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ASPECTS OF THE SYNTAXONOMY AND SYNECOLOGY OF THE GRASSLANDS OF SOUTHERN KWAZULU-NATAL

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Aspects of the syntaxonomy and synecology of the grasslands of southern KwaZulu-Natal

by

Luke Perkins

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Submitted in partial fulfilment of the requirements
for the degree

MAGISTER SCIENTIAE (WILDLIFE MANAGEMENT)

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Pretoria

Supervisor: Prof. G.J. BREDENKAMP
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"You must not arouse a rain bull, but you must make a she-rain, which is not angry, which rains gently, because it is a slow shower. It is one that falls gently, softening the ground so that it may be wet inside the earth. For people are afraid of a he-rain, when they hear it come thundering, as it gets its legs."

- //Kabbo, a San Rainmaker (trans.) (Bleek & Lloyd 1911).

"...enriched with ancient woods and dear dutchy deeplinns mid which were an old knoll and a troutbeck..."

- James Joyce, *Finnegans Wake*.

ABSTRACT

**Aspects of the
syntaxonomy and synecology
of the grasslands of southern KwaZulu-Natal**

by

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MAGISTER SCIENTIAE (WILDLIFE MANAGEMENT)

The Grassland biome of South Africa is of major importance to this country's agriculture, mining and conservation practices. The extent of urbanisation and economic activity within this biome has led to the destruction or alteration of large areas of it, and concerns over this have led to the formation of a Grasslands Biome Project. A primary objective of the project is to improve our understanding of the workings of grassland systems, so that land use planning and conservation practices can be facilitated.

The identification and description of major vegetation types and subtypes in the grasslands of southern KwaZulu-Natal forms part of this study. A total of 547 sample plots were randomly distributed over an area of 14 000 km² between Estcourt and the Eastern Cape border. Stratification was based on Turner's Physiographic Regions (1967), Phillips' Bioclimatic Subregions (1973), and terrain units. The vegetation was classified by means of TWINSPAN and Braun-Blanquet procedures. Altogether 27 plant communities and 41 sub-communities were identified, described phytosociologically and ecologically interpreted. The diversity of these grassland communities was compared to that of grasslands in other parts of the country, and their conservation status was assessed in terms of land utilisation, endemism and biodiversity.

UITTREKSEL

**Aspekte van die
sintaksonomie en sinekologie
van die grasvelde van suiderlike KwaZulu-Natal**

deur

Luke Perkins

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MAGISTER SCIENTIAE (NATUURLEWEBESTUUR)

Die grasveldbioom van Suid-Afrika is van groot belang vir die land se mynbou, landbou en natuurbewaring. Verstedeliking en ekonomiese bedryf binne dié bioom het tot die vernietiging of verandering van groot gedeeltes daarvan gelei, en bekommernis hieroor het tot die vorming van 'n Grasveldbioomprojek gelei. 'n Primêre doel van die projek is om die mens se begrip van die funksionering van grasveldsisteme te verbeter, sodat landgebruikbeplanning en natuurbewaring kan geskied.

Die identifikasie en beskrywing van hoof plantegroeitipes in die grasveld van suidelike KwaZulu-Natal vorm 'n deel van die huidige studie. 'n Totaal van 547 monsterpersele is ewekansig oor 'n gebied van 14 000 km² tussen Estcourt en die Ooskaap grens uitgeplaas. Stratifisering is gebaseer op Turner se Fisiografiese Eenhede (1967), Phillips se Bioklimatiese Subeenhede (1973), en terreineenhede. Die plantegroei is deur middel van TWINSPAN en Braun-Blanquet-prosedures geklassifiseer. 'n Totaal van 27 plantgemeenskappe en 41 subgemeenskappe is geidentifiseer, beskryf en ekologies geïnterpreteer. Die diversiteit van hierdie grasveldgemeenskappe is vergelyk met die van grasvelde in ander dele van die land, en hulle bewaringsstatus is geanaliseer in terme van benutting, endemisme en biodiversitiet.

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TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER 2

CHAPTER 3

CHAPTER 4

CHAPTER 5

CHAPTER 6

CHAPTER 7

CHAPTER 8

CHAPTER 9

LIST OF TABLES

CHAPTER 1

INTRODUCTION

The Grassland Biome of South Africa covers about 27% (333 942 km ²) of the surface area of the country (Low & Rebelo 1996). Major crops grown within this biome include maize, wheat, sorghum and sunflowers. Grassland areas are also the focus of dairy, beef and wool production in South Africa (Rutherford & Westfall 1986). Natural grasslands are threatened not only by such agriculture but by urbanisation and other economic activities. The Grassland Biome is the site of major urbanisation centres of the country, including Gauteng, Bloemfontein and Pietermaritzburg. Large coal deposits lie beneath the surface of the biome, especially in northern KwaZulu-Natal, Mpumalanga and parts of the Free State, and coal-mining and associated industry have destroyed much grassland in these parts (Ledger 1991). Gold, aluminium, diamond and uranium mining also take place largely in the Grassland Biome (Eckhardt 1993). In other areas, grasslands have been destroyed and are threatened by exotic afforestation (Cooper 1991; Huntley, Siegfried & Sunter 1989).

The Grassland Biome has a high biodiversity; in South Africa only the Fynbos Biome is more diverse (Low & Rebelo 1996). The remaining grasslands are seen as important national genetic resources in which a wide variety of medicinal plants and rare plant species occur. The value of many grassland plant species in medicine and nutrition is becoming increasingly apparent worldwide (Chrispeels & Sadava 1994) and the value of many species is yet to be realised (Ledger 1991). Many plant species become extinct even before they are described by science (Hall, de Winter, de Winter & van Oosterhout 1980). In addition many of these grassland areas can be used for recreation (Ledger 1991).

A further threat to South African grasslands is periodic drought, the effect of which on the country's vegetation is aggravated by the activities of man (Tainton 1981). Mismanagement of the land and the influence of droughts have interacted to seriously affect the vegetation cover and species composition (Eckhardt 1993). The deterioration of the Grassland Biome has been noted for some time (Acocks 1988; Tainton 1981), and is apparent in the reduction in number

and vigour of palatable food plants, an increase in the proportion of less palatable and less nutritious plants, and a decrease in the absolute vegetation cover with a subsequent increase in soil erosion (Phillips 1973).

The Grassland Biome Project was launched in response to growing concerns about the state of the remaining grasslands (Mentis & Huntley 1982). The main objective of this project is to develop a better understanding and knowledge of the grassland structure and functioning to permit efficient land use planning, utilisation, conservation and management (Mentis & Huntley 1982). The vegetation classifications produced by Acocks (1988) and Low & Rebelo (1996) are insufficient for detailed investigation, and management planning, of one biome. The veld types outlined by Acocks (1988) provide a useful basis for the Grassland Biome Project, and at the same time need refining. Therefore a more detailed identification, description and mapping of the grassland types is required (Scheepers 1986). To this end, a considerable body of publications and theses concerning different parts of the Grassland Biome have been produced (e.g. Van Wyk & Bredenkamp 1986; Bezuidenhout 1988; Bredenkamp, Joubert & Bezuidenhout 1989; Turner 1989; Kooij 1990; Du Preez & Bredenkamp 1991; Matthews 1991; Smit 1992; Eckhardt 1993).

The portion of the KwaZulu-Natal grasslands south of Estcourt were identified as one area where insufficient phytosociological data existed. This area was therefore selected for a syntaxonomic and synecological study to further the ends of the Grassland Biome Project. The results of this study should be of use in land use planning and conservation in southern KwaZulu-Natal. The identification of areas suitable for conservation was also undertaken. The Department of Environment Affairs considers such identification important for ensuring the preservation of genetic resources and the diversity of species (Department of Environment Affairs 1988).

CHAPTER 2

THE PHYSICAL ENVIRONMENT OF THE STUDY AREA

The study area is situated in southern KwaZulu-Natal, between Estcourt and the KwaZulu-Natal - Eastern Cape border. The northern boundary is 29° 00' latitude, the southern boundary the Eastern Cape (former Transkei) border, the western boundary is the *Themeda-Festuca* Alpine Veld (Veld Type 58) of Acocks (1988) of the high Drakensberg, and the eastern boundary is the irregular transition area between grassland and other veld types (mainly valley bushveld (Acocks 1988) (Figure 1). The enclave of the Eastern Cape (formerly Transkei) within KwaZulu-Natal was included in the study area. The whole study area covers approximately 14 400 km² and includes large areas under conservation management, large areas of commercial farm land, much afforestation, and parts of the former Homelands of KwaZulu and Transkei, where subsistence agriculture is chiefly practised.

GEOLOGY

The nomenclature of the South African Committee for Stratigraphy (SACS) (1980) is followed in the description of the geology of the study area. Most of this geology comprises sedimentary strata.

THE KAROO SEQUENCE

Rock strata derived from the Karoo Sequence cover most of the study area. The Karoo Sequence is widespread in South Africa, covering roughly half the country (Du Toit 1954). They occur especially in the southern and eastern parts of the country (Visser 1984). The Karoo rocks were laid down largely by sedimentation, with the earliest deposits resulting from glacial action. Subsequent strata were deposited under continental fluvial and deltaic conditions. The Drakensberg Basalt Formation contains the youngest rocks in the Karoo Sequence and resulted from volcanic action. Extensive dolerite intrusion into all the Karoo

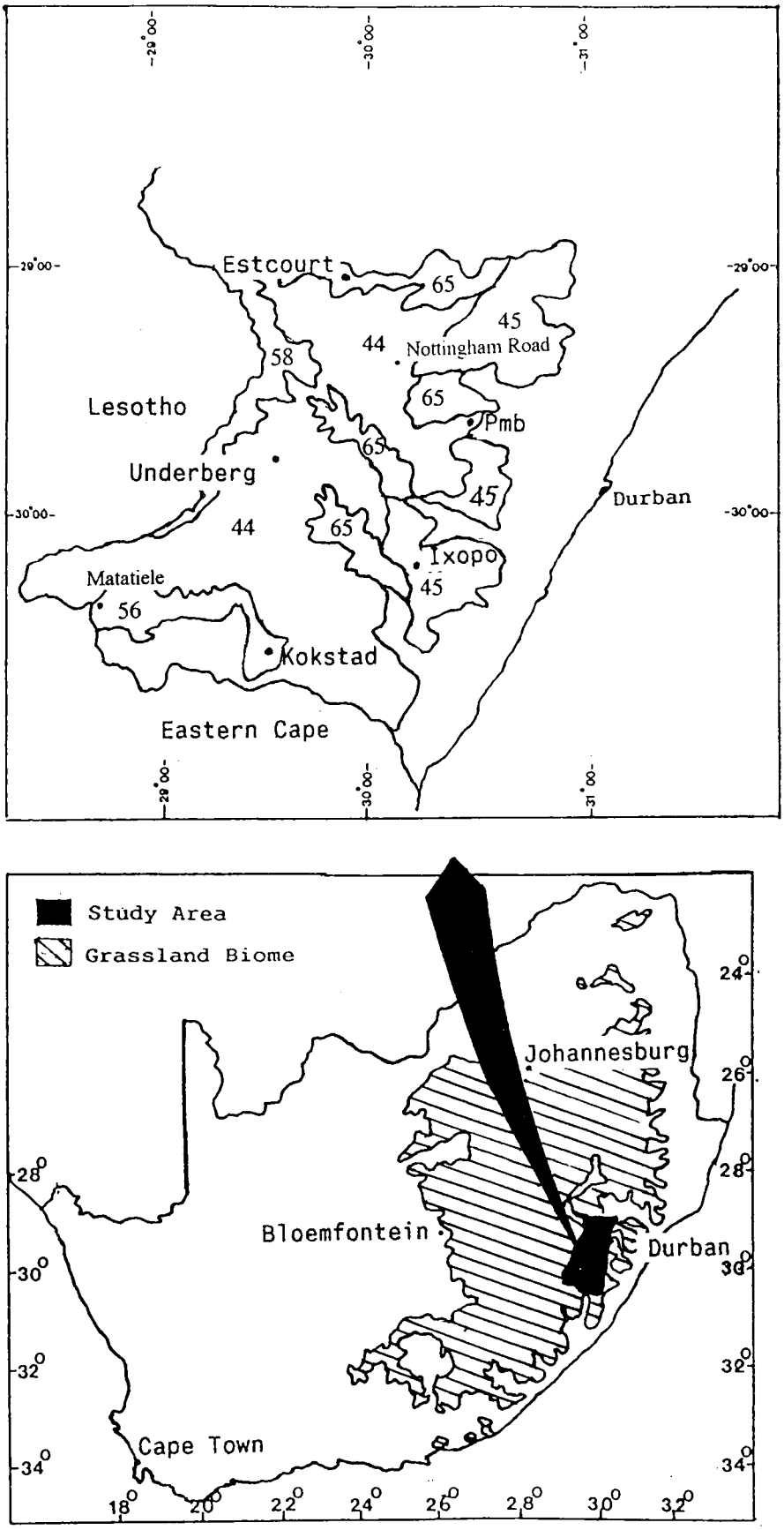


Figure 1. Location of the study area within the Grassland Biome, and the distribution of Acocks' Veld Types within and adjacent to the study area. 44 = Highland Sourveld, 45 = Mist Belt 'Ngongoni Veld, 56 = Highland Sourveld to *Cymbopogon* - *Themeda* Veld Transition, 58 = *Themeda* - *Festuca* Alpine Veld, 65 = Southern Tall Grassveld (after Acocks 1988).

strata accompanied this period of volcanic activity (Du Toit 1954; SACS 1980). Three groups are recognised in the Karoo Sequence: the Ecca, Beaufort and Stormberg groups. The Dwyka formation, which is not included in any of the above groups, is also present in parts of the study area.

The Dwyka Formation

The Dwyka formation is a glacial deposit, dating from the Carboniferous Period about 345 million years ago, and consisting of tillite. The rock is composed of a clayey blue or green matrix, in which other rock fragments are embedded. These fragments were collected by glacial movement and vary in size from pebbles to large rocks (Du Toit 1954). The Dwyka formation is found only in a narrow band running north and south through Pietermaritzburg; in the rest of the study area, rocks of the Ecca Group overlie the Dwyka formation.

THE ECCA GROUP

The Ecca Group is well represented in the study area by the Volksrust formation, with smaller areas being covered by the Vryheid and Pietermaritzburg formations. The rocks of the Ecca Group were laid down during the Carboniferous and Permian Periods.

The Pietermaritzburg Formation

This is the oldest formation of the Ecca Group, and consists of dark grey shales. In the study area, the Pietermaritzburg Group lies in a band west of the Dwyka formation, extending north-east to south-west. It does not cover a large part of the study area, being overlain by other rocks of the Ecca and other groups in most of the study area.

The Vryheid Formation

This formation is composed of bands of medium-grained buff sandstone alternating with bands of grey shales and mudstones. Coal seams are also present since this formation was deposited

during the Carboniferous Period (Du Toit 1954). Deltaic conditions are thought to have been associated with this rock deposition (Du Toit 1954).

The Volksrust Formation

This is the youngest formation of the Ecca Group, overlying the preceding formations. The Volkrust Formation contains dark grey shales which are interspersed with sandstone horizons. In the study area, it is exposed in extensive patches in the KwaZulu-Natal midlands, and in parts of East Griqualand.

THE BEAUFORT GROUP

Rocks of the Beaufort Group were deposited during the Permian and Triassic periods, and overly much of the Ecca Group strata. In the study area, the Beaufort Group is strongly represented by the Estcourt and Tarkastad Formations, and to a lesser extent by the Adelaide Formation.

The Estcourt Formation

This is the oldest formation of the Beaufort Group, consisting of carbonaceous dark grey shales, siltstones, and sandstones. Thin coal seams also occur (SACS 1980). This formation is frequently exposed in the KwaZulu-Natal midlands.

The Adelaide Formation

This formation is exposed to a lesser extent than the Estcourt Formation, and consists of grey and reddish-brown mudstone and fine-grained sandstone. It is exposed in the southern part of the KwaZulu-Natal midlands and parts of East Griqualand.

The Tarkastad Formation

This formation consists of fine to medium-grained sandstone, and blue and green mudstone. It is widely exposed in a broad band running north to south through the study area, from Estcourt south to East Griqualand. It is an important parent material in that it is found in much of the good agricultural land and in conservation areas supporting diverse grasslands. The Tarkastad sandstone forms a complex mosaic with dolerite which intruded during the Jurassic Period into much of the Tarkastad Formation. The dolerites also support highly productive agricultural lands and grasslands from near Estcourt south to East Griqualand and from the Little 'Berg east to Pietermaritzburg and Greytown.

THE STORMBERG GROUP

The Stormberg Group was deposited above the Beaufort Group, during the Jurassic and Triassic Periods. Rocks of the Stormberg Group occur in the west of the study area, giving rise to the Little 'Berg and High Berg and largely occuring in conservation areas. Of the four formations in the Stormberg Group, the Drakensberg Formation of basaltic lava lies west of the study area and was specifically excluded from the present study as it supports alpine as opposed to grassland vegetation (Acocks 1988). The other three formations occur in relatively narrow bands west of the Tarkastad Formation.

The Molteno Formation

This formation occurs in a very narrow band at the foot of the Little 'Berg, and consists of coarse-grained blue-grey sandstones with thin grit beds, green, grey and maroon mudstones, and also carbon-rich beds (Department of Mineral and Energy Affairs 1981; Irwin & Irwin 1992).

The Elliot Formation

Formerly called the Red Beds, the Elliot Formation contains maroon, green and blue-grey

mudstones and fine to medium-grained sandstones. It is exposed primarily in the steep slopes below the Little 'Berg cliffs.

The Clarens Formation

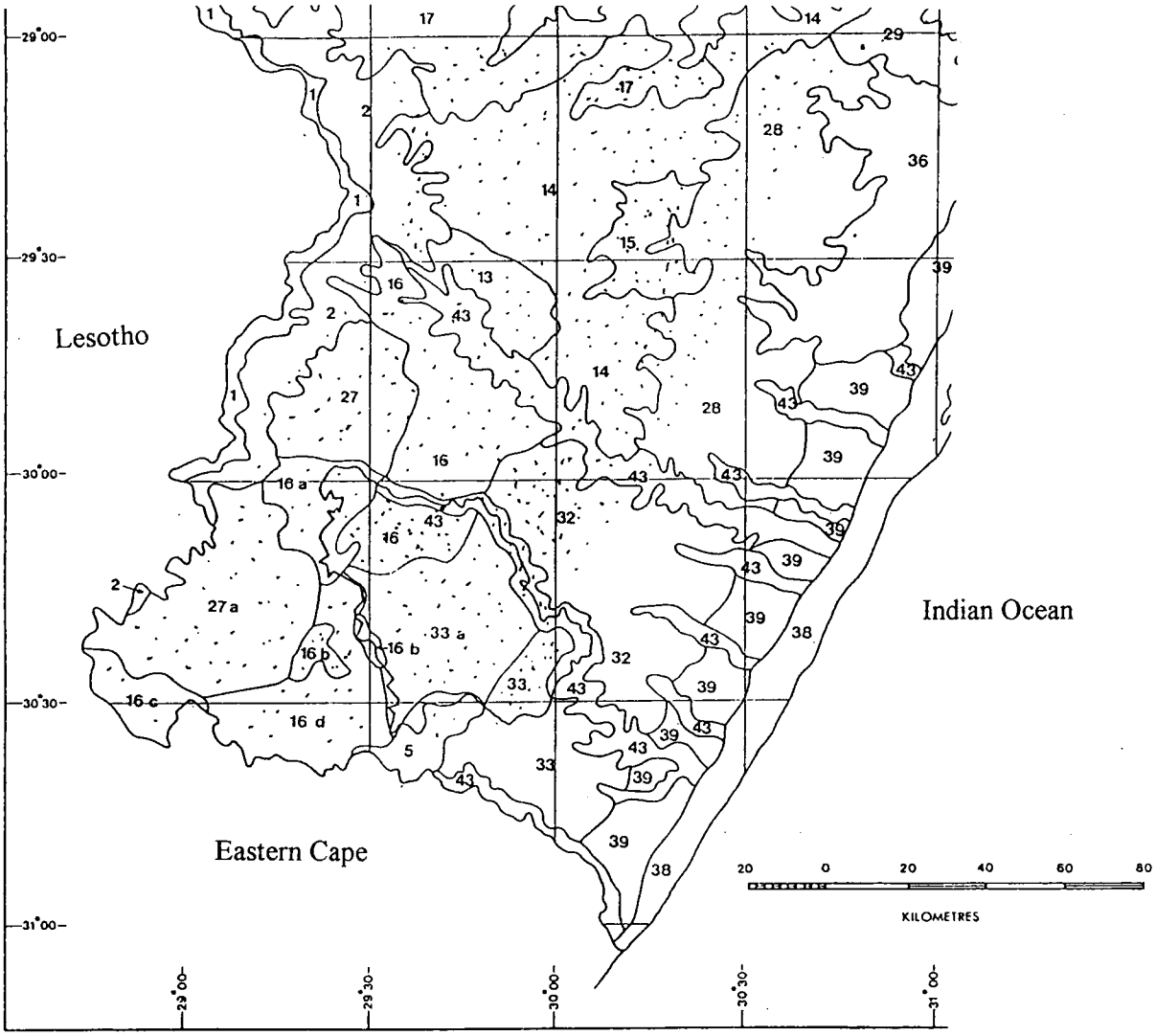
This is the westernmost geological formation in the study area, and lies above the Elliot Formation. It consists of yellow to light red fine-grained sandstone, and is thought to have been an aeolian deposition (SACS 1980). It forms the prominent cliffs of the Little 'Berg and is relatively erodable, giving rise to frequent overhangs and caves, hence its former name of Cave Sandstone.

PHYSIOGRAPHY

The physiography of an area is a description of the topography and drainage of that area, and may be used for stratification purposes (Strahler & Strahler 1987). Stratification of KwaZulu-Natal for ecological research has frequently made use of the concepts of Physiographic Regions (Turner 1967) and Bioclimatic Subregions (Phillips 1973) (e.g. Grimsdell & Raw 1984; MacDonald & Jarman 1985; Begg 1986; Eckhardt, Van Rooyen & Bredenkamp 1996). The Physiographic Regions (Turner 1967) are presented in Figure 2 and the Bioclimatic Subregions (Phillips 1973) in Figure 3.

TOPOGRAPHY

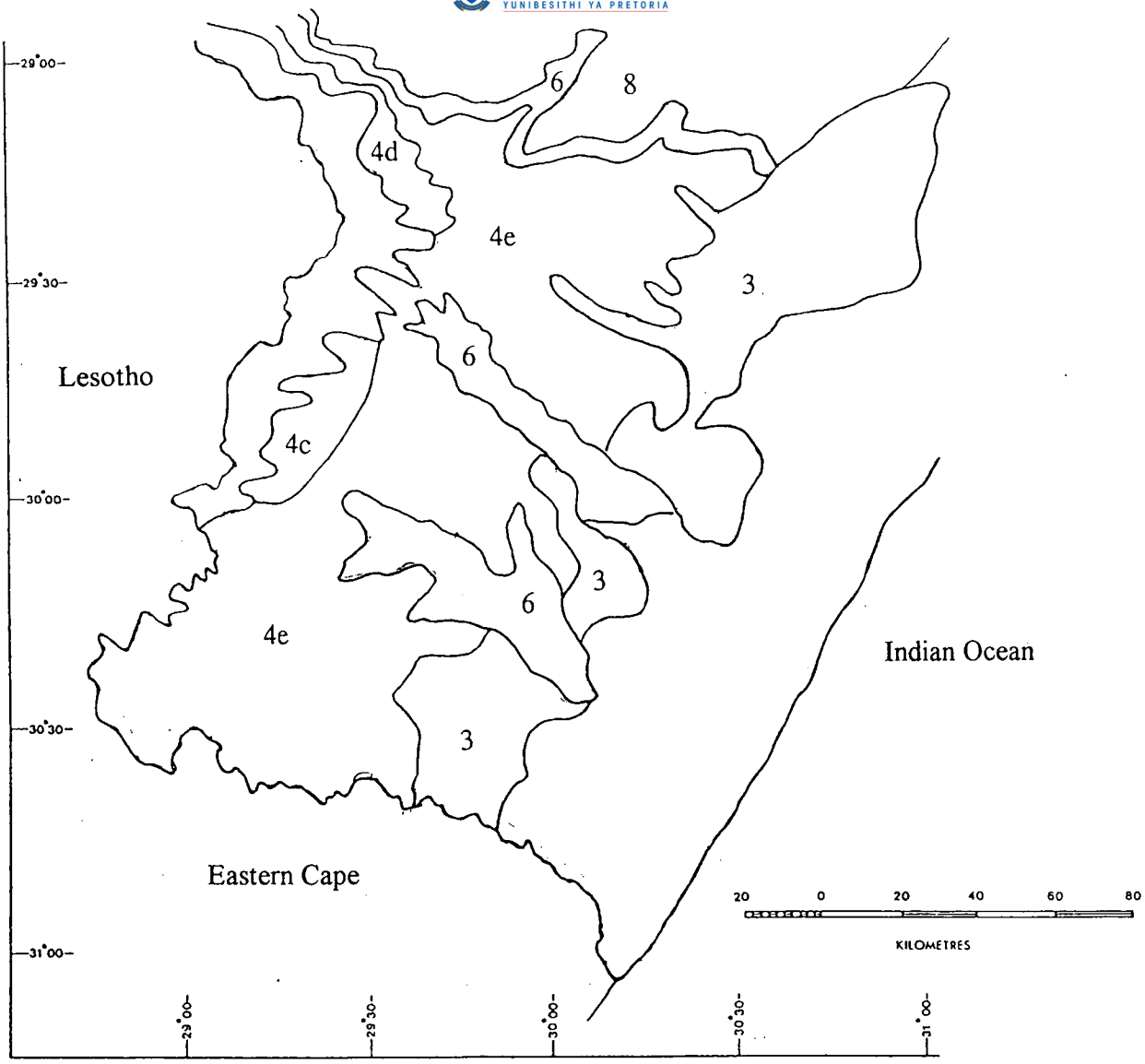
The study area is bordered in the west by the Lesotho Plateau and High Drakensberg Escarpment which has an elevation of 2500 - 3300 m (Turner 1967). The northernmost area of the Drakensberg in the study area is in the vicinity of Monk's Cowl from where the escarpment follows a south-easterly direction to Giant's Castle and then turns back to the south-west, decreasing in altitude as it approaches the Free State - Eastern Cape border. The Eastern Cape border forms the southern boundary of the study area. The Drakensberg Lavas, which erupted extrusively and flowed on top of the Stormberg Group during the Jurassic Period, have been eroded back to form the present escarpment. The Basa'tic erosion exposes



Legend

1 = Lesotho Plateau & High Drakensberg Escarpment
2 = Spurs & Foothills of the High Drakensberg (the "Little Berg")
13 = Imphendle Block
14 = Natal Midlands
15 = Howick Benchland
16 = Bulwer Block
16a = Swartberg Block
16b = Kokstad Block
16c = Matatiele Block
16d = East Griqualand Uplands
17 = Winterton - Estcourt - Muden Plain
27 = Underberg - Himeville Plain
27a = East Griqualand Plains
28 = Greytown - Pietermaritzburg - Richmond Benchland
29 = Kranskop Divide
32 = Ixopo - Highflats Benchland
33 = Harding Benchland
33a = Umzimkulu Benchland
43 = Incised River Valleys

Figure 2. Physiographic Regions within and adjacent to the study area (stippled) (After Turner 1967 and Schulze 1982).



Legend

3 = Mistbelt

4c = Highland Montane (Open Grassland to Wooded Savanna to Forest, Sub-Montane and Highland)

4d = Montane Protea Savanna

4e = Highland Montane (Open Grassland to Wooded Savanna)

6 = Open Grassland to Wooded Savanna (Moister Faciation)

8 = Open Grassland to Wooded Savanna (Drier Faciation)

Figure 3. Bioclimatic Subregions within and adjacent to the study area (after Phillips, 1973).

the softer Clarens Formation which erodes rapidly to form deep valleys and gorges (Irwin & Irwin 1992). Continental uplift has accompanied the Basaltic and Clarens erosion and also contributed to forming the present landscape. This landscape includes deeply incized valleys separated by spurs leading east, north-east and south-east from the high plateau. The slope gradient decreases to the east, as the landscape becomes less abrupt and more undulating; rolling hills being the dominant feature of the KwaZulu-Natal Midlands. The spurs and foothills of the Little 'Berg reach an altitude of 1700 - 2100 m, while the KwaZulu-Natal Midlands have an altitude of typically 1200 - 1650 m (Turner 1967). The landscape becomes terraced between the Little 'Berg and the Indian Ocean, a step-wise loss in altitude having resulted from continental uplift in gradual stages during the Caenozoic and Quaternary stages (King 1972; Irwin & Irwin 1992).

In places, the Drakensberg Lavas have resisted weathering and resulted in "outliers" of the African landsurface. These mesas or buttes are separated from the main escarpment by headwater valleys (e.g. of the Mooi and Mkomazi Rivers), and include the Imphendle Block and the Bulwer Block (Turner 1967). The latter area incorporates the Mahwaqa Mountain which rises to 2689 m above sea level.

DRAINAGE

A large number of streams and rivers originate in the High Drakensberg Plateau and flow eastwards through the valleys of the Little 'Berg. Some of these, such as the eNjesuthi, are tributaries of the Tugela system, the largest river in KwaZulu-Natal, while others flow into the Bushmans River, the Mooi River, the Mgeni River, the Mkomazi River, and the Mzimkulu River. The latter two rivers are the two largest which flow through the study area, and have contributed to the formation of the deep Mkomazi and Mzimkulu valleys. These two valleys are only about 200 - 500 m above sea level; this low altitude having a marked effect on the vegetation cover (Acocks 1988). All the water flowing east from the High Drakensberg Plateau eventually drains into the Indian Ocean.

PHYSIOGRAPHIC REGIONS

The Physiographic Regions of KwaZulu-Natal were proposed by Turner (1967). Subsequently, East Griqualand was incorporated into KwaZulu-Natal in 1978 and Schulze (1982) updated and modified Turner's (1967) regions. The Physiographic Regions occurring in the present study are presented in Figure 2. Turner's (1967) numbering of the regions is retained here. Those regions occurring in the present study area are briefly described below.

2. **The Spurs and Foothills of the High Drakensberg** (the "Little 'Berg") reach an elevation of 1 700 to 2 100 m above sea level. This region is deeply dissected by streams and river valleys and in many places abrupt cliffs of aeolian Clarens formation sandstone are found (Schulze 1982). The difference between north and south aspect is enhanced here by the steep gradients of many of the valleys. In most places the basaltic lavas of the Stormberg series have been eroded away (Turner 1967). The soils are yellow and red apedal, dystrophic and freely-drained, with Clovelly and Mispah forms predominating (Fitzpatrick 1978). The annual average precipitation is from 1 200 to 1 600 mm (Schulze 1982). This Physiographic Region is divided into the Montane Fynbos (5b), Montane Protea Savanna (4d), and Sub-Montane and Highland Open Grassland to Wooded Savanna to Forest (4c) Bioclimatic Subregions (Phillips 1973).

5. **Ingeli Mountain** attains a height of over 2 100 m above sea level, and lies east of Kokstad, being part of a mountainous ring that encircles the town. The doleritic sheets that have intruded the Beaufort series are particularly thick here (Turner 1967). At the southern extremity of the mountain lies the Mtamvuna River, forming the Eastern Cape boundary. The soils here are similar to those of the Little 'Berg: dystrophic, feely-drained red and yellow apedals chiefly of the Mispah and Clovelly forms (Fitzpatrick 1978). Average annual rainfall amounts to 1 200 to 1 400 mm (Schulze 1982). The whole of Ingeli Mountain is now under conservation management (Cloete, pers. com. 1997). Phillips (1973) includes the mountain in the Mist Belt Forest and Wooded Savanna (3a) Bioclimatic Subregion.

13. **The Imphendle Block** rises to over 1 800 m above sea level and is separated from the

Little 'Berg near Giant's Castle by the valleys of the Mooi and Mkomazi Rivers. In this area, coloured sandstones, shales and mudstones of the Beaufort series are considerably intruded by dolerite dykes and sills. A dolerite sheet near the plateau surface provides an impervious stratum which allows water to run off the plateau. Soils are similar to those of the Little 'Berg: yellow and red apedals derived from Karoo rocks, freely drained and with low base status (Fitzpatrick 1978). Average rainfall reaches over 1 000 mm per annum (Turner 1967). The Imphendle Block is included in Phillips' (1973) Open Grassland to Wooded Savanna (4e) Bioclimatic Subregion, the largest Subregion in the study area and one which corresponds closely with Acocks' Highland Sourveld veld type.

14. **The Natal Midlands**, referred to herein as the KwaZulu-Natal Midlands, also corresponds closely with Acock's Highland Sourveld veld type, and is largely occupied with Phillips (1973) Open Grassland to Wooded Savanna (4e) Bioclimatic Subregion. Smaller tracts of the region are included in Phillips' (1973) Mist Belt Forest and Wooded Savanna (3a, 3c, 3d) and Open Grassland to Wooded Savanna (6a, 8a) Bioclimatic Subregions. It is a diverse tract of land, including the upper valleys of the Mooi, Mgeni, Msinduzi and Illovo Rivers, and showing considerable relief between 1 200 m and 1 600 m above sea level (Turner 1967). In the west it adjoins the Imphendle Block and the Little 'Berg below Giant's Castle, and in the east borders the Richmond - Pietermaritzburg - Greytown escarpment. In the east, at lower altitude, and in the river valleys, Ecca series beds are exposed, while in the west at higher altitude the Beaufort shales, sandstones and mudstones are prominent. Doleritic intrusions are found throughout, and some massive sheets of dolerite occur above Byrne, in the Karkloof, and in the Swartkop range. Again, yellow and red apedals dominate, freely drained and well leached (Fitzpatrick 1978). Much of the region is in the mistbelt of KwaZulu-Natal, and the rainfall varies from 889 mm to 1143 mm (Turner 1967).

15. **The Howick Benchland** is formed by a thick sheet of dolerite at the edge of the Pietmaritzburg escarpment, which has arrested the downward erosion of the Mgeni and Karkloof Rivers. This broad flat benchland lies above the Howick and Karkloof falls (Turner 1967). Soils are freely drained, mainly red apedals, with mesotrophic clays and some yellow apedal loams (Fitzpatrick 1978). Average annual precipitation is in the region of 800 to 1 000

mm (Schulze 1982). The Howick Benchland is included in the Mist Belt Forest and Wooded Savanna (3a, 3c, 3d) and Open Grassland to Wooded Savanna (6a) Bioclimatic Subregions (Phillips 1973).

16. **The Bulwer Block** lies between the Mkomazi and Ingangwana Rivers, west of the Pietermaritzburg - Kokstad railway line, at a general elevation of 1 700 m to 2 000 m above sea level. A portion of land south of the Ingangwana River has been included in the block since the incorporation of East Griqualand into KwaZulu-Natal (Schulze 1982). The Polela and Mzimkulu Rivers deeply incise the southern part of the region, while the northerly region forms a more compact plateau. From this plateau the outlier mountain of Mahwaqa (part of a biosphere reserve) rises to 2 083 m above sea level. Soils are yellow and red, freely drained, well leached apedals (Fitzpatrick 1978). Precipitation averages between 900 and 1 200 mm (Schulze 1982). The Mist Belt Forest and Wooded Savanna (3a) and Open Grassland to Wooded Savanna (4c, 4e, 6a) Bioclimatic Subregions are found within this Physiographic Region (Phillips 1973).

16a. **The Swartberg Block** lies due south of the Underberg - Himeville Plain at an elevation of 1 800 to 2 100 m above sea level (Schulze 1982). Soils are similar to those of the Little 'Berg (Fitzpatrick 1978). Average annual rainfall is 800 to 900 mm (Schulze 1982). The Open Grassland to Wooded Savanna (4e) Bioclimatic Subregion also occurs in this block (Phillips 1973, Schulze 1982).

16b. **The Kokstad Block** occurs in two small patches northwest and northeast of Kokstad (Schulze 1982). The soils are similar to those of the Little 'Berg (Fitzpatrick 1978), and the average annual rainfall reaches between 900 and 1 200 mm (Schulze 1982). The typical elevation is 1 700 m to 1 900 m above sea level (Schulze 1982). In both patches the Open Grassland to Wooded Savanna Bioclimatic Subregion (4e) is recognised (Phillips 1973, Schulze 1982).

16c. **The Matatiele Block** occupies a small area in the extreme south-west of the study area, just south of the town of Matatiele and bordering the Eastern Cape. Soils are yellow and grey

hydromorphic, mainly mesotrophic sands and loams with some red clays and duplex soils (Fitzpatrick 1978). Rainfall varies between 900 and 1 200 mm anually (Schulze 1982). The block has a general elevation of 1 650 m to 1 950 m above sea level (Schulze 1982). Open Grassland to Wooded Savannah (4e) is the Bioclimatic Subregion in the Matatiele Block (Phillips 1973, Schulze 1982).

16d. **The East Griqualand Uplands** stretch from the Eastern Cape border, through the town of Kokstad, and adjoin the Swartberg Block in the north. The elevation is somewhat lower here than the surrounding blocks, at 1 350 m to 1 650 m above sea level (Schulze 1982). Soils are similar to those of the Matatiele Block; mainly mesotrphic sands and loams (Fitzpatrick 1978). The precipitation averages from 900 to 1 100 mm annually (Schulze 1982). Open Grassland to Wooded Savanna/ Scrub (4f) and Open Grassland to Wooded Savanna (8b) are the Bioclimatic Subregions found in this region (Phillips 1973, Schulze 1982).

17. **The Winterton - Estcourt - Muden Plain** is in the north of the study area and forms a transitional region between the Tugela thornveld and the KwaZulu-Natal uplands. This region stretches from the south bank of the Tugela River to the northern Little 'Berg, south to the Bushman's River area at Estcourt, and east from here to the Mooi River valley near Muden. The general elevation is 1 000 m. Beaufort beds are found on this plain, extending even east of Estcourt due to their lowering by the Tugela Fault. Further east, the Ecca series is exposed (Turner 1967). Soils found on this plain are mainly black clays and duplex soils with some areas of yellow and grey dystrophic clays, and red clays. Several rivers cross this plain, rising in the High Drakensberg to the west. These include the Lindeque, Sterkspruit, Little Tugela, Bloukrans and Bushmans Rivers. The rainfall in this region is considerably lower than that further south in the study area, averaging 635 mm per annum (Phillips 1973). The Winterton - Estcourt - Muden Plain falls within the Open Grassland to Wooded Savanna (6a, 8a) Bioclimatic Subregions (Phillips1973).

27. **The Underberg - Himeville Plain** lies between the Bulwer Block and the foothills of the High Drakensberg, at a general elevation of 1 500 m above sea level. The term "plain" is relative, for the relief in this region is considerable (Turner 1967). Beaufort beds, as well as

dolerite sills and dykes, are prominent over the whole area. Soils are the same as those found in the Little 'Berg (Fitzpatrick 1978). The Mzimkulu River deeply dissects the plain as it traverses it from west to east. The rainfall is high, upwards of 1 000 mm per annum, and severe frosts and snowfalls are common in winter (Turner 1967). The plain lies within the Open Grassland to Wooded Savanna (4e, 6a) Bioclimatic Subregion (Phillips 1973).

27a. **The East Griqualand Plains** are separated from the Underberg - Himeville plain by the Swartberg Block, and display a similar elevation of 1 500 m to 1 600 m above sea level (Schulze 1982). These plains border the southern Little 'Berg to the west, and include the village of Swartberg in the east. They stretch south to include the town of Matatiele and abut the Matatiele Block. The soils include yellow and grey mesotrophic sands and loams, red and black clays, and duplex soils (Fitzpatrick 1978). The annual average precipitation is rather lower than in other parts of the study area, at 700 to 900 mm (Schulze 1982). The Bioclimatic Subregions in this plain are the Open Grassland to Wooded Savanna/Scrub (4f) and Open Grassland to Wooded Savanna/Scrub (8c) (Phillips 1973, Schulze 1982).

28. **The Greytown - Pietmaritzburg - Richmond Benchland** is an extensive area reaching 112 km from Greytown in the north to the Mkomazi River south of Richmond. The Pietermaritzburg escarpment borders the benchland in the west, and extends east about 30 km before terminating abruptly at the Valley of a Thousand Hills and the Mvoti River valley in the north, and fading more gradually in the south-east into the hilly countryside of the coastal hinterland (Turner 1967). The general elevation is 760 - 900 m above sea level. The Mvoti, Mgeni, Msinduzi, Mlazi and Illovo Rivers cross the region from west to east. The soils here vary widely, and include yellow and red apedal, humic, freely drained, dystrophic soils, weakly developed lithocutanic B soils, some duplex soils and some red and black clays (Fitzpatrick 1978). Rainfall varies between 800 and 1 000 mm per annum (Schulze 1982). This large benchland is divided into a number of Bioclimatic Subregions by Phillips (1973): Coast Hinterland Forest, Bush and Wooded Savanna (2a, 2b, 2d, 2f), Mist Belt Forest and Wooded Savanna (3a, 3c), Open Grassland to Wooded Savanna (6a), and Wooded Savanna and Scrub of Riverine and other low-lying areas (10a) (Phillips 1973).

29. **The Kranskop Divide** is a narrow plateau (8 - 16 km wide) in the extreme north-east of the study area. It separates the deep valleys of theTugela and Hlimbitwa Rivers in the vicinity of Kranskop and Mapumulo. Table Mountain sandstone underlies the plateau except for a small area of Dwyka tillite near Kranskop. The sandstone gives rise to steep escarpments dominating the river valleys to the north and south (Turner 1967). Yellow and red, apedal, humic, freely drained, dystrophic soils are found in this region (Fitzpatrick 1978). Rainfall averages 1 000 mm per annum (Schulze 1982). The plateau, 1 000 to 1200 m above sea level, is assigned to the Coast Hinterland Forest and Wooded Savanna (2a) and Mist Belt Forest and Wooded Savanna (3a) Bioclimatic Subregions by Phillips (1973).

32. **The Ixopo - Highflats Benchland**, at a general elevation of 900 m, lies between the Mkomazi and Mzimkulu Rivers. In the north-west of this region, near Donnybrook, Ecca sandstone cliffs separate this benchland from the neighbouring Bulwer Block. Lower Ecca shales are evident near Ixopo, and Dwyka tillite succeeds these in the south-east around Highflats. Further south-east, beyond Highflats, Natal Group sandstone emerges from beneath the tillite (Turner 1967). The soils are rather varied, including yellow and red apedal, freely drained, mesotrophic clays, yellow apedal loams, dystrophic apedals, and weakly developed lithocutanic B soils (Fitzpatrick 1978). The average annual rainfall is from 800 to 1 000 mm (Schulze 1982). A number of Bioclimatic Subregions form a mosaic over this benchland: the Coast Hinterland Forest and Wooded Savanna (2a, 2b), Mist Belt Forest and Wooded Savanna (3a, 3c, 3d), Open Grassland to Wooded Savanna (4e, 6a), and Wooded Savanna and Scrub of Riverine and other low-lying areas (10a) (Phillips 1973).

33. **The Harding Benchland** lies between the Mzimkulu and Mtamvuna Rivers, in the south of the study area and bordering the Eastern Cape. A gradual inclination eastwards is observed, from 900 m above sea level in the west to 600 m in the east. The westerly section displays rocks of the Ecca series, with Dwyka tillite becoming more common further east. The topography here is rolling. The soils are similar to those of the Ixopo - Highflats Benchland (Fitzpatrick 1978). From west to east the rainfall decreases, with an average annual precipitation of around 1 270 mm near Weza, and less than 760 mm in the east where the region lies in the rain shadow of the Natal Group sandstone plateau (Turner 1967). Most of

the benchland falls within the Upland Forest and Wooded Savanna Bioclimatic Subregion (3b), with a smaller part falling in the Coast Hinterland Bush and Wooded Savanna (2f) (Phillips 1973).

33a. **The Umzimkulu Benchland** lies at an elevation of 700 - 1 250 m above sea level (Schulze 1982), between the Umzimkulu River to the north and the East Griqualand Uplands to the south-west. This region includes much of the Eastern Cape enclave within KwaZulu-Natal. The land is rolling, lying mainly on sandstones and shales of the Ecca series. The soils are similar to those of the Little 'Berg (Fitzpatrick 1978). The average annual precipitation varies from 700 mm near the Umzimkulu River to over 1 000 mm at the higher ground further west (Schulze 1982). The Upland Forest and Wooded Savanna Bioclimatic Subregion (3b) coincides with the Umzimkulu Benchland (Phillips 1973; Schulze 1982).

43. **The Incised River Valleys of Natal** occur in eight places in the study area, only two of which extend sufficiently inland to support grassland rather than valley bushveld (Acocks 1988). These two extend along the deeply incised Mkomazi and Mzimkulu River valleys, the former extending inland almost all the way to the Little 'Berg. The other six river valleys in question are those of the Mlazi, Illovo, Mpambanyone, Mzumbe, Mtwalume and Mtamvuna Rivers. These latter six have subarid climates which support what Acocks (1988) termed "Valley Bushveld". The Mkomazi and Mzimkulu River valleys are more deeply incised and have a subhumid to mild subarid climate. The general elevation of these two river valleys is around 1 200 m above sea level, in the case of the Mkomazi River valley this is 600 m below the surrounding landscape (the Imphendle and Bulwer Blocks). The soils in this Physiographic Region are yellow and grey hydromorphic, mainly mesotrophic sands/loams, with some duplex soils and red clays (Fitzpatrick 1978). The annual average precipitation in these regions is considerably lower than in most of the study area, with 700 mm being recorded in the drier parts and up to 900 mm in the wetter parts further inland (Schulze 1982). These river valleys correspond well with the Open Grassland to Wooded Savanna (6a) Bioclimatic Subregion (Phillips 1973), although Phillips (1973) includes the sections nearer the coast in the Wooded Savanna and Scrub of Riverine and other low-lying areas (10a) Bioclimatic Subregion. In the

case of the Mkomazi, this is a long narrow segment stretching nearly 80 km from near Bulwer in the west to about 10 km short of the coast in the east.

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CLIMATE

The climate of an area may be defined as the average weather pattern recorded over at least 30 years (Tyson 1986). Factors influencing climate include altitude, ocean currents, atmospheric pressure, physiography, precipitation, temperature, mist, frost, wind and solar radiation (Strahler & Strahler 1987; Tyson 1986). In the present study area, the following factors are of prime importance in influencing climate:

Altitude

Very marked differences in altitude occur in the present study area, with a generally steep gradient from west to east. Altitude affects local temperature and rainfall more than any other factor (Tyson, Preston-Whyte & Schulze 1976). As altitude increases, air density, humidity and temperature decrease (Tyson *et al.* 1976). Altitude is also associated with the distribution of endemic plant species (Matthews, Van Wyk & Bredenkamp 1993).

The Agulhas Current

The warm Agulhas current flowing southward along the KwaZulu-Natal coast increases the temperature and moisture content of the air above it; this air usually moves westward over KwaZulu-Natal and the resultant precipitation makes KwaZulu-Natal the wettest province in the country (Meadows 1985). The warm moist air is forced to rise over the Drakensberg mountains, cooling and bringing orographic (relief) rainfall to the escarpment (Killick 1990).This rainfall, occuring mainly in the summer months, makes the Drakensberg one of the wettest places in South Africa (Killick 1990).

Atmospheric Pressure

The atmospheric pressure over and adjacent to southern Africa is responsible for creating high and low pressure systems. These govern the wind direction, which dur ng summer is mainly easterly, bringing warm moist air to the interior, and during winter is often westerly, creating dry "Berg Winds" (Tyson *et al.* 1976).

Physiography

Physiography exercises a local effect on the climate; the aspect of a slope will influence how much sunlight it will receive, which in turn will influence the relative humidity and convection currents. Since the study area is in the southern hemisphere, north-facing slopes receive relatively more solar radiation than south-facing slopes. The north-facing slopes are also affected less by changes in the altitude of the sun.Consequently, the no th-facing slopes are on average 3-4 °C warmer than south-facing ones, and are drier (Killick 1963). They tend to support grassland or protea savanna, whereas south-facing slopes are more prone to encroachment by forest precursor scrub (Granger & Schulze 1977).

Climatic factors of importance in the study area include precipitation, light, temperature, humidity, frost, mist and wind (Tyson *et al.* 1976). These factors are broadly predictable from season to season, although they may change drastically within a few hours (Tyson *et al.* 1976).

The study area is large and factors such as precipitation vary considerably from one region to another. Climatic data was therefore obtained for a number of sites, the data being obtained from the Department of Agriculture and Water Supply (1986), the Weather Bureau (1986) and the publications of Shulze (1982) and Meadows (1985). The following climatic factors affect the vegetation in the study area:

Precipitation

The absolute amount of water falling on an area is less important than the relationship between

rainfall and evaporation, the effectivity of the rain, and how consistent it is (Meadows 1985; Schulze 1982). The effectivity of rain refers to how much of it penetrates into the soil; gentle prolonged rain falling on soil without a crust will have greater effectivity than short hard rainfall on an encrusted surface (Strahler & Strahler 1987). In the study area, most of the rainfall arrives during short violent storms, and the effectivity is thus reduced. This factor is especially significant at higher altitudes in the Drakensberg, but is also important in the KwaZulu-Natal Midlands (Schulze 1982).

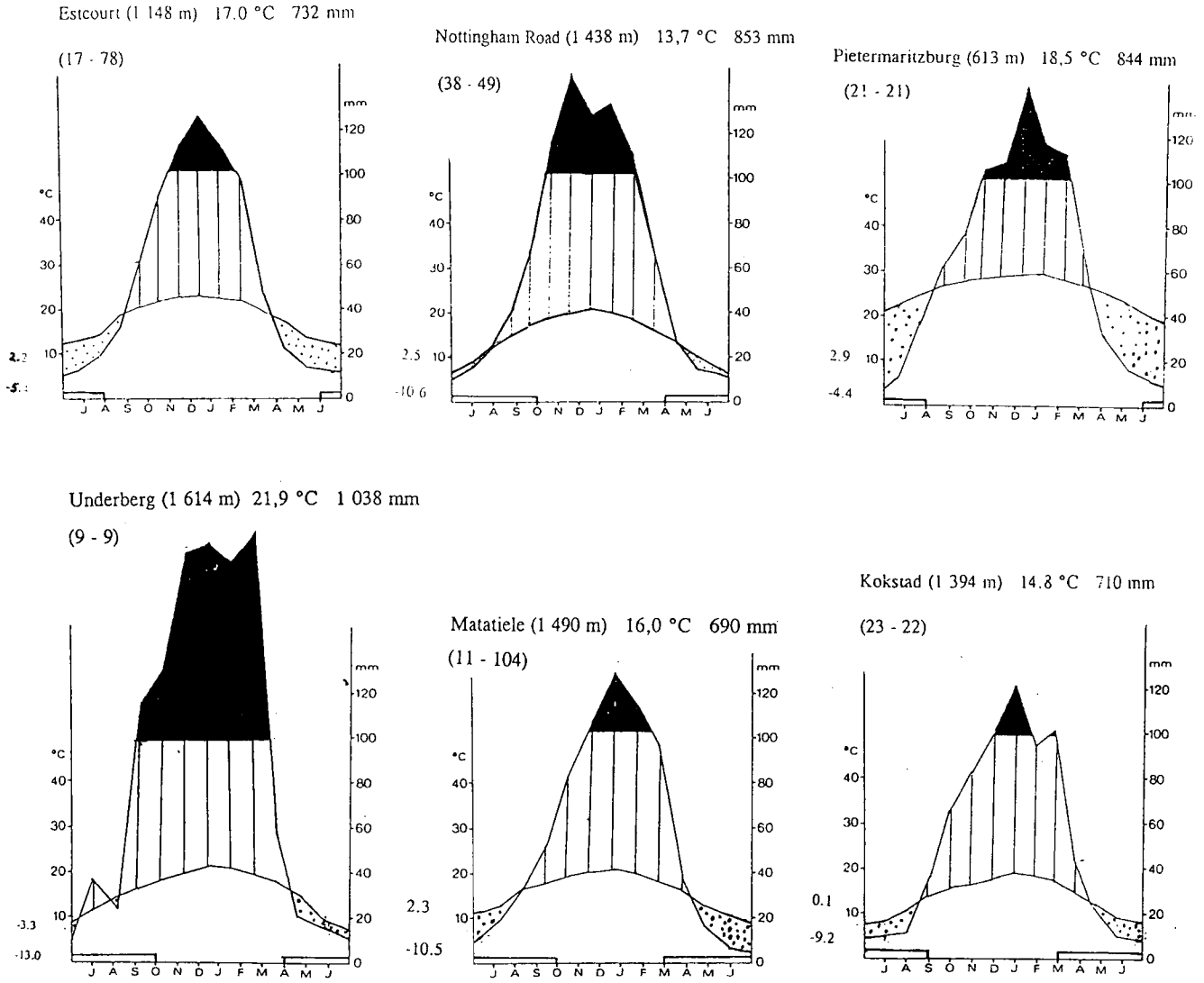
Precipitation data for Estcourt, Nottingham Road, Pietermaritzburg, Underberg, Matatiele and Kokstad are presented in the form of Walter diagrams (Figure 4) (Walter 1979). The advantage of Walter diagrams is that they convey the relationship between precipitation and evaporation (Meadows 1985).The Mean Annual Precipitation (MAP) for the study area is presented in Figure 5 (data from Schulze 1982).

The Mean Annual Precipitation is highest on the summit of the escarpment, where it is in the region of 2 000 mm per year. Most of this rainfall is precipitated in January, with an average rainfall of 290 mm atop the escarpment. In July, the driest month, a scant 10 - 20 mm per year is recorded on average (Schulze 1982).

The precipitation decreases away from the Drakensberg, steeply at first and then less steeply from the Midlands to the Indian Ocean. In the eastern-most parts of the study area, around Pietermaritzburg, Mean Annual Precipitation averages 1 000 mm per year (Schulze 1982), the average for January is 120 mm and the average for July, 20 mm (Schulze 1982).

Temperature

Temperature is important in determing rates of plant growth and is also a factor in maintaining grassland, as woody vegetation generally requires higher temperatures in order to proliferate (Schulze 1982; Killick 1990). The temperature in the study area generally decreases with altitude, but increases slightly in the south of the study area (Killick 1990). The average January temperature near the escarpment is 16 °C, and at Pietermaritzburg is 22 °C (Schulze



Key:

a	- name of town
(b)	- altitude (m)
c_1	- period with temperature data (years)
c_2	- period with rainfall data (years)
d	- mean annual temeperature
e	- mean annual rainfall
f	- mean daily minimum of coldest month
g	- absolute minimum temperature
h	- months with absolute minimum temperature below 0 °C
m	- dry period
n	- mesic period
o	- wet period
r	- mean monthly rainfall
t	- mean monthly temperature

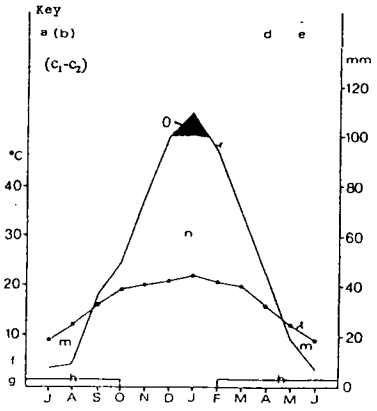


Figure 4. Climate diagrams for selected towns in the study area (after Walter 1979).

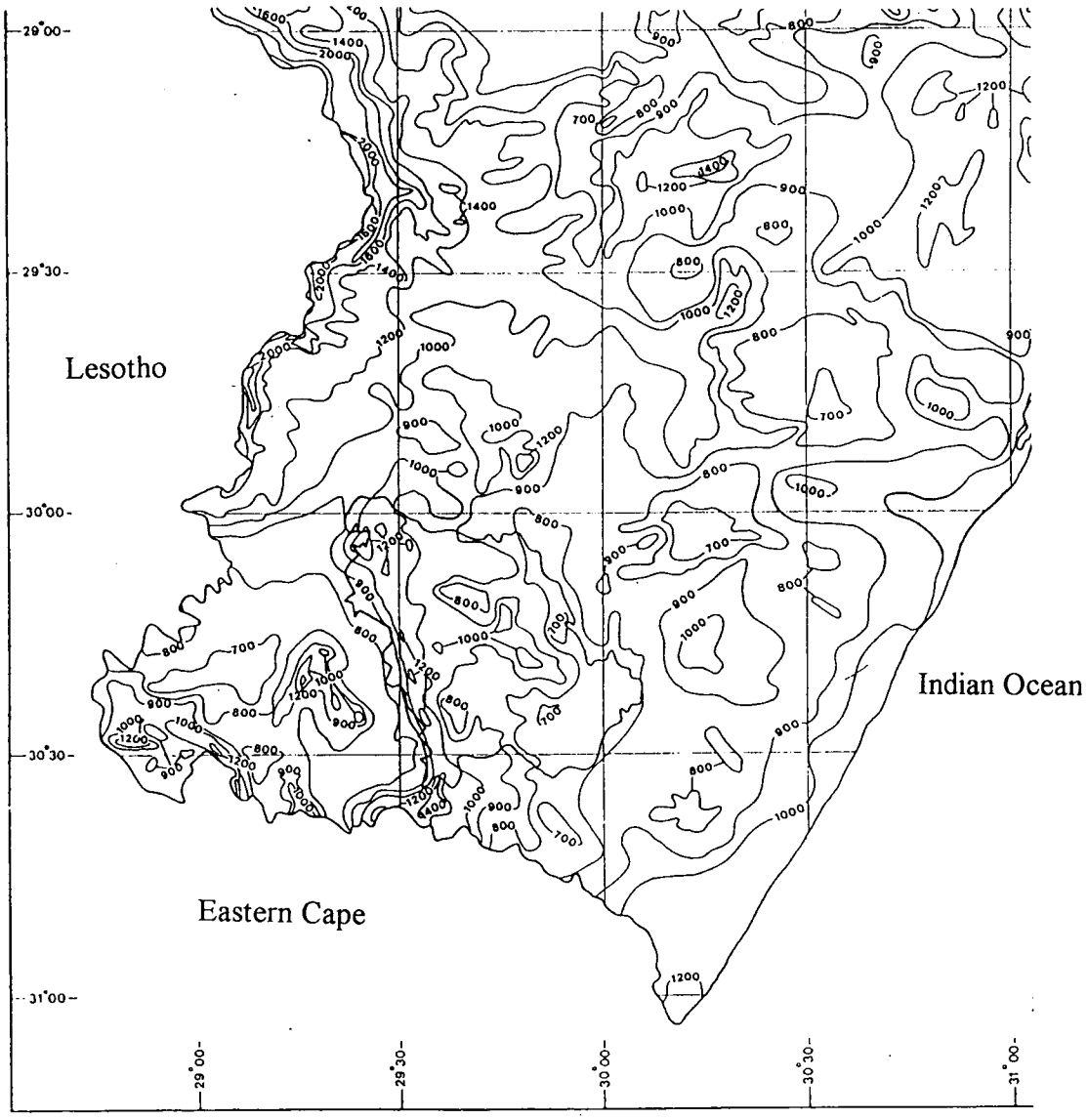


Figure 5. Isohyets of Mean Annual Precipitation (mm) for the study area (after Schulze 1982).

1982). The July equivalents are 2 °C and 13 °C respectively (Schulze 1982). At the escarpment near Matatiele in the south, January temperatures average 18 °C and July temperatures, 9 °C (Schulze 1982). Mean annual temperatures for the study area are presented in Figure 6, mean temperatures for January (the hottest month) in Figure 7, and mean temperatures for July (the coldest month) in Figure 8 (data from Schulze 1982).

Temperature data are also included in the Walter diagrams (Figure 4).

Mist

Mist is caused by air cooling close to the land surface (Tyson 1986), and this phenomenon is sufficiently prevalent in parts of the KwaZulu-Natal Midlands that they are termed the "Mist Belt" (Bourquin 1987). Acocks (1988) recognised a distinct Veld Type here, the Natal Mist Belt 'Ngongoni veld. The mist is formed mainly in the summer months, and can be an important additional source of moisture for plants (Schulze & McGee 1978). Furthermore it does not contribute to soil erosion in the same way that rainfall does, as there is no splashing from water droplets.

Frost

Frost formation requires still air and and a ground temperature below 0 °C, conditions which occur more frequently on the Drakensberg summit and Little 'Berg valleys than elsewhere in the study area (Killick 1963). Parts of the Drakensberg may receive as much as 150 nights of frost per annum (Tyson *et al.* 1976). A severe frost, sometimes called a black frost, can result in the plant moisture freezing, leading to rupturing of plant cells and consequent blackening and wilting (Meadows 1985).

Wind

Wind is a major factor during August, September and October (Phillips 1973). High atmospheric pressure over the escarpment may lead to dry westerly winds reaching velocities

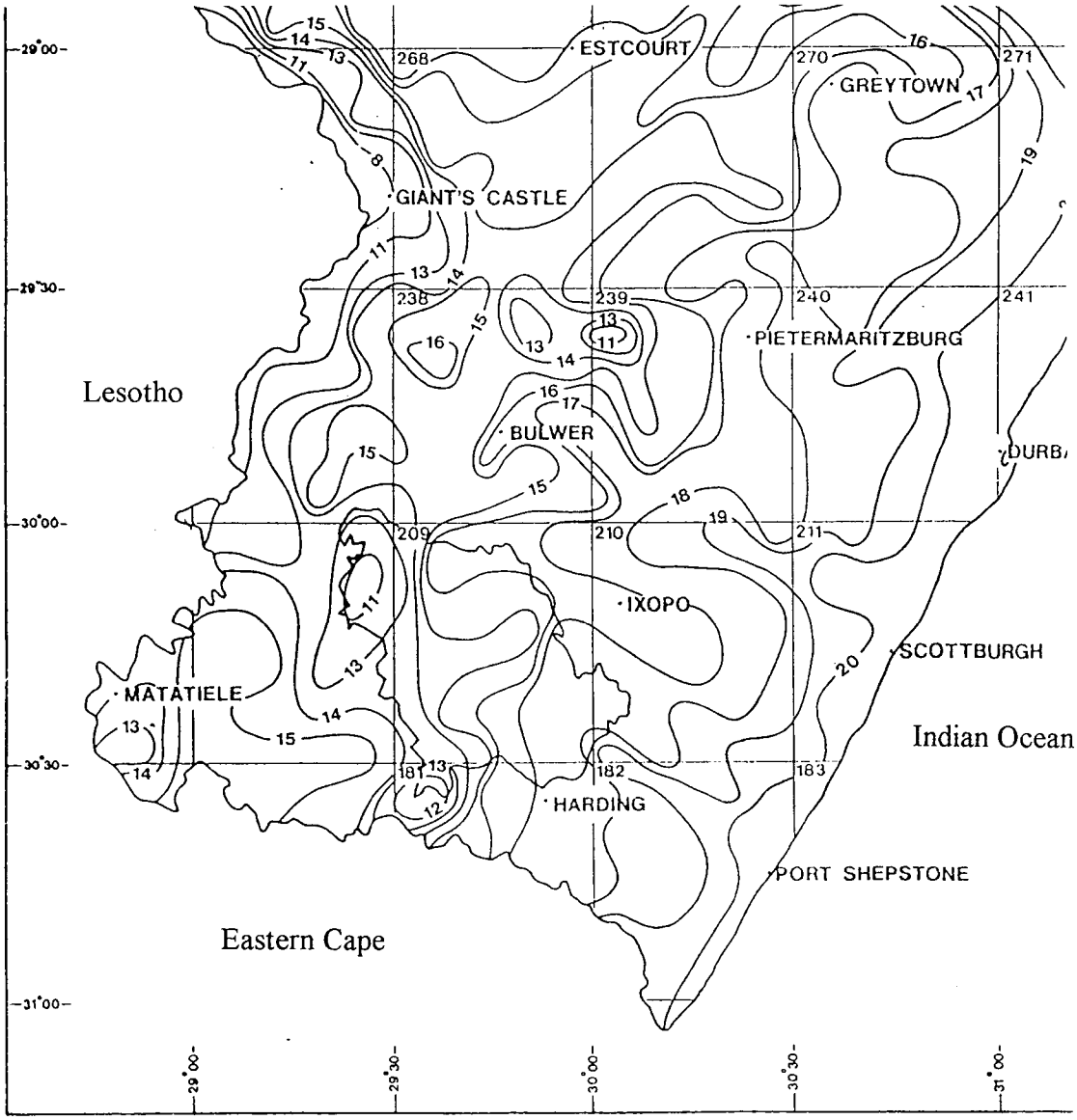


Figure 6. Isohyets of Mean Annual Temperatures (°C) for the study area (after Schulze 1982).

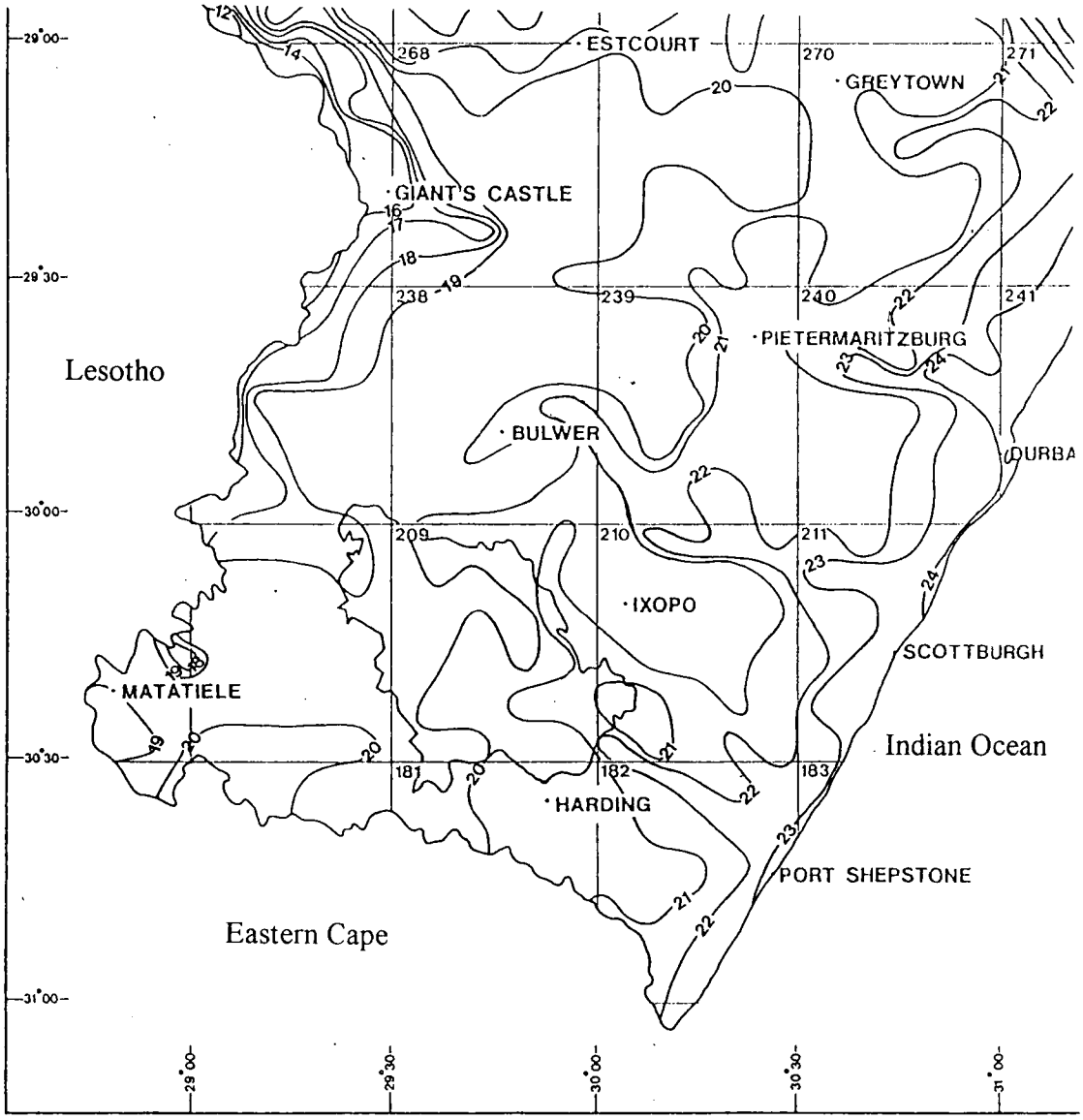


Figure 7. Isohyets of Mean Temperatures (°C) for January (after Schulze 1982).

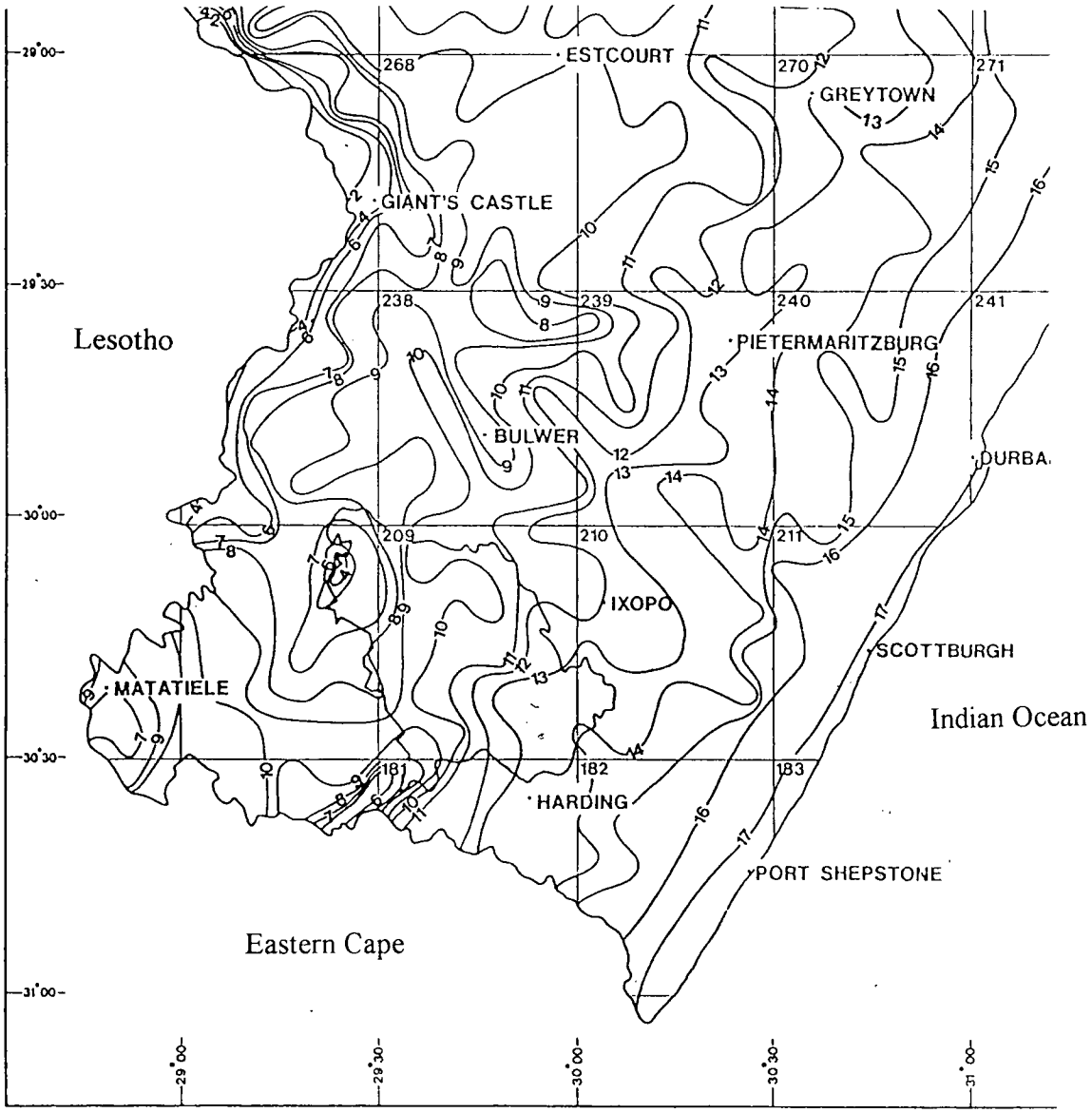


Figure 8. Isohyets of Mean Temperatures (°C) for July (after Schulze 1982).

of 80 km/h. As the air flows down the escarpment into the Midlands it may become warmed, being known as a "Berg Wind". During these winter months, soil moisture is at a minimum and the wind, by increasing transpiration rates, exacerbates the dry conditions for the vegetation (Phillips 1973). Fire hazard is also increased. Regional air movements associated with the Drakensberg include the "Minza" - the flow of air away from the escarpment at night - and the "Umzanzi", the daytime flow of air towards the escarpment (Irwin & Irwin 1992).

Solar Radiation

Solar radiation affects the rate of photosynthesis and also has a heating effect on the plant and on the soil. Increased water loss can result from this heating effect (Schulze & McGee 1978). Various soils may react differently to solar heating, which may in turn affect water and nutrient availability. These factors may greatly influence plant growth and species distribution (Schulze & McGee 1978).

The amount of radiation reaching the vegetation will be modified by the aspect and gradient of the terrain. In the southern hemisphere, level ground will receive oblique rather than perpendicular insolation, and a north-facing slope will receive more insolation than a south-facing one (Granger & Schulze 1977). South-facing slopes tend therefore to be moister, and are less prone to fire. They are also more likely to support scrub or forest growth than north-facing slopes (Granger & Schulze 1977). In the Little 'Berg, average daily sunshine measures around 5,5 hours in the summer, and 8,3 hours during winter (Killick 1990). Towards the bottoms of valleys, and nearer the high escarpment, the amount and intensity of sunlight is reduced (Killick 1990), favouring the growth of plants which are adapted to shorter durations of intense irradiation .

ENVIRONMENTAL SYNTHESIS

The environmental factors influencing vegetation growth can vary widely between Physiographic Regions, and the climatic, geological, pedological and topographical factors which may influnce plant growth are therefore synthesised by referring to the Bioclimatic

Subregions (Phillips 1973) found in the study area (see Figure 3).

BIOCLIMATIC SUBREGIONS

The Bioclimatic Subregions of KwaZulu-Natal (see Figure 3) were delineated and described by Phillips (1973) and have subsequently been consistently used as a basis for stratification in various ecological studies (Begg 1986). A Bioclimatic Subregion is

> "differentiated by an interplay of climatic factors and biotic phenomena, so integrated as to permit the development of natural vegetation and the associated animal life - that is the *biotic community* - to a mosaic of climax stages in equilibrium with the climate."

Phillips (1973), p. 53.

Although Phillips (1973) referred to a "mosaic of climate stages" he later referred to various disturbances (e.g. fire, cultivation, grazing) and stated that in KwaZulu-Natal, "we are concerned almost wholly with secondary communities within our terrain." (p. 53). The fact that much of the landscape and vegetation in the present study area have been altered should be borne in mind when interpreting the results of this study.

The Bioclimatic Subregions relevant to the present study are the Mistbelt (Subregion 3), Highland Montane (Subregion 4), Open Grassland to Wooded Savanna (Moister Faciation) (Subregion 6) and Open Grassland to Wooded Savanna (Drier Faciation) (Subregion 8).

The Mistbelt Subregion is the most easterly region in the present study area that supports grassland (Acocks 1988). As the name suggests it is subject to frequent mists (Phillips 1973) as well as a high rainfall (mean annual rainfall range of 800 - 1 600 mm) (Schulze 1982). The elevation is from 915 - 1 372 m (Phillips 1973). The mean annual temperature ranges from 16 to 18 °C (Phillips 1973). This region is intensively farmed and the alteration of the vegetation has been significant. Moll (1976) estimated that 60 - 70 % of the vegetation has been altered

and stated that much of the grassland originally dominated by *Themeda triandra* is now dominated by *Aristida junciformis*.

The main environmental factors that influence vegetation are the high precipitation, encouraging rapid plant growth, and the mild climate with infrequent frosts. Beaufort and upper Ecca sediments occur, overlain by dolerite. The soils are generally classed as "moderately good" to "good" (Phillips 1973), and include Hutton, Clovelly, Griffin and Inanda soils, among others. The Subregion does not have extremes of topography but does lie downstream from the Drakensberg catchment area, and can be subjected to flash floods which strip away the topsoil. The environmental factors are thus generally conducive to plant growth, but also to agriculture which has displaced much of the original vegetation.

The Highland Montane Subregion is located to the west of the Mistbelt and extends towards the Drakensberg plateau, but does not include the plateau itself. It includes several subsections, of which 4c (the Little 'Berg at the foot of the southern escarpment), 4d (Montane *Protea* Savanna) and 4e (the undulating hills of the KwaZulu-Natal Midlands further east) are relevant to the present study. The Little 'Berg at the foot of the escarpment, especially south of Giant's Castle, is colder than the grasslands to the east and the grasslands at the foot of the northern Drakensberg (Hilliard & Burtt 1987). The mean annual temperature in the Subregion 4c, at the foot of the southern Little 'Berg, is 13 °C, and in the Subregion 4e in the Midlands, ranges from 15 - 16 °C (Schulze 1982).

The mean annual rainfall range in the Highland Montane Subregion is 800 - 1 500 mm (Schulze 1982). The elevation is from 1 372 - 1981 m (Phillips 1973).

The vegetation in Subregion 4e has been greatly modified by agriculture, especially cultivation and grazing (Moll 1976), but that in Subregion 4c has been largely conserved in various reserves which currently form part of the Natal Drakensberg Park (Killick 1990). This latter area is nevertheless subject to anthropomorphic influences such as burning (Hilliard & Burtt 1987).

Crucial environmental factors for the Highland Montane vegetation are the very high precipitation, which encourages rapid growth, the extremes of climate, which may retard growth during periods of snow and frost, and the extremes of topography, especially in the west. Frost and hail may be severe, damaging plant tissue, and dry "berg" winds occasionally dessicate the vegetation. The rainfall runoff from the high slopes is rapid, resulting in little moisture accumulation in the soil. The soils are generally leached due to the high precipitation. In the east of the Subregion, i.e. the Midlands, however, greater moisture accumulation is possible and the soils are less leached. The Midlands soils are generally highly productive (Phillips 1973), and as with the Mistbelt, agriculture has displaced much of the natural vegetation.

The Open Grassland to Wooded Savanna (Moister Faciation) is located in deeply incised river valleys which have cut back towards the Drakensberg escarpment (Turner 1967). These river valleys are described under the physiographic descriptions (pg 17). The elevation of these valleys is from 915 to 1 372 m (Phillips 1973), which corresponds to the elevation of the Mistbelt Subregion. The rainfall is lower than that in Subregions 3 and 4, the mean annual range being from 800 - 1 000 mm (Schulze 1982). This relatively dry climate is responsible for a denser and more diverse woody vegetation than in Subregions 3 and 4 (Phillips 1973). The mean annual temperature ranges from 16 to 18 °C (Phillips 1973).

The vegetation is influenced primarily by the drier conditions in this Subregion, with three to four dry months, and occasional drought. Moderate frost can also occur for three to four months. The Subregion is subjected to periodic floods, as it occurs mainly in river valleys draining catchment areas near the Drakensberg. Soil erosion is severe in parts, and subsistence agriculture is practised over much of the area, which may contribute to soil erosion. The soils include the Avalon Form which is rated "excellent" and is highly productive (Phillips 1973); however much of the Subregion is covered by less productive soils such as Bleeksand, Ruston, Kleinfontein, Kromvlei, Wesselsnek and Driepan Series which are rated much lower by Phillips (1973). The rainfall, while lower than in Subregions 3 and 4, is nevertheless fairly consistent. The topography is characterised by the deeply incised valleys, with the south-facing slopes being cooler and more conducive to plant growth, especially during drought. In general

therefore, the environment is somewhat less favourable for vegetation than that in Subregions 3 and 4.

The Open Grassland to Wooded Savanna (Drier Faciation) is found at the northern limit of the present study area, in the vicinity of Estcourt and Greytown. River valleys are not the sites of this Bioclimatic Subregion, but the vegetation is equally woody and merges both with that of Subregion 6 and with the Valley Bushveld veld type (Acocks 1988) which extends into the north, east and south of the present study area (Acocks 1988). This faciation of the Open Grassland to Wooded Savanna is drier, with a mean annual rainfall range of 600 - 800 mm (Schulze 1982). The elevation is however the same as in Subregion 6, from 915 to 1372 m (Phillips 1973). The mean annual temperature range is also the same, from 16 to 18 °C (Phillips 1973).

Environmental influences in Subregion 8 are similar to those in Subregion 6, with several exceptions:

1) The rainfall is lower, and less reliable, creating a less hospitable climate, especially for herbaceous plants.

2) The soils are more basic, due to the lower rainfall. The structure is more developed, limiting root penetration, inhibiting water infiltration and increasing the risk of erosion (MacVicar *et al.* 1991).

3) The topography is less varied, as most of the Subregion in the present study occupies an undulating plain (the "Winterton-Estcourt-Muden Plain") (Turner 1967). The vegetation is also therefore less varied, consisting of a more uniform wooded grassland.

In general therefore the environmental conditions in the Dry Upland Savanna are the least favourable for vegetation, and for agriculture, in the study area.

ANTHROPOGENIC INFLUENCES

Evidence of hominids having lived in South Africa, including southern KwaZulu-Natal, from at least 2 million years ago, and *Homo sapiens* from approximately 130 000 years ago, exists (Wenke 1984). These communities interacted with the natural environment, partially modifying it, and were regularly joined by new waves of immigrants (Sampson 1974). Anthropogenic influences have increased rapidly during the past few thousand years (Sampson 1974). Three main categories of influence in the study area are recognised here: past land use, present land use and fire.

a) PAST LAND USE

Human occupation of southern KwaZulu-Natal has been dated to at least 200 000 years BP (before present), when Early Stone Age and Middle Stone Age people lived in the area (Wenke 1984). Evidence of Late Stone Age people from at least 40 000 years BP also exists from Smithfield deposits in Giant's Castle, Karkloof, New Amalfi and Pigeon Rocks in the study area (Sampson 1974). The San were Late Stone Age people who inhabited southern KwaZulu-Natal from at least 8 000 years BP. The land at this stage was not farmed or used as grazing land, but certain territorial hunting borders may have been recognised (Sampson 1974). Fire was used to drive game and possibly to encourage the return of game to an area where fresh herbaceous growth was reappearing after fire (Vinnicombe 1976).

Early Iron Age (c. 2 000 - 1 200 YBP) and and Later Iron Age (c. 1 200 - 150 YBP), Bantu-speaking people moved into the area and, as pastoralists, competed to a certain extent with the San for land Sampson (1974). Intermarriage between the San and Bantu-speaking people also occurred (Dowson 1994). The Iron Age communities used land in two main ways: cultivation for crops, and as pasture for domestic livestock. The impact of this land usage on the natural vegetation is difficult to ascertain. Although the grasslands have evolved to cope with fire (Stuart-Hill & Mentis 1982), some of which was anthropogenic, the initial population numbers were small and Sampson (1974) has credited these Iron Age populations with very little impact on the ecological balance of their habitat. However, the Iron Age populations grew

steadily and the impact on the grasslands of southern KwaZulu-Natal has undeniably increased accordingly. The state of the grasslands when the first White settlers entered the area was therefore a product of thousands of years of human interaction with the vegetation.

White settlers entered the area from the 19th century onwards and increased the area of land under cultivation and under grazing management. Farming units were fenced off for the first time. The competition for natural resources between San, Bantu and White settlers began to increase. The San discovered that wild game was becoming more scarce, due to hunting and the expansion of agriculture (Mazel 1989). They consequently began hunting domestic livestock of Bantu and White settlers. In part as a buffer between the San and White settlement, a number of Bantu settlements were set up between the Drakensberg Range (the remaining habitat of the San) and the White settlements between Estcourt and Durban. Most of these settlements were later incorporated in the Homeland of KwaZulu. Through intermarriage, emigration and extermination, the last of the Drakensberg San probably left the area in the 1930's (Mazel 1989).

The 1913 Land Act reserved approximately 13 % of the land for Black people (Pomeroy 1986). Since the formalisation of the Homelands policy, the parts of KwaZulu in the present study area have been subjected to greater and greater population pressure, with concomitatnt subsistence agriculture. The often poor agricultural techniques have contributed to the severe soil erosion evident in many places, such as the Draycott Plain (Phillips 1973). Agriculture in the White farming land has placed less strain on the natural resources, but evidence of overgrazing and poor management techniques exists in many places.

b) PRESENT LAND USE

The rigid separation of White and Black living and farming areas ceased in the early 1990's, but in practice the system continues because few Blacks can afford the high prices for farms in previously White areas. Therefore the pattern set by the Natal Colonial Government continues to the present day . Large parts of the study area are under cultivation, with maize predominating. Cattle farming is also widespread, and the cultivation of exotic timber extends

over many hectares of land. Parts of the study area, such as the Mist Belt, are so extensively cultivated that natural areas are only found in small, isolated patches (Bourquin 1987). The result of this agricultural activity is that most of the natural grasslands of the KwaZulu-Natal Midlands and East Griqualand have been lost or have reduced biodiversity.

The Drakensberg escarpment, however, is largely under conservation management. The "Drakensberg Catchment Area" encompasses

> "all land from Royal National Park to East Griqualand which lies between the great watershed (the Natal/Lesotho border) and the Administrative Catchment Boundary on the eastern margins of the Drakensberg State Forests and nature reserves."

(Irwin &Irwin 1992)

This land is managed for water production, conservation and tourism. The area has been zoned from west to east into four zones: a "wilderness heart", "landslide zone", "trail zone" and "Drakensberg threshold". Increasing utilisation (mainly for tourism) is permitted from west to east, or from high altitude to low altitude (Irwin & Irwin 1992). Although the future conservation of these areas seems relatively secure, fragile ecosystems to the east such as Inzinga Ranches are threatened with exotic afforestation. Fragile ecosystems, especially wetlands, in the Midlands area outside the Drakensberg Mountain Park are threatened with drainage, afforestation and other agricultural practices (Begg 1986). The existing legislation and enforcement seem insufficient to protect fragile areas, and there is a lack of cooperation between the various bodies responsible for their management (Kotze, Breen & Quinn 1995). A number of farmers have however set up conservancies, including wetlands and other fragile ecosystems, and these possibly have the greatest potential for ecosystem conservation.

c) FIRE

Fire has existed in the area even before the arrival of man, as a natural result of lightning and other causes (Booysen & Tainton 1984). The early San inhabitants of the Drakensberg and

adjacent grasslands used fire to drive game and for other purposes (Thompson 1936; Vinnicombe 1976). Later Bantu-speaking settlers in the region continued with the practice of burning (Phillips 1973). The grasslands of South Africa co-evolved with fire and other pressures such as grazing (Stuart-Hill & Mentis 1982; Tainton 1981). The grasslands of this area have generally been regarded as "fire-climax" grasslands, i.e. where fire and grazing maintain the grass cover and prevent the establishment of woody vegetation (Moll 1976; Tainton 1981; Acocks 1988). More recently, however, these grasslands have been considered to be primary grasslands, i.e. grass cover and not forest or bush is the climax vegetation. Meadows & Linder (1993) presented palaeontological evidence for the primary nature of South African grasslands. Although fire can and has been used as a tool for good vegetation management, it has also been misused, leading to deterioration of the vegetation (Tainton 1981). One of the main problems has been the burning of the veld at inappropriate times to obtain fresh green growth during winter (Trollope 1989). The vigour, canopy cover and basal cover of the vegetation is thereby reduced, and soil erosion may be increased (Trollope 1989). When fire is used effectively, it can remove moribund material which tends to accumulate in the high-rainfall sourveld, such as the present study area. To this end, the veld should be burned within four weeks before the onset of spring rains, up to two weeks after the first spring rains (Trollope 1989). The Natal Parks Board has divided the grassland into blocks corresponding to catchment areas, and these are burned in alternate years. The sub-alpine grasslands (above 1 800 m) are burned less frequently, due to the slower accumulaton of fuel load (Hillard & Burtt 1987).

CHAPTER 3

METHODS

The boundaries of the study area were demarcated on the Government Survey topographical sheets 2928 DRAKENSBERG, 2930 DURBAN, and 3028 KOKSTAD, scaled 1:250 000. Although Land Type Series maps have been the standard basis for stratigraphy in other studies of the Grassland biome (e.g. Bezuidenhout 1988; Smit 1992; Eckhardt 1993), Land Type Series maps are not as yet published for the whole of the present study area. In KwaZulu-Natal, Phillips' Bioclimatic Subregions (1973) and the Physiographic Regions described by Turner (1967) and Schulze (1982) are frequently used instead of Land Types (Begg 1986), and were therefore used in the present study for stratification purposes. The Relatively Homogenous Farming Units (Cedara Agricultural Development Institute 1996) are partly based on Phillips' Bioclimatic Subregions and were also used for stratification purposes.

Geological information was acquired from the 1:250 000 Geological Series 2928 DRAKENSBERG, 2930 DURBAN, and 3028 KOKSTAD maps (Geological Survey, Department of Mineral and Energy Affairs 1981). The soil classification of MacVicar *et al.* (1991) was followed, and the soil map of Fitzpatrick (1978) was also used. Climatic information was obtained from the Department of Agriculture and Water Supply (1986), the Weather Bureau (1986), and the Agricultural Catchments Research Unit Report no. 14 (Schulze 1982). Background information on the vegetation of the study area was obtained from Pentz (1949), West (1951), Edwards (1967), Moll (1976), Acocks (1988) and Phillips' Bioclimatic Groups (1973).

Number, size and distribution of sample plots

The number of plots within a given region should depend on the heterogeneity of the area, the scale of the area and the accuracy required for the classification (Bredenkamp 1982). In the present study, area size was taken as the basis for the number of sample plots per stratification unit. Sample plots were randomly distributed within each stratification unit, and one relevé

was compiled in each plot. Stratification was based primarily on physiographic regions proposed by Turner (1967) and modified by Schulze (1982). The Relatively Homogenous Farming Units delineated by the Cedara Agricultural Development Institute (1996) was also used to stratify certain areas. Furthermore, it was decided to include representative numbers of plots in the following terrain units: crest, scarp, midslope, footslope and valley floor/ river bed (Figure 9) (Land Type Survey Staff 1984). A terrain unit is any part of the land surface with homogenous form and slope (Land Type Survey Staff 1984). Within each stratification unit, the site of each relevé was subjectively chosen so as adequately represent the topography and the vegetation concerned (Werger 1974; Bredenkamp 1982; Eckhardt 1993). The above approach is that of the Zürich-Montpellier school of phytosociology (Mueller-Dombois & Ellenberg 1974), which has been successfully applied in the Grassland Biome (Bezuidenhout 1988; Bredenkamp *et al.* 1989; Matthews *et al.* 1991; Eckhardt 1993).

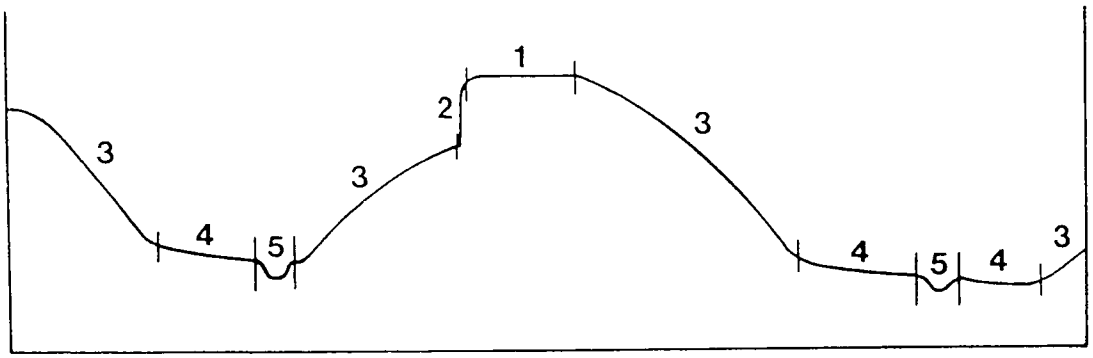
Previous phytosociological research in South African grasslands has shown that a sample plot size of 25 m^2 is adequate to sample the diversity of vegetation (Eckhardt 1993), and this size was therefore also used in the present study. The plots were varied in shape to suit the terrain, e.g. elongated along watercourses or rectangular on midslopes. Sampling was carried out during the summer months of 1995 and 1996. A total of 547 sample plots were surveyed.

Sampling method

The Braun-Blanquet method (Mueller-Dombois & Ellenberg 1974) was used as the sampling technique in this study, as it is a standardised and widely used technique in South Africa (Bredenkamp 1982). Use of this technique also permits incorporation of the data into the data bank of the Grassland Biome Project.

Floristic analysis

Within each sample plot, all plant species were recorded. Each species was allocated a value of the Braun-Blanquet cover-abundance scale (Mueller-Dombois & Ellenberg 1974), according to the cover and abundance of each species. However, scale-unit 2 was separated as suggested



Terrain unit

1 crest/ plateau
2 scarp/ cliff
3 midslope
4 footslope
5 valley bottom

Figure 9. Sketch showing the principal terrain units in a landscape (after Land Type Survey Staff 1984).

by Werger (1974), as follows:

2A: covering 5 - 12% of the sample plot area; and

2B: covering 12 - 25% of the sample plot area.

The following cover-abundance scale was therefore used:

r	one or few individuals (rare) with less than 1% cover of total sample plot area.
+	occasional and less than 1% of total sample plot area.
1	abundant and with very low cover, or less abundant but with higher cover, 1 - 5% cover of total sample plot area.
2	abundant with <5 - 25% cover of total sample plot area, A: >5 - 12% B: >12 - 25%
3	>25 - 50% cover of total sample plot area, irrespective of the number of individuals.
4	>50 - 75% cover of total sample plot area, irrespective of the total number of individuals.
5	>75% cover of total sample plot area, irrespective of the number of individuals.

Habitat analysis

The influence of environmental conditions on the distribution of plant communities, as well as on the growth of individual plants, is important (Gauch 1982). Land use planning can be facilitated if environmental factors can be used as reliable predictors of vegetation growth in a given area. In the present study, the following factors were considered to be important environmental variables:

1. Geology

The geology of an area usually influences the soil found in that area (Mac Vicar *et al.* 1991). The 1:250 000 geological survey maps (Department of Mineral and Energy Affairs 1981) were referred to in describing the geology of the study area.

2. Topography

The topography of an area can moderate the effects of sunlight, rainfall, leaching, erosion and wind on the vegetation of that area (Strahler & Strahler 1987). The following topographical positions were identified in the study area and representatively selected for sample sites:

1 - crests
2 - scarps
3 - midslopes
4 - footslopes
5 - valley bottoms, floodplains or drainage lines
(Land Type Survey Staff 1984).

Furthermore, altitude, aspect and slope were determined for each sample site. The altitudes were ascertained by means of a hand-held GPS (Geographical Positioning System) device, aspect was detemined with a compass, and slope was determined with a gradient estimator.

3. Rockiness

The rockiness of the soil can influence the vegetative growth by affecting drainage, ease of germination and root penetration, and was expressed in terms of percentage cover of the sample plot. The average rock size was also estimated.

4. Soil form and soil depth

Soil form was determined at various sites in the field, but time constraints did not allow for pits to be dug at every sample site. Data from Geographic Information Systems (GIS) programmes such as EnPat 94 (Department of Environmental Affairs) was used to determine the soil forms occuring in the study area, and these were verified by field work conducted after all the botanical information had been obtained.

5. Soil texture

The relative quantities of sand, clay and silt in the soil affect plant growth as they influence drainage and water retention (MacVicar *et al.* 1991). Soil texture was determined by the "sausage method" (Du Toit 1982). The texture was expressed as percentage of clay content of the soil.

6. General observations

The extent of disturbance, in the form of erosion, trampling and utilisation, was noted at each relevé site. These factors can seriously influence the state of the vegetation (Tainton 1981).

Data Analysis

The floristic data together with the environmental observations for each sample plot is termed a relevé (Eckhardt 1993). The floristic data sets were subjected to the Two-Way Indicator Species Analysis technique (TWINSPAN) (Hill 1979). This technique indicated a first approximation of the vegetation units. Each major vegetation unit was subjected to a further TWINSPAN, and a phytosociological table was created using the computer programme MEGATAB (Hennekens 1996). Outlier relevés were removed, and the data sets subsequently refined using Braun-Blanquet procedures, in order to delineate the plant communities more accurately.

The ordination technique, Detrended Correspondence Analysis (DECORANA) (Hill 1979) was then applied to each of the major data sets identified by TWINSPAN in order to discern environmental gradients associated with variation between plant communities (Eckhardt 1993; Greig-Smith 1983).

Diversity of the grasslands was investigated with a view to comparison to other grassland regions. Unfortunately few other studies of the Grassland Biome Project have investigated diversity in any detail, and those that have (e.g. Eckhardt 1993) have mainly used species richness, or alpha diversity (Whittaker 1975) as a measure of diversity. Alpha and Beta diversity (Whittaker 1975) measures alone can be misleading in diversity comparisons as varying sample plot sizes and cover abundance scales may have been used. Therefore, in addition to species richness, it was decided to use dominance-diversity curves (Whittaker 1975; Odum 1983) as a measure of the two principal components of species diversity, namely species diversity and evenness or equitability (Odum 1983). This method involves plotting the importance values (mean cover-abundance was used in the present study) of species (ordinate), against the species numbers in sequence from the most to the least abundant (abscissa). The richness and relative abundance of species diversity, and niche partitioning in the ecosystem, can be depicted in this way (Odum 1983). A steeper curve indicates a lower overall diversity and greater dominance by a few species (Odum 1983) than a flatter curve. Conversely, a flatter curve indicates greater evenness of diversity distribution and greater overall diversity, if the "tail" of the curve extends further than the steeper curve. In the present study, major vegetation groups were subjected to this analysis. Cover-abundance values ("importance values") were calculated by summing the cover-abundance percentages for each species in each table, and dividing the total by the number of relevés in that table. The results are presented in Chapter 4.

A TWINSPAN dendrogram, abbreviated synoptic table and diversity figures are presented in Chapter 4. The results of the community classifications are presented in Chapters 5-9.

CHAPTER 4

RESULTS: DENDOGRAM, ABBREVIATED SYNOPTIC TABLE AND BIODIVERSITY

The dendrogram produced from the original TWINSPAN classification is shown in Figure 10. A synoptic table of the whole data set was produced and abbreviated and is presented in Table 1.

TWINSPAN analysis indicated the existence of six major groups within the data set, and Braun-Blanquet tables were processed separately, using MEGATAB, for five of these data sets. The sixth set comprised just 3 relevés and is representative of the *Podocarpus* forests at the altitudinal limit of the present study. These forests are not part of the Grassland Biome (Rutherford and Westfall 1986) and were cursorily investigated in order to compare their vegetation with the surrounding grasslands and scrub. An interesting forest margin ecotone is apparent from the synoptic table (Table 1). The other five major data sets represent plant communities from (i) the western part of the study area (the Drakensberg Foothills and Little 'Berg spurs), (ii) the undulating hills of the KwaZulu-Natal Midlands, (iii) the Mistbelt, (iv) the incised river valleys and dry upland savanna (together called the Wooded Grassland), and (v) the Wetlands.

The principal features of the abbreviated synoptic table are:

1) The *Podocarpus* forests, dominated by the trees *Podocarpus henkelii, P. latifolius, Rhus lucida, Kiggelaria africana, Clausena anisata, Trimeria grandifolia* and *Heteromorpha trifoliata*, the shrubs *Canthium ciliatum, Carissa bispinosa, Scutia myrtina* and *Pavetta cooperi*, and the fern *Adiantum poiretii*.

2) The forest margin, which includes species common to the grasslands and the forest: the fern *Mohria caffrorum* var. *caffrorum*, the shrubs *Maytenus heterophylla, Rhus dentata* and *Buddleja salviifolia*, the tree *Cussonia spicata* and the grasses *Melinis repens, Panicum*

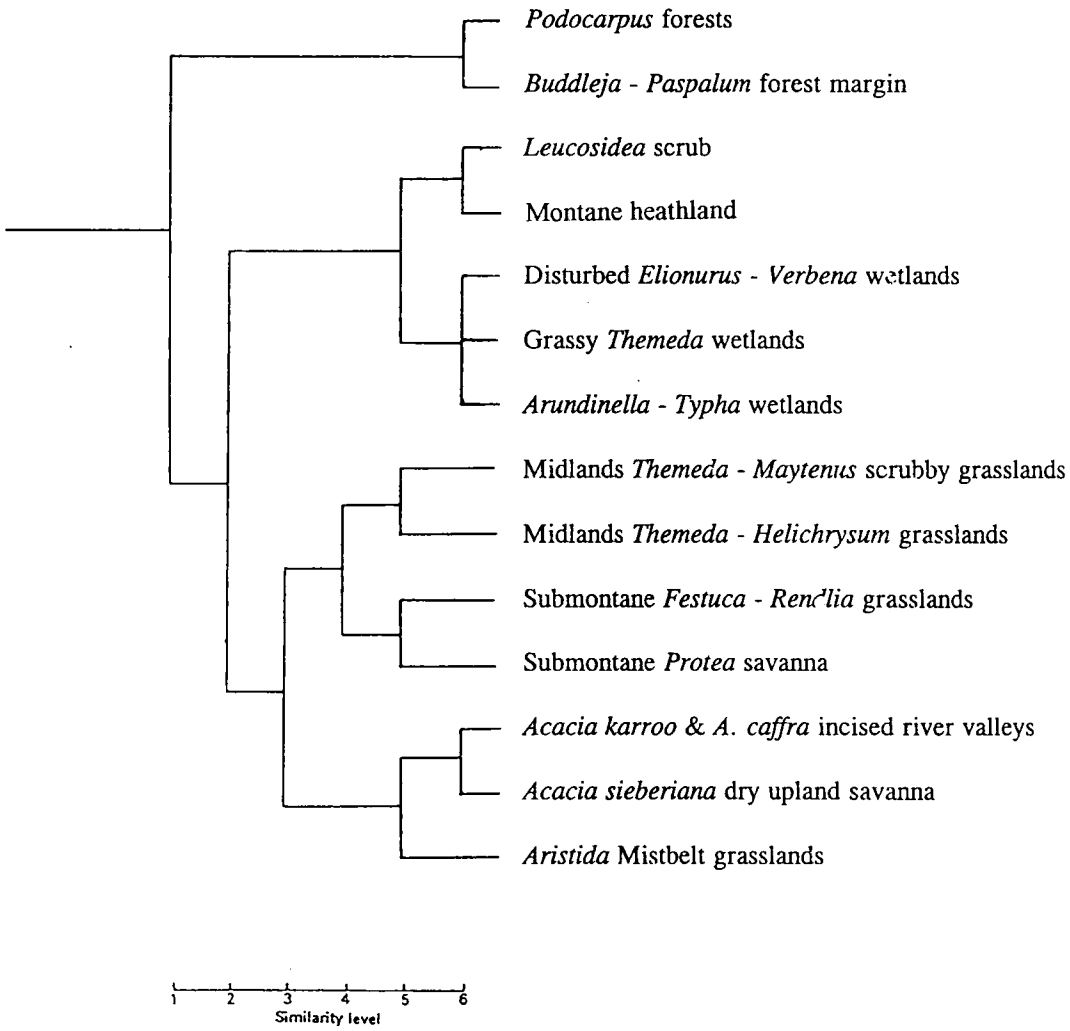


Figure 10. Simplified TWINSPAN dendrogram showing the major vegetation communities.

TABLE 1 Abbreviated Synoptic Table of the entire data set

Vegetation type	1	2	3	4	5	6
Number of relevés	3	100	98	49	31	215
FOREST						
Canthium ciliatum	100 (2)	2 (2)	.	3 (3)	.	.
Adiantum poiretii	100 (2)	.	.	.	.	.
Podocarpus henkelii	100 (5)	.	.	.	.	.
Podocarpus latifolius	100 (5)	.	.	.	.	.
Carissa bispinosa	100 (2)	.	.	.	.	.
Rhus lucida	67 (2)	.	0.7 (2)	.	.	.
Clausena anisata	67 (2)	.	.	.	.	.
Scutia myrtina	67 (2)	.	.	.	.	.
Kiggelaria africana	67 (2)	.	.	.	.	.
Heteromorpha trifoliata	67 (3)	.	.	.	.	.
Crocosmia paniculata	67 (2)	0.8 (2)	.	.	2 (2)	0.6 (2)
Polystichum dracomontana	67 (2)	.	.	.	.	0.6 (2)
Pavetta cooperi	67 (2)	.	.	.	.	.
Trimeria grandifolia	67 (5)	.	0.7 (3)	.	.	.
Scolopia mundii	33 (2)	0.8 (2)	.	.	.	.
Xymalos monospora	33 (6)	.	.	.	.	.
Ekebergia capensis	33 (3)	.	.	.	.	.
Dioscorea diversifolia	33 (5)	.	.	.	.	.
Calodendrum capense	33 (3)	.	.	.	.	.
Panicum deustum	33 (2)	.	.	.	.	.
Sanicula elata	33 (2)	.	.	.	.	.
Impatiens hochstetteri	33 (2)	.	.	.	.	0.6 (2)
Pteris catoptera	33 (2)	.	.	.	.	0.6 (2)
Carex spicato-paniculata	33 (2)	.	.	.	.	0.6 (2)
Cassinopsis ilicifolia	33 (2)	.	.	.	.	.
Desmodium repandum	33 (2)	.	.	.	.	.
Blechnum attenuatum v.gigan	33 (2)	.	.	.	.	.
Dioscorea sylvatica	33 (3)	.	.	.	.	.
Dioscorea rupicola	33 (5)	.	.	.	.	.
Podocarpus falcatus	33 (3)	.	.	.	.	.
Maytenus undata	33 (2)	.	.	.	.	.
Maytenus peduncularis	33 (2)	.	.	.	.	.
Celtis africana	33 (2)	.	.	3 (2)	.	.
Pterocelastrum echinatus	33 (2)	.	.	.	.	.
FOREST MARGIN						
Ochna serrulata	33 (2)	3 (3)	2 (3)	.	.	.
Mohria caffrorum v. caffr	33 (2)	15 (2)	0.7 (2)	16 (2)	6 (2)	.
Cussonia spicata	33 (2)	3 (4)	1 (2)	10 (2)	4 (2)	.
Melinis repens	33 (2)	10 (5)	6 (3)	23 (2)	13 (3)	4 (3)
Maytenus heterophylla	33 (2)	8 (3)	9 (3)	19 (3)	10 (3)	0.6 (2)
Panicum natalense	67 (2)	29 (3)	17 (4)	3 (2)	17 (3)	0.6 (2)
Rhus dentata	67 (2)	26 (4)	6 (3)	52 (3)	21 (5)	12 (5)
Paspalum dilatatum	100 (2)	3 (2)	6 (2)	16 (3)	13 (3)	26 (4)
Buddleja salviifolia	100 (6)	13 (4)	3 (2)	10 (5)	2 (2)	7 (3)
GENERAL SPECIES						
Eragrostis plana	.	21 (5)	29 (6)	36 (5)	42 (5)	25 (6)
Eragrostis racemosa	.	58 (4)	44 (3)	36 (3)	44 (3)	2 (3)
Monocymbium ceresiiforme	.	29 (6)	16 (5)	7 (2)	35 (4)	.
Helichrysum aureonitens	.	44 (4)	52 (4)	16 (4)	50 (4)	9 (5)
Tristachya leucothrix	.	45 (5)	44 (5)	23 (3)	40 (3)	1 (2)
Rhus discolor	.	25 (3)	12 (2)	10 (2)	13 (4)	1 (2)
Trachypogon spicatus	.	41 (6)	44 (5)	16 (4)	50 (3)	1 (5)
Loudetia simplex	.	31 (5)	14 (4)	7 (2)	17 (5)	.
Themeda triandra	.	63 (6)	71 (6)	52 (6)	50 (6)	4 (3)
HIGH-LYING GRASSLANDS						
Harpochloa falx	.	37 (3)	8 (2)	.	.	0.6 (2)
Rendlia altera	.	29 (5)	3 (3)	.	.	.
Festuca costata	.	19 (5)	2 (3)	.	.	.
Festuca scabra	.	8 (3)	1 (3)	.	.	1 (2)
Protea roupelliae	.	8 (4)	1 (6)	.	.	.
Protea caffra	.	6 (4)	3 (7)	.	.	.
Kyllinga pauciflora	.	7 (2)	.	.	.	.
Delosperma obtusum	.	3 (2)	.	.	.	.
Myrica serrata	.	3 (5)	.	.	.	0.6 (2)
Cotula hispida	.	3 (2)	0.7 (2)	.	.	.
Bulbostylis schoenoides	.	3 (2)	.	.	.	.
Aristea montana	.	3 (2)	.	.	.	.
Kniphofia ichopensis	.	3 (2)	.	.	.	.
Bulbostylis humilis	.	2 (2)	0.7 (2)	.	.	.
Menodora africana	.	2 (2)	.	.	.	.
Pseudognapha oligandrum	.	2 (2)	.	.	.	.
Polygala uncinata	.	2 (2)	.	.	.	.
Protea subvestita	.	2 (2)	.	.	.	.
Cyperus schlechteri	.	2 (2)	.	.	.	.
MIDLANDS GRASSLANDS						
Gladiolus crassifolius	.	0.8 (2)	5 (2)	.	.	.
Hoffmannsegg sanderson	.	.	3 (2)	.	.	.
Euryops pedunculatus	.	.	2 (2)	.	.	.
Zornia milneana	.	.	2 (2)	.	.	.
Rhynchosia totta	.	.	2 (2)	.	.	.
Bulbine narcissifolia	.	.	2 (6)	.	.	1 (2)
Berkheya zeyheri	.	.	1 (2)	.	.	.
Ctenium concinnum	.	.	1 (7)	.	.	.
Lithospermum papillosum	.	.	1 (2)	.	.	.
Senecio anomalochrous	.	.	1 (2)	.	.	.
Hebenstretia dregei	.	.	1 (2)	.	.	.
Helichrysum longifolium	.	.	1 (2)	.	.	.
Asclepias albens	.	.	1 (2)	.	.	.
Euryops laxus	.	.	1 (2)	.	.	.
Corchorus confusus	.	.	1 (2)	.	.	.
Acalypha pubiflora	.	.	1 (2)	.	.	.
Indigofera hedyantha	.	.	1 (2)	.	.	.
Setaria sphacelata v. seric	.	.	1 (2)	.	.	0.6 (2)
Senecio scitus	.	.	1 (2)	.	.	.
Hypoxis kraussiana	.	.	1 (2)	.	.	.
Cyphia elata	.	.	1 (2)	.	.	.
Oxalis smithiana	.	.	1 (2)	.	.	0.6 (2)

INCISED RIVER VALLEYS AND DRY UPLAND SAVANNAS

Hyparrhenia hirta	33	(2)	35	(6)	24	(6)	77	(6)	40	(6)	15	(6)
Acacia karroo	.		2	(2)	2	(2)	45	(5)	6	(3)	.	
Acacia sieberiana	.		.		.		32	(5)	.		.	
Acacia caffra	.		0.8	(3)	.		16	(3)	2	(3)	.	
Ziziphus mucronata	.		5	(2)	4	(3)	13	(2)	8	(2)	.	
Aloe arborescens	.		6	(5)	1	(5)	13	(2)	.		.	
Euclea crispa	.		0.8	(2)	.		13	(2)	2	(2)	4	(3)
Cussonia paniculata	.		3	(2)	2	(3)	13	(3)	.		0.6	(2)
Grewia occidentalis	.		2	(2)	.		13	(2)	2	(2)	.	
Ozoroa paniculosa	.		2	(5)	.		13	(2)	.		.	
Rhus rehmanniana v. rehman	.		.		.		7	(2)	.		.	
Acacia nilotica	.		.		.		7	(2)	.		.	
Haemanthus humilis	.		0.8	(2)	.		7	(2)	.		.	
Rhynchosia reptabunda	.		0.8	(2)	0.7	(2)	7	(2)	.		0.6	(2)
Indigofera vicioides	.		.		.		3	(2)	.		.	
Othonna pinnatilobata	.		.		.		3	(2)	.		.	
Jamesbrittenia pristisep	.		.		.		3	(2)	.		.	
Putterlickia verrucosa	.		.		.		3	(2)	.		.	
Pachycarpus grandiflora	.		.		.		3	(2)	.		.	
Othonna natalensis	.		.		.		3	(2)	.		0.6	(2)
Hibiscus pusillus	.		.		.		3	(2)	.		.	
Hypoxis colchicifolia	.		.		.		3	(2)	.		.	
Vigna unguiculata s. stenop	.		.		.		3	(2)	.		.	
Wahlenbergia capensis	.		.		0.7	(2)	3	(2)	.		0.6	(2)
Zaluzianskya maritima	.		.		.		3	(2)	.		.	
Nemesia fruticans	.		.		.		3	(2)	.		.	
Kniphofia northiae	.		.		.		3	(2)	.		.	
Hermannia oblongifolia	.		.		.		3	(2)	.		.	
Habenaria epipactidea	.		.		.		3	(2)	.		.	
Lantana camara	.		.		.		3	(2)	.		.	
MISTBELT GRASSLANDS												
Aristida junciformis	.		17	(5)	0.7	(2)	7	(2)	92	(5)	.	
Aristida congesta s. conge	.		3	(2)	3	(2)	3	(2)	10	(5)	2	(2)
Chamaesyce inaequilatera	.		.		0.7	(2)	.		6	(2)	.	
Thunbergia atriplicifolia	.		6	(2)	1	(2)	.		4	(2)	.	
Aloe aristata	.		.		.		.		4	(2)	.	
Tephrosia macropoda	.		.		0.7	(2)	.		4	(2)	.	
Convolvulus natalensis	.		.		0.7	(2)	.		4	(2)	.	
Oxalis tragopoda	.		.		0.7	(2)	.		4	(2)	.	
Heliophila alpina	.		2	(2)	.		.		4	(2)	.	
Gladiolus parvulus	.		.		.		.		4	(2)	.	
Gnidia capitata	.		.		.		.		2	(2)	.	
Eriosema simulans	.		.		.		.		2	(2)	.	
Rhynchosia cooperi	.		.		0.7	(2)	.		2	(2)	.	
Senecio ilicifolius	.		.		0.7	(2)	.		2	(2)	.	
Hyparrhenia anamesa	.		0.8	(2)	.		.		2	(2)	.	
Helichrysum vernum	.		.		.		.		2	(2)	.	
Cucumis africanus	.		.		0.7	(2)	.		2	(2)	.	
Senecio glaberrimus	.		.		.		.		2	(2)	.	
Pimpinella caffra	.		.		.		.		2	(2)	.	
Lobelia preslii	.		.		.		.		2	(2)	.	
Linum africanum	.		.		0.7	(2)	.		2	(2)	.	
Ozoroa paniculosa v. panic	.		.		.		.		2	(2)	.	
Helichrysum nanum	.		2	(2)	.		.		2	(2)	.	
Hebenstretia oatesii s. oates	.		.		.		.		2	(2)	.	
Lotononis pulchella	.		.		.		.		2	(2)	.	
Thesium rigidum	.		.		.		.		2	(2)	.	
Myrica kraussiana	.		.		.		.		2	(2)	.	
Helichrysum acutatum	.		.		.		.		2	(2)	.	
Syncolostemom parviflorum	.		.		.		.		2	(2)	.	
Helichrysum albo-brunneum	.		.		.		.		2	(2)	.	
Hypoxis acuminata	.		0.8	(2)	.		.		2	(2)	.	
Helichrysum cymosum	.		.		.		.		2	(2)	.	
Syncarpha paniculata	.		.		0.7	(2)	.		2	(2)	.	
WETLANDS												
Arundinella nepalensis	.		.		1	(6)	.		2	(5)	38	(5)
Leucosidea sericea	33	(5)	8	(3)	1	(2)	.		8	(6)	24	(6)
Verbena bonariensis	.		.		.		.		10	(5)	34	(3)
Mariscus congestus	.		0.8	(2)	.		.		4	(2)	35	(5)
Typha capensis	.		.		.		.		.		18	(6)
Salix mucronata s. woodii	.		.		0.7	(2)	.		.		14	(5)
Gunnera perpensa	.		.		0.7	(2)	.		.		11	(4)
Phragmites australis	.		.		0.7	(5)	.		.		12	(6)
Oenothera indecora s. bonar	.		0.8	(2)	3	(2)	.		.		9	(3)
Ranunculus multifidus	.		3	(2)	0.7	(2)	.		.		8	(3)
Carex austro-africana	.		0.8	(2)	.		.		.		9	(6)
Cliffortia nitidula	.		.		.		.		.		7	(6)
Trifolium repens	.		.		.		.		.		5	(3)
Persicaria serrulata	.		.		.		.		.		5	(2)
Panicum schinzii	.		.		.		.		.		6	(2)
Ilex mitis	.		.		.		.		.		5	(2)
Sium repandum	.		.		.		.		.		4	(3)
Passerina montana	.		.		.		.		.		4	(4)
Sonchus asper	.		.		.		.		.		4	(2)
Psoralea pinnata	.		.		.		.		.		4	(3)
Erica anomala	.		.		.		.		.		4	(2)
Olinia emarginata	.		.		.		.		.		3	(2)
Passerina filiformis	.		.		.		.		.		2	(3)
Fuirena pubescens	.		.		.		.		.		3	(3)
Senecio dissimulans	.		0.8	(2)	.		.		.		2	(2)
Helichrysum cooperi	.		.		.		.		2	(5)	3	(3)
Agrostis lachnantha	.		.		.		.		.		2	(2)
Valeriana capensis	.		.		.		.		.		3	(2)
Salix babylonica	.		.		.		.		.		3	(6)
Schizostylis coccinea	.		.		.		.		.		3	(3)
Myrothamnus flabellifolius	.		.		.		.		.		3	(2)
Lactuca indica	.		.		.		.		.		1	(2)
Brachiaria eruciformis	.		.		.		.		.		1	(2)
Cyperus fastigiatus	.		.		.		.		.		1	(2)
Solanum panduriforme	.		.		.		.		.		1	(2)
Berkheya echinacea s. echin	.		.		.		.		.		1	(2)
Paspalum distichum	.		.		.		.		.		1	(3)
Digitaria brazzae	.		.		.		.		.		1	(2)
Juncus dregeanus	.		.		.		.		.		1	(2)
Datura stramonium	.		.		.		.		.		1	(2)
Juncus inflexus	.		.		.		.		.		1	(3)
Senecio purpureus	.		.		.		.		.		1	(2)
Ascolepis capensis	.		.		.		.		.		1	(2)
Pycreus flavescens	.		.		.		.		.		1	(2)
Lolium rigidum	.		.		.		.		.		1	(2)
Cliffortia linearifolia	.		.		.		.		.		1	(2)

Tulbaghia natalensis	.		.		.		.		.		1	(2)
Dierama dracomontanum	.		.		.		.		.		1	(2)
Agrostis lachnantha v. lachn	.		.		.		.		.		1	(2)
Psoralea restioides	.		.		.		.		.		1	(2)
Cliffortia lanceolata	.		.		.		.		.		1	(5)
Agrostis montevidensis	.		.		.		.		.		2	(2)
Juncus punctorius	.		.		.		.		.		2	(2)
Andropogon eucomus	.		.		.		.		.		2	(2)
Pycreus macranthus	.		.		.		.		.		2	(2)
Rhynchospora brownii	.		.		.		.		.		2	(2)
Juncus oxycarpus	.		.		.		.		.		2	(4)
Plantago longissima	.		.		.		.		.		2	(2)
Hyparrhenia dregeana	.		.		.		.		.		2	(3)
Nidorella auriculata	.		.		0.7	(2)	.		.		2	(2)
Rumex crispus	.		.		.		.		.		2	(2)
Oenothera rosea	.		.		.		.		.		2	(2)
OTHER GENERAL SPECIES												
Halleria lucida	.		8	(2)	0.7	(2)	3	(2)	8	(2)	4	(2)
Rubus ludwigii	.		12	(3)	4	(2)	7	(2)	4	(5)	4	(3)
Melinis nerviglumis	.		16	(3)	6	(3)	7	(3)	6	(3)	.	
Diospyros lycioides	.		11	(5)	4	(3)	13	(4)	2	(2)	1	(2)
Pellae calomelanos v. leuco	.		11	(2)	.		10	(2)	4	(2)	0.6	(2)
Geranium pulchrum	.		2	(2)	3	(2)	3	(2)	2	(2)	6	(3)
Cliffortia paucistamin	.		3	(2)	.		.		.		4	(5)
Alloteropsis semial s. semia	.		14	(2)	6	(2)	.		.		.	
Eragrostis capensis	.		23	(3)	16	(3)	7	(2)	13	(2)	0.6	(2)
Rhoicissus tridentata	33	(3)	4	(3)	.		32	(3)	4	(2)	0.6	(3)
Rubus cuneifolius	.		11	(3)	16	(5)	23	(3)	10	(2)	18	(4)
Sporobolus africanus	.		7	(4)	22	(5)	29	(6)	29	(4)	14	(3)
Paspalum urvillei	.		0.8	(2)	1	(5)	.		2	(2)	34	(5)
Polygonum hystriculum	.		.		.		3	(2)	4	(6)	39	(4)
Senecio inornatus	.		7	(3)	9	(4)	10	(2)	13	(2)	19	(3)
Acacia mearnsii	.		3	(2)	2	(2)	.		2	(5)	19	(6)
Miscanthus capensis	.		3	(3)	2	(2)	.		2	(2)	26	(6)
Juncus effusus	.		2	(2)	0.7	(7)	.		2	(2)	22	(5)
Helichrysum kraussii	.		10	(3)	8	(3)	3	(2)	8	(2)	0.6	(2)
Plantago lanceolata	.		0.8	(2)	0.7	(2)	3	(2)	.		5	(7)
Conyza albida	.		6	(2)	2	(2)	.		6	(3)	17	(3)
Bidens pilosa	.		0.8	(2)	5	(2)	.		2	(2)	8	(2)
Tagetes minuta	.		0.8	(2)	3	(3)	7	(2)	.		8	(3)
Conyza obscura	.		5	(2)	10	(3)	13	(3)	27	(2)	9	(3)
Conyza canadensis	.		3	(2)	1	(2)	.		2	(2)	1	(2)
Senecio harveianus	.		2	(2)	4	(2)	.		2	(2)	12	(3)
Pseudognaphalium luteo-album	.		5	(3)	4	(3)	.		10	(2)	15	(2)
Helichrysum mundtii	.		.		2	(2)	.		6	(2)	5	(3)
Monopsis decipiens	.		8	(2)	10	(3)	.		6	(2)	5	(2)
Cymbopogon validus	.		13	(5)	14	(4)	23	(5)	25	(6)	9	(5)
Kyllinga erecta	.		0.8	(2)	.		.		.		1	(2)
Leersia hexandra	.		.		0.7	(5)	.		.		5	(6)
Hesperantha baurii s. bauri	.		3	(2)	0.7	(2)	.		.		0.6	(2)
Conyza scabrida	.		0.8	(2)	.		.		.		3	(2)
Conyza bonariensis	.		0.8	(2)	.		.		.		3	(2)
Anthospermum monticola	.		.		0.7	(2)	.		.		2	(2)
Erica evansii	.		.		.		.		.		2	(2)
Cheilanthes quadripinnata	.		24	(2)	3	(2)	3	(2)	19	(2)	6	(2)
Chrysanthemona monilifera	.		3	(4)	.		3	(2)	.		0.6	(2)
Alectra sessiliflorus v. sess	.		9	(2)	4	(2)	3	(2)	8	(2)	0.6	(2)
Diheteropogo amplecten	.		19	(5)	16	(4)	3	(2)	17	(3)	.	
Helichrysum glomeratum	.		35	(2)	22	(3)	3	(2)	17	(2)	.	
Sebaea leiostyla	.		24	(2)	20	(2)	10	(2)	21	(2)	.	
Watsonia pillansii	.		3	(2)	1	(2)	.		4	(2)	.	
Protea dracomontana	.		0.8	(2)	1	(2)	3	(2)	4	(2)	.	
Alloteropsis semialata	.		14	(3)	6	(2)	.		4	(2)	.	
Scilla natalensis	.		6	(2)	.		3	(2)	.		.	
Zanthoxylum capense	33	(5)	3	(2)	3	(2)	3	(2)	4	(2)	.	
Greyia sutherlandii	33	(3)	3	(4)	1	(5)	3	(3)	2	(2)	.	
Rabdosiella calycina	.		8	(2)	.		.		2	(2)	1	(5)
Diospy austro v. austr	.		3	(2)	1	(2)	3	(2)	4	(2)	0.6	(2)
Rhus pyroides	.		5	(5)	3	(2)	10	(2)	.		0.6	(2)
Aloe ferox	.		0.8	(2)	1	(5)	.		.		.	
Rhus rehmanniana	.		5	(3)	4	(3)	3	(2)	4	(3)	.	
Microchloa caffra	.		9	(3)	7	(4)	3	(2)	2	(2)	.	
Mohria rigida	.		3	(2)	.		3	(2)	2	(2)	0.6	(2)
Diospyros whyteana	.		3	(4)	1	(2)	3	(2)	.		.	
Pentaschistis tysonii	.		5	(2)	0.7	(2)	.		.		.	
Polygala hispida	.		7	(2)	1	(2)	.		.		.	
Moraea inclinata	.		6	(2)	0.7	(2)	.		2	(2)	.	
Helichrysum cephaloide	.		7	(2)	8	(3)	3	(2)	2	(2)	.	
Erica drakensbergensis	.		8	(3)	1	(2)	.		2	(2)	.	
Crassula setulosa	.		3	(2)	2	(2)	3	(2)	.		.	
Cheila viridi v. virid	.		3	(2)	1	(2)	7	(2)	2	(2)	0.6	(2)
Asparagus setaceus	.		.		0.7	(2)	3	(2)	6	(2)	0.6	(2)
Pteridium aquilinum	33	(2)	3	(5)	9	(3)	.		2	(2)	4	(3)
Elionurus muticus	.		24	(3)	20	(4)	3	(2)	4	(5)	8	(5)
Myrsine africana	.		6	(3)	4	(3)	3	(2)	2	(2)	5	(3)
Watsonia meriana	.		6	(2)	5	(3)	.		4	(2)	0.6	(2)

natalense and *Paspalum dilatatum*.

3) The high-lying grasslands, characterised by the presence of the grasses *Festuca costata, F. scabra, Rendlia altera* and *Harpochloa falx*, and the savanna of *Protea caffra* and *P. roupelliae*. These grasslands are nevertheless dominated by more widespread grasses: *Themeda triandra, Trachypogon spicatus, Eragrostis racemosa, Loudetia simplex, Monocymbium ceresiiforme* and others.

4) The grasslands of the midlands, dominated also by *Themeda triandra, Trachypogon spicatus, Eragrostis racemosa, Loudetia simplex, Monocymbium ceresiiforme*, as well as by forbs such as *Helichrysum aurionitens* and distinguished by the presence of the forbs *Gladiolus crassifolius, Hoffmannseggia sandersonii, Euryops pedunculatus* and others. The absence of the high altitude grasses and *Protea* species also characterises this group.

5) The drier and woodier vegetation of the incised river valleys of Mkomazi and Mzimkulu and dry upland savanna around Estcourt: the thorn trees *Acacia karroo, A. sieberiana, A. caffra, A. nilotica* and *Ziziphus mucronata*, the trees or shrubs *Ozoroa paniculosa, Cussonia paniculata, Euclea crispa, Grewia occidentalis* and *Rhus rehmanniana*, and the succulent *Aloe arborescens* dominate the woody vegetation in this group. The herbaceous vegetation is dominated by the grasses *Hyparrhenia hirta* and *Themeda triandra*, and contains a wide variety of forbs such as *Haemanthus humilis, Rhynchosia reptabunda* and *Indigofera vicioides*.

6) The Mistbelt vegetation is dominated by the unpalatable grass *Aristida junciformis*, which has replaced *Themeda triandra* in much of this small area. *Themeda triandra* is, nevertheless, still common in this group. Few woody species are found in the Mistbelt grasslands. A wide variety of forbs, including *Chamaesyce inaequilatera, Thunbergia atriplicifolia, Tephrosia macropoda, Convulvulus natalensis* and *Oxalis tragopoda*, is found.

7) The wetland vegetation is dominated by a few species which are commonly found bordering most vleis and rivers in the study area: these include the grasses *Arundinella nepalensis* and

Phragmites australis, the sedge *Mariscus congestus*, the forb *Typha capensis*, the exotic weed *Verbena bonariensis*, and the indigenous willow *Salix mucronata* ssp. *woodii*. Lining many water courses, especially in conserved and high-lying areas, is the shrub *Leucosidea sericea*, often found in association with *Buddleja salviifolia* and *Olinia emarginata*. Elements of a heathland vegetation are associated with moist areas at high altitude: these elements include *Passerina* and *Erica* species.

Species Richness data for the major vegetation groups, in terms of mean number of species per relevé, are presented in a bar chart (Figure 11).

Dominance-diversity curves for the five major vegetation groups are presented in Figure 12. A bar chart for the ten most abundant species in the Wetlands, Drakensberg Foothills and Wooded Grassland is presented in Figure 13, and a similar bar chart for the Wetlands, Mistbelt Grassland and Midlands Grassland is presented in Figure 14. These results are discussed in Chapter 10.

The principal features of the Biodiversity Figures are as follows:

The Species Richness data (Figure 11) indicates the Drakensberg Foothills as having on average the greatest number of species per relevé (24.31), with the Wetlands having the lowest number (12.00). These figures are a simple way of depicting the alpha diversity (Whittaker 1975) of the vegetation. The species richness of the vegetation in the present study is comparable to that found by Eckhardt *et al.* (1996) in northern KwaZulu-Natal, where the highest number of species per relevé was 30, the lowest 10, and the mean 21.40. The relevé sizes of Eckhardt *et al.* (1996) were however greater, at 100 m². The mean number of species per 100 m² relevé in Eastern Cape grasslands was found to be considerably higher, at 28.67 (Hoare, in prep.).

The biodiversity curves (Figures 12 to 14) indicate a spread of diversity within the Wetlands, with no extremes of domination. The other vegetation groups are all dominated by a few species, with the Midlands Grassland being the most dominated (by *Themeda triandra)* and

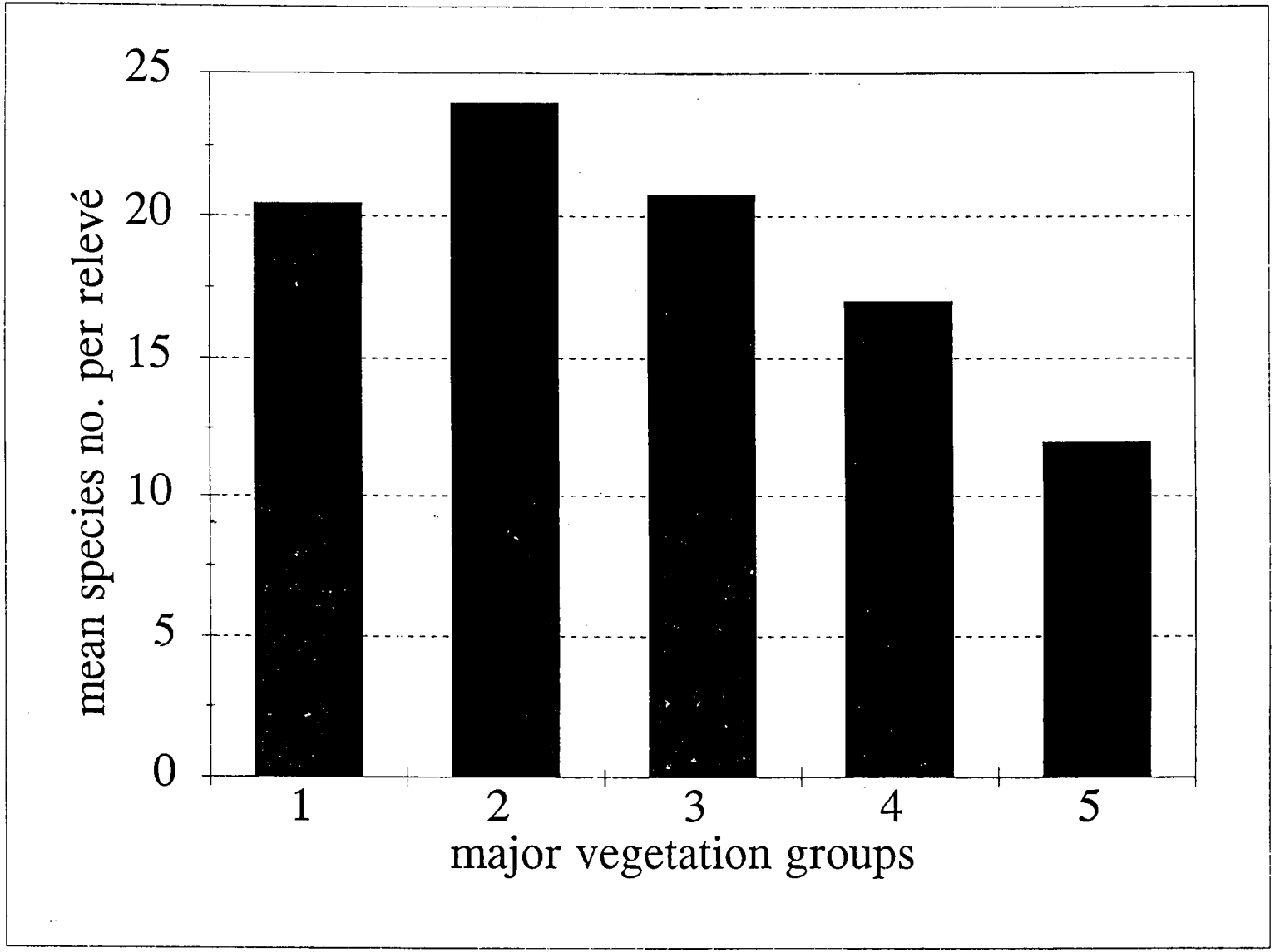


Figure 11. Species Richness (mean species number/relevé) for the major vegetation groups. 1 = Wooded Grassland; 2 = Drakensberg Foothills; 3 = Midlands Grassland; 4 = Mistbelt Grassland; 5 = Wetlands

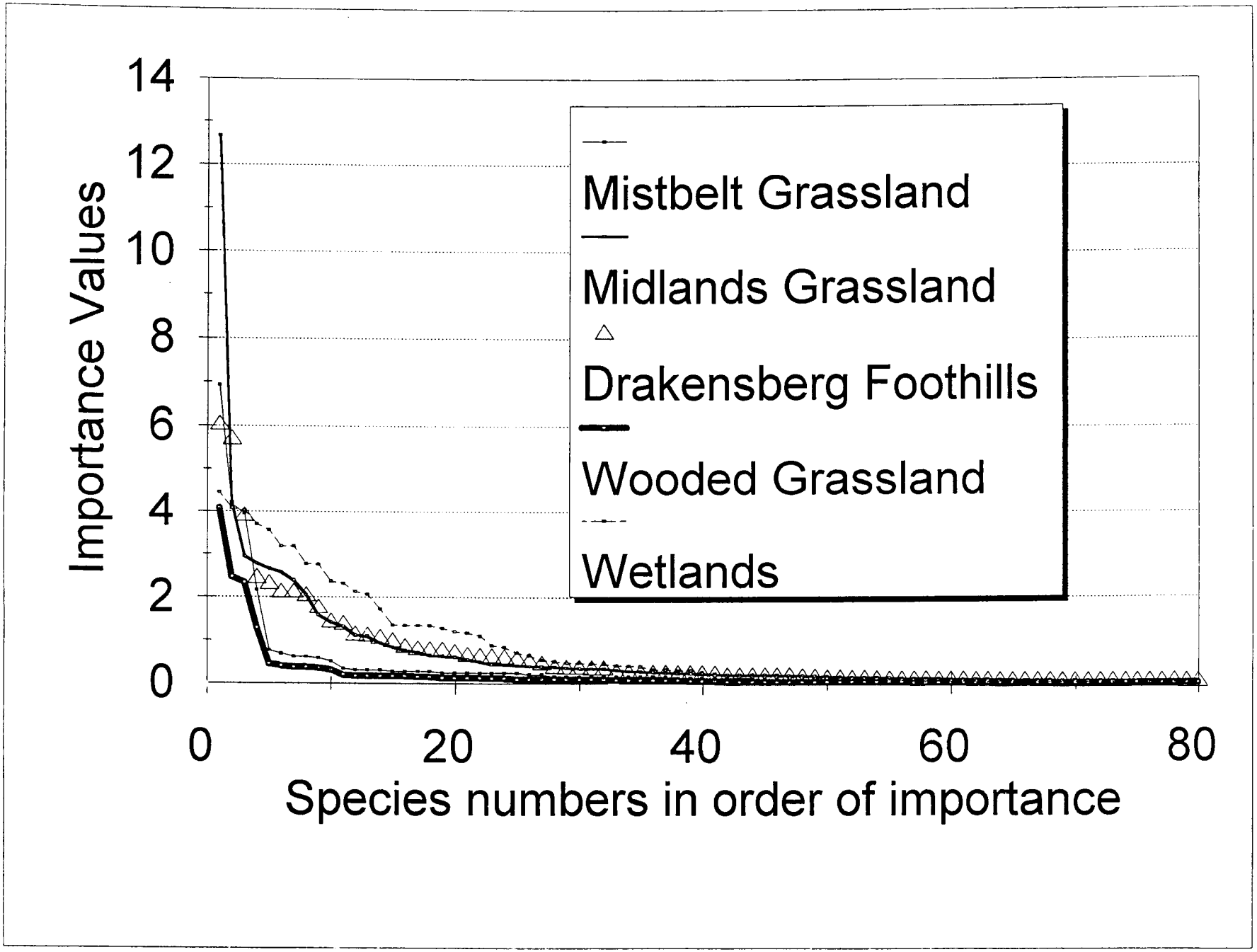


Figure 12. Dominance-diversity curves for the major vegetation groups (After Whittaker 1975). See text for explanation.

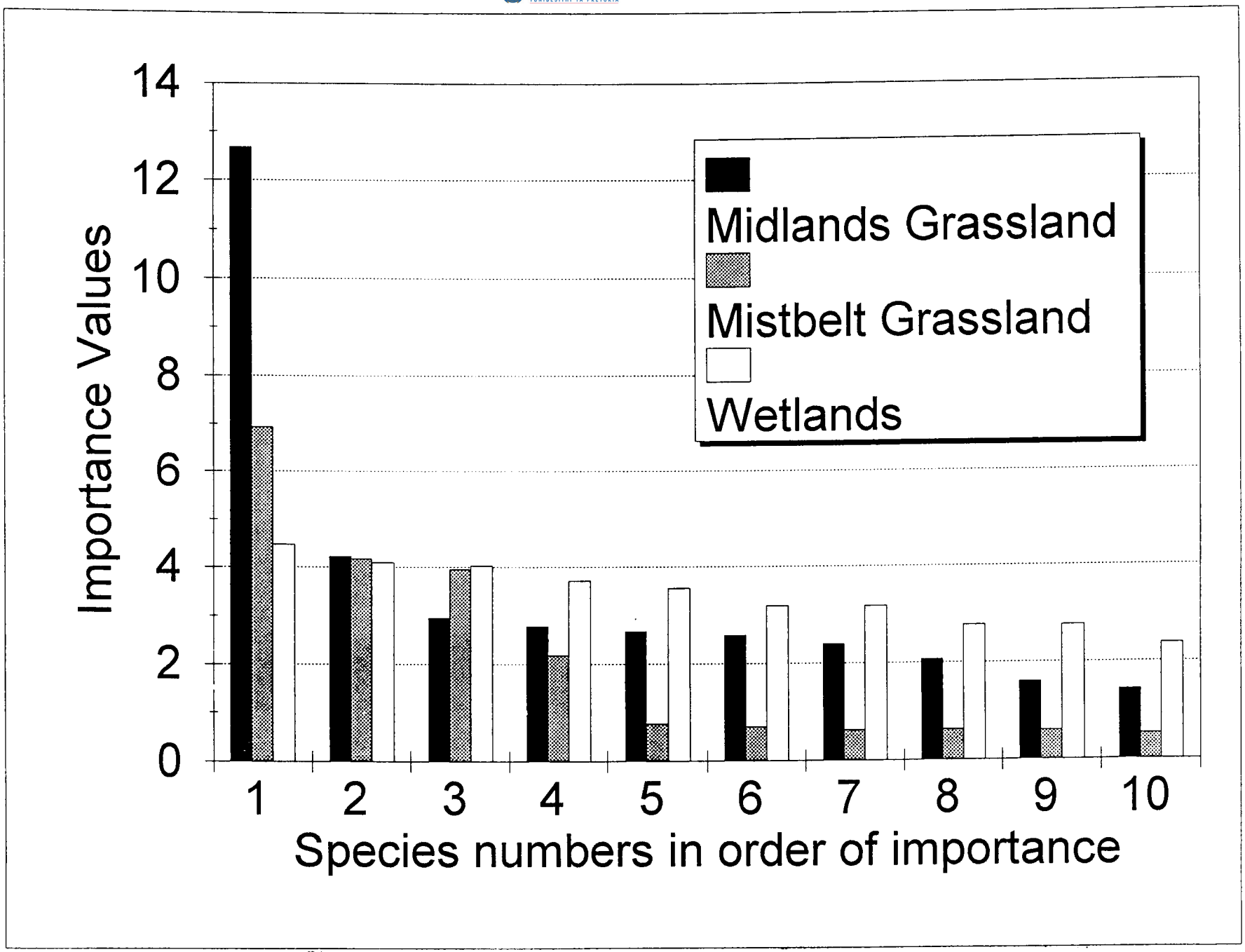


Figure 13. Dominance-diversity bar charts for the ten most common species in the Midlands, Mistbelt and Wetlands.

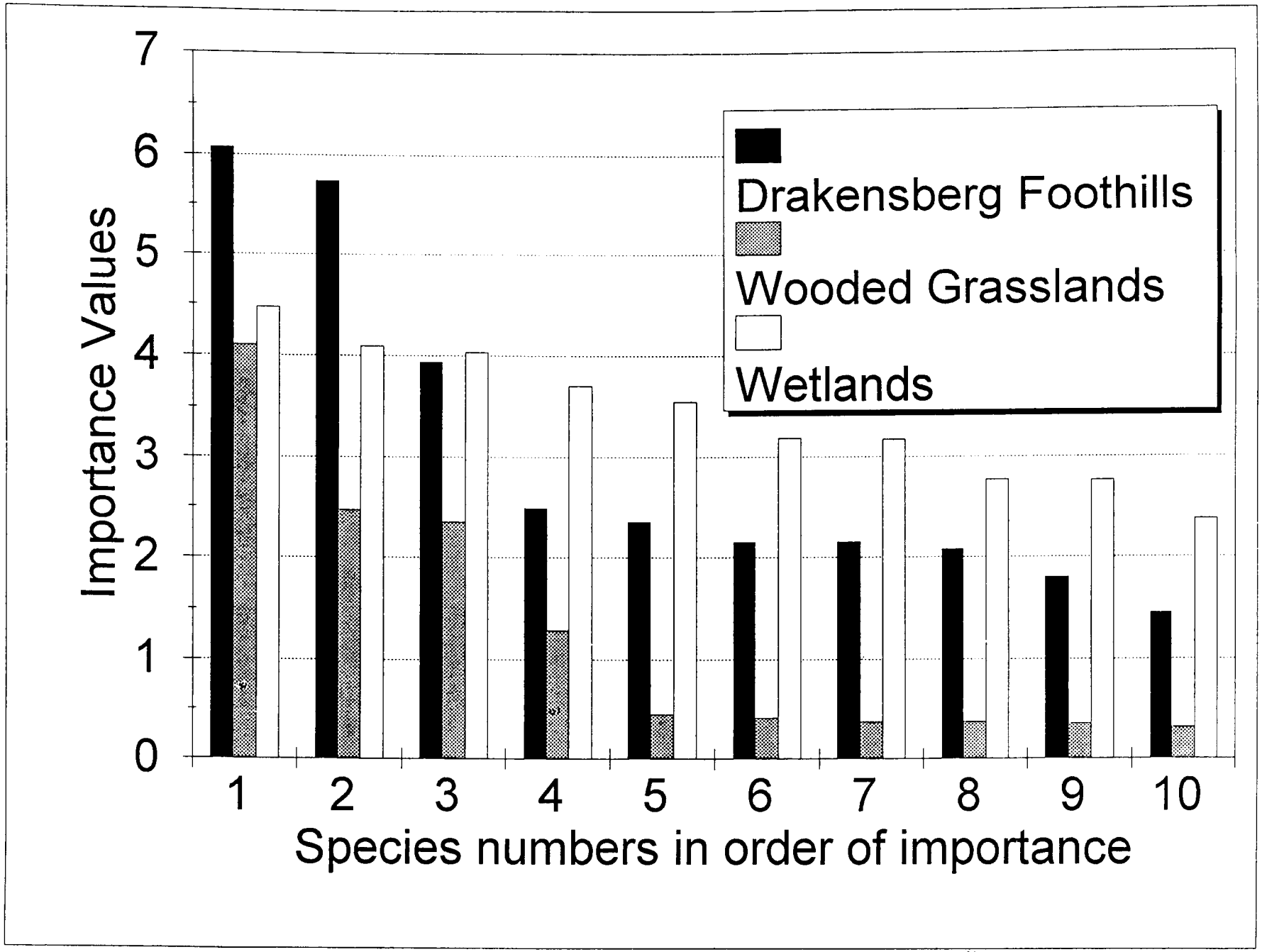


Figure 14. Dominance-diversity bar charts for the ten most common species in the Drakensberg Foothills, Wooded Grassland and Wetlands.

therefore showing the most unequal distribution of diversity. The Drakensberg Foothills, while also dominated by *Themeda triandra*, show more of a spread of diversity, and the Mistbelt Grassland and Incised River Valleys/ Dry Upland Savanna (here labelled the Wooded Grassland) show dominance by a few grasses and *Acacia* species. These results are discussed in Chapter 11.

Detrended Correspondence Analysis (DECORANA) was used as an ordination technique to attempt to identify environmental gradients in the communities (Eckhardt 1993). Disappointing results were obtained: although moisture availability was identified as an environmental gradient in the Midlands and Wetlands data sets, no other meaningful environmental gradients were discernible. Further, experimenting with various combinations of axes and re-ordination after removing outliers did not account for more than 45 % to 50 % of the variability. Consequently, the environmental interpretation was instead derived from environmental data obtained in the field.

CHAPTER 5

THE PHYTOSOCIOLOGY OF THE KWAZULU-NATAL DRAKENSBERG FOOTHILLS AND SPURS

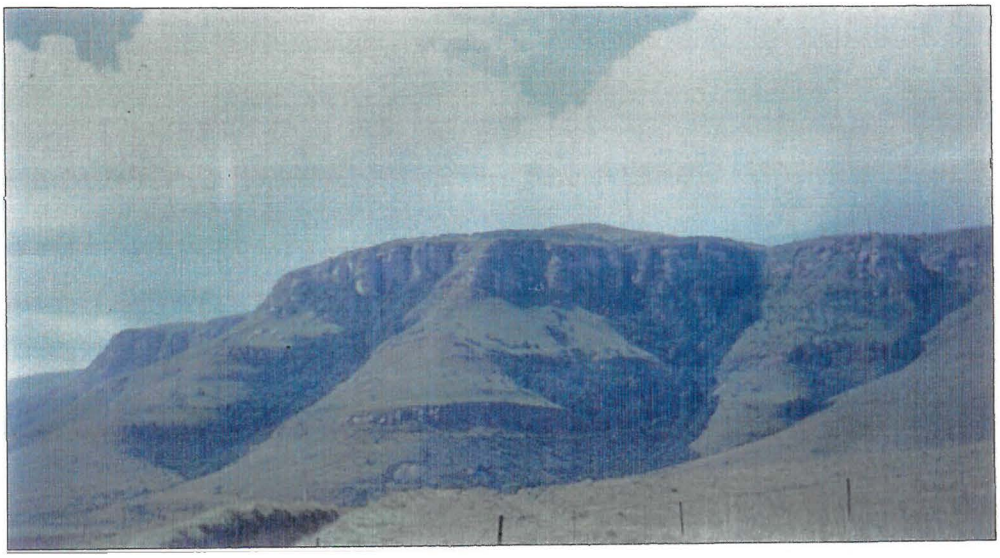


Figure 15. Spurs of the Northern Drakensberg, near Hillside, Giant's Castle. *Podocarpus* forests in the sheltered ravines, *Themeda triandra* - dominated grassland on the slopes, and *Themeda* - *Rendlia* grassland on the crests.

Figure 16. *Protea* savanna in the Drakensberg Foothills near Inzinga Ranches, with *Themeda triandra* dominating the herbaceous layer.

The 121 relevés collected in the Drakensberg foothills and spurs are presented in Table 2. In general the vegetation of the Drakensberg foothills and spurs can be classified as a *Themeda triandra* - *Trachypogon spicatus* undisturbed grassland.

This grassland occurs in the westernmost regions of the study area, and falls within the veld type described as "Highland Sourveld" by Acocks (1988). It also falls within the submontane Bioclimatic Subregion (region 4) described by Phillips (1973). This westernmost region is the least disturbed of the whole study area, as much of it lies within nature reserves or other conservation areas.

The mean annual precipitation varies from 1 200 mm to 2 000 mm, resulting in a sourveld grassland in which the grasses lose much of their grazing value during the dry winter, becoming unpalatable. *Themeda triandra* is an important grazing grass during the summer. Other common grasses are *Eragrostis curvula, Panicum natalense, Trachypogon spicatus, Tristachya leucothrix, Monocymbium ceresiiforme, Eragrostis racemosa, Eragrostis plana, Heteropogon contortus* and *Harpochloa falx*.

The altitude varies from 1 000 m to 1 900 m above sea level. Hilliard & Burt (1987) give an account of the High Drakensberg vegetation (above 1 800 m). This latter vegetation is also a grassland, but shows differences associated with the higher altitude and more extreme climate. For example, with increasing altitude, *Themeda triandra* becomes more restricted to warmer north-facing slopes (Irwin & Irwin 1992).

The soils are generally shallow and erodible, but are deeper in flatter areas towards the foot of the Little 'Berg. The upland soils have a high aluminium and iron content, are heavily leached, and are typically low in available phosphates, thus lowering the soil fertility (Killick 1990). Soils lower down the Little 'Berg are generally more fertile, having gained the nutrients leached from the uplands. The topsoil is acidic (pH 3.9 to 5.9), and the clay minerals smectite, kaolinite and gibbsite are common (Killick 1990).

Anthropogenic influences include the use of fire, both historically and as part of the current

management plan of the Natal Parks Board under whose jurisdiction much of this grassland falls. Where the grassland is protected from fire, *Hyparrhenia* spp. tend to replace the other dominant grass species such as *Themeda triandra* and *Monocymbium ceresiiforme*. Many forbs are associated with this grassland, including *Pentanisia prunelloides*, *Berkheya rhapontica*, *Gnidia kraussiana*, *Wurmbea kraussii* and species of the genera *Helichrysum*, *Senecio*, *Acalypha*, *Aster*, *Hypoxis*, *Erica*, *Disa*, *Sebaea* and *Crassula*. Shrubs and trees are generally restricted to south-facing slopes, rocky areas, and other areas protected from fire, and include *Halleria lucida*, *Greyia sutherlandii*, *Buddleja salviifolia*, *Leucosidea sericea* and species of the genera *Diospyros*, *Rhus* and *Protea*. Some of the north-facing slopes support a Protea savanna and this open vegetation structure contrasts strongly with the more densely woody south-facing slopes. There are some differences between the Little 'Berg north of Giant's Castle and south of it, but these are mainly restricted to the distribution of certain grasses such as *Hyparrhenia hirta*, *Rendlia altera*, *Diheteropogon filifolius* and *Sporobolus pyrimidalis*, and the distribution of trees such as *Protea roupelliae* and *Protea caffra*.

The classification revealed 6 communities and 8 sub-communities. These are:

1. *Festuca costata* - *Bromus firmior* moist grassland community.

    1.1 *Festuca costata* - *Rhus dentata* moist rocky grassland sub-community.
    1.2 *Festuca costata* - *Eragrostis racemosa* moist non-rocky grassland sub-community.

2. *Themeda triandra* - *Rendlia altera* undulating grassland community.

    2.1 *Rendlia altera* - *Hypoxis argentea* moist slope sub-community.
    2.2 *Rendlia altera* - *Rhodohypoxis baurii* rocky crest sub-community
    2.3 *Rendlia altera* - *Stiburus alopecuroides* non-rocky crest sub-community.
    2.4 *Rendlia altera* - *Diheteropogn filifolius* north-facing slope sub-community.

3. *Themeda triandra* - *Elionurus muticus* dry grassland community.

4. *Festuca costata - Themeda triandra* grassland crest community.

5. *Protea roupelliae - Protea caffra - Themeda triandra* open savanna community.

   5.1 *Protea roupelliae - Trachypogon spicatus* non-rocky savanna sub-community.
   5.2 *Protea caffra - Halleria lucida* rocky savanna sub-community.

6. *Buddleja salviifolia - Melinis nerviglumis* rocky scarp community.

Description of the plant communities

1. *Festuca costata - Bromus firmior* moist grassland community.

This grassland community is found on moist slopes above 1 800 m. It is characterised by species group A (Table 2), and is dominated by the grasses *Festuca costata* and *Bromus firmior (species group A),* and *Themeda triandra, Tristachya leucothrix, Eragrostis racemosa* and *Trachypogon spicatus* (species group P, Table 2). Other grasses in species group A are *Pentaschistis tysonii* and *Festuca scabra*. This community occurs on south-facing slopes where a reduced insolation confers higher moisture levels than on north-facing slopes (Granger & Schulze 1977). The radiation load is especially reduced in winter, creating more mesic conditions on south-facing slopes. According to Granger & Schulze (1977), these mesic conditions facilitate scrub invasion on south-facing slopes, especially on fire-protected ones.The soils are leached and two sub-communities can be distinguished based on rockiness.

1.1. *Festuca costata - Rhus dentata* moist rocky grassland sub-community.

This grassland is found on south-facing rocky slopes where the evaporation is relatively slow and the ground moisture is therefore higher than on north-facing slopes. The rocks, of both sandstone and doleritic origin, provide protection from fire and consequently several woody species are found in this sub-community which would otherwise be absent. These include *Rhus*

dentata (species group B), *Rabdosiella calycina* (species group M) and *Rhus discolor* (species group P). Species group B, which is characteristic of this sub-community, also includes other species which are associated with rock cover, namely the grass *Cymbopogon validus* (Gibbs Russell *et al.* 1991) and the forbs *Thunbergia atriplicifolia, Wahlenbergia undulata* and *Crassula vaginata* (Van Wyk & Malan 1988).

1.2 *Festuca costata - Eragrostis racemosa* moist non-rocky grassland sub-community.

This sub-community is characterised by the presence of species group A and the absence of species group B. South-facing slopes without rocks are the site of this sub-community, which is dominated by grasses of species group A (*Festuca costata, Bromus firmior, Pentaschistis tysonii, Festuca scabra*) and species group P (*Eragrostis racemosa, Themeda triandra, Monocymbium ceresiiforme, Trachypogon spicatus, Panicum natalen. e* and others).

The absence of rocks and therefore of fire refuge sites accounts for the lack of woody species. Forbs growing in this sub-community include *Polygala hispida* and *Euphorbia epicyparissi* (species group A), *Hypoxis rigidula* (secies group G), *Helichrysum oreophilum* (species group H), *Vernonia natalensis* and *Helichrysum aureonitens* (species group K), and *Helichrysum glomeratum, Sebaea leiostyla* and *Helichrysum miconiifolium* (species group P).

2. *Themeda triandra - Rendlia altera* undulating grassland community.

This grassland occurs predominantly on crests of spurs and certain slopes in the Little 'Berg, especially above 1 600 m. The short grass *Rendlia altera* (species group C, Table 2) is both dominant and characteristic of this grassland community. Other dominant grasses include *Diheteropogon filifolius (species group C), Harpochloa falx* (species group J) and *Themeda triandra (species group P)*, while diagnostic grasses are *Stiburus alopecuroides* and *Sporobolus centrifugus* (species group D). The community is divided into a number of sub-communities based on rockiness, moisture availability and topography.

The ground cover is often stony, and the soil tends to be sandy and well-drained. The rockier

ground tends to be associated with the presence of *Diheteropogon filifolius*.

2.1. *Rendlia altera - Hypoxis argentea* moist slope sub-community.

This sub-community is characterised by species group E, and is found on south or east-facing slopes just beneath the *Rendlia altera - Diheteropogon filifolius* ridges. These slopes have a slightly higher moisture content and this accounts for the presence of the forb *Hypoxis argentea* and the sedge *Bulbostylis humilis* (species group E). These slopes are also less stony than the community as a whole and this accounts for the sparse occurrence of *Diheteropogon filifolius.*

Other forbs present are *Wurmbea kraussii* and *Gnidia kraussianum* (species group D), and sedges include *Cyperus obtusiforus* var. *obtusiflorus*, *Kyllinga pauciflora* and *Cyperus semitrifidus* (species group D).

Dominant grasses are *Rendlia altera* (species group C), *Eragrostis racemosa, Themeda triandra* and *Trachypogon spicatus* (species group P).

2.2. *Rendlia altera - Rhodohypoxis baurii* rocky crest sub-community.

This sub-community is located on dry, stony or rocky crests. The grasses *Rendlia altera* and *Diheteropogon filifolius* (species group C) are dominant and characteristic of this community. *Diheteropogon filifolius* is associated with rocky environments (Gibbs Russell *et al.* 1991). Other dominant grasses include *Harpochloa falx* (species group J), *Eragrostis racemosa, Themeda triandra* and *Trachypogon spicatus* (species group P). Species group F is characteristic of this sub-association, and includes the forbs *Rhodohypoxis baurii*, which is associated with dry habitats (Killick 1990), *Silene burchellii* and *Senecio venosus*, both of which are associated with stony habitats (Van Wyk & Malan 1988). The grasses *Microchloa caffra* and *Eulalia villosa* (species group F) are also represented in this rocky grassland. The species of species group D are sparsely represented, owing to the drier nature of this sub-community.

2.3. *Rendlia altera - Stiburus alopecuroides* crest sub-community.

This sub-community is found on crests in the Little 'Berg which are less rocky than the previous sub-community, and species such as *Diheteropogon filifolius* (species group C), *Silene burchellii* and *Senecio venosus* (species group D), which emphasised the rockiness of sub-community 2.2., are rare or absent here. The grasses *Stiburus alopecuroides* (species group D), *Alloteropsis semialata* (species group J), *Eragrostis racemosa* and *Trachypogon spicatus* (species group P) are well represented. The presence of the short grass *Rendlia altera* and of species group D confirms the classification of this grassland in the community.

2.4. *Rendlia altera - Diheteropogon filifolius* north-facing slope sub-community.

This sub-community occurs on north-facing slopes just beneath the *Rendlia altera - Rhodohypoxis baurii* sub-community. The slopes are sandy and stony or rocky, but are limited to the northern part of the Little 'Berg; this sub-community was not found south of Giant's Castle. There is no characteristic species group for this sub-community; it is characterised by the presence of species group C and the absence of species groups D, E and F. Besides *Rendlia altera* and *Diheteropogon filifolius* (species group C), other common grasses include *Eragrostis capensis* (species group I), *Alloteropsis semialata, Elionurus muticus* (species group J), *Sporobolus pyrimidalis* (species group K), and *Themeda triandra* (species group P). In spite of the rockiness of the slopes, few woody species were recorded; this is attributed to the northerly aspect of the slopes. The greater insolation, compared to the south-facing slopes, makes these slopes inhospitable for woody growth. There were also fewer forbs recorded on these slopes; but those found include *Vernonia natalensis, Helichrysum pilosellum* and *Helichrysum aurionitens* (species group K).

3. *Themeda triandra - Elionurus muticus* dry grassland community.

This community is present on north-facing slopes, where conditions are warmer and few trees or shrubs are present. This community is characterised by the presence of species groups I, J,

K and P and the absence of species groups A - H (Table 2). The grasses *Themeda triandra* (species group P), *Elionurus muticus* and *Alloteropsis semialata* (species group J) are dominant in this grassland, while there are no diagnostic species for this community.

In the northern part of the study area, these north-facing slopes are characterised by an increased presence of the grasses *Sporobolus pyramidalis* (species group K) and *Hyparrhenia hirta* (species group P). The ground is typically not very rocky here, although the soils are generally sandy. The absence of rocks, and therefore of protection from fire, is the most important reason for the lack of woody plants, especially *Protea* species which favour these drier slopes, in this community.

4. *Festuca costata- Themeda triandra* grassland crest community.

This community is found on the ridges between *Festuca* - dominated slopes and *Themeda* - dominated slopes. It contains a mixed composition of both grasslands. The community is characterised by a mixture of the species in species group A and certain of the species in species groups J, K and P (Table 2). The grasses *Festuca costata* and *Festuca scabra* are the important inclusions from species group A, and the grasses *Elionurus muticus* and *Alloteropsis semialata* are the most important from species group J. The grassland is dominated by the grasses *Themeda triandra, Eragrostis racemosa, Tristachya leucothrix* (species group P), *Elionurus muticus* and *Alloteropsis semialata* (species group J) and *Festuca costata* (species group 4).

There are fewer forbs present than in the *Themeda triandra - Elionurus muticus* grassland; most noticeably absent are *Acalypha punctata, Haplocarpha scaposa* and *Hermannia depressa* (species group I), and the grass *Eragrostis capensis* from species group I. The ridges on which this association was found were not sufficiently rocky to encourage the germination of woody plants. The absence of the grass *Rendlia altera* makes these crests significantly different from the ridges on the Little 'Berg spurs on which the *Rendlia altera - Diheteropogon filifolius* sub-community was found.

5. *Protea caffra - Protea roupelliae - Themeda triandra* open savanna community.

This community is found on certain stony slopes and crests where the presence of *Protea* species is favoured by the shallow stony soil, especially *Protea caffra* and *Protea roupelliae* (species group L, Table 2) which are diagnostic of this community. The soils are generally shallow, sandy and well-drained. A certain amount of rockiness is present, which also favours the presence of other woody species such as *Rubus ludwigii* (species group M) and *Buddleja salviifolia* (species group O). The *Protea* species are moderately fire-tolerant and have a tough bark. The seeds, however, are not fire-resistant and will not germinate except in conditions where there has been no fire for at least four years (Irwin & Irwin 1992). Therefore the rockiness of the ground is an important factor in providing fire protection for the Proteas. The rockiness of the slopes also differentiates the two sub-communities, one supporting more woody species than the other.

5.1. *Protea roupelliae - Trachypogon spicatus* non-rocky savanna sub-community.

This sub-community is found on north-facing slopes of the Little 'Berg, where there is less moisture presence than on the southern slopes. These drier conditions, together with the shallow stony soil, are favoured by the distinctive trees *Protea caffra* and *Protea roupelliae* (species group L). The sub-community also occurs on certain crests, where the soils is shallow and stony.

Although the soil is stony, it is not rocky and there are few other woody plants besides the Protea species. Some specimens of *Rhus dentata* were the only other woody plants recorded in this sub-community.

The herbaceous layer is characterised by a similar vegetation to that of community 3, the *Themeda triandra - Elionurus muticus* community. There is no characteristic species group for this sub-community, but the the dominant grasses are *Themeda triandra* and *Trachypogon spicatus* (species group P), while *Alloteropsis semialata*, *Elionurus muticus* and *Harpochloa falx* (species group J) are also found. Forbs growing among the grasses include *Helichrysum*

confertifolium, Wahlenbergia huttonnii (species group L), *Helichrysum glomeratum, Sebaea leiostyla* and *Helichrysum miconiifolium* (species group P).

The slopes supporting this sub-community are sparsely wooded with the two *Protea* species, the trees being usually between 10 and 20 metres apart. These north-facing slopes contrast strongly with the more wooded south-facing slopes, especially in the southern part of the Little 'Berg (south of Giant's Castle), where the valleys are deeper and the effect of aspect is more enhanced (Hillard and Burt 1987). In addition, *Protea roupelliae* was found to be more common in the southern Little 'Berg, and *Protea caffra* in the north. This observation agrees with that of Killick (1990).

The soils on these slopes are shallow and stony, which accounts for the presence of the *Protea* species (Irwin & Irwin 1992). The soils on the north-facing slopes which support community 3 are deeper and less habitable by the Proteas.

The dominant grasses are *Themeda triandra, Monocymbium ceresiiforme* and *Trachypogon spicatus* (species group P), and the dominant woody plants are *Protea caffra* and *Protea roupelliae* (species group L). Common forbs are *Helichrysum adenocapum* and *Helichrysum odoratissimum* (species group 8). No single species is diagnostic of this sub-association. The soils tend to be shallow and sandy. There is little evidence of moisture in the soil.

5.2. *Protea caffra - Halleria lucida* rocky savanna sub-community.

The sub-community is characterised by the species in species group M, but is also represented by species in species groups B, J, K, L, O and P. (Table 2). The dominant grasses are *Themeda triandra, Eragrostis racemosa* and *Trachypogon spicatus* (species group P), and *Elionurus muticus* and *Alloteropsis semialata* (species group J). The trees *Protea roupelliae* and *Protea caffra* (species group L) dominate the woody layer, often forming a separate canopy 3-4 metres above the ground.

This sub-community, like the previous one, is limited to north-facing slopes with shallow soils,

but here the slopes are rockier and this factor accounts for the presence of more woody species, besides the two *Protea* species. These include *Halleria lucida, Rubus ludwigii*, (species group M), *Buddleja salviifolia* (species group O), *Rhus dentata* (species group B) and *Rhus discolor* (species group P). The herbaceous vegetation is similar to that of sub-community 5.1., with the addition of the forb/ small shrub *Rabdosiella calycina* (species group M), the grass *Melinis repens* (species group M) and the fern *Cheilanthes quadripinnata*. The latter woody plants and the fern all utilise the rocky environment as a fire refuge and *Cheilanthes quadripinnata* also utilises the moist micro-climate associated with rocky cracks.

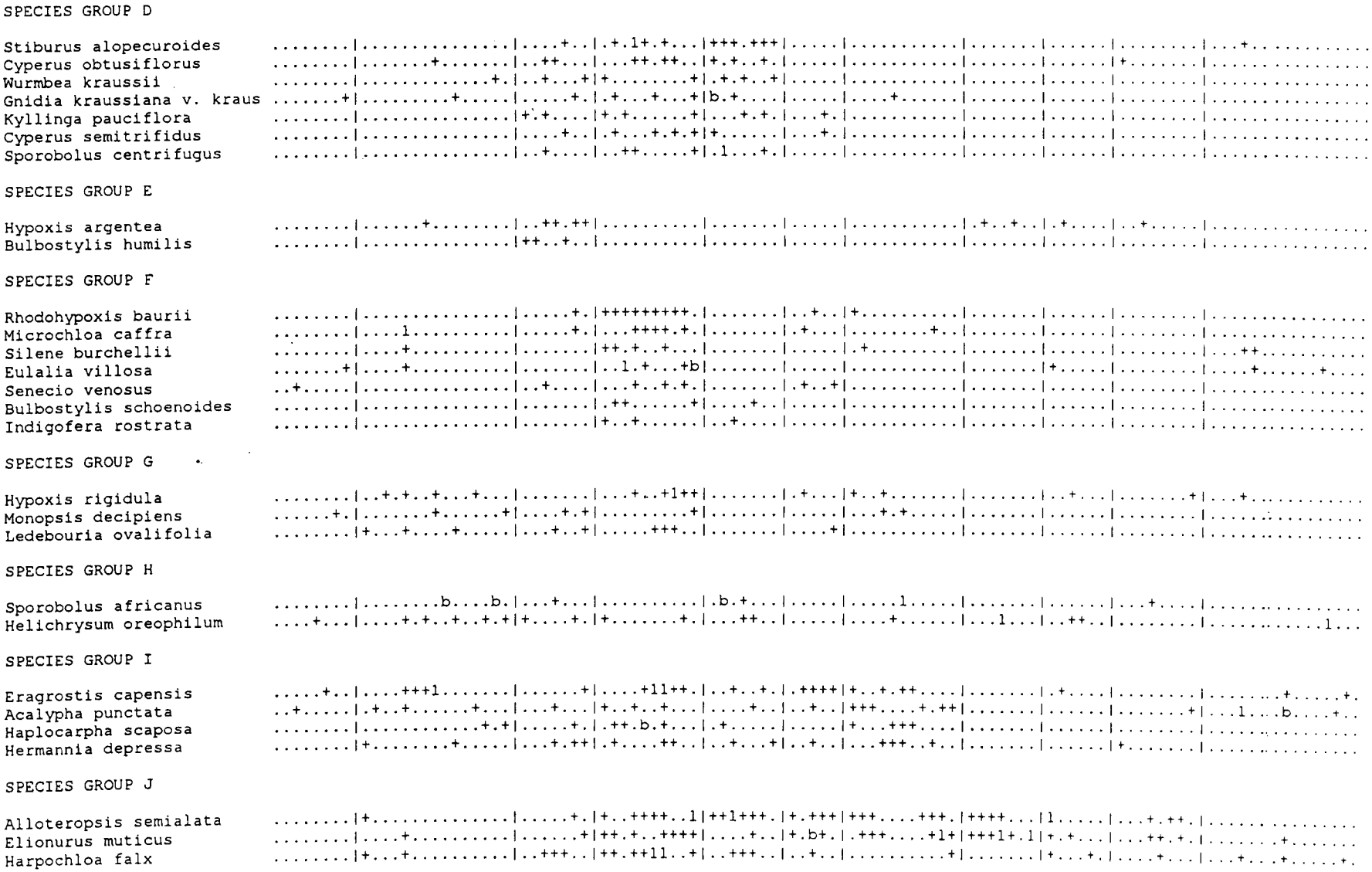
6. *Cheilanthes quadripinnata - Melinis nerviglumis* rocky scarp community.

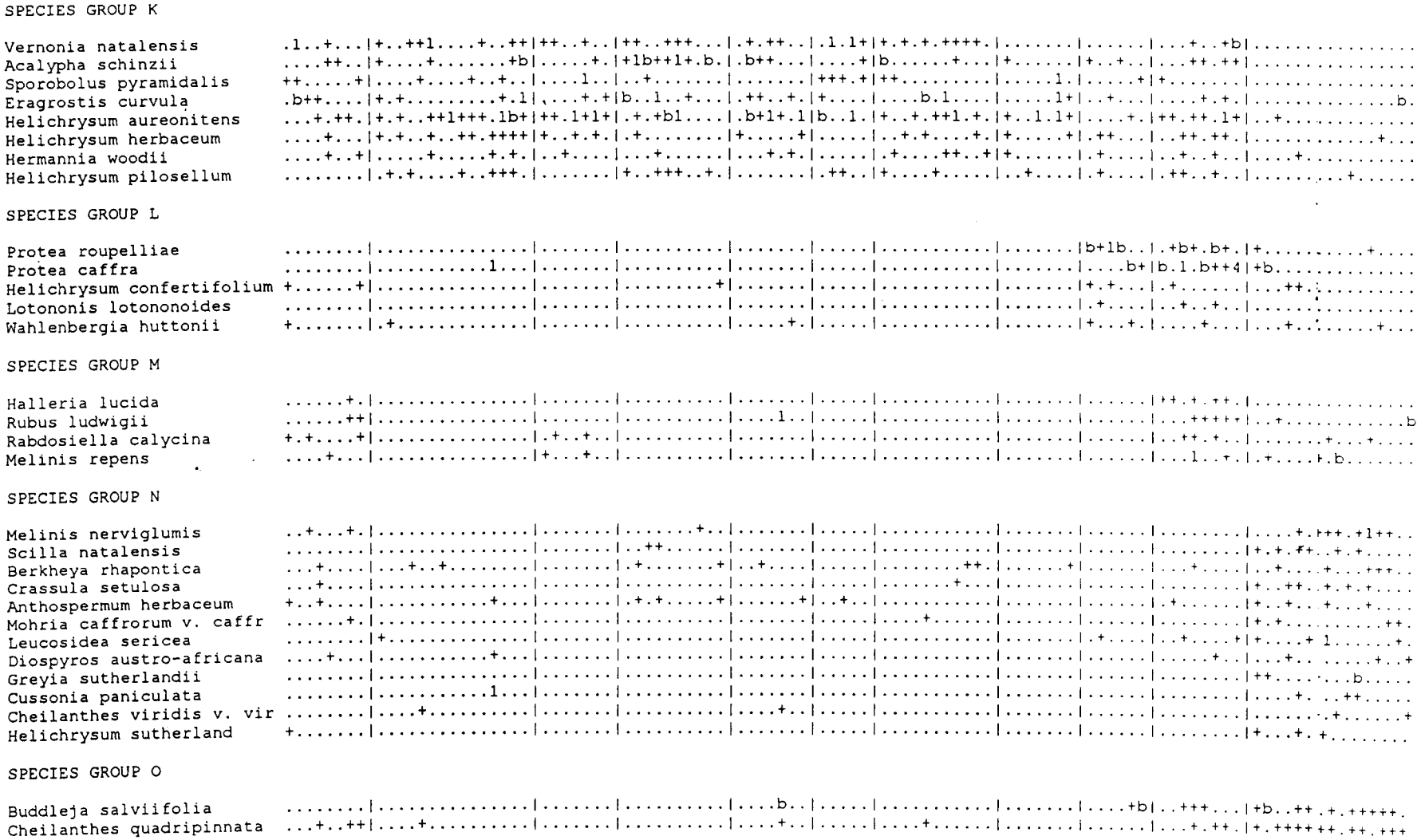
Vertical or near-vertical scarps are the site of this community, which is relatively undisturbed due to the inaccessibility of the terrain. The community is characterised by species group N (Table 1). The shrub or small tree *Buddleja salviifolia* (species group O) dominates the woody component of this community, with other woody plants including *Leucosidea sericea, Cussonia paniculata, Diospyros lycioides, Greyia sutherlandii and Diospyros austro-africana* (species group N) and *Rhus discolor* (species group P). The grass *Melinis nerviglumis* (species group N) is diagnostic of this association, and is often associated with undisturbed areas (Gibbs Russell *et al.* 1991). Other common grasses include *Loudetia simplex, Eragrostis racemosa* and *Themeda triandra* (species group P). The fern *Cheilanthes quadripinnata* (species group O) is very common in this association, as it can utilise the moist and shady cracks between and under the rocks. Other common ferns are *Cheilanthes viridis* var. *viridis* and *Mohria caffrorum* var. *caffrorum* (species group N). The herbaceous layer is characterised by the presence of the forbs *Scilla natalensis, Berkheya rhapontica, Anthospermum herbaceum, Helichrysum sutherlandii* and *Crassula setulosa* (species group N).

The community described above is also found at the base of Clarens sandstone cliffs, and according to Killick (1990) a similar vegetation characterises the lowermost Basalt cliffs, which were not sampled in the present study.

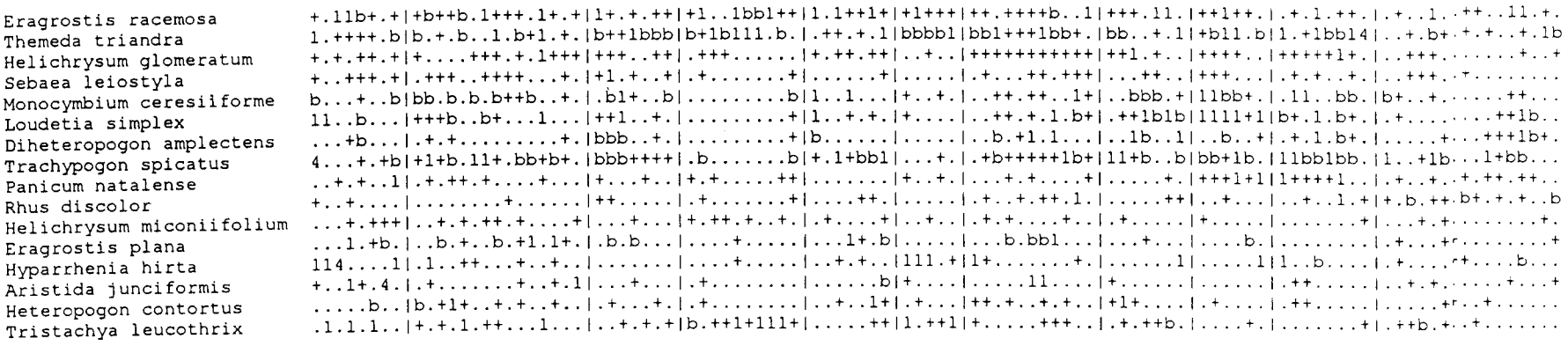
TABLE 2. Phytosociological Table of the KwaZulu-Natal Drakensberg Foothills and Spurs

Number in table												
											1	
	11111111112222	2222223	3333333334	4444444	44555	55555556666	6666667	777777	87778880	888888	9999999999
51427638	901234567890123	4567890	1234567890	1234567	89012	34567890123	4567890	123456	49780120	835679	0123456789
Unique relevé no.											
44444444	4444444444444	4444444	4444444444	4444444	44444	4444444444	4444444	444444	44444444	444444	4444444444
10000001	0001001000001000	0010000	0000000001	1000010	00000	01000000000	0110100	110100	01100100	000110	0100010000
05959550	695089056590555	9905555	8588788880	0599905	57858	80955559799	5009059	009095	50099098	955005	8086509959
11344450	935304150750797	4524199	1923901021	2944525	29120	20359985083	9225213	037360	13376355	509008	0100132386
56146542	051099920427095	5369236	3020220012	0838883	57824	80404797102	5751479	554411	53730847	051138	1131128305
SPECIES GROUP A											
Festuca costata	1.b3b++b	.111.bb.b++.111	.	.	.	.	...+.....+1	....+.+	.	.	.
Bromus firmior	+++++++.	..+.1.+.+.....+	.	.	.	.	.....+.....	.	.	.	.
Polygala hispida	++..+...	++..++.+.....+.	.	.	.	.	.	.	.	...+....	.
Pentaschistis tysonii	.+.+....	+....+.++.+...+	.	.	.	.	.	.	.	.	.
Festuca scabra	.1+.....	1..+...+..1....	.	.	.	...1.	.	....+1.	.	.	.
Euphorbia epicyparissias	...+.+.+	+.....+....+...	.	.	.+	.	.	.	+.....	.....+..	...+..+.....
SPECIES GROUP B											
Rhus dentata	+1+++.+.	.	.+..+..	.	.	.	.....+.....	.	..+.+b	..+..1++	.....+b++..b
Cymbopogon validus	1+++..1.	.	.	.	.	+....	+1.....	+++...+	+.....	.	.1..+..b.....
Thunbergia atriplicifolia	.++++.++	.....+....	.	.	.	.	.	.	.	.	.
Wahlenbergia undulata	+..+.++.	.	.	.+....+	.	.	.	.	.	...+....	.+.....+....+
Moraea inclinata	+..+...+	.	.	.....+	.	.	....++.....	.....+.	+.....	.	..+.....
Kohautia amatymbica	...+.+..	.	...+...	.....+	.	.	.....+..	.	.	.	.
Cotula hispida	...+.+..	.	.	.	.	.	.	.	.	.	..+.....
Alepidea natalensis	+..+....	.	.	.	.	.	.	.	.	.	.....+.
Asparagus laricinus	...+..+.	.	.	....+..	.	.	.	.	.	.	.....+.....
Sutera polelensis	+..+....	.	.	....+..	.	.	.	.	.	.	.
Crassula vaginata	...+.+..	.+.....	...+...	.+.....	.	.....+.....	.	.	.	.	..+.....
SPECIES GROUP C											
Rendlia altera	.+.+.+..	.	lbb.bbb	bb1b11b+1+	11bbb+1	++.1+	.	.	.	.	..+.....
Diheteropogon filifolius	.....+.+	+...b.....	....+++	+.b...++.+	1	++b+b	.	.	.	.	.

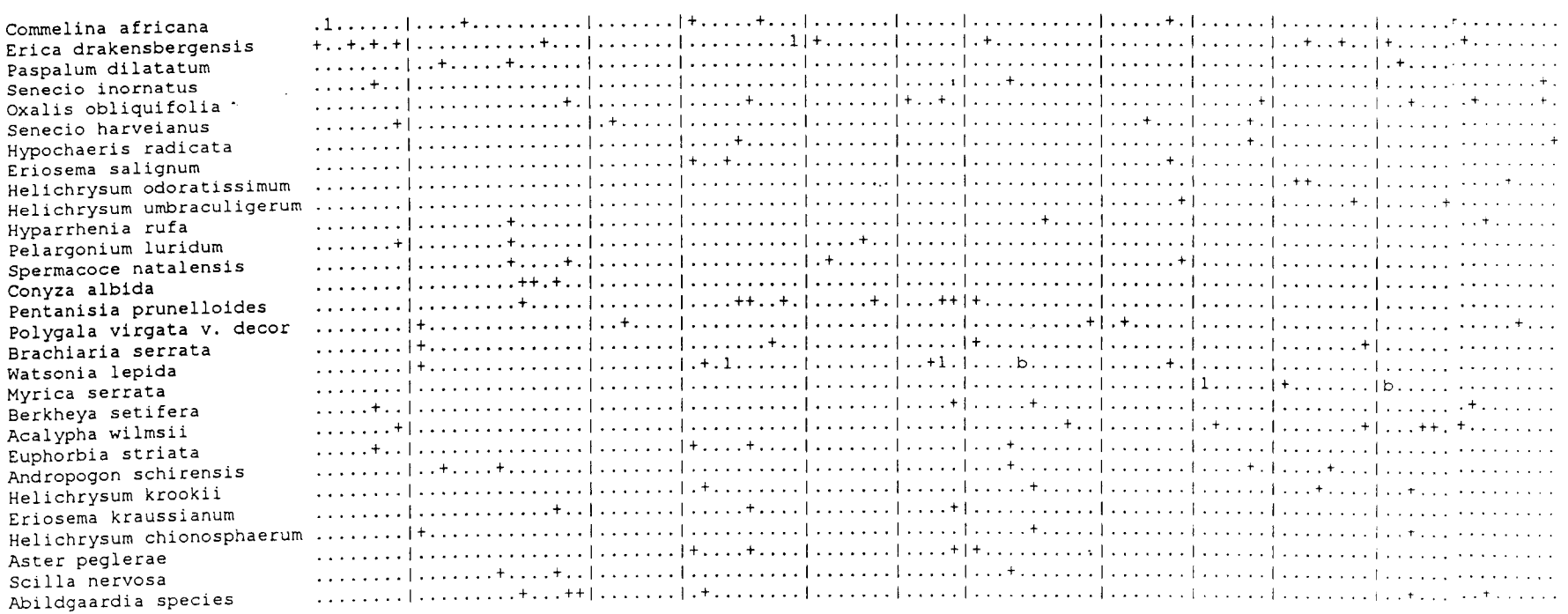




SPECIES GROUP P



OTHER SPECIES



CHAPTER 6

THE PHYTOSOCIOLOGY OF THE KWAZULU-NATAL MIDLANDS

Figure 17. Grazed Midlands Grassland, dominated by *Themeda triandra*, looking west towards Ntabamhlope (White Mountain).

Figure 18. The Midlands Grasslands have been highly modified by agricultural practices. Exotic plantations, "escaped" *Eucalyptus* trees, and grazing land are visible near Nottingham Road. The tall grass *Hyparrhenia hirta* (foreground) lines many roadsides in the Midlands.

Data collected in the 98 relevés sampled in the Midlands of KwaZulu-Natal were collated in a phytosociological table. This table was further refined, using the computer programme MEGATAB, to produce Table 3.

The Midlands region in the present study occupies the area south of Estcourt and north of the Eastern Cape border, bordered on the west by the Little 'Berg foothills and on the east by the vegetation boundaries of the Mistbelt, Incised River Valleys and Coast Hinterland bushveld (Turner 1967; Phillips 1973).

The vegetation of the KwaZulu-Natal Midlands can in general be described as a *Themeda triandra - Helichrysum aureonitens* undulating grassland. This grassland covers the rolling hills of the KwaZulu-Natal Midlands, from the vicinity of Estcourt in the north to Kokstad in the south, and may extend further south into the northern parts of the Eastern Cape. There are no extremes of topography comparable to the Drakensberg range to the west or the incised river valleys which protrude into parts of the grassland from the east. The hills are seldom steep and scarps are rare, with the result that the influence of aspect is less than that encountered in other parts of the study area. The number of general species in Table 3 is therefore high. Furthermore, the ecotones between plant communities are gradual transitions rather than sharp boundaries.

The extent of the grassland corresponds well with the sub-montane, "open grassland to wooded savanna/ scrub" (4e) Bioclimatic Subregion of Phillips (1973), and to the Highland Sourveld (veld type 44) of Acocks (1988). The altitudinal range is from 1 350 m to 1 650 m, and mean annual precipitation varies from 900 mm to 1 200 mm (Schulze 1982).

The grassland in this Subregion has been drastically altered, largely by agriculture (Moll 1976). Much of the area is given over to grazing and the growing of maize, sorghum and sunflowers. Large tracts are also covered by exotic plantations, mostly wattle, bluegum and pine trees. Furthermore, many wetlands have been drained. However, there is little urbanisation in the area; the N3 national road between Escourt and Pietermaritzburg cuts across the north-east corner of the grassland, but the only other significant urbanisation is

around Underberg and Kokstad.

An analysis of Table 3 revealed 5 communities and 6 sub-communities. These are:

1. *Themeda triandra - Rhus discolor* scrubby grassland community.

    1.1. *Rhus discolor - Leucosidea sericea* sub-community of rocky scarps.
    1.2. *Themeda triandra - Greyia sutherlandii* sub-community of rocky dolerite crests.
    1.3. *Themeda triandra - Diheteropogon filifolius* sub-community of rocky sandstone crests.
    1.4. *Themeda triandra - Myrsine africana* sub-community of non-rocky crests.
    1.5. *Themeda triandra - Rhus rehmanniana* sub-community of south-facing rocky slopes.
    1.6. *Themeda triandra - Hyparrhenia hirta* sub-community of south-facing non-rocky slopes.

2. *Sporobolus africanus - Monocymbium ceresiiforme* non-rocky overgrazed grassland community.
3. *Helichrysum miconiifolium - Haplocarpha scaposa* grassland community of overgrazed north-facing slopes.
4. *Themeda triandra - Helichrysum miconiifolium* grassland community of north-facing slopes.
5. *Themeda triandra - Tristachya leucothrix* grassland community of East Griqualand sandy plains

Description of the Plant Communities

1. *Themeda triandra - Rhus discolor* scrubby grassland community.

This community covers a wide area, geographically, and includes the crests and undulating south-facing slopes in the Midlands. It also includes the rare rocky scarps in the Midlands. The grassland is characterised by species group A (Table 3), which contains a number of woody species such as *Rhus discolor*, *Maytenus heterophylla* and *Rhus dentata*. The presence of these and other woody species is accounted for by environmental factors, including rockiness, aspect and moisture availability.

The woody species seldom attain more than a scrubby nature, and the woody vegetation is usually under 1 metre high. The herbaceous layer is dominated by the grasses *Hyparrhenia hirta* (species group A), *Eragrostis plana* (species group J), *Themeda triandra, Eragrostis curvula* and *Eragrostis racemosa* (species group L). The tall grass *Hyparrhenia hirta* is more common in the north of the grassland, but is believed to have spread at the expense of *Themeda triandra*, due to a variety of agricultural practices (Moll 1976).

A large number of forbs occur, especially *Acalypha punctata* (species group A), *Helichrysum miconiifolium, Vernonia natalensis, Acalypha schinzii* (species group J), *Helichrysum aureonitens, Cyanotis speciosa* and *Hypoxis rigidula* (species group L).

1.1. *Rhus discolor - Leucosidea sericea* sub-community of rocky scarps.

This sub-community is found on the limited number of rocky scarps within the Midlands grassland. The aspect varies, but the principal environmental factor is the rockiness and steep gradient of these sites. The woody plants utilise the scarps as a fire refuge site, and sometimes grow horizontally out of the cliff face. Woody species include the shrubs *Rhus discolor, Maytenus heterophylla, Rhus dentata, Rubus ludwigii, Diospyros lycioides* (species group A), *Leucosidea sericea* and *Felicia filifolia* (species group B).

The herbaceous layer is comprised of a number of grasses, including *Hyparrhenia hirta, Melinis nerviglumis* (species group A), *Eragrostis plana* (species group J), *Themeda triandra* and *Eragrostis curvula* (species group L), and hardy forbs, especially *Acalypha punctata* (species group A), *Crassula sarcocaulis* and *Senecio inornatus* (species group B). A number of ferns are found, their rhizomes inserted into the rock cracks; these include *Pellea calomelanos* (species group B), *Cheilanthes quadripinnata* and *Mohria caffrorum* var. *caffrorum* (species group G).

Species group B is characteristic of this sub-community, but species groups A, G, J and L are also represented.

1.2. *Themeda triandra - Greyia sutherlandii* sub-community of rocky dolerite crests.

Rocky dolerite crests are the site of this sub-community, which is restricted to the plateau of Cunningham's Castle, the most easterly outlier of the Highland Sourveld (Acocks 1988). The rock cover in these sample sites averages 60 % and the average rock size is 20 cm in diameter. These crests support a number of woody plants which can attain a height of 5 to 6 metres. The trees include *Greyia sutherlandii, Trimeria grandifolia* and *Buddleja salviifolia* (species group C). Smaller woody plants include *Aloe arborescens* and *Ochna serrulata* (species group C), *Rhus discolor, Maytenus heterophylla* and *Rubus ludwigii* (species group A). The moisture present on these rocky crests accounts for the presence of the tall grass *Miscanthus capensis* and the red-hot poker *Kniphofia caulescens* (species group C). Species group C is characteristic of this sub-community.

The grasses *Themeda triandra, Eragrostis curvula* and *Eragrostis racemosa* (species group L) dominate the herbaceous layer. The forb component on these crests is sparse, with *Helichrysum aureonitens* (species group L) being the most common.

1.3. *Themeda triandra - Diheteropogon filifolius* sub-community of rocky sandstone crests.

Stony crests on dolerite are the site of this sub-community; there is less moisture on these crests than in the *Themeda triandra - Greyia sutherlandii* sub-community. The relevés in this sub-community were mostly but not exclusively collected in the Kokstad area, in the most southerly region of Highland Sourveld (Acocks 1988) in KwaZulu-Natal. Species group D is characteristic. Some of the woody species from the sandstone crests are also represented here (*Rhus discolor* and *Maytenus heterophylla*) but others are different: *Myrsine africana* (species group E) and *Rhus rehmanniana* (species group F). The herbaceous layer is richer, containing elements from species group L but with the addition of *Diheteropogon filifolius, Silene burchelli, Watsonia meriana, Rhodohypoxis baurii* (species group D), *Helichrysum miconiifolium, Vernonia natalensis, Acalypha schinzii, Heteropogon contortus* (species group J), *Hermannia depressa, Gnidia kraussianum* and *Elionurus muticus* (species group K).

1.4. *Themeda triandra - Myrsine africana* sub-community of non-rocky crests.

This sub-community occurs on crests which are stony but lack the large rocks (greater than 20 cm) of the previous two sub-communities. There is no characteristic species group for this sub-community, but species groups A, E, F, G, I, J, K and L are represented. The grasses *Hyparrhenia hirta* (species group A), *Trachypogon spicatus, Heteropogon contortus* (species group J), *Tristachya leucothrix* (species group K), *Themeda triandra* and *Eragrostis racemosa* (species group L) dominate the herbaceous layer.

The woody vegetation layer is less diverse than in the sub-communities of the rocky crests, lacking the shrubs and trees of species groups B and C, but nevertheless includes *Rhus discolor, Maytenus heterophylla* and *Rubus ludwigii* from species group A, *Myrsine africana* and *Diospyros whyteana* from species group E, *Rhus rehmanniana* and *Zanthoxylum capense* from species group F, and *Ziziphus mucronata* from species group G.

1.5. *Themeda triandra - Rhus rehmanniana* sub-community of south-facing rocky slopes.

This sub-community is located on rocky, south-facing slopes. The moisture presence is more pronounced than on north-facing slopes, due to the lower temperatures and slower evaporation rate. The rocks provide micro-environments for a variety of herbaceous and woody species. The most common woody species are *Maytenus heterophylla* (species group A), *Rhus rehmanniana, Zanthoxylum capense* (species group F) and *Ziziphus mucronata* (species group G).

The herbaceous layer is dominated by the grass *Themeda triandra* and the forb *Helichrysum aureonitens* (species group L). The grasses *Eragrostis plana, Heteropogon contortus* (species group J), *Tristachya leucothrix* (species group K) and *Eragrostis racemosa* (species group L) are also common. Forbs frequently encountered were *Vernonia natalensis, Acalypha wilmsii* (species group J), *Gnidia kraussianum* (species group K) as well as the fern *Cheilanthes quadripinnata* (species group G).

1.6. *Themeda triandra - Hyparrhenia hirta* sub-community of south-facing non-rocky slopes.

This sub-community is located on cool south-facing slopes and consequently has a significant moisture presence, which encourages woody growth. However the woody growth is limited by the absence of rocks, and thus the absence of fire refuge sites. The sub-community is characterised by the presence of species groups A, I, J, K and L, and the absence of species groups B-H. Species group A includes most of the woody species in this sub-community, most prominently *Rhus discolor, Maytenus heterophylla* and *Rhus dentata*, with *Rubus ludwigii* and *Diospyros lycioides* being less conspicuous.

The herbaceous layes is dominated by the grass *Themeda triandra* (species group L) and the forb *Vernonia natalensis* (species group J). Other common grasses include *Tristachya leucothrix* (species group K) and *Eragrostis curvula* (species group L). The forbs *Helichrysum aureonitens* (species group L), *Acalypha schinzii, Helichrysum miconiifolium*

(species group J) and *Acalypha punctata* (species group A) are also common.

2. *Sporobolus africanus - Monocymbium cersiiforme* non-rocky overgrazed grassland community.

Overgrazed, non-rocky slopes within the grassland are the site of this community. The absence of rocks means a lack of protection for woody plants, which are consequently absent from this comunity. Species group H is characteristic of this community. The herbaceous layer is dominated by the grasses *Sporobolus africanus, Monocymbium ceresiiforme, Hyparrhenia rufa* (species group H), *Eragrostis plana, Trachypogon spicatus* (species group J) and *Themeda triandra* (species group L). Other grasses present are *Paspalum dilatatum* (species group H), *Heteropogon contortus* (species group J), *Elionurus muticus* (species group K), *Eragrostis racemosa* and *Eragrostis curvula* (species group L). Common forbs include *Richardia brasiliensis* (species group I), *Sebaea leiostyla*, *Helichrysum herbaceum* (species group I), *Helichrysum miconiifolium, Vernonia natalensis* (species group J) and *Helichrysum aureonitens* (species group L).

There is evidence of grazing in most parts of this community; often severe, and this is indicated by the presence of the ruderals *Richardia brasiliensis, Conyza obscura, Helichrysum argyrophyllum* and *Spermacoce natalensis* (species group H), (Bromilow 1995; Low & Rebelo 1996). The invasive shrub *Rubus cuneifolius* is also present in this community and is known as an aggressive invader in many parts of KwaZulu-Natal where poor management has occurred (Bromilow 1995). The grass *Sporobolus africanus* is also associated with poor grazing management (van Oudtshoorn 1991).

3. *Helichrysum miconiifolium - Haplocarpha scaposa* grassland community of overgrazed north-facing slopes.

There is no characteristic species group for this community, but the species groups I, J, K and L are represented. The herbaceous layer is dominated by forbs, an indication of overgrazing (Tainton 1981). The most common grasses are *Heteropogon contortus, Trachypogon spicatus*

(species group J), *Tristachya leucothrix* (species group K) and *Themeda triandra* (species group L). Forbs occurring in this grassland include *Haplocarpha scaposa, Helichrysum glomeratum, Sebaea leiostyla, Helichrysum pilosellum* (species group I), *Helichrysum miconiifolium, Vernonia natalensis, Acalypha schinzii* (species group J), and *Hermannia depressa* (species group K).

No woody plant species except for *Rubus cuneifoilius* (species group I) were recorded. This is attributed to the lack of rocks and therefore lack of fire refuge in this community. The presence of *Rubus cuneifolius* is attributed to poor grazing management. The north-facing aspect is also responsible for the lack of woody plants, as moisture accumulation is inhibited by the high evaporation rate.

4. *Themeda triandra - Helichrysum miconiifolium* grassland community of north-facing slopes.

This community is located on north-facing slopes which have been subjected to less intense grazing pressure than the previous community. Evidence for this is found in the domination of the herbaceous layer by grasses rather than forbs, the dominant grasses being *Trachypogon spicatus, Eragrostis plana* (species group J) and *Themeda triandra* (species group L). Other grasses present include *Heteropogon contortus* (species group J) and *Elionurus muticus* (species group K). The most common forbs are *Helichrysum miconiifolium, Vernonia natalensis, Acalypha schinzii* (species group J) and *Helichrysum aureonitens* (species group L).

No characteristic species group was identified for this community, but species groups J, K and L are present. There is no rock cover on these slopes, and consequently no fire refuge sites and no woody species.

5. *Themeda triandra - Tristachya leucothrix* grassland community of the East Griqualand Sandy Plains.

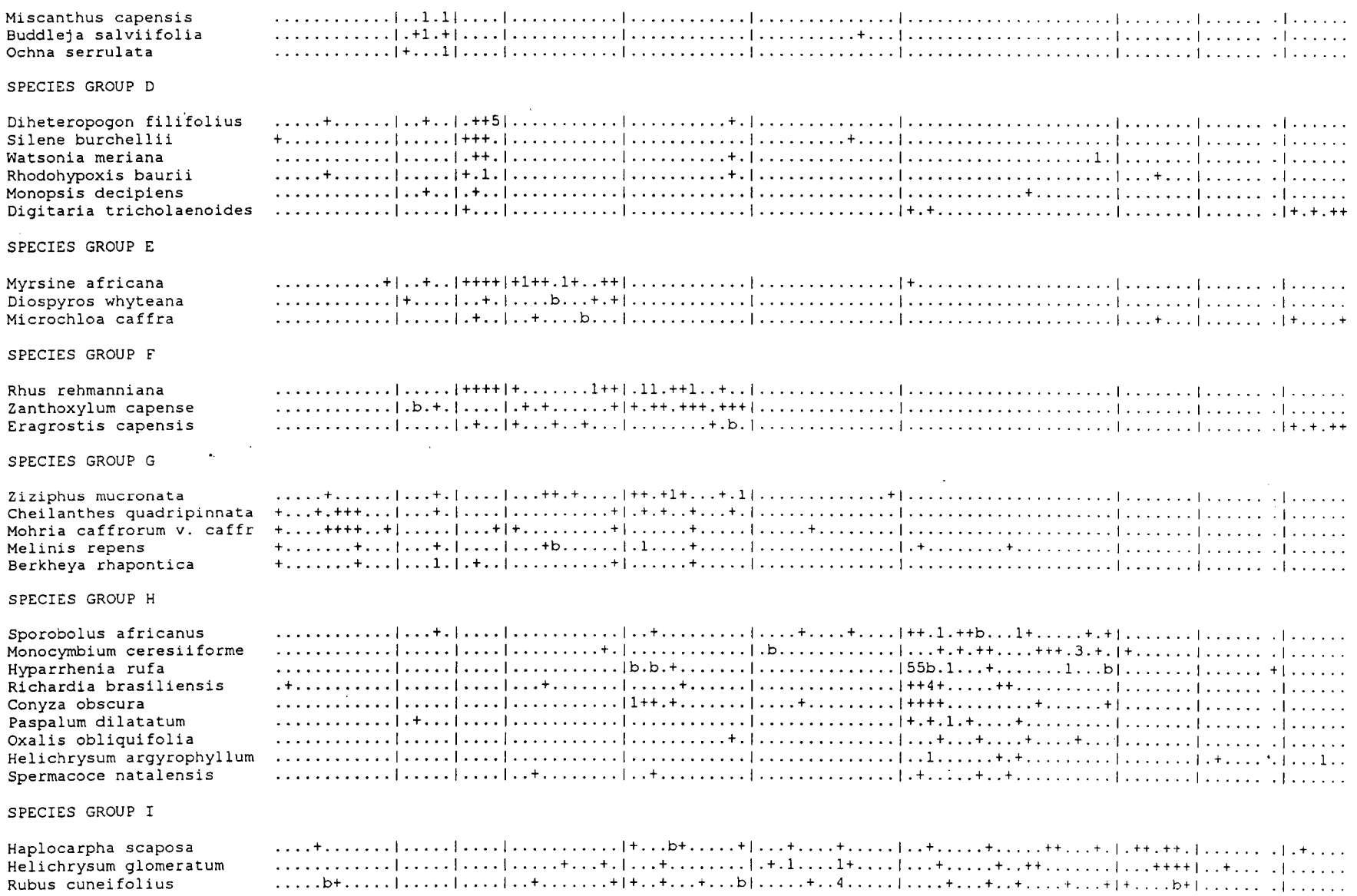
This community is located on flat, sandy plains in the Cedarville area, between Matatiele and Kokstad in East Griqualand. Unlike the other communities in the midlands, it appears to be restricted to this area and corresponds roughly to the Highland Sourveld to *Cymbopogon-Themeda* veld transition Veld Type of Acocks (1988). There is no diagnostic species group for this community, but the presence of species groups K and L, and the absence of species groups A-J, is characteristic of this community. No woody plant species were recorded in this community, which is dominated by grasses, especially *Themeda triandra* (species group L) and *Tristachya leucothrix* (species group K). Other grasses occurring here are *Elionurus muticus* (species group K), *Eragrostis curvula, Eragrostis racemosa* and *Harpochloa falx* (species group L).

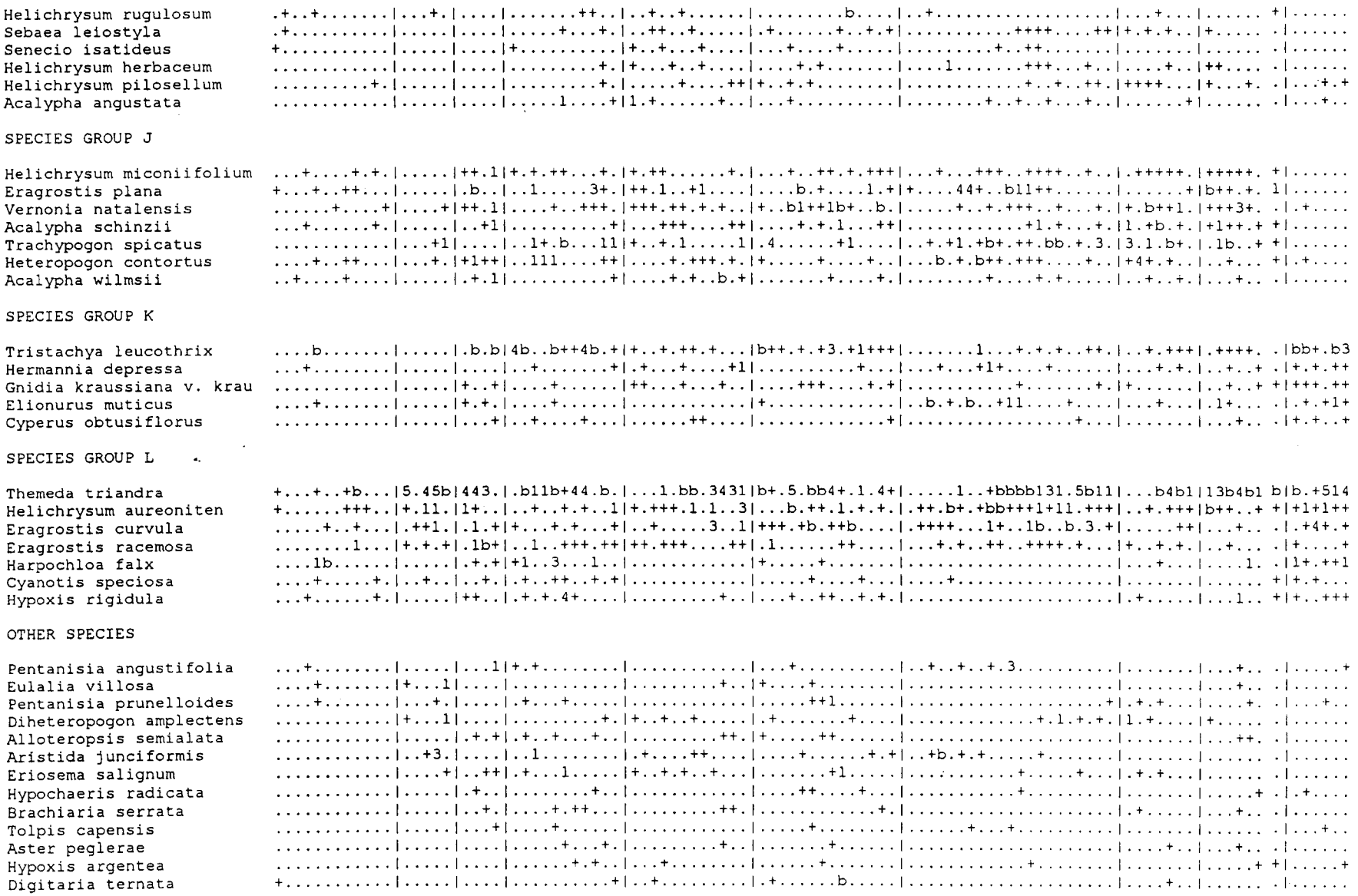
A number of forbs were found, including *Hermannia depressa, Gnidia kraussianum* (species group K), *Helichrysum aureonitens, Cyanotis speciosa* and *Hypoxis rigidula* (species group L). Acocks (1988) noted that *Tristachya leucothrix* is co-dominant with *Themeda triandra* and suggests that this indicates an affinity with more northerly veld types.

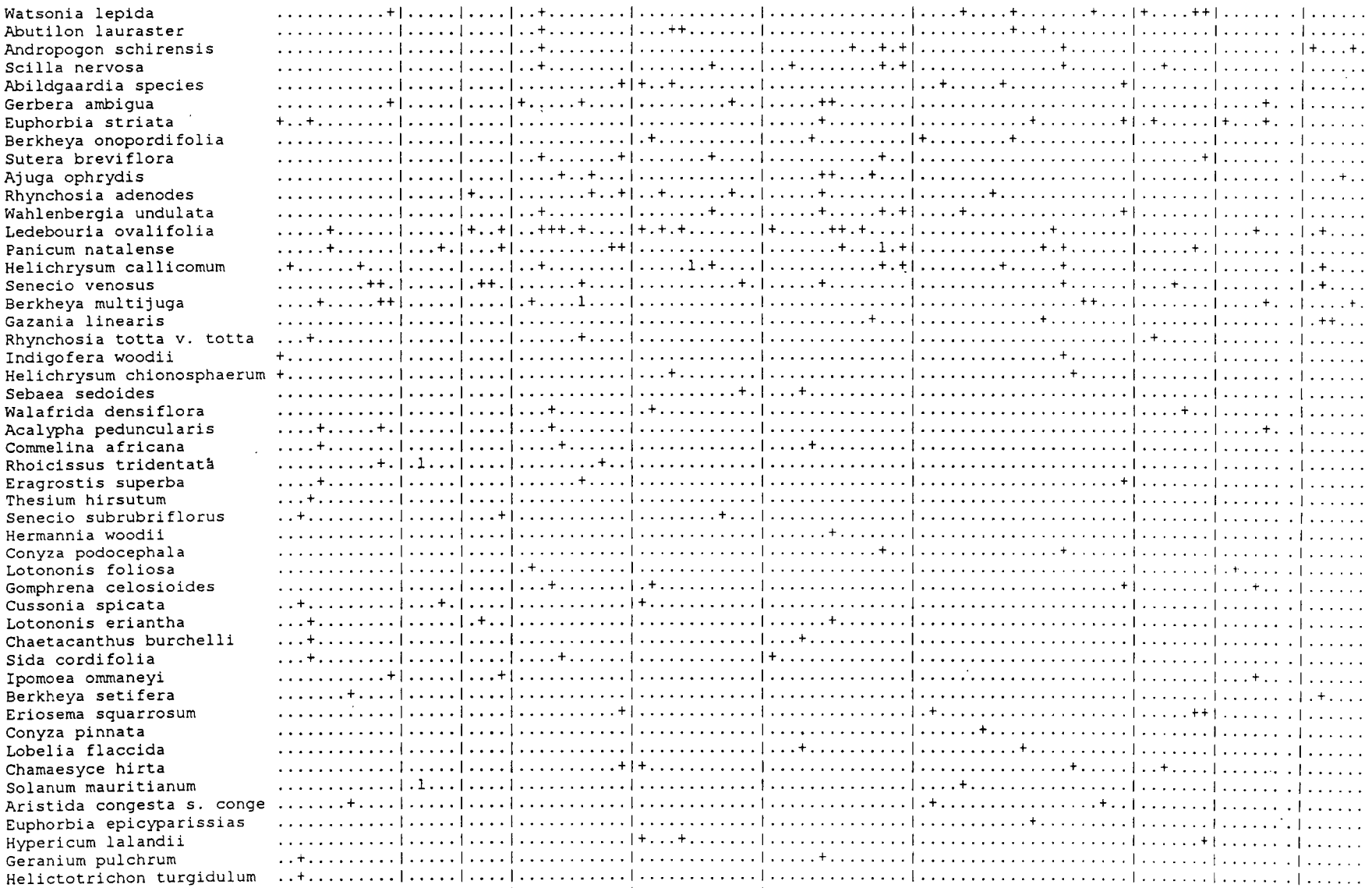
This community is unique in South Africa, lying as it does on a very localised geological formation. The region is extensively farmed, and conservation of the remaining natural vegetation is recommended.

TABLE 3. Phytosociological Table of the KwaZulu-Natal Midlands

Number in table	1111 111	1	1111	1 11 111	1 111	1 111 1 11 1	11 1	1	11	1 1111
	489002247402	6	2323	91104104146	566254873515	44026883167737	6646 55653522215 452	5951477	413304 8	797277
	179392349450	81277	5811	81640408209	746768056053	15262237583624	039866572678567143283	9406378	687067 5	214489
Unique relevé no.	444444444444	44444	4444	44444444444	444444444444	44444444444444	444444444444444444444	4444444	444444 4	444444
	000000000000	00000	0000	00000000000	000000000000	00000000000000	000000000000000000000	0000000	000000 0	000000
	677778867878	55595	8888	77578578766	696566778886	86789778597786	666659966695555655665	6768677	656876 7	777888
	124673310763	32293	5635	38566358819	379632006823	62556116492059	442930093106665322146	4332100	251572 1	222477
	649287895245	36772	0666	70538901154	901883604355	90218125082279	254313224149676398704	1126834	172552 9	183967
SPECIES GROUP A										
Rhus discolor	+..++.b+1.+.	...++	+..+	.+.+......+	...+.+..+...	++.+.+.+.++.+.	....	....	....	......
Hyparrhenia hirta	..+++.b..b1b	...+.	..+.	111b....+.b	1b..........	..3+1....3+...	...+.1+1.............	...b...	....+. .	......
Acalypha punctata	...+.++....+	...1.	....	++++.......	..+.....+++.	.....+++.++.+.	.+............+......	.+.....	...b.. .	......
Maytenus heterophylla	...+.......+	.+.1.	1+.+	+1.+.1.1++.	++++++1.....	..+.+++.+....+	....	....	....	......
Rhus dentata	.1b+++...11+	.....	....	..+13...+++	.+.....+..+.	b.+...+...+1+1	....	....	....	.+....
Rubus ludwigii	..+..+1..+..	..1+.	+...	....	...+.....+..	.....++...+.+.	....	....	....	.+....
Diospyros lycioides	.+++.++.....	.....	....	+........1.	...........+	+.+.+++.......	....	....	....	......
Melinis nerviglumis	++...++.....	+.1..	....	..+........	.......1....	b..........+.1	.................1...	....	....	......
Setaria pallide-fusca	....+.......	....+	....	........+..	.........+..	+.+....+......	.................1..+	....	....	......
Vernonia hirsuta	..+.+.....+.	.....	...+	.+.........	....	.......+....+.	....	....	....	......
SPECIES GROUP B										
Leucosidea sericea	b..+...++b..	.....	....	....	....	............+.	....	....	....	......
Crassula sarcocaulis	++...+.++.+.	.....	....	....	....	....	....	....	....	......
Pellaea calomelanos v. leu	+++....++..+	...+.	....	....	....	..+...........	....	....	....	......
Senecio inornatus	....+++...++	.....	....	....	........+...	....	............+++......	....	....	......
Felicia filifolia	.3....+..3..	.....	....	....	....	....	....	....	....	......
Asparagus cooperi	.+.+.......b	.....	....	....	....	....	....	....	....	......
Rhynchosia reptabunda	..+.+.....+.	.....	....	....	....	....	....	....	....	......
Asparagus plumosus	..+.+......+	.....	...+	......+....	....	..+...........	....	....	....	......
SPECIES GROUP C										
Aloe arborescens	....	1.1.b	....	....	....	....	....	....	....	......
Greyia sutherlandii	....	b1.+b	....	....	....	....	....	....	....	......
Trimeria grandifolia	....	.b..1	....	....	....	....	....	....	....	......
Kniphofia caulescens	....	1...1	....	..+........	....	....	....	....	....	......







CHAPTER 7

THE PHYTOSOCIOLOGY OF THE KWAZULU-NATAL MISTBELT REGION

Figure 19. Much of the Mistbelt Grassland has been converted to exotic plantations, such as *Pinus* spp., or is disturbed and dominated by weeds such as *Verbena bonariensis* and *Tagetes minuta*. Near Ixopo.

The interpreted data of the 31 relevés representing the Mistbelt region of KwaZulu-Natal are presented in Table 4.

The vegetation of the mistbelt region of southern KwaZulu-Natal can be described as a moist *Eragrostis plana - Cymbopogon validus* grassland (species group L, Table 4). This moist grassland occurs in a region of southern KwaZulu-Natal which is exposed to frequent mist in addition to a mean annual rainfall of 950 mm (Schulze 1982). Having such a high

precipitation, the soils are leached and the vegetation is consequently a sourveld, the grasses losing much of their palatability during winter. Due to the proximity of a large human population, and the high precipitation, the region is highly cultivated and disturbed by other activities such urbanisation. Large tracts have been given over to exotic plantations, and in 1976 Moll estimated that approximately 60-70 % of the natural vegetation had been cleared. It is possible that a large part of the area was covered in forest or thick bush prior to the large-scale agricultural intervention by humans (Moll 1976), but as indicated in Chapter 11, recent opinion is inclined towards a primary grassland. The historical occurrence of large-scale timber exploitation in the area can, however, not be denied (Moll 1976). One consequence of the expansion of agriculture has been an increase in the presence of the unpalatable grass species *Aristida junciformis,* replacing much of the original *Themeda triandra*-dominated veld (Moll 1976). The widespread occurrence of the grasses *Eragrostis plana* and *Cymbopogon validus* indicates both the disturbed and moist nature of this grassland. The soils are generally sandy and well-drained, and derived from Karoo sediments. The most common soil forms are Mispah and Clovelly (Fitzpatrick 1978). An indication of the severe disturbance in the area is the relatively low average number of species per relevé, namely 17.85.

Refinement of the table, using MEGATAB, revealed 3 communities with 4 sub-communities and 2 variations. These are:

1. *Hyparrhenia hirta - Helichrysum aureonitens* moist grassland community.

    1.1. *Hyparrhenia hirta - Spermacoce natalensis* moist grassland sub-community on south-facing slopes.

    1.1.1. *Spermacoce natalensis - Andropogon schirensis* rocky moist grassland variation.

    1.1.2. *Spermacoce natalensis - Eragrostis curvula* non-rocky moist grassland variation.

    1.2. *Hyparrhenia hirta - Diheteropogon amplectens* undisturbed rocky crest sub-community.

2. *Tristachya leucothrix - Themeda triandra* non-rocky grassland community.

   2.1. *Tristachya leucothrix - Loudetia simplex* north-facing grassland sub-community.

   2.2. *Tristachya leucothrix - Monocymbium ceresiiforme* non-rocky crest sub-community.

3. *Cymbopogon validus - Cussonia spicata* rocky scarp community.

Description of the Plant Communities

1. *Hyparrhenia hirta - Helichrysum aureonitens* moist grassland community.

This community represents most of the grassland vegetation on the south-facing slopes and rocky crests of the Mistbelt. Species group A (Table 4) is characteristic of this grassland. The vegetation is dominated by grasses and forbs, with few woody species being recorded. The dominant grass is the tall *Hyparrhenia hirta* (species group A), with less common grasses including *Melinis repens, Sporobolus africanus* (species group A), *Themeda triandra, Trachypogon spicatus, Eragrostis capensis* and *Eragrostis racemosa* (species group J), *Eragrostis plana* and *Cymbopogon validus* (species group L).

The forbs *Pentanisia angustifolia* (species group A) *and Helichrysum aureonitens* (species group J) are the most widespread in this grassland. In parts, this grassland is scrubby and woody plants such as *Rhus* species (species group E) tend to be found where the soil is moist or where there are rocks, which provide a fire refuge.

This grassland can be classified into 2 sub-communities and 2 variations, based on rockiness and topography.

1.1 *Hyparrhenia hirta - Spermacoce natalensis* moist grassland sub-community on south-facing slopes.

This sub-community is characterised by species group D. Diagnostic grasses are *Digitaria diagonalis* and *Panicum ecklonii* (species group D) whereas *Hyparrhenia hirta* (species group A) is the dominant grass species. The weed *Spermacoce natalensis* (species group D) is also diagnostic with *Helichrysum aureonitens* (species group J) conspicuous. This grassland covers south-facing slopes in the mistbelt areas, where there is a greater moisture presence in the soil than on north-facing slopes, due to a lower exposure to radiant energy. This higher moisture content explains the presence of *Panicum ecklonii* and *Digitaria diagonalis*, both of which often grow on sandy soils in moist places (Gibbs Russell *et al.* 1991). *Digitaria diagonalis* was also found on moist south-facing slopes at Suikerbosrand by Bredenkamp & Theron (1980). *Spermacoce natalensis* is known to favour moist places (van Wyk & Malan 1988). Interestingly, there is less evidence of the encroaching *Aristida junciformis* on the south-facing slopes, possibly indicating less disturbance on these slopes.

1.1.1. *Spermacoce natalensis - Andropogon schirensis* rocky moist grassland variation.

This grassland occurs on rocky south-facing slopes in the mistbelt. Species group B is characteristic of this variation, but elements of species groups A, D, J and L are also present. The herbaceous layer is dominated by the grass *Hyparrhenia hirta* and the forb *Spermacocce natalensis* (species group D), while characteristic species in this variation are the grasses *Andropogon schirensis* and *Paspalum dilatatum* (species group B) and the forbs *Lobelia flaccida* and *Berkheya rhapontica* (species group B). There are no diagnostic species for this variation.

The woody layer is not conspicuous on these slopes, but the shrubs *Rhus dentata* and *Rhus discolor* (species group E) were recorded, as well as the grass *Diheteropogon amplectens* (species group E), which favours rocky habitats (Gibbs Russell *et al.* 1991), and the fern *Cheilanthes quadripinnata* (species group E). The rocks provide a fire refuge for the seeds of the *Rhus* species, and *Cheilanthes quadripinnata* utilises the moist micro-climate provided by

the rocks.

1.1.2. *Spermacoce natalensis - Eragrostis curvula* non-rocky moist grassland variation.

This variation is found on south-facing slopes with a rock cover of 20% or less. Species group C is characteristic of this grassland variation, and the forbs *Helichrysum herbaceum* and *Chaetacanthus setiger* (species group C) are diagnostic. The grasses *Hyparrhenia hirta* (species group A), *Eragrostis curvula* (species group C), *Panicum ecklonii, Digitaria diagonalis* (species group D) and *Eragrostis capensis* (species group J) dominate the variation. Other forbs recorded include *Spermacoce natalensis* (species group D), *Helichrysum miconiifolium* and *Helichrysum aureonitens* (species gro ıp J). The lack of rocks accounts for the absence of woody species. Disturbance in the form of overgrazing was evident on these slopes, and this together with the moisture availability accounts for the presence of the weeds *Oenothera rosea, Verbena bonariensis* and *Lactuca inermis* (species group C).

The south-facing aspect of these slopes results in a lower evaporation rate relative to the north-facing slopes, and a relatively higher accumulation of moisture. This moisture is responsible for the presence of the grasses *Panicum ecklonii* and *Digitaria diagonalis* (Gibbs Russell *et al*. 1991).

1.2. *Hyparrhenia hirta - Diheteropogon amplectens* undisturbed rocky crest sub-community.

This sub-community is characterised by species group E, which includes the diagnostic forbs *Zantedeschia aethiopica* and *Sutera floribunda* and the diagnostic shrub *Asparagus setaceous*. The herbaceous layer is dominated by grasses, these including *Hyparrhenia hirta, Melinis repens* (species group A), *Diheteropogon amplectens* (species group E), *Aristida junciformis* (species group I), *Themeda triandra, Trachypogon spicatus* (species group J), *Eragrostis plana* and *Cymbopogon validus* (species group L). The association is restricted to crests which show a rockiness of 25% or more, and these rocks encourage the presence of

species in species group E. The fern *Cheilanthes quadripinnata* (species group E) requires shade and moisture (Burrows 1990) and this is provided by the cracks in and underneath the rocks. The grass *Diheteropogon amplectens* (species group E) is commonly associated with a rocky environment (van Oudtshoorn 1991), as is the forb *Zantedeschia aethiopica* (species group E). The small tree or shrub *Rhus dentata* (species group E) establishes in such an environment as the rocks provide a fire refuge for the seeds. Some of the crests are too rocky to provide easy grazing for livestock, and are thus relatively undisturbed. This is indicated by the lower frequency of *Aristida junciformis* on these crests as compared with the non-rocky crests (sub-community 2.2).

2. *Tristachya leucothrix - Themeda triandra* non-rocky grassland community.

This community is characterised by species group F, and dominated by the grasses *Themeda triandra* (species group J) and *Tristachya leucothrix* (species group F). The grasses *Heteropogon contortus* (species group F) and *Aristida junciformis* (species group J) are also well represented in this grassland. The community is restricted to crests and north-facing slopes where the rock cover is 25% or less. The relative absence of rocks accounts for the lack of woody plants in the association. *Pentanisia prunelloides* (species group F) is a common forb in this community, while other forbs recorded are *Acalypha schinzii* (species group H), *Vernonia natalensis, Helichrysum miconiifolium* (species group I), and *Helichrysum aureonitens* (species group J). The community provides good grazing, as indicated by the abundance of *Themeda triandra*, but the presence of *Aristida junciformis* indicates that disturbances of various kinds are altering the species composition of the grassland.

2.1. *Tristachya leucothrix - Loudetia simplex* north-facing grassland sub-community.

This grassland is located mostly on north-facing slopes, with few or no rocks present. The sub-community is dominated by a number of grasses: *Themeda triandra* (species group J), *Heteropogon contortus* and *Tristachya leucothrix* (species group F). The unpalatable grasses *Loudetia simplex* and *Alloteropsis semialata* (species group G) are respectively characteristic

and diagnostic of this grassland, but due to their low cover-abundance values, not dominant. The forbs *Hypoxis argentea, Eriosema kraussianum, Thunbergia atriplicifolia, Senecio scitus, Silene burchellii, Helichrysum nudifolium* and *Conyza pinnata* (species group G) are all diagnostic for this sub-community. The most common forbs are however *Acalypha punctata* (species group G) and *Pentanisia prunelloides* (species group F). The soils are typically sandy and shallow, with insufficient rockiness to provide a fire refuge for woody species. The ground is sufficiently stony in places, however, to support *Alloteropsis semialata* which is associated with stony soils (Gibbs Russell *et al.* 1991).

2.2. *Tristachya leucothrix - Monocymbium ceresiiforme* non-rocky crest sub-community.

This sub-community is characterised by species group H. The grasses *Themeda triandra, Trachypogon spicatus* (species group J), *Aristida junciformis* (species group I) and *Tristachya leucothrix* (species group F) dominate the sub-community, with *Heteropogon contortus* (species group F), *Monocymbium ceresiiforme* and *Brachiaria serrata* (species group H) also common. The sub-community is found on crests with few or no rocks, and consequently have no woody plants recorded. Diagnostic species include the grass *Monocymbium ceresiiforme* and the grey-green forb *Helichrysum glomeratum* (species group H). *Monocymbium ceresiiforme* is an indicator of acidic soils (Gibbs Russell *et al.* 1991); an indication of the base leaching which occurs in the soils of this mistbelt area. The absence of rocks encourages domestic stock to graze on these crests, and the high frequency of the pioneer grass *Aristida junciformis* is an indication of the grazing disturbance to which this grassland has been subjected.

3. *Cymbopogon validus - Cussonia spicata* rocky scarp community.

This community is found on rocky scarps, which are scarce as a land form in the mistbelt and hence represented by only two relevés in Table 4. A particular type of plant community is associated with these scarps, represented by species group K. The main grasses present include *Cymbopogon validus* (species group L) and *Setaria sphacelata* (species group B), although *Sporobolus africanus, Melinis repens* (species group A), *Andropogon schirensis*

(species group B), *Aristida junciformis*, (species group I), *Eragrostis plana* (species group L) and *Eragrostis plana* (species group L) are also found. A number of woody plants grow on the scarps, possibly because they are well protected from fire as the rock cover is high and the vegetation cover is low. *Cussonia spicata, Grewia lasiocarpa, Canthium mundianum* and *Rhus chirindensis* (species group K) and *Rhus dentata* (species group E) are all trees or shrubs found in this community. These woody species are all diagnostic except *Rhus dentata*. *Cussonia spicata*, in particular, has a high aerial cover in this association. Other diagnostic species include the fern *Cheilanthes hirta*, and the forbs *Senecio hieracioides, Tephrosia glomeruliflorus* and *Rhynchosia caribaea* (species group K).

The rocks on these scarp-faces are sandstone, and the soil that forms is sandy and well-drained. Any water that collects will collect in cracks between rocks, and it is here that many of the above-mentioned plants have their roots.

TABLE 4. Phytosociological Table of the KwaZulu-Natal Mistbelt Region

Unique relevé no.						
	44444	444444	44444	4444444	444444	44
	00000	000000	01000	0000000	000011	00
	99998	879777	80999	7788878	888700	89
	11228	840334	94220	1199446	999444	68
	08136	788981	76029	5405241	416543	07
SPECIES GROUP A						
Hyparrhenia hirta	b+bb1	.+b...	..+bb	.....	....+.	..
Pentanisia angustifolia	+.+++	+.....	..++.	.....+	.....	..
Setaria sphacelata	.++..	.....	.....	....+.	.....	.1
Melinis repens	+.+..	....+.	..+.+	.....+	.....	+.
Sporobolus africanus	...+.	+.....	...+.	1.....	.....	.+
SPECIES GROUP B						
Andropogon schirensis	+++..	.....	.....	....+.	.....	+.
Lobelia flaccida	.+++.	.....	.....	.+....	+....	..
Berkheya rhapontica	+..+.	.....	..+..	.....	....+	..
Paspalum dilatatum	...++	.....	.....	.....	.....	..
SPECIES GROUP C						
Eragrostis curvula	.....	++..b.	.....	....++.	.....	..
Senecio harveianus	....+	.a...+	.....	.....	.....	..
Helichrysum herbaceum	.....	+.+...	.....	.....	.....	..
Chaetacanthus setiger	.....	+...+.	.....	.....	.....	..
Oenothera rosea	.....	...+.+	.....	.....	.....	..
Verbena bonariensis	.....	.+...+	.....	....+.	.....	.+
Lactuca inermis	.....	...+.+	.....	.....	.....	..
SPECIES GROUP D						
Spermacoce natalensis	+++1.	+.+.+.	.....	.....	.....	..
Digitaria diagonalis	.+++.	+...+.	.....	.....	.....	..
Panicum ecklonii	.+.+.	.++.+.	.....	.....	.....	..

SPECIES GROUP E

Diheteropogon amplectens	+.+..	.....	++..+	.....	.....	..
Rhus discolor	.+...	.....	++..+	.....	.....	..
Rhus dentata	.+...	.....	++.+.	.....+.	.....	+.
Acalypha wilmsii	.....	.....	++..+	.....	.....+	..
Asparagus setaceus	.....	.....	.++.+	.....	.....	..
Zantedeschia aethiopica	.....	.....	+.++.	.....	.....	..
Cheilanthes quadripinnata	++...	.....	.++..	.....	.....	..
Sutera floribunda	.....	.....	.++..	.....	.....	..

SPECIES GROUP F

Tristachya leucothrix	....+	1.....	.....	+++all+	++.3.+	..
Heteropogon contortus	.....	.....	...++	+++.++1	1++...	..
Pentanisia prunelloides	.+...	.....	.....	+++..+.	....++	..

SPECIES GROUP G

Loudetia simplex	.....	.....	...+1	+.++++.	.....	..
Acalypha punctata	.....	.....+	+....	+.++.++	.....	.+
Alloteropsis semialata	.....	.....	.....	.++++.+	.....	..
Hypoxis argentea	.....	.....	.....	.+...+.	.....	..
Eriosema kraussianum	.....	.....	.....	.+....+	.....	..
Thunbergia atriplicifolia	.....	.....	.....	+.....+	.....	..
Senecio scitus	.....	.....	.....	.....++	.....	..
Silene burchellii	.....	.....	.....	..+...+	.....	..
Helichrysum nudifolium	.....	.....	.....	..++...	.....	..
Conyza pinnata	.....	.....	.....	..++...	.....	..
Pteridium aquilinum	.....	.....	.....	....+.+	.....	+.

SPECIES GROUP H

Monocymbium ceresiiforme	.....	.....	.....	.....	+++++.	..
Acalypha schinzii	.....	.....	.....	....+..	+1+.+.	..
Brachiaria serrata	.....	....+.	.....	.....	+..+.+	..
Helichrysum glomeratum	.....	.....	.....	.....	+.+...	..

SPECIES GROUP I

Aristida junciformis	.....	..+...	.3+.+	b..+...	++++3b	.+
Vernonia natalensis	.....	..+...	.+.+.	.+..+..	+++..+	..
Helichrysum miconiifolium	.....	+.+.++	.....	.+1..+.	.+....	..

SPECIES GROUP J

Themeda triandra	a+...	b.....	+.a+.	++bb++b	3b3+1a	..
Helichrysum aureonitens	+1++.	..+.+.	..a..	.+.....	+.+.+.	..
Trachypogon spicatus	.+...	..+...	1+..+	...1+..	1++++.	..
Eragrostis racemosa	..1..	..+.+.	1	....1.1	.++.++	..
Eragrostis capensis	..+..	+++.+.	..+..	....+..	..+...	..

SPECIES GROUP K

Cussonia spicata	.....	.....	.....	.....	.....	1+
Senecio hieracioides	.....	.....	.....	.....	.....	++
Grewia lasiocarpa	.....	.....	.....	.....	.....	++
Tephrosia glomeruliflora	.....	.....	.....	.....	.....	++
Rhus chirindensis	.....	.....	.....	.....	.....	++
Abildgaardia species	.....	.....	.....	.....	.....	++
Rhynchosia caribaea	.....	.....	.....	.....	.....	++
Cheilanthes hirta	.....	.....	.....	.....	.....	+.

SPECIES GROUP L

Eragrostis plana	.+++.	+..1..	a..+.	.+.....	+....+	.+
Cymbopogon validus	.+...	.....	.++.+	...+...	.....+	+1

OTHER SPECIES

Senecio venosus	..+.+	+.....	.....	.+.....	.....	..
Rubus cuneifolius	....+	.....+	.....	.+...+.	.....	..
Leucosidea sericea	.....	.....	.....	...+.+.	+.....	..
Canthium mundianum	.....	.....	.....	.....	.....	+.
Polygonum hystriculum	.....	...+..	.....	.....	.....	..
Senecio inornatus	.....	.....	.....	....+..	.....	+.
Setaria pallide-fusca	.....	.....	.....	.....+	.....	+.
Oenothera indecora s. bona	...+.	.....	.....	.....	.....	..
Plantago lanceolata	.....	3	.....	.....	.....	..
Oxalis depressa	.....	.....+	.....	.....	.....	..
Acacia mearnsii	....+	....+.	.....	.....	.....	..
Solanum mauritianum	.....	....+.	.....	.....	.....	..
Ranunculus multifidus	.....	...+..	.....	.....	.....	..
Senecio isatideus	.....	...+..	.....	+.....	.....	.+
Helichrysum mundtii	.....	....+.	.....	.....	.....	.+
Pelargonium luridum	....+	....+.	.....	.....	.....	..
Polygala virgata v. decor	.....	..+...	.....	.....	.....	..
Geranium pulchrum	.....	.....	.....	.....	.....	.+
Conyza albida	.+...	.....	.....	.....	.....	..

Rubus ludwigii	.	.	+	.	.	.
Eulalia villosa	.	.	.	.	.	+
Hypochaeris radicata	a	.	+	.	.	.
Hypoxis rigidula	.	.	.	+	+	.
Oxalis tragopoda	.	.	.	+	+	.
Digitaria tricholaenoides	.	.	.	+	+	.
Panicum natalense	.	.	.	+	+	.
Melinis nerviglumis	.	.	.	+	+	.
Digitaria eriantha	.	.	.	+	+	.
Harpochloa falx	.	.	.	+	+	.
Scabiosa columbaria	+	+	.	.	.	.
Hebenstretia dregei	+	+	.	.	.	.
Conyza chilensis	+	+	.	.	.	.
Tolpis capensis	+	+	.	.	.	.
Rhoicissus tridentata	+	.	.	.	.	+
Commelina africana	.	+	+	.	+	+
Pseudognapha luteo-album	.	.	+	.	+	+
Kyllinga alba	+	.	+	.	.	.
Sebaea leiostyla	+	+	+	.	.	.
Lotononis eriantha	.	+	.	+	.	.
Helichrysum harveyanum	.	+	.	+	.	.
Senecio arabidifolius	.	+	.	+	.	.
Helichrysum pilosellum	.	+	.	+	+	.
Helichrysum oreophilum	.	+	.	.	+	.
Eriosema salignum	+	+	.	.	.	+
Asparagus microraphis	+	.	.	.	+	+
Athrixia phylicoides	.	.	.	+	.	+
Pellae calomelanos v. leuc	.	+	.	.	.	+
Berkheya multijuga	.	+	+	.	+	.
Hibiscus trionum	+	.	.	.	.	.
Ciclospermum leptophyllum	+	.	+	.	.	.
Gerbera ambigua	.	.	.	.	+	+
Ischaemum fasciculatum	1	.	+	.	.	.
Cyperus obtusiflorus	.	.	.	.	+	+
Anthospermum herbaceum	.	.	.	.	+	+
Asparagus laricinus	+	.	.	.	.	.
Berkheya setifera	+	.	.	.	.	.
Eriosema cordatum	.	.	.	+	.	+
Berkheya speciosa	.	+	.	.	.	.
Sida cordifolia	.	+	.	.	.	.
Vernonia poskea s. botsw	.	+	.	.	.	.
Ipomoea crassipes	.	+	.	.	.	.
Aeschynomene micrantha	.	+	.	.	.	.
Becium obovatum	.	+	.	.	.	.
Hypoxis kraussiana	.	+	.	.	.	.

CHAPTER 8

THE PHYTOSOCIOLOGY OF THE INCISED RIVER VALLEYS AND DRY UPLAND SAVANNA OF SOUTHERN KWAZULU-NATAL

Figure 20. Wagendrift dam near Estcourt, surrounded by Dry Upland Savanna (Bioclimatic Subregion 8 of Phillips 1973). The dominant tree is *Acacia sieberiana.*

The 39 relevés collected in the Incised River Valleys of the Mkomazi and Mzimkulu Rivers (Phillips' Bioclimatic Subregion 6), together with the 10 relevés from the Dry Upland Savanna (Phillips' Bioclimatic Subregion 8), were grouped together as indicated in Chapter 4. These relevés were classified and refined using the MEGATAB programme, to produce Table 5.

In general the vegetation of the incised river valleys and dry upland savanna of southern KwaZulu-Natal can be classified as a *Hyparrhenia hirta - Themeda triandra* dry wooded

grassland. The prominent though often sparse cover of microphyllous trees such as *Acacia karroo, A. sieberiana* and *A. caffra* is characteristic of this wooded grassland.

This grassland is found in the river valleys of southern KwaZulu-Natal, especially the Mkomazi and Mzimkulu River valleys. There is also an important component of the grassland in the north of the present study area, in the vicinity of Estcourt. Here the grassland of the river valleys (Acocks' Southern Tall Grassveld) merges with that of the dry upland savanna (the "Natal Central Bushveld" of Low & Rebelo 1996) which extends into northern KwaZulu-Natal.

The Physiographic Regions of Turner (1967) in which this grassland falls are the "Incised River Valleys" and "Winterton-Estcourt-Muden Plain". Phillips (1973) classified them in the "Open Grassland to Wooded Savanna" Bioclimatic Subregion. The crucial factor the two regions have in common is the climate, which is drier than in the other regions of the present study area. The annual rainfall varies from 650-900 mm. The altitude of the incised river valleys varies from 600 to 1 050 m, considerably lower than the Highland Sourveld or Mistbelt regions. In places the river valleys are 600 m below the surrounding countryside (e.g. the Mkomazi at Hela Hela). These river valleys have been incised far back towards the Drakensberg range; the Mzimkulu lies in a deep gorge only 35 km from the escarpment crest. The gorges containing the Mlazi, Illovo, Mpambinyoni, Mtwalume and Mzumbe Rivers are not included in Phillips' (1973) Open Grassland to Wooded Savanna Bioclimatic Subregion, but rather in the Riverine Scrub and Wooded Savanna (Subregion 10). Acocks (1988) also classified the vegetation of these river valleys as scrub or "Valley Bushveld". This vegetation can therefore not be regarded as "wooded grassland" and is not included in the present classification.

The soils, derived from arenaceous Karoo sediments, are yellow and grey hydromorphic, mainly mesotrophic sands and loams with some red clays and duplex spoils (Fitzpatrick 1978). The subsoil is erodible and the topsoil is shallow (less than 500 mm).

A great deal of subsistence farming is practised in these low-lying areas, as parts of the

KwaZulu homeland fell in this region. Poor farming methods, unstable soil and a large human population have contributed to the ecological deterioration of this grassland. Being drier and warmer, the grassland contains a higher number of woody species than the Highland sourveld or the Mistbelt, and in places is an open savannah. The thorn trees *Acacia karroo* and *Acacia caffra* are distinctive in the incised river valleys, and *Acacia karroo* and *Acacia sieberiana* are typical of the savanna around Estcourt. *Acacia karroo* is known as an indicator of sweet veld (Pooley 1993), and this grassland is less sour than the Highland Sourveld (Acocks (1988) due to the lower rainfall. North-east of Estcourt and Greytown, the upland savanna merges into Valley Bushveld (Acocks 1988), a thicker and woodier vegetation than that of the incised river valleys.

The tall grass *Hyparrhenia hirta* is the most common grass in this grassveld, being a prominent feature of all the grasslands in the north of the study area and also a prominent feature in the river valleys further south.

An analysis of Table 5 revealed 5 communities and 9 sub-communities. These are:

1. *Hyparrhenia hirta* - *Acacia sieberiana* wooded grassland community of the Winterton-Estcourt-Muden Plain.

    1.1. *Acacia sieberiana* - *Eriosema salignum* wooded crest sub-community.
    1.2. *Acacia sieberiana* - *Maytenus heterophylla* wooded slope sub-community.

2. *Hyparrhenia hirta* - *Acacia caffra* south-facing wooded grassland community of the incised river valleys.

    2.1. *Acacia caffra* - *Tristachya leucothrix* south-facing non-rocky grassland sub-community.
    2.2. *Acacia caffra* - *Ozoroa paniculosa* south-facing rocky grassland sub-community.

3. *Hyparrhenia hirta - Acacia karroo* north-facing wooded grassland community.

   3.1. *Hyparrhenia hirta - Rhus dentata* north-facing rocky grassland sub-community.
   3.2. *Acacia karroo - Themeda triandra* north-facing non-rocky grassland sub-community.

4. *Hyparrhenia hirta - Themeda triandra* grassland crest community.

   4.1. *Themeda triandra - Sebaea leiostyla* undisturbed crest sub-community.
   4.2. *Themeda triandra - Brachiaria serrata* severely disturbed crest sub-community.
   4.3. *Themeda triandra - Thesium costatum* moderately disturbed crest sub-community.

5. *Diospyros lycioides - Aloe arborescens* rocky scarp sub-community.

Description of the Plant Communities

1. *Hyparrhenia hirta - Acacia sieberiana* wooded grassland community of the Winterton-Estcourt-Muden Plain.

This wooded grassland is restricted to the northern parts of the study area, in the Estcourt - Greytown vicinity. Species group A (Table 5) is characteristic of this community. The distinctive paper-bark thorn tree *Acacia sieberiana* (species group A) is diagnostic of this community, and also dominates the woody layer, growing to a height of about 7,5 m. Other woody species include *Rhus pyroides* (species group A), *Rhus dentata* (species group F) and *Acacia karroo* (species group G). The herbaceous layer is open and dominated by tufted grasses such as *Themeda triandra*, *Hyparrhenia hirta, and Eragrostis curvula* (species group P). The grass layer reaches a maximum height of 1,5 m. The forb component is sparse relative to the Highland Sourveld (Acocks 1988) and includes *Hypoxis rigidula, Rhynchosia totta* var.

totta, Berkheya multijuga (species group A), *Acalypha punctata* (species group C) *and Tagetes minuta* (species group J).

The grassland is fire-maintained, but where there is protection from fire, woody species increase and the vegetation approaches a closed woodland type (Moll 1968). This is also the case where fire protection is provided on rocky slopes, enabling the woody vegetation to proliferate.

The soils are sandy, derived from Ecca shales and moderately leached. Arcadia and Estcourt soil forms are the most common (Phillips 1973).

Large parts of this wooded grassland have been altered, either by cultivation (e.g. exotic plantations) or by removing trees for fuel. According to Moll (1968) these disturbances have also led to an increase in *Hyparrhenia hirta* at the expense of *Themeda triandra*.

1.1. *Acacia sieberiana - Eriosema salignum* wooded crest sub-community.

This sub-community is found on crests and gentle slopes (gradient less than 5°) with no rocks in the north of the study area. The thorn trees *Acacia sieberiana* (species group A) and *Acacia karroo* (species group G) dominate this sub-community. Few other woody species occur except *Rhus pyroides* (species group A) and *Rhus dentata* (species group F). There is little protection from fire and woody plant growth is thereby limited. The canopy is open and the spaces between trees range from 5 to 15 metres.

The herbaceous layer includes grass species such as *Themeda triandra, Hyparrhenia hirta, Eragrostis curvula* (species group P) and *Heteropogon contortus* (species group M).

Forbs in this sub-community include *Hypoxis rigidula, Rhynchosia totta* var. *totta, Berkheya multijuga* (species group A), *Eriosema salignum* and *Trachyandra asperata* (species group B). Species group B is characteristic of this sub-community.

1.2. *Acacia sieberiana - Maytenus heterophylla* wooded slope sub-community.

This sub-community is found within the *Hyparrhenia hirta - Acacia sieberiana* wooded grassland, on slopes with a gradient greater than 10° and with rock cover of more than 25%. The rocks provide protection from fire and consequently woody plants can germinate and grow. The thorn tree *Acacia sieberiana* (species group A) dominates the woody layer. Other common woody species are *Maytenus heterophylla*, *Diospyros austro-africana, Cussonia paniculata,* (species group C), *Rhus dentata* (species group F), and *Rubus cuneifolius* (species group M). Less common woody species include *Buddleja salviifolia, Rhus pyroides* (species group A), *Acacia nilotica, Cussonia spicata, Rhus rehmanniana* var. *rehmanniana* (species group C), *Ziziphus mucronata* (species group F) and *Acacia karroo* (species group G).

The herbaceous layer is dominated by *Themeda triandra* and *Hyparrhenia hirta* (species group P). Forbs present include *Hypoxis rigidula* (species group A), *Acalypha punctata, Sutera polelensis, Haemanthus humilis* (species group C) *and Hermannia depressa* (species group M). Species group C is characteristic of this sub-community, and *Diospyros austro-africanus, Buddleja salviifolia, Acacia nilotica*, *Sutera polelensis, Haemanthus humilis* and *Rhus rehmanniana* var. *rehmanniana* are diagnostic.

As with the previous sub-association, large parts of this grassland are transformed, mainly by cultivation or wood-fuel stripping. There is also more *Hyparrhenia hirta* now present than was recorded by Bews (1917). The consequence of this is that the grazing value of the grassland is reduced, the replaced *Themeda triandra* being a superior grazing grass to *Hyparrhenia hirta*.

2. *Hyparrhenia hirta - Acacia caffra* south-facing wooded grassland community of the incised river valleys.

This community is restricted to south-facing slopes, largely in the valleys of the Mkomazi and Mkzimkulu rivers. The south-facing slopes are protected somewhat from hot winds and insolation, and consequently more soil moisture is available. The woody vegetation is more

prominent than on the exposed crests or north-facing slopes. Where the rock cover is significant, 30% or more, the woody vegetation is additionally benefited due to fire protection.

Species group D is characteristic of this community. The dominant woody plants are the trees *Acacia karroo* (species group G) and *Acacia caffra* (species group D). Other common woody plants are *Grewia occidentalis, Euclea crispa* (species group D), *Ziziphus mucronata*, *Rhus dentata* (species group F) and the creeper *Rhoicissus tridentata* (species group F). The herbaceous layer is dominated by grasses and forbs in species groups M and P. The grasses *Paspalum dilatatum* (species group D) and *Sporobolus africanus* (species group O) are also present. The tall grass *Hyparrhenia hirta* is the most dominant grass species. Although this community has been disturbed, the presence of *Hyparrhenia hirta* here is not attributed to this disturbance, but appears always to have been dominant in this grassland (Moll 1968).

The soils are shallow (300-450 mm) and easily erodable. The most common soil form is Avalon (Phillips 1973). Drainage through the soils is rapid and there is little moisture accumulation in the soil. The geology is characterised by the presence of sandstone and dolerite. *Themeda* and *Hyparrhenia* species are most commonly found on dolerite (Acocks 1988).

2.1. *Acacia caffra - Tristachya leucothrix* south-facing non-rocky sub-community.

This sub-community is located on south-facing slopes within incised river valleys, but is restricted to slopes with a rock cover of 20% or less. The presence of woody vegetation is ascribed to the moist conditions brought about by aspect, but the lack of rocks means less protection from fire and this limits the woody vegetation growth. The canopy is open and the canopy cover in these relevés averaged 23%.

No characteristic species group for this sub-community was identified; it is however characterised by the presence of species group D and the absence of species group E. The dominant woody species are the trees *Acacia caffra* (species group D) and *Acacia karroo* (species group G). *Acacia caffra* is associated with rocky slopes (Pooley 1993). Other shrubs

and trees recorded include *Grewia occidentalis*, *Euclea crispa* (species group D), *Ziziphus mucronata* and *Rhus dentata* (species group F). The creeper *Rhoicissus tridentata* (species group F) is also common. Dominant grasses are *Tristachya leucothrix* (species group M), *Hyparrhenia hirta*, *Eragrostis curvula* and *Themeda triandra* (species group P). The forb component was less prominent than the grasses, but *Hypoxis rigidula* (species group A), *Sebaea leiostyla* (species group I), *Vernonia natalenisis*, *Acalypha schinzii*, and *Hermannia depressa* (species group M) were among those recorded.

2.2. *Acacia caffra* - *Ozoroa paniculosa* south-facing rocky sub-community.

This sub-community is located on south-facing slopes with a gradient greater than 10° and a rock cover of 20% or greater. The cooler, moist conditions provided by the aspect and the fire protection provided by the rocks result in a suitable habitat for woody plants. The dominant woody plants are the thorn trees *Acacia caffra* (species group D) and *Acacia karroo* (species group G). Other woody plants are present from species group D, including *Grewia occidentalis* and *Euclea crispa*, and the succulent *Aloe arborescens* (species group N) was recorded twice. Species group E is characteristic of this sub-community. This includes the woody shrub/tree *Ozoroa paniculosa*, the fern *Mohria caffrorum* var. *caffrorum*, and the forbs *Pentanisia angustifolia* and *Taraxacum officinale*. The fern *Mohria caffrorum var. caffrorum* utilises the cracks between the rocks to avoid fire and obtain moisture, and its rhizome is usually situated in these cracks.

Dominant grasses are *Sporobolus africanus* (species group O), *Hyparrhenia hirta* and *Themeda triandra* (species group P). Besides the forbs of species group E, a number of others are present, including *Helichrysum aureonitens*, *Richardia brasiliensis*, *Conyza obscura* (species group L), *Acalypha schinzii*, *Hermannia depressa* and *Helichrysum miconiifolium* (species group M).

3. *Hyparrhenia hirta* - *Acacia karroo* north-facing wooded grassland community.

This community is restricted to north-facing slopes in the incised river valleys. The thorn tree

Acacia karroo (species group G) is the characteristic woody plant in this community, with other woody plants being found on the rocky slopes. There is no characteristic species group for this community; it is characterised by the presence of *Acacia karroo* and the absence of species groups A-E.

The herbaceous layer is dominated by grasses, especially *Themeda triandra* and *Hyparrhenia hirta* (species group P), and to a lesser extent by *Tristachya leucothrix, Eragrostis racemosa, Heteropogon contortus* (species group M), and *Eragrostis curvula* (species group P). The forbs are less prominent; the most common ones being *Helichrysum aureonitens* (species group L), *Hermannia depressa, Pentanisia prunelloides* and *Pelargonium luridum* (species group M).

3.1. *Hyparrhenia hirta - Rhus dentata* north-facing rocky grassland sub-community.

This sub-community is located on north-facing slopes with a rock cover of 20% or more. The low altitude combined with direct solar radiation results in a hot dry environment. The rocky ground provides good habitat for the occurrence of woody vegetation. The dominant trees are *Acacia karroo* (species group G) and *Rhus dentata* (species group F). Other common shrubs/small trees are *Ziziphus mucronata* and *Rhoicissus tridentata* (species group F). Dominant grasses are *Themeda triandra,* and *Hyparrhenia hirta* (species group P), with *Eragrostis curvula* (species group P) also present. Canopy cover is seldom greater than 20%.

3.2. *Acacia karroo - Themeda triandra* north-facing non-rocky grassland sub-community.

This sub-community is found on north-facing slopes with few or no rocks. Consequently there is little protection from fire and the soil contains little moisture. The only woody species recorded was *Acacia karroo* (species group G), which is nevertheless common in this sub-community. The grass cover is denser than in the previous sub-community. Dominant grasses are *Themeda triandra* and *Hyparrhenia hirta* (species group P) and abundant grasses include *Tristachya leucothrix, Eragrostis racemosa, Heteropogon contortus* (species group M) and *Eragrostis curvula* (species group P). The grasses *Trachypogon spicatus* and *Digitaria*

tricholaenoides (species group L) are less common in this sub-community. Forbs present include *Vernonia natalensis, Acalypha schinzii, Hermannia depressa, Pentanisia prunelloides, Pelargonium luridum* (species group M) and *Helichrysum aureonitens* (species group L).

No characteristic species group was identified for this sub-community. It is characterised by the presence of *Acacia karroo* (species group G) and the absence of species group F.

4. *Hyparrhenia hirta - Themeda triandra* grassland crest community.

This community is restricted to the crests of the low-lying areas in the vicinity of the incised river valleys. These crests are grass-covered and do not support trees, unlike the slopes beneath them. Species group H, although sparse, is characteristic of this community.

The dominant grasses are *Hyparrhenia hirta* and *Themeda triandra* (species group P). Other grasses include *Eragrostis curvula* (species group P), *Sporobolus africanus* (species group O) and *Heteropogon contortus* (species group M). Forbs present include *Hoffmannseggia sandersonii, Abildgaardia ovata* (species group H), *Helichrysum aureonitens, Richardia brasiliensis, Conyza obscura* (species group L), *Acalypha schinzii,Hermannia depressa* and *Helichrysum miconiifolium* (species group M). Three sub-communities were classified in this communitiy.

4.1. *Themeda triandra - Sebaea leiostyla* undisturbed crest sub-community.

This sub-community is characterised by species group I, which includes the forb *Sebaea leiostyla* and the grasses *Microchloa caffra* and *Elionurus muticus*. This sub-community was found on crests which showed little or no disturbance, but with relatively low species richness. The herbaceous layer is dominated by the grasses *Themeda triandra* and *Hyparrhenia hirta* (species group P). Other grasses include *Eragrostis curvula* (species group p), *Sporobolus africanus* (species group O), *Heteropogon contortus* and *Eragrostis plana* (species group M). The forbs *Hoffmannseggia sandersonii, Abildgaardia ovata* (species group H), *Helichrysum*

aureonitens and *Richardia brasiliensis* (species group L) were also recorded.

4.2. *Themeda triandra - Brachiaria serrata* severely disturbed crest sub-community.

This sub-community is characterised by species group J, which includes the grasses *Brachiaria serrata* and *Setaria sphacelata*, and the forbs *Tagetes minuta, Gymnopentzia bifurcata, Solanum mauritianum* and *Bidens pilosa*. These forbs are all ruderals and indicate severe disturbance (Van Wyk & Malan 1988; Bromilow 1995). The grass *Brachiaria serrata* is associated with shallow stony soils (Gibbs Russell *et al.* 1991). The crests which are the site of this sub-community can therefore be described as disturbed areas with shallow soils.

Other grasses in this sub-community include *Heteropogon contortus* (species group M), *Themeda triandra, Hyparrhenia hirta* and *Eragrostis curvula* (species group P). The forbs *Helichrysum aureonitens, Richardia brasiliensis* and *Conyza obscura* (the latter two are also ruderals) (species group L) were also recorded.

4.3. *Themeda triandra - Thesium costatum* moderately disturbed crest sub-community.

Species group K is characteristic of this sub-community, which is found on crests with shallow soils that show less disturbance than the previous sub-community. Some disturbance is indicated by the presence of the grasses *Eragrostis capensis* and *Eragrostis chloromelas* (species group K) (Gibbs Russell *et al.* 1991), and the forbs *Scabiosa columbaria* and *Zornia capensis* are associated with disturbance (Bromilow 1995). The small shrub *Thesium costatum* (species group K) is common in this sub-community, and the forbs *Rhychosia totta* var. *totta* and *Leonotis leonuris* (species group K) are also present.

The grasses *Sporobolus africanus* (species group O), *Themeda triandra* and *Hyparrhenia hirta* (species group P) dominate this sub-community, while *Tristachya leucothrix, Eragrostis racemosa, Eragrostis plana* and *Heteropogon contortus* (species group M) are all common. The forbs *Acalypha schinzii* and *Hermannia depressa* (species group M) are also well represented.

5. *Diospyros lycioides - Aloe arborescens* rocky scarp community.

This community is restricted to rocky scarps in the incised river valleys of southern KwaZulu-Natal. Species group N is characteristic of this community. The rocky crevices are favoured by the small tree *Diospyros lycioides* and succulent *Aloe arborescens* (species group N), as well as the ferns *Mohria caffrorum* var. *caffrorum* (species group E) and *Cheilanthes quadripinnata* (species group N). The grasses *Melinis nerviglumis* (species group N) and *Sporobolus africanus* (species group O) are common on these scarps, as are the forbs *Plectranthus dolichopodus* and *Conyza albida* (species group N). There are no diagnostic species for this community.

The soils on these scarps are very shallow, if present at all, and the vegetation cover is sometimes less than 30%. Due to the inaccessibility of the scarps for agricultural purposes, they are relatively undisturbed, as indicated by the presence of the grass *Melinis nerviglumis* (Van Oudtshoorn 1992). As a community, however, they do not occupy much surface area in this dry grassland.

TABLE 5. Phytosociological Table of the Incised River Valleys and Dry Upland Savanna of southern KwaZulu-Natal

Number in table										
	63777	67778	145	3342228	8814	13145	334	14122	2452	68 24
	39321	94962	3047	0185964	1320	756167	4721	13304	7908	27215
Unique relevé no.										
	44444	44444	4444	4444444	4444	444444	4444	44444	4444	44444
	00000	00000	0000	0000000	0000	000000	0000	00000	0000	00000
	77777	77778	6675	6686668	7867	666796	6676	67666	6896	68667
	53776	67871	2464	7737773	8355	686513	8852	46567	7417	84268
	31109	72744	7811	8993742	9107	540871	3695	90182	5016	25692
SPECIES GROUP A										
Acacia sieberiana	1.b+3	31b1+	....	.....	....	.....	....	.....	....	.....
Hypoxis rigidula	.++1.	.++..	..+.	..+....	....	.....	....	.+...	....	....+
Rhynchosia totta v. totta	+++..	.+...	....	.....	....	.....	...+	.+.+.	....	....+
Rhus pyroides	.+..+	++...	....	.....	....	.....	....	.....	....	.....
Berkheya multijuga	...+.	.+...	....	.....+	.+..	.....	....	.+...	....	.....
SPECIES GROUP B										
Eriosema salignum	+++..	.....	....	.....	....	..+...	....	.....	....	.....
Trachyandra asperata	..++.	.....	....	.....	....	.....	..+.	.....	....	.....
SPECIES GROUP C										
Maytenus heterophylla	.....	++.+b	..+.	.....	...+	.....	....	.....	.+..	.+...
Diospyros austro-africana	.....	+.+.+	....	.....	....	.....	....	.....	....	.....
Cussonia paniculata	.....	.+.11	....	.....	....	.....	..+.	.....	....	....+
Acalypha punctata	.+...	.+.++	....	.....	.1..	.....	..+.	.+...	....	.....
Buddleja salviifolia	.....	.b..b	....	.....	....	.....	....	.....	....	.....
Acacia nilotica	.....	+.+..	....	.....	....	.....	....	.....	....	.....
Cussonia spicata	.....	.+.+.	....	.....	..+.	.....	....	.....	....	+...+
Sutera polelensis	.....	...++	....	.....	....	.....	....	.....	....	.....
Haemanthus humilis	.....	.+..+	....	.....	.+..	.....	....	.....	....	.....
Rhus rehmanniana v. rehman	.....	.r.+.	....	.....	....	.....	....	.....	....	.....

SPECIES GROUP D

Acacia caffra	.	.	1	+	+	1	.	.	.	.
Grewia occidentalis	.	.	+	+	.	+	.	.	.	.
Euclea crispa	.	.	+	+	.	+	.	.	.	.
Paspalum dilatatum	.	.	+	.	+	.	.	.	+	.

SPECIES GROUP E

Pentanisia angustifolia	.	+	.	.	+	+	.	.	+	+
Ozoroa paniculosa	.	.	+	.	+	+	.	.	.	.
Taraxacum officinale	+	.	.	.	+	.	.	+	.	.
Mohria caffrorum v. caffr	.	.	.	.	+	+	.	.	.	+

SPECIES GROUP F

Rhoicissus tridentata	.	.	+	.	+	+	.	.	.	+
Ziziphus mucronata	.	+	.	.	+	+	.	.	.	.
Rhus dentata	.	+	.	+	+	+	.	.	.	b

SPECIES GROUP G

Acacia karroo	b	+	1	1	+	+	.	.	.	.

SPECIES GROUP H

Hoffmannseggia sandersonii	.	.	.	.	.	+	+	.	.	.
Abildgaardia ovata	.	.	.	.	+	.	+	.	.	.

SPECIES GROUP I

Zornia milneana	.	.	.	.	.	.	+	.	.	.
Microchloa caffra	.	.	.	.	.	.	+	.	.	.
Sebaea leiostyla	.	.	+	.	.	.	+	.	.	.
Elionurus muticus	.	+	.	.	.	.	+	.	.	.

SPECIES GROUP J

Brachiaria serrata	+	.	.	.	+	.	.	+	.	.
Tagetes minuta	.	+	.	.	.	.	.	+	1	.
Gymnopentzia bifurcata	.	.	.	.	.	.	.	+	1	.
Setaria sphacelata	.	.	.	.	.	1	.	.	+	+
Solanum mauritianum	.	.	+	.	+	.	.	.	+	+
Bidens pilosa	.	.	+	.	.	.	.	+	.	.

SPECIES GROUP K

Thesium costatum	.....	.....	....	.....	....	.....+	....	.....	++++	.....
Scabiosa columbaria	.....	.....	....	.....	....	.....	....	.+...	.+++	.+...
Eragrostis capensis	.....	.....	....	..+..	....	.....+	....	.....	.b+.	.+...
Eragrostis chloromelas	..+..	.....	....	.....	....	.....	..+.	.....	.++.	.....
Zornia capensis	.....	.....	....	.....	....	.....	....	.....	+..+	.....
Rhynchosia totta	.....	.....	....	.....	....	.....	....	.+...	++..	.....
Leonotis leonurus	.....	....+	....	.....+.	....	.....	....	.....	+.+.	...+.

SPECIES GROUP L

Helichrysum aureonitens	.....	.....	....	.+..++.	.1+.	.b..++	b1..	..+..	b..+	.....
Trachypogon spicatus	.....	.....	....	.....++	+...	.b+.++	.1+.	....+	.++.	.....
Digitaria tricholaenoides	.....	.....	....	.+.+.+.	.+..	.++..+	+.+.	b..++	....	.....
Richardia brasiliensis	.....	.....	+...	+..b1+.	..+.	.....	+..b	...+.	...+	..+b.
Conyza obscura	.....	.....	+..+	++..1..	..+.	.....	+1..+	...+.	+..+	..+..

SPECIES GROUP M

Tristachya leucothrix	....+	...+.	1++1	..1...+	..+.	.+++1+	...1	++.+1	1+++	.+...
Eragrostis racemosa	.....	+.+..	++.+	...+...	++..	++++++	+...	++.++	+++.	.+...
Eragrostis plana	.....	..b..	++..	1...+3.	b...	+.....	1..+	..++.	+.+b	.4...
Cymbopogon validus	3	b....	...b	..1...3	..3.	.+....	....	3.+..	.1..	....b
Vernonia natalensis	.....	...+.	...1	..+....	.+..	..b...	....	+.+..	++..	.....
Heteropogon contortus	+4...	..+..	....	.....	++	+..+	.+++++	+.++	+.+1+	++.+	.+...
Acalypha schinzii	+....	.+...	...1	.+....	+.	+...	..+...	.+..	+..+.	3.+1	.....
Hermannia depressa	.....	++...	..++	+...+..	...+	..++..	+...	.+++.	+++.	+....
Rubus cuneifolius	.....	.+.++	....	1....+.	.+..	.+....	+...	..3..	...+	1....
Pentanisia prunelloides	++...	.....	..+.	.....	+.++	...+..	....	+++..	..+.	.....
Melinis repens	+....	..+.+	...+	..+....	....	.....	....	...+.	.+..	.....
Pelargonium luridum	.+...	.....	.+..	.....	+.	++..	..+...	....	.....	.+..	.....
Helichrysum miconiifolium	.+...	.....	...+	..+...+	..+.	.....	.+..	.+...	++..	+....

SPECIES GROUP N

Conyza albida	.....	.....	....	.....	..+.	.....	....	.....	....	+++++
Diospyros lycioides	...+.	..+..	....	.....	....	.....	..+.	.....	....	+.41+
Aloe arborescens	.....	.+...	..+.	+..+...	...1	.....	....	.....	....	+.b1+
Melinis nerviglumis	.....	.....	....	.....	...+	.....	..+.	.+...	....	.++++
Plectranthus dolichopodus	.....	.....	....	.....	....	+....	....	.....	....	.++++
Cheilanthes quadripinnata	.....	.....	....	.....	..+.	.....	....	.....	....	++.++
Pellaea calomelanos v. leu	.....	.....	....	.....	....	.....	....	.....	....	+.+..

SPECIES GROUP O

Sporobolus africanus	.....|	.....|	++..|	b3.33..|	....|	1+...+|	1..b|	..+1+|	1.+4|	b.1+1

SPECIES GROUP P

Themeda triandra	+.4..|	44...|	b11.|	1+4+1..|	+.1+|	b1+4bb|	+++b|	b++bb|	+b4.|	.b...
Hyparrhenia hirta	..1.+|	.b.b1|	44bb|	111+1++|	.315|	3++1+b|	+.+1|	1bbb4|	.1b+|	b.+..
Eragrostis curvula	3.+..|	..b1.|	1.++|	...+..+|	+++.|	++.+.+|	b.+.|	+...+|	.b..|	.4+..

OTHER SPECIES

Helichrysum herbaceum	.....|	.....|	....|	.....|	..+.|	..+..+|	....|	+..+.|	....|	...+.
Diheteropogon amplectens	.....|	.....|	....|	.....|	....|	..3.+.|	.+..|	.....|	..+.|	.....
Aristida congesta s. conge	.....|	.....|	+...|	.....|	..+.|	+.....|	....|	...+.|	....|	...+.
Chamaesyce plumosa v. erec	.....|	.....|	....|	.....|	....|	.....|	....|	..+..|	....|	...+.
Sporobolus pyramidalis	..+..|	.....|	....|	.....|	....|	.....|	....|	.....|	+...|	.....
Senecio isatideus	.....|	....+|	....|	.....|	....|	..+...|	+...|	.....|	..+.|	.....
Cynodon dactylon	.....|	.....|	....|	.....|	....|	.....|	....|	....+|	....|	.....
Pycreus oakfortensis	.....|	.....|	....|	.....|	....|	+.....|	....|	.....|	....|	.....
Zinnia peruviana	.....|	.....|	....|	.....|	....|	.....|	....|	.....|	....|	...b.
Hyparrhenia rufa	.....|	.....|	...1|	.....|	....|	.....|	....|	..+..|	....|	....+
Acacia mearnsii	.....|	.....|	.+..|	.....|	....|	.....|	....|	.....|	....|	....+
Verbena brasiliensis	.....|	.....|	.+..|	.....|	....|	.....|	....|	+....|	....|	.....
Verbena bonariensis	.....|	.....|	++..|	.....|	....|	.....|	....|	.....|	....|	.....
Spermacoce natalensis	.....|	.....|	....|	.....|	..+.|	.....+|	....|	.....|	+..+|	.....
Oxalis depressa	.....|	...+.|	....|	.....|	....|	.....|	....|	.....|	....|	.....
Commelina africana	.....|	..+..|	....|	.....+.|	+...|	....+.|	....|	.....|	....|	.....
Geranium pulchrum	.....|	.....|	....|	.....|	....|	.....|	....|	.+...|	....|	.....
Helichrysum mundtii	.....|	.....|	....|	.....|	....|	...+..|	....|	.....|	....|	.....
Pachycarpus asperifolius	.....|	.....|	....|	.....|	....|	.....|	....|	.....|	....|	.+...
Cirsium vulgare	..+..|	.+...|	..+.|	.....|	...+|	.....|	....|	.+...|	....|	.....
Chamaesyce hirta	.....|	.....|	....|	.....|	....|	.....|	....|	..+..|	....|	.....
Crassula sediflora	.....|	.....|	....|	+.....|	....|	.....|	....|	.....|	...+|	.....
Setaria sphacelata v. seri	.....|	.....|	....|	.....|	....|	.....|	....|	.+...|	...+|	.....
Ipomoea crassipes	.....|	.....|	....|	....+..|	....|	.....|	....|	.....|	....|	.....
Senecio inornatus	.....|	....+|	....|	.....|	.+..|	.....|	....|	.+...|	....|	.....
Ischaemum fasciculatum	.....|	.....|	....|	.....|	....|	....4.|	....|	.....|	....|	.....
Cymbopogon plurinodis	.....|	.....|	....|	.....+|	....|	+.....|	....|	.....|	....|	.....
Watsonia lepida	.....|	.....|	....|	.....|	....|	..+...|	....|	.....|	+...|	.....
Kniphofia ritualis	.....|	.....|	....|	.....|	....|	.....|	....|	.+...|	....|	.....
Ipomoea pellita	..+..|	.....|	....|	.....|	....|	..+...|	....|	.....|	....|	.....
Helichrysum rugulosum	+....|	.....|	....|	.+.....|	....|	++...+|	....|	.....|	+..+|	...++
Ipomoea obscura	.....|	.....|	....|	.....|	....|	.....+|	....|	.....|	....|	.....

CHAPTER 9

THE PHYTOSOCIOLOGY OF THE WETLANDS OF SOUTHERN KWAZULU-NATAL

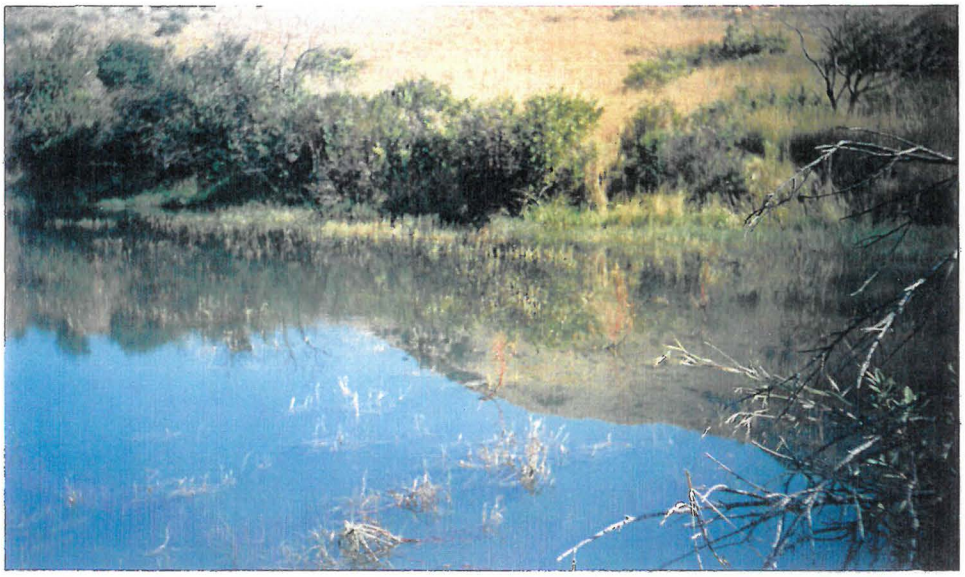


Figure 21. Vlei with open standing water supporting *Polygonum hystriculum*, and banks supporting *Rhus, Rhoicissus, Euclea, Arundinella* and *Paspalum* species. Near Kranskop.

Figure 22. The Tugela River in flood, January 1996, near Tugela. Conservation management of wetlands upsteam can help to attenuate such floods.

The 215 relevés from wetlands of all parts of the study area, i.e. the Drakensberg Foothills and Little 'Berg, Midlands, Mistbelt and Incised River Valleys, were grouped together by the TWINSPAN classification and after removing the outlier relevés, are presented in Table 6.

These wetlands in general can be classified as *Arundinella nepalensis - Paspalum dilatatum* (species group S, Table 6) wetlands. Some of the wetlands are relatively undisturbed, especially those in the Natal Drakensberg Park, while others in agricultural areas show signs of trampling and overgrazing. Deliberate or accidental drying up of wetlands for agricultural purposes has reduced or eliminated many wetlands from southern KwaZulu-Natal (Begg 1986). Franklin Vlei (30° 15' S 29° 25' E), for example, is the largest wetland in the present study, but has been reduced by agricultural activities to less than half of its former area (Begg 1986). Other wetlands have been incorporated into exotic timber plantations, or drained for grazing land, but the overall reduction of wetland habitat is impossible to quantify (Begg 1986).

Encroachment of exotic weeds such as *Verbena bonariensis* and *Rubus cuneifolius* or indigenous species such as the grass *Sporobolus africanus* and the forb *Helichrysum argyrophyllum* are indications of disturbance. A number of the wetlands and stream margins are dominated by woody species: in protected areas these are often *Leucosidea sericea, Buddleja salviifolia* and *Rhus* species, while in disturbed areas *Acacia mearnsii* prevails. Even within protected areas *Acacia mearnsii, Acacia mellifera, Verbena bonariensis* and *Rubus cuneifolius* are present in small quantities and the Park authorities maintain ongoing control measures against these invaders.

Other wetlands, particularly on moist footslopes between a midslope and valley bottom (see Figure 9), have no woody species and instead support a variety of grasses and forbs. Grazing and trampling by livestock is a common problem on these footslopes, except in nature reserves and other well-managed areas.

The terrain unit classified as valley bottom (Land Type Survey Staff 1984) may contain a flowing stream or a still pan (vlei) or marsh. A feature of the vleis and marshes is the low

species diversity in individual marshes, but a high species turnover from one marsh to the next. This phenomenon was also noted by Fuls (1993) and Eckhardt (1993). A large number of relatively small communities and sub-communities is therefore apparent in Table 6. Eight communities and fourteen sub-communities were identified. These are:

1. *Miscanthus capensis - Leucosidea sericea - Cliffortia nitidula* scrub community of stream margins

    1.1. *Miscanthus capensis - Leucosidea sericea* disturbed scrub sub-community
    1.2. *Miscanthus capensis - Leucosidea sericea - Euclea crispa* scrub sub-community
    1.3. *Miscanthus capensis - Leucosidea sericea - Myrsine africana* streambank sub-community
    1.4. *Miscanthus capensis - Passerina montana - Erica anomala* fynbos sub-community
    1.5. *Carex austro-africana - Oenothera indecora* disturbed streambank sub-community
    1.6. *Miscanthus capensis - Artemisia afra* streambank sub-community

2. *Typha capensis - Paspalum urvillei* pan community

    2.1. *Typha capensis - Mariscus congestus* undisturbed pan sub-community
    2.2. *Typha capensis - Solanum mauritianum* disturbed pan sub-community

3. *Hyparrhenia rufa - Conyza albida* disturbed floodplain community

    3.1. *Conyza albida - Sporobolus africana* moderately disturbed floodplain sub-community
    3.2. *Conyza albida - Hyparrhenia tamba* severely disturbed floodplain sub-community

4. *Elionurus muticus - Helichrysum argyrophyllum* overgrazed floodplain community

4.1. *Elionurus muticus - Senecio retrorsus* wet overgrazed floodplain sub-community

4.2. *Elionurus muticus - Themeda triandra* drier overgrazed floodplain sub-community

5. *Themeda triandra - Helichrysum aureonitens* grassy floodplain community

5.1. *Themeda triandra - Monopsis decipiens* wet grassy floodplain sub-community

5.2. *Themeda triandra - Tristachya leucothrix* drier grassy floodplain sub-community

6. *Hyparrhenia hirta - Eragrostis plana* grassy wetland community

7. *Rubus cuneifolius - Verbena bonariensis* disturbed wetland community

8. *Juncus effusus - Polygonum hystriculum* wetland community

Descritions of the Plant Communities

1. *Miscanthus capensis - Leucosidea sericea - Cliffortia nitidula* scrub community

This community is found on the banks of steep gullies and in protected places near water where there is generally low grazing pressure, and where the occurrence of fire is infrequent. The community is characterised by species group A (Table 6), and is dominated by the shrub/ small tree *Leucosidea sericea* (species group A) and the grasses *Miscanthus capensis* (species group L) and *Arundinella nepalensis* (species group S). Other common woody species include the indigenous shrubs *Cliffortia nitidula, Salix mucronata* s. *woodii* and *Rhus dentata* (species

group A). A common forb in this community is the large-leaved *Gunnera perpensa* (species group A). The soils are clayey and drainage is often slow. This community is restricted to the western part of the study area, generally above 1 500 m.

1.1. *Miscanthus capensis - Leucosidea sericea* disturbed scrub sub-community

This sub-community is found in gullies and streambank verges in the Little 'Berg, but shows signs of disturbance, either in the form of woodcutting or utilisation by livestock. The relative paucity of species is a result of this utilisation. Species group A is characteristic of this sub-community. The dominant woody species are *Leucosidea sericea, Salix mucronata* s. *woodii* and *Rhus dentata* (species group A). The tall grasses *Miscanthus capensis* (species group L) and *Arundinella nepalensis* (species group S) dominate the herbaceous layer, and forbs encountered include *Gunnera perpensa* (species group A) and *Senecio inornatus* (species group S). The soils are loamy clay and slow-draining. The community tends to forms long thin patches of woody vegetation alongside streams and gullies, and rarely exceeds a width of three metres.

1.2. *Miscanthus capensis - Leucosidea sericea - Euclea crispa* scrub sub-community

This sub-community is found on streambanks and in gullies in the Little 'Berg above about 1 600 m. Species group B in Table 6 is characteristic of this scrub sub-community. The shrub or small tree *Leucosidea sericea* is dominant; other woody plants include *Rhus dentata, Salix mucronata* ssp. *woodii* (species group A), *Halleria lucida, Buddleja salviifolia, Rhamnus prinoides, Euclea crispa, Ilex mitis,* and *Olinia emarginata* (species group B). *Rhamnus prinoides, Euclea crispa* and *Olinia emarginata* are diagnostic of this sub-community.

The herbaceous layer is dominated by the grasses *Miscanthus capensis* and *Arundinella nepalensis*, while other grasses include *Paspalum dilatatum* and *Paspalum urvillei* (species group S). Common forbs are *Gunnera perpensa* (species group A), *Geranium pulchrum* (species group B), *Polygonum hystriculum* and *Senecio inornatus* (species group S). Sedges

present include *Mariscus congestus* and *Juncus effusus* (species group S).

This scrub sub-community occurs in sheltered spots where there is little disturbance, which accounts for the greater species richness compared with the *Miscanthus capensis - Leucosidea sericea* sub-community. The soils tend to be moist and fairly clayey. The herbaceous cover varies from 80 - 90 % and the arboreal cover, from 55 - 65 %. Many of the plants in species group B are shade-loving. Killick (1990) refers to this sub-community as the *Leucosidea sericea* scrub.

1.3. *Miscanthus capensis - Leucosidea sericea - Myrsine africana* streambank sub-community.

This sub-community is most common in fire-protected areas along streams, in gullies and on rocky outcrops. It is characterised by species group C, with the shrub/ small tree *Myrsine africana* (species group C) and the grasses *Miscanthus capensis* and *Arundinella nepalensis* being dominant. Other woody plants in this sub-community include *Leucosidea sericea* (species group A), *Passerina montana* (species group C) and all the woody plants of species group B. The herbaceous layer of this community is sparse, possibly due to the shade created by the woody canopy.

1.4. *Miscanthus capensis - Passerina montana - Erica anomala* heathland sub-community

Species group D together with species group C is characteristic of this sub-community, which includes a scrubby component of *Leucosidea sericea, Passerina montana, Passerina filiformis, Cliffortia paucistamina* (species group C), *Phygelius aequalis, Anthospermum monticola* and *Cliffortia lanceolata* (species group D), as well as a herbaceous component of *Cephalaria natalensis* (species group C), *Cycnium racemosum, Valeriana capensis* and *Erica evansii* (species group D). The dominant grasses are again *Miscanthus capensis* and *Arundinella nepalensis.*

The heath *Erica anomala* (species group C) is also found in this sub-community, and this together with the *Passerina* species and *Erica evansii* forms the heathland element in this sub-community. The term "heathland element" is appropriate for this sub-community as the Ericaceous belt or "Sub-alpine fynbos" (Killick 1963) is typically found in more extensive patches higher up the Drakensberg range, above 1 900 m (Killick 1963; Hilliard & Burtt 1987). The present study included relevés in the vicinity of 1 800 m, and in some of these the heathland elements were recorded. The term "fynbos", although previously applied to similar communities (e.g. Killick 1963), is appropriate to the Cape Floristic Region only (Kruger 1979). The "Sub-alpine fynbos" was described as the natural climax community of the sub-alpine belt by Killick (1963). No such inference is made here, as the present study is a cross-sectional one and no successional data were gathered.

This sub-community is located at fairly high altitudes in the Little 'Berg, above 1 800 m. It corresponds roughly with the *Cliffortia linearifolia* scrub described by Killick (1963), although different *Cliffortia* species were found in the present study. Stream banks and gullies with moist clayey soil are the habitat of this sub-community.

1.5. *Carex austro-africana - Oenothera indecora* disturbed streambank sub-community

Species group E is characteristic of this sub-community. Certain streambanks and marshes are disturbed by overgrazing and trampling from domestic livestock, and a number of weeds characterise these areas: *Oenothera indecora, Ranunculus multifudus, Ciclospermum leptophyllum* (species group E) and *Cirsium vulgare* (species group S). The sedges *Carex austro-africana* (species group D) and *Juncus effusus* (species group S) are also found in this sub-community, as is the fern *Cheilanthes quadripinnata* (species group E). A number of woody plant species are also found lining these streams, warranting the inclusion of this sub-community in the *Miscanthus capensis - Leucosidea sericea - Cliffortia nitidula* scrub community. These woody species include *Leucosidea sericea, Salix mucronata* s. *woodii, Rhus dentata* and *Cliffortia nitidula* (species group A). Soil erosion caused by livestock trampling is a feature of the immediate environment of these streambanks.

1.6. *Miscanthus capensis - Artemisia afra* streambank sub-community

The banks of flowing streams are the site of this sub-community, which is not extensive but shows little of the signs of disturbance of the *Carex austro-africana - Oenothera indecora* sub-community. Species group F is characteristic of this sub-community. The small tree *Artemisia afra* (species group F) dominates the woody component of these streambanks, which also includes *Leucosidea sericea* (species group A). The herbaceous component includes *Gunnera perpensa* (species group A), *Acalypha punctata* (species group F) and the grasses *Cymbopogon validus* (species group A), *Miscanthus capensis* (species group L) and *Hyparrhenia hirta* (species group Q). The soils are sandy, which accounts for the presence of *Hyparrhenia hirta.*

2. *Typha capensis - Paspalum urvillei* pan community

The many small pans found throughout the study area commonly have *Typha capensis* (species group G), which appears to favour the still water, growing in the shallows. The alpha species diversity of these pans is quite low, with few species recorded per relevé. However the Beta diversity, or the diversity between one pan and the next, can be quite high. Thus a nearby pan can have a considerably different species composition, with only *Typha capensis* being common to them both. This phenomenon is reflected in the table, where species group G consists only of *Typha capensis*. Few woody species are found in or near these pans, although the exotic wattle *Acacia mearnsii* (species group L) was recorded several times at disturbed pans. Herbaceous species associated with these pans include *Pseudognaphalium luteo-album* (species group S), *Polygonum hystriculum*, usually growing in the shallow water (species group S), the grasses *Paspalum urvillei* and *Arundinella nepalensis* (species group S), and the sedges *Mariscus congestus* and *Juncus effusus* (species group S).

2.1. *Typha capensis - Mariscus congestus* undisturbed pan sub-community

A number of the pans were in relatively good condition, in that signs of trampling and overgrazing were minimal or absent. These pans form a sub-community dominated by *Typha*

capensis, but also found here were the forbs *Pseudognaphalium luteo-album* and *Polygonum hystriculum* (species group S), and the grasses *Paspalum dilatatum, Paspalum urvillei* and *Arundinella nepalensis* (species group S). The soils in this sub-community are clayey and drainage is slow.

2.2. *Typha capensis* - *Solanum mauritianum* disturbed pan sub-community

Some of these pans show signs of disturbance, in the form of trampling and overgrazing, by domestic livestock. Besides *Typha capensis*, associated with these pans are the exotic Bugweed *Solanum mauritianum* and the indigenous forb *Senecio harveianus* (species group H). The grasses *Paspalum urvillei* and *Phragmites australis* (species group S) and the sedge *Mariscus congestus* (species group S) were also found in this sub-community. Moist clayey soils with slow drainage are again characteristic of these pans.

3. *Hyparrhenia rufa* - *Conyza albida* disturbed floodplain community

This community is characterised by species group I and is dominated by a variety of weeds: *Conyza albida* (species group I), *Tagetes minuta, Bidens pilosa, Gymnopentzia bifurcata* (species group J) and *Conyza obscura* (species group K). The exotic tree *Acacia mearnsii* (species group L) is strongly represented in this community, as is the grass *Sporobolus africanus* (species group I), which is associated with disturbed areas (Gibbs Russell *et al.* 1991). The introduced weed *Verbena bonariensis* (species group S) is also common in this community.

This community is one of the the most disturbed in terms of grazing and trampling pressure, hence the high occurrence of exotic plants and weeds. Most of the sites of this community are close to standing or running water, and subjected to trampling pressure when animals approach to drink. It is also extensively grazed by the animals at this time. The community is also more accessable than the others described, generally occuring on flatter terrain to the east of the Drakensberg foothills. A large proportion of Midlands wetlands, habitat for rare bird and amphibian species (Grimsdell & Raw 1984) are disturbed in this way.

3.1. *Conyza albida - Sporobolus africana* moderately disturbed floodplain sub-community

This sub-community is characterised by the presence of species group I and the absence of species group J. The grasses *Hyparrhenia rufa, Paspalum urvillei* and *Paspalum dilatatum* dominate the community, and the ruderals *Conyza albida* and *Verbena bonariensis* are also present but not dominant. This sub-community is subjected to a degree of disturbance but this is moderate as the grass species are more dominant than the ruderals.

3.2. *Conyza albida - Hyparrhenia tamba* severely disturbed floodplain sub-community

This sub-community is characterised by species groups I, J and K. The grasses *Hyparrhenia rufa, Sporobolus africanus*, *Hyparrhenia tamba* and *Setaria sphacelata* (species goup K) are common, as well as the ruderals *Conyza albida, Tagetes minuta, Bidens pilosa, Gymnopentzia bifurcata* (species group J) and *Conyza obscura* (species group K). The presence of these ruderals is an indication of the severely disturbed nature (in terms of grazing and trampling) of this floodplain sub-community. Standing water is common on these floodplains during the summer months, but they dry up during winter.

4. *Elionurus muticus - Helichrysum argyrophyllum* overgrazed floodplain community

This community is subjected to a high degree of grazing pressure, as is evidenced by the presence of the grass *Elionurus muticus* and the forbs *Helichrysum argyrophyllum* and *Senecio retrorsus* (species group M). Species group M is characteristic of this community, which is located on gentle footslopes and floodplains.

4.1. *Elionurus muticus - Senecio retrorsus* wet overgrazed floodplain sub-community

This sub-community is found on floodplains with gentle gradients of zero to two degrees. Water collects on these floodplains and attracts livestock which also graze in the vicinity. The dominance of the grass *Elionurus muticus* and the forbs *Helichrysum argyrophyllum* and *Senecio retrorsus* (species group M) are indications of this grazing pressure (Low & Rebelo

1996). Other common grasses are *Eragrostis plana* and *Paspalum urvillei* (species group S). Where standing water occurs, the hydrophilic *Polygonum hystriculum* (species group S) is found.

4.2. *Elionurus muticus* - *Themeda triandra* drier overgrazed floodplain sub-cpmmunity

This sub-community shows less evidence of moisture than the *Elionurus muticus* - *Senecio retrorsus* sub-community, and these floodplains are consequently under less severe grazing pressure. The forbs *Senecio retrorsus* and *Helichrysum argyrophyllum* and the grass *Elionurus muticus* (species group M) are less common and less dominant, and there is a greater presence of other grasses such as *Themeda triandra* and *Tristachya leucothrix* (species group N). Few woody species were recorded in this sub-community. The soils are loamy sand, with moderate to rapid drainage. The gradient is from 3 to 5 degrees and this explains the greater runoff of water compared to the *Elionurus muticus* - *Senecio retrorsus* sub-community.

5. *Themeda triandra* - *Helichrysum aureonitens* grassy floodplain community

This community is characterised by species group N, and contains many more grasses than the other wetlands. These grasses include *Themeda triandra, Tristachya leucothrix, Eragrostis racemosa, Harpochloa falx, Monocymbium ceresiiforme* and *Trachypogon spicatus* (species group N). The position of these wetlands is usually between a gentle midslope and a valley bottom or river. Grazing is apparent in much of the community but is usually not extensive, either because the land is well managed or the site falls within a nature reserve. However, a small number of the grassy wetlands sample plots showed minimal disturbance. Two sub-communities are classified on the basis of moisture content.

5.1. *Themeda triandra - Monopsis decipiens* wet grassy floodplain sub-community

Footslopes with a high moisture content are the site of this sub-community; during the rainy season shallow pans may be formed here. The sub-community is characterised by the presence of species groups N, O and P. Forbs associated with this marshy ground include *Rhodohypoxis baurii* (species group O), *Monopsis decipiens, Commelina africana, Rhodohypoxis baurii* and *Hypoxis rigidula* (species group P). Grasses include *Panicum natalense* (species group O) and *Eragrostis capensis* (species group P). The dominant grass is *Themeda triandra* (species group N). No woody species were recorded in this sub-community. Disturbance is low on these footslopes, either because of good management or (more frequently) the occurrence of the sample site in a nature reserve. The principal nature reserves for the conservation of these wet footslopes are Craigie Burn, Coleford and Mt. Currie.

5.2. *Themeda triandra - Tristachya leucothrix* drier grassy floodplain sub-community

Drier footslopes in the study area are characterised by the presence of species group N and the absence of species group O and P. The footslopes are dominated by grasses, including *Themeda triandra* (species group N), *Eragrostis curvula* (species group S) and *Setaria pallide-fusca* (species group R) and forbs such as *Helichrysum aureonitens* (species group S). Again, no woody species were recorded in this sub-community. Signs of disturbance are minimal in this sub-community; this in indicated by the relative absence of weedy species. The soils of these drier footslopes are sandier than those of the *Themeda triandra - Monopsis decipiens* sub-community, and drainage is more rapid. This accounts for the absence of such moisture-loving forbs as *Monopsis decipiens.*

6. *Hyparrhenia hirta - Eragrostis plana* grassy wetland community

This community is characterised by the strong presence of the tall grass *Hyparrhenia hirta*

(species group Q). The extent of standing water in these wetlands is minimal, due to the relatively rapid drainage through the stony soils of this community. *H. hirta* is a grass commonly associated with sandy, stony soils (Gibbs Russell *et al.* 1991). This community is relatively species-poor, and other grasses found in it include *Eragrostis plana* and *Paspalum dilatatum.* There are signs of grazing in this community but no signs of overgrazing.

7. *Rubus cuneifolius - Verbena bonariensis* disturbed wetland community

This community is found in a variety of habitats, with a gradient of moisture presence, but all showing signs of alien encroachment and inadequate management of this encroachment. This is evidenced by the dominance of the exotic bramble *Rubus cuneifolius* (species group R), which is characteristic of this community. In the wetter parts of this community, the sedge *Juncus effusus* and the grasses *Paspalum dilatatum* and *Arundinella nepalensis* (species group S) are common. Other exotic weeds common throughout the community are *Verbena bonariensis* and *Cirsium vulgare* (species group S).

8. *Juncus effusus - Polygonum hystriculum* wetland community

This wetland community is found in marshes or pans where there is extensive standing water, which is the habitat of *Polygonum hystriculum* (species group S). The sedge *Juncus effusus* (species group S) is typically found in shallow water in the littoral zone. Other plants growing on the edge of the water or in shallow water are the grasses *Phragmites australis, Paspalum urvillei* and *P. dilatatum*, the weed *Verbena bonariensis* and the sedge *Mariscus congestus* (species group S). There is little evidence of overgrazing in these wetlands.

TABLE 6. Phytosociological Table of the Wetlands of southern KwaZulu-Natal

Number in table	1 1111111121112	12112 1	2 2212	1 1 1	111 2 11111 1	1112	11111221	111121111		111	2 111111	2 1 1	11 1 1 111 1 111	1 1 11	11111111111	11 11	1 2 111
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	53046298060716866	4215199	9354005	79423	5909264717580	3583	677405425681057	22781468937	8163089445185 2	283656920136793788	92267896924	8786473	1443120677652071743789411	0443660509399	19501667420	0025343	8255124391258
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	77083948583713643	4901449	9900273	09645	9230676513205	0716	122986215822654	70947974643	4978189634530 7	388759556742352018	18761560725	8447940	9611611098672724489466483	3547636552643	65666323539	8765043	333391247706
SPECIES GROUP A																	
Leucosidea sericea	....5.b5b.bb+11+1	1+415b3	1+b3314	b.b..	...........++	+.+4	....	....	....	.......1..........	+..+.......	+......	....	....	....	....	............+
Gunnera perpensa	...+....++....+..	....+..	.b++...	.+...	.+b.b.......+	+b..	....	....	....	.......+..........	.........+.	......+	.................+.......	....+.......	....	....	....
Salix mucronata s. woodii	.+.+......+b.....	.+.1..+	+...+..	+....	.......4...1.	....	....	..b........	.............b	........1.....+..	.+....b...	......+	.....................+...	....	......+....	...b...	.....1.....4.
Rhus dentata	....3..b..1......	..4...1	..+..1+	..+..	...........+1	....	....	.1.........	++............	.........1...+....	....	.+.....	....	....	....	....	..1..........
Cymbopogon validus	1..+........b..1.	....+..	..+...b	.....	....	11..	.1.............	....+......	...........b..	....	....	....	....	.........1...	.b.+.......	....	..+..........
Cliffortia nitidula	......+........4.	.++.3..	....b.b	....+	..........3..	....	..............+	....	....	....	........+...	....	....	....	....	....	....
Ischaemum fasciculatum	.........+.......	++.....	..+....	.+.3.	......+......	....	............+...	....	....	....	....	....	.......b.................	......++....+	..1........	....	....
Rubus ludwigii	.......+.........	....	..+....	.....	....b.....+..	+...	....	....	....	....	....	....	....................+......	....	....	....1..	....
SPECIES GROUP B																	
Rhamnus prinoides	....	...+.+1	+++1...	.....	....	....	....	....	....	....	....	....	....	....	....	....	....
Euclea crispa	....	..+.+++	1..+...	.....	....	....	....	....	....	....	....	....	....	....	....	....	....
Ilex mitis	....	+++.++.	++.....	.....	....+........	....	....	....	....	....	....	....	....	....	....	....	....
Geranium pulchrum	....	.+..+..	.1++...	.....	.b....+....+.	.+..	....	....	....	....	....	....	..........+.........+....	.............+	....	....	....
Halleria lucida	....	..++.++	+...+..	.....	....	....	....	....	....	....	....	....	....	....	....	....	....
Olinia emarginata	....	+.....+	.+...++	.....	....	....	....	....	....	....	....	....	....	....	....	....	....
Buddleja salviifolia	....	+.+....	..++.+.	.....	.......b.....	+..+	....	....	....	....	....+.+....	....	....	....	....	..+....	....
Diospyros austro-africana	....	..+...+	+......	.....	....	....	....	....	....	....	....	....	....	....	....	....	....
SPECIES GROUP C																	
Myrsine africana	.......+.........	....	.++1.++	...+.	....	....	....	....	....	....	....	....	....	....	....	....	....
Cephalaria natalensis	....	....	..+....	+++.+	....	....	....	....	....	....	....	....	....	....	....	....	....
Pteridium aquilinum	....	....	+.++...	...+.	.+............	....	....	....	....	....	....	....	..................3.......	....	....	....	....
Passerina montana	.............b1..	....	....1.+	+.++.	....	....	....	....	....	....	....	....	....	....	....	....	....
Erica anomala	.............+...	....	....+.+	+.+.+	....	....	....	....	....	....	....	....	....	....	....	....	....

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Schizostylis coccinea        ..............+..|.......|..1.+..|.+...|.............|....|...............|...........|.............|.................|...........|.......|......................|.............|...........|.......  ........
Cliffortia paucistamina      .....+...1.......|.......|..+b...|..b..|.......+.....|....|...............|...........|.............|.................|...........|.......|......................|.............|...........|.......  ........
Passerina filiformis         .................|.......|....+..|.+.+1|.............|....|...............|...........|.............|.................|...........|.......|......................|.............|...........|.......  ........

SPECIES GROUP D

Cycnium racemosum            .................|.......|.......|.++++|.............|....|...............|...........|.............|.................|...........|.......|......................|.............|...........|.......  ........
Valeriana capensis           .. ..............|.......|.......|+.+++|.......+.....|....|...............|...........|.............|.................|...........|.......|......................|.............|...........|.......  ........
Erica evansii                .. ..............|.......|.......|.+++.|.............|....|...............|...........|.............|.................|...........|.......|......................|.............|...........|.......  ........
Phygelius aequalis           .. ..............|.......|.......|.+++.|.............|....|...............|...........|.............|.................|...........|.......|......................|.............|...........|.......  ........
Cliffortia lanceolata        .. ..............|.......|.......|.b.+.|.............|....|...............|...........|.............|.................|...........|.......|......................|.............|...........|.......  ........
Anthospermum monticola       .. ..............|.......|.......|+..+.|.......+.....|....|...............|...........|.............|.................|...........|.......|..+...................|.............|...........|.......  ........

SPECIES GROUP E

Carex austro-africana        .  .............+|.......|..+....|.....|54......313+.|....|.+.............|...........|.............|.................|...........|.......|.+!....................|.......+....+|.....+.....|.......  ........
Oenothera indecora s. bona   .  ...+..+.......|.......|.+.....|.....|.+.b+.++...++|....|.........+.....|...........|.............|.................|.+.........|...+...|.......+.........+.+...|.............|...++.+...|+......  ........
Ranunculus multifidus        .  ...+..........|.......|.......|.....|..+..++.+...+|....|.........+.....|..+.....+..|.............|..............+...|...........|...+...|++........++............|+.b..........|....+......|+......  ....+...
Cheilanthes quadripinnata    +  ....+.....+...|....+..|.......|.....|.+..+.....+..|....|...............|...........|.+...........|.................|...........|.......|.....................+.|.............|...........|.......  .....+..
Ciclospermum leptophyllum    .  ..............|.......|.......|.....|......++...+.|....|...............|.........+.|.............|.................|...........|.......|..+...................|.............|...........|.......  ........
Agrostis lachnantha          .  ..............|.......|.......|.....|......+....++|....|...............|...........|.............|.................|...........|.......|......................|.............|...........|.......  ........
Salix babylonica             .  ..............|.......|.......|.....|...........33|....|...............|...........|.............|.................|...........|.......|......................|....1........|...........|.......  ........

SPECIES GROUP F

Artemisia afra               .  ...+..........|.......|.......|.....|.............|++++|...............|...........|.............|.................|...........|.......|.....................+...|.........+...|...........|.......  ........
Acalypha punctata            .  ..............|..+....|.......|.....|.............|+++.|...............|...........|.............|.................|.........+..|.......|..+.3.+...........+.....|.........+...|...........|.......  ........

SPECIES GROUP G

Typha capensis               .  ..............|.......|.......|...+.|...+.........|....|14bbb5444b343b1|+b4+344b...|.............|.................|...........|.......|...........+...........|.............|...........|.......  .......

SPECIES GROUP H

Senecio harveianus           .  .....++.......|..+....|.......|.....|......++.....|....|...............|+.+11+...1+|.............|......+..........|......+....|.......|..+.....3..........+....|.............|+...+......|..+..+.  .......
Solanum mauritianum          .  ..............|.......|.......|.....|.............|....|...............|++....++++.|.............|.................|..1........|.......|.......................|......+......|...........|.....+.  .......

SPECIES GROUP I

Hyparrhenia rufa             .  ..............|.......|.......|.....|.............|....|....b..........|...........|++b+..+..+.+.+.|+.1.1...345b.bb++.|...........|.......|.......................|.............|...........|.......  +......
Conyza albida                .  ..............|.....+.|.......|.....|.............|+...|+..+...........|...........|+..+.+..+++++.|+1++11+.+....++...|..++..+....|.......|.......................|.............|...........|.+.....  .+.....
Sporobolus africanus         .  ..............|.....+.|.......|.....|.............|....|...............|...........|.++++b+b.+.++.|+......+..++..++b.|....++.....|.......|..1....................|.........b.b..|..+....+.+.|.......  5......
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SPECIES GROUP J

Tagetes minuta
Bidens pilosa
Gymnopentzia bifurcata

SPECIES GROUP K

Conyza obscura
Hyparrhenia tamba
Setaria sphacelata

SPECIES GROUP L

Miscanthus capensis
Acacia mearnsii

SPECIES GROUP M

Elionurus muticus
Helichrysum argyrophyllum
Senecio retrorsus

SPECIES GROUP N

Themeda triandra
Tristachya leucothrix
Helichrysum pilosellum
Harpochloa falx
Oxalis depressa
Eragrostis racemosa
Monocymbium ceresiiforme
Trachypogon spicatus
Vernonia natalensis

SPECIES GROUP O

Helichrysum miconiifolium
Helichrysum rugulosum
Rhodohypoxis baurii
Helichrysum glomeratum
Panicum natalense
Heteropogon contortus
Helichrysum herbaceum

SPECIES GROUP P

Eragrostis capensis
Senecios venosus
Oxalis obliquifolia
Monopsis decipiens
Commelina africana
Hypoxis rigidula

SPECIES GROUP Q

Hyparrhenia hirta

SPECIES GROUP R

Rubus cuneifolius
Senecio isatideus
Zantedeschia aethiopica
Setaria pallide-fusca

SPECIES GROUP S

Verbena bonariensis
Cirsium vulgare
Eragrostis plana
Helichrysum aureonitens
Pseudognaphalium luteo-alb
Phragmites australis
Paspalum urvillei
Juncus effusus
Polygonum hystriculum
Mariscus congestus
Arundinella nepalensis
Paspalum dilatatum
Eragrostis curvula
Senecio inornatus

OTHER SPECIES

Conyza scabrida
Helichrysum sutherlandii
Richardia brasiliensis
Acalypha wilmsii
Cliffortia linearifolia
Myrothamnus flabellifolius

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Helichrysum umbraculigerum  ........+.......|.......|.......|....|.............|.+..|+...............|...........|..............|..................|........+..|.......|.........................|.........+...|...........|.......   ..............|
Acalypha schinzii           ................|.......|.......|....|.............|..++|................|...........|..............|..................|...........|.......|+...................+....|.............|....+......|.......   ..............|
Sonchus asper               ................|.......|.......|....|...........+.|....|.......+......+.|...........|..............|..................|...........|.......|.........................|.............|.....+.....|.......   ........++....|
Panicum aequinerve          ................|.......|..+....|....|.............|....|................|...........|........+.....|..................|...........|.......|.................+.......|.............|...........|.......   ..............|
Euphorbia striata           ................|.......|+......|....|.............|....|................|...........|..............|...+..............|...........|.......|....................+....|.............|...........|.......   ..............|
Indigofera woodii           ................|.......|+......|....|.............|....|................|...........|..............|...+..............|...........|.......|....................+....|.............|...........|.......   ..............|
Rhynchospora brownii        ...............+|.......|.......|....|.............|....|................|...........|.....+........|..................|...........|.......|.........................|.............|...........|.......   ..............|
Andropogon eucomus          ...............+|.......|.......|....|.............|....|................|...........|....+.........|............+.....|...........|.......|.........................|.............|...........|.......   ..............|
Juncus punctorius           ...........+....|.......|.......|....|.............|....|................|...........|..............|.......+..........|...........|.......|.........................|.............|...........|.......   ..............|
Pycreus macranthus          ................|.......|.......|....|.............|....|...+...........+|...........|...+..........|..................|...........|.......|.........+...............|.............|...........|.....+.   ..............|
Senecio inaequidens         ................|.....+.|.......|....|.............|....|................|...........|..............|..................|...........|.......|.........................|....+........|...........|.......   ..............|
Cynodon dactylon            ................|.......|.......|....|.............|....|................|...........|.....+........|..................|......3....|.......|.........1...............|.............|...........|.......   ..............|
Solanum sisymbrifolium      ................|.......|.......|....|.............|....|................|.........+.|..............|..................|......+....|.......|.........................|.............|...........|.....+.   ..............|
Pentanisia angustifolia     ................|.......|.......|....|.............|....|+...............|...........|..............|..................|...........|.......|.........................|.............|+......+...|.......   ..............|
Hibiscus trionum            ................|.......|.......|....|.............|....|.......+........|...........|..............|..................|.+.........|.......|....................+....|.............|...........|.......   ..............|
Bromus firmior              ................|.......|.......|....|.............|....|..3.............|...........|............+.|....+............5|.+.........|.......|.........................|.............|...........|.......   ..............|
Persicaria serrulata        ...............+|.......|.......|....|.............|....|+.+.............|...........|+.............|..................|...........|.......|.............+......+....|.............|...........|.......   .......+......|
Abildgaardia species        ...............+|.......|.......|....|.............|....|................|...........|.+............|....+.............|...........|.......|.....................+...|.............|...........|.......   ..............|
Watsonia lepida             ................|.......|.......|....|.............|....|................|.........+.|..............|..................|.+.........|.......|..............+.....+....|.............|...........|.......   ..............|
Berkheya rhapontica         ................|.......|.......|....|.............|....|................|...........|...........+..|..................|...........|.......|..............+.....+....|.............|...........|.......   ..............|
Senecio arabidifolius       ........+.......|.......|.......|....|......+......|...+|................|...........|.......+......|+.................|...........|.......|.........................|.............|...........|..+....   +.............|
Anthospermum herbaceum      ................|.......|.......|....|......+......|....|................|...........|..............|..................|...........|.......|................+...+....|.............|...........|.......   ..............|
Scirpus falsus              ................|.......|..+....|....|.............|....|................|...........|.......+......|.....+............|...........|.......|.........................|.............|.......+...|.......   ..............|
Rumex crispus               ................|......+|.......|....|.............|....|................|...........|..............|....+.............|...+.......|.......|......+..................|.........+...|...........|.......   ..............|
Mentha aquatica             ................|.......|.......|....|.............|....|+...............|...........|..............|..................|...........|+......|.........................|.........+...|...........|.......   ..............|
Centella asiatica           ................|.......|.......|....|..+..........|....|................|...........|..............|..................|...........|.......|..............+..........|.............|...........|.......   ..............|
Bulbine narcissifolia       ................|.......|.......|....|........+....|....|................|...........|..............|..................|...........|.......|.........................|..+..........|...........|.......   ........+.....|
Polygala virgatata v. dec   ................|.......|.......|..+.|.............|..+.|................|...........|..............|...+..............|.+.........|.....+.|.............+......+....|.............|.......+...|..++...   ..............|
Digitaria ternata           ................|.....+.|.......|....|.............|....|................|...........|..............|........+.........|...........|....+.+|.........................|.............|...........|.......   .......+......|
Eriosema salignum           ........+.......|.......|.......|....|.............|....|................|...........|...........+..|..................|....+.....+|.......|...........+.............|.....+.......|...........|.......   .............r|
Eulalia villosa             ................|.......|.......|....|.............|...+|................|...........|..............|..................|...........|.......|...+.....................|+............|...........|.......   ...+..........|
Hermannia depressa          ................|.......|.......|....|.............|....|................|...........|..+...........|..................|...........|.......|....+....................|.............|+..........|.......   ..............|
Berkheya speciosa           ................|.......|.......|....|...+.........|....|................|...........|..............|..................|...........|.......|..........+..............|.+...........|...........|.......   .......+......|
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CHAPTER 10

DISCUSSION

The use of the Braun-Blanquet approach in phytosociological research, as applied by Behr & Bredenkamp (1988), Du Preez & Bredenkamp (1991) and Eckhardt *et al.* (1993) was proven successful in a part of the country where Braun-Blanquet techniques have been little applied. The stratification of the study area into terrain units (Eckhardt 1993) again proved useful. However, broad-scale stratification was not carried out using land types, as has been done by Bezuidenhout (1988) and Eckhardt *et al.* (1993), but by using Physiographic Regions (Turner 1967; Schulze 1982) and Bioclimatic Subregions (Phillips 1973). These stratifications of the land in KwaZulu-Natal are therefore shown to be compatible with the Braun-Blanquet approach. Furthermore, the application of Bioclimatic Subregions is shown to be useful in vegetation studies in KwaZulu-Natal, which in conjunction with such studies as those of Grimsdell & Raw (1984), MacDonald & Jarman (1985) and Smit (1992) confirms the appropriateness of using Bioclimatic Subregions in ecological research in KwaZulu-Natal.

The results described in Chapters 4 through 9 confirm the validity of many of the veld types and boundaries recognised by Acocks (1988). The synecological work of Pentz (1949), West (1951), Killick (1963) Edwards (1967) and Moll (1968; 1976) is also confirmed, but in broader perspective as the present study area was much larger than any of the latter authors'. The relevé data used in the present study provides more detailed information than the reconnaissance work of previous researchers.

The results also show that vegetation patterns in southern KwaZulu-Natal are closely related to Phillips' (1973) Bioclimatic Subregions, and that the climatic and altitudinal factors on which these Subregions are based, are more predictive of vegetation patterns than are other environmental variables. Within each major vegetation group environmental factors including aspect, gradient, geology, edaphic factors, rockiness, topography, fire, proximity of water, grazing intensity, agriculture, and other anthropogenic factors provided an environmental basis for further classifying the vegetation communities.

The results pertinent to the vegetation of each Bioclimatic Subregion are discussed below under separate headings.

Table 2

The Drakensberg Spurs and Foothills

The phytosociological analysis separated the Highland Sourveld Veld Type of Acocks (1988) into two main parts: the vegetation of the higher-lying areas (above 1 700 m) constituting the foothills of the Drakensberg, and the lower altitude (below 1 700 m) of the KwaZulu-Natal midlands. These areas correspond with Low & Rebelo's (1996) Wet Cold Highveld Grassland Vegetation Type 41 (above 1 750 m altitude) and North-eastern Mountain Grassland Vegetation Type 43 (above 1 400 m altitude) respectively. The usefulness of the Bioclimatic units delineated by Phillips (1973), as the Highland Montane Bioclimatic Group (4) is also confirmed: 4e (Open Grassland to Wooded Savanna) is at a lower altitude to the east; 4d (Montane Protea Savanna) is at a higher altitude to the west and 4c (Open Grassland to Wooded Savanna to Forest, Sub-Montane and Highland) is at a higher altitude to the south-west.

The present analysis also confirmed the vegetation stratification suggested by Killick (1990) and confirmed by Hill (1996) for the northern Drakensberg foothills, and indicated that this stratification is applicable, at least in part, to the southern Drakensberg foothills. Hilliard & Burtt (1987) suggested that the southern Drakensberg (south of Giant's Castle; 29° 30' S) has a different vegetation due to the colder climate compared to the northern Drakensberg. However, they did not carry out phytosociological surveys to verify this hypothesis. Their research was taxonomical and they expressly made no claim to be carrying out a phytosociological survey. The results of the present study have demonstrated no significance difference in the vegetation of the southern Drakensberg foothills (22 relevés having been lifted from this area), but the case may be different above 1 800 m, which is the general altitudinal limit of the present survey. Hilliard & Burtt (1987) took 1 800 m as their lower limit, and the extremes of climate above this altitude may well encourage a different vegatation

growth. However, specific phytosociological studies above 1 800 m will have to carried out to test this hypothesis. At present the model of Killick (1990) for the northern Drakensberg foothills is valid for the southern Drakensberg foothills, at least up to 1 800 m.

The vegetation communities described by Kay, Bredenkamp & Theron (1993) from Golden Gate National Park (28° 30' S 28° 40' E) were mirrored to some extent by the communities described in Chapter 4: the *Festuca caprina* Grassland communities and *Rendlia altera* Grassland communities of Kay *et al.* (1993) are similar to the *Festuca costata - Bromus firmior* moist grassland and *Themeda triandra - Rendlia altera* undulating grassland communities of the present study. In Golden Gate, *Festuca caprina* was found to be the dominant *Festuca* species, as opposed to *Festuca costata* in southern KwaZulu-Natal. Other grass species found to be dominant in both areas include *Harpochloa falx, Tristachya leucothrix, Elionurus muticus, Cymbopogon* species, *Aristida* species and *Eragrostis* species. The altitudes at which these grasses were found are also found to be comparable. The grassland communities found on the Drakensberg foothills and slopes in the present study are representative of the *Tristachya leucothrix - Trachypogon spicatus* Grassland of moist mountain slopes and plateaux (class 6) described by Du Preez and Bredenkamp (1991). Prominent grasses in this class are *Tristachya leucothrix, Trachypogon spicatus, Themeda triandra, Elionurus muticus, Eragrostis capensis, Eragrostis racemosa, Eragrostis curvula, Heteropogon contortus, Harpochloa falx* and *Microchloa caffra*, and prominent forbs include *Helichrysum nudifolium, Haplocarpha scaposa, Oxalis depressa, Commelina africana, Gazania krebsiana, Helichrysum aureonitens* and *Senecio othonniflorus* (Du Preez & Bredenkamp 1991).

It has also been shown that some of the plant communities associated with the Drakensberg foothills and Montane belt can be found at considerable distances eastwards from the Drakensberg foothills, in the Submontane belt, for example the *Protea* savanna communities in Mt. Currie Nature Reserve, approximately 50 km from the Drakensberg foothills. The occurrence of the *Protea* savanna on Mt. Currie is explained by the fact that the altitude rises to over 2 000 m, similar in height to the Drakensberg escarpment. The *Miscanthus capensis - Leucosidea sericea - Cliffortia nitidula* community described in Chapter 9, and generally

found in the Drakensberg foothills, is also represented at Mt. Currie.

The habitat of the *Protea* savannas is of interest as the aspect appears to differ depending on the latitude. In the present study area, north-facing slopes with a degree of rockiness and shallow soils are the typical environment supporting *Protea* savannas. Similar finding were reported by Killick (1963) and Hill (1996) from the northen Drakensberg. From Pretoria northwards, however, south-facing slopes on similar soils are the typical habitat (Coetzee, Bredenkamp & Van Rooyen 1995). The transition region would appear to be in the Bankenveld of Gauteng, as at the Witwatersrand Botanical Gardens (near Roodepoort) the *Protea* savanna occurs on south-facing slopes (Behr & Bredenkamp 1988), while at Suikerbosrand (south of Johannesburg) the habitat is north-facing slopes (Bredenkamp & Theron 1978; Bredenkamp & Theron 1980). Coetzee *et al.* (1995) note that at higher (and therefore cooler) altitudes in the Bankenveld, *Protea caffra* occurs on the north-facing slopes, while at lower altitudes it occurs on south-facing slopes. Temperature would therefore seem to be the criterion. The KwaZulu-Natal Drakensberg is significantly cooler than the Bankenveld and Highveld, and north-facing slopes which receive higher radiation levels are therefore the habitat of *Protea* trees.

In sheltered ravines on cool, moist southerly slopes, *Podocarpus latifolius* forests occur. These are representative of the *Scolopia mundii* Afromontane Forest class of Du Preez & Bredenkamp (1991).

The spreading of woody vegetation from the kloofs into the open grassland appears to be restricted by fire (Tainton 1981). These grasslands are therefore considered fire-climax grasslands (Du Preez & Bredenkamp 1991). However, this does not mean that these are secondary grasslands transformed by fire, as recent evidence points to the long existence of these grasslands as primary grasslands. This evidence includes fossil pollen evidence reported by Meadows & Linder (1993), which indicates that South African grasslands are at least 12 000 years old, and the high level of endemism which suggests a long evolutionary history (Bredenkamp & Van Rooyen, in prep.). As Matthews *et al.* (1993) point out, the remaining grasslands are the true relict vegetation of the Afromontane region. In the Mpumalanga and

Northen Province Drakensberg, only about 1% of these grasslands are conserved, and a higher conservation status should be accorded them. In the KwaZulu-Natal Drakensberg, a higher percentage of the grasslands is conserved in the extensive Drakensberg Mountain Park, but the forest patches as opposed to the grasslands are still regarded as relicts and this perception may now change as the long history of the grasslands become increasingly recognised. Indeed, for effective management, it is desirable that the grasslands are recognised as the original vegetation of much of the area.

Table 3

The KwaZulu-Natal Midlands

The Submontane Bioclimatic Subregion 4e (Phillips 1973) adequately delineates the area occupied by the vegetation of the KwaZulu-Natal Midlands; this is a part of the Highland Sourveld of Acocks (1988). Low & Rebelo (1996) classified this grassland as the Moist Upland Grassland (Vegetation Type 42). This large and rolling grassland is intensively farmed and the original vegetation is severely altered. Exotic plantations and cultivated pastures have replaced vast tracts of this grassland and most of the rest is cultivated for crops or used for cattle and sheep grazing. This severe altering of the vegetation may account in part for the phytosociological separation of this area from the rest of the Highland Sourveld in the Little 'Berg, which is largely conserved. The lower altitude and precipitation of the Midlands are environmental factors to which may be ascribed some of the vegetational differences. The geology (mainly Tarkastad sandstone and dolerite) does not differ significantly from the Midlands up to about 2 000 m above sea level.

The grassland communities of the Midlands found in the present study fall generally into the *Monocymbium ceresiiforme - Tristachya leucothrix* Plant Community Type (Type 11) described by O'Connor & Bredenkamp (1997). Smit (1992) and Smit *et al.* (1993) also described this grassland class from north-western KwaZulu-Natal, east of the escarpment. It is a sour grassland found on leached, shallow, often rocky soils in moist areas and according to O'Connor & Bredenkamp (1997), stretches from Mpumalanga southwards through Swaziland, western and southern KwaZulu-Natal to the north-eastern Cape. The *Themeda*

triandra - Eragrostis plana moist grassland class (class 5) described by Du Preez & Bredenkamp (1991) from the Free State, is similar to these midlands grasslands, but differs to a certain extent in respect of floristics.

Within the Midlands grasslands, scrub and forest patches occur mainly in the valleys, but the ridges are generally devoid of woody growth. This phenomenon is attributed by Edwards (1967) to climatic factors (frost in winter) which affect the exposed ridges more than the sheltered slopes below. As with the higher altitude grasslands of the Drakendberg foothills, anthropogenic fires act to prevent the spread of woody vegetation into the grasslands. The woody vegetation in the midlands was found to be dominated by *Rhus discolor, Maytenus heterophylla, Rhus dentata, Rubus ludwigii, Diospyros lycioides* and *Leucosidea sericea*. This vegetation is comparable to the *Rhus erosa* shrubland described from the Free State by Du Preez & Bredenkamp (1991), but cannot be said to be identical. The *Rhus dentata - Leucosidea sericea* low thickets of mountain slopes (Plant Community Type 10) described by O'Connor & Bredenkamp (1997) are however very similar to the woody vegetation of the midlands. Species common to both types include *Leucosidea sericea, Rhus dentata, Myrsine africana, Euclea* spp. and *Diospyros* spp. The habitat too is very similar: On moist, steep, south-facing slopes a dense vegetation, dominated by a non-grassy herbaceous layer, is found (O'Connor & Bredenkamp 1997).

The grassland has been greatly modified by agriculture, especially grazing, and it is not certain how much of the original vegetation remains. A shortcoming of the present study is that much of the vegetation sampling had to be carried out on small areas of apparently natural vegetation. These areas were less disturbed by grazing than others, possibly due to a greater surface rockiness, and may not be representative of the entire grassland.

Table 4

The Mistbelt of southern KwaZulu-Natal

The phytosociological classification of this area confirmed the widespread presence of the unpalatable grass *Aristida junciformis* at the expense of *Themeda triandra*, a trend observed

by Moll (1976), and others. The vegetation of this area has been drastically altered due to large-scale cultivation and over-grazing, but the remaining vegetation was classified into communities which give an indication of the original vegetation of the Mistbelt. The region is poorly conserved and no rare plant species were found. Plant Community Type 8 (*Aristida junciformis - Eragrostis plana* Grassland) of O'Connor & Bredenkamp (1997), found in moist cold temperate grassland of the Free State, is similar floristically to the Mistbelt vegetation found in the present study. The *Themeda triandra - Eragrostis plana* moist grassland (class 5) of Du Preez & Bredenkamp (1991) is also almost synonymous with the KwaZulu-Natal Mistbelt grassland. Low & Rebelo (1996) adopted Acocks' delineation and classified this grassland as Short Mistbelt Grassland. The Mistbelt region is favoured by timber companies as a prime area for exotic plantations, and these are probably the single greatest threat to the remaining grassland of this region.

Table 5

The Incised River Valleys and Dry Upland Savanna

This wooded grassland corresponds with Acocks' (1988) Southern Tall Grassland and Low & Rebelo's (1996) Natal Central Bushveld. The phytosociological analysis revealed that this patchy area is relatively species-poor, especially with regard to the diversity of grasses and forbs. This low diversity can be attributed to the lower rainfall (MAR 800 mm) in this area compared to the rest of the study area, and the presence of many subsistence farmers whose farming methods appear to further degrade the vegetation. The soils are not stable (Fitzpatrick 1978) and large-scale erosion is evident. The erosion cycle is exacerbated by the poor ground cover noted in many relevés.

One of the dominant grasses in this dry grassland is *Hyparrhenia hirta*, and the various communities in which it dominates are a component of the *Hyparrhenia hirta* Tall Grassland (Plant Community Type 16) of O'Connor & Bredenkamp (1997). The concomitant species described by O'Connor & Bredenkamp (1997) were also found in the present study: *Themeda triandra, Eragrostis curvula, Sporobolus pyramidalis, Aristida congesta, Walafrida densiflora, Cucumis zeyheri, Spermacoce natalensis*, and several woody shrubs: *Maytenus*

heterophylla, Zanthoxylum capense, Ziziphus mucronata, Rhus species and *Acacia* species.

This area contains a greater number of woody plant species than the remainder of the study area; this is attributed to the drier climate and the lower occurrence of frost. The *Acacia* savannas on the steeper slopes are transitional to valley bushveld at lower altitudes, nearer the coast, and transitional to Montane forest scrub at higher altitudes nearer the Drakensberg foothills (Moll 1976). The Montane forests, however, contain no *Acacia* species. The *Hyparrhenia hirta - Acacia sieberiana, Hyparrhenia hirta - Acacia caffra* and *Hyparrhenia. hirta - Acacia karroo* wooded grasslands described in Table 5 correspond to the *Acacia karroo* Woodlands Type (Type 17) of O'Connor & Bredenkamp (1997). The *Acacia karroo* riparian thicket (class 3) of Du Preez & Bredenkamp (1991) is also equivalent to the *Acacia* - dominated slopes which reach down towrds the Mzimkulu and Mkomazi rivers.

This grassland is less of a sourveld than the other grasslands in the study area, due to the lower rainfall.

Large parts of these dry grasslands support subsistence farmers and evidence of soil erosion is abundant. The population pressure would appear to be too high for the sustainable use of these grasslands and an inevitable deterioration has been underway for some time (Phillips 1973). There are no conservation areas within these dry grasslands and biodiversity, especially in the herbaceous layer, can be assumed to be declining. The harvesting of plant material for medicinal and other uses (Newton & Bodasing 1994) is also contributing to the scarcity of certain herbaceous plants.

Table 6

Wetlands

The *Rhus dentata - Leucosidea sericea* thickets described by Eckhardt (1993) and Fuls (1993) in the south-eastern Orange Free State were also found in the present study area in similar conditions: moist, steep, south-facing slopes. These thickets represent one of the vegetation types (Type 10) described by O'Connor & Bredenkamp (1997).

The *Passerina montana* Afromontane fynbos class (O'Connor & Bredenkamp 1997) is not well represented in the present survey, as the fynbos vegetation grows at high altitude (1 800 - 2 800 m) (Killick 1963; Edwards 1967), and the heathland described in the present study can not be termed "fynbos" as it occurs outside the Cape Floristic Region (Kruger 1979). However, the present survey included relevés at sufficiently high altitude (1 900 m) to include some of the lower altitudinal limit of the heathland. These relevés were sufficient to create a separate sub-community (Table 6). Du Preez & Bredenkamp (1991) also refer to the *Passerina montana* Afromontane fynbos, without restricting it to the Cape Floristic Region. A comparable fynbos community is described from the eastern Cape mountains (Hoare, in prep.)

Riparian vegetation at lower altitudes (below c. 1 700 m) in the study area tends to be more disturbed as it falls outside the conserved area of the Drakensberg Parks, and is often trampled by livestock approaching drinking points. Regular flooding also contributes to disturbance of the riparian vegetation, and pioneer species and exotics such as *Verbena bonariensis, Tagetes minuta, Datura ferox, Oenothera rosea* and *Melinis repens* are distinctive of these areas. Grasses lining river banks include *Leersia hexandra, Arundinella nepalensis, Paspalum dilatatum, Paspalum urvillei* and *Miscanthus capensis*. Woody species commonly include the exotic wattle *Acacia mearnsii*, the exotic willow *Salix babylonica*, the indigenous willow *Salix mucronata, Rhus* species, *Rubus ludwigii*, *Leucosidea sericea* and *Euclea* species. Similar riparian vegetation in the Free State grasslands was described by Eckhardt (1993) and Smit (1992).

In open, still water, *Aponogeton* and *Polygonum* species frequently occur, with *Polygonum* often growing in the littoral zone.

The vegetation of marshes and bottomlands is often dominated by one or a few species (Bloem 1988; Fuls 1993). In the present study these species were usually *Phragmites australis, Typha capensis, Mariscus congestus, Conyza* species, or *Cyperus* species. In still, shallow water or marshy land, forbs such as *Monopsis decipiens, Lobelia flaccida* and *Pseudognaphalium luteo-album* are common. Although the species diversity of a particular marsh might be low, nearby marshes often support a very different plant species composition.

This phenomenon is also mentioned by Smit (1992) and Fuls (1993). The importance of wetland conservation is underlined by this phenomenon as species diversity might be easily overlooked if one marsh is taken to be representative of wetland species diversity. The dominance-diversity curve (Whittaker 1975) of the Wetlands data (Figure 12) displays this spread of diversity graphically, with no identifiable group of species dominating the vegetation. Other reasons for wetland conservation, besides preservation of biodiversity, include their functions as water storage systems, stream flow regulators, flood attenuators, water purifiers, erosion control agents, and specialised habitats for various animals (Begg 1986; Walmsley 1988). While the water catchment areas of the high Drakensberg are adequately conserved by the KwaZulu-Natal Parks Board (this being one of the prime reasons for Drakensberg conservation), the wetlands downstream and outside the park are poorly conserved and often overgrazed and trampled. Burning of wetlands is also a common agricultural practice, decreasing the moisture and organic material in the wetland (Begg 1986). Their functions as outlined above are thus compromised. Afforestation of wetland habitat has continued, despite numerous commissions of enquiry (e.g. Malherbe 1968) and academic research reports (e.g. Whitmore 1983), most of them advising against wetland afforestation (Begg 1986). Other wetlands are drained for a variety of purposes, consistent with the widespread attitude that wetlands are "wastelands" (Begg 1986). The downstream consequences of this wetland loss, in terms of flood attenuation, water storage and pollution control are impossible to quantify. The vegetation described in the present study can only be said to be tentatively representative of these disturbed wetlands, as a great deal of floristic change is expected to have occurred due to the various disturbances.

Limitations of the study

The present study was limited in the fulfilment of its aims in a number of ways:

1) Field work was conducted during 2 summer seasons over a wide area. It was impossible to monitor the flowering of all the species, especially the forbs, over the entire area and consequently identification of all the species encountered was not always possible. The raw data is therefore incomplete and should be taken as a sample of the vegetation present.

2) Access to the high altitude regions was limited because of the rugged terrain and the dearth of roads. Parts of the Drakensberg foothills are therefore undersampled.

3) Comparison with other projects in the Grassland Biome was difficult because of the differences in size of study area and therefore of sampling intensity in various regions. Certain projects were undertaken in regions of 1 000 km² (e.g. Smit 1992), whereas the present study was conducted in an area of approximately 14 000 km². Comparisons of species richness and biodiversity can therefore not confidently be made.

4) The high level of disturbance and modification of the grasslands, which is ongoing, has resulted in a patchwork of less disturbed natural areas from which most of the relevés were taken. Large tracts of especially exotic plantations cover much terrain which formerly supported grassland. The data which was lifted is therefore not necessarily representative of all the plant communities which were present before large-scale agriculture began.

CHAPTER 11

BIODIVERSITY, ENDEMISM AND CONSERVATION

Biodiversity

Figures 12, 13 and 14 (Chapter 4) indicate a number of differences between the diversity patterns of the major vegetation groups. The flattest curve (Figure 12) is generated by the Wetlands data, which at first may seem puzzling. However, Bloem (1988), Fuls *et al.* (1993) and Eckhardt (1993) have all noted the low alpha but high beta diversity in wetlands. The high species turnover between wetlands, with adjacent pans having considerably different species composition, causes the relatively flat curve of the Wetlands data. Although single pans may be dominated by *Typha* or *Phragmites*, overall there are fewer very dominant species. The lower species richness of the Wetlands compared to the other vegetation groups is evident in Figure 11.

Both the Midlands Grassland and Drakensberg Foothills are dominated by *Themeda triandra*, but the Midlands to a much greater extent. This is attributed to two factors:

1) The greater agricultural pressure on the Midlands Grassland has led to the destruction of habitat and probably of a number of herbaceous species, and the type of agriculture has encouraged the spread of grazing land at the expense of more diverse vegetation communities.

2) The topography and climate of the Drakensberg Foothills is more diverse than that of the Midlands, creating a greater number of niches which plants and plant communities can exploit. This more equitable distribution of biodiversity is evident in Figures 12, 13 and 14.

The Mistbelt Grassland is similarly dominated by *Themeda triandra, Aristida junciformis* and a few other species. The species cover, or dominance, drops sharply in the early part of the curve. A low overall diversity and low equitability is indicated for this Grassland, probably due to the highly modified nature of this region. The Wooded Grassland (i.e. the Grasslands of the

Incised River Valleys and Dry Upland Savanna) is dominated by *Themeda triandra*, *Hyparrhenia hirta* and *Acacia* species, and this curve drops sharply to indicate a low overall diversity and equitability in this grassland, largely due to a depauperate herbaceous layer, which itself may be caused by heavy agricultural pressure in the region.

The bar charts in Figures 13 and 14 emphasize these findings for the first 10 species, with the Wetlands data being incorporated into both charts for purposes of comparison. Overall the data argue for the conservation of the Wetlands and the continued conservation of the Drakensberg flora, as these two areas show the flattest curves and therefore the highest spread of diversity across them. These results mirror similar findings in the eastern Cape grasslands (Hoare, in prep.) which indicate a relatively high spread of diversity in the wetlands and a lower spread and extreme dominance of *T. triandra* in the mesic grasslands.

Endemism

The high level of endemism of the Drakensberg flora has been discussed by Killick (1963), Hilliard & Burtt (1987), Davis & Heywood (1994), Cowling & Hilton-Taylor (1994), and others. Myers (1988) incorporated the phenomenon of endemism into his definition of a "hot-spot": a region of high species richness, high concentration of endemics, and rapid habitat or species loss. Subsequently, Myers (1990) recognised the Cape Floristic Region as the "hottest" of the world's hot-spots, with roughly 6 000 endemics, an endemic percentage of 68 %, and a high species to land area ratio.

The KwaZulu-Natal Drakensberg and associated mountains in Lesotho and the eastern Cape are termed the "Eastern Mountain" Region (Hilliard & Burtt 1987; Cowling & Hilton-Taylor 1994). Hilliard & Burtt (1987) found an endemism percentage of 29.3 % in the southern Drakensberg (south of the Giant's Castle Spur) above 1 800 m. The present study included an area much larger than that investigated by Hillard & Burtt (1987), stretching from the Drakensberg foothills to Kranskop, and Estcourt to the Eastern Cape border, and thus a comparison of endemism percentages would have little meaning. However, of the Drakensberg species alone found in the present study, only 3% match the (apparently

abbreviated) list of endemic species of Hilliard & Burtt (1987) (see Appendix 2). The most likely reason for the relative paucity of endemics in the present study is that the Drakensberg range above 1 800 m was not sampled (apart from isolated sample plots). The concentration of endemics at high altitude, in leached, nutrient-poor soils and in extreme climatic conditions is higher than that in milder conditions (Matthews *et al.* 1993), possible because the ecological stresses encourage a higher mutation rate (Matthews *et al.* 1993). Thus the Drakensberg above 1 800 m can be expected to have more endemic species. A second reason is that the northern KwaZulu-Natal Drakensberg appears to have fewer endemics than the south (34 species compared to 70) (Hilliard & Burtt 1987). The northern Little 'Berg up to Monk's Cowl was included in the present study, and so the total proportion of endemics can be expected to be smaller than in the southern range exclusively.

Hilliard & Burtt (1987) emphasised the differences between the northern and southern 'Berg (the south-east facing spur of Giant's Castle being taken as the boundary) above 1 800 m. Forest and scrub patches were reported to be more common in the northern Berg, and significant floristic differences were noted. However, the authors state "... certain plant species which, common though they may be in the northern Berg, south of Giant's Castle forsake the face of the Berg for lower altitudes" (p. 63). At these lower altitudes, as in the present study, fewer floristic differences can thus be expected and this is the finding of the present study. Furthermore, the 'Berg north of Monk's Cowl fell outside the present study area (29° S being the northern limit) and therefore even fewer differences would have been noted. A phytosociological study from The Royal Natal National Park to Sehlabathebe National Park in Lesotho (29° 45' S 29° 10' E) above 1 800 m, and including outlier Blocks (the Mahwaqa Block and Ingeli Mountain), is required to further elucidate the distribution and frequency of endemics in these areas, and their conservation status as west of the Natal Drakensberg Park these grasslands are poorly conserved.

Previous authors (Coetzee 1967; Killick 1978; White 1983) have identified the KwaZulu-Natal Drakensberg as part of the "Afroalpine" region, but Hilliard & Burtt (1987) found stronger links to the Cape flora, especially in terms of relatedness of genera, than to the flora of east and central African highlands. However they also note the presence of species from

various different centres (the southern Berg being the range limit for many southern and northen species) and regard the Eastern Mountain region as an independent phytogeographical entity.

The present study supports Hillard & Burtt (1987), Matthews *et al.* (1993) and Killick (1994) in finding that forbs and low shrubs associated with grassland constitute all or most of the endemics, with no trees being endemic. (The situation in tropical forests is different, with many trees being endemic (Cowling & Hilton-Taylor 1994). The finding that Poaceae and Orchidaceae are under-represented by endemics was also supported by the present study. While Hillard & Burtt (1987) found that the families Asteraceae, Scrophulariaceae and Ericaceae had above average levels of endemism, the present study found that Asteraceae, Ericaceae and Liliaceae had the most endemic species (Hilliard & Burtt (1987) ranked Liliaceae fourth).

The average endemism of the southern KwaZulu-Natal Drakensberg of nearly 30 % is the third highest of the eight "Centres of Plant Diversity" identified by Cowling & Hilton-Taylor (1994), after Davis & Heywood (1994) and Matthews *et al.* (1993). The two highest are the Fynbos Region and the Succulent Karoo (68 % and 35 % respectively) (Davis & Heywood 1994). In spite of this third position, Hilliard & Burtt (1987) argued that the Eastern Mountain region does not qualify as a regional Centre of Endemism, as defined by White (1978). The total flora and number of endemics were held to be too small. Instead, Hilliard & Burtt (1987) proposed that the Eastern Mountain region fits the description of a Regional Mosaic (White 1978), in terms of the mixture of floristic elements and richness of endemic species. Since the region is in the south-east of Africa, Hilliard & Burtt (1987) proposed the term "South-eastern Mountain Regional Mosaic".

In spite of this proposal, Cowling & Hilton-Taylor (1994) included the Eastern Mountain region both as a Centre of Plant Diversity and as a "hot-spot". The latter grouping is justified in terms of the many threats to these Eastern Mountain grasslands: chiefly afforestation, overgrazing, agriculture, plant harvesting, and invasive plants (Cowling & Hilton-Taylor 1994). The current conservation areas in South Africa largely mismatch the "hot-spots"

(Rebelo 1994), and this is also true of the Eastern Mountain grasslands which are only 5.5% conserved (Cowling & Hilton-Taylor 1994). However the principal conservation area in these grasslands, the Natal Drakensberg Park, is located in the present study area. The high-lying grasslands (above c. 1 700 m) of the present study area are thus adequately conserved, but those at lower altitudes, in the midlands, incised river valleys and mistbelt, are largely altered and unconserved. The small nature reserves of Colesford, Mt. Currie and Craigie Burn are the chief conservation sites. Their total area is however very small and the biodiversity of the whole region has probably declined considerably, as evidenced by the low species richness found in many sample sites outside nature reserves in the present study. Within nature reserves, the mean number of species per relevé is sharply higher. Further west, in the high grasslands of Lesotho and the Eastern Cape, there are few conservation areas and the anthropogenic pressures are similar to those in KwaZulu-Natal (Cowling & Hilton-Taylor 1994).

Conservation

Cowling & Hilton-Taylor (1994) point to advances in applied economics which make it possible to quantify the value of environmental resources, including biodiversity (citing Tobias & Mendelsohn 1991), and note that this is yet to be done in South Africa. They advise that environmental resources be quantified and managed in such a way so as to ensure sustainability, and generation of income for local people who can act as guardians. In the light of decreased government funding, and the scant possibility that conservation areas will be proclaimed so as to include most of the "hot-spots", this appears to be sound advice. Certainly in the grasslands east of the Drakensberg in the present study area, the demand for land is enormous and the expansion of current conservation sites here is unlikely. It will be up to private landowners to conserve what they can of their land, and a great many farmers in KwaZulu-Natal are doing this via conservancies which have been set up. However, afforestation on company land and by individual farmers, sometimes sponsored by large companies, is on the increase as a greater revenue can apparently accrue in certain areas from plantations than from ranching or crops. An example of this is in the Inzinga ranches near the Little 'Berg, an area which Phillips (1973) expressly identified as "unsuitable for plantations".

The clearing of grassland habitat and wetlands for these purposes is most unfortunate, for the following reasons:

1. Genetic biodiversity is lost.

2. The traditional medicinal plant market is forced to exploit hitherto pristine areas for plants.

3. Soil erosion may increase if afforestation is unsuitably planned.

4. Water resources are utilised by the planted trees, decreasing the downstream flow.

5. The functions of wetlands as outlined in Chapter 10 are disrupted.

6. The habitat of specialised plants and animals is destroyed, the most conspicuous of which are probably the Blue, Wattled and Crowned Cranes.

SUMMARY

The present study of the phytosociology of the southern KwaZulu-Natal grasslands forms part of the Grassland Biome Project, begun in the 1980's and now coming to an end. The aims of the present study were to identify, classify and describe the main vegetation communities, relate these to the physical environment and place them in the context of phytosociological work conducted in neighbouring parts of the grassland. By so doing, the synecological work of Acocks (1988) and others was verified in places and added to where necessary.

The Braun-Blanquet approach to phytosociological research was adopted, in line with other studies of the Grassland Biome Project. Five hundred and forty-seven sample plots were laid out on a random stratified basis in the study area, and environmental and floristic data obtained from each of them. This data was processed and analysed using TWINSPAN, ordination and tabular Braun-Blanquet techniques, to produce phytosociological tables indicating the vegetation communities and sub-communities in the study area. Climatic, geological, pedological and topographical information was used, in conjunction with Turner's (1967) Physiographic Regions and Phillips' (1973) Bioclimatic Subregions, to interpret the distribution of these communities and sub-communities. The effects of anthropogenic factors on the vegetation were considered when classifying and describing the vegetation.

The biodiversity of the major vegetatation groups was investigated, using species richness and dominance-diversity curves as measures of diversity. The major vegetation groups were thereby compared to each other and to similar vegetation groups in adjacent grassland regions, and implications for conservation were discussed in the light of the biodiversity findings. Among these were that the Drakensberg slopes require continued protection and that wetlands require urgent protection whether they occur on the Drakensberg slopes, in the Midlands, the Mistbelt or in Wooded Grassland.

Possible differences between the vegetation north and south of Giant's Castle were discussed, as well as the phenomenon of endemism which manifests itself especially at high (above 1 800 m) altitudes. The status of the grasslands as primary or secondary grasslands was

discussed, in the light of relatively recent palaeontological evidence. The weight of this evidence together with the high levels of endemism in the grasslands would tend to support the view that they are primary grasslands with a long evolutionary history. Finally the conservation of the remaining grassland habitat was discussed, in the light of increasing human pressure on these grasslands and the apparently irreversible process of Wetland destruction. The utilisation of the grasslands and wetlands by endangered mammals, birds and amphibians was also considered. The implications of further habitat destruction were addressed (not the least of these being increased flood risk, water pollution and water shortages should wetland destruction continue) and mechanisms for habitat conservation were discussed. The conclusion was that current conservation techniques in the Drakensberg Mountain Park and isolated reserves outside the park are adequate, but that individual farmers, operating through conservancies, provide the greatest hope of preventing total transformation of the natural vegetation.

APPENDIX 1. **A checklist of the plant species found in the present study (nomenclature after Arnold & De Wet 1993).**

PTERIDOPHYTA

SCHIZAEACEAE

Mohria caffrorum (L.) Desv. var. caffrorum
Mohria rigida J.P.Roux

ADIANTACEAE

Cheilanthes contracta (Kunze) Mett. ex Kuhn
Cheilanthes hirta
Cheilanthes quadripinnata (Forssk.) Kuhn
Cheilanthes viridis (Forssk.) Sw. var. viridis
Pellaea calomelanos (Sw.) Link var. calomelanos
Pellaea calomelanos (Sw.) Link var. leucomelas (Mett. ex Kuhn) J.E.Burrows
Pellaea dura (Willd.) Hook.
Pellaea pectiniformis Baker
Adiantum capillus-veneris L.
Adiantum poiretii Wikstr.
Pteris buchananii Baker ex Sim
Pteris catoptera Kunze

CYATHEACEAE

Cyathea dregei Kunze

DENNSTAEDTIACEAE

Pteridium aquilinum (L.) Kuhn

THELYPTERIDACEAE

Thelypteris confluens (Thunb.) Morton
Thelypteris gueinziana (Mett.) Schelpe

ASPIDIACEAE

Polystichum dracomontanum Schelpe & N.C.Anthony

BLECHNACEAE

Blechnum attenuatum (Sw.) Mett. var. giganteum (Kaulf.) Bonap.
Blechnum inflexum (Kunze) Kuhn

GYMNOSPERMAE

PODOCARPACEAE

Podocarpus falcatus (Thunb.) R.Br. ex Mirb.
Podocarpus henkelii Stapf ex Dallim. & Jacks.
Podocarpus latifolius (Thunb.) R.Br. ex Mirb.

ANGIOSPERMAE

MONOCOTYLEDONAE

TYPHACEAE

Typha capensis (Rohrb.) N.E.Br.

APONOGETONACEAE

Aponogeton junceus

POACEAE

Ischaemum afrum (J.F.Gmel.) Dandy
Ischaemum fasciculatum Brongn.
Hemarthria altissima (Poir.) Stapf & C.E.Hubb.
Elionurus muticus (Spreng.) Kunth
Elionurus tripsacoides Willd.
Miscanthus capensis (Nees) Andersson
Eulalia villosa (Thunb.) Nees
Bothriochloa bladhii (Retz.) S.T.Blake
Bothriochloa insculpta (A.Rich.) A.Camus
Andropogon appendiculatus Nees
Andropogon eucomus Nees
Andropogon schirensis A.Rich.
Cymbopogon species
Cymbopogon excavatus (Hochst.) Stapf ex Burtt Davy
Cymbopogon plurinodis (Stapf) Stapf ex Burtt Davy
Cymbopogon validus (Stapf) Stapf ex Burtt Davy
Hyparrhenia anamesa Clayton
Hyparrhenia cymbaria (L.) Stapf
Hyparrhenia dregeana (Nees) Stapf
Hyparrhenia hirta (L.) Stapf
Hyparrhenia rufa
Hyparrhenia tamba (Steud.) Stapf
Monocymbium ceresiiforme (Nees) Stapf
Trachypogon spicatus (L.f.) Kuntze
Heteropogon contortus (L.) Roem. & Schult.

Diheteropogon amplectens (Nees) Clayton
Diheteropogon filifolius (Nees) Clayton
Themeda triandra Forssk.
Digitaria argyrograpta (Nees) Stapf
Digitaria brazzae (Franch.) Stapf
Digitaria diagonalis (Nees) Stapf var. diagonalis
Digitaria diagonalis
Digitaria eriantha Steud.
Digitaria flaccida Stapf
Digitaria sanguinalis (L.) Scop.
Digitaria ternata (A.Rich.) Stapf
Digitaria tricholaenoides Stapf
lloteropsis semialata
lloteropsis semialata (R.Br.) Hitchc. ssp. semialata
Brachiaria eruciformis (Sm.) Griseb.
Brachiaria serrata (Thunb.) Stapf
Paspalum dilatatum Poir.
Paspalum distichum L.
Paspalum notatum Flüggé
Paspalum scrobiculatum L.
Paspalum urvillei Steud.
Panicum aequinerve Nees
Panicum deustum Thunb.
Panicum dregeanum Nees
Panicum ecklonii Nees
Panicum maximum Jacq.
Panicum natalense Hochst.
Panicum schinzii Hack.
Setaria incrassata (Hochst.) Hack.
Setaria nigrirostris (Nees) T.Durand & Schinz
Setaria pallide-fusca (Schumach.) Stapf & C.E.Hubb.
Setaria sphacelata
Setaria sphacelata (Schumach.) Moss var. sericea (Stapf) Clayton
Setaria sphacelata (Schumach.) Moss var. sphacelata
Melinis nerviglumis (Franch.) Zizka
Melinis repens
Pennisetum clandestinum Chiov.
Pennisetum sphacelatum (Nees) T.Durand & Schinz
Pennisetum thunbergii Kunth
Leersia hexandra Sw.
Phalaris arundinacea L.
Arundinella nepalensis Trin.
Tristachya leucothrix Nees
Loudetia simplex (Nees) C.E.Hubb.
Helictotrichon turgidulum (Stapf) Schweick.
Pentaschistis tysonii Stapf
Phragmites australis (Cav.) Steud.
Agrostis lachnantha Nees var. lachnantha
Agrostis lachnantha

Agrostis montevidensis Spreng. ex Nees
Aristida bipartita (Nees) Trin. & Rupr.
Aristida canescens
Aristida congesta
Aristida congesta Roem. & Schult. ssp. congesta
Aristida diffusa
Aristida junciformis
Stipa dregeana
Sporobolus africanus (Poir.) Robyns & Tournay
Sporobolus centrifugus (Trin.) Nees
Sporobolus natalensis (Steud.) T.Durand & Schinz
Sporobolus pyramidalis P.Beauv.
Sporobolus stapfianus Gand. 165,
Eragrostis capensis (Thunb.) Trin.
Eragrostis chloromelas Steud. 259,271,340,411,
Eragrostis curvula (Schrad.) Nees
Eragrostis plana Nees
Eragrostis racemosa (Thunb.) Steud.
Eragrostis superba Peyr.
Microchloa caffra Nees
Rendlia altera (Rendle) Chiov.
Cynodon dactylon (L.) Pers.
Harpochloa falx (L.f.) Kuntze
Ctenium concinnum Nees
Eustachys paspaloides (Vahl) Lanza & Mattei
Styppeiochloa gynoglossa (Gooss.) De Winter
Koeleria capensis (Steud.) Nees
Stiburus alopecuroides (Hack.) Stapf
Festuca costata Nees
Festuca elatior L.
Festuca longipes Stapf
Festuca scabra Vahl
Bromus catharticus Vahl
Bromus firmior (Nees)
Lolium multiflorum Lam.
Lolium perenne L.
Lolium rigidum Gaudin

CYPERACEAE

Ascolepis capensis (Kunth) Ridl.
Cyperus denudatus L.f.
Cyperus distans L.f.
Cyperus esculentus
Cyperus fastigiatus Rottb.
Cyperus obtusiflorus
Cyperus rupestris
Cyperus schlechteri C.B.Clarke
Cyperus semitrifidus

Pycreus betschuanus (Boeck.) C.B.Clarke
Pycreus cooperi C.B.Clarke
Pycreus flavescens (L.) Rchb
Pycreus intactus (Vahl) J.
Pycreus macranthus (Boeck.) C.B.
Pycreus mundii Nees
Pycreus oakfortensis C.B.
Mariscus congestus (Vahl) C.B.Clarke
Kyllinga alba Nees
Kyllinga erecta
Kyllinga melanosperma Nees
Kyllinga pauciflora Ridl
Kyllinga pulchella
Ficinia gracilis Schrad
Ficinia stolonifera Boeck
Fuirena pubescens (Poir.)
Scirpus falsus C.B.Clarke
Schoenoplectus corymbosus (Roth ex Roem. & Schult.) J. Raynal
Schoenoplectus muricinux (C.B.Clarke) J. Raynal
Schoenoplectus paludicola (Kunth) Palla ex J.Raynal
Isolepis fluitans (L.) R.Br
Eleocharis dregeana Steud
Fimbristylis complanata (Retz.)
Bulbostylis contexta (Nees) M.
Bulbostylis humilis (Kunth) C.B. Clarke
Bulbostylis oritrephes (Ridl.) C.B. Clarke
Bulbostylis schoenoides (Kunth) C.B.Clarke
Abildgaardia species
Abildgaardia hygrophila (Gordon-Gray) Lye
Abildgaardia ovata (Burm.f.) Kral
Rhynchospora brownii Roem. & Schult.
Tetraria cuspidata (Rottb.) C.B.Clarke
Scleria bulbifera Hochst. ex A.Rich.
Schoenoxiphium sparteum (Wahlenb.) C.B.Clarke
Carex austro-africana (Kük.) Raymond
Carex spicato-paniculata C.B.Clarke
Carex zuluensis C.B.Clarke

ARACEAE

Zantedeschia aethiopica (L.) Spreng.
Zantedeschia albomaculata

XYRIDACEAE

Xyris capensis Thunb.
Xyris nivea Welw. ex Rendle

COMMELINACEAE

Commelina africana
Commelina modesta Oberm.
Cyanotis speciosa (L.f.) Hassk.

JUNCACEAE

Juncus dregeanus Kunth
Juncus effusus L.
Juncus exsertus
Juncus exsertus Buchenau ssp. exsertus
Juncus inflexus L.
Juncus kraussii
Juncus lomatophyllus Spreng.
Juncus oxycarpus E.Mey. ex Kunth
Juncus punctorius L.f
Juncus rigidus Desf.
Juncus tenuis Willd.

COLCHICACEAE

Wurmbea kraussii Baker

ASPHODELACEAE (PART A)

Bulbine narcissifolia Salm-Dyck
Trachyandra asperata

ASPHODELACEAE (PART B)

Kniphofia albomontana Baijnath
Kniphofia angustifolia (Baker) Codd
Kniphofia caulescens Baker
Kniphofia evansii Baker
Kniphofia gracilis Harv. ex Baker
Kniphofia ichopensis
Kniphofia linearifolia Baker
Kniphofia northiae Baker
Kniphofia porphyrantha Baker
Kniphofia praecox Baker
Kniphofia ritualis Codd
Kniphofia triangularis
Aloe arborescens Mill.
Aloe aristata Haw.
Aloe boylei Baker
Aloe ferox Mill.

ALLIACEAE

Agapanthus campanulatus
Agapanthus praecox
Tulbaghia leucantha
Tulbaghia natalensis Baker

HYACINTHACEAE

Albuca nelsonii N.E.Br.
Albuca rupestris Hilliard & B.L.
Urginea capitata (Hook.) Baker
Scilla natalensis Planch.
Scilla nervosa (Burch.) Jessop
Eucomis autumnalis
Ledebouria cooperi (Hook.f.)
Ledebouria marginata (Baker) Jessop
Ledebouria ovalifolia (Schrad.) Jessop

ASPARAGACEAE

Asparagus aethiopicus L
Asparagus buchananii Baker
Asparagus cooperi Baker
Asparagus devenishii (Oberm.) Fellingham & N.L.Mey
Asparagus falcatus L.
Asparagus laricinus Burch.
Asparagus microraphis (Kunth) Baker
Asparagus plumosus Baker
Asparagus racemosus Willd.
Asparagus setaceus (Kunth) Jessop

AMARYLLIDACEAE

Haemanthus humilis
Scadoxus puniceus (L.) Friis & Nordal
Brunsvigia natalensis Baker

HYPOXIDACEAE

Hypoxis acuminata Baker
Hypoxis argentea
Hypoxis colchicifolia Baker
Hypoxis hemerocallidea Fisch. & C.A.Mey.
Hypoxis iridifolia Baker
Hypoxis kraussiana Buchinger
Hypoxis multiceps Buchinger ex Baker
Hypoxis rigidula
Rhodohypoxis baurii

VELLOZIACEAE

Talbotia elegans Balf.

DIOSCOREACEAE

Dioscorea diversifolia Griseb.
Dioscorea retusa Mast
Dioscorea rupicola Kunth
Dioscorea sylvatica Kunth

IRIDACEAE

Moraea inclinata Goldblatt
Aristea abyssinica Pax
Aristea flexicaulis Baker
Aristea montana Baker
Aristea woodii N.E.Br.
Schizostylis coccinea Backh. & Harv.
Hesperantha baurii Baker ssp. baurii
Hesperantha candida Baker
Hesperantha hygrophila Hilliard & B.L.Burtt
Hesperantha scopulosa Hilliard & B.L.Burtt
Dierama dracomontanum Hilliard
Dierama latifolium N.E.Br.
Dierama medium N.E.Br.
Dierama pictum N.E.Br.
Dierama reynoldsii I.Verd.
Tritonia lineata
Crocosmia paniculata (Klatt) Goldblatt
Gladiolus crassifolius Baker
Gladiolus oppositiflorus
Gladiolus parvulus Schltr.
Gladiolus saundersii Hook.f.
Gladiolus woodii Baker
Watsonia densiflora Baker
Watsonia gladioloides Schltr.
Watsonia lepida N.E.Br.
Watsonia meriana (L.) Mill.
Watsonia pillansii L.Bolus

ORCHIDACEAE

Habenaria epipactidea Rchb.f
Brachycorythis conica
Satyrium cristatum Sond. var.
Satyrium longicauda

Disperis disaeformis Schltr
Pterygodium hastatum Bolus
Pterygodium magnum Rchb.f.
Eulophia clavicornis
Eulophia leontoglossa Rchb.f.

DICOTYLEDONAE

SALICACEAE

Populus x canescens (Aiton) Sm.
Salix babylonica L.
Salix mucronata Thunb. ssp. woodii (Seemen) Immelman
Myrica kraussiana Buchinger ex Meisn.

MYRICACEAE

Myrica pilulifera Rendle
Myrica serrata Lam.

ULMACEAE

Celtis africana Burm.f.

MORACEAE

Ficus ingens

PROTEACEAE

Protea caffra Meisn. ssp. caffra
Protea caffra
Protea dracomontana Beard
Protea roupelliae
Protea subvestita N.E.Br.

SANTALACEAE

Thesium costatum
Thesium griseum Sond.
Thesium hirsutum A.W.Hill
Thesium rigidum Sond.
Thesium scirpioides A.W.Hill

POLYGONACEAE

Rumex acetosella,
Rumex crispus L.
Polygonum hystriculum J.Schust.
Polygonum meisnerianum Cham. & Schltdl.
Persicaria serrulata (Lag.) Webb & Moq.
Oxygonum dregeanum

AMARANTHACEAE

Gomphrena celosioides Mart.

AIZOACEAE

Psammotropha myriantha Sond.

PHYTOLACCACEAE

Phytolacca heptandra Retz.

MESEMBRYANTHEMACEAE

Delosperma galpinii
Delosperma obtusum L.Bolus

CARYOPHYLLACEAE

Silene burchellii
Dianthus basuticus
Dianthus mooiensis

RANUNCULACEAE

Clematis brachiata Thunb.
Ranunculus baurii MacOwan
Ranunculus multifidus Forssk.

TRIMENIACEAE

Xymalos monospora (Harv.) Baill.

LAURACEAE

Cryptocarya woodii Engl.

FUMARIACEAE

Fumaria muralis Sond. ex W.D.J.Koch ssp. muralis

BRASSICACEAE

Heliophila alpina Marais
Heliophila pinnata L.f.
Heliophila rigidiuscula Sond.
Lepidium bonariense L.
Descurainia sophia (L.) Webb ex Prantl

DROSERACEAE

Drosera natalensis Diels

CRASSULACEAE

Cotyledon orbiculata
Crassula acinaciformis Schinz
Crassula corallina Thunb. ssp. corallina
Crassula crenulata Thunb.
Crassula grammanthoides (Sch"nland) Toelken
Crassula natalensis Sch"nland
Crassula natans
Crassula pellucida
Crassula sarcocaulis
Crassula sediflora
Crassula setulosa
Crassula vaginata

MYROTHAMNACEAE

Myrothamnus flabellifolius Welw.

ROSACEAE

Rubus cuneifolius Pursh
Rubus ludwigii
Rubus pinnatus Willd.
Rubus rigidus Sm.
Alchemilla woodii Kuntze
Agrimonia procera Wallr.
Leucosidea sericea Eckl. & Zeyh.
Cliffortia lanceolata Weim.
Cliffortia linearifolia Eckl. & Zeyh.
Cliffortia nitidula
Cliffortia paucistaminea Weim.
Cliffortia repens Schltr.
Cliffortia serpyllifolia Cham. & Schltdl.
Cliffortia stricta Weim.

FABACEAE

Acacia caffra (Thunb.) Willd.
Acacia karroo Hayne
Acacia mearnsii De Wild.
Chamaecrista plumosa E.Mey. var. erecta (Schorn & Gordon-Gray) Lock
Chamaecrista stricta E.Mey.
Hoffmannseggia sandersonii (Harv.) Engl.
Caesalpinia decapetala (Roth) Alston
Calpurnia aurea (Aiton) Benth. ssp. aurea
Calpurnia capensis (Burm.f.) Druce
Calpurnia sericea Harv.
Calpurnia villosa Harv. var. intrusa (R.Br. ex Aiton f.) E.Mey.
Lotononis carinata (E.Mey.) Benth.
Lotononis eriantha Benth.
Lotononis foliosa Bolus
Lotononis listii Polhill
Lotononis lotononoides (Scott-Elliot) B.-E.van Wyk
Lotononis mucronata Conrath
Lotononis pulchella (E.Mey.) B.E. van Wyk
Pearsonia cajanifolia
Pearsonia sessilifolia
Crotalaria brachycarpa (Benth.) Burtt Davy ex I.Verd.
Crotalaria eremicola
Crotalaria globifera E.Mey.
Argyrolobium humile E.Phillips
Argyrolobium rupestre (Eckl. & Zeyh.) Walp.
Argyrolobium sankeyi Harms
Argyrolobium speciosum Eckl. & Zeyh.
Argyrolobium stipulaceum Eckl. & Zeyh.
Melilotus alba Desr.
Trifolium africanum
Trifolium burchellianum
Trifolium repens
Indigofera cuneifolia
Indigofera dimidiata Vogel ex Walp.
Indigofera dregeana E.Mey.
Indigofera foliosa E.Mey.
Indigofera hedyantha Eckl. & Zeyh.
Indigofera hilaris Eckl. & Zeyh.
Indigofera longebarbata Engl.
Indigofera natalensis Bolus
Indigofera obscura N.E.Br.
Indigofera rostrata Bolus
Indigofera torulosa
Indigofera tristis E.Mey.
Indigofera tristoides N.E.Br.
Indigofera vicioides
Indigofera woodii

Indigofera zeyheri Spreng. ex Eckl. & Zeyh.
Indigastrum argyraeum (Eckl. & Zeyh.) Schrire
Indigastrum costatum (Guill. & Perr.) Schrire ssp. macrum (E.Mey.) Schrire
Indigastrum fastigiatum (E.Mey.) Schrire
Indigastrum parviflorum (B.Heyne ex Wight & Arn.) Schrire ssp. parviflorum var. parviflorum
Psoralea pinnata L.
Psoralea restioides Eckl. & Zeyh.
Tephrosia capensis
Tephrosia glomeruliflora
Tephrosia macropoda
Tephrosia marginella H.M.L.Forbes
Tephrosia multijuga R.G.N.Young
Sesbania punicea (Cav.) Benth.
Lessertia stricta L.Bolus
Aeschynomene micrantha DC.
Zornia capensis Pers.
Zornia milneana Mohlenbr.
Desmodium repandum (Vahl) DC.
Pseudarthria hookeri
Alysicarpus rugosus
Alysicarpus zeyheri Harv.
Rhynchosia adenodes Eckl. & Zeyh.
Rhynchosia caribaea (Jacq.) DC.
Rhynchosia cooperi (Harv. ex Baker f.) Burtt Davy
Rhynchosia densiflora
Rhynchosia longiflora Schinz
Rhynchosia reptabunda N.E.Br.
Rhynchosia totta (Thunb.) DC. var. totta
Rhynchosia totta
Eriosema cordatum E.Mey.
Eriosema distinctum N.E.Br.
Eriosema kraussianum Meisn.
Eriosema lucipetum C.H.Stirt.
Eriosema parviflorum E.Mey.
Eriosema preptum C.H.Stirt.
Eriosema salignum E.Mey
Eriosema simulans C.H.Stirt.
Eriosema squarrosum (Thunb.) Walp.
Vigna nervosa Mark"tter
Vigna unguiculata
Vigna unguiculata (L.) Walp. ssp. stenophylla (Harv.) Maréchal et al.
Vigna vexillata

GERANIACEAE

Geranium caffrum Eckl. & Zeyh.
Geranium natalense Hilliard & B.L.Burtt
Geranium pulchrum N.E.Br
Geranium wakkerstroomianum R.Knuth

Monsonia angustifolia E.Mey. ex A.Rich.
Pelargonium alchemilloides (L.) L'Hér.
Pelargonium caffrum (Eckl. & Zeyh.) Harv.
Pelargonium luridum (Andrews) Sweet
Pelargonium sidoides DC.
Pelargonium zonale (L.) L'Hér.

OXALIDACEAE

Oxalis corniculata L.
Oxalis depressa Eckl. & Zeyh.
Oxalis latifolia Humb., Bonpl. & Kunth
Oxalis obliquifolia Steud. ex Rich.
Oxalis smithiana Eckl. & Zeyh.
Oxalis tragopoda Salter

LINACEAE

Linum africanum L.
Linum thunbergii Eckl. & Zeyh.

RUTACEAE

Zanthoxylum capense (Thunb.) Harv.
Calodendrum capense (L.f.) Thunb.
Clausena anisata (Willd.) Hook.f. ex Benth.

MELIACEAE

Ekebergia capensis Sparrm.

POLYGALACEAE

Polygala amatymbica Eckl. & Zeyh.
Polygala hispida Burch.
Polygala hottentotta C.Presl
Polygala leendertziae Burtt Davy
Polygala ohlendorfiana Eckl. & Zeyh.
Polygala uncinata E.Mey. ex Meisn.
Polygala virgata Thunb. var. decora (Sond.) Harv.
Polygala virgata
Polygala virgata Thunb. var. virgata

EUPHORBIACEAE

Phyllanthus burchellii Müll.Arg.
Phyllanthus glaucophyllus Sond.
Acalypha angustata Sond.
Acalypha caperonioides Baill.

Acalypha peduncularis E.Mey. ex Meisn.
Acalypha pubiflora Baill. ,
Acalypha punctata Meisn.
Acalypha schinzii Pax
Acalypha wilmsii Pax ex Prain & Hutch.
Clutia abyssinica
Clutia monticola S.Moore
Clutia natalensis Bernh. ex C.Krauss
Clutia pulchella
Euphorbia clavarioides
Euphorbia clavarioides Boiss. var. truncata (N.E.Br.) A.C.White, R.A.Dyer &
Euphorbia epicyparissias
Euphorbia ericoides Lam.
Euphorbia natalensis Bernh.
Euphorbia striata
Chamaesyce hirta (L.) Millsp.
Chamaesyce inaequilatera (Sond.) Soj k
Chamaesyce serpens (Humb., Bonpl. & Kunth) Small

ANACARDIACEAE

Ozoroa paniculosa
Ozoroa paniculosa (Sond.) R.& A.Fern. var. paniculosa
Rhus chirindensis Baker f.
Rhus dentata Thunb.
Rhus discolor E.Mey. ex Sond.
Rhus gerrardii (Harv. ex Engl.) Sch"nland
Rhus krebsiana C.Presl ex Engl.
Rhus lancea L.f.
Rhus lucida L. fo. elliptica (Sond.) Moffett
Rhus pyroides
Rhus rehmanniana
Rhus rehmanniana Engl. var. rehmanniana
Rhus tomentosa L.

AQUIFOLIACEAE

Ilex mitis

CELASTRACEAE

Maytenus heterophylla (Eckl. & Zeyh.) N.Robson
Maytenus peduncularis (Sond.) Loes.
Maytenus undata (Thunb.) Blakelock
Putterlickia verrucosa (E.Mey. ex Sond.) Szyszyl.
Pterocelastrus echinatus N.E.Br.
Cassinopsis ilicifolia (Hochst.) Kuntze

GREYIACEAE

Greyia sutherlandii Hook. & Harv.

BALSAMINACEAE

Impatiens hochstetteri Warb. ssp. hochstetteri

RHAMNACEAE

Ziziphus mucronata
Ziziphus mucronata Willd. ssp. mucronata
Scutia myrtina (Burm.f.) Kurz
Rhamnus prinoides L'Hér.
Phylica paniculata Willd.

VITACEAE

Rhoicissus tridentata

TILIACEAE

Corchorus confusus Wild
Grewia lasiocarpa E.Mey. ex Harv.
Grewia occidentalis L.

MALVACEAE

Abutilon lauraster Hochr.
Sida cordifolia L.
Hibiscus calyphyllus Cav.
Hibiscus micranthus L.f.
Hibiscus pusillus Thunb.
Hibiscus trionum L

BOMBACACEAE

Adansonia digitata L.

STERCULIACEAE

Hermannia coccocarpa (Eckl. & Zeyh.) Kuntze
Hermannia cordata (E.Mey. ex E.Phillips) De Winter
Hermannia depressa N.E.Br.
Hermannia oblongifolia (Harv.) Hochr.
Hermannia quartiniana
Hermannia woodii Schinz

OCHNACEAE

Ochna serrulata (Hochst.) Walp.

CLUSIACEAE

Hypericum aethiopicum
Hypericum lalandii Choisy
Hypericum roeperianum Schimp. ex A.Rich. var. roeperianum

FLACOURTIACEAE

Kiggelaria africana L.
Scolopia mundii (Eckl. & Zeyh.) Warb.
Trimeria grandifolia (Hochst.) Warb.

CACTACEAE

Opuntia exaltata A.Berger
Opuntia ficus-indica (L.) Mill.

OLINIACEAE

Olinia emarginata Burtt Davy

THYMELACEAE

Gnidia burchellii (Meisn.) Gilg
Gnidia calocephala (C.A.Mey.) Gilg
Gnidia capitata L.f.
Gnidia kraussiana Meisn. var. kraussiana
Gnidia polyantha Gilg
Passerina filiformis L.
Passerina montana Thoday

LYTHRACEAE

Rotala tenella (Guill. & Perr.) Hiern

MYRTACEAE

Syzygium gerrardii (Harv. ex Hook.f.) Burtt Davy

ONAGRACEAE

Epilobium salignum Hausskn.
Oenothera affinis Cambess.
Oenothera indecora Cambess. ssp. bonariensis W.Dietr.
Oenothera jamesii Torr. & A.Gray

Oenothera rosea L'Hér. ex Aiton
Oenothera stricta Ledeb. ex Link

HALORAGACEAE

Gunnera perpensa L.

ARALIACEAE

Schefflera umbellifera (Sond.) Baill.
Cussonia paniculata
Cussonia spicata Thunb.

APIACEAE

Hydrocotyle americana L.
Centella asiatica (L.) Urb.
Sanicula elata Buch.-Ham. ex D.Don
Alepidea amatymbica
Alepidea insculpta Hilliard & B.L.Burtt
Alepidea natalensis J.M.Wood & M.S.Evans
Heteromorpha trifoliata (H.L.Wendl.) Eckl. & Zeyh.
Ciclospermum leptophyllum (Pers.) Eichler
Pimpinella caffra (Eckl. & Zeyh.) D.Dietr.
Sium repandum Welw. ex Hiern
Peucedanum caffrum (Meisn.) E.Phillips

ERICACEAE

Erica anomala Hillard & Burtt
Erica drakensbergensis Guthrie & Bolus
Erica ebracteata Bolus
Erica evansii (N.E.Br.) E.G.H.Oliv.

MYRSINACEAE

Myrsine africana L.
Rapanea melanophloeos (L.) Mez

PRIMULACEAE

Anagallis arvensis L.

EBENACEAE

Euclea crispa
Diospyros austro-africana De Winter var. austro-africana
Diospyros austro-africana
Diospyros lycioides

Diospyros whyteana (Hiern) F.White

OLEACEAE

Menodora africana Hook.
Gomphostigma virgatum (L.f.) Baill.

LOGANIACEAE

Buddleja salviifolia (L.) Lam.

GENTIANACEAE

Sebaea filiformis Schinz
Sebaea grandis (E.Mey.) Steud.
Sebaea leiostyla Gilg
Sebaea natalensis Schinz
Sebaea sedoides
Chironia peglerae Prain

APOCYNACEAE

Carissa bispinosa

ASCLEPIADACEAE

Araujia sericifera Brot.
Xysmalobium parviflorum Harv. ex Scott-Elliot
Aspidonepsis diploglossa (Turcz.) Nicholas & Goyder
Gomphocarpus fruticosus (L.) Aiton f.
Gomphocarpus physocarpus E.Mey.
Pachycarpus asperifolius Meisn.
Pachycarpus grandiflorus
Asclepias affinis (Schltr.) Schltr.
Asclepias albens (E.Mey.) Schltr.
Asclepias aurea (Schltr.) Schltr.
Asclepias eminens (Harv.) Schltr.
Asclepias gibba
Asclepias macropus (Schltr.) Schltr.

CONVULVULACEAE

Convolvulus natalensis
Ipomoea cairica (L.) Sweet
Ipomoea crassipes Hook.
Ipomoea obscura
Ipomoea ommaneyi Rendle
Ipomoea pellita Hallier f.
Ipomoea purpurea (L.) Roth

BORAGINACEAE

Heliotropium steudneri Vatke
Cynoglossum hispidum Thunb.
Lithospermum papillosum Thunb.

VERBENACEAE

Verbena bonariensis L.
Verbena brasiliensis Vell.
Verbena tenuisecta Briq.
Lantana camara L.
Lantana rugosa Thunb.
Lippia javanica (Burm.f.) Spreng.
Clerodendrum glabrum E.Mey. var. glabrum

LAMIACEAE

Ajuga ophrydis Burch. ex Benth.
Leonotis leonurus (L.) R.Br.
Leonotis ocymifolia
Leonotis ocymifolia (Burm.f.) Iwarsson var. raineriana (Vis.) Iwarsson
Stachys cymbalaria Briq.
Stachys natalensis
Stachys nigricans Benth.
Stachys rivularis J.M.Wood & M.S.Evans
Stachys tysonii Skan
Mentha aquatica L.
Pycnostachys reticulata (E.Mey.) Benth.
Plectranthus dolichopodus Briq.
Plectranthus ecklonii Benth.
Plectranthus grallatus Briq.
Plectranthus hereroensis Engl.
Rabdosiella calycina (Benth.) Codd
Syncolostemon eriocephalus I.Verd.
Syncolostemon parviflorus
Becium obovatum

SOLANACEAE

Solanum aculeatissimum Jacq.
Solanum chenopodioides Lam.
Solanum mauritianum Scop.
Solanum nigrum L.
Solanum panduriforme E.Mey.
Solanum sisymbrifolium Lam.
Solanum tomentosum L.
Datura stramonium L.

SCROPHULARIACEAE (PART A)

Nemesia fruticans (Thunb.) Benth.
Diclis reptans Benth.
Diclis rotundifolia (Hiern) Hilliard & B.L.Burtt
Halleria lucida L.
Phygelius aequalis Harv. ex Hiern
Sutera breviflora N.E.Br.
Sutera floribunda (Benth.) Kuntze
Sutera polelensis
Jamesbrittenia pristisepala (Hiern) Hilliard
Zaluzianskya maritima (L.f.) Walp.
Zaluzianskya microsiphon (Kuntze) K.Schum.
Zaluzianskya natalensis Hochst.
Zaluzianskya pulvinata Killick

SELAGINACEAE

Hebenstretia dregei Rolfe
Hebenstretia oatesii Rolfe ssp. oatesii
Selago galpinii Schltr.
Selago longipedicellata Rolfe
Selago monticola J.M.Wood & M.S.Evans
Walafrida densiflora (Rolfe) Rolfe

SCROPHULARIACEAE (PART B)

Veronica anagallis-aquatica L.
Melasma scabrum P.J.Bergius
Alectra sessiliflora (Vahl) Kuntze var. sessiliflora
Graderia scabra (L.f.) Benth.
Sopubia cana Harv. var. cana
Buchnera dura Benth.
Buchnera glabrata Benth.
Cycnium racemosum Benth.
Striga asiatica (L.) Kuntze
Striga bilabiata (Thunb.) Kuntze
Striga elegans Benth.

GESNERIACEAE

Streptocarpus bolusii C.B.Clarke

ACANTHACEAE

Thunbergia atriplicifolia E.Mey. ex Nees
Thunbergia neglecta Sond.
Chaetacanthus burchellii Nees
Chaetacanthus setiger (Pers.) Lindl.

Ruellia cordata Thunb.
Ruellia stenophylla C.B.Clarke
Monechma grandiflorum Schinz

PLANTAGINACEAE

Plantago lanceolata L.
Plantago longissima Decne.

RUBIACEAE

Kohautia amatymbica Eckl. & Zeyh.
Kohautia cynanchica DC.
Cephalanthus natalensis Oliv.
Pentanisia angustifolia (Hochst.) Hochst.
Pentanisia prunelloides
Canthium ciliatum (Klotzsch) Kuntze
Canthium mundianum Cham. & Schltdl.
Canthium spinosum (Klotzsch) Kuntze
Pavetta cooperi Harv. & Sond.
Anthospermum herbaceum L.f.
Anthospermum monticola Puff
Richardia brasiliensis Gomes
Spermacoce natalensis Hochst.
Galium thunbergianum
Rubia cordifolia

VALERIANACEAE

Valeriana capensis

DIPSACACEAE

Cephalaria natalensis Kuntze
Cephalaria oblongifolia (Kuntze) Szabó
Scabiosa columbaria L.

CUCURBITACEAE

Cucumis africanus L.f.
Cucumis hirsutus Sond.
Cucumis zeyheri Sond.
Coccinia hirtella Cogn.
Coccinia quinqueloba (Thunb.) Cogn.

CAMPANULACEAE

Wahlenbergia capensis (L.) A.DC.
Wahlenbergia fasciculata Brehmer

Wahlenbergia huttonii (Sond.) Thulin
Wahlenbergia undulata (L.f.) A.DC.
Wahlenbergia virgata Engl.

LOBELIACEAE

Cyphia elata
Lobelia erinus L.
Lobelia flaccida
Lobelia preslii A.DC.
Lobelia vanreenensis (Kuntze) K.Schum.
Monopsis decipiens (Sond.) Thulin

ASTERACEAE

Vernonia galpinii Klatt
Vernonia hirsuta (DC.) Sch.Bip. ex Walp.
Vernonia natalensis Sch.Bip. ex Walp.
Vernonia oligocephala (DC.) Sch.Bip. ex Walp.
Vernonia poskeana Vatke & Hildebr. ssp. botswanica G.V.Pope
Ageratum conyzoides L.
Aster bakeranus Burtt Davy ex C.A.Sm.
Aster erucifolius (Thell.) Lippert
Aster harveyanus Kuntze
Aster lydenburgensis Lippert
Aster peglerae Bolus
Aster perfoliatus Oliv.
Aster pleiocephalus (Harv.) Hutch.
Felicia filifolia
Felicia uliginosa (J.M.Wood & M.S.Evans) Grau
Nidorella anomala Steetz
Nidorella auriculata DC.
Nidorella hottentotica DC.
Conyza albida Spreng.
Conyza bonariensis (L.) Cronquist
Conyza canadensis (L.) Cronquist
Conyza chilensis Spreng.
Conyza obscura DC.
Conyza pinnata (L.f.) Kuntze
Conyza podocephala DC.
Conyza scabrida DC.
Chrysocoma ciliata L.
Denekia capensis Thunb.
Pseudognaphalium luteo-album (L.) Hilliard & B.L.Burtt
Pseudognaphalium oligandrum (DC.) Hilliard & B.L.Burtt
Syncarpha paniculata (L.) B.Nord.
Helichrysum acutatum DC.
Helichrysum adenocarpum
Helichrysum albo-brunneum S.Moore

Helichrysum appendiculatum (L.f.) Less.
Helichrysum argyrophyllum DC.
Helichrysum athrixiifolium (Kuntze) Moeser
Helichrysum aureonitens Sch.Bip.
Helichrysum aureum
Helichrysum caespititium (DC.) Harv.
Helichrysum cephaloideum DC.
Helichrysum chionosphaerum DC.
Helichrysum confertifolium Klatt
Helichrysum cooperi Harv.
Helichrysum coriaceum Harv.
Helichrysum cymosum
Helichrysum dasymallum Hilliard
Helichrysum diffusum DC.
Helichrysum ecklonis Sond.
Helichrysum felinum Less.
Helichrysum glomeratum Klatt
Helichrysum gymnocomum DC.
Helichrysum harveyanum Wild
Helichrysum herbaceum (Andrews) Sweet
Helichrysum hyphocephalum Hilliard
Helichrysum inornatum Hilliard & B.L.Burtt
Helichrysum kraussii Sch.Bip.
Helichrysum krebsianum Less.
Helichrysum krookii Moeser
Helichrysum longifolium DC.
Helichrysum miconiifolium DC.
Helichrysum mundtii Harv.
Helichrysum nanum Klatt
Helichrysum natalitium DC.
Helichrysum nudifolium (L.) Less.
Helichrysum obductum Bolus 316,
Helichrysum odoratissimum (L.) Sweet
Helichrysum oreophilum Klatt
Helichrysum oxyphyllum DC.
Helichrysum pallidum DC.
Helichrysum pilosellum (L.f.) Less.
Helichrysum ruderale Hilliard & B.L.Burtt
Helichrysum rugulosum Less.
Helichrysum spiralepis Hilliard & B.L.Burtt
Helichrysum sutherlandii Harv.
Helichrysum tenuifolium Killick
Helichrysum thapsus (Kuntze) Moeser
Helichrysum umbraculigerum Less.
Helichrysum vernum Hilliard
Metalasia densa (Lam.) P.O.Karis
Athrixia arachnoidea J.M.Wood & M.S.Evans ex J.M.Wood
Athrixia phylicoides DC.
Printzia pyrifolia Less.

Pulicaria scabra (Thunb.) Druce
Callilepis laureola DC.
Zinnia peruviana (L.) L.
Helianthus argophyllus Torr. & A.Gray
Bidens formosa (Bonato) Sch.Bip.
Bidens pilosa L.
Tagetes minuta L.
Inulanthera calva (Hutch.) Källersj"
Inulanthera coronopifolia (Harv.) Källersj"
Acacia nilotica (L.) Delile
Cotula hispida (DC.) Harv.
Schistostephium crataegifolium (DC.) Fenzl ex Harv.
Schistostephium heptalobum (DC.) Oliv. & Hiern
Artemisia afra Jacq. ex Willd.
Gymnopentzia bifurcata Benth.
Crassocephalum rubens (Juss. ex Jacq.) S.Moore
Cineraria aspera Thunb.
Cineraria geifolia (L.) L.
Senecio achilleifolius DC.
Senecio anomalochrous Hilliard
Senecio arabidifolius O.Hoffm.
Senecio asperulus DC.
Senecio bupleuroides DC.
Senecio burchellii DC.
Senecio cathcartensis O.Hoffm.
Senecio conrathii N.E.Br.
Senecio coronatus (Thunb.) Harv.
Senecio dissimulans Hilliard
Senecio erubescens
Senecio glaberrimus DC.
Senecio glanduloso-pilosus Volkens & Muschl.
Senecio harveianus MacOwan
Senecio hieracioides DC.
Senecio ilicifolius L.
Senecio inaequidens DC.
Senecio inornatus DC.
Senecio isatideus DC.
Senecio mauricei Hilliard & B.L.Burtt
Senecio othonniflorus DC.
Senecio paludaffinis Hilliard
Senecio parascitus Hilliard
Senecio polelensis Hilliard
Senecio purpureus L.
Senecio retortus (DC.) Benth.
Senecio retrorsus DC.
Senecio scitus Hutch. & Burtt Davy
Senecio serratuloides
Senecio subrubriflorus O.Hoffm.
Senecio tropaeolifolius MacOwan

Senecio umgeniensis Thell.
Senecio venosus Harv.
Euryops laxus (Harv.) Burtt Davy
Euryops pedunculatus N.E.Br.
Othonna burttii B.Nord.
Othonna natalensis Sch.Bip.
Othonna pinnatilobata Sch.Bip.
Dimorphotheca caulescens Harv.
Chrysanthemoides monilifera
Haplocarpha scaposa Harv.
Gazania krebsiana
Gazania linearis
Berkheya cirsiifolia (DC.) Roessler
Berkheya discolor (DC.) O.Hoffm. & Muschl.
Berkheya echinacea (Harv.) O.Hoffm. ex Burtt Davy ssp. echinacea
Berkheya insignis (Harv.) Thell.
Berkheya multijuga (DC.) Roessler
Berkheya onopordifolia
Berkheya purpurea (DC.) Mast.
Berkheya rhapontica
Berkheya setifera DC.
Berkheya speciosa
Berkheya umbellata DC.
Berkheya zeyheri
Acacia sieberiana DC.
Cirsium vulgare (Savi) Ten.
Dicoma anomala Sond.
Gerbera ambigua (Cass.) Sch.Bip.
Gerbera cordata (Thunb.) Less.
Gerbera viridifolia
Gerbera viridifolia (DC.) Sch.Bip. ssp. natalensis (Sch.Bip.) H.V.Hansen
Tolpis capensis (L.) Sch.Bip.
Hypochaeris radicata L.
Taraxacum officinale Weber sensu lato
Sonchus asper
Sonchus dregeanus DC.
Sonchus gigas Boulos ex Humbert
Sonchus integrifolius
Sonchus nanus Sond. ex Harv.
Lactuca indica L.
Lactuca inermis Forssk.
Crepis capillaris (L.) Wallr.

APPENDIX 2. **A checklist of the plant species found in the present study and endemic to the KwaZulu-Natal Drakensberg (Hilliard & Burtt 1987)**

ASTERACEAE

Helichrysum inornatum
Othonna burttii
Senecio mauricei
Senecio polelensis

ERICACEAE

Erica ebracteata
Erica anomala

LILIACEAE

Albuca rupestris
Tulbaghia natalensis

AMARYLLIDACEAE

Nerine appendiculata

LEGUMINOSAE

Indigofera cuneifolia

THYMELAEACEAE

Passerina filiformis

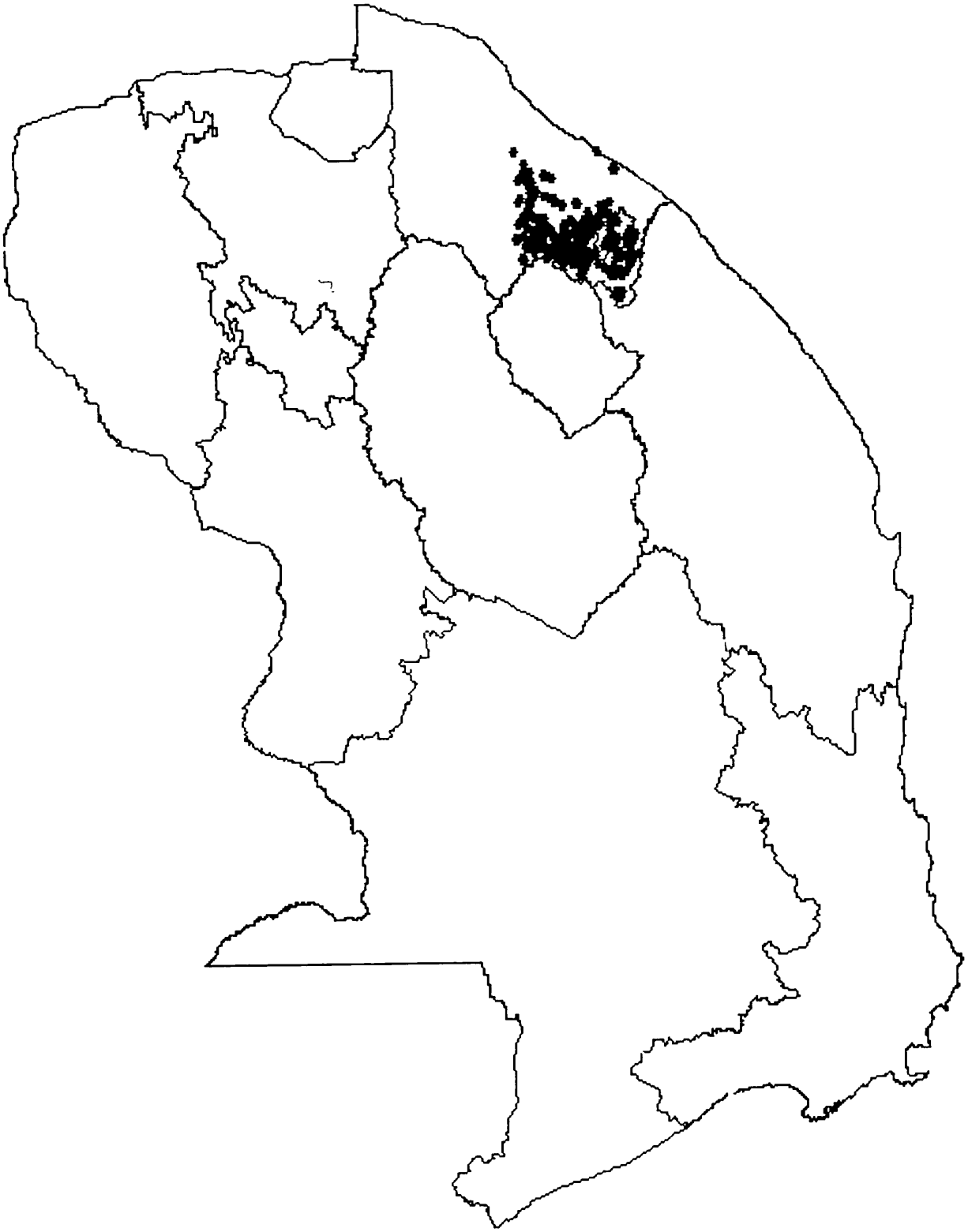
CRUCIFERAE

Heliophila alpina

APPENDIX 3. Distribution of the sample plots representing

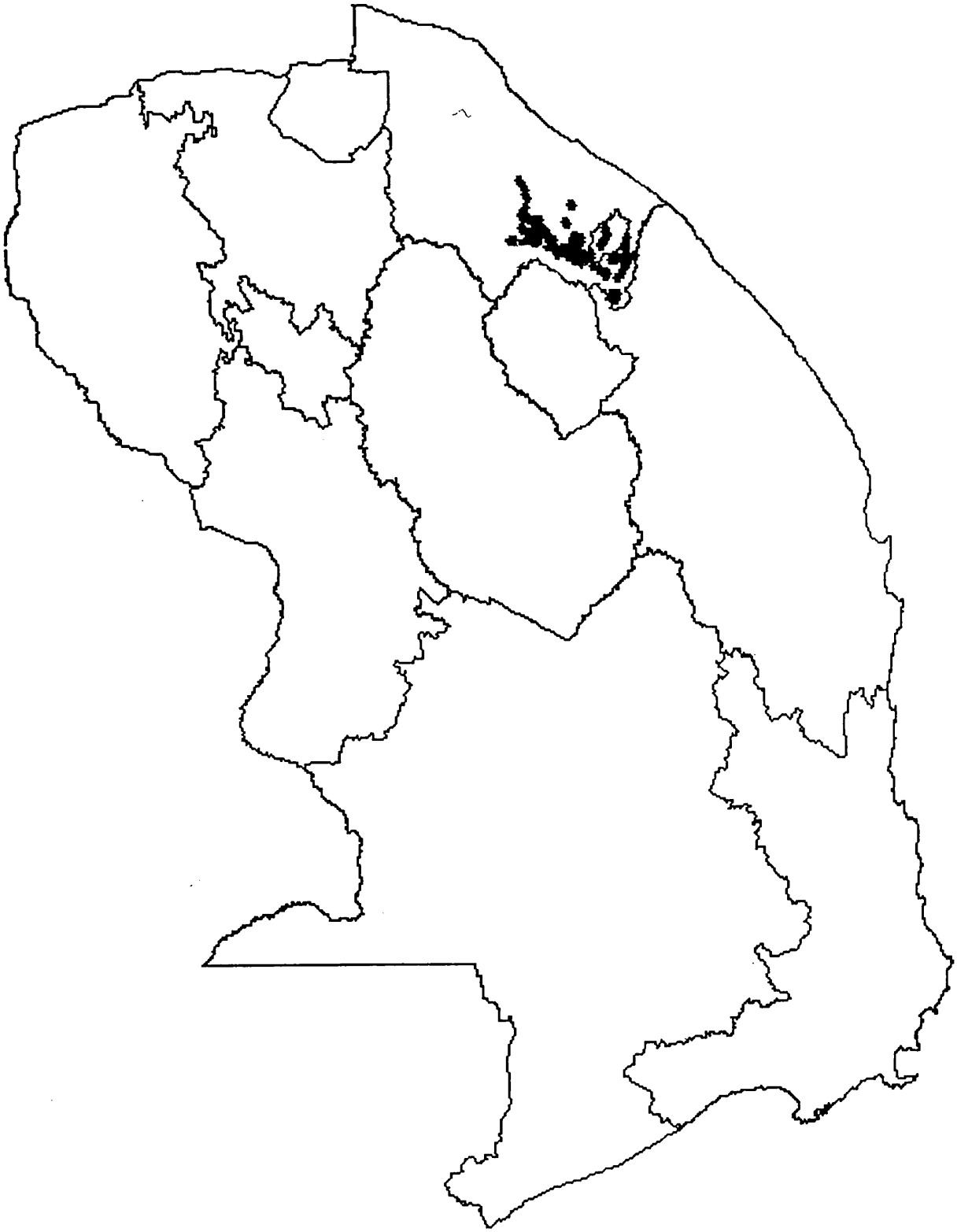
(3a) the total study area
(3b) the Drakensberg Foothills
(3c) the Midlands Grassland
(3d) the Mistbelt Grassland
(3e) the Incised River Valleys and Dry Upland Savanna.

The Wetlands sample plot distribution is not included as the wetlands were located in each of the above areas.

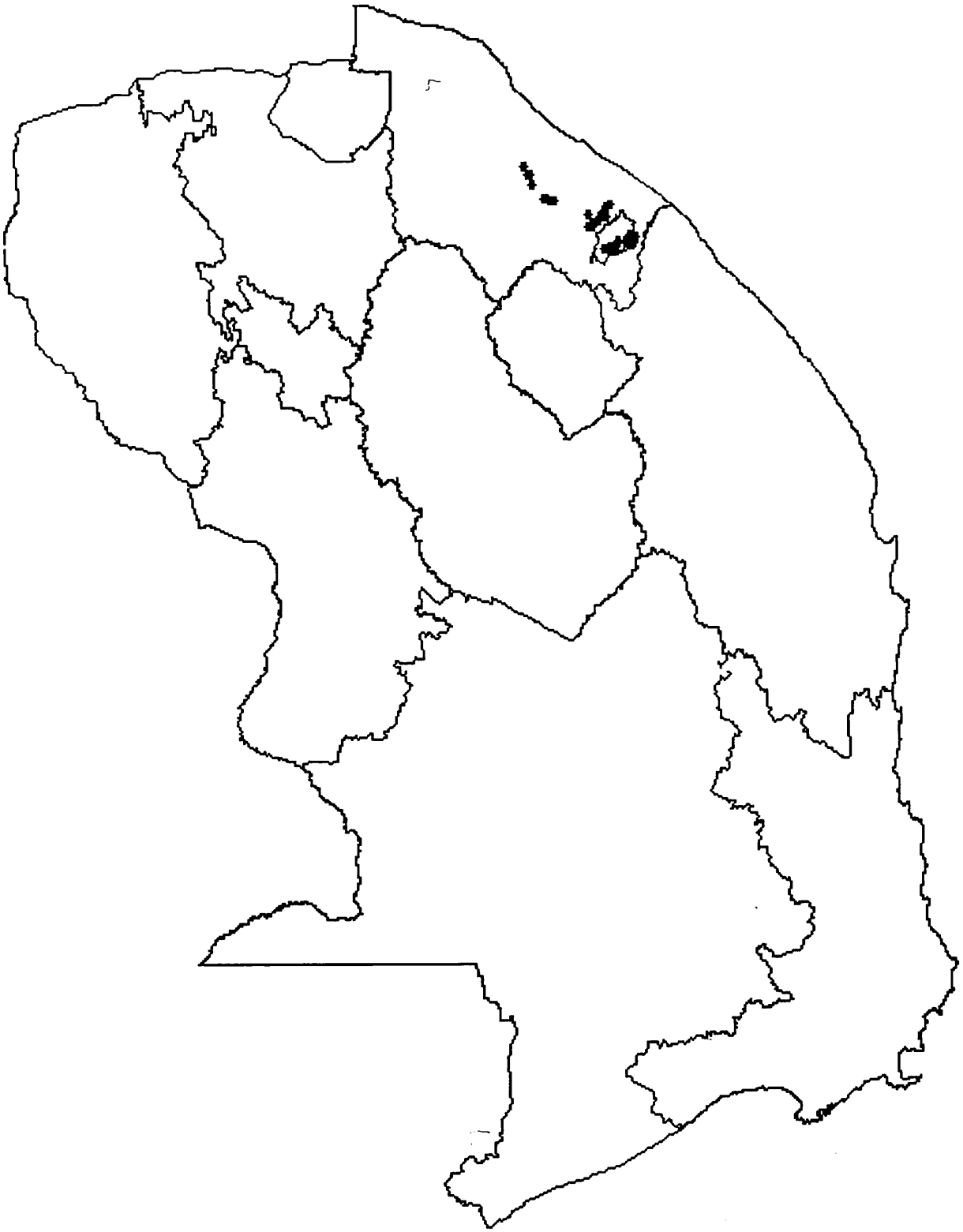


3a. Sample plots of the total study area

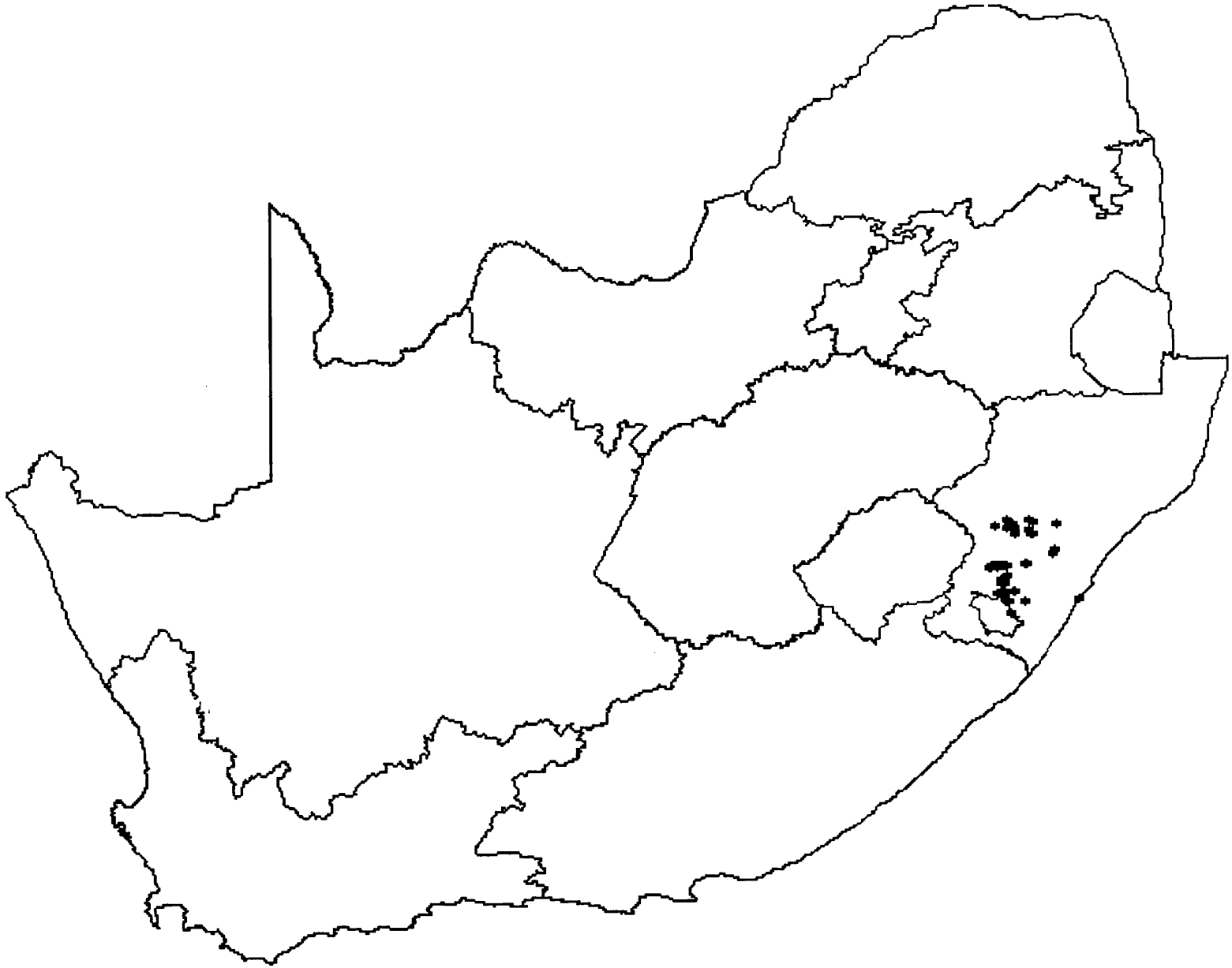
3b. Sample plots of the Drakensberg Foothills



3c. Sample plots of the Midlands Grassland



3d. Sample plots of the Mistbelt Grassland



3e. Sample plots of the Incised River Valleys and Dry Uplands Savanna

APPENDIX 4. Coordinates of the sample plots.

NOTES:

a) Sample plot number 1 corresponds to relevé number 40501, and 547 corresponds to 41047 in Tables 2 through 6.

b) Latitude is given in degrees, minutes and seconds South, and Longitude in degrees, minutes and seconds East.

c) Environmental data for each sample plot is stored in the TURBOVEG Grassland Data Base at the University of Pretoria.

Sample Plot No.	Latitude	Longitude
1	290434	292410
2	290417	292516
3	290449	292511
4	290325	292604
5	292330	292600
6	290318	292603
7	290025	294218
8	290820	293431
9	290815	293430
10	290851	293432
11	290735	293451
12	290726	293409
13	291342	293419
14	291435	294214
15	291919	293928
16	291936	294312
17	291914	294325
18	291905	294336
19	291926	293508
20	291906	294304
21	291935	294340
22	291958	294213
23	291901	294246
24	291941	293458
25	291945	294002
26	294830	301021
27	294731	301019
28	294856	301011
29	294834	301012
30	294718	301019

31	294845	301034
32	294840	301018
33	294846	301024
34	294541	293137
35	294456	293130
36	294341	293149
37	294015	293630
38	294440	293650
39	295012	293728
40	295151	294217
41	294511	295350
42	293540	300909
43	293544	300924
44	294523	292714
45	294545	292750
46	294524	292749
47	294222	293232
48	294253	293244
49	293810	293348
50	294714	292717
51	294804	292616
52	294808	292254
53	295129	292223
54	295127	292319
55	294803	292738
56	294806	293201
57	294834	293651
58	294712	293728
59	294817	293922
60	295026	294615
61	295010	294641
62	294730	294539
63	294314	294446
64	294620	293822
65	294640	293711
66	294544	293651
67	294516	293635
68	294512	293615
69	294759	293723
70	294730	292713
71	295051	292732
72	295018	292717
73	295516	292451
74	295457	292218
75	295417	291809
76	295418	291812
77	295339	291720
78	295340	291700
79	295315	291534
80	295002	291815
81	295139	291824
82	295114	291835
83	294736	292345
84	294756	292311

85	294532	292414
86	294530	292436
87	294418	292452
88	294612	293846
89	294503	292900
90	294417	292914
91	294430	292901
92	294332	292209
93	294324	292627
94	294351	292630
95	294348	292638
96	294330	292728
97	293755	293353
98	293754	293323
99	293650	293454
100	293614	340810
101	293209	293836
102	293211	293856
103	293609	293445
104	293755	293431
105	293740	293438
106	293714	293326
107	293933	293320
108	293949	293314
109	294847	293513
110	294840	293541
111	294950	293134
112	295014	293145
113	295104	293130
114	295113	293144
115	295247	293041
116	295301	292943
117	295537	292903
118	295746	292708
119	295718	292951
120	295639	293125
121	295130	293749
122	295213	293720
123	295241	293718
124	295213	295051
125	295235	295021
126	295150	295206
127	294920	295132
128	294910	295147
129	294917	295123
130	294912	294929
131	295155	294946
132	295253	294138
133	295230	293918
134	295344	293926
135	295348	293917
136	295428	294115
137	295443	294116
138	295340	294146

139	295314	294145
140	295354	293909
141	295315	293914
142	295442	294310
143	295551	294341
144	295447	294319
145	294912	294325
146	295950	294542
147	295940	294550
148	295900	295023
149	295915	295036
150	295901	295019
151	295820	294842
152	295928	295113
153	295917	295112
154	295328	295512
155	295312	295510
156	295412	295231
157	295417	295706
158	295744	295721
159	295811	295849
160	293929	293858
161	293813	294134
162	293831	294110
163	293831	294130
164	293813	294112
165	293731	294436
166	293746	294319
167	293815	294445
168	293718	294410
169	293748	294431
170	293830	294551
171	293746	294651
172	293745	294713
173	293801	294809
174	293816	294917
175	293809	294916
176	293825	294929
177	293744	295133
178	293701	295119
179	293715	295120
180	293706	295151
181	293721	295140
182	293736	295138
183	293724	295242
184	293816	295344
185	293807	295405
186	293812	295430
187	294140	295714
188	294150	295720
189	294142	292938
190	293930	292512
191	294435	295516
192	292109	295912

193	292134	295951
194	291802	295950
195	291646	295934
196	291625	295948
197	291415	293045
198	291428	295916
199	295627	292249
200	295344	293451
201	294245	292633
202	295713	292227
203	300256	292814
204	300219	293046
205	295949	292938
206	294703	292306
207	294536	292015
208	294540	292026
209	294505	292113
210	301902	292635
211	302225	292746
212	302826	292701
213	303405	292640
214	303134	293912
215	303017	294758
216	302021	295514
217	301448	300144
218	301451	300116
219	300355	292136
220	301010	291841
221	301718	291938
222	302225	291557
223	302417	291330
224	302510	291127
225	302336	285809
226	302224	285318
227	302236	285308
228	301912	285444
229	301946	285843
230	291249	300027
231	291213	300026
232	291012	300743
233	291604	302120
234	291514	301952
235	290528	303105
236	290814	302549
237	291018	302316
238	291231	302739
239	291212	302755
240	291134	302841
241	290910	303646
242	290900	303652
243	290938	303650
244	290919	303641
245	290927	303647
246	285703	305250

247	285706	305229
248	290519	304324
249	291110	301648
250	291119	301631
251	291028	301933
252	291017	301926
253	290412	303447
254	290102	303043
255	290045	301135
256	290050	301141
257	290218	301516
258	290204	301525
259	290214	301536
260	290750	301128
261	290751	301111
262	291231	300043
263	291200	300115
264	291216	300120
265	290714	295852
266	290512	295817
267	290430	295914
268	290313	295740
269	290314	295707
270	290118	295312
271	290254	295449
272	290551	295759
273	290716	295920
274	290616	300124
275	290901	300034
276	290718	300245
277	290759	300241
278	290744	300213
279	290617	300347
280	290613	300319
281	290645	300140
282	291133	301440
283	291131	301425
284	291138	301420
285	292218	303312
286	292218	303351
287	292413	303327
288	292400	303321
289	292745	303124
290	290814	293630
291	290843	293623
292	290650	293625
293	290629	293609
294	290638	293601
295	290636	293531
296	290628	293502
297	290612	293535
298	285923	294114
299	285931	294144
300	285946	294110

301	285857	294209
302	290836	293621
303	290831	293618
304	290844	293639
305	291133	293824
306	291121	293813
307	291253	294144
308	291232	294118
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