded for any of the associations in the study area. The total number of plant species recorded is a minimum of 130 taxa (14 relevés) (Table 21). This association has 18 plant taxa with conservation value, of which 10 are SCPE endemics and eight SCPE near-endemics (Table 20). Of these, a high number (3) plant species are Red Data List taxa and one a taxon with a biogeographically noteworthy distribution and rarity in nature, *Eulophia leachii*. Six plant taxa with a conservation value, the most for the Closed Mountain Bushveld, are restricted to the association.

4.1 *Hippocrateo longipetiolatae-Euphorbietum tirucalli emilietosum transvaalensis* sub-ass. nova hoc loco

Nomenclatural type: relevé 395 (holotypus)

Environmental data. The habitat is a scattered dense shrubland on midslopes and footslopes of heavily grazed hills to the east of the Leolo Mountains. It occurs on no specific aspect and these are moderately sloped (5–7°). It is found predominantly on shalow Mispah soils overlying anorthosite and norite. An average rock cover of approximately 45–55% covers the soil surface, with a relatively large size of 1–2 m in diameter (Table 21).

Diagnostic and dominant/prominent taxa. Characteristic species are presented in species group AE (Table 19). There are predominantly herbaceous species diagnostic for this sub-association and include the indigenous forbs *Cyanotis speciosa*, *Emilia transvaalensis*, *Eulophia petersii*, *Lophiocarpus tenuissimus*, *Monsonia angustifolia*, *Ruellia patula*, *Thamnosma africana*, the geophyte *Ledebouria floribunda*, the sedge *Cyperus margaritaceus*, the fern *Cheilanthes involuta*, and the naturalised alien weeds *Acalypha indica*, *Atriplex lindleyi*, *Gomphrena celosioides* and *Mollugo nudicaulis*. The following two grasses are diagnostic: *Brachiaria brizantha* and *Schizachyrium sanguineum*. *Grewia vernicosa* and *Hippocratea longipedunculata* are prominent shrubs. Forbs such as

Geigeria ornativa, *Schkuhria pinnata* and *Waltheria indica* are the prominent forbs. *Aristida rhiniochloa*, *Melinis nerviglumis*, *Panicum natalense* and especially *Heteropogon contortus* are the most abundant grasses.

Notes on floristic diversity. Floristic relationships are the same as for the association. The average number of plant species encountered per sample plot in this association is 45, the highest for any sub-association in the study, with the total number of plant species being 97 taxa (three relevés) (Table 21). There are eight plant taxa of conservation value in the association (Table 20), namely four SCPE endemics and four SCPE near-endemics, of which one endemic is a Red Data List taxon.

4.2 *Hippocrateo longipetiolatae–Euphorbietum tirucalli aristidetosum transvaalensis* sub-ass. nova hoc loco
Nomenclatural type: relevé 400 (holotypus)

Environmental data. This is low closed woodland of midslopes and footslopes, usually associated with small kloofs. It lies on gentle slopes of 3–5° on all aspects. The geological substrate is norite and anorthosite and soils are predominantly of the Glenrosa form. A large proportion of approximately 45–65% of the soil surface is covered by large rocks, with a diameter of 0.5–2 m (Table 21).

Diagnostic and dominant/prominent taxa. Diagnostic species are represented by species group AF (Table 19). Small trees/shrubs are diagnostic of this community, namely *Calodendrum capense*, *Combretum petrophilum*, *Obetia tenax*, *Tecomaria capensis* and *Vangueria cyanescens*. Diagnostic herbs occur and include the fern *Cheilanthes hirta*, the climber *Clematis brachiata*, and the forbs *Commelina erecta*, *Hibiscus cannabinus*, *Leonotis intermedia*, *Leucas martinicensis*, *Orthosiphon tubiformis*, *Plectranthus venterii*, *Thunbergia neglecta* and *Tragia rupestris*. Diagnostic grasses are *Aristida transvaalensis*, *Brachiaria serrata*, *Mosdenia leptostachys* and *Urochloa panicoides*. Other taxa of importance are the grasses *Aristida congesta* and *Melinis nerviglumis*, the forbs *Hibiscus barnardii* and *Kedrostis foetedissima*, and the shrubs *Grewia vernicosa*, *Hippocratea longipetiolata* and the conspicuous large succulent *Aloe castanea*.

Notes on floristic diversity. Floristic relationships are the same as for the association. However, it seems as if this sub-association might be at an intermediate stage of disturbance, for it shares alien plant species with sub-associations 4.1 and 4.3 in species groups AG and AI respectively (Table 19). The average number of plant species encountered per sample plot is 38, with the total number of plant species being 130 taxa (six relevés), which is the highest number for any sub-association in the association (Table 21). This sub-association has the highest number of plant taxa with conservation value in this particular Closed Mountain Bushveld major vegetation type. The 14 taxa with a conservation priority include nine SCPE endemics (the highest number for the association and the study as a whole) and five SCPE near-endemics (Table 20). Of these three are Red Data List taxa and three species are resticted to the sub-association, namely the SCPE endemic *Plectranthus venteri* and the SCPE near-endemics *Orthosiphon tubiformis* and *Combretum petrophilum* (Rare).

4.3 *Hippocrateo longipetiolatae–Euphorbietum tirucalli bothriochloetosum insculptae* sub-ass. nova hoc loco
Nomenclatural type: relevé 393 (holotypus)

Environmental data. In the SCPE this sub-association represents open grazing between fields, characterised by large trees (> 10 m) that are remnants of former closed woodland. It is common on all aspects of footslopes and valleys. The habitat is characterised by alluvium and exposed layers of norite rock. Average rock diameter is below average for the study area and approximately 100–300 mm, covering a low percentage of the soil surface, namely 10–20%. It is characterised by gentle slopes (1–3°). Soil types are characterised black clays and turfs, predominantly the Steendal form.

Diagnostic and dominant/prominent taxa. The diagnostic species for this sub-association are presented in species group AH (Table 19). Diagnostic species of the vegetation type includes the indigenous forbs *Commicarpus plumbagineus, Cucumis zeyheri, Dyschoriste rogersii, Indigastrum parviflorus, Indigofera spicata* and *Sida cordifolia*, and the alien weeds *Alternanthera sessilis, Corchorus tridens, Flaveria bidentis*, *Solanum nigrum* and *Xanthium strumarium*. *Combretum imberbe* is a large diagnostic tree. The weedy shrubs *Gossypium herbaceum* (indigenous) and *Senna didymobotrya* (alien), the alien succulents *Agave americana* and *A. sisalana* are also diagnostic. Large stands occur of the diagnostic grasses *Bothriochloa insculpta* and *Ischaemum fasciculatum*. *Aristida stipitata*, *Brachiaria eruciformis*, *Cynodon dactylon*, *Eragrostis cilianensis* and *Urochloa oligotricha* are the other diagnostic grasses. Prominent plant taxa include large specimens of *Acacia karroo*, *Boscia foetida*, *Schotia brachypetala*, *Ziziphus mucronata* and the succulent *Euphorbia tirucalli*. Conspicuous forbs are *Abutilon guineense*, *Achyranthes aspera* and *Sesamum triphyllum*. *Aristida congesta*, *A. rhiniochloa*, *Heteropogon contortus* and *Panicum maximum* are the abundant grasses.

Notes on floristic diversity. A strong floristic relationship exists with association 5 in species group AO (Table 19). Probably the result of both vegetation types occurring on alluvium near rivers. The average number of plant species encountered per sample plot is 38, with the total number of plant species recorded being 122 taxa (five relevés) (Table 21). There are six taxa of conservation value occurring in this sub-association, namely three SCPE endemics and three SCPE near-endemics (Table 20). This is one of the lowest numbers of taxa with conservation status recorded for sub-associations in this bushveld type.

5. *Celtido africanea–Combretetum erythrophyllii* ass. nova hoc loco
Nomenclatural type: relevé 184 (holotypus)

Environmental data. This riparian vegetation represents closed thickets with an alien plant species component in valleys along larger rivers such as the Steelpoort and Olifants. It is associated with the areas between the rural settlements and fields, and the rivers. It is a vegetation unit on predominantly red loam Oakleaf soils (ortic A-horizon and a neocutanic B-horizon). The slope is more or less level (1–5°), characteristic of the large alluvium filled valleys. Rock cover percentage is relatively low and varies from 5 to 40%, and average rock diameter is 50–300 mm (Table 21).

Diagnostic and dominant/prominent taxa. Species group AK contains the diagnostic species for this association (Table 19). Woody species are diagnostic of the sub-association, namely the indigenous trees *Celtis africana*, *Combretum erythrophyllum*, *Ficus sur*, *Olea europaea*, *Spirostachys africana*, the alien *Melia azedarach*, and the shrubs *Lippia javanica* and *Rhus pyroides*. Diagnostic forbs include *Asparagus racemosus*, *Pavonia burchellii*, *Sida spinosa*, and the climber *Secamone filiformis*. *Cymbopogon validus* is the only diagnostic grass. Other important dominant taxa include the woody species *Acacia karroo*, *Diospyros lycioides* subsp. *lycioides*, *Flueggea virosa*, *Hippobromus pauciflorus* and *Ziziphus mucronata*. Prominent forbs are *Achyranthes aspera*, *Cardiospermum corindum* and *Hypoestes aristata*. Prominent grasses in the association are *Panicum deustum* and *Sporobolus fimbriatus*.

Notes on floristic diversity. A floristic link exists with sub-association 4.3 in species group AO, and with sub-associations 1.1 and 1.2 in species group AP (Table 19). A slight floristic relationship is also visible with certain sub-associations of association 2 and 3 in species group AN (Table 19). The average number of species encountered per sample plot is 30, and the minimum total number of plant species for this sub-association is 66 (eight relevés). Three plant taxa of conservation value occur in this association, namely two SCPE endemics, one SCPE near-endemic taxon. This association has no Red Data List taxa and one taxon that merits conservation priority is restricted to it.

5.1 *Celtido africanea–Combretetum erythrophyllii acacietosum caffrae* sub-ass. nova hoc loco

Nomenclatural type: relevé 177 (holotypus)

Environmental data. This vegetation type is closed scattered woodland along the Steelpoort River in the broad valleys between mountains. The habitat is predominantly underlain by deep alluvial soils, especially by the red loam Oakleaf form. It lies on level slopes of 1–3°, on no specific aspect. Soil surface cover by rock is low for the study area, namely 5–20%, with a diameter averaging between 100 and 300 mm (Table 21).

Diagnostic and dominant/prominent taxa. The diagnostic species are represented by species group AL (Table 19), with the woody species, *Acacia caffra*, *Tarchonanthus camphoratus* and *Zanthoxylum thorncroftii* conspicuous in the sub-association. No grasses are diagnostic, but there is one diagnostic forb, *Barleria obtusa*. *Acacia karroo*, *Celtis africana*, *Combretum erythrophyllum*, *Cryptolepis oblongifolium*, *Diospyros lycioides* subsp. *lycioides*, *Ehretia rigida*, *Hippobromus pauciflorus*, *Rhus pyroides* and *Ziziphus mucronata* are other dominant woody species of the sub-association. Important dominant grasses include *Cymbopogon validus*, *Panicum deustum* and *Sporobolus fimbriatus*. Common forbs are *Achyranthes aspera*, *Asparagus racemosus*, *Hypoestes aristata* and *Raphionacme galpinii*.

Notes on floristic diversity. Floristic links are the same as for the association. The average number of plant species encountered per sample plot is 32, with the total number for this sub-association 52 (four relevés) (Table 21). It has three taxa of conservation value, namely two SCPE near-endemics and one SCPE near-endemic (Table 20).

5.2 *Celtido africanea–Combretetum erythrophyllii acacietosum galpinii* sub-ass. nova hoc loco

Nomenclatural type: relevé 184 (holotypus)

Environmental data. The vegetation is tall, closed woodland on the banks of rivers in the SCPE. Hence, the vegetation unit is restricted to the broad valleys. The community is usually encountered as meandering vegetation (gallery woodland) on riverbanks amidst any of the communities discussed in the paper. It occurs on no specific aspects and a gentle slope (1–5°). It is found predominantly on deep alluvial soils of the Oakleaf form. Rock cover is average and approximately 5–40% of the soil surface, with a relatively small average diameter of 50–100 mm (Table 21).

Diagnostic and dominant/prominent taxa. Characteristic species are presented in species group AM (Table 19). The diagnostic herbaceous species for this sub-association are the forbs *Acalypha villicaulis* and *Kleinia fulgens*, and the sedges *Bulbostylis burchellii* and *Fuirena pubescens*. Diagnostic grasses include *Andropogon eucomis*, *Hyparrhenia* *filipendula* and the alien, *Paspalum dilatatum*. *Acacia galpinii*, *Syzygium cordatum* and the alien, *Morus japonica*, are the diagnostic woody species. *Acacia karroo*, *Celtis africana*, *Combretum erythrophyllum*, *Diospyros lycioides* subsp. *lycioides*, *Ficus sur*, *Olea europea* subsp. *africana* and *Spirostachys africana* are the dominant trees, *Lippia javanica* is a common shrub, *Achyranthes aspera* and *Pavonia burchellii* are conspicuous forbs, and *Panicum deustum*, *P. maximum* and *Sporobolus fimbriatus* the most abundant grasses.

Notes on floristic diversity. Floristic relationships are the same as for the association. For this sub-association the average number of plant species encountered per sample plot is 28, with the total number of species being 66 taxa (four relevés) (Table 21). There are three plant taxa of conservation value in the association (Table 20), namely two SCPE endemics, one SCPE near-endemic. One plant species with a disjunct distribution, *Gnidia polycephala*, which has its main distribution area in the Northern Cape, is restricted to this sub-association in the SCPE.

8.4 Vegetation key

A vegetation key is presented to aid with the identification of the various syntaxa (Table 22). The definitions are broad indications of typical groups and should be seen as a guideline. A diagnostic characteristic of the vegetation or habitat is given, followed by the most diagnostic and visual species of a group. The first species is restricted to the specific group only, and the second is dominant in the group, but also occurs in other groups. Where one species is given, no species was restricted to the group only.

8.5 Ordination

On a local scale the Closed Mountain Bushveld is characterised by dry woodlands, which is quite distinctive from the Open Mountain Bushveld's low diversity of small trees/shrubs. The structure of this vegetation type is similar to that of typical Mixed Bushveld (Van Rooyen & Bredenkamp 1996) and does not have the stunted, sparse structure of the Open Mountain Bushveld. An extremely heterogeneous environment determines the plant communities within the Closed Mountain Bushveld. A combination of many factors such as terrain type (slope or aspect), soil depth (lithosols or alluvium), soil moisture (riverbanks or open plains) or anthropogenically altered areas (fields or overgrazed areas), affects the species composition of these plant communities. The ordination indicated the gradients caused by the topography.

The scatter diagram displays the distribution of relevés along the first and second ordination axes (Figure 14). The vegetation units are represented as groups, their distribution on the diagram corresponding with certain physical environmental conditions. The terrain type, and consequently soil moisture, determines a definite gradient that is depicted by both the first (eigen value = 0.700) and second axis (eigen value = 0.499).

Topography influences the slope and soil depth, which in turn determines soil fertility and moisture retention. The gradient on the x-axis expresses nutrient levels, where the soils of the valleys on the right have higher concentrations than those of the hills on the left. This is supported by the high density of agriculture on the alluvium soils of the valleys, and hence the greater disturbance in these areas on the right of the scatter diagram. On the y-axis, the gradient indicates higher moisture availibity at the bottom of the scatter diagram, because high rock cover percentages reduces water evaporation in these communities, while other plant communites at the bottom of the graph are on the banks of permanent rivers. In the valleys the soils are clay-loams and on the rocky hillsides light clays. These loams and clays have lower water retention ability than the calcareous soils at the top of the scatter diagram, and therefore higher moisture availability. Calcium-rich soils have higher salt concentrations, which result in high moisture levels, but less available water. It is therefore expected that the calcareous soils would harbour a vegetation type with floristic elements that are common in the more arid Mopaneveld north of the Soutpansberg.

All these gradients correlate closely with each other and have a strong influence on the vegetation structure and species composition. The three most dominant and conspicuous taxa of each growth form (trees/shrubs/suffrutices, forbs/sedges and grasses) are given for each of the eight major vegetation types depicted in the scatter diagram (Table 23).

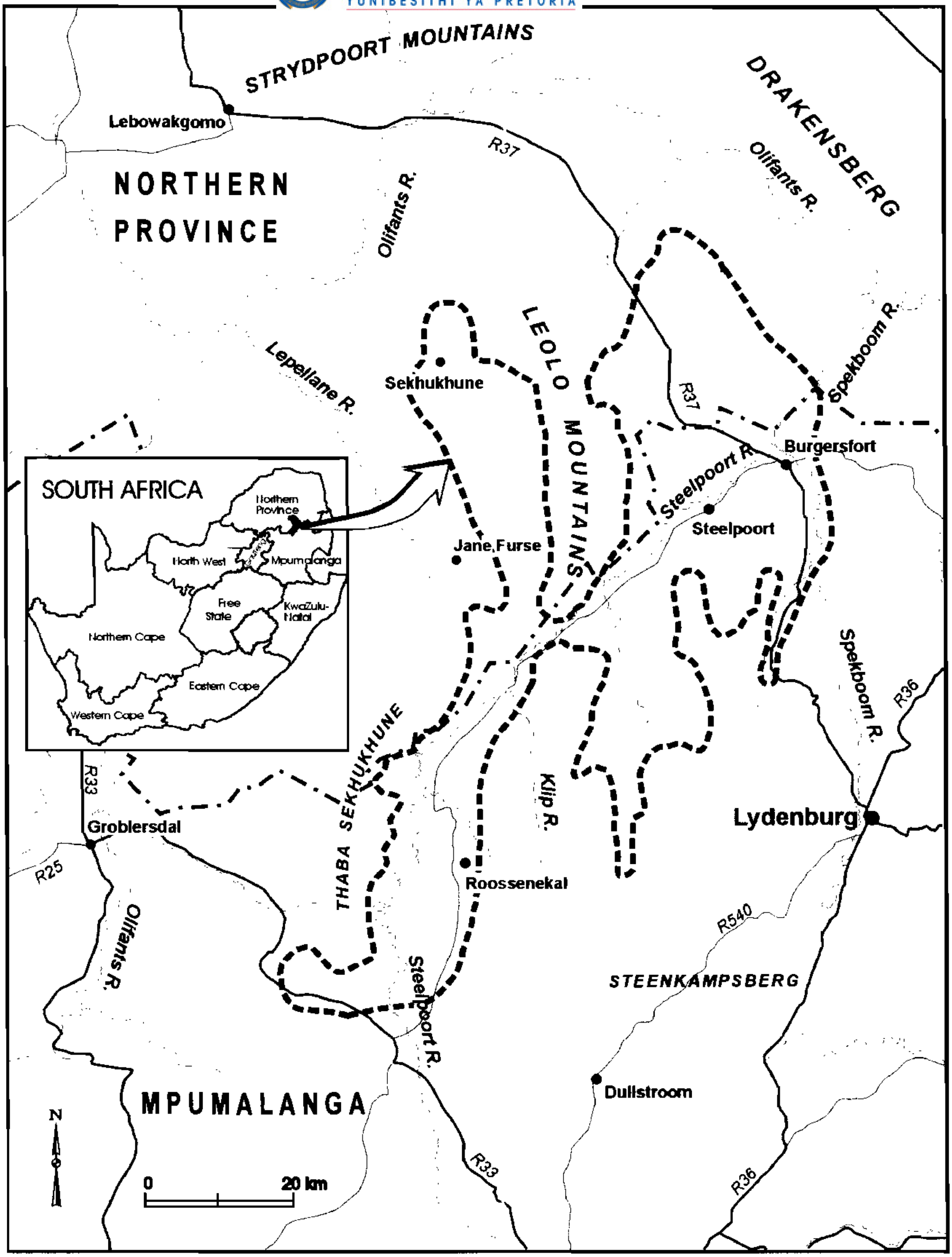

Figure 13 Location of the Closed Mountain Bushveld of the Sekhukhuneland Centre of Plant Endemism in the Northern Province and Mpumalanga, South Africa.

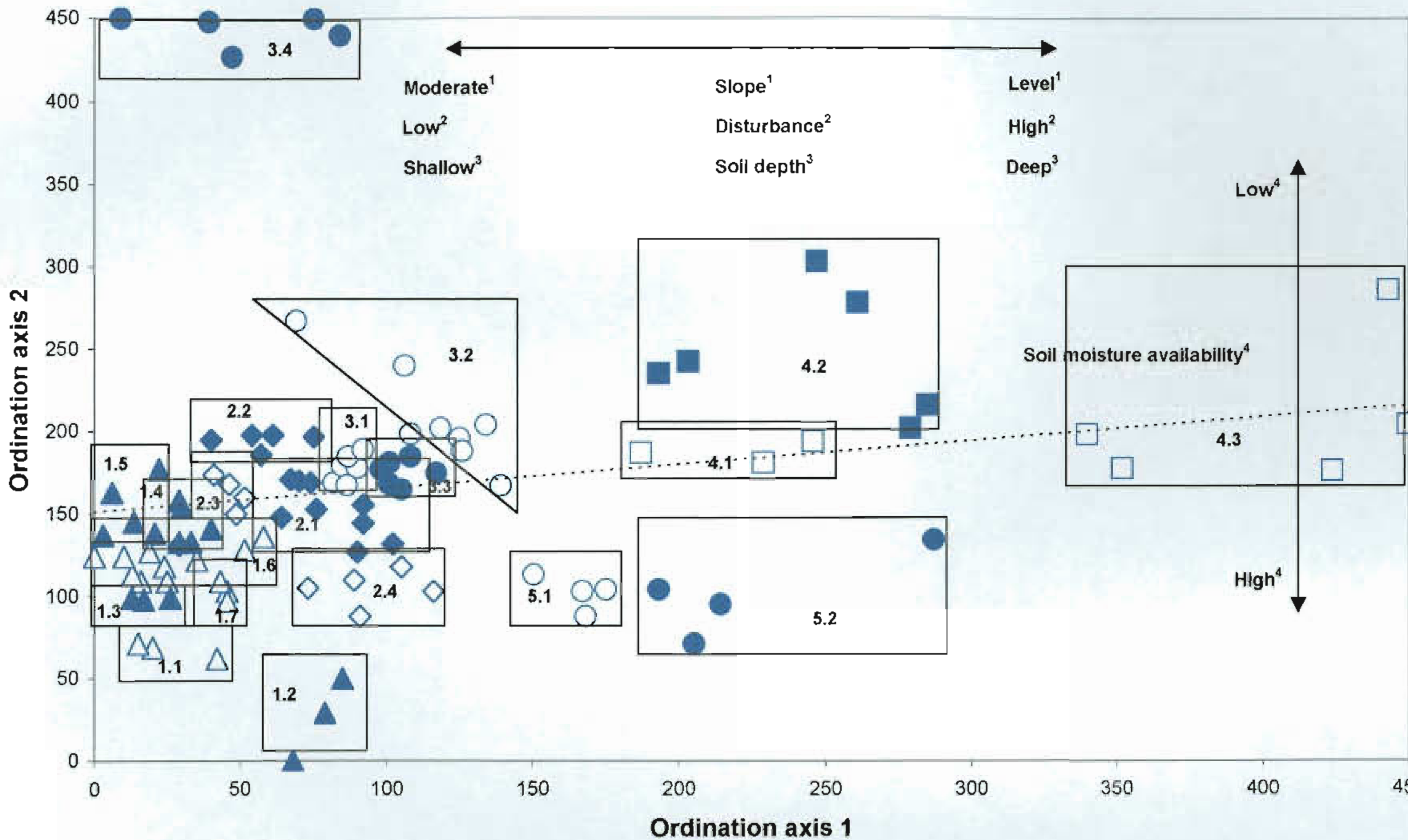

Figure 14 Relative positions of all the releves along the first and second axis of the ordination of the Closed Mountain Bushveld of the Sekhukhuneland Centre of Plant Endemism. Numbers correspond with the plant communities in Table 19.

Table 19 A phytosociological table of the Closed Mountain Bushveld of the Sekhukhuneland Centre of Plant Endemism.

Relevé number	115 119 121	113 116 118	290 298 300 304	206 213 220 223 232	161 241 250 262 263	131 151 154 165 168 170 172 189 191 194	186 197 211	155 157 158 159 187 198 258 273 274	149 212 228 270 330	148 289 308 309	114 117 120 327 329	126 140 145 147 217 229	143 150 160 163 201 202 253 256	267 256 305 306 326 328	292 293 294 311 325	392 394 395	391 396 400 405 411 412	384 385 386 393 404	176 177 178 236	179 184 280 389
Alliance	I											II								
Association	1 .	1 .	1 .	1 .	1 .	1 .	1 .	2 .	2 .	2 .	2 .	3 .	3 .	3 .	3 .	4 .	4 .	4 .	5 .	5 .
Sub-association	1	2	3	4	5	6	7	1	2	3	4	1	2	3	4	1	2	3	1	2
Species group A																				
Acacia exuvialis	1 + 1	+ 1	. R . .	. . . . R	. R . . .	. + 1 . + . 1 . . .	. R .	. . . R	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Triaspis glaucophylla	+ 1 +	. . .	+ + + 1	R	1 R . R +	R R R + R 1 + . . +	+ . R	. . R + ...	. . . . .	R . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Combretum apiculatum	+ + +	1 + 1	1 1 1 1	1 1 + 1 .	+ + 1 + +	1 + . + + 1 + 1 + .	. + .	. . . .	. + . R .	. . . .	. . . R R	. . . . . .	. . . .	. . . . . .	R . R R +	. . .	. . R . . .	. . . . .	. . . .	. . . .
Grewia monticola	+ R +	R . R	1 + 1 +	R + + + +	. + . . +	R . R + . . R + + +	+ + R	. . . .	. . R + .	. . R .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Aloe marlothii	R + .	+ . +	. . + +	. . 1 . .	R	. R R + . + R . . +	. R .	. . . . R	. . . . +	. . . .	. . R R +	. . . . R .	. . . .	. . . . + R	. . . . .	. . .	. . . + . .	. . 1 . .	. . . .	. . . .
Pellaea calomelanos	R R R	R R +	R R + R	+ + R R .	R . R + R	R . . + R R . R . .	R . .	. . R	. . . . .	. . . .	. R . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . R	+	. . . . .	. . . .	. . . .
Species group B																				
Dombeya rotundifolia	+ + +	. . .	. . . .	R . R . .	. . . . .	. . . . R . .	. + .	. . . .	. . . . R	. . . .	. . . . .	. . . . . .	. . . .	. . . . + .	. . . . .	. . R	+ . . R . .	. . . . .	. . . .	. . . .
Clerodendrum glabrum	+ + 1	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	R	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	+ R . R .	. . . .	. . . .
Buttonia superba	+ + R	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Ormocarpum kirkii	+ + R	. . .	. . . .	. . . . .	. . . . .	. . . . R	. . .	. . . .	. . . . .	. . . .	. . . R .	. . . . . .	. . . .	. . . . . R	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Selaginella dregei	R + R	. R .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. + .	. . . . . .	. . . . .	. . . .	. . . .
Plectranthus xerophilus	R R +	R . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Rhus batophylla	+ R .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Cucumis hirsutus	. + R	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Species group C																				
Eustachys paspaloides	. . .	+ + 1	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Commiphora glandulosa	. . .	+ R +	. R + .	. . . . .	. . . . .	. . . .	. . .	. . . .	. + . . .	. . . .	+ R . . R	. . . . . .	+	. . R R . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Solanum incanum	. . .	R + R	R . R R	. . . . .	. . . . .	. . . .	. . .	. . . .	. + . . .	. . . .	R	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Boophane disticha	. . .	+ R .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Rhoicissus tridentata	. . .	+ . +	. . . .	. . + . .	. . . . .	. . . .	+ . .	. . . .	. . . . .	. . . .	R	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Ceropegia ampliata	. . .	R R .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Lotononis pulchra	. . .	. R R	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . . R . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Pergularia daemia	. . .	. R R	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Species group D																				
Elephantorrhiza goetzei	+ 1 R	R + +	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Setaria lindenbergiana	. + R	R + +	. . . .	. . . . R	. . . . R	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Species group E																				
Bridelia mollis	. . .	. . .	+ R . R	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . R . .	. . . . .	. . . .	. . . .
Rhynchosia pauciflora	. . .	. . .	R . + R	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Justicia odora	. . .	. . .	+ . . +	. . . . .	. . . . .	. . + ...	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Melhania burchellii	. . .	+ R .	. + + .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. + . . .	. . . . . .	. . . .	. + R + . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Indigofera filipes	. . .	. . .	. R R .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Aristida bipartita	. . .	. . .	. . + +	. R . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . R	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Species group F																				
Cymbopogon excavatus	. . .	. . .	. . . .	+ . + . .	. . . R .	. . . .	. . R	. . . .	. . . . .	. . . .	. . . . .	. . R . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Lannea discolor	. . .	. . .	. . . .	R . . R .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Tylosema fassoglense	. . .	. . .	. . . .	R . . . R	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Sphenostylis angustifolia	. . .	. . .	. . . .	. R + . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	+	. . . .	. . . .
Ipomoea obscura	. . .	. . .	. . . .	. . + R .	. R . . .	. . . .	. . .	. . . .	. . . R .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. R	. . . . .	. . . .	. . . .
Sphedamnocarpus pruriens	. . .	. . .	. . . .	. . R + .	. . . R .	. R	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Sorghum bicolor	. . .	. . .	. . . .	. . . R +	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . . . . + .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .

Table 19 continued.

Relevé number	116 119 121	113 116 118	280 298 300 304	208 213 220 223 232	161 241 250 262 263	131 151 154 165 168 170 172 189 191 194	186 197 211	155 157 158 159 167 198 268 273 274	149 212 228 270 330	148 289 308 309	114 117 120 327 329	126 140 145 147 217 229	143 150 160 163 201 202 253 256	267 268 305 305 326 328	292 293 294 311 325	392 394 395	391 398 400 405 411 412	384 385 386 393 404	176 177 178 236	179 184 280 389
Alliance	I											II								
Association	1.	1.	1.	1.	1.	1.	1.	2.	2.	2.	2.	3.	3.	3.	3.	4.	4.	4.	5.	5.
Sub-association	1	2	3	4	5	6	7	1	2	3	4	1	2	3	4	1	2	3	1	2
Species group G																				
Pappea capensis	+ + R	R + +	+ + + +	. + + + +	. . . . .	. . . .	R + R	. . R	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . R	. . . . .	. . .	. . . + . .	. . . . .	. . + +	. . . .
Lantana rugosa	. . +	R R +	+ . R R	+ . R . R	. . . . .	. . . . R .	. . .	. . . . R R . R .	. R R . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	R . .	. . . . . .	. . . . .	. . . .	. . . .
Digitaria eriantha	. . R	1 B A	. + R .	. 1 + . +	. . . . .	. R	. . .	. . + ...	. . . . .	. . . .	1 + R . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . + +	. . + . .	. . . .	. . . .
Ozoroa sphaerocarpa	. + .	+ . .	. R + .	. . . + R	. . R . .	. . . .	. . .	. . . . . . R . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	R R	. . . . .	. . R	. . . . . .	. . . . .	. . . .	. . . .
Species group H																				
Hermannia boraginiflora	. . .	. . .	. . . .	. . R . .	+ R + . +	. . . .	. . .	. . R R	. . . . .	. . . .	. . . . .	. . . . . .	R . . . R . . .	. . . . . .	. . . . .	. R .	. . . . . .	. . . . R	. . . .	. . . .
Hermannia glanduligera	. . .	. . .	. . . .	R	. R + + R	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Mundulea sericea	. . .	. . .	. . . .	. . . . .	+ . . + .	. . . . . . R . . .	. R .	. . . .	. . . R .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. + ...	. . . . .	. . . .	. . . .
Tephrosia forbesii	. . .	. . .	. . . .	. . . . .	. . + . R	. . . .	R . .	. . . .	. . . R .	. . . .	. . . . .	. . . . . .	. . . . + . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Pentarrhinum insipidum	. . .	. . .	. . . .	. . . . .	. . + R .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Species group I																				
Jasminum multipartitum	. . .	. . .	. . . .	R + + R 1	+ R + . +	. . . .	. . R	. R . . . . . R R	. . . R .	R . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Jatropha latifolia	. . .	. . .	. . . .	R + R R R	R + R R R	. . . . R + ...	. R .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Decorsea galpinii	. . .	. . .	. . . .	R R . R +	. R + R R	. + . R	. R .	. . . . R .	. . R . .	+ . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Aristida meridionalis	. . .	. . .	R . R .	. 1 . . 1	. . 1 . +	. . . .	. . .	. . . . R .	. R . + .	. . . .	. . . . .	. . . . R +	. . . .	. . . . . .	. 1 . R +	. . .	. . . . . .	. . . . .	. . . .	. . . .
Ledebouria revoluta	. . .	. . .	. . . .	. + R . +	R . + R .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Species group J																				
Euphorbia schinzii	. . .	. . .	. . . .	. . . . .	. . . . .	+ . R . + . R . . .	. . .	. . . . . . R . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. 1 +	. . . . . .	. . . . .	. . . .	. . . .
Thesium burkei	. . .	. . .	. . . .	. . R . .	. . . . .	+ . . . R + R . . +	. . .	. . . . R	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Pavetta inandensis	. . .	. . .	. . . R	. . . . .	. . . . .	+ . . + . . . R R .	. . .	. . . .	. . . R .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . +	. . . + . .	. . . . .	. . . .	. . . .
Karomia speciosa	. . .	. . .	. . . .	. . . . .	. . . . .	. R + ... R + .	R R .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Tulbaghia ludwigiana	. . .	. . .	. . . .	. . . . .	. . . . .	. . . + . R . . . R	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Rhynchosia totta	. . .	. . .	. . . .	. . . . .	. . . . .	. . . . . R R R . .	. R .	. . . . . . R . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. R	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Cussonia transvaalensis	. . .	. . .	. . . .	. . . . .	. . . . .	. . . . R . . + . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Rhynchosia crassifolia	. . .	. . .	. . . .	. . . . .	. . . . .	. . . . + R .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Solanum pseudocapsicum	. . .	. . .	. . . .	. . . . .	. . . . .	. . . . R R .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Species group K																				
Hermannia floribunda	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	+ R .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	+ . R	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Acacia davyi	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	R + .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Rhoicissus sekhukhuniensis	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	R . +	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. + . + . .	. . . . .	. . . .	. . . .
Cyphia transvaalensis	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	R . R	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Ruttya ovata	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. + 1	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Nuxia congesta	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. + +	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Tetradenia brevispicata	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. + +	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Barleria rotundifolia	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. R 1	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . + . . .	. . . . .	. . . .	. . . .
Ficus abutilifolia	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. R +	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Species group L																				
Elephantorrhiza praetermissa	. . .	. . .	. . . .	+ . + 1 1	R + + + +	+ + + + + + + . . +	+ + .	. . R	. . . R .	. + R .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. + R + . .	. . . . .	. . . .	. . . .
Ochna inermis	. . .	. . .	. . . .	R R . . R	R . . R .	+ 1 R + R R + . + R	. . +	. . . R	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Stylochiton sp. (S 1332)	. . .	. . .	. . . .	R . . R +	. . R . .	R . . . R . R R . R	. . +	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . + +	. . . . .	. . . .	. . . .
Eragrostis rigidior	. . .	. . .	. + . .	. + R . .	. . . 1 .	+ + . + . . + . 1 .	1 1 .	R . R + ...	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Blepharis subvolubilis	. . .	. . .	. . . .	. R . . .	+ . + . +	. 1 R . + . R . . +	. R R	. . . .	. . . R .	. . . .	. + . . .	. . . . . R	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Species group M																				
Commiphora mollis	. . .	1 1 +	+ . . .	+ . + + 1	. + + 1 1	+ 1 1 R 1 . R . 1 +	+ + R	. . . R	. + + . .	. . . .	R . . + .	. . . . . .	. . . .	. . . . . R	+	. . .	. . . . . .	. . . . .	. . . .	. . . .
Commiphora africana	. . .	+ + +	1 + . 1	. 1 1 + R	1 1 R . +	. . 1 R . 1 + . 1 R	. . +	. . + ...	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Sterculia rogersii	. . .	+ + R	+ . . .	+ 1 + 1 +	. . R + .	R 1 + . 1 . R . + +	+ + .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Clerodendrum ternatum	. . .	+ + .	+ R + +	1 + + R +	+	+ + . R + + R . + .	. + .	. . . + ...	. . . . .	. . . .	. . . + +	. . R . . .	R	. . . . . .	. . . . .	R . .	. + ...	. . . 1 .	. . . .	. . . .
Pouzolzia mixta	. . .	+ R +	. . + .	. . . . .	. . . . .	. + ...	R R +	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Aspilia mosambicensis	. . .	+ R +	. . . .	. . + . .	1	. + R 1 + + ...	. + .	. . . + ...	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Barleria lancifolia	. . .	+ R R	R + + R	. . . . .	. . R . .	R . + R 1 . R . . +	. + .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .

Table 19 continued.

Relevé number	115 119 121	113 116 118	290 298 300 304	206 213 220 223 232	161 241 250 262 263	131 151 154 165 168 170 172 189 191 194	186 197 211	155 157 158 159 167 196 188 273 274	149 212 226 270 330	148 299 306 309	114 117 120 327 329	126 140 145 147 217 229	143 150 160 163 201 202 253 256	267 268 305 306 322 328	292 293 294 311 325	392 394 395	391 398 400 405 411 412	384 385 386 393 404	176 177 178 236	179 184 180 389
Alliance	I											II								
Association	1 .	1 .	1 .	1 .	1 .	1	1 .	2 .	2 .	2 .	2 .	3 .	3 .	3 .	3 .	4 .	4 .	4 .	5 .	5 .
Sub-association	1	2	3	4	5	6	7	1	2	3	4	1	2	3	4	1	2	3	1	2
Species group M cont.																				
Sclerocarya birrea	. . .	+ . +	. + 1 +	. + + + +	. + . + .	+ . . + R + + . + .	+ + .	. . . .	R R + . R	. . . .	. . . R .	+ . . . . +	. . . . . R . .	. . . . R .	. . . . .	. . .	. . + . . .	R	. . . .	. . . .
Indigofera lydenburgensis	. . .	R R R	. . . .	. R . . R	R . . R .	. . . R . R . R . R	. . .	. . R	R R R . .	. . . .	. R . . .	R . . . . R	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Dalechampia galpinii	. . .	. . .	R R . R	R R . R +	. R . . R	R . . . R . . R . .	. R .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Species group N																				
Sporobolus stapfianus	R 1 +	. . .	. . . .	. . . R .	. . . . .	. . . .	. . .	A A . . 1 A . R 1	. . . . .	. . . .	1	. . . . . .	. 1 . . . . + .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Croton menyharti	. . .	. . .	. . . .	. . . . .	. . . . .	. . + ... R	. . .	1 R . . R + . . R	. . . . .	. . . .	. . . . .	. . . . . .	. + R . + R . R	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Rhigozum obovatum	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	+ + . R R . . R .	. + . . .	. . . .	. . . . .	. . . . . .	. . + ...	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Cenchrus ciliaris	. . .	. . .	. . . .	. . . . .	. . . . .	. . . + . + ...	. . .	+ . + ... + .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Fockea angustifolia	. . .	. . .	. . . .	. . . . .	. . . . .	. . . . R	. . .	R . R . . . . . R	. . . . .	. . . .	. . . . .	. . R . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Monechma divaricatum	. . .	. . .	. . . .	. + . . .	. . . . .	. . . .	. . .	. + . + + + . + R	. . . . +	. . . .	. . . . .	. . . . . .	. + . + . + 1 .	. . . . 1 .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Bauhinia tomentosa	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. + ... R . +	. . . + .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Rhus gueinzii	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . R . R . R . .	. R . . .	. . + .	. . . . .	. R	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Tinnea rhodesiana	R . R	. . .	. . . .	R	R	. . . .	. . .	. . + + . . + . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . + ...	. R	. . . . .	. . .	. . . + . .	. . . . .	. . . .	. . . .
Digitaria argyrograpta	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . + + . + . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Species group O																				
Maerua angolensis	. . .	. . .	. . . .	. . . . .	+	. . . .	. . .	. . + ...	+ R . R +	. . . .	. . . . .	. . . . . .	. . . .	. . . . + .	+ . . . R	. . .	. . . . . .	. . . . .	. . . .	. . . .
Chlorophytum bowkeri	. . .	. . .	. . . .	. . . . .	. . . R .	. . . .	. . .	. . . .	R + R . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Ledebouria dolomiticola	. . .	. . .	. . . .	. . . . .	. . R . .	. . . R	. . .	. . . .	. R + . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Evolvulus alsinoides	. . .	. . .	. . . .	. R . . .	. + . . .	. . . .	. . .	. . . . . . + . .	. + . + R	. . . .	. . . . .	. . . . . .	. . . .	. + ...	. . . . .	. R .	. . . . + +	. . . . .	. . . .	. . . .
Orthosiphon fruticosus	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . + 1 .	. . . .	. . . . .	. . . . + .	. . . .	. . . . . .	. . . . .	. . .	. + ...	. . . . .	. . . .	. . . .
Enteropogon macrostachys	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . + R R	. . . .	. . . . .	. . . . . .	. R	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Species group P																				
Melhania prostrata	. . .	. . .	. . R .	. . . . .	. . . . .	. . . . R . .	. . .	. . . .	. + R . .	+ 1 + +	. . R . .	. . . R . .	. . . R	. . . . . .	. . . . .	+ . .	. . . . . .	. . . . .	. . . .	. . . .
Bolusanthus speciosus	. . .	. . .	. . . .	. . . . .	. . . . .	R . . . + ...	. . .	. . . .	+	+ + . +	. . . . .	. . . . . .	. . . . . . + .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Diheteropogon amplectens	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	+ . . 1	. . . . .	. . R + . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Ptycholobium plicatum	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . R	. . . . .	R + R .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Jatropha zeyheri	. . .	. . .	R . . R	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. R + R	R	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Crabbea angustifolia	. . .	. . .	. . . .	. . . . .	. . . . .	. . . . R	. . .	. . . .	. . . . .	. R . +	. . . . .	. . . . . .	. . . . R R . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Species group Q																				
Melhania acuminata	. . .	. . .	. . . .	. . . . .	R	. . . .	. . .	. . . .	+ . . R R	. . . .	+ 1 . 1 +	. . . . . .	. . . 1	. . . . 1 .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Gardenia volkensii	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	+ R . R .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Phyllanthus incurvus	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	R . R . .	. . . . . .	. . . .	. . . . . .	. . . . .	R . .	. . . . . .	. . . . .	. . . .	. . . .
Plectranthus neochilus	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	R . . R .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Pavonia senegalensis	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. + + R .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . R .
Cyphostemma sp. B (*SS* 1383)	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. R .	. . . .	. . . . .	. . . .	. + R R .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Cassine aethiopica	. . .	. . .	. . . .	. . . . .	. . . . .	. . . . + . .	. . .	. . . .	. . . . .	R . . .	. R + . R	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . . R	. . . .
Species group R																				
Enneapogon scoparius	1 1 1	1 A 1	B . . B	A A 1 1 1	+ 1 1 1 +	1 A + 1 R + + B 1 1	1 1 .	A 1 + 1 1 1 + 1 1	. + + 1 1	1 1 + +	. + . R .	. . . . . +	. . . .	. . . . 1 +	. . . . .	. . .	. . . . . .	. 1 . . .	. . . .	. . . .
Asparagus buchananii	+ R R	R + R	R + R R	R + + R R	R R R R +	R R R R R R R R R .	. R .	R R R + + R R R R	R R R R R	. R R R	. + + . R	R . . . . R	. . . .	. R	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Commelina africana	R R +	1 1 R	R + R +	+ R + R +	1 + R + R	R + + + 1 R + R + +	. R .	R . R . R R . . .	. . . + R	. . R +	R . + . +	. . R . . .	+ . R . R R . .	. . . . . .	. . . . .	. . .	. . . R . .	. . . . .	. . . .	. . . .
Acacia nigrescens	. . .	1 + .	1 R . .	. . . 1 .	. + . . +	+ . + . + . 1 . + .	. . R	+ + R . R + . + +	. R . . .	+ R . .	+ + . R .	. . . . . .	. . . . +	. . . . . .	. . . . .	R . .	. . . . . .	+ + . . .	. . . .	. . . .
Species group S																				
Sarcostemma viminale	. . .	. . .	. . . .	R	. . . . .	. . . .	. . +	. . . . R . . + .	+ R . . R	. . . .	. . R . .	+ R + 1 + R	+ . 1 1 R 1 R +	R . + R . +	R R R R +	. + .	. . . . . .	. . . . .	. . . .	. . . .
Aloe burgersfortensis	. . .	. . .	. . . .	. + . . .	. . . . .	. . . .	. . .	. . . . + R . . +	R	. . . .	. . . . .	+ . + + . .	+ 1 + 1 . . . +	. . . . . .	1 + + R 1	. . .	. . . . . .	. . . . .	. . . .	. . . .
Boscia foetida	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. + R 1 . +	+ . R . + . R 1	+ R . + + R	. 1 + 1 .	. . .	. . . . . .	. . + + .	. . . .	. . . .
Fingerhuthia africana	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . + . . . R . .	. . . . .	. . + .	. . . . .	. . . + + +	. + . . + + + A	R R + 1 . .	+ . + 1 +	. . .	. . . . . .	. 1 . . .	. . . .	. . . .
Kalanchoe paniculata	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . . R	. R . . .	. . . .	. . . . .	. . R . + R	+	+	+ . R . 1	. . .	. . R . . .	. . . . .	. . . .	. . . .
Species group T																				
Elaeodendron transvaalensis	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	R . . .	. R . . .	+ R . R . +	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	R . . .	. . . .
Eragrostis capensis	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	+	. . . .	. . . . .	+ R . R . R	. . . .	R	. . . . .	+ . .	. . . . . .	. . + . .	. . . .	. . . .

Table 19 continued.

Relevé number	115	119	121	113	116	118	290	298	300	304	206	213	220	223	232	161	241	250	282	263	131	151	154	165	188	170	172	189	191	194	186	197	211	155	157	158	159	167	196	258	273	274	149	212	228	270	330	148	299	308	309	114	117	120	327	329	126	140	146	147	217	229	143	150	180	183	201	202	263	266	267	268	305	306	326	328	292	293	294	311	325	382	394	395	391	398	400	405	411	412	384	385	386	393	404	176	177	178	236	179	184	280	389
Alliance	I																																																								II																																															
Association	1.			1.			1.				1.					1.					1.										1.			2.									2.					2.				2.					3.						3.								3.						3.					4.			4.						4.					5.				5.			
Sub-association	1			2			3				4					5					6										7			1									2					3				4					1						2								3						4					1			2						3					1				2			
Species group T cont.																																																																																																										
Catha transvaalensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	+	R	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Indigofera nebrowniana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	R	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Helichrysum rugulosum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Abutilon pycnodon	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.
Species group U																																																																																																									
Chaetacanthus costatus	.	.	.	.	.	.	.	.	.	.	1	+	+	+	+	.	.	.	+	.	.	.	.	1	.	1	.	.	.	+	.	.	.	+	.	+	+	.	.	.	.	.	+	.	+	.	.	.	.	.	.	R	R	.	.	.	+	+	+	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acacia senegal var. *leiorachis*	.	.	.	.	.	+	.	.	+	.	+	1	.	+	+	R	.	+	+	+	.	+	1	1	1	+	+	+	+	.	.	.	.	+	+	+	+	+	+	A	1	+	R	1	.	1	R	.	1	+	1	.	.	R	.	.	.	R	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Barleria saxatilis	.	.	.	.	.	.	.	R	.	+	.	R	.	.	+	+	+	+	+	+	.	R	.	.	.	.	.	+	+	.	.	.	.	.	+	+	.	+	1	.	1	+	+	+	.	+	.	.	.	.	.	.	.	+	.	.	.	.	+	+	+	+	R	R	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	+	R	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Themeda triandra	.	.	.	.	.	.	.	.	.	.	.	.	1	B	.	1	B	+	1	1	A	.	1	1	A	A	1	A	A	.	+	+	.	.	.	+	1	+	.	+	.	.	1	.	+	A	.	1	A	B	B	.	+	.	+	.	1	.	1	.	+	1	.	.	.	.	.	1	.	.	.	+	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Andropogon schirensis	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	+	.	.	.	R	+	.	.	+	.	.	.	.	+	1	.	.	+	+	+	+	.	.	.	A	1	.	.	.	.	1	+	.	+	.	.	.	R	+	.	.	R	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Grewia flavescens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	R	.	.	+	.	+	.	.	.	.	.	.	+	R	+	.	+	R	R	R	R	R	R	+	1	.	+	+	R	.	.	+	+	R	+	+	+	.	.	R	R	.	.	.	.	.	.	.	.	.	.	.	.	1	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Species group V																																																																																																								
Aloe globuligemma	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	+	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	+	1	.	1	1	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acacia luederitzii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	+	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Barleria prionitis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	R	.	.	+	1	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Setaria incrassata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	R	.	.	R	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pearsonia uniflora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	R	R	.	+	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hibiscus micranthus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eragrostis pseudosclerantha	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	+	R	.	+	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cadaba natalensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	1	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chascanum pinnatifidum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	R	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Stapelia gigantea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	+	.	+	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ximenia caffra	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
Cadaba aphylla	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lotononis macrosepala	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	R	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Peristrophe decorticans	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	+	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species group W																																																																																																								
Petalidium oblongifolium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	+	.	+	.	+	R	+	.	.	+	.	.	.	+	+	+	.	R	+	1	.	+	R	.	R	.	.	R	.	.	.	.	.	.	.	.	A	+	R	+	.	+	1	R	1	.	.	R	+	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Albizia anthelmintica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	R	.	.	.	.	.	.	.	.	.	.	.	1	R	.	.	A	+	.	R	R	1	R	+	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sporobolus nitens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	+	1	+	.	.	+	+	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Seddera suffruticosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	R	.	.	.	.	.	+	.	.	+	.	.	R	.	.	.	+	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Blepharis saxatilis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	R	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	1	.	.	.	+	+	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lepidagathis scabra	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	R	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	R	.	.	+	.	.	+	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dyschoriste fischeri	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	+	R	.	R	+	.	R	1	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sida ovata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	R	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	R	.	.	R	R	.	+	+	.	R	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acacia grandicornuta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	R	.	.	R	+	.	+	+	+	R	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species group X																																																																																																									
Euphorbia ingens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	R	.	.	.	.	.	+	.	.	.	+	R	R	.	+	.	.	+	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	R	.	.	R	.	+	+	1	+	1	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.
Eleusine coracana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	A	A	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ptycholobium contortum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Indigofera circinnata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ammocharis coranica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Erythrina lysistemon	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species group Y																																																																																																							
Eragrostis lehmanniana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	R	.	R	.	.	.	.	+	.	.	.	1	1	1	.	R	.	.	.	.	R	.	+	A	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Kleinia longiflora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	.	+	.	+	.	.	+	R	.	+	.	.	.	.	.	.	.	.	R	.	R	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dicliptera fruticosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	R	1	+	.	.	+	.	.	.	.	+	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acacia gerrardii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	R	.	.	R	+	+	+	+	.	.	R	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aloe greatheadii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	R	.	R	.	+	.	1	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Schmidtia pappophoroides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	+	.	.	.	.	+	+	.	.	.	R	1	+	.	R	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Melhania rehmannii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	+	.	R	.	.	R	+	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

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Table 19 continued.

Relevé number																				
	1 1 1	1 1 1	2 2 3 3	2 2 2 2 2	1 2 2 2 2	1 1 1 1 1 1 1 1 1 1	1 1 2	1 1 1 1 1 1 2 2 2	1 2 2 2 3	1 2 3 3	1 1 1 3 3	1 1 1 1 2 2	1 1 1 1 2 2 2 2	2 2 3 3 3 3	2 2 2 3 3	3 3 3	3 3 4 4 4 4	3 3 3 3 4	1 1 1 2	1 1 2 3
	1 1 2	1 1 1	8 9 0 0	0 1 2 2 3	6 4 5 5 6	3 5 5 6 6 7 7 8 9 9	8 9 1	5 6 6 5 8 9 5 7 7	4 1 2 7 3	4 8 0 0	1 1 2 2 2	2 4 4 4 1 2	4 5 8 8 0 0 5 5	6 6 0 0 2 2	9 9 8 1 2	9 9 9	9 9 0 0 1 1	8 8 8 9 0	7 7 7 3	7 8 8 8
	5 9 1	3 6 8	0 8 0 4	6 3 0 3 2	1 1 0 2 3	1 1 4 5 6 0 2 9 1 4	6 7 1	5 7 8 9 7 8 8 3 4	9 2 6 0 0	8 9 8 9	4 7 0 7 9	6 0 5 7 7 9	3 0 0 3 1 2 3 6	7 8 5 6 6 8	2 3 4 1 5	2 4 5	1 6 0 5 1 2	4 5 6 3 4	6 7 8 6	9 4 0 9
Alliance	I											II								
Association	1 .	1 .	1 .	1 .	1 .	1 .	1 .	2 .	2 .	2 .	2 .	3 .	3 .	3 .	3 .	4 .	4 .	4 .	5 .	5 .
Sub-association	1	2	3	4	5	6	7	1	2	3	4	1	2	3	4	1	2	3	1	2
Species group Z																				
Ximenia americana	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. R .	+ + . . + + . . .	+ . + . R	R . . .	. . R . .	+ . + R + R	. R R + + + R .	R . + R . +	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Acacia nilotica	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	+ . R . . + . + .	. R . . +	+ . . 1	+ 1 . . .	. R . . + +	. + R . + + 1 +	R 1 + 1 . +	. . . . .	. . .	. . . . . .	 1	. . . .	. . . .
Opuntia ficus-indica	+ . .	. . .	. . . .	. . . . .	. . . . .	. . . .	R . .	R . . . . . + . .	. . + . .	R . . .	. . . . .	R + . . R .	R R R + . . . R	. R + R . .	. . . . .	R . +	. . + . . .	+ . . . +	. R . .	. . + .
Acacia tortilis	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. + . . + . + R +	. . R + 1	. + + R	. + . 1 1	. . + + 1 1	+ . 1 1 1 1 1 R	R . 1 1 1 1	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Sporobolus ioclados	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. R . R . . R . .	+ + + . .	. R . .	. . . 1 R	+ R . . . R	. R . + . R . .	. R . B . .	. . . . .	. + .	. . . . . .	. . . . .	. . . .	. . . .
Species group AA																				
Dichrostachys cinerea	. . .	+ 1 +	R + + +	. R . R +	+ . + . +	+ . . . 1 . 1 . . +	. . .	. . . . + 1 + + +	1 1 1 1 +	+ + 1 +	1 + + A 1	1 + . R + 1	+ R + A + 1 R +	. R 1 1 . 1	. . . . .	. . .	. . . . . .	+ . + + .	. . . .	. . . .
Tephrosia purpurea	. . .	+ R .	R . . R	+ 1 + . .	. . . + .	. + + + . . . 1 . .	+ . .	+ + . + . . . + +	. + . R .	. . + R	. . . R .	. + . + . .	. + + . . . + .	+ . . . R .	R . . . R	. . .	. . . . . .	. . . . .	. . . .	. . . .
Urginea epigea	. . .	R + +	. . . .	. R . . .	. . . . .	. . . .	. R .	. . R	. . . . +	. . . .	R + . . .	. . . . . .	. + ... +	+ . 1 + . +	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Grewia flava	. . .	. . +	. R + .	. . R + R	. . . . .	. + . . R . R 1 + R	. . .	. . . .	. + . . .	+ . . .	R . . R +	. . . R . .	R + + + R R + 1	R R R R . +	. . . . .	. . .	. . . . . .	. R + . .	. . . .	. . . .
Commiphora pyracanthoides	. . .	. . .	+ . . .	. R . . R	. . . . .	. . . . R +	. . .	+ . . . + + . R R	. . . . .	. . . .	. . . R R	. . . . . .	. + R . + + . .	R . . . R .	. . . . .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Psiadia punctulata	. . .	. . .	+ . + .	. . . . .	+ + . + +	. + + R + R . + R +	. R .	. R + R + + + + +	R . . . +	R . . .	. . . . .	. . . + + +	. + ... +	+ + . . + .	. . . . .	R . .	. + . + . .	. . . . .	. . . R	. . . .
Species group AB																				
Cleome hirta	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	1 + + + +	. . .	. . . . . .	. . . . .	. . . .	. . . .
Holubia saccata	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	+ + R + .	R . .	. . . . . .	R R . R .	. . . .	. . . .
Maerua juncea	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	+ + R + .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Felicia mossamedensis	. . .	. . .	. R R .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	+ + R . +	. . .	. . . . . .	. . . . .	. . . .	. . . .
Sesamothamnus lugardii	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	+ + . + +	. . .	. . . . . .	. . . . .	. . . .	. . . .
Euphorbia sp. (*W 13194*)	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	+ R . . +	. . .	. . . . . .	. . . . .	. . . .	. . . .
Albuca sp. (*S 856*)	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	1 . . + R	. . .	. . . . . .	. . . . .	. . . .	. . . .
Pogonarthria squarrosa	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	+ . + + +	. . .	. . . . . .	. . . . .	. . . .	. . . .
Aristida adscensionis	. . .	. . .	. . . .	. . . . .	. . + . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	+ . . 1 1	. . .	. . . . . .	. . . . .	. . . .	. . . .
Melinis repens	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	R + . + .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Indigofera heterotricha	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	R R R + +	. . .	. . . . . .	. . . . .	. . . .	. . . .
Pterodiscus ngamicus	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	+ . R R .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Triaspis hypericoides ssp. *nelsonii*	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	R . + . +	. . .	. . . . . .	. . . . .	. . . .	. . . .
Cissus quadrangularis	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	R . R R .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Stipagrostis hirtigluma var. *patula*	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. 1 1 . +	. . .	. . . . . .	. . . . .	. . . .	. . . .
Grewia bicolor	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. + + R +	. . .	. . . . . .	. . . . .	. . . .	. . . .
Cadaba termitaria	. . .	. . .	. . . .	. . . . .	. . . . .	. . + . R . . R . R	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. + + 1 .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Merremia kentrocaulos	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. R + + .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Maerua edulis	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. R . R .	. . .	. . . . . .	. . . . .	. . . .	. . . .
Decorsea schlechteri	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . + + +	. . .	. . . . . .	. . . . .	. . . .	. . . .
Species group AC																				
Aristida canescens	. . .	. . .	. . . R	1 + . . +	. . + + .	+ . . . . + + . . +	. R .	. + . + + . + . .	1 + + 1 .	+ . + .	+	+ . + + . +	. . + + + 1 . +	+ + ...	+ . + + 1	. R .	. . . . . .	. . . . .	. . . .	. . . .
Kyphocarpa angustifolia	R . R	. + .	. . R .	. + . . +	. + . R R	. 1 + R . . . . . R	. . .	R R R + R R + R R	+ . R + R	R . . .	. + . . R	R . . R . R	R R + . R . . R	R + . . . R	. + + + .	. R R	. . . . . .	. . . . .	. . . .	. . . .
Boscia albitrunca	. . .	. . .	. . . .	. + . . R	R	. . R	. . .	+ + R . + + + + +	. + + . R	. . . R	. . R . .	+ + . R + +	+ + + + + + + +	. + 1 + . R	+ . + . +	. . .	. . . . . .	. . . . .	. . . .	. . . .
Dolichos trilobus	. . .	R . .	. R R .	. R R . R	. . . . .	. R R . . . . R . R	. . .	. . . .	. . . . .	. R . R	. . . . .	. . . . . .	. . . . . R . .	. . . . . .	+ R . . .	. . .	. . . . . .	. . . . .	. . . +	R . . .
Sansevieria hyacinthoides	. . .	. R R	. . . .	. . + R +	. + . . .	+ + + . + . + . . .	+ . R	. . + ... +	+ . 1 + +	. R . .	. . . . .	+ + ...	+ . + 1 . . . +	. . . R R .	. + + . +	. . .	. . . . . .	. . . . .	. . . .	. . . .
Justicia protracta	. . .	. . .	+ . . +	. . . + +	. . . + .	. . + 1 . + ...	. . .	. . . .	. . . + .	+ . + .	+	. . . . . .	. . . .	. . . . . .	+ + R + +	. . .	. . . . . .	. . . . .	. . . .	. . . .
Species group AD																				
Hippocratea longipetiolata	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	1 R .	1 . + + + +	. R . 1 .	. . . .	. . . .
Schkuhria pinnata	. . .	. . .	. . R .	. . . . .	. . . . .	. . R	. . .	. . . . R	. . . . .	. . . .	R	. . . . R .	. . . . + . . .	. . . . . .	. . . . .	+ + +	+ . 1 . . .	. R + . .	. . . .	. . . .
Senna italica	. . .	. . .	. . . .	R R . R R	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . R .	. . . . . .	. . . .	. . . . . .	. . . . .	+ + R	. . + R . .	. . + R .	. . . .	. . . .
Dicoma tomentosa	. . .	. . .	. . . .	. . . . .	. . . . .	. . . R . R	. . .	. . . R	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	+ . R	+ . + . . R	R	. . . .	. . . .
Catharanthus roseus	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	R . +	+ . . . . R	. . . R +	. . . .	. . . .
Chloris virgata	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	R . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. 1 +	. R . R . .	+ . . . +	. . . .	. . . .
Leucas capensis	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	+ . . . R R . + R	. . . . .	+ . . .	. . . . .	. + ...	. R	. . . . . .	. . . . .	. + +	. . + . R .	+ . . . +	. . . .	. . . .
Ledebouria marginata	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. + R	. . + . R .	. . R . +	. . . .	. . . .
Euphorbia tirucalli	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	+ . . + .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . A	. + . . R .	1 + A . 1	. . . .	. . . .
Species group AE																				
Brachiaria brizantha	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	+ + .	. . . . . .	. . . . .	. . . .	. . . .

Table 19 continued.

Relevé number	115 119 121	113 116 118	290 298 300 304	206 213 220 223 232	161 241 250 262 263	131 151 154 165 168 170 172 189 191 194	166 197 211	155 157 158 159 167 198 258 273 274	149 212 228 270 330	148 299 308 309	114 117 120 327 329	126 140 145 147 217 229	143 150 180 183 201 202 253 256	267 268 305 306 326 328	292 293 294 311 325	392 394 395	391 398 400 405 411 412	384 385 386 393 404	176 177 178 236	179 184 280 389
Alliance	I											II								
Association	1 .	1 .	1 .	1 .	1 .	1 .	1 .	2 .	2 .	2	2 .	3 .	3 .	3 .	3 .	4 .	4 .	4 .	5 .	5 .
Sub-association	1	2	3	4	5	6	7	1	2	3	4	1	2	3	4	1	2	3	1	2
Species group AE cont.																				
Ledebouria floribunda	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	+ R R	. . . . . .	. . . . .	. . . .	. . . .
Emilia transvaalensis	. . .	. . .	. . . .	R	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	R + +	R	. . . . .	. . . .	. . . .
Eulophia petersii	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	R + +	. . . . . .	. . . . .	. . . .	. . . .
Atriplex lindleyi	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	R + .	. . . . . .	. . . . .	. . . .	. . . .
Cheilanthes involuta	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . . R	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	R . +	. . . . . .	. . . . .	. . . .	. . . .
Cyanotis speciosa	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	R . +	. . . . . .	. . . . .	. . . .	. . . .
Schizachyrium sanguineum	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	R . +	. . . . . .	. . . . .	. . . .	. . . .
Thamnosma africana	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	R . +	. . . . . .	. . . . .	. . . .	. . . .
Acalypha indica	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. + R	. . . . . .	. . . . .	. . . .	. . . .
Cyperus margaritaceus	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. + R	. . . . . .	. . . . .	. . . .	. . . .
Dovyalis zeyheri	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. R +	. . . . . .	. . . . .	. . . .	. . . .
Ruellia patula	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. R +	. . . . . .	. . . . .	. . . .	. . . .
Gomphrena celosioides	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. R R	. . + . . .	. . . . .	. . . .	. . . .
Lophiocarpus tenuissimus	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. R R	. . . . . .	. . . . .	. . . .	. . . .
Mollugo nudicaulis	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. R R	. . . . . .	. . . . .	. . . .	. . . .
Monsonia angustifolia	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. R R	. . . . . .	. . . . .	. . . .	. . . .
Species group AF																				
Aristida transvaalensis	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	+ 1 1 . + +	. . . . .	. . . .	. . . +
Vangueria cyanescens	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . R	+ + . + . .	. . . . .	. . . .	. . . .
Cheilanthes hirta	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. R .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	+ + . R . .	. . . . .	. . . .	. . . .
Leonotis intermedia	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	+ . + + R .	+ . . R .	. . . .	. . . .
Leucas martinicensis	. . .	. R .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . R .	. . . . .	. R .	+ . + . . R	. . . . .	. . . .	. . . .
Hibiscus cannabinus	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	R . . + . R	. . . . .	. . . .	. . . .
Commelina erecta	. . .	. . .	. . . .	. . . . .	. . . . .	. . . . R . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . R	. + + + . .	. . . . .	. . . .	. . . .
Orthosiphon tubiformis	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. + R . . R	. . . . .	. . . .	. . . .
Urochloa panicoides	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. R + . . R	. . . . .	. . . .	. . . .
Tragia rupestris	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . . . R . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. R R . R .	. . . . .	. . . .	. . . .
Calodendrum capense	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. R . + R .	. . . . .	. . . .	. . . .
Tecoma capensis	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. R . + R .	. . . . .	. . . .	. . . .
Clematis brachiata	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. + .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . + + R .	. . + . .	. . . .	. . . .
Obetia tenax	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . + R R .	. . . . .	. . . .	. . . .
Plectranthus venteri	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . R + . R	. . . . .	. . . .	. . . .
Thunbergia neglecta	. . .	. . .	. . . .	. . . . .	. . . . .	. . . . R . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . R . R +	. . . . .	. . . .	. . . .
Combretum petrophilum	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . + R .	. . . . .	. . . .	. . . .
Mondenia leptostachys	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . R + R	. . . . .	. . . .	. . . .
Brachiaria serrata	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . R R +	. . . . .	. . . .	. . . .
Species group AG																				
Geigeria ornativa	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	R . .	R + . R . . + R R	. . . . .	. . R R	. . . . .	. . . . . .	. + . . . + . .	. R	. . . . .	+ 1 1	+ + 1 . . .	. . . . .	. . . .	. . . .
Panicum natalense	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	1 . . .	. . . . .	. . . . . R	. . . .	. . . . . .	. . . . .	+ + R	. + . + . .	. . . . .	. . . .	. . . .
Seddera capensis	. . .	. . .	. . . .	. . . . .	. . . . .	. 1 + ...	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . + . . + . .	. . . . . .	. . . . .	+ R .	. . R . + +	. . . . .	. . . .	. . . .
Hibiscus bernardii	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	R . R	+ R + + R +	. . . . .	. . . .	. . . .
Kedrostis foetidissima	. . .	. . .	. . . .	R	. . . . .	. . . . . R	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	R . R	+ . + + + +	. . . . .	. . . .	. . . .
Portulaca kermesina	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. + R	R . . . + +	. . . . .	. . . .	. . . .
Hibiscus pusillus	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. + R	. R + R . .	. . . . .	. . . .	. . . .
Richardia brasiliensis	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . +	. R + R . .	. . . . .	. . . .	. . . .
Species group AH																				
Bothriochloa insculpta	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	A + . A 1	. . . .	. . . .
Ischaemum fasciculatum	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	+	A . + 4 .	. . . .	. . . .
Cynodon dactylon	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	1 + R + .	. . . .	. . . R
Xanthium strumarium	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	1 R . + 1	. . . .	. . . .
Combretum imberbe	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . . . . R .	. . . . . .	. . . . .	. . .	. . . . . .	1 . R . R	. . . .	. . . .
Flaveria bidentis	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	+ 1 . R +	. . . .	. . . .
Senna didymobotrya	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	+ + R . .	. . . .	. . . .
Corchorus tridens	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	+ + . R R	. . . .	. . . .

Table 19 continued.

Relevé number	115 119 121	113 116 118	290 298 300 304	206 213 220 223 232	161 241 250 262 263	131 151 154 165 166 170 172 189 191 194	186 197 211	155 157 158 159 187 198 268 273 274	149 212 226 270 330	148 298 308 309	114 117 120 327 329	126 140 145 147 217 228	143 150 160 180 201 202 253 256	267 268 305 306 326 328	292 293 294 311 325	392 394 395	391 398 400 405 411 412	384 385 386 393 404	176 177 178 336	179 184 280 389
Alliance	I											II								
Association	1	1	1	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	5	5
Sub-association	1	2	3	4	5	6	7	1	2	3	4	1	2	3	4	1	2	3	1	2
Species group AH cont.																				
Agave sisalana	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	+ . 1 + .	. . . .	. . . R
Cucumis zeyheri	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	+ . R R +	. . . .	. . . .
Eragrostis cilianensis	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	+ . R + .	. . . .	. . . .
Agave americana	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	R . + . R	. . . .	. . . .
Brachiaria eruciformis	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. R + + .	. . . .	. . . .
Indigastrum parviflorum	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. R + R .	. . . .	. . . .
Urochloa oligotricha	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. 1 . + .	. . . .	. . . .
Sida cordifolia	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. R . + R	. . . .	. . . .
Solanum nigrum	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. R . . +	. . . .	. . . .
Aristida stipitata	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . 1 + R	. . . .	. . . R
Dyschoriste rogersii	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . + R .	. . . .	. . . .
Gossypium herbaceum	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . R + R	. . . .	. . . .
Indigofera spicata	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . R . +	. . . .	. . . .
Alternanthera sessilis	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . R +	. . . .	. . . .
Commicarpus plumbagineus	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . R +	. . . .	. . . .
Species group AI																				
Sesamum triphyllum	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	+ + R . . .	+ A . + .	. . . .	. . . .
Gomphocarpus tomentosus	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	+ R . . . R	. . R . +	. . . .	. . . .
Zinnia peruviana	. . .	. . .	. . R .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . R	. . . . .	. . . . . .	. . . .	. . . . R .	. . . . .	. + .	. R 1 . + .	R + . R +	. . . .	. . . .
Leucas sexdentata	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. R + + R .	. + R . +	. . . .	. . . .
Abutilon guineense	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . . R + . .	. . R . . .	. . . . .	. . .	. R + . R .	+ + . 1 1	. . . .	. . . .
Solanum panduriforme	. . .	. . .	. . . .	. . . . .	. . . . .	. R	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	R . R	. . . . . R	. . . . .	. . .	. . + + . .	+ . . . 1	. . . .	. . . .
Cereus peruvianus	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . + + . .	. + + . +	. . . .	. . . .
Hibiscus trionum	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . . R . . R .	. . . . .	. . . .	. . . . .	. . . . R .	. . . .	. . . . . .	. . . . .	. . .	. . + . R .	. + . + .	. . . .	. . . .
Commicarpus decipiens	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . R . R +	R . . 1 .	. . . .	. . . .
Setaria sphacelata	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . R . .	. . . .	. . . . . .	. . . . .	. . .	. . R . . +	+ . . + R	. . . .	. . . .
Asparagus virgatus	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . + R .	. R + . .	. . . .	. . . .
Species group AJ																				
Aristida rhiniochloa	. . .	. . .	. . . .	1 R . . .	R . . R .	. 1 1 . . . . R . .	. . R	1 1 . . . . . 1 1	. . . 1 .	. . R .	. . . R .	R	. . + ... R	. . . . . .	. . . . .	1 1 1	1 . . + . .	1 A . . +	. . . .	. . . .
Enneapogon cenchroides	. . .	. . .	. . . .	+	+	. . . . . + ...	. . .	. . . . . . R . .	. + . . 1	. . . .	. A + . .	. . . . + .	. . . + B 1 . .	. . . . 1 .	. . . . .	. . R	. . . + + +	. 1 . . .	. . R .	. . . .
Aristida congesta	. . .	. . .	. . . .	+	. . . . .	. . . .	. . .	A + . . . R . . .	. . . . .	. . . .	. . . . .	+ 1 R R + R	+ + ... R	R	. + + + .	1 . +	1 + + . + +	. . + + .	. . . .	. . . +
Aloe cryptopoda	. . .	. . .	. . . .	R . + R .	R . . + .	. . . + . + . + + .	. . +	1 R + + + + . R .	. . . + .	. . . .	. . . . .	. . . . + R	. . . + + . + R	. . . . . .	R . R + R	R . .	. + . + R R	. . . . .	. . . .	. . . .
Waltheria indica	. . .	. . .	. . . .	. . . . .	R R R . R	. . . R . . . . . R	. . .	. . . . R R R R R	. . . . .	. R R R	+	. R . . R +	. R . . . R . R	. R	. . . . .	R + +	+ + + . . .	. . + . .	. . . .	. . . .
Grewia vernicosa	. . .	. . .	. . . .	. . . + R	. + R + +	+ . . . . R . R . .	. . .	. . . . 1 . . . +	. . . . .	. 1 + 1	. . . . .	. . R + + R	. . . . +	. . . . . .	+ + . + .	1 . 1	1 1 1 + . .	. . . . +	. . . .	. . . .
Melinis nerviglumis	. . .	. . .	. . + .	. + . . .	. . . . .	. . 1 . + . + . . .	. . +	+ R	. . . . .	. . . .	. . . . +	. . . . . .	. . . .	. . . . + .	+ + . 1 +	. R 1	+ + . + + +	. . . . .	. . . .	. . . .
Eragrostis curvula	R . .	. . .	. 1 . .	. . . . .	. . . . .	. . . . + . .	. . .	. R + . 1 + . + +	. . . R .	. + 1 .	. . + . R	. 1 . + 1 .	R 1 1 1 . 1 . 1	1 + + + . .	1 + . + .	. . .	+ + . . R .	. + . + .	. . . .	. . . .
Species group AK																				
Celtis africana	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	A 1 + +	+ 1 1 .
Combretum erythrophyllum	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	A + 1 .	1 + 1 .
Rhus pyroides	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	+ + + +	+ R . R
Cymbopogon validus	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	+ . 1 1	1 . . R
Pavonia burchellii	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	+ . + .	+ A 1 .
Melia azedarach	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	+ . R .	+ . R R
Asparagus racemosus	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	R R + +	+ . R .
Sida spinosa	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	R + . +	R R + .
Ficus sur	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	+ . . +	A A . R
Secamone filiformis	R + R	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . R . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. R + +	+ + + .
Spirostachys africana	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. R . +	A 1 . R
Lippia javanica	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . R	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . R +	+ + R .
Olea europaea	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . . + . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	. . R +	. + R R
Species group AL																				
Zanthoxylum thorncroftii	. . .	. . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	1 + 1 .	. . . .
Acacia caffra	. . .	. . .	. . . .	R . R . .	. . . . .	. . . .	. . .	. . . .	. . . . .	. . . .	. . . . .	. . . . . .	. . . .	. . . . . .	. . . . .	. . .	. . . . . .	. . . . .	+ 1 . 1	. . . .

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Table 19 continued.

Relevé number	115	119	121	113	116	118	290	298	300	304	206	213	220	223	232	161	241	251	260	263	131	151	154	165	166	170	172	188	191	194	186	197	211	155	157	168	159	187	198	258	273	274	149	212	228	270	330	146	299	306	309	114	117	120	327	329
Alliance	I																																																							
Association	1			1			1				1					1					1										1			2									2					2				2				
Sub-association	1			2			3				4					5					6										7			1									2					3				4				
Species group AL cont.																																																								
Barleria obtusa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tarchonanthus camphoratus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species group AM																																																								
Acacia galpinii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Morus japonica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acalypha villicaulis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Fuirena pubescens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Kleinia fulgens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Andropogon eucomus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hyparrhenia filipendula	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Syzygium cordatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bulbostylis burchellii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Paspalum dilatatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Combretum hereroense	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	R	.	.	.	.	.	R	.	.	.	.	.	.	+	+	+	.	.	.	.	R
Ehretia rigida	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	+	.	R	+	+	R
Hippobromus pauciflorus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	R	.	.	.	.	.	.
Carissa bispinosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	R	.	.	+	.	.
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Sporobolus fimbriatus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Flueggea virosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	R	R
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Schotia brachypetala	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Peltophorum africanum	.	.	.	.	.	.	.	R	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	R	R
Hypoestes aristata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Diospyros lycioides var. lycioides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acacia karroo	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cyphostemma sulcatum	.	.	.	.	.	.	.	.	.	.	.	R	R	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	+	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species group AP																																																								
Achyranthes aspera	+	1	+	.	R	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cryptolepis oblongifolium	+	R	+	+	R	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.
Species group AG																																																								
Panicum deustum	1	1	+	+	+	1	.	.	.	.	R	.	1	.	.	1	+	R	+	+	1	1	R	1	+	+	R	R	R	R	A	+	.	.	+	A	+	+	.	.	1	+	+	+	+	1	+	1	A	.	A	1	1	B	1	1
Panicum maximum	1	+	1	.	.	.	.	.	R	.	.	.	+	.	.	.	.	.	R	.	.	+	+	.	.	.	R	.	.	.	.	.	R	R	.	.	.	.	R	.	.	+	.	.	R	.	.	.	.	R	.	.	+	.	1	.
Kirkia wilmsii	+	1	1	+	1	1	1	+	+	1	+	+	+	+	+	+	1	+	+	1	1	1	1	+	+	+	.	+	+	R	1	1	.	R	R	R	1	R	R	.	+	+	R	+	R	R	.	+	R	R	+	+	1	+	.	.
Aloe castanea	+	R	+	.	.	.	1	.	.	+	R	.	.	.	.	.	R	.	.	.	.	.	.	R	.	+	.	.	R	.	.	.	R	R	R	.	.	.	.	A	.	1	+	.	+	.	.	.	R	.	.	.	+	+	1	1
Heteropogon contortus	.	R	+	1	3	B	.	1	A	.	1	A	+	.	1	1	.	1	1	1	1	+	.	+	A	1	1	+	+	1	+	+	.	+	+	B	1	.	.	1	1	+	.	R	.	1	.	1	3	.	.	.	R	.	+	+
Vigna unguiculata	.	.	+	R	.	.	.	R	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	R	.	.	.	.	.
Stylochiton natalensis	.	.	R	R	+	R	.	R	R	.	+	.	.	.	.	.	.	R	.	.	R	.	.	.	.	R	.	.	.	.	.	R	.	.	.	.	.	R	.	R	.	.	.	.	R	.	.	.	.	R	.	+	.	.	.	.
Rhynchosia minima	.	.	.	R	R	R	.	.	.	.	.	.	.	R	R	.	.	.	.	.	.	.	.	.	.	.	.	R	R	.	R	.	.	.	.	.	.	R	.	.	R	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.
Corbichonia decumbens	.	.	.	R	R	.	.	.	.	.	+	.	+	.	.	.	.	R	.	1	.	+	+	.	.	.	.	.	+	+	.	.	.	R	+	.	R	.	R	.	.	R	.	.	.	.	.	.	R	R	R	.	.	.	.	.
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Ziziphus mucronata	.	.	.				R	.	.	+	+	+	+	+	+	.	R	+	.	R	+	.	+	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	+	R	R	.	R	.	.	.	R	.	+	.	.
Raphionacme galpinii	.	.	.								R	.	.	R	+	R	.	.	.	.	.	R	.	R	.	R	.	.	.	.	.	R	.	.	.	R	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Croton gratissimus	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	1	R	.	+	+	.	.	.	.	.	.	+	.	.	.	+	1	+	R	+	.	A	.	.	.	+	.	1	.	+	+	.	1	.	.	.	.	.	.	.	.
Terminalia prunioides	.	.	.	.	.	.	.	.	.	.	.	.	.	R	R	+	R	+	R	R	+	R	R	1	R	+	+	+	+	R	R	+	.	+	1	1	1	+	+	+	+	+	+	+	R	1	.	1	.	.	.	1	1	1	.	.

Relevé number	126	140	145	147	217	229	143	150	180	183	201	202	253	256	267	268	305	306	326	328	292	293	294	311	325	392	394	395	381	398	400	405	411	412	384	385	386	393	404	176	177	178	236	179	184	280	389
Alliance	II																																														
Association	3						3								3						3					4			4						4					5				5			
Sub-association	1						2								3						4					1			2						3					1				2			
Species group AL cont.																																															
Barleria obtusa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.
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Morus japonica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.
Acalypha villicaulis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	R	R	R	.
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Kleinia fulgens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	R	.
Andropogon eucomus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	1
Hyparrhenia filipendula	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	1
Syzygium cordatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	+
Bulbostylis burchellii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	+
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Euclea divinorum	1	.	1	+	1	1	1	.	.	+	+	+	1	1	.	+	+	+	.	+	.	.	.	.	.	+	R	.	.	.	.	.	.	.	.	.	.	.	.	R	+	R	.	+	.	R	.
Rhus engleri	+	.	1	1	+	+	+	.	.	+	+	1	+	+	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	R	R	+	.	R	+	.	.
Combretum hereroense	.	+	+	.	R	.	.	R	+	+	.	.	.	.	.	+	.	.	.	R	.	.	R	+	.	.	.	.	.	R	.	+	.	.	.	.	R	.	.	+	.	+	+	.	+	.	+
Ehretia rigida	.	.	.	.	+	.	.	.	.	R	+	.	.	.	.	+	R	+	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	1	R	+	R	+	.	R	.
Hippobromus pauciflorus	+	R	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	R	1	.	1	R	.
Carissa bispinosa	R	.	R	.	.	.	R	.	.	.	R	R	+	+	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	R	.	+	R	R
Maytenus heterophylla	.	+	R	.	+	+	.	.	.	.	.	+	R	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	R	+	+	.	+	+	.	.
Sporobolus fimbriatus	.	.	.	+	.	.	+	1	1	1	1	1	.	.	A	.	A	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	+	A	1	1	+
Flueggea virosa	.	.	.	.	R	.	.	.	R	.	1	+	.	.	R	.	.	.	+	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	R	+	+	.
Species group AO																																															
Cardiospermum corindum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	R	+	R	+	R	.	.	1	+	.
Schotia brachypetala	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	+	+	1	.	.	+	.	.	+	R	.	+
Peltophorum africanum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	+	.	.	.	+	.	R	R	+	R	.	+	R	+	.	.
Hypoestes aristata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	+	.	.	+	+	+	.	+	1	+	R
Diospyros lycioides var. lycioides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	+	.	R	R	.	.	.	.	.	1	R	+	1	.	1	+	+	1	1	.
Acacia karroo	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	R	1	+	+	A	R	.
Cyphostemma sulcatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	R	.	R	+	+	.	+	.	+
Species group AP																																															
Achyranthes aspera	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	+	1	.	R	.	1	1	.	.	.	+	1
Cryptolepis oblongifolium	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	+	R	R	+	+	+	+	R	R	R	.
Species group AG																																															
Panicum deustum	+	A	.	1	1	+	+	+	1	+	+	+	+	.	+	+	A	1	R	1	+	+	R	+	.	.	.	.	.	.	R	.	.	.	.	.	.	R	.	A	A	1	A	1	1	1	.
Panicum maximum	.	.	R	.	.	.	.	.	.	+	+	.	.	+	R	.	.	.	1	+	.	.	.	.	.	+	.	.	.	.	.	1	.	.	.	.	1	.	1	.	.	.	.	.	.	+	+
Kirkia wilmsii	R	R	.	.	R	R	.	.	R	.	R	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	R	.	.	+	.	+	.	.	.	R	.	.	.	.	+	.	.	+	+	.	.
Aloe castanea	+	+	.	.	.	R	R	+	1	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	R	+	.	A	3	.	3	.	R	.	R	.	.	.	.	.	.	R	.	.	.	R	.
Heteropogon contortus	.	.	1	A	.	R	.	.	.	+	.	.	R	.	+	1	.	.	R	.	R	.	R	.	.	A	A	A	A	1	+	1	.	.	.	1	1	.	.	.	R	.	R	.	R	.	.
Vigna unguiculata	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	+	.	R	.	.	.	.	.	.	.	.	.	.	R	.	.	+	.	.	.	.	.	.	.	.	.
Stylochiton natalensis	.	R	.	.	.	.	.	R	R	.	.	.	.	.	.	+	R	.	.	.	.	1	R	+	.	.	R	.	.	R	R	+	+	R	.	.	.	.	R	.	.	.	.	.	.	.	.
Rhynchosia minima	.	.	.	.	R	R	.	.	.	.	R	.	R	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	+	+	.	R	.	.	.	R	R	.	.	.	.
Corbichonia decumbens	.	.	.	.	.	.	R	+	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Rhus leptodictya	.	R	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	+	R	R	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.
Ziziphus mucronata	.	.	.	.	.	.	.	.	.	.	+	R	+	.	.	.	R	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	1	.	+	+	+	+	.	+	+	.	.
Raphionacme galpinii	.	.	R	.	.	.	.	.	R	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	R	.	.	.	.	.
Croton gratissimus	+	+	+	1	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	A	.	+	.	.	.	.	.	.	.	R	R	.	.	+	R	.	.
Terminalia prunioides	+	+	1	+	+	+	+	1	+	1	1	1	+	1	+	+	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	R	R	R	.	R	+	.	.

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Table 20 Sekhukhuneland Centre endemic/near-endemic and Red Data List plant taxa of the Closed Mountain Bushveld.

Taxon	Family	Syntaxa																			
		I											II								
		1.1	1.2	1.3	1.4	1.5	1.6	1.7	2.1	2.2	2.3	2.4	3.1	3.2	3.3	3.4	4.1	4.2	4.3	5.1	5.2
Acacia sp. nov. (*H pers. comm.*.)	FABA	.	.	.	.	.	.	.	.	.	.	.	.	$r	$r	.	.	.	$+	$1	$1
Albuca sp. nov. (*S856*)	LILI	.	.	.	.	.	.	.	.	.	.	.	.	.	.	$+	.	.	.	.	.
Aloe burgersfortensis	LILI	.	.	.	$r	.	.	.	$+	$r	.	.	$+	$1	.	$1	.	.	.	.	.
Aloe castanea	LILI	#+	.	#+	#r	.	#r	.	#+	#+	.	#1	#+	#+	.	.	#+	#1	.	.	.
Asparagus clareae	ASPA	.	.	.	.	.	.	K#r	.	.	.	.	.	.	.	K#+	.	.	.	.	.
Bauhinia tomentosa [form] (*S444*)	FABA	.	.	.	.	.	.	.	$r	$r	.	.	.	.	.	.	.	.	.	.	.
Brachylaena ilicifolia [form] (*S613*)	ASTE	.	.	.	.	.	.	.	.	#r	#r	#r	.	.	.	.	#r	.	.	.	.
Catha transvaalensis	CELA	.	.	.	.	.	.	.	.	.	.	$r	$r	.	.	.	.	.	.	.	.
Combretum petrophilum	COMB	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R#r	.	.	.
Cyphia transvaalensis	LOBE	.	.	.	.	.	.	#r	.	.	.	.	.	.	.	.	.	.	.	.	.
Cyphostemma sp. nov. (*S1383*)	VITA	.	.	.	.	.	.	$r	.	.	.	$r	.	.	.	.	.	.	.	.	.
Dicliptera fruticosa	ACAN	.	.	.	.	.	.	.	.	.	#r	.	.	#+	#r	.	.	.	.	.	.
Elephantorrhiza praetermissa	FABA	.	.	.	K$1	K$+	K$1	K$+	K$r	K$r	K$r	.	.	.	.	.	.	K$+	.	.	.
Euclea linearis [form] (*S937*)	EBEN	.	.	.	.	.	.	.	.	.	#r	.	#r	.	.	.	.	.	.	.	.
Euphorbia sp. nov. (*W13194*)	EUPH	.	.	.	.	.	.	.	.	.	.	.	.	.	.	$+	.	.	.	.	.
Gnidia caffra [form] (*W&S12975*)	TILI	.	.	.	.	.	.	.	.	.	.	$r	.	.	.	.	.	.	.	.	.
Grewia vernicosa	TILI	.	.	.	#+	#+	#r	.	#+	.	#1	.	#+	#r	.	#+	#1	#1	#r	.	.
Gymnosporia sp. nov. B (*S458*)	CELA	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	$r	$r
Hibiscus barnardii	MALV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R$+	R$1	.	.	.
Indigofera lydenburgensis	FABA	.	#+	.	#r	#r	#r	.	#r	#r	.	#r	#r	.	.	.	.	.	.	.	.
Jatropha latifolia var. *latifolia*	EUPH	.	.	.	#+	#+	#+	#r	.	.	.	.	.	.	.	.	.	.	.	.	.
Kleinia longiflora [form] (*W&S13239*)	ASTE	.	.	.	.	.	.	.	$r	$r	.	.	.	$+	$+	.	.	$+	.	.	.
Kleinia stapeliiformis	ASTE	.	.	.	.	.	.	.	.	.	.	.	#r	#r	.	#r	.	#r	.	.	.
Leucas capensis [form] (*W&S13007*)	LAMI	.	.	.	.	.	.	.	$+	.	$r	.	$r	$r	.	.	$+	$r	$+	.	.

Table 20 continued.

Taxon	Family	1.1	1.2	1.3	1.4	1.5	1.6	1.7	2.1	2.2	2.3	2.4	3.1	3.2	3.3	3.4	4.1	4.2	4.3	5.1	5.2
		Syntaxa																			
Orthosiphon fruticosus	LAMI	.	.	.	.	.	.	.	.	$r	.	.	$r	.	.	.	.	$r	.	.	.
Orthosiphon tubiformis	LAMI	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	#r	.	.	.
Pochypodium saundersii	APOC	.	.	.	.	.	.	.	.	.	.	.	.	.	.	Nr	.	.	.	.	.
Petalidium ablongifolium	ANAC	.	.	.	.	#r	#+	.	#1	#+	#r	.	#1	#+	.	.	.	.	.	.	.
Phyllanthus sp. nov. (*S470*)	EUPH	.	.	.	.	$r	$+	.	$+	$r	.	$r	.	$+	.	.	$+	$r	$r	.	.
Plectranthus venterii	LAMI	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	$+	.	.	.
Plectranthus xerophilus	LAMI	#+	#r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Premna mooiensis [form] (*W&S13004*)	VERB	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	$r	$+	.	.	.
Rhoicissus sekhukhuniensis	VITA	.	.	.	.	.	.	$r	.	.	.	.	.	.	.	.	.	$+	.	.	.
Rhus batophylla	ANAC	R$+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rhus engleri	ANAC	.	.	.	#r	.	.	.	#+	#+	#r	#r	#1	#1	#+	.	.	.	#r	#+	#r
Solanum incanum [form] (*W&S13013*)	SOLA	.	$+	$+	.	.	.	.	.	$r	.	$r	.	.	.	.	.	.	.	.	.
Stylochaeton sp. nov. (*S1332*)	ARAC	.	.	.	$+	$r	$+	$r	.	.	.	.	.	.	.	.	.	.	.	.	.
Triaspis glaucophylla	MALP	#1	.	#1	#r	#+	#+	#r	#r	.	#r	.	.	.	.	.	.	.	.	.	.
Vitex obovata subsp. *wilmsii*	VERB	.	.	.	.	.	.	#r	.	.	.	.	#r	.	.	.	#r	.	#r	.	.
Xerophyta retinervis [form] (*W&S13208*)	VELL	.	$r	.	$r	$r	$r	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SCPE endemics		1	2	1	4	4	4	4	6	7	2	5	4	5	2	3	4	9	3	2	2
SCPE near-endemics		3	2	2	6	5	6	5	6	5	7	4	8	6	2	3	4	5	3	1	1
Red Data List		1	0	0	1	1	1	2	1	1	1	0	0	0	0	2	1	3	0	0	0
Restricted to syntaxon		1	0	0	0	0	0	1	0	0	0	1	0	0	0	3	0	3	0	0	0
Restricted to association					6					2				3				5		1	
Total for syntaxon		4	4	3	10	9	10	9	12	12	9	9	12	11	4	7	8	14	6	3	3
Total for association					20					20				20				18		3	

Endemism: $ = endemic, # = near-endemic; **Red Data List:** K = Insufficiently Known, R = Rare, N = Not threatened in the northern provinces of South Africa, but in other areas of southern Africa;

Abundance in communities: 1 = abundant, + = frequent, r = rare, . = absent; **Collectors:** H = Hurter, S = Siebert, W = Van Wyk; **Bold** blocks represent community/syntaxon specific taxa;

Table 21 Environmental factors and selected attributes associated with the different plant communities of the Closed Mountain Bushveld.

Factors/attributes	Syntaxa																			
	I											II								
	1.1	1.2	1.3	1.4	1.5	1.6	1.7	2.1	2.2	2.3	2.4	3.1	3.2	3.3	3.4	4.1	4.2	4.3	5.1	5.2
Number of relevès	3	3	4	5	5	10	3	9	5	4	5	6	8	6	5	3	6	5	4	4
Total number of species	40	55	60	100	84	123	73	114	96	65	82	98	131	83	55	97	130	122	52	66
Average number of species per relevé	30	41	34	45	39	40	32	39	38	32	29	38	43	29	33	45	38	38	32	28
Number of endemics/ near-endemics	4	4	3	10	9	10	9	12	12	9	9	12	11	4	7	8	14	6	3	3
Number of Red Data List taxa	1	0	0	1	1	1	2	1	1	1	0	0	0	0	2	1	3	0	0	0
Geology*	S	S	G/F	P	N/A	P/N/A	P/N/A	N/A/M	P/F	G	S/M	P/Q	Q	F/Q	N/A	N/A	N/A	N/Q	Q	Q
Topographic position**	M	M	M	M/S	M/S	M/S	S	M/F	F	F	F	F	V	F/V	F	F	F	F/V	V	V
Slope (°)	9–12	12–15	7–12	5–12	5–15	5–15	9	3–5	3–5	3–5	3–5	1–3	1–3	1–3	3–5	5–7	3–5	1–3	1–3	1–5
Aspect	S	N	N	N	N	N	N	N/S/W	N/E	N/S/W	N/S/W	W	E/W	N/E/W	N/E	N/E/S	N/E/W	N/E/S/W	-	-
Predominant soil type***	Gs	Gs	Gs	Gs	Gs	Gs/Ms	Ms	Bo/Hu	Sd/Hu	Hu	Gs/Sd	Hu/Bo/Sd	Bo/Va	Bo/Va/Gs	Hu/Gs	Ms	Gs	Sn/Gs	Oa	Oa

Table 21 continued.

Factors/attributes	Syntaxa																			
	1.1	1.2	1.3	1.4	1.5	1.6	1.7	2.1	2.2	2.3	2.4	3.1	3.2	3.3	3.4	4.1	4.2	4.3	5.1	5.2
Rock cover percentage (%)	50–65	40–60	30–50	30–50	35–55	35–60	50–70	25–40	30–50	10–15	15–40	10–20	10–50	5–20	30–40	45–55	45–65	10–20	5–20	5–40
Average rock size (mm)	500–800	450–600	500–750	400–1000	650–1000	300–750	750–1500	200–400	500–1000	100–150	300–500	100–300	100–200	50–400	400–500	900–2000	500–2000	100–300	100–300	50–100

* A = anorthosite; F = ferrogabbro; G = granofire; M = magnetite; N = norite; P = pyroxenite; Q = Alluvium; S = Shale

** S = scarp; M = midslope; F = footslope; V = valley

*** Bo = Bonheim; Gs = Glenrosa; Hu = Hutton; Ms = Mispah; Sd = Shortlands; Sn = Steendal; Va = Valsrivier (X[1] Dominant soil type)

Table 22 A key to the syntaxa of the Closed Mountain Bushveld of the hills and valleys of the Sekhukhuneland Centre of Plant Endemism.

Leads/description	Go to/syntaxon
1a Steep sloped bushveld 5–12° (*Combretum apiculatum* & *Kirkia wilmsii*)	**2**
b Moderately sloped bushveld 1–7° (*Combretum hereroense*)	**3**
2a Rocks predominantly Rustenburg Layered Suite (*Elephantorrhiza praetermissa* & *Themeda triandra*)	**4**
b Rocks mainly Transvaal Sequence (*Pappea capensis*)	**5**
3a Lithosols (*Hippocratea longipetiolata* & *Heteropogon contortus*)	**6**
b Diverse sandy-loam soils (*Euclea divinorum* & *Terminalia prunoides*)	**7**
4a Mispah & Glenrosa soils (*Eragrostis rigidior*)	**8**
b Only Glenrosa soils (*Jasminum multipartitum*)	**9**
5a Granofire & ferrogabbro (*Bridelia mollis* & *Rhus leptodictya*)	1.3 *Combreto apiculati–Kirkietum wilmsii bridelietosum mollis*
b Shale (*Elephantorrhiza goetzei* & *Acacia exuvialis*)	**10**
6a Rock cover < 20% (*Bothriochloa insculpta* & *Schotia brachypetala*)	4.3 *Hippocrateo longipetiolatae–Euphorbietum tirucalli bothriochloetosum insculptae*
b Rock cover > 45% (*Panicum natalense* & *Melinis nerviglumis*)	**11**
7a Only Oakleaf soils (*Combretum erythrophyllum* & *Sporobolus fimbriatus*)	**12**
b Divers soils (*Sarcostemma viminale* & *Boscia albitrunca*)	**13**
8a Rock size < 750 mm (*Karomia speciosa* & *Petalidium oblongifolium*)	1.6 *Combreto apiculati–Kirkietum wilmsii themedetosum triandrae*
b Rock size > 750 mm (*Nuxia congesta* & *Croton gratissimus*)	1.7 *Combreto apiculati–Kirkietum wilmsii nuxietosum congestae*
9a Pyroxenite (*Sphedamnocarpus pruriens* & *Sterculia rogersii*)	1.4 *Combreto apiculati–Kirkietum wilmsii choetacanthetosum costatii*
b Norite (*Mundulea sericea* & *Barleria saxatilis*)	1.5 *Combreto apiculati–Kirkietum wilmsii hermannietosum boraginiflorae*
10a Southern aspect (*Clerodendrum glabrum* & *Panicum maximum*)	1.1 *Combreto apiculati–Kirkietum wilmsii clerodendretosum glabrae*
b Northern aspect (*Eustachys paspaloides* & *Commiphora africana*)	1.2 *Combreto apiculati–Kirkietum wilmsii eustachetosum paspaloidis*
11a Mispah (*Emilia transvaalensis* & *Aristida rhiniochloa*)	4.1 *Hippocrateo longipetiolatae–Euphorbietum tirucalli emilietosum transvaalensis*
b Glenrosa (*Aristida transvaalensis* & *Ocimum americanum*)	4.2 *Hippocrateo longipetiolatae–Euphorbietum tirucalli aristidetosum transvaalensis*
12a Rock size > 100 mm (*Acacia caffra* & *Cryptolepis oblongifolium*)	5.1 *Celtido africanea–Combretetum erythrophyllii acacietosum caffrae*
b Rock size < 100 mm (*Acacia galpinii* & *Ficus sur*)	5.2 *Celtido africanea–Combretetum erythrophyllii acacietosum galpinii*
13a Footslopes to midslopes (*Acacia nigrescens*)	**14**
b Footslopes to valleys (*Fingerhuthia africana* & *Eragrostis curvula*)	**15**

Table 22 continued.

Leads/description	Go to/syntaxon
14a Hutton (*Acacia senegal* var. *leiorachis*)	**16**
b Lithosol (*Gardenia volkensii* & *Aloe castanea*)	2.4 *Panico deustii–Dichrostachetum cinereae melhanietosum acuminatae*
15a Bonheim soils (*Acacia tortilis*)	**17**
b No Bonheim soil form (*Cadaba termitaria* & *Sanseviera hyacinthoides*)	3.4 *Fingerhuthio africanae–Boscietum foetidae sesamothamnetosum lugardii*
16a Rock cover > 25% (*Ximenia americana*)	**18**
b Rock cover < 15% (*Bolusanthus speciosus* & *Grewia vernicosa*)	2.3 *Panico deustii–Dichrostachetum cinereae melhanietosum prostratae*
17a No Valsrivier soil form (*Elaeodendron transvaalensis* & *Maytenus heterophylla*)	3.1 *Fingerhuthio africanae–Boscietum foetidae elaeodendretosum transvaalensis*
b Valsrivier soils (*Acacia gerrardii* & *Grewia flava*)	**19**
18a Rock size < 400 mm (*Rhigozum obovatum* & *Monechma divaricatum*)	2.1 *Panico deustii–Dichrostachetum cinereae sporoboletosum stapfianii*
b Rock size > 500 mm (*Maerua angolensis* & *Sclrocarya birrea*)	2.2 *Panico deustii–Dichrostachetum cinereae maeruetosum angolensis*
19a Alluvium (*Acacia luederitzii* & *Alae globuligemma*)	3.2 *Fingerhuthio africanae–Boscietum foetidae oloetosum globuligemmae*
b Alluvium interspersed with lithosols (*Eleusine coracana* & *Euphorbia ingens*)	3.3 *Fingerhuthio africanae–Boscietum foetidae euphorbietosum ingentis*

Table 23 The three most dominant and conspicuous plant taxa of each of the major vegetation types of the Closed Mountain Bushveld depicted in the DECORANA scatter diagram.

Major vegetation type	Trees/shrubs	Forbs/sedges	Grasses
1. *Combreto apiculati–Kirkietum wilmsii*	***Combretum apiculatum***	*Asparagus laricinus*	*Enneapogon scoparius*
(*Combretum apiculatum–Kirkia wilmsii*)	*Commiphora mollis*	*Clerodendrum ternatum*	*Heteropogon contortus*
	Kirkia wilmsii	*Commelina africana*	*Panicum deustum*
2. *Panico deustii–Dichrostachetum cinereae*	*Acacia senegal* var. *leiorachis*	*Barleria saxatilis*	*Enneapogon scoparius*
(*Panicum deustum–Dichrostachys cinerea*)	***Dichrostachys cinerea***	*Kyphocarpa angustifolia*	*Themeda triandra*
	Terminalia prunioides	*Waltheria indica*	***Panicum deustum***
3. *Fingerhuthio africanae–Boscietum foetidae*	*Acacia tortilis*	*Aloe burgersfortensis*	*Eragrostis curvula*
(*Fingerhuthia africana–Boscia foetida*)	*Boscia albitrunca*	*Psiadia punctulata*	***Fingerhuthia africana***
	Boscia foetida	*Sarcostemma viminale*	*Panicum deustum*
4. *Hippocrateo longipetiolatae–Euphorbietum tirucalli*	***Euphorbia tirucalli***	*Abutilon guineense*	*Aristida congesta*
(*Hippocratea longipetiolata–Euphorbia tirucalli*)	***Hippocratea longipetiolata***	*Leucas capensis*	*Aristida rhiniochloa*
	Diospyros lycioides	*Ocimum americanum*	*Heteropogon contortus*
5. *Celtido africanea–Combretetum erythrophyllii*	***Celtis africana***	*Achyranthes aspera*	*Cymbopogon validus*
(*Celtis africana–Combretum erythrophyllum*)	***Combretum erythrophyllum***	*Hypoestes aristata*	*Panicum deustum*
	Ehretia rigida	*Pavonia burchellii*	*Sporobolus fimbriatus*

CHAPTER 9

ARID NORTHERN BUSHVELD

9.1 Background

Few phytosociological studies have been conducted on bushveld (the local term equivalent to savanna) vegetation types of the Northern Province (Werger *et al.* 1978; Van der Meulen 1979; Breebaart & Deutschlander 1997). Therefore, the vegetation of some areas still remains to be investigated and described, both on reconnaissance level and in more detail. Such an area is the arid valleys and hills of the Potlake Nature Reserve-Mecklenburg region, identified as the Arid Northern Bushveld (Siebert *et al.* 2002a) in the northern areas of the Steelpoort Subcentre in the SCPE (Van Wyk & Van Wyk 1997; Van Wyk & Smith 2001). The Steelpoort Subcentre is floristically noteworthy in that many endemics with distributions correlated with the geological substrate, occur here (Siebert 1998; Siebert *et al.* 2001).

Bredenkamp & Van Vuuren (1977) recognised various arid bushveld vegetation types on the adjacent Pietersburg Plateau, which show a definite floristic affinity with the Steelpoort Subcentre (Siebert *et al.* 2002a). Acocks (1953) mapped the vegetation of the study area as Tropical Bush and Savanna veld types, namely Mixed Bushveld (18) and Sourish Mixed Bushveld (19). Acocks (1953) accurately distinguished a sour bushveld type on the mountain slopes of the northern ranges of the Leolo Mountains that links with the vegetation on the southern slopes of the Serala Subcentre and the western slopes of the Blyde River Subcentre (Matthews 1991). It is not a typical sour bushveld and needs further attention to determine its true identity. The vegetation described here only includes those plant communities that are part of the SCPE Arid Northern Bushveld (*Acacia tortilis*–*Eragrostis barbinodis* Arid Northern Bushveld) (Siebert *et al.* 2002a). Arid thornveld is the major vegetation type of this drier northern parts of the Steelpoort Subcentre. It is mostly restricted to the valleys between the Leolo Mountains and the Northeastern Escarpment.

The study area (northern limit of the SCPE) is situated in the southern part of the Northern Province between latitude 24°15'00"–24°30'00"S and longitude 29°30'00"–30°10'00"E (Figure 15). The area covers approximately 1 250 km^2 and comprises a heterogeneous geology (Visser *et al.* 1989), with a moderately heterogeneous physiography (Land Type Survey Staff 1987). Which is underlain by different types of pyroxenite belts covered by surficial deposits of alluvium and scree (Visser *et al.* 1989). Other prominent rocks include Jagdlust harzburgite, Shelter norite and Karoo dolerite.

In this arid northern region of sequential bands of hills and large valleys, the predominant characteristic vegetation feature is low open savanna. The difference in altitude between the two most extreme locations is approximately 200 m. The study area lies in the summer rainfall region, with the annual precipitation averaging about 460 mm (South African Weather Bureau). The rainfall pattern is strongly influenced by the area's topography (Siebert 1998), varying from 416 mm in the east to 499 mm per annum in the west, and 522 mm in the south to 478 mm per annum in the north (Erasmus 1985). Daily average temperatures range from a minimum of 8°C in winter to a maximum of 38°C in summer, with an average annual temperature of 20°C (South African Weather Bureau). Minimum temperatures of below freezing point are extremely rare, even in the high-lying areas.

9.2 Classification

The analysis resulted in the identification of eight plant communities, classified as four associations and five sub-associations (Table 24). Since the study area lies in the climatically uniform dry and warm northern region of the SCPE, no major macro-climatic variation plays a role in local differentiation of the plant communities. The major plant communities relate to soil character, aspect and terrain type. Communities were not always distinctive in the field and this is attributed to the heterogeneity of the environmental factors, which cause a complex mosaic distribution pattern of habitats and associated vegetation.

The hierarchical classification of the vegetation reinforces the correlation between habitat and plant communities (Figure 16). The distribution of SCPE endemic/near-endemic and rare/threatened taxa among the various plant communities is listed in Table 25. A summary of selected community attributes is supplied in Table 26.

Plant communities of the SCPE dry northern bushveld (*Acacia tortilis–Eragrostis barbinodis* Arid Northern Bushveld) are classified as follows:

***Panico maximi–Acacietea tortilis* class (Winterbach *et al.* 2000)**

I. *Eragrostis barbinodis–Acacia tortilis* community of arid systems

1. *Panico colorati–Crotonetum menyhartii*
2. *Melhanio rehmannii–Acacietum tortilis*
    2.1 *Melhanio rehmannii–Acacietum tortilis grewetosum bicoloris*
    2.2 *Melhanio rehmannii–Acacietum tortilis rhigozetosum obovati*
    2.3 *Melhanio rehmannii–Acacietum tortilis diospyretosum lycioidis*
    2.4 *Melhanio rehmannii–Acacietum tortilis acacietosum niloticae*
    2.5 *Melhanio rehmannii–Acacietum tortilis indigoferetosum rhytidocarpae*
3. *Enneapogono cenchroidis–Salvadoretum australis*
4. *Urochloo panicoidis–Agavetum americanae*

9.3 Description

The *Acacia tortilis–Eragrostis barbinodis* Arid Northern Bushveld is predominantly restricted to the valleys and lower slopes of undulating hills. Surface rocks are common and abundant in many of the communities, with soil clay percentages varying from 15% to 35%. The structure of the vegetation can mainly be classified as shrubland thicket (bush encroachment) and open tree savanna (anthropogenic grassland) (Edwards 1983).

I. *Eragrostis barbinodis–Acacia tortilis* community of arid systems

Classified under the *Panico maximi–Acacietea tortilis* class (Winterbach *et al.* 2000).

Environmental data. The vegetation representing this order, forms a transition from anthropogenic grassland to degraded systems with bush encroachment and could be interpreted as anthropogenically driven vegetation units. It rather seems to be part of a management practice whereby the veld is manipulated for grazing by game or cattle, a disturbed system of fields, and a highly erodable upper horizon associated with the soils of the region. These habitats and vegetation occur on gentle footslopes (1–5°) on all aspects (Table 26). The dominant soil types are the Steendal and Valsrivier forms. Average rock size varies from 100–400 mm and covers 10–50% of the soil surface.

Diagnostic and dominant/prominent taxa. This order is characterised by species group W (Table 24). The forb *Seddera suffruticosa*, the grass *Eragrostis barbinodis* and the tree *Acacia tortilis* are the diagnostic species of this syntaxon. The acacias are the most distinctive, dominant and largest group of trees in this vegetation type. They are generally associated with typical Mixed Bushveld landscapes. Other prominent herbaceous species include the forbs *Felicia clavipilosa*, *Kleinia longiflora*, *Leucas capensis* and *Tribulus terrestris*, and the graminoids *Aristida congesta*, *Enneapogon cenchroides* and *Tragus berteronianus*. Prominent woody taxa of the order are *Acacia grandicornuta*, *Albizia anthelmintica* and *Ehretia rigida*.

Notes on floristic diversity. Alien species are common in this vegetation type and human disturbance is a key determinant of this arid bushveld. Important, but widely distributed, species with conservation value in this order is the endemic form of *Leucas capensis*, the red data list taxa *Boscia foetida* subsp. *minima* (Rare) and *Plinthus rehmannii* (Vulnerable), and the small tree near-endemic *Rhus engleri* (Table 25).

1. *Panico colorati–Crotonetum menyhartii* ass. nova hoc loco
Nomenclatural type: relevé 383 (holotypus)

Environmental data. The vegetation is a short, sparse open shrubland associated with the lower midslopes and footslopes of hills. The habitat is restricted to predominantly eastern aspects that are gently sloped (1–3°) and slightly eroded (Table 26). Loam soils are predominant, mostly the Glenrosa form, with a black coloured ortic A-horizon over a lithocutanic B-horizon. The surface rock cover percentage is 20–50% and the average rock diameter between 250–500 mm (Table 26).

Diagnostic and dominant/prominent taxa. Characteristic species are represented in species group A (Table 24). Dominant trees/shrubs of the association are the diagnostic *Maerua cafra* and *Mundulea sericea*. Diagnostic forbs include *Blepharis pruinosa, Cleome angustifolia, Helichrysum cerastioides, Petalidium oblongifolium* and *Polygala* sp. nov. (*Van Wyk & Siebert 13311*). Diagnostic grasses of this association are *Eustachys paspaloides, Fingerhuthia africana* and *Panicum coloratum*. Other prominent trees/shrubs of the sub-association are *Acacia mellifera, Balanites maughamii, Croton menyhartii* and *Rhus engleri*. Dominant forbs are *Geigeria filifolia, Indigofera enormis* and *Kleinia longiflora*. Conspicuous grasses of the sub-association include *Enneapogon scoparius* and *Eragrostis barbinodis*.

Notes on floristic diversity. Floristically the sub-association shows an affinity with other associations and sub-associations in species groups F, H, N and T (Table 24). The average number of plant species encountered per sample plot is 25, with the total number for this association being 59 (six relevés) (Table 26). The SCPE near-endemic *Petalidium oblongifolium* is restricted to this sub-association. A further two endemics, two near-endemics and two Red Data List taxa occur (Table 25).

2. *Melhanio rehmannii–Acacietum tortilis* ass. nova hoc loco
Nomenclatural type: relevé 368 (holotypus)

Environmental data. The vegetation is short sparse open shrubland that is associated with valleys, footslopes and lower midslopes of hills. It is managed for grazing purposes in and arround to the Potlake Nature Reserve. It is situated on relatively level slopes (1–5°) and with a surface rock cover percentage of 5–15% (Table 26). Average rock diameter is approximately 100–500 mm (Table 26).

Diagnostic and dominant/prominent taxa. Characteristic species of the association are represented in species group B (Table 24). *Corchorus asplenifolius, Corbichonia decumbens, Limeum viscosum, Melhania rehmannii, Ptycholobium contortum, Solanum coccineum, S. panduriforme* and *Sericorema remotiflora* are the diagnostic forbs. Diagnostic grasses for the association include *Schmidtia pappophoroides* and *Tricholaena* *monachme*. *Eragrostis barbinodis*, *Panicum maximum* and *Tragus bertoronianus* are abundant grasses. Diagnostic woody species typical of the association include the small trees *Acacia mellifera*, *Balanites maughamii*, *Commiphora pyracanthoides* and *Euclea undulata*. *Acacia grandicornuta*, *A. tortilis*, *Dichrostachys cinerea*, *Ehretia rigida* and *Rhus engleri* are the dominant small trees of the association.

Notes on floristic diversity. The association shows strong floristic affinities with the other associations of the study area in especially species groups N, T and W (Table 24). The average number of plant species encountered per sample plot is 40, with the minimum total number of species estimated for this association being 110 (34 relevés) (Table 26). Of the three taxa restricted to this association one is a SCPE endemic *Aloe* sp. nov. (*Siebert 1419*) and the other a SCPE near-endemic *Huernia stapelioides* (Table 25). The highest number of endemics (4) and near-endemics (3) occur in this association, which is also the community with the highest number of taxa (10) with a conservation value.

2.1 *Melhanio rehmannii–Acacietum tortilis grewetosum bicoloris* sub-ass. nova hoc loco
Nomenclatural type: relevé 354 (holotypus)

Environmental data. In the study area this sub-association represents vegetation units on black loam soils underlain by gypsum-rich lower horizons. This short shrub thicket occurs on moderately sloped (3–5°) of footslopes and lower midslopes of hills. It is occurs on predominantly northern aspects. The dominant soil types are melanic, namely the Steendal form (soft carbonate B-horizon) interspersed by Milkwood form (A-horizon underlain with hard rock). Rocks cover a relatively small area of approximately 10–15% of the soil surface, with an average size of 100–400 mm (Table 26).

Diagnostic and dominant/prominent taxa. Species group C contains the diagnostic species for this sub-association (Table 24), which are dominated by the woody shrub species *Cadaba aphylla*, *Grewia bicolor* and *Triaspis hypericoides* subp. *nelsonii*. The climber *Dregea macrantha*, and the forbs *Hybanthus enneaspermus*, *Indigofera tristoides*, *Limeum pterocarpum*, *Oropetium capense*, *Psiadia punctulata* and *Tephrosia burchellii*, and the succulents *Huernia stapelioides*, *Opuntia ficus-indica* (naturalised alien), *Portulaca* *kermesina*, *Sarcostemma viminale* and *Talinum arnotii* are the diagnostic herbaceous taxa. Other prominent taxa of the sub-association include the trees *Acacia grandicornuta*, *A. mellifera*, *Albizia anthelmintica*, *Commiphora pyracanthoides*, *Croton menyhartii* and *Ptaeroxylon obliquum*. Forbs such as *Becium filamentosum*, *Hibiscus praeteritus*, *Lantana rugosa*, *Melhania rehmannii* and *Seddera suffruticosa* occur frequently. Dominant grasses are *Aristida congesta*, *Eragrostis barbinodis*, *Panicum maximum*, *Schmidtia pappophoroides* and *Tragus berteronianus*.

Notes on floristic diversity. Floristically the sub-association is noteworthy in that it shows a link with association 3 in species group R (Table 24). Plant species encountered per sample plot average 50 and the total number recorded for this association was 110 (five relevés) (Table 26). One SCPE near-endemic is restricted to this association, namely *Huernia stapelioides*. One SCPE endemic, three SCPE near-endemics and two Red Data List taxa of conservation value are part of this association (Table 25).

2.2 *Melhanio rehmannii–Acacietum tortilis rhigozetosum obovati* sub-ass. nova hoc loco
Nomenclatural type: relevé 368 (holotypus)

Environmental data. This sub-association is tall, closed shrubland of footslopes and midslopes. It occurs on relatively deep loam soils of the Valsrivier form (ortic A-horizon over a pedocutanic B-horizon) that is interspersed with shallow soils of the Glenrosa form (ortic A-horizon over a lithocutanic B-horizon). It prefers south-easterly aspects of hills. The habitat is characterised by gentle slopes of approximately 1–5°. Rock cover of the surface is 10–20%, with rocks reaching a maximum average size of 300–500 mm (Table 26).

Diagnostic and dominant/prominent taxa. Diagnostic species are presented in species group D (Table 24). The shrub *Rhigozum obovatum* is the diagnostic woody species. *Aneilema hockii*, *Asparagus suaveolens*, *Barleria prionitis*, *Commelina livingstonii*, *Melhania virescens*, *Mollugo nudicaulis* and *Polygala hottentotta*. Other diagnostic species comprise the succulents *Aloe* sp. (*Siebert 1419*), *Portulaca quatrifida* and *Stapelia gettliffei*. The grasses are the common and abundant *Aristida congesta*, *Eragrostis* *barbinodis*, *Panicum maximum* and *Tragus berteronianus*. Forbs that occur frequently are *Felicia clavipilosa*, *Melhania rehmannii*, *Phyllanthus maderaspatensis* and *Seddera suffruticosa*. Conspicuous trees/shrubs include *Acacia luderitzii*, *A. tortilis*, *Croton menyhartii* and *Ptaeroxylon obliquum*.

Notes on floristic diversity. Floristically the sub-association, together with sub-association 1.2, is noteworthy in that it shows a link with association 3 in species group R (Table 24). The average number of species encountered per sample plot is 46, with the total number for this sub-association being 92 (four relevés) (Table 26). An undescribed Sekhukhuneland Centre endemic, *Aloe* sp. nov. (*Siebert 1419*), is restricted to the communities of this sub-association. Of the two SCPE endemic and two SCPE near-endemic taxa, one is a Red List taxon with conservation value (Table 25).

2.3 *Melhanio rehmannii–Acacietum tortilis diospyretosum lycioidis* sub-ass. nova hoc loco
Nomenclatural type: relevé 360 (holotypus)

Environmental data. This sub-association represents short, sparse open tree savanna of footslopes and lower midslopes on red loam soils. It lies on gently sloped areas on southern aspects of undulating hills (1–5°). Soils are predominantly of the Shortlands form (ortic A-horizon with a red-structured B-horizon), interspersed with soils of the Glenrosa form. Rock cover of the surface is 10–20%, with rocks reaching a maximum size of 100–400 mm in diameter (Table 26).

Diagnostic and dominant/prominent taxa. Diagnostic species are represented by species group G (Table 24). *Diospyros lycioides* is the only woody diagnostic species in the sub-association. However, the syntaxon is rich in diagnostic forbs which include *Coccinia rehmannii*, *Dipcadi viride*, *Melhania acuminata*, *Phyllanthus incurvus* and *Pollichia campestris*. Only one diagnostic graminoid occurs, namely *Eragrostis trichophora* along the footpaths. Other dominant grasses are *Aristida congesta*, *Cenchrus ciliaris*, *Eragrostis barbinodis*, *Schmidtia pappophoroides*, *Tragus berteronianus* and *Urochloa mosambicensis*. Prominent forbs are *Blepharis integrifolia*, *Monechma divaricatum*, *Pechuel-Loeschea leubnitzia*, *Phyllanthus maderaspatensis* and *Seddera suffruticosa*.

Dominant, conspicuous woody species include the small trees *Acacia tortilis*, *A. mellifera* and *Ehretia rigida*.

Notes on floristic diversity. Species groups J and K shows the relationship between this vegetation unit and the other sub-associations of association 2 (Table 24). In this sub-association the average number of plant species encountered per sample plot is 34, with the total number for this sub-association being 87 (seven relevés) (Table 26). No taxa with conservation are restricted to the sub-association. Four taxa of conservation value are present and include one SCPE endemics, two near-endemics (one is also a Red List taxon) and a Red Data List species (Table 25).

2.4 *Melhanio rehmannii–Acacietum tortilis acacietosum niloticae* sub-ass. nova hoc loco
Nomenclatural type: relevé 361 (holotypus)

Environmental data. This association represents short secondary thicket. It occurs on deep, loam clay soils (500–1000 mm) of the Valsrivier form (ortic A-horizon). It is situated on gently sloped footslopes and valleys (1–3°) that are heavily grazed. It is found predominantly on north and south aspects. Approximately 5–10% of the soil surface is covered by rocks, with an average size of 200–400 mm (Table 26).

Diagnostic and dominant/prominent taxa. Diagnostic species are represented by species group I (Table 24). The diagnostic woody species found in the association are the trees *Acacia nilotica* and *Ziziphus mucronata*, and the shrub *Gossypium herbaceum*. Diagnostic forbs are plentiful and include the geophyte *Dipcadi glaucum*, the climber *Pergularia daemia*, and herbs *Hibiscus palmatus*, *Ipomoea magnusiana*, *Kohautia cynanchica*, *Lycium cinereum*, *Polygala uncinata*, *Seddera capensis* and *Tragia rupestris*. Diagnostic grass species are *Eragrostis rigidior* and *Melinis repens*. Although disturbed, the grass cover is dense and species rich, including graminoids such as *Aristida adscensionis*, *A. congesta*, *Enneapogon cenchroides*, *Eragrostis barbinodis*, *Panicum maximum*, *Tragus berteronianus* and *Urochloa mosambicensis*. The association is dominated by the encroachment of *Acacia tortilis*, with other conspicuous trees including *Albizia anthelmintica*, *Cadaba termitaria*, *Dichrostachys cinerea* and *Ehretia rigida*. Herbs are frequent and this species rich growth form is dominated by *Corchorus asplenifolius*, *Gisekia africana*, *Hermannia odorata*, *Hibiscus praeterius*, *Indigastrum costatum*, *Lantana rugosa*, *Leucas capensis*, *Melhania rehmannii*, *Monechma divaricatum*, *Phyllanthus maderaspatensis* and *Solanum panduriforme*.

Notes on floristic diversity. Species groups J, K and L (Table 24) show the strong floristic relationship that exists with association 1. Species group Q indicates a slight floristic link with association 3. The average number of species encountered per sample plot is 38, with the total number for this association being 109 (11 relevés) (Table 26). *Gossypium herbaceum* subsp. *africanum*, a Red Data List taxon described as Insufficiently Known (K) for Swaziland, is the only species restricted to the association. Altogether there are six taxa of conservation value that include three SCPE endemics, two near-endemics (one also a Red List taxon) and the Red Data List species mentioned above (Table 25).

2.5 *Melhanio rehmannii–Acacietum tortilis indigoferetosum rhytidocarpae* sub-ass. nova hoc loco
Nomenclatural type: relevé 370 (holotypus)

Environmental data. In the Arid Northern Bushveld of the SCPE this association represents plant communities of disturbed zones of previously cultivated land. The soils are characterised by melanic loams of the Bonheim form (pedocutanic B-horizon). This short, open disturbed tree savanna occurs in the valleys and on lower footslopes. It is characterised by gentle slopes of 1–3° (Table 26). The vegetation of the alliance prefers warmer northern aspects. Average rock size varies from 300–400 mm in diameter and cover 05–10% of the soil surface (Table 26).

Diagnostic and dominant/prominent taxa. Species group M contains the diagnostic species for this association (Table 24). Diagnostic grasses for the association are *Eragrostis biflora* in the shade, *Sporobolus nitens* in the open and the alien *Dactyloctenium aegyptium* where water collects. No diagnostic woody species were recorded for this association, however, diagnostic forbs are frequent and dominant. The herbs are *Corallocarpus bainesii*, *Dipcadi gracillimum*, *Indigofera circinnata*, *I. rhytidocarpa*, *Ipomoea sinensis*, *Kohautia* *aspera*, *Leucas sexdentata*, *Limeum sulcatum*, *Peliostomum leucorrhiza*, *Phyllanthus burchellii* and *Trianthema salsoloides*. Certain alien forb species are also diagnostic of this association, namely *Acalypha segetalis*, *Amaranthus thunbergii* and *Schkuhria pinnata*. Dominant grasses of the association include *Aristida congesta*, *Chloris virgata*, *Eragrostis barbinodis*, *Sporobolus ioclados*, *Tragus berteronianus* and *Urochloa mosambicensis*. Prominent forbs are *Becium filamentosum*, *Corchorus asplenifolius*, *Felicia clavipilosa*, *Gisekia africana*, *Hermannia modesta*, *Phyllanthus maderaspatensis* and *Seddera suffruticosa*. *Acacia tortilis* dominates the association with *A. grandicornuta* and *Dichrostachys cinerea* to a lesser degree.

Notes on floristic diversity. A strong floristic relationship exists with associations 1 and 2 in species groups N and association 2 and 3 in species group S (Table 24). In this association the average number of plant species encountered per sample plot is 39, with the total number for this sub-association being 108 (seven relevés) (Table 26). In the Arid Northern Bushveld this is the association with the most plant species with Red Data List categories (three taxa). Five taxa of conservation value can be found and include two endemic and one near-endemic species (Table 25).

3. *Enneapogono cenchroidis–Salvadoretum australis* ass. nova hoc loco
Nomenclatural type: relevé 356 (holotypus)

Environmental data. This short, closed to open tree savanna represents relatively undisturbed vegetation units of predominantly warm, but moist, northerly aspects. It is characterised by gentle footslopes and valley undulations (1–3°). The dominant soil type is the Steendal form. Average rock size varies between 250 and 400 mm in diameter and covers 05–15% of the soil surface.

Diagnostic and dominant/prominent taxa. Species group O (Table 24) contains the diagnostic species for this association in the Arid Northern Bushveld of the SCPE, which are characterised by diagnostic tree species such as *Acacia robusta*, *Cordia monoica*, *Maerua edulis* and *Salvadora australis*. Diagnostic grasses are plentiful and include *Brachiaria deflexa*, *Diplachne eleusine*, *Enneapogon desvauxii*, *Eragrostis curvula* and

Setaria verticillata. *Abutilon grandiflorum*, *Hibiscus micranthus*, *Justicia odora*, *Pegolettia senegalensis* and the succulent *Sansevieria hyacinthoides* are the diagnostic forbs of the association. Prominent, frequently occurring trees of the association include *Acacia grandicornuta*, *Boscia foetida* and *Cadaba termitaria*. Graminoids such as *Aristida adscensionis*, *Cenchrus ciliaris*, *Chloris virgata*, *Enneapogon cenchroides*, *E. scoparius*, *Sporobolus ioclados* and *Tragus berteronianus* dominate the grass layer. Forbs that are common include *Barleria senensis*, *B. virgula*, *Becium filamentosum*, *Blepharis integrifolia*, *Hermannia modesta*, *Ruellia patula* and *Tribulus terrestris*.

Notes on floristic diversity. Floristically this association shows an affinity with all the other associations of the Arid Northern Bushveld of the SCPE (Table 24). On average 48 species were recorded per sample plot for this association, with a total of 98 different plant species overall (four relevés) (Table 26). No taxa of conservation value are restricted to this association, however, one SCPE endemic, one SCPE near-endemics and two Red Data List taxa occur (Table 25).

4. *Urochloo panicoidis–Agavetum americanae* ass. nova hoc loco
Nomenclatural type: relevé 390 (holotypus)

Environmental data. Association of sparse, open, species-poor savanna on disturbed, compacted soils adjacent to natural migration routes of the Pedi and their domestic livestock. It lies on gently sloped undulating valleys of 1–3°. All aspects are favoured. Soils are divers and may include turf soils such as the Arcadia form (vertic A-horizon), clay soils such as the Steendal form (melanic A-horizon), loam soils such as the Shortlands form (ortic A-horizon, red-structured B-horizon) and sandy soils such as the Hutton form (ortic A-horizon, red-apedale B-horizon). Approximately 05–10% of the soil surface is covered by stones with an average size of 50–100 mm (Table 26).

Diagnostic and dominant/prominent taxa. Diagnostic species are represented by species group U (Table 24). A sparse herb layer dominates the vegetation unit with the predominant diagnostic forbs including *Aptosimum lineare*, *Chamaesyce prostrata* (alien species), *Dicoma tomentosa*, *Felicia mossamedensis*, *Geigeria burkei*, *Indigofera spicata*, *Melhania forbesii*, *Phyllanthus parvulus*, *Sida dregei* and *Withania somnifera*. *Aristida canescens*, *Eragrostis racemosa*, *Heteropogon contortus* and *Urochloa panicoides*. The large succulent alien species, *Agave americana*, is the dominant diagnostic in the association. Large individuals of *Schotia brachypetala* are scattered in this anthropogenic grassland and dense clumps of the succulent *Euphorbia tirucalli* are also common. The vegetation is species-poor due to long-term wood harvesting and overgrazing and trampling by cattle and goats. *Aristida congesta* and *Eragrostis barbinodis* are other dominant grasses of the association. No other common species of the local bushveld type of the study area occur frequently in this association.

Notes on floristic diversity. Floristically the association only shows a slight relationship with the other associations in species groups V and W (Table 24), however this association is distinct and is only grouped with the other associations due to its locality in the SCPE and its anthropogenical alteration. Plant species encountered per sample plot average 24 and the total number recorded for this association was 55 (three relevés) (Table 26). Three taxa of conservation value are restricted to this association, namely the SCPE near-endemics *Aloe castanea* and *Grewia vernicosa* and a common endemic taxon (Table 25). These are also the only taxa of conservation value found in this association.

9.4 Vegetation key

A vegetation key is presented to facilitate plant community identification (Table 27). The definitions are broad indications of typical groups and should be seen as a guideline. A diagnostic characteristic of the vegetation or habitat is given, followed by the most diagnostic and visual species of a group. The first species is restricted to the specific group only, and the second is dominant in the group, but also occurs in other groups. Where one species is given, no species was restricted to the group only.

9.5 Ordination

On a regional scale the northern bushveld vegetation of the SCPE is characterised as naturally sparsely vegetated due to aridity, with many taxa that are locally typical for this habitat—occurring nowhere else in the study area. When compared with other habitats of the SCPE, the major environmental factors such as climate and geology for this major vegetation group is relatively homogeneous. However, a combination of factors such as rock cover, soil moisture and soil depth affects the species composition of its plant communities. The ordination indicated the gradients which are mainly caused by topography.

The scatter diagram displays the distribution of relevés along the first and second ordination axes (Figure 16). The vegetation units are represented as groups, their distribution on the diagram corresponding with certain physical environmental conditions. The rockiness and soil properties determine a definite gradient that is depicted by both the first (eigen value = 0.629) and second axis (eigen value = 0.344). Rockiness, soil moisture and soil depth determines the moisture retention and drainage of the habitat. The gradient on the x-axis expresses rock cover as a percentage of the soil surface, with the left of the scatter diagram representing rocky foot slopes with and the right depicting the open valley plains. This relates closely to soil moisture, as rock covered soils have large resources of available water. On the y-axis, the gradient indicates deeper soils at the bottom of the graph that indicates water availability over the long term, because deep clayey soils remain moist over a longer period. Steep slopes with shallow soils dry out quickly and are at the top of the diagram. The scatter diagram exhibits a gradient from the top, left corner (available moisture in the wet season) to deep, clay soils at the bottom, right corner (low soil moisture due to water retention, but a valuable resource in the dry season).

All these gradients correlate closely with each other and have a strong influence on the vegetation structure and species composition. The three most dominant and conspicuous taxa of each growth form (trees/shrubs/suffrutices, forbs/sedges and grasses) are given for each of the eight major vegetation types depicted in the scatter diagram (Table 28).

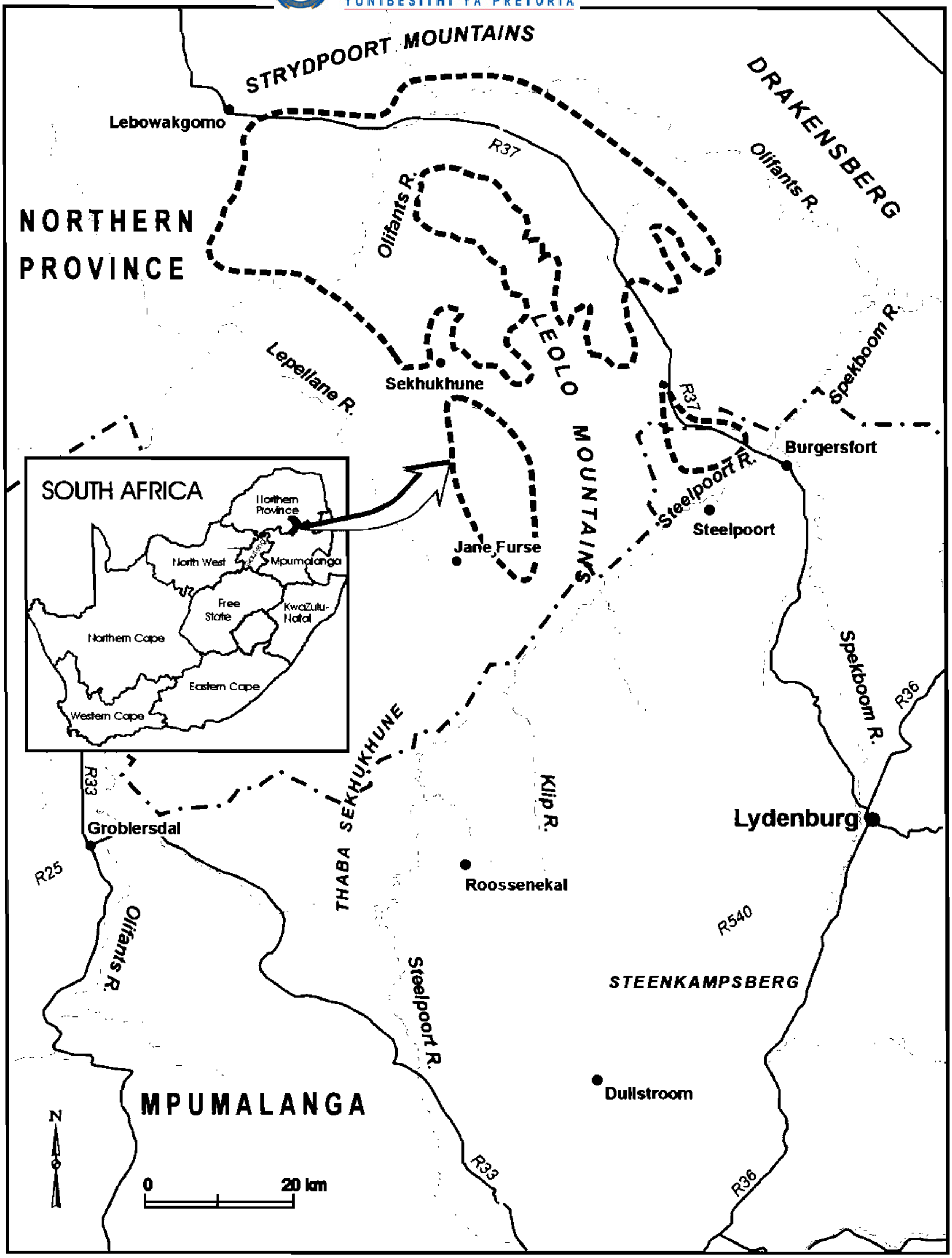


Figure 15 Location of the Arid Northern Bushveld of the Sekhukhuneland Centre of Plant Endemism in the Northern Province, South Africa.

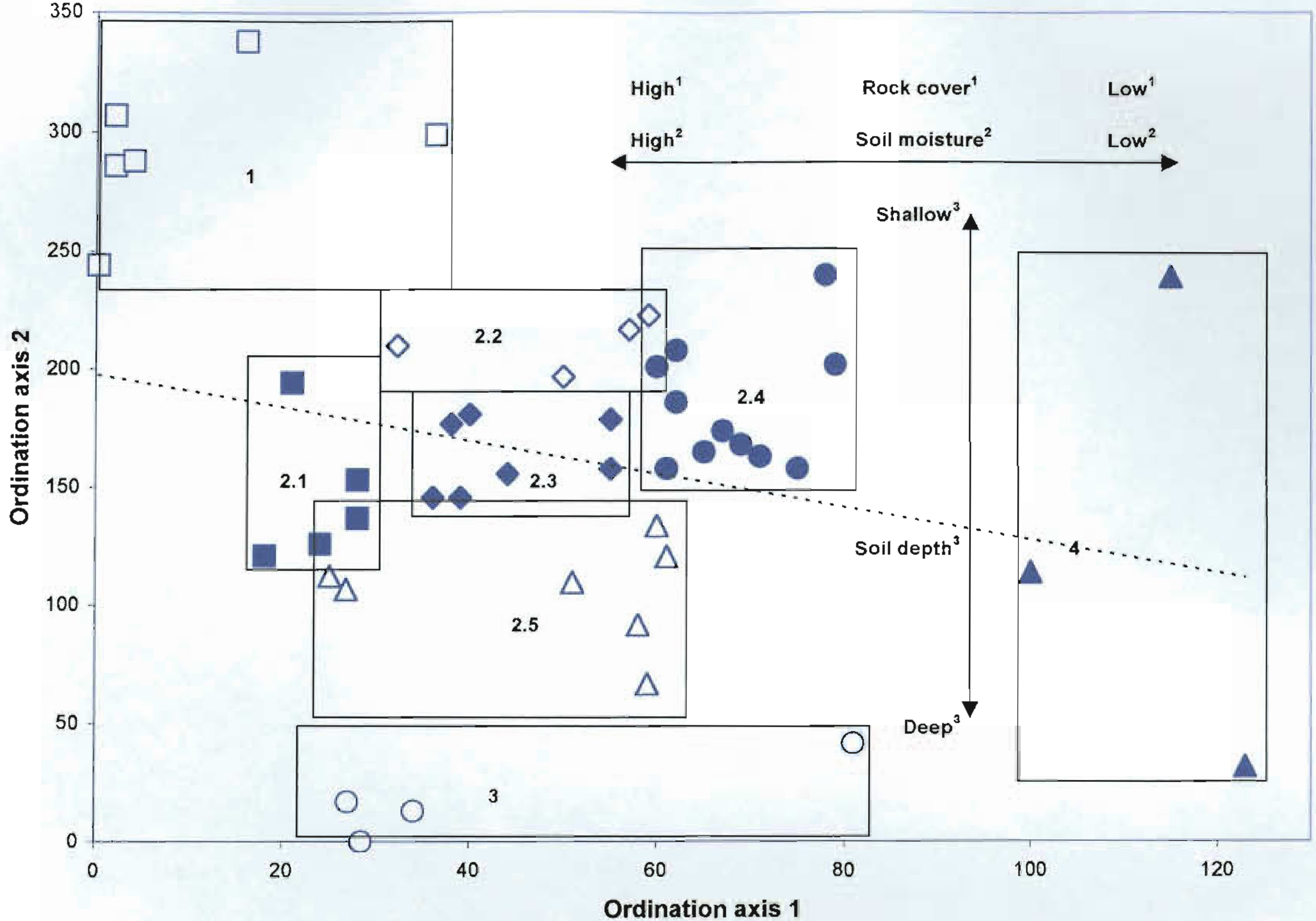


Figure 16 Relative positions of all the releves along the first and second axis of the ordination of the Arid Northern Bushveld of the Sekhukhuneland Centre of Plant Endemism. Numbers correspond with the plant communities in Table 24.

Table 24 A phytosociological table of the Arid Northern Bushveld of the Sekhukhuneland Centre of Plant Endemism.

Relevé	372	379	380	381	382	383	340	346	350	354	366	344	367	368	374	357	358	359	360	371	377	378	343	345	348	351	353	355	361	362	363	364	376	341	342	349	369	370	373	375	347	352	356	365	390	396	402
Association	1						2					2				2							2											2							3				4		
Sub-association							1					2				3							4											5													
Species group A																																															
Panicum coloratum	1	+	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.
Maerua cafra	+	+	.	+	.	R	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	R	.	.	.	.	.	.	.
Blepharis pruinosa	R	+	.	+	R	R	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Helichrysum cerastioides	1	.	R	+	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Polygala sp. (*SS 449*)	+	.	.	.	R	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Petalidium oblongifolium	.	1	1	1	A	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Mundulea sericea	.	1	+	+	.	+	R	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cleome angustifolia	.	+	+	+	+	+	.	.	R	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	+	.	.	.
Eustachys paspaloides	.	R	R	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Fingerhuthia africana	.	.	+	+	+	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.
Species group B																																															
Schmidtia pappophoroides	.	.	.	+	.	.	1	R	+	+	+	.	+	1	+	1	1	1	+	.	R	.	R	R	+	.	.	R	.	.	.	.	+	R	+	R	.	+	R	.	.	.	.	.	.	.	.
Melhania rehmannii	.	R	.	.	.	.	+	+	+	+	+	+	+	+	+	+	R	+	1	.	.	.	+	1	+	+	+	+	R	+	+	+	+	R	.	.	+	+	R	.	.	.	.	.	R	.	.
Ptycholobium contortum	.	R	.	.	.	.	+	+	+	+	R	+	.	+	+	.	R	R	.	.	R	.	+	+	+	+	.	.	R	.	.	.	.	.	R	.	.	+	R	R	.	.	.	.	.	.	.
Tricholaena monachne	.	.	.	.	.	.	R	.	.	+	R	.	R	.	R	.	.	.	.	R	.	+	.	.	.	.	.	.	+	1	.	.	1	.	.	.	.	R	.	R	.	.	.	.	.	.	.
Limeum viscosum	.	.	.	.	.	.	.	.	+	.	R	+	R	.	R	R	.	+	+	.	.	.	.	.	+	+	.	.	.	.	+	.	.	+	R	.	.	.	.	.	.	.	.	.	R	.	.
Solanum coccineum	.	R	.	.	.	.	+	R	R	+	.	R	+	.	.	.	R	R	+	.	R	R	.	.	+	R	.	+	R	+	+	.	+	+	R	.	R	.	.	R	.	.	.	.	.	R	.
Corchorus asplenifolius	R	.	.	.	.	.	R	.	+	.	.	.	.	.	.	+	+	+	+	.	.	R	+	+	+	+	+	+	+	+	R	.	.	+	+	+	+	1	.	R	.	.	.	.	.	.	.
Sericorema remotiflora	.	.	.	.	.	.	.	+	.	+	.	.	.	+	.	.	.	.	.	R	.	.	1	.	.	+	.	.	.	.	.	.	.	.	+	.	.	R	.	.	.	.	.	.	.	.	.
Corbichonia decumbens	.	.	.	.	.	.	.	R	.	.	.	+	.	.	R	.	.	.	.	.	.	+	+	+	.	.	.	+	+	.	+	.	+	.	+	.	.	R	R	.	.	.	.	.	.	.	.
Solanum panduriforme	.	.	.	.	.	.	.	.	.	.	.	+	+	R	.	+	.	R	.	.	.	R	R	.	R	R	+	.	1	+	+	+	R	R	.	+	.	.	.	+	.	.	.	.	.	R	.
Species group C																																															
Grewia bicolor	.	.	.	.	.	.	R	+	+	1	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.
Hybanthus enneaspermus	.	.	.	.	.	.	R	+	R	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.
Cadaba aphylla	.	.	.	.	.	.	R	+	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Talinum arnotii	.	.	.	.	.	.	R	+	.	R	+	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	R	.	.	.	.	.	.	.	.	.	.	.
Opuntia ficus-indica	.	.	.	.	.	.	A	.	+	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tephrosia burchellii	.	.	.	.	.	.	+	.	+	+	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Sarcostemma viminale	.	.	.	.	.	R	R	.	+	.	+	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	R	.	.	.
Huernia stapelioides	.	.	.	.	.	.	R	.	R	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Indigofera tristoides	.	R	.	.	.	.	+	.	.	1	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Limeum pterocarpum	.	.	.	.	.	.	.	+	+	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
Psiadia punctulata	.	.	.	.	.	.	.	R	R	.	R	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Triaspis hyperiodes subsp. *nelsonii*	.	.	.	.	.	.	.	1	+	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Oropetium capense	.	.	.	.	.	.	.	R	.	R	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dregea macrantha	.	.	.	.	.	.	.	R	.	R	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Portulaca kermesina	.	.	.	.	.	.	.	.	R	R	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species group D																																															
Polygala hottentotta	.	.	.	.	.	.	.	R	.	.	.	+	+	+	R	.	R	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Mollugo nudicaulis	.	.	.	.	.	.	.	.	.	.	.	+	R	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Barleria prionitis	.	.	.	.	.	.	.	.	.	.	.	R	R	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Commelina livingstonii	.	.	.	.	.	.	R	.	.	.	.	+	+	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aloe sp. (*SS 1419*)	.	.	.	.	.	.	.	.	.	.	.	+	R	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Asparagus suaveolens	.	.	.	.	.	.	.	R	.	.	.	+	.	R	1	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.
Aneilema hockii	.	.	.	.	.	.	.	.	.	.	.	+	.	R	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Stapelia gettliffei	.	.	.	.	.	R	.	.	.	.	.	+	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rhigozum obovatum	.	.	.	.	.	.	.	.	.	.	.	.	+	A	R	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Portulaca quadrifida	.	.	.	.	.	.	.	.	.	.	.	.	+	+	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.
Melhania virescens	.	.	.	.	.	.	.	.	.	.	.	.	+	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species group E																																															
Kalanchoe paniculata	.	.	.	.	.	.	.	R	R	.	+	.	.	+	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acacia luederitzii	.	.	.	.	.	.	+	A	.	.	.	A	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Rhus gueinzii	.	.	.	.	.	.	R	.	R	+	.	.	.	+	R	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Blepharis diversispina	.	.	.	R	.	.	R	.	.	+	.	+	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species group F																																															
Ptaeroxylon obliquum	+	R	.	+	.	.	B	1	.	R	.	B	.	R	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.
Blepharis subvolubilis	+	.	R	.	+	.	R	.	.	.	+	.	+	+	R	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Croton menyhartii	.	A	A	1	1	A	B	1	A	.	.	B	A	B	B	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	R	.	+	.	.	.	.	.	.
Asparagus africanus	.	1	.	R	.	R	.	.	R	R	+	.	+	+	.	.	.	.	.	.	.	R	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	R	.	.	.	.
Species group G																																															
Pollichia campestris	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	R	.	+	+	.	.	R	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eragrostis trichophora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	R	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Melhania acuminata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	R	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dipcadi viride	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	R	+	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Diospyros lycioides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	+	.	R	+	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	R	.

Table 24 continued.

Relevé	372 379 380 381 382 383	340 346 350 354 386	344 367 368 374	357 358 359 360 371 377 378	343 345 348 351 353 355 361 362 363 364 376	341 342 349 369 370 373 375	347 352 356 365	390 398 402
Association	1	2	2	2	2	2	3	4
Sub-association		1	2	3	4	5		
Species group G cont.								
Phyllanthus incurvus	. . . . . .	. . . . .	. . . .	. + . . + . 1	. . . .	. . . .	. . . .	. . .
Coccinia rehmannii	. . . . . .	. . . . .	. . . .	. . R R + R R	. . . . R .	. . . .	. . . R	. . .
Species group H								
Commiphora pyracanthoides	+ 1 . + . .	1 1 R + 1	. R A +	. . + + R . .	. . . R	. . . .	+ . . .	. . .
Geigeria filifolia	+ . . + + +	. . . R R	. R . .	+ + + R . . +	. . . .	. . . .	. . . .	. . .
Acacia mellifera	. A 1 R R +	1 . 1 . A	+ . . .	1 1 R + . . 1	. . . .	. . . .	. . R .	. . .
Euclea undulata	. + + + . R	. R . 1 1	. . . .	R + R + . . +	. . . . R	. . . .	. . . .	. . .
Balanites maughamii	. . + + 1 +	+	R + + .	. + . R . + .	. . . .	R	. . . .	. R .
Digitaria eriantha	. . R . R .	. + . . .	. . + R	. + . . R . R	. . . .	. . . .	. . . R	. . .
Species group I								
Kohautia cynanchica	. . . R . .	. . . . .	. . . .	. . . .	+ + . + . . . + . . R	. R . R . . .	. . . .	. . .
Eragrostis rigidior	. . . . . .	. . . . .	. . . .	. . . .	+ . R . 1 1 . . R . +	. . . .	. R . .	. . .
Hibiscus palmatus	. . . . . .	. . . . .	. . . .	. . . .	R . + . R . . . + R R	. . . .	R . . .	. . .
Tragia rupestris	. . . . . .	. . . . .	. . . .	. . . .	R . . . R . . + . + .	. . . .	. . . .	. . .
Ziziphus mucronata	. . . . . .	. . . . .	. . . .	. . . .	R . . . . + 1 . R . .	. . . .	. . . .	. . .
Acacia nilotica	. . . . . .	. . . . .	. . . .	. . . .	. 1 R 1 + 1 + + . R +	. . . . . . R	. . . .	. . .
Dipcadi glaucum	. . . . . .	. . . . .	. . . .	. . . .	. + R . . R . . R . .	R	. . . .	. . .
Gossypium herbaceum	. . . . . .	. . . . .	. . . .	. . . .	. + . R . . + . R . +	. . . .	. . . .	. . .
Ipomoea magnusiana	. . . . . .	. . . . .	. . . .	. . . .	. R + . . . + R . . .	. . . .	. . . .	. . .
Polygala uncinata	. . . . . .	. . . . .	. . . .	. . . .	. R . + . + . . . R .	. . . .	. . . .	. . .
Seddera capensis	. . . . . .	. . . . .	. . . .	. . . .	. . + . + . . 1 . + .	. . . .	. R . .	. . .
Lycium cinereum	. . . . . .	. . . . .	. . . .	. . . . . R .	. . + . . R . . + + R	. . . .	. R . .	. . .
Melinis repens	. . . . . .	. . . . .	. . . .	. . . .	. . . R R . . + . . +	. . . .	. . . .	. . .
Pergularia daemia	. . . . . .	. . . . .	. . . .	. . . .	. . . . + . R + . + .	. . . .	. . . .	. . .
Species group J								
Indigastrum costatum	. . . . . .	. . . . .	+ . . +	+ . . + . + .	. + + + + + + 1 1 + .	. R . . . R .	. . . .	. . .
Acalypha indica	. . . . . .	. . . . .	. + R .	R R . . + . .	R . . . R . + . . + R	. . . .	R . . .	. . .
Pechuel-Loeschea leubnitzia	. . . . . .	. . . . .	. . R .	+ . 1 + . + 1	. . + 1 . + . R . 1 .	. . R	. . . .	. R .
Senna italica	. . . . . .	R	. . . +	. R . . R . .	. R + ... + . + R	. . . . R . .	. . . .	R R .
Species group K								
Hibiscus praeteritus	. . . . . .	1 R R + +	+ + + .	. . . . . + .	+ . + R + . 1 + + 1 R	R	. . R R	. . .
Kyphocarpa angustifolia	. . . . . .	. + + . +	. . + +	. . . + R . +	. . . + . + . . R . R	. . . .	. . . R	. + .
Hibiscus pusillus	. . . . . .	. + R + R	. . . .	. + R . . . +	. . R R . R	. . . .	. . . .	. . .
Grewia flava	. . . . . .	R R . 1 .	. . . .	R . + . . R 1	. R . . R . 1 . . . 1	. . . .	. . . .	. . .
Evolvulus alsinoides	R	. . . + .	+ R . .	. . . + . . R	. . + + R . . + + + +	R	. . . .	. . R
Species group L								
Rhus engleri	. A + R R +	. R . . 1	. . . R	. + . + . . R	+ R . . A . R . R . +	. . . .	. . R .	. . .
Panicum maximum	. + + . . .	1 . R 1 +	+ + 1 .	1 R R + . R R	+ . + + B . B + 1 A 1	. . . .	. . . R	. . .
Species group M								
Indigofera rhytidocarpa	R	. . . . R	. . . .	. R	. . . .	+ R + + + + +	R . . .	. . .
Dactyloctenium aegyptium	. . . . . .	. . . . .	. . . .	. . . .	. . . .	+ + R . R . .	. . . .	. . .
Amaranthus thunbergii	. . R . . R	. . . . .	. R . .	. . . .	. . . .	+ R . R . + .	. . . .	. . .
Eragrostis biflora	. . . . . .	. . . . .	. . . .	. . . .	. . . .	R + . R . . R	. . . .	. . .
Leucas sexdentata	. . . . . .	. . . . .	. R . .	. . . .	. . + ...	+ . + + R . .	+ . . .	. . .
Schkuhria pinnata	. . . . . .	. R . . .	. . . .	. . . .	. . . .	R . . + + . R	. . . .	. . R
Indigofera circinnata	. . . . . .	. . . . .	. . . .	. . . .	. . . .	R . . R . . +	. . . .	. . .
Dipcadi gracillimum	. . . . . .	. . . . .	. . . .	. . . .	. . . .	. + R . R . R	. . . .	. . .
Sporobolus nitens	. . . . . .	. . . . .	. . . .	. . . .	. . . . . R	. R R . R 1 .	. . . .	. . .
Phyllanthus burchellii	. . . . . .	. . . . .	. . . .	. . . .	. . . .	. R . R . . +	. . . .	. . .
Kohautia aspera	R	. . . . .	. . . .	. . . .	. . . .	. R . . + . .	. . . .	. . .
Vernonia fastigiata	. . . . . .	. . . . .	. . . .	. . . .	. . . . R	. . + R + . .	. . . .	. . .
Pellostomum leucorrhiza	. . . . . .	. . . . .	. . . .	. . . .	. . . .	. . R + . + .	. . . .	. . .
Trianthema salsoloides	. . . . . .	. . . . .	. . . .	. . . . . R .	. . . .	. . R R R + .	. . . R	. . .
Corallocarpus bainesii	. . . . . .	. . . . .	. . . .	. . . .	. . . .	. . R R R . .	. . . .	. . .
Ipomoea sinensis	. . . . . .	. . . . .	. . . .	. . . .	. . . .	. . + . R R .	. . . .	. . .
Acalypha segetalis	. . . . . .	. . . . .	. . . .	. . . .	. . . .	. . + . . R R	. . . .	. . .
Limeum sulcatum	. . . . . .	. . . R .	. . . .	. . . .	. . . .	. . . + + . R	. . . .	. . .
Species group N								
Indigofera enormis	+ + + + + +	R A + . +	+ R + +	. 1 + + . . R	+ + + + . . R	R . . + + . R	. . . .	. . .
Monechma divaricatum	+ + + + + .	. R 1 + +	. + + 1	+ + . 1 . . 1	1 + 1 1 1 1 . . . 1 1	. + 1 . R + .	. . . .	. . .
Plinthus rehmannii	+ . R + + .	. . . . R	. . + .	. R	. . R . . . R R . . .	. . . . . + +	. . . .	. . .
Gisekia africana	+ . . . R .	R + + + .	+ 1 R .	R + . R R . +	+ + + + + B + . + . R	1 1 . . + + 1	. . . .	. . .
Dichrostachys cinerea	. R . + . .	R . + 1 .	. . R .	R R + . . . 1	R A . 1 R A R . . 1 +	. 1 + R + . .	. . R R	. . .
Hermannia odorata	. . + + . +	R + . + +	. + R +	. R + + R . +	R + 1 + + + + + + + R	. . . R + . +	. . . R	. . .
Species group O								
Salvadora australis	. . . . . .	. . . . .	. . . .	. . . .	. . . .	. . . .	1 1 1 1	. . .
Justicia odora	. . . . . .	. . + . .	. . . .	. . . .	+	. . R	+ 1 1 1	. . .

Table 24 continued.

Relevé	372	379	380	381	382	383	340	346	350	354	366	344	367	368	374	357	358	359	360	371	377	378	343	345	348	351	353	355	361	362	363	364	376	341	342	349	369	370	373	375	347	352	356	365	390	396	402
Association	1						2					2				2							2											2							3				4		
Sub-association							1					2				3							4											5													
Species group O cont.																																															
Maerua edulis	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	1	.	1	.	.	.
Brachiaria deflexa	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	+	R	.	R	.	.	.
Acacia robusta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	A	.	1	1	.	.	.
Setaria verticillata	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	.	.	.	.	.
Cordia monoica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	R	.	.	.	.
Pegolettia senegalensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	1	.	.	.	.
Hibiscus micranthus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	R	.	.	.	.
Sansevieria hyacinthoides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	1	.	.	.
Abutilon grandiflorum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	R	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	R	+	.	.	.
Eragrostis curvula	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	+	1	.	.	.
Diplachne eleusine	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	R	.	.	.	.
Enneapogon desvauxii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	R	.	.	.
Species group P																																															
Limeum argute-carineum	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	R	+	.	.	+	+	.	.	.	.
Boscia foetida	.	R	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	R	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	+	.	R	.	1	R	+	A	+	+	.	.	.
Asystasia subbiflora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	R	+	.	.	+	.	R	.	+	+	.	.	.
Chloris virgata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	R	+	+	+	+	+	+	+	.	.	R
Species group Q																																															
Hermannia modesta	.	.	.	.	.	.	.	.	.	.	R	.	R	.	.	.	.	.	.	.	.	.	R	+	.	+	.	+	.	R	.	+	.	+	+	+	.	1	1	+	+	+	1	R	.	.	.
Cadaba termitaria	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	R	R	.	.	+	A	1	+	.	R	.	1	.	.	+	+	R	.	.	1	+	+	1	.	.	.
Zaleya pentandra	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	+	.	.	.	.	.	.	.	R	+	.	.	.	R	R	+	.	.	.	.	.
Hermbstaedtia fleckii	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	R	.	+	.	R	.	.	.	.	R	+	+	.	.	+	.	R	+	.	R	.	.	.
Species group R																																															
Barleria virgula	.	.	.	.	.	.	.	+	.	.	+	+	+	+	.	.	.	.	.	.	.	.	+	.	R	.	R	.	.	.	.	.	R	.	.	.	.	.	.	.	+	+	+	+	.	.	.
Barleria senensis	.	.	.	.	.	.	+	+	.	R	.	.	.	+	R	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	+	+	+	+	.	.	.
Peristrophe cernua	.	R	.	.	.	.	R	+	.	.	.	+	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	.	R	.	.	.
Ruellia patula	.	.	.	.	.	.	R	R	+	.	.	.	R	+	R	.	.	.	R	.	.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	+	1	1	1	.	.	.
Species group S																																															
Bacium filamentosum	.	.	.	.	.	.	1	+	1	+	+	+	+	R	+	+	+	R	+	.	.	+	+	+	+	+	.	.	R	.	.	+	.	+	+	+	+	+	.	.	+	+	1	R	.	.	.
Urochloa mosambicensis	.	.	.	.	.	.	+	+	.	+	+	.	+	+	+	1	.	+	R	.	R	+	1	+	.	+	1	+	+	+	1	+	1	+	1	B	A	A	+	1	+	.	+	R	.	.	.
Phyllanthus maderaspatensis	.	.	.	.	.	.	+	.	+	R	+	+	+	+	+	1	A	1	A	.	.	.	R	1	+	+	+	1	+	+	+	+	R	+	+	+	+	+	+	+	+	R	+	+	.	.	.
Cenchrus ciliaris	.	.	.	.	.	.	.	R	.	.	+	R	.	R	.	1	1	+	R	.	+	R	.	.	.	.	R	.	.	.	.	+	.	.	.	+	.	.	.	.	.	1	1	.	.	.	.
Lantana rugosa	.	.	.	.	.	.	+	+	+	1	R	R	.	.	.	+	R	R	A	.	.	+	+	+	R	+	+	.	+	+	.	.	+	.	+	.	R	.	+	.	+	.	.	R	.	.	.
Aristida adscensionis	.	.	.	.	.	.	.	.	.	+	1	.	.	+	R	.	.	.	1	.	R	+	.	.	.	+	1	R	+	1	1	1	+	.	.	.	R	+	.	.	.	R	A	+	.	.	.
Pupalia lappacea	.	.	.	.	.	.	R	.	.	R	R	.	.	R	.	.	.	.	.	.	.	.	+	.	.	.	+	.	+	R	+	+	.	.	R	.	.	.	.	.	R	+	.	R	.	.	.
Boscia albitrunca	.	.	.	.	.	.	.	.	.	.	+	R	R	R	.	R	R	.	R	.	R	.	.	.	.	.	.	.	.	.	R	.	R	R	.	.	.	.	.	R	.	R	.	.	.	.	.
Albizia anthelmintica	.	.	.	.	.	.	1	A	B	B	.	.	.	.	.	.	.	.	.	.	.	.	B	+	.	1	+	R	.	.	.	.	R	.	A	+	+	.	R	.	R	.	.	+	.	.	.
Acacia grandicornuta	R	.	.	.	.	.	A	A	+	A	.	R	R	.	.	+	.	R	+	.	.	1	.	R	.	.	.	R	.	R	R	A	.	.	1	R	+	+	1	R	1	B	1	B	.	.	.
Leucas glabrata	.	.	.	.	.	.	+	+	.	R	.	+	.	.	R	.	.	.	.	.	R	.	.	R	.	.	.	.	.	.	.	1	.	.	.	.	.	R	+	.	.	R	.	.	.	.	.
Sporobolus ioclados	.	.	.	.	.	.	.	+	1	.	.	+	.	.	R	.	.	.	.	+	+	.	.	.	.	1	+	1	.	.	.	.	.	+	.	A	A	+	.	+	1	.	1	1	.	.	.
Blepharis integrifolia	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	A	B	A	.	.	.	+	1	.	.	+	+	+	.	.	+	+	.	.	A	1	R	+	R	.	B	1	+	1	.	.	.
Aristida scabrivalvis	.	.	.	.	.	.	.	+	.	+	.	+	.	.	R	.	+	.	.	R	.	+	.	+	.	+	.	R	.	+	+	.	.	.	R	.	.	+	+	.	+	.	+	.	.	.	.
Species group T																																															
Enneapogon scoparius	+	+	+	+	+	+	R	+	.	.	+	R	.	R	.	.	.	.	.	.	.	+	.	R	.	.	.	.	.	.	.	.	+	.	.	.	R	.	.	.	+	+	.	1	.	.	.
Felicia clavipilosa	R	.	R	.	.	+	+	+	+	+	R	+	+	+	+	.	+	R	R	.	.	+	R	+	+	+	+	+	.	.	R	.	+	+	R	+	+	+	+	+	.	+	.	.	.	.	.
Kleinia longiflora	.	+	R	+	+	+	+	+	+	.	+	+	R	+	R	.	.	.	+	.	.	.	+	+	R	.	.	R	+	+	+	+	1	.	.	.	.	.	R	+	+	1	R	R	.	.	.
Tragus berteronianus	.	+	R	.	.	.	R	+	1	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	1	R	+	R	R	.	+	+	+	+	1	1	.	+	+	+	+	.	.	.
Ehretia rigida	.	R	R	.	R	.	.	.	.	R	+	.	.	R	.	+	+	+	.	.	.	R	+	.	.	R	.	.	1	.	R	R	1	.	.	+	.	.	.	R	.	1	R	R	.	.	.
Enneapogon cenchroides	.	+	.	.	.	+	+	R	+	+	.	.	+	+	+	.	.	.	R	.	.	.	+	+	R	.	+	.	R	+	+	+	.	R	R	.	.	R	R	.	+	+	1	1	.	.	.
Species group U																																															
Agave americana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	+
Aptosimum lineare	R	.	.	.	.	.	+	.	.	.	.	R	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	+	.	.	.	.	.	.	.	.	+	1	+
Urochloa panicoides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	+	1	+
Dicoma tomentosa	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	+	+	1
Indigofera spicata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+
Eragrostis racemosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+
Heteropogon contortus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	1	R
Phyllanthus parvulus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	.	.	R	+	R
Aristida canescens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	.
Sida dregei	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	R	.
Withania somnifera	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	+	.
Geigeria burkei	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	1
Schotia brachypetala	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+
Felicia mossamedensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+
Chamaesyce prostrata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	+	.	+
Euphorbia tirucalli	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+
Melhania forbesii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+

Table 24 continued.

Relevé	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4
	7	7	8	8	8	8	4	4	5	5	6	4	6	8	7	5	5	5	8	7	7	7	4	4	4	5	5	5	8	8	6	8	7	4	4	4	6	7	7	7	4	5	5	6	9	9	0
	2	8	0	1	2	3	0	6	0	4	6	4	7	8	4	7	8	9	0	1	7	8	3	5	8	1	3	5	1	2	3	4	6	1	2	9	9	0	3	5	7	2	6	5	0	6	2
Association	1						2	.				2	.			2	.						2											2							3				4		
Sub-association							1					2				3							4											5													
Species group V																																															
Aristida congesta	.	.	.	.	.	.	1	+	+	1	+	B	.	+	+	1	1	1	A		.	R	+	+	+	A	+	1	1	1	A	+	B	1	+	.	+	+	+	+	R	.	A	+	1	R	1
Leucas capensis	.	.	.	.	.	.	R	.	R	.	R	.		.	+	+	.	R	+	.	.	+	1	.	.	1	1	+	.	.	+	+	.	.	.	.	R	.	+	1		.	+	R	1	.	.
Tribulus terrestris	.	.	.	.	.	.	.	+	R	.	.	.	+	.	.	.	.	.	.	R	.	.	.	.	R	.	.	.	R	.	.	+	.	.	.	.	.	.	1	.	+	+	+	+	.	R	R
Geigeria ornativa	.	.	.	.	.	.	.	.	.	.	.	R	.	.	+	.	R		.	.	R	.	R	.	.	+	.	.	.	R	.	.	.	.	.	R		R	+	.	.	.	+	R	.	1	.
Species group W																																															
Eragrostis barbinodis	B	A	1	A	B	1	A	+	+	+	1	A	1	+	1	A	1	B	+	B	B	+	+	+	B	A	.	1	1	+	1	1	B	A	+	1	A	1	1	B	R	.	1		+	+	.
Seddera suffruticosa	+	+	.	.	.	+	+	+	+	+	+	+	+	1	+	1	1	+	+	.	.	1	+	+	1	+	+	+	.	.	+	+	.	+	R	+	R	+	+	.	+	R	.	1	+	.	+
Acacia tortilis	+	R	.	+	+	R	1	.	.	1	+	1	B	R	A	A	1	1	A	+	A	A	1	B	B	B	3	B	B	B	3	B	B	B	A	A	+	+	A	A	.	.	+	.	.	+	R

Table 25 Sekhukhuneland Centre of Plant Endemism endemic/near-endemic and Red Data List plant taxa of the Arid Northern Bushveld.

Taxon	Family	Syntaxa							
		1	2.1	2.2	2.3	2.4	2.5	3	4
Aloe castanea	LILI	.	.	.	.	.	.	.	#+
Aloe sp. nov. (*S 1419*)	LILI	.	.	$+	.	.	.	.	.
Boscia foetida subsp. *minima*	CAPP	Rr	Rr	.	Rr	.	R+	R+	.
Gossypium herbaceum	MALV	.	.	.	.	N+	.	.	.
Grewia vernicosa	TILI	.	.	.	.	.	.	.	#r
Heurnia stapelioides	ASCL	.	#+	.	.	.	.	.	.
Leucas capensis [form] (*W&S13007*)	LAMI	.	$r	$r	$+	$1	$+	$+	$+
Pegolettia senegalensis	ASTE	.	.	.	.	.	Nr	N+	.
Petalidium oblongifolium	ACAN	#1	.	.	.	.	.	.	.
Phyllanthus sp. nov. (*S 470*)	EUPH	$r	.	.	.	$r	$r	.	.
Plinthus rehmannii	AIZO	V#+	V#+	V#r	V#r	V#+	V#+	.	.
Polygala sp. nov. (*S 449*)	POLY	$+	.	.	.	$r	.	.	.
Rhus engleri	ANAC	#1	#+	#r	#r	#1	.	#r	.
SCPE Endemics		2	1	2	1	3	2	1	1
SCPE Near-endemics		3	3	2	2	2	1	1	2
Red Data List		2	2	1	2	2	3	2	0
Restricted to syntaxon		1	1	1	0	1	0	0	2
Restricted to association		1			3			0	2
Total for syntaxon		6	5	4	4	6	5	4	3
Total for association		6			10			4	3

Endemism: $ = endemic, # = near-endemic; **Red Data List:** R = Rare, V = Vulnerable, N = Not threatened in the northern provinces of South Africa, but in other areas of southern Africa; **Abundance in communities:** 1 = abundant, + = frequent, r = rare, . = absent; **Collectors:** S = Siebert, W = Van Wyk; **Bold** blocks represent community/syntaxon specific taxa.

Table 26 Environmental factors and selected attributes associated with the different plant communities of the Arid Northern Bushveld.

Factors/attributes	Syntaxa							
	1	2.1	2.2	2.3	2.4	2.5	3	4
Number of relevés	6	5	4	7	11	7	4	3
Total number of species	59	110	92	87	109	108	98	55
Average number of species per relevé	25	50	46	34	38	39	48	24
Number of endemics/near-endemics	5	4	4	3	5	3	2	3
Number of Red Data List taxa	2	2	1	2	2	3	2	0
Geology*	SH	SH	SH	SH	SH/Q	SH/Q	SH/Q	Q
Topographic position**	F/M	F/M	F/M	F/M	V/F	V/F	V/F	V
Slope (°)	1–3	3–5	1–5	1–5	1–3	1–3	1–3	1–3
Aspect	E	NW	SE	S	NS	N	N	NE/SW
Predominant soil type***	Gs	Sn/Mw	Va/Gs	Sd/Gs	Va	Bo	Sn	-
Rock cover percentage (%)	15–50	10–15	10–20	10–20	05–10	05–10	05–15	05–10
Average rock size (mm)	250–500	100–400	300–500	100–400	200–400	300–400	250–400	50–100

* SH = Serpentinized harzburgite; Q = ALluvium

** M = midslope; F = footslope; V = valley

*** Bo = Bonheim; Gs = Glenrosa; Mw = Milkwood; Sd = Shortlands; Sn = Steendal; Va = Valsrivier

Table 27 A key to the syntaxa of the Arid Northern Bushveld of the Potlake Nature Reserve and surrounding areas in the Sekhukhuneland Centre of Plant Endemism.

Leads/description	Go to/syntaxon
1a Only Glenrosa soils (*Panicum coloratum* & *Croton menyhartii*)	1. *Panico colorati–Crotonetum menyhartii*
b Various soil types (*Aristida congesta* & *Lantana rugosa*)	**2**
2a Rock size < 100 mm (*Agave americana* & *Geigeria ornativa*)	4. *Urochloo panicoidis–Agavetum americanae*
b Rock size > 100 mm (*Becium filamentosum* & *Acacia tortilis*)	**3**
3a Steendal soils (*Barleria virgula* & *Ruellia patula*)	**4**
b Various soil types (*Indigastrum costatum* & *Eragrostis barbinodis*)	**5**
4a Slope 1–3° (*Salvadora australis* & *Tribulus terrestris*)	3. *Enneapogono cenchroidis–Salvadoretum australis*
b Slope 3–5° (*Grewia bicolor* & *Felicia clavipilosa*)	2.1 *Melhanio rehmannii–Acacietum tortilis grewetosum bicoloris*
5a Predominantly southern aspects (*Balanites maughamii*)	**6**
b Predominantly northern aspects (*Cadaba termitaria*)	**7**
6a Valsriver soils (*Rhigozum obovatum* & *Solanum panduriforme*)	2.2 *Melhanio rehmannii–Acacietum tortilis rhigozetosum obovati*
b Shortlands soils (*Diospyros lycioides* & *Pechuel-Loeschea leubnitzia*)	2.3 *Melhonio rehmannii–Acacietum tortilis diospyretosum lycioidis*
7a Valsriver soils (*Acacia nilotica* & *Hibiscus praeteritus*)	2.4 *Melhonio rehmannii–Acacietum tortilis acacietosum niloticoe*
b Bonheim soils (*Indigofera rhytidocarpa* & *Boscia foetida*)	2.5 *Melhanio rehmonnii–Acacietum tortilis indigoferetosum rhytidocarpoe*

Table 28 The three most dominant and conspicuous plant taxa of each of the major vegetation types of the Arid Northern Bushveld depicted in the DECORANA scatter diagram.

Major vegetation type	Trees/shrubs	Forbs/sedges	Grasses
1. *Panico colorati–Crotonetum menyhartii*	*Acacia mellifera*	*Geigeria filifolia*	***Panicum coloratum***
(*Panicum coloratum–Croton menyhartii*)	*Commiphora pyracanthoides*	*Indigofera enormis*	*Schmidtia pappophoroides*
	Croton menyhartii	*Seddera suffruticosa*	*Tragus berteronianus*
2. *Melhanio rehmannii–Acacietum tortilis*	*Acacia nilotica*	*Indigofera rhytidocarpa*	*Eragrostis barbinodis*
(*Melhania rehmannii–Acacia tortilis*)	***Acacia tortilis***	***Melhania rehmannii***	*Panicum maximum*
	Dichrostachys cinerea	*Phyllanthus maderaspatensis*	*Urochloa mosambicensis*
3. *Enneapogono cenchroidis–Salvadoretum australis*	*Acacia grandicornuta*	*Blepharis integrifolia*	*Chloris virgata*
(*Enneapogon cenchroides–Salvadora australis*)	*Boscia foetida*	*Justicia odora*	***Enneapogon cenchroides***
	Salvadora australis	*Tribulus terrestris*	*Sporobolus ioclados*
4. *Urochloo panicoidis–Agavetum americanae*	***Agave americana***	*Aptosimum lineare*	*Aristida congesta*
(*Urochloa panicoides–Agave americana*)	*Acacia tortilis*	*Dicoma tomentosa*	*Eragrostis racemosa*
	Schotia brachypetala	*Senecio latifolius*	***Urochloa panicoides***

CHAPTER 10

PLANT-SOIL ASSOCIATIONS

Abstract

Maize seedlings were grown in chromium-rich soils collected from an ultramafic catena. The seedlings showed typical symptoms of Ni and Cr toxicity. The response of maize plants suggested that accumulation of heavy metals, notably Cr and Ni, by indigenous plants could be possible. To investigate this hypothesis, 20 indigenous plant species were sampled along 13 points of the ultramafic catena. Plant material and soil samples were analysed with standard analytical methods to determine the concentrations of 33 elements, including several heavy metals. Twelve rock types of the Sekhukhuneland Centre of Plant Endemism were also analysed to determine whether a chemical relationship exists between the rocks of the study area and serpentinite. Nine SCPE endemics, three SCPE near-endemics, and eight wide-spread species were used for the analyses. None of the investigated taxa were clear hyperaccumulators of Cr or Ni, but plants of seven indigenous species accumulated more than 1 000 mg/kg of Fe and Al. The accumulation of high concentrations of heavy metals was mostly found in species that were common on and of the ultramafic soils, but included one SCPE near-endemic and one SCPE endemic form. Three of the hyperaccumulators belong to the Asteraceae.

10.1 Introduction

The past twenty years have witnessed an extraordinary increase in the interest of plants that hyperaccumulate heavy metals on ultramafic substrates such as serpentinite. These unusual species have found a ready application in such diverse fields as geobotany, phytochemistry, archaeology, mineral exploration, ecology, phytoremediation and phytomining (Cole & Le Roex 1978; Brooks 1998).

Serpentinite and other ultramafic rocks are rich in ferro-magnesium minerals. They outcrop as raised segments of a continent's crust and constitute a small proportion of the earth's land surface (Brooks 1987). Soils formed from ultramafic rocks have unusual characteristics, and are rich sources of heavy metals especially nickel (Ni), chromium (Cr), manganese (Mn) and iron (Fe) (Wild 1978). The remaining soil matrix is largely composed of relatively inert ferric and chromic oxides. In addition, calcium (Ca) deficiency and toxic levels of magnesium (Mg) in these soils can create an unfavourable Mg:Ca ratio which may lead to poor Ca assimilation. It should be noted that minerals such as arsenic, serpentine and gypsum have importance as constituents of ultramafic soils (Wild 1978).

On serpentinite the adverse effect of heavy metals is enhanced by the low levels of calcium in relation to magnesium, the lack of organic matter, and poor physical texture of the soil (Wild 1974a; Wild 1974b; Brooks & Yang 1984; Hughes & Noble 1991; Roberts & Proctor 1992). The poor soil structure and restricted soil depth, reduces root penetration and water content, and contributes to water stress in plants. As a result, serpentineferous areas have several endemic species adapted to high concentrations of heavy metals and generally adverse edaphic conditions (Proctor 1971; Proctor & Woodell 1975; Morrey *et al.* 1989; Roberts & Proctor 1992; Freitas & Mooney 1996).

Globally about six plant families are known to include more than ten species able to hyperaccumulate Ni (Borhidi 1998). Two of these families, Brassicaceae and Euphorbiaceae, have more than 80 plant species that can hyperaccumulate heavy metals (Borhidi 1998). The remaining four families, namely the Asteraceae, Buxaceae, Flacourtiaceae and Rubiaceae, have less than 30 hyperaccumulator species,.

In Sekhukhuneland, some species from the Araceae, Euphorbiaceae and Vitaceae exhibit a specific relationship with certain heavy metal soils (Siebert 2000). None of these species have been tested for the accumulation of heavy metals. One of the hypotheses suggested by Siebert (1998) was that indigenous plants from the Sekhukhuneland region, and notably some of the taxa endemic to the region, could possibly accumulate Cr.

There are conflicting views concerning the uptake and translocation of Cr (VI) in plants (Kimbrough *et al.* 1999). Wild (1974b) reported considerable uptake of Cr by the serpentine endemics, *Dicoma niccolifera* and *Jamesbrittenia fodina* (*Sutera fodina*), though this was subsequently ascribed to contamination (Cr on leaf surface) (Brooks & Yang 1984). Other plants that have been identified as Cr accumulators are *Sporobolus pectinatus* and a species of *Sutera* (Morrey *et al.* 1989).

Chromium is the seventh most abundant element on Earth (Katz & Salem 1994). It occurs in several oxidation states, with the trivalent and hexavalent states, namely Cr (III) and Cr (VI), being the most stable and common in terrestrial environments. Chromium can be both beneficial and toxic to animals and humans depending on its oxidation state and concentration (Kimbrough *et al.* 1999). At low concentration, Cr (III) is essential for animal and human health. Cr (VI) is a potent, extremely toxic carcinogen and may cause death to animals and humans if ingested in a large dose (Nriagu & Nieboer 1988).

There is a notable dearth of information in the literature pertaining to Cr uptake, toxicity, translocation, soil/plant relationships and effects on plant growth. Clearly these are aspects that require substantial investigation, specifically for regions such as Sekhukhuneland, where the soil concentrations of Cr and Ni are in certain areas respectively 500 and 60 times higher than the maximum permissible soil concentration of trace elements allowed in legislation and guidelines for South Africa (Steyn *et al.* 1996).

Very little is known about the uptake of Cr by plants. Nowhere in the world is it as abundant in natural soils as in the SCPE. This chapter includes discussions on the occurrence and geobotany of a selected number of plant species growing in the vicinity of chromitite outcrops in the SCPE. It also touches on a specific group of metals that are abundant in the ultramafic soils of the Rustenburg Layered Suite.

Footnote

Methods for this chapter are presented in Chapter 3, 3.2 Plant and soil analyses.

10.2 Maize seedlings grown in ultramafic soils

10.2.1 Background

This section deals with the growth limiting effect that ultramafic soil samples from chromitite outcrops in the SCPE have on maize seedlings. This effect is presumably caused by the toxicity of the soil samples. The limiting factor is measured as the average biomass production of maize seedlings grown in toxic soils (Table 29) as a percentage of the average biomass production of maize seedlings grown in the control soils.

The levels of N, P, S, Mg, Ca, Ni and Cr was determined in the roots and leaves of maize grown on metalliferous soil samples from a chromitite outcrop in the SCPE. The heavy metal concentrations in plant tissue tested for, is known to induce growth limiting effects on maize at certain critical levels (Cooper 1986). These levels were determined as the concentration of elements present in the maize when growth of roots and leaves becomes restricted in containers with Cr rich soils, compared with maize grown in containers with neutral quartzite sand as a control.

The objective of the experiment was to test applicability of results found by Cooper (1986) with regards to Cr toxicity, before more expensive methods were used to determine absorbtion and accumulation of heavy metals such as Cr and Ni in indigenous plants from Sekhukhuneland

10.2.2 Results and discussion

Root development of maize seedlings grown in the soil samples from the chromitite outcrop was stunted during the first two weeks, but the growth rate increased over time when compared with control plants (Figure 17; Table 30). As the soil became less toxic, and Cr and Ni were translocated from the roots to the leaves, the leaves showed a decrease in their average biomass production (Table 30). During the first two weeks the effect of Cr and Ni toxicity was minimal in the leaves of maize seedlings grown in the heavy metal soil. Plants grown in the heavy metal soil were dark green and indistinguishable from control plants. From 3 to 4 weeks leaf growth became stunted (Figure 17) and developed a degree of chlorosis and purpling (Figure 18).

Ultramafic soils from chromitite outcrops in Sekhukhuneland proved to be toxic to maize. Apart from severe stunting that occurred in leaf growth, the most important abnormalities were interveinal chlorosis and purpling, especially on newly extending leaves. Interveinal chlorosis (longitudinal striping of maize leaves) and leaf purpling was visible on plants grown in the ultramafic soils of the chromitite outcrop (Figure 18). Control plants in the quartzite soil had no such symptoms. This was clear evidence of the toxic effect that Ni has on maize. Interveinal chlorosis of leaves resulted from uptake of Ni in leaves (Table 31; Figure 19). The chlorosis was similar to that described specifically for Ni toxicity where Ni was translocated to leaves (Hunter & Vergano 1952). Leaf purpling is specific to and the result of Cr accumulation in leaves (Cooper 1986). Foliar analysis supported the hypothesis, as chlorotic and purple leaves showed higher levels of Ni and Cr than leaves of plants grown in the control soil (Table 31; Figure 19).

Chromium was accumulated more in the leaves than Ni (Figure 19). More Ni accumulation took place in the roots (Figure 19). Overall accumulation of both metals was more or less restricted to the roots, a phenomenon previously recorded (Cary *et al.* 1977). Overall very low concentrations were recorded in the leaves and roots. Chromium and Ni concentrations in the plant tissues decrease with time as the heavy metal concentrations in the root environment become depleted as a result of plant growth and uptake (the "plant size:heavy metal concentration" ratio increases). The same tendencies with regards to low levels of Cr and Ni accumulation were observed in indigenous grasses (Poaceae family) growing naturally at the site where the soil samples were collected (Table 32; Figure 20). However, Fe and Al were accumulated extensively.

Maize seedlings in this experiment (Table 31) showed similar Cr and Ni concentrations in their leaves to those of eleven tested vegetable crops (Zayed *et al.* 1998) and considerably lower concentrations in their roots. The wild grass species analysed (Table 32) also showed higher Cr and Ni concentrations in their leaves and lower concentrations in their roots than the vegetable crops analysed by Zayed *et al.* (1998). However, two of the grass species accumulated Al and Fe at levels above 1 000 mg/kg. This will be discussed in the next section.

During the first two weeks nutrient levels of N, P and S in roots and leaves of maize seedlings were high (Figure 21). These levels decreased substantially in the third week and kept on declining in the fourth week. Overall the nutrient levels were higher in the leaves than the roots. Mg and Ca levels of the roots and leaves of the seedlings remained more or less constant throughout the four weeks (Figure 21). No leaf edge splitting was recorded, indicating that there was no Ca deficiency in the plants (Cooper 1978; Kawaski & Moritsugu 1979). The Mg:Ca ratio in the plant material is low, namely 1:1.35 (Table 31), whereas the Mg:Ca ratio in the soil samples is high, namely 1:0.45 (Table 31). Nutrient levels in the indigenous grasses varied and no distinct patterns could be observed (Figure 22). The Mg:Ca ratio for the indigenous grasses is approximately 1:2.

A possible external factor that might have influenced the results obtained in the maize experiment is that the control soil was sterilised, hence also without any arbuscular mycorrhiza. This means the experiment could have been influenced by natural occurring mychorrhiza in the chromitite outcrop soil samples. Experiments have shown that maize can grow in heavy metal soil due to selective immobilization of heavy metals within the root tissues containing fungal cells of arbuscular mycorrhiza (Kaldorf *et al.* 1999) which serve as an exclusion mechanism.

10.3 Natural vegetation on ultramafic soils

10.3.1 Background

As would be expected in a sub-continent with about 30 000 native plant species, southern Africa proved to have its own unique serpentiniferous flora. The Great Dyke of Zimbabwe and the Barberton Sequence of South Africa harbour a number of plant species that hyperaccumulate Ni. Wild (1970) and Brooks & Yang (1984) recorded several hyperaccumulators of Ni on the Great Dyke. Morrey *et al.* (1992) reported hyperaccumulation of Ni by several members of the Asteraceae from the Barberton Sequence in Mpumalanga. One of these species, *Berkheya coddii*, is renowned for its ability to hyperaccumulate Ni. Its ability to accumulate Ni in large quantities was first reported by Morrey *et al.* (1989) and its economic viability in phytoremediation was investigated by Anderson *et al.* (1995).

This section focuses on the potential heavy metal accumulators of the eastern Rustenburg Layered Suite (RLS), a part of the Bushveld Complex that is one of the world's largest ultramafic complexes. The work conducted in this section is similar to the approach followed by Brooks & Yang (1984) on the Great Dyke, Zimbabwe, and by Cole (1992) on the ultramafics of the South African Lowveld. The RLS underlies the Sekhukhuneland Centre of Plant Endemism in Mpumalanga and the Northern Province, South Africa (Siebert 1998) (Figure 1). It shows considerable diversity in habitat and soil chemistry (Land Type Survey Staff 1989; Visser *et al.* 1989), and supports a highly diverse and unusual type of Mixed Bushveld (Acocks 1953) flora of more than 2 000 angiosperm species and infraspecific taxa (Siebert 2000; Chapter 11). Siebert (1998) recognised approximately 50 taxa as being endemic to the ultramafic substrates of Sekhukhuneland. These substrates are classified as serpentine in botanical literature (Knowles & Witkowski 2000).

The ultramafic soils analysed in this study are representative of the regions where the local flora exhibit high degrees of endemism. This thesis is a preliminary investigation into the heavy metal soils of the Critical Zone of the RLS, the richest area in both plant endemics (Siebert 1998) and heavy metals (Schurmann *et al.* 1998). The purpose of this investigation was to determine whether the concentrations of heavy metals from soils in the SCPE are comparable with other serpentineferous soils in the world. This forms the basis to determine whether the plant taxa on heavy metal outcrops in the SCPE are accumulators or excluders (as defined by Baker (1981)) of heavy metals. One of the aims of this section is to stimulate further research on heavy metal soils and its associated vegetation, as more information on the concentrations of trace elements in such soils is much needed (Steyn *et al.* 1996). It is hoped that this contribution may stimulate further scientific research and commercial use of plants growing on the heavy metal outcrops of the SCPE.

10.3.2 Results and discussion

The results and discussion of this section is divided into five subheadings. The rocks of the study area are discussed followed by the soils, the catena, the plants and concludes with the plant-soil associations.

10.3.2.1 Rock analyses

Rocks were analysed and sorted according to their Mg:Ca ratio (Figure 23), and were ordered according to this relationship in the data tables (Appendix 2). Rock types presented in the graphs were also displayed in this order to standardise the x-axis of the figures (Figure 26), with Groen Valley serpentinite left (A, Mg:Ca ratio = 34.52 Mg : 1 Ca) and Leolo Mountain norite right (M, Mg:Ca ratio = 1 Mg : 5.56 Ca). Exposed rocks of serpentinized harzburgite, magnetitite and chromitite showed similar Mg:Ca ratios and high chromium/nickel concentrations, as was found in the serpentine control Groen Valley, Barberton Greenstone Belt (Balkwill & Burlin 1995). The serpentine related rock types are typical of the Critical Zone of the Rustenburg Layered Suite.

When the chemical composition of the rock data are compared, the following is evident from the gradient (Appendix 2):

- Cr, Ni and Mg are highest in the serpentinite, serpentinized harzburgite, magnetitite and chromitite—in addition the magnetitite shows high Zn concentrations;
- Ti, V and Fe are highest in magnetite, chromate and black sand in dongas;
- K is highest in Getlane shales and Burgersfort pyroxenite;
- Cl is highest in Burgersfort pyroxenite and Roossenekal norite;
- P is highest in Olifantspoortjie pyroxenite and diabase dykes – in addition Cu is highest in diabase dykes;
- Ca is highest in Olifantspoortjie pyroxenite, concresions of the Steelpoort Valley, and Leolo and Roossenekal norite – in addition Leolo norite is rich in Na;
- Si is highest in quartzite sills.

These heterogeneities in element concentrations across the range of sampled rock support the diverse range of plant communities reported on in Chapter 4, 4.3 Hierarchical classification. From here onwards, focus will be on the rock associated with the transect/catena (Figure 24) that was sampled for the study of the plant species that grow abundantly on heavy metals soils of the SCPE. Note that there is a difference between the gradient obtained here and the soil catena discussed in section 10.3.2.3.

10.3.2.2 Soil analyses

A profile of the study site (catena) on the Critical Zone of the RLS is given in Figure 24. A transect of the catena can be divided into a floodplain (A & B), dongas or erosion gulleys (C, D & K), slopes (E–I), and a chromitite outcrop (J, L & M). Soils most frequently associated with the Critical Zone are melanic A-horizons over pedocutanic/carbonate B-horizons such as the Bonheim and Steendal forms, and ortic A-horizons over hard rock/lithocutanic B-horizons such as Mispah and Glenrosa forms. Soil samples from these regions were analysed and described as follows:

- Floodplain soils occur on the wide alluvial flats where they drain the areas between the norite and pyroxenite hills (A & B). In places these soils may overlie the Merensky and Bastard Reefs, including magnetitite outcrops (B). These landforms experience periodic local flooding during the rainy season. The profiles are deep (> 1.5 m), and can vary from black to dark brown, and may show characteristics of vertisols. Texture of the surface soil is a medium clay that gradually increases to a medium to heavy clay in low-lying areas, or adversely decreases to a medium to heavy loam on more raised areas. The soil layer where water collects during the wet season, is usually underlain by silica concretions.

- The soils of lower and footslopes can either be shallow or very stony and overlie partially weathered ultramafic rock, or moderately deep and depositional with stony profiles. The shallow soil type occurs directly at the foot of mountains and hills (E & F). These soils overlie exposed rock. They are black or dark brown, with a loam surface grading and clayey subsoil. The deeper depositional soils occur below raised areas in the floodplains (F). The raised areas (G) occur where the alluvium overlie rock outcrops. Gravel and stone are common throughout the profile. Soils are usually dark brown clays. Small siliceous nodules often occur in the subsoil. Below the hills natural erosion occurs (C & D). These soils lie within the floodways of drainage lines. The bottoms of these dongas are typically shallow and overlie gravel and stone. The profile of the soil on the raised sides is deep black or brown cracking clays that are poorly structured.

- Upper slopes and crests (H & I) of hills and mountains, and to some extent raised areas in the floodplains (B), overlie weathered ultramafic rock. They are typically shallow and extremely rocky. The soil texture is predominantly loam on the surface and has a light clay subsoil. Soil colour varies from reddish-brown to brownish-black. On the hills and mountains, narrow alluvial drainage flats occur (K). During the rainy season these soils become eroded due their weak structures. These landforms are basically landfills and are similar to the soils of the floodplains, but not as well developed. Outcrops of chromitite can occur on the crests and upper slopes of hills and mountains (J, L-M). These soils are extremely shallow (< 30 cm) with the bulk of the profile comprised of freshly weathered Cr, Ni and Fe ore, which mask the diffuse change to the parent material.

When the serpentine characteristics of the soils along the catena are compared, topographic positions J, K and M (chromitite outcrop) proved to be most closely related to serpentine, namely with low nutrient levels, high heavy metal levels and a high Mg:Ca ratio (Figure 25; see stippling for catena). Topographic positions E, F, G and H (hill slope) are least related to serpentine, and are possibly more related to the soils of the dolomites of the adjacent Transvaal Sequence. The valleys and erosion gulleys are intermediate between the outcrop and the hill slope.

Diagnostic metals for the soils of the valley and erosion gulleys are Cu, Mn and Ti and include other diagnostic elements, namely S, Cl and Si (Appendix 3; Table 33). Chromitite outcrop soils is characterised by Cr, Ni, Mo and Zn, which are relatively abundant. The valleys, erosion gulleys and chromitite outcrop soils can be distinguished from the mountain slope soils by high concentrations of metals, namely Co, Fe and V, and high levels of Mg (Appendix 3). The chemical composition of the soils on the mountain slope is different in that it has high concentrations of Ca, K, Na and P, and metals such as Al and Pb are abundant.

Scatter diagrams of selected serpentine related chemical attributes were plotted to determine the relationship between heavy metal concentrations, Mg:Ca ratios and nutrient levels for rocks and soils in the study area (Figures 26 & 27):

- *Nutrient levels (%) vs metal concentrations (mg/kg).* For both the rock and soil samples the metal concentrations decreased as nutrient levels increased. This tendency relates directly to rocks with high heavy metal concentrations, because these rocks have lower levels of other elements per square meter of solid rock.

- *Metal concentrations (mg/kg) vs magnesium-calcium ratio (1Mg:xCa).* The tendency in both rocks and soils is that of increasing metal concentrations with increasing Mg levels. This is best explained by the chemical composition of the ultramafic rocks. Soils in close proximity to serpentine related ultramafic rocks will exhibit the same Mg-heavy metal proportion.

- *Magnesium-calcium ratio (1Mg:xCa) vs nutrient levels (%).* Rock and soil analysis show results that are not similar. Rocks show a slight positive, and soils a strong positive relationship between Mg:Ca ratios and nutrient levels. Ca-rich ultramafic soils are poor in nutrients, but in comparison with Mg-rich, serpentine-related substrates they are nutrient rich, hence the strong positive relationship. However, the rock samples are not all ultramafic and some have high Mg and high nutrient levels and others have high Ca and low nutrient levels. This gives rise to a weak positive relationship.

10.3.2.3 Catena analyses

Scatter diagrams of heavy metal, nutrient and Mg/Ca concentrations were plotted on the same y-axis as the topographic positions (metres above valley bottom) of the catena (Figure 25). It is evident that nutrient concentrations are the highest on the mountain slope (E–H). The higher nutrient concentrations occur on the mountain slope, because the rock of the chromitite outcrop is not fully weathered into minerals and the nutrients in the valley has been eroded away with the topsoil. Metal concentrations are highest at positions B, J, L and M and these areas are located above chromitite and magnetitite outcrops which are only partially weathered. The Mg/Ca ratio is lowest at positions E–I along the catena. These areas are also rich in Ca which it obtained from the underlying norite mother material.

Soils from 13 sites (Figure 24) along a catena/transect have been analysed (Appendix 4) to compare specific element levels in the local soils with those of serpentineferous areas in South Africa (Table 34) and the world (Table 35). In the soils of the catena, levels of pH vary from 6.67 to 7.84, total Ni from 81 to 1 133 µg/g, total Cr from 479 to 178 020 µg/g, total Mg from 6.44 to 23.44 %, total Ca from 5.61 to 18.53 % and the Mg:Ca ratio from 0.23 to 2.14 (Table 36).

On a local level (Table 34), the Mg/Ca ratio of Sekhukhuneland soils is much lower than that of serpentineferous areas elsewhere in Mpumalanga (Barberton) (Morrey *et al.* 1989). This is ascribed to the much higher Ca levels in the soils (and rocks) of Sekhukhuneland. K and N levels in the Sekhukhuneland soils are up to twice as high, Na levels are 10 to 20 times as high and C levels are more than twice as high than those measured for serpentines. Minimum levels of Cr and Ni concentrations in the Sekhukhuneland soils are two and 20 times lower respectively. Maximum levels of Ni in the Barberton serpentines are nearly four times higher than what was recorded for the Sekhukhuneland soils, but Cr levels are nearly 50 times higher in the Sekhukhuneland soils. Serpentinite soils therefore only have extreme concentrations of Mg and Ni which are higher than those of the Sekhukhuneland soils. In addition the pH of the Mpumalanga serpentinites are lower than that of the Sekhukhuneland soils.

On a world scale of selected ultramafic sites (Table 35), the Sekhukhuneland soils have low maximum Ni levels, but extremely high maximum levels of Cr. Mg levels in the Sekhukhuneland soils are average, but the Ca levels are two times higher than the average. The Mg:Ca ratio is therefore lower than that of serpentineferous soils, but higher than that of polluted Canadian soils.

10.3.2.4 Plant analyses

The Great Dyke is probably the most well-known serpentineferous area in southern Africa. Average levels of element accumulation by plants of Sekhukhuneland and the Great Dyke (Brooks & Yang 1984) differ in that eight times higher levels of Ni, as well as higher levels of Fe and Mn, were recorded in species of the Great Dyke (Table 36). Six times higher levels of Mg were also recorded for plants of the Great Dyke (Table 36). On the other hand, two times higher Cr levels and nearly three times higher Al levels were recorded for Sekhukhuneland soils. Sekhukhuneland soils have 0.5 times higher Ca levels in plant material.

Twenty plant species were sampled from the catena and analysed, with five dicotyledon species proving to be hyperaccumulators of heavy metals (Appendix 4). Hyperaccumulation was restricted to Fe and Al. *Pterothrix spinescens*, *Jamesbrittenia atropurpurea*, *Dicoma gerrardii*, *Berkheya insignis* and *Euclea linearis* accumulated levels above 1 000 mg/kg of Al and Fe in their leaves, roots and stems. To this list can be added the monocotyledons (grasses) *Diheteropogon amplectens* and *Heteropogon contortus* (10.2.2 Results) (Table 32). The highest levels were recorded in the roots of *Berkheya insignis*. Leaves with the highest Al and Fe levels belong to *Pterothrix spinescens*. Eight species also showed levels of Fe and Al above 500 mg/kg, but below 1 000 mg/kg. These species are all potential hyperaccumulators of Fe and Al (Table 40). *Pterothrix spinescens* also had the highest concentrations of Cr of any plant parts (stem) that were sampled along the catena (420 mg/kg).

In a scatter diagram of the nutrient level versus the metal concentration of all plant material collected along the catena, it is shown that metal uptake increases as the nutrient uptake decreases (Figure 28). It is also shown that the metal concentrations in the plant material increases as the Ca in the plant tissues increases (Figure 28). Ca levels in the plant material was also related to high nutrient levels in the tissue, which probably relates to the mother material on which the species with high Ca levels grow (Figure 28).

A detailed analysis of serpentine associated chemical attributes in plant tissue indicated specific tendencies in each of the three major areas along the catena, namely eroded areas, hill slope and chromitite outcrop (Figure 29; Table 37):

- *Eroded areas.* Scatter diagrams of the Mg:Ca ratios, heavy metal concentrations and nutrient levels in the leaves and roots of species growing in the dongas (erosion gulleys) show tendencies similar to those of the catena as a whole. The only difference was observed in the Mg:Ca ratio versus heavy metal concentration of the root tissues. In this case metal concentrations increased as Ca levels decreased.

- *Hill slope.* Scatter diagrams of the Mg:Ca ratios, heavy metal concentrations and nutrient levels in the leaves and roots of species growing on the hill slope show different tendencies than the catena as a whole. The first difference was observed in the Mg:Ca ratio versus heavy metal concentration of the root tissue. In this case metal concentrations increased as Ca levels decreased. The second difference is found in the metal concentration versus nutrient level scatter diagrams of both the leaves and roots. In these diagrams the metal concentrations increased with those of the nutrient levels.

- *Chromitite outcrop.* Scatter diagrams of the Mg:Ca ratios, heavy metal concentrations and nutrient levels in the roots of species growing on the outcrop show similar tendencies than the catena as a whole. However, leaf tissue shows different tendencies. The Mg:Ca ratio versus heavy metal concentration of the leaf tissue shows an increase in metal concentration with an increase in nutrient levels. In the case of metal concentrations versus the Mg:Ca ratio, Ca levels decreased with increasing metal concentrations. Leaf tissue also exhibit decreasing Ca levels where nutrient levels are high.

10.3.2.5 Plant-soil associations

Soil nutrient levels plotted against plant nutrient levels, soil metal concentrations against plant metal concentrations and soil Mg:Ca ratios against plant Mg:Ca ratios, present graphs with different relations (Figure 30). The results were not expected, as levels in the soil should be reflected in the plant tissue. However, concentrations in plant tissue were related to positions along the catena. Plants growing on the more fertile mountain slopes have higher nutrient levels in their tissue compared to the plants of the eroded areas and the chromitite outcrop. The same trend was observed for the Mg:Ca levels with higher levels of Ca in plants growing on the Ca-rich slopes and higher Mg levels in the plants growing on the Mg-rich soils of the eroded areas and dongas. The scatter diagram of the heavy metal concentrations exhibits a completely different pattern than would be expected. Lower accumulation rates by plants at higher soil metal concentrations of the study sites indicate that these species are excluders. From this graph it is clear that the plants sampled for this study accumulate heavy metals when it occurs at approximately 20–25 mg/kg in the soil, but with increasing soil concentrations the levels in the plant tissue becomes lower and finally, the heavy metals are excluded.

At Cr concentrations of below 5 000 mg/kg in the soil, accumulation by plants in the eroded areas are the highest (Figure 31). This indicates that there are higher levels of available Cr in the dongas (erosion gulleys). Ni concentrations of 400 to 600 mg/kg in the dongas give rise to the highest levels of Ni accumulation by plants (Figure 31), probably also as a result of its availability in these areas.

	2 weeks	3 weeks	4 weeks
Mean leaf length %	97	89	77
Mean root length %	88	95	95
Mean leaf dry mass %	96	94	77
Mean root dry mass %	78	82	88

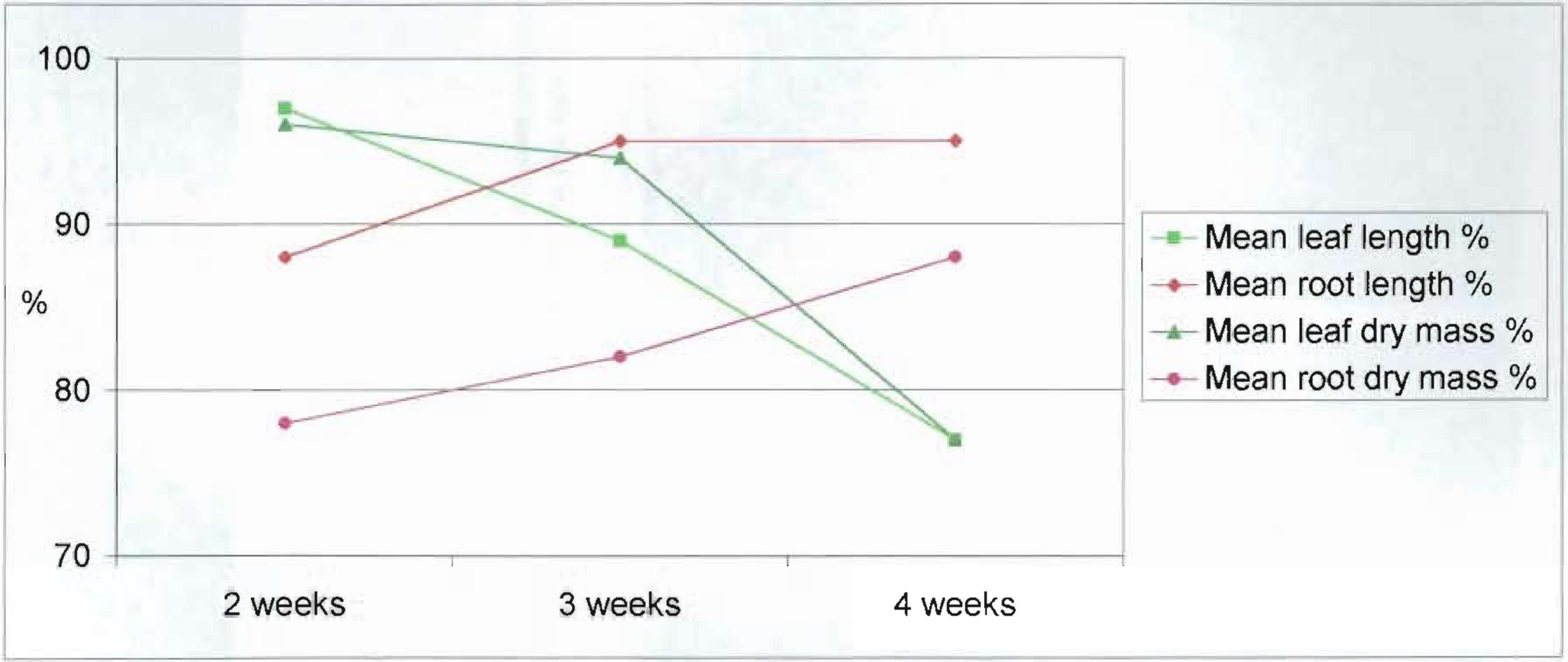


Figure 17 Average biomass production of the roots and leafs of *Zea mays* seedlings grown in an ultramafic soil mixture. The averages are expressed as a percentage of the control.

i). Eight seedlings per pot in quartzite soil (left) and chromium soil (right) after four weeks.

ii). Four seedlings per pot in quartzite soil (left) and chromium soil (right) after four weeks.

iii). Two seedlings per pot in quartzite soil (left) and chromium soil (right) after four weeks.

Figure 18 Interveinal chlorosis and leaf purpling in *Zea mays* as a result of Ni and Cr toxicity respectively (i-iii are different densities of seedlings).

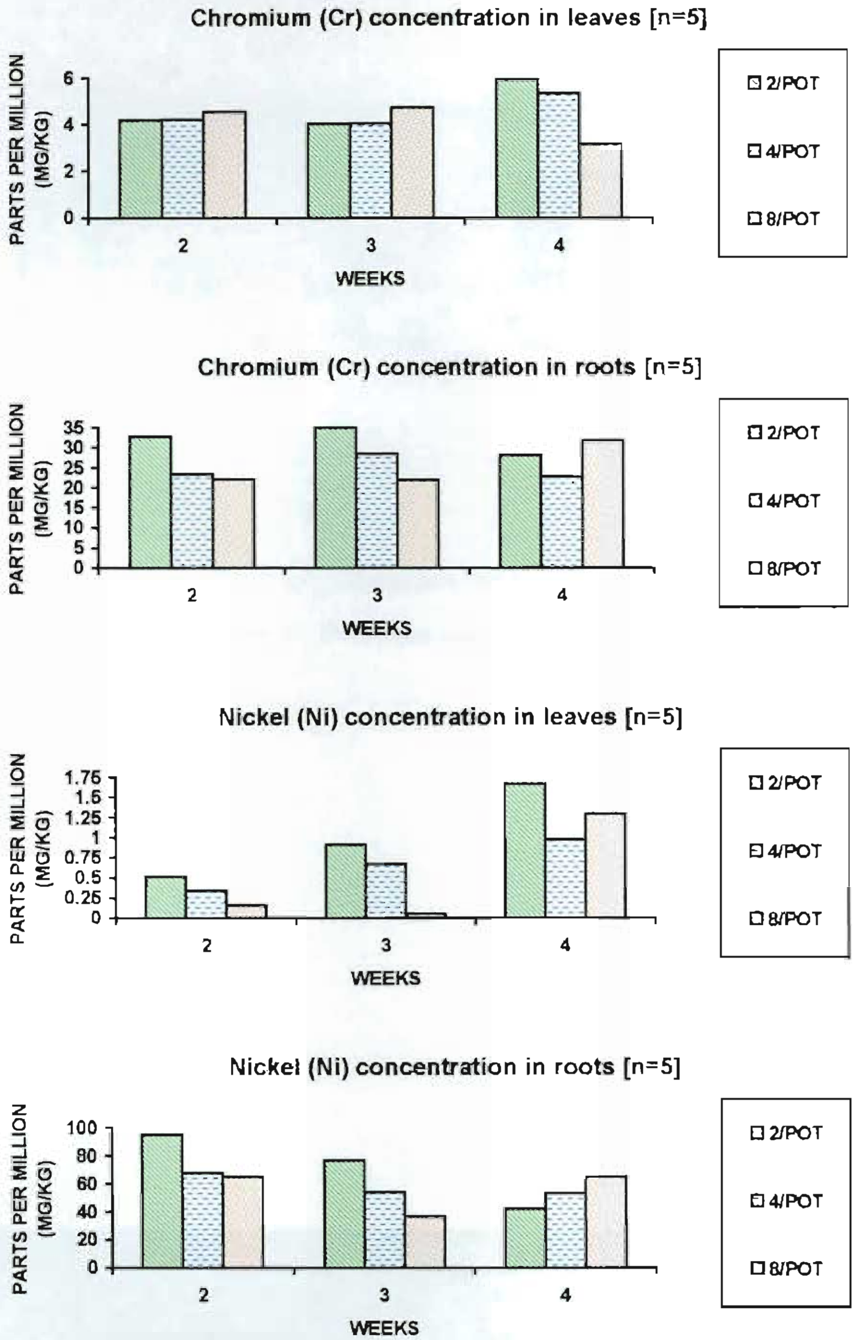


Figure 19 Heavy metal concentrations in the leaves and roots of *Zea mays* seedlings grown at different densities in a chromitite outcrop soil mixture for 2, 3 and 4 weeks respectively.

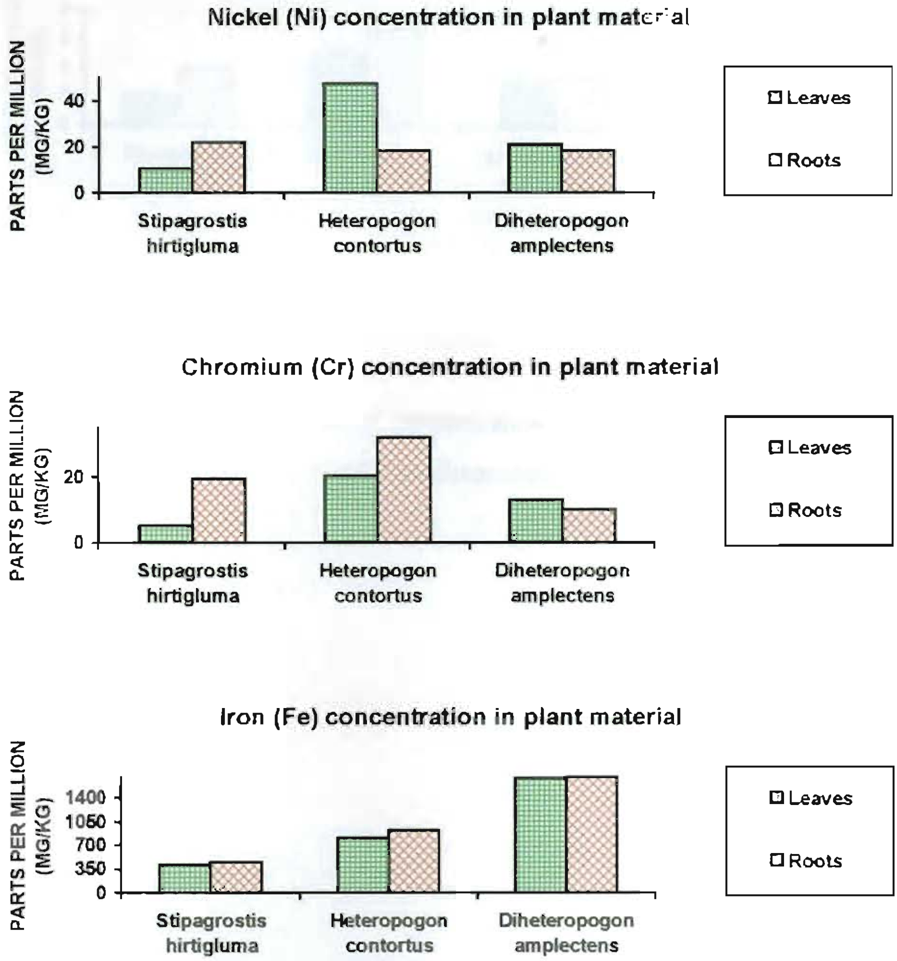


Figure 20 Heavy metal concentrations in the leaves and roots of three indigenous grass species growing naturally on chromitite outcrops.

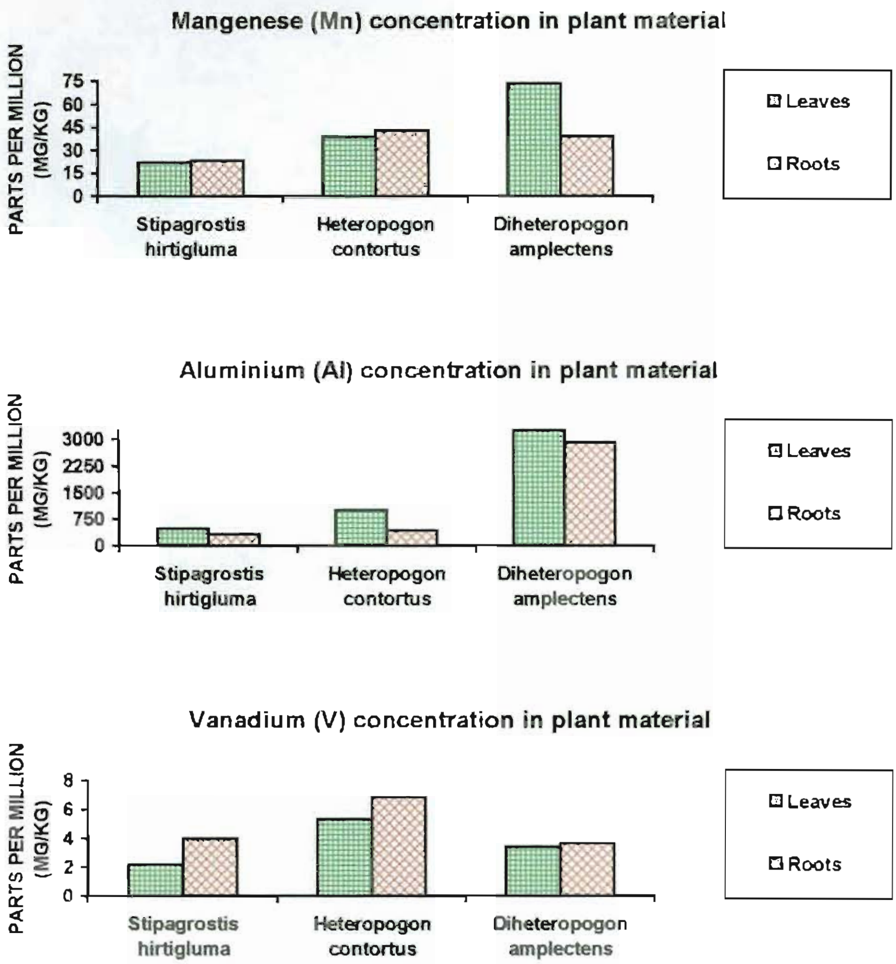
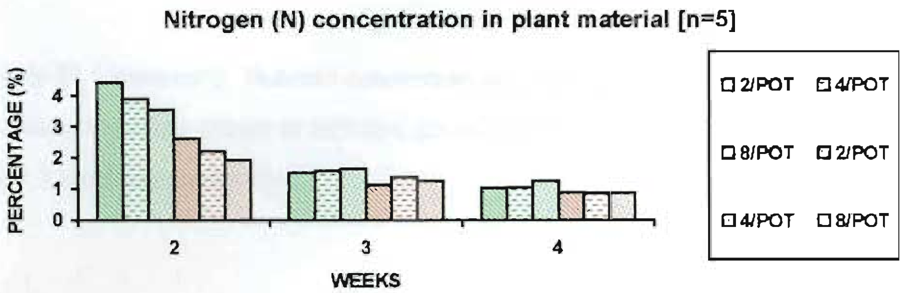
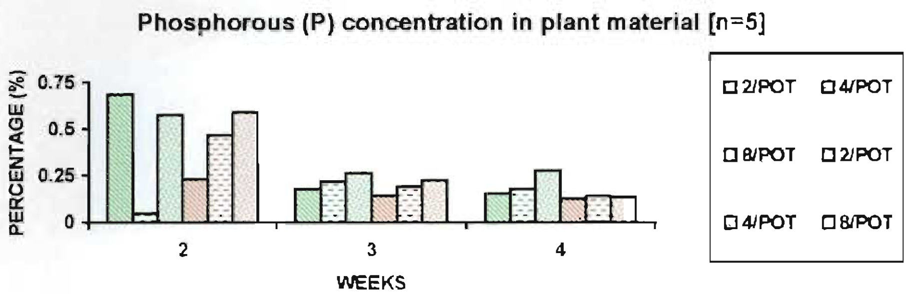


Figure 20 (continued) Heavy metal concentrations in the leaves and roots of three indigenous grasses growing naturally on chromitite outcrops.





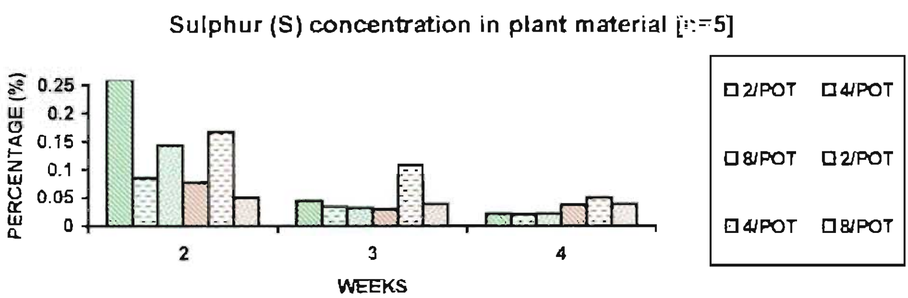
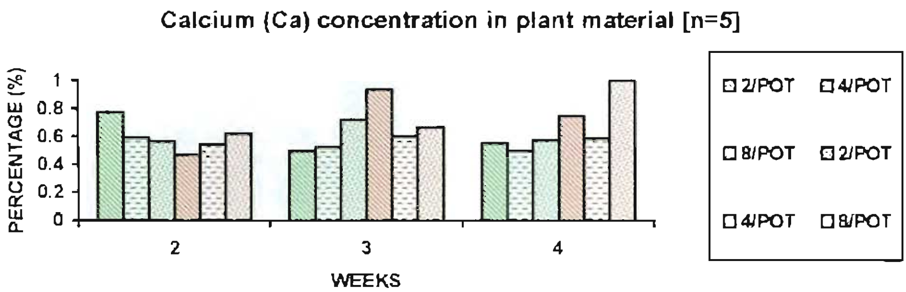


Figure 21 Nutrient concentrations in the leaves (green) and roots (brown) of *Zea mays* seedlings grown at different densities in a chromium outcrop soil mixture for 2, 3 and 4 weeks respectively.



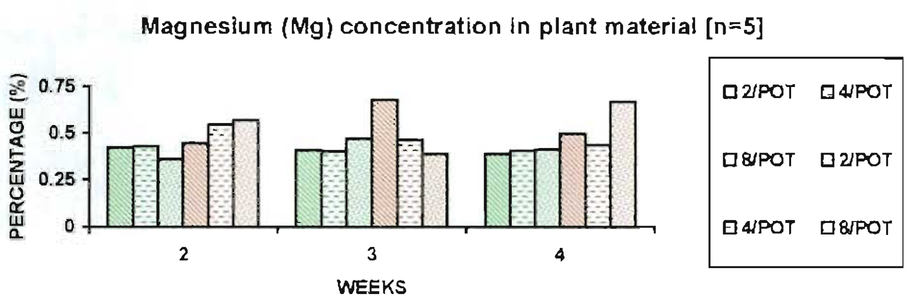


Figure 21 (continued) Nutrient concentrations in the leaves (green) and roots (brown) of *Zea mays* seedlings grown at different densities in a chromium outcrop soil mixture for 2, 3 and 4 weeks respectively.

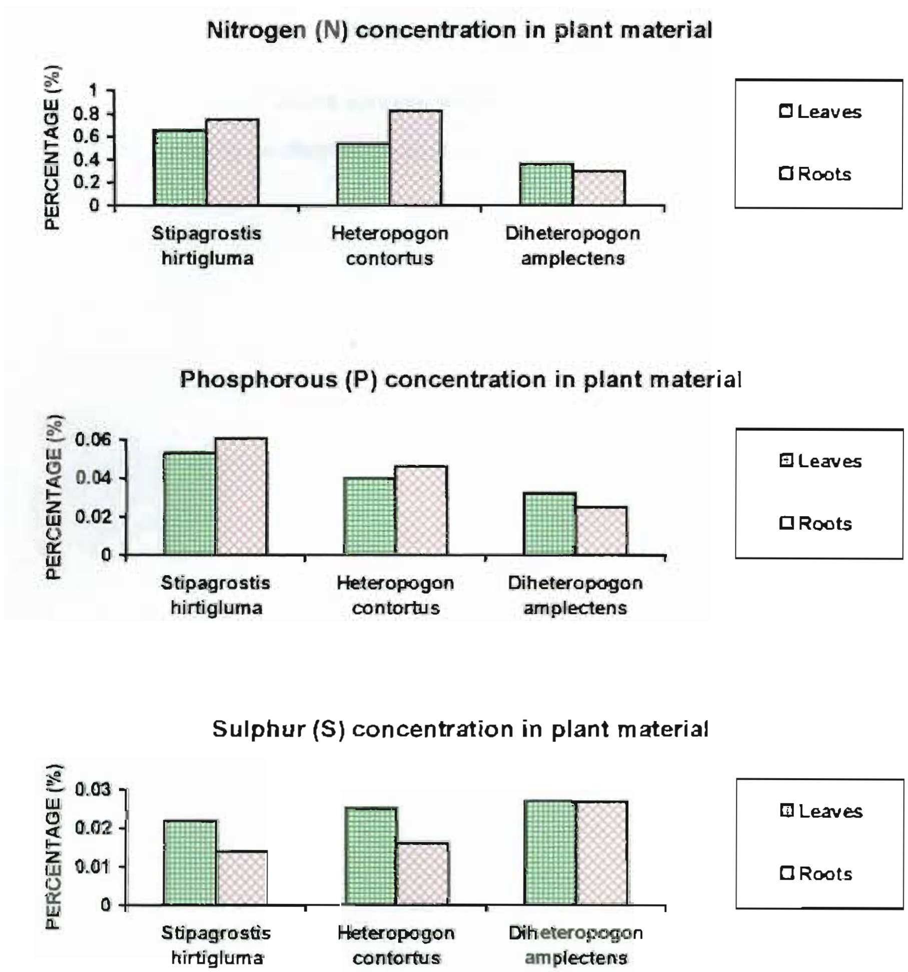
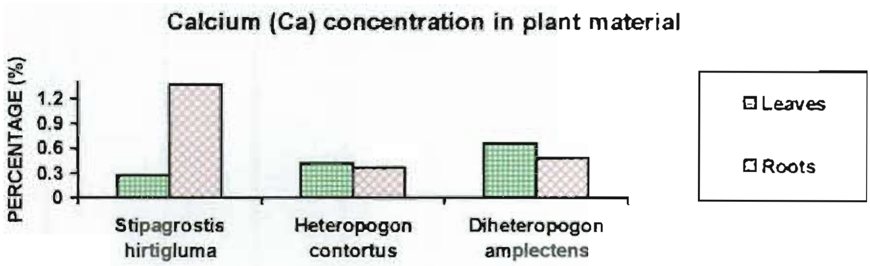


Figure 22 Nutrient concentrations in the leaves and roots of three indigenous grasses growing naturally on chromium outcrops.



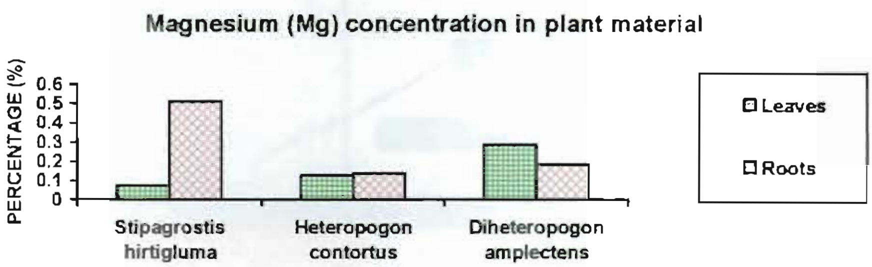


Figure 22 (continued) Nutrient concentrations in the leaves and roots of three indigenous grasses growing naturally on chromium outcrops.

	Mg:Ca Ratio
I	34.52
II	18.2
III	14
IV	9.84
V	3.68
VI	1.33
VII	1.3
VIII	1.13
IX	1.03
X	0.9
XI	0.47
XII	0.45
XIII	0.18

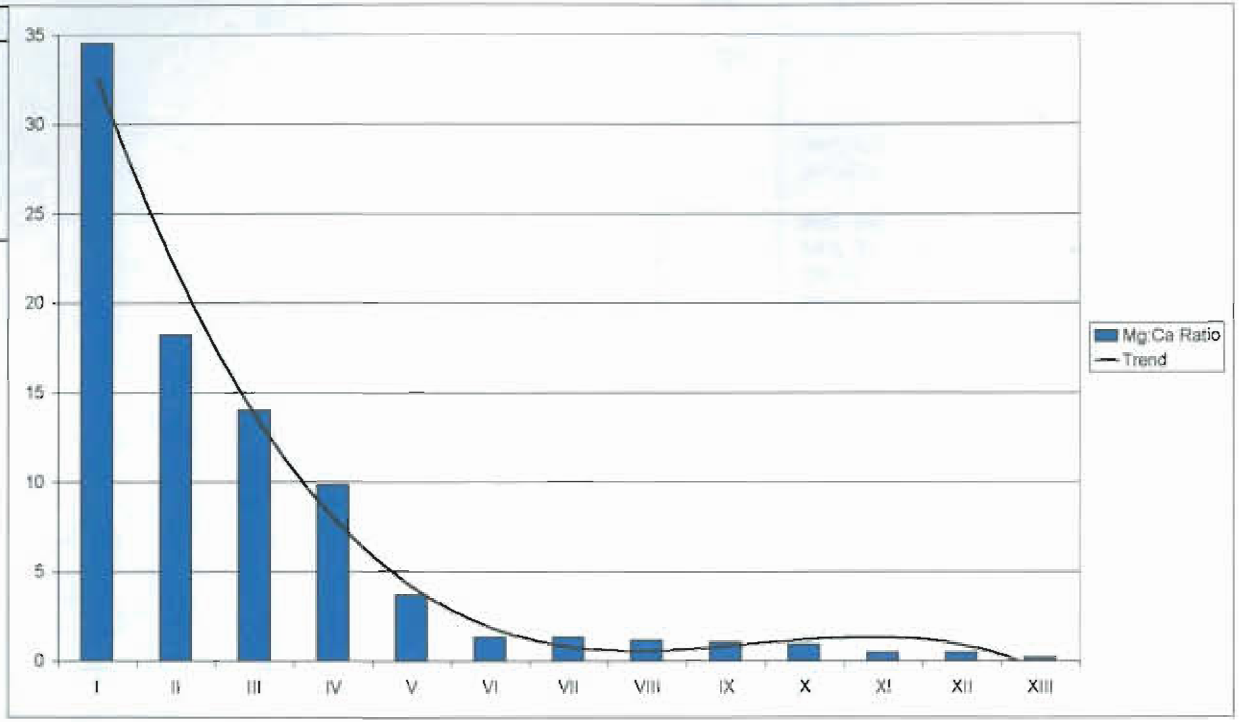


Figure 23 Analysed rocks were sorted according to their Mg:Ca ratio (as an idication of the serpentine gradient), with Green Valley serpentine left (A, Mg:Ca ratio = 34.52) and Leolo Mountain norite right (M, Mg:Ca ratio = 0.18). This gradient was used for the bar graphs in Appendix 2.

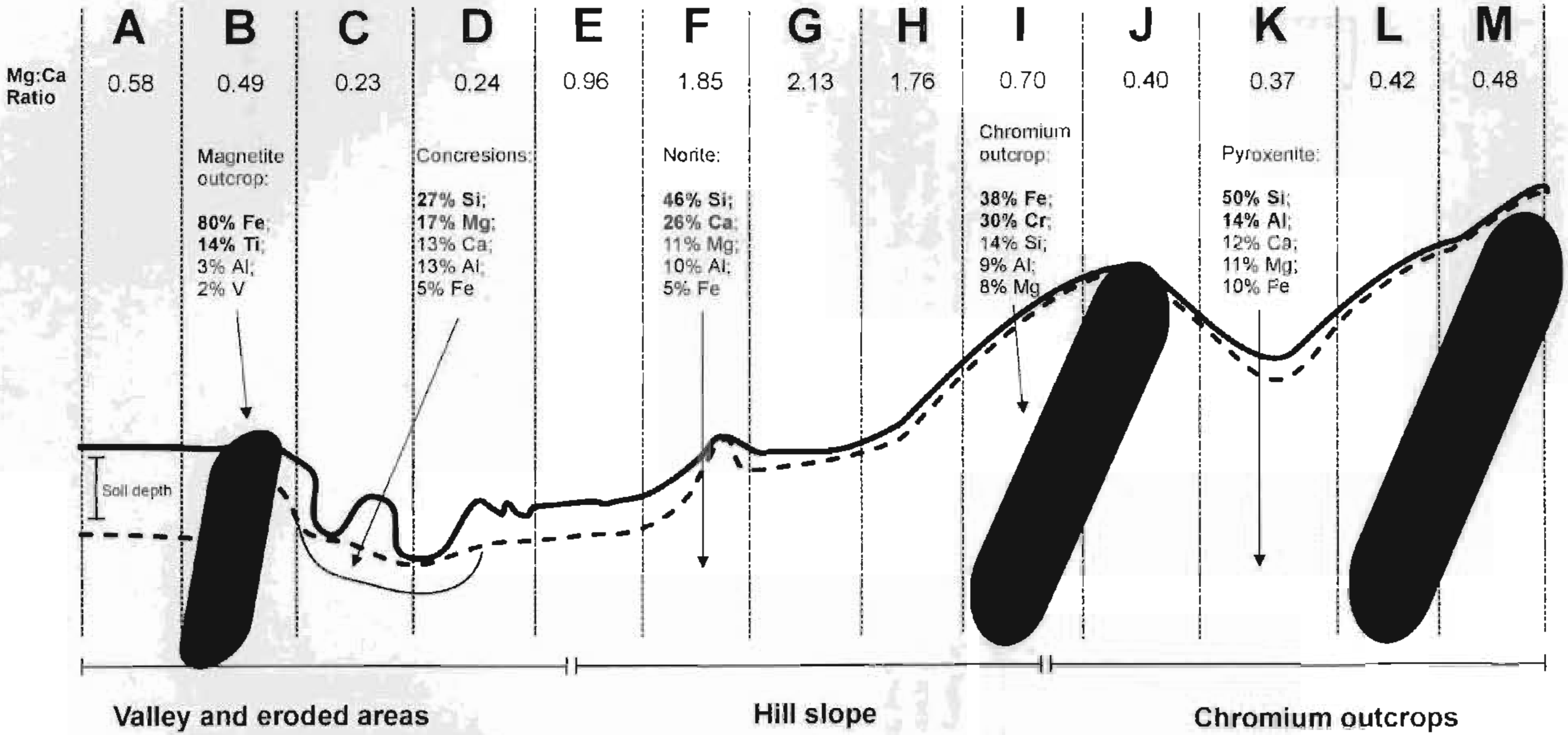
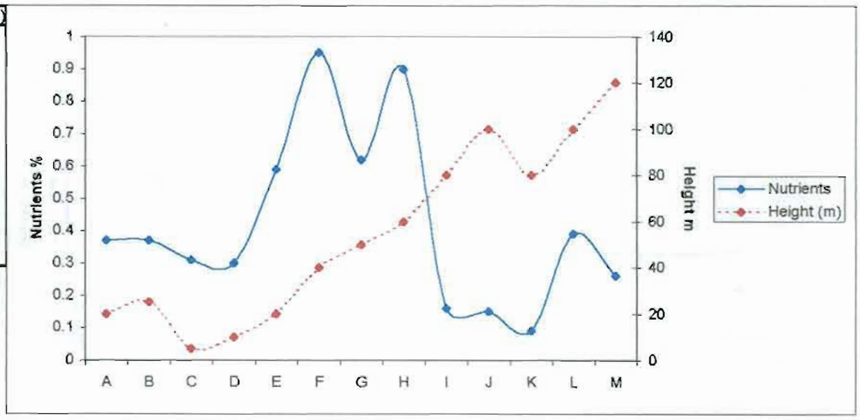
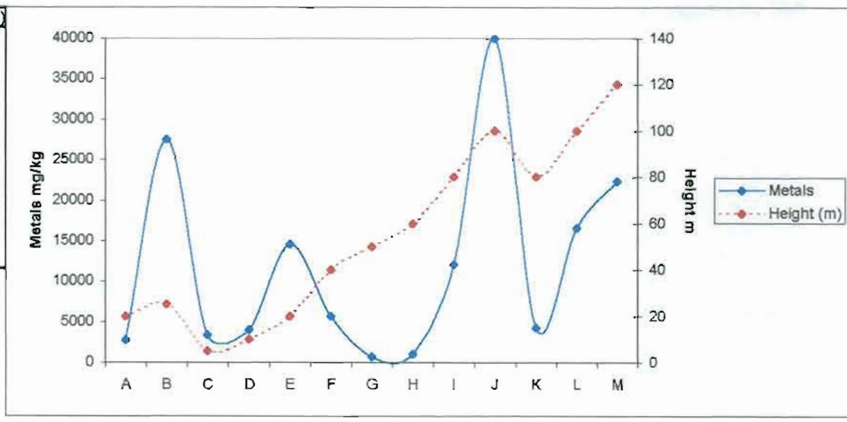


Figure 24 Transect of a catena in the Sekhukhuneland Centre of Plant Endemism with associated underlying rock.

	Nutrients	Height (m)
A	0.37	20
B	0.37	25
C	0.31	5
D	0.3	10
E	0.59	20
F	0.95	40
G	0.62	50
H	0.9	60
I	0.16	80
J	0.15	100
K	0.09	80
L	0.39	100
M	0.26	120



	Metals	Height (m)
A	2794	20
B	27521	25
C	3383	5
D	3994	10
E	14578	20
F	5650	40
G	727	50
H	1050	60
I	12066	80
J	40000	100
K	4287	80
L	16569	100
M	22339	120



	Mg:Ca	Height (m)
A	0.58	20
B	0.49	25
C	0.23	5
D	0.24	10
E	0.96	20
F	1.85	40
G	2.14	50
H	1.73	60
I	0.7	80
J	0.4	100
K	0.37	80
L	0.42	100
M	0.48	120

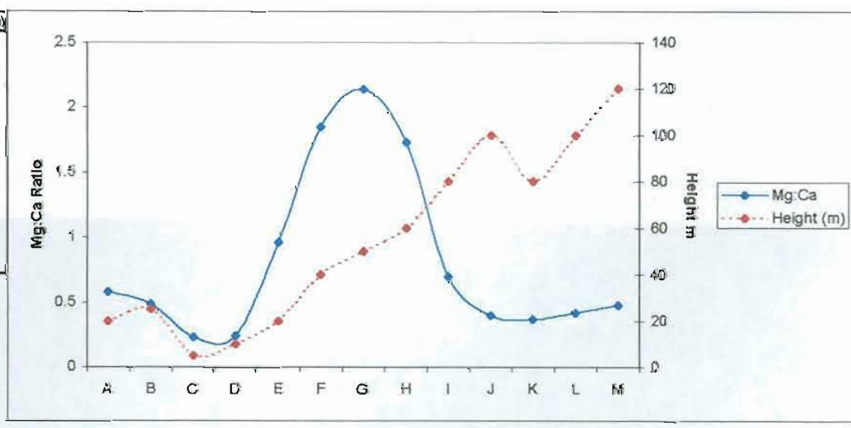
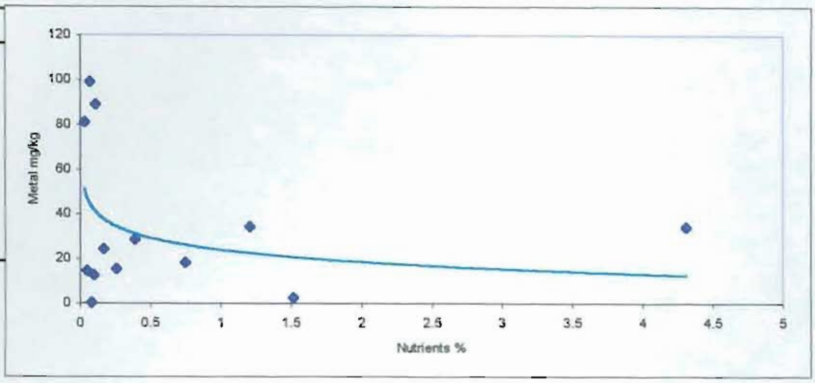
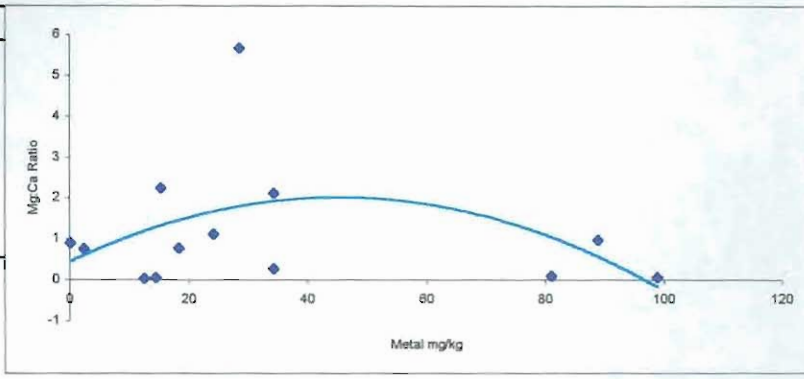


Figure 25 Topographic based distribution of the nutrient levels, heavy metal concentrations and Mg:Ca ratios along the catena (stippling; see Figure 24 for an explanation of A to M). These graphs summarise the results obtained from the soil analysis.

Nutrients %	Metals mg/kg
0.1	12.6
0.05	14.53
0.07	99.01
0.03	81.12
4.31	34.4
1.52	2.45
0.75	18.45
0.08	0.22
0.11	88.95
0.17	24.23
1.21	34.4
0.26	15.43
0.39	28.68



Metals mg/kg	Mg:Ca Ratio
12.6	0.03
14.53	0.05
99.01	0.07
81.12	0.1
34.4	0.27
2.45	0.75
18.45	0.77
0.22	0.89
88.95	0.97
24.23	1.11
34.4	2.11
15.43	2.24
28.68	5.67



Mg:Ca Ratio	Nutrients %
0.03	0.1
0.05	0.05
0.07	0.07
0.1	0.03
0.27	2
0.75	1.52
0.77	0.75
0.89	0.08
0.97	0.11
1.11	0.17
2.11	1.21
2.24	0.26
5.67	0.39

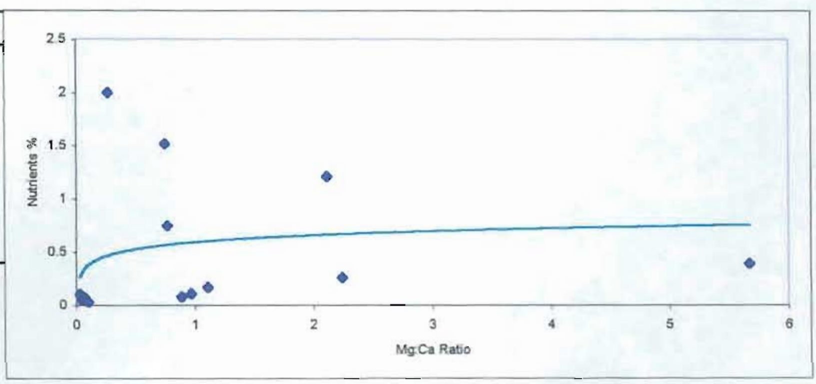


Figure 26 Ordination of selected chemical attributes of the rocks sampled in the Sekhukhuneland Centre of Plant Endemism.

Nutrients %	Metals mg/kg
0.37	23.9
0.37	31.9
0.31	18.4
0.3	17.2
0.59	26.2
0.95	20.5
0.62	14.7
0.9	22.2
0.16	22.8
0.15	52.8
0.09	20.2
0.39	24.8
0.26	20.4

Metals mg/kg	Mg:Ca Ratio
23.9	0.58
31.9	0.49
18.4	0.23
17.2	0.24
26.2	0.96
20.5	1.85
14.7	2.14
22.2	1.73
22.8	0.7
52.8	0.4
20.2	0.37
24.8	0.42
20.4	0.48

Mg:Ca Ratio	Nutrients %
0.58	0.37
0.49	0.37
0.23	0.31
0.24	0.3
0.96	0.59
1.85	0.95
2.14	0.62
1.73	0.9
0.7	0.16
0.4	0.15
0.37	0.09
0.42	0.39
0.48	0.26

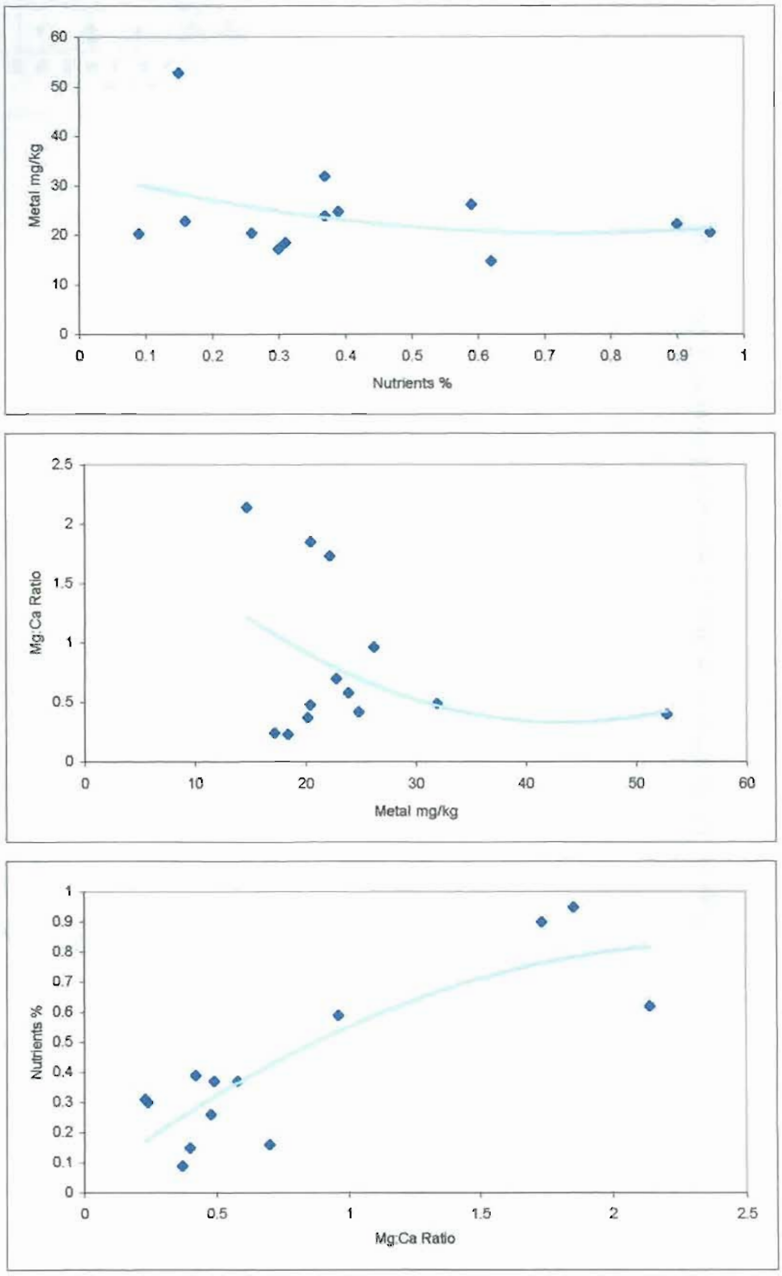


Figure 27 Ordination of selected chemical attributes of the soils sampled along the catena in the study area.

		Nutrient levels	Metal levels	Metal levels	Mg:Ca ratio	Mg:Ca ratio	Nutrient levels
Es	L	5.616	187.1	187.1	15.29	15.29	5.616
Es	R	5.82	946.7	946.7	35.4	35.4	5.82
Ps	L	2.302	9388.8	9388.8	13.43	13.43	2.302
Ps	S	4.792	7642.5	7642.5	54.2	54.2	4.792
Ps	R	3.313	1520.05	1520.05	34	34	3.313
Rk	L	2.813	254.79	254.79	14.76	14.76	2.813
Rk	R	2.228	1382.46	1382.46	27.6	27.6	2.228
Ja	L	3.823	2717.52	2717.52	16.7	16.7	3.823
Ja	R	1.666	2251.28	2251.28	14.34	14.34	1.666
Dg	L	3.203	5611.9	5611.9	15.44	15.44	3.203
Dg	R	1.41	2462.9	2462.9	11.04	11.04	1.41
Pn	L	3.954	248.08	248.08	16.22	16.22	3.954
Pn	R	1.198	614.6	614.6	4.03	4.03	1.198
Bi	L	2.678	328.71	328.71	7.01	7.01	2.678
Bi	R	2.414	989.95	989.95	13.33	13.33	2.414
El	L	4.854	293.59	293.59	60.88	60.88	4.854
El	S	2.897	275.24	275.24	41.32	41.32	2.897
El	R	3.238	2190.57	2190.57	50.24	50.24	3.238
Ib	L	5.453	339.04	339.04	19.64	19.64	5.453
Ib	R	7.027	991.03	991.03	89.3	89.3	7.027
Bs	L	4.761	1398.65	1398.65	86.25	86.25	4.761
Bs	S	1.99	492.18	492.18	23.7	23.7	1.99
Bs	R	4.307	10094.6	10094.6	37.93	37.93	4.307
Rb	L	3.149	383.81	383.81	24.55	24.55	3.149
Rb	S	1.986	226.47	226.47	21.33	21.33	1.986
Rb	R	1.896	1483.93	1483.93	30.23	30.23	1.896
Tr	L	4.257	503.96	503.96	17.1	17.1	4.257
Tr	R	2.072	850.66	850.66	31.23	31.23	2.072
Lc	L	6.563	363.01	363.01	2.6	2.6	6.563
Lc	S	1.112	171.13	171.13	1.75	1.75	1.112
Lc	R	4.11	1152.64	1152.64	12.61	12.61	4.11
Of	L	4.511	388.39	388.39	3.59	3.59	4.511
Of	S	1.484	321.15	321.15	3.02	3.02	1.484
Of	R	2.437	995.31	995.31	5.85	5.85	2.437
Tp	L	5.246	272.02	272.02	10.43	10.43	5.246
Tp	S	10.485	288.55	288.55	80.99	80.99	10.485
Tp	R	6.398	648.19	648.19	22.76	22.76	6.398
Po	L	7.196	146.64	146.64	4.78	4.78	7.196
Po	S	3.734	143.23	143.23	60.76	60.76	3.734
Po	R	7.502	507.67	507.67	13.96	13.96	7.502
Ct	L	3.36	139.86	139.86	4.7	4.7	3.36
Ct	S	3.884	127.95	127.95	23.55	23.55	3.884
Ct	R	4.673	1174.94	1174.94	29.48	29.48	4.673

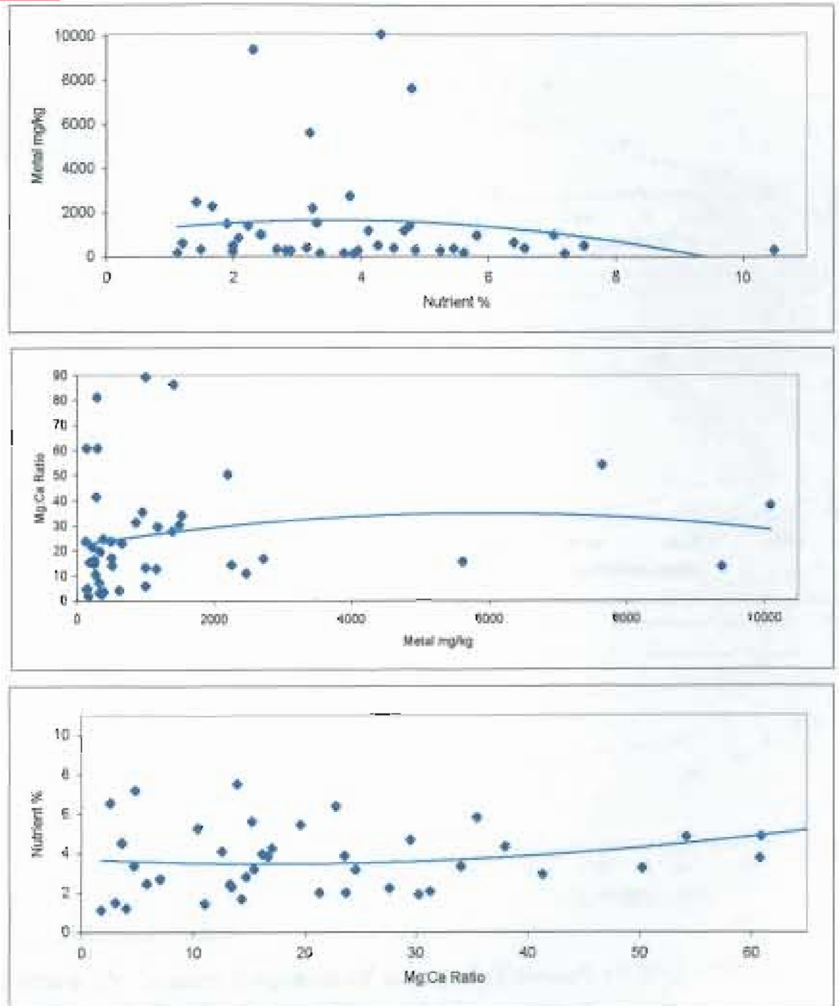
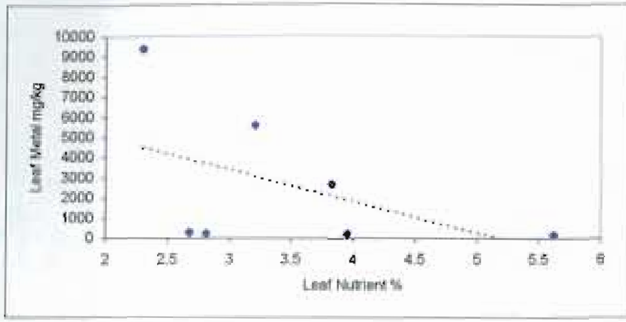
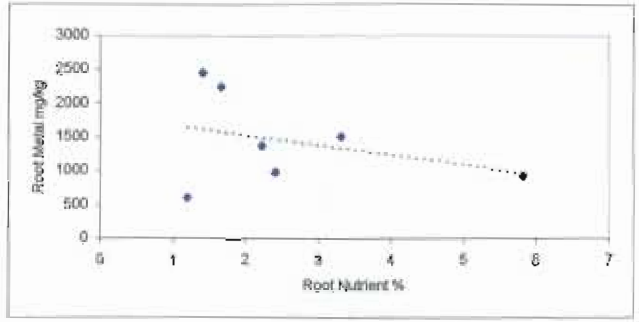


Figure 28 Scatter diagrams of selected chemical attributes of plant material collected along the catena in the study area.

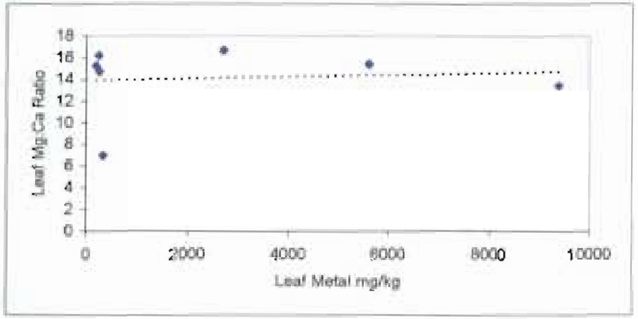
Eroded areas (Figure 29; part I)

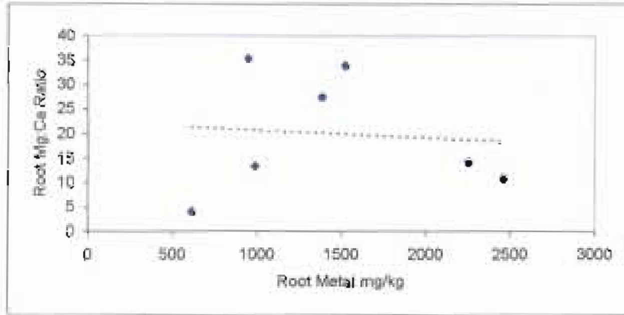
		Nutrient %	Metals mg/kg
Bl	L	2.678	328.71
Dg	L	3.203	5611.9
Es	L	5.616	187.1
Ja	L	3.823	2717.52
Pn	L	3.954	248.08
Ps	L	2.302	9388.8
Rk	L	2.813	254.79
Bl	R	2.414	989.95
Dg	R	1.41	2462.9
Es	R	5.82	946.7
Ja	R	1.686	2251.28
Pn	R	1.198	614.6
Ps	R	3.313	1520.05
Rk	R	2.228	1382.46



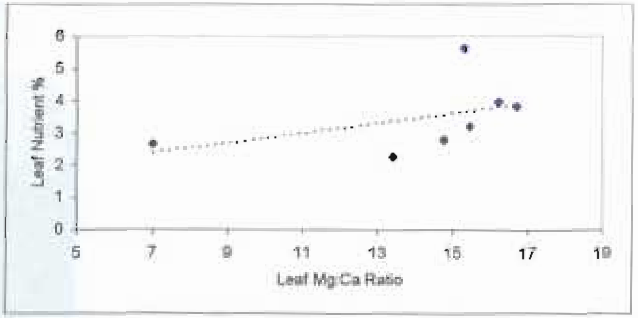


		Metals mg/kg	Mg:Ca 1:x
Bl	L	328.71	7.01
Dg	L	5611.9	15.44
Es	L	187.1	15.29
Ja	L	2717.52	16.7
Pn	L	248.08	16.22
Ps	L	9388.8	13.43
Rk	L	254.79	14.76
Bl	R	989.95	13.33
Dg	R	2462.9	11.04
Es	R	946.7	35.4
Ja	R	2251.28	14.34
Pn	R	614.6	4.03
Ps	R	1520.05	34
Rk	R	1382.46	27.6





		Mg:Ca 1:x	Nutrient %
Bl	L	7.01	2.678
Dg	L	15.44	3.203
Es	L	15.29	5.616
Ja	L	16.7	3.823
Pn	L	16.22	3.954
Ps	L	13.43	2.302
Rk	L	14.76	2.813
Bl	R	13.33	2.414
Dg	R	11.04	1.41
Es	R	35.4	5.82
Ja	R	14.34	1.686
Pn	R	4.03	1.198
Ps	R	34	3.313
Rk	R	27.6	2.228



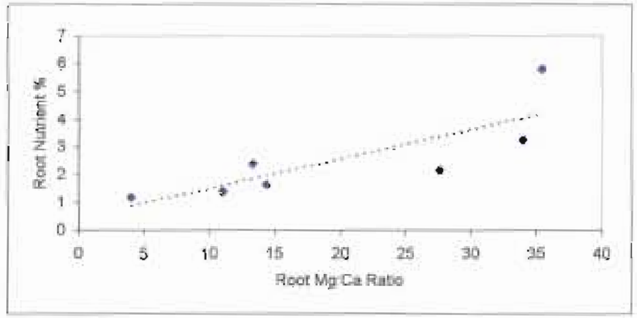


Figure 29 Scatter diagrams of selected chemical attributes of leaf and root material collected along the eroded areas, hill slope and chromitite outcrops of the catena (see Figure 24 for sampling points).

Hill slope (Figure 29; part II)

		Nutrient %	Metals mg/kg
Bs	L	4.761	1398.65
El	L	4.854	293.59
Ib	L	5.453	339.04
Rb	L	3.149	383.81
Tr	L	4.257	503.96
Bs	R	4.307	10094.6
El	R	3.238	2190.57
Ib	R	7.027	991.03
Rb	R	1.896	1483.93
Tr	R	2.072	850.66

		Metals mg/kg	Mg:Ca 1:x
Bs	L	1398.65	86.25
El	L	293.59	60.88
Ib	L	339.04	19.64
Rb	L	383.81	24.55
Tr	L	503.96	17.1
Bs	R	10094.6	37.93
El	R	2190.57	50.24
Ib	R	991.03	89.3
Rb	R	1483.93	30.23
Tr	R	850.66	31.23

		Mg:Ca 1:x	Nutrient %
Bs	L	86.25	4.761
El	L	60.88	4.854
Ib	L	19.64	5.453
Rb	L	24.55	3.149
Tr	L	17.1	4.257
Bs	R	37.93	4.307
El	R	50.24	3.238
Ib	R	89.3	7.027
Rb	R	30.23	1.896
Tr	R	31.23	2.072

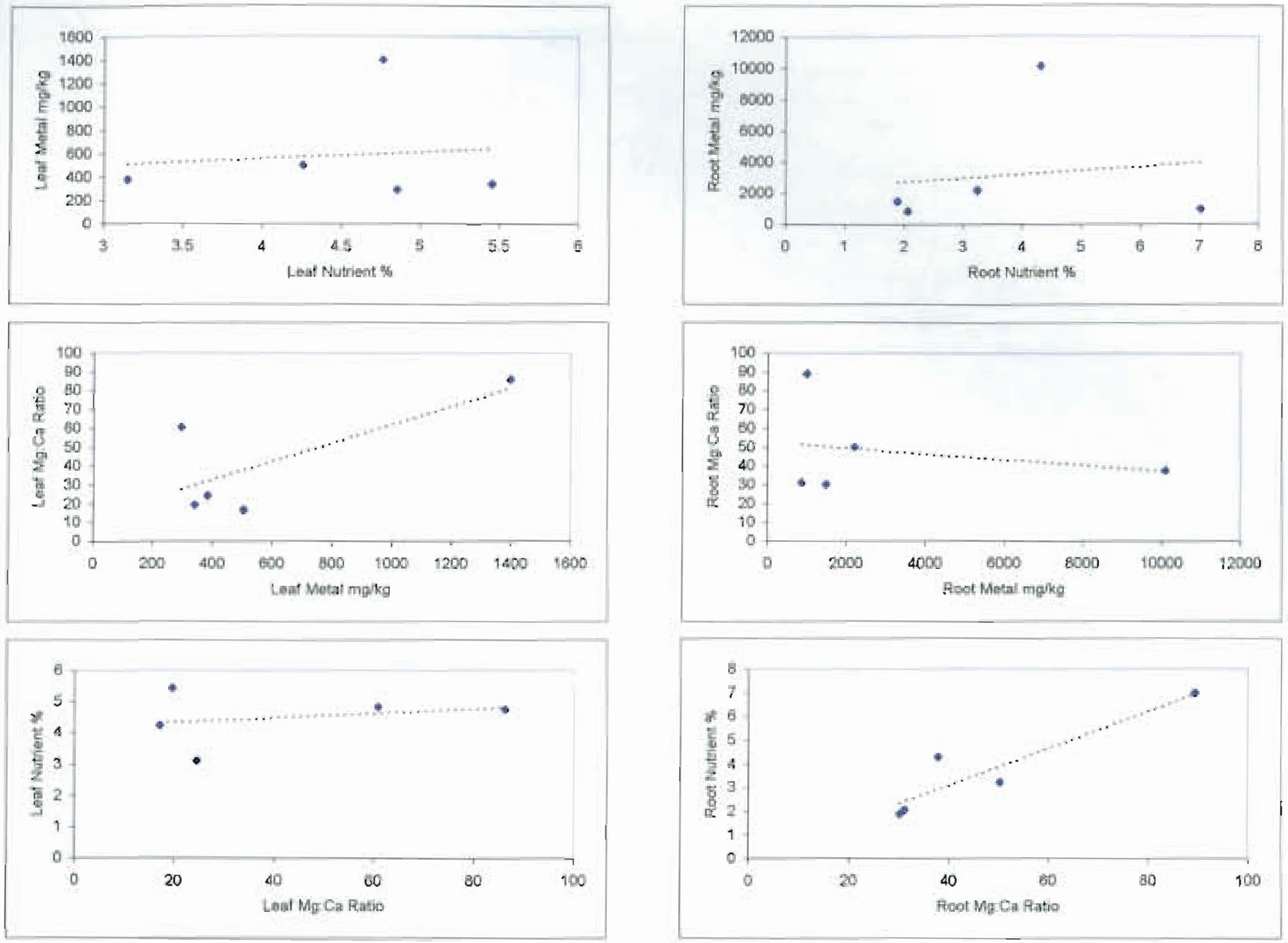


Figure 29 continued. Scatter diagrams of selected chemical attributes of leaf and root material collected along the eroded areas, hill slope and chromitite outcrops of the catena (see Figure 24 for sampling points).

Chromitite outcrops (Figure 29; part III)

		Nutrient %	Metals mg/kg
Ct	L	3.36	139.86
Lc	L	6.563	363.01
Of	L	4.511	388.39
Po	L	7.196	146.64
Tp	L	5.246	272.02
Ct	R	4.673	1174.94
Lc	R	4.11	1152.64
Of	R	2.437	995.31
Po	R	7.502	507.67
Tp	R	6.398	648.19

		Metals mg/kg	Mg:Ca 1:x
Ct	L	139.86	4.7
Lc	L	363.01	2.6
Of	L	388.39	3.59
Po	L	146.64	4.78
Tp	L	272.02	10.43
Ct	R	1174.94	29.48
Lc	R	1152.64	12.61
Of	R	995.31	5.85
Po	R	507.67	13.96
Tp	R	648.19	22.76

		Mg:Ca 1:x	Nutrient %
Ct	L	4.7	3.36
Lc	L	2.6	6.563
Of	L	3.59	4.511
Po	L	4.78	7.196
Tp	L	10.43	5.246
Ct	R	29.48	4.673
Lc	R	12.61	4.11
Of	R	5.85	2.437
Po	R	13.96	7.502
Tp	R	22.76	6.398

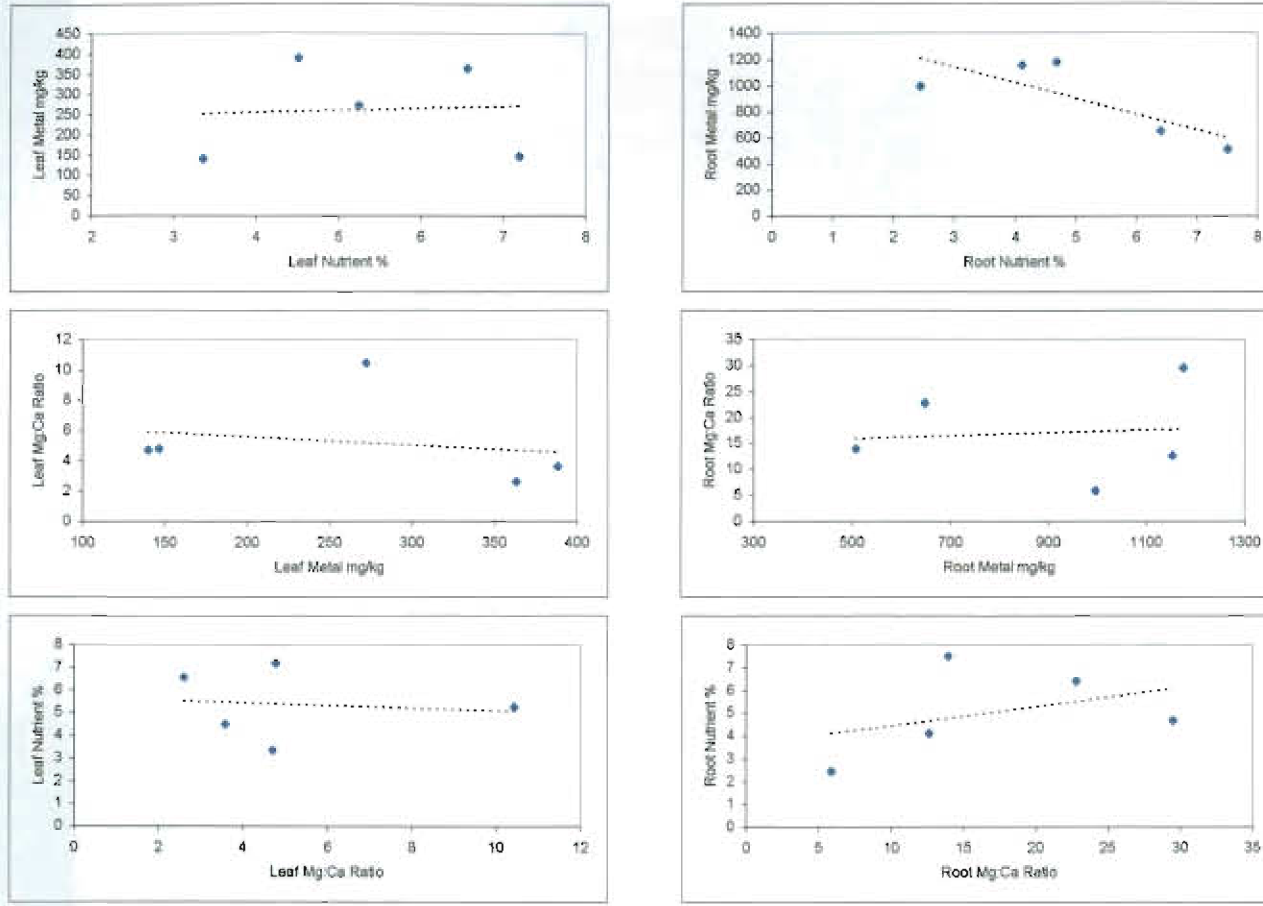


Figure 29 continued. Scatter diagrams of selected chemical attributes of leaf and root material collected along the eroded areas, hill slope and chromitite outcrops of the catena (see Figure 24 for sampling points).

		Soil Nutrients	Plant Nutrients	Soil Metals	Plant Metals	Soil Mg:Ca	Plant Mg:Ca
Es	L	0.37	5.616	23.9	187.1	0.56	15.29
Es	R	0.37	6.82	23.9	946.7	0.56	35.4
Ps	L	0.3	2.302	23.9	9388.6	0.24	13.43
Ps	S	0.3	4.792	23.9	7642.5	0.24	54.2
Ps	R	0.3	3.313	23.9	1520.06	0.24	34
Rk	L	0.37	2.813	18.4	254.79	0.23	14.76
Rk	R	0.37	2.228	18.4	1382.46	0.23	27.6
Ja	L	0.31	3.823	31.9	2717.52	0.49	16.7
Ja	R	0.31	1.666	31.9	2251.28	0.49	14.34
Dg	L	0.3	3.203	23.9	5611.9	0.24	15.44
Dg	R	0.3	1.41	23.9	2462.9	0.24	11.04
Pn	L	0.31	3.954	31.9	248.08	0.49	16.22
Pn	R	0.31	1.198	31.9	614.6	0.49	4.03
Bi	L	0.37	2.678	17.2	328.71	0.58	7.01
Bi	R	0.37	2.414	17.2	989.96	0.58	13.33
El	L	0.59	4.854	20.5	293.59	0.96	60.88
El	S	0.59	2.897	20.5	275.24	0.96	41.32
El	R	0.59	3.238	20.5	2190.57	0.96	50.24
Ib	L	0.95	5.453	26.2	339.04	1.85	19.64
Ib	R	0.95	7.027	26.2	991.03	1.85	89.3
Be	L	0.62	4.761	14.7	1398.65	2.14	86.25
Be	S	0.62	1.99	14.7	492.18	2.14	23.7
Be	R	0.62	4.307	14.7	10094.6	2.14	37.93
Rb	L	0.9	3.149	22.2	383.81	1.73	24.55
Rb	S	0.9	1.986	22.2	226.47	1.73	21.33
Rb	R	0.9	1.896	22.2	1483.93	1.73	30.23
Tr	L	0.16	4.257	22.8	503.96	0.69	17.1
Tr	R	0.16	2.072	22.8	850.68	0.69	31.23
Lc	L	0.15	6.563	42.8	383.01	0.4	2.6
Lc	S	0.15	1.112	42.8	171.13	0.4	1.75
Lc	R	0.15	4.11	42.8	1152.64	0.4	12.61
Of	L	0.09	4.511	20.2	388.39	0.48	3.69
Of	S	0.09	1.484	20.2	321.15	0.48	3.02
Of	R	0.09	2.437	20.2	995.31	0.48	5.65
Tp	L	0.39	5.246	24.8	272.02	0.37	10.43
Tp	S	0.39	10.485	24.8	288.55	0.37	80.99
Tp	R	0.39	6.398	24.8	648.19	0.37	22.76
Po	L	0.26	7.196	20.4	146.64	0.48	4.78
Po	S	0.26	3.734	20.4	143.23	0.48	6.76
Po	R	0.26	7.502	20.4	507.67	0.48	13.96
Ct	L	0.15	3.36	42.8	139.86	0.42	4.7
Ct	S	0.15	3.884	42.8	127.96	0.42	23.55
Ct	R	0.15	4.673	42.8	1174.94	0.42	29.48

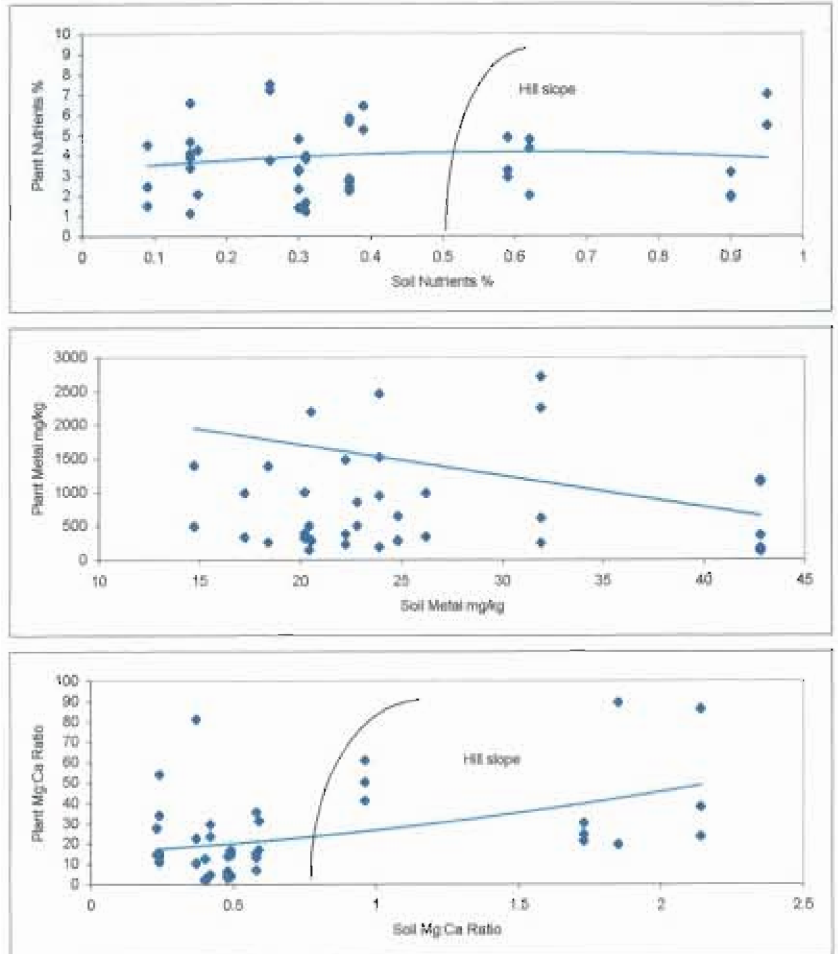


Figure 30 Scatter diagrams depicting the trends of selected chemical attributes in plant-soil associations.

Species (n=5)	Cr mg/kg Plant	Cr mg/kg Soil	Position	Ni mg/kg Plant	Ni mg/kg Soil
Ea	17.6	3272	D	16.1	506
Ps	60	2641	C	30	529
Rk	7.5	2214	A	4.3	321
Ja	23.9	3272	D	21.3	506
Dg	51.2	2641	C	24.5	529
Pn	7.1	26238	B	5.4	401
Bl	11.6	2214	A	16.4	321
El	6.6	14102	E	10	201
Ib	6.6	10824	I	12	1028
Bs	11.4	5283	F	7	122
Rb	8	479	G	4.9	81
Tr	24.5	724	H	12.9	114
Lc	4.7	2937	K	2.3	1133
Of	5.5	15671	L	2.1	646
Tp	5.9	21206	M	3.9	812
Po	4.3	15671	L	6.9	646
Ct	3.9	30000	J	3	930

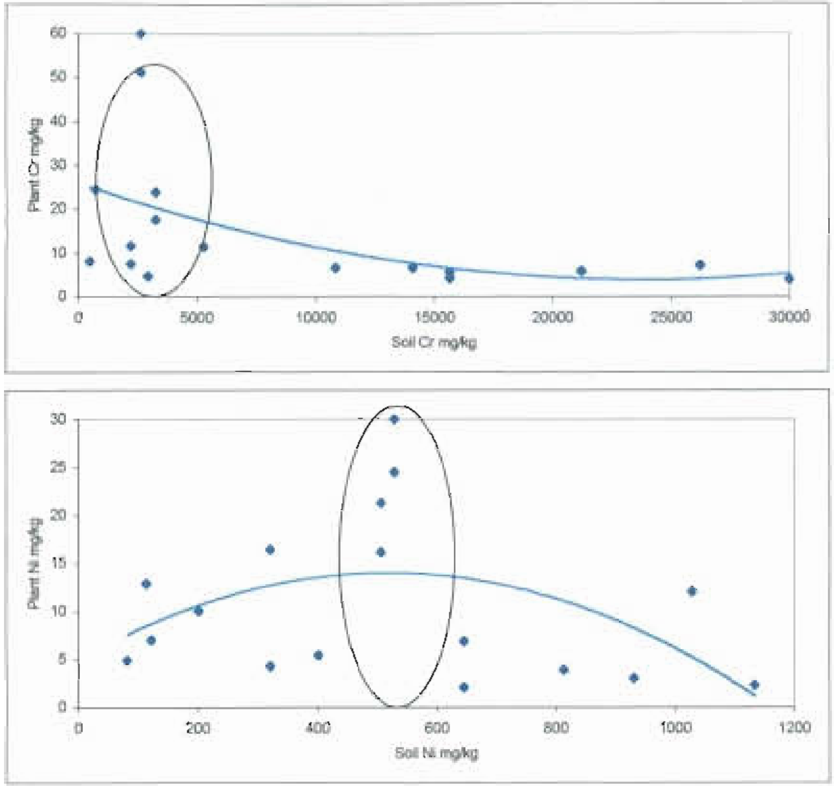


Figure 31 Scatter diagram depicting the optimum accumulation levels of nickel and chromium by plants along the catena.

Table 29 Concentrations of selected elements in the chromitite outcrop soil mixture.

Element	mg/kg (n=25)	Mineral	% (n=25)
Cr	45732	SiO_2	36.48
Ni	910	MgO	17.26
S	392	Fe_2O_3	13.75
V	340	Al_2O_3	8.42
Cl	143	CaO	7.76
Sr	137	Cr_2O_3	7.31
Zn	117	Na_2O	0.88
Co	107	TiO_2	0.23
Zr	33	NiO	0.21
Cu	25	MnO	0.20
Ga	22	K_2O	0.15
W	20	V_2O_5	0.07
Sc	14	P_2O_5	0.02
Y	9		
Pb	7	Mg:Ca Ratio	
Rb	7		
As	6	= 17.26	: 7.76
Mo	4	= 1	: 0.45
Nb	3	= 2.22	: 1
Th	2		

Table 30 Growth comparison of seedlings of *Zea mays* (cultivar SNK 2340 Vryburg) grown in neutral quartzite soil and natural chromium-rich soil [n=3].

	Quartzite soil			Chromium-rich soil			%*
Plants/container	2	4	8	2	4	8	
Week 2							
Average leaf length (mm)	286	304	270	283 (99%)	300 (99%)	254 (94%)	97
Average root length (mm)	238	271	256	220 (92%)	245 (90%)	208 (81%)	88
Average leaf dry mass (mg)	174	189	158	160 (92%)	188 (99%)	152 (96%)	96
Average root dry mass (mg)	79	137	98	77 (97%)	91 (66%)	69 (70%)	78
Week 3							
Average leaf length (mm)	457	426	388	405 (89%)	390 (92%)	339 (87%)	89
Average root length (mm)	314	280	261	303 (96%)	268 (96%)	243 (93%)	95
Average leaf dry mass (mg)	629	452	362	615 (98%)	429 (95%)	319 (88%)	94
Average root dry mass (mg)	459	366	273	407 (89%)	257 (70%)	241 (88%)	82
Week 4							
Average leaf length (mm)	608	527	472	466 (77%)	415 (79%)	352 (75%)	77
Average root length (mm)	361	294	274	319 (88%)	292 (99%)	268 (98%)	95
Average leaf dry mass (mg)	1033	698	598	932 (90%)	560 (80%)	363 (61%)	77
Average root dry mass (mg)	598	413	342	513 (86%)	359 (87%)	313 (92%)	88

**Average biomass production of maize seedlings grown in toxic soils as a percentage of the average biomass production of maize seedlings grown in the control soils.*

Table 31 Concentrations of selected minerals and metals in the roots (R) and leaves (L) of *Zea mays* (cultivar SNK 2340 Vryburg) grown in chromium-rich soil; pH (H_2O) 6.5–7 [n=5]. Shaded areas indicate the highest concentrations for each element during each week.

Plants/container	N%	P%	S%	Mg%	Ca%	Mg: Ca	Cr mg/kg	Ni mg/kg
Week 2								
2 L[1]	4.43	0.688	0.260	0.42	0.77	1.83	4.21	0.52
4 L	3.90	0.046	0.085	0.43	0.59	1.37	4.23	0.34
8 L	3.54	0.577	0.144	0.36	0.56	1.56	4.55	0.15
2 R[2]	2.62	0.230	0.077	0.45	0.47	1.04	32.8	94.8
4 R	2.21	0.467	0.167	0.55	0.54	0.98	23.3	67.9
8 R	1.92	0.592	0.050	0.57	0.62	1.09	22.1	64.9
Average for leaves	3.96	0.436	0.163	0.40	0.64	1.59	4.33	0.34
Average for roots	2.25	0.419	0.098	0.52	0.54	1.04	26.1	75.9
Week 3								
2 L	1.51	0.179	0.044	0.41	0.50	1.22	4.05	0.91
4 L	1.58	0.218	0.033	0.40	0.52	1.30	4.07	0.68
8 L	1.63	0.263	0.031	0.47	0.72	1.53	4.75	0.05
2 R	1.12	0.144	0.029	0.68	0.94	1.38	37.9	77.0
4 R	1.37	0.192	0.108	0.46	0.60	1.30	28.4	54.3
8 R	1.23	0.225	0.039	0.39	0.66	1.69	22.0	36.6
Average for leaves	1.57	0.220	0.036	0.43	0.58	1.35	4.29	0.55
Average for roots	1.24	0.187	0.059	0.51	0.73	1.46	29.4	55.9
Week 4								
2 L	1.02	0.153	0.021	0.39	0.55	1.41	5.96	1.67
4 L	1.05	0.178	0.020	0.41	0.50	1.22	5.35	0.98
8 L	1.23	0.276	0.021	0.41	0.58	1.41	3.14	1.3
2 R	0.88	0.125	0.038	0.50	0.75	1.50	28.1	42.0
4 R	0.86	0.136	0.050	0.44	0.59	1.34	22.8	53.3
8 R	0.84	0.132	0.039	0.67	1.02	1.52	32.0	64.8
Average for leaves	1.10	0.202	0.021	0.40	0.54	1.82	4.82	1.31
Average for roots	0.86	0.131	0.042	0.54	0.78	1.45	27.6	53.4

[1]L = leaves; [2]R = roots

Table 32 Concentrations of selected minerals and metals in the roots (R) and leafs (L) of selected indigenous grass species that grow naturally in the ultramafic soil that was used for the maize experiment. Shaded areas indicate hyperaccumulation of heavy metals.

Species Name	Plant Part	N%	P%	S%	Ca%	Mg%	Cr mg/kg	Ni mg/kg	Fe mg/kg	Mn mg/kg	Al mg/kg	V mg/kg
Stipagrostis	L[1]	0.649	0.053	0.022	0.271	0.074	5.22	10.5	411	22	490	2.2
hirtigluma	R[2]	0.746	0.061	0.014	1.37	0.512	19.5	22	454	23.31	325	4
Heteropogon	L	0.536	0.04	0.025	0.418	0.126	20.3	47.5	811	38.5	1015	5.34
contortus	R	0.822	0.046	0.016	0.365	0.135	32	18.1	924	42.7	437	6.85
Diheteropogon	L	0.361	0.032	0.027	0.656	0.286	13.1	20.9	1687	73.4	3246	3.41
amplectens	R	0.299	0.025	0.027	0.48	0.182	10.1	18.3	1703	39	2926	3.68
Average for leaves		**0.515**	**0.042**	**0.074**	**0.448**	**0.162**	**12.87**	**26.3**	970	**44.63**	**1583**	**3.65**
Average for roots		**0.623**	**0.044**	**0.057**	**0.738**	**0.276**	**20.53**	**19.47**	**1027**	**35**	**1229**	**4.84**

[1]L = leaves; [2]R = roots

Table 33 Diagnostic elements for each major position along the catena.

Element	Valley	Outcrop	Slope
Cu	H[1]	M	M
Mn	H	M	L
S	H	M	L
Cl	H	L	M
Si	H	L	M
Sc	H	L	M
Ti	H	L	M
Ni	M[2]	H	M
Zn	M	H	M
Cr	M	H	L
As	L[3]	H	M
Mo	L	H	M
Ga	L	H	L
Co	H	H	L
Fe	H	H	L
Mg	H	H	L
V	H	H	L
Al	M	M	H
Y	M	M	H
Na	M	M	H
Nb	M	L	H
Rb	M	L	H
Sr	L	M	H
Th	L	M	H
Ca	L	L	H
K	L	L	H
P	L	L	H
Pb	L	L	H
W	L	L	H
Zr	L	L	H

[1]H = high; [2]M = medium; [3]L = low

Table 34 A comparison of the average concentrations of selected elements in the Barberton serpentineferous soils (nine sites) and Sekhukhuneland ultramafic soils (13 samples along one catena). Shaded areas indicate the highest values.

Element	**Minimum**		**Maximum**	
	Barberton*	Sekhukhuneland	Barberton*	Sekhukhuneland
pH	5.84	6.67	7.14	7.84
Mg:Ca ratio	2.11	0.23	10.96	2.14
Mg%	7.06	6.44	29.71	23.44
Ca%	0.57	3.39	12.08	18.53
K%	0.10	0.12	0.47	0.87
Na%	0.02	0.18	0.09	1.88
C%	0.58	0.85	8.78	19.86
N%	0.07	-	0.49	0.77
Cr mg/kg	938	479	3 556	178 020
Ni mg/kg	1 929	81	4 392	1 133

*From Hughes & Noble (1991)

Table 35 A comparison of the average elemental concentrations recorded for soil samples in this study and that of other serpentinite sites in the world. Shaded areas indicate the highest values.

Serpentineferous soil (region)	**Soil µg/g (highest figure recorded)**		**Soil % (average figure recorded)**		**Soil Ratio**	**pH (average)**	**Authority**
	Ni mg/kg	Cr mg/kg	Mg %	Ca %	Mg:Ca		
Australia	2 600	4 700	18.6	5.84	3.18	7.25	Forster & Baker (1995)
Canada*	611	-	3.05	3.01	1.01	(4.5)	McHale & Winterhalder (1995)
Cuba	8 954	5 220	9.57	0.48	19.94	-	Reeves *et al.* (1999)
Greece	5 950	-	10.14	1.74	5.83	-	Reeves *et al.* (1995)
New Zealand	1 386	1 843	76.50	8.30	9.22	-	Lee *et al.* (1995)
Philippines	8 100	18 000	6.14	0.57	10.77	6.45	Proctor *et al.* (1995)
South Africa	2 406	5 170	(20.8)	(1)	20.80	6.58	Balkwill *et al.* (1995)
South Africa	4 392	3 556	18.02	7.26	2.50	6.49	Hughes & Noble (1991)
South Africa	3 178	7 329	18.96	1.18	16.07	6.09	Morrey *et al.* (1989)
Zimbabwe	9 375	15 500	10.3	2.20	4.70	6.73	Wild (1974b)
8 countries	**4 695**	**7 665**	**19.21**	**3.15**	**6.1**	**6.6**	**AVERAGE**
Sekhukhuneland	1 133	20 000	17.26	7.76	2.22	7.15	

*Heavy metal contaminated soil

Table 36 A comparison of the average elemental concentrations recorded for plant material in Sekhukhuneland and the Great Dyke of Zimbabwe.

Study Site	Ca%	Mg%	P%	S%
Sekhukhuneland	2.45	0.17	0.33	0.12
Great Dyke*	1.63	1.14	0.11	0.11

Study Site	Cr mg/kg	Ni mg/kg	Fe mg/kg	Mn mg/kg	Al mg/kg	Sr mg/kg
Sekhukhuneland	25	11	735	17	583	82
Great Dyke*	11	792	1066	158	208	41

*From Brooks & Yang (1984)

Table 37 A summary of the nutrient levels, metal concentrations and magnesium:calcium ratios recorded for the sampled plant material.

Species (n=5)	Code*	Plant Part	Nutrient %	Metals mg/kg	Mg:Ca 1:x
Euclea sp. nov.	**Es**	L[1]	5.616	187.1	15.29
Euclea sp. nov.	**Es**	R[3]	5.82	946.7	35.4
Pterothrix spinescens	**Ps**	L	2.302	9388.8	13.43
Pterothrix spinescens	**Ps**	S[2]	4.792	7642.5	54.2
Pterothrix spinescens	**Ps**	R	3.313	1520.05	34
Rhus keetii	**Rk**	L	2.813	254.79	14.76
Rhus keetii	**Rk**	R	2.228	1382.46	27.6
Jamesbrittenia atropurpurea	**Ja**	L	3.823	2717.52	16.7
Jamesbrittenia atropurpurea	**Ja**	R	1.666	2251.28	14.34
Dicoma gerrardii	**Dg**	L	3.203	5611.9	15.44
Dicoma gerrardii	**Dg**	R	1.41	2462.9	11.04
Polygala sp. nov.	**Pn**	L	3.954	248.08	16.22
Polygala sp. nov.	**Pn**	R	1.198	614.6	4.03
Brachylaena ilicifolia	**Bi**	L	2.678	328.71	7.01
Brachylaena ilicifolia	**Bi**	R	2.414	989.95	13.33
Euclea linearis	**El**	L	4.854	293.59	60.88
Euclea linearis	**El**	S	2.897	275.24	41.32
Euclea linearis	**El**	R	3.238	2190.57	50.24
Ipomoea bathycolpos	**Ib**	L	5.453	339.04	19.64
Ipomoea bathycolpos	**Ib**	R	7.027	991.03	89.3
Berkheya insignis	**Bs**	L	4.761	1398.65	86.25
Berkheya insignis	**Bs**	S	1.99	492.18	23.7
Berkheya insignis	**Bs**	R	4.307	10094.6	37.93
Rhus batophylla	**Rb**	L	3.149	383.81	24.55
Rhus batophylla	**Rb**	S	1.986	226.47	21.33
Rhus batophylla	**Rb**	R	1.896	1483.93	30.23
Tinnea rhodesiana	**Tr**	L	4.257	503.96	17.1
Tinnea rhodesiana	**Tr**	R	2.072	850.66	31.23
Leucas capensis	**Lc**	L	6.563	363.01	2.6
Leucas capensis	**Lc**	S	1.112	171.13	1.75
Leucas capensis	**Lc**	R	4.11	1152.64	12.61
Orthosiphon fruticosus	**Of**	L	4.511	388.39	3.59
Orthosiphon fruticosus	**Of**	S	1.484	321.15	3.02
Orthosiphon fruticosus	**Of**	R	2.437	995.31	5.85
Terminalia prunoides	**Tp**	L	5.246	272.02	10.43
Terminalia prunoides	**Tp**	S	10.485	288.55	80.99
Terminalia prunoides	**Tp**	R	6.398	648.19	22.76
Petalidium oblongifolium	**Po**	L	7.196	146.64	4.78
Petalidium oblongifolium	**Po**	S	3.734	143.23	6.76
Petalidium oblongifolium	**Po**	R	7.502	507.67	13.96
Catha transvaalensis	**Ct**	L	3.36	139.86	4.7
Catha transvaalensis	**Ct**	S	3.884	127.95	23.55
Catha transvaalensis	**Ct**	R	4.673	1174.94	29.48

*Abbreviations used for graphs in Appendix 4
[1]L = leaves; [2]S = stems; [3]R = roots

CHAPTER 11

FLORISTIC ANALYSES

Abstract

Eighty plant species of the Sekhukhuneland Centre of Plant Endemism were assessed according to the 2000 IUCN categories of threat. Twenty-six of these taxa met the criteria. This analysis together with the level of endemism supports the listing of the region as an important Centre of Plant Endemism that contains a high diversity of plants requiring conservation attention. A first division of the Centre into sub-centres is presented to aid future conservation actions. Endemic plant species are listed, as well as the near-endemic and disjunct taxa that are shared between the Centre and other centres or floristic regions. Major threats to the floristic diversity of Sekhukhuneland are considered and a probable conservation solution is presented. Approximately 2 000 of the plant taxa occurring in the 4 000 km^2 of the Sekhukhuneland Centre of Plant Endemism are listed. Taxa in the checklist are arranged alphabetically by family, with the genera and species listed alphabetically within the families.

11.1 Introduction

Locating the world's 'hotspots' of biodiversity has long been advocated as one of the primary tactics in conservation (Wilson 1992). South Africa has a rich vascular plant flora and harbours prominent foci of plant diversity and endemism (Cowling & Hilton-Taylor 1994; Van Wyk & Van Wyk 1997), several of which are recognised internationally (Davis *et al.* 1994; Myers *et al.* 2000). What still remains to be done, is to identify smaller, lesser known 'hotspots', some of which are often located within already depleted floristic regions, and to investigate the rare and endemic species they contain. Van Wyk & Van Wyk (1997) proposed Sekhukhuneland as a micro-regional centre of plant endemism, which was subsequently investigated (Siebert 2000).

Prior to the democratisation of South Africa in 1994, floristic surveys of the SCPE were lacking. Large areas north of the Steelpoort River used to be part of the former self-governing homeland of Lebowa (Botha 1983). Although the geology of Sekhukhuneland has been thoroughly studied and mining possibilities in the region investigated for many years (Marlow 1976; Coetzee 1985; Blom 1989; Schürmann *et al.* 1998; Cawthorn 1999), the study of its biota has been largely neglected, despite the observation by Acocks (1953) that the vegetation of the Steelpoort region is unique and should receive further attention. Botanical surveys were conducted mainly on the periphery of this territory and focused on the floristic diversity of the adjacent Wolkberg Centre of Endemism (Ferrar *et al.* 1988; Deall *et al.* 1989; Matthews *et al.* 1993; Stalmans *et al.* 1997). These studies have contributed considerably to the knowledge of the rich plant diversity of the northeastern Drakensberg Escarpment and inspired an interest in the flora of the bordering Sekhukhuneland. This resulted in the first detailed floristic survey (Siebert 1998) and first comprehensive phytosociological study (Siebert *et al.* 2002a) of this botanically poorly known region.

In recent years the local flora of the Sekhukhuneland region has come under threat as a result of the rapid development and disturbance of the region. Surface outcrops of iron-rich chromite and vanadium (associated with titaniferous magnetite) is being removed at a rapid rate by strip or opencast mining, usually without any detailed knowledge of the flora on these sites. It has now become necessary to predict species' survival in the light of habitat loss and fragmentation. All over the world this has become one of the greatest challenges facing conservation biologists, particularly if disturbance could result in extinction (Mace & Hudson 1999; With & King 1999; Joubert & Dreyer 2000).

There are numerous techniques suitable for application to the particular situation in Sekhukhuneland. Some of these are the identification of conservation priorities and include *under-represented or rare ecosystems* and *distributions of rare or threatened plants* as focal areas (Lambeck 1997; Pfab & Witkowski 1997; Hoffmann & Welk 1999; Loomis & Echohawk 1999). However, before any conservation priorities can be identified, it is necessary to determine the Red List status of rare plants using the new IUCN categories and criteria (IUCN 1994).

The Red Data List of southern African plants (Hilton-Taylor 1996) is currently the most comprehensive and widely used list of threatened plants and their status. The criteria used for assessing conservation status have now been replaced by a new system. Consequently the status of all threatened species has to be re-evaluated, a process which is currently in progress (Golding 1999). The new method requires much more comprehensive field knowledge than the previous system, but the final result provides much more information to users such as the steps that should be taken to conserve a species. The new approach for determining the status of threatened plants was formally adopted by the Council of the International Union for Conservation of Nature (IUCN) in 1994. The study of Sekhukhuneland flora provided an ideal opportunity to gather data for these assessments, and in turn the assessments will provide much information for future conservation planning of the region.

Conservation related work in data-deficient countries should be fast tracked to identify threatened taxa (Golding 2001b). It is hoped that the updated list of the SCPE endemic plant taxa, definined boundaries of the SCPE, proposed Red Data List status for selected plant species, and discussions surrounding major threats and conservation strategies, will contribute towards this initiative.

11.2 Plant endemism, diversity, threatened taxa and conservation

11.2.1 Flora

About 2 000 species, but probably more, of vascular plants occur in the SCPE (Siebert 2000). Recently undescribed, endemic plant taxa have been discovered on a regular basis, for example *Plectranthus venteri* (Van Jaarsveld & Hankey 1997), *Gladiolus sekhukhuniensis* (Manning *et al.* 1999) and *Rhoicissus sekhukhuniensis* (Retief *et al.* 2001).

After the Serpentines of Barberton (Balkwill *et al.* 1995) and the Great Dyke of Zimbabwe (Wild 1965), Sekhukhuneland is the third richest in ultramafic-induced endemic plant species in southern Africa (Siebert 1998). The endemic taxa of the SCPE, and those shared with the Wolkberg Centre (near-endemics), are listed in Table 38. There are 57 endemic and approximately 58 near-endemic species/infraspecific taxa. These taxa belong to

36 families of which the Liliaceae (*sensu lato*) and the Euphorbiaceae are the largest. SCPE endemics and near-endemics represent a wide spectrum of growth forms, including trees, shrubs, suffrutices, succulents, forbs, geophytes and annual herbs (Siebert 1998).

The SCPE exhibits a percentage endemism of 5%. As a poorly collected region, its degree of endemism is thus comparable with the other Centres of Endemism in southern Africa. The Transvaal Drakensberg has an estimated endemicity of 4% (Matthews *et al.* 1993), the KwaZulu-Natal Southern Drakensberg has an estimated endemicity of 5% (Hilliard & Burtt 1987), and the Great Dyke of Zimbabwe has an estimated endemicity of 6% (Wild 1965). Most of the SCPE endemics appear to be palaeoendemics (e.g. *Rhus batophylla*). In addition, populations of many widespread species growing on ultramafic soils are morphologically slightly different from their counterparts on surrounding substrates, and these ecotypes may represent incipient species (neoendemics).

In southern Africa, centres of plant endemism and diversity are often associated with specific geological substrates (Wild 1963; Wild 1965; Matthews *et al.* 1993; Mustart *et al.* 1994; Van Wyk 1994; Balkwill *et al.* 1995). This is also the case in the SCPE, where the vegetation on ultramafics tends to have a distinct species composition which is rich in local endemics (Siebert 1998). Endemics on ultramafic substrates are of conservation value, mainly because they contain an important genepool that can be applied in the rehabilitation of 'problematic' substrates such as toxic mine dumps (Ellery & Walker 1986; Liston & Balkwill 1995; Howes *et al.* 1998). Furthermore, the SCPE is probably the region with the most extensive areas of surface-exposed chromitite in the world, thus providing unrivalled opportunities to study the possible effects of chrome on plants.

Many species adapted to ultramafic substrates are shared between, and are near-endemic to, the SCPE and mainly the dolomites of the adjacent Wolkberg Centre (Campbell-Young & Balkwill 2001). Most endemics and near-endemics are associated with one or more specific major plant communities (Siebert *et al.* 2002a). In view of the many species shared between the two regions (and endemic to the combined region), one may well ask whether the SCPE should be redefined so as to also include the western, more arid parts of the

Transvaal Supergroup, including the dolomites of the Chuniespoort Group (now treated as Wolkberg Centre).

There are also floristic links between the SCPE and the Waterberg (e.g. *Rhus keetii* and *Euclea linearis*), as well as the arid parts of the Soutpansberg, including the middle Limpopo River valley (e.g. *Sesamothamnus lugardii* and *Decorsea schlechteri*). Disjunct distributions of taxa, such as *Melhania randii*, between the SCPE, Barberton Centre of Endemism and the even more distant Great Dyke in Zimbabwe, are best explained by the mutual presence of ultramafic substrates in these three regions. Subtropical lowveld elements have entered the SCPE via the Olifants River valley (e.g. *Balanites maughamii, Diospyros mespiliformis, Merremia kentrocaulos, Ptaeroxylon obliquum*). The most intriguing disjunctions, however, are the satellite outlier populations in the SCPE of floristic elements otherwise found mainly in the Great Karoo and arid parts of the western Free State and North-West Province (e.g. *Amphiglossa triflora* (= *Pterothrix spinosa*), *Jamesbrittenia atropurpurea*, *Plinthus rehmannii* and *Rhigozum obovatum*). To this one can add disjunct distributions between the SCPE and the arid Griqualand West (e.g. *Gnidia polycephala, Nuxia gracilis, Phyllanthus parvulus* var. *garipensis, Polygala krumanina* and *Stipagrostis hirtigluma* var. *patula*). An ancient link between the SCPE and Pondoland is reflected by *Catha transvaalensis* [to be transferred to *Lydenburgia cassinoides*] (SCPE endemic) and its nearest relative, *C. abbottii* [to be transferred to *Lydenburgia*] (Pondoland endemic). A first record for South Africa was also recorded in that *Nemesia zimbabwensis*, a member of the Schrophulariaceae, occurs in the Afromontane forests on the summit of the Leolo Mountains. This species is usually restricted to damp forests of Mutare, Chibinga, Mt. Inyanga and Melsetter in the eastern highlands of Zimbabwe and Mt. Gorangosa west of Beira in Mozambique.

The flora of the SCPE is mainly of Zambezian extraction, with Afromontane elements, especially at higher altitudes. Afromontane links are to be expected as the region abuts on the northeastern Drakensberg Escarpment with its mainly Afromontane flora (Wolkberg Centre). The change from Afromontane to Zambezian is particularly noticeable as one descends from the high-lying, wetter, more temperate Steenkampsberg to the low-lying, much drier, subtropical Roossenekal-Steelpoort area.

The complete checklist of SCPE plant species is given in Appendix 5. Totals of species by family are given in Table 39. SCPE endemics and SCPE near-endemics, rare and threatened, and other noteworthy taxa are also indicated in Appendix 5. The ultramafic flora of the Great Dyke is seen as impoverished (Wild 1965). Sekhukhuneland can, however, be seen as extremely rich in taxa when compared with other regions in the world (see Chapter 1). On a national level the SCPE compares well with the southern Drakensberg (Bester 1998), both these areas harbouring approximately 2 000 vascular plant species on approximately 4 000 km^2.

Currently the Flora for the region stands at 172 families, 757 genera and 1957 species/infraspecific taxa. The Angiosperms represent 127 families, 677 genera and 1826 species/infraspecific taxa, the ferns and fern-allies 11 families, 17 genera and 31 species/infraspecific taxa, and the mosses 34 families, 63 genera and 100 species/infraspecific taxa. Most of the present flora (Appendix 5) originated from the surrounding flora and suggests that the ability to evolve resistance to ultramafic soils is a widespread attribute amongst angiosperm families. Approximately 20 species/infraspecific taxa are new to science and are currently being described, several in collaboration with staff of the National Botanical Institute (NBI), Pretoria. Based on PRECIS records, one out of every 15 plant specimens collected during this study was a new record for the region.

The species checklist is part of a specimen-label database that can assist conservationists and taxonomists alike during systematic, floristic and biogeographic studies in this region, and a high quality inventory will assist researchers in meeting their objectives when investigating and developing self-sustainable protected area strategies (Balmford & Gaston 1999; Soberon *et al.* 2000; Ter Steege 2000). The data presented here are linked to georeferenced herbarium specimens which can in future be integrated into a geographic information system for spatial analysis (Rhoads & Thompson 1992; Siebert & Willis 2000; Fish & Steyn 2001).

Plant collections were first made in the area at least 75 years ago and some of the earlier collections were by J.P.H. Acocks, W.G. Barnard, L.E.W. Codd, D.S. Hardy, R.O. Moffet, A.O.D. Mogg, N.J. van Warmelo, F. Wilms and R.G.N. Young. In the last decade important collections were made by E. Retief, S.J. Siebert, F. Venter, A.E. van Wyk and P.J.D. Winter. A relatively high number of Bryophyte species collected in grid 2430 C is a result of a collecting trip to Sekhukhuneland by R.E. Magill in 1977 (Van Rooy 2000). Since 1997 extensive botanical work was conducted in the region, which include the discovery of many undescribed plant taxa.

11.2.1.1 Eleven largest families

- Only families with more than 15 genera and 30 species/infraspecific taxa were considered.
- Position determined by prioritising high numbers of genera in a family; the formula: $(n^1 x2) + n^2 = y$; the higher y, the more favourable the position, with n^1 = number of genera and n^2 = number of species/infraspecific taxa.

(1) POACEAE (70 genera/161 species)

The *Grass family* is the largest family in Sekhukhuneland, which is not surprising, for the dominant vegetation types of the region are bushveld and grassland. The family is well colleced in the region and species are well represented at PRE.

(2) ASTERACEAE (59 genera/192 species)

Most habitats in Sekhukhuneland are characterised by the *Daisy family*, especially in the grasslands on rocky hillsides. Many taxa are shared with the adjacent Wolkberg- and Barberton Centres of Endemism and some are considered to be near-endemic to the SCPE (endemic to combined region).

(3) FABACEAE s.l. (46 genera/179 species)

Legumes are conspicuous in Sekhukhuneland and are characteristic of most vegetation types of the region. All three subfamilies of the *Pea family* are important: Caesalpinoideae 7 genera and 15 species; Mimosoideae 4 genera and 31 species; Papilionoideae 35 genera and 133 species.

(4) LILIACEAE s.l. (27 genera/111 species)

The *Lily* family, defined here in a broad sense, is very well represented in the region, as it is elsewhere in southern Africa. There were surprisingly few undescribed species from Sekhukhuneland. Important subfamilies are: Asparagoideae 1 genus and 19 species; Asphodeloideae 4 genera and 31 species; Hyacinthoideae 11 genera and 35 species.

(5) ASCLEPIADACEAE (31 genera/67 species)

Individuals of the *Milkweed* family are prominent in most communities of the region. The family is, however, not well collected throughout the SCPE.

(6) LAMIACEAE (21 genera/66 species)

Mainly herbaceous plants of the *Mint* family are common throughout Sekhukhuneland. Taxa are abundant especially on rocky hillsides, ridges and outcrops. Although still poorly collected in the region, it is the fifth largest family in Sekhukhuneland.

(7) ACANTHACEAE (21 genera/60 species)

The *Acanthus* family is prominent in Sekhukhuneland; several species growing as dense stands in specific plant communites. Their large, colourful flowers draw attention in summer and autumn, and hence the family is well collected.

(8) SCHROPHULARIACEAE (25 genera/45 species)

Another family that is poorly collected in the region is the *Snapdragon* family. However, taxa of the family are conspicuous in all the plant communities of the region.

(9) EUPHORBIACEAE (17 genera/59 species)

Several succulents endemic/near-endemic to the region are represented in the *Euphorbia* family. These endemics grow in communities unique to the SCPE. Many non-succulents also occur.

(10) CYPERACEAE (18 genera/48 species)

The *Sedge* family is dominant in especially the wetland vegetation of the region, but also in the high rainfall grassland areas of the Roossenekal and Leolo Subcentres. The group has been extensively collected.

(11) RUBIACEAE (22 genera/41 species)

Representatives of the *Coffee* family are noticeable in many of the more humid habitats, and also prefer the rocky outcrops and ridges of the region.

11.2.2 Subcentres of endemism

Three main subcentres were identified for the SCPE (Figure 32), based on the distribution of endemic/near-endemic and threatened plant taxa recorded for each of these areas (Siebert 1998) (Table 38):

a) Roossenekal Subcentre (Roossenekal-Dwars River area). This is the most southern plant diversity 'hotspot' and is characterised by undulating norite hills. This 1 000 km^2 area is a unique ecotone between the Highveld and Lowveld of South Africa. A total of 67 (31/36) SCPE endemics/near-endemics and nine taxa recommended for Red Data List status occur in this subcentre (Table 38; 40). Six taxa are exclusively endemic to this subcentre.

b) Leolo Mountain Subcentre. The subcentre is merely a geological extension of the former, but is isolated by broad, dry valleys. The Leolo Mountains harbour relict patches of Afromontane Forest and there are rare wetland systems on the summit. There are 39 (22/17) SCPE endemics/near-endemics and eight taxa worthy of Red Data List status in this 400 km^2 subcentre (Table 38; 40). Six taxa are endemic to this subcentre only.

c) Steelpoort Subcentre (Steelpoort-Burgersfort area). It is located in the larger Steelpoort River valley, where it comprises undulating norite, pyroxenite and magnetitite outcrops and hills, and dongas (areas of weakly structured soils). This 2 600 km^2 is the core region of the SCPE and it is a unique *Kirkia wilmsii*-dominated mountain bushveld. There are 90 (42/48) SCPE endemics/near-endemics and 16 newly assessed Red Data List taxa in this subcentre (Table 38; 40). Twenty taxa are endemic to this centre only and occur nowhere else.

11.2.3 Red Data List

The Red Data List for southern African plants (Hilton-Taylor 1996) lists 37 species that were recorded in the study area. These species are listed in Table 2. Using the old IUCN Red Data List Categories, 1 species is considered Endangered (E), 1 Vulnerable (V), 8 Rare (R), 2 Indeterminate (I), 15 Insufficiently Known (K) and 10 Not Threatened in the SCPE, but in other provinces/countries of southern Africa (N). Of these, 12 can be considered as threatened (E, V, R and I), with the remainder (K and N) under no immediate threat. However, in the light of the development pressure on the SCPE, the plants of the region were once again assessed to try and identify additional threatened species.

Table 40 provides details of 26 taxa that ***provisionally*** met the criteria for a category of threat in the SABONET Red Data List Project (Golding 1999), along with the justification for assigning the status. Seven species that were listed in Hilton-Taylor (1996) as either indeterminate or insufficiently known have now been assigned a category of threat; and four that were listed as threatened still meet the criteria for a category of threat. In addition to these, 15 species, that have not been listed previously, have now been added to the Red Data List.

Table 41 includes taxa for which no category could be assigned owing to lack of necessary information, i.e. Data Deficient (DD), taxa not yet evaluated (NE), and those which have been evaluated but have not met the criteria for a category of threat. Data Deficient taxa should be treated as threatened unless proven otherwise, although most of these species are found to be not threatened according to the new IUCN categories and criteria. Species listed were assessed because of their endemicity and in some cases because of their previous listing by Hilton-Taylor (1996).

11.2.4 Major threats

The SCPE has five major kinds of land ownership, namely communal land, mining property, commercial farmland, residential areas and a protected reserve (Botha 1983). No accurate figures were available on the percentage of the SCPE belonging to each of these land-uses.

A large population of mainly impoverished people inhabit the *communal lands* of the SCPE, a scenario typical for sub-Saharan Africa (Hackel 1999). It lies in rural South Africa, with the local inhabitants being a cultural people, known as the Pedi (Di Friuli 1998). For many of these people the only means of survival is subsistence farming and the sustainable use of natural resources (Crookes *et al.* 2000). Financial income is predominantly acquired from work on the mines and farms in the area. It is estimated that at least 35% of the SCPE is communal land. Overgrazing by domestic livestock has seriously degraded the vegetation in the densely populated areas in and around the Leolo Mountains, which is a threat to certain endemics of the region (Knowles & Witkowski 2000).

Approximately 15% of the SCPE belongs to *mining companies*. Mining property in the SCPE produces 75% of the world's platinum (Cowley 1998) and 35% of the world's chromium (Ringdahl & Oosterhuis 1998), all of which comes from the Bushveld Complex, more precisely the Critical Zone of the Rustenburg Layered Suite (Schürmann *et al.* 1998). Expansion of mining activities in these regions, including Sekhukhuneland, depends upon demand and future prices for these metals (Cawthorn 1999). This means that further mining pressure on the Sekhukhuneland Centre could arise if markets are favourable for the platinum group metals and chromium, which is being mined at present. Recently, dimension stone mining (norite) in the region has sparked an outcry from local interest groups in the region.

Commercial farming in the region is a small-scale venture, with cattle ranging and citrus production the major farming activities. These activities are restricted to about 30% of the land area of the SCPE. Owing to the ruggedness of the terrain, the mountainous parts of the SCPE are still fairly intact, with many private landowners keen to promote game farming and/or ecotourism because of the scenic beauty of the region (Joubert & Dreyer 2000).

Residential areas (towns and informal settlements) occupy some 15% of the SCPE. These areas are growing rapidly. Human population density in the 25 major hot spots of the world is 73 people/km^2, 71% more than in the world as a whole (Cincotta *et al.* 2000). Although the SCPE does not fall into one of these major regions, its current population density of approximately 40 people/km^2 (163 477 people on 4 000 km^2), is an example of a southern African plant diversity 'hotspot' that will increasingly come under pressure from human population impact.

Despite the region's scenic landscapes, Potlake Nature Reserve is the only officially *protected area* in the SCPE. Together with the Pedi-cattle Breeding Station, Stellenbosch, less than one percent of the SCPE is protected. Potlake Nature Reserve is rather small and covers 2 800 ha of bushveld and mountain in the northern part of the SCPE, between the Olifants River and the Burgersfort-Pietersburg road. This reserve probably faces loss of plant species due to its small size and dense human population on its boundaries (Harcourt *et al.* 2001). Although prolonged settlement in the past has left its mark on parts of the reserve, the mountain range and its foothills harbour a wide variety of plant species typical to the Centre.

While conservationists are fighting to conserve government land in South Africa, communal land is continually being lost to commercial and residential development (Shackleton 1993; Knight 1999). This is due to a poor understanding of the complexity and diversity of rural livelihood systems, and because the products from communal lands are usually not measured in monetary terms. Settlements and mine dumps today cover large areas of the SCPE that used to be communal grazing land. As the mining industry expands and the infrastructure of the region improves, more and more people will move into the area, putting even more pressure on the already dwindling natural resources.

Rapid development in the SCPE is a threat not only to the common species that are used by the locals, but also to the endemics that are dependent on specific habitats. This is best illustrated by the fact that two of us (SJS & AVW) recently discovered new species of *Stylochaeton*, *Tragia* and *Tulbaghia* within densely populated residential areas.

11.2.5 Threatened status

A short analysis of the conservation status of each of the major vegetation types are given below (only those species that were recorded during the survey are included in the statistics):

- Among the 17 plant communities of the Grassland and Wetland Vegetation, 45 plant species/infraspecific taxa were identified as of conservation significance (Table 4). Sixteen are SCPE endemics and 19 SCPE near-endemics. Of these 17 were listed in the southern African Red Data List for plants. Nineteen of these taxa are restricted to this vegetation type in the SCPE. Norite mining and aforestation threaten these communities.
- Among the 17 plant communities of the Rock Outcrop Vegetation, 36 plant species/infraspecific taxa were identified as of conservation significance (Table 9). Sixteen are SCPE endemics and 18 SCPE near-endemics. Of these eight were listed in the southern African Red Data List for plants. Fifteen of these taxa are restricted to this vegetation type in the SCPE. Strip mining of magnetite and vanadium is a major threat.
- Among the 20 plant communities of the Open Mountain Bushveld, 48 plant species/infraspecific taxa were identified as of conservation significance (Table 15). Twenty-six are SCPE endemics and 21 SCPE near-endemics. Of these 12 were listed in the southern African Red Data List for plants. Five of these taxa are restricted to this vegetation type in the SCPE. Slimes dams and dumping sites pose a major threat.
- Among the 20 plant communities of the Closed Mountain Bushveld, 44 plant species/infraspecific taxa were identified as of conservation significance (Table 20). Twenty-two are SCPE endemics, 17 SCPE near-endemics and four were unique species. Of these six were listed in the southern African Red Data List for plants. Fourteen of these taxa are restricted to this vegetation type in the SCPE. Wood harvesting is responsible for the loss of large areas.
- Among the 8 plant communities of the Arid Northern Bushveld, 13 plant species/infraspecific taxa were identified as of conservation significance (Table 25). Four are SCPE endemics and 6 SCPE near-endemics. An additional six are listed in the southern African Red Data List for plants. Five of these taxa are restricted to this vegetation type in the SCPE. Overgrazing and chromium/platinum mining poses a threat.

For all 82 syntaxa that occur the SCPE region, 125 plant species/infraspecific taxa were identified as of conservation significance (Table 38). Fifty-eight are SCPE endemics and 67 SCPE near-endemics, of which 20 are Red Data List taxa according to Hilton-Taylor (1996). An additional 17 are listed in the southern African Red Data List for plants.

Obviously the 58 SCPE endemics are restricted to the plant communities of the SCPE. This numbers compare well with serpentineferous sites elsewhere in the world, namely 18 rare plants and endemics in central Queensland, Australia (Batianoff *et al.* 1995), 20 endemics on the Great Dyke, Zimbabwe (Wild 1965) and 22 endemics in southern Mpumalanga, South Africa (Balkwill *et al.* 1995).

The priority vegetation types of the Grassland and Wetland Vegetation are associations 2, 3, 4 and 5, of which sub-association 3.1, the *Brachiario serratae–Melhanietum randii helichrysetosum rugulosii*, a rocky grassland on the scarps and crests of norite hills, is probably the most important and threatened (Chapter 5). It should also be noted that the wetlands are sensitive systems that are easily disturbed and should be protected (Doust & Doust 1995; Van Wyk *et al.* 2000). Important wetlands to conserve are the seepage areas, namely the *Limosello maioris–Ranunculetum meyeri* and the *Fuireno pubescentis–Schoenietum nigricantis bulbostylietosum hispidulae*.

Certain plant communities, namely associations 2 and 6-10 (Chapter 6), are of conservation priority in the Rocky Outcrop Vegetation. These communities have large numbers of threatened taxa, which occur on specific chemical substrates that are not continuous, but interspersed as isolated islands within other major vegetation types. A good example is the *Commiphoro marlothii–Crotonetum gratissimi* with four taxa restricted to it.

Important communities of conservation value in the Open Mountain Bushveld are in associations 4, 5 and 7 (more specifically sub-associations 4.2, 4.3, 5.2, 7.1 and 7.2) (Chapter 7). Associations 1 and 6 should also be considered for they have high numbers of taxa with conservation value restricted to them. All the associations represent very unique plant communities that are restricted to the SCPE. This vegetation type has proven to contain the highest numbers of rare taxa and is threatened the most by development. The Open Mountain Bushveld is a vegetation type that is endemic to the SCPE. All the other vegetation types of the SCPE are more or less represented along the northeastern Escarpment (Grassland Vegetation Type), Pietersburg Plateau (Arid Northern Bushveld), Western Rustenburg Layered Suite (Closed Mountain Bushveld) and Bushveld Complex (Rock Outcrop Vegetation).

Important communities of conservation value in the Closed Mountain Bushveld are distributed across all the associations (Chapter 8). Important communities are subassociations 2.1, 2.2, 3.3 and most specifically sub-association 4.2, *Hippocrateo longipetiolatae–Euphorbietum tirucalli aristidetosum transvaalensis*. Sub-associations 3.4, 4.1 and 5.2 should also be considered for they are very unique plant communities.

The Arid Northern Bushveld does not harbour any specific communities in need of conservation when compared with the other major vegetation types of the SCPE. Its plant communities should remain conserved in the Potlake Nature Reserve.

The following associations and sub-associations of the SCPE are of conservation value (*the number of taxa of conservation value are in brackets*):

- Open Mountain Bushveld (O):

(30) Association 4 – *Tristachyo leucothricis–Cussonietum transvaalensis*

(25) Sub-association 4.2 – *Tristachyo leucothricis–Cussonietum transvaalensis melinetosum nerviglumis*

(23) Sub-association 4.3 – *Tristachyo leucothricis–Cussonietum transvaalensis argylobietosum wilmsii*

(16) Sub-association 4.4 – *Tristachyo leucothricis–Cussonietum transvaalensis combretetosum zeyheri*

(26) Association 7 – *Loudetio simplicis–Eucleetum linearis*

(23) Sub-association 7.1 – *Loudetio simplicis -Eucleetum linearis diheteropogonetosum amplectentis*

(21) Sub-association 7.2 – *Loudetio simplicis–Eucleetum linearis heteropogonetosum contorti*

(19) Sub-association 7.3 – *Loudetio simplicis- Eucleetum linearis andropogonetosum chinensis*

(24) Association 5 – *Eragrosti lehmannianae–Hippobrometum pauciflori*

(19) Sub-association 5.2 – *Eragrosti lehmannianae–Hippobrometum pauciflori sorgetosum bicoloris*

(21) Association 2 – *Enneapogono scoparii–Acacietum leiorachis*

(18) Sub-association 2.3 – *Enneapogono scoparii–Acacietum leiorachis brachylaenetosum*

ilicifoliae

(21) Association 6 – *Aristido rhiniochloo–Gnidietum polycephalae*

(19) Association 3 – *Phyllantho glaucophyllae–Brachylaenetum ilicifoli*

(17) Sub-association 3.2 – *Phyllantho glaucophyllae–Brachylaenetum ilicifoli brachiarietosum serratae*

(16) Sub-association 3.1 – *Phyllantho glaucophyllae–Brachylaenetum ilicifoli setarietosum sphacelatae*

(19) Association 8 – *Petalidio oblongifolii–Raphionacmetum procumbentis*

- Grassland Vegetation (G):

(23) Association 3 – *Brachiario serratae–Melhanietum randii*

(18) Sub-association 3.1 – *Brachiario serratae–Melhanietum randii helichrysetosum rugulosii*

(16) Sub-association 3.3 – *Brachiario serratae–Melhanietum randii gnidietosum capitatae*

(16) Association 2 – *Zantedeschio pentlandii–Aloetum castaneae*

(16) Association 5 – *Jamesbrittenio macranthae–Loudetietum simplicis*

- Closed Mountain Bushveld (C):

(20) Association 1 – *Combreto apiculati–Kirkietum wilmsii*

(20) Association 2 – *Panico deustii–Dichrostachetum cinereae*

(20) Association 3 – *Fingerhuthio africanae–Boscietum foetidae*

(18) Association 4 – *Hippocrateo longipetiolatae–Euphorbietum tirucalli*

From Table 42 it can be seen that of all the plant communities with conservation value, association O 4 is of the highest priority for conservation and association G 2 the lowest. On the sub-association level O 4.2 is of the highest priority and O 4.4 of the lowest. These communities of conservation value are also important on other levels. If endemics species are to be conserved plant communities O 4 to O 6 should be conserved (Table 42). If the focus is on near endemics, plant communities O 4, O 7, C 1 and C 2 must be considered. For Red List taxa G 3, G 3.1 and G 2 are the best options for maximum conservation. If taxa with restricted distributions are to be conserved, G 5, G 3 and C 1 should be seen as priority.

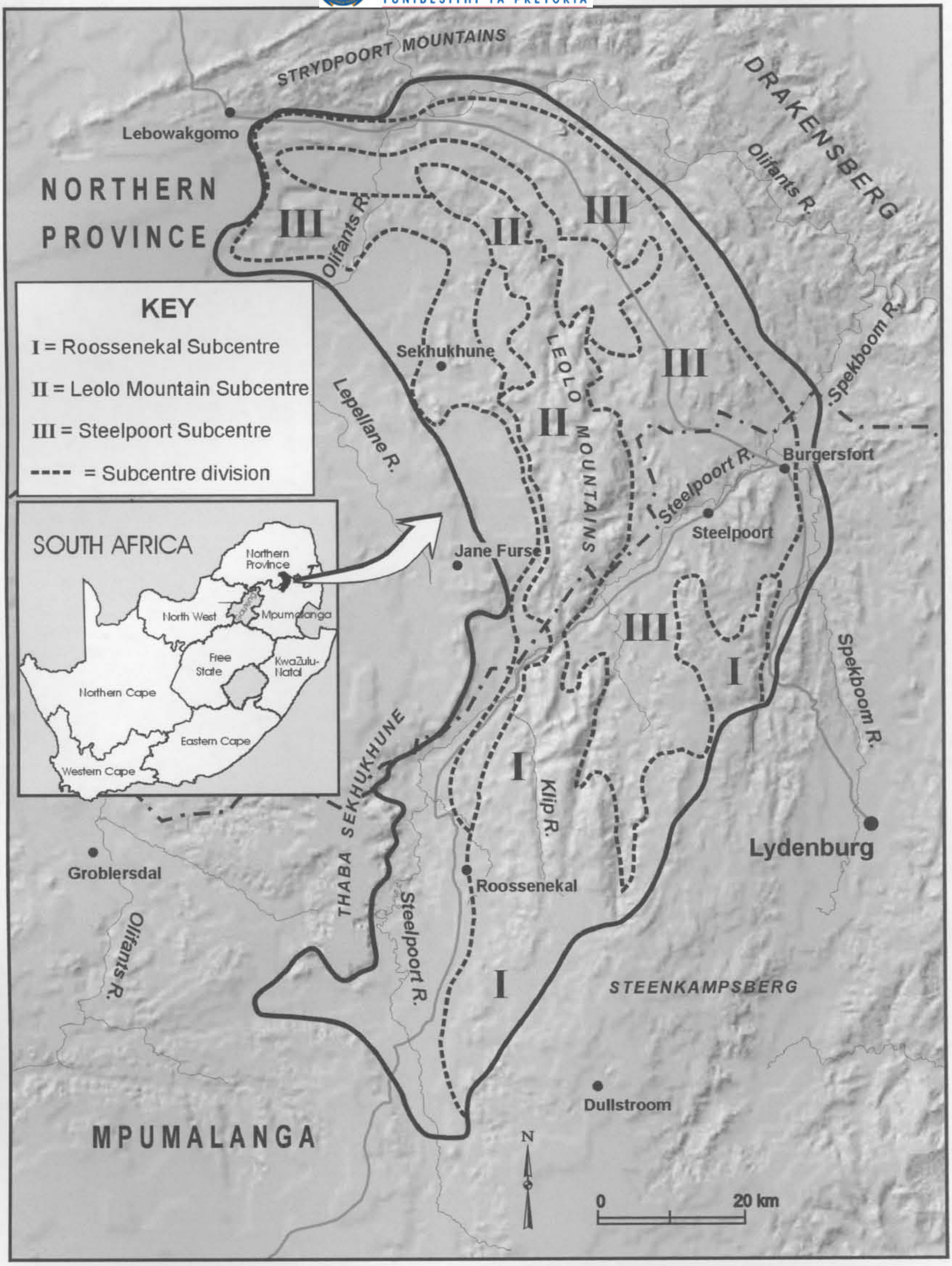


Figure 32 Subcentres of endemism of the Sekhukhuneland Centre of Plant Endemism (based on Siebert (1998)).

Table 38 List of the Sekhukhuneland Centre of Plant Endemism angiosperm endemics/near-endemics. Taxa are arranged in order of relative abundance in subcentres.

A = Roossenekal Subcentre; B = Leolo Mountain Subcentre; C = Steelpoort Subcentre; E = SCPE endemic; N-E = SCPE near-endemic;
X = rare in subcentre; XX = frequent in subcentre; XXX = abundant in subcentre

Species	Family	E	N-E	A	B	C
Melhania randii Baker f. [form] (*Siebert 46*)	STERCULIACEAE	✓	.	XXX	.	.
Acacia karroo Hayne [form] (*Swartz 4*)	FABACEAE	✓	.	XX	.	.
Protea caffra Meisn. Subsp. *caffra* [form] (*Siebert 1382*)	PROTEACEAE	✓	.	XX	.	.
Rhoicissus sp. nov. (*Siebert 48*)	VITACEAE	✓	.	XX	.	.
Cyphostemma sp. nov. C (*Dednam FAA 4142*)	VITACEAE	✓	.	X	.	.
Schizoglossum sp. nov. (*Siebert 628*)	ASCLEPIADACEAE	✓	.	X	.	.
Zantedeschia jucunda Letty	ARACEAE	✓	.	.	XXX	.
Tulbaghia sp. nov. (*Siebert 1304*)	LILIACEAE (Allioidea)	✓	.	.	XX	.
Carissa sp. nov. (*Hurter pers. comm.*)	APOCYNACEAE	✓	.	.	X	.
Dioscorea sp. nov. (*Hurter pers. comm.*)	DIOSCOREACEAE	✓	.	.	X	.
Euphorbia sp. nov. (*Archer pers. comm.*)	EUPHORBIACEAE	✓	.	.	X	.
Psychotria sp. nov. (*Hurter pers. comm.*)	RUBIACEAE	✓	.	.	X	.
Gnidia caffra (Meisn.) Gilg [form] (*Van Wyk & Siebert 12975*)	THYMELAEACEAE	✓	.	XX	XX	.
Pavetta zeyheri Sond. [form] (*Siebert 22*)	RUBIACEAE	✓	.	XX	XX	.
Ledebouria sp. nov. (*Siebert 1865*)	LILIACEAE (Hyacinthoidea)	✓	.	X	X	.
Aloe burgersfortensis Reynolds	LILIACEAE (Alooidea)	✓	.	.	.	XXX
Hibiscus barnardii Exell	MALVACEAE	✓	.	.	.	XXX
Asparagus sekukuniensis (Oberm.) Fellingham & N.L. Mey.	LILIACEAE (Asparagoidea)	✓	.	.	.	XX
Asparagus sp. nov. (*Van Wyk & Siebert 1358*)	LILIACEAE (Asparagoidea)	✓	.	.	.	XX
Premna mooiensis (H. Pearson) W. Piep. [form] (*Van Wyk & Siebert 13004*)	VERBENACEAE	✓	.	.	.	XX

Table 38 continued.

Species	**Family**	**E**	**N-E**	**A**	**B**	**C**
Rhus batophylla Codd	ANACARDIACEAE	✓	.	.	.	XX
Acacia sp. nov. (*Hurter pers. comm.*)	FABACEAE	✓	.	.	.	X
Albuca sp. nov. (*Siebert 856*)	LILIACEAE (Hyacinthoidea)	✓	.	.	.	X
Aloe sp. nov. (*Siebert 1419*)	LILIACEAE (Alooidea)	✓	.	.	.	X
Bauhinia tomentosa L. [form] (*Siebert 444*)	FABACEAE	✓	.	.	.	X
Ceropegia distincta N.E. Br. subsp. *verruculosa* R.A. Dyer	ASCLEPIADACEAE	✓	.	.	.	X
Clerodendrum suffruticosum Gürke [form] (*Siebert 1563*)	VERBENACEAE	✓	.	.	.	X
Euphorbia barnardii C. White, R.H. Dyer & B.Sloane	EUPHORBIACEAE	✓	.	.	.	X
Kleinia longiflora DC. [form] (*Van Wyk 13239*)	ASTERACEAE	✓	.	.	.	X
Orbeopsis gerstneri (Letty) L.C. Leach subsp. *elongata* (R.A. Dyer) L.C. Leach	ASCLEPIADACEAE	✓	.	.	.	X
Schotia latifolia Jacq. [form] (*Codd 9828* (PRE))	FABACEAE	✓	.	.	.	X
Stylochaeton sp. nov. A (*Siebert 1845*)	ARACEAE	✓	.	.	.	X
Stylochaeton sp. nov. B (*Siebert 672*)	ARACEAE	✓	.	.	.	X
Tragia sp. nov. (*Siebert 1573*)	EUPHORBIACEAE	✓	.	.	.	X
Gladiolus sekhukhuniensis P.J.D. Winter	IRIDACEAE	✓	.	.	X	X
Plectranthus venteri Van Jaarsv. & Hankey	LAMIACEAE	✓	.	.	X	X
Euclea linearis Zeyh. ex Hiern [form] (*Siebert 937*)	EBENACEAE	✓	.	X	.	XXX
Euclea sp. nov. (*Van Wyk & Siebert 1686*)	EBENACEAE	✓	.	X	.	XXX
Brachylaena ilicifolia (Lam.) E. Phillips & Schweick. [form] (*Siebert 613*)	ASTERACEAE	✓	.	X	.	XX
Jamesbrittenia sp. nov. (*Van Wyk & Siebert 13026*)	SCROPHULARIACEAE	✓	.	X	.	XX
Polygala sp. nov. (*Van Wyk & Siebert 13311*)	POLYGALACEAE	✓	.	X	.	XX

Table 38 continued.

Species	Family	E	N-E	A	B	C
Rhoicissus sekhukhuniensis Retief, Siebert & Van Wyk	VITACEAE	✓	.	X	.	XX
Asclepias sp. nov. (*Kritzinger 110*)	ASCLEPIADACEAE	✓	.	X	.	X
Cyphostemma sp. nov. B (*Van Wyk & Siebert 1383*)	VITACEAE	✓	.	X	.	X
Gymnosporia sp. nov. B (*Siebert 458*)	CELASTRACEAE	✓	.	X	.	X
Hemizygia sp. nov. (*Siebert 615*)	LAMIACEAE	✓	.	X	.	X
Phyllanthus sp. nov. (*Siebert 470*)	EUPHORBIACEAE	✓	.	X	.	X
Berkheya insignis (Harv.) Thell. [form] (*Siebert 257*)	ASTERACEAE	✓	.	XX	X	XX
Catha transvaalensis Codd	CELASTRACEAE	✓	.	XX	X	XX
Elephantorrhiza praetermissa J. H. Ross	FABACEAE	✓	.	XX	X	XX
Euclea crispa (Thunb.) Guerke subsp. *crispa* [form] (*Van Wyk & Siebert 13205*)	EBENACEAE	✓	.	XX	X	XX
Jamesbrittenia macrantha (Codd) Hilliard	SCROPHULARIACEAE	✓	.	XX	X	X
Xerophyta retinervis Baker [form] (*Van Wyk 13208*)	VELLOZIACEAE	✓	.	XX	X	X
Cyphostemma sp. nov. A (*Van Wyk & Siebert 13389*)	VITACEAE	✓	.	XX	X	.
Rhus sekhukhuniensis Moffett	ANACARDIACEAE	✓	.	XX	X	X
Leucas capensis (Benth.) Engl. [form] (*Van Wyk 13007*)	LAMIACEAE	✓	.	X	X	XX
Orthosiphon fruticosus Codd	LAMIACEAE	✓	.	X	X	XX
Ipomoea bathycolpos Hallier f. var. *sinuatodentata* Hallier f.	CONVOLVULACEAE	✓	.	X	X	X
Zantedeschia pentlandii (Watson) Wittm.	ARACEAE	.	✓	XXX	.	.
Argyrolobium wilmsii Harms	FABACEAE	.	✓	XX	.	.
Helichrycum uninervium Burtt Davy	ASTERACEAE	.	✓	XX	.	.
Hermannia antonii I. Verd.	STERCULIACEAE	.	✓	XX	.	.

Table 38 continued.

Species	Family	E	N-E	A	B	C
Jasminum quinatum Schinz	OLEACEAE	.	✓	XX	.	.
Aloe reitzii Reynolds var. *reitzii*	LILIACEAE (Alooidea)	.	✓	X	.	.
Argyrolobium lancifolium Burtt Davy	FABACEAE	.	✓	X	.	.
Berkheya densifolia Bohnen ex Roessler	ASTERACEAE	.	✓	X	.	.
Eucomis vandermerwei I. Verd	LILIACEAE (Hyacinthoidea)	.	✓	X	.	.
Pegolettia lanceolata Harv.	ASTERACEAE	.	✓	X	.	.
Gymnosporia sp. nov. A (*Van Wyk & Siebert 13351*)	CELASTRACEAE	.	✓	.	XX	.
Helichrycum albilanatum Hilliard	ASTERACEAE	.	✓	XX	X	.
Aloe pretoriensis Pole Evans	LILIACEAE (Alooidea)	.	✓	X	X	.
Rhus wilmsii Diels	ANACARDIACEAE	.	✓	XX	X	.
Jatropha latifolia Pax var. *angustata* Prain	EUPHORBIACEAE	.	✓	X	X	.
Jatropha zeyheri Sond. var. *subsimplex* Prain	EUPHORBIACEAE	.	✓	X	X	.
Rhus tumulicola S. Moore var. *meeuseana* forma *pumila*	ANACARDIACEAE	.	✓	X	X	.
Lotononis wilmsii Dummer	FABACEAE	.	✓	X	X	.
Tulbaghia coddii Vosa & R.B. Burb.	LILIACEAE (Allioidea)	.	✓	X	X	.
Petalidium oblongifolium C.B. Clarke	ACANTHACEAE	.	✓	.	.	XXX
Adenia fruticosa Burtt Davy subsp. *fruticosa*	PASSIFLORACEAE	.	✓	.	.	XX
Aloe fosterii Pillans	LILIACEAE (Alooidea)	.	✓	.	.	XX
Dyschoriste erecta C.B. Clarke	ACANTHACEAE	.	✓	.	.	XX
Rhus engleri Britten	ANACARDIACEAE	.	✓	.	.	XX
Adenia wilmsii Harms	PASSIFLORACEAE	.	✓	.	.	X
Aloe immaculata Pillans	LILIACEAE (Alooidea)	.	✓	.	.	X

Table 38 continued.

Species	Family	E	N-E	A	B	C
Asparagus clareae (Oberm.) Fellingham & N.L. Mey.	LILIACEAE (Asparagoidea)	.	✓	.	.	X
Asparagus lynettae (Oberm.) Fellingham & N.L. Mey.	LILIACEAE (Asparagoidea)	.	✓	.	.	X
Asparagus sp. nov. (*Van Wyk 13598*)	LILIACEAE (Asparagoidea)	.	✓	.	.	X
Boscia albitrunca (Burch.) Gilg & Gilg-Ben. 'var. *macrophylla* Toelken' [form] (*Van Wyk & Siebert 13182*)	CAPPARACEAE	.	✓	.	.	X
Ceropegia stapeliiformis Haw. subsp. *serpentina* (E.A. Bruce) R.A. Dyer	ASCLEPIADACEAE	.	✓	.	.	X
Combretum petrophilum Retief	COMBRETACEAE	.	✓	.	.	X
Cyphia transvaalensis E. Phillips	LOBELIACEAE	.	✓	.	.	X
Delosperma rileyii L. Bolus	MESEMBRYANTHEMACEAE	.	✓	.	.	X
Delosperma zeederbergii L. Bolus	MESEMBRYANTHEMACEAE	.	✓	.	.	X
Dicliptera fruticosa K. Balkwill	ACANTHACEAE	.	✓	.	.	X
Dombeya autumnalis I. Verd.	STERCULIACEAE	.	✓	.	.	X
Euphorbia enormis N.E. Br.	EUPHORBIACEAE	.	✓	.	.	X
Euphorbia lydenburgensis Schweick. & Letty	EUPHORBIACEAE	.	✓	.	.	X
Euphorbia maleolens E. Phillips	EUPHORBIACEAE	.	✓	.	.	X
Euphorbia schinzii Pax [form] (*Van Wyk & Siebert 13194*)	EUPHORBIACEAE	.	✓	.	.	X
Huernia insigniflora C.A. Maass	ASCLEPIADACEAE	.	✓	.	.	X
Huernia stapelioides Schltr.	ASCLEPIADACEAE	.	✓	.	.	X
Ledebouria dolomiticola S. Venter	LILIACEAE (Hyacinthoidea)	.	✓	.	.	X
Ozoroa albicans R. & A. Fern.	ANACARDIACEAE	.	✓	.	.	X
Pachycarphus transvaalensis (Schltr.) N.E. Br.	ASCLEPIADACEAE	.	✓	.	.	X
Plinthus rehmanni G. Schellenb.	AIZOACEAE	.	✓	.	.	X

Table 38 continued.

Species	Family	E	N-E	A	B	C
Rhynchosia spectabilis Schinz	FABACEAE	.	✓	.	.	X
Thesium multiramulosum Pilg.	SANTALACEAE	.	✓	.	.	X
Aloe castanea Schönland	LILIACEAE (Alooidea)	.	✓	XXX	.	XX
Solanum incanum L. [form] (*Van Wyk & Siebert 13013*)	SOLANACEAE	.	✓	X	.	XX
Plectranthus xerophilus Codd	LAMIACEAE	.	✓	X	.	XX
Rhus keetii Schönland	ANACARDIACEAE	.	✓	X	.	XX
Aneilema longirrhizum Faden	COMMELINACEAE	.	✓	X	.	X
Chlorophytum cyperaceum Kies ex Oberm.	LILIACEAE (Anthericoidea)	.	✓	X	.	X
Dyschoriste perrottetii (Nees) Kuntze	ACANTHACEAE	.	✓	X	.	X
Kleinia stapeliiformis (E. Phillips) Stapf	ASTERACEAE	.	✓	X	.	X
Nuxia gracilis Engl.	LOGANIACEAE	.	✓	X	.	X
Orthosiphon amabilis (Bremek.) Codd	LAMIACEAE	.	✓	X	.	X
Aloe cryptopoda Baker [form] (*Siebert 609*)	LILIACEAE (Alooidea)	.	✓	XX	X	XX
Indigofera lydenburgensis N.E. Br.	FABACEAE	.	✓	XX	X	XX
Triaspis glaucophylla Engl.	MALPIGHIACEAE	.	✓	XX	X	XX
Vitex obovata E. Mey. subsp. *wilmsii* (Gùrke) C.L. Bredenkamp & D.J. Botha	VERBENACEAE	.	✓	XX	X	XX
Grewia vernicosa Schinz	TILIACEAE	.	✓	X	X	XXX
Karomia speciosa (Hutch. & Corbishley) R. Fern. forma *speciosa*	VERBENACEAE	.	✓	X	X	XX
Orthosiphon tubiformis R.D. Good	LAMIACEAE	.	✓	X	X	XX
Jatropha latifolia Pax var. *latifolia*	EUPHORBIACEAE	.	✓	X	X	X
TOTAL		58	67	67	39	90
[E / N-E]				31/36	22/17	42/48

Specimens are housed in the H.G.W.J. Schweickerdt Herbarium (PRU), University of Pretoria; [form] = morphologically undifferentiated race of widespread species.

Table 39 Statistics of the families that are represented in the Sekhukhuneland Centre of Plant Endemism.

Family	Fam.	Gen.	Spp.	Subsp.	Var.	sp. nov.	Forms	End.	N-End.
AMARYLLIDACEAE		8	13	1	1	-	-	-	-
ARACEAE		2	9	2	-	2	-	3	1
COMMELINACEAE		3	12	-	3	-	-	-	1
CYPERACEAE		18	48	3	4	-	-	-	-
DIOSCOREACEAE		1	5	-	1	1	-	1	-
ERIOCAULACEAE		1	2	-	1	-	-	-	-
HYPOXIDACEAE		1	7	-	2	-	-	-	-
IRIDACEAE		9	25	4	3	-	-	1	-
JUNCACEAE		1	4	-	-	-	-	-	-
LILIACEAE s.l.	8*	27	112	9	10	4	2	7	13
Allioideae		*2*	*6*	*1*	-	*1*	-	*1*	*1*
Anthericoideae		*2*	*8*	-	*1*	-	-	-	*1*
Asparagoideae		*1*	*19*	*1*	*6*	*1*	*1*	*2*	*3*
Asphodeloideae		*4*	*31*	*3*	*2*	-	*1*	*2*	*6*
Colchicoideae		*5*	*7*	*1*	-	-	-	-	-
Dracaenoideae		*1*	*3*	-	-	-	-	-	-
Eriospermoideae		*1*	*3*	*1*	*1*	-	-	-	-
Hyacinthoideae		*11*	*35*	*2*	-	*2*	-	*2*	*2*
ORCHIDACEAE		11	36	6	5	-	-	-	-
POACEAE		70	161	14	9	-	-	-	-
POTAMOGETONACEAE		1	2	-	-	-	-	-	-
TYPHACEAE		1	1	-	-	-	-	-	-

Table 39 continued.

Family	Fam.	Gen.	Spp.	Subsp.	Var.	sp. nov.	Forms	End.	N-End.
VELLOZIACEAE		1	4	-	-	-	1	1	-
XYRIDACEAE		1	1	-	-	-	-	-	-
MONOCOTYLEDONAE	**23**	**156**	**442**	**39**	**39**	**7**	**3**	**13**	**15**
ACANTHACEAE		21	60	1	3	-	-	-	4
AIZOACEAE		8	15	2	7	-	-	-	1
AMARANTHACEAE		9	15	1	4	-	-	-	-
ANACARDIACEAE		4	28	2	6	-	-	2	5
ANNONACEAE		2	2	-	1	-	-	-	-
APIACEAE		9	14	1	5	-	-	-	-
APOCYNACEAE		5	6	2	-	-	-	1	-
AQUIFOLIACEAE		1	1	-	1	-	-	-	-
ARALIACEAE		3	6	1	-	-	-	-	-
ASCLEPIADACEAE		31	67	7	3	2	-	4	4
ASTERACEAE		59	192	19	6	-	3	3	5
BALANITACEAE		1	1	-	-	-	-	-	-
BALSAMINACEAE		1	1	1	-	-	-	-	-
BIGNONIACEAE		4	5	-	-	-	-	-	-
BORAGINACEAE		5	10	-	-	-	-	-	-
BRASSICACEAE		2	2	-	-	-	-	-	-
BURSERACEAE		1	7	-	-	-	-	-	-
BUXACEAE		1	1	-	-	-	-	-	-

Table 39 continued.

Family	Fam.	Gen.	Spp.	Subsp.	Var.	sp. nov.	Forms	End.	N-End.
CACTACEAE		1	1	-	-	-	-	-	-
CAMPANULACEAE		1	7	1	-	-	-	-	-
CAPPARACEAE		5	22	7	3	-	-	-	1
CARYOPHYLLACEAE		2	4	2	2	-	-	-	-
CELASTRACEAE		8	19	1	1	2	-	2	1
CHENOPODIACEAE		3	5	-	1	-	-	-	-
CLUSIACEAE		1	4	1	-	-	-	-	-
COMBRETACEAE		2	10	2	-	-	-	-	1
CONVOLVULACEAE		8	26	4	9	-	-	1	-
CRASSULACEAE		4	18	6	4	-	-	-	-
CUCURBITACEAE		10	22	1	1	-	-	-	-
DIPSACACEAE		2	2	-	-	-	-	-	-
DROSERACEAE		1	3	-	-	-	-	-	-
EBENACEAE		2	16	6	5	-	2	3	-
ERICACEAE		1	5	-	3	-	-	-	-
EUPHORBIACEAE		17	59	4	9	3	1	4	7
FABACEAE s.l.	3*	46	182	29	29	-	3	5	5
Caesalpinioidea		*7*	*16*	*1*	*1*	-	*2*	-	-
Mimosoidea		*4*	*31*	*6*	*6*	-	*1*	-	-
Papilionoideae		*35*	*135*	*22*	*22*	-	-	-	-
FLACOURTIACEAE		6	7	-	-	-	-	-	-
GENTIANACEAE		4	11	3	1	-	-	-	-
GERANIACEAE		3	9	1	-	-	-	-	-

Table 39 continued.

Family	Fam.	Gen.	Spp.	Subsp.	Var.	sp. nov.	Forms	End.	N-End.
GESNERIACEAE		1	3	-	-	-	-	-	-
GREYIACEAE		1	1	-	-	-	-	-	-
ICACINACEAE		3	3	1	-	-	-	-	-
ILLECEBRACEAE		1	1	-	-	-	-	-	-
LAMIACEAE		21	66	5	14	1	1	4	3
LINACEAE		1	1	-	-	-	-	-	-
LOBELIACEAE		3	7	1	2	-	-	-	1
LOGANIACEAE		4	8	-	-	-	-	-	1
LORANTHACEAE		4	9	-	-	-	-	-	-
LYTHRACEAE		1	2	-	1	-	-	-	-
MALPIGHIACEAE		2	4	3	-	-	-	-	1
MALVACEAE		5	34	1	2	-	-	1	-
MELASTOMATACEAE		1	1	-	-	-	-	-	-
MELIACEAE		3	3	-	-	-	-	-	-
MENISPERMACEAE		4	4	-	1	-	-	-	-
MESEMBRYANTHEMACEAE		2	5	-	-	-	-	-	2
MORACEAE		1	7	1	1	-	-	-	-
MYRICACEAE		1	1	-	-	-	-	-	-
MYROTHAMNACEAE		1	1	-	-	-	-	-	-
MYRSINACEAE		3	3	-	-	-	-	-	-
MYRTACEAE		2	3	-	-	-	-	-	-
NYCTAGINACEAE		2	7	-	-	-	-	-	-

Table 39 continued.

Family	Fam.	Gen.	Spp.	Subsp.	Var.	sp. nov.	Forms	End.	N-End.
OCHNACEAE		1	3	-	-	-	-	-	-
OLACACEAE		1	2	-	1	-	-	-	-
OLEACEAE		5	9	2	2	-	-	-	1
OLINIACEAE		1	2	-	-	-	-	-	-
ONAGRACEAE		2	3	-	-	-	-	-	-
OXALIDACEAE		1	4	-	-	-	-	-	-
PAPAVERACEAE		1	1	1	-	-	-	-	-
PASSIFLORACEAE		1	4	2	1	-	-	-	2
PEDALIACEAE		7	8	2	1	-	-	-	-
PERIPLOCACEAE		3	6	-	-	-	-	-	-
PIPERACEAE		1	1	-	-	-	-	-	-
PITTOSPORACEAE		1	1	-	-	-	-	-	-
PLANTAGINACEAE		1	2	-	-	-	-	-	-
PLUMBAGINACEAE		1	1	-	-	-	-	-	-
POLYGALACEAE		1	9	-	1	I	-	1	-
POLYGONACEAE		4	10	4	-	-	-	-	-
PORTULACACEAE		3	6	-	-	-	-	-	-
PRIMULACEAE		1	I	-	-	-	-	-	-
PROTEACEAE		2	6	2	-	-	1	1	-
PTAEROXYLACEAE		1	I	-	-	-	-	-	-
RANUNCULACEAE		3	5	-	1	-	-	-	-
RHAMNACEAE		5	5	1	-	-	-	-	-

Table 39 continued.

Family	Fam.	Gen.	Spp.	Subsp.	Var.	sp. nov.	Forms	End.	N-End.
ROSACEAE		6	8	1	-	-	-	-	-
RUBIACEAE		22	41	12	4	-	1	2	-
RUTACEAE		5	5	-	-	-	-	-	-
SALVADORACEAE		1	1	-	-	-	-	-	-
SANTALACEAE		3	11	-	1	-	-	-	1
SAPINDACEAE		5	6	-	-	-	-	-	-
SAPOTACEAE		2	2	-	-	-	-	-	-
SCROPHULARIACEAE		25	45	3	2	1	1	2	-
SELAGINACEAE		3	8	-	-	-	-	-	-
SIMAROUBACEAE		1	2	-	-	-	-	-	-
SOLANACEAE		6	15	-	-	-	1	-	1
STERCULIACEAE		5	25	-	3	-	1	1	2
THYMELAEACEAE		3	9	-	-	-	1	1	-
TILIACEAE		3	19	-	2	-	-	-	1
TURNERACEAE		2	2	-	-	-	-	-	-
ULMACEAE		2	2	-	-	-	-	-	-
URTICACEAE		4	4	1	-	-	-	-	-
VERBENACEAE		9	25	1	8	-	1	2	2
VIOLACEAE		1	1	-	-	-	-	-	-
VISCACEAE		1	4	1	-	-	-	-	-
VITACEAE		3	18	2	-	4	-	5	-
ZYGOPHYLLACEAE		1	2	1	-	-	-	-	-

Table 39 continued.

Family	Fam.	Gen.	Spp.	Subsp.	Var.	sp. nov.	Forms	End.	N-End.
DICOTYLEDONAE	**104**	**521**	**1384**	**153**	**152**	**14**	**17**	**45**	**52**
ADIANTACEAE		5	13	1	4	-	-	-	-
ASPLENIACEAE		2	4	-	1	-	-	-	-
EQUISETACEAE		1	1	-	-	-	-	-	-
ISOETACEAE		1	1	-	-	-	-	-	-
LYCOPODIACEAE		1	1	-	-	-	-	-	-
OPHIOGLOSSACEAE		1	2	-	-	-	-	-	-
POLYPODIACEAE		1	1	1	-	-	-	-	-
SCHIZAEACEAE		2	3	-	1	-	-	-	-
SELLAGINELLACEAE		1	2	-	-	-	-	-	-
THELYPTERIDACEAE		1	2	-	-	-	-	-	-
VITTARIACEAE		1	1	-	-	-	-	-	-
PTERIDOPHYTA	**11**	**17**	**31**	**2**	**6**	**-**	**-**	**-**	**-**
AMBLYSTEGIACEAE		1	1	-	-	-	-	-	-
ARCHIDIACEAE		1	1	-	-	-	-	-	-
AYTONIACEAE		1	2	-	-	-	-	-	-
BARTRAMIACEAE		2	2	-	-	-	-	-	-
BRYACEAE		4	10	-	-	-	-	-	-
CALYMPERACEAE		2	3	-	-	-	-	-	-

Table 39 continued.

Family	Fam.	Gen.	Spp.	Subsp.	Var.	sp. nov.	Forms	End.	N-End.
DICRANACEAE		3	9	-	-	-	-	-	-
ENTODONTACEAE		3	3	-	-	-	-	-	-
ERPODIACEAE		2	2	-	-	-	-	-	-
EXORMOTHECACEAE		1	1	-	-	-	-	-	-
FABRONIACEAE		1	2	-	-	-	-	-	-
FISSIDENTACEAE		1	6	-	-	-	-	-	-
FUMARIACEAE		1	1	-	-	-	-	-	-
GRIMMIACEAE		1	1	-	-	-	-	-	-
HEDWIGIACEAE		2	2	-	-	-	-	-	-
HOOKERIACEAE		1	1	-	-	-	-	-	-
HYPNACEAE		1	1	-	-	-	-	-	-
LEPTODONTACEAE		2	2	-	-	-	-	-	-
LESKEACEAE		2	6	-	-	-	-	-	-
LEUCODONTACEAE		2	2	-	-	-	-	-	-
METEORIACEAE		4	4	-	-	-	-	-	-
ORTHOTRICHACEAE		2	2	-	-	-	-	-	-
PALLAVICINIACEAE		1	1	-	-	-	-	-	-
POLYTRICHACEAE		3	3	-	-	-	-	-	-
PORELLACEAE		1	1	-	-	-	-	-	-
POTTIACEAE		10	17	-	-	-	-	-	-
PRIONODONTACEAE		1	1	-	-	-	-	-	-
PTEROBRYACEAE		1	2	-	-	-	-	-	-

Table 39 continued.

Family	**Fam.**	**Gen.**	**Spp.**	**Subsp.**	**Var.**	**sp. nov.**	**Forms**	**End.**	**N-End.**
PTYCHOMITRIACEAE		1	4	-	-	-	-	-	-
RICCIACEAE		1	3	-	-	-	-	-	-
SEMATOPHYLLACEAE		1	1	-	-	-	-	-	-
SPHAGNACEAE		1	1	-	-	-	-	-	-
THAMNOBRYACEAE		1	1	-	-	-	-	-	-
TRACHYPODACEAE		1	1	-	-	-	-	-	-
BRYOPHYTA	**34**	**63**	**100**	-	-	-	-	-	-
MONOCOTYLEDONAE	*23*	*156*	*442*	*39*	*39*	*7*	*3*	*13*	*15*
DICOTYLEDONAE	*104*	*521*	*1384*	*153*	*152*	*14*	*17*	*45*	*52*
ANGIOSPERMAE	127	677	1826	192	191	21	20	58	67
PTERIDOPHYTA	11	17	31	2	6	-	-	-	-
BRYOPHYTA	34	63	100	-	-	-	-	-	-
TOTAL	**172**	**757**	**1957**	**194**	**197**	**21**	**20**	**58**	**67**

* Statistics incorporated with those for the family.

Table 40 Recommended IUCN Red Data List status of the Sekhukhuneland Centre of Endemism flora.

[1]According to new IUCN categories (Hilton-Taylor 2000)

[2]According to Red Data List (RDL) of southern African plants (Hilton-Taylor 1996)

Species	**Family**	**Global status**[1]	**National status**[1]	**RDL**[2] **(1996)**	**Justification for allocation of status**
Adenia wilmsii Harms	PASSIFLORACEAE	VU A1cd+D2	VU A1cd+D2	K	Restricted distribution
Aloe burgersfortensis Reynolds	ALOACEAE	VU A2c	VU A2c		Mining; residential development
Aloe reitzii Reynolds var. *reitzii*	ALOACEAE	VU A2ac+D2	VU A2ac+D2	I	Norite mining; afforestation
Aneilema longirrhizum Faden	COMMELINACEAE	EN B1+2bce	EN B1+2bce		Overgrazing; erosion
Asparagus clareae (Oberm.) Fellingham & N.L. Mey.	ASPARAGACEAE	VU D2	VU D2	K	Restricted distribution
Asparagus sekukuniensis (Oberm.) Fellingham & N.L. Mey.	ASPARAGACEAE	VU D2	VU D2	K	Restricted distribution
Boscia albitrunca (Burch.) Gilg & Gilg-Ben. "var. *macrophylla* Toelken"	CAPPARACEAE	VU D2	VU D2		Restricted distribution
Catha transvaalensis Codd	CELASTRACEAE	VU B1+2e	VU B1+2e		Firewood; mining in general
Euclea sp. nov. (*Siebert 934*)	EBENACEAE	VU A2c+D2	VU A2c+D2		Chromium mining
Euphorbia barnardii C. White, R.H.Dyer & B. Sloane	EUPHORBIACEAE	VU A1ac, B1, B2be, C1, D2	VU A1ac, B1, B2be, C1, D2	E	Diseases; over-grazing (Knowles & Witkowski 2000)
Euphorbia sekhukhuniensis R.A. Dyer	EUPHORBIACEAE	VU D2	VU D2	R	Restricted distribution
Gymnosporia sp. nov. A (*Van Wyk 13351*)	CELASTRACEAE	VU D2	VU D2		Destruction of forests
Huernia stapelioides Schltr.	ASCLEPIADACEAE	VU D2	VU D2		Soil degradation; restricted distribution
Melhania randii Baker f.	STERCULIACEAE	-	VU B1+2bc	K	Norite mining
Nemesia zimbabwensis Rendle	SCHROPHULARIACEAE	VU B1+2e	CR B1+2c		Chopping down of forests

Table 40 continued.

Species	Family	Global status[1]	National status[1]	RDL[2] (1996)	Justification for allocation of status
Nuxia gracilis Engl.	LOGANIACEAE	VU B1+2bc	VU B1+2bc	K	Mine dumps
Pegolettia lanceolata Harv.	ASTERACEAE	VU D2	VU D2		Afforestation
Plectranthus venteri Van Jaarsv. & Hankey	LAMIACEAE	VU D2	VU D2		Restricted distribution
Plinthus rehmannii G. Schellenb.	AIZOACEAE	EN B1+2bc	EN B1+2bc	V	Overgrazing; residential development
Raphionacme chimanimaniana Venter & R.L.Verh.	PERIPLOCACEAE	VU D2	VU D2		Trampling and overgrazing
Rhus batophylla Codd	ANACARDIACEAE	VU D2	VU D2	R	Restricted distribution
Stylochaeton sp. nov. (*Siebert 1332*)	ARACEAE	CR B1+2abcd	CR B1+2abcd		Overgrazing; residential development
Tulbaghia coddii Vosa & R.B. Burb.	LILIACEAE	VU D2	VU D2	K	Overgrazing; restricted distribution
Tulbaghia sp. nov. (*Siebert 1304*)	LILIACEAE	CR B1+2abc	CR B1+2abc		Overgrazing; housing development
Zantedeschia jucunda Letty	ARACEAE	VU A2d+D2	VU A2d+D2	I	Restricted distribution; residential development
Zantedeschia pentlandii (Watson) Wittm.	ARACEAE	EN B1+2bce	EN B1+2bce	R	Illegal collection; norite mining

Table 41 List of species in the Sekhukhuneland Centre assessed as not threatened, as well as those in need of assessment.

NE = Not evaluated

[1]According to new IUCN categories (Hilton-Taylor 2000)

Species	**Family**	**Global status**[1]	**National status**[1]	**Red Data List status (Hilton-Taylor 1996)**
Argyrolobium wilmsii Harms	FABACEAE	LR (lc)	LR (lc)	
Asparagus intricatus (Oberm.) Fellingham & N.L. Mey.	ASPARAGACEAE	LR (lc)	LR (lc)	
Boscia foetida Schinz subsp. *minima* Toelken	CAPPARACEAE	NE	NE	R (northern provinces)
Callilepis leptophylla Harv.	ASTERACEAE	LR (lc)	LR (lc)	R (KwaZulu-Natal)
Chlorophytum cyperaceum Kies ex Oberm.	LILIACEAE	LR (nt)	LR (nt)	
Combretum petrophilum Retief	COMBRETACEAE	NE	NE	R (northern provinces)
Dicliptera fruticosa K. Balkwill	ACANTHACEAE	LR (nt)	LR (nt)	
Disa rhodantha Schltr.	ORCHIDACEAE	LR (lc)	LR (lc)	K (northern provinces)
Dombeya autumnalis I. Verd.	STERCULIACEAE	LR (lc)	LR (lc)	
Dyschoriste erecta C.B. Clarke	ACANTHACEAE	LR (lc)	LR (lc)	
Dyschoriste perrottetii (Nees) Kuntze	ACANTHACEAE	LR (lc)	LR (lc)	
Dyschoriste rogersii S. Moore	ACANTHACEAE	NE	NE	
Elephantorrhiza praetermissa J.H. Ross	FABACEAE	LR (lc)	LR (lc)	K (northern provinces)
Eucomis autumnalis (Mill.) Chitt. subsp. *clavata* Baker (Reyneke)	LILIACEAE	LR (nt)	LR (nt)	R (Free State); V (KwaZulu-Natal)
Eucomis montana Compton	LILIACEAE	LR (nt)	LR (nt)	R (northern provinces)
Eulophia leachii Greatrex ex A.V. Hall	ORCHIDACEAE	NE	NE	
Euphorbia enormis N.E. Br.	EUPHORBIACEAE	LR (nt)	LR (nt)	
Euphorbia lydenburgensis Schweick. & Letty	EUPHORBIACEAE	LR (nt)	LR (nt)	

Table 41 continued.

Species	Family	Global status[1]	National status[1]	Red Data List status (Hilton-Taylor 1996)
Gossypium herbaceum L. subsp. *africanum* (Watt) Vollesen	MALVACEAE	LR (lc)	LR (lc)	K (Swaziland)
Hibiscus barnardii Exell	MALVACEAE	LR (nt)	LR (nt)	R (northern provinces)
Huernia insigniflora C.A. Maas	ASCLEPIADACEAE	LR (lc)	LR (lc)	
Ipomoea bathycolpos Hallier f. var. *sinuatodentata* Hallier f.	CONVOLVULACEAE	LR (nt)	LR (nt)	
Jamesbrittenia macrantha (Codd) Hilliard	SCHROPHULARIACEAE	LR (nt)	LR (nt)	K (northern provinces)
Jamesbrittenia silenoides (Hilliard) Hilliard	SCHROPHULARIACEAE	LR (lc)	LR (lc)	V (KwaZulu-Natal)
Jatropha latifolia Pax var. *angustata* Prain	EUPHORBIACEAE	LR (nt)	LR (nt)	
Jatropha latifolia Pax var. *latifolia*	EUPHORBIACEAE	LR (lc)	LR (lc)	
Ledebouria dolomiticola S. Venter	LILIACEAE	LR (nt)	LR (nt)	
Mosdenia leptostachys (Ficalho & Hiern) Clayton	POACEAE	LR (nt)	LR (nt)	K (northern provinces)
Orthosiphon fruticosus Codd	LAMIACEAE	LR (lc)	LR (lc)	
Orthosiphon tubiformis R.D. Good	LAMIACEAE	LR (lc)	LR (lc)	
Ozoroa albicans R. & A. Fern.	ANACARDIACEAE	LR (nt)	LR (nt)	K (northern provinces)
Pachypodium saundersii N.E. Br.	APOCYNACEAE	LR (lc)	LR (lc)	K (Swaziland)
Pavetta zeyheri Sond.	RUBIACEAE	LR (lc)	LR (lc)	K (Swaziland)
Pegolettia senegalensis Cass.	ASTERACEAE	LR (lc)	LR (lc)	R (KwaZulu-Natal)
Petalidium oblongifolium C.B. Clarke	ACANTHACEAE	LR (lc)	LR (lc)	
Rhoicissus sekhukhuniensis Retief, Siebert &Van Wyk	VITACEAE	LR (nt)	LR (nt)	
Rhus keetii Schönland	ANACARDIACEAE	NE	NE	
Rhus rogersii Schönland	ANACARDIACEAE	LR (lc)	LR (lc)	I (Swaziland)
Rhus sekhukhuniensis Moffett	ANACARDIACEAE	LR (nt)	LR (nt)	R (northern provinces)

Table 41 continued.

Species	**Family**	**Global status**[1]	**National status**[1]	**Red Data List status (Hilton-Taylor 1996)**
Rhus wilmsii Diels	ANACARDIACEAE	LR (nt)	LR (nt)	K (northern provinces)
Rhynchosia nitens Benth.	FABACEAE	LR (nt)	LR (nt)	K (northern provinces)
Scilla natalensis Planch.	LILIACEAE	LR (nt)	LR (nt)	V (Free State); V (KwaZulu-Natal)
Stapelia gigantea N.E. Br.	ASCLEPIADACEAE	LR (nt)	LR (nt)	R (western provinces)
Thesium gracilentum N.E. Br.	SANTALACEAE	DD	DD	K (northern provinces)
Thesium multiramulosum Pilg.	SANTALACEAE	DD	DD	
Tristachya biseriata Stapf	POACEAE	LR (lc)	LR (lc)	K (northern provinces)

Table 42 Summary of the conservation value of the Sekhukhuneland Centre plant communities that are a priority for conservation. Figures in bold are of value to determine conservation priorities.

	O	O	O	O	G	O	O	O	O	O	C	C	C
	4	7	4.2	5	3	4.3	7.1	6	2	7.2	1	2	3
SCPE endemics	**18**	15	15	15	**8**	14	13	12	14	13	9	9	9
SCPE near-endemics	**11**	**11**	10	9	9	**8**	10	9	**7**	**8**	**11**	**11**	10
Red Data List taxa	6	4	5	2	**8**	4	3	4	2	3	3	1	2
Restricted taxa	4	3	1	1	**6**	1	0	3	1	1	**6**	2	3
Total	**30**	**26**	**25**	**24**	**23**	**23**	**23**	**21**	**21**	**21**	**20**	**20**	**20**

	O	O	O	O	C	G	O	O	G	G	G	O	O
	3	8	7.3	5.2	4	3.1	2.3	3.2	5	2	3.3	3.1	4.4
SCPE endemics	13	11	11	11	10	6	11	11	**8**	6	6	10	10
SCPE near-endemics	6	**8**	**8**	**8**	**8**	**7**	**7**	6	**8**	6	6	6	6
Red Data List taxa	2	1	3	1	3	**7**	1	2	3	**7**	6	2	2
Restricted taxa	0	0	0	1	5	1	0	0	**7**	5	0	0	0
Total	**19**	**19**	**19**	**19**	**18**	**18**	**18**	**17**	**16**	**16**	**16**	**16**	**16**

CHAPTER 12

GENERAL DISCUSSION

12.1 Introduction

The principle hypotheses of this thesis state that the SCPE is characterised by plant communities, each being specific to a particular set of environmental variables, including a rich biodiversity with endemic and threatened taxa, and a specific relationship between certain plants and heavy metal soils. The results obtained support the hypotheses. The SCPE proved to have a diversity of plant communities which are specifically related to certain environmental variables (Chapters 4 to 9). The study did not aim to determine the endemic and threatened taxa, but merely to establish how these species were linked to specific plant communities. Endemic taxa have already been determined as part of a study to classify the area as a Centre of Plant Endemism (Siebert 1998). However, the present study revisited the topic and concentrated on rare and threatened taxa in the light of conservation priorities (Chapter 10). In addition, a first checklist has been provided for the study area to support its recognition as a Centre of Plant Diversity. Although Siebert (1998) indicated that a correlation exists between ultramafic soils and plant endemism for the SCPE, the question still remained as to what influence different soils of the SCPE have on the vegetation (Chapter 11).

This study adopted a broad approach in the floristic classification of vegetation to address the need for sound information on the floristic patterns and diversity of the threatened plants and communities of the SCPE. It aimed to provide useful botanical information that was lacking for the SCPE until recently. Basic techniques and statistical procedures were used to describe the vegetation of the SCPE. Apart from the identification of plant communities, analyses of plant-soil associations of indigenous plants were also explored. Thoughts on the phytogeography of the SCPE were presented in an attempt to explain some of the patterns of diversity. Various ideas born from speculations on conservation in the SCPE are put forward. Research opportunities were addressed to focus future activities of serpentine related research, not only in the SCPE, but also in similar savanna and/or ultramafic areas. Hence, this chapter not only comprises a discussion on the results of the study, but also on observations made during different stages of research which may be relevant to further botanical work in the ultramafic areas of the SCPE.

12.2 Plant communities

12.2.1 Syntaxonomy of major vegetation types

This study is the first attempt to classify vegetation types for the SCPE based on relevé data. It was intended to present a floristic classification of the vegetation of the SCPE and, where possible, correlate it with environmental factors. The plant diversity of the SCPE is enhanced by the complex topography and geology of the region, a sharp climatic gradient from northwest to southeast and specifically adapted plant endemics (Siebert 1998). A multitude of environmental factors give rise to complex ecosystems that are often characterised by diverse vegetation (plant communities) (Pignatti 1994). These diverse plant communities and heterogeneous environmental factors in turn constitute habitat for various plant species, which consequently lead to a high floristic diversity in the SCPE.

The study of vegetation often engenders the understanding of ecological processes and, therefore, for various practical, management and academic reasons, deserves to be described. Careful analyses of plant communities within the SCPE therefore constitute a valid scientific basis for assessing the floristic diversity.

The TWINSPAN classification and its subsequent refinement by Braun-Blanquet procedures resulted in the delineation of six major vegetation types and 82 syntaxa. This is a very high number of syntaxa when compared with other savanna regions (Lubbe 1997; Winterbach 1998; Hin 2000). When considering that only 50% (1 010 plant species/infraspecific taxa) of the total flora was recorded for these syntaxa, the richness of the region's plant communities is further emphasised, probably because many other combinations of taxa have not yet been recorded. This could also imply that about 50% of the plant taxa are so scattered or so rare that they were not recorded in the representative ecosystems identified. The 82 syntaxa belong to the major vegetation types in the following manner:

- Grassland and Wetland Vegetation – 17 (12 grassland; 5 wetland) plant communities
- Rock Outcrop Vegetation – 17 plant communities
- Open Mountain Bushveld – 20 plant communities
- Closed Mountain Bushveld – 20 plant communities
- Arid Northern Bushveld – 8 plant communities

Formal names of these major vegetation types, which represent higher syntaxa (probably at the class or order level), cannot be validly described according to the Code for Phytosociological Nomenclature (Barkman *et al.* 1986), because formal descriptions of the associations are not yet published. In addition, Pignatti *et al.* (1995) indicated that the definition of classes is not useful to give an account of vegetation under complex conditions. Taking into account the complexity of the SCPE, description were mostly restricted to the alliance and order level.

The SCPE predominantly falls in the Savanna Biome. Apart from the typical savanna (bushveld) plant species, such as *Dichrostachys cinerea*, *Enneapogon scoparius* and *Evolvulus alsinoides*, typical grassland elements such as *Acalypha punctata*, *Clerodendrum triphyllum* and *Thesium gracilentum*, and typical forest elements such as *Maytenus undata*, *Allophylus africanus* and *Apodytes dimidiata*, expresses the floristic identity of the SCPE. As discussed in the results, the Grassland and Wetland Vegetation show a relationship with the plant communities described by Bloem (1988), Deall *et al.* (1989), Du Preez & Bredenkamp (1991), Matthews *et al.* 1991 Smit *et al.* (1997) and Burgoyne *et al.* (2000). The Rock Outcrop Vegetation, Open and Closed Mountain Bushveld and Arid Northern Bushveld are related to communities identified by Werger *et al.* (1978), Van der Meulen (1979), Deall *et al.* (1989), Bredenkamp & Van Vuuren (1977), Matthews *et al.* (1992b), Bredenkamp & Deutschlander (1995), Visser *et al.* (1996) and Breebaart & Deutschlander (1997). The reasons for these relationships are discussed under the section on phytogeography (12.4).

Furthermore, these plant communities, in some instances, show species composition similarities with other regions in South Africa. A floristic link exists with the Northern Cape and Northwest Province (arid part of Savanna Biome), with species shared including *Gnidia polycephala*, *Jamesbrittenia atropurpurea*, *Nuxia gracilis*, *Polygala krumanina*, *Pterothrix spinescens*, *Rhigozum obovatum* and *Stipagrostis hirtugluma* subsp. *patula*. Another floristic link is with the Lowveld. These species most probably reached Sekhukhuneland via the Olifants River valley and include taxa such as *Balanites maughamii*, *Diospyros mespiliformis*, *Lonchocarpus capassa* and *Ptaeroxylon obliquum*. In addition, many other floristic links exist with other areas in South Africa, for instance, *Schotia latifolia* and *Protosparagus intricatus* with the Eastern Cape, and *Sesamothamnus lugardii* and *Commiphora tenuipetiolata* with the areas north of the Soutpansberg. It is, therefore, clear that although the SCPE falls predominantly in the Savanna Biome, it is extremely divers and carries elements from various other regions in South Africa.

A heterogeneous environment gave rise to diverse vegetation patterns in the SCPE. Hence, the bushveld of the SCPE is floristically distinctive and deserve recognition as a separate major vegetation type, provisionally referred to as **Sekhukhuneland Mountain Bushveld**. There are also other Mountain Bushveld types in the northern Provinces of South Africa, e.g. those of the Lebombo Mountains, Soutpansberg, Waterberg and Ohrigstad area. However, the following aspects concerning the classification of the zonal vegetation in the SCPE separates it from all the other Mountain Bushveld types:

- *Acacia tortilis–Dichrostachys cinerea* Arid Northern Bushveld should be seen as part of the proposed class of *Panico maximi–Acacietea tortilis* (Winterbach *et al.* 2000) — it also has a link with the lowveld of South Africa in the form of tree species such as *Ptaeroxylon obliquum*, *Lonchocarpus capassa*, *Diospyros mespiliformis* and *Combretum imberbe*.
- *Themeda triandra–Senecio microglossus* Cool Moist Grassland is representative of the *Tristachya leucothrix- Trachypogon spicatus* Class proposed by Du Preez & Bredenkamp (1991)—however, in the case of the SCPE it might be considered as an ecotone between highveld grassland and mountain bushveld.

- Currently the *Kirkia wilmsii–Terminalia prunioides*, *Combretum hereroense–Grewia vernicosa* and *Hippobromus pauciflorus–Rhoicissus tridentata* vegetation types are considered as part of the proposed class of *Englerophytum magalismontanum–Acacia caffra* Mountain Bushveld (Winterbach *et al.* 2000). However, this class does not consider the entire range of mountain bushveld types on clay and sandy soils of South Africa. A more inclusive *Acacia caffra* Mountain Bushveld Class is proposed, with an *Englerophytum magalismontanum–Acacia caffra* Order on nutrient-poor sandy soils and a *Kirkia wilmsii–Acacia caffra* Order on nutrient-rich clay soils. It should be kept in mind that ecological characterisation of classes depends more on soil characters than climate, and therefore these vegetation types can be seen as separate classes. However, a vegetation class should have a wide distribution range (Pignatti *et al.* 1995) and a local class restricted to the SCPE would not be meaningful.
- The proposed *Kirkia wilmsii–Acacia caffra* Alliance (Figure 33) is representative of Sekhukhuneland. Diagnostic species for this alliance would be *Aloe burgersfortensis*, *Asparagus sekhukhuniensis*, *Catha transvaalensis*, *Cyphostemma* sp. nov. (*Van Wyk 13389*), *Elephantorrhiza praetermissa*, *Euphorbia sekukuniensis*, *Hibiscus barnardii*, *Jamesbrittenia macrantha*, *Plectranthus venteri*, *Rhoicissus sekhukhuniensis*, *Rhus batophylla*, *Rhus sekhukhuniensis*, *Stylochaeton* sp. nov. (*Siebert 1332*), *Vitex obovata* subsp. *wilmsii* and *Zantedeschia pentlandii* (species groups B, D, E, G, H, I and J; Table 1). This conforms to the proposal of Pignatti *et al.* (1995) to use character species with certain uniformity in their geographical distribution.
- Many types of natural vegetation are far less stable than it appears to be, for small transient environmental changes can cause large and long-lasting vegetation change (Trollope 1998; Sprugel 1991). Open Mountain Bushveld which is an unstable form of the Closed Mountain Bushveld, is a result of yet unidentifiable natural disturbance regimes (possibly soil related). In many instances this thesis addresses the phenomenon.

Some of the floristic relationships of the SCPE with other regions are strong and others are weak, which emphasises that, although it can be related to some extent, the SCPE is a too diverse system in its own right to be incorporated in the Mixed Bushveld and should rather be seen as Mountain Bushveld. Additional support for the proposed recognition of the SCPE as a separate vegetation type, namely Mountain Bushveld, include the following:

- One of the characteristic trees in this type of bushveld is *Kirkia wilmsii*, a species that is relatively rare in other parts of the Mixed Bushveld;
- Almost pure grassland covers some of the mountain slopes in the region;
- Vegetation between the north- and south-facing aspects of the mountains are often strikingly different and floristically quite unlike other parts of the Mixed Bushveld;
- Intriguing vegetation anomalies associated with heavily eroded soils are present throughout the region;
- Species endemic to the region, for instance *Catha transvaalensis* and *Euphorbia sekukuniensis*, are abundant and are diagnostic species for certain major groups;
- Geology, and subsequently soil, is an important natural factor in the region, affecting both vegetation structure and composition.

This description and classification of the syntaxa of SCPE is a contribution towards the understanding of the vegetation and flora in the SCPE region as a whole. The identified vegetation units should be considered as ecologically interpretable communities for the area concerned at a given point in time. It has been claimed that no equilibrium exists in African savannas (Sprugel 1991), because individual disturbances are too large or infrequent and climate changes interrupt any movement toward equilibrium. However, not all workers are in agreement with this view. It is nevertheless important to note that the communities identified in this thesis were the “natural” plant communities for 1998 and 1999 seasons and the species composition may well change in future. The influence of climate on savanna plant communities has been described in detail on several occasions (Van Rooyen 1978; Bredenkamp 1982; Siebert 1998) and will therefore not be repeated here.

12.2.2 Ordinations

Plant communities of the SCPE can be related to certain environmental factors, which are illustrated along gradients in the various DECORANA scatter diagrams. This phenomenon is supported by the theory that local diversity and community patterns are strongly influenced on temporal and spatial scales by regional processes such as immigration (Loreau & Mouquet 1999) and changes in rainfall, soil nutrients, fire regime and herbivory (Skarpe 1991), with geology and topographic diversity explaining much of the remaining variance (Holland 1978; Schulze & McGee 1978).

This indirect gradient analysis is an exploratory approach which aims to produce hypotheses about possible environmental factors causing the observed gradients in the data. Results of the ordinations not only confirm the classification, but also reflect floristic and associated habitat gradients. Floristic variation is explained by climate, hence the occurrence of grasslands in the moist, cool southern region, mountain bushveld in the moderate central region and thornveld in the dry, warm northern part of the SCPE. Rainfall patterns have a direct consequence as continuous water source in the case of mountain grasslands, permanent water bodies/sources in the case of wetlands, and drought stress in the case of bushveld. It is known that the amount of and availability of soil moisture is not just a simple function of precipitation. Soil moisture availability is affected by factors such as surface drainage, evapotranspiration due to high temperatures and moisture retention. However, a suspected correlation between plant distribution patterns and environmental factors, such as soil moisture, is no proof of a cause-effect relationship and should ideally be tested by experimentation (Heikkinen *et al.* 1998).

However, on a larger scale the ordinations strongly support a continuum instead of several distinct vegetation units for the SCPE. It may also be interpreted that the vegetation units occur in certain regions of the gradient, and that the ecotones between units may be narrow or wide, forming a complex mosaic of continuity and discontinuity (Whittaker 1977). This is due to the gradual change of soil moisture availability along the slopes, aspect, soil types and rock cover of the landscape. Dynamics of soil moisture in the SCPE landscape clearly control the structure of the community at the first physiognomic level. This is a common phenomenon in savanna areas (Skarpe 1992; Solbrig 1993) and on southern African serpentinites (Proctor & Cole 1992). It is in an indirect effect as a source of soil moisture that rainfall has its most profound influence on the major vegetation gradients of the SCPE (e.g. Figure 8, 10, 12, 14 and 16).

For instance, as water stress is reduced, conditions become more favourable, and productivity would normally rise (Specht & Specht 1999). This effect is commonly observed between the north and south facing slopes of hills in the central area of Sekhukhuneland. As water stress, in terms of the relative amounts of evaporative demand increases on the north slopes, drought hardy species become prominent. The floristic composition of this Mountain Bushveld has a definite relationship with the Arid Northern Bushveld. However, on the cool, moist south-facing slopes the Mountain Bushveld shows a strong floristic affinity with the Afromontane elements of the Rock Outcrop Vegetation.

Surface drainage, evapotranspiration, moisture retention, and hence soil moisture availability, is determined by the soil type, which in turn was determined by the topographical position of the substrate during pedogenesis. The gradients of the ordination scatter diagrams are therefore an indirect consequence of topography and climate. The topography and climate gave rise to a diversity of soil types, of which most have a clay base due to the mineral properties of the mother rock. It can be concluded that the clay content and moisture index of the soils are the most important components of the ecosystem affecting the vegetation.

The texture and the type of clay minerals in the soils of the SCPE determine the percentage moisture of the soils and therefore it can be said that the:

- southern region where rainfall is high and evenly distributed, soils have sufficient available moisture for growth and therefore variability in vegetation composition on different soils are small;
- drier central and northern parts have differences in vegetation as changes in soil texture become marked, and the moisture-demanding species move from the clay soils to the more loamy and sandy soils;
- arid, most northern part, has small differences in vegetation, as different textured soils are all water deficient and become inhabited by the same drought-resistant species.

Catenal differentiation also plays an important role in that hill scarps, slopes and valleys all have different soil types and mineral concentrations (Chapter 5). Preference of plant communities for specific habitats in the Klaserie Nature Reserve (Witkowski & O'Connor 1996) compares well with the situation derived from the ordinations for the SCPE. The similarity in tree species composition and resulting topo-edaphic preferences between the two studies supports the results in this thesis, to name but a few:

- Vegetation types characterised by *Acacia nigrescens* in both studies prefer deep soils of relatively flat areas;
- Vegetation types characterised by *Spirostachys africana* in both studies prefer seasonal watercourses with clay soils;
- Vegetation types characterised by *Combretum imberbe* in both studies prefer lowlying areas with high silt content;
- Vegetation types characterised by *Pappea capensis* in both studies prefer rocky hillsides with gravel soils.

Although the various ordinations allowed a meaningful description of floristic variation locally, it does not fully identify the responsible environmental gradients. This can be explained through a holistic approach, because the region has an extremely heterogeneous environment resulting in intermingled major vegetation types with ecotones. For example, if the geology is considered, grasslands tend to be restricted to norites, mountain bushveld to pyroxenites, and mixed bushveld to alluvium.

As stated before, the study area lies on soils and exposed rock derived from related ultramafic substrates (Wild 1974; Roberts & Proctor 1992). It has been shown that the vegetation of rock outcrops is specifically adapted to their chemical environments (Morrey *et al.* 1989; Bredenkamp & Deutschlander 1995; Tyler 1996). It is therefore speculated that in addition to soil moisture availability, the chemistry of the study area's rocks, and subsequently soils, as well as the soil structure and soil depth, are responsible for the unique plant communities that occur in this region (this is discussed in sections 12.3.2 and 12.3.3).

12.2.3 Vegetation processes

Many studies have shown that the vegetation of serpentinite contrasts markedly with adjoining non-serpentinite vegetation in its structure (e.g. Wild 1965; Davie & Benson 1995; Brooks 1998). This is because the species have adapted to the chemical composition of the soil and the harsh, shallow-soiled physical environment of serpentinite outcrops (Baker 1981; Reeves *et al.* 1983; Morrey *et al.* 1989). The areas of the SCPE that are most influenced by soil chemistry are recognisable as areas with stunted and/or depauperated vegetation. It is clear that soils from serpentineferous areas are a distinct and important factor in plant ecology.

The vegetation classification emphasized the dominance of grasses in the herbaceous layer of plant communities on ultramafics, a phenomenon also characteristic of the vegetation on the ultramafics of Zimbabwe (Wild 1974; Guy 1975; Proctor & Cole 1992). Grass-tree coexistence in the SCPE, like other southern African savannas, is driven by the limited opportunities for tree saplings to escape both drought and the flame zone into the adult stage (Higgins *et al.* 2000), and hence is influenced by a complex network of local and large-scaled factors, notably water availability, herbivory, fire, soil texture, nutrients, phenological changes and anthropogenic interference (Cole 1986; Skarpe 1992; Breshears *et al.* 1998; Briske & Henderson 1998; Jeltsch *et al.* 1998; Lock 1998; Bjornstad *et al.* 1999; Higgins *et al.* 1999; Fischer 2000).

The *Kirkia wilmsii*-dominated vegetation of the ultramafic mountain slopes is dominated by broad-leaved woodlands and as a result of its structure should not be seen as Mixed Bushveld, but rather a type of Mountain Bushveld. Woodlands are common on ultramafic soils (Jaffrè 1980), and ultramafics should not always be seen as open grassland areas (Wild 1965). Guy (1975) and Chiarucci (1994) has reported woody coenoses that grow almost exclusively on sites with special pedo-morphological characters and do not show the extremely stunted woody species and grassland dominated communities typical of continents where the flora evolved before the ultramafic rock was exposed.

In addition, the classification of the vegetation indicates that long-term intensive grazing and wood harvesting has modified the vegetation structure of this dry bushveld in certain areas. Vegetation structure of savanna ecosystems can strongly be influenced by land-use. Altered species composition, decreased biomass and decreased species richness have been recorded in the woody communities of southern African communal grazing lands (Higgins *et al.* 1999). Briske & Hendrickson (1998) explain changes in vegetation structure, as a result of over-utilization, as an ecological consequence to minimise the effect of selective grazing/harvesting. This change in vegetation structure will reduce the probability of localised population extinction caused by long-term selective grazing/harvesting. Thus we can speculate that the dry bushveld areas of the SCPE are event-driven systems, and should the disturbance be removed, it will return to a type of savanna that will be determined by the environmental factors at that given time (Du Plessis 2001).

It has been shown that a good relationship exists between the floristic and structural-physiognomic classification of vegetation (Werger & Sprangers 1982). This implies that species composition is of the same level of importance as the structural-physiognomic feature. In turn this indicates that an area such as Sekhukhuneland, where the structural-physiognomic feature changes frequently, has a rich alpha diversity. This was supported by the findings of the phytosociological study. Areas with a heterogeneous environment has a varying structural-physiognomic feature and hence a rich plant diversity.

Interestingly, species diversity of vegetation anomalies is high when compared with bushveld vegetation types in the region (Tables 5, 10, 16, 21 and 26). The reason being that the vegetation anomaly has many open niches where the seed from plants in surrounding areas can germinate. Unlike favourable habitats, there are usually not many species dominating in a vegetation anomaly. Although the species richness of anomalies is lower than that of surrounding areas, the species diversity is high in comparison.

Foliar Projective Cover (FPC) determined for the vegetation structure on anomalies is quite different from the surrounding vegetation (Specht *et al.* in press). Where open bushveld usually has a FPC of Σ (20% overstorey and 30% understorey), an anomaly tends to have a FPC of Σ (5% overstorey and 45% understorey). The overstorey is comprised of scattered, sparse shrubs and the understorey by a few perennial and annual forbs and grasses. As the average height of a plant community increases, so does the FPC (Specht &

Specht 1999). Vegetation anomalies have a much lower average height than surrounding vegetation due to the stunting effect of the soil. A lower FPC implies lower soil moisture, because more bare areas are exposed to the sun. This in turn implies that a harsher environment is induced, which worsens the hostile effect of the soils towards the colonisation of the area by plant species from surrounding moister areas. This also explains why Karoo elements (*Pterothrix spinescens, Gnidia polycephala, Jamesbrittenia atropurpurea*, etc.) found these soils so attractive, because the soil moisture is probably the same as that which is experienced in the arid parts of the Northern Cape. Typical bushveld species prefer the moister slopes of hills and mountains. The absence of microphyllous thornveld on the anomalies, which are usually typical on clay soils in the valleys of the SCPE, can possibly be ascribed to the low nutrient levels and high Mg-levels found in the soils of anomalies.

Wild (1974a) reported that there is strong field evidence that where nickel values are low and the Mg:Ca ratio is high, pronounced vegetation anomalies are produced in the absence of a nickel effect. It is speculated that the scattered treeless hills among a majority of tree-covered hills in Sekhukhuneland can possibly be ascribed to extremely high Mg:Ca ratios rather than toxic effects of metals. A rock analysis of the treeless Mashishi Hill showed similar concentrations of Mg and relatively high Mg:Ca ratios comparable with that of serpentinite (Appendix 1).

12.2.4 Disturbance

Frequent droughts, extensive plant harvesting and unsustainable former land-use have left its scars in the SCPE. An analysis of the size structure in southern African communal lands suggested that grazing lands have a reduced capacity for regeneration that consequently predicts future species losses (Higgins *et al.* 1999). Large areas of the study area have already reached this stage.

The Afromontane Forests (<1 000mm/annum) in the SCPE are not as diverse as in the past due to over harvesting. It is doubtful whether 'disclimax' in forests created through past land use activities will ever develop into stands similar to the previous state, given the present state of fragmentation and continued disturbance taking place within these ecosystems (Roth 1999). Not only the forests, but also the mountain bushveld vegetation types are experiencing the same problem.

The ongoing unsustainable destruction of the woody canopy of the Bushveld plant communities is detrimental to its future recovery, as it has been shown that the woody canopy of communities in the SCPE region has a nurse plant effect on younger seedlings of trees and especially succulents (Thrash 1998). Due to continuous non-sustainable harvesting of indigenous trees in this region no more protection is given to seedlings during fire. Hence, the main factor for vegetation distribution and depletion during the past 50 years has possibly been anthropogenic. Small-scale disturbances act to increase the range of environmental conditions under which trees and grasses coexist as savanna (Jeltsch *et al.* 1998). However, large-scale disturbance, such as over-harvesting of trees, result in annual grasslands or bush encroachment by certain shrubs. According to Roth (1999), thorn scrub, which is structurally similar to the *Acacia tortilis* dominated shrublands of the northern part of the SCPE, is a form of secondary climax created through past land-use activities in areas once bearing more diverse dry woodlands. In semi-arid regions where event driven systems prevail, sustained disturbance will alter species composition to such an extent that the original, viable composition may never be regained (Westoby *et al.* 1989).

Alien species primarily invade areas of high indigenous species richness (Lonsdale 1999; Stohlgren *et al.* 1999), such as the grasslands of southern Africa. *Acacia dealbata*, an alien tree from Australia, has invaded large areas of the Roossenekal Subcentre and especially the adjacent Steenkampsberg. Removal of these trees is totally dependent on the owner of the land, with no large-scale projects being implemented. It is an ironic situation, with people 50 km to the north extensively chopping down indigenous bushveld trees for firewood. Future legislation might counter this indirect disturbance regime.

Species richness for small areas are positively related to the isolation of a plant community (Bruun 2000), which means that should rocky outcrops be disturbed, the species richness will be influenced negatively due to the long distances between similar plant communities. Therefore certain vegetation units, for example Rock Outcrop Vegetation and the associated habitats, will need special attention and should be considered for conservation purposes. Certain SCPE plant endemics of the rock outcrops are restricted to specific communities and these areas therefore require immediate attention in the light of the rapid developing mining industry of the region.

Certain SCPE plant endemics of the Open Mountain Bushveld are restricted to specific plant communities with a restricted distribution on heavy metal soils. Conservation of many localities of the same plant community is the most effective approach for the protection and survival of endemics of fractal landscapes such as ultramafic substrates (Witkowski & Liston 1997; With & King 1998; Harrison 1999). In the light of the intensive mining of areas rich in heavy metals, certain vegetation units or areas need immediate attention and should be considered for conservation purposes, as it may provide detailed historical knowledge for the application of ecosystem management (Swetnam *et al.* 1999).

No formal measures are in place for the protection of sponges in the major water catchments of the SCPE. Seepage areas are under threat on the Leolo Mountains. Increasing overgrazing and farming activities on the Leolo Mountains might cause future destruction of this important endemic area.

Highly degraded ecosystems, especially those in semi-arid regions, do not recover once the stress loads are lessened (Rapport & Whitford 1999), for these systems are event-driven (Ellis & Swift 1988). If the disturbance was drought, the species composition alternates between this event and the one during wetter periods. However, if this species composition is changed as a result of persistent human disturbance, the vegetation might be unable to recover to its so-called stable state. This is quite obvious in Sekhukhuneland, with old fields, heavily grazed areas, open cast mines and mine dumps covered by an annual grass layer and alien species infestations in the Closed Mountain Bushveld and Arid Northern Bushveld.

Locally dominant species are usually the most abundant during early successional phases and locally subordinate species are usually restricted to very harsh conditions (Olff & Bakker 1998). This phenomenon is a possible explanation for the Closed Mountain Bushveld-Open Mountain Bushveld gradient in the SCPE. In the Closed Mountain Bushveld, that has a low disturbance and late successional phase, the most common species are regionally dominant and include *Acacia nigrescens*, *Commiphora mollis*, *Acacia senegal* var. *leiorachis*, *Combretum apiculatum*, *Kirkia wilmsii*, *Terminalia prunioides*, *Clerodendrum ternatum*, *Barleria saxatilis*, *Psiadia punctulata*, *Sanseviera hyacinthoides*, *Aristida canescens*, *Enneapogon scoparius*, *Heteropogon contortus* and *Panicum deustum*. Open Mountain Bushveld can be divided into three different successional phases. The first is the vegetation of mountain slopes that is induced by a dry environment (form of natural disturbance) and include species such as *Combretum apiculatum*, *C. molle*, *Dombeya rotundifolia*, *Kirkia wilmsii*, *Ozoroa spahaerocarpa*, *Acacia ataxacantha*, *Enneapogon scoparius*, *Eragrostis chloromelas*, *Panicum maximum*, *Justicia protracta*, *Thesium burkei*, *Tephrosia purpurea*, *Pellaea calomelanos* and *Aloe castanea*. Locally dominant species are starting to colonise these dry habitats. The second successional phase is the Open Mountain Bushveld of the valleys, which is kept in this state by continuous sheet erosion during the rainy season. Both local dominant species like *Bolusanthus speciosus*, *Combretum hereroense*, *Aloe burgersfortensis*, *Rhynchosia komatiensis*, *Andropogon chinensis*, *Aristida adscensionis*, *Elionurus muticus*, *Loudetia simplex*, *Diheteropogon amplectens* and *Heteropogon contortus* and subordinate species like *Dicoma gerrardii*, *Tinnea rhodesiana*, and *Rhus keetii* are part of this system. Eroded donga systems are the third successional phase and are characterised by mainly subordinate species that prefer the harsh environment to escape competition. These species are *Gnidia polycephala*, *Pechuel-Loeschea leubnitzia*, *Nuxia gracilis*, *Rhus sekhukhuniensis*, *Stipagrostis hirtigluma* var. *patula*, *Euclea* sp. (*Siebert 934*), *Dicoma gerrardii*, *Jamesbrittenia* sp. (*Van Wyk 13026*), *Ledebouria marginata* and *Polygala* sp. (*Siebert 449*).

Throughout the SCPE the remaining natural populations of plants and animals are under intense pressure from exploitative land uses that can cause the local extinction of certain plant species due to the smaller range size and moderate to low local abundance. This is in accordance with the hypotheses on the relationship between distribution and abundance (Johnson 1998). There are certain areas with specific syntaxa (plant communities) that need special attention and were identified for consideration as a priority for conservation purposes. Some plant endemics of the southern region of the SCPE are restricted to specific syntaxa and these habitats therefore require urgent attention for conservation as a result of the rapid expanding mining industry, a common threat to southern Africa's rich phytodiversity (Dold & Johnson 1997).

12.3 Plant-soil associations

12.3.1 Maize experiment

It was observed that maize grown in the chromitite outcrop soil mixture became severely stunted (low Average Biomass Production) as a result of two factors. The first factor is directly related to interspecific competition for nutrients, with containers with eight seedlings showing retarded growth. However, the same was witnessed for the control. The second factor relates to soil toxicity. Cr and Ni are responsible for a reduction in biomass production. It is claimed that Cr and Ni limits the growth of maize indirectly by inducing phosphate deficiency (Robinson *et al.* 1935; Soane & Saunder 1959).

The study of the maize on typical ultramafic soils shows that areas in the SCPE have Cr and Ni available for uptake by plants, as low concentrations of both were accumulated by maize and symptoms characteristic of Ni and Cr toxicity were visible in maize leaves. Although Cr toxicity was not as intense as expected, the results predicted potential Cr toxicity in the SCPE, because many soils of the region contain high levels of total Cr in the subsoil.

As no leaf splitting was noted in the experiment, there was apparently no Ca-deficiency, which supports a theory that the ultramafic soils of Sekhukhuneland are Ca-rich and different from those of the Great Dyke in Zimbabwe; maize grown in serpentineferous soils of the Great Dyke displayed leaf edge splitting due to Ca deficiency (Cooper 1986). Maize seedlings had higher concentrations of Ca in their leaves than the levels of the ultramafic soil samples used for the experiment. This phenomenon possibly buffers the heavy metal toxicity to a certain degree, as high Ca concentrations in plant tissue is known to protect plants against heavy metal toxicity (Proctor & Cole 1992).

After the first two weeks, the root development of the maize seedlings grown in the toxic soils was stunted and the accumulation of the heavy metals was at its highest levels in the roots (Figure 27). Its is speculated that a kind of exclusion mechanism was initiated in the third week, with the root length catching up to that of the control and the heavy metal concentrations dropping slightly. Another reason for lower heavy metal concentrations in the root tissue during the third week could possibly be the depletion of heavy metals in the roots' soil environment as a result of intense uptake during the first two weeks and translocation to the leaves during weeks 3 and 4.

The maize experiment was motivated by the work of Cooper (1986) on the Great Dyke and speculations by Siebert (1998) that Cr levels in the soils of ultramafic rocks are available for plant uptake. However, once again no conclusive results were obtained with regards to Cr accumulation by plants. The results obtained are best supported by a study conducted on seven common vegetable crops by Zayed *et al.* (1999). They found the following with regards to Cr accumulation:

- Cr (VI) is converted in the root to insoluble Cr (III);
- Translocation of both Cr forms from roots to shoots is extremely limited;
- Accumulation of Cr by roots was 100-fold higher than in shoots.

Chromium is known to interact with Fe nutrition in plants (Bonet *et al.* 1991) by increasing its availability. This explains the extremely high concentrations of over 1 000 mg/kg of Fe in the roots and leaves of *Diheteropogon amplectens* in the natural environment and is supported by high levels in the other two indigenous grasses. These indigenous species, like *Zea mays*, belong to the same family as the Poaceae, and although maize is a possible indicator that high Cr levels are available for plant uptake, none of these indigenous grasses accumulated significant levels. It is a more likely scenario that Cr-induced Fe accumulation is the limit of the Cr effect in natural systems.

12.3.2 Catena soils

The physical and chemical properties of soils (edaphic factors) can elicit sharp discontinuities in the distribution of plants, and soils of highly contrasting lithological origin exert marked selective effects on floras (Kruckeberg 1969; Van Wyk & Smith 2001).

Across the ultramafic catena studied, soils vary considerably and harbour different plant communities with quite different species composition. This is because plants are adapted to different chemical concentrations and soil structures. There are various possible causes of the chemical concentrations and structure of the soils. The most important are the pH, Mg:Ca ratio and nutrient levels. Heavy metal concentrations are also important and are discussed in section 12.3.3.

The formation of organic floor humus after establishment of vegetation on ultramafic soils is certainly a reason for top-soil acidification and subsequent Mg leaching (Roberts & Rodenkirchen 1995). In similar studies conducted on the soil profiles of Australian serpentinites, it was found that pH becomes more alkaline (rises) with increasing depth (Forster & Baker 1995). It was also shown that as the soil depth increases, Ca concentration decreases and Mg increases, giving rise to a higher Mg:Ca ratio. The binding strength of Mg at humic exchange places is lower than that of Ca. As in Australian ultramafic soils, Mg moves (leaches) down the soil profile in alluvium soils of Sekhukhuneland. A similar sequence of events was most probably responsible for the leaching and subsequent donga formation (erosion) in the lowlands of Sekhukhuneland. This is supported by the concretions which are exposed by erosion. These concretions consist of 27% silicon, 17% magnesium, 13% calcium and 13% aluminium (Figure 24). Magnesium leaching weakens the structure of the top-soil and extensive soil erosion takes place – a natural phenomenon which is enhanced by prolonged overgrazing and trampling.

Chemical and physical analyses of soils derived from ultramafic rocks of the SCPE region have demonstrated similarities with some soils of the Barberton Greenstone Belt (Morrey *et al.* 1991). However, differences in chemical and physical characteristics between soils of both regions were evident (Table 37), and are likely to have resulted from differences in geochemistry, elevation and climate.

Soils of certain mountain slopes of the SCPE have Ca concentrations which are similar to those that can be expected for calcretes (Specht *et al.* in press) and gypsum (Wild 1974c). Although the Ca-rich mountain slopes of the SCPE are not calcrete or gypsum soils, they harbour a rich plant diversity with many SCPE endemics, SCPE near-endemics and Red Data List taxa. In addition the flora is ecologically distinctive and the dwarfing of of woody species very characteristic (certain plant communities of the Open Mountain Bushveld). It is speculated that these soils have a similar chemical composition to the dolomites of the Wolkberg Centre of Plant Endemism (Van Wyk & Smith 2001).

Vegetation anomalies on serpentinites have been shown to be a result of soil infertility (Brooks 1987). Fertility levels of P, K and S are higher in Sekhukhuneland soils (Appendix 3) than on serpentinites (Morrey *et al.* 1989; Balkwill *et al.* 1995; Forster & Baker 1995). However, the anomalies in Sekhukhuneland have low nutrient levels, and although the average nutrient level for the whole SCPE is higher than that of serpentineferous areas, the anomalies have similar levels and subsequent stunted vegetation. The heterogeneous geology of the SCPE gave rise to diverse soil patterns, and subsequently areas with high nutrient levels, especially the lower mountain slopes.

The pH levels for the ultramafic soils of the SCPE are more alkaline than the levels known for serpentinite. Under high rainfall conditions soils tend to be acidic, but where leaching is not severe under lower rainfall regimes, such as is the case in the SCPE, soils are often decidedly alkaline (Rattray 1963). Similar to the results obtained by Wild (1974a) for the Great Dyke, in Sekhukhuneland two types of ultramafic rocks are present, namely those with high Mg:Ca ratios and those with high Ca levels (Appendix 2). Hence, this higher soil fertility, higher Ca-levels and more alkaline pH levels in certain areas of the SCPE are not typical for serpentineferous areas and indicate that the habitats in Sekhukhuneland are even more diverse than serpentinite areas, as both serpentine and non-serpentine (dolomite-related) characteristics are intermingled.

12.3.3 Metal accumulation

Thresholds of hyperaccumulation of heavy metals have not yet been officially formulated, but it can be explained that 1 μg/g of gold in plant material might well represent hyperaccumulation since this level is probably a few hundred times the normal concentration of this element in soil (Brooks 1998). However, hyperaccumulation of heavy metals has been arbitrary defined as the accumulation of a heavy metal to concentrations of more than

1 000 μg/g on a dry matter basis in above ground plant tissues (Brooks *et al.* 1977). If geochemical associations in the soil are reflected in the plant material, then the accumulation is indicative of passive uptake by the plant without specific accumulation or exclusion (Brooks & Yang 1984).

The main interest in heavy metals of the SCPE arose from the high levels of Cr in its soils. Despite high total Cr concentrations in ultramafic rocks, and subsequently soils, of the SCPE, its toxicity in plants is rare in the field, because its plant availability is generally low (Kimbrough *et al.* 1999). Soil Cr concentrations are largely determined by parent material, but total soil Cr content is of little relevance to plant uptake because most is present as insoluble Cr (III) at normal pH (Wild 1974b; Bartlett & James 1988; Sumner & Naidu 1995), which is mostly the case in Sekhukhuneland.

Chromium can exist in soil solution in a number of oxidation states, the dominant state being determined by both the E_h and pH of the soil environment (Rai *et al.* 1989). Under normal soil pH and E_h conditions, Cr (VI) species are anionic and are generally mobile in most neutral to alkaline soils. In acidic soils Cr (VI) is removed from the solution by adsorption on to positively charged sorption sites (Zachara *et al.* 1989). Cr (VI) is also rapidly reduced to Cr (III) by Fe (II) minerals and organic compounds under acidic conditions (Hughes & Noble 1991). It is speculated that this may be the case in the SCPE, which would explain the low levels of available Cr.

Chromium (VI) is the source of plant available chromium (Nriagu & Nieboer 1988). The argument in the previous paragraph supports the lower Cr accumulation on mountain slopes, because Cr (VI) is rapidly converted to the insoluble Cr (III) compounds by organic matter (acidic). However, the lower the pH, the greater the solubility in the soil and the higher the accumulation of heavy metals such as Ni by plants (Sumner & Naidu 1995; Steyn *et al.* 1996). Nickel moves from the insoluble pool into the soluble pool in the soil when it is taken up by plants (Balkwill & Burlin 1995). Nickel is able to use the calcium transport proteins to facilitate its uptake into the plant (Antonovics *et al.* 1971). Calcium is limiting in serpentineferous soils, thus it could be expected that more Ca-ports are open to enhance the

Ca-uptake and subsequently Ni-uptake. This was not the case in the Sekhukhuneland study area and Ni was not markedly accumulated.

As is the case with ultramafic soils in Australia (Forster & Baker 1995), heavy metals do not appear to mobilise down the soil profile, but is transported via the different soil groups onto the alluvial plains. Where surface soils are exposed in the eroded areas, such as certain parts of the Steelpoort River valley, Cr (VI) mobility in subsurface soil horizons are less likely to be retarded due to the absence of organic matter. Hence, the higher uptake of Cr by plants growing in the dongas of the valleys. However, the pH is also lower in these areas and subsequently inhibits Cr accumulation to the relatively low levels recorded for this study as a result of the reduction of Cr (VI) to the insoluble Cr (III). High levels of Fe (II) minerals might also have a binding effect.

Concentrations of elements in plant material of species growing naturally on ultramafic soil in Sekhukhuneland show that species are unable to totally isolate themselves from the unusual chemical composition of the soils. Many studies have been done on the physiological methods whereby plants exhibit tolerance or react to heavy metals (Gabbrielli *et al.* 1995; Mesjasz-Pryzybylovics *et al.* 1995; Mattioni *et al.* 1997; Pletsch & Charlwood 1997; Takuwa *et al.* 1997; Chardonnens *et al.* 1998; Zheng *et al.* 1998; Dannel *et al.* 1999; Pandey *et al.* 1999; Przymusinski & Gwozdz 1999; Schickler & Caspi 1999; Wollgiehn & Neumann 1999; Yamaguchi *et al.* 1999). In a scatter diagram of the nutrient level versus the heavy metal concentration of all plant material collected along the catena, it is shown that metal uptake increases as nutrient uptake decreases (probably due to low soil fertility). The reason for this remains unclear as element levels alone are inadequate for understanding ultramafic tolerance and need to be interpreted in the context of the nutrient requirements and tolerance of each species. As this and other studies have shown, ultramafic tolerance can be achieved by species differing markedly in the heavy metal levels of their tissues.

Normal linear relationships between soil concentration and plant uptake of nutrients and Mg was recorded for the catena. However, the same trend was not evident for the heavy metal concentrations and a noteworthy phenomenon was recorded for the study area. As the metal concentrations in the soil increases, the levels in the plants decrease. This was investigated further and it was found that the plants take up heavy metals from the soil up to a certain threshold level, where after an exclusion mechanism switches on to prevent excessive uptake and subsequent toxicity. Hence, the plants of the study area can be seen as excluders of heavy metals when a specific soil concentration level is reached. The critical levels are different for different elements.

It is known that certain plants accumulate up to four times higher calcium concentrations in their tissues to counter the toxic effects of heavy metals (Robertson 1985; Brooks 1987). Uptake of calcium is not related directly or otherwise to magnesium, but rather that magnesium affects uptake of other nutrients (Brooks & Yang 1984). The Mg:Ca ratio is in almost all cases higher than 1 in serpentineferous soils (Johnston & Proctor 1981), but the contrary is true in plants, where Ca concentrations tend to be higher than Mg concentrations (Konstantinou & Babalonas 1996). It has also been shown that plants can be calciotrophic, especially succulents, which means they are able to accumulate and store calcium in their tissue saps (Meyer & Popp 1997). A more likely scenario for the higher Ca concentrations in plant species from the SCPE, therefore, possibly relates to the biological Ca-cycle. Foliar concentrations of Ca invariably exceed those of Mg. Subsequently the plant species analysed in the present study (these are found on both ultramafic and non-ultramafic soils), have higher Ca than Mg foliar concentrations, but have lower foliar concentrations of Ca than those higher plants restricted predominantly to ultramafic soils (Brooks & Yang 1984; Morrey *et al.* 1989) (similar trends were found by Lee *et al.* (1995)). This could be ascribed to the lower toxicity of SCPE soils.

In addition, the presence of savanna on the dolomites of the adjacent northeastern Drakensberg Escarpment (Wolkberg Centre of Plant Endemism) also reinforces the floristic relationship which exists with the SCPE. The arid dolomitic areas of the Wolkberg Centre share many near-endemics with the SCPE. The floristic similarities may be explained in part by the high concentrations of Mg and Ca in both the dolomite-derived soils of the Wolkberg Centre and norite/pyroxenite-derived soils of certain mountain slopes in the SCPE.

12.4 Phytogeography

12.4.1 Local speciation

The extreme diversity of landscapes in the study area is reflected in the diversity of its botanic composition. Diversity increases with altitude and is highest on the grassy slopes of the mountainous areas in the south. In the bushveld areas, rocky outcrops and footslopes of hills have lower diversity, but midslopes of hills and valleys have higher diversity of almost the same magnitude as the grasslands. The diversity of the study area must not be underestimated, as floristic elements from the adjacent Northeastern Mountain Grassland, Mixed Bushveld and Afromontane Forests are well represented. In addition the study area has an endemic flora of its own, and floristic relationships with the Eastern Cape forests, Northern Cape Kalahari thornveld, Northern Province semi-arid Mopaneveld north of the Soutpansberg and the Mpumalanga Lowveld.

In the SCPE soils of ultramafic origin have obviously stimulated the development of syntaxa adapted to the specific soil conditions and have created refugia for taxa from other areas, with high concentrations of certain elements, notably heavy metals. Such a plant community (syntaxon)-soil association on ultramafic substrates has previously been identified for southern Africa, on the Great Dyke of Zimbabwe (Werger *et al.* 1978) and the Barberton Greenstone Belt in South Africa (Morrey *et al.* 1989). Due to the ultramafic nature of the serpentinized harzburgite, pyroxenite, anorthosite and norite of the SCPE, many taxa of the study area are uncommon or absent in other savanna areas of southern Africa (Siebert 1998). Variation in the plant community can therefore be seen as synchronic or ecological (factors acting in the present) as was indicated with the scatter diagrams of the ordinations (section 12.2.2) (Pignatti 1994).

However, variation in plant communities can also be ascribed to historical or diachronic factors (Pignatti 1994). Many plant communities in the SCPE are rich in endemic species. Plant endemics and distribution patterns are a direct consequence of the earth's historical phytogeography (Stott 1981; Major 1988). For instance, many plants in the northern hemisphere exhibit endemism and distributions which correlate with past glacial advances (Stuessy 1990). Endemism on the ultramafic soils of Sekhukhuneland is extremely low when compared with other ultramafic areas of the world, for instance Cuba (Reeves *et al.* 1999) and New Caledonia (Jaffre 1992). Time on the million year scale (possibly since the Miocene), without glaciation, is necessary for speciation processes to take place on ultramafics, as the surface cover of these soils are well out of proportion to the land area covered by other soils of the same floristic region (Reeves *et al.* 1999). Croizat (1968) indicated that the dispersal of an endemic taxon is never less complex than the historical geology of its substrate. However, Balkwill *et al.* (1995) has shown that a stronger similarity exist between true serpentinite floras of Mpumalanga and those grassland areas of other parts of Mpumalanga, than with other serpentinite areas of southern Africa such as the Great Dyke of Zimbabwe. Admittedly these two serpentinite areas are quite far apart.

There is some evidence that endemic taxa of the eastern Rustenburg Layered Suite have evolved as a result of a neoendemic process due to the presence of nearby possible precursors which might have led to recent speciation to become operative (Siebert 1998). It is speculated that the endemic forms of common widespread species are "soil-adapted" neo-endemics which speciated recently, perhaps after the Pleistocene (Brooks 1983; Reeves *et al.* 1983), and has not yet had the time to migrate out of the Steelpoort River valley. It is suggested that these ecotypes developed from common species as a result of the genetic propensity of the latter to colonise ultramafic soils such as serpentinite (Wild 1974a). The presence of physiological races of widespread species on soils rich in heavy metals implies tolerance of metal toxicity.

Sekhukhuneland endemics prefer the Ca-rich soils. Very few endemics were recorded on the Mg-rich chromium outcrops and eroded areas (dongas). Morphologically slightly deviating forms of abundant common species were, however, common to Mg-rich soils—possibly indicating early adaptation and the beginning of speciation. Tolerance of heavy metals by plants of the Sekhukhuneland region is a direct selective consequence of the presence of heavy metals and has a high heritability. According to Kruckeberg & Rabinowitz (1985), populations in non-toxic environments may contain tolerant genotypes preadaptively, so natural variation in the capacity to withstand the metals is present in natural populations. In other words, it is the genetically inherited exclusion mechanisms within indigenous plants (Morrey *et al.* 1989), which counter heavy metal toxicity.

Generally ecologically driven speciation is the result of habitat specific preferences. This has been investigated and confirmed for an endemic species and its widespread congener (Chung & Kang 1996), as well as for two endemics of the same region (Menges *et al.* 1999). In the case of the endemics of the SCPE, open niches of vegetation anomalies drove speciation on an anomalous Ca-rich substrate or Mg-rich substrates. Similar trends have been perceived between especially limestone (Ca-rich) and sandstone, once again for an endemic and its widespread congener (Walck *et al.* 1999), as well as two endemics of the same region (Mustart et al. 1994). Like limestone, the soils of mountain slopes of pyroxenite and norite hills are Ca-rich, being almost double that recorded for the growth medium of surrounding soils. Furthermore, the Ca-rich soils have relatively high concentrations of Al, Fe and Ni (typical elements of serpentinite).

The plant taxa from heavy metal soils analysed in this study are recurring members of the flora, and also occur on other phytogeographical distinct associations on uncontaminated soils elsewhere in the Northern Province and Mpumalanga. The ecological amplitude of a species can be wide enough for it to live not only in its usual habitat, but also in less favourable surroundings, where under different conditions a base is provided for further ecological adaptation (Rattray 1963). Physiological races of a species can explain this adaptation. However, it is not yet clear if physiological races of widespread taxa exist for the SCPE.

Species that are totally confined to metalliferous soils are often accumulators and those, which have evolved tolerant and non-tolerant races on and off contaminated soils, frequently behave as excluders (Baker 1981). It can therefore be accepted that no hyperaccumulators of Cr and Ni were recorded for the SCPE, for the majority of species occurring on metalliferous outcrops are probably physiological races belonging to the group defined as excluders. It can, however, also be speculated that species from surrounding non-ultramafic soils are probably accumulators when in rare occasions they do grow on the ultramafic soils. Common plant species on the ultramafic soils of the SCPE are therefore classified as heavy metal tolerant, have developed exclusion mechanisms and therefore perform much better than other local species. These excluders are dominant in the plant community, although they can grow better elsewhere where they are usually not the dominant species. Most of these plant species appear to have a broad tolerance of shallow, poorly drained, rocky soils.

To give one single explanation for the high degree of endemism in Sekhukhuneland would be impossible, because endemism is the product of a number of interactive environmental and biotic factors. Soils rich in heavy metals have already been discussed. Certain soils in Sekhukhuneland are also rich in nutrients, such as Mg and Ca, and occur in drier areas where nutrients are not significantly leached out. Sharp changes in climate as a result of the region's topography also contribute to endemism. Annual precipitation is for instance an important vegetation determinant in the Mixed Bushveld and can be used to determine the distribution of plant communities (Palmer & Van Staden 1992). In the SCPE the regions that fall within the rain shadow of the Drakensberg Escarpment is a prime example of this. The diverse habitats that result from the varying patterns of high and low rainfall and/or temperature over short distances create ample opportunities for plants to adapt to specific habitats and to give rise to unique floristic pockets restricted to specific geographical regions. One way of analysing this unique flora as a consequence of a heterogeneous environment is to look at the environmental factors that gave rise to the specific plant communities (Chapters 4 to 9).

12.4.2 Local floristic classification

Floristic plant geography is applied to classify the land areas of the earth into floristic areas. Unfortunately, floristic geographers usually adopt such classifications for reasons of convenience, not because analyses of plant distributions have revealed geographic patterns that are inherently hierarchical and hence best described by a hierarchical system.

According to McLaughlin (1992), some of the earliest classifications of land areas into floristic regions were conducted at the beginning of the 1800s. A thorough treatment of the floristic kingdoms and regions of the world is provided by Takhtajan (1986). He refers to floristic areas of any rank as phytochoria and classifies these hierarchically as district, province, region and kingdom. These classifications are hierarchical—smaller areas are nested within successively larger areas. The primary purpose of a floristic classification is storage and retrieval of information. It is used to determine to what degree the choria defined at lower levels are nested within those defined at higher levels.

A hierarchical classification is also evident for the northeastern Escarpment. However, it is unclear how the SCPE fits into it. The occurrence of Wolkberg Centre elements in the Sekhukhuneland Centre and visa versa accentuates the close floristic affinity that exists between these two Centres of Plant Endemism. This implies that although it seems appropriate to classify the Sekhukhuneland Centre as a subcentre of the Wolkberg Centre, it has a strong Zambezian affinity and cannot be classed at the same hierarchical level as the Blyde and Serala Subcentres of the Wolkberg Centre (Matthews *et al.* 1993), because these subcentres are mainly Afromontane. The SCPE lies mainly in the Zambezian Region, with Afromontane Elements. When the families of endemic plant taxa are compared with the ranking of families which predominate in the Afromontane, Grassland and Savanna Biomes (Gibbs Russell 1987), it shows a better association with savanna (Siebert 1998).

Only after all the Centres of Endemism in the northeastern Drakensberg Escarpment have been adequately resolved and their floras described, will it become clear where the SCPE should be classed in a hierarchical classification of floristic regions. The ideal scenario is a main Centre of Endemism for the northeastern Drakensberg Escarpment with several subcentres, similar to the idea proposed by Croizat (1965), concerning the Barberton Node of Diversity. Such a main centre in the northeastern Drakensberg Escarpment may well solve the problem concerning the status of near-endemics on the regional scale.

At present a viable alternative to the hierarchical classification of the Sekhukhuneland Centre under the Wolkberg Centre as a subcentre, is to consider the Sekhukhuneland Centre areas, which are rich in Wolkberg Elements, as transitional zones. Recognising the arid bushveld vegetation of the adjacent Transvaal Sequence, with its similar physiognomy, as floristically different to Sekhukhuneland, further strengthens this alternative. In addition, the demarcation of the SCPE as the land area underlain by the Rustenburg Layered Suite further emphasise its uniqueness, as floristic regions have shown to be associated with specific geological units The above is suggested because the northeastern Drakensberg

Escarpment has a very rich and heterogeneous flora and no definite lines can be drawn for floristic regions based on existing floristic information.

It is speculated that much of the floristic diversity and vegetation distribution in the savanna of the SCPE can be attributed to the vegetation dynamics and historic evolution of the region, which is influenced by the surrounding flora and continual disturbance by flooding of the Olifants River. Immigration from introduced (human) and regional (Olifants River valley) sources had a considerable influence on the local patterns and species composition of this region. Loreau & Mouquet (1999) have demonstrated that local diversity, community patterns and ecosystem processes are strongly influenced by plant immigration. This is certainly the case for the bushveld of the SCPE with its link with the surrounding flora (Serala, Lowveld, Pietersburg Plateau), continual flooding disturbance (alien species, bush encroachment) and aridity (Karoo, western Rustenburg Layered Suite, area north of Soutpansberg). The history of the region therefore illustrates how the Sekhukhuneland Centre has played a role as a transitional zone for plant migration.

The above argument brings us to the question whether the higher syntaxonomic levels (class or alliance) of plant communities can be used to determine the lower hierarchical levels of Centres of Endemism. Binary (presence/absence) data sets have been used successfully in many biodiversity and phytogeographic studies and will for the foreseeable future remain the source of information for broad-scale analysis of plant diversity and distributions (Kadmon & Heller 1998; Siebert 1998; Van Jaarsveld *et al.* 1998; Van Rooy 2000).

It is for this reason that vegetation and floristic data cannot be brought together in a hierarchical system of classification. The flora is classified on the grounds of species presence/absence, usually at the quarter degree grid scale. However, vegetation classifications work at a different scale, usually plot size and are based on species abundance in plant communities (syntaxa). Since character species have their specific ecology, their presence implies that the members of a syntaxon must correspond to the same ecological space. Syntaxa are therefore not only small floristic units, but also have an ecological meaning. In contrast, centres of endemism are large floristic units, and character species do not necessarily correspond to the same ecological space.

The measure of abundance, namely the number of specimens of each taxon collected, which is used in phytosociological databases, is not considered as practical for biodiversity and phytogeographic studies (Oliver *et al.* 1983). It can be said that the main reason why floristic regions cannot be linked to phytosociological classes, is that the floristic region's definition is based on the occurrence of rare species with restricted distributions and that of the vegetation class on the abundance of common species. Also, vegetation classification does not, at least at lower hierarchical levels, consider the total geographical range of a species, but merely presence/absence in a plot.

Pignatti *et al.* (1995) proposed that associations belonging to a class should be grouped according to a common ecology and be recognised by character species with a similar geographical range. Therefore, the higher syntaxa (class or alliance) should show some relationship with phytogeography as it takes into account the distribution range of the most abundant taxa. However, it also takes into account the ecological species composition, which is usually very specific for endemic species.

In South Africa vegetation classification at the higher levels does not currently take into account the occurrence of local endemic species, but focuses more on widespread, prominent species. The current study takes into account the common ecology of associations with a similar geographical range to argue for the recognition of an Alliance (section 12.2.1). If this alliance is recognised by the broader scientific community, this thesis has brought together phytosociology and phytogeography, as the alliance and the Subcentre of Endemism are likely to have the same geographical range.

However, presently the SCPE will be treated as a Centre on its own. It has levels of endemism and diversity comparable with various other centres of floristic endemism in southern Africa. Its unique geology and associated plant diversity alone indicates its recognition as a Centre of Plant Endemism and a Centre of Plant Diversity when measured against the criteria given by Davis *et al.* (1994). Should the proposed alliance be accepted, we will have a measurable entity to accurately map the extent of the SCPE based on the distribution of specific associations. In addition it will be a good example to illustrate the importance of phytosociology in the demarcation and lower classification of Centres of Endemism/Diversity.

12.5 Conservation essay

The rapid political, economic and social changes in South Africa have resulted in a critical review of issues such as land allocation, sustained utilisation of natural resources and conservation policies (Smith 1994; Wells 1996; Hackel 1999). In addition, conservation of rare plant populations has become an important dimension of, and central to, the preservation of biodiversity (Smith 1994; Naeem & Li 1997). The argument for conservation of plant populations is determined by a high plant diversity and plant endemism, a high degree of threatened plant taxa, as well as a unique climate and physiography of a floristic region (Prendergast *et al.* 1999; Myers *et al.* 2000).

The study area is a part of South Africa with hardly any formally protected areas; it is also a region where the emphasis is on mining, farming and rural development. The Sekhukhuneland floristic region also has a rich plant diversity and endemism, a high degree of threatened plant taxa, as well as a unique climate and physiography (Siebert 1998; Siebert *et al.* 2002b). This satisfies the *international requirements for the conservation of plant populations* (Prendergast *et al.* 1999; Myers *et al.* 2000) and means attention should be given to the development of conservation plans for the region. However, currently only one conservation area (Potlake Nature Reserve - proclaimed in 1975) enjoys official conservation status in the region. Three conservation areas were proposed for Lebowa (Botha 1983) of which Potlake Nature Reserve would have been located within the SCPE. It is clear that nature conservation in this unique floristic region has lagged behind and there is a need for this neglect to be addressed as soon as possible.

When the state of the environment in the SCPE is considered in the light of current developments in the region, the future looks rather bleak. Pressure from the mining industry and a growing human population are not likely to disappear, nor is it likely that government will spend much money on the development of conservation areas in this relatively small

Centre. Hence, an obligation to develop a conservation area in the SCPE should lie with financially strong parties, such as the mining industry.

In my judgement the future conservation of the SCPE is dependent on the *formation of a partnership for ecosystem conservation* (Franklin *et al.* 1995). This partnership should involve the mining industry and leading, capable agencies such as the provincial nature conservation departments and interested parties. A sound and successful conservation plan would, however, be totally dependent on the participation of a third party, the local people. The attitude of local people towards sustainability and extinction is a rather controversial topic, and should be addressed before an area is conserved (Mace & Hudson 1999).

Land-use change is seen as the most important factor in biodiversity change in the world over the next 100 years (Sala *et al.* 2000). Although the mining industry owns extensive land areas, their activities only impact negatively on the biodiversity of small areas of their property. It is especially obvious when compared with large-scale activities such as commercial afforestation. It therefore seems appropriate to target the land areas of mining companies for conservation actions.

For obvious reasons, no mining company will part with its land. It is suggested that the mining companies, in collaboration with nature conservation agencies and the local people, design a management plan for pristine areas of their land. Such a plan would consider the sustainable utilisation and conservation of these management units, because no-entry for parks and reserves are rejected by large numbers of local people who live off the land (Carruthers 1993; 1994).

The main conservation objective in the SCPE is therefore the sound management of the land. When management units are declared, the carrying capacity of each should be determined. These units should then be managed according to their ability and resilience, and monitored to prevent future loss of important species. Sustainable harvesting of wild and/or endangered plant species should be based on basic principles of economic behaviour and should be properly monitored. This will ensure species protection through control measures to avoid wasting of valuable resources and through financial incentive projects to realise the monetary value of ecosystems (Hampicke 1994; Medellin 1999; Shogren *et al.* 1999; Gullison *et al.* 2000; Musters *et al.* 2000).

Among the initial expenses will be the training and employment of local people to control the harvesting of natural resources. Sacrifices to be made by the mining companies would be limited to the sustainable use of their land by the local people, a pledge to sell the land for the sole purpose of more comprehensive conservation actions, and to refrain from any development in the pristine conservation areas. This would make the protection of this unique floristic region a relatively inexpensive incentive. If approached in the correct manner, this could be the first step towards a biosphere initiative for the SCPE. Conservation outside nature reserves in hospitable environments in managed landscapes is essential in a species-rich area such as South Africa, because large numbers of plant species are not being protected formally (Wessels *et al.* 2000).

Red Data List information should be used to motivate for the management and conservation of the vegetation and habitats, especially the areas threatened by the mining industry and inappropriate forms of land-use, specifically overgrazing by domestic stock. Baseline data such as this will provide botanists with sites to conduct further studies on rare and threatened plant species (Bevill & Louda 1999; Golding 2001a), which will provide a rough guideline of important botanical regions to conserve formally. Detailed site-specific studies remain a prerequisite before suggestions concerning land-use (mining, farming, conservation, etc.) can be made and work should be based on local SCPE studies such as the work conducted by Knowles & Witkowski (2000). It is also important to remember that species diversity 'hotspots' are rarely congruent for all groups of organisms (Van Jaarsveld *et al.* 1998) and future research might show the importance of other groups of organisms, such as the herpetofauna or lepidoptera. Biodiversity increases ecosystem stability by promoting diversity among species in their responses to environmental fluctuations (Naeem & Li 1997; Grime 1998; Ives *et al.* 1999) and hence, is imperative for successful conservation initiatives.

Statistical analysis incorporating all the threatened and endemic groups can then be used to select fully representative reserve networks for the SCPE (Bedward *et al.* 1992; Pressey *et al.* 1999). The establishment of nature reserves or protected areas is one solution to this problem of biodiversity loss; this is best achieved through a land-use stratification derived from a holistic overview. Such a strategic environmental assessment that includes an adequate database of natural features and other land uses (Bedward *et al.* 1992; Wessels *et al.* 2000) should be a priority for conservation agencies in the region. This provides a basis for proper and sound assessment of the region's vegetation, as it includes aspects such as species richness, rarity and habitat preference.

However, to abscond from yet another priority-setting exercise, it is important for nature conservation agencies to work in collaboration with other role players such as academics at institutions of tertiary education and the National Botanical Institute. Such an effort would establish teams that are capable to negotiate on the basis of factual evidence with the relevant mining companies. Partnerships are a means to increase the capacities of local communities, government agencies, outside experts and financially capable companies for environmental stewardship (Michaels *et al.* 1999).

If we manage to gain the scientific, financial and political means to protect the rare and threatened plant species of the SCPE by accomplishing the above conservation objective with the help of the South African mining industry and nature conservation agencies, we will comply with the means for effective biological conservation, namely to satisfy human needs in a sustainable manner while still protecting our unique floral heritage in southern Africa (McLarney 1999). To ensure the long-term support of the rural people in the SCPE, local schools should be actively involved and children educated about the importance to conserve the natural ecosystems in their region (Rivas & Owens 1999).

Even if we manage to gain the scientific, financial and political means to save the main subcentres in the SCPE, we would still face loss of species diversity due to the large human population (Cincotta *et al.* 2000; Harcourt *et al.* 2001). Unless we find ways to protect ecosystem (plant community) function and ensure the long-term stability and well-being of the poor rural people, priority-setting exercises would merely serve as historical documents showing us the patterns of diversity we have lost.

The SCPE is an important area for the protection of taxa with conservation value along the northeastern Drakensberg Escarpment, especially the plant communities of the *Tristachyo leucothricis–Cussonietum transvaalensis* (specifically the *melinetosum nerviglumis* and *argylobietosum wilmsii*) moist bushclump areas of grasslands, the *Loudetio simplicis–Eucleetum linearis* (specifically the *diheteropogonetosum amplectentis* and *heteropogonetosum contorti*) anomalous open mountain bushveld, the *Eragrosti lehmannianae–Hippobrometum pauciflori* bushclumps of dongas, the *Enneapogono scoparii–Acacietum leiorachis* dry woodland stands, the *Aristido rhiniochloo–Gnidietum polycephalae* disturbed donga vegetation and the *Brachiario serratae-Melhanietum randii* rocky hill grasslands.

Hence, SCPE plant plant taxa are restricted to specific plant communities with a restricted distribution. Conservation of many localities of the same plant community is the most effective approach for the protection and survival of endemics of fractal landscapes such as ultramafic substrates (Witkowski & Liston 1997; With & King 1998; Harrison 1999). In addition, the region boasts a rich natural and human history (Pollock *et al.* 1963), and representative ecologically viable portions of the region should be protected and conserved for future generations.

12.6 Future research

There is a growing interest worldwide in applying knowledge on vegetation ecology in nature conservation and natural resource management. The new interest is based on the increasing awareness that careful analyses of plant communities and their associated habitats constitute a valid scientific basis for evaluating the consequences of environmental change. Future vegetation studies can provide detailed information on the vegetation change on a regional scale. A holistic approach is needed to explain the ecological processes of the SCPE before sound information can be provided for environmental management.

The information provided in this thesis is based on data acquired on a regional scale and could provide meaningful baseline data to which vegetation dynamics can be referenced. A better understanding of the region's vegetation dynamics will allow local authorities to develop comprehensive management plans for the conservation and sustainable use of the SCPE's natural resources. However, much still remains to be done. With this section it is hoped that a detailed assessment is given to focus future research on the vegetation of the study area:

Plant communities

• A complex mosaic, together with a gradient distribution pattern, makes the mapping of the plant communities in the SCPE extremely difficult. Mapping the communities is a study on its own and should be considered on a fine scale, possibly 1:50 000. Palmer & Van Staden (1992) has used annual rainfall and elevation to map plant communities of Mixed Bushveld in semi-arid regions. This method could proof useful for future work.

• Winterbach *et al.* (2000) did not consider the work of Van der Meulen (1979) in their classification of the South African central bushveld. This leads to confusion in the classification of the SCPE. Further work should attempt to combine into a single database the relevés of this study and those of Van der Meulen (1979) which were sampled on gabbro, norite, pyroxenite and allied rocks (such as anorthosite) of the western Rustenburg Layered Suite.

• A phytosociological synthesis of data acquired from the vegetation of the entire Rustenburg Layered Suite will improve our knowledge of the processes that gave rise to the SCPE flora and plant communities. Data from the serpentine-related ultramafic rocks of the Bushveld Complex can be included into this phytosociological data set for comparative studies; this will contribute towards a better understanding of the plant community ecology of the unique vegetation types on ultramafic rock.

• From a management point of view it is therefore proposed that further research be conducted in the ecosystems and management units of the SCPE. Van Rooyen (1978) and Bredenkamp (1982) indicated the need for research into the following aspects when management of plant communities becomes pivotal to a region:

- carrying capacity of the different plant communities;
- quality, availability and utilisation of grazing in different seasons;

- production of the different useful plant species;
- water requirements of the different plant species;
- influence of artificial water sources and infrastructure on the distribution of animals and the subsequent utilization of vegetation;
- phenology of the different plant communities;
- veld reclamation in over-utilised/disturbed areas.

- There is a need for detailed phytosociological studies on disturbed vegetation types of different ages to derive hypothetical succession pathways for future grazing management and rehabilitation in especially the overgrazed and intensely harvested areas as well as surrounding mining areas. Pristine species rich bushveld, together with man-made ecotones, should be studied further to understand the system dynamics of the plant communities using the following as a guideline:
  - immediately after disturbance re-colonisation of the site depends on the seedbank that remained or arrived from an external source and the vegetative resprouting of survivors;
  - recruitment is rapid at first due to little competition;
  - recruitment decreases as competition increases and established plants start to dominate;
  - recruitment of new species becomes restricted and inhibited by the species present;
  - with no further disturbances the long-lived vegetation will dominate the site and regeneration will be mainly for selected dominant species.

- Fire has been identified as an important determinant of vegetation structure on ultramafics (McCoy *et al.* 1999), but in the SCPE the fuel load is extremely low due to overgrazing, over harvesting and frequent droughts. Future research should investigate the influence of fire, especially as it relates to the vegetation structure and dynamics of the still to be described plant communities of the SCPE.

- Seasonal fire obviously has an effect on the plant species composition of the study area. What is the 'normal' fire cycle of plant communities and is recruitment taking place? Further work should look at the occurrence of fire and determine how best control too frequent burning in the SCPE.

• The phytososiological study did not focus in detail on threatened areas, but provided a broad overview of the region. Areas containing threatened vegetation units require immediate research in the light of the rapid developing mining industry and fast growing human population in the region. Particular emphasis should be placed on documenting the plant communities on the rocky ridges east and west of the Potlake Nature Reserve and the adjacent lying Leolo Mountains, which possibly harbours still to be discovered plant communities.

• A detailed investigation into the vegetation and catchment ecosystems of the Leolo Mountains and Mapochs Gronde is required and should receive priority due to its importance as a water reservoir for a very arid environment in the Steelpoort River valley. These systems should be studied with regards to plant community dynamics and subsequent state of the environment analysis focussing on the plant diversity as an indicator.

• To gain a more comprehensive knowledge of the class, it appears necessary to integrate the actual aspect of the vegetation with its historical interpretation (Pignatti *et al.* 1995). Syntaxonomic work in the central Bushveld of South Africa will need more work in this regard before it can be classified as Winterbach *et al.* (2000) attempted. The SCPE is a very small part of a poorly studied, possibly larger, Mountain Bushveld system. Sekhukhuneland has already shown that the system has a complex and heterogeneous history and physical environment, which should be studied in more detail before classification at the class level can be attempted.

Plant-soil associations

• Description and classification of the different vegetation units of the SCPE contribute towards the understanding of the association between plant communities and geology in the SCPE and southern Africa as a whole. As Brooks (1998) rightly stated, it is clear that the 'serpentine problem' is far from solved and much work remains to be done before it can be established with certainty why certain plant communities can be found over ultramafic rocks.

• This thesis was the first study to focus on the accumulation of heavy metals by plants in Sekhukhuneland. The data is of a baseline level and future work should include the following, as the soils of the SCPE will start playing a major role in mine rehabilitation in the near future:

- investigate the Ni pool and forms and mobility of Ni in ultramafic soils to measure its unavailability to accumulators in the SCPE;
- investigate Cr toxicity to determine if it is seasonal and depended on rainfall cycles, as oxidation of Cr (III) from chromite in soil to soluble forms of Cr (VI) may occur as a result of weathering;
- investigate whether Cr (III) and/or (VI) cause changes in soil pH that can inhibit nutrient uptake;
- determine whether plant element levels of ultramafic tolerant species reflect, when growing on ultramafic soil, any of the distinctive chemical characteristics of ultramafic soils;
- determine whether element accumulation patterns differ amongst different topographical positions on ultramafic outcrops of Sekhukhuneland;
- establish what influence does different accumulators have on one another in a system;
- determine what influence do accumulators have on excluders; do their accumulation favour excluders?
- what is the ratio of accumulators and excluders in a plant community on ultramafic soils?

• Further research is needed on the plant-soil association phenomenon of the SCPE, especially as it relates to the formal description of the still to be described endemic taxa which may well include edaphic specialists.

• Plants proven to be resistant to heavy metal toxicity, can find a ready application in the rehabilitation of disturbed sites. The following work is needed:

- it is known that certain plants accumulate high calcium concentrations in their tissues to counter the toxic effects of heavy metals. Certain succulent genera, which do occur in the study area, are calciotrophic CAM plants. Future work should investigate the tolerance of succulents to toxic soils.

• higher Ca concentrations in certain soils of the SCPE could be very important in the biological Ca-cycle of plants growing on heavy metal soils. It is recommended that future work in Sekhukhuneland should test rare species on the ultramafics for possible accumulation of Ca and exclusion of heavy metals. It is suggested that research focus should be more on excluding mechanisms, as much less is known of this plant physiological ability.

• research elsewhere has shown that specifically heavy-metal soil adapted mycorrhizae have an economical potential and practical application as inoculants on certain plants for the revegetation of heavy-metal polluted areas (Gildon & Tinker 1983; Gadd 1993; Gonçalves *et al.* 1995; Hildebrandt *et al.* 1999). Work in this direction might proof usefull for rehabilitation in Sekhukhuneland.

• Leopold *et al.* (1999) indicated that the induction of phytochelatins is a general answer of higher plants to heavy metal exposition, but only some of the heavy metal ions are able to form stable complexes with phytochelatins. With regard to rehabilitation of mining sites, it could proof profitable to determine whether phytochelatins are responsible for heavy metal tolerant phenotypes of certain plants.

• analysis of variance need to be applied to determine whether there was a difference in the results of the numbers of plants per pot. Competition plays an important role in the phytotoxicity of soil (Weidenhamer *et al.* 1989). Plants might survive easier on heavy metal soils if they grow close to other species.

Phytogeography

• As is the case with the Zimbabwean Great Dyke (Wild 1965), the flora of the SCPE provides considerable opportunities to study the evolution of edaphic specialist plants on ultramafic substrates. There is a great need for closer taxonomic scrutiny of taxa in the SCPE to ensure the appropriate labelling of ecotypes, endemic forms of common species and undescribed taxa.

• Attention must be given to the further analysis of the flora in Chapter 11. Appropriate figures and charts should be used to make comparisons between regions using quantitative techniques. Comparisons between the subcentres are also necessary once more accurate numbers have been obtained on the endemic and near-endemic species. The Chapter can be taken much further.

• Species in any given region may not have completed natural migrations and may still be in the process of extending its range. However, it does hold that a species can only live in the area to which it is confined, such as is the case with serpentinite endemics. The following questions arise with regards to the phytogeography of the SCPE:

- how did the disjunct species get to their current location in the SCPE?
- how far, if at all, does the plant communities extend beyond their currently known boundary?
- how large is the Centre and what are the most accurate boundaries for the SCPE?
- what is the biological status of the threatened plant populations? (are the number of individuals increasing, decreasing or stable?)
- what life history stage(s) have the greatest effect on population growth?
- what are the biological causes of variation in those life history stages that have a major demographic impact?
- should long-term monitoring of the plant diversity distribution be implemented?
- what is the real and potential impact of exotic weeds on the indigenous vegetation of the SCPE?

• Future research should focus on ways to determine the genetic resources of the plant diversity of the SCPE (genetic resources are defined as plant material with a current or future value for food, agriculture and forestry (Allem 2000)). This can be achieved by including Sekhukhuneland species in projects related to biochemistry and molecular biology.

• The demarcation of plant diversity foci in the SCPE is based in part on field observations and plant diversity work done by Siebert (1998). This work needs to be refined and the areas defined using accepted statistical methods. Available techniques for the identification of diversity 'hotspots' include approaches such as under-represented or rare ecosystems and distributions of rare plants as focal areas (Pfab & Witkowski 1997; Loomis & Echohawk 1999), vulnerable or threatened taxa as focal species (Lambeck 1997; Hoffmann & Welk

1999) and statistical analysis to select fully representative reserve networks (Bedward *et al.* 1992; Pressey *et al.* 1999).

• The human influence cannot be ignored as a factor that influence vegetation distribution, for anthropogenical plant communities are common in former communal lands, for example the old-fields in the Transkei (Smits *et al.* 1999). Work in this direction might shed some light on the doubtful occurrence of many species in the SCPE.

Conservation

• The main question that prevails in the light of rapid future development, is how ecosystem functioning and species richness are related? And in addition to this, which plant species are an essential component of an ecosystem? This is baseline information required for conservation initiatives and monitoring, and of which no information exist for the threatened plant communities of the SCPE.

• Further studies are needed to derive hypothetical succession pathways for future management of the dwindling valuable plant resources of the SCPE. The manner in which natural resources are used will have a direct relation to its future productive capacity (Aucamp *et al.* 1992). The following questions arises:

- what are the socio-economic and biophysical factors/dynamics associated with the plant communities?
- to what extend and which plant species are being used by local communities?
- for what purposes do the local communities use the plant species and is the harvesting of the sustainable?
- what additional threats are being faced by the plant populations?
- how can the plant communities be protected whilst at the same time also benefiting the local communities?
- what impact will increase access to, and public awareness of, the threatened plant populations have on its long term survival?
- what are the present patterns of land use in the area, and what are their environmental, historical and socio-economic determinants?

- at what rate are the patterns of land use changing, and why?
- what are the key ecological processes sustaining production in the plant communities and how are these being affected by current and envisaged land use in the area?
- what are the consequences of current and planned/predicted land use changes in the area?

• It is clear that the plant resources of the SCPE need to be conserved. Future research on conservation should consider the following perspectives that shape societal choices in the conservation of species as illustrated by Knegtering *et al.* (2000):

- aesthetical perspectives, especially the appreciation of physical and behavioural characteristics of the individuals of certain species;
- ecological perspectives, in particular knowledge of species populations;
- ethical perspectives regarding species with respect to specific human-species relationships such uses.

• The following questions can be addressed in future projects related to sustainable harvesting of useful plants and rehabilitation of mine dumps in the SCPE:

- what are the plant biodiversity patterns in the woodlands of the region, and what factors control these patterns?
- what is the relation between stand structure, stand development stage and biodiversity in different woodland types, and how could this be used in mapping biodiversity patterns across the Centre?
- what are the trends and patterns in recruitment, growth and mortality of species and stands in different woodland types and in different stand development stages?
- what are the growth rates through the life cycle of important species across their areas of occurrence in the Centre, and how are these growth rates affected by climate, competition and harvesting intensity?
- what rapid growth assessment techniques would give the best estimate of the actual growth as measured on the monitoring plots, and could be used as a general tool in timber harvesting planning?

- The creation of well placed nature reserves for the sustainable harvesting of natural resources is a solution to the problem of habitat loss in the SCPE. Its effectiveness will depend on an adequate database of natural features and other land uses (Bedward *et al.* 1992). A strategic environmental assessment should be conducted to source all data available on the study area's natural resources.

- Use of species composition in addition to species richness as a parameter of ecosystem quality is applicable to compare ranges within savanna ecosystems (Van Andel 1998). The best approach for the monitoring of nature reserves used for the sustainable harvesting is to evaluate the occurrence of unique plant communities. An analysis of species composition will determine the level of disturbance by evaluating the changes in plant communities. This is logically a better approach for future work to not only focus on species richness, but also the region's diverse species composition (plant communities).

- The SCPE is in urgent need of research to determine the endangered plant taxa and plant communities:
    - a useful initiative for future work in Sekhukhuneland would be to interpret Red Data List information in herbaria (Golding 2001b) in the light of rapid development objectives in the SCPE. From this study it became clear that the threatened plant species are not well known and have remained absent in the most recent literature on threatened species (Golding 2001a).
    - this thesis linked threatened species to plant communities, plant communities to GIS points, and hence, GIS points to threatened species. The locality information can prove extremely useful in future studies on the rare and threatened plants of the SCPE.
    - the work of Bevill & Louda (1999) provides a useful overview of the variables necessary for comparative studies on rare and common related plant species. This kind of work supplies data that are useful in determining the boundaries for a conservation area. Research in this field will comply with the latest initiatives for southern Africa.
    - species diversity 'hotspots' are rarely congruent for different groups of organisms (Van Jaarsveld *et al.* 1998). Diversity 'hotspots' for the SCPE are currently only seen as

important **botanical** regions to preserve. Further research might show the importance of other groups of organisms, such as the herpetofauna or lepidoptera.

- The hierarchical Braun-Blanquet classification of this study will enable authorities to group floristic and ecological related plant communities into bigger units encompassing the whole biological spectrum, which can be used in the formulation of effective and practical management systems. This should receive immediate priority and could form the basis for a strategic environmental assessment.

- A detailed investigation into the endemism, vegetation and catchment ecosystems of the grasslands of the Leolo Mountains and the Mapochs Gronde is required and should receive priority due to its importance as a water reservoir for the industrial development zone in the very arid Steelpoort River valley. The dynamics of these systems should be studied with regards to human impact; determining what the human carrying capacity of these catchments are. The Leolo Mountains are also important for the relictual Afromontane elements it may harbour.

- Alien plant invasions in habitats and distinctive plant communities pose a significant challenge in centres of plant diversity (Chiarucci & De Dominicis 1995; Stohlgren 1999). Ultramafic vegetation is poorly protected in South Africa and therefore more areas in Sekhukhuneland deserve to be conserved. Management plans should be drawn up for heavily populated residential areas of the SCPE, to ensure that potential invasive alien taxa are not introduced to the unique ecosystems of this region.

- A detailed assessment of the phytodiversity, endemism and Red Data List taxa in the plant communities of the study area is needed to supply authorities with baseline data to apply in future conservation actions and ecosystem management. An adequate database of natural features and other land uses is essential for effective land-use management and implementation (Kent & Ballard 1988; Bedward *et al.* 1992; Rhoads & Thompson 1992; Wessels *et al.* 2000).

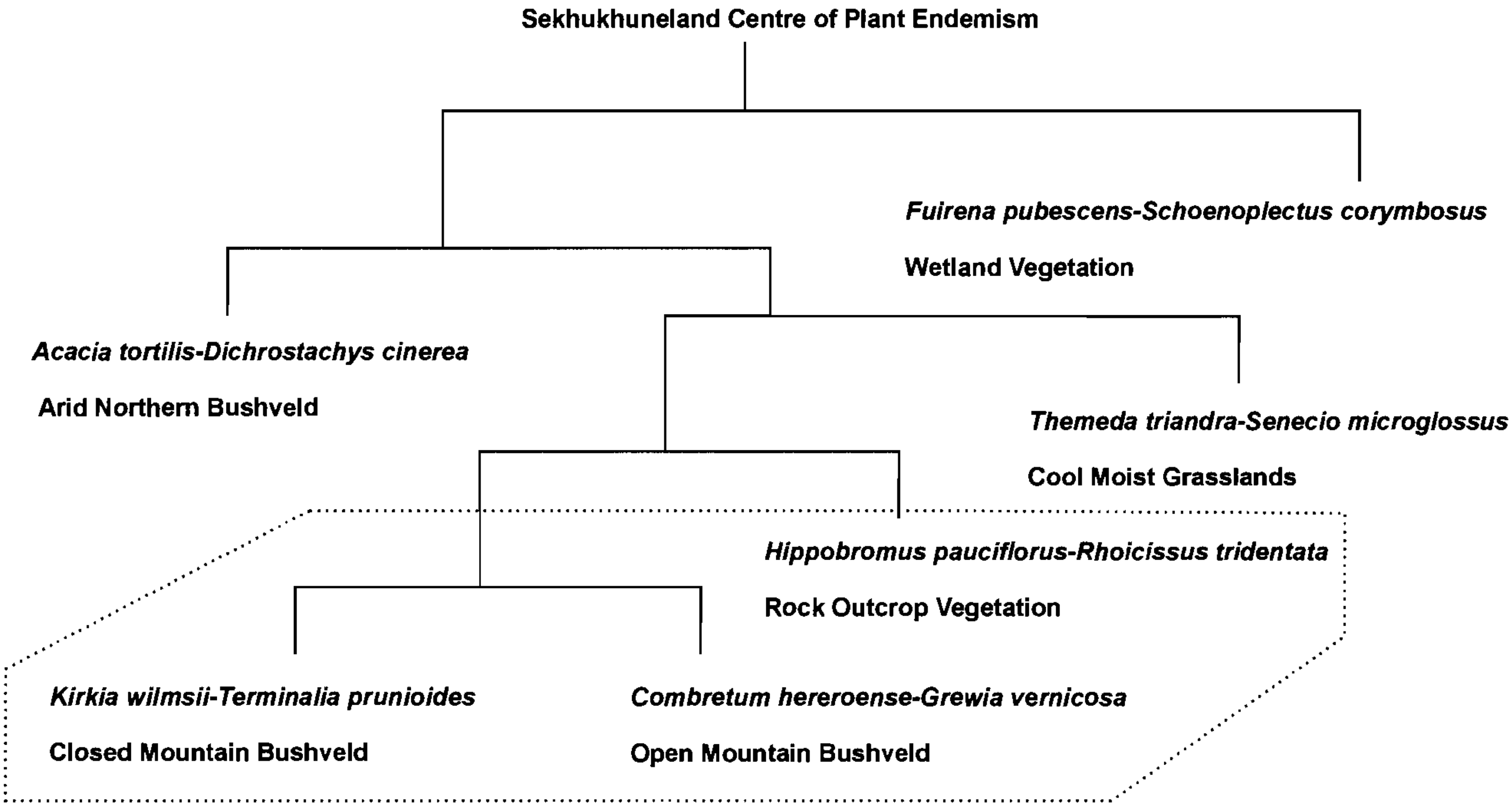


Figure 33 Dendrogram depicting the TWINSPAN division of the six major vegetation types of the Sekhukhuneland Centre of Plant Endemism (Dotted lines demarcate the vegetation types that are part of the proposed *Kirkia wilmsii-Acacia caffra* Alliance on clay soils).

CONCLUSION

Phytosociology

- Structure and distribution patterns of the indigenous vegetation of the SCPE are a direct product of the environment.
- Six major vegetation types have been identified for the SCPE, namely Wetland Vegetation, Cool Moist Grassland, Rock Outcrop Vegetation, Open Mountain Bushveld, Closed Mountain Bushveld and Arid Northern Bushveld.
- Several ecological interpretable plant communities have been distinguished for each of the major vegetation types. Eighty-two syntaxa were identified, characterised, classified, described and ecologically interpreted for the study area.
- Fifty-two SCPE endemics, 52 SCPE near-endemics and 37 Red Data List taxa were recorded for the 82 syntaxa.
- Analysis of the Grassland and Wetland Vegetation resulted in the identification of 17 plant communities, ordered as eight associations, 11 sub-associations and four variants.
- Nineteen SCPE endemics, 18 SCPE near-endemics and 17 Red Data List taxa were recorded for the 17 syntaxa of the Grassland and Wetland Vegetation.
- Analysis of the Rock Outcrop vegetation resulted in the identification of 17 plant communities that were subsequently hierarchically classified as 17 associations.
- Twenty-three SCPE endemics, 24 SCPE near-endemics and 13 Red Data List taxa were recorded for the 17 syntaxa of the Rocky Outcrop Vegetation.
- Analysis of the Open Mountain Bushveld resulted in the identification of 20 plant communities, which are grouped as eight associations and 18 sub-associations.
- Thirty-one SCPE endemics, 20 SCPE near-endemics and 13 Red Data List taxa were recorded for the 20 syntaxa of the Open Mountain Bushveld.
- Analysis of the Closed Mountain Bushveld resulted in the identification of 20 plant communities, which are grouped as five associations and 20 sub-associations
- Twenty-eight SCPE endemics, 22 SCPE near-endemics and 10 Red Data List taxa were recorded for the 20 syntaxa of the Closed Mountain Bushveld.

- Analysis of the Arid Northern Bushveld resulted in the identification of eight plant communities, classified as four associations and five sub-associations.
- Four SCPE endemics, seven SCPE near-endemics and four Red Data List taxa were recorded for the eight syntaxa of the Arid Northern Bushveld.
- Heterogeneous environmental factors in the SCPE give rise to an intricate mosaic of plant communities, thus making it extremely difficult to produce a vegetation map.

Plant-soil associations

- Root development of maize seedlings grown in soil samples from a chromitite outcrop was stunted during the first two weeks and leaf growth during weeks three and four.
- Interveinal chlorosis and purpling of leaves indicated Ni and Cr toxicity.
- No calcium deficiency was recorded in the maize seedlings, which indicates that the soil of the SCPE is different from that of serpentinites.
- Two major groups of rock occur in the SCPE, namely rocks related to serpentinite with high Mg levels and rocks related to dolomite with high Ca levels.
- Chemical compositions of the rocks in the SCPE are highly variable.
- Soil analysis of a catena across the Critical Zone of the Rustenburg Layered Suite showed that topographic positions determine the serpentinite affinity.
- Rock outcrops and eroded areas are chemically most related to serpentinite and mountain slopes are most related to calcretes.
- Elements are associated with specific topographic positions, e.g. eroded areas are rich in Cu and Mn, chromitite outcrops are rich in Cr and Ni and mountain slopes are rich in Al and Pb.
- Soil metal concentrations decrease as nutrient levels increase; soil metal concentrations increase as Mg levels increase; nutrient levels in the soil decrease as the Mg levels increase.
- Sekhukhuneland has low relative Ni levels and high relative Cr levels when compared to serpentinites on a global level.
- Only Fe and Al were hyperaccumulated (more than 1 000 mg/kg) by plant species sampled from the catena in the study area.

• The following seven species accumulated high levels of Fe and Al in their roots and leaves: *Berkheya insignis*, *Dicoma gerrardii*, *Diheteropogon amplectens*, *Euclea linearis*, *Heteropogon contortus*, *Jamesbrittenia atropurpurea* and *Pterothrix spinescens*.

• Metal uptake by plants increases as the nutrient uptake decreases; metal concentrations in the plant material increases as the Ca in the plant tissues increases; Ca levels in the plant material is related to high nutrient levels in the tissue.

• Metal, nutrient and Mg/Ca levels in plant tissue are dependent on the availability of the elements in the soil.

• Metal, nutrient and Mg/Ca levels in plant tissue are dependent on the concentration of the elements in the soil.

Floristic analyses

• Identified taxa requiring conservation action, contributed towards reserve site selection on the basis of taxon richness and endemism, and provided a baseline inventory of plant resources with sustainable harvesting and bioprospecting potential—conforms to the Darwin Declaration (Environment Australia 1998).

• Fifty-eight SCPE endemic and approximately 67 SCPE near-endemic species/ infraspecific taxa were recorded for the study area. These taxa belong to 36 families.

• The SCPE has a species endemism of 5%; 115 endemic/near-endemic taxa out of a total number of 2 000 species/infraspecific taxa.

• Floristic links exist with various regions of South Africa, e.g. Karoo, Eastern Cape, Northern Cape etc.

• Currently the Flora for the region stands at 172 families, 757 genera and 1952 species/infraspecific taxa.

• The ten largest families in the SCPE in descending order are: Poaceae, Asteraceae, Fabaceae, Liliaceae, Asclepiadaceae, Lamiaceae, Acanthaceae, Schrophulariaceae, Euphorbiaceae and Cyperaceae/Rubiaceae

• There are three subcentres in the SCPE: Roossenekal, Leolo and Steelpoort.

• An assessment using the old IUCN Red Data List Categories identified 1 species as Endangered, 1 Vulnerable, 8 Rare, 2 Indeterminate, 15 Insufficiently Known and 10 Not Threatened in the SCPE, but in other provinces/countries of southern Africa (N).

- The major threats to the vegetation of the SCPE are communal lands, mining companies, commercial farming, residential development and a shortage of protected areas.
- The Grassland and Wetland Vegetation has 45 taxa of conservation significance, the Rock Outcrop Vegetation 36, the Open Mountain Bushveld 48, the Closed Mountain Bushveld 44 and the Arid Northern Bushveld 13.
- Priority plant communities for conservation are the *Tristachyo leucothricis–Cussonietum transvaalensis*, *Loudetio simplicis–Eucleetum linearis*, *Eragrosti lehmannianae–Hippobrometum pauciflori* and *Brachiario serratae–Melhanietum randii*.
- The largest number of endemic species, 18, occurs in the *Tristachyo leucothricis - Cussonietum transvaalensis*.
- The largest number of Red Data List taxa, eight, was recorded for the *Brachiario serratae–Melhanietum randii*.
- Most sensitive habitats include the seepage areas and Afromontane grasslands of the Roossenekal and Leolo Mountain Subcentres. These areas form the major catchment for large parts of the SCPE and should be protected.
- One national conservation reserve has been established in the study area, but is placed in the region with the least number of rare and threatened species.

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APPENDICES

APPENDIX 1. Average length and weight of leaves and roots of *Zea mays* grown in pots with quartzite control soils or ultramafic soil samples.

APPENDIX 2. Heavy metal and mineral concentrations of the rocks of the Sekhukhuneland Centre of Plant Endemism.

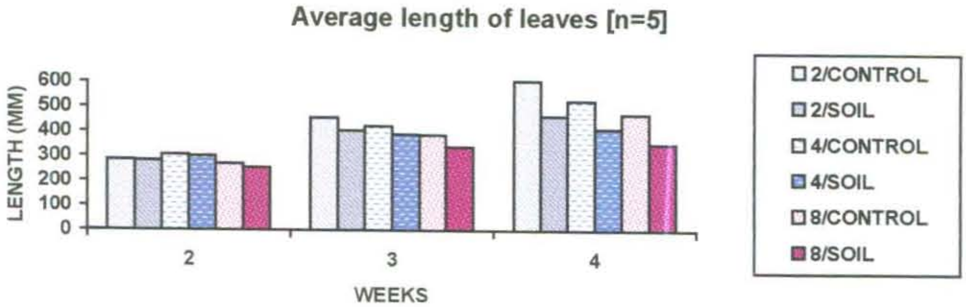
APPENDIX 3. Heavy metal and mineral concentrations of soil samples along a catena in the Sekhukhuneland Centre of Plant Endemism.

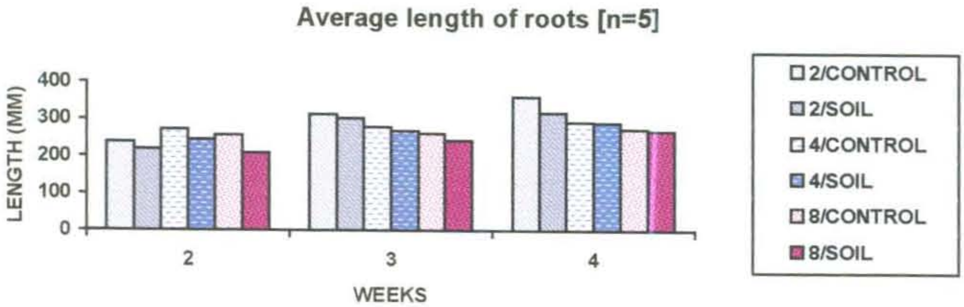
APPENDIX 4. Heavy metal and mineral concentrations of plant material collected along a catena in the Sekhukhuneland Centre of Plant Endemism.

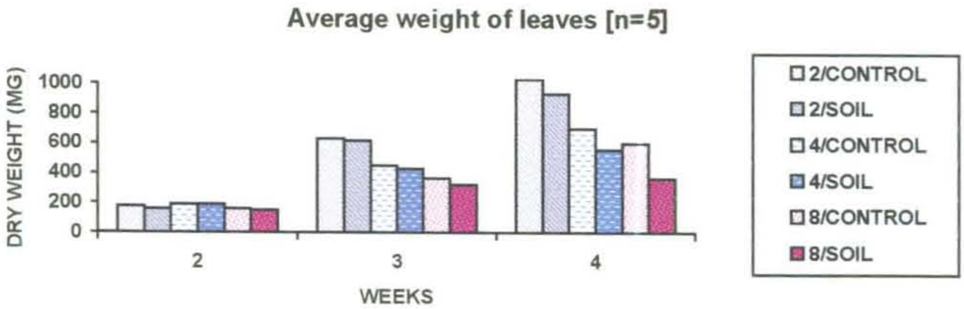
APPENDIX 5. Checklist of the plant species/infraspecific taxa occurring in the Sekhukhuneland Centre of Plant Endemism.

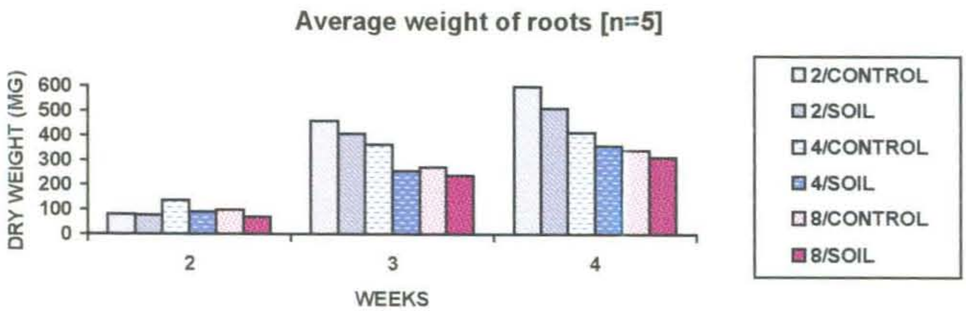
Appendix 1 Average length and weight of leaves and roots of *Zea mays* grown in pots with quartzite control soils or ultramafic soil samples.

	Quartzite control soil			Chromium-rich soil		
Plants/container	**2**	**4**	**8**	**2**	**4**	**8**
Week 2						
Average leaf length (mm)	286	304	270	283	300	254
Average root length (mm)	238	271	256	220	245	208
Average leaf dry mass (mg)	174	189	158	160	188	152
Average root dry mass (mg)	79	137	98	77	91	69
Week 3						
Average leaf length (mm)	457	426	388	405	390	339
Average root length (mm)	314	280	261	303	268	243
Average leaf dry mass (mg)	629	452	362	615	429	319
Average root dry mass (mg)	459	366	273	407	257	241
Week 4						
Average leaf length (mm)	608	527	472	466	415	352
Average root length (mm)	361	294	274	319	292	268
Average leaf dry mass (mg)	1033	698	598	932	560	363
Average root dry mass (mg)	598	413	342	513	359	313


Average length of leaves [n=5]
LENGTH (MM)
600
500
400
300
200
100
0
2
3
4
WEEKS
2/CONTROL
2/SOIL
4/CONTROL
4/SOIL
8/CONTROL
8/SOIL


Average length of roots [n=5]
LENGTH (MM)
400
300
200
100
0
2
3
4
WEEKS
2/CONTROL
2/SOIL
4/CONTROL
4/SOIL
8/CONTROL
8/SOIL

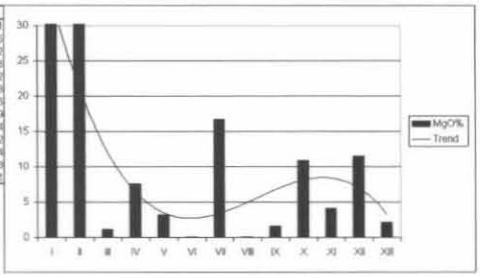

Average weight of leaves [n=5]
DRY WEIGHT (MG)
1000
800
600
400
200
0
2
3
4
WEEKS
2/CONTROL
2/SOIL
4/CONTROL
4/SOIL
8/CONTROL
8/SOIL


Average weight of roots [n=5]
DRY WEIGHT (MG)
600
500
400
300
200
100
0
2
3
4
WEEKS
2/CONTROL
2/SOIL
4/CONTROL
4/SOIL
8/CONTROL
8/SOIL

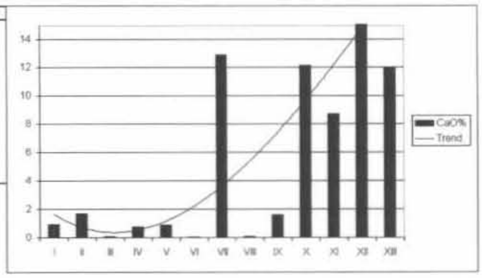
Appendix 2 Heavy metal and mineral concentrations of the rocks of the Sekhukhuneland Centre of Plant Endemism (I to XIII is a serpentine gradient based on the Mg:Ca Ratio of the different rocks (see Figure 23)).

PERCENTAGE ANALYSIS

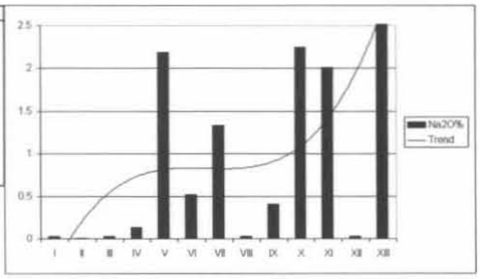
	MgO%
I	32.1
II	30.75
III	1.12
IV	7.58
V	3.22
VI	0.08
VII	16.73
VIII	0.09
IX	1.64
X	10.92
XI	4.14
XII	11.48
XIII	2.11



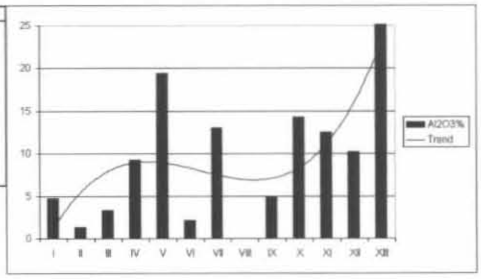
	CaO%
I	0.93
II	1.69
III	0.08
IV	0.77
V	0.88
VI	0.06
VII	12.90
VIII	0.08
IX	1.59
X	12.15
XI	8.72
XII	25.67
XIII	11.97



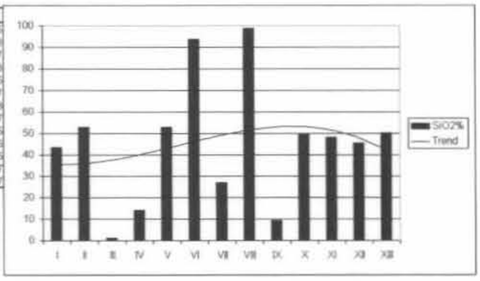
	Na_2O%
I	0.03
II	0.01
III	0.03
IV	0.13
V	2.19
VI	0.52
VII	1.33
VIII	0.03
IX	0.41
X	2.25
XI	2.01
XII	0.03
XIII	3.56



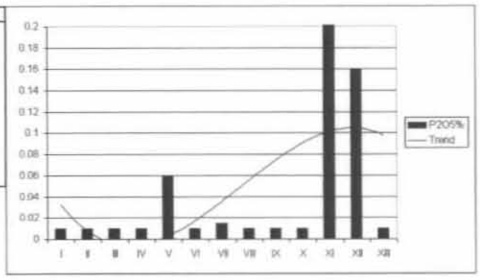
	Al_2O_3%
I	4.72
II	1.36
III	3.34
IV	9.27
V	19.47
VI	2.18
VII	13.05
VIII	0.01
IX	4.88
X	14.32
XI	12.56
XII	10.24
XIII	25.81



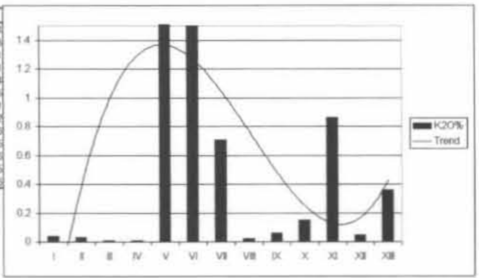
	SiO_2%
I	43.5
II	52.8
III	1.07
IV	14.18
V	52.85
VI	93.7
VII	26.98
VIII	98.7
IX	9.55
X	49.76
XI	48.25
XII	45.67
XIII	50.27



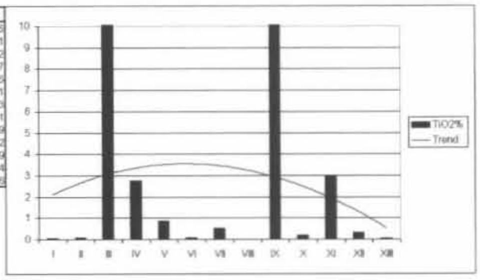
	P_2O_5%
I	0.01
II	0.01
III	0.01
IV	0.01
V	0.06
VI	0.01
VII	0.02
VIII	0.01
IX	0.01
X	0.01
XI	0.29
XII	0.16
XIII	0.01



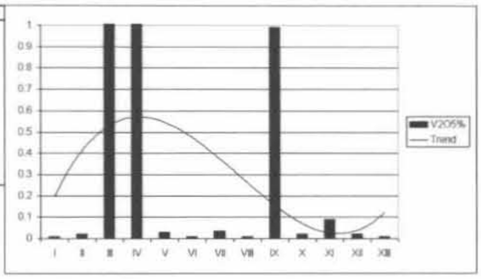
	K_2O%
I	0.04
II	0.03
III	0.01
IV	0.01
V	4.24
VI	1.5
VII	0.71
VIII	0.02
IX	0.06
X	0.15
XI	0.86
XII	0.05
XIII	0.36



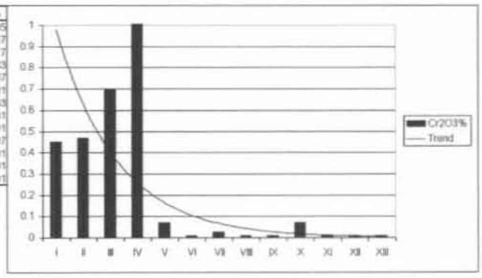
	TiO_2%
I	0.06
II	0.1
III	13.52
IV	2.77
V	0.86
VI	0.1
VII	0.53
VIII	0.01
IX	12.69
X	0.2
XI	2.99
XII	0.34
XIII	0.06



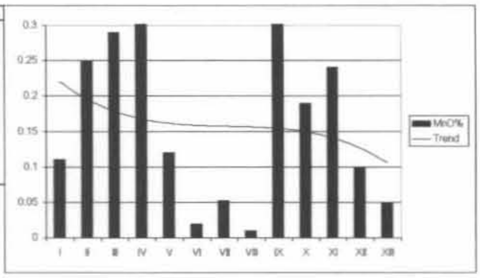
	V_2O_5%
I	0.01
II	0.02
III	1.53
IV	1.01
V	0.03
VI	0.01
VII	0.04
VIII	0.01
IX	0.99
X	0.02
XI	0.09
XII	0.02
XIII	0.01



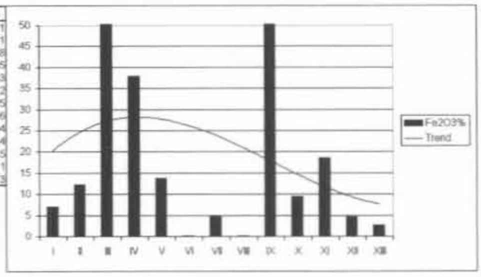
	Cr_2O_3%
I	0.45
II	0.47
III	0.7
IV	29.83
V	0.07
VI	0.01
VII	0.03
VIII	0.01
IX	0.01
X	0.07
XI	0.01
XII	0.01
XIII	0.01



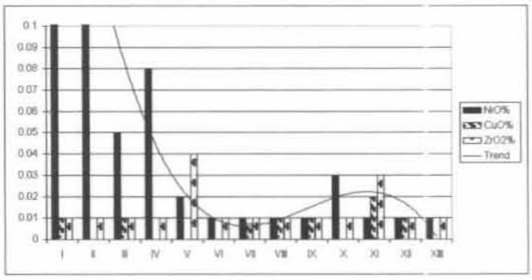
	MnO%
I	0.11
II	0.25
III	0.29
IV	0.31
V	0.12
VI	0.02
VII	0.05
VIII	0.01
IX	0.33
X	0.19
XI	0.24
XII	0.1
XIII	0.05



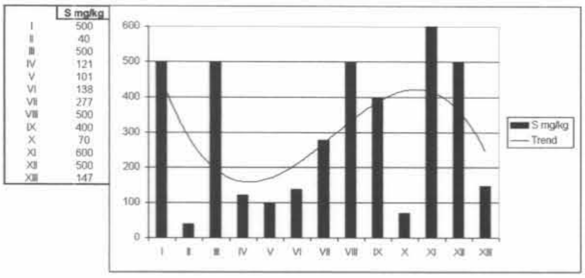
	Fe_2O_3%
I	7.01
II	12.21
III	79.58
IV	37.85
V	13.83
VI	0.12
VII	4.75
VIII	0.16
IX	70.04
X	9.4
XI	18.5
XII	4.71
XIII	2.73

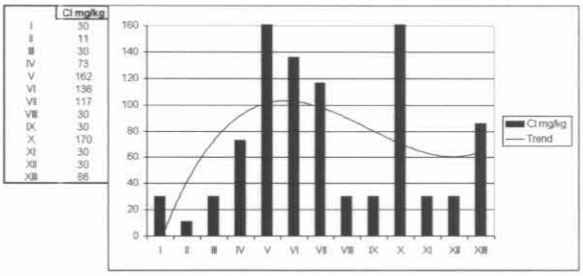


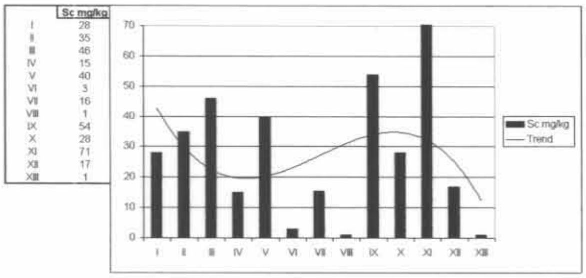
	NiO%	CuO%	ZrO_2%
I	0.24	0.01	0.01
II	0.12	-	0.01
III	0.05	0.01	0.01
IV	0.08	-	0.01
V	0.02	-	0.04
VI	0.01	-	0.01
VII	0.01	0.01	0.01
VIII	0.01	0.01	0.01
IX	0.01	0.01	0.01
X	0.03	-	0.01
XI	0.01	0.02	0.03
XII	0.01	0.01	0.01
XIII	0.01	-	0.01

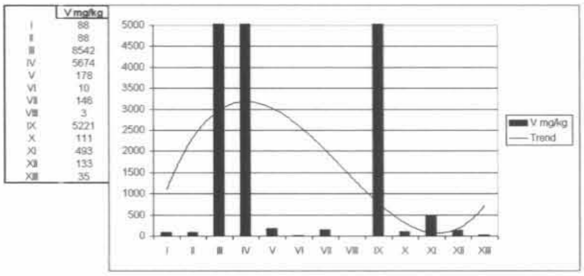


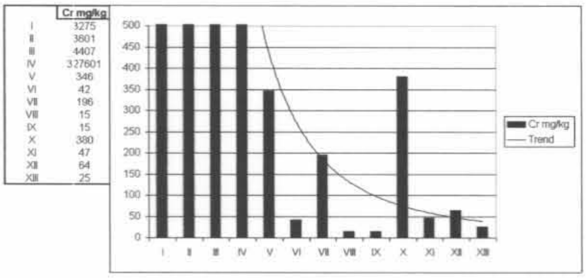
MG/KG ANALYSIS

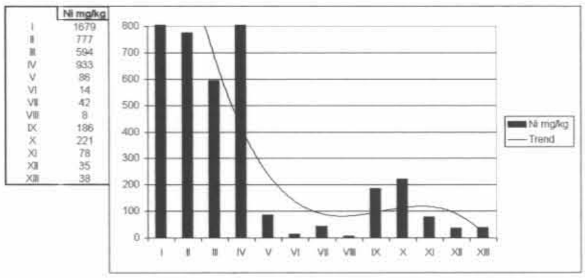


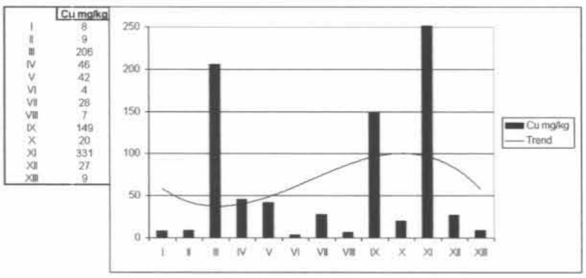


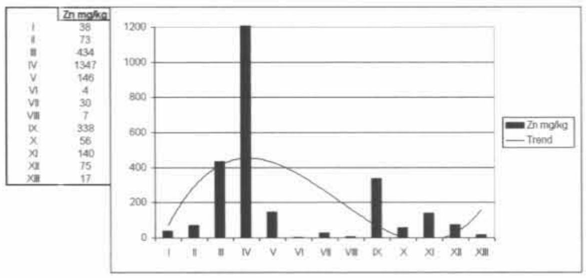




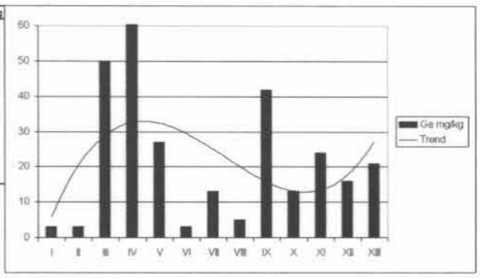




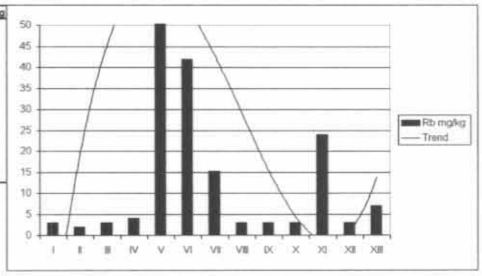




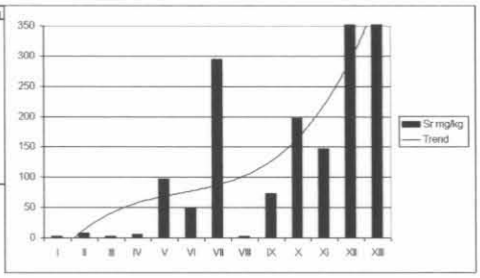
	Ga mg/kg
I	3
II	3
III	50
IV	63
V	27
VI	3
VII	13
VIII	5
IX	42
X	13
XI	24
XII	16
XIII	21



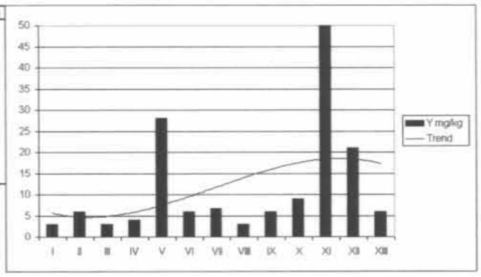
	Rb mg/kg
I	3
II	2
III	3
IV	4
V	208
VI	42
VII	15
VIII	3
IX	3
X	3
XI	24
XII	3
XIII	7



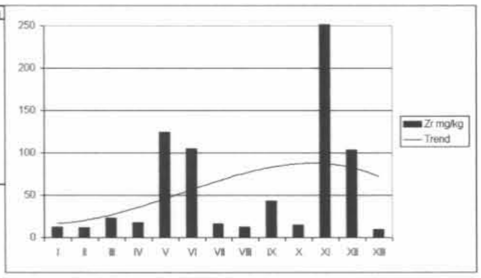
	Sr mg/kg
I	3
II	8
III	3
IV	6
V	97
VI	49
VII	295
VIII	3
IX	73
X	197
XI	147
XII	355
XIII	388



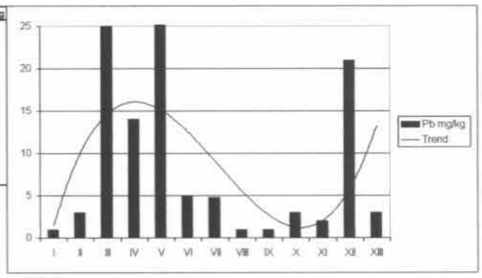
	Y mg/kg
I	3
II	6
III	3
IV	4
V	28
VI	6
VII	7
VIII	3
IX	6
X	9
XI	50
XII	21
XIII	6



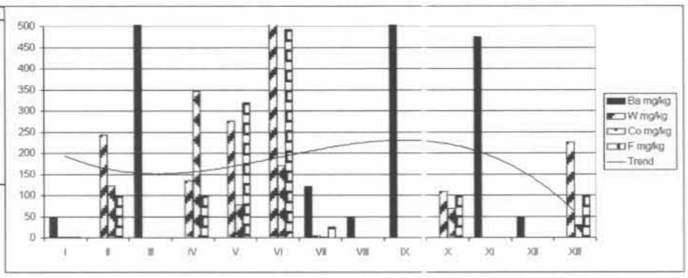
	Zr mg/kg
I	13
II	12
III	23
IV	18
V	125
VI	105
VII	17
VIII	13
IX	43
X	15
XI	262
XII	104
XIII	10



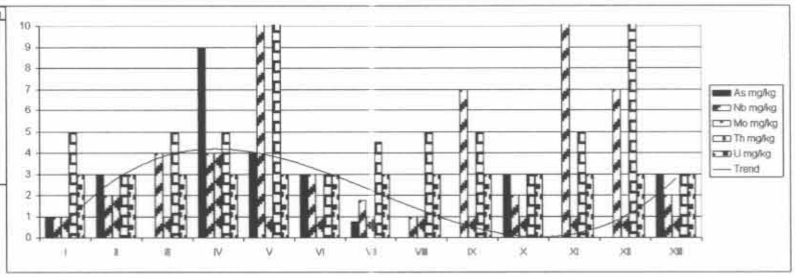
	Pb mg/kg
I	1
II	3
III	25
IV	14
V	26
VI	5
VII	5
VIII	1
IX	1
X	3
XI	2
XII	21
XIII	3



	Ba mg/kg	W mg/kg	Co mg/kg	F mg/kg
I	50	1	1	1
II	-	244	122	100
III	900	-	-	-
IV	-	135	346	100
V	-	276	77	319
VI	-	2194	170	493
VII	121	4	1	25
VIII	50	-	-	-
IX	660	-	-	-
X	-	109	68	100
XI	475	-	-	-
XII	50	-	-	-
XIII	-	225	30	100



	As mg/kg	Nb mg/kg	Mo mg/kg	Th mg/kg	U mg/kg
I	1	1	1	5	3
II	3	2	2	3	3
III	-	4	1	5	3
IV	9	4	4	5	3
V	4	14	1	16	3
VI	3	3	1	3	3
VII	1	2	1	5	3
VIII	-	1	1	5	3
IX	-	7	1	5	3
X	3	2	1	3	3
XI	-	18	1	5	3
XII	-	7	1	17	3
XIII	3	2	1	3	3



Appendix 2 Heavy metal and mineral concentrations of the rocks of the Sekhukhuneland Centre of Plant Endemism (I to XIII is a serpentine gradient based on the Mg:Ca Ratio of the different rocks (see Figure 23)).

Rock Samples [n=1]		Mg:Ca	MgO%	CaO%	Na_2O%	Al_2O_3	SiO_2%	P_2O_5%	K_2O%	TiO_2%	V_2O_5%	Cr_2O_3	MnO%	Fe_2O_3	NiO%	CuO%	ZrO_2%	LOI	Total	**SN
Groen Valley serpentinite	I	0.03	32.1	0.93	0.03	4.72	43.5	0.01	0.04	0.06	0.01	0.45	0.11	7.01	0.24	0.01	0.01	9.63	98.86	647
Mashishi serpentinized harzburgite	II	0.05	30.75	1.69	0.01	1.36	52.8	0.01	0.03	0.1	0.02	0.47	0.25	12.21	0.12	-	0.01	-0.61	99.22	634
Mapoch Caves magnetitite	III	0.07	1.12	0.08	0.03	3.34	1.07	0.01	0.01	13.52	1.53	0.7	0.29	79.58	0.05	0.01	0.01	-0.38	100.97	642
Critical Zone chromate	IV	0.1	7.58	0.77	0.13	9.27	14.18	0.01	0.01	2.77	1.01	29.83	0.31	37.85	0.08	-	0.01	-2.73	101.08	637
Getlane shale	V	0.27	3.22	0.88	2.19	19.47	52.85	0.06	4.24	0.86	0.03	0.07	0.12	13.83	0.02	-	0.04	1.13	99.01	635
Burgersfort pyroxenite	VI	0.75	0.08	0.06	0.52	2.18	93.7	0.01	1.5	0.1	0.01	0.01	0.02	0.12	0.01	-	0.01	0.42	98.75	633
Steelpoort valley concresions	VII	0.77	16.73	12.90	1.33	13.05	26.98	0.02	0.71	0.53	0.04	0.03	0.05	4.75	0.01	0.01	0.01	22.89	100.02	645
Mapoch Caves quartsite sill	VIII	0.89	0.09	0.08	0.03	0.01	98.7	0.01	0.02	0.01	0.01	0.01	0.01	0.16	0.01	0.01	0.01	0.02	99.19	641
Deo Gloria black sand	IX	0.97	1.64	1.59	0.41	4.88	9.55	0.01	0.06	12.69	0.99	0.01	0.33	70.04	0.01	0.01	0.01	-2.01	100.22	646
Roossenekal norite	X	1.11	10.92	12.15	2.25	14.32	49.76	0.01	0.15	0.2	0.02	0.07	0.19	9.4	0.03	-	0.01	0.53	100.01	631
Mapoch Caves diabase dyke	XI	2.11	4.14	8.72	2.01	12.56	48.25	0.29	0.86	2.99	0.09	0.01	0.24	18.5	0.01	0.02	0.03	0.95	99.67	640
Olifantspoortjie pyroxenite	XII	2.24	11.48	25.67	0.03	10.24	45.67	0.16	0.05	0.34	0.02	0.01	0.1	4.71	0.01	0.01	0.01	1.06	99.57	648
Leolo Mountain norite	XIII	5.67	2.11	11.97	3.56	25.81	50.27	0.01	0.36	0.06	0.01	0.01	0.05	2.73	0.01	-	0.01	1.16	98.13	632
Certified	*GSNC*	-	*2.3*	*2.5*	*3.77*	*14.67*	*65.8*	*0.28*	*4.63*	*0.68*	*0.012*	*0.008*	*0.06*	*3.75*	*0.004*	*0.003*	*0.032*	*1.32*	*99.819*	-
Control analysis	*GSN*	-	*2.24*	*2.53*	*3.8*	*14.59*	*66.04*	*0.31*	*4.75*	*0.67*	*0.01*	*0.01*	*0.05*	*3.8*	*0.01*	*0.01*	*0.035*	*1.31*	*100.17*	-
Percentage analysis																				
Groen Valley serpentinite	I		***100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**			647
Mashishi serpentinized harzburgite	II		96	182	33	29	121	100	75	167	200	104	227	174	50	-	100			634
Mapoch Caves magnetitite	III		3	9	100	71	2	100	25	22533	15300	156	264	1135	21	100	100			642
Critical Zone chromate	IV		24	83	433	196	33	100	25	4617	10100	6629	282	540	33	-	100			637
Getlane shale	V		10	95	7300	413	121	600	10600	1433	300	16	109	197	8	-	400			635
Burgersfort pyroxenite	VI		0	6	1733	46	215	100	3750	167	100	2	18	2	4	-	100			633
Steelpoort valley concresions	VII		52	1387	4442	277	62	150	1769	875	350	6	48	68	4	75	100			645
Mapoch Caves quartsite sill	VIII		0	9	100	0	227	100	50	17	100	2	9	2	4	100	100			641
Deo Gloria black sand	IX		5	171	1367	103	22	100	150	21150	9900	2	300	999	4	100	100			646
Roossenekal norite	X		34	1306	7500	303	114	100	375	333	200	16	173	134	13	-	100			631
Mapoch Caves diabase dyke	XI		13	938	6700	266	111	2900	2150	4983	900	2	218	264	4	200	300			640
Olifantspoortjie pyroxenite	XII		36	2760	100	217	105	1600	125	567	200	2	91	67	4	100	100			648
Leolo Mountain norite	XIII		7	1287	11867	547	116	100	900	100	100	2	45	39	4	-	100			632

Rock Samples [n=1]		S	Cl	Sc	V	Cr	Ni	Cu	Zn	Ga	Rb	Sr	Y	Zr	Pb	Ba	W	Co	F	As	Nb	Mo	Th	U	**SN
Groen Valley serpentinite	I	500	30	28	88	3275	1679	8	38	3	3	3	3	13	1	50	1	1	1	1	1	1	5	3	647
Mashishi serpentinized harzburgite	II	40	11	35	88	3601	777	9	73	3	2	8	6	12	3	-	244	122	100	3	2	2	3	3	634
Mapoch Caves magnetitite	III	500	30	46	8542	4407	594	206	434	50	3	3	3	23	25	900	-	-	-	-	4	1	5	3	642
Critical Zone chromate	IV	121	73	15	5674	327601	933	46	1347	63	4	6	4	18	14	-	135	346	100	9	4	4	5	3	637
Getlane shale	V	101	162	40	178	346	86	42	146	27	208	97	28	125	26	-	276	77	319	4	14	1	16	3	635
Burgersfort pyroxenite	VI	138	136	3	10	42	14	4	4	3	42	49	6	105	5	-	2194	170	493	3	3	1	3	3	633
Steelpoort valley concresions	VII	277	117	16	146	196	42	28	30	13	15	295	7	17	5	121	4	1	25	1	2	1	5	3	645
Mapoch Caves quartsite sill	VIII	500	30	1	3	15	8	7	7	5	3	3	3	13	1	50	-	-	-	-	1	1	5	3	641
Deo Gloria black sand	IX	400	30	54	5221	15	186	149	338	42	3	73	6	43	1	660	-	-	-	-	7	1	5	3	646
Roossenekal norite	X	70	170	28	111	380	221	20	56	13	3	197	9	15	3	-	109	68	100	3	2	1	3	3	631
Mapoch Caves diabase dyke	XI	600	30	71	493	47	78	331	140	24	24	147	50	262	2	475	-	-	-	-	18	1	5	3	640
Olifantspoortjie pyroxenite	XII	500	30	17	133	64	35	27	75	16	3	355	21	104	21	50	-	-	-	-	7	1	17	3	648
Leolo Mountain norite	XIII	147	86	1	35	25	38	9	17	21	7	388	6	10	3	-	225	30	100	3	2	1	3	3	632
Certified	*GSNC*	*140*	*450*	*7*	*65*	*55*	*34*	*20*	*48*	*22*	*185*	*570*	*19*	*235*	*53*	*1400*	*490*	*65*	*1050*	*1.6*	*21*	*1.2*	*42*	*8*	-
Control analysis	*GSN*	*115*	*256*	*11*	*65*	*52*	*34*	*23*	*51*	*21*	*184*	*571*	*22*	*226*	*52*	*1046*	*487*	*68*	*1448*	*3*	*26*	*1.5*	*41*	*8*	-
Percentage analysis																									
Groen Valley serpentinite	I	***100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	647
Mashishi serpentinized harzburgite	II	8	37	125	100	110	46	113	192	100	67	267	200	92	300	-	24400	12200	10000	300	200	200	60	100	634
Mapoch Caves magnetitite	III	100	100	164	9707	135	35	2575	1142	1667	100	100	100	177	2500	1800	-	-	-	-	400	100	100	100	642
Critical Zone chromate	IV	24	243	54	6448	10003	56	575	3545	2100	133	200	133	138	1400	-	13500	34600	10000	900	400	400	100	100	637
Getlane shale	V	20	540	143	202	11	5	525	384	900	6933	3233	933	962	2600	-	27600	7700	31900	400	1400	100	320	100	635
Burgersfort pyroxenite	VI	28	453	11	11	1	1	50	11	100	1400	1633	200	808	500	-	219400	17000	49300	300	300	100	60	100	633
Steelpoort valley concresions	VII	55	388	55	166	6	3	350	78	433	508	9825	225	129	475	242	375	75	2500	75	175	100	90	100	645
Mapoch Caves quartsite sill	VIII	100	100	4	3	0	0	88	18	167	100	100	100	100	100	100	-	-	-	-	100	100	100	100	641
Deo Gloria black sand	IX	80	100	193	5933	0	11	1863	889	1400	100	2433	200	331	100	1320	-	-	-	-	700	100	100	100	646
Roossenekal norite	X	14	567	100	126	12	13	250	147	433	100	6567	300	115	300	-	10900	6800	10000	300	200	100	60	100	631
Mapoch Caves diabase dyke	XI	120	100	254	560	1	5	4138	368	800	800	4900	1667	2015	200	950	-	-	-	-	1800	100	100	100	640
Olifantspoortjie pyroxenite	XII	100	100	61	151	2	2	338	197	533	100	11833	700	800	2100	100	-	-	-	-	700	100	340	100	648
Leolo Mountain norite	XIII	29	287	4	40	1	2	113	45	700	233	12933	200	77	300	-	22500	3000	10000	300	200	100	60	100	632

*Formula used in percentage calculations: % = (I x 100 / I); = (II x 100 / I); = (III x 100 / I); etc.
**Sample number

Appendix 3 Heavy metal and mineral concentrations of soils sampled along a catena in the Sekhukhuneland Centre of Plant Endemism.

Soil Samples [n=5]		Mg:Ca	MgO%	CaO%	Na2O%	SiO2%	P2O5%	K2O%	Al2O3	TiO2%	V2O5%	Cr2O3	MnO%	Fe2O3	NiO%	LOI	Total	pH	*SN
Valley	A**	0.58	13.79	7.98	1.44	48.05	0.03	0.31	11.24	0.46	0.04	0.3	0.23	11.51	0.03	4.25	99.66	6.59	659
Magnetite outcrop	B	0.49	13.21	6.43	0.41	39.17	0.03	0.27	7.79	1.45	0.13	3.4	0.25	18.83	0.04	8.5	99.91	6.69	657
Eroded area	C	0.23	19.27	4.36	0.26	50.61	0.01	0.27	6.48	0.27	0.02	0.33	0.28	10.94	0.07	5.3	98.46	7.05	928
Eroded area edge edge	D	0.24	19.38	4.66	0.31	48.45	0.01	0.26	5.31	0.27	0.02	0.41	0.21	10.93	0.07	8.22	98.5	7.09	931
Lower footslope of hill	E	0.96	7.44	7.13	1.17	53.77	0.03	0.52	16.33	0.38	0.04	2.07	0.12	7.23	0.03	4.65	100.91	7.54	655
Upper footslope of hill	F	1.85	7.66	14.19	1.17	58.01	0.05	0.87	11.52	0.72	0.04	0.88	0.17	7.19	0.02	-2.63	99.86	7.75	654
Lower midslope of hill	G	2.14	8.67	18.53	0.6	32.95	0.04	0.57	7.71	0.56	0.02	0.04	0.11	6.28	0.01	19.86	95.95	7.84	937
Upper midslope of hill	H	1.73	6.44	11.31	1.14	47.94	0.07	0.79	11.36	0.81	0.04	0.07	0.16	9.54	0.01	7.16	96.83	7.56	936
Lower scarp of hill	I	0.7	15.89	11.09	0.61	33.93	0.01	0.12	5.63	0.17	0.03	2.2	0.21	14.35	0.19	12.11	99.54	7.45	683
Lower chrome outcrop	J	0.4	14.11	5.61	0.48	26.87	0.03	0.08	11.7	0.36	0.19	25.68	0.19	14.64	0.09	0.85	100.89	6.67	682
Outcrop gulley	K	0.37	23.44	8.65	0.14	40.12	0.01	0.05	6.19	0.14	0.02	1.25	0.19	11.85	0.48	6.89	99.42	7.07	673
Upper scarp of hill	L	0.42	15.24	6.39	1.28	41.59	0.03	0.3	7.98	0.23	0.04	2.82	0.22	13.34	0.16	9.57	99.19	6.95	684
Upper chrome outcrop	M	0.48	14.63	7.07	1.88	39.87	0.01	0.22	10.6	0.26	0.06	4.58	0.21	14.57	0.15	4.85	98.97	6.71	685
Certified	*GSNC*	-	*2.3*	*2.5*	*3.77*	*65.8*	*0.28*	*4.63*	*14.67*	*0.68*	*0.012*	*0.008*	*0.06*	*3.75*	*0.004*	*1.32*	*99.784*	-	-
Control analysis	*GSN*	-	*2.16*	*2.56*	*3.63*	*66.78*	*0.28*	*4.77*	*14.29*	*0.66*	*<0.01*	*<0.01*	*0.05*	*3.8*	*<0.01*	*1.29*	*100.27*	-	-

Soil Samples [n=5]		S	Cl	Sc	V	Cr	Ni	Cu	Zn	Ga	Rb	Sr	Y	Zr	Pb	W	Co	As	Nb	Mo	Th	*SN
Valley	A**	327	196	30	163	2214	321	28	68	12	10	133	13	47	6	85	-	0	4	1	0	659
Magnetite outcrop	B	773	388	29	704	26238	401	39	139	14	10.5	113	11	59	6	74	149	0	4	1	0	657
Eroded area	C	297	245	32	109	2641	529	36	68	9	16	88	9	46	7	76	110	0	4	1	3	928
Eroded area edge edge	D	275	166	31	121	3272	506	27	68	8	14	114	10	51	3	87	111	0	4	1	0	931
Lower footslope of hill	E	442	213	14	191	14102	201	13	71	14	18.5	176	9	78	11	165	-	0	4	3	3	655
Upper footslope of hill	F	347	126	9	182	5283	122	22	41	10	27	168	11	94	7	376	-	0	3	1	4	654
Lower midslope of hill	G	93	214	34	85	479	81	32	50	11	19	206	20	120	11	30	46	3	6	1	3	937
Upper midslope of hill	H	351	284	46	112	724	114	36	64	14	27	172	19	198	15	43	32	2	8	0	7	936
Lower scarp of hill	I	311	121	1	121	10824	1028	20	73	13	7	149	9	28	9	0	127	8	2	3	2	683
Lower chrome outcrop	J	447	94	12	1084	50000	930	45	273	42	5	85	6	24	11	61	156	4	10	13	4	682
Outcrop gulley	K	334	280	30	116	2937	1133	20	81	8	4	124	8	34	4	0	21	3	0	0	0	673
Upper scarp of hill	L	596	135	13	168	15671	646	21	63	30	10	137	10	36	6	36	130	7	3	2	4	684
Upper chrome outcrop	M	273	84	12	208	21206	812	20	93	17	8	189	10	44	4	2	101	7	2	0	0	685
Certified	*GSNC*	*140*	*450*	*7*	*65*	*55*	*34*	*20*	*48*	*22*	*185*	*570*	*19*	*235*	*53*	*490*	*65*	*1.6*	*21*	*1.2*	*42*	-
Control analysis	*GSN*	*115*	*482*	*7*	*63*	*60*	*33*	*20*	*48*	*20*	*181*	*565*	*20*	*235*	*50*	*487*	*68*	*<3*	*25*	*2*	*41*	-

* Sample number
** **Figure 24**; Chapter 10

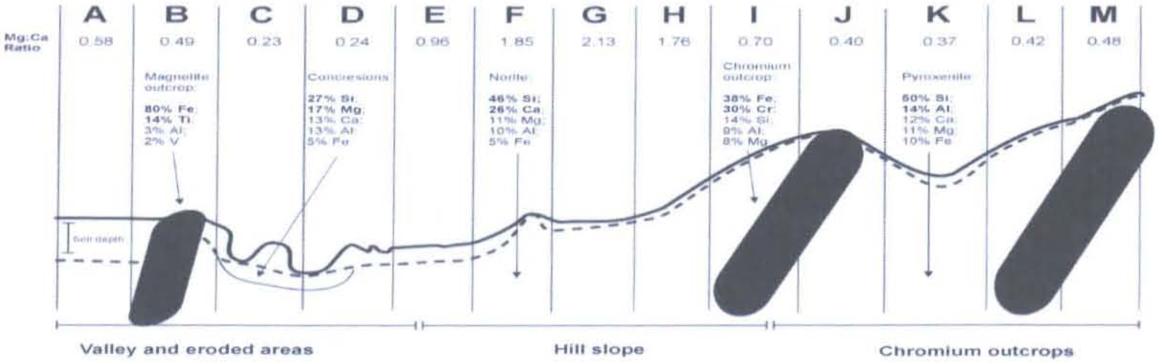
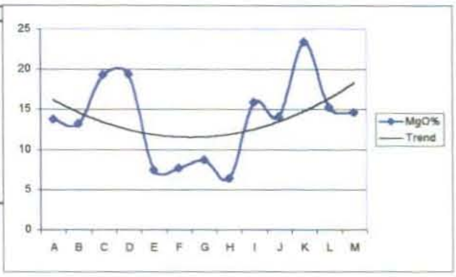


Figure 24 Transect of a catena in the Sekhukhuneland Centre of Plant Endemism with associated underlying rock.

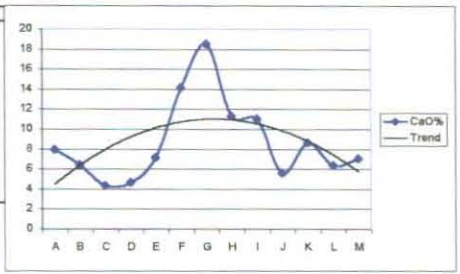
Appendix 3 Heavy metal and mineral concentrations of soils sampled along a catena in the Sekhukhuneland Centre of Plant Endemism.

PERCENTAGE ANALYSIS

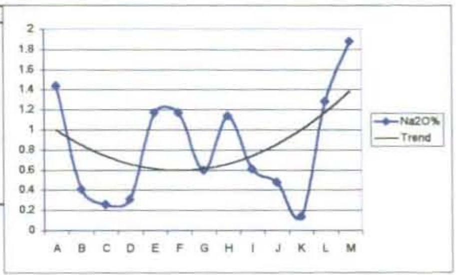
	$MgO\%$
A	13.79
B	13.21
C	19.27
D	19.38
E	7.44
F	7.66
G	8.67
H	6.44
I	15.89
J	14.11
K	23.44
L	15.24
M	14.63



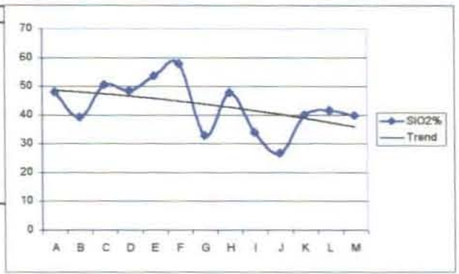
	$CaO\%$
A	7.98
B	6.43
C	4.36
D	4.66
E	7.13
F	14.19
G	18.53
H	11.31
I	11.09
J	5.61
K	8.65
L	6.39
M	7.07



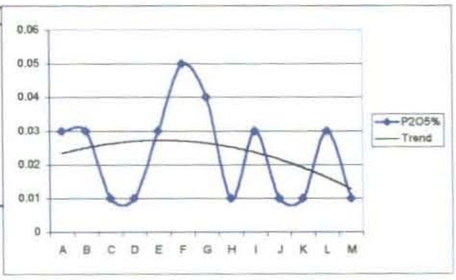
	$Na_2O\%$
A	1.44
B	0.41
C	0.26
D	0.31
E	1.17
F	1.17
G	0.6
H	1.14
I	0.61
J	0.48
K	0.14
L	1.28
M	1.88



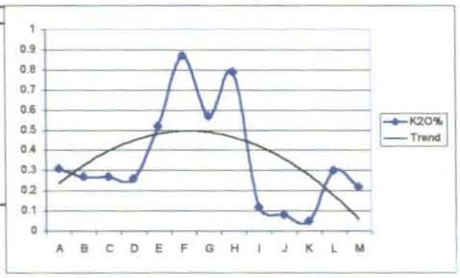
	$SiO_2\%$
A	48.05
B	39.17
C	50.61
D	48.45
E	53.77
F	58.01
G	32.95
H	47.94
I	33.93
J	26.87
K	40.12
L	41.59
M	39.87



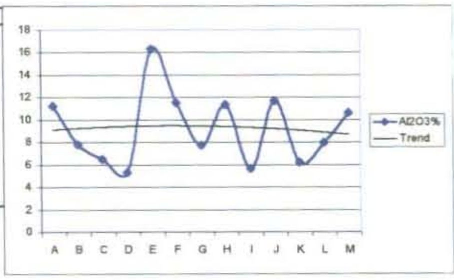
	$P_2O_5\%$
A	0.03
B	0.03
C	0.01
D	0.01
E	0.03
F	0.05
G	0.04
H	0.01
I	0.03
J	0.01
K	0.01
L	0.03
M	0.01



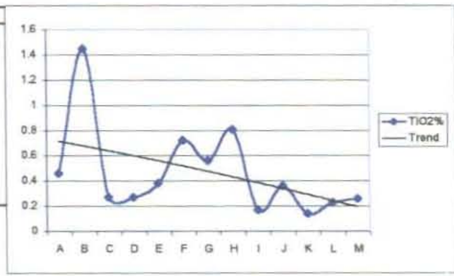
	$K_2O\%$
A	0.31
B	0.27
C	0.27
D	0.26
E	0.52
F	0.87
G	0.57
H	0.79
I	0.12
J	0.08
K	0.05
L	0.3
M	0.22



	$Al_2O_3\%$
A	11.24
B	7.79
C	6.48
D	5.31
E	16.33
F	11.52
G	7.71
H	11.36
I	5.63
J	11.7
K	6.19
L	7.98
M	10.6

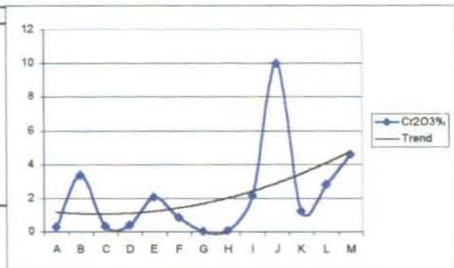


	$TiO_2\%$
A	0.46
B	1.45
C	0.27
D	0.27
E	0.38
F	0.72
G	0.56
H	0.81
I	0.17
J	0.36
K	0.14
L	0.23
M	0.26

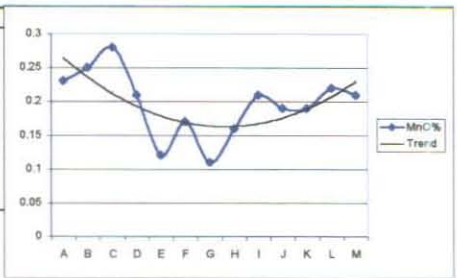


	$V_2O_5\%$
A	0.04
B	0.13
C	0.02
D	0.02
E	0.04
F	0.04
G	0.02
H	0.04
I	0.03
J	0.19
K	0.02
L	0.04
M	0.06

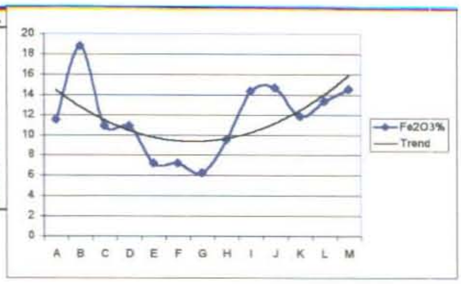
	$Cr_2O_3\%$
A	0.3
B	3.4
C	0.33
D	0.41
E	2.07
F	0.88
G	0.04
H	0.07
I	2.2
J	10
K	1.25
L	2.82
M	4.58



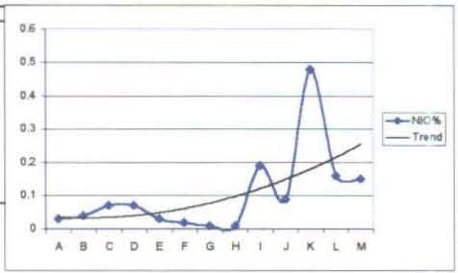
	MnO%
A	0.23
B	0.25
C	0.28
D	0.21
E	0.12
F	0.17
G	0.11
H	0.16
I	0.21
J	0.19
K	0.19
L	0.22
M	0.21



	Fe_2O_3%
A	11.51
B	18.83
C	10.94
D	10.93
E	7.23
F	7.19
G	6.28
H	9.54
I	14.35
J	14.65
K	11.85
L	13.34
M	14.57

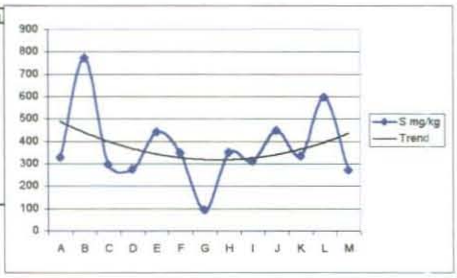


	NiO%
A	0.03
B	0.04
C	0.07
D	0.07
E	0.03
F	0.02
G	0.01
H	0.01
I	0.19
J	0.09
K	0.48
L	0.16
M	0.15

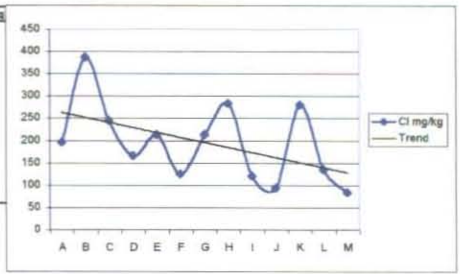


MG/KG ANALYSIS

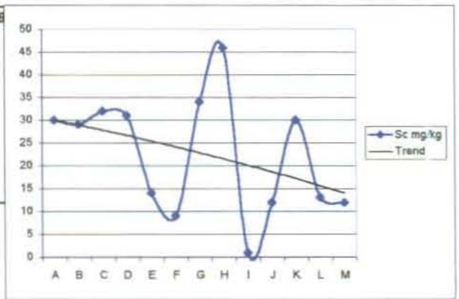
	S mg/kg
A	327
B	773
C	297
D	275
E	442
F	347
G	93
H	351
I	311
J	447
K	334
L	596
M	273



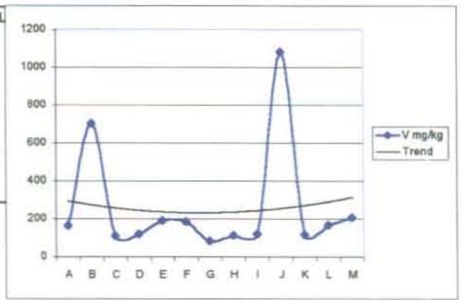
	Cl mg/kg
A	196
B	388
C	245
D	166
E	213
F	126
G	214
H	284
I	121
J	94
K	280
L	135
M	84



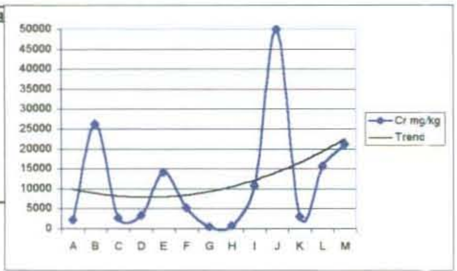
	Sc mg/kg
A	30
B	29
C	32
D	31
E	14
F	9
G	34
H	46
I	1
J	12
K	30
L	13
M	12



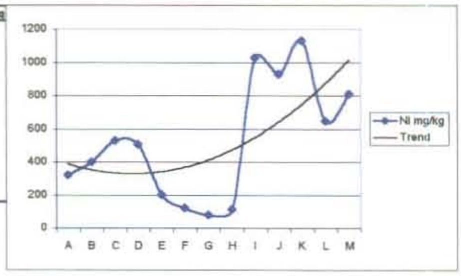
	V mg/kg
A	163
B	704
C	109
D	121
E	191
F	182
G	85
H	112
I	121
J	1084
K	116
L	168
M	206



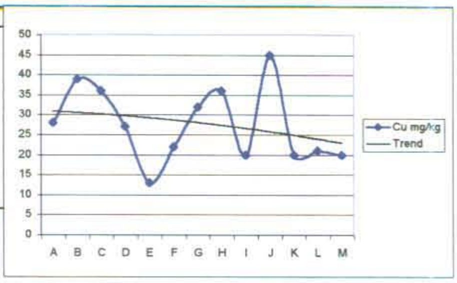
	Cr mg/kg
A	2214
B	26238
C	2641
D	3272
E	14102
F	5283
G	479
H	724
I	10824
J	50000
K	2937
L	15671
M	21206



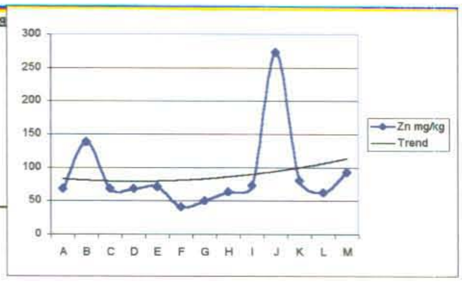
	Ni mg/kg
A	321
B	401
C	529
D	506
E	201
F	122
G	81
H	114
I	1028
J	930
K	1133
L	646
M	812



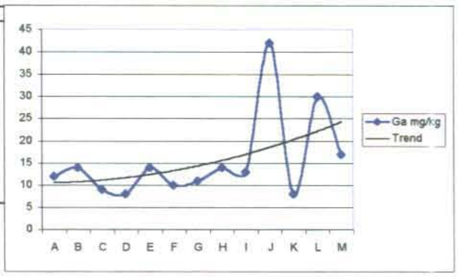
	Cu
A	28
B	39
C	36
D	27
E	13
F	22
G	32
H	36
I	20
J	45
K	20
L	21
M	20



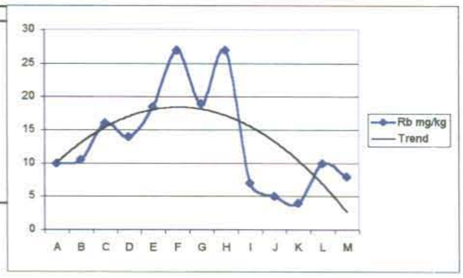
	Zn mg/kg
A	68
B	139
C	68
D	68
E	71
F	41
G	50
H	64
I	73
J	273
K	81
L	63
M	93



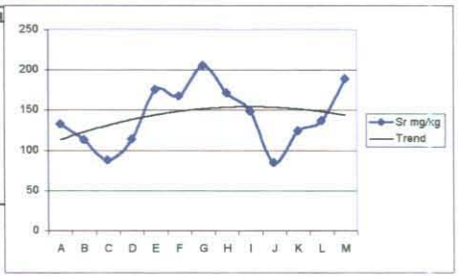
	Ga
A	12
B	14
C	9
D	8
E	14
F	10
G	11
H	14
I	13
J	42
K	8
L	30
M	17



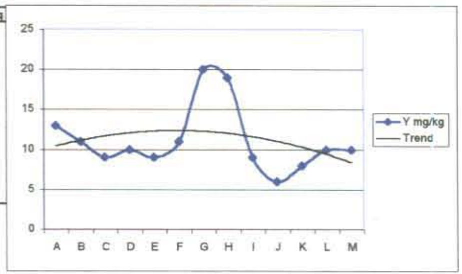
	Rb
A	10
B	10.5
C	16
D	14
E	18.5
F	27
G	19
H	27
I	7
J	5
K	4
L	10
M	8



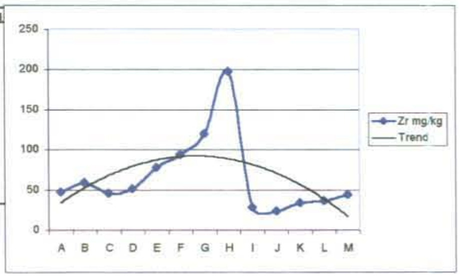
	Sr mg/kg
A	133
B	113
C	88
D	114
E	176
F	168
G	206
H	172
I	149
J	85
K	124
L	137
M	189



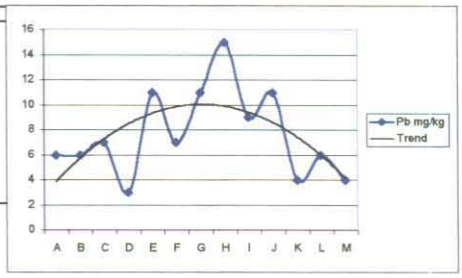
	Y mg/kg
A	13
B	11
C	9
D	10
E	9
F	11
G	20
H	19
I	9
J	6
K	8
L	10
M	10



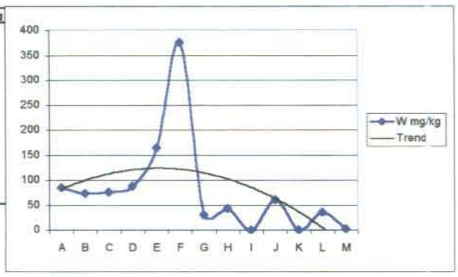
	Zr mg/kg
A	47
B	59
C	46
D	51
E	78
F	94
G	120
H	198
I	28
J	24
K	34
L	36
M	44



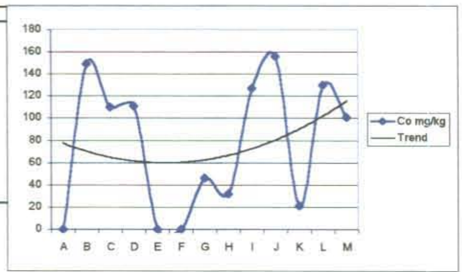
	Pb
A	6
B	6
C	7
D	3
E	11
F	7
G	11
H	15
I	9
J	11
K	4
L	6
M	4



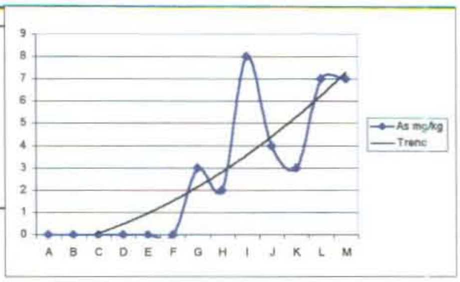
	W mg/kg
A	85
B	74
C	76
D	87
E	165
F	376
G	30
H	43
I	0
J	61
K	0
L	36
M	2



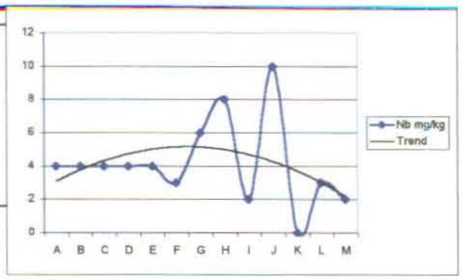
	Co
A	0
B	149
C	110
D	111
E	0
F	0
G	46
H	32
I	127
J	156
K	21
L	130
M	101



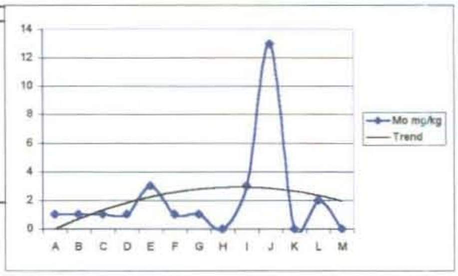
	As
A	0
B	0
C	0
D	0
E	0
F	0
G	3
H	2
I	8
J	4
K	3
L	7
M	7



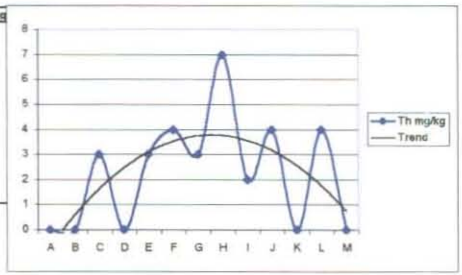
	Nb
A	4
B	4
C	4
D	4
E	4
F	3
G	6
H	8
I	2
J	10
K	0
L	3
M	2



	Mo
A	1
B	1
C	1
D	1
E	3
F	1
G	1
H	0
I	3
J	13
K	0
L	2
M	0



	Th mg/kg
A	0
B	0
C	3
D	0
E	3
F	4
G	3
H	7
I	2
J	4
K	0
L	4
M	0



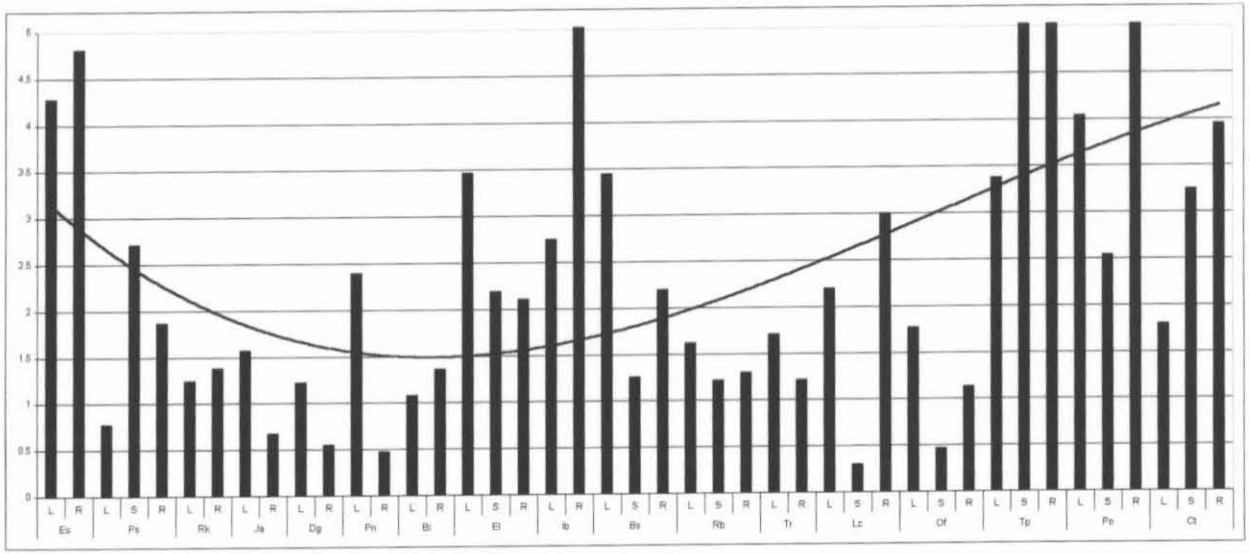
Appendix 4 Heavy metal and mineral concentrations of plant material collected along a catena (see Figure 24) in the Sekhukhuneland Centre of Plant Endemism.

Species (n=5)		Plant Part	Ca%	Mg%	N%	P%	S%	Cr mg/kg	Ni mg/kg	Fe mg/kg	Mn mg/kg	Al mg/kg	V mg/kg	Sample Number
Euclea sp. nov.	Es	L	4.28	0.28	0.679	0.271	0.106	17.4	26.8	46.5	12.7	76	7.7	938
		R	4.81	0.134	0.529	0.247	0.1	17.7	5.4	**607**	9.7	302	4.9	938
Pterothrix spinescens	Ps	L	0.779	0.058	0.641	0.748	0.076	152.8	61.5	**5180**	40	**3911**	43.5	928
		S	2.71	0.05	0.549	1.32	0.163	**420**	38.5	**1820**	40	**1490**	52	928
		R	1.87	0.055	0.624	0.688	0.076	30	11.4	**766**	24.5	**676**	12.15	928
Rhus keetii	Rk	L	1.24	0.084	0.999	0.338	0.152	6.5	2.63	117.3	10.7	117	0.66	619
		R	1.38	0.05	0.397	0.347	0.054	14.4	5.9	**673**	7.7	**677**	4.46	619
Jamesbrittenia atropurpurea	Ja	L	1.57	0.094	1	0.943	0.216	24.1	16.9	**1414**	32.7	**1224**	5.82	616
		R	0.674	0.047	0.547	0.336	0.062	23.7	25.7	**1085**	15.6	**1095**	6.28	616
Dicoma gerrardii	Dg	L	1.22	0.079	1.031	0.697	0.176	74.2	29.4	**3155**	27.8	**2305**	20.5	618
		R	0.552	0.05	0.434	0.284	0.09	28.2	19.5	**1392**	9.1	**1007**	7.1	618
Polygala sp. nov.	Pn	L	2.4	0.148	1.05	0.238	0.118	4.73	3	81	8.35	151	0.01	602
		R	0.476	0.118	0.472	0.06	0.072	9.41	7.82	254	3.36	338	2.01	602
Brachylaena ilicifolia [form]	Bi	L	1.08	0.154	1.1	0.191	0.153	6.96	9.64	88.3	6.81	215	2	613
		R	1.36	0.102	0.715	0.176	0.061	16.2	23.2	**415**	7.34	**524**	4.21	613
Euclea linearis	El	L	3.47	0.057	0.838	0.395	0.094	7.45	9.63	121	27.4	127	1.11	937
		S	2.19	0.053	0.435	0.135	0.084	5.18	18.1	106	7.66	138	0.3	937
		R	2.11	0.042	0.599	0.398	0.089	7.07	2.28	**1220**	8.86	**951**	1.36	937
Ipomoea bathycolpos	Ib	L	2.75	0.14	1.78	0.435	0.348	5.91	6.72	153	8.56	164	0.85	617
		R	5.09	0.057	0.521	1.298	0.061	7.31	17.6	**530**	8.72	**426**	1.4	617
Berkheya insignis [form]	Bs	L	3.45	0.04	0.566	0.557	0.148	6.79	5.08	**740**	10.5	**635**	1.28	942
		S	1.256	0.053	0.263	0.353	0.065	4.01	0.71	201	56.4	230	0.06	942
		R	2.2	0.058	0.67	0.677	0.702	23.3	15.2	**6510**	36.9	**3496**	13.2	942
Rhus batophylla	Rb	L	1.62	0.066	1.07	0.302	0.091	5.68	5.75	167	6.64	198	0.74	936
		S	1.216	0.057	0.455	0.175	0.083	7.98	3.69	84.6	4.92	124	1.28	936
		R	1.3	0.043	0.421	0.071	0.061	10.3	5.24	**928**	5.74	**532**	2.65	936
Tinnea rhodesiana	Tr	L	1.71	0.1	0.865	1.466	0.116	19.6	16.5	199	11.4	252	5.46	614
		R	1.218	0.039	0.549	0.22	0.046	29.3	9.33	374	6.63	**425**	6.4	614
Leucas capensis [form]	Lc	L	2.2	0.847	2.6	0.166	0.75	4.18	0.92	129	43.9	184	1.01	596
		S	0.302	0.173	0.576	0.041	0.02	1.14	0.08	87.3	9.8	72.4	0.41	596
		R	3	0.238	0.791	0.036	0.045	9.27	5.82	**567**	26.8	**541**	2.75	596
Orthosiphon fruticosus	Of	L	1.77	0.493	2	0.124	0.124	7.42	0.37	175	35.7	168	1.9	615
		S	0.468	0.155	0.769	0.065	0.027	6.11	3.24	149	10.6	151	1.2	615
		R	1.13	0.193	1.04	0.054	0.02	2.89	2.67	**525**	18.1	**446**	0.65	615
Terminalia pruncides	Tp	L	3.38	0.324	1.4	0.072	0.07	6.56	5.33	56.8	18.7	183	1.63	605
		S	9.8	0.121	0.473	0.064	0.027	3.81	0.01	160	24.5	97.7	2.53	605
		R	5.6	0.246	0.45	0.069	0.033	7.35	6.28	262	10.2	360	2.36	605
Petalidium oblongifolium	Po	L	4.04	0.846	2.13	0.098	0.082	2.59	1.88	68.7	12.8	59.5	1.17	598
		S	2.54	0.376	0.767	0.039	0.012	2.04	13.1	54.1	7.8	65.4	0.79	598
		R	6.35	0.455	0.634	0.034	0.029	8.16	5.66	205	13.9	273	1.95	598
Catha transvaalensis	Ct	L	1.8	0.383	0.929	0.065	0.183	3.06	3.08	55.6	12	65	1.12	604
		S	3.25	0.138	0.436	0.042	0.018	3.3	3.94	53.8	5.85	60.15	0.91	604
		R	3.95	0.134	0.517	0.041	0.031	5.4	1.84	**624.5**	24.45	**516.5**	2.25	604

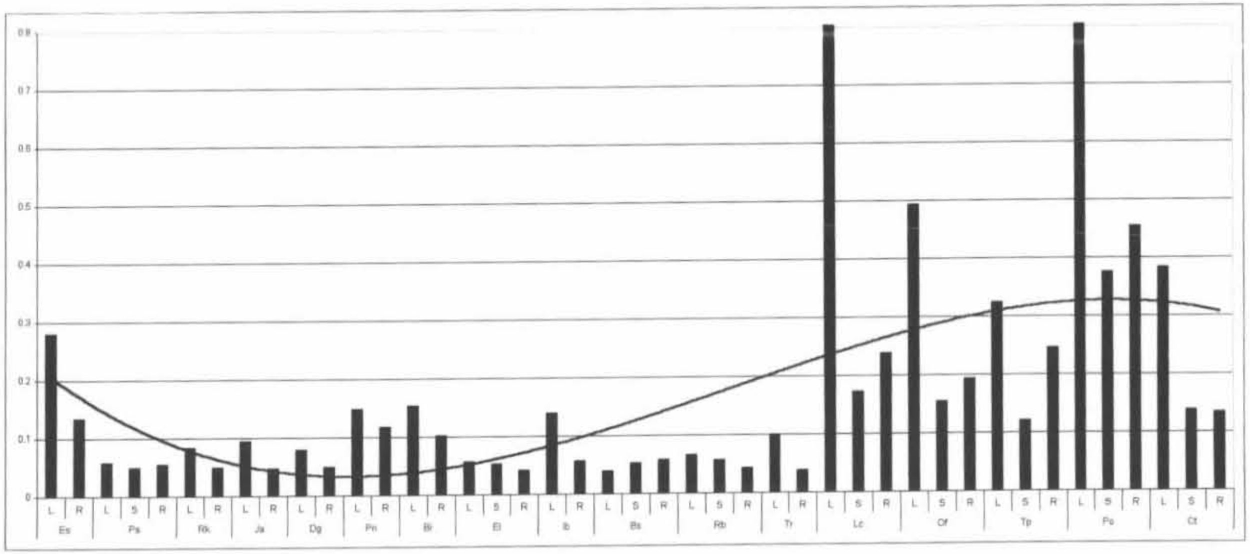
L = leafs, S = stems & R = roots
Highest concentrations recorded for leaves and roots are given in blocks
Hyperaccumulation and accumulation of metals are shaded

Appendix 4 Heavy metal and mineral concentrations of plant material collected along a catena (see Figure 24) in the Sekhukhuneland Centre of Plant Endemism.

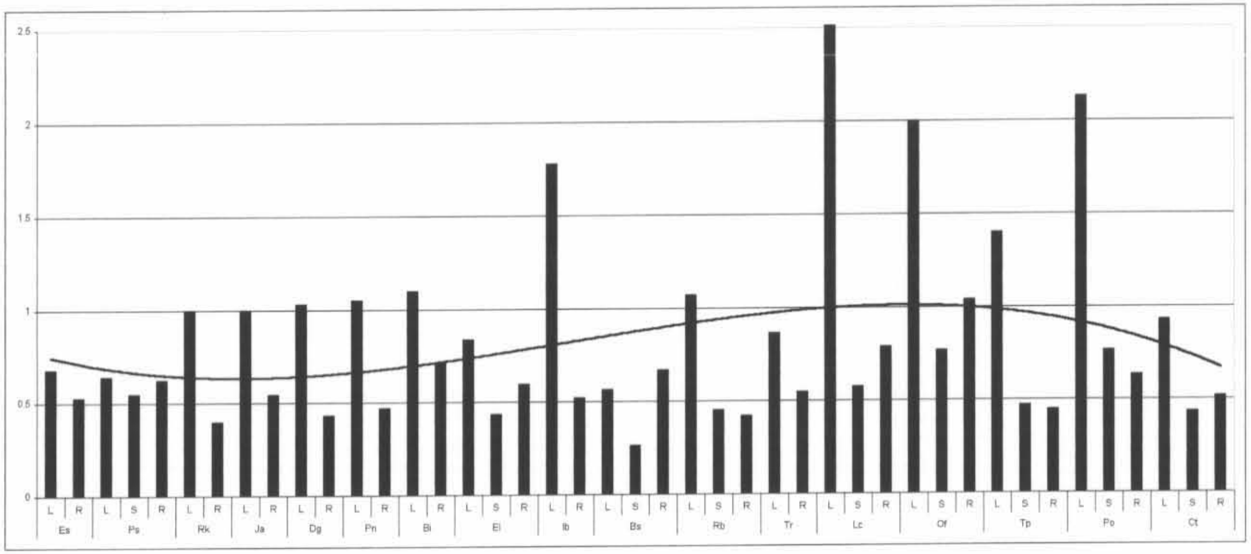
		Ca%
Es	L	4.28
	R	4.81
Ps	L	0.779
	S	2.71
	R	1.87
Rk	L	1.24
	R	1.38
Ja	L	1.57
	R	0.674
Dg	L	1.22
	R	0.552
Pn	L	2.4
	R	0.478
Bl	L	1.08
	R	1.38
El	L	3.47
	S	2.19
	R	2.11
Ib	L	2.75
	R	5.09
Bs	L	3.45
	S	1.258
	R	2.2
Rb	L	1.82
	S	1.218
	R	1.3
Tr	L	1.71
	R	1.218
Lc	L	2.2
	S	0.302
	R	3
Of	L	1.77
	S	0.468
	R	1.13
Tp	L	3.38
	S	9.8
	R	5.8
Po	L	4.04
	S	2.54
	R	6.35
Ct	L	1.8
	S	3.25
	R	3.95



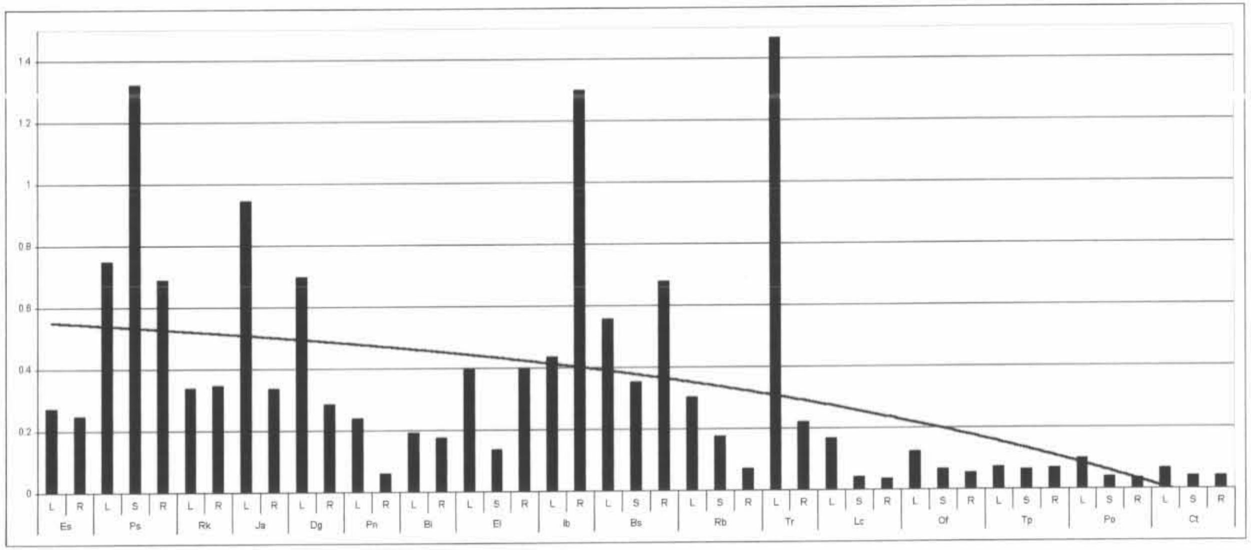
		Mg%
Es	L	0.28
	R	0.134
Ps	L	0.058
	S	0.05
	R	0.055
Rk	L	0.084
	R	0.05
Ja	L	0.094
	R	0.047
Dg	L	0.079
	R	0.05
Pn	L	0.148
	R	0.118
Bl	L	0.154
	R	0.102
El	L	0.057
	S	0.053
	R	0.042
Ib	L	0.14
	R	0.057
Bs	L	0.04
	S	0.053
	R	0.058
Rb	L	0.068
	S	0.057
	R	0.043
Tr	L	0.1
	R	0.038
Lc	L	0.847
	S	0.173
	R	0.238
Of	L	0.493
	S	0.155
	R	0.193
Tp	L	0.324
	S	0.121
	R	0.248
Po	L	0.848
	S	0.378
	R	0.465
Ct	L	0.383
	S	0.138
	R	0.134



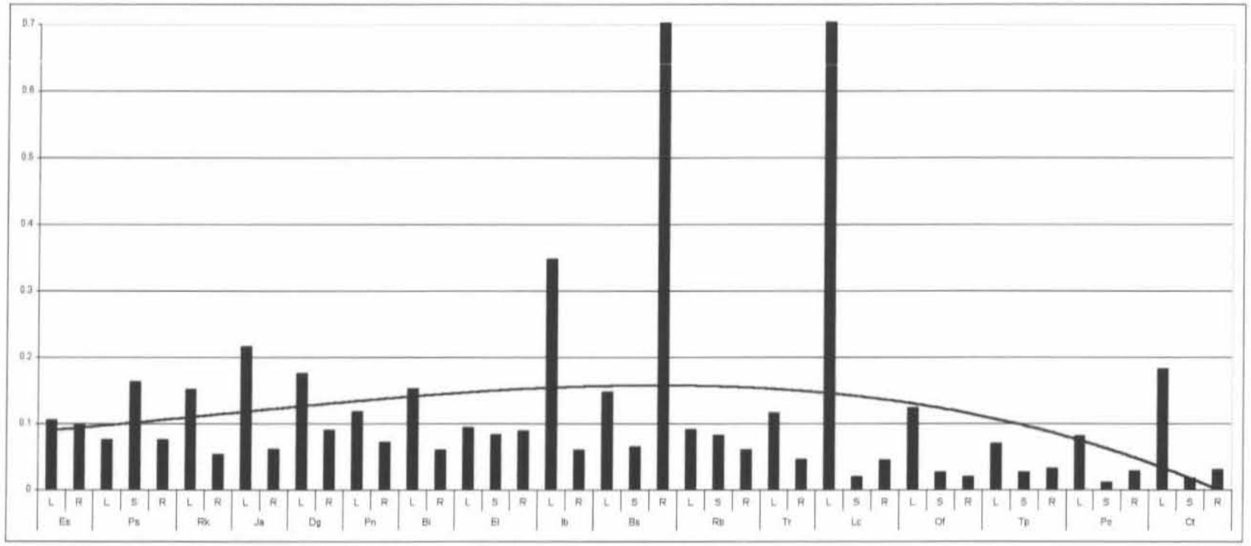
		N%
Es	L	0.679
	R	0.529
Ps	L	0.641
	S	0.548
	R	0.624
Rk	L	0.999
	R	0.397
Ja	L	1
	R	0.547
Dg	L	1.031
	R	0.434
Pn	L	1.05
	R	0.472
Bi	L	1.1
	R	0.715
El	L	0.838
	S	0.435
	R	0.599
Ib	L	1.78
	R	0.521
Bs	L	0.566
	S	0.283
	R	0.67
Rb	L	1.07
	S	0.455
	R	0.421
Tr	L	0.865
	R	0.549
Lc	L	2.6
	S	0.576
	R	0.791
Of	L	2
	S	0.769
	R	1.04
Tp	L	1.4
	S	0.473
	R	0.45
Po	L	2.13
	S	0.787
	R	0.634
Ct	L	0.929
	S	0.436
	R	0.517



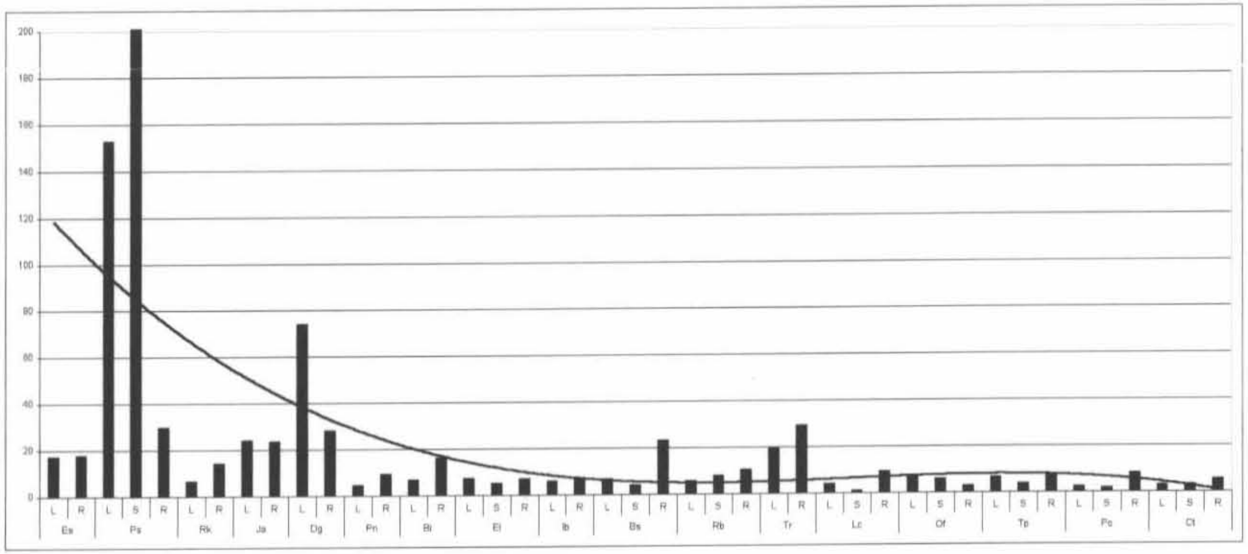
		P%
Es	L	0.271
	R	0.247
Ps	L	0.748
	S	1.32
	R	0.686
Rk	L	0.338
	R	0.347
Ja	L	0.943
	R	0.336
Dg	L	0.697
	R	0.284
Pn	L	0.238
	R	0.06
Bi	L	0.191
	R	0.176
El	L	0.395
	S	0.135
	R	0.398
Ib	L	0.435
	R	1.298
Bs	L	0.557
	S	0.353
	R	0.677
Rb	L	0.302
	S	0.175
	R	0.071
Tr	L	1.466
	R	0.22
Lc	L	0.166
	S	0.041
	R	0.036
Of	L	0.124
	S	0.065
	R	0.064
Tp	L	0.072
	S	0.064
	R	0.069
Po	L	0.098
	S	0.038
	R	0.034
Ct	L	0.065
	S	0.042
	R	0.041



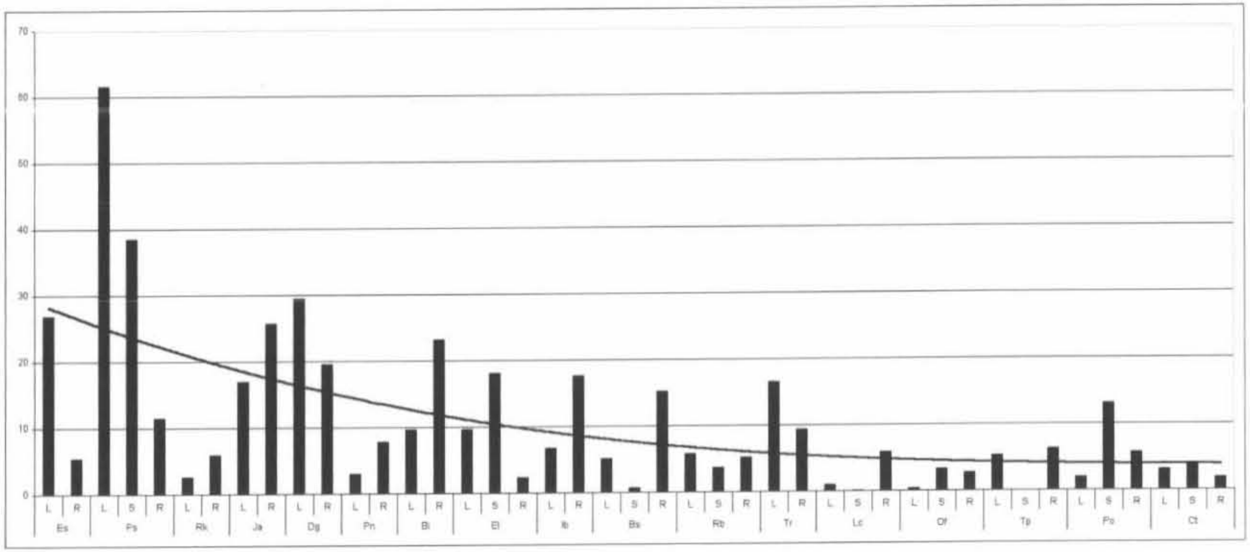
		S%
Es	L	0.106
	R	0.1
Ps	L	0.078
	S	0.163
	R	0.078
Rk	L	0.152
	R	0.054
Ja	L	0.216
	R	0.062
Dg	L	0.176
	R	0.09
Pn	L	0.118
	R	0.072
Bi	L	0.153
	R	0.061
El	L	0.094
	S	0.084
	R	0.089
Ib	L	0.348
	R	0.061
Bs	L	0.148
	S	0.065
	R	0.702
Rb	L	0.091
	S	0.083
	R	0.061
Tr	L	0.116
	R	0.048
Lc	L	0.75
	S	0.02
	R	0.045
Of	L	0.124
	S	0.027
	R	0.02
Tp	L	0.07
	S	0.027
	R	0.033
Pe	L	0.082
	S	0.012
	R	0.029
Ct	L	0.183
	S	0.018
	R	0.031



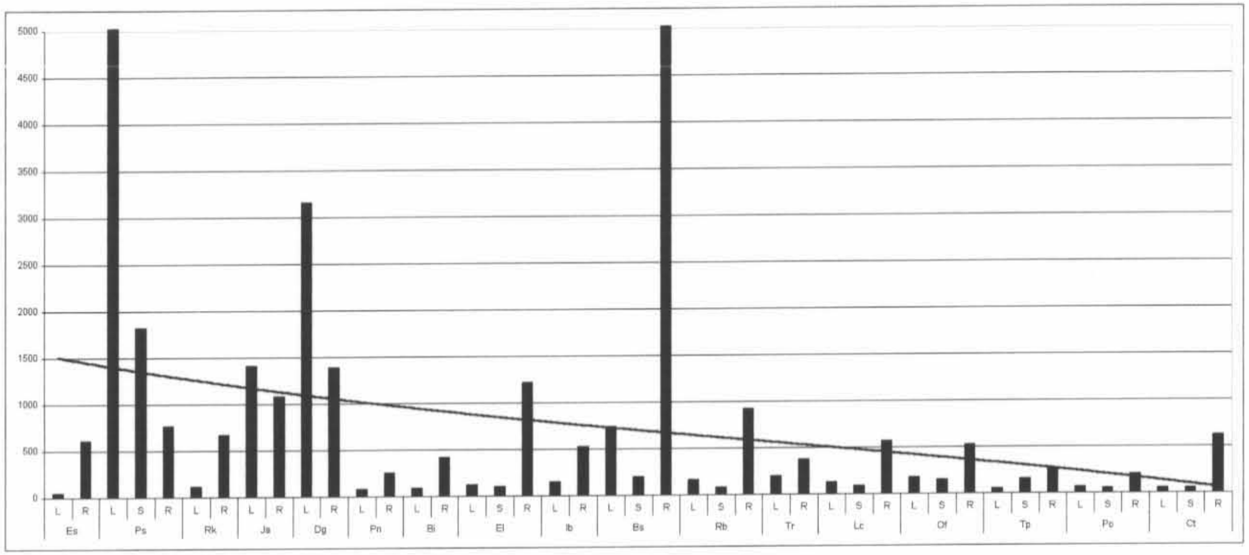
		Cr mg/kg
Es	L	17.4
	R	17.7
Ps	L	152.8
	S	420
	R	30
Rk	L	6.5
	R	14.4
Ja	L	24.1
	R	23.7
De	L	74.2
	R	29.2
Pn	L	4.73
	R	9.41
Bl	L	6.96
	R	18.2
El	L	7.45
	S	5.18
	R	7.07
Ib	L	5.91
	R	7.31
Bs	L	6.79
	S	4.01
	R	23.3
Rb	L	5.66
	S	7.98
	R	10.3
Tr	L	19.8
	R	29.3
Lc	L	4.16
	S	1.14
	R	9.27
Of	L	7.42
	S	6.11
	R	2.89
Te	L	6.56
	S	3.81
	R	7.35
Pe	L	2.59
	S	2.04
	R	6.16
Ct	L	3.06
	S	3.3
	R	5.4



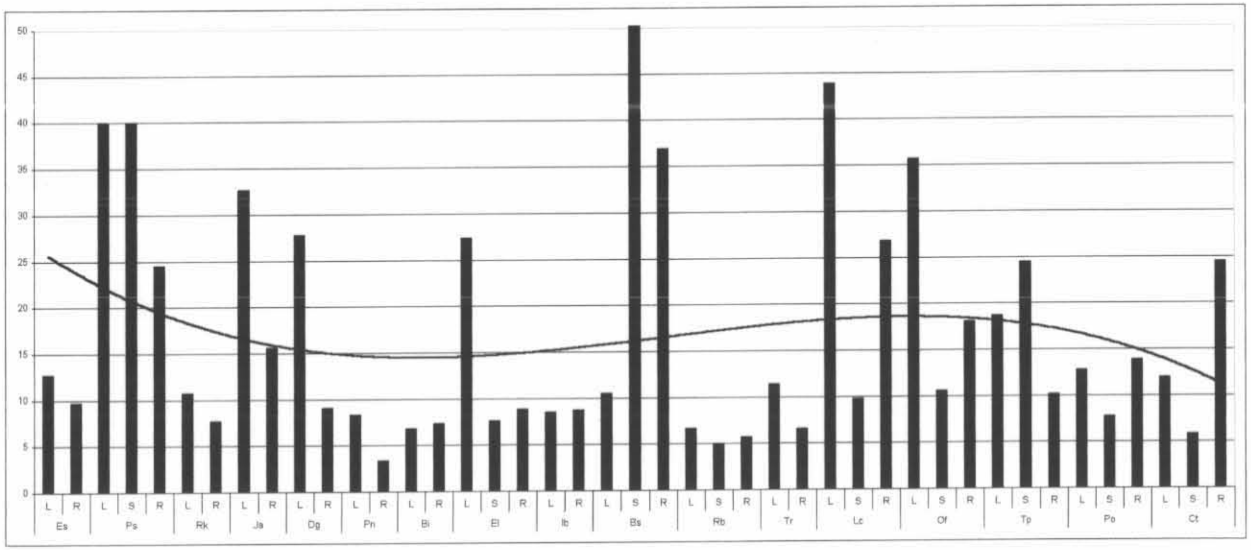
		Ni mg/kg
Es	L	26.9
	R	5.4
Ps	L	61.5
	S	38.5
	R	11.4
Rk	L	2.63
	R	5.9
Ja	L	16.9
	R	25.7
De	L	29.4
	R	19.5
Pn	L	3
	R	7.82
Bl	L	9.64
	R	23.2
El	L	9.63
	S	18.1
	R	2.28
Ib	L	6.72
	R	17.8
Bs	L	5.06
	S	0.71
	R	15.2
Rb	L	5.76
	S	3.89
	R	5.24
Tr	L	16.5
	R	9.33
Lc	L	0.92
	S	0.09
	R	5.82
Of	L	0.37
	S	3.24
	R	2.87
Te	L	5.33
	S	0.01
	R	6.28
Pe	L	1.98
	S	13.1
	R	5.88
Ct	L	3.08
	S	3.94
	R	1.94



		Fe mg/kg
Es	L	48.5
	R	607
Ps	L	5180
	S	1820
	R	766
Rk	L	117.3
	R	673
Ja	L	1414
	R	1085
Da	L	3155
	R	1392
Pn	L	81
	R	254
Bl	L	88.3
	R	415
El	L	121
	S	106
	R	1220
Ib	L	153
	R	530
Bs	L	740
	S	201
	R	6510
Rb	L	167
	S	84.6
	R	928
Tr	L	199
	R	374
Lc	L	129
	S	87.3
	R	567
Of	L	175
	S	149
	R	525
To	L	58.8
	S	160
	R	262
Po	L	88.7
	S	54.1
	R	205
Ct	L	55.6
	S	53.8
	R	624.5



		Mn mg/kg
Es	L	12.7
	R	9.7
Ps	L	40
	S	40
	R	24.5
Rk	L	10.7
	R	7.7
Ja	L	32.7
	R	15.6
Da	L	27.8
	R	9.1
Pn	L	8.35
	R	3.36
Bl	L	6.81
	R	7.34
El	L	27.4
	S	7.66
	R	8.86
Ib	L	8.58
	R	8.72
Bs	L	10.5
	S	56.4
	R	36.9
Rb	L	6.64
	S	4.92
	R	5.74
Tr	L	11.4
	R	6.63
Lc	L	43.9
	S	9.8
	R	26.9
Of	L	35.7
	S	10.6
	R	18.1
To	L	18.7
	S	24.5
	R	10.2
Po	L	12.8
	S	7.8
	R	13.9
Ct	L	12
	S	5.85
	R	24.45



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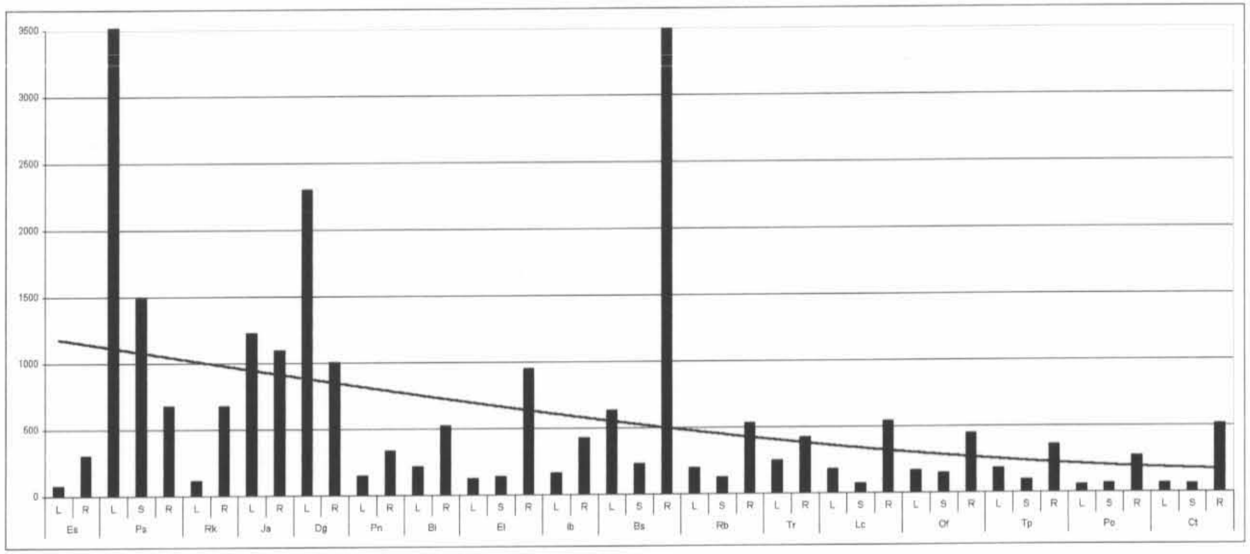
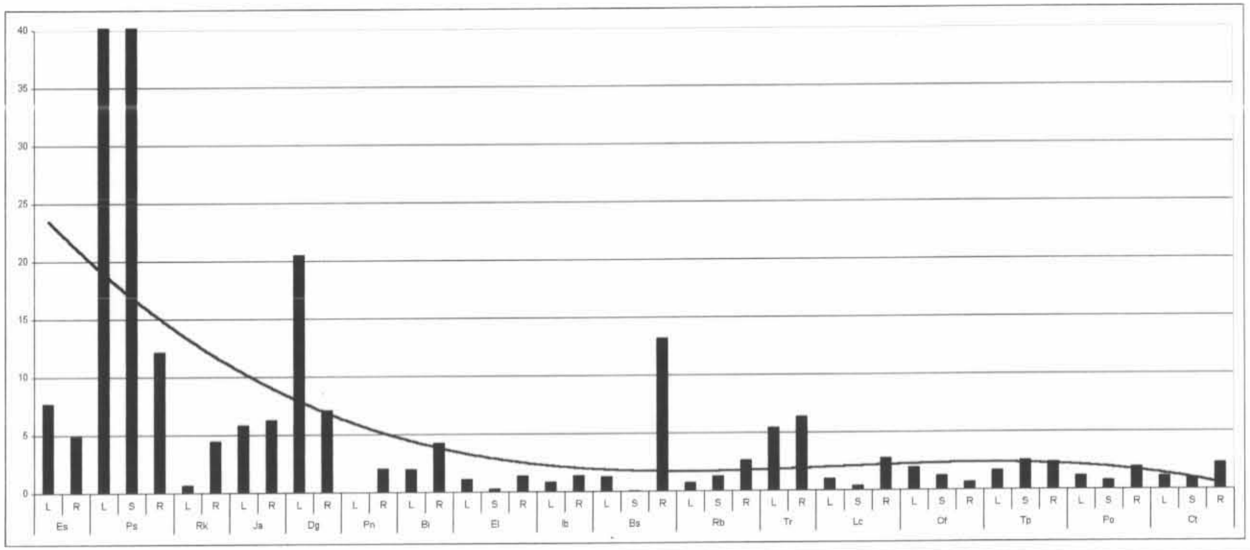
		Al mg/kg
Es	L	78
	R	302
Ps	L	3911
	S	1490
	R	678
Rk	L	117
	R	677
Ja	L	1224
	R	1095
Dg	L	2306
	R	1007
Pn	L	151
	R	338
Bl	L	215
	R	524
El	L	127
	S	136
	R	951
Ib	L	184
	R	428
Bs	L	635
	S	230
	R	3498
Rb	L	196
	S	124
	R	532
Tr	L	252
	R	425
Lc	L	184
	S	72.4
	R	541
Of	L	168
	S	151
	R	446
Tp	L	183
	S	97.7
	R	360
Po	L	59.5
	S	65.4
	R	273
Ct	L	65
	S	80.15
	R	516.5



		V mg/kg
Es	L	7.7
	R	4.9
Ps	L	43.5
	S	52
	R	12.15
Rk	L	0.66
	R	4.45
Ja	L	5.82
	R	6.28
Dg	L	20.5
	R	7.1
Pn	L	<0.01
	R	2.01
Bl	L	2
	R	4.21
El	L	1.11
	S	0.3
	R	1.36
Ib	L	0.85
	R	1.4
Bs	L	1.28
	S	0.06
	R	13.2
Rb	L	0.74
	S	1.28
	R	2.85
Tr	L	5.46
	R	6.4
Lc	L	1.01
	S	0.41
	R	2.75
Of	L	1.9
	S	1.2
	R	0.85
Tp	L	1.63
	S	2.53
	R	2.36
Po	L	1.17
	S	0.79
	R	1.95
Ct	L	1.12
	S	0.91
	R	2.25



Appendix 5 Checklist of the plant species/infraspecific taxa occurring in the Sekhukhuneland Centre of Plant Endemism.

Scientific names of taxa are based mainly on those used by Arnold & De Wet (1993) and Retief & Herman (1997), but also on relevant recent literature. The checklist is arranged alphabetically according to families of angiosperms, pteridophytes and bryophytes. Within each major division, taxa are listed alphabetically by genus and species.

Codes directly after names indicate the degree of endemism of species, specifying whether a species is a local endemic (∈) or near-endemic (∉). An asterisk (*) denotes alien taxa. A bullet (•) indicates medicinal plants. A diamond (♦) indicates taxa which are also prominent on the Great Dyke of Zimbabwe.

In the checklist each species name is followed by a collector's number for the specimen. All the collectors numbers listed in square brackets can be found in the H.G.W.J. Schweickerdt Herbarium (PRU), University of Pretoria.

The checklist is continually updated and will be published when all collected specimens have been identified. To contribute to this checklist, collectors numbers will be obtained from the Pretoria National Herbarium (PRE), National Botanical Institute, for each of taxa housed in their collections.

The last code is an indication of the distribution of the taxa in the SCPE. These QDG distributions only indicate data available from the specimens used to compile the checklist. The code is upper case and in square brackets and represent the following:

A = 2429BC	B = 2429BD	C = 2429DB	D = 2429DD
E = 2430AC	F = 2430CA	G = 2430CB	H = 2430CC
I = 2430CD	J = 2529BB	K = 2529BD	L = 2530AA

Provisional Red List categories are assigned in accordance with the guidelines set by the IUCN-Species Survival Commission (IUCN 1994). The three categories of threat used in the provisional assessments, as part of the SABONET Red Data List Project (Golding 1999), are in order of decreasing risk of extinction Critically Endangered (CR), Endangered (EN), Vulnerable (VU) and Low Risk (LR). The assessments of Hilton-Taylor (1996) are also included, namely Rare (R), Endangered (E), Vulnerable (V), Indeterminate (I), Insufficiently Known (K).

SUMMARY OF CODES:

Floristics

$\in$ – endemic $\not\in$ – near-endemic

* – alien taxa • – medicinal plants

♦ – prominent on the Great Dyke of Zimbabwe

Herbarium

PRU – H.G.W.J. Schweickerdt Herbarium, University of Pretoria

PRE – Pretoria National Herbarium, National Botanical Institute

Conservation

CR – Critically Endangered	EN or E – Endangered
VU or V – Vulnerable	R – Rare
I – Indeterminate	K – Insufficiently Known
LR – Low Risk	

Collectors

PB – Priscilla Burgoyne	GD – Graham Deall
WF – Willem de Frey	FP – Franci du Plessis
GD – Gawie Dednam	JH – Johan Hurter
JK – Johan Kritzinger	MM – Maryna Matthee
ER – Elisabet Retief	SS – Stefan Siebert
YH – Yashica Singh	RS – Renet Smit
YS – Yolandi Steenkamp	AW – Braam van Wyk

Collector's numbers

Only given for specimens housed in the H.G.W.J. Schweickerdt Herbarium [PRU], University of Pretoria. Additional listed species were taken from the PRECIS database at the National Herbarium [PRE], National Botanical Institute, Pretoria.

ALPHABETICAL CHECKLIST:

BRYOPHYTES

AMBLYSTEGIACEAE
Platyhypnidium macowanianum (Paris) M. Fleisch. [PRU: *AW* & *SS 13443*] [JF]

ARCHIDIACEAE
Archidium species [PRE] [CD]

AYTONIACEAE
Asterella bachmannii (Steph.) S.W. Arnell [PRE] [L]
A. wilmsii (Steph.) S.W. Arnell [PRE] [L]

BARTRAMIACEAE
Bartramia aristaria C. Müll. [PRE] [GH]
Philonotis dregeana (C. Müll.) A. Jaeger [PRE] [I]

BRYACEAE
Anomobryum filiforme (Dicks.) Solms [PRE] [L]
Brachymenium acuminatum Harv. in Hook. [PRE] [F]
B. pulchrum Hook. [PRE] [F]
B. systylium (C. Müll.) A. Jaeger [PRE] [F]
Bryum argenteum Hedw. [PRE] [FL]
B. capillare Hedw. [PRE] [CDFGH]
B. cellulare Hook. [PRE] [GH]
B. dichotomum Hedw. [PRE] [FGH]
B. pycnophyllum (Dixon) Mohamed [PRE] [F]
Pohlia baronii Wijk & Margad. [PRE] [L]

CALYMPERACEAE
Hypodontium dregei (Hornsch.) C. Müll. [PRE] [FI]
Syrrhopodon asper Mitt. [PRE] [I]
S. gaudichaudii Mont. [PRE] [GH]

DICRANACEAE
Campylopus atroluteus (C. Müll.) Paris [PRE] [L]
C. introflexus (Hedw.) Brid. [PRE] [FI]
C. pilifer Brid. [PRE] [CDFIL]
C. pyriformis (Schultz) Brid. [PRE] [CD]
C. robillardei Besch. [PRE] [CDIL]
C. savannarum (C. Müll.) Mitt. [PRE] [GH]
C. stenopelma (C. Müll.) Paris [PRE] [I]
Leucobryum acutifolium (Mitt.) Card. [PRE] [I]
Leucoloma rehmannii (C. Müll.) Rehmann ex Paris [PRE] [GHI]

ENTODONTACEAE
Entodon macropodus (Hedw.) C. Müll. [PRE] [F]
Erythrodontium subjulaceum (C. Müll.) Paris [PRE] [F]
Levierella perserrata P. de la Varde & J.-F. Leroy [PRE] [F]

ERPODIACEAE
Aulacopilum trichophyllum Ångstr. [PRE] [F]
Erpodium beccarii C. Müll. [PRE] [F]

EXORMOTHECACEAE
Exormotheca holstii Steph. [PRE] [A]

FABRONIACEAE
Fabronia leikipiae C. Müll. [PRE] [F]
F. pilifera Hornsch. [PRE] [F]

FISSIDENTACEAE
Fissidens asplenioides Hedw. [PRE] [I]
F. borgenii Hampe [PRE] [GH]
F. bryoides Hedw. [PRE] [FGH]
F. curvatus Hornsch. [PRE] [F]
F. glaucescens Hornsch. [PRE] [FI]
F. rufescens Hornsch. [PRE] [F]

FUMARIACEAE
Funaria bergiana (Hornsch.) Broth. [PRE] [GH]

GRIMMIACEAE
Schistidium apocarpum (Hedw.) Bruch & Schimp. [PRE] [F]

HEDWIGIACEAE
Braunia secunda (Hook.) Bruch, Schimp. & W. Gümbel [PRE] [FGH]
Hedwigia ciliata (Hedw.) P. Beauv. [PRE] [F]

HOOKERIACEAE
Hookeriopsis pappeana (Hampe) A. Jaeger [PRE] [GHI]

HYPNACEAE
Hypnum cupressiforme Hedw. [PRE] [F]

LEPTODONTACEAE
Forsstroemia producta (Hornsch.) Paris [PRE] [F]
Leptodon smithii (Hedw.) F. Weber & Mohr [PRE] [FI]

LESKEACEAE
Lindbergia haplocladioides Dixon [PRE] [F]
L. patentifolia Dixon [PRE] [F]
L. pseudoleskeoides Dixon [PRE] [F]
L. viridis Dixon [PRE] [F]
Pseudoleskeopsis claviramea (C. Müll.) Thér. [PRE] [F]
P. pseudoattenuata (C. Müll.) Thér. [PRE] [F]

LEUCODONTACEAE
Leucodon assimilis (C. Müll.) A. Jaeger [PRE] [FI]
Pterogonium gracile (Hedw.) Sm. [PRE] [F]

METEORIACEAE
Aerobryopsis capensis (C. Müll.) M. Fleisch. [PRE] [GHI]
Papillaria africana (C. Müll.) A. Jaeger [PRE] [FI]

Pilotrichella panduraefolia (C. Müll.) A. Jaeger [PRE] [F]
Squamidium brasiliense (Hornsch.) Broth. [PRE] [F]

ORTHOTRICHACEAE
Macrocoma tenue (Hook. & Grev.) Vitt [PRE] [F]
Schlotheimia ferruginea (Hook. & Grev.) Brid. [PRE] [GH]

PALLAVICINIACEAE
Symphyogyna brasiliensis Nees & Mont. [PRE] [L]

POLYTRICHACEAE
Atrichum androgynum (C. Müll.) A. Jaeger [PRE] [I]
Pogonatum capense (Hampe) A. Jaeger [PRE] [GH]
Polytrichum commune Hedw. [PRE] [IL]

PORELLACEAE
Porella capensis (Gottsche) Steph. [PRE] [F]

POTTIACEAE
Barbula ehrenbergii (Lorentz) M. Fleisch. [PRE] [GH]
B. eubryum C. Müll. [PRE] [CD]
B. indica (Hook.) Spreng. [PRE] [GH]
Bryoerythrophyllum campylocarpum (C. Müll.) H.A. Crum [PRE] [F]
Leptodontium longicaule Mitt. [PRE] [I]
Pseudocrossidium porphyreoneurum (C. Müll. ex Venturi) R.H. Zander [PRE] [AF]
Syntrichia ammonsiana (H.A. Crum & L.E. Anderson) Ochyra [PRE] [FGH]
S. chisosa (Magill, Delgad. & L.R. Stark) R.H. Zander [PRE] [GH]
S. fragilis (Taylor) Ochyra [PRE] [F]
S. pagorum (Milde) J.J. Amann [PRE] [F]
S. princeps (De Not.) Mitt. [PRE] [F]
S. ruralis (Hedw.) F. Weber & Mohr [PRE] [F]
Tortella humilis (Hedw.) Jenn. [PRE] [F]
Tortula atrovirens (Sm.) Lindb. [PRE] [FGH]
Trichostomum brachydontium Bruch ex F.A. Müll. [PRE] [BCDFGHIK]
Weisiopsis plicata (Mitt.) Broth. [PRE] [F]
Weissia controversa Hedw. [PRE] [F]

PRIONODONTACEAE
Prionodon densus (Hedw.) C. Müll. [PRE] [GH]

PTEROBRYACEAE
Calyptothecium acutifolium (Brid.) Broth. [PRE] [F]
C. hoehnelii (C. Müll.) Argent [PRE] [GH]

PTYCHOMITRIACEAE
Ptychomitrium crispatum (Hedw.) A. Jaeger [PRE] [F]
P. depressum (C. Müll.) Paris [PRE] [F]
P. eurybasis Dixon [PRE] [FI]
P. subcrispatum Thér. & P. Vard. [PRE] [F]

RICCIACEAE
Riccia atropurpurea Sim [PRE] [CD]
R. elongata Perold [PRE] [F]
R. okahandjana S.W. Arnell [PRE] [J]

SEMATOPHYLLACEAE
Sematophyllum brachycarpum (Hampe) Broth. [PRE] [F]

SPHAGNACEAE
Sphagnum capense Hornsch. [PRE] [GH]

THAMNOBRYACEAE
Porotrichum madagassum Kiaer ex Besch. [PRE] [FGHI]

TRACHYPODACEAE
Trachypodopsis serrulata (P. Beauv.) Fleisch. [PRE] [F]

PTERIDOPHYTES

ADIANTACEAE
Actiniopteris radiata (J. König ex Sw.) Link [PRE] [I]
Adiantum capillus-veneris L. [PRE] [FH]
Cheilanthes dolomiticola (Schelpe) Schelpe & N.C. Anthony [PRE] [EH]
  C. eckloniana (Kunze) Mett. [PRE] [L]
  C. hirta Sw. [PRU: *SS 791*] [BEFJL] ♦
  C. inaequalis (Kunze) Mett. var. *inaequalis* [PRE] [GH]
  C. involuta (Sw.) Schelpe & N.C. Anthony var. *obscura* (N.C. Anthony) N.C. Anthony [PRE] [H]
  C. multifida (Sw.) Sw. subsp. *lacerata* N.C. Anthony & Schelpe [PRE] [L] ♦
  C. quadripinnata (Forssk.) Kuhn [PRE] [FL]
  C. viridis (Forssk.) Sw. var. *glauca* (Sim) Schelpe & N.C. Anthony [PRU: *MM 381*] [BJL]
Pellaea calomelanos (Sw.) Link var. *calomelanos* [PRU: *SS 611*] [BFHJKL] • ♦
Pteris buchananii Baker ex Sim [PRE] [GH]
  P. vittata L. [PRU: *AW & SS 13362*] [FHL]

ASPLENIACEAE
Asplenium adiantum-nigrum L. var. *adiantum-nigrum* [PRE] [F]
  A. aethiopicum (Burm. f.) Bech. [PRE] [HL]
  A. theciferum (Humb., Bonpl. & Kunth) Mett. *concinnum* (Schrad.) Schelpe [PRU: *AW & SS 13453*] [F]
Ceterach cordatum (Thunb.) Desv. [PRE] [HJL] ♦

EQUISETACEAE
Equisetum ramosissimum Desf. [PRE] [CDEHI]

ISOETACEAE
Isoetes transvaalensis Jermy & Schelpe [PRE] [L]

LYCOPODIACEAE
Lycopodium clavatum L. [PRE] [L]

OPHIOGLOSSACEAE
Ophioglossum polyphyllum A. Braun ex Seub. [PRU: *SS 1134*] [AHL]
  O. reticulatum L. [PRE] [JK]

POLYPODIACEAE
Polypodium polypodioides (L.) Hitchc. subsp. *ecklonii* (Kunze) Schelpe [PRU: *AW & SS 13444*] [F]

SCHIZAEACEAE
Anemia dregeana Kunze [PRE] [I]
Mohria caffrorum (L.) Desv. var. *ferruginea* J.E. & S.M. Burrows [PRE] [FHL]
M. rigida J.P. Roux [PRE] [L]

SELLAGINELLACEAE
Selaginella dregei (Presl) Hieron. [PRE] [HL]
S. mittenii Baker [PRE] [L] ♦

THELYPTERIDACEAE
Thelypteris confluens (Thunb.) Morton [PRE] [GH]
T. oppositiformis (C. Chr.) Ching [PRE] [L]

VITTARIACEAE
Vittaria isoetifolia Bory [PRE] [I]

ANGIOSPERMS

MONOCOTYLEDONS

AMARYLLIDACEAE
Ammocharis coranica (Ker Gawl.) Herb. [PRE] [ACDJ]
Boophane disticha (L.f.) Herb. [PRE] [HI] • ♦
Brunsvigia radulosa Herb. [PRU: *SS 765*] [K]
Crinum delagoense I. Verd. [PRE] [E]
C. foetidum I. Verd. [PRE] [A]
C. macowanii Baker [PRE] [GH] •
Cyrtanthus breviflorus Harv. [PRE] [L]
C. contractus N.E. Br. [PRE] [K]
C. stenanthus Baker var. *major* R.A. Dyer [PRU: *AW & SS 1300*] [FGH]
Nerine rehmannii (Baker) L. Bolus [PRE] [L]
Pancratium tenuifolium Hochst. ex A. Rich. [PRE] [BEGH]
Scadoxus multiflorus (Martyn) Raf. subsp. *multiflorus* [PRE] [CD]
S. puniceus (L.) Friis & Nordal [PRE] [BJ] •

ARACEAE
Stylochiton natalense Schott [PRU: *AW & SS 1333*] [ABCFGHI]
S. sp. nov. A [PRU: *SS 1845*] [H] ∈ **CR**
S. sp. nov. B [PRU: *SS 672*] [H] ∈
Zantedeschia albomaculata (Hook.) Baill. subsp. *albomaculata* [PRE] [FHL]
Z. albomaculata (Hook.) Baill. subsp. *macrocarpa* (Engl.) Letty [PRU: *YH & AW 47*] [FL]
Z. elliottiana (Watson) Engl. [PRE] [L]
Z. jucunda Letty [PRU: *AW & SS 13424*] [CDEFGH] ∈
Z. pentlandii (Watson) Wittm. [PRU: *SS 1189*] [HJKL] ∉ **R EN**
Z. rehmannii Engl. [PRE] [GHL] **VU**

COMMELINACEAE
Aneilema hockii De Wild. [PRE] [B]
A. longirrhizum Faden [PRE] [AB] ∉ **EN**
Commelina africana L. var. *africana* [PRU: *SS 107*] [JL]
C. africana L. var. *krebsiana* (Kunth) C.B. Clarke [PRU: *SS 691*] [HJ]
C. africana L. var. *lancispatha* C.B. Clarke [PRU: *SS 145*] [BCDFHJ]

C. benghalensis L. [PRE] [BFL]
C. eckloniana Kunth [PRU: *SS 203*] [J]
C. erecta L. [PRE] [FH]
C. livingstonii C.B. Clarke [PRU: *SS 606*] [BCDH]
C. modesta Oberm. [PRU: *MM 347*] [BF]
Cyanotis pachyrrhiza Oberm. [PRU: *SS 98*] [JL]
C. speciosa (L.*f*.) Hassk. [PRU: *SS 474*] [FHL]

CYPERACEAE
Abildgaardia ovata (Burm. *f*.) Kral [PRU: *SS 958*] [JK]
Ascolepis capensis (Kunth) Ridl. [PRE] [L]
Bulbostylis boeckeleriana (Schweinf.) A.A. Beetle [PRE] [F]
B. burchellii (Fical. & Hiem.) C.B. Clarke [PRU: *SS 478*] [H]
B. contexta (Nees) Bodard [PRU: *SS 868*] [J]
B. hispidula (Vahl) R. Haines [PRE] [F]
B. humilis (Kunth) C.B. Clarke [PRU: *SS 608*] [HL]
B. oritrephes (Ridl.) C.B. Clarke subsp. *australis* B.L. Burtt [PRE] [KL]
B. schoenoides (Kunth) C.B. Clarke [PRE] [L]
Carpha capitellata (Nees) Boeck. [PRE] [L]
Coleochloa setifera (Ridl.) Gilly [PRU: *SS 956*] [JL]
Cyperus albostriatus Schrad. [PRE] [CD]
C. denudatus L.*f*. [PRE] [L]
C. esculentus L. [PRE] [L]
C. longus L. [PRE] [CD]
C. margaritaceus Vahl. [PRU: *SS 676*] [H]
C. marginatus Thunb. [PRU: *SS 864*] [J]
C. rotundus L. subsp. *rotundus* var. *rotundus* [PRE] [F]
C. rubicundus Vahl [PRU: *SS 195*] [J]
C. rupestris Kunth var. *rupestris* [PRE] [L]
C. schlechteri C.B. Clarke [PRE] [L]
C. sexangularis Nees [PRU: *SS 959*] [CDFJ]
C. sphaerospermus Schrad. [PRU: *SS 962*] [J]
Ficinia species [PRE] [L]
Fimbristylis dichotoma (L.) Vahl [PRE] [F]
F. ferruginea (L.) Vahl [PRU: *SS 960*] [CDJ]
Fuirena pubescens (Poir.) Kunth [PRU: *AW* & *SS 13008*] [HJK]
Isolepis costata (Boeck.) A. Rich. var. *macra* (Boeck.) B.L. Burtt [PRE] [L]
I. fluitans (L.) R. Br. [PRE] [L]
Kyllinga alba Nees [PRE] [F]
K. erecta Schumach. [PRU: *SS 957*] [BEJL]
Mariscus congestus (Vahl) C.B. Clarke [PRE] [GHL]
M. dregeanus Kunth [PRE] [CDGH]
M. keniensis (Kük.) Hooper [PRE] [GHL]
M. macer Kunth subsp. *macer* [PRE] [GH]
M. rehmannianus C.B. Clarke [PRE] [FGHIJ]
M. sumatrensis (Retz.) J. Raynal [PRE] [GH]
Pycreus cooperi C.B. Clarke [PRE] [K]
P. macranthus (Boeck.) C.B. Clarke [PRE] [K]
P. nitidus (Lam.) J. Raynal [PRE] [L]
P. oakfortensis C.B. Clarke [PRU: *SS* & *WF 972*] [J]
P. rehmannianus C.B. Clarke [PRE] [L]
Schoenoplectus corymbosus (Roth ex Roem. & Schult.) J. Raynal var. *corymbosus* [PRU: *SS 952*] [J]
S. muriculatus (Kük.) J. Browning [PRE] [L]
Schoenoxiphium sparteum (Wahlenb.) C.B. Clarke [PRU: *AW* & *SS 13377*] [J]

Schoenus nigricans L. [PRU: *SS 955*] [J]
Scirpus burkei C.B. Clarke [PRU: *SS* & *WF 970*] [J]
Scleria dieterlenii Turrill [PRE] [HL]

DIOSCOREACEAE
Dioscorea cotinifolia Kunth [PRE] [I]
D. dregeana (Kunth) T. Durand & Schinz [PRU: *SS 104*] [HJ] •
D. quartiniana A. Rich. var. *quartiniana* [PRE] [I]
D. species [PRE] [CDF]
D. sylvatica (Kunth) Eckl. [PRU: *SS 1146*] [BFGHKL] • ♦

ERIOCAULACEAE
Eriocaulon abyssinicum Hochst. [PRU: *AW* & *SS 13391*] [J]
E. dregei Hochst. var. *sonderianum* (Körn.) Oberm. [PRE] [L]

HYPOXIDACEAE
Hypoxis argentea Harv. ex Baker var. *argentea* [PRE] [JL]
H. filiformis Baker [PRU: *AW* & *SS 13461*] [FJ]
H. hemerocallidea Fisch. & C.A. Mey. [PRE] [FGHJ] •
H. interjecta Nel [PRE] [J]
H. iridifolia Baker [PRE] [J]
H. multiceps Buchinger ex Baker [PRE] [JK]
H. rigidula Baker var. *rigidula* [PRE] [GHJ]

IRIDACEAE
Aristea woodii N.E. Br. [PRE] [K]
Babiana hypogea Burch. var. *hypogea* [PRE] [L]
Crocosmia paniculata (Klatt.) Goldblatt [PRU: *SS 778*] [J]
Dierama medium N.E. Br. [PRU: GB & *SS 1022*] [K]
D. mossii (N.E. Br.) Hilliard [PRE] [J]
D. nebrownii Hilliard [PRE] [L]
D. pauciflorum N.E. Br. [PRE] [L]
Freesia laxa (Thunb.) Goldblatt & Manning [PRU: *SS 61*] [HJK]
Gladiolus crassifolius Baker [PRU: *AW*, *SS* & *YS 1476*] [HIJKL] ♦
G. dalenii Van Geel [PRE] [GHK]
G. ecklonii Lehm. subsp. *ecklonii* [PRU: *SS* & *WF 989*] [JL]
G. ecklonii Lehm. subsp. *vinoso-maculatus* (Kies) Oberm. [PRU: *SS 233*] [J]
G. longicollis Baker var. *platypetalus* (Baker) Oberm. [PRU: *AW* & *SS 1308*] [F]
G. sekukuniensis P.J.D. Winter [PRE] [F] ∊
G. sericeovillosus Hook. *f.* subsp. *calvatus* (Baker) Goldblatt [PRE] [L]
G. species [PRU: *SS 771*] [K]
G. varius F. Bolus var. *micranthus* (Baker) Oberm. [PRE] [L]
G. woodii Baker [PRU: *AW* & *SS 13069*] [L]
Hesperantha baurii Baker subsp. *baurii* [PRE] [L]
H. rupestris N.E. Br. ex R.C. Foster [PRE] [J]
Moraea elliotii Baker [PRE] [L]
M. spathulata (L.f.) Klatt [PRU: *SS 824*] [J]
M. stricta Baker [PRE] [J]
M. trifida R.C. Foster [PRE] [L]
Schizostylis coccinea Backh. & Harv. [PRE] [GHL]

JUNCACEAE
Juncus exsertus Buchenau [PRE] [CDL]
J. oxycarpus E. Mey. ex Kunth [PRE] [L]

J. punctorius L.*f*. [PRU: *SS 953*] [J]
J. rigidus Desf. [PRU: *SS 1177*] [H]

LILIACEAE
Allioidea
Agapanthus inapertus P. Beauv. subsp. *inapertus* [PRE] [JL] •
Tulbaghia acutiloba Harv. [PRE] [L]
T. coddii Vosa & R.B. Burb. [PRE] [GHL] ∉ **K VU**
T. leucantha Baker [PRU: *AW* & *SS 13067*] [KL]
T. ludwigiana Harv. [PRU: *SS 1113*] [J]
T. sp. nov. A [PRU: *SS 1304*] [F] ∈ **CR**

Anthericoidea
Anthericum fasciculatum Baker [PRE] [GH]
A. transvaalense Baker [PRE] [GHJKL]
Chlorophytum angulicaule (Baker) Kativu [PRU: *SS 222*] [J]
C. bowkeri Baker [PRU: *SS 1111*] [AHJK]
C. cooperi (Baker) Nordal [PRU: *AW* & *SS 13429*] [FL]
C. cyperaceum (Kies) Nordal [PRU: *AW* & *SS 13011*] [FHL] ∉ **LR**
C. galpinii (Baker) Kativu var. *galpinii* [PRU: *SS 435*] [H]
C. polyphyllum (Baker) Kafivu [PRU: *SS 471*] [H]

Asparagoidea
Asparagus acocksii Jessop [PRE] [EI]
A. africanus Lam. [PRE] [BF]
A. angusticladus (Jessop) Fellingham & N.L. Mey. [PRE] [F]
A. asparagoides (L.) W. Wight [PRU: *AW* & *SS 13449*] [FL]
A. buchananii Baker [PRU: *SS 1163*] [ABFI]
A. clareae (Oberm.) Fellingham & N.L. Mey. [PRU: *SS 202*] [J] ∉ **K VU**
A. divaricatus (Oberm.) Fellingham & N.L. Mey. [PRE] [BI]
A. falcatus L. [PRE] [F]
A. flavicaulis (Oberm.) Fellingham & N.L. Mey. subsp. *flavicaulis* [PRE] [FJ]
A. intricatus (Oberm.) Fellingham & N.L. Mey. [PRU: *AW*, *SS* & *YS 1501*] [CF] [form] ∈ **LR**
A. laricinus Burch. [PRU: *RS 2799*] [JKL]
A. lynetteae (Oberm.) Fellingham & N.L. Mey. [PRU: *AW* & *SS 1373*] [I] ∉
A. nelsii Schinz [PRU: *SS 1693*] [ABE]
A. racemosus Willd. [PRU: *SS 143*] [J]
A. schroederi Engl. [PRE] [A]
A. sekukuniensis (Oberm.) Fellingham & N.L. Mey. [PRU: *AW* & *SS 1355*] [BF] ∈ **K VU**
A. sp. nov. [PRU: *AW 13598*] [B] ∉
A. suaveolens Burch. [PRU: *SS 468*] [BCDFGHIJ]
A. virgatus Baker [PRU: *SS* & *FP 1532*] [EFL]

Asphodeloidea
Aloe aculeata Pole Evans [PRE] [AIL]
A. affinis A. Berger [PRE] [A]
A. arborescens Mill. [PRU: *SS 1667*] [AFJL]
A. burgersfortensis Reynolds [PRU: *SS 1682*] [CDFHI] ∈ **VU**
A. castanea Schönland [PRU: *SS 645*] [CFGHJKL] ∉
A. chortolirioides A. Berger var. *woolliana* (Pole Evans) Glen & D.S. Hardy [PRE] [L]
A. cooperi Baker subsp. *cooperi* [PRU: *SS* & *WF 1419*] [HIJKL] [form] ∈
A. cryptopoda Baker [PRU: *SS 1678*] [ABCDFHIJL] ♦
A. fosteri Pillans [PRU: *AW*, *SS* & *YS 1446*] [EFL] ∉
A. globuligemma Pole Evans [PRU: *SS 646*] [AFIJ

A. greatheadii Schönland var. *davyana* (Schönland) Glen & D.S. Hardy [PRE] [AFGHI]
A. greatheadii Schönland var. *greatheadii* [PRE] [A]
A. immaculata Pillans [PRE] [AC] ∉
A. integra Reynolds [PRE] [I]
A. laxissima Reynolds [PRE] [BCDFK]
A. marlothii A. Berger subsp. *marlothii* [PRE] [HJ]
A. monotropa I. Verd. [PRE] [A]
A. pretoriensis Pole Evans [PRU: *SS 837*] [GHJ] ∉
A. reitzii Reynolds var. *reitzii* [PRE] [KL] ∉ I VU
A. verdoorniae Reynolds [PRU: *SS 951*] [J]
A. verecunda Pole Evans [PRU: *SS 317*] [FH]
A. zebrina Baker [PRE] [A]
Bulbine angustifolia Poelln. [PRE] [F]
B. latifolia (L.*f*.) Roem. & Schult. [PRE] [GH]
Kniphofia ensifolia Baker subsp. *ensifolia* [PRE] [FKL]
K. linearifolia Baker [PRE] [JL]
K. rigidifolia E.A. Bruce [PRE] [L]
K. typhoides Codd [PRE] [L]
Trachyandra asperata Kunth var. *basutoensis* (Poelln.) Oberm. [PRE] [K]
T. reflexipilosa (Kuntze) Oberm. [PRE] [J]
T. saltii (Baker) Oberm. var. *saltii* [PRU: *AW* & *SS 1376*] [L] ♦

Colchicoidea
Androcymbium longipes Baker [PRU: *SS 796*] [J]
A. melanthioides Willd. var. *striatum* (Hochst.) Baker [PRE] [K]
A. melanthioides Willd. var. *subulatum* Baker [PRU: *AW* & *SS 1306*] [F]
Camptorrhiza strumosa (Baker) Oberm. [PRE] [H]
Gloriosa superba L. subsp. *superba* [PRU: *AW* & *SS 1338*] [BEFJL]
Littonia modesta Hook. [PRE] [K]
Ornithoglossum vulgare B. Nord. [PRU: *SS 686*] [FH]

Dracaenoidea
Sansevieria aethiopica Thunb. [PRU: *SS 69*] [BFHJ]
S. hyacinthoides (L.) Druce [PRU: *SS 375*] [BCDFH] •
S. pearsonii N.E. Br. [PRU: *AW*, *SS* & *ER 13216*] [EFI]

Eriospermoidea
Eriospermum cooperi Baker var. *cooperi* [PRE] [KL]
E. mackenii (Hook.f.) Baker subsp. *galpinii* (Schinz) P.L. Perry [PRU: *AW* & *SS 1375*] [I]
E. porphyrium Archibald [PRU: *SS 41*] [J]

Hyacinthoidea
Albuca angolensis Welw. [PRU: *SS 1401*] [G]
A. setosa Jacq. [PRU: *SS* & *GB 1016*] [BJ]
A. shawii Baker [PRE] [F]
A. species [PRU: *SS 1044*] [H]
A. sp. nov. [PRU: *AW* & *SS 13296*] [BG] ∈
Dipcadi glaucum (Ker Gawl.) Bak. [PRU: *AW*, *SS* &*ER 1313*] [BEG]
D. gracillimum Baker [PRU: *MM 527*] [BL]
D. marlothii Engl. [PRU: *SS 687*] [H]
D. rigidifolium Baker [PRU: *MM 407*] [B]
D. viride (L.) Moench [PRU: *SS 259*] [BGHJL]
Drimia elata Jacq. [PRU: *SS* & *WF 975*] [J]
D. kniphofioides (Baker) Oberm. [PRU: *AW* & *SS 13376*] [J] •

Drimiopsis atropurpurea N.E. Br. [PRU: *AW* & *SS 13056*] [HL]
D. burkei Baker [PRU: *SS 389*] [HK]
D. maxima Baker [PRU: *SS 85*] [FHJ]
Eucomis autumnalis (Mill.) Chitt. subsp. *clavata* (Baker) Reyneke [PRU: *SS 781*] [JL] • **N LR**
E. montana Compton [PRU: *SS 1855*] [K] **R LR**
E. vandermerwei I. Verd. [PRU: *AW* & *SS 13074*] [JL] ∉
Ledebouria cooperi (Hook. f.) Jessop [PRE] [JKL]
L. dolomiticola S. Venter [PRU: *SS 1112*] [HJ] ∉ **LR**
L. floribunda (Baker) Jessop [PRU: *AW* & *SS 1372*] [CDFHJ]
L. inquinata (C.A. Sm.) Jessop [PRE] [J]
L. marginata (Baker) Jessop [PRU: *AW*, *SS* & *ER 13209*] [FHL]
L. revoluta (L.f.) Jessop [PRU: *SS 168*] [FJL]
L. sp. nov. [PRU: *SS 1867*] [BH] ∈
Ornithogalum saundersiae Baker [PRE] [K]
O. seineri (Engl. & Krause) Oberm. [PRE] [F]
O. tenuifolium D. Delaroche subsp. *tenuifolium* [PRU: *AW* & *SS 1339*] [EL]
Schizobasis intricata (Baker) Baker [PRE] [GH]
Scilla natalensis Planch. [PRE] [J] • **N LR**
S. nervosa (Burch.) Jessop [PRU: *SS 96*] [J]
Thuranthos basuticum (E. Phillips) Oberm. [PRE] [K]
Urginea altissima (L.f.) Baker [PRE] [F]
U. epigea R.A. Dyer [PRU: *AW*, *SS* & *ER 13223*] [HIJ] •
U. modesta Baker [PRU: *AW*, *SS* & *ER 13210*] [H]

ORCHIDACEAE
Bonatea speciosa (L.f.) Willd. var. *antennifera* (Rolfe) Sommerville [PRU: *AW*, *SS* & *YS 1431*] [FG]
Brachycorythis conica (Summerh.) Summerh. subsp. *transvaalensis* Summerh. [PRE] [J]
B. ovata Lindl. [PRE] [K]
Brownleea coerulea Harv. Ex Lindl. [PRU: *SS 777*] [J]
Cheirostylis gymnochiloides (Ridl.) Rchb. f. [PRE] [E]
Corycium dracomontanum Parkman & Schelpe [PRU: *SS* & *WF 984*] [J]
Disa alticola H.P. Linder [PRE] [L]
D. cooperi Rchb. f. [PRE] [L]
D. fragrans Schltr. [PRE] [L]
D. rhodantha Schltr. [PRE] [L] **K LR**
D. stachyoides Rchb. f. [PRE] [L]
D. versicolor Rchb. f. [PRE] [L]
Eulophia aculeata (L.f.) Spreng. subsp. *aculeata* [PRU: *AW* & *SS 13447*] [FKL]
E. callichroma Rchb. f. [PRE] [JL]
E. clavicornis Lindl. var. *nutans* (Sond.) A.V. Hall [PRE] [KL]
E. cooperi Rchb. f. [PRE] [K]
E. foliosa (Lindl.) Bolus [PRE] [KL]
E. hians Spreng. var. *hians* [PRU: GB & *SS 1001*] [K]
E. leontoglossa Rchb. f. [PRE] [GH]
E. ovalis Lindl. subsp. *bainesii* (Rolfe) A.V. Hall [PRU: *SS* & *WF 983*] [GHJ]
E. ovalis Lindl. subsp. *ovalis* [PRU: GB & *SS 1002*] [K]
E. parvilabris Lindl. [PRU: *SS 632*] [J]
E. petersii Rchb. f. [PRU: *SS* & *FP 1555*] [F]
E. speciosa (R. Br. ex Lindl.) Bolus [PRE] [F]
E. streptopetala Lindl. [PRU: *SS 19*] [CDFJL]
Habenaria barbertonii Kraenzl. & Schltr. [PRE] [L]
H. clavata (Lindl.) Rchb. f. [PRE] [J]
H. dregeana Lindl. [PRE] [L]

H. epipactidea Rchb. f. [PRE] [J]
H. falcicornis (Burch. ex Lindl.) Bolus subsp. *caffra* (Schltr.) J.C. Manning [PRE] [J]
H. lithophila Schltr. [PRE] [GH]
H. tridens Lindl. [PRE] [GH]
Mystacidium capense (L.f.) Schltr. [PRU: *AW 13044*] [H]
Satyrium cristatum Sond. var. *cristatum* [PRE] [FJ]
S. longicauda Lindl. var. *longicauda* [PRU: *SS* & *WF 978*] [J]
Schizochilus cecilii Rolfe subsp. *transvaalensis* (Rolfe) H.P. Linder [PRE] [L]

POACEAE
Agrostis eriantha Hack. var. *eriantha* [PRE] [L]
A. lachnantha Nees var. *lachnantha* [PRE] [FL]
Alloteropsis semialata (R. Br.) Hitchc. subsp. *eckloniana* (Nees) Gibbs.-Russ. [PRE] [L]
Andropogon appendiculatus Nees [PRE] [L]
A. chinensis (Nees) Merr. [PRE] [B]
A. eucomus Nees [PRE] [HJ]
A. lacunosus J.G. Anderson [PRE] [L]
A. mannii Hook. f. [PRE] [L]
A. ravus J.G. Anderson [PRE] [L]
A. schirensis A. Rich. [PRE] [L] ♦
Aristida adscensionis L. [PRE] [AB]
A. aequiglumis Hack. [PRE] [L]
A. bipartita (Nees) Trin. & Rupr.[PRE] [J]
A. canescens Henrard subsp. *canescens* [PRU: *SS 933*] [BHJL] ♦
A. congesta Roem. & Schult. subsp. *barbicollis* (Trin. & Rupr.) De Winter [PRE] [BCDH]
A. congesta Roem. & Schult. subsp. *congesta* [PRE] [ABJL]
A. diffusa Trin. subsp. *burkei* (Stapf) Melderis [PRU: *AW* & *SS 1409*] [ABH]
A. junciformis Trin. & Rupr. subsp. *junciformis* [PRE] [BL]
A. meridionalis Henrard [PRE] [F]
A. pilgeri Henrard [PRE] [AB] ♦
A. rhiniochloa Hochst. [PRU: *SS 409*] [BGH]
A. scabrivalvis Hack. subsp. *contracta* (De Winter) Melderis [PRU: *SS* & *WF 1041*] [BJ]
A. scabrivalvis Hack. subsp. *scabrivalvis* [PRE] [BJ] ♦
A. transvaalensis Henrard [PRU: GB & *SS 1006*] [FHJK]
A. vestita Thunb. [PRE] [CD] ♦
Arthraxon lanceolatus (Roxb.) Hochst. var. *lanceolatus* [PRE] [F]
Arundinella nepalensis Trin. [PRU: *SS 854*] [J]
Bewsia biflora (Hack.) Gooss. [PRU: *SS 466*] [HJ]
Bothriochloa insculpta (A. Rich.) A. Camus var. vegetior (Hack.) C.E. Hubb. [PRU: *SS* & *FP 1524*] [BFHIJ]
Brachiaria brizantha (A. Rich.) Stapf [PRE] [FL]
B. deflexa (Schumach.) C.E. Hubb. ex Robyns [PRE] [BF]
B. eruciformis (Sm.) Griseb. [PRE] [B] ♦
B. nigropedata (Ficalho & Hiern) Stapf [PRU: *AW* & *SS 1362*] [CI]
B. serrata (Thunb.) Stapf [PRU: *SS 482*] [BFHJL]
Cenchrus ciliaris L. [PRE] [BFI]
Chloris gayana Kunth* [PRE] [AB]
C. virgata Sw. [PRE] [B]
Ctenium concinnum Nees [PRE] [L]
Cymbopogon plurinodis (Stapf) Stapf ex Burtt Davy [PRE] [E]
C. prolixus (Stapf) E. Phillips [PRE] [FL]
C. validus (Stapf) Stapf ex Burtt Davy [PRE] [L]
Cynodon dactylon (L.) Pers. [PRE] [BFJL]
Dactylis glomerata L.* [PRE] [L]

Dactyloctenium aegyptium (L.) Willd. [PRU: *SS 283*] [BH]
Digitaria ciliaris (Retz.) Koeler [PRE] [IL]
D. eriantha Steud. [PRU: *SS 464*] [BCDEFIJ]
D. monodactyla (Nees) Stapf [PRE] [L]
Diheteropogon amplectens (Nees) Clayton [PRE] [ABFHJL]
Diplachne eleusine Nees [PRE] [B]
Eleusine coracana (L.) Gaertn. subsp. *africana* (Kenn.-O'Byrne) Hilu & De Wet [PRE] [K]
Elionurus muticus (Spreng.) Kunth [PRE] [HL]
Enneapogon cenchroides (Roem. & Schult.) C.E. Hubb. [PRE] [BF]
E. desvauxii Beauv. [PRE] [B]
E. scoparius Stapf [PRU: *SS* & *WF 1040*] [BDFGHIJ]
Enteropogon macrostachyus (A. Rich.) Benth. [PRE] [ABFI]
Eragrostis aspera (Jacq.) Nees [PRE] [FL]
E. barbinodis Hack. [PRU: *SS 673*] [ABCDHI]
E. biflora Hack. ex Schinz [PRE] [BL]
E. caesia Stapf [PRE] [L]
E. capensis (Thunb.) Trin. [PRU: *AW* & *SS 13465*] [FHJL]
E. chloromelas Steud. [PRU: *SS 408*] [FHIL]
E. cilianensis (All.) F.T. Hubb. [PRE] [BEF]
E. curvula (Schrad.) Nees [PRU: *AW* & *SS 13463*] [ABEFGHIJKL]
E. gummiflua Nees [PRE] [I]
E. heteromera Stapf [PRE] [F]
E. lehmanniana Nees var. *lehmanniana* [PRE] [BF]
E. micrantha Hack. [PRE] [J]
E. nindensis Ficalho & Hiern [PRE] IJ]
E. plana Nees [PRE] [JL] ♦
E. planiculmis Nees [PRE] [L]
E. pseudosclerantha Chiov. [PRE] [FL]
E. racemosa (Thunb.) Steud. [PRU: *SS 462*] [BJL]
E. rigidior Pilg. [PRE] [BF]
E. sclerantha Nees subsp. *sclerantha* [PRE] [L]
E. superba Peyr. [PRU: *SS 1124*] [ABFHJ] ♦
E. trichophora Coss. & T. Durand [PRU: *SS* & *FP 1614*] [BH]
Eulalia villosa (Thunb.) Nees [PRE] [FL]
Eustachys paspaloides (Vahl) Lanza & Mattei [PRE] [B]
Festuca caprina Nees [PRE] [L]
F. costata Nees [PRE] [L]
F. scabra Vahl [PRE] [L]
Fingerhuthia africana Lehm. [PRU: *SS* & *FP 1541*] [BFGH]
Harpochloa falx (L.f.) Kuntze [PRE] [FL]
Hemarthria altissima (Poir.) Stapf & C.E. Hubb. [PRE] [KL]
Heteropogon contortus (L.) Roem. & Schult. [PRU: *SS 600*] [ABFHJKL] ♦
Hyparrhenia anamesa Clayton [PRE] [CDL]
H. collina (Pilg.) Stapf [PRE] [F]
H. cymbaria (L.) Stapf [PRE] [F]
H. dregeana (Nees) Stapf [PRE] [J]
H. filipendula (Hochst.) Stapf var. *filipendula* [PRE] [F] ♦
H. hirta (L.) Stapf [PRE] [BCDEFJL]
H. quarrei Robyns [PRE] [J]
H. tamba (Steud.) Stapf [PRE] [FI]
H. variabilis Stapf [PRE] [F]
Imperata cylindrica (L.) Raeusch. [PRE] [K]
Koeleria capensis (Steud.) Nees [PRU: *SS 14*] [JL]
Leersia hexandra Sw. [PRE] [L]

Lolium multiflorum Lam.* [PRE] [L]
Loudetia simplex (Nees) C.E. Hubb [PRU: *SS 932*] [FGHJL] ♦
Melinis nerviglumis (Franch.) Zizka [PRE] [JKL]
M. repens (Willd.) Zizka subsp. *repens* [PRE] [BFHJL]
Merxmuellera macowanii (Stapf) Conert [PRE] [L]
Microchloa caffra Nees [PRE] [KL]
Miscanthus junceus (Stapf) Pilg. [PRE] [IL]
Monocymbium ceresiiforme (Nees) Stapf [PRE] [FKL]
Mosdenia leptostachys (Ficalho & Hiern) Clayton [PRE] [CDFI] **K LR**
Oropetium capense Stapf [PRE] [B]
Panicum coloratum L. var. *coloratum* [PRE] [BF]
P. deustum Thunb. [PRE] [ABEF]
P. maximum Jacq. [PRE] [BFHJL]
P. natalense Hochst. [PRE] [L]
Paspalum dilatatum Poir.* [PRE] [FL]
Pennisetum setaceum (Forssk.) Chiov.* [PRE] [F]
Pentaschistis chippindalliae H.P. Linder [PRE] [L]
P. natalensis Stapf [PRE] [L]
Perotis patens Gand. [PRE] [E]
Phragmites australis (Cav.) Steud. [PRE] [FHJ]
P. mauritianus Kunth [PRU: *SS 1125*] [DE]
Poa annua L.* [PRE] [L]
P. binata Nees [PRE] [L]
Pogonarthria squarrosa (Roem. & Schult.) Pilg. [PRU: *AW* & *SS 13306*] [CDL] ♦
Rendlia altera (Rendle) Chiov. [PRE] [JL]
Sacciolepis chevalieri Stapf [PRE] [CD]
Schizachyrium sanguineum (Retz.) Alst. [PRE] [L]
Schmidtia pappophoroides Steud. [PRE] [B]
Setaria incrassata (Hochst.) Hack. [PRE] [F]
S. lindenbergiana (Nees) Stapf [PRU: *AW* & *SS 1363*] [CF] ♦
S. nigrirostris (Nees) T. Durand & Schinz [PRE] [FL]
S. rigida Stapf [PRU: *SS 862*] [J]
S. sagittifolia (A. Rich.) Walp. [PRE] [F]
S. sphacelata (Schumach.) Moss var. *sphacelata* [PRE] [FHJ] ♦
S. sphacelata (Schumach.) Moss var. *torta* (Stapf) Clayton [PRU: *AW* & *SS 13381*] [FIJL]
S. verticillata (L.) P. Beauv. [PRE] [BHL]
Sorghum bicolor (L.) Moench subsp. *arundinaceum* (Desv.) De Wet & Harlan [PRE] [BJ]
Sporobolus africanus (Poir.) Robyns & Tournay [PRE] [L]
S. centrifugus (Trin.) Nees [PRE] [L]
S. discosporus Nees [PRU: *SS* & *WF 965*] [J]
S. fimbriatus (Trin.) Nees [PRE] [ABF]
S. ioclados (Trin.) Nees [PRE] [BF]
S. natalensis (Steud.) T. Durand & Schinz [PRE] [F]
S. nitens Stent [PRU: *SS 1199*] [BJ]
S. panicoides A. Rich. [PRU: *SS* & *FP 1543*] [AF]
S. pectinatus Hack. [PRE] [L]
Stiburus alopecuroides (Hack.) Stapf [PRE] [L]
S. conrathii Hack. [PRE] [L]
Stipagrostis hirtigluma (Trin. & Rupr.) De Winter subsp. *patula* (Hack.) De Winter [PRU: *AW* & *SS 13323*] [BGHI]
S. zeyheri (Nees) De Winter subsp. *sericans* (Hack.) De Winter [PRU: *SS 867*] [J]
Styppeiochloa gynoglossa (Gooss.) De Winter [PRE] [L]
Themeda triandra Forssk. [PRU: *SS 678*] [BCFHJKL] ♦
Trachypogon spicatus (L.f.) Kuntze [PRU: *SS 465*] [FHJL] ♦

Tragus berteronianus Schult. [PRU: *MM 630*] [BFHJ]
T. koelerioides Asch. [PRU: *AW & SS 1410*] [H]
Tricholaena monachne (Trin.) Stapf & C.E. Hubb. [PRU: *RS 2742*] [BCDFK]
Triraphis andropogonoides (Steud.) E. Phillips [PRU: *AW & SS 13012*] [FHJ]
Tristachya biseriata Stapf [PRE] [KL] **K LR**
T. leucothrix Nees [PRU: *AW & SS 13464*] [FHJL]
T. rehmannii Hack. [PRE] [CD]
Urelytrum agropyroides (Hack.) Hack. [PRE] [L]
Urochloa mosambicensis (Hack.) Dandy [PRE] [B]
U. panicoides P. Beauv. [PRE] [AB]
U. trichopus (Hochst.) Stapf [PRU: *SS 407*] [EFH]

POTAMOGETONACEAE
Potamogeton crispus L. [PRE] [J]
P. pusillus L. [PRE] [J]

TYPHACEAE
Typha capensis (Rohrb.) N.E. Br. [PRE] [CDF] •

VELLOZIACEAE
Xerophyta retinervis Baker [PRU: *SS 1144*] [EFGHJK] [form] • ∈
X. schlechteri (Baker) N.L. Menezes [PRE] [AF]
X. villosa (Baker) Smith & Ayensu [PRE] [A]
X. viscosa Baker [PRU: *AW & SS 1302*] [BFGHIJL] ♦

XYRIDACEAE
Xyris capensis Thunb. [PRU: *SS 785*] [J]

DICOTYLEDONS

ACANTHACEAE
Asystasia retrocarpa T.J. Edwards [PRE] [F]
A. schimperi T. Anderson [PRU: *AW & SS 1321*] [BG]
A. subbiflora C.B. Clarke [PRE] [B]
Barleria affinis C.B. Clarke [PRU: *SS 1705*] [E]
B.crossandriformis C.B. Clarke [PRE] [A]
B. galpinii C.B. Clarke [PRU: *SS 315*] [BEH]
B. kaloxytona Lindau [PRU: *AW, SS & YS 1442*] [G]
B. lancifolia T. Anderson [PRU: *SS 207*] [ABHJ]
B. obtusa Nees [PRU: *SS 441*] [CDFH]
B. ovata E. Mey. ex Nees [PRU: *SS 124*] [HJK]
B. prionitis L. [PRU: *SS 944*] [BGH]
B. rotundifolia Oberm. [PRU: *SS 421*] [BFHJ]
B. saxatilis Oberm. [PRU: *SS 378*] [ABEFHJ]
B. senensis Klotzsch [PRE] [BFI]
B. transvaalensis Oberm. [PRU: *SS 945*] [G]
B. virgula C.B. Clarke [PRE] [B]
B. wilmsiana Lindau [PRU: *SS 438*] [H]
Blepharis angusta (Nees) T. Anderson [PRU: *SS 200*] [HJ]
B. diversispina (Nees) C.B. Clarke [PRE] [B]
B. inaequalis C.B. Clarke [PRU: *SS 379*] [H]
B. integrifolia (L.f.) E. Mey. ex Schinz var. *integrifolia* [PRU: *MM 201*] [B]
B. pruinosa Engl. [PRU: *MM 405*] [B]

B. saxatilis Oberm. [PRU: *AW* & *SS 12999*] [AH]
B. subvolubilis C.B. Clarke var. *subvolubilis* [PRU: *SS 395*] [BEFGHIJ]
Chaetacanthus burchellii Nees [PRE] [GH]
C. costatus Nees [PRU: *SS 266*] [HIJL]
Crabbea acaulis N.E. Br. [PRU: *SS 232*] [J]
C. angustifolia Nees [PRU: *SS 189*] [FGHJ]
C. hirsuta Harv. [PRU: *SS 393*] [CDHJK]
Crossandra fruticulosa Lindau [PRE] [B]
Dicliptera fruticosa K. Balkwill [PRE] [AHI] ∉ **LR**
Duosperma crenatum (Lindau) P.G. Mey. [PRU: *AW, SS* & *YS 1483*] [B]
Dyschoriste erecta C.B. Clarke [PRU: *AW, SS* & *YS 1462*] [EGH] ∉ **LR**
D. fischeri Lindau [PRU: *AW* & *SS 13016*] [ABFGHIJ]
D. perrottetii (Nees) Kuntze [PRU: *SS 11*] [J] ∉ **LR**
D. rogersii S. Moore [PRU: *SS* & *FP 1530*] [ABCFGHI]
D. species [PRE] [ABGH]
D. transvaalensis C.B. Clarke [PRE] [F]
Hypoestes aristata (Vahl) Sol. ex Roem. & Schult. var. *alba* K. Balkwill [PRU: *SS 74*] [FJ]
Isoglossa grantii C.B. Clarke [PRE] [BFG]
I. origanoides (Nees) Lindau [PRU: *AW, SS* & *YS 1440*] [GH]
Justicia anagalloides (Nees) T. Anderson [PRU: *SS 479*] [GHL]
J. flava (Vahl) Vahl [PRU: *SS 363*] [HI]
J. odora (Forssk.) Vahl [PRU: *SS 377*] [ABEGHI]
J. protracta (Nees) T. Anderson subsp. *protracta* [PRU: *SS 209*] [J]
Lepidagathis scabra C.B. Clarke [PRU: *SS 361*] [AH]
Metarungia longistrobus (C.B. Clarke) Baden [PRE] [AB]
Monechma divaricatum (Nees) C.B. Clarke [PRU: *SS 336*] [BFH]
Peristrophe cernua Nees [PRE] [B]
P. decorticans K. Balkwill [PRU: *AW, SS* & *YS 1454*] [EFH]
Petalidium oblongifolium C.B. Clarke [PRU: *SS 380*] [ABEFHI] ∉ **LR**
Ruellia cordata Thunb. [PRU: *SS 477*] [HIJ]
R. malacophylla C.B. Clarke [PRE] [A]
R. patula Jacq. [PRU: *SS 394*] [BHI]
R. stenophylla C.B. Clarke [PRU: *SS 59*] [J]
Ruttya ovata Harv. [PRU: *SS 368*] [BH]
Sclerochiton harveyanus Nees [PRU: *AW* & *SS 13345*] [F]
Thunbergia atriplicifolia E. Mey. ex Nees [PRU: *SS 77*] [GHJK]
T. natalensis Hook. [PRE] [GH]
T. neglecta Sond. [PRU: *AW* & *SS 1337*] [E]

AIZOACEAE
Corbichonia decumbens (Forssk.) Exell [PRU: *SS 424*] [BEHJ]
Gisekia africana (Lour.) Kuntze var. *africana* [PRU: *AW* & *SS 1357*] [BC]
Limeum argute-carinatum Wawra & Peyr. var. *argute-carinatum* [PRE] [B]
L. fenestratum (Fenzl) Heimerl var. *fenestratum* [PRU: *SS 657*] [H]
L. pauciflorum Moq. [PRE] [L]
L. pterocarpum (J. Gay) Heimerl var. *pterocarpum* [PRU: *AW* & *SS 13295*] [BG]
L. sulcatum (Klotzsch) Hutch. var. *sulcatum* [PRU: *SS 272*] [BGH]
L. viscosum (J. Gay) Fenzl subsp. *transvaalense* Friedrich [PRE] [F]
L. viscosum (J. Gay) Fenzl subsp. *viscosum* [PRU: *SS 654*] [BH]
Mollugo nudicaulis Lam.* [PRU: *SS 658*] [BH]
Plinthus rehmannii G. Schellenb. [PRU: *MM 696*] [B] ∉**V EN**
Psammotropha myriantha Sond. [PRE] [L]
Trianthema parvifolia E. Mey. ex Sond. var. *parvifolia* [PRU: *AW, SS* & *YS 1485*] [B]
T. salsoloides Fenzl ex Oliv. var. *stenophylla* Adamson [PRE] [B]

Zaleya pentandra (L.) Jeffrey [PRE] [B]

AMARANTHACEAE
Achyranthus aspera L. var. *aspera* * [PRU: *SS 362*] [FH] ♦
Alternanthera sessilis (L.) DC. [PRE] [B]
Amaranthus hybridus L. subsp. *hybridus* var. *hybridus* * [PRE] [F]
A. spinosus L.* [PRE] [F]
A. thunbergii Moq. [PRE] [BK]
Cyathula cylindrica Moq. [PRE] [L]
C. lanceolata Schinz [PRE] [B]
C. uncinulata (Schrad.) Schinz [PRE] [K]
Gomphrena celosioides Mart.* [PRE] [B]
Hermbstaedtia fleckii (Schinz) Baker & C.B. Clarke [PRE] [B]
H. odorata (Burch.) T. Cooke var. *odorata* [PRE] [B]
H. scabra Schinz [PRE] [B]
Kyphocarpa angustifolia (Moq.) Lopr. [PRU: *SS 186*] [BEFHJ] ♦
Pupalia lappacea (L.) Juss. var. *lappacea* [PRU: GB & *SS 1018*] [BFK]
Sericorema remotiflora (Hook. f.) Lopr.[PRE] [B]

ANACARDIACEAE
Lannea discolor (Sond.) Engl. [PRE] [FHL] ♦
L. edulis (Sond.) Engl. var. *edulis* [PRE] [GHL] •
Ozoroa albicans R. & A. Fern. [PRU: *SS 442*] [EFH] ∉ **K LR**
O. insignis Delile subsp. *reticulata* (Baker f.) J.B. Gillett [PRE] [F]
O. paniculosa (Sond.) R. & A. Fern. [PRE] [HI]
O. sphaerocarpa R. & A. Fern. [PRU: *SS 17*] [FGHJ]
Rhus batophylla Codd [PRU: *SS 34*] [BEFHI] ∈ **R VU**
R. dentata Thunb. [PRU: *SS 146*] [GHJK]
R. discolor E. Mey. ex Sond. [PRU: *SS 161*] [FJKL]
R. engleri Britten [PRU: *SS 452*] [ABFGH] ∉
R. gerrardii (Harv. ex Engl.) Schönland [PRE] [L]
R. gracillima Engl. var. *gracillima* [PRE] [CDFJ]
R. gueinzii Sond. [PRU: *SS 412*] [BFH]
R. keetii Schönland [PRU: *AW* & *SS 12994*] [ADEFGH] ∉
R. leptodictya Diels [PRE] [AFHJ]
R. pallens Eckl. & Zeyh. [PRE] [K]
R. pentheri Zahlbr. [PRE] [H]
R. pyroides Burch. var. *pyroides* [PRU: *SS* & *WF 969*] [FHJL]
R. pyroides Burch. var. *integrifolia* (Engl.) Moffett [PRU: *SS 630*] [J]
R. rigida Mill. var. *dentata* (Engl.) Moffett [PRU: *SS 216*] [JK]
R. rogersii Schonland [PRE] [JK] **N LR**
R. sekhukhuniensis Moffett [PRU: *AW*, *SS* & *ER 13201*] [FHJ] ∈ **R LR**
R. species [PRE] [BEJL]
R. transvaalensis Engl. [PRE] [GH]
R. tumulicola S. Moore var. *meeuseana* (R. & H. Fern.) Moffett forma *meeuseana* [PRU: *AW* & *SS 13423*] [DFJL] ∉
R. wilmsii Diels [PRU: *AW* & *SS 12970*] [FHJKL] ∉ **K LR**
R. zeyheri Sond. [PRU: *SS 106*] [FHJKL]
Sclerocarya birrea (A. Rich.) Hochst. subsp. *caffra* (Sond.) Kokwaro [PRU: *SS 1155*] [BEFHJ] •

ANNONACEAE
Hexalobus monopetalus (A. Rich.) Engl. & Diels var. *monopetalus* [PRU: *SS 1808*] [EF]
Xylopia odoratissima Welw. ex Oliv. [PRE] [L]

APIACEAE

Alepidea amatymbica Eckl. & Zeyh. var. *amatymbica* [PRU: *SS 826*] [JL] •
A. basinuda Pott var. *basunida* [PRE] [I]
A. longifolia E. Mey. ex Dummer var. *longifolia* [PRE] [I]
A. setifera N.E. Br. [PRU: *SS 755*] [JKL]
Ammi majus L. var. *glaucifolium* (L.) Godr.* [PRU: *SS 637*] [J]
Annesorhiza wilmsii H. Wolff [PRE] [K]
Berula erecta (Huds.) Coville subsp. *thunbergii* (DC.) B.L. Burtt [PRE] [JKL] •
Bupleurum mundii Cham. & Schltdl. [PRE] [FK]
Heteromorpha stenophylla Welw. ex Schinz var. *transvaalensis* (Schltr. & H. Wolff) P.J.D. Winter [PRE] [JK] •
H. trifoliata (Wendl.) Eckl. & Zeyh. [PRU: *AW* & *SS 12984*] [FHJL] ♦
Pimpinella caffra (Eckl. & Zeyh.) Harv. [PRU: *SS 833*] [JK]
P. transvaalensis H. Wolff [PRE] [L]
Sium repandum Welw. ex Hiern [PRE] [JL]
Steganotaenia araliaceae Hochst. [PRU: *JK 105*] [FH]

APOCYNACEAE *5/6*

Acokanthera oppositifolia (Lam.) Codd [PRU: *SS 127*] [BEFHJL] •
Allamanda blanchetii DC.* [PRU: *SS 316*] [H]
Carissa bispinosa (L.) Desf. ex Brenan subsp. *bispinosa* [PRU: *AW* & *SS 13365*] [BFGH]
C. bispinosa (L.) Desf. ex Brenan subsp. *zambesiensis* Kupicha [PRU: *AW* & *SS 13431*] [F]
Catharanthus roseus (L.) G. Don* [PRU: *SS* & *FP 1558*] [EF]
Pachypodium saundersii N.E. Br. [PRU: *AW* & *SS 13322*] [G] **N LR**

AQUIFOLIACEAE *1/1*

Ilex mitis (L.) Radlk. var. *mitis* [PRU: *AW* & *SS 13436*] [FGH] ♦

ARALIACEAE

Cussonia natalensis Sond. [PRE] [GH]
C. paniculata Eckl. & Zeyh. subsp. *sinuata* (Reyneke & Kok) De Winter [PRE] [FGHL]
C. spicata Thunb. [PRU: *AW* & *SS 13356*] [CDF]
C. transvaalensis Reyneke [PRE] [BCDFHIJL]
Schefflera umbellifera (Sond.) Baill. [PRE] [E]
Seemannaralia gerrardii (Seem.) Harms [PRE] [J]

ASCLEPIADACEAE

Asclepias affinis (Schltr.) Schltr. [PRU: *AW* & *SS 13380*] [JK]
A. albens (E. Mey.) Schltr. [PRU: *SS 1406*] [J]
A. cultriformis Harv. ex Schltr. [PRE] [KL]
A. densiflora N.E. Br. [PRU: *SS 634*] [J]
A. eminens (Harv.) Schltr. [PRE] [K]
A. fallax (Schltr.) Schltr. [PRU: *AW* & *SS 13390*] [BFHJ]
A. sp. nov. [PRU: *JK 110*] [F] ∊
Aspidoglossum glabrescens (Schltr.) Kupicha [PRE] [CK]
Aspidonepsis diploglossa (Turcz.) Nicholas & Goyder [PRU: *AW* & *SS 1421*] [J]
Brachystelma coddii R.A. Dyer [PRE] [E]
B. decipiens N.E. Br. [PRE] [E]
B. minor E.A. Bruce [PRE] [L]
B. thunbergii N.E. Br. [PRE] [L]
Ceropegia ampliata E. Mey. [PRU: *AW, SS* & *YS 1511*] [AFGHI]
C. decidua E.A. Bruce subsp. *pretoriensis* R.A. Dyer [PRE] [I]
C. distincta N.E. Br. subsp. *haygarthii* (Schltr.) H.E. Huber [PRE] [B]
C. distincta N.E. Br. subsp. *verruculosa* R.A. Dyer [PRE] [B] ∊

C. meyeri Decne. [PRE] [L]
C. nilotica Kotschy [PRE] [I]
C. rendallii N.E. Br. [PRE] [L]
C. stapeliiformis Haw. subsp. *serpentina* (E.A. Bruce) R.A. Dyer [PRE] [AH] ∉
Cordylogyne globosa [PRU: *SS 801*] [J]
Cynanchum ellipticum (Harv.) R.A. Dyer [PRU: *AW* & *SS 13350*] [F]
C. gerrardii (Harv.) Liede [PRU: *AW* & *SS 13017*] [B]
Duvalia polita N.E. Br. [PRE] [I]
Ectadiopsis oblongifolia (Meisn.) Benth. Ex Schltr. [PRU: *SS 364*] [H] ♦
Fockea angustifolia K. Schum. [PRU: *SS 322*] [AH]
Gomphocarpus fruticosus (L.) Aiton f. • [PRU: *AW*, *SS* & *YS 1679*] [AFH]
G. physocarpus (E. Mey.) Aiton f. [PRE] [GH]
G. tomentosus Burch. [PRU: *AW* & *SS 13415*] [BEFH]
Huernia hystrix (Hook. f.) N.E. Br. var. *hystrix* [PRE] [IKL]
H. insigniflora C.A. Maass [PRE] [FGHKL] ∉ **LR**
H. kirkii N.E. Br. [PRE] [DF] ♦
H. quinta (E. Phillips) A.C. White & B. Sloane var. *quinta* [PRU: *AW* & *SS 1425*] [IJ]
H. stapelioides Schltr. [PRE] [ABI] ∉ **VU**
H. zebrina N.E. Br. subsp. *zebrina* [PRU: *SS 1695*] [E]
Huerniopsis atrosanguinea (N.E. Br.) A.C. White & B. Sloane [PRE] [CDJ]
Marsdenia macrantha (Klotzsch) Schltr. [PRU: *MM 457*] [B]
M. sylvestre (Retz.) Schult. [PRU: *MM 453*] [B]
Miraglossum davyi (N.E. Br.) Kupicha [PRE] [I]
Orbea tapscottii (I. Verd.) L.C. Leach [PRE] [I]
Orbeopsis gerstneri (Letty) L.C. Leach subsp. *elongata* (R.A. Dyer) L.C. Leach [PRE] [IJ] ∈
O. melanantha (Schltr.) L.C. Leach [PRE] [ACD]
Orthanthera jasminiflora (Decne.) Schinz [PRE] [A]
Pachycarpus asperifolius Meisn. [PRU: *AW* & *SS 13078*] [J]
P. concolor E. Mey. [PRE] [GH]
P. macrochilus (Schltr.) N.E. Br. [PRE] [L]
P. scaber (Harv.) N.E. Br. [PRE] [GHK]
P. transvaalensis (Schltr.) N.E. Br. [PRU: *SS 49*] [JL] ∉
Pachycymbium keithii (R.A. Dyer) L.C. Leach [PRE] [I]
Pentarrhinum insipidum E. Mey. [PRE] [ACE]
Pergularia daemia (Forssk.) Chiov. var. *daemia* [PRU: *AW*, *SS* & *YS 1428*] [BD]
Riocreuxia picta Schltr. [PRU: *AW 13586*] [EF]
Sarcostemma viminale (L.) R. Br. [PRU: *SS 1118*] [BFHJ]
Schizoglossum bidens E. Mey. subsp. *galpinii* (Schltr.) Kupicha [PRU: *AW* & *SS 13270*] [L]
S. hamatum E. Mey. [PRE] [K]
S. sp. nov. [PRU: *SS 628*] [J] ∈
Secamone alpini Schult. [PRU: GB & *SS 1027*] [K]
S. filiformis (L.f.) J.H. Ross [PRE] [AF]
S. parvifolia (Oliv.) Bullock [PRU: *AW* & *SS 1378*] [ABCDFI]
Sisyranthus huttoniae (S. Moore) S. Moore [PRE] [K]
S. randii S. Moore [PRE] [GH] ♦
Stapelia gettliffei Pott-Leend. [PRE] [B]
S. gigantea N.E. Br. [PRU: *SS 1856*] [H] **N LR**
Tavaresia barklyi (Dyer) N.E. Br. [PRE] [A]
Tenaris rubella E. Mey. [PRU: *SS 29*] [JL]
Tylophora flanaganii Schltr. [PRE] [AB]

ASTERACEAE
Artemisia afra Jacq. ex Willd. [PRE] [FL] •
Aspilia mossambicensis (Oliv.) Wild [PRU: *AW* & *SS 1744*] [F]

Aster bakeranus Burtt Davy ex C.A. Sm. • [PRU: *SS 751*] [J]
A. comptonii Lippert [PRE] [K]
A. harveyanus Kuntze [PRU: *SS 793*] [GHJK]
A. squamatus (Spreng.) Hieron.* [CD]
Athrixia arachnoidea J.M. Wood & M.S. Evans ex J.M. Wood [PRU: GB & *SS 1013*] [K]
A. elata Sond. [PRU: *SS 401*] [FJ]
A. phylicoides DC. [PRU: *SS 219*] [FHJL]
Berkheya densifolia Bohnen ex Roessler [PRE] [EHJ] ∉
B. echinacea (Harv.) O. Hoffm. ex Burtt Davy subsp. *echinacea* [PRE] [FL]
B. insignis (Harv.) Thell. [PRU: *SS 257*] [DFHJKL] [form] ∈
B. mackenii (Harv.) Roessler [PRE] [I]
B. onopordifolia (DC.) O. Hoffm. ex Burtt Davy var. *onopordifolia* [PRU: GB & *SS 1019*] [JK]
B. seminivea Harv. & Sond. [PRU: *SS 829*] [J]
B. setifera DC. [PRU: *SS 841*] [J]
B. zeyheri (Sond. & Harv.) Oliv. & Hiern subsp. *zeyheri* [PRE] [BL] ♦
Bidens bipinnata L.* [PRE] [ABDE]
B. pilosa L.* [PRU: *SS 810*] [FJ] ♦
Blumea mollis (D. Don) Merr. [PRE] [F]
Brachylaena huilensis O. Hoffm. [PRE] [AB]
B. ilicifolia (Lam.) E. Phillips & Schweick. [PRU: *AW*, *SS* & *ER 13244*] [BFGHJL] [form] ∈
B. transvaalensis E. Phillips & Schweick. [PRE] [ABFHK]
Callilepis laureola DC. [PRU: *SS 86*] [J]
C. leptophylla Harv. [PRE] [J] **N LR**
Centaurea species* [PRE] [F]
Chrysanthemoides monilifera (L.) Norl. subsp. *canescens* (DC.) Norl. [PRU: *SS 794*] [J]
C. monilifera (L.) Norl. subsp. *septentrionalis* Norl. [PRE] [GHJ]
Cineraria parvifolia Burtt Davy [PRE] [K]
Conyza albida Spreng.* [PRE] [F]
C. bonariensis (L.) Cronquist* [PRE] [F]
C. pinnata (L.f.) Kuntze [PRE] [GHL]
C. podocephala DC. [PRU: *SS 142*] [J]
C. scabrida DC. [PRU: *SS 181*] [GHJ]
C. ulmifolia (Burm. f.) Kuntze [PRE] [GH]
Denekia capensis Thunb. [PRU: *AW* & *SS 13460*] [F]
Dicoma anomala Sond. [PRU: *AW* & *SS 12993*] [FHJL]
D. galpinii F.C. Wilson [PRU: *AW*, *SS* & *YS 1438*][G]
D. gerrardii Harv. ex F.C. Wilson [PRU: *AW*, *SS* & *YS 1469*] [ABFGH]
D. macrocephala DC. [PRE] [ACD]
D. tomentosa Cass. [PRU: *SS 271*] [BFH]
D. zeyheri Sond. subsp. *zeyheri* [PRU: *SS 160*] [JK]
Dimorphotheca jucunda E. Phillips [PRE] [L]
Emilia transvaalensis (Bolus) C. Jeffrey [PRU: *SS 426*] [CEFGHI]
Euryops brevipapposus M.D. Hend. [PRU: *AW* & *SS 1310*] [F]
E. pedunculatus N.E. Br. [PRE] [F]
E. transvaalensis Klatt subsp. *setilobus* (N.E. Br.) B. Nord. [PRE] [L]
Felicia clavipilosa Grau subsp. *transvaalensis* Grau [PRU: *AW* & *SS 1351*] [BCFHJ]
F. fascicularis DC. [PRU: *SS 301*] [H]
F. filifolia (Vent.) Burtt Davy subsp. *filifolia* [PRU: *SS 827*] [JKL]
F. mossamedensis (Hiern) Medonca [PRU: *AW*, *SS* & *YS 1452*] [CDEF]
F. muricata (Thunb.) Nees subsp. *muricata* [PRU: *SS 241*] [JK]
Flaveria bidentis (L.) Kuntze* [PRU: *SS 338*] [BH]
Gamochaeta coarctata (Willd.) Kerguelen [PRU: *SS 800*] [J]
Gazania krebsiana Less. subsp. *arctotoides* (Less.) Roessler [PRE] [J]
G. krebsiana Less. subsp. *serrulata* (DC.) Roessler [PRE] [FL]

Geigeria burkei Harv. subsp. *burkei* [PRE] [F]
G. filifolia Mattf. [PRE] [B]
G. ornativa O. Hoffm. [PRU: *SS 190*] [BEJ]
Gerbera ambigua (Cass.) Sch. Bip. [PRE] [K]
G. jamesonii Adlam [PRU: *SS 1140*] [BFGHJL]
G. piloselloides (L.) Cass. [PRE] [H]
G. viridifolia (DC.) Sch. Bip. subsp. *natalensis* (Sch. Bip.) H.V. Hansen [PRU: GB & *SS 1020*] [K]
G. viridifolia (DC.) Sch. Bip. subsp. *viridifolia* [PRE] [A]
Haplocarpha scaposa Harv. [PRU: *AW* & *SS 1424*] [GHJL]
Helichrysum adenocarpum DC. subsp. *adenocarpum* [PRE] [L]
H. albilanatum Hilliard [PRU: *SS 756*] [JKL] ∉
H. argyrolepis MacOwan [PRE] [L]
H. argyrosphaerum DC. [PRU: *SS 1820*] [EF] ♦
H. aureonitens Sch. Bip. [PRE] [L]
H. aureum (Houtt.) Merr. [PRE] [L]
H. candolleanum H. Buek [PRU: *SS 1709*] [EF]
H. cephaloideum DC. [PRU: *SS 242*] [JL]
H. cerastioides DC. var. *cerastioides* [PRU: *AW* & *SS 13020*] [B]
H. chrysargyrum Moeser [PRU: *AW* & *SS 13326*] [F]
H. confertifolium Klatt [PRE] [E]
H. cooperi Harv. [PRU: GB & *SS 1023*] [K]
H. coriaceum Harv. [PRE] [K]
H. decorum DC. [PRE] [GH]
H. edwardsii Wild [PRE] [BF]
H. galpinii N.E. Br. [PRE] [L]
H. gerberifolium Sch. Bip. ex A. Rich. [PRU: *SS 1179*] [HL]
H. harveyanum Wild [PRU: *SS 247*] [HJ]
H. herbaceum (Andrews) Sweet [PRU: *SS 853*] [FJ]
H. kraussii Sch. Bip. [PRE] [GH]
H. lepidissimum S. Moore [PRU: GB & *SS 1015*] [K]
H. lineare DC. [PRE] [B]
H. miconiifolium DC. [PRE] [L]
H. mimetes S. Moore [PRE] [L]
H. mutabile Hilliard [PRU: *SS 849*] [J]
H. nudifolium (L.) Less. [PRE] [FGH]
H. odoratissimum (L.) Sweet [PRE] [GH]
H. oreophilum Klatt [PRU: *SS 224*] [GHJ]
H. oxyphyllum DC. [PRU: *SS 45*] [J]
H. pilosellum (L.f.) Less. [PRE] [GHL]
H. platypterum DC. [PRE] [L]
H. polycladum Klatt [PRE] [CDL]
H. reflexum N.E. Br. [PRE] [L]
H. rudolfii Hilliard [PRE] [F]
H. rugulosum Less. [PRU: *SS 806*] [GHJKL]
H. setosum Harv. [PRU: *SS 111*] [GJK]
H. species [PRE] [BGHL]
H. spiralepis Hilliard & B.L. Burtt [PRE] [L]
H. splendidum Thunb. (Less.) [PRU: *AW* & *SS 13432*] [FGHL]
H. subglomeratum Less. [PRE] [L]
H. swynnertonii S. Moore [PRE] [GH]
H. thapsus (Kuntze) Moeser [PRU: *SS 836*] [J]
H. umbraculigerum Less. [PRE] [E]
H. uninervium Burtt Davy [PRU: *AW* & *SS 12996*] [HJ] ∉

Hirpicium bechuanense (S. Moore) Roessl. [PRU: *AW* & *SS 1369*] [CDFI]
Kleinia fulgens Hook. f. [PRU: *AW, SS* & *YS 1430*] [DFI]
K. longiflora DC. [PRU: *AW, SS* & *ER 13229*] [BFHIJK] [form] ∊
K. stapeliiformis (E. Phillips) Stapf [PRU: *SS 1190*] [ACEHJ] ∉
Laggera decurrens (Vahl) Hepper & Wood [PRU: *SS 311*] [FH]
Litogyne gariepina (DC.) Anderb. [PRU: *AW* & *SS 1748*] [ABF]
Lopholaena coriifolia (Sond.) E. Phillips & C.A. Sm. [PRU: *AW* & *SS 990*] [AFKL]
L. disticha (N.E. Br.) S. Moore [PRU: *SS 845*] [J]
L. segmentata (Oliv.) S. Moore [PRU: *RS 2638*] [KL]
Melanthera triternata (Klatt) Wild [PRU: *SS 306*] [H]
Nidorella anomala Steetz [PRE] [B]
N. auriculata DC. [PRU: *AW* & *SS 13394*] [KL]
N. hottentotica DC. [PRU: *SS 414*] [H]
N. resedifolia DC. subsp. *resedifolia* [PRU: *SS 138*] [FHJ] ♦
Nolletia rarifolia (Turcz.) Steetz [PRE] [GH]
Osteospermum muricatum E. Mey. ex DC. subsp. *muricatum* [PRE] [IK]
Othonna natalensis Sch. Bip. [PRU: *RS 2629*] [KL]
Pechuel-Loeschea leubnitziae (Kuntze) O. Hoffm. [PRU: *SS 1691*] [BE]
Pegolettia lanceolata Harv. [PRU: *SS 6*] [GHJL] ∉**VU**
P. senegalensis Cass. [PRU: *SS* & *FP 1528*] [BF] **N LR**
Philyrophyllum schinzii O. Hoffm. [PRU: *AW, SS* & *YS 1487*] [B]
Pluchea dioscoridis (L.) DC. [PRU: *SS 1196*] [H]
Pseudognaphalium luteo-album (L.) Hilliard & Burtt [PRU: *AW* & *SS 13404*] [FJ]
Psiadia punctulata (DC.) Oliv. & Hiem ex Vatke [PRU: *SS 343*] [ABFHJK] •
Pterothrix spinescens DC. [PRU: *AW* & *SS 13024*] [H]
Pulicaria scabra (Thunb.) Druce [PRU: *SS 1197*] [H]
Schistostephium crataegifolium (DC.) Fenzl ex Harv. [PRU: *SS 852*] [EJL]
S. heptalobum (DC.) Oliv. & Hiem. [PRU: *AW* & *SS 13325*] [FGH]
Schkuhria pinnata (Lam.) Cabrera* [PRE] [BHJ]
Senecio achilleifolius DC. [PRU: *SS 76*] [J]
S. barbatus DC. [PRU: *AW* & *SS 13071*] [L]
S. barbertonicus Klatt [PRE] [FH]
S. conrathii N.E. Br. [PRE] [KL]
S. coronatus (Thunb.) Harv. [PRE] [GH]
S. deltoideus Less. [PRU: *AW* & *SS 13352*] [F]
S. erubescens Aiton var. *erubescens* [PRU: *SS 139*] [JK]
S. evelyniae Muschl. [PRE] [D]
S. gerrardii Harv. [PRU: *SS 180*] [JL]
S. glaberrimus DC. [PRE] [L]
S. glanduloso-pilosus Volkens & Muschl. [PRU: GB & *SS 1021*] [K]
S. gregatus Hilliard [PRU: *SS 1126*] [DL]
S. hieracioides DC. [PRE] [K]
S. inaequidens DC. [PRU: *AW* & *SS 13303*] [AJ]
S. latifolius DC. [PRU: *SS 68*] [FGHJK]
S. lygodes Hilliard [PRU: *SS 140*] [J]
S. microglossus DC. [PRU: *SS 66*] [GHJL]
S. oxyriifolius DC. [PRU: *SS 834*] [J]
S. pleistocephalus S. Moore [PRU: *SS* & *FP 1602*] [FH]
S. polyodon DC. var. *polyodon* [PRE] [L]
S. pterophorus DC. [PRE] [GH]
S. retortus (DC.) Benth. [PRE] [K]
S. scitus Hutch. & Burtt Davy [PRE] [K]
S. serratuloides DC. [PRE] [L] •
S. speciosus Willd. [PRE] [FL]

S. subcoriaceus Schltr. [PRE] [L]
S. venosus Harv. [PRU: *SS 420*] [HK]
Sonchus oleraceus L.* [PRE] [ACEGH]
Stoebe vulgaris Levyns [PRE] [GHL]
Stomatanthes africanus (Oliv. & Hiern) R.M. King & H. Rob. [PRU: GB & *SS 1028*] [GHK]
Tarchonanthus camphoratus L. [PRU: *SS 1840*] [BEFHL] • ♦
Tithonia rotundifolia (Mill.) Blake* [PRU: *SS* & *FP 1604*] [F]
Tolpis capensis (L.) Sch. Bip. [PRE] [L]
Tripteris aghillana DC. var. *aghillana* [PRU: *SS 831*] [H]
T. auriculata S. Moore [PRU: *AW 13588*] [AFJKL]
Ursinia nana DC. subsp. *nana* [PRU: GB & *SS 1024*] [K]
Verbesina encelioides (Cav.) Benth. & Hook. var. *encelioides** [PRU: *AW* & *SS 1734*] [F]
Vernonia crataegifolia Hutch. [PRU: *AW* & *SS 13019*] [FHI]
V. dregeana Sch. Bip. [PRU: *SS 653*] [H]
V. fastigiata Oliv. & Hiern [PRU: *SS 313*] [BEFH] ♦
V. galpinii Klatt [PRU: *SS 75*] [GHJL]
V. hirsuta (DC.) Sch. Bip. ex Walp. [PRU: *SS 844*] [FGHJL]
V. myriantha Hook. *f*. [PRU: *AW* & *SS 13349*] [F]
V. natalensis Sch. Bip. ex Walp. [PRE] [GHJ]
V. neocorymbosa Hilliard [PRE] [JK]
V. oligocephala (DC.) Sch. Bip. ex Walp. [PRU: *SS 16*] [BGHJ] •
V. poskeana Vatke & Hildebr. subsp. *botswanica* G.V. Pope [PRE] [H] ♦
V. staehelinoides Harv. [PRE] [AFL]
V. steetziana Oliv. & Hiern [PRE] [CD]
V. sutherlandii Harv. [PRE] [GH]
V. tigna Klatt [PRU: *SS 629*] [FJK]
Xanthium spinosum L.* [PRU: *SS* & *FP 1518*] [FL]
X. strumarium L.* [PRE] [F]
Zinnia peruviana (L.) L.* [PRU: *SS 1120*] [BEFHJ]

BALANITACEAE
Balanites maughamii Sprague [PRU: *AW*, *SS* & *ER 13233*] [BEFH] •

BALSAMINACEAE
Impatiens hochstetteri Warb. subsp. *hochstetteri* [PRU: *AW* & *SS 13438*] [F]

BIGNONIACEAE
Jacaranda mimosifolia D. Don* [PRE] [JK]
Kigelia africana (Lam.) Benth. [PRE] [A]
Rhigozum obovatum Burch. [PRU: *SS 1129*] [BFH]
Tecoma stans (L.) Juss. ex H.B.K.* [PRU: *JK 26*] [F]
T. capensis (Thunb.) Lindl. [PRU: *MM 80*] [BF]

BORAGINACEAE
Cordia monoica Roxb. [PRU: *SS 1827*] [BE]
Cynoglossum lanceolatum Forssk. [PRU: *AW* & *SS 13333*] [FJ]
Ehretia amoena Klotzsch [PRU: *RS 2800*] [HJ]
E. rigida (Thunb.) Druce [PRU: *SS 1121*] [BFHJ]
Heliotropium ciliatum L. Kaplan [PRE] [F]
H. giessii Friedr.-Holzh. [PRU: *AW 13595*] [E]
H. lineare (A. DC.) Gürke [PRE] [AB]
H. steudneri Vatke [PRU: *AW* & *SS 13422*] [D]
H. strigosum Willd. [PRU: *SS 428*] [H]
Myosotis species [PRU: *AW* & *SS 13334*] [F]

BRASSICACEAE
Diplotaxis muralis (L.) DC.* [PRE] [B]
Heliophila rigidiuscula Sond. [PRU: *SS & WF 971*] [J]

BURSERACEAE
Commiphora africana (A. Rich.) Engl. [PRU: *SS 1158*] [FHI]
C. glandulosa Schinz [PRU: *SS 1157*] [H]
C. marlothii Engl. [PRU: *SS 1160*] [ABFH]
C. merkeri Engl. [PRE] [A]
C. mollis (Oliv.) Engl. [PRU: *SS 660*] [AGHIJ]
C. pyracanthoides Engl. [PRE] [BHJ]
C. tenuipetiolata Engl. [PRE] [BEFH]

BUXACEAE
Buxus macowanii Oliv. [PRU: *AW 13049*] [EH]

CACTACEAE
Opuntia ficus-indica (L.) Mill.* [PRE] [BHJ]

CAMPANULACEAE
Wahlenbergia androsacea A. DC. [PRE] [L]
W. capillacea (L.f.) A. DC. subsp. *capillacea* [PRE] [L]
W. denticulata (Burch.) A. DC. [PRE] [CD]
W. lycopodioides Schltr. & Brehmer [PRE] [L]
W. squamifolia Brehmer [PRE] [L]
W. undulata (L.f.) A. DC. [PRU: *AW & SS 13402*] [JL]
W. virgata Engl. [PRE] [GH]

CAPPARACEAE
Boscia albitrunca (Burch.) Gilg & Gilg-Ben. var. *albitrunca* [PRU: *AW, SS & ER 13227*] [BFGHJ]
B. albitrunca (Burch.) Gilg & Gilg-Ben. var. *macrophylla* Toelken [PRU: *AW, SS & ER 13183*] [BH] ⊄ **VU**
B. filipes Gilg. [PRE] [GH]
B. foetida Schinz subsp. *foetida* [PRU: *AW, SS & ER 13217*] [FI]
B. foetida Schinz subsp. *minima* Toelken [PRE] [BF] **R**
B. foetida Schinz subsp. *rehmanniana* (Pestal.) Toelken [PRU: *SS 1809*] [ABFHJ]
Cadaba aphylla (Thunb.) Wild [PRU: *AW, SS & ER 13230*] [BF]
C. natalensis Sond. [PRE] [AB]
C. termitaria N.E. Br. [PRU: *SS 451*] [BFGH]
Capparis fascicularis DC. var. *fascicularis* [PRU: *SS 1832*] [EFJ]
C. tomentosa Lam. [PRU: *SS 1831*] [E]
Cleome angustifolia Forssk. subsp. *diandra* (Burch.) Kers [PRE] [B]
C. angustifolia Forssk. subsp. *petersiana* (Klotzsch ex Sond.) Kers [PRU: *AW & SS 13294*] [ABEFGHIJ]
C. gynandra L. [PRE] [ABF]
C. hirta (Klotzsch) Oliv. [PRU: *SS 279*] [AEGH]
C. monophylla L. [PRU: *AW & SS 1368*] [BCH]
Maerua angolensis DC. [PRU: *SS 1116*] [ABDFIJ]
M. caffra (DC.) Pax [PRU: *MM 485*] [ABJ]
M. edulis (Gilg & Gilg-Ben.) De Wolf [PRU: *MM 249*] [BF]
M. juncea Pax subsp. *crustata* (Wild) Wild [PRU: *MM 307*] [AB]
M. juncea Pax subsp. *juncea* [PRU: *AW, SS & ER 13188*] [G]
M. parvifolia Pax [PRE] [AF]

CARYOPHYLLACEAE
Dianthus basuticus Burtt Davy subsp. *basuticus* var. *basuticus* [PRE] [L]
D. transvaalensis Burtt Davy [PRU: *SS 125*] [J]
D. zeyheri Sond. subsp. *natalensis* Hooper [PRE] [L]
Silene burchellii Otth var. *burchellii* [PRU: *SS & WF 968*] [J] ♦

CELASTRACEAE
Cassine aethiopica Thunb. [PRE] [AFH]
Catha edulis (Vahl) Forssk. & Endl. [PRU: *AW, SS & YS 1674*] [FGHJ] •
C. transvaalensis Codd [PRU: *SS 38*] [ABCEFGHJL] ∈ **VU**
Elaeodendron transvaalensis (Burtt Davy) R.H. Archer • [PRU: *SS 314*] [ABCDEFHJL]
Gymnosporia glaucophylla [PRU: *AW & SS 1736*] [CFJ]
G. buxifolia (L.) Szyszyl. [PRU: *MM 471*] [BFHJL]
G. mossambicensis Klotzsch [PRE] [F]
G. polyacantha Szyszyl. [PRE] [ABF]
G. senegalensis (Lam.) Loes. [PRU: *SS 1703*] [ABEFHJ]
G. sp. nov. A [PRU: *AW & SS 13351*] [FGHJL] ∉ **VU**
G. sp. nov. B [PRU: *SS 458*] [FGHJL] ∈
G. tenuispina (Sond.) Marais [PRE] [ABGH]
Hippocratea longipetiolata Oliv. [PRU: *SS 946*] [ABEGI]
Maytenus acuminata (L.f.) Loes. var. *acuminata* [PRU: *AW & SS 13046*] [H]
M. undata (Thunb.) Blakelock [PRU: *AW & SS 13305*] [ABCDFHJKL]
Pleurostylia capensis Loes. [PRU: *AW, SS & ER 13200*] [H]
Pterocelastrus echinatus N.E. Br. [PRU: *SS 627*] [FGHJL]
P. tricuspidatus (Lam.) Walp. [PRE] [F]

CHENOPODIACEAE
Atriplex semibaccata R. Br. var. *typica* Aellen [PRU: *AW, SS & YS 1492*] [B]
Chenopodium album L.* [PRE] [F]
C. giganteum D. Don* [PRE] [B]
C. murale L. [PRE] [ABC]
Lophiocarpus tenuissimus Hook. f. [PRU: *SS 675*] [H]

CLUSIACEAE
Hypericum aethiopicum Thunb. subsp. *sonderi* (Bredell) N. Robson [PRE] [GH]
H. lalandii Choisy [PRU: *SS 784*] [J]
H. revolutum Vahl [PRE] [GH]
H. wilmsii R. Keller [PRU: *AW & SS 13458*] [F]

COMBRETACEAE
Combretum apiculatum Sond. subsp. *apiculatum* [PRU: *SS 423*] [ABFHJ] ♦
C. celastroides Welw. ex G. Lawson subsp. *orientale* Exell [PRE] [AB]
C. collinum Fresen. [PRE] [H]
C. erythrophyllum (Burch.) Sond. [PRE] [AFHJ]
C. hereroense Schinz [PRU: *SS 413*] [ABFGHJ] ♦
C. molle R. Br. ex G. Don. [PRE] [ABFHJL] ♦
C. petrophilum Retief [PRU: *SS 1147*] [EF] ∉ **R**
C. zeyheri Sond. [PRU: *AW, SS & YS 1710*] [EFGH] ♦
Terminalia prunioides G. Lawson [PRU: *SS 605*] [BFGH]
T. sericea Burch. ex DC. [PRU: *AW, SS & YS 1704*] [EF] •

CONVOLVULACEAE
Convolvulus natalensis Bernh. apud O. Krauss var. *natalensis* [PRU: *AW & SS 13384*] [JL]
C. sagittatus Thunb. [PRU: *SS 174*] [GHJ]

Dichondra repens J.R. & G. Forst. var. *repens* [PRE] [F]
Evolvulus alsinoides (L.) L. var. *linifolius* (L.) Baker [PRU: *MM 555*] [BF]
Ipomoea adenioides Schinz [PRE] [ABF]
I. albivenia (Lindl.) Sweet [PRE] [AF]
I. bathycolpos Hallier f. var. *bathycolpos* [PRU: *SS 326*] [GH]
I. bathycolpos Hallier f. var. *sinuatodentata* Hallier f. [PRU: *AW & SS 13010*] [FGHKL] ∊ **LR**
I. carnea Jacq. subsp. *fistulosa* (Mast. ex Choisy) D.F. Austin* [PRU: *SS 1833*] [E]
I. coscinosperma Hochst. ex Choisy [PRU: *AW & SS 13009*] [H]
I. crassipes Hook. [PRU: *SS 651*] [FGHJ]
I. hochstetteri House [PRE] [ABG]
I. magnusiana Schinz var. *eenii* (Rendle) A. Meeuse [PRE] [ACE]
I. magnusiana Schinz var. *magnusiana* [PRU: *SS 270*] [BCDEFH]
I. obscura (L.) Ker Gawl. var. *obscura* [PRU: *SS 480*] [FGHI]
I. oblongata E. Mey. ex Choisy [PRU: *SS 325*] [HK]
I. ommaneyi Rendle [PRU: *SS 649*] [GH]
I. pellita Rendle [PRU: *SS 860*] [J]
I. plebeia R. Br. subsp. *africana* A. Meeuse [PRE] [A]
I. sinensis (Desr.) Choisy subsp. *blepharosepala* (Hochst. ex A. Rich.) Verdc. [PRE] [B]
Merremia kentrocaulos (C.B. Clarke) Rendle [PRU: *SS 690*] [FGH]
Seddera capensis (E. Mey. ex Choisy) Hallier f. [PRU: *AW & SS 1335*] [BDEHJ]
S. suffruticosa (Schinz) Hallier f. var. *hirsutissima* Hallier f. [PRU: *AW & SS 13039*] [BH]
Turbina holubii (Baker) A. Meeuse [PRE] [E] ♦
T. robertsiana (Rendle) A. Meeuse [PRE] [DF]
Xenostegia tridentata (L.) D.F. Austin & Staples subsp. *angustifolia* (Jacq.) A. Meeuse [PRU: *AW & SS 13041*] [H] ♦

CRASSULACEAE
Adromischus umbraticola C.A. Sm. [PRE] [F]
Cotyledon barbeyi Schweinf. ex Baker [PRU: *AW & SS 13321*] [AFGH]
C. orbiculata L. var. *oblonga* (Haw.) DC. [PRE] [L] •
Crassula acinaciformis Schinz [PRE] [GH]
C. alba Forssk. var. *alba* [PRU: *SS 105*] [J]
C. brevifolia subsp. *brevifolia* [PRE] [GH]
C. expansa Dryand. subsp. *fragilis* (Baker) Toelken [PRE] [EF]
C. lanceolata (Eckl. & Zeyh.) Endl. ex Walp. subsp. *lanceolata* [PRU: *AW & SS 13452*] [CDFKL]
C. sarcocaulis Eckl. & Zeyh. subsp. *sarcocaulis* [PRU: *SS 790*] [FHJKL]
C. setulosa Harv. var. *deminuta* (Diels) Toelken [PRU: *AW & SS 13075*] [L]
C. setulosa Harv. var. *setulosa* [PRE] [CDL]
C. swaziensis Schönland [PRU: GB & *SS 1008*] [KL]
C. vaginata Eckl. & Zeyh. subsp. *vaginata* [PRU: *SS 1854*] [FKL]
Kalanchoe luciae Raym.-Hamet subsp. *luciae* [PRU: *SS 238*] [GHJ]
K. paniculata Harv. [PRU: *SS 148*] [BEFJ]
K. rotundifolia (Haw.) Haw. [PRU: *SS 764*] [HIJL]
K. species [PRE] [ABH]
K. thyrsiflora Harv. [PRU: GB & *SS 1005*] [K]

CUCURBITACEAE
Citrullus lanatus (Thunb.) Matsum. & Nakai [PRE] [ACE]
Coccinia adoensis (A. Rich.) Cogn. [PRE] [GHJK]
C. rehmannii Cogn. [PRU: *SS 1122*] [ABEFJ]
C. sessilifolia (Sond.) Cogn. [PRE] [FI]
Corallocarpus bainesii (Hook. f.) A. Meeuse [PRE] [B]
C. triangularis Cogn. [PRE] [I]

Cucumella cinerea (Cogn.) C. Jeffrey [PRE] [BE]
Cucumis africanus L.f. [PRU: *AW, SS & YS 1453*] [BEF]
C. anguria L. var. *longaculeatus* J.H. Kirkbr. [PRU: *SS & FP 1545*] [F]
C. hirsutus Sond. [PRU: *AW, SS & YS 1437*] [D]
C. melo L. [PRE] [BDF]
C. metuliferus Naudin [PRU: *AW & SS 998*] [H]
C. myriocarpus Naudin susbsp. *myriocarpus* [PRU: *SS & FP 1603*] [H]
C. zeyheri Sond. [PRU: *SS 141*] [CDFGHJ]
Kedrostis foetidissima (Jacq.) Cogn. [PRU: *SS 42*] [BEHJ]
K. hirtella (Naudin) Cogn. [PRE] [GH]
Lagenaria siceraria (Molina) Standl. [PRE] [ACE]
L. sphaerica (Sond.) Naudin [PRE] [AB]
Momordica balsamina L. [PRE] [BDF]
M. cardiospermoides Klotzsch [PRU: *SS & AW 13…*] [B]
Peponium caledonicum (Sond.) Engl. [PRE] [BF]
Zehneria scabra (L.f.) Sond. subsp. *scabra* [PRU: *AW, SS & YS 1450*] [E]

DIPSACACEAE
Cephalaria zeyheriana Szabo [PRU: *SS 842*] [CDJKL]
Scabiosa columbaria L. [PRU: *SS 137*] [GHJ] • ♦

DROSERACEAE
Drosera burkeana Planch. [PRE] [L]
D. collinsiae N.E. Br. ex Burtt Davy [PRE] [L]
D. dielsiana Exell & J.R. Laundon [PRE] [L]

EBENACEAE
Diospyros austro-africana De Winter var. *microphylla* (Burch.) De Winter [PRE] [L]
D. lycioides Desf. subsp. *guerkei* (Kuntze) De Winter [PRE] [JL]
D. lycioides Desf. subsp. *lycioides* [PRU: *JK 29*] [BCDFI]
D. lycioides Desf. subsp. *nitens* (Harv. ex Hiern) De Winter [PRU: *AW & SS 13022*] [CDEFGHL]
D. lycioides Desf. subsp. *sericea* (Bernh.) de Winter [PRU: *SS & FP 1570*] [FK]
D. mespiliformis Hochst. ex A. DC. [PRU: *SS 1814*] [EF]
D. whyteana (Hiern) F. White [PRU: *SS 807*] [FGHJL]
Euclea crispa (Thunb.) Guerke subsp. *crispa* [PRU: *AW, SS & ER 13205*] [ABCFGHJKL] [form] ∊
E. divinorum Hiern. [PRU: *SS 433*] [ABFH] ♦
E. linearis Zeyh. ex Hiern [PRU: *AW & SS 13060*] [DFHIJ] [form] ∊ ♦
E. natalensis A. DC. subsp. *angustifolia* F. White [PRU: *SS 1813*] [E]
E. schimperi A. DC. var. *daphnoides* (Hiern) De Winter [PRU: *GD 4186*] [H]
E. schimperi A. DC. var. *schimperi* [PRU: *SS 1700*] [BF]
E. sekhukhuniensis Siebert, Van Wyk & Retief [PRU: *AW & SS 13313*] [FHJ] ∊ EN
E. undulata Thunb. var. *undulata* [PRE] [B] •
E. undulata Thunb. var. *myrtina* (Burch.) Hiern [PRU: *JK 33*] [ABFGHIJ]

ERICACEAE
Erica alopecurus Harv. var. *alopecurus* [PRE] [L]
E. atherstonei Diels ex Guthrie & Bolus [PRU: *SS & WF 977*] [IJ]
E. caffrorum Bolus var. *caffrorum* [PRE] [L]
E. cerinthoides L. var. *cerinthoides* [PRE] [L]
E. drakensbergensis Guthrie & Bolus [PRE] [L]

EUPHORBIACEAE
Acalypha angustata Sond. var. *glabra* [PRU: *SS 117*] [GHJ]
A. caperonioides Baill. [PRU: *SS 15*] [GHJL] ♦
A. indica L. [PRU: *AW* & *SS 1315*] [BGJ]
A. peduncularis E. Mey. ex Meisn. [PRE] [K]
A. punctata Meisn. [PRU: *SS 82*] [JK]
A. segetalis Müll. Arg. [PRE] [B]
A. villicaulis Hochst. [PRU: *SS 99*] [JK]
A. wilmsii Pax ex Prain & Hutch. [PRE] [JK]
Adenocline acuta (Thunb.) Baill. [PRE]]K]
Andrachne ovalis (Sond.) Müll. Arg. [PRU: *AW* & *SS 13450*] [F]
Bridelia mollis Hutch. [PRE] [BH]
Cephalocroton mollis Klotzsch [PRE] [E]
Chamaesyce hirta (L.) Millsp. [PRU: *JK 111*] [F]
C. inaequilatera (Sond.) Soják [PRE] [F]
C. neopolycnemoides (Pax & K. Hoffm.) Koutnik [PRE] [E]
C. prostrata (Aiton) E. Small* [PRU: *MM 819*] [B]
Clutia affinis Sond. [PRE] [GHI]
C. monticola S. Moore [PRE] [GH]
C. pulchella L. [PRU: *AW* & *SS 13448*] [CDFH]
C. virgata Pax & K. Hoffm. [PRE] [GH]
Croton gratissimus Burch. var. *gratissimus* [PRU: *SS 369*] [ABFGHJ] • ♦
C. gratissimus Burch. var. *subgratissimus* (Prain) Burtt Davy [PRE] [BCD]
C. megalobotrys Müll. Arg. [PRU: *SS 1817*] [EF]
C. menyhartii Pax [PRU: *SS 355*] [BHJ]
Dalechampia galpinii Pax [PRU: *AW* & *SS 13051*] [H]
Euphorbia aeruginosa Schweick. [PRE] [B]
E. barnardii A.C. White, R.A. Dyer & B. Sloane [PRU: *SS* & *FP 1612*] [F] ∈ **E VU**
E. clavarioides Boiss. var. *truncata* (N.E. Br.) A.C. White, R.A. Dyer & B. Sloane [PRU: *AW*, *SS* & *ER 13242*] [J]
E. cooperi N.E. Br. ex Berger var. *cooperi* [PRU: *AW*, *SS* & *YS 1507*] [CG]
E. enormis N.E. Br. [PRU: *SS 328*] [ABDFGH] ∉ **LR**
E. exelsa A.C. White, R.A. Dyer & B. Sloane [PRE] [BEF]
E. ingens E. Mey. ex Boiss. [PRE] [HJ]
E. lydenburgensis Schweick. & Letty [PRU: *AW*, *SS* & *ER 13215*] [EFHIL] ∉ **LR**
E. maleolens E. Phillips [PRE] [EF] ∉
E. monteiroi Hook. f. subsp. *ramosa* L.C. Leach [PRU: *SS 342*] [AEH] ♦
E. schinzii Pax [PRU: *AW* & *SS 13316*] [FGHJ] [form] ∈ ♦
E. sekukuniensis R.A. Dyer [PRU: *AW*, *SS* & *YS 1427*] [DFHJ] ∈ **R VU**
E. sp. nov. [PRU: *AW* & *SS 13194*] [H] ∈
E. tirucalli L. [PRU: *SS 1151*] [BEFH]
Flueggea virosa (Roxb. ex Willd.) Voigt subsp. *virosa* [PRU: *SS 177*] [ABFGHJK]
Jatropha gossypifolia L.* [PRU: *SS 1842*] [E]
J. latifolia Pax var. *angustata* Prain [PRU: *SS 35*] [FH] ∉ **LR**
J. latifolia Pax var. *latifolia* [PRU: *SS 239*] [BCEFGHJ] ∉ **LR**
J. schlechteri Pax [PRE] [B]
J. zeyheri Sond. var. *zeyheri* [PRU: *SS 861*] [FJ]
J. zeyheri Sond. var. *subsimplex* Prain [PRE] [FHJ] ∉
Monadenium lugardiae N.E. Br. [PRU: *SS* & *FP 1613*] [F]
Phyllanthus burchellii Müll. Arg. [PRE] [B]
P. glaucophyllus Sond. [PRU: *AW* & *SS 12991*] [BH] ♦
P. incurvus Thunb. [PRU: *SS 406*] [BHJ]
P. maderaspatensis L. [PRE] [B]
P. parvulus Sond. subsp. *parvulus* [PRU: *SS* & *FP 1561*] [BCDH]

P. parvulus Sond. subsp. *garipensis*
P. sp. nov. [PRU: *SS 470*] [ABGH] ∊
Ricinus communis L.* [PRE] [F]
Spirostachys africana Sond. [PRU: *SS 1837*] [ABEFH]
Tragia okanyua Pax [PRU: *SS* & *FP 1534*] [F]
T. rupestris Sond. [PRU: *SS 386*] [BFH]
T. sp. nov. [PRU: *SS 1573*] [ABGH] ∊

FABACEAE
Caesalpinioidea
Bauhinia galpinii N.E. Br. [PRE] [I]
B. tomentosa L. [PRU: *SS 444*] [BCEFH] [form] ∊
Caesalpina decapetala (Roth.) Alston* [PRU: *AW* & *SS 1307*] [F]
C. gilliesii (Wall. Ex Hook.) Benth.* [PRU: *SS 1844*] [H]
Chamaecrista absus (L.) Irwin & Barneby [PRU: *SS 288*] [H]
C. biensis (Steyaert) Lock [PRU: *SS 179*] [J]
C. comosa E. Mey. var. *capricornia* (Steyaert) Lock [PRU: *SS 1194*] [JK]
C. stricta E. Mey. [PRU: *SS 1193*] [CDH]
Peltophorum africanum Sond. [PRU: *SS 1138*] [BFHIJ] • ♦
Schotia brachypetala Sond. [PRU: *AW, SS* & *ER 13189*] [AFGHL] •
S. latifolia Jacq. [PRE] [AB] [form] ∊
Senna bicapsularis (L.) Roxb.* [PRU: *AW* & *SS 1317*] [G]
S. italica Mill. subsp. *arachoides* (Burch.) Lock [PRU: *SS 278*] [BFGH]
S. occidentalis (L.) Link* [PRU: *AW* & *SS 13366*] [EF]
S. septemtrionalis (Viv.) Irwin & Barneby* [PRE] [I]
Tylosema fassoglense (Schweinf.) Torre & Hillc. [PRE] [GI] ♦

Mimosoidea
Acacia ataxacantha DC. [PRE] [AFHJ]
A. borleae Burtt Davy [PRE] [L]
A. burkei Benth. [PRU: *AW* & *SS 1743*] [FH]
A. caffra (Thunb.) Willd. [PRU: *JK 67*] [AFHJL]
A. dealbata Link* [PRU: GB & *SS 1003*] [K]
A. erioloba E. Mey. [PRE] [E]
A. exuvialis I. Verd. [PRE] [FHI]
A. galpinii Burtt Davy [PRE] [FHJ]
A. gerrardii Benth. var. *gerrardii* [PRU: *AW* & *SS 13412*] [AFHJ]
A. grandicornuta Gerstner [PRE] [BCDFGHJ]
A. karroo Hayne [PRU: *SS 1152*] [BFGHIJK] • ♦
A. karroo Hayne [PRU: PS *4*] [HIJ] [form] ∊
A. luederitzii Engl. var. *retinens* (Sim) J.H. Ross & Brenan [PRU: *MM 149*] [BFHJ]
A. mellifera (Vahl) Benth. subsp. *detinens* (Burch.) Brenan [PRE] [B]
A. nigrescens Oliv. [PRE] [BHJ]
A. nilotica (L.) Willd. ex Delile subsp. *kraussiana* (Benth.) Brenan [PRU: *AW* & *SS 13301*] [BFH]
A. permixta Burtt Davy [PRE] [A]
A. robusta Burch. subsp. *robusta* [PRU: *MM 1135*] [BCDHK]
A. schweinfurthii Brenan & Exell var. *schweinfurthii* [PRE] [J]
A. senegal (L.) Willd. var. *leiorhachis* Brenan [PRU: *SS 607*] [ABFHJ]
A. senegal (L.) Willd. var. *rostrata* Brenan [PRE] [ABFJ]
A. sieberana DC. var. woodii (Burtt Davy) Keay & Brenan [PRU: *AW* & *SS 13369*] [K]
A. sp. nov. [PRE: *JH pers. comm.]* [H]
A. swazica Burtt Davy [PRE] [F]
A. tenuispina I. Verd. [PRE] [AB]

A. tortilis (Forssk.) Hayne subsp. *heteracantha* (Burch.) Brenan [PRU: *JK 32*] [BFHIJ]
Albizia anthelmintica (A. Rich.) Brongn. [PRU: *AW* & *SS 1742*] [BFHI]
Dichrostachys cinerea (L.) Wright & Arn. subsp. *africana* Brenan & Brummitt [PRU: *AW* & *SS 13304*] [BFHJ]
Elephantorrhiza burkei Benth. [PRE] [ABFJ]
E. elephantina (Burch.) Skeels [PRE] [JKL] • ♦
E. goetzei (Harms) Harms subsp. *goetzei* [PRU: *SS 286*] [AH]
E. praetermissa J.H. Ross [PRU: *SS 197*] [FGHJ] ∈ **K LR**

Papilionoideae
Abrus laevigatus E. Mey. [PRU: *MM 378*] [BFH]
Aeschynomene rehmannii Schinz var. *leptobotrya* (Harms ex Baker f.) J.B. Gillett [PRE] [K]
Alysicarpus rugosus (Willd.) DC. subsp. *perennirufus* J. Léonard [PRE] [K]
Argyrolobium amplexicaule (E. Mey.) Dummer [PRU: *SS 133*] [J]
A. lancifolium Burtt Davy [PRE] [GH] ∉
A. patens Eckl. & Zeyh. [PRU: *SS 436*] [H]
A. pauciflorum Eckl. & Zeyh. var. *pauciflorum* [PRU: *AW*, *SS* & *YS 1472*] [F]
A. speciosum Eckl. & Zeyh. [PRU: *SS 636*] [J]
A. transvaalense Schinz [PRU: *AW* & *SS 1422*] [AFGIJ]
A. tuberosum Eckl. & Zeyh. [PRU: *SS 243*] [JK]
A. wilmsii Harms [PRU: *AW*, *SS* & *ER 13236*] [J] ∉ **LR**
Bolusanthus speciosus (Bolus) Harms [PRE] [ABFHJ] ♦
Calpurnia aurea (Aiton) Benth. [PRU: *AW* & *SS 13354*] [F]
Crotalaria eremicola Baker f. subsp. *eremicola* [PRE] [H]
C. doidgeae I. Verd. [PRU: *SS 1810*] [E]
C. lotoides Benth. [PRE] [HJ]
C. monteiroi Taub. ex Baker f. var. *monteiroi* [PRU: *AW* & *SS 13410*] [FJ]
C. monteiroi Taub. ex Baker f. var. *galpinii* Burtt Davy ex I. Verd. [PRE] [ABGHJ]
C. podocarpa DC. [PRU: *SS 692*] [H]
C. sphaerocarpa Perr. ex DC. subsp. *sphaerocarpa* [PRU: *AW* & *SS 1314*] [CDEG]
Decorsea galpinii (Burtt Davy) Verdc. [PRU: *SS 341*] [AFH]
D. schlechteri (Harms) Verdc. [PRU: *SS 277*] [ABG]
Dichilus pilosus P. Conrath ex Schinz [PRE] [GHL]
D. strictus E. Mey. [PRU: *AW* & *SS 12985*] [FKL]
Dolichos falciformis E. Mey. [PRE] [JK]
D. trilobus L. subsp. *transvaalicus* Verdc. [PRU: *SS 298*] [AFGH]
Dumasia villosa DC. [PRU: *AW* & *SS 13358*] [F]
Eriosema angustifolium Burtt Davy [PRU: *AW* & *SS 13400*] [J]
E. cordatum E. Mey. [PRE] [CDK]
E. ellipticifolium Schinz [PRE] [K]
E. gunniae C.H. Stirt. [PRE] [K]
E. kraussianum Meisn. [PRE] [GHL]
E. psoraleoides (Lam.) G. Don [PRU: *AW* & *SS 13370*] [K]
E. salignum E. Mey. [PRE] [GHKL]
Erythrina lysistemon Hutch. [PRU: *JK 103*] [FHJL] •
E. zeyheri Harv. [PRU: *SS 1166*] [K]
Galactia tenuiflora (Willd.) Wight & Arn. var. *villosa* (Wight & Arn.) Benth. [PRE] [GH]
Indigastrum burkeanum (Benth. ex Harv.) Schrire [PRU: *SS 89*] [J]
I. costatum (Guill. & Perr.) Schrire subsp. *macrum* (E. Mey.) Schrire [PRE] [B]
I. parviflorum (B. Heyne ex Wight & Arn.) Schrire subsp. *parviflorum* [PRU: *AW* & *SS 13398*] [J]
Indigofera aquae-nitentis Bremek. [PRU: *AW* & *SS 13379*] [J]
I. arrecta Hochst. ex A. Rich. [PRU: *JK 30*] [F]
I. circinnata Benth. ex Harv. [PRU: *SS 1198*] [BFJ]

I. comosa N.E. Br. [PRU: *SS 100*] [CDJ]
I. cryptantha Benth. ex Harv. var. *cryptantha* [PRE] [F]
I. daleoides Benth. ex Harv. var. *daleoides* [PRE] [CD]
I. egens N.E. Br. [PRU: *SS 250*] [JL]
I. enormis N.E. Br. [PRU: *SS 601*] [BH]
I. evansiana Burtt Davy [PRU: *SS 255*] [JK]
I. filipes Benth. ex Harv. [PRE] [CD]
I. frondosa N.E. Br. [PRU: *RS 2735*] [K]
I. hedyantha Eckl. & Zeyh. [PRE] [L]
I. heterotricha DC. [PRU: *SS 661*] [ABH] ♦
I. hilaris Eckl. & Zeyh. [PRU: *SS 95*] [HJ] ♦
I. hochstetteri Baker subsp. *streyana* (Merxm.) A. Schreib. [PRU: *AW, SS & YS 1495*] [F]
I. holubii N.E. Br. [PRU: *SS 205*] [BEFJ]
I. ingrata N.E. Br. [PRU: *AW & SS 1325*] [G]
I. longebarbata Engl. [PRE] [L]
I. lydenburgensis N.E. Br. [PRU: *SS 356*] [H] ⊄
I. melanadenia Benth. Ex Harv. [PRU: *SS 1698*] [E]
I. mollicoma N.E. Br. [PRU: *SS 1806*] [E]
I. nebrowniana J.B. Gillett [PRU: *SS 359*] [CDHJ]
I. reducta N.E. Br. [PRE] [GH]
I. rhytidocarpa Benth. ex Harv. subsp. *rhytidocarpa* [PRE] [B]
I. sanguinea N.E. Br. [PRU: *AW & SS 13076*] [GHL]
I. schinzii N.E. Br. [PRE] [L]
I. sessilifolia DC. [PRU: *SS 431*] [H]
I. species [PRE] [ABFL]
I. torulosa E. Mey. var. *torulosa* [PRE] [F]
I. tristoides N.E. Br. [PRU: *SS 94*] [BJ]
I. trita L.f. subsp. *subulata* (Vahl ex Poir.) Ali [PRE] [B]
I. verrucosa Eckl. & Zeyh. [PRU: *SS 230*] [J]
I. vicioides Jaub. & Spach var. *vicioides* [PRU: *AW & SS 1327*] [G]
I. zeyheri Spreng. ex Eckl. & Zeyh. [PRE] [JK]
Lonchocarpus capassa Rolfe [PRU: *SS 1805*] [E]
Lotononis adpressa N.E. Br. subsp. *adpressa* [PRU: *SS 231*] [J]
L. calycina (E. Mey.) Benth. [PRU: *SS 115*] [CDFJ]
L. carinata (E. Mey.) Benth. [PRE] [GHJKL]
L. eriantha Benth. [PRE] [L]
L. foliosa Bolus [PRU: *AW & SS 1309*] [F]
L. laxa Eckl. & Zeyh. [PRU: *SS 10*] [J]
L. macrosepala P. Conrath [PRU: *AW & SS 13086*] [DL]
L. mucronata P. Conrath [PRE] [L]
L. pulchra Dummer [PRE] [L]
L. wilmsii Dummer [PRU: *SS 122*] [GHJ] ⊄
Lotus discolor E. Mey. subsp. *discolor* [PRE] [GH]
Mundulea sericea (Willd.) A. Chev. [PRU: *JK 101*] [BFGHIJ] ♦
Neorautanenia amboensis Schinz [PRU: *SS 693*] [H]
Ormocarpum kirkii S. Moore [PRU: *AW 12986*] [DGHL]
O. trichocarpum (Taub.) Engl. [PRU: *AW, SS & YS 1461*] [AEGH]
Otholobium polystictum (Benth. Ex Harv.) C.H. Stirt. [PRU: *AW 13584*] [F]
O. wilmsii (Harms) C.H. Stirt. [PRU: *SS 625*] [JKL]
Otoptera burchellii DC. [PRE] [F]
Pearsonia aristata (Schinz) Dummer [PRU: *SS 240*] [HJ]
P. cajanifolia (Harv.) Polhill subsp. *cajanifolia* [PRU: *SS 828*] [J]
P. cajanifolia (Harv.) Polhill subsp. *cryptantha* (Baker) Polhill [PRU: *SS & WF 964*] [CDGHJKL]

P. grandifolia (Bolus) Polhill subsp. *latibracteolata* (Dummer) Polhill [PRE] [L]
P. obovata (Schinz) Polhill [PRE] [E]
P. sessilifolia (Harv.) Dummer subsp. *sessilifolia* [PRU: *AW* & *SS 13399*] [JL]
P. uniflora (Kensit) Polhill [PRE] [GH]
Ptycholobium contortum (N.E. Br.) Brummitt [PRU: *AW* & *SS 13417*] [BH]
P. plicatum (Oliv.) Harms [PRU: *SS 211*] [J]
Pueraria lobata (Willd.) Ohwi var. *lobata** [PRE] [L]
Rhynchosia adenodes Eckl. & Zeyh. [PRE] [KL]
R. albissima Gand. [PRU: *SS 132*] [J]
R. crassifolia Benth. [PRE] [I]
R. densiflora (Roth) DC. subsp. *chrysadenia* (Taub.) Verdc. [PRU: *SS 1685*] [E]
R. komatiensis Harms [PRU: GB & *SS 1026*] [HJK]
R. minima (L.) DC. var. *minima* [PRE] [BJ]
R. minima (L.) DC. var. *prostrata* (Harv.) Meikle [PRU: *SS* & *FP 1525*] [BFJ] ♦
R. monophylla Schltr. [PRE] [BGHL]
R. nervosa Benth. & Harv. var. *nervosa* [PRE] [JL]
R. reptabunda N.E. Br. [PRE] [K]
R. sordida (E. Mey.) Schinz [PRU: *SS 261*] [JK]
R. spectabilis Schinz [PRU: *AW* & *SS 13002*] [FHK] ∉
R. totta (Thunb.) DC. var. *totta* [PRU: *SS 819*] [BJL] ♦
Sesbania bispinosa (Jacq.) W. Wight var. *bispinosa** [PRE] [B]
S. punicea (Cav.) Benth.* [PRU: *SS 1128*] [D]
Sphenostylis angustifolia Sond. [PRU: *SS 113*] [HJ]
Stylosanthes fruticosa (Retz.) Alston [PRU: *SS 1811*] [CDE]
Tephrosia burchellii Burtt Davy [PRE] [B]
T. capensis (Jacq.) Pers. [PRE] [GHK]
T. elongata E. Mey. var. *elongata* [PRU: *SS 44*] [CDJ]
T. longipes Meisn. subsp. *longipes* [PRU: *SS 445*] [BHJL] ♦
T. multijuga R.G.N. Young [PRE] [F]
T. purpurea (L.) Pers. subsp. *leptostachya* (DC.) Brummitt var. *leptostachya* [PRU: *SS 206*] [CDEGHJ]
T. purpurea (L.) Pers. subsp. *leptostachya* (DC.) Brummitt var. *pubescens* Baker [PRU: *SS 110*] [HJ] ♦
T. purpurea (L.) Pers. subsp. *purpurea* [PRE] [J]
T. semiglabra Sond. [PRE] [I]
Trifolium africanum Ser. var. *africanum* [PRE] [J]
Vicia sativa L.* [PRE] [GH]
Vigna frutescens A. Rich. subsp. *frutescens* var. *frutescens* [PRU: *AW* & *SS 13401*] [HJ]
V. luteola (Jacq.) Benth. var. *luteola* [PRU: *SS 347*] [H]
V. unguiculata (L.) Walp. subsp. *unguiculata* [PRU: *SS 404*] [EH]
V. vexillata (L.) A. Rich. var. *angustifolia* (Schumach. & Thonn.) Baker [PRE] [I]

FLACOURTIACEAE
Dovyalis caffra (Hook. f. & Harv.) Hook. f. [PRE] [ACE]
D. zeyheri (Sond.) Warb. [PRE] [CDFGHIJL]
Flacourtia indica (Burm. f.) Merr. [PRU: *MM 279*] [B]
Homalium dentatum (Harv.) Warb. [PRU: *SS 373*] [BH]
Kiggelaria africana L. [PRU: *AW* & *SS 13435*] [F]
Scolopia zeyheri (Nees) Harv. [PRU: *SS 803*] [FHJ]
Trimeria grandifolia (Hochst.) Warb. [PRE] [EGH]

GENTIANACEAE
Chironia krebsii Griseb. [PRE] [L]
C. palustris Burch. subsp. *palustris* [PRE] [L]

C. palustris Burch. subsp. *transvaalensis* (Gilg) Verd. [PRU: *SS 70*] [FJK]
C. purpurascens (E. Mey.) Benth. & Hook. f. subsp. *humulis* (Gilg) I. Verd. [PRE] [J]
Enicostema hyssopifolium (Willd.) I. Verd. [PRE] [B]
Sebaea bojeri Griseb. [PRE] [E]
S. grandis (E. Mey.) Steud. [PRE] [EL] ♦
S. leiostyla Gilg [PRE] [FI]
S. longicaulis Schinz [PRE] [L]
S. sedoides Gilg var. *confertiflora* (Schinz) Marais [PRE] [L]
Swertia welwitschii Engl. [PRU: *SS 787*] [J]

GERANIACEAE
Geranium wakkerstroomianum R. Knuth [PRU: *AW* & *SS 13440*] [FGH]
Monsonia angustifolia E. Mey. ex A. Rich. [PRU: *AW*, *SS* & *YS 1494*] [FL]
M. burkeana Planch. ex Harv. [PRE] [K]
M. glauca R. Knuth [PRU: *SS* & *WF 974*] [JL]
M. grandifolia R. Knuth [PRU: *SS 798*] [J]
Pelargonium alchemilloides (L.) L'Her. [PRU: GB & *SS 1000*] [K]
P. acraeum R.A. Dyer [PRU: *AW* & *SS 13331*] [F]
P. luridum (Andr.) Sweet [PRU: *AW* & *SS 13372*] [CDKL] •
P. multicaule Jacq. subsp. *subherbaceum* (R. Knuth) J.J.A. van der Walt [PRE] [L]

GESNERIACEAE
Streptocarpus dunnii Hook. f. [PRE] [CDL]
S. parviflorus Hook. f. [PRE] [I]
S. vandeleurii Baker f. & S. Moore [PRE] [L]

GREYIACEAE
Greyia radlkoferi Szyszyl. [PRU: *AW* & *SS 13330*] [FJL]

ICACINACEAE
Apodytes dimidiata E. Mey. ex Arn. subsp. *dimidiata* [PRU: *SS 21*] [FHJKL] ♦
Cassinopsis ilicifolia (Hochst.) Kuntze [PRU: GB & *SS 1034*] [GHK]
Pyrenacantha grandiflora Baill. [PRE] [F]

ILLECEBRACEAE
Pollichia campestris Aiton [PRU: *SS 97*] [BFHIJL] ♦

LAMIACEAE
Acrotome hispida Benth. [PRE] [A]
Aeollanthus buchnerianus Briq. [PRU: *SS 814*] [JK]
A. parvifolius Benth. [PRE] [CD]
Ajuga ophrydis Burch. ex Benth. [PRE] [L]
Becium filamentosum (Forssk.) Chiov. [PRU: *AW* & *SS 1320*] [BFG]
B. obovatum (E. Mey. ex Benth.) N.E. Br. subsp. *obovatum* var. *obovatum* [PRU: *AW* & *SS 13427*] [F]
B. obovatum (E. Mey. ex Benth.) N.E. Br. subsp. *obovatum* var. *galpinii* (Gürke) N.E. Br. [PRE] [CDJ]
Endostemon obtusifolius (E. Mey. ex Benth.) N.E. Br. [PRU: *MM 366*] [B]
E. tenuiflorus (Benth.) M.R. Ashby [PRE] [AB]
Geniosporum angolense Briq. [PRE] [K]
Hemizygia albiflora (N.E. Br.) M.R. Ashby [PRU: *AW* & *SS 13072*] [FL]
H. canescens (Gürke) M.R. Ashby [PRU: *AW*, *SS* & *YS 1432*] [G]
H. obermeyerae M.R. Ashby [PRE] [E]
H. petrensis (Hiern) M.R. Ashby [PRU: *SS 120*] [CDJ]

H. pretoriae (Gürke) M.R. Ashby subsp. *pretoriae* [PRE] [GH]
H. rehmannii (Gürke) M.R. Ashby [PRE] [E]
H. sp. nov. [PRU: *SS 615*] [FHJ] ∈
Leonotis leonurus (L.) R. Br. [PRU: *SS 823*] [JL] •
L. nepetifolia (L.) R. Br. [PRE] [I]
L. ocymifolia (Burm. f.) Iwarsson var. *ocymifolia* [PRE] [CDFL]
L. ocymifolia (Burm. f.) Iwarsson var. *schinzii* (Gürke) Iwarsson [PRE] [F]
Leucas capensis (Benth.) Engl. [PRU: *AW* & *SS 13007*] [BFGH] [form] ∈
L. glabrata (Vahl) Sm. var. *glabrata* [PRU: *AW* & *SS 1344*] [C]
L. glabrata (Vahl) Sm. var. *linearis* Codd [PRE] [B]
L. martinicensis (Jacq.) R. Br. [PRU: *AW, SS* & *YS 1497*] [F]
L. neuflizeana Courbon [PRU: *SS* & *FP 1578*] [H]
L. sexdentata Skan [PRU: *MM 208*] [BFI]
Mentha aquatica L. [PRE] [L]
M. longifolia (L.) L. subsp. *polyadena* (Briq.) Briq. • [PRU: *SS 130*] [JK]
Ocimum americanum L. var. *americanum* [PRU: *SS 346*] [BFH]
O. gratissimum L. subsp. *gratissimum* var. *gratissimum* [PRU: *SS 1680*] [FH]
Orthosiphon amabilis (Bremek.) Codd [PRE] [F] ∉
O. fruticosus Codd [PRU: *AW* & *SS 12998*] [EFGH] ∈ **LR**
O. labiatus N. E. Br. [PRU: *SS 7*] [HL]
O. pseudoserratus M.R. Ashby [PRE] [A]
O. serratus Schltr. [PRE] [L]
O. suffrutescens (Thonn.) J.K. Morton [PRU: *AW* & *SS 13042*] [EH]
O. tubiformis R.D. Good [PRU: *AW, SS* & *YS 1478*] [FGHI] ∉ **LR**
Plectranthus cylindraceus Hochst. ex Benth. [PRU: *AW* & *SS 1416*] [GHJ]
P. fruticosus L'Hér. [PRE] [E]
P. hadiensis (Forssk.) Schweinf. ex Spreng. var. *hadiensis* [PRE] [F]
P. hadiensis (Forssk.) Schweinf. ex Spreng. var. *tomentosus* (Benth.) Codd [PRU: *SS 415*] [GH]
P. hadiensis (Forssk.) Schweinf. ex Spreng. var. *woodii* (Gürke) Codd [PRE] [K]
P. laxiflorus Benth. [PRE] [E]
P. madagascariensis (Pers.) Benth. var. *ramosior* Benth. [PRE] [CD]
P. mutabilis Codd [PRE] [E]
P. neochilus Schltr. [PRU: *SS 293*] [FJK]
P. rubropunctatus Codd [PRU: *SS 769*] [J]
P. venteri Van Jaarsv. & Hankey [PRU: *SS* & *FP 1605*] [F] ∈ **VU**
P. verticillatus (L.f.) Druce [PRU: *AW, SS* & *YS 1429*] [G]
P. xerophilus Codd [PRU: *AW* & *SS 1415*] [AEFGHI] ∉
Pycnostachys reticulata (E. Mey.) Benth. [PRU: *SS 780*] [FJL]
Rabdosiella calycina (Benth.) Codd [PRU: *SS 835*] [EFJL]
Salvia runcinata L.f. [PRU: *AW* & *SS 13376*] [J]
S. reflexa Hornem. [PRU: *SS* & *FP 1523*] [F]
S. stenophylla Burch. ex Benth. [PRE] [F]
Stachys caffra E. Mey. Ex Benth. [PRU: *AW* & *SS 13343*] [F]
S. graciliflora Presl [PRE] [E]
S. natalensis Hochst. var. *galpinii* (Briq.) Codd [PRU: *SS 815*] [JL]
S. natalensis Hochst. var. *natalensis* [PRE] [CD]
Syncolostemon concinnus N.E. Br. [PRU: *SS* & *WF 976*] [JL]
Tetradenia brevispicata (N.E. Br.) Codd [PRU: *SS* & *FP 1599*] [BCDFGHK]
T. riparia (Hochst.) Codd [PRU: *SS 1812*] [EL] •
Teucrium trifidum Retz. [PRE] [CDFKL]
Tinnea galpinii Briq. [PRE] [L]
T. rhodesiana S. Moore [PRU: *SS 185*] [ABCDEFGHIJ]

LINACEAE
Linum thunbergii Eckl. & Zeyh. [PRE] [GHL]

LOBELIACEAE
Cyphia elata Harv. var. *elata* [PRU: *SS 128*] [FHJ]
C. elata Harv. var. *glabra* Harv. [PRU: *SS 753*] [J]
C. transvaalensis E. Phillips [PRU: *SS 622*] [F] ⊄
Lobelia erinus L. [PRU: *SS* & *FP 1547*] [AFL]
L. flaccida (Presl) A. DC. subsp. *flaccida* [PRE] [L]
L. vanreenensis (Kuntze) K. Schum. [PRU: *SS* & *WF 980*] [J]
Monopsis decipiens (Sond.) Thulin [PRU: *SS 786*] [CDJL]

LOGANIACEAE
Buddleja auriculata Benth. [PRU: *AW* & *SS 13355*] [FJKL]
B. salviifolia (L.) Lam. [PRU: GB & *SS 1009*] [KL]
Gomphostigma virgatum (L.f.) Baill. [PRU: *SS 182*] [J]
Nuxia congesta R. Br. ex Fresen. [PRE] [BHJ]
N. gracilis Engl. [PRU: *AW* & *SS 12980*] [BFHJKL] ⊄ K VU
Strychnos madagascariensis Poir. [PRE] [BFH]
S. pungens Soler. [PRE] [ACE]
S. spinosa Lam. [PRE] [BDFH]

LORANTHACEAE
Erianthemum dregei (Eckl. & Zeyh.) Tiegh. [PRU: *SS 163*] [BFJ]
E. ngamicum (Sprague) Danser [PRE] [BF]
Phragmanthera glaucocarpus (Peyr.) Balle [PRE] [I]
Tapinanthus forbesii (Sprague) Wiens [PRE] [GH]
T. leendertziae (Sprague) Wiens [PRE] [F]
T. lugardii (N.E. Br.) Danser [PRU: *MM 469*] [B]
T. rubromarginatus (Engl.) Danser [PRU: *AW*, *SS* & *ER 13237*] [JL]
T. species [PRU: *JK*] [F]
Tieghemia bolusii (Sprague) Wiens [PRE] [F]

LYTHRACEAE
Nesaea sagittifolia (Sond.) Koehne var. *sagittifolia* [PRE] [FK]
N. schinzii Koehne [PRU: *SS 234*] [J]

MALPIGHIACEAE
Sphedamnocarpus pruriens (Juss.) Szyszyl. subsp. *galphimiifolius* (Juss.) P.D. de Villiers & D.J. Botha [PRE] [E]
S. pruriens (Juss.) Szyszyl. subsp. *pruriens* [PRU: *SS 126*] [BFHJ] ♦
Triaspis glaucophylla Engl. [PRU: *SS 210*] [ABDFGHJL] ⊄
T. hypericoides (DC.) Burch. subsp. *nelsonii* (Oliv.) Immelman [PRU: *AW* & *SS 1330*] [BFGH]

MALVACEAE
Abutilon astro-africanum Hochr. [PRU: *AW 13083*] [DFHJ]
A. grandiflorum G. Don [PRE] [B]
A. guineense (K. Schum.) Baker f. & Exell [PRU: *SS 397*] [BH]
A. hirtum (Lam.) Sweet [PRE] [F]
A. piloso-cinereum A. Meeuse [PRE] [A]
A. pycnodon Hochr. [PRU: *AW* & *SS 1750*] [BF]
Gossypium herbaceum L. var. *africanum* (Watt) Vollesen [PRU: *SS 453*] [BF] N LR
Hibiscus aethiopicus L. var. *ovatus* Harv. [PRU: *SS 53*] [JK]

H. barnardii Exell [PRU: *AW & SS 1340*] [BCEFH] ∈ **R LR**
H. caesius Garcke [PRE] [B]
H. calyphyllus Cav. [PRU: *SS 1119*] [HJ]
H. cannabinus L.* [PRE] [AF]
H. coddii Exell [PRE] [BF]
H. engleri K. Schum. [PRU: *AW & SS 1745*] [F]
H. lunarifolius Willd. [PRE] [K]
H. mastersianus Hiern [PRE] [A]
H. micranthus L.f. [PRU: *SS 352*] [BFH]
H. palmatus Forssk. [PRE] [B]
H. praeteritus R.A. Dyer [PRU: *SS 281*] [BH]
H. pusillus Thunb. [PRU: *SS 262*] [BJ]
H. schinzii Gürke [PRE] [AB]
H. sidiformis Baill. [PRU: *SS 656*] [H]
H. subreniformis Burtt Davy [PRU: *MM 429*] [B]
H. trionum L. [PRU: *SS 131*] [FHJ] ♦
H. upingtoniae Gürke [PRE] [B]
H. vitifolius L. subsp. *vulgaris* Brenan & Exell [PRE] [B]
Pavonia burchellii (DC.) R.A. Dyer [PRU: *SS 178*] [BHJ]
P. columella Cav. [PRE] [GHIL]
P. dentata Burtt Davy [PRE] [ABF]
P. senegalensis (Cav.) Leistner [PRU: *SS 1180*] [H]
Sida cordifolia L. [PRU: *SS 1683*] [EK]
S. dregei Burtt Davy [PRE] [I]
S. ovata Forssk. [PRE] [B]
S. spinosa L. [PRE] [B]

MELASTOMATACEAE
Dissotis canescens (E. Mey. ex R.A. Graham) Hook. f. [PRE] [GH]

MELIACEAE
Ekebergia pterophylla (C. DC.) Hofmeyr [PRE] [GH]
Melia azedarach L.* [PRE] [HJ] ♦
Turraea obtusifolia Hochst. [PRU: *SS 121*] [ABFHJ]

MENISPERMACEAE
Antizoma angustifolia (Burch.) Miers ex Harv. [PRU: *AW & SS 13317*] [H]
Cissampelos torulosa E. Mey. ex Harv. [PRE] [GH]
Stephania abyssinica (Quart.-Dill. & A. Rich.) Walp. var. *tomentella* (Oliv.) Diels [PRE] [GH]
Tinospora fragosa (I. Verd.) I. Verd. & Troupin [PRU: *SS 1148*] [ABEF]

MESEMBRYANTHEMACEAE
Delosperma cooperi (Hook.f.) L. Bolus forma *cooperi* [PRU: *SS 1435*] [G]
D. rileyii L. Bolus [PRE] [H] ∉
D. zeederbergii L. Bolus [PRE] [F] ∉
Khadia alticola Chesselet & H.E.K. Hartmann [PRE] [L]
K. beswickii (L. Bolus) N.E. Br. [PRE] [L]

MORACEAE
Ficus abutilifolia Miq. [PRU: *JK 73*] [ABDFHJ]
F. capreifolia Delile [PRE] [I]
F. cordata Thunb. subsp. *salicifolia* (Vahl) O. Berg [PRE] [HL]
F. glumosa (Miq.) Delile [PRU: *JK 77*] [BDF]
F. ingens (Miq.) Miq. var. *ingens* [PRU: *JK 40*] [ABCDFHJL]

F. sur Forssk. [PRU: *RS 2797*] [BFHJL]
F. thonningii Blume [PRE] [AFHJL]

MYRICACEAE
Morella pilulifera (Rendle) Killick [PRU: *AW* & *SS 13466*] [F]

MYROTHAMNACEAE
Myrothamnus flabellifolius (Sond.) Welw. [PRU: GB & *SS 1004*] [BCDFHJKL] •

MYRSINACEAE
Maesa lanceolata Forssk. [PRE] [GH]
Myrsine africana L. [PRE] [GHJL]
Rapanea melanophloeos (L.) Mez [PRE] [E] • ♦

MYRTACEAE
Heteropyxis natalensis Harv. [PRE] [FHI] •
Syzygium cordatum Hochst. [PRE] [GHJ] •
S. gerrardii (Harv. ex Hook. f.) Burtt Davy [PRE] [E]

NYCTAGINACEAE
Boerhavia cordobensis Kuntze [PRU: *SS 274*] [H]
B. diffusa L.* [PRU: *AW* & *SS 13018*] [J]
B. erecta L. [PRU: *AW* & *SS 1341*] [B]
Commicarpus decipiens Meikle [PRE] [E]
C. pentandrus (Burch.) Heimerl [PRU: *SS* & *FP 1522*] [AF]
C. pilosus (Heimerl) Meikle [PRU: *SS 1815*] [AHF]
C. plumbagineus (Cav.) Standl. [PRU: *MM 417*] [B]

OCHNACEAE
Ochna confusa Burtt Davy & Greenway [PRE] [GH]
O. inermis (Forssk.) Schweinf. [PRU: *SS 349*] [ABEHI]
O. serrulata (Hochst.) Walp. [PRU: *AW 12989*] [FL]

OLACACEAE
Ximenia americana L. [PRU: *JK 95*] [BFHJ]
X. caffra Sond. var. *caffra* [PRU: *SS* & *WF 1042*] [ABDFHJL] ♦

OLEACEAE
Chionanthus foveolatus (E. Mey.) Stearn var. *foveolatus* [PRE] [FHJL]
Jasminum multipartitum Hochst. [PRU: *MM 391*] [BFHJL]
J. quinatum Schinz [PRU: *AW* & *SS 13374*] [FHIJKL] ∉
J. stenolobum Rolfe [PRE] [A]
J. streptopus E. Mey. var. *transvaalensis* (S. Moore) I. Verd. [PRE] [I]
Menodora africana Hook. [PRU: *SS 253*] [J]
Olea capensis L. subsp. *enervis* (Harv. ex C.H. Wright) I. Verd. [PRE] [FGHJL]
O. europaea L. subsp. *africana* (Mill.) P.S. Green [PRU: *AW*, *SS* & *YS 1436*] [ABCDEFGH] •
Schrebera alata (Hochst.) Welw. [PRE] [BEI]

OLINIACEAE
Olinia emarginata Burtt Davy [PRU: *AW* & *SS 13403*] [JKL]
O. rochetiana Juss. [PRE] [JL]

ONAGRACEAE
Epilobium hirsutum L. [PRE] [K]

Oenothera rosea L'Hér. ex Aiton* [PRE] [GH]
O. tetraptera Cav.* [PRU: *SS 1167*] [GHK]

OXALIDACEAE
Oxalis corniculata L.* [PRE] [GH]
O. depressa Eckl. & Zeyh. [PRE] [BCD]
O. obliquifolia Steud. ex Rich. [PRE] [L]
O. semiloba Sond. [PRU: *SS 3*] [FJ]

PAPAVERACEAE
Argemone ochroleuca Sweet subsp. *ochroleuca** [PRU: *SS 1818*] [E]

PASSIFLORACEAE
Adenia digitata (Harv.) Engl. [PRU: *SS & FP 1577*] [FH]
A. fruticosa Burtt Davy subsp. *fruticosa* [PRU: *SS 1829*] [ABDEFH] ∉
A. gummifera (Harv.) Harms var. *gummifera* [PRE] [B]
A. wilmsii Harms [PRU: *AW, SS & YS 1449*] [F] ∉K VU

PEDALIACEAE
Ceratotheca triloba (Bernh.) Hook. f. [PRU: *SS 1804*] [AEFHL]
Dicerocaryum senecioides (Klotzsch) Abels subsp. *senecioides* [PRU: *AW, SS & YS 1496*] [CDEFJ]
Harpagophytum zeyheri Decne. subsp. *zeyheri* [PRE] [F]
Holubia saccata Oliv. [PRU: *SS & FP 1520*] [FG]
Pterodiscus ngamicus N.E. Br. Ex Stapf [PRU: *AW & SS 13293*] [G]
Sesamothamnus lugardii N.E. Br. Ex Stapf [PRU: *AW, SS & ER 13192*] [G]
Sesamum alatum Thonn. [PRU: *AW & SS 1319*] [G]
S. triphyllum Welw. ex Asch. var. *triphyllum* [PRU: *SS & FP 1527*] [BF]

PERIPLOCACEAE
Cryptolepis oblongifolia (Meisn.) Schltr. [PRE] [GH]
Raphionacme galpinii Schltr. [PRU: *SS 39*] [GHJK]
R. hirsuta (E. Mey.) R.A. Dyer ex E. Phillips [PRE] [K]
R. procumbens Schltr. [PRU: *SS 324*] [FHL]
R. velutina Schltr. [PRE] [F]
Stomatostemma monteiroae (Oliv.) N.E. Br. [PRU: *AW & SS 1331*] [AG]

PIPERACEAE
Peperomia tetraphylla (G. Forst.) Hook. & Arn. [PRU: *AW & SS 13445*] [EF]

PITTOSPORACEAE
Pittosporum viridiflorum Sims [PRE] [JL] •

PLANTAGINACEAE
Plantago lanceolata L.* [PRE] [GH]
P. virginica L.* [PRE] [L]

PLUMBAGINACEAE
Plumbago zeylanica L. [PRU: *AW, SS & YS 1457*] [EFI]

POLYGALACEAE
Polygala gerrardii Chodat [PRE] [J]
P. gracilenta Burtt Davy [PRE] [JK]
P. hottentotta Presl [PRU: *AW & SS 1381*] [ABEFHJKL] ♦

P. krumanina Burch. ex Ficalho & Hiern [PRU: *AW* & *SS 13385*] [J]
P. leptophylla Burch. [PRE] [B]
P. sphenoptera Fresen. [PRU: *SS 212*] [DJ] ♦
P. sp. nov. [PRU: *AW* & *SS 13311*] [BFGHJKL] ∈ **LR**
P. uncinata E. Mey. ex Meisn. [PRU: *AW* & *SS 1380*] [BGHJ] ♦
P. virgata Thunb. var. *decora* (Sond.) Harv. [PRU: *AW* & *SS 13439*] [FGHI]

POLYGONACEAE
Oxygonum dregeanum Meisn. subsp. *lanceolatum* Germish. [PRU: *SS 650*] [HL]
O. dregeanum Meisn. subsp. *swazicum* (Burtt Davy) Germish. [PRU: *SS 469*] [GH]
O. sinuatum (Hochst. & Steud. ex Meisn.) Dammer [PRU: *SS* & *FP 1553*] [CDHK]
Persicaria lapathifolia (L.) Gray* [PRE] [F]
Polygonum meisnerianum Cham. & Schltdl. [PRE] [L]
Rumex acetosella L. subsp. *angiocarpus* (Murb.) Murb.* [PRE] [L]
R. crispus L.* [PRE] [L]
R. dregeanus Meisn. subsp. *montanus* B.L. Burtt [PRE] [L]
R. lanceolatus Thunb. [PRE] [GH] •
R. sagittatus Thunb. [PRU: *AW* & *SS 13360*] [FL]

PORTULACACEAE
Portulaca kermesina N.E. Br. [PRU: *AW* & *SS 1413*] [BH]
P. oleracea L. [PRU: *MM 610*] [B]
P. quadrifida L. [PRU: *SS* & *FP 1557*] [BH]
Portulacaria afra Jacq. [PRE] [A]
Talinum arnotii Hook. f. [PRU: *AW* & *SS 1316*] [BG]
T. caffrum (Thunb.) Eckl. & Zeyh. [PRU: *SS 1137*] [FH]

PRIMULACEAE
Anagallis huttonii Harv. [PRU: *AW 13578*] [F]

PROTEACEAE
Faurea saligna Harv. [PRE] [FHJL] ♦
Protea caffra Meisn. subsp. *caffra* [PRU: *SS 32*] [FHJKL] [form] ∈
P. parvula Beard [PRE] [L]
P. roupelliae Meisn. subsp. *roupelliae* [PRU: *SS 825*] [FGHJL]
P. rubropilosa Beard [PRE] [L]
P. welwitschii Engl. [PRE] [L] ♦

PTAEROXYLACEAE
Ptaeroxylon obliquum (Thunb.) Radlk. [PRU: *AW* & *SS 13014*] [ABCF] •

RANUNCULACEAE
Clematis brachiata Thunb. [PRU: *SS 816*] [BFJL]
C. oweniae Harv. [PRE] [F]
Knowltonia transvaalensis Szyszyl. var. *transvaalensis* [PRE] [GH]
Ranunculus meyeri Harv. [PRU: *AW* & *SS 13459*] [F]
R. multifidus Forssk. [PRU: *SS 1127*] [DFGHL]

RHAMNACEAE
Berchemia zeyheri (Sond.) Grubov [PRE] [ABFHIJ]
Helinus integrifolius (Lam.) Kuntze [PRU: *SS 217*] [FJ]
Phylica paniculata Willd. [PRU: *SS 631*] [GHJ]
Rhamnus prinoides L'Hér. [PRU: *SS 626*] [FGHJ]
Ziziphus mucronata Willd. subsp. *mucronata* [PRU: *JK 104*] [BFGHIJL] • ♦

ROSACEAE
Alchemilla cryptantha Steud. [PRE] [L]
A. woodii Kuntze [PRE] [L]
Cliffortia linearifolia Eckl. & Zeyh. [PRE] [GHL]
Leucosidea sericea Eckl. & Zeyh. [PRU: *AW* & *SS 13367*] [FL]
Prunus africana (Hook. f.) Kalkman [PRU: *AW* & *SS 13337*] [F] •
Rosa eglanteria L.* [PRU: *AW* & *SS 1407*] [L]
Rubus ludwigii Eckl. & Zeyh. subsp. *ludwigii* [PRE] [IJL]
R. rigidus Sm. [PRU: *SS 811*] [J]

RUBIACEAE
Anthospermum rigidum Eckl. & Zeyh. subsp. *rigidum* [PRE] [FGH]
A. rigidum Eckl. & Zeyh. subsp. *pumilum* (Sond.) Puff [PRU: *SS 134*] [FHJ]
A. welwitschii Hiern [PRU: *AW* & *SS 13437*] [FHJK]
Canthium mundianum Cham. & Schltdl. [PRE] [JK]
C. suberosum Codd [PRU: *SS 164*] [FHJL]
Catunaregam spinosa (Thunb.) Tirveng. subsp. *spinosa* [PRE] [AB]
Cephalanthus natalensis Oliv. [PRE] [GHL]
Galium capense Thunb. subsp. *garipense* (Sond.) Puff [PRE] [F]
Galopina circaeoides Thunb. [PRU: *SS 813*] [J]
Gardenia volkensii K. Schum. subsp. *volkensii* var. *volkensii* [PRU: *SS 434*] [ABFH]
Hyperacanthus amoenus (Sims) Bridson [PRE] [F]
Kohautia amatymbica Eckl. & Zeyh. [PRU: *AW* & *SS 13371*] [K]
K. aspera (B. Heyne ex Roth) Bremek. [PRE] [B]
K. caespitosa Schnizl. subsp. *brachyloba* (Sond.) Mantell [PRU: *SS 198*] [J]
K. cynanchica DC. [PRU: *AW* & *SS 1366*] [BC]
K. subverticillata (K. Schum.) D. Mantell subsp. *subverticillata* [PRU: *SS* & *FP 1609*] [H]
K. virgata (Willd.) Bremek. [PRU: *SS 251*] [J]
Oldenlandia herbacea (L.) Roxb. var. *herbacea* [PRE] [CDJL]
Otiophora calycophylla (Sond.) Schltr. & K. Schum. subsp. *calycophylla* [PRE] [K]
O. cupheoides N.E. Br. [PRE] [E]
Pachystigma coeruleum Robyns [PRE] [GH]
P. macrocalyx (Sond.) Robyns [PRE] [F]
Pavetta eylesii S. Moore [PRU: *AW* & *SS 1347*] [FC]
P. gardeniifolia A. Rich. subsp. *subtomentosa* K. Schum. [PRE] [L]
P. inandensis Bremek. [PRU: *SS 297*] [FH]
P. lanceolata Eckl. [PRE] [GH]
P. schumanniana F. Hoffm. ex K. Schum. [PRE] [H]
P. zeyheri Sond. [PRU: *AW*, *SS* & *YS 1465*] [BEFGHJ] [form] ∈ **N LR**
Pentanisia angustifolia (Hochst.) Hochst. [PRE] [GHL]
P. prunelloides (Klotzsch ex Eckl. & Zeyh.) Walp. subsp. *prunelloides* [PRU: *AW* & *SS 1311*] [FGHJK] •
Plectroniella armata (K. Schum.) Robyns [PRU: *SS 1712*] [BEF]
Psydrax livida (Hiern) Bridson [PRU: *SS 1711*] [EI]
P. obovata (Eckl. & Zeyh.) Bridson subsp. *obovata* [PRU: *SS 165*] [HJ]
Pygmaeothamnus chamaedendrum (Kuntze) Robyns var. *chamaedendrum* [PRE] [K]
Rothmannia capensis Thunb. [PRU: *AW* & *SS 13335*] [F]
Rubia horrida (Thunb.) Puff [PRU: *SS 759*] [JK]
Spermacoce natalensis Hochst. [PRE] [GH]
S. senensis (Klotzsch) Hiern [PRU: *SS* & *FP 1564*] [H]
Tricalysia capensis (Meisn. ex Hochst.) Sim var. *galpinii* (Schinz) Robbr. [PRU: *MM 468*] [B]
Vangueria cyanescens Robyns [PRU: *SS 663*] [BFH]
V. infausta Burch. subsp. *infausta* [PRE] [BFGHJL]

RUTACEAE
Calodendrum capense (L.f.) Thunb. [PRU: *SS & FP 1607*] [CDFJ]
Clausena anisata (Willd.) Hook. f. ex Benth. [PRE] [HJ]
Thamnosma africana Engl. [PRU: *SS & FP 1562*] [FHIJK]
Vepris reflexa I. Verd. [PRU: *AW & SS 13023*] [BFGH]
Zanthoxylum capense (Thunb.) Harv. [PRE] [FHJL] •

SALVADORACEAE
Salvadora australis Schweick. [PRU: *MM 311*] [BF]

SANTALACEAE
Osyridicarpos schimperianus (Hochst. ex A. Rich.) A. DC. [PRE] [A]
Osyris lanceolata Hochst. & Steud. [PRU: *AW & SS 13425*] [AF]
O. quadripartita [PRE] [H]
Thesium burkei A.W. Hill [PRU: *SS 647*] [HJ]
T. costatum A.W. Hill var. *costatum* [PRU: *MM 403*] [B]
T. gracilarioides A.W. Hill [PRU: *SS 682*] [H]
T. gracilentum N.E. Br. [PRU: *SS 78*] [J] **K LR**
T. lesliei N.E. Br. [PRE] [JK]
T. magalismontanum Sond. [PRU: *SS 248*] [JL]
T. multiramulosum Pilg. [PRU: *AW & SS 12990*] [H] ∉
T. rogersii A.W. Hill [PRE] [K]

SAPINDACEAE
Allophylus melanocarpus (Sond.) Radlk. [PRE] [F]
A. transvaalensis Burtt Davy [PRU: *AW & SS 13434*] [EFHJL]
Cardiospermum corindum L. [PRU: *SS 204*] [BJ]
Dodonaea angustifolia L.f. [PRU: *SS 949*] [HJ] •
Hippobromus pauciflorus (L.f.) Radlk. [PRU: *JK 36*] [ABCDFGHJL]
Pappea capensis Eckl. & Zeyh. [PRE] [BDFHJ]

SAPOTACEAE
Englerophytum magalismontanum (Sond.) T.D. Penn. [PRE] [BDFGHL] ♦
Mimusops zeyheri Sond. [PRU: *AW, SS & YS 1470*] [ACEFGHJL]

SCROPHULARIACEAE
Alectra sessiliflora (Vahl.) Kuntze var. *sessiliflora* [*SS 782*] [IJL]
A. welwitschii (Hiern) Hemsl. [PRE] [F]
Aptosimum lineare Marloth & Engl. [*SS 290*] [BEFGHIJ] ♦
A. lugardiae (N.E. Br.) E. Phillips [*AW & SS 1328*] [G]
Bowkeria cymosa MacOwan [PRE] [L]
Buchnera glabrata Benth. [*SS 779*] [JEL]
Buttonia superba Oberm. [*SS 299*] [BEFH]
Craterostigma wilmsii Engl. ex Diels [*SS 792*] [JL]
Cycnium adonense E. Mey. ex Benth. subsp. *adonense* [PRE] [GH]
C. racemosum Benth. [PRE] [GH]
C. tubulosum (L.f.) Engl. [*AW & SS 13393*] [J]
Graderia linearifolia Codd [PRE] [L]
Halleria lucida L. [*SS 850*] [CDFGHJL]
Jamesbrittenia accrescens (Hiern) Hilliard [PRE] [HJ]
J. atropurpurea (Benth.) Hilliard subsp. *atropurpurea* [PRE] [ABF]
J. aurantiaca (Burch.) Hilliard [PRU: *AW & SS 13457*] [AFL]
J. burkeana (Benth.) Hilliard [*SS 237*] [HJ] ♦
J. huillana (Diels) Hilliard [*SS 616*] [F]

J. macrantha (Codd) Hilliard [*SS 184*] [DEFGHJK] ∈ **K LR**
J. macrantha (Codd) Hilliard [*AW, SS & YS 1664*] [J] [white form] ∈
J. montana (Diels) Hilliard [*AW & SS 13392*] [J]
J. silenoides (Hilliard) Hilliard [*AW & SS 1305*] [F] **N LR**
J. sp. nov. [*AW & SS 13310*] [H] ∈
Limosella maior Diels [*AW & SS 13446*] [F]
Linaria vulgaris Mill.* [PRE] [L]
Lindernia wilmsii (Engl. & Diels) Philcox [PRE] [GH]
Manulea parviflora Benth. var. *parviflora* [*AW & SS 1301*] [CDF]
M. rhodantha Hilliard subsp. *aurantiaca* Hilliard [PRE] [L]
Melanospermum transvaalense (Hiem) Hilliard [PRE] [L]
Melasma scabrum P.J. Bergius [PRE] [L]
Mimulus gracilis R. Br. [PRE] [K]
Nemesia zimbabwensis Rendle [*AW & SS 13454*] [F] **VU**
Peliostomum leucorrhizum E. Mey. ex Benth. [PRE] [B]
Phygelius aequalis Harv. ex Hiem [PRE] [GHL]
Striga asiatica (L.) Kuntze (red) [*AW & SS 13455*] [FJK]
S. asiatica (L.) Kuntze (yellow) [PRU: *SS 84*] [J]
S. bilabiata (Thunb.) Kuntze [PRU: *SS 840*] [BGHJKL]
S. elegans Benth. [PRU: *AW & SS 13386*] [HJ]
S. gesnerioides (Willd.) Vatke ex Engl. [PRE] [BCDGH] ♦
Sutera floribunda (Benth.) Kuntze [PRU: *AW & SS 13332*] [CDFL]
S. neglecta (J.M. Wood & M.S. Evans) Hiern [PRE] [L]
S. species [PRE] [AL]
Teedia lucida Rudolphi [PRE] [L]
Tetraselago wilmsii (Rolfe) Hilliard & B.L. Burtt [PRU: *SS 226*] [CDJKL]
Zaluzianskya elongata Hilliard & B.L. Burtt [PRU: *SS 797*] [J]

SELAGINACEAE
Hebenstretia angolensis Rolfe [PRE] [L]
H. dura Choisy [PRU: *AW & SS 13329*] [EF]
H. integrifolia L. [PRE] [L]
Selago capitellata Schltr. [PRE] [L]
S. glabrata Choisy [PRE] [GHL]
S. lydenburgensis Rolfe [PRU: *SS 795*] [JL]
S. muddii Rolfe [PRE] [E]
Walafrida densiflora (Rolfe) Rolfe [PRE] [CDL]

SIMAROUBACEAE
Kirkia acuminata Oliv. [PRE] [F]
K. wilmsii Engl. [PRU: *SS 429*] [ABCDEFGHIJ]

SOLANACEAE
Datura stramonium L.* [PRE] [BFJ]
Lycium cinereum Thunb. [PRU: *AW & SS 1367*] [BCEF]
Nicotiana glauca Graham* [PRU: *SS 1816*] [BE]
Physalis peruviana L.* [PRE] [F]
Solanum aculeatissimum Jacq. [PRU: *AW & SS 13361*] [F]
S. coccineum Jacq. [PRU: *AW, SS & YS 1451*] [BEFH]
S. incanum L. [PRU: *AW & SS 13013*] [EFHJ] [form] ∉
S. kwebense N.E. Br. [PRU: *SS 1707*] [AEF]
S. leucophaeum Dunal [PRE] [FH]
S. nigrum L.* [PRU: *AW, SS & YS 1456*] [EF] ♦
S. panduriforme E. Mey. [PRU: *SS 264*] [BFHJ]

S. retroflexum Dunal [PRE] [K]
S. rigescens Jacq. [PRE] [L]
S. tomentosum L. [PRE] [E]
Withania somnifera (L.) Dunal [PRU: *AW, SS & YS 1444*] [FK] •

STERCULIACEAE
Dombeya autumnalis I. Verd. [PRU: *MM 83*] [ABE] ∉ **LR**
D. pulchra N.E. Br. [PRU: *SS 166*] [J]
D. rotundifolia (Hochst.) Planch. var. *rotundifolia* [PRE] [BDFHJL] • ♦
Hermannia antonii Verdoorn [PRU: *AW & SS 12981*] [HJ] ∉
H. boraginiflora Hook. [PRU: *AW & SS 12995*] [EH]
H. cristata Bolus [PRU: *AW & SS 13409*] [JK]
H. floribunda Harv. [PRU: *SS 372*] [CHJ]
H. glanduligera K. Schum. [PRU: *SS 360*] [ABH]
H. lancifolia Szyszyl. [PRE] [JL]
H. modesta (Ehrenb.) Mast. [PRU: *MM 974*] [B]
H. montana N.E. Br. [PRE] [L]
H. species [PRE] [ABFL]
H. staurostemon K. Schum. [PRU: *AW & SS 13309*] [GHL]
H. transvaalensis Schinz [PRE] [L]
Melhania acuminata Mast. var. *acuminata* [PRU: *SS 410*] [BDHJ]
M. acuminata Mast. var. *agnosta* (K. Schum.) Wild [PRU: *SS 289*] [H]
M. burchellii DC. [PRU: *SS 357*] [BH]
M. forbesii Planch. ex Mast. [PRU: *SS 348*] [AH] ♦
M. prostrata DC. [PRU: *SS 213*] [AHJ]
M. randii Baker f. [PRU: *SS 46*] [JK] [form] ∈ **K VU**
M. rehmannii Szyszyl. [PRU: *SS 312*] [BCEGH]
M. transvaalensis Szyszyl. [PRE] [A]
M. virescens (K. Schum.) K. Schum. [PRU: *MM 433*] [BF]
Sterculia rogersii N.E. Br. [PRU: *SS 1132*] [ABEFH]
Waltheria indica L. [PRU: *SS 291*] [BEHJ]

THYMELAEACEAE
Dais cotinifolia L. [PRE] [GH]
Gnidia caffra (Meisn.) Gilg [PRU: *AW & SS 12975*] [GHJL] [form] ∈
G. canoargentea (C.H. Wright) Gilg [PRE] [L]
G. capitata L.f. [PRU: *AW & SS 13395*] [GHJKL] ♦
G. gymnostachya (C.A. Mey.) Gilg [PRE] [GHKL]
G. polycephala (C.A. Mey.) Gilg [PRU: *SS 1697*] [ABE]
G. splendens Meisn. [PRE] [AEL]
G. variabilis (C.H. Wright) E. Phillips [PRU: *SS 229*] [JL]
Peddiea africana Harv. [PRE] [E]

TILIACEAE
Corchorus asplenifolius Burch. [PRU: *AW & SS 13416*] [BEHJ] ♦
C. confusus Wild [PRU: *AW & SS 1323*] [G]
C. tridens L.* [PRU: *SS & FP 1521*] [FH]
Grewia bicolor Juss. [PRU: *SS 330*] [BGHI]
G. caffra Meisn. [PRE] [B]
G. flava DC. [PRU: *SS 1136*] [BCDFGHJ]
G. flavescens Juss. var. *flavescens* [PRU: *SS 942*] [BCDEFGJ]
G. hexamita Burret [PRU: *SS 948*] [GI]
G. monticola Sond. [PRE] [BFHIJ]
G. occidentalis L. [PRU: *SS 258*] [FGHJL]

G. species [PRE] [ABF]
G. subspathulata N.E. Br. [PRU: *MM 336*] [ABF]
G. tenax (Forssk.) Fiori [PRE] [CD]
G. verrucosa Schinz [PRU: *SS 81*] [ABCDEFHIJKL] ∉
G. villosa Willd. [PRU: *SS 943*] [GH]
Triumfetta obtusicornis Spraque & Hutch. [PRE] [L]
T. pentandra A. Rich. [PRE] [K]
T. pilosa Roth var. *tomentosa* Szyszyl. ex Spraque & Hutch. [PRU: *SS 236*] [FJ]
T. sonderi Ficalho & Hiern [PRU: *SS 119*] [CDJK]

TURNERACEAE
Piriqueta capensis (Harv.) Urb. [PRU: *SS 684*] [H]
Tricliceras glanduliferum (Klotzsch) R. Fern. [PRU: *SS 655*] [H]

ULMACEAE
Celtis africana Burm. f. [PRE] [FHJL]
Chaetacme aristata Planch. [PRU: *AW & SS 13055*] [FH]

URTICACEAE
Laportea peduncularis (Wedd.) Chew subsp. *peduncularis* [PRU: *AW & SS 13339*] [F]
Obetia tenax (N.E. Br.) Friis [PRE] [ABFJ]
Pouzolzia mixta Solms [PRU: *SS 668*] [BDFHJ]
Urtica lobulata E. Mey. ex Blume [PRU: *AW & SS 13451*] [F]

VERBENACEAE
Chascanum hederaceum (Sond.) Moldenke var. *hederaceum* [PRE] [A]
C. hederaceum (Sond.) Moldenke var. *natalense* (H. Pearson) Moldenke [PRE] [E]
C. incisum (H. Pearson) Moldenke [PRU: *AW & SS 13418*] [EH]
C. pinnatifidum (L.f.) E. Mey. var. *pinnatifidum* [PRU: *SS 249*] [J]
Clerodendrum glabrum E. Mey. var. *glabrum* [PRU: *SS & FP 1519*] [BFHJ]
C. louwalbertsii P.P.J. Herman [PRU: *SS 473*] [GHJ]
C. myricoides (Hochst.) Vatke [PRU: *SS 402*] [BCJK] ♦
C. suffruticosum Gürke [PRU: *SS & FP 1563*] [CH] [form] ∉
C. suffruticosum Gürke var. *suffruticosum* [PRU: *AW & SS 1352*] [ABC]
C. ternatum Schinz [PRU: *AW & SS 13047*] [ABDEHL]
C. triphyllum (Harv.) H. Pearson var. *triphyllum* [PRE] [GHJ]
Karomia speciosa (Hutch. & Corbishley) R. Fern. forma *speciosa* [PRU: *SS 376*] [ABFGHL]
Lantana rugosa Thunb. [PRU: *SS 47*] [BFHJL]
Lippia javanica (Burm. f.) Spreng. [PRU: PRU: *SS 175*] [FHJL] • ♦
L. rehmannii H. Pearson [PRU: *SS 50*] [HJL]
L. wilmsii H. Pearson [PRE] [GH] ♦
Premna mooiensis (H. Pearson) W. Piep. [PRU: *AW & SS 13004*] [CFH] [form] ∈
Priva cordifolia (L.f.) Druce var. *abyssinica* (Jaub. & Spach) Moldenke [PRE] [I]
P. meyeri Jaub. & Spach var. *meyeri* [*AW & SS 1348*] [C]
Verbena bonariensis L.* [PRU: *AW & SS 13373*] [GHKL]
V. venosa Gillies & Hook.* [PRE] [L]
Vitex obovata E. Mey. subsp. *wilmsii* (Gürke) C.L. Bredenkamp & D.J. Botha [PRU: *AW & SS 13406*] [BDFGHIJKL] ∉
V. patula E.A. Bruce [PRE] [A]
V. rehmannii Gürke [PRU: *MM 474*] [ABCDK]
V. zeyheri Sond. ex Schauer [PRE] [F]

VIOLACEAE
Hybanthus enneaspermus (L.) F. Muell. [PRE] [BJ]

VISCACEAE

Viscum capense L.f. subsp. *capense* [PRU: *AW* & *SS 12969*] [J] •
V. combreticola Engl. [PRE] [CD]
V. rotundifolium L.f. [PRU: *SS 804*] [ABJ]
V. verrucosum Harv. [PRE] [ACD]

VITACEAE

Cissus quadrangularis L. [PRU: *AW, SS* & *ER 13191*] [BFG]
Cyphostemma humile (N.E. Br.) Desc. ex Wild & R.B. Drumm. subsp. *dolichopus* (C.A. Sm.) Wild & R.B. Drumm. [PRE] [FGHKL] ♦
C. lanigerum (Harv.) Desc. ex Wild & R.B. Drumm. [PRE] [K]
C. oleraceum (Bolus) J.J.M. van der Merwe [PRU: *AW* & *SS 1343*] [CHJ]
C. puberulum (C.A. Sm.) Wild & R.B. Drumm. [PRU: *SS 365*] [ABJ]
C. segmentatum (C.A. Sm.) J.J.M. van der Merwe [PRE] [B]
C. sp. nov. A [*SS 1383*] [EFHJ] ∈
C. sp. nov. B [*AW 13389*] [HJ] ∈
C. sp. nov. C [*GD 4142*] [IK] ∈
C. spinosopilosum (Gilg & M. Brandt) Desc. [PRU: *RS 2818*] [IKL]
C. subciliatum (Baker) Desc. ex Wild & R.B. Drumm. [PRE] [I]
C. sulcatum (C.A. Sm.) J.J.M. van der Merwe [PRU: *AW* & *SS 1352*] [BCF]
C. woodii (Gilg & M. Brandt) Desc. [PRU: *SS 1150*] [ABFJ]
Rhoicissus rhomboidea (E. Mey. ex Harv.) Planch. [PRU: *AW* & *SS 13363*] [F]
R. sekhukhuniensis Retief, Siebert & Van Wyk [PRU: *SS 304*] [CDFHJ] ∈ **LR**
R. sp. nov. [PRU: *SS 48*] [HJ] ∈
R. tomentosa (Lam.) Wild & R.B. Drumm. [PRU: *AW, SS* & *ER 13199*] [BDFHJ] •
R. tridentata (L.f.) Wild & Drum. subsp. *cuneifolia* (Eckl. & Zeyh.) Urton [PRU: *AW* & *SS 12976*] [BCDEFGHJKL] • ♦

ZYGOPHYLLACEAE

Tribulus terrestris L. [PRE] [B]
T. zeyheri Sond. subsp. *zeyheri* [*AW* & *SS 1370*] [C]
