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SYNTAXONOMY AND SYNECOLOGY OF THE GRASSLANDS OF THE SOUTHERN PARTS OF THE EASTERN CAPE

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Syntaxonomy and synecology of the grasslands of the southern parts of the Eastern Cape

by

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What we observe is not nature itself, but nature exposed to our method of questioning.

WERNER HEISENBERG

Everything is vague to a degree you do not realise till you have tried to make it precise.

BERTRAND RUSSELL

One can make a model complex and more faithful to reality, or simpler and easier to handle. Only the most naive scientist believes that the perfect model is the one that perfectly represents reality. Such a model would have the same drawbacks as a map as large and detailed as the city it represents...were such a map possible, its specificity would defeat its purpose: to generalise and abstract.

JAMES GLEICK, IN "CHAOS", PP 278.

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1. Introduction

The Eastern Cape is an important agricultural region of South Africa. Most stock-farming in the region makes use of natural vegetation, namely grassland and karoo vegetation types, and it is important that sufficient information exists for management and to maintain productivity. The region is an area of transition, where the climate merges from Winter to Summer, and two major geological substrates converge. It is thus a juncture for most major biomes of South Africa. This makes it a natural biogeographical laboratory and its flora is therefore of important scientific interest.

A number of phytogeographical zones converge in the region (Goldblatt 1978; Werger 1978; Gibbs-Russell & Robinson 1981; White 1983; Cowling 1983a, 1983b; Lubke *et al.* 1986; Lubke 1988). The complexity of the vegetation can be seen in the numerous descriptions done by various authors: Rutherford & Westfall (1986) described three biomes, Acocks (1988) described 18 Veld Types and Low & Rebelo (1996) described 15 vegetation units in the parts of the Eastern Cape covered by this study. The result of this phytochorological complexity is a mosaic of communities with different affinities (Cowling 1983a) and probably the region with the greatest gamma diversity in the world (Mucina pers. comm.).

Tongaland-Pondoland elements (White 1983) enter the region along the east coast from Natal and extend up the river valleys. The Kalahari-Highveld and Afromontane elements include the low and high altitude grasslands respectively, both of which enter from the north-east. Elements of the Cape flora are found mainly on infertile soils derived from Cape Supergroup rocks. These occur mostly in mountains in the south-western part of the study area. Non-specialist species of the Cape flora are common and sometimes problematic in the Afromontane grasslands (Trollope 1970) acting as increaser species in the event of overgrazing. Karoo-Namib elements in the form of dwarf shrublands extend southwards from the arid interior.

Rutherford and Westfall (1986) described nine biomes for the whole of South Africa and distinguished these on the basis of a Summer Aridity Index and rainfall seasonality. The

Grassland Biome is limited to the summer or strong summer rainfall areas where the mean lowest minimum temperature is consistently below +1°C (Rutherford & Westfall 1986). These grasslands are temperate in nature, whereas grasslands within the limits of the Savanna Biome are tropical in nature. In the Eastern Cape temperate grasslands are found mainly in the mountain regions and represent the southern and south-western limit of the Grassland Biome. The Nama Karoo Biome starts in the western part of the Eastern Cape and the Savanna Biome to the south and east.

To date only a few descriptive vegetation studies covering the whole Eastern Cape have been undertaken (Acocks 1988; Lubke, Tinley & Cowling 1988; Low & Rebelo 1996). Acocks's descriptions were fairly broad and have been criticised for including a number of unrelated vegetation types into a single Veld Type. Thus they are only adequate for general purposes. Phytosociological research on the vegetation of the Grassland Biome Project (Mentis & Huntley 1982; Scheepers 1986) has been continuing for a number of years. This study forms the final phase of this project, and covers the south eastern extent of the Grassland Biome.

The objectives of this study were to:

- produce a phytosociological inventory of the grassland communities of the Eastern Cape,
- relate the identified floristic units to environmental variables,
- model and thus predict the distribution of grassland communities, and
- establish patterns of diversity within grasslands and grassland-related vegetation.

2. Physical environment

Study area

The study area is situated in the Eastern Cape and extends from 30°30'S to 33°30'S and 23°30'E to 28°00'E. This area comprises the 1:250 000 South African Topographical Series sheets 3026 Aliwal North, 3126 Queenstown, 3226 King Williams Town, 3326 Grahamstown, 3124 Middelburg and 3224 Graaff-Reinet. Only Pure Grassveld Types and False Macchia (Acocks 1988) and *Acacia* savanna were studied. Savanna and grasslands on the plains south of the southern mountain chain were only superficially sampled since these have already been studied in detail and classified by Martens & Morris (1993) and Palmer (1989, 1991a). Parts of the Elliot District have already been studied (Bester unpubl.) and were excluded from the study. Pure Karroid Veld types and Valley Bushveld (Acocks 1988) and the coastal sub-region of the Eastern Cape, i.e. all areas below 300 m altitude (Nicol 1988), were excluded from the study area. The coastal sub-region of the Eastern Cape forms part of another study which is currently being undertaken (Judd Ph.D. in progress).

The Free State and Lesotho borders and the border of the former Transkei demarcate the northern and eastern boundaries of the study area respectively. Towards the west grasslands grade into karoo shrublands.

Physiography

The Eastern Cape may be divided into a number of physiographic regions (e.g. Wellington 1928; Nicol 1988), the mountain region, the lowland region (or middle lands, according to Rennie 1946), the Southern Folded Belt, and the coastal region (Figure 1). The high-lying topography of the study area (the mountain region) is dominated by two east-west running mountain ranges which meet in the Karoo south-west of Middelburg and form the Great and Little Escarpments (Figure 2). The Great Escarpment is represented by a number of locally named mountain ranges: Drakensberg, Witteberg, Stormberg, Bamboesberg, Kikvorschberg,

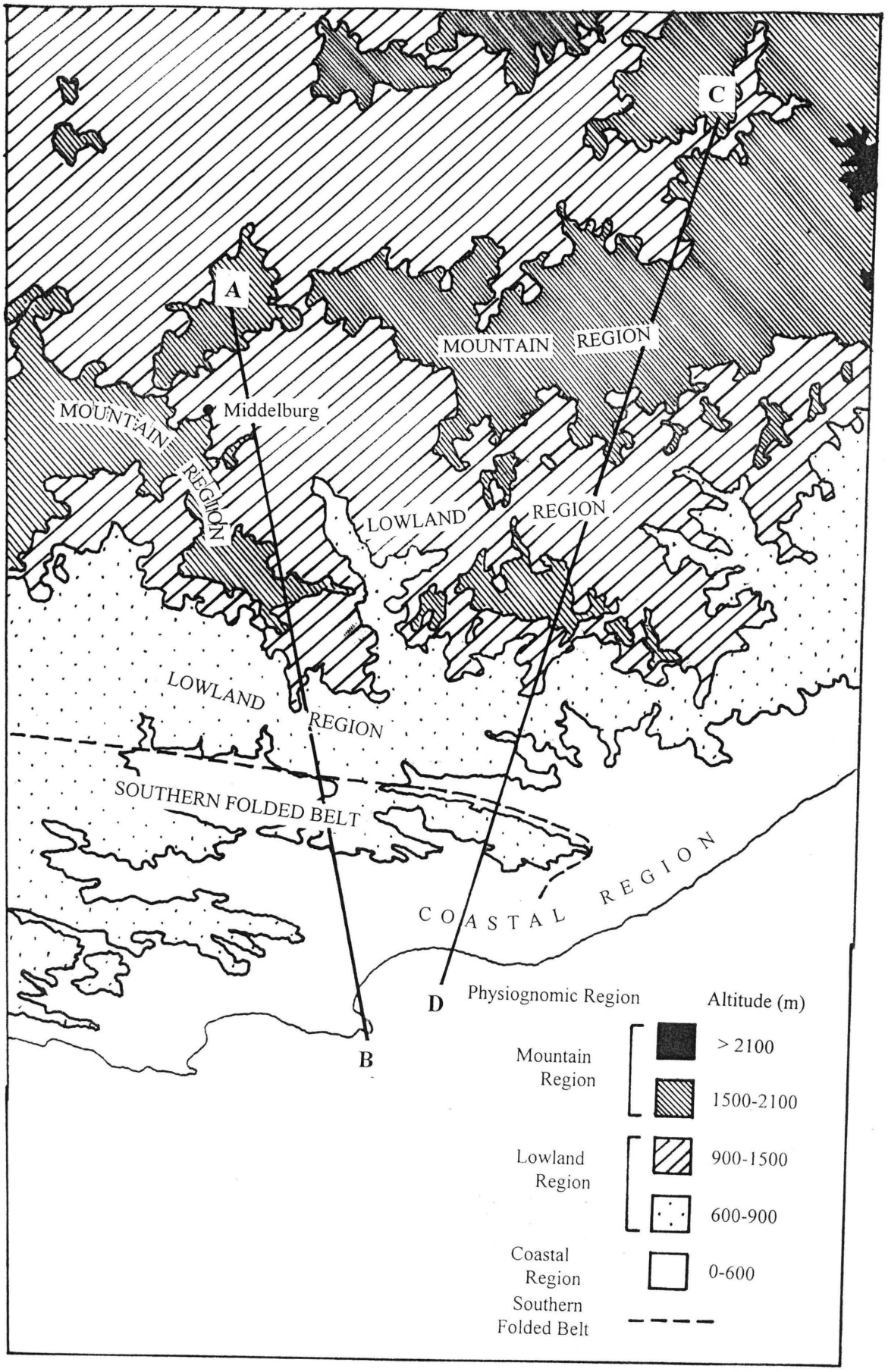


Figure 1: Topography and physiognomic regions of the Eastern Cape.

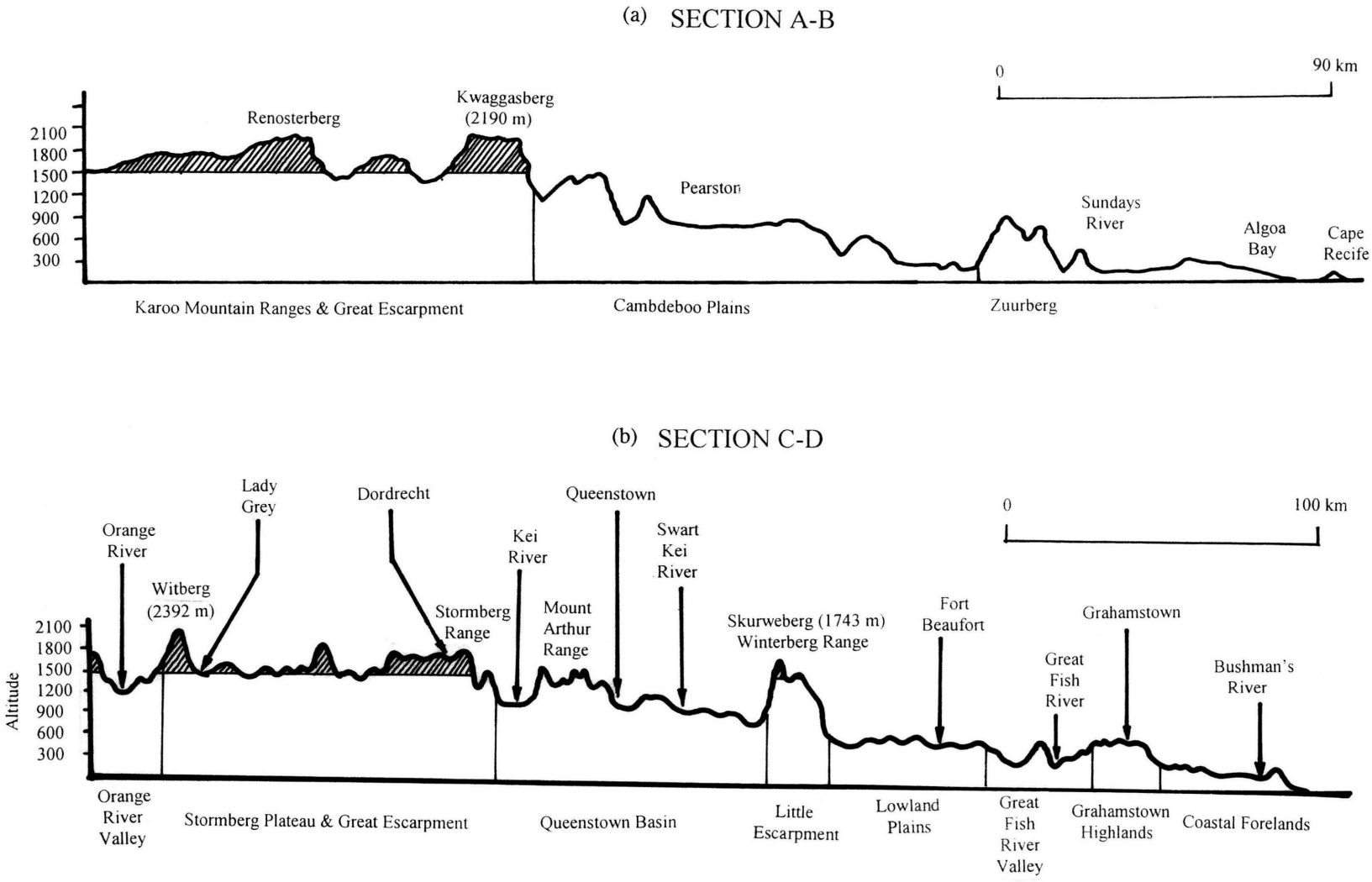


Figure 2: Profile diagrams (from Figure 1) to show topography of study area. Physiographic regions are indicated beneath each profile. Hatched areas are regions with altitude greater than 1500 m.

Agter Renosterberg and Sneeuberg, which vary in height from 1800 to 3000 m, descending northwards into the Stormberg plateau at 1400 to 1800 m in altitude (Figure 2, b).

The three major river systems that drain the middle-lands of the study area, Kei, Fish and Sundays, have caused the Great Escarpment to retreat approximately 150 km from its initial position. This former edge was probably the orographic line marked by the Little Escarpment mountains, i.e. the eastern portion of the Sneeuberg, the Bankberg, Grootbruintjieshoogte, the Tandjiesberg, the Cambdeboo Mountains, the Great Winterberg, the Amatola and the Kologha Mountains (Wellington 1928) ranging in height from 1000 to 1200 m above sea level in the east and 1500 to 2200 m above sea level in the west (Figures 1 & 2). The plateau has retreated less in the west indicating that present precipitation patterns have existed for a considerable portion of the Tertiary Period (Nicol 1988).

The plains south of these mountain ranges (part of the lowlands region) vary from 400 to 900 m above sea level. North of the Amatola-Winterberg Mountains the land descends into an area known as the Queenstown Basin (Figure 2, b), which ranges from 900 to 1500 m above sea level and is interspersed by small mountain peaks, e.g. Mount Arthur (1860 m). The Queenstown Basin is also considered as part of the lowlands region.

The Southern Folded Belt consists of mountains of the Cape system and extends into the south-western part of the study area. The Zuurberg Mountains and the high-lying regions around Grahamstown are the only parts of this system within the present study area. These mountains are higher in altitude in the west than the east (Figure 2, a & b).

Geology

The dominant geological group in the study area is the Karoo Supergroup (Figure 3). This is widespread and underlies most of the Eastern Cape. The Karoo Supergroup comprises alternating bands of fine-grained sandstone, shale and mudstone that were deposited in the slowly subsiding 'Karoo Basin' (Maud 1996) (Table 1). About 190 million years ago the Karoo sedimentation was ended by an extrusion of the volcanic basalt lavas of the Drakensberg Group

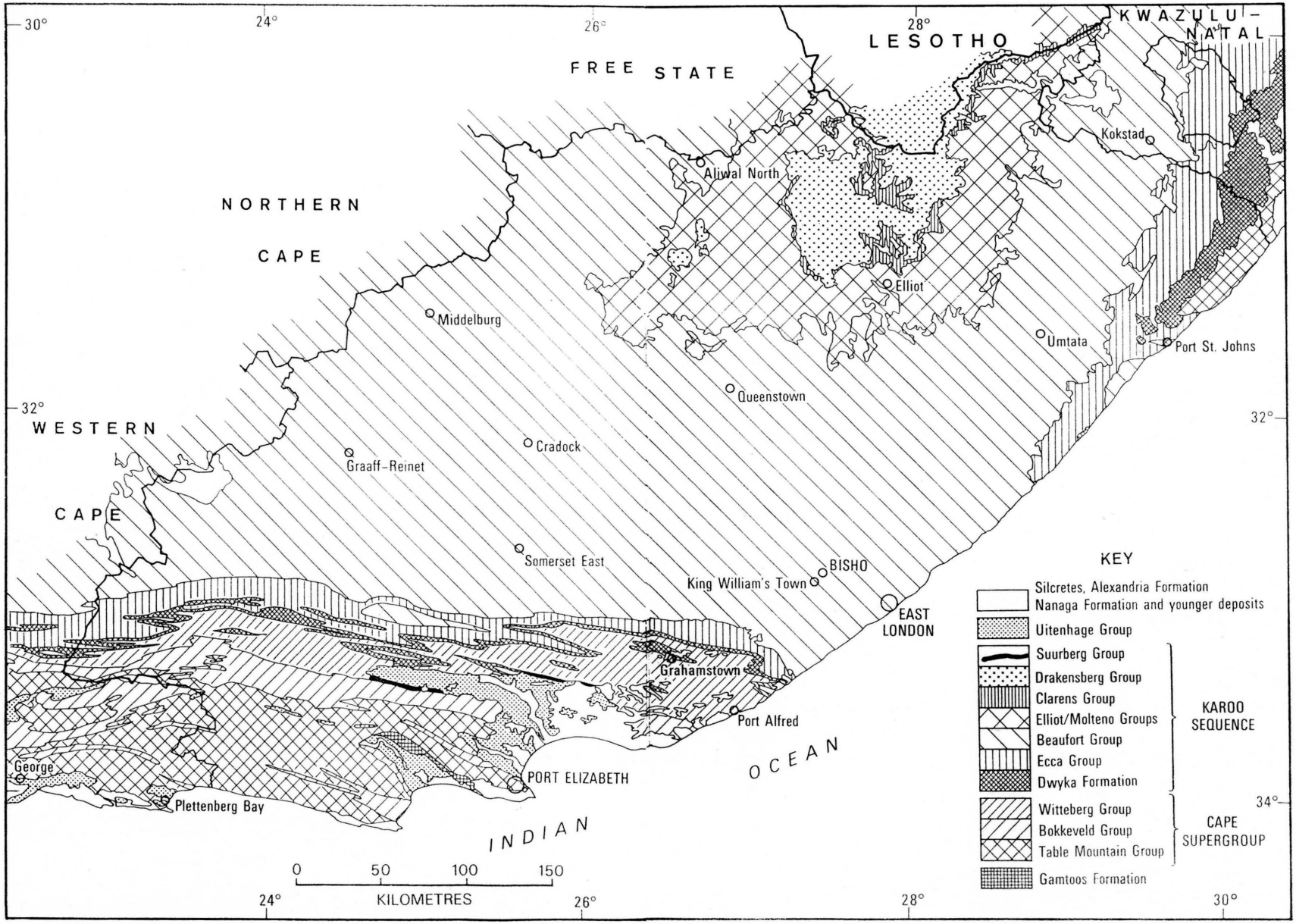


Figure 3: Geology of the study area (from Maud 1996)

which today make up the highlands of Lesotho and the northern part of the Eastern Cape (Maud 1996). At the same time the Karoo sedimentary rocks were extensively intruded by dykes, sills and inclined sheets of dolerite (Johnson & Keyser 1976).

There are limited instances where the main geological formation is overlain by Quaternary or Tertiary deposits, e.g. around Aliwal North, and intrusive rocks of pyroclastic lava may be found within the strata in some high altitude places.

Table 1: Geological succession in the Eastern Cape (Visser 1984; Maud 1996).

Geological group / formation	Geological epoch / period	Age in millions of years	Constituent elements
	Holocene	0.01–0	alluvium, sand, calcrete
Algoa Group:			
Grahamstown Silcrete Formation	Palaeocene	65–55	silcrete
Karoo Supergroup:			
Drakensberg Group	Jurassic	213–144	dolerite, gabbro, basalt, tuff, agglomerate
Clarens Formation	Triassic	248–213	very fine-grained sandstone, siltstone
Elliot Formation			mudstone, sandstone
Molteno Formation			grey mudstone, shale, gritty sandstone
Beaufort Group			mudstone, shale, sandstone
Ecca Group	Permian	286–248	shale, sandstone
Dwyka Formation			tillite, mudstone, sandstone, shale
Cape Supergroup:			
Witteberg Group	Devonian	408–360	quartzitic sandstone, shale, diamictite
Bokkeveld Group			shale

In the south-west part of the study area around Grahamstown geological formations of the Cape Supergroup may be found which form the backbone of the Zuurberg Mountains in this region. Witteberg sandstones are responsible for the hilly, rounded appearance of the Zuurberg.

Soils

Very little data exist on soil types in the study area. Only local soil studies (e.g. irrigation projects) have been done in the study area. Land-types, which could provide broad soil categories, have been surveyed, but are not available in printed form. The broad soil patterns described here are, therefore, mostly from Hartmann (1988). Soil characteristics are dependant on land-form and geology. In this regard the soils in the study area may be divided into mountain and plain types, with local geological influences playing a part in soil characteristics. The dominant soil series associated with dolerite are often deep red clays. They have a higher nutrient content than surrounding soils derived from sedimentary rocks.

The soils of the mountain areas are generally shallow and weakly developed consisting essentially of a topsoil horizon overlying rock or partially weathered rock (Hartmann 1988). The high rainfall areas of the Amatola mountains are characteristically deep, freely-drained and highly weathered. The northern mountain regions (Drakensberg, Stormberg & Witteberg) have lithosols, black or red clays and sandy-loam soils (Hartmann 1988). The soils of the Karoo mountains area are weakly developed lime rich soils, solonetzic soils or lithosols (Hartmann 1988). In the southern Sneeuberg and Tandjiesberg areas the soils are shallow with weak profile differentiation. The Zuurberg and the remainder of the Sneeuberg have red clays and sandy-loamy soils.

Most of the low-lying areas between the south-eastern mountain ranges and the coast are formed from argillaceous sedimentary material and contain high proportions of fine sand (Hartmann 1988). These tend to be hard-setting when dry, a factor which is unfavourable for plant growth. High clay, impermeable soils are found in valley bottoms (Hartmann 1988). The Queenstown Basin has black and red clays and solonetzic soils (Hartmann 1988). The soils are usually shallow, poorly drained and have high clay subsoils. The black soils have a high percentage of clay causing them to swell and shrink markedly in response to moisture changes. Soils in the Great Fish River valley are weakly developed and lime rich, and are generally shallow and associated with rocky terrain. The lowland plains in the dryer parts of the study area often have duplex soils (pers. obs.).

Climate

Detailed climate statistics were obtained for 14 stations in the study area and were used to draw up climate diagrams (Figure 4) after Walter & Leith (1967). Specific information from these is given below. A comparison of the stations was made using Emberger's pluviometric quotient (Daget 1977). From this comparison (Figure 5) it can be seen that a wide range of conditions exists in the study area, from semi-arid to sub-humid and from extremely cold to hot. This wide climatic amplitude has a strong effect on the nature of the vegetation.

Altitude has a strong influence on most climatic variables. Generally, an increase in altitude corresponds with a decrease in temperature and an increase in rainfall. Mountains also have an orographic influence on rainfall, escarpment zones usually experiencing increased rainfall and mists, and, depending on aspect, cause an increase or decrease in mean daily insolation levels.

Temperature

The study area can be divided into three broad temperature regimes (Kopke 1988):

1. The inland lowland region and most of the Karoo have hot summers and frost prone, cold winters. The mean annual range in temperature is also high for these inland stations (14.0–16.6°C). Coastal stations have the lowest mean range in temperature (8.5–8.8°C). The stations in sheltered valleys at Addo, P.K. le Roux Dam and Graaff-Reinet have the highest mean annual temperatures.
2. On the escarpment and in the mountains mean temperatures, modified by topography, are lower. Buffelsfontein and Barkly-East are the highest altitude stations and have the lowest mean annual temperatures. The average temperatures on the southern escarpment are reduced by the daily presence of a south-easterly wind in the afternoon, especially in summer (Kopke 1988). In January and February berg winds bring midsummer drought to the foothills of the mountains (Kopke 1988).
3. The coastal sub-region experiences mild winters and warm summers.

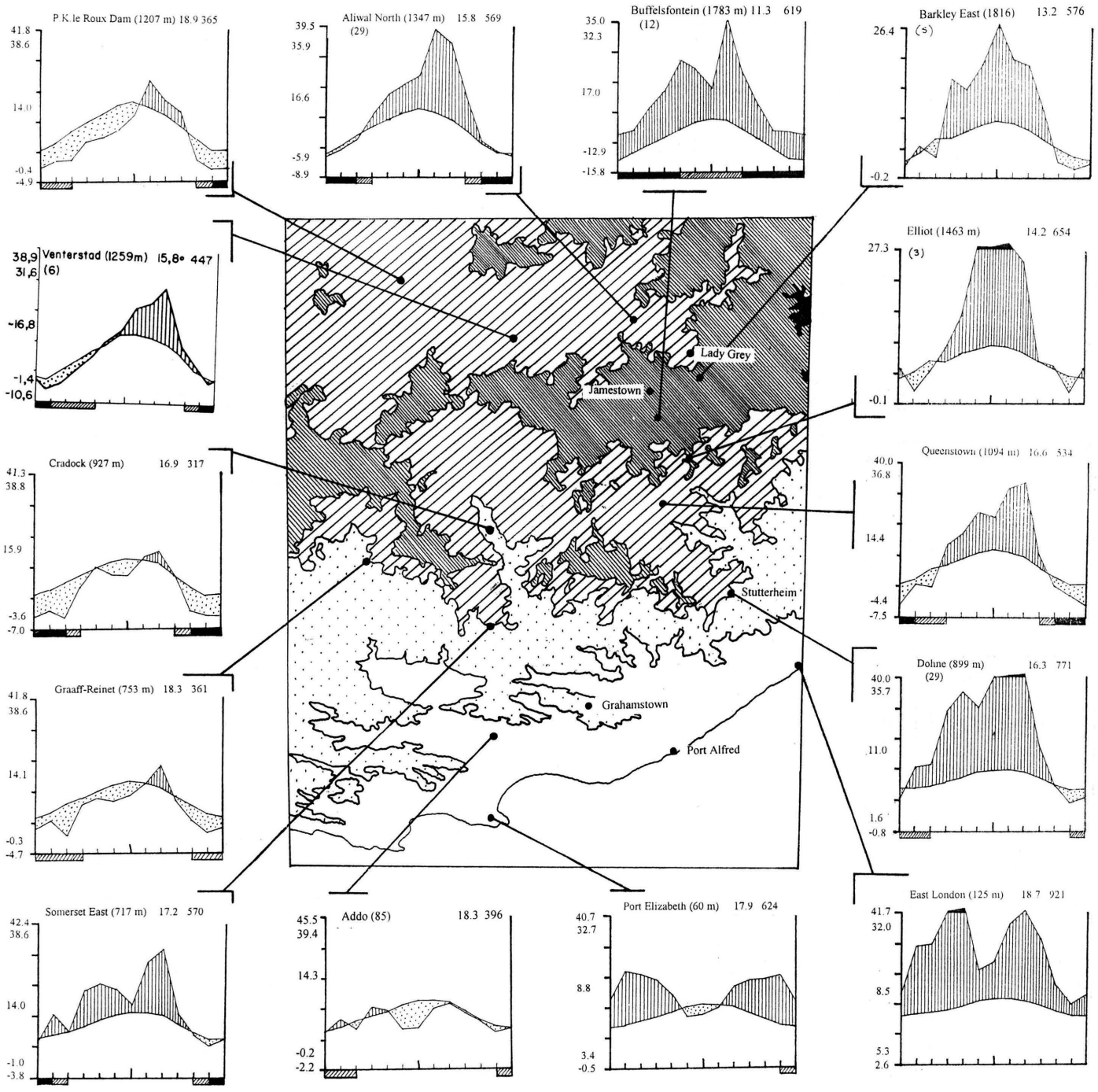
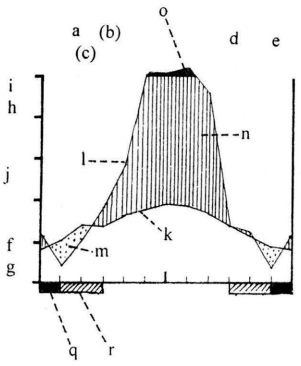


Figure 4: Climate diagrams for selected stations in the Eastern Cape. Refer to Table 2 for data from additional stations.

LEGEND: (See example on right)
Twelve month period starts with July on left hand side.
(a) Name of station; (b) Altitude (m); (c) Number of years of observation; (d) Mean annual temperature(°C); (e) Mean annual precipitation (mm); (f) Mean daily minimum temperature of coldest month; (g) Absolute minimum temperature; (h) Mean daily maximum temperature of hottest month; (i) Absolute maximum temperature; (j) Mean range of temperature; (k) Curve of mean monthly temperature (1 unit = 10 °C); (l) Curve of mean monthly precipitation (1 unit = 20 mm); (m) Dry season; (n) Wet season; (o) Mean monthly precipitation over 1000 mm (reduced to 1/10); (q) Months with mean daily minimum temperature under 0 °C; (r) Months with absolute daily minimum temperature under 0 °C.



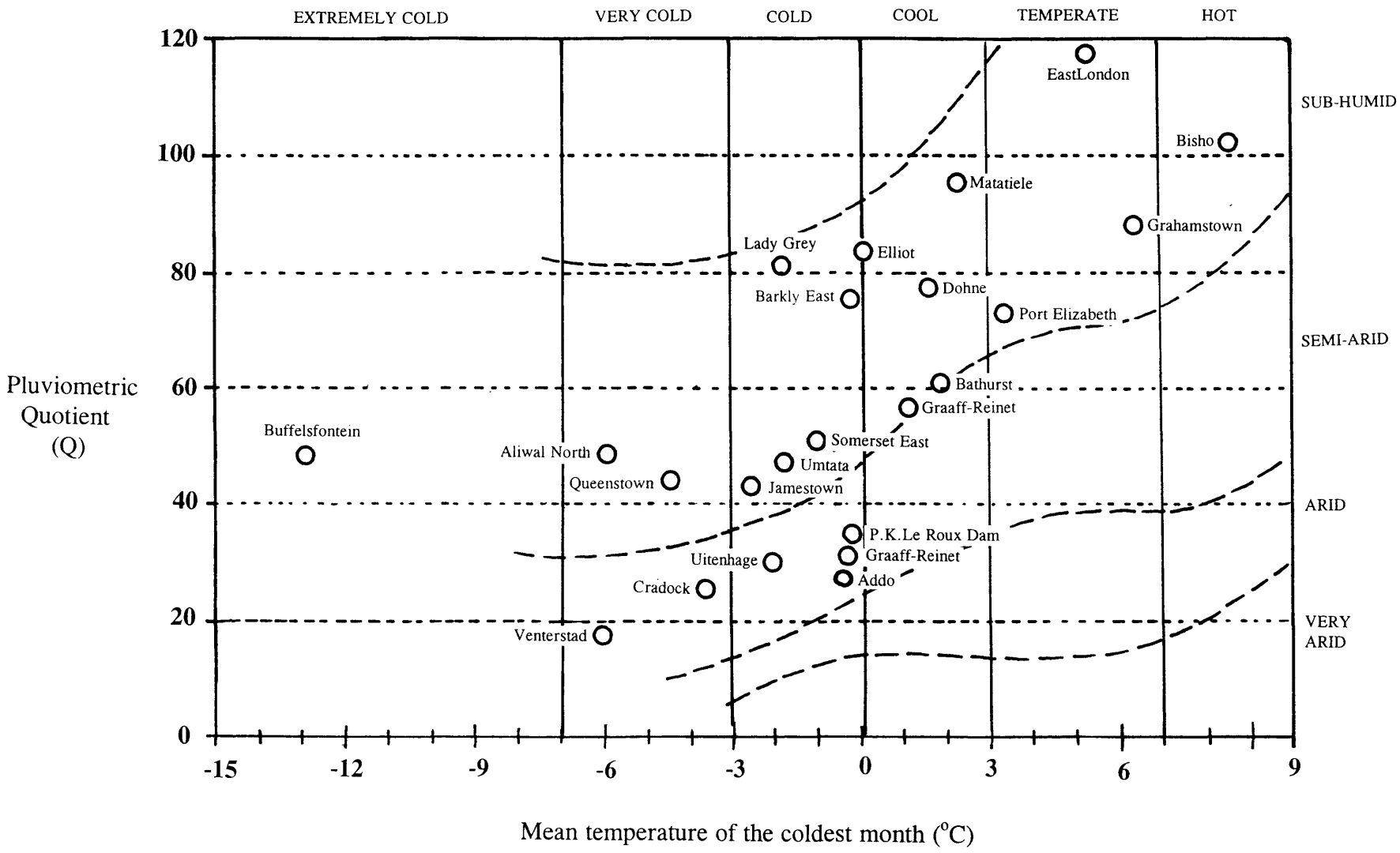


Figure 5: Climagram showing Emberger's (1955) pluviometric quotient (Q) and the mean temperature of the coldest month (m) for weather stations in the Eastern Cape (climate data from Weather Bureau).

The average daily minima for the coldest months are below freezing for all stations except those at the coast. Three stations (Cradock, Graaff-Reinet, Aliwal North) experienced an average of one day of snow a year and Buffelsfontein an average of two. The significance of the minimum temperatures is that, except at the coast, winter frost is a moderate limiting factor for plant growth at all stations and severely limiting at high altitude stations.

Rainfall

Most of the study area receives more than 500 mm of rainfall a year, except in the low lying regions towards the west, which receive less than 500 mm per annum (Figure 4 & Table 2). Some of the high altitude mountain region receives over 1000 mm and Hogsback over 2000 mm of rainfall per annum (Kopke 1988). Rainfall differences are often due to topographic influences. For example, the southern flanks of the Winterberg-Amatola-Kologha ranges receive greater orographic precipitation than the northern slopes (Van Wyk 1963) and the minor rivers to the south are more vigorous at their heads. Buffelsfontein receives more rain than Jamestown and Elliot more than Barkly East; in both cases the higher rainfall station is closer to the escarpment (Figure 4). Cradock receives less rain than either Graaff-Reinet or Somerset East; it is on the northern side of the mountain ranges whereas the other two stations are south of the mountains (Figure 4). The large range in precipitation (from 317 mm per annum at Cracock to over 2000 mm per annum at Hogsback) has a strong effect on the vegetation in the study area, ranging from severely limiting for plant growth to abundant.

Table 2: Rainfall data for stations in the Eastern Cape excluded from Figure 4 (source: Weather Bureau 1996).

Station	Altitude (m)	Latitude (S)	Longitude (E)	Annual rainfall (mm)
Stutterheim	710	32°35'	27°34'	538
Lady Grey	1780	30°53'	27°14'	664
Port Alfred	36	33°35'	26°53'	604
Grahamstown	642	33°18'	26°32'	504
Jamestown	1603	31°07'	26°48'	399

Dohne and Somerset East receive significant amounts of fog every year (average 113 and 71 days respectively, Table 3). This not only supplements rainfall, but reduces mean insolation levels.

Table 3: Mean annual relative humidity and cloud cover (at 14h00), days of thunder, hail, snow and fog at selected weather stations in the Eastern Cape (source: Weather Bureau 1996).

Station	Humidity (%)	Cloud cover (eighths)	Thunder (days)	Hail (days)	Snow (days)	Fog (days)
P.K. le Roux Dam			5	1	0	0
Cradock	29	2.6	22	1	1	15
Graaff-Reinet	37	3.0	25	1	1	15
Buffelsfontein			3	0	2	1
Aliwal North	35	2.9	60	3	1	3
Somerset East	39	3.4	23	2	0	71
Port Elizabeth	60	3.5	14	1	0	24
East London	65	4.1	25	0	0	14
Dohne	49	4.1	33	2	0	113
Addo	46	3.8	15	1	0	22
Queenstown	42	3.4	41	3	0	26

The part of the study area between the Winterberg escarpment and the coast is a bimodal autumn / spring rainfall region (Cowling 1983a). Northwards of the Katberg-Winterberg escarpment the maximum rainfall occurs in late summer, but also with a partially bimodal pattern. Elliot and Barkly East are the only true summer rainfall stations. However, except for Port Elizabeth, a winter rainfall region, most stations have a drought period over winter. Although clear patterns exist for rainfall seasonality on the climate diagrams (average for a number of years), in any one year the season of maximum rainfall can shift dramatically. Considered together with aspects of plant phenology this effect can lead to successively increased and decreased abilities for species to extend their range in the study area.

A number of stations have many days of thunder every year, mostly during summer (Table 3).

Relative humidity

In the study area relative humidity tends to decrease in a north-westerly direction. In March the relative humidity is highest over the whole region with values averaging 45% (Table 3, excluding the coastal region). This maximum corresponds with the period of maximum precipitation. The lowest relative humidities are recorded during July and August, except Aliwal North which has spring minima (Weather Bureau 1996).

Cloudiness

The period of greatest cloud cover occurs in spring and late summer with a trend towards decreased cloudiness in a north-westerly direction (Weather Bureau 1996). Cloudiness increases in the afternoon in the wet season at some stations (e.g. Dohne), but remains stable or decreases in others.

Solar radiation

The effect of slope and aspect on insolation levels is well-known and has a concomitant effect on soil moisture status (e.g. Granger & Schulze 1977). In the study area there is little difference in potential radiation on all slopes and aspects in summer, but in winter steep north slopes receive markedly more radiation than steep south slopes (Cowling 1984).

Winds

The Eastern Cape is considered to be one of the windiest parts of South Africa (Kopke 1988). Persistent north-westerly winds occur throughout the year bringing dry heat. This can have a severe desiccating effect on the vegetation in any aspects exposed to this wind. In contrast, cold, moist south-easterly winds may blow occasionally in summer. Northerlies, mostly in summer, bring thunderstorms by advecting moist tropical air. Cold fronts, mostly in winter, bring cold sometimes dry winds.

Vegetation

The part of the Eastern Cape covered by this study includes numerous vegetation types. Based on physiognomy these can be divided into grassland, xerophytic dwarf shrubland, savanna, thicket, forest and fynbos. Various authors have described or mapped the vegetation of this region (e.g. Pole-Evans 1936; Adamson 1938; Keay 1958; Acocks 1953, 1988; Low & Rebelo 1996). The most recent map of the vegetation of South Africa was by Low & Rebelo (1996) for which the Biomes of the Eastern Cape region is given in Figure 6. The mountains and inland regions are dominated by grassland (five types), the valleys by Valley Thicket, and the coastal forelands by Eastern Thorn Bushveld (a savanna-type vegetation) and Coastal Grassland. Subarid Thorn Bushveld (a savanna-type vegetation) is found in a large patch south of Bedford. Large areas of Afromontane Forest may be found on the southern escarpment with numerous small patches elsewhere in the region except the northern escarpment and plateau. Grassy Fynbos extends into the region through the Zuurberg and into the area around Grahamstown. Karoo-type vegetation (Eastern Mixed Nama-Karoo) dominates the lowlands westwards from approximately the 26°E meridian.

Current land-use

Commercial livestock farming is the main agricultural pursuit and type of land use in the Eastern Cape (Roux & Van der Vyver 1988) and depends on natural vegetation as a source of stock feed. In the grassland areas sheep-farming for wool and mutton are the most important activities, followed by dairy cattle farming. Crop production is secondary, with maize, pineapple and chicory being the main crops. Approximately 80% of the pineapples of South Africa are produced in the Eastern Cape, but not in areas covered by this study. In higher rainfall areas winter cereals and rye grasses form important supplementary fodder crops (Roux & Van der Vyver 1988). Commercial farms in the Eastern Cape are fairly extensive thus placing the management of large parts of the landscape under the management of relatively few people.

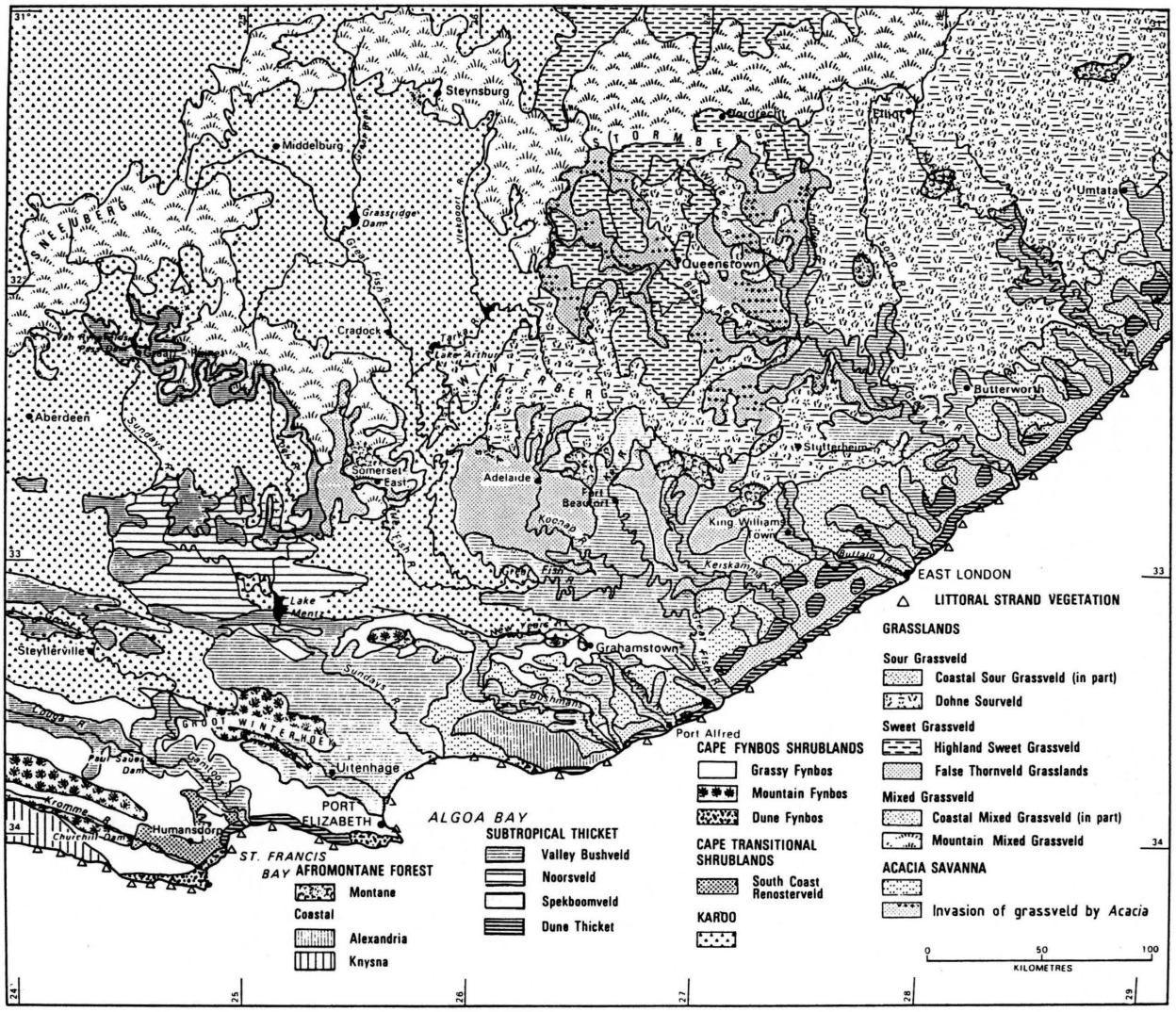


Figure 6: Vegetation of the Eastern Cape (from Lubke *et al.* 1986)

In 1988 the Directorate of Forestry was the biggest land owner in the Eastern Cape (Cobby 1988). Apart from plantations, this land supports indigenous forests, mountain catchments and unused areas suitable for forestry. Until recently the largest forest plantations were in the Winterberg, Amatola and Kologha mountain region within what was previously known as Dohne Sourveld (Acocks 1985). However, large areas of grassland were also forested in the Elliot-Maclear region (Bester 1997.). Mountain catchments are managed by the Directorate of Forestry as "reservoirs for water, flora and fauna as well as providing ideal facilities for outdoor recreation" (Cobby 1988, p. 132), thus preserving some parts of the vegetation in a natural state.

3. Floristic classification

Introduction

Various local or regional vegetation studies have been undertaken in the Eastern Cape (Werger 1980; Palmer 1991a; Bester 1997), but to date the only broad accounts covering the whole area are Acocks's (1988) description, Lubke *et al.*'s account and Low and Rebelo's (1997) Vegetation of South Africa, Lesotho and Swaziland. Acocks's descriptions of Veld Types in South Africa are based on agro-ecological units and are, therefore, fairly broad. He admits that "variation in the veld even over short distances are legion" (Acocks 1988). The descriptions are adequate for general purposes, but often incorporate structurally and floristically unrelated vegetation into a single Veld Type (Cowling 1984) thus making predictive research difficult. For managing the finer responses of vegetation a classification based on the full floristic composition is required (Taylor 1996).

Researchers have attempted to correlate environmental factors with the distribution of plant communities (e.g. Palmer 1993; Dargie & El Demerdash 1991). Many phytosociological publications include a description of the environment in addition to the phytosociological classification (e.g. in South Africa, Eckhardt *et al.* 1996a, 1996b; Taylor 1996; Palmer 1991a; Breytenbach *et al.* 1993 and others), which adds to the value of these studies. For these relationships to be successful communities have to be rigorously defined, and their distributions must be known. Patterns that repeat themselves and can be correlated with environmental parameters are useful because of their good predictive value, enabling a greater understanding of vegetation patterns (Cowling & Holmes 1992).

The aim of this chapter is to classify the grassland vegetation of the Eastern Cape into recognisable vegetation units and to relate these to environmental parameters.

Methods

Stratification

Acocks's (1988) Veld Type map was used to identify all areas within the Eastern Cape which were not likely to contain grassland, i.e. Pure Karroid Veld Types, Valley Bushveld and Coastal Tropical Forest. These areas were eliminated from further examination. In the remaining area, samples were stratified using a cross-classification of temperature and rainfall classes (Palmer & Van Staden 1992), thus ensuring that variation in these environmental factors was covered during sampling.

At a local scale topography was used as a stratification method in the field, i.e. crest, scarp, mid- and footslopes and valley bottoms were sampled within the previously stratified units. Variations in surface rockiness, slope, aspect and soil type were also sampled and, during the course of field work, any obviously different assemblage of species which had not yet been observed were also sampled, thus ensuring that any variations in the vegetation were covered by the study.

Combining the stratification methods described above produces a scale hierarchical approach and also ensures that samples may be associated with environmental variables which can be used to model the relationship between the community and those variables.

Site variables

Relevés were compiled for each sample plot, which included Braun-Blanquet cover / abundance values for all taxa recorded, structure and a subjective assessment of the condition of the vegetation. Altitude and latitude-longitude positions for each relevé were obtained from a Global Positioning System (Ensign from Trimble Navigation) in the field. Aspect, slope and surface rock size and cover were estimated in the field as well as soil depth, soil clay content, soil colour and the degree of erosion in selected samples. The geology (petrology and stratigraphy) of the sample was read from a geological map or, where these were not available, determined from rock types observed at the surface in the field. A total of 400 relevés were

done during the summers of 1995 and 1996. These were standardised at a size of 100 m^2 in order to make comparisons between them unproblematic.

Classification

Throughout the project, the Braun-Blanquet approach (Westhoff & Van der Maarel 1978) has been adopted. Data were imported into a data-base using the programme Turbo(veg) (Hennekens 1996b). Within Turbo(veg) a preliminary classification of the data was performed using TWINSPAN (Hill 1979b), after which the phytosociological table was refined using subjective Braun-Blanquet procedures (Mueller-Dombois & Ellenberg 1974) within the software package MEGATAB (Hennekens 1996a). Although this process is controversial (Whittaker 1980), it is only subjective in that it is not fully formalised (Mucina, pers. comm.) and serves to find such structure (relevé / species coincidence patterns) which carry ecological information. Species groups were only recognised if (i) the species was represented in the relevé group more often than outside the group (at least two constancy classes greater presence in the group than out, i.e. if the species showed high fidelity to the group), and (ii) if the resultant group could be ecologically interpreted. Higher order patterns with associated species were established before further subdivisions in the data were sought. Both agglomerative and divisive approaches were then adopted iteratively to produce relevé groupings within major patterns (cf. Coetzee 1983). Additional refinement of the classification was achieved by iteratively plotting the classification order against selected environmental factors. The choice of environmental factor differed according to the representative scale of the floristic data.

Nomenclature

Associations and sub-associations were formally described according to the Code of Phytosociological Nomenclature (Barkman *et al.* 1986), but no attempt was made to formally fix names for higher syntaxa identified in this study. Associations revealed by the phytosociological analysis could be grouped into larger units based on species of wider amplitude and for descriptive purposes a hierarchical approach was adopted of vegetation type, association and sub-association. Where syntaxa were deemed synonymous with published

descriptions then the published name was preserved in this study. Diagnostic species were listed for each syntaxon. These included (i) dominant species, which occurred in most relevés of the syntaxon (constancy of IV or V) and with high cover / abundance values, (ii) distinguishing species, which occurred in the syntaxon described and not elsewhere (constancy III) and so could be used to differentiate the syntaxon from others, and (iii) constant companion species, which were widely spread amongst other syntaxa, but were common in the syntaxon being described (constancy IV or V).

Ordination

Ordinations were performed on the two main groups of vegetation types in the study area, viz. grassland and woody vegetation. The programme DECORANA (Hill 1979a) has been the standard ordination package used in recent years, but this has been demonstrated to be beset by serious flaws (Minchin 1987; Oksanen 1988; Knox 1989; Van Groenewoud 1992; Tausch *et al.* 1995; Oksanen & Minchin 1997; Podani 1997). Additionally, DECORANA detrends the arch or horseshoe effect, assuming that this should be automatically corrected for. This arch is a result of linear algebraic principles being applied to data which may exhibit non-linear relationships between variables (Podani 1994). It was therefore decided to use Principle Coordinates Analysis (PCoA, Gower 1966) within the software package Syntax 5.0 (Podani 1993).

Results and Discussion

The initial TWINSPAN classification revealed a floristic gradient in the data that can be related strongly to a moisture gradient. This may be demonstrated (Figure 7) by plotting the order of the relevés in the classification against median annual rainfall (Dent *et al.* 1989) which is a fairly representative value of moisture across a geographical gradient; mean annual precipitation is considered to be the factor which determines, more than any other, sub-continental scale vegetation patterns (Walter 1979). Plotting the classification order against other environmental factors, e.g. altitude, failed to produce obvious gradients.

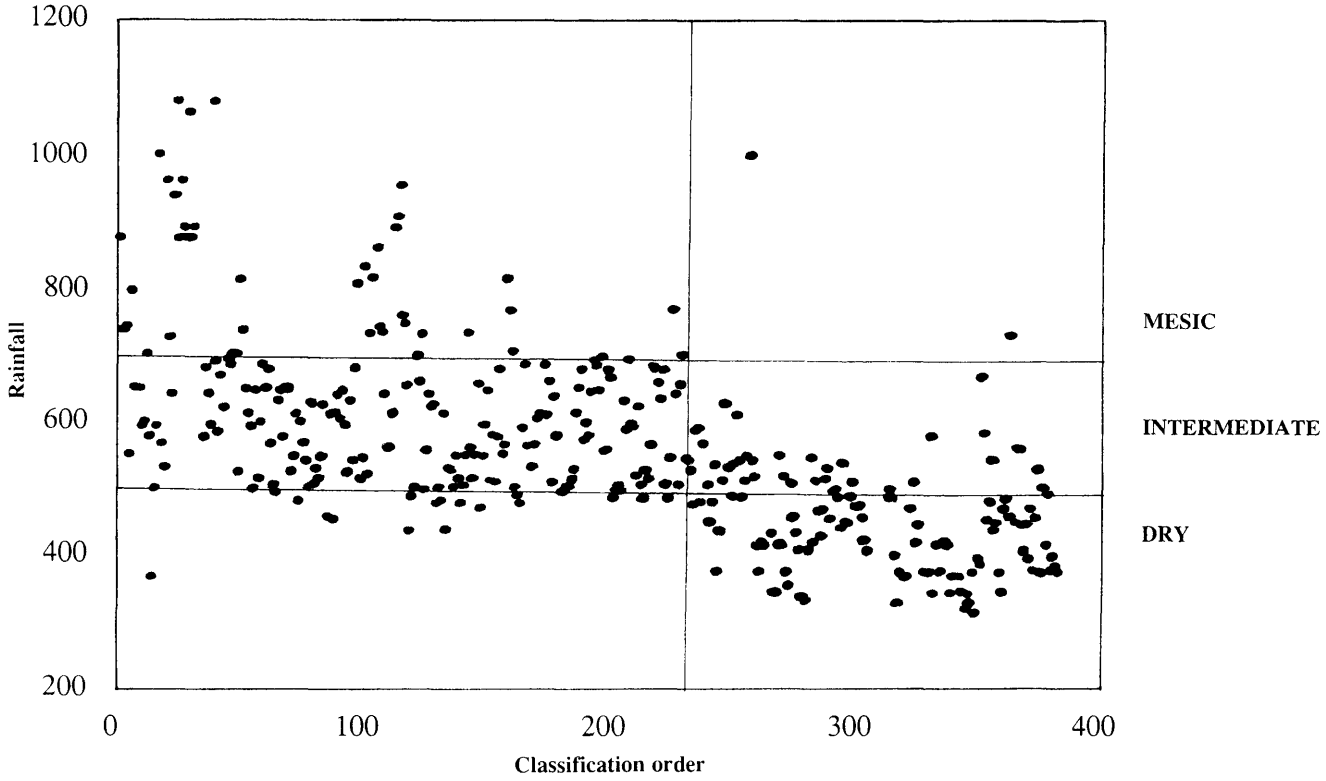


Figure 7: Plot of original TWINSPAN classification order against median annual rainfall to show moisture gradient in the data. Dry grasslands occur where annual rainfall is below 500 mm and mesic grasslands where annual rainfall is above 700 mm (Rutherford & Westfall 1986).

The first division in the TWINSPAN classification of the entire data set was between mesic and dry vegetation types. The former comprised mostly mountain grasslands and the latter lowland grasslands, Karoo mountain grasslands and savanna. The mountain grasslands showed a clear separation between the Stormberg and Drakensberg mountain chain in the northern part of the study area and the Kologha, Amatola and Winterberg mountain chain in the southern part of the study area. The classification thus showed a clear trend in rainfall and terrain and distinguished geographically separated entities. It was, however, decided to separate structurally distinct vegetation for the purposes of the classification rather than to regionalise data since this would enable comparison between similar vegetation both within the study area and from other parts of the country. The manner in which TWINSPAN regionalised the data was probably as a result of regional floras infiltrating all communities in a geographical area thus producing greater floristic similarity within regions than within vegetation types. This has been described as mass effect or biogeographical autocorrelation (Shmida & Ellner 1985). Structural classes distinguished for classification purposes were grassland, shrubland, savanna, grassy Cape shrubland, karroid dwarf shrubland and wetlands.

For further analysis the initial data set was divided in six to represent the main divisions in the data discussed above, and classifications were performed on each data set separately. Grasslands were further sub-divided into dry and mesic grasslands, and drainage line grasslands were grouped with wetlands. In each case TWINSPAN was used for an initial sorting of the data followed by subjective re-arrangement (as discussed above). The effect of sub-dividing the data was to by-pass the main gradient in the data (moisture regime) and focus on factors which were more likely to manifest themselves at this next scale of analysis. Phytosociological tables were provided for each data set (Tables 4–10), which included only common and distinguishing species. Rare and infrequent species for each table were placed in appendices (Appendix 1–7).

Classification

1. Grasslands

Dry Grasslands

1.1 *Cymbopogono excavati-Digitarietum argyrograptae*

1.2 *Elytropappo rhinocerotis-Merxmuelleretum distichae*

1.2.1 *eragrostietosum obtusae*

1.2.2 *senecietosum asperuli*

1.3 *Hermannio depressae-Eragrostietum chloromeladis*

1.3.1 *eragrostietosum gummifluae*

1.3.2 *eragrostietosum curvulae*

1.4 *Eragrostis chloromelas-Helictotrichon turgidulum* grassland community

Mesic grasslands

1.5 *Elionuro muticori-Themedetum triandrae*

1.6 *Eragrostio curvulae-Themedetum triandrae*

1.7 *Themedo triandrae-Helichrysetum aurei*

1.7.1 *eragrostietosum capensis*

1.7.2 *berkheyetosum rhaponticae*

1.8 *Andropogono appendiculati-Festucetum scabrae*

1.8.1 *typicum*

1.8.2 *ericetosum*

1.9 *Eragrostio chloromeladis-Festucetum caprinae*

2. Woody vegetation within the grasslands

Shrublands (Rhoetae erosae Werger)

2.1 *Cymbopogono excavati-Rhoetum discoloris*

2.1.1 *rhoetosum pyroidis*

2.1.2 *rhoetosum discoloris*

2.2 *Merxmuellero distichae-Diospyretum austro-africani*

2.2.1 *passerinetosum montanae*

2.2.2 *Elionuretosum mutici*

2.2.3 *pentzietosum globosae*

2.2.4 *elytropappetosum rhinocerotis*

2.2.5 *eragrostietosum curvulae*

Acacia karroo Savanna

2.3 *Acacia karroo-Cymbopogon validus* savanna

2.4 *Trago koelerioidis-Acacietum karroo*

2.4.1 *pentzietosum incanae*

2.4.2 *michrochloetosum kunthii*

2.4.3 *diospyretosum austro-africani*

2.5 *Acacia karroo-Eragrostis capensis* mesic "coastal" savanna community

3. Grassy fynbos

3.1 *Restio triticei-Oldenburgietum arbusculae*

4. Karroid vegetation

4.1 *Chrysocomo ciliatae-Digitarietum argyrograptae*

4.2 *Trago koelerioidis-Aristidetum diffusae*

4.3 *Tragus berteronianus-Enneapogon desvauxii* disturbed karroid grassland community

4.4 *Pentzia globosa-Eriocephalus spinescens* dwarf shrubland community

4.5 *Rhus longispina-Enneapogon scoparius* grassy open karroid bushland community

5. Wetlands and drainage line communities

5.1 *Phragmito australis-Schoenoplectetum tabernaemontani*

5.2 *Schoenoplecto paludicolae-Pennisetetum macrouri*

5.3 *Schoenoplecto corymbosi-Typhetum capensis*

5.4 *Cypero sexangularis-Schoenoplectetum corymbosi*

5.5 *Eragrostio curvulae-Miscanthetum capensis*

5.5.1 *helichrysetosum splendidi*

5.5.2 *cynodetosum dactyli*

5.6 *Festuco costatae-Merxmuelleretum drakensbergensis*

Descriptions

Syntaxa described below are each accompanied by a distribution map which shows the position of relevés classified into that syntaxon on a physiognomic map of the region.

1. Grasslands of the Eastern Cape

The data for grasslands consisted of 195 relevés and 642 species. Eight associations with six sub-associations were identified within these grasslands. A moisture gradient was identified and two main grassland types were identified: dry and mesic. The grasslands of the Eastern Cape were dominated by *Themeda triandra*, with *Eragrostis curvula* and *Elionurus muticus* as the most common co-dominants. *Eragrostis chloromelas* was dominant in many of the grasslands, but was absent in two of the mesic grassland associations.

Dry grasslands (Table 4)

Three dry grassland associations were recognised. An example is shown in Figure 8.

Figure 8: Dry grassland near Molteno with Rhoetae erosae (Werger) in the background. Note the tussocks of *Merxmuellera disticha* in the foreground.

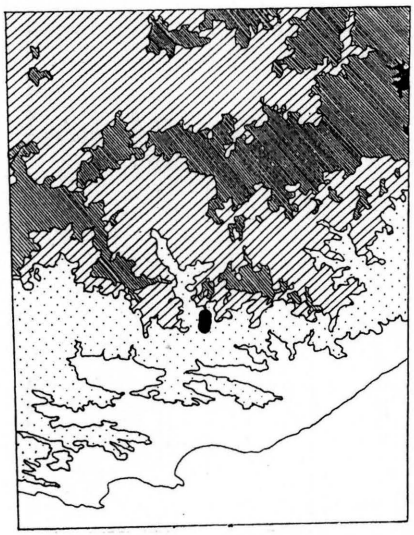
Table 4: Phytosociological table of the dry grasslands of the Eastern Cape

Relevé number	556666 890123	222233313334444 355558933880000 978999050271245	11111111112222222222211 32667777791111111222366 52301248613457894676 78	233333333333332 811222222446998 729125678891213	739222332222222233 678234116667888866 4 329786787124548	1111113333 5888993445 8023499045
Species of the *Cymbopogono excavatii-Digiterietum argyrograptae*						
Digitaria argyrograpta	113411	.....b.a.a...	..+.....	.1.....	.....	.....
Hermannia althaeifolia	++.+++	.....	.....	.....	.....	.....
Cymbopogon excavatus	+.1aaa	.....	.....	.....	.....	.....
Tephrosia capensis	..+1.+	.....	.....	.....	.....+.....+	.....
Species of the *Elytropappo rhinocerotis-Merxmuelleretum distichae*						
Merxmuellera disticha	1	r+33b33..b34b+4	34.+3.+a..4+3bb4..+4353	.....	.....	.....
Melica decumbens	.....	+++..+..+..+...	.+...++..+.++++...1+...	.....	.....+.....+...	.....+....
Elytropappus rhinocerotis	.....	..+....+.1b.r..	....+.....+..31.r.1...	.....	.....	.....
Tetrachne dregei	.....	...+.....+r+.+	.....1a..1+..1.+a.++...	.....	.....	.....
Trichodiadema species	....+.	..+....+...+.++	.....+.....+..	.....	....+.....	.....
Berkheya pinnatifida	.....	.....+.++++	.....++.++.+.....	.....	.....	.+.....
Lycium prunus-spinosa	.....	...1..++..+....	.....+.+..	.....	.....	.....
Asparagus laricinus	.....	...+.....	..+.....+..+...++....	.....	.....	.....
Pterothrix spinescens	.....	.....+...+....	.....+..+.++..	.....	.....+.....	.....
Species of the *eragrostietosum obtusae*						
Eragrostis obtusa	.....	..++.+..+1+++1+	.....+.....	.....+..+....	.....++.....++..	.....
Eriocephalus ericoides	.....	.....1.b...4a	.....	.....	.....	.....
Species of the *senecio asperuloris*						
Senecio asperulus	.....	...+.....	.+++++...+.....+..++++	.....	.....+	.+...+....
Pentaschistis airoides	.....	.....	.....+..+..+a+.+.....	.....	.....	...+.....
Bulbine narcissifolia	.....	.....	.+.....+..1+	.....	.....	.....
Asparagus capensis	.....	.....	....+.....+.1+	.....	.....	.....
Bromus commutatus	.....	.....	.....+...++++.....	.....	.....	.....
Species of the *Hermannio depressae-Eragrostietosum chloromeladis*						
Hermannia depressa	.....	.....	.....+.....	.++++++.++..+..	...+..+1.1+1++.+..	.....
Ptycholobium species	.....	.....	.....	++.++++.....+	.....+.....++.+++	.....
Solanum supinum	.....	...+.....	.....+.....	.+.....+..	.+.....+++++...+..	.....+..
Blepharis integrifolia	.....	.....	.....+.....	.....	....+.++...+...+..	.....
Panicum stapfianum	.....	.....	.....	.....+..+....	.....1+++...	.....
Oxalis depressa	.....	....+.....	.....	+...+++...+....	.....++..+...+...	.....+..
Commelina africana	..++..	.....	.....	.++++++....+..+	.++.+....+...+..+.	.....
Hypoxis argentea	....+.	.....	r.....+	...++.+..+.....	...+++.+.+.....	.....+..
Helichrysum pilosellum	.....	....+.....	.....	+.....+..+	...++.....+++...+	.....
Anthospermum rigidum	.....	.....	.....	.+..+++.....	.+....++...+.....+	.+.....+..
Species of the *eragrostietosum gummifluae*						
Eragrostis gummiflua	.....	.....	.....	13+33+1++3r1a1+	..+.....	.....
Setaria sphacelata	+.....	....+.....	.....	.1++++++.+.11++	.....+.+.....+...	.....
Trichoneura grandiglumis	.....	.....	.....	....+++.+...+.+	.+.....+.	.....
Arctotis venusta	.....	.....	.....	..+.+++.+.....	.....	.....
Species of all associations except the *Eragrostis chloromelas-Helictotrichon turgidulum* community						
Tragus koelerioides	33b3b1	.1a+.+1baaa+1a1	.....+...+..1+..1a.a+.	.a+1.....++....	1..+3.aaa.1..11b..	.....
Lycium species	+a+++.	+++.....++.+a.+	+.+.++++..1a..+..+.....	.++.++.+.++++.+	+..+.+..+++++.++..	.....
Aristida congesta	....+.	.+....+1aaar+1.	.....+.....+.....	11a+1+1a3++.+.+	++b.1.a+...+++.1++	.....
Pentzia globosa	b3....	..11.+++3b+11++	..+.++....aa+.+..1a....	.1..+..+.++.+..	...r.+++.++....1+.	....+.....
Species of all associations except *Cymbopogono excavatii-Digitarietum argyrograptae* and *Eragrostis chloromelas-Helictotrichon turgidulum* community						
Salvia stenophylla	.....	+...+...+.+.....	.....+.++.....+..	.+..++.+.++...+	...+.++++++.+.++.+	.....+
Sutera halimifolia	.....	....+.....++.+.	.....+.....+.	....+.++..+....	....+....+...+....	.....
Euryops annae	.....	.....1+.....	..3.....+1....	.+.+.....a.	.....1.....1...	.....+
Eragrostis lehmanniana	.....	...+.....+1....	.....+.....	+.+....+.a....1	3.....a.....	.....
Herniaria erckertii	.....	....+.....+...	.....+.+.....	..+++.....	.....+.	.....+
Sporobolus discosporus	.....	.....++++	.....a..++.....	+.....+..+....	.....+.+.....+.	.....
Cynodon dactylon	.....	.a1.....b..1+b+	.....+...a.1...++....	.....a+.+...	.+.+.....+++.	.....
Species of the *Eragrostis chloromelas-Helictotrichon turgidulum* community						
Helictotrichon turgidulum	.....	....++.....	.+.....+.....	1.....+.....+.	.....+....1.1..+	++.1++aa.+
Species of *Cymbopogono excavatii-Digitarietum argyrograptae* and *eragrostietosum gummifluae*						
Eragrostis plana	11+1++	.....1.....	1.....	++..a++++a...+.	..+.....+.	.....++3.
Species of general occurrance						
Themeda triandra	+..+++	4.+.a3.....1a.+	1b.+++11.++....++..1a+.	aa3+++a3..3+3.3	1.+3113bb+ba1+b...	131+1b+a.+
Gazania krebsiana	+.++..	.++....+++.....	...++..+..+..+.+++++.++	+..++.....++...	...++..++++++.+..+	+++....+.+
Eragrostis curvula	+.3134	.ba1.....+	.a1+34.11+.a..+.1....++	+.1+....1....++	+.+.++.+1b.1..a1..	1..++1.+..
Helichrysum rugulosum	+.++..	+++.++.....	...+....+.....+..	+..+.+.....+..1	.+.+.+...+++.+...+	+....+...+
Eragrostis capensis	11ab+.	....1+.....	+...+..+.+....1.....	+...++++...+..1	..+1.+.....+a+..+.	...+++++.+
Felicia muricata	..+1..	++1+++..+.....	+..++++..+..+..+.+.+.+.	.+.++.+.a++....	..+++..++.++++++++	..+++++..+
Cyperus usitatus	1++11+	+11.+..1aaaaa+1	.+...++....+.....	+111+....+1.+.+	+.r+..+1.1.+.++++.	.....+
Melolobium burchelli	..1.++	.+.....+....	.+.....+....+..+.+..+..	+.....	.....+.....	.....
Pelargonium sidoides	..++..	.....	.....+..+.++.	+.....	..++....++.+....++	+.....+..
Arctotis arctotoides	.....+	++.....+...	.....+...+...	+.....+....	.....+.+..+	.+.+....+.
Oxalis species	....++	.....+.++..+.1+	.....	..++...+.....	.....	.....++..
Berkheya species	++11.+	.....+.....	+.....+.....+....	.....+....	+...++.....+	.....+..
Species of all associations except *Cymbopogono excavatii-Digitarietum argyrograptae*						
Eragrostis chloromelas	.....	aaa.aaa.a1a11.a	+.aa..a.aaa1aaaa1aa1a..	1+1a1aaa+a.a+aa	.a.aaa.11aa.a1.aa+	aaaa1aaaaa
Cymbopogon plurinodis	.....	..++.+1.+.++a.1	+..++..+..1.1..1.a.1.+1	a.1+++1+r+aa1.+	aa+a1++a1aaa1a1a+a	..1.+.1+..
Aristida diffusa	.....	+.+1.+a.++1....	..+...+aa+...+.+++1.+++	+1+1..1.+.++1+1	+..+...aa...a+1.++	....+.11.a
Chrysocoma ciliata	.....	.+....+.++.....	.+.r..+..+....+.++++...	.+...++.+.....	....+.1+.....+.	.....++..+
Elionurus muticus	.....	....1+1.r.....	..+1+.aa+1.....+...+.+.	aa++11a+.++++a+	..a..a.++..ra11.+a	11aaaaa+.+
Heteropogon contortus	.....	..+.....+.+..	.....a.....+...+...	a+++.+++..++.+1	++.+.a.+a..a+++..+	...+...a.+
Helichrysum asperum	.....	++..++....++...	.+1....++.+++++++.+..++	.+.++.+.+..++..	.....+.....+.	++.1+....+
Microchloa kunthii	.....	..+....a....1+.	.....+.....	a1a.+.11..+11..	.1.a1..+++a+a..+a+	+.....1a.+
Karroochloa purpurea	.....	....a....+..+.+	..+1++++11++.1a+a.a1.++	.....	.....+.	++.+1.+...
Senecio retrorsus	....+.	..+.+1..+.....	....++++.....++....+...	++..+++...+...1	..++.1.++..1++++.+	++++..1+1.
Walafrida species	.....	.+.....	.....++..+1a++.+....	+.+..++++.....	..+.+..+....+.....	....+...++
Pseudognaphalium oligandrum	.....	.+..++....+1.1.	.....++..+.1++.+.....	.++.++++...++..	.....++....+.....	.+.+.++...
Walafrida saxatilis	.....	..+.+.++11+.+++	..1+++++...1.....+a1++.	.++1+.++.++++..	...+.+++++.....++.	.....++.+
Helichrysum rosum	.....	....++++...+...	..++++++++..++.+.+.+...	+.++++.+.+++...	...+++++1...+.+.++	.+.+++++.+
Digitaria eriantha	.....	.....+..+...a.a	...+++.+.....	1.++a.1...+1..+	.11.++++.++a1++11.	a.++...+1.
Ifloga glomerata	.....	.+..+.+.....++	.....+++.+.....	.++++++++.+....	.....++.....+.	+.....+++.
Moraea species	.....	.....	.....+++.+.+..+..+..	.....	.....+.	++..++....
Hermannia cordata	.....	.....+.....	.....+.+.....	+..++.+.....+	.+.+.....+....+	.+.....+..
Stoebe vulgaris	.....	.....+.....	.....+.....	.1..+a+.+..+.a.	.....+..+.	.+..+.+a..
Berkheya onopordifolia	.....	.+++....+.....	.....++.....+.....	.+.....r	...+...++....+1+..	.+....+.1.
Hermannia coccocarpa	.....	.++....+.....	.....+...+.+...+.....+.	+.+..+.++.+....	...++.+++...+....+	....+.+...
Kyllinga alata	.....	.....+..a+1+	.....+...1.....	.+++.....+.+...	.+a...++..+..1..1.	.....++..
Sonchus dregeanus	..r...	..+.....	+..++.+.....+.	+.....++.	...+.....+.....	.....+...
Felicia filifolia	.....	+.r..+.....	..++.+.1.+.....+...++1+	.....	....+...+....1...+	.+++..+...
Euphorbia striata	.....	.....+.....	..++..+.....+.....	++.....	..+.....+.....++	++.....+..
Senecio erubescens	.....	+.....	...+.++.....++.....	.+.....	.....++.....	.+.+.....+
Lactuca inermis	.....	....+.....	.....+...+.....	..+....+.....+	.+....++...+.++...	.....+

1.1 *Cymbopogono excavati-Digitarietum argyrograptae* ass. nova

(*Digitaria argyrograpta-Cymbopogon excavatus* grassland community)

typus: Table 4, relevé 61, holotypus



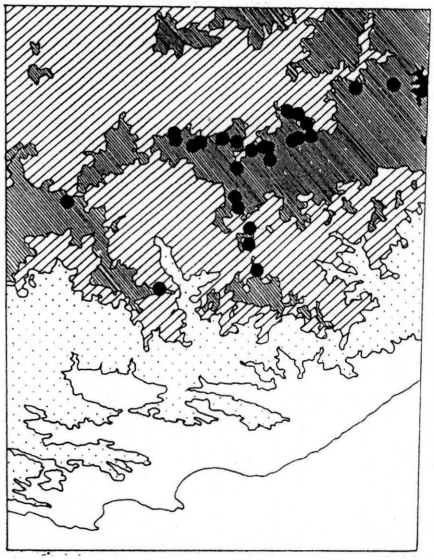
This association occurred on the flat to gently undulating plains south of Bedford and the Winterberg Mountains at altitudes between 660 and 900 m. This particular area is known as the Smaldeel area and has been studied by Martens & Morris (1993) using a point survey method. This association matches the Dry Bedford Grassveld of Martens & Morris (1993) in species composition as well as distribution. It also falls within the distribution of Subarid Thorn Bushveld (Low & Rebelo 1996) and Acocks's (1988) combined Eastern Province Grassveld and False Thornveld of the Eastern Province, although it matches only the Eastern Province Grassveld (Acocks 1988) in species composition. Acocks (1988) states that the False Thornveld is degraded Eastern Province Grassveld and that remnants of the Grassveld may be found within the Thornveld. The distribution of the present association does not, therefore, conflict with Acocks's (1988) descriptions. Drainage lines here are dominated by *Trago koelerioidis-Acacietum karroo.*

This association had *Digitaria argyrograpta, Tragus koelerioides, Eragrostis curvula* and *Cymbopogon excavatus* as dominant species and *Hermannia althaefolia* and *Digitaria argyrograpta* as distinguishing species. Many of the less common species characteristic of dry grasslands were lacking in this association and *Merxmuellera disticha* was almost entirely absent. However, the grasses *Tragus koelerioides* and *Digitaria argyrograpta* linked this association to the dry grasslands and the karoo communities respectively. Other commonly occurring species here were *Cyperus usitatus, Eragrostis capensis, Eragrostis plana, Lycium* sp. and *Themeda triandra.*

1.2 *Elytropappo rhinocerotis-Merxmuelleretum distichae* ass. nova

(*Merxmuellera disticha-Elytropappus rhinocerotis* karroid grassland sensu Palmer 1991a)

typus: Table 4, relevé 258, holotypus



This grassland is found in the mountains of the Karoo and in patches on the Stormberg / Drakensberg Plateau corresponding to the distribution of Low & Rebelo's (1996) South-Eastern Mountain Grassland. This distribution is wider than Acocks's *Merxmuellera* Mountain Veld; it includes his Stormberg Plateau Sweet Veld and *Themeda-Festuca* Alpine Veld thus lending support to Lubke's (1996) decision to combine these three Acocks Veld types in the new vegetation map (Low & Rebelo 1996). Acocks (1988) does, however, indicate that the *Merxmuellera* grassland starts in patches in the eastern mountains, as observed above, on "rocky, dry aspects", rather than as a continuous unit. The range of altitudes at which this association is found is from 1350 to 1920 m altitude.

The grass *Merxmuellera disticha* is both diagnostic and dominant in this grassland. It is a robust tussock-forming grass which produces a dense sward 30–50 cm tall. Although this species has a wider distribution than the current association (Gibbs-Russell *et al.* 1991), its dominance is restricted to this association. Co-dominant species are *Eragrostis chloromelas* and *Themeda triandra* and occasionally *Karrochloa purpurea, Cynodon dactylon* and *Aristida congesta*. Distinguishing species are *Melica decumbens*, *Elytropappus rhinocerotis, Tetrachne dregei, Trichodiadema* sp. and *Berkheya pinnatifida*. The grasses *Cymbopogon plurinodis, Eragrostis curvula, Elionurus muticus, Karroochloa purpurea* and *Aristida diffusa* are common within this grassland type. Although this is primarily a grassland, dwarf shrubs are an important component of the vegetation and *Chrysocoma ciliata, Felicia filifolia* and *Walafrida saxatalis* are found throughout. Other species often present are *Senecio asperulus, S. retrorsus, Helichrysum rosum, H. asperum, Pseudognaphalium oligandrum, Felicia muricata* and *Gazania krebsiana*. The mean number of species per relevé for this vegetation unit is 26.

Two sub-associations were recognised which appeared to be related to a moisture gradient, *eragrostietosum obtusae* and *senecietosum asperuli:*

1.2.1 The *eragrostietosum obtusae* subass. nova (typus: Table 4, relevé 258) was distinguished by the presence of *Eragrostis obtusa, Eriocephalus ericoides* (rarely), *Aristida congesta* and *Cyperus usitatus*. The grass *Tragus koelerioides* was more dominant and had a greater constancy in the *eragrostietosum obtusae*.

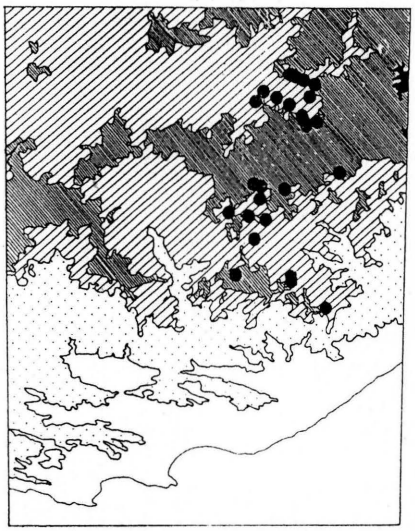
1.2.2 The *senecietosum asperuli* subass. nova (typus: Table 4, relevé 170) was distinguished by the presence of *Senecio asperulus, Pentaschistis airioides, Bulbine narcissifolia, Asparagus capensis, Bromus commutatus* and *Karrochloa purpurea*.

It would be possible to sub-divide this association further, but patterns were not clear enough to justify such action. Floristically, this association matches Palmer's (1991a) *Merxmuellera disticha-Elytropappus rhinocerotis* Montane Grassland very closely except for infrequently occurring species such as *Diospyros austro-africana* and *Rhus erosa* which occur in Palmer's (1991a) data, but not here and *Trichodiadema* spp., *Berkheya pinnatifida* and *Melolobium burchelli* which are amongst the species in the present data set, but do not occur on Palmer's (1991a) synoptic table. It was due to the similarity that it was decided to give the same name as Palmer's (1991a) published one to this association, although here the name is formalised. The association here also fits into Van der Walt's (1980) *Merxmuellera disticha* communities, although Van der Walt does not clearly separate grassland and shrubland vegetation.

1.3 *Hermannio depressae-Eragrostietum chloromeladis* ass. nova

(Eragrostis chloromelas-Hermannia depressa dry plains grassland)

typus: Table 4, relevé 326, holotypus



This association was found on the flat to gently sloping 'lowland' plains of the Queenstown Basin and north of the Stormberg Plateau ranging in altitude from 1110 to 1620 m above sea level. It is dominated by the grass species *Eragrostis chloromelas, Cymbopogon plurinodis, Themeda triandra* and *Elionurus muticus* and occasionally *Michroa kunthii* and *Heteropogon* contortus. Other common grasses are *Aristida diffusa, Eragrostis curvula, Eragrostis capensis, Digitaria eriantha, Tragus koelerioides, Aristida congesta* and the dwarf shrubs and herbs *Pentzia globosa, Lycium* sp., *Salvia stenophylla, Walafrida saxatilis, Gazania krebsiana, Felicia muricata, Helichrysum rugulosum, H. rosum, Senecio retrorsus, Cyperus usitatus, Kyllinga alata, Commelina africana* and *Hermannia coccocarpa.* The herb *Hermannia depressa* is the only distinguishing species found with high constancy in this association, but *Ptycholobium* sp. is also restricted to the association.

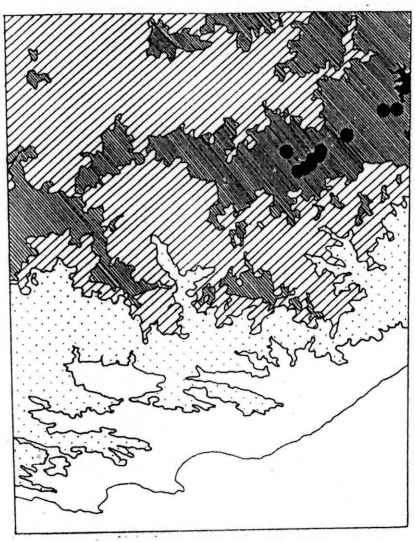
Two sub-associations were recognised, the *eragrostietosum gummifluae* subass. nova (typus: Table 4, relevé 326) and the *eragrostietosum curvulae* subass. nova (typus: Table 4, relevé 318).

1.3.1 The grass *Eragrostis gummiflua* was both diagnostic and one of the dominant species in the *eragrostietosum gummifluae*. Additional species of common occurrance which distinguished this sub-association from the other were *Ifloga glomerata, Helichrysum asperum, Pseudognaphalium oligandrum, Setaria sphacelata, Oxalis depressa* and *Eragrostis plana.* The *eragrostietosum gummifluae* was found mainly north of the Stormberg Plateau on sandy and well-drained soils at altitudes ranging from 1350 to 1620 m. There were on average 35 species per relevé in this sub-association, which is slightly higher than the 29 for grasslands altogether. The species composition corresponds with that of Werger's (1980) *Eragrostis plana-Eragrostis gummiflua*

community found between Aliwal North and Lady Grey, a very similar distribution as for the *eragrostietosum gummifluae*. Werger distinguished two sub-communities for his *Eragrostis plana-Eragrostis gummiflua* community, but the distinction is unclear with the present data set. His descriptions for both sub-communities were based on only 6 relevés.

1.3.2 The *eragrostietosum curvulae* was found mainly on the plains of the Queenstown Basin at altitudes of 1110 to 1590 m above sea level on heavier soils (loamy or clay-loam soils) than the other sub-association. Dominant species for the *eragrostietosum curvulae* correspond to those for the whole association. The *eragrostietosum curvulae* lacks diagnostic species of its own and is distinguished from *eragrostietosum gummifluae* by the absence of the latter sub-associations distinguishing species. There were 30 species per relevé in the *eragrostietosum curvulae*.

1.4 *Eragrostis chloromelas-Helictotrichon turgidulum* grassland community



This association was found away from the escarpment in the Drakensberg and Stormberg range. Relevés occurred either on dryer aspect midslopes or on the top of hills where grazing animals tend to trample the vegetation. It was dominated by *Themeda triandra, Eragrostis chloromelas* and *Elionurus muticus* and had high constancy values for *Eragrostis capensis, Karroochloa purpurea, Digitaria eriantha, Felicia muricata, Senecio retrorsus* and *Helichrysum rosum*. The grass *Helictotrichon turgidulum* had a high constancy in this community although it occurred occasionally elsewhere.

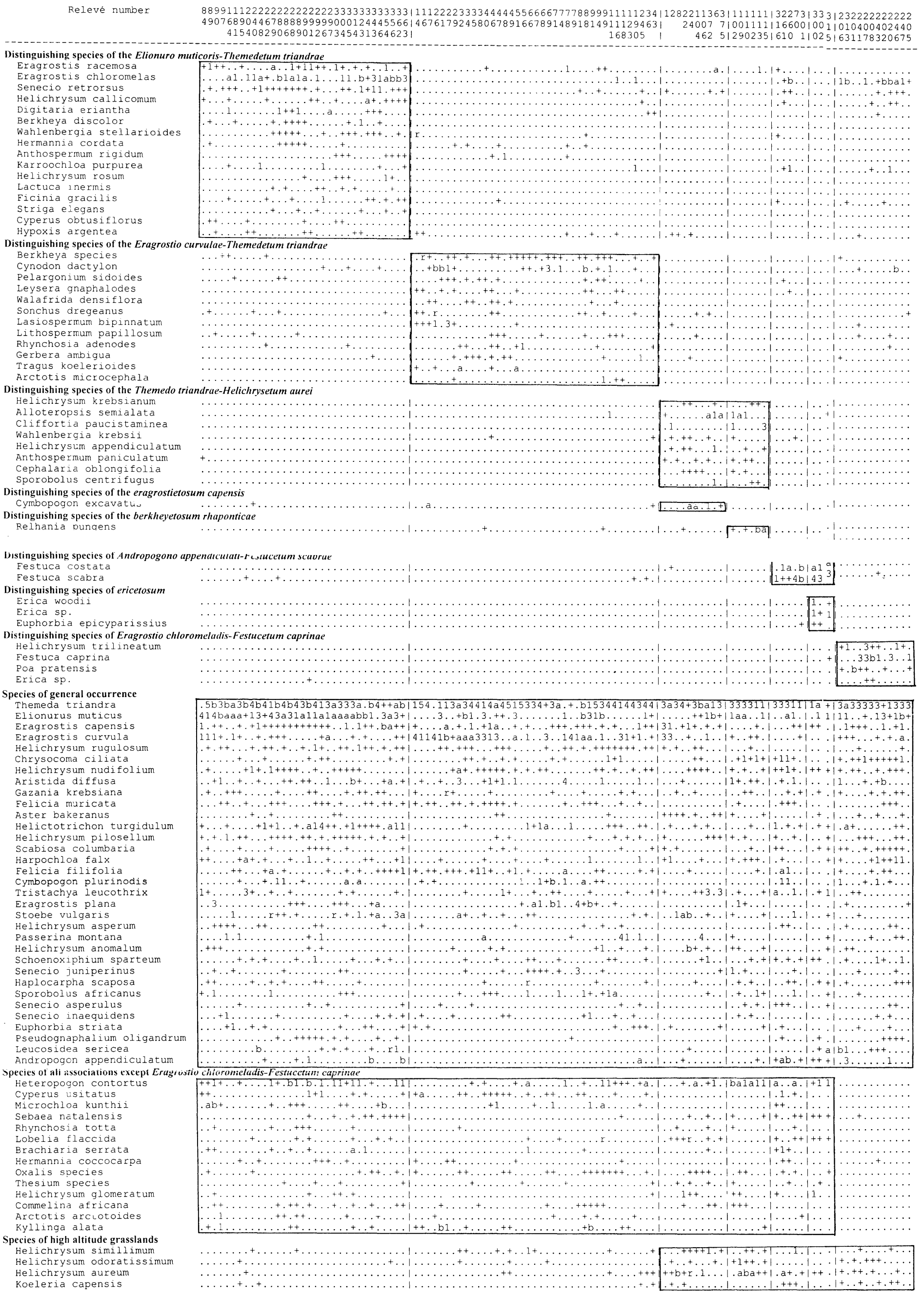
The community has not been formalised, because it does not appear to form a natural group. Species richness varies from 10 to 56 species and there were no obvious distinguishing species, except for *Helictotrichon turgidulum*. It may be that this relevé group formed as an artifact of the classification procedure, since it shared none of the diagnostic species of other dry grassland associations, but had many of the general species.

Mesic grasslands (Table 5)

A number of species distinguished mesic from dry grasslands. The species *Helichrysum nudifolium, Schoenoxiphium sparteum, Tristachya leucothrix, Lobelia flaccida* and *Aster bakeranus* were only found in mesic grasslands and the species *Tragus koelerioides, Aristida congesta, Pentzia globosa* and *Lycium* sp. were found only in the dry grasslands. Five mesic grasslands grassland associations were identified. An example of mesic grasslands is shown in Figure 9.

Figure 9: Mesic grasslands in the Amatola Mountains dominated by *Themeda triandra* with *Stoebe vulgaris* in the foreground. The mountain in the background is Elandsberg (2016 m).

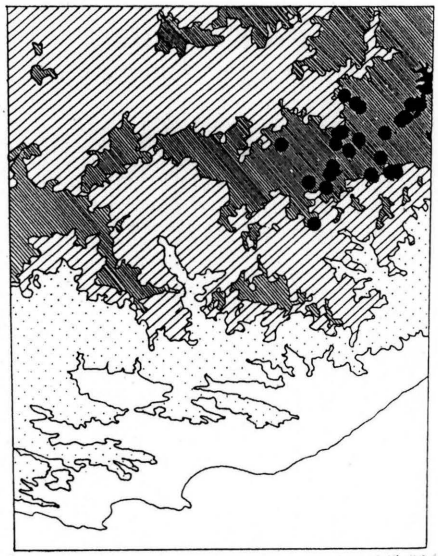
Table 5: Phytosociological table of the mesic grasslands of the Eastern Cape.



1.5 *Elionuro muticori-Themedetum triandrae* ass. nova

(Themeda triandra-Elionurus muticus mesic grassland)

typus: Table 5, relevé 292, holotypus

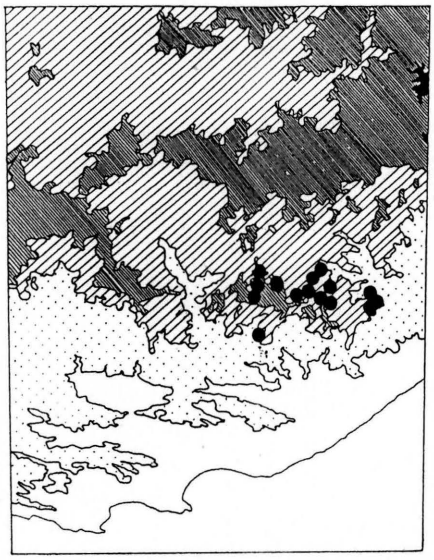


This association occurred at altitudes from 1230 to 2310 m in the Stormberg and Drakensberg region and was the most widespread grassland association in this region. Dominant species were *Themeda triandra, Elionurus muticus* and *Eragrostis chloromelas.* Other common species were the grasses *Helictotrichon turgidulum, Aristida diffusa, Heteropogon contortus, Eragrostis capensis, E. curvula* and *E. racemosus* and the forbs *Helichrysum nudifolium, H. rugulosum, H. rosum, Pseudognaphalium oligandrum, Stoebe vulgaris, Felicia muricata* and *Senecio retrorsus.* This association could be distinguished from other mesic grasslands by the presence of *Eragrostis chloromelas* (except the *Themedo triandrae-Festucetum caprinae*), *Senecio retrorsus, Digitaria eriantha, Berkheya discolor* and *Wahlenbergia stellarioides* and from all grassland associations by the presence of *Eragrostis racemosa* and *Helichrysum callicomum.* There were 32 species per relevé in this association which is only slightly higher than for grasslands in general.

1.6 *Eragrostio curvulae-Themedetum triandrae* ass. nova

(Themeda triandra-Eragrostis curvula mesic grassland)

typus: Table 5, relevé 47, holotypus

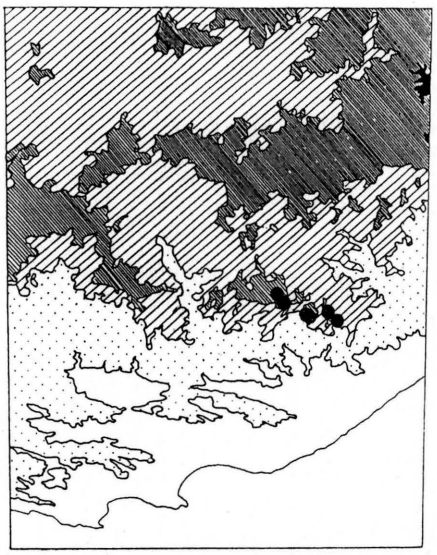


This association was the widespread grassland type in the Amatola, Kologha and Winterberg Mountains and was found at altitudes ranging from 720 to 1980 m. It was dominated by the grasses *Themeda triandra* and *Eragrostis curvula.* Commonly occurring species were the grasses *Elionurus muticus, Heteropogon contortus, Eragrostis capensis, Sporobolus africanus, Cynodon dactylon* and *Eragrostis plana* and the herbs *Helichrysum nudifolium, H. rugulosum, Felicia muricata, F. filifolia* and *Cyperus usitatus.* Many of these species are indicators of disturbance or overgrazing. The association lacked the presence of distinguishing species, and was separated by the absence of the distinguishing species of the other associations. There were on average only 23 species per relevé in this association, which is significantly lower than for grasslands as a whole. The combination of (i) species indicative of disturbance or overgrazing, (ii) the poor species richness and (iii) the lack of distinguishing species suggests that this grassland has been mismanaged / overgrazed.

1.7 *Themedo triandrae-Helichrysetum aurei* ass. nova

(Helichrysum aureum-Themeda triandra mesic asteraceous grassland)

typus: Table 5, relevé 110, holotypus



This association occurred at altitudes from 840 to 1770 m and corresponded with the highest altitude ridge of the Katberg, Amatola and Kologha range. The association was dominated by *Themeda triandra* and occasionally *Helichrysum aureum, Elionurus muticus* or *Heteropogon contortus*. Distinguishing species were the group that include *Helichrysum appendiculatum, Anthospermum paniculatum, Cephalaria oblongifolia. Helichrysum krebsianum* along with *Alloteropsis semialata,* when it occurred, had high cover / abundance values. Common species were *Helichrysum simillimum, H. mixtum, H. odoratissimum* and *H. nudifolium*. The number of *Helichrysum* species in this association is noteworthy and one relevé (no. 24) had 11 of them.

This association is probably what Acocks (1988) referred to when he remarked on the similarity of grassy fynbos to some parts of the Dohne Sourveld on the summits of the Amatola and Katberg Mountains. One relevé in particular (no. 102) could be regarded as azonal (afromontane) fynbos and contains, amongst others, *Protea subvestita, Erica peltata, Cliffortia paucistaminea* and *Aspalathus frankenioides*. Similar azonal fynbos, including *Restio, Protea, Erica, Cliffortia* and other species may be found on the slopes of Gaika's Kop near Hogsback (pers. obs.). Previous studies have indicated that in the absence of fire and management mountain grasslands in this area change to a *Cliffortia-Erica* dominated fynbos-type vegetation (Story 1952). Other species of diagnostic value also found in the grassy fynbos and this association were *Aster bakeranus* and *Alloteropsis semialata*. The grasses *Themeda triandra, Eragrostis curvula, E. capensis, Heteropogon contortus* and *Tristachya leucothrix* and the forbs *Helichrysum nudifolium* and *H. anomalum* were also shared. Climatically the present association receives Autumn maximum rainfall (cf. Chapter 2, Climate, and Figure 5) and grassy fynbos falls within the transition between Spring and

Autumn maximum rainfall (cf. Kopke 1988, Fig. p. 49 and Weather Bureau), thus providing a climatic "window" through which species may migrate. The two regions are, however, geologically distinct (Visser 1984) and shared species are likely to be substrate generalists.

Two sub-associations were recognised, the *eragrostietosum capensis* subass. nova (typus: Table 5, relevé 372) and the *berkheyetosum rhaponticae* subass. nova (typus: Table 5, relevé 110):

1.7.1 The *eragrostietosum capensis* lacked diagnostic species, but could be distinguished from *berkheyetosum rhaponticae* by the presence of a number of general species which were of low constancy or lacking in the *eragrostietosum capensis*. These were *Lobelia flaccida, Aster bakeranus, Eragrostis capensis, Stoebe vulgaris* and *Cymbopogon excavatus*. There were only 29 species per relevé in the *eragrostietosum capensis*.

1.7.2 The *berkheyetosum rhaponticae* had 37 species per relevé, which is significantly higher than for all grasslands. Distinguishing species were *Relhania pungens, Berkheya rhapontica* and *Wahlenbergia capensis*.

1.8 *Andropogono appendiculati-Festucetum scabrae* ass. nova

(*Festuca scabra-Andropogon appendiculatus* mesic grassland)

typus: Table 5, relevé 300, holotypus

This association occurred at altitudes from 1590 to 2100 m on the mesic eastern parts of both the Great and Little Escarpments. It was dominated by *Festuca scabra, F. costata* (which were also distinguishing species) and *Themeda triandra*. Other common species were *Helichrysum nudifolium, H. aureum, Haplocarpha scaposa, Scabiosa columbaria, Senecio asperulus, Schoenoxiphium sparteum, Sebaea natalensis, Lobelia flaccida, Elionurus muticus, Tristachya leucothrix, Eragrostis capensis, Heteropogon contortus, Andropogon appendiculatus* and *Helictotrichon turgidulum*.

Two sub-associations were recognised, the association *chrysocometosum ciliatae* subass. nova (typus: Table 5, relevé 260) and the *ericetosum* subass. nova (typus: Table 5, relevé 300):

1.8.3 The *chrysocometosum ciliatae* was found on escarpment slopes, but not on the summit, and was distinguished by the presence of *Chrysocoma ciliata, Felicia muricata, F. filifolia, Cymbopogon plurinodis, Cyperus usitatus, Brachiaria serrata, Hermannia coccocarpa* and *Koeleria capensis,* and the absence of the *ericetosum* distinguishing species.

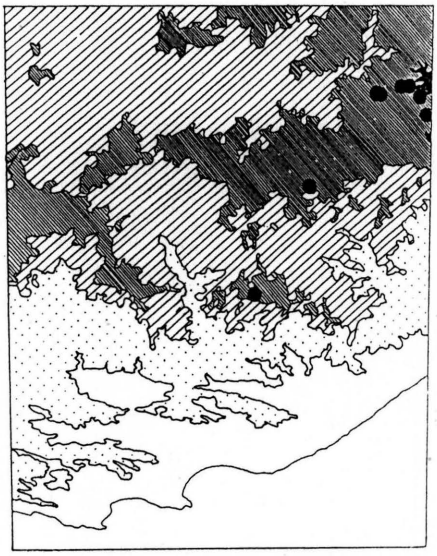
1.8.2 The *ericetosum*, was also found on the summit of steep escarpment slopes, and was distinguished by the presence of two *Erica* species and *Euphorbia epicyparissius*.

There were on average 39 species per relevé in this association, which is higher than for the grasslands as a whole.

1.9 *Themedo triandrae-Festucetum caprinae* ass. nova

(*Festuca caprina-Themeda triandra* mesic grassland)

typus: Table 5, relevé 207, holotypus



This was a relatively high-altitude association and occurred from 1680 to 2370 m in the Stormberg, Drakensberg, Witberg and Winterberg Mountains. Dominant species were *Themeda triandra* and *Eragrostis chloromelas* and in some cases *Elionurus muticus* and *Festuca caprina.* Common species were the shrubs *Leucosidea sericea, Helichrysum trilineatum* and *Chrysocoma ciliata* and the herbs and grasses *Helichrysum nudifolium, Gazania krebsiana, Eragrostis curvula, E. capensis, Harpochloa falx* and *Scabiosa columbaria.* Distinguishing species for the association were *Helichrysum trilineatum, Festuca caprina* and *Poa pratensis*. The association had 30 species per relevé.

2. Woody vegetation within the grasslands of the Eastern Cape

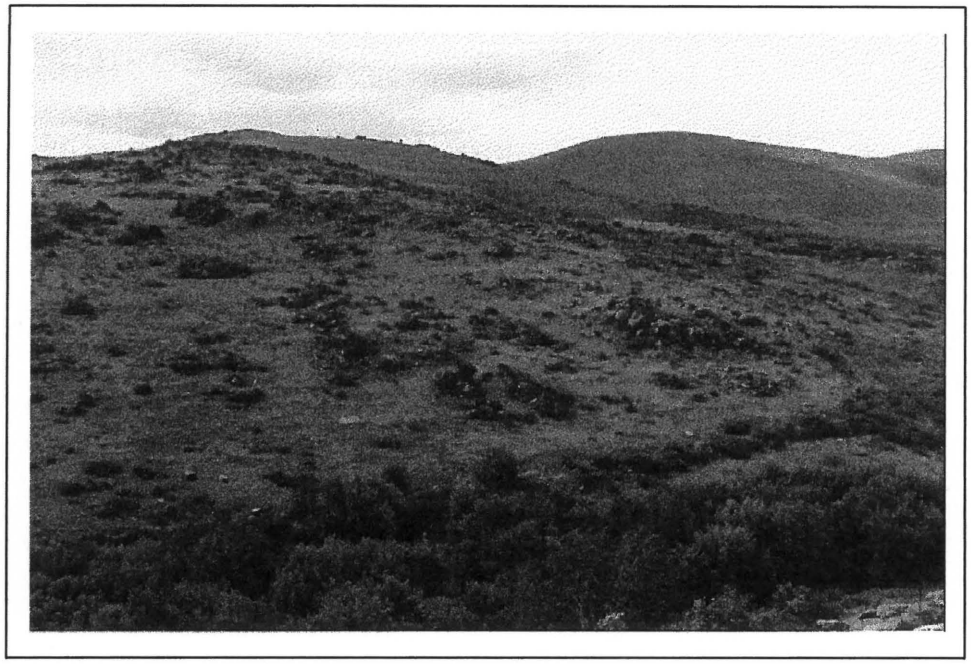


Figure 10: Shrublands on dolerite boulder outcrops near Waterdown Dam. The drainage line in the foreground is heavily invaded by *Acacia mearnsii*.

Woody vegetation was found throughout the grassland region of the Eastern Cape. One example is shown in Figure 10. It could be divided into shrubland and thorn-tree savanna. The shrubland was intrazonal, occurring on rocky terrain within the grasslands, but the savanna usually occupied a zone adjacent to the grasslands with a dynamic tension existing between the grasslands and the savanna. Woody vegetation could be distinguished from grassland generally on the basis of vegetation structure, i.e. woody vegetation had a layered structure which included grass and forb layers as well as a distinct woody strata ranging in height from 1 to 3 m, whereas grassland in the study area usually consisted of a single layer of grasses and forbs and occasionally some dwarf shrubs seldom exceeding the height of the grasses. The presence of woody species, e.g. Acacia karroo, Rhus erosa, R. discolor, R. pyroides and Diospyros austro-africana, as the dominant species, could usually be used to distinguish woody vegetation floristically from grassland.

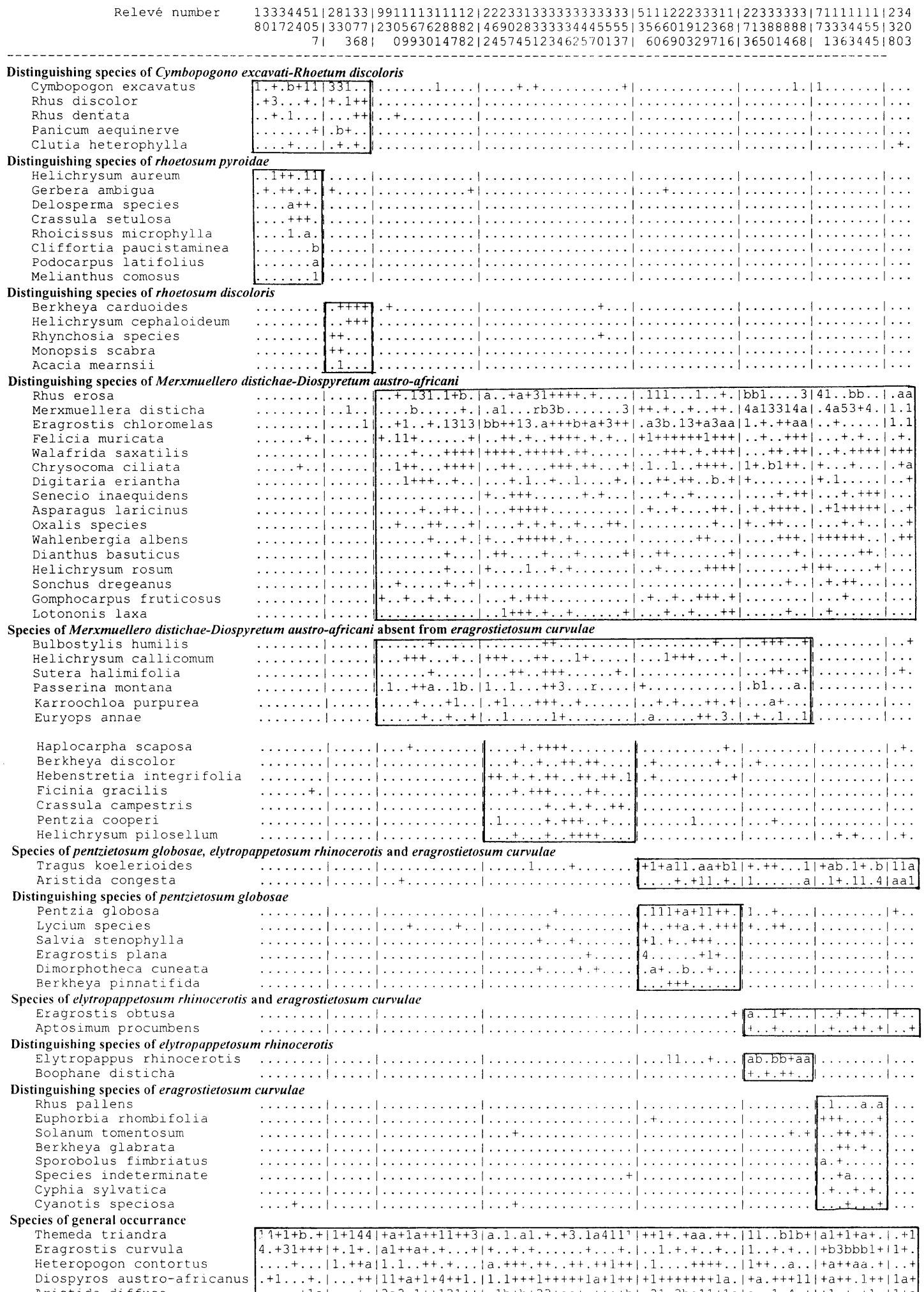
Shrublands (Rhoetae erosae Werger 1980) (Table 6)

Shrublands formed a distinctive structural vegetation type within the matrix of grasslands. They were restricted to rocky talus slopes and outcrops where the surface rockiness was high and where soils were usually shallow and stony. Based on species composition (discussed below) these shrublands fall within the class Rhoetae erosae described by Werger (1980) and analysed by Du Preez (1991).

Werger (1980) argues that the floristic similarity of these communities is enough to suggest that Acocks's (1953) False Upper Karoo and *Cymbopogon-Themeda* grassland (in which the Rhoetae erosae Werger occur) were once more similar. In fact the class is known to be widespread (Du Preez 1991) and spans many more of Acocks's other Veld Types. It is unreasonable to expect that all these Veld Types were once more similar. The Rhoetae erosae Werger is merely a widespread class which occurs under particular conditions. There is, nevertheless, evidence to suggest that management practices may influence the extent of this community. The shrub *Rhus erosa* (on rocky areas, hills and ridges) tends to increase when overgrazing opens the grass layer, but better management which restores the grass layer results in the shrubs dying. The grass layer is probably intercepting and utilising water from precipitation at the expense of the shrubs.

The relationship of the present associations to published (Werger 1980) and unpublished descriptions (Du Preez 1991) will await formal synthesis of these communities despite placement of the data here into the Rhoetae erosae Werger. Two shrubland associations were recognised here.

Table 6: Phytosociological table of the shrublands (Rhoetae erosae Werger) of the Eastern Cape.

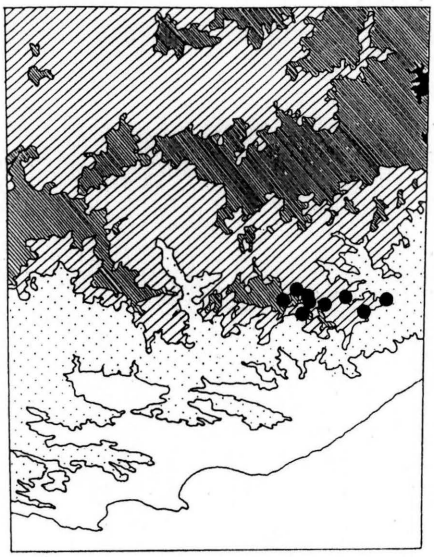


2.1 *Cymbopogono excavati-Rhoetum discoloris* ass. nova

(*Rhus discolor-Cymbopogon excavatus* mesic grassy shrubland)

typus: Table 6, relevé 50, holotypus

This low grassy shrubland was found on rocky outcrops or steep tallus slopes in the mesic Amatola and Kologha Mountains. Soils were generally shallow and stony. Distinguishing species were *Cymbopogon excavatus, Rhus discolor* and *R. dentata*. The grasses *Themeda triandra* and *Eragrostis curvula* were usually present and often dominant in the understorey along with the differential *Cymbopogon excavatus*. The forb *Helichrysum nudifolium* was usually present. The shrub *Diospyros austro-africana* and its associated species were occasionally present to link this association to the other shrubland association, but *Rhus erosa* and its associated species were entirely absent. Surface rock cover was often directly related to woodiness of the association and as the rock cover decreased the association resembled grassland more closely in structure.



Two sub-associations were recognised, *rhoetosum pyroidis* subass. nova (typus: Table 6, relevé 50) and *rhoetosum discoloris* subass. nova (typus: Table 6, relevé 103):

2.1.1 The *rhoetosum pyroidis* was the typical vegetation of rocky outcrops and tallus slopes of the Amatola and Kologha Mountains. It could be distinguished mostly by the absence of the *rhoetosum discoloris* distinguishing species, and by the presence of *Helichrysum aureum* and *Gerbera ambigua*. It was dominated by the shrub *Rhus pyroides* and the dwarf shrub *Felicia filifolia* giving the vegetation a multi-layered structure. The grass layer was dominated by *Cymbopogon excavatus, Eragrostis curvula* and *Themeda triandra*.

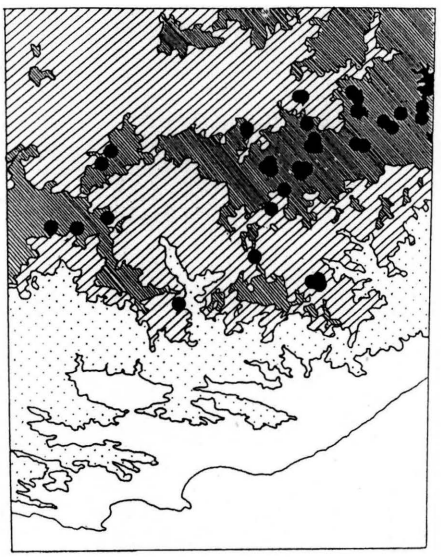
2.1.2 The *rhoetosum discoloris* occurred on steep slopes in the Amatola and Kologha Mountains that had a lower surface cover of rocks than in the *rhoetosum pyroidae*. It could be distinguished by the presence of *Berkheya carduoides* and *Helichrysum cephaloideum*. It was dominated by the grasses *Cymbopogon excavatus, Themeda*

triandra, Heteropogon contortus, Eragrostis curvula and *Tristachya leucothrix*, but with the dwarf shrub *Stoebe vulgaris* and the herbs *Helichrysum nudifolium* and *Senecio retrorsus* usually present. The woody component was represented by sporadic occurrances of *Diospyros austro-africana, Rhus discolor* and *R. dentata.*

2.2 *Merxmuellero distichae-Diospyretum austro-africani* ass. nova

(*Diospyros austro-africana-Merxmuellera disticha* dry grassy shrubland)

typus: Table 6, relevé 332, holotypus



This dryer shrubland type was found in the mountains of the Karoo, in the Stormberg and Drakensberg Mountains and plateau, and in the dryer northern parts of the Amatola Mountains at 1200 and 2130 m altitude. There was always some combination of high surface rock cover, steep slope and / or shallow, stony soil or surface soil erosion. This was the classic shrubland of the study area dominated by the shrubs *Diospyros austro-africana, Rhus erosa, R. pyroides* and *Passerina montana.* The grass *Merxmuellera disticha* is one of the dominant species in the grass layer. The distribution of this shrubland association and the *Elytropappo rhinocerotis-Merxmuelleretum distichae* grassland overlap and it is therefore expected that the grassland species would migrate into the understorey of the shrubland (cf. mass effect, Shmida & Ellner 1984). Other dominant grasses in this shrubland are *Aristida diffusa, Themeda triandra, Cymbopogon plurinodis, Elionurus muticus* and *Eragrostis chloromelas.* Species distinguishing this shrubland are *Wahlenbergia albens*, *Merxmuellera disticha* and the shrub *Rhus erosa.* Other common species were the forbs *Cheilanthes eckloniana, Felicia muricata* and *Sutera pinnatifida* and the dwarf shrubs *Felicia filifolia,*
Walafrida saxatilis, Chrysocoma ciliata and *Asparagus laricinus.* Many species of this association are shared with Werger's (1980) Rhoetae erosae, but the exact nature of the relationship will not be determined here.

Five subassociations were recognised, *passerinetosum montanae, Elionuretosum mutici, pentzietosum globosae, elytropappetosum rhinocerotis* and *eragrostietosum curvulae:*

2.2.1 The *passerinetosum montanae* subass. nova (typus: Table 6, relevé 188) is dominated by *Elionurus muticus, Aristida diffusa* and *Eragrostis chloromelas*, and occasionally *Merxmuellera disticha, Rhus erosa,* and *Passerina montana.* Commonly occurring species are the grasses *Themeda triandra, Cymbopogon plurinodis* and *Heteropogon contortus*, the forbs *Cheilanthes eckloniana, Sutera pinnatifida, Scabiosa columbaria, Gazania krebsiana, Felicia muricata, Cyperus usitatus, Senecio retrorsus* and *Helichrysum nudifolium*, the dwarf shrubs *Walafrida saxatilis, Chrysocoma ciliata, Stoebe vulgaris* and *Felicia filifolia*, and the shrubs *Diospyros austro-africana* and *Rhus pyroides.* The only distinguishing species is *Scabiosa columbaria,* with *Andropogon appendiculatus* showing some fidelity to the *passerinetosum montanae.*

2.2.2 The *elionuretosum mutici* subass. nova (typus: Table 6, relevé 332) is dominated by *Elionurus muticus* and *Aristida diffusa.* Commonly occurring species are *Themeda triandra, Cymbopogon plurinodis, Eragrostis curvula* and *Digitaria eriantha*, dwarf shrubs *Passerina montana, Walafrida saxatilis, Chrysocoma ciliata, Stoebe vulgaris* and *Felicia filifolia*, forbs *Felicia muricata, Senecio retrorsus* and *Helichrysum nudifolium*, and shrubs *Diospyros austro-africana, Rhus erosa* and *R. pyroides.*

2.2.3 The *pentzietosum globosae* subass. nova (typus: Table 6, relevé 312) is dominated by *Aristida diffusa* and *Eragrostis chloromelas.* Other commonly occurring species are *Themeda triandra, Cymbopogon plurinodis, Elionurus muticus* and *Tragus koelerioides,* the forbs *Gazania krebsiana, Felicia muricata, Cyperus usitatus, Senecio retrorsus,* the dwarf shrubs *Pentzia globosa, Walafrida saxatilis, Chrysocoma ciliata, Felicia filifolia* and *Lycium* sp. and the shrub *Diospyros austro-africana.*

2.2.4 The *elytropappetosum rhinocerotis* subass. nova (typus: Table 6, relevé 380) is dominated by *Merxmuellera disticha* and *Elytropappus rhinocerotis*, the presence of which distinguishes the *elytropappetosum rhinocerotis* from the other subassociations. Commonly occurring species are *Themeda triandra, Cymbopogon plurinodis, Aristida diffusa, Eragrostis chloromelas, Tragus koelerioides, Cheilanthes eckloniana, Sutera pinnatifida, Wahlenbergia albens, Felicia muricata, Walafrida saxatilis* and *Chrysocoma ciliata,* and the shrub *Diospyros austro-africana.*

2.2.5 The *eragrostietosum curvulae* subass. nova (typus: Table 6, relevé 144) was dominated by *Merxmuellera disticha* and *Eragrostis curvula*. *Rhus erosa* was dominant when it occurred. Common species were *Helictotrichon turgidulum, Heteropogon contortus, Themeda triandra, Cymbopogon plurinodis, Aristida diffusa, A. congesta, Tragus koelerioides, Wahlenbergia albens* and *Helichrysum nudifolium, Walafrida saxatilis* and *Asparagus laricinus* and the shrub *Diospyros austro-africana.* The subassociation is distinguished by the absence of *Eragrostis chloromelas.*

***Acacia karroo* Savanna** (Table 7)

Savanna was fairly widely distributed in the study area, but the primary focus of the study was on grasslands and savanna was, therefore, only sampled in order to indicate its relationship with grassland vegetation. All the savanna vegetation sampled was dominated by the small tree *Acacia karroo* accompanied by the grass *Eragrostis curvula*. Data for savanna had a moisture gradient with mesic savanna (example Given in Figure 11) closer to the coast and dry savanna further inland. These were classified as two associations and two communities.

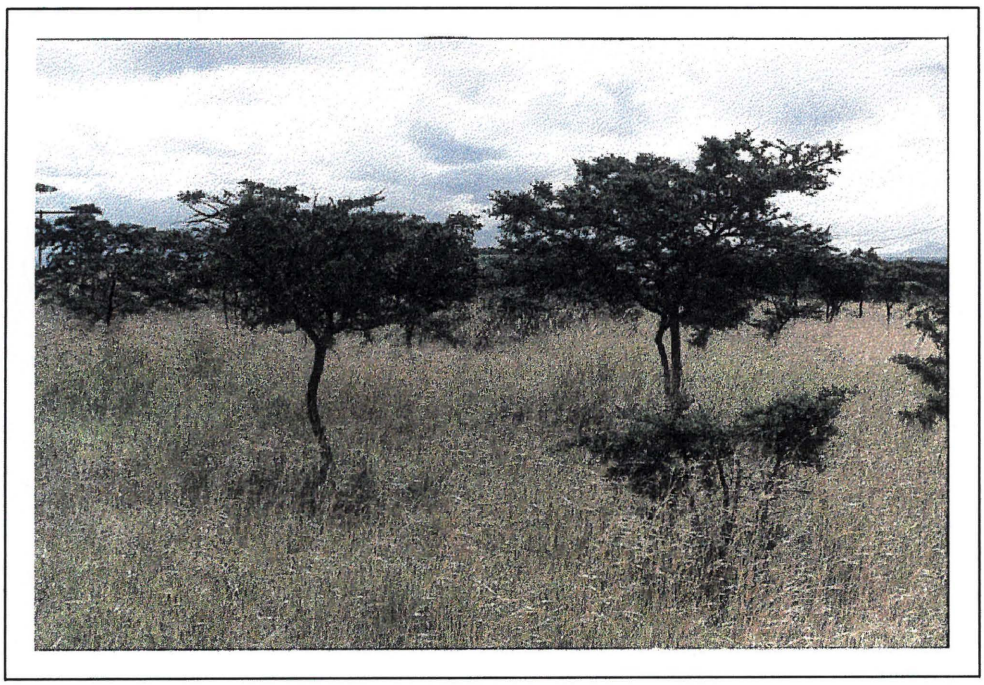


Figure 11: Mesic "coastal" savanna near East London with *Acacia karroo* and *Themeda triandra* dominating the two main vegetation strata.

Table 7: Phytosociological table of the savanna vegetation of the Eastern Cape.

Relevé number	2	61112222	79222333362	2222	2223
	0	53343555	26333666645	2357	6771
		8995012	0345679 6	5158	9010
Distinguishing species of *Acacia karoo-Cymbopogon validus* community					
Cymbopogon validus	3	.....	.....	....	....
Asparagus filicladus	+	.....	.....	....	....
Bidens pilosa	1	.....	.....	....	....
Distinguishing species of *Trago koelerioidis-Acacietum karoo*					
Tragus koelerioides	.	31+3a+3b	11..1+++1.1	1.1+	....
Cymbopogon plurinodis	.	111...1.	41b3ab+4a..	a331	.+..
Aristida congesta	.	.+5+++.1	.aa.++3+3..	.a.1	....
Asparagus laricinus	.	.+++++..	.+.++.+++.1	..+.	....
Aristida diffusa	.	13....3.	.+...1..+..	.+..	....
Walafrida saxatilis	.	...+..+.	...++.....	+.+.	....
Blepharis integrifolia	.	.....+..	..+.++.+...	.+.+	....
Opuntia ficus-indica	.	.1b..+..	.....+..+.+	..+.	....
Felicia filifolia	.	.+.1....	..1.....	1+..	....
Pentzia globosa	.	.....	..++.....1	.+1.	....
Cyanotis speciosa	.	.....+1+	....+++....	.+.+	....
Digitaria argyrograpta	.	.1+1....	1+.....	....	....
Eustachys paspaloides	.	1+.....	++...1..+..	....	....
Helichrysum rosum	.	.....++	.....+.....	++..	....
Hermannia coccocarpa	.	...++...	..+.++.+...	...+	....
Berkheya onopordifolia	.	.....	..+.....+.	.++.	....
Hermannia althaeifolia	.	+....+.+	+.....	....	....
Ipomoea crispa	.	.....++	.+...+.....	.+..	....
Maytenus heterophylla	.	.+1....a	.1.....1.	++..	....
Crassula dependens	.	.....+	.....+.a	....	....
Asparagus aethiopicus	.	.+...+..	.....1.....	+...	....
Panicum maximum	.	.....+..	1.a....1...	....	....
Pelargonium sidoides	.	.....	.....+.....	+..+	....
Boophane disticha	.	.....	..+.....+..	.+..	....
Gerbera piloselloides	.	.....	.....	++..	....
Lotononis laxa	.	.....+.	.....	+..+	....
Hermannia depressa	.	.....++	.....	..+1	....
Schkuhria pinnata	.	.....	.....++...	...+	....
Tribulus terrestris	.	.....	..+..+.....	..+.	....
Limeum aethiopicum	.	..+.....	....+.....	..+.	....
Jamesbrittenia atropurpurea	.	.....++.	.....	..+.	....
Trichodiadema species	.	...+...+	.....+	....	....
Rhus longispina	.	..1....	.....	.+..	....
Species common to *Acacia karoo-Cymbopogon validus* community and *Trago koeleroidis-Acacietum karoo*					
Lycium species	+	.....+	.++.+....1+	..++	....
Cotyledon orbiculata	+	....1...	.....	++..	....
Oxalis species	r	.....++.	+++..+.+...	....	....
Polygala amatymbica	+	.....	.....	.+.+	....
Distinguishing species of *pentzietosum incanae*					
Pentzia incana	.	..+1.+a+	.....	....	....
Lycium prunus-spinosa	.	..+1+++.	...+.....	....	....
Asparagus striatus	.	..+..+1+	.....	....	....
Euphorbia rhombifolia	.	.+.+...+	.....	....	....
Eriocephalus ericoides	.	...1a...	.....	....	....
Sporobolus fimbriatus	.	.++b....	.....+.....	....	....
Aizoon glinoides	.	.++..+..	.....	....	....
Tragus berteronianus	.	.....b+.	.....	....	....
Dolichos species	.	.....+.+	.....	....	....
Sporobolus nitens	.	.....++.	.....	....	....
Aloe africana	.	..+...++	.....	....	....
Berkheya heterophylla	.	.....++	.....	....	....
Nenax microphylla	.	.....1+	.....	....	....
Grewia robusta	.	.....1.+	.....	....	....
Ruschia cradockensis	.	.....b	.....	....	....

Distinguishing species of *michrochloetosum kunthii*

Microchloa kunthii	.|	.....+|	.++.1++....|	....|	....
Solanum tomentosum	.|	.....+..|	.....++++..|	....|	....
Diospyros lycioides	.|	........|	.....++..1.|	....|	....
Aristida junciformis	.|	........|	.......a1..|	....|	....
Mariscus congestus	.|	........|	.....++....|	....|	....
Ruschia spinescens	.|	........|	.........b|	....|	....

Species common to *diopyretosym austro-africani* and *Acacia karoo-Eragrostis capensis* community

Elionurus muticus	.|	........|	......+....|	+1.+|	11+.
Eragrostis capensis	.|	...1....|	+.........|	++.+|	111b
Helichrysum nudifolium	.|	........|	.........|	++..|	++..
Senecio inaequidens	.|	........|	......+....|	.+++|	..++
Lactuca inermis	.|	........|	.........|	...+|	..++
Thesium species	.|	........|	.........|	++..|	.++.

Distinguishing species of *diospyretosum austro-africani*

Diospy austro v. austr	.|	........|	.........|	1+..|	....
Scabiosa columbaria	.|	........|	.........|	.+.+|	....
Rhus pyroides	1|	........|	.........|	1+..|	....
Euphorbia striata	.|	........|	.........|	+..+|	....
Eragrostis racemosa	.|	........|	.........|	++..|	....
Salvia repens v. repen	.|	........|	.........|	+.+.|	....
Melica decumbens	.|	........|	.........|	.++.|	....

Distinguishing species of *Acacia karoo-Eragrostis capensis* community

Centella asiatica	.|	........|	.........|	....|	1++a
Moraea polystachya	.|	........|	.........|	....|	..++
Lobelia flaccida	.|	........|	.........|	....|	.++.
Rhynchosia ciliata	.|	........|	.........|	....|	++.+
Crassula tetragona	.|	........|	.........|	....|	+..+
Chamaecrista stricta	.|	........|	.........|	....|	++..
Schoenoxiphi sparteum	.|	........|	.........|	....|	11..
Selago corymbosa	.|	........|	.........|	....|	.+a.
Helictotrich turgidulu	.|	........|	.........|	....|	..1+
Richardia humistrata	.|	........|	.........|	....|	++..

Species common to *michrochloetosum kunthii, diospyretosum austro-africani* and *Acacia karoo-Eragrostis capensis* community

Arctotis arctotoides	.|	........|	.....+.+...|	..+.|	...+
Bulbine narcissifolia	.|	........|	+.........|	+...|	...+
Berkheya discolor	.|	........|	.....+..+..|	...+|	...+
Themeda triandra	.|	........|	.++1...++..|	aaa.|	.1.a
Brachiaria serrata	.|	........|	.++..++.+..|	+a..|	.+..
Senecio retrorsus	.|	........|	.....+.+...|	+..+|	+.+.
Hyparrhenia hirta	.|	........|	..+...+....|	.+..|	a1..
Helichrysum pilosellum	.|	........|	.....+.....|	...+|	++..
Anthospermum rigidum	.|	........|	........+..|	...+|	+...

Species of general occurrance in *Acacia karoo* savanna

Acacia karroo	4|	bab+33a1|	4bb13333343|	b411|	a++1
Eragrostis curvula	.|	ab1a.a+.|	+abb3a1+++3|	1ba1|	+.1+
Eragrostis obtusa	.|	..+..a11|	.11..++++.+|	...+|	...+
Heteropogon contortus	.|	++....1.|	.+.....11..|	+11+|	34a.
Gazania krebsiana	+|	.......+|	..+++...+..|	++++|	+...
Digitaria eriantha	.|	.....++a|	..1..a11+..|	...3|	..+.
Helichrysum rugulosum	+|	+.......|	.++.......+|	..++|	+..+
Pellae calome v. leuco	.|	.1......|	.........|	++..|	+...
Commelina africana	+|	........|	+.+..+.++..|	..+.|	.++.
Cynodon dactylon	.|	...1....|	..1.1+...41|	...+|	.1.1
Kyllinga alata	.|	.......+|	.....11....|	...+|	..+.
Eragrostis plana	.|	1.......|	1.....+..+.|	....|	.+.b
Hibiscus aethiopicus	.|	..+++.+.|	.........|	++..|	.+..
Setaria sphacelata	.|	+11..++.|	.........|	....|	+1a.
Eragrostis lehmanniana	1|	........|	....++.....|	....|	....
Solanum supinum	.|	+.......|	..+.+......|	..++|	.+..
Chrysocoma ciliata	.|	..+3..++|	..r+.......|	..+.|	...+
Cyperus usitatus	.|	1.+1++.a|	..+.1+....1|	..+.|	...+
Felicia muricata	.|	......++|	....+.++.++|	+.++|	...+
Eragrostis chloromelas	.|	....3...|	....+.a....|	...+|	...+

2.3 *Acacia karroo-Cymbopogon validus* savanna

A single relevé in the Amatola Mountains was classified into this community, situated on a gentle west-facing slope at an altitude of 1290 m. There was a 15% covering of surface rocks. It was the only inland savanna relevé to be found in the mountain region of the study area. It was dominated by *Acacia karroo* and had some of the species of general occurrance in other savanna, i.e. *Commelina africana, Gazania krebsiana* and *Eragrostis lehmanniana*, but *E. curvula, E. obtusa, Heteropogon contortus* and *Cyperus usitatus* were absent. The species *Asparagus filicladus* and *Bidens pilosa* were found only in this savanna community.

2.4 *Trago koelerioidis-Acacietum karroo* ass. nova

(Acacia karroo-Tragus koelerioides dry savanna)

typus: Table 7, relevé 365, holotypus

This dry savanna type was found mainly in the inland lowlands of the study area, especially in the Queenstown Basin. The association was found at altitudes ranging from 450–1740 m, but mostly below 1300 m.

The understorey of this association was dominated by *Eragrostis curvula, Cymbopogon plurinodis* and *Tragus koelerioides*. This association could be distinguished from other savanna in the study area by the presence of a large group of species (Table 7), most noticeably *Tragus koelerioides, Cymbopogon plurinodis, Aristida congesta* and *Asparagus laricinus*. Other commonly occurring species were *Eragrostis obtusa, Heteropogon contortus, Digitaria eriantha, Cyperus usitatus, Gazania krebsiana* and *Felicia muricata*.

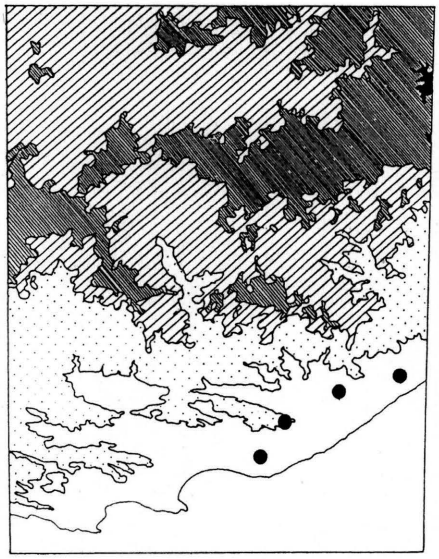
Three sub-associations were recognised:

2.4.1 The *pentzietosum incanae* subass. nova (typus: Table 7, relevé 251) could be distinguished by a fairly large group of species, including *Pentzia incana, Lycium prunus-spinosa* and *Asparagus striatus*.

2.4.2 The *michrochloetosum kunthii* subass. nova (typus: Table 7, relevé 365) was distinguished by the presence of the grass *Michrochloa kunthii* and the absence of the other sub-association distinguishing species.

2.4.3 The *diospyretosum austro-africani* subass. nova (typus: Table 7, relevé 231) was distinguished by the presence of its own species group, including *Diospyros austro-africana, Rhus pyroides* and others, as well as the presence of a number of species shared with the mesic savanna community, namely *Elionurus muticus, Eragrostis capensis, Senecio inaequidens, Hypoxis argentea* and others. This subassociation appeared to be transitional to valley bushveld type vegetation.

2.5 *Acacia karroo-Eragrostis capensis* mesic "coastal" savanna community



This community occurred on the coastal side of the mountain ranges of the study area at altitudes between 450 and 630 m. The distribution coincides with that of Acocks's (1988) Eastern Province Thornveld, Southern Form. It was distinguished from the other savanna vegetation by the presence of the forb *Centella asiatica* and the absence of the grasses *Cymbopogon plurinodis, Aristida diffusa, Tragus koelerioides* and *Aristida congesta,* the dwarf shrub *Pentzia globosa* and the woody *Lycium* sp. Dominant species were *Acacia karroo* and *Heteropogon contortus,* accompanied by *Eragrostis capensis, Elionurus muticus, Centella asiatica, Rhyncosia ciliata, Eragrostis curvula* and *Setaria sphacelata.*

There were reasons for not formally describing this community. Firstly, only four relevés were placed into this community, which is a low sampling intensity. Secondly, it is known that savanna occurs extensively in the Eastern Cape in this "coastal" belt (see distribution above). Little other data is available to clarify the relationship of this community to other savanna communities in the sub-region.

Grassy fynbos of the Eastern Cape (Table 8)

Acocks described grassy fynbos as False Macchia and mapped it as a unit centralised near Humansdorp. Only outliers of grassy fynbos occur in the part of the Eastern Cape covered by this study (see example in Figure 12). A number of researchers have studied grassy fynbos in more detail than Acocks. More recently, Cowling (1983b, 1984) covered grassy fynbos vegetation in the Humansdorp Region, Euston-Brown (1995) the Baviaanskloof Mountains north of Port Elizabeth and Van Wyk et al. (1988) the Zuurberg Mountains. These and other authors have suggested various reasons to explain the distinction between fynbos and other vegetation types. The relevant ones to this study are geological differences and rainfall seasonality, since altitude and geographical distinctions are insufficient to separate the vegetation units. It is also obvious from an examination of the descriptions of the communities by these authors that grassy fynbos is floristically variable, with the gradient of variability in an east-west direction.

Figure 12: Grassy fynbos east of Grahamstown containing the endemic asteraceous shrub, *Oldenburgia arbuscula*.

Table 8: Phytosociological table of grassy fynbos of the Eastern Cape.

Relevé number	22233	11
	77700	23
	45689	90
Community 1 species		
Metalasia densa	.1b1+a	..
Tristachya leucothrix	111++.	..
Argyrolobium species	+..+++	..
Andropogon appendicula	b11...	..
Brachiaria serrata	++.+.+	..
Rhus lucida	1b.+..	..
Tetraria species	a+1...	..
Burchellia bubalina	+1++..	..
Erica species	+.+..4	..
Agathosma ovata	a..a+.	..
Aspalathus species	...1+1	..
Euphorbia species	.1++..	..
Tephrosia capensis	++1...	..
Phylica species	+.1.+.	..
Acacia mearnsii	....1a	..
Digitaria eriantha	.b....	..
Eragrostis capensis	+.+.+.	..
Helichrysum odoratissi	..+++.	..
Thesium species	+...++	..
Rhynchosia totta	+.++..	..
Ficinia gracilis	.++.+.	..
Anthospermum species	...+++	..
Helichrysum miconiifolium	...+1.	..
Colpoon compressum	.+.+.+	..
Community 2 species		
Phylica gnidioides	.....	11
Crassula mollis	.....	++
Cliffortia paucistamin	.....	.a
Cynodon dactylon	.....	.a
Hypoxis multiceps	.....	++
Species of general occurrance		
Bobartia orientalis	1+aa+a	31
Restio triticeus	1+3a1b	4.
Eragrostis curvula	+1++11	11
Themeda triandra	3.a+31	1.
Senecio retrorsus	+..+++	+.
Heteropogon contortus	1a1+..	+.
Helichrysum anomalum	+..++.	b+
Selago corymbosa	1+1+..	++
Oldenburgia grandis	.b.1.a	.3
Helichrysum species	+.a..+	+.
Arctotis arctotoides	+...++	+.
Helichrysum nudifolium	r..+..	++
Cheilanthes eckloniana	.+.+..	.+
Setaria sphacelata	++....	++
Disparago tortilis	...+++	+.
Aspalathus chortophila	...++.	++
Diospyros dichrophylla	.+....	11
Alepidea capensis	...++.	+.
Helictotrich turgidulu	....1.	++
Commelina africana	....+.	++
Gazania krebsiana	...++.	+.
Berkheya species	.....+	++
Schoenoxiphi sparteum	....++	.+
Senecio juniperinus	...++.	.+
Panicum aequinerve	....a.	++
Senecio speciosus	+....+	+.
Lobelia tomentosa	...+.+	+.
Erica cerinthoides	....+.	++

3.1 *Restio triticei-Oldenburgietum grandii* ass. nova

(Oldenburgia grandis-Restio triticeus grassy fynbos of the Grahamstown highlands)

typus: Table 8, relevé 308, holotypus

The association is distinguished by the presence of *Bobartia orientalis* and *Restio triticeus* and has *Metalasia densa, Rhus lucida, Burchellia bubalina, Agathosma ovata, Selago corymbosa* and *Disparago tortillis* amongst the commonly occurring species. Of the species occurring widely in the grasslands of the Eastern Cape, *Themeda triandra, Heteropogon contortus, Eragrostis curvula, Tristachya leucothrix* and *Helichrysum anomalum* are found in this association. The species composition corresponds to the description of grassy fynbos by Cowling & Holmes (1992). Two varieties were distinguished, but not recognised due to insufficient data to determine the significance of the split.

The grassy fynbos described here was found at altitudes between 570 and 900 m in the hills around Grahamstown on south-facing slopes. Rainfall ranged from 550 to 800 mm per year. These south facing slopes are also influenced by orographic rainfall and heavy mists. Rainfall seasonality is probably important and is transitional between spring and autumn maximum (Kopke 1988). The geology is consistently of Cape Supergroup origin resulting in a nutrient poor, leached substrate, as is dominant in the Fynbos Biome, but possibly supplemented by influences of a more fertile geological origin.

Acocks (1988) remarked on the transition of the False Macchia to Dohne Sourveld, especially its similarity to vegetation on the summits of the Amatola and Katberg mountains. Trollope (1970) remarked on how non-specialist fynbos species are common and sometimes problematic in afromontane grasslands. In this study an association was described (*Themedo triandrae-Helichrysetum aurei*) in which linking elements between grassy fynbos and grassland were identified. There is, therefore, a clear link between grassy fynbos and certain afromontane grasslands in the study area.

4. Karroid Dwarf Shrubland of the Eastern Cape (Table 9)

Karoo-type vegetation (see example in Figure 13) was found towards the western side of the study area on flat plains between sloping landscapes at altitudes from 540 to 1560 m. The mountain slopes were dominated by the *Merxmuellero distichae-Diospyretum austro-africani* or *Elytropappo rhinoceroties-Merxmuelleretum distichae*. One major vegetation group, with two associations, was identified, as well as three communities represented by a single relevé each. The major group contained a number of species of *Pentzio-Chrysocomion* Werger (1980), namely *Chrysocoma ciliata, Tragus koelerioides, Aristida congesta, Walafrida saxatilis, Felicia muricata* and *Eragrostis obtusa*. Werger (1980) considers these to be "Karoo pioneers" and suggests that a widespread class could be described based on these species. Since it shares some species the associations described here have some relationship to Werger's group, but the nature of this is unknown at this stage. There is also some relationship to Van der Walt's (1980) *Eragrostis obtusa-Eragrostis curvula* grassland and shrubland communities, Palmer's (1989) Dwarf Shrubland and his Karoo Dwarf Shrublands (Palmer 1991a).

Figure 13: Karroid dwarf shrubland in a patch within dry grasslands near Nieu-Bethesda north of Graaff-Reinet.

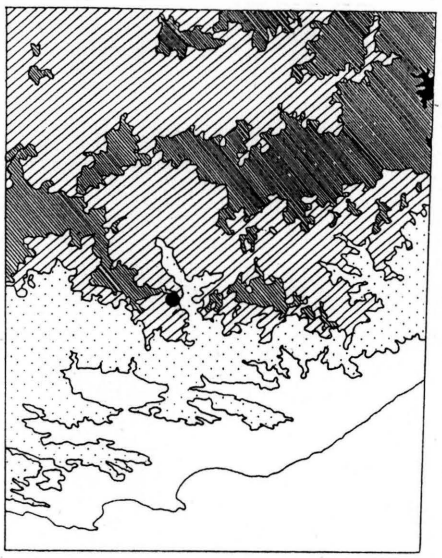
Table 9: Phytosociological table of karroid vegetation of the Eastern Cape.

Relevé number	111111111 1222 1 4 1 334444445 5557 0 1 3 240167892 3342 1 0 7
Species of *Chrysocomo ciliatae-Digitarietum argyrograptae*	
Digitaria argyrograpta	+3+.++b1. ....
Eragrostis capensis	+.+1+.11. .... 1 . .
Chloris virgata	1..1.++.+ ....
Eragrostis racemosa	.b...+..+ ....
Berkheya glabrata	.+..++... ....
Panicum coloratum	....++1.. ....
Mestoklema elatum	..+..++.. ....
Themeda triandra	.+....a.. ....
Species of *Trago koelerioidis-Aristidetum argyrograptae*	
Aristida diffusa	..... 33.+ . + .
Heliophila carnosa	..... .+++ . . .
Blepharis mitrata	..... .++. . . .
Talinum caffrum	..... .+1. . . .
Melolobium burchelli	..... 1..1 . . .
Helichrysum rosum	..... ++.. . . .
Species of *Chrysocomo ciliatae-Digitarietum argyrograptae* and *Trago koelerioidis-Aristidetum argyrograptae*	
Lycium prunus-spinosa	++111aa11 +1.. . . .
Chrysocoma ciliata	31+.a333. ++.+ . . +
Cynodon dactylon	1.+3.3114 ..1. . . .
Eriocephalus ericoides	a.+.+.+1. ...+ . . .
Felicia muricata	+.+..... ++.+ . . .
Chenopodium album	.....r..a +.+. . . .
Euphorbia species	+.+.1.... +... . . .
Indigofera alternans	.....++.. ..++ . . .
Gazania krebsiana	+.+..... ++.. . . .
Phymaspermum parvifolium	1..... ..+1 . . .
Hermannia coccocarpa	1.....+. ...+ . . .
Cyanotis speciosa	+..... .++. . . .
Wahlenbergia albens	1.....+ .+.. . . .
Species of *Trago berteronianus-Enneapogon desvauxii* community	
Tragus berteronianus	.... 3 . .
Enneapogon desvauxii	.... a . .
Cyphia sylvatica	.... 1 . .
Species of *Pentzia globosa-Eriocephalus spinescens* community	
Pentzia globosa	.... 3 .
Eriocephalus spinescens	.... a .
Species of *Rhus longispina-Enneapogon scoparius* community	
Rhus longispina	.... a
Enneapogon scoparius	....+. . . b
Heteropogon contortus	.... a
Pachycarpus species	 1
Rhus refracta	 1
Salvia africana-lutea	 1
Aizoon glinoides	 1
Opuntia ficus-indica	 1
Species of general occurrance	
Tragus koelerioides	bb41ba331 aab1 . b 1
Pentzia incana	+++a4a113 1aba + . a
Eragrostis curvula	a3a1a.ba+ .11a . . 4
Merxmuellera disticha	a1a+.r111 +..3 . 1 .
Asparagus laricinus	+..+1.+++ .+++ + + +
Cyperus usitatus	aa..1111+ 11.1 + 1 .
Eragrostis obtusa	..+.+.... ..1+ . 1 .
Euphorbia rhombifolia	..+.+.++. ++.. . . +
Aristida congesta	3a++...++ 1... + + .
Trichodiadema species	.....+. ++++ b + .
Aptosimum procumbens	.++.+++++ +... . . +
Walafrida saxatilis	...+...++ ++.. . 1 .
Lepidium africanum	..++....+ +..+ . + .
Melica decumbens	.+.+....+ ...+ . + .
Microchloa kunthii	..1..+... 1... . + .
Sporobolus fimbriatus	.....+.b. .... a . .
Nenax microphylla	..+..... +..+ . + .
Eragrostis lehmanniana	1..... ..+. . 1 .

4.1 *Chrysocomo ciliatae-Digitarietum argyrograptae* ass. nova

(Digitaria argyrograpta-Chrysocoma ciliata dwarf shrubland)

typus: Table 9, relevé 149, holotypus

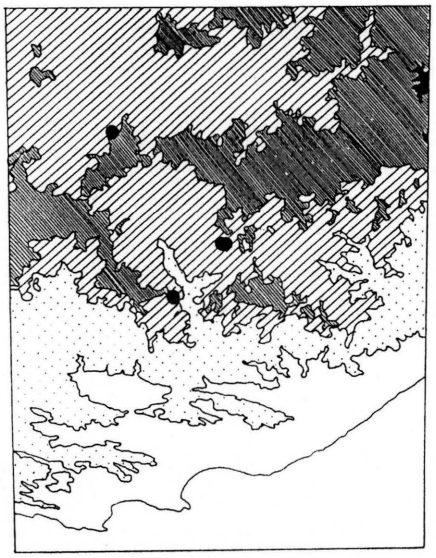


All relevés classified into this association were recorded on the farm Karreebosch in the mountains between Cradock and Somerset East (Blomfonteinberge) at altitudes between 1290 and 1500 m. Dominant species were *Digitaria argyrograpta, Lycium prunus-spinosa, Chrysocoma ciliata, Cynodon dactylon, Tragus koelerioides, Pentzia incana, Eragrostis curvula, Cyperus usitatus* and *Merxmuellera disticha.* Other common species were *Eragrostis capensis, Eriocephalus ericoides, Asparagus laricinus, Aristida congesta* and *Aptosimum procumbens*. Species which could be used to distinguish this association from others were *Digitaria argyrograpta, Eragrostis capensis* and *Chloris virgata.*

4.2 *Trago koelerioidis-Aristidetum diffusae* ass. nova

(Aristida diffusa-Tragus koelerioides grassy dwarf shrubland)

typus: Table 9, relevé 253, holotypus



This association was found on the boundary between Acocks's (1988) False Upper Karoo and Karroid *Merxmuellera* Mountain Veld at altitudes between 1100 and 1560 m. The species present suggest the transitional nature of this association, eg. *Merxmuellera disticha, Pentzia incana, Asparagus laricinus, Tragus koelerioides, Eragrostis obtusa, E. curvula, Aristida diffusa, A. congesta* and *Melolobium burchellii* are found in this association as well as one of the Acocks Veld Types mentioned. The association is also transitional between the *Elytropappo rhinocerotis-Merxmuelleretum distichae* and the *Chrysocomo ciliatae-Digitarietum argyrograptae* through shared species. Dominant species

in the association were *Aristida diffusa, Tragus koelerioides, Pentzia incana* and *Eragrostis curvula*. Other common species were *Heliophila carnosa*, which was also a distinguishing species for the association along with the other group B species, *Chrysocoma ciliata, Felicia muricata, Asparagus laricinus, Cyperus usitatus* and *Trichodiadema* sp.

4.3 *Tragus berteronianus-Enneapogon desvauxii* dry disturbed karroid grassland community

(Syn.: False Central Lower Karoo sensu Acocks 1988)

The single relevé representing this community was found south of Somerset East corresponding in distribution with Acocks's (1988) False Central Lower Karoo, which he considers to be marginal grassveld or shrub savanna. The relevé was on flat, lowland plains between the hills on orange clay / loam soil and was dominated by the grasses *Tragus berteronianus, Enneapogon desvauxii* and *Sporobolus fimbriatus* and the herb *Trichodiadema* species. The first two are annuals which occur in disturbed places or overgrazed veld throughout Africa and other parts of the world and *Sporobolus fimbriatus* occurs in sandy loam in disturbed areas or shady spots (Gibbs-Russell *et al.* 1991). The species *Pentzia incana, Eriocephalus spinescens, Hermannia cuneifolia* and *Enneapogon desvauxii*, all present in the relevé, are species listed by Acocks (1988) which should occur in this association. The community is, therefore, considered to be synonymous with Acocks's (1988) False Central Lower Karoo.

4.4 *Pentzia globosa-Eriocephalus spinescens* dwarf shrubland community

The relevé representing this community was found east of Noupoort on the summit of a gentle slope on a plateau. The soil was shallow and pebbly on the surface. The relevé was dominated by *Pentzia globosa, Eriocephalus spinescens* and *Tragus koelerioides*. The former two species were distinguishing for this community on this table, having their only occurrance here. Other species occurring in this relevé were *Merxmuellera disticha, Asparagus laricinus, Cyperus usitatus, Eragrostis obtusa, E. lehmanniana, Aristida congesta, Trichodiadema* sp., *Walafrida saxatilis* and others. This community could not be exactly matched to any published descriptions, but resembled closely (due mainly to shared

companion species) Palmer's (1991a) various Dwarf Shrublands, and fell within the distribution of Acocks's (1988) *Merxmuellera* Mountain Veld.

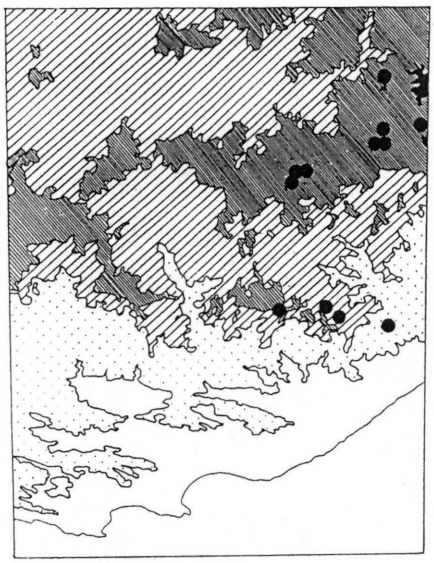
4.5 *Rhus longispina-Enneapogon scoparius* grassy open karroid bushland community

The relevé representing this community was found on the farm Karreebosch in the Blomfonteinberge between Cradock and Somerset East. It was near the bottom of a slope in a hot valley. The soil was sandy, stony and there was some surface erosion. The locality of the relevé falls within the distribution of Acocks's (1988) Valley Bushveld (Fish River Scrub) and shares a number of species with this Veld Type, namely *Protasparagus striatus, Carissa haematocarpa, Opuntia ficus-indica* (exotic invader esp. in bushveld, Acocks 1988), *Rhus refracta, Pentzia incana, Chrysocoma ciliata, Limeum aethiopicum* and others. Within the present classification this relevé shares species of both karroid dwarf shrublands and dry savanna.

This relevé was dominated by the grasses *Eragrostis curvula, Enneapogon scoparius, Heteropogon contortus* and *Tragus koelerioides,* the dwarf shrub *Pentzia incana* and the shrub *Rhus longispina.* Other species occurring in this relevé were *Pachycarpus* sp., *Rhus refracta, Salvia africana-lutea, Aizoon glinioides, Opuntia ficus-indica* and *Tragus koelerioides.* The grass *Enneapogon scoparius* is usually found in dry grassland on rocky hillslopes (Gibbs-Russell *et al.* 1991) as was the case here. Structurally the relevé had a tree layer 3 m in height, but this only covered 10 % of the relevé.

This community also resembles Palmer's (1991a) *Aptosimum procumbens-Rhus burchellii* Broken Dwarf Shrubland in floristics and structure (but *Rhus burchellii* is replaced by *R. longispina*) and Acocks's (1988) False Karroid Broken Veld.

5. Wetlands and Drainage Line Communities of the Eastern Cape (Table 10)



The distribution of the data for these communities demonstrates their azonal nature. True wetlands separated distinctly from drainage lines in this data set. Insufficient data was collected to describe wetlands adequately. The wetlands were divided into four communities, of which two were closely related. Each was represented by only a single relevé. The drainage lines were divided into two associations, one with two sub-associations. An average of 23 species per relevé was found for both wetlands and drainage lines.

Wetlands

5.1 *Phragmito australis-Schoenoplectetum tabernaemontani* ass. nova

(*Schoenoplectus tabernaemontani-Phragmites australis* wetland)

typus: Table 10, relevé 151, holotypus

This wetland was situated in a vlei down a gently sloping valley in the mountains south of Cradock. There was sufficient surface water for a trickle to run through the vegetation in the wetland. The sedge *Cyperus longus* was also abundant in this community, accompanied by *Isolepis costata*, *Berula erecta* and *Cynodon incompletus*. The shrub *Rhus pyroides* was present on the side of the community. Other species found adjacent to the wetland were *Arctotis arctotoides*, *Cirsium vulgare* and *Hypochaeris radicata*.

5.2 *Schoenoplecto paludicolae-Pennisetetum macrouri* ass. nova

(*Pennisetum macrourum-Schoenoplectus paludicola* wetland)

typus: Table 10, relevé 86, holotypus

The sample for this wetland was situated in the hills south-east of Cathcart in a valley bottom. There was surface water, but not running. Species accompanying the dominants were *Paspalum distichum*, *Eleocharis palustris*, *Cynodon dactylon* and *Eragrostis planiculmis*.

5.3 *Schoenoplecto corymbosi-Typhetum capensis* ass. nova

(*Typha capensis-Schoenoplectus corymbosus* wetland)

typus: Table 10, relevé 33, holotypus

This sample was located in a valley bottom in the Amatola Mountains. There was permanent standing water which deepened with distance inwards so that a degree of zonation could be observed in the wetland community. *Typha capensis*, accompanied by *Juncus effusus*, dominated the deepest parts, with open water beyond. Landwards these species were replaced by *Schoenoplectus corymbosus*, *Kyllinga erecta*, *Berula erecta* and *Ranunculus multifidus*. At the edges where there was no longer surface water the wetland graded into hygrophilous grassland with species such as *Helichrysum simillimum*, *Paspalum dilatatum*, *Pennisetum sphacelatum*, *Hypochaeris radicata* and others.

5.4 *Cypero sexangularis-Schoenoplectetum corymbosi* ass. nova

(*Schoenoplectus corymbosus-Cyperus sexangularis* wetland)

typus: Table 10, relevé 95, holotypus

The sample for this wetland was situated in a valley bottom near Cathcart which was cut by an erosion gulley. There was no surface water and many of the species present were reminiscent of drainage line communities. As with this sample, it was often found in this area that drainage lines were dominated by the tree *Salix babylonica*. Various other species were fairly abundant, namely *Cyperus sexangularis*, *Schoenoplectus corymbosus*, *Eragrostis plana*, *Paspalum distichum*, *Mentha longifolia*, *Hyperrhenia hirta*, *Oenothera rosea*, *Cynodon incompletus* and *Miscanthus capensis*.

Table 10: Phytosociological table of wetlands and drainage lines of the Eastern Cape.

Relevé number	1	8	3	9	3	2221233	1111117
	5	6	3	5	0	4999257	7890054
	1				1	4493127	59 57
Species of *Phragmito australi-Schoenoplectetum tabernaemontani*							
Schoenoplectus tabernaemontanum	4	.	.	.	.	.....	.....
Phragmites australis	b	.	.	.	.	.....	11....
Cyperus longus	a	.	.	.	.	..+....	.....
Isolepis costata	1	.	.	.	.	.....	.....
Species of *Schoenoplecto paludicolae-Pennisetetum macrourum*							
Pennisetum macrourum	.	4	.	.	.	.....	.....
Schoenoplectus paludicola	.	a	.	.	.	.....	.....
Eleocharis palustris	.	+	.	.	.	.....	.....
Species of *Schoenoplecto corymbosi-Typhetum capensis* and *Cypero sexangularis-Schoenoplectetum corymbosi*							
Schoenoplectus corymbosus	.	.	b	3	.	.....	.....
Species of *Schoenoplecto corymbosi-Typhetum capensis*							
Typha capensis	.	.	3	.	.	.....	.....
Kyllinga erecta	.	.	a	.	.	.....	.....
Juncus effusus	.	.	a	.	.	.....	.....
Species of *Cypero sexangularis-Schoenoplectetum corymbosi*							
Cyperus sexangularis	.	.	.	b	.	.....	.....
Schoenoplectus decipiens	.	.	.	+	.	.....	.....
Datura stramonium	.	.	.	+	.	.....	.....
Pulicaria scabra	.	.	.	+	.	.....	.....
Species of *Festuco costatae-Merxmuelleretum drakensbergensis*							
Merxmuellera drakensbergensis	.	.	.	.	3	b.....	.....
Festuca costata	.	.	.	.	b	.....	.....
Festuca scabra	.	.	.	.	b	.....	.....
Helichrysum aureum	.	.	.	.	+	.....	.....
Euphorbia epicyparissius	.	.	.	.	+	.....	.....
Carex cognata	.	.	.	.	+	.....	.....
Fuirena coerulescens	.	.	.	.	+	.....	.....
Berkheya cirsiifolia	.	.	.	.	+	.....	.....
Berkheya macrocephala	.	.	.	.	+	.....	.....
Species occurring in more than wetland association							
Paspalum distichum	.	1	.	a	.	.....	.....
Cynodon incompletus	1	.	.	1	.	.....	.....
Berula erecta	1	.	1	.	.	.....	.....
Species of *Erogrostio curvulae-Miscanthetum capensis*							
Miscanthus capensis	.	.	.	1	.	3ba1b33	aa..3..
Eragrostis curvula	.	.	.	.	+	+.1b1..	+.+.11.
Bromus catharticus	.	.	.	.	.	+..++..	++++++.
Themeda triandra	.	.	.	.	1	+++abba	.....1a
Species of *helichrysetosum splendidi*							
Helichrysum splendidum	.	.	.	.	.	++b1.+.	.....
Leucosidea sericea	.	.	.	.	.	.b+..+.	.....
Gomphostigma virgatum	.	.	.	.	.	..b....	.....
Eragrostis chloromelas	.	.	.	.	.	.a1+++	.....
Helictotrichon turgidulum	.	+	.	.	+	++.+++.	.....
Senecio retrorsus	.	.	.	.	.	+.+++..	.....
Pennisetum sphacelatum	.	.	+	.	.	+1+1...	.....
Berkheya purpurea	.	.	.	.	.	+.1....	.....
Cyperus marginatus	.	.	.	.	.	...1...	.....
Gunnera perpensa	.	.	.	.	.	..1....	.....
Artemisia afra	.	.	.	.	.	...+.+.	.....
Species of *cynodetosum dactyli*							
Cynodon dactylon	.	1	b	.	.	.....	.a44b+1
Lasiospermum bipinnatum	.	.	.	+	.	....+..	+.r++1.
Chrysocoma ciliata	.	.	.	.	.	+..+...	...3+..
Sporobolus africanus	.	.	.	+	.	.....	..b.1.1
Juncus inflexus	.	.	.	.	.	.....	....b..

Species of general occurrence in wetland and drainage line associations

Eragrostis plana	.	+	.	a	.	.....	1
Eragrostis capensis	.	.	.	.	+	+.a....	.....+
Andropogon appendiculatus	.	.	.	+	+	a...b..	.....4.
Hyparrhenia hirta	.	.	.	a	.	3	.....a
Oenothera indecorus	.	.	.	1	+	++.....	...+.a.
Salix babylonica	.	.	.	b	.	b.....	b.....
Arctotis arctotoides	+	.	.	.	+	++.....	+....+.
Cirsium vulgare	+	.	.	+	.	+...+..	.+..++.
Senecio inaequidens	.	.	.	.	.	.++....	+..++..
Mentha longifolia	.	.	.	a	.	.+.....	.....
Pseudognaphalium luteo-album	.	+	.	+	+	.+.....	.....
Paspalum dilatatum	.	+	+	+	.	.....	..+....
Hypochaeris radicata	+	+	+	.	.	.....	...++..
Cotula heterocarpa	.	+	.	.	.	....++.	...1...
Taraxacum officinale	.	.	.	.	.	+...+..	+..+...
Senecio asperulus	.	.	.	.	.	....+..	+..+...
Senecio juniperinus	.	+	.	+	.	+.....	.....+
Berkheya species	.	+	.	.	.	.....	++...++
Lobelia flaccida	.	+	+	.	+	.....	....+.+
Mariscus congestus	.	.	.	+	.	.++....	.....
Gazania krebsiana	.	.	.	.	+	...++..	.....
Schoenoxiphium sparteum	.	.	.	.	+	..+.++.	.....+

Drainage line grasslands

5.5 *Eragrostio curvulae-Miscanthetum capensis* ass. nova

(*Miscanthus capensis-Eragrostis curvula* drainage line grassland)

typus: Table 10, relevé 107, holotypus

These occupied drainage lines throughout the study area and tended to have a strong grassy component. An example is shown in Figure 14.

Figure 14: Drainage line dominated by large tussocks of Miscanthus capensis in the Winterberg Mountains.

Two distinct sub-associations were recognised, *helichrysetosum splendidi* and *cynodetosum dactyli*:

5.5.1 The *helichrysetosum splendidi* subass. nova (typus: Table 10, relevé 299) was dominated by the grass *Miscanthus capensis*, which had a strong tussock habit. Also abundant was the low shrub *Helichrysum splendidum* accompanied by a high presence of the grasses *Helictotrichon turgidulum, Eragrostis chloromelas* and *Pennisetum sphacelatum* and the herb *Senecio retrorsus*. An average of 27 species per relevé were

found in this sub-association. The woody shrub / small tree *Leucosidea sericea* was occasionally present, as was the grass *Andropogon appendiculatum*. In the Stormberg Plateau area and into the Drakensberg *Leucosidea sericea* often dominated drainage lines and was viewed as an increaser plant and problematic by land-owners.

5.5.2 The *cynodetosum dactyli* subass. nova (typus: Table 10, relevé 107) was dominated by grasses such as *Eragrostis curvula, Bromus catharticus*, *Cynodon dactylon* and occasionally *Sporobolus africanus*. The herb *Lasiospermum bipinnatum* and the dwarf shrub *Chrysocoma ciliata* were occasionally abundant suggesting overgrazing and disturbance. This is supported by the low species richness of only 19 species per relevé for this sub-association.

5.6 *Festuco costatae-Merxmuelleretum drakensbergensis* ass. nova

(*Merxmuellera drakensbergensis-Festuca costata* sub-alpine drainage line grassland)

typus: Table 10, relevé 301, holotypus

At high altitudes in the Drakensberg and Witteberg Mountains drainage lines and streambanks are dominated by the tall, tussock-forming *Merxmuellera drakensbergensis*. This endemic species is found in the alpine belt where the soil is deeper than in surrounding areas (Gibbs-Russell *et al.* 1991). Only one sample was placed in this association (relevé 301) and the general description which follows is based on this. The association was dominated by *Merxmuellera drakensbergensis, Festuca costata* and *F. scabra*, but unlike other drainage line grasslands, had high species richness (48 species). A number of wetland-related species were recorded, viz. *Carex cognata, Fuirena coerulescens* and *Foeniculum vulgare*, as well as *Euphorbia epicyparissius*, which was also found on steep, south-facing escarpment slopes at lower altitudes. This sample was at an altitude of 2100 m on a gentle, north-facing slope within a steeply-sloping landscape. The soil was deep and peaty.

Ordination

Initially the complete data set was ordinated, but resulted in one group containing the majority of the data and a few outliers. Successive removal of outliers and re-ordination produced the same result every time. Data for each table (Tables 4–10) were then ordinated, but the variability in the data was so great that the first three axes of the ordination routinely failed to capture more than 33% of the variability. This failure to identify any major gradients could be due to inadequate discontinuities in the data which could be used to indicate distinct communities. The results of the ordination therefore did not contribute more to the knowledge gained from the classification, and the results are not presented.

The floristic complexity of the Eastern Cape has made ordination a difficult method to use for establishing the relationship between floristic and environmental variables. This may be due to co-variables confounding interpretations (Palmer 1991b). An alternative approach to ordination is to categorise variables and apply a statistical approach. This approach is attempted in more detail in the following chapter on modelling.

4. Environmental relationships and community distributions

Introduction

The distribution of plant communities is directly related to cretain environmental variables (Palmer 1991b). Macroclimate, a broad scale environmental factor, has long been recognised by plant geographers as determining the overall distribution of plant species, and plant community distributions depend on species distributions (e.g. Pigott & Huntley 1981; Huntley *et al.* 1995). Assuming an individualistic response of plant communities and individuals to environmental variables it is possible to model the relationship between the plant community and those variables (e.g. Palmer 1991b; Palmer & Van Staden 1992).

There are two ways in which the relationship between plant community classifications and environmental factors may be interpreted (Palmer 1991b). The first is by the use of ordination, but the disadvantage is that co-variables can confound interpretations. The second is a statistical approach in which environmental variables are converted to categorical variables and contingency tables are created. Cells with the highest frequencies can be used to provide the conditions under which a community may occur. This distribution of the plant community provides a testable hypothesis of the potential vegetation. In this way, and using annual rainfall and elevation, Palmer & Van Staden (1992) successfully predicted the distribution of plant communities of two Veld Types (Acocks 1988) in northern Mpumalanga, South Africa.

A strong precipitation gradient exists in the Eastern Cape, increasing towards the west and away from the coast (see Chapter 2). The topography is also highly variable and has an influence on precipitation. Altitude also influences plant distributions through correlated changes in more direct variables, for example temperature (Austin *et al.* 1984). Altitude and precipitation together have been shown to have a very strong influence on vegetation composition (Daubenmire 1943; Allen *et al.* 1991) and may, therefore, have a great potential for predicting plant community distributions. There may also be other environmental variables which influence the distribution of species, e.g. geology and soil type. However, in practice, these other environmental variables may manifest themselves at a different scale in the landscape to

altitude and rainfall. These will also be examined to determine their influence on plant community distributions.

The aims of this chapter are:

- to determine which of the examined habitat factors may be important in influencing the distribution of plant communities at the association level in the Eastern Cape grasslands.
- to predict the potential distribution of selected associations of the Eastern Cape grasslands using the modelling procedure of Palmer & Van Staden (1992).

Methods

Habitat factors

A number of environmental factors were examined in this study. Data for these factors were obtained from various sources. Median annual rainfall for each sample was obtained by linking latitude / longitude positions of floristic samples to a model of median annual rainfall within a GIS (Geographical Information System) environment. The altitude of each sample was obtained using a portable GPS (Global Positioning System) in the field. The cover of surface rocks was estimated in the field as a percentage. Slope was measured in degrees asnd aspect was obtained from a compass reading in the field. Topographical position was taken as the top of a slope, the crest or scarp of a slope, midslope, footslope or bottom of the slope (drainage line). Geology was determined from geological maps or in the field.

The environmental variables were converted into categorical variables. Following Palmer & Van Staden (1992) six elevation classes (<1000 m, 1000–1250 m, 1251–1500 m, 1501–1750 m, 1751–2000 m and >2000 m) and five median annual rainfall classes (<400 mm, 401–500 mm, 501–600 mm, 601–700 mm and > 700mm) were subjectively selected after examination of a scatterplot of these variables (Figure 15). Six classes were subjectively selected for percentage cover of surface rock (0–9, 10–19, 20–29, 30–39, 40–49 and >50%). For slope a logarithmic scale was used resulting in five classes (0–1, 2–5, 6–15, 16–29 and >30°). Aspect was divided

Table 17: Contingency table of observed and expected frequencies for the *Hermannio depressae-Eragrostietum chloromeladis*.

Median Annual Rainfall		Altitude <1000	1001–1250	1251–1500	1501–1750	1751–2000	>2000
<400	f_{obs}		1	0	0		
	f_{exp}		0.2	0.6	0.3		
400–500	f_{obs}		4*	2	3		
	f_{exp}		1.4	5.3	2.3		
500–600	f_{obs}		0	14*	3		
	f_{exp}		2.7	10.1	4.25		
600–700	f_{obs}		0	3	2		
	f_{exp}		0.8	3	1.3		
>700	f_{obs}						
	f_{exp}						

Chi-square = 16.94; d.f. = 6; Significance = 0.009;*cells selected for defining the communities.

Table 18: Contingency table of observed and expected frequencies for the *Eragrostio curvulae-Themedetum triandrae*.

Median Annual Rainfall		Altitude <1000	1001–1250	1251–1500	1501–1750	1751–2000	>2000
<400	f_{obs}						
	f_{exp}						
400–500	f_{obs}	1	0	0	3*	0	0
	f_{exp}	0.3	0.4	1.5	1.5	0.3	0.1
500–600	f_{obs}	0	2	6*	2	1	0
	f_{exp}	0.7	1.1	4	4	0.7	0.4
600–700	f_{obs}	1	1	4*	4*	1	0
	f_{exp}	0.7	1.1	4	4	0.7	0.4
>700	f_{obs}	0	0	1	2	0	1
	f_{exp}	0.3	0.4	1.5	1.5	0.3	0.1

Chi-square = 19.5; d.f. = 15; Significance = 0.192;*cells selected for defining the communities.

Table 19: Contingency table of observed and expected frequencies for the *Merxmuellero distichae-Diospyretum austro-africani.*

Median Annual Rainfall		Altitude <1000	1001–1250	1251–1500	1501–1750	1751–2000	>2000
<400	f_{obs}			3*	1	1	0
	f_{exp}			1.3	2.6	1	0.1
400–500	f_{obs}			3	9*	2	0
	f_{exp}			3.7	7.3	2.7	0.3
500–600	f_{obs}			5*	9*	3	0
	f_{exp}			4.5	8.9	3.2	0.4
600–700	f_{obs}			0	2	2*	0
	f_{exp}			1	2.1	0.8	0.1
>700	f_{obs}			0	1	0	1
	f_{exp}			0.5	1	0.4	0.05

Chi-square = 26.64; d.f. = 8; Significance = 0.009;*cells selected for defining the communities.

Table 20: Contingency table of observed and expected frequencies for the *Elytropappo rhinocerotis-Merxmuelleretum distichae.*

Median Annual Rainfall		Altitude <1000	1001–1250	1251–1500	1501–1750	1751–2000	>2000
<400	f_{obs}			0	1	0	
	f_{exp}			0.1	0.6	0.2	
400–500	f_{obs}			4	11	3	
	f_{exp}			2.7	11.3	4	
500–600	f_{obs}			0	5	2	
	f_{exp}			1	4.4	1.6	
600–700	f_{obs}			0	0	1	
	f_{exp}			0.1	0.6	0.2	
>700	f_{obs}						
	f_{exp}						

Chi-square = 6.53; d.f = 6; Significance = 0.366; H_o not rejected.

Table 21: Contingency table of observed and expected frequencies for the *Elionuro muticori-Themedetum triandrae.*

Median Annual Rainfall		Altitude <1000	1001–1250	1251–1500	1501–1750	1751–2000	>2000
<400	f_{obs}						
	f_{exp}						
400-500	f_{obs}						
	f_{exp}						
500–600	f_{obs}		1	4	2	3	0
	f_{exp}		0.6	2.6	2.6	3.9	0.3
600–700	f_{obs}		1	2	5	9	1
	f_{exp}		1.2	4.6	4.6	7	0.6
>700	f_{obs}		0	2	1	0	0
	f_{exp}		0.2	0.8	0.8	1	0.3

Chi-square = 7.39; d.f. = 8; Significance = 0.495; H_0 **not rejected.**

Table 22: Contingency table of observed and expected frequencies for the *Trago koelerioidis-Acacietum karroo.*

Median Annual Rainfall		Altitude <1000	1001–1250	1251–1500	1501–1750	1751–2000	>2000
<400	f_{obs}	3	2	1	0		
	f_{exp}	2.6	1.9	1	0.5		
400–500	f_{obs}	4	4	3	0		
	f_{exp}	4.8	3.5	1.8	0.9		
500–600	f_{obs}	3	2	0	2		
	f_{exp}	3.1	2.2	1.1	0.6		
600–700	f_{obs}	1	0	0	0		
	f_{exp}	0.4	0.3	0.2	0.1		
>700	f_{obs}						
	f_{exp}						

Chi-square = 8.36; d.f. = 9; Significance = 0.498; H_0 **not rejected.**

Table 23: Crosstabulation of the predicted communities in relation to the digitised image of Acocks's (1953) Veld Type map in the study area. Values are the number of pixels which satisfied the conditions of elevation and median annual rainfall for each community. Values in bold are Acocks's Veld Types in which that association was expected to be found.

Acocks's Veld Type	*Hermannio depressae-Eragrostietum chloromeladis*	*Eragrostio curvulae-Themedetum triandrae*	*Merxmuellero distichae-Diospyretum austro-africani*
Knysna Forest (4)	149	56	56
False Thornveld (21)	478	627	610
Valley Bushveld (23)	51	81	143
Spekboomveld (25)	39	108	852
Karroid Broken Veld (26)	51	76	1522
Central Upper Karoo (27)	0	0	736
Central Lower Karoo (30)	10	21	138
False Karroid Broken Veld (37)	61	58	87
False Central Lower Karoo (38)	231	198	1372
Dohne Sourveld (44)	876	**1215**	1199
Cymbopogon-Themeda Veld (48)	**137**	332	223
Dry *Cymbopogon-Themeda* Veld (50)	**797**	**1651**	2437
Pan Turf Veld (51)	325	400	492
Themeda-Festuca Alpine Veld (58)	121	510	**590**
Stormberg Plateau Sweetveld (59)	369	555	**928**
Merxmuellera Mountain Veld (60)	371	**1288**	**15154**
Eastern Province Grassveld (68)	27	5	40
False Fynbos (70)	81	17	44
Total	**4174**	**7198**	**26623**

Discussion

Environmental factors

Where vegetation patterns are determined by environmental differences, there may be a correlation between them — unless historical factors conspire against this (Greig-Smith 1983). However, it must be emphasised that correlation between variables is no proof of a causal relationship and additional experimental information and ecological knowledge are required to support such a supposition.

Data categorisation was successful in elucidating vegetation / environmental relationships in this study. Floristic patterns exist at different scales and the relationship between the environment and vegetation patterns is also scale-dependent. Environmental variables were successfully used to discriminate between vegetation pattern at different levels. Rainfall and altitude operated across the whole study area, whereas factors such as slope inclination and surface rockiness had a more local influence. Enigmatically, this meant that factors with a local influence were useful for distinguishing structural classes of vegetation, and factors with a wider influence discriminated between associations.

Rainfall classes successfully distinguished between associations within structural classes, especially grassland, shrubland and savanna associations. Similarly, altitude could be used to distinguish between associations within structural classes, but not as effectively. Grassland and shrubland associations were restricted to limited altitude classes. Altitude could also be used to discriminate between some structural classes, for example, savanna and fynbos appeared to only occur in the lower altitude classes. Surface rock cover could be used to distinguish between structural classes since grasslands always occurred on surfaces with low surface rock cover whereas shrublands were often on landscapes with a high surface rock cover. Other structural classes generally had low surface rock cover. Slope inclination could be used to distinguish between structural classes to a certain extent. Savanna, karroid dwarf shrublands and some grassland associations were found on flat to gently sloping surfaces; shrublands, grassy fynbos and some high altitude grasslands occurred on moderate to steeply sloping landscapes.

One disadvantage of the categorical method, as applied here, is that it does not consider the effect of habitat factors acting together on plant communities. For example, a steep south-facing slope would be environmentally very distinct to a steep north-facing slope. It remains for the ecologist to interpret data meaningfully so that composite variables are taken into consideration. Several factors, some of which may not be independent, may be jointly responsible for observed vegetation patterns (Greig-Smith 1983).

Taking environmental patterns together it was possible to provide environmental conditions under which each vegetation association and structural class were found. Conversely, it was possible to use environmental conditions as a key to arrive at the most likely association / vegetation type in the study area. The availability of environmental data thus provided an opportunity to attempt predictive modelling of the distribution of associations.

Modelling

The modelling was not wholly successful, and the procedure requires some modifications before further modelling is attempted. This exercise has been useful in that it has shown how the procedure of Palmer & Van Staden (1992) cannot be used at the level required in the present study (i.e. association), and, has highlighted the areas where the procedure can be modified and improved upon for use at lower levels. The major shortcomings were with respect to sample size and scale of observation. Palmer & Van Staden (1992) combined a number of communities for modelling, whereas individual associations were modelled here. The boundaries of associations in the present study do not match those of Acocks (1988), so the method of combining associations (Palmer & Van Staden 1992) could not be used. This is a problem of scale — floristically defined associations are not synonymous with Acocks's (1988) Veld Types. Combining associations is problematic, since many of the associations described in this thesis are not restricted to a single Acocks's Veld Type. For example, the *Merxmuellero distichae-Diospyretum austro-africani* is widespread and was predicted to be found in nineteen of Acocks's Veld Types in the study area. It was apparent during fieldwork that this predicted distribution is not an exaggeration and corresponds fairly well with observed patterns. This resulted in a large dilution of sample size and can be seen in that only three of

the six selected associations (selected on the basis of sufficient sample size) met the statistical criteria for modelling. Therefore validation by means of Acocks's Veld Types is somewhat tenuous. A more standard approach of validating by means of additional classified samples is required.

The modelling did produce some interesting predictions which require some explanation. One aberrant prediction is 478 out of 4174 pixels for *Hermannio depressae-Eragrostietum chloromeladis* falling within False Thornveld of the Eastern Province (Veld Type 21, Acocks 1988). A different grassland association was described for the region within False Thornveld, namely *Cymbopogono excavati-Digiterietum argyrograptae*, which was the only other dry grassland association of lowland regions to be described in this study. Although the macro-environment appears to be similar for these two associations, they are geographically separated and are not floristically closely related. Modelling also predicted 627 out of 7198 pixels of *Eragrostio curvulae-Themedetum triandrae* occurring in False Thornveld. This can only be explained by the fact that Dohne Sourveld (in which *Eragrostio curvulae-Themedetum triandrae* is most likely to occur) and False Thornveld border on one another and the prediction reflects the potential transition between these two Veld Types. The *Merxmuellero distichae-Diospyretum austro-africani* was predicted to occur in a number of unexpected Acocks Veld Types, even though the expected distribution was predicted with 63% accuracy. This probably reflects the widespread nature of this association. Modelling predicts its overall distribution, but more specific predictions can be made by including further environmental factors, for example surface rockiness.

Acocks (1956) used altitude and rainfall isohyets to map the distribution of Veld Types (Palmer & Van Staden 1992). There thus remains some circularity in employing these environmental conditions for the present model and then validating against Acocks's (1988) Veld Type map. To overcome this requires a larger data set in which a percentage of samples can be randomly selected to use for testing the model. These samples which would not be used for establishing the model parameters could be used to validate the model and establish confidence limits. Alternatively the model could be tested by ground-truthing, but this would still require a fairly

detailed knowledge of the floristics of the vegetation. Another alternative is to use satellite imagery to test models.

Other ideas for modelling which were not attempted here, but could be of value are as follows: modelling beta diversity against the environment (Palmer & Cowling 1994); modelling vegetation structure; modelling taxonomic entities, e.g. C_3 vs. C_4 grasses, woody vegetation (cf. O'Brein 1993), families or genera; and modelling the potential distribution of species based on palaeo-environmental conditions. Modelling gives an idea of the process linked to observed patterns and, if it can be achieved successfully, provides a meaningful insight into vegetation patterns. The modelling in this study has established the limits of the procedure formerly used. It has successfully highlighted where the boundaries of Acocks (1988) Veld Types are compatible or incompatible with those of the present study.

5. Diversity

Introduction

The aim of this chapter is to identify the main diversity components of the grassland and grassland-related vegetation of the Eastern Cape and relate them to each other. There are two major ways to analyse species diversity in different situations (Odum 1983). The first is using diversity indices, the most important of which is species richness (Odum 1983). The second is by examining evenness or equitability in the apportionment of individuals among species (Odum 1983).

The richness of a regional flora can be attributed to three independent measures of diversity, namely alpha, beta and gamma diversity (Whittaker 1972; Cody 1983; Westoby 1985). Alpha diversity is defined as the within-habitat or intra-community diversity (Whittaker 1972). Here species richness is used (number of species per site) and is considered to be an appropriate measure (Peet 1974; Whittaker 1972, 1977). Beta diversity is the turnover of species along an environmental gradient and gamma diversity the turnover of species between distinct geographical localities. Beta diversity is conceptually significant because it relates the species packing characteristics of community gradients (Peet 1978). A landscape may have species-rich communities (high alpha diversity) or else turnover along environmental or geographical gradients may be high (with high beta or gamma diversity respectively). There have been few studies in the Eastern Cape which have considered the relationship between these independent components (e.g. Cowling 1990), but such studies can explain how and why species richness varies across a landscape. The diversity indices together give an indication of the overall diversity or biotic heterogeneity of an area (Wilson & Shmida 1984).

Beta and gamma diversity can be measured in various ways. Wilson and Shmida (1984) evaluated six of these indices used with presence / absence data and made specific recommendations. Based on this evaluation, it was decided that Whittaker's index ($ß_w$) and Wilson & Shmida's (1984) index ($ß_T$) were most appropriate for the purposes of this study.

Odum (1983) suggests using dominance / diversity curves (Whittaker 1972) as a good way of examining evenness or equitability among species. This is done by plotting an importance value related to abundance on the x-axis with the species arranged in sequence from most to least abundant on the y-axis. This not only accurately depicts the richness and relative abundance of species, but explains how niche space is partitioned (Odum 1983). It is a way of investigating the structure of a community from observations made at one point in space and time (Wilson 1991). Various measures of abundance, including cover and biomass, have been used in dominance / diversity curves, but Wilson (1991) suggests that cover, which has an intrinsic maximum valve, is inappropriate for this type of work. He was, however, making recommendations for fitting curves to ecological models. Cover may still reveal general patterns and has the added advantage of being much easier and less time-consuming to estimate than biomass.

Methods

Alpha diversity was taken as species richness (S), which was counted as a mean of all samples for each association. The relative dominance of species for each vegetation type, following Whittaker's (1965) dominance / diversity curves, was calculated as a mean of all cover / abundance values for each species. The median value of each Braun-Blanquet cover / abundance class was used for this calculation (r = 1%, + = 2%, 1 = 3%, 2a = 8%, 2b = 18%, 3 = 38%, 4 = 68%, 5 = 88%). Only the first 10 species were shown since additional species had low frequencies and cover / abundance values and thus only increased the length of the tail on the curve (as in Figure 16). The species were plotted in order of decreasing importance (mean abundance).

Beta diversity was calculated along gradients using Wilson & Shmida's (1984) function:

$$ß_T = [g(H)+l(H)]/2\alpha$$

where g(H) is the number of species gained along the habitat gradient (H), l(H) is the number of species lost, and α is the average number of species per sample.

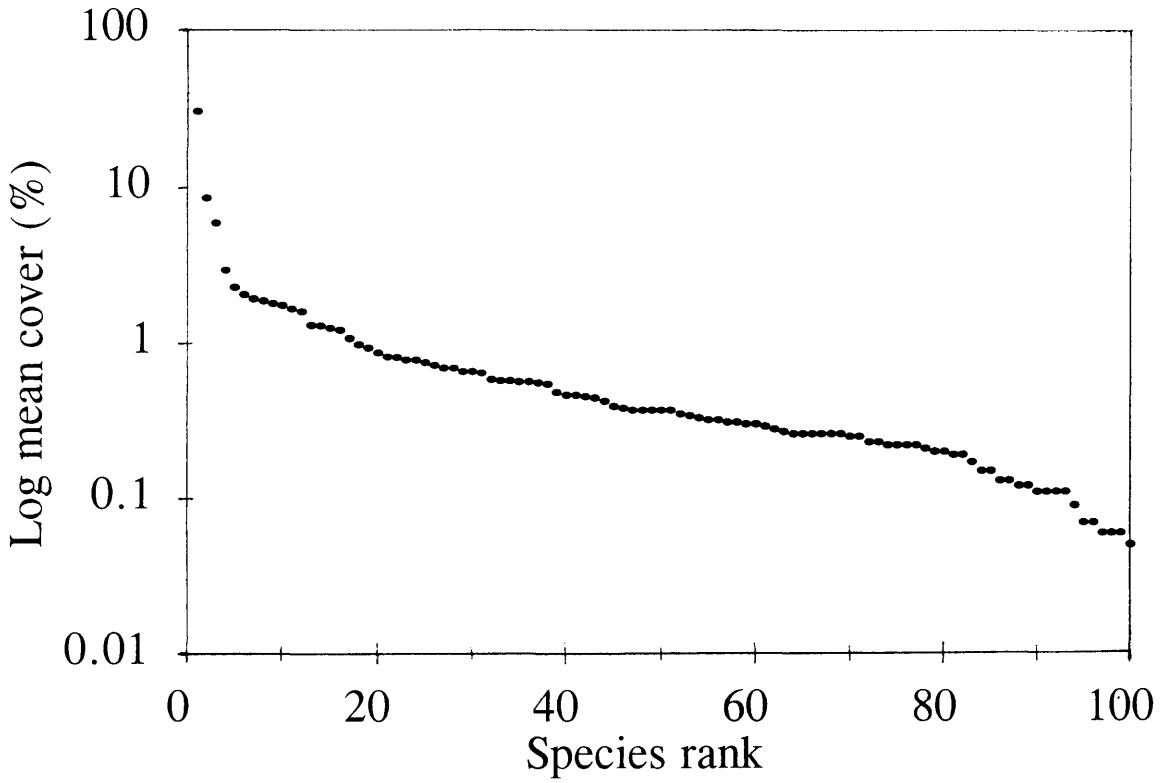


Figure 16: Dominance / diversity curve (after Whittaker 1975) of species in mesic grasslands of the Eastern Cape.

Beta diversity within associations (as a measure of within-association heterogeneity) was calculated using Whittaker's (1972) function:

$$ß_w = (S/\alpha)-1$$

where S is the total number of species recorded in the system, and α is the average number of species per sample.

The gradients used for the measurement of beta diversity were those previously identified as being important in explaining floristic patterns (Chapters 3 & 4). Median annual rainfall values were extracted for each sample from a surface response model for southern Africa (Dent *et al.* 1989). Altitude and substrate variables were extracted from the original field data sheets. Diversity along rainfall and altitude gradients was measured across the whole study area, but controlling for other environmental factors. Species turnover resulting from degree of surface rockiness was measured within a limited topo / moisture region. Seven samples were selected from each category of available data. Samples were selected from the 1501–1750 m altitude class, which had data covering the widest range in rainfall classes. These were standardised for aspect, slope and surface rockiness. No drainage line samples were used. Samples were only taken from the Stormberg / Drakensberg mountains region so as to avoid the effects of geographical species turnover.

For gamma diversity, the same beta diversity indices were used, but the comparison was made between geographically distinct localities. Environmental differences were minimised to ensure that gamma and beta diversity were independent. Seven samples were selected for each of the three regions for which data were available, namely the Amatola / Winterberg mountain range, the Stormberg / Drakensberg mountain range and the Queenstown Basin region. Samples were selected from the 1251–1500 m altitude class and the 501–600 mm rainfall class, and were standardised for aspect, slope and surface rockiness. No drainage line samples were used.

Results

Alpha diversity

Alpha diversity varied substantially between associations (Table 24). The lowest alpha diversity was recorded for *Eragrostio curvulae-Miscanthetum capensis* drainage line grasslands (19 species per relevé) and the highest for *Restio triticei-Oldenburgietum arbusculae* grassy fynbos (50 species per relevé). Grasslands had between 21 and 37 species per relevé, shrublands 30 and 39 species per relevé and savanna 30 and 33 species per relevé.

Association heterogeneity ($ß_T$)

The highest within-association heterogeneity (Table 24) was recorded for the *Merxmuellera distichae-Diospyretum austro-africani* shrubland ($ß_w$ = 10.9), and the *Eragrostio curvulae-Themedetum triandrae* grassland ($ß_w$ = 10.6). In the *Merxmuellera distichae-Diospyretum austro-africani* shrubland this may have been due to the fact that samples were widely dispersed, thus encompassing more variability. However, the *Eragrostio curvulae-Themedetum triandrae* grasslands were restricted to the Amatola / Winterberg mountains and the same reasoning cannot be applied there. The beta diversity within the *Elytropappo rhinocerotis-Merxmuelleretum distichae* grassland ($ß_w$ = 8.1), the *Elionuro mutici-Themedetum triandrae* grassland ($ß_w$ = 8.5) and the *Trago koelerioidis-Acacietum karroo* savanna ($ß_w$ = 8.2) were also fairly high. Low beta diversity scores were obtained for the *Cymbopogono excavati-Digitarietum argyrograptae* grassland ($ß_w$ = 2.6), the *Acacia karroo-Eragrostis capensis* savanna ($ß_w$ = 2.7) and the *Trago koelerioidis-Aristidetum diffusae* karroid dwarf shrubland ($ß_w$ = 2.4) with *Restio triticei-Oldenburgietum arbusculae* grassy fynbos ($ß_w$ = 3.5) and *Chrysocomo ciliatae-Digitarietum argyrograptae* karroid dwarf shrubland ($ß_w$ = 3.5) also being fairly low.

Table 24: Patterns of species richness and beta diversity in the grassland communities of the Eastern Cape.

Syntaxa	No. of relevés (n)	Mean species richness (α)	Standard deviation (σ)	Total species richness (S)	Beta diversity (heterogeneity) (β_w)
Grasslands					
Cymbopogono excavati-Digitarietum argyrograptae	6	21	4.4	54	2.6
Elytropappo rhinocerotis-Merxmuelleretum distichae	38	25	5.3	200	8.1
Hermannio depressae-Eragrostietum chloromeladis	33	32	9.1	214	6.8
Eragrostis chloromelas-Helictotrichon turgidulum grassland	10	28	12.5	127	4.5
Elionuro mutici-Themedetum triandrae	33	31	8.8	261	8.5
Eragrostio curvulae-Themedetum triandrae	39	23	7.9	239	10.6
Themedo triandrae-Helichrysetum aurei	16	32	8.8	209	6.6
Andropogono appendiculati-Festucetum scabrae	8	37	6.6	153	4.2
Eragrostio chloromeladis-Festucetum caprinae	12	29	11.1	150	5.1
Shrublands					
Cymbopogono excavati-Rhoetum discoloris	13	32	12.7	212	6.7
Merxmuellero distichae-Diospyretum austro-africani	61	39	11.0	428	10.9
Savanna					
Trago koelerioidis-Acacietum karroo	23	30	12.0	246	8.2
Acacia karroo-Eragrostis capensis savanna	4	33	1.9	89	2.7
Grassy fynbos					
Restio triticei-Oldenburgietum arbusculae	7	50	14.1	169	3.5
Karoo shrublands					
Chrysocomo ciliatae-Digitarietum argyrograptae	9	28	7.8	98	3.5
Trago koelerioidis-Aristidetum diffusae	4	29	4.4	69	2.4
Drainage-lines					
Eragrostio-curvulae-Miscanthetum capensis	13	19	*	134	7.1

Beta diversity

Species turnover along the rainfall gradient was fairly constant (Table 25). In both cases the shared species were approximately 39% of the combined species pool for the rainfall classes being compared.

Table 25: Species turnover along a rainfall gradient (Rainfall classes: 1 = 401–500 mm, 2 = 501–600 mm, 3 = 601–700 mm).

Rainfall Classes	1 and 2	2 and 3
Beta diversity ($ß_T$)	1.82	1.85

Between regions of low and high rock cover the beta diversity differed only slightly and was lower in the 501–600 mm rainfall class (Table 26). The shared species were 33% and 39% of the combined species pool for these two comparisons.

Table 26: Species turnover along a surface rockiness gradient. In both cases the species turnover was measured between regions of low and high surface rockiness.

Rainfall Class	401–500 mm	501–600 mm
Beta diversity ($ß_T$)	1.83	1.64

Gamma diversity

The greatest species turnover (Table 27) was between the Amatola / Winterberg region and the Stormberg / Drakensberg region ($ß_T$ = 2.34). The lowest species turnover was between the Queenstown Basin and the Stormberg / Drakensberg region ($ß_T$ = 1.36). Species turnover between the Queenstown Basin and the Amatola / Winterberg region was also fairly high ($ß_T$ = 2.01).

Table 27: Species turnover ($ß_T$) between geographical regions in the Eastern Cape.

Stormberg/Drakensberg to Amatola/Winterberg	Stormberg/Drakensberg to Queenstown Basin	Queenstown Basin to Amatola/Winterberg
2.34	1.36	2.01

Species relative dominance

The pattern of species dominance on the dominance / diversity graphs for mesic grasslands (Figure 16) is a typical pattern of all other vegetation types studied. This was a high mean cover / abundance for the first few species resulting in a steep initial part of the curve followed by a rapid tapering off of cover / abundance. The tail end, comprising the major portion of the curve, represented species of low importance in contributing to total cover. This pattern indicates a strong degree of dominance in a few species. Since patterns of dominance after the first ten species were similar for all vegetation types, only patterns in the first ten species are investigated hereafter for comparisons between vegetation types. In addition, bar graphs with a linear y-axis scale are used (Figures 17 & 18) to make interpretation easier in these first ten species.

Mesic grasslands were strongly dominated by a single species, *Themeda triandra* (Figure 17). The next two species were sub-dominant, but the following species were already of negligible importance. Dry grasslands and drainage line grasslands (Figure 17) had relatively low importance values for the first three species, and were not overwhelmingly dominated by a single species. Dominance values in subsequent species were consistently higher than for mesic grasslands. Wetlands had moderate dominance in the first two species, but dominance did not fade until the fifth species (Figure 17). Savanna was mostly dominated by a single species (Figure 18), but the following species were sub-dominant to some degree, unlike in mesic grassland. Shrubland (Rhoetae erosae Werger) showed no dominance by a single species and the reduction in importance of consecutive species was very gradual (Figure 18). Karroid vegetation and grassy fynbos showed a very similar pattern of species dominance (Figure 18). Both were dominated by a single species, but the next four species were only slightly less dominant. The following five species showed consistently higher relative dominance than for other vegetation types.

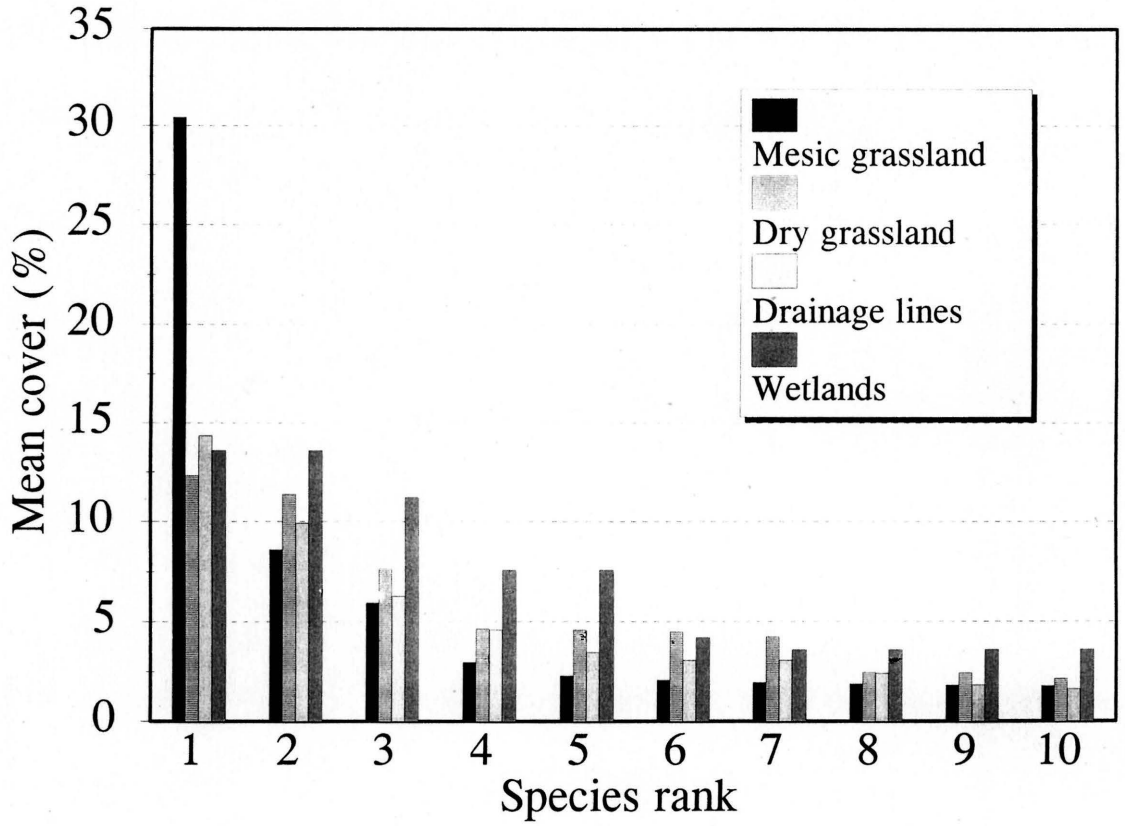


Figure 17: Mean cover of the top ten species in mesic grasslands, dry grasslands, drainage line grasslands and wetlands of the Eastern Cape.

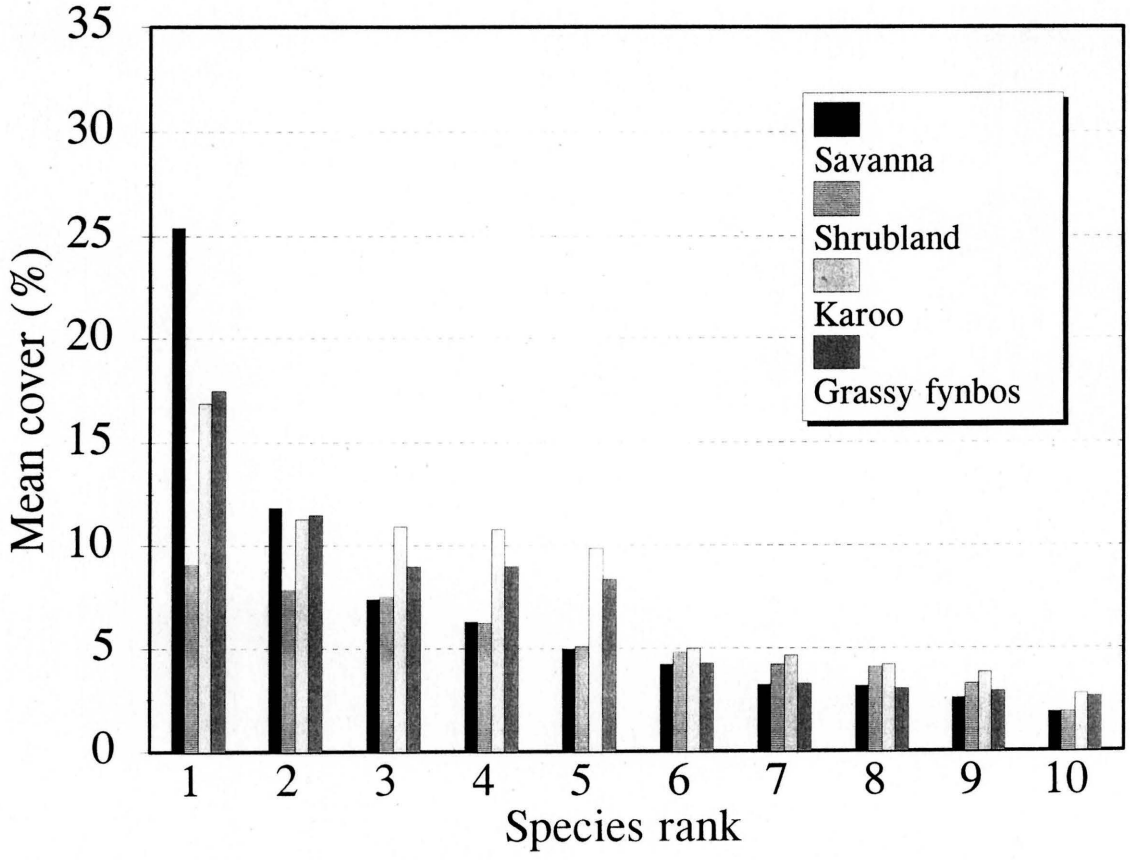


Figure 18: Mean cover of the top ten species in savanna, shrublands (Rhoetae erosae Werger), karroid vegetation and grassy fynbos of the Eastern Cape.

Discussion

This study has shown that diversity relations are not identical throughout the study area. Cowling (1983b) states that it is difficult to separate the complex of factors which influence and maintain diversity in a given region and that ecological, historical and biological factors should all be considered. However, Peet (1978) suggests that historical explanations, while important for the interpretation of local patterns, have not proven useful for explaining variations in diversity between localities. Peet (1978) also suggests that successional and geographical patterns should also be considered amongst explanatory factors. Ecological and historical factors are considered to explain patterns in the Eastern Cape.

Cowling (1983b) suggests that biogeographical relations can have a significant influence on species diversity and shows that phytochorological diversity is significantly correlated with species richness. This is because species transgress phytogeographical zones most freely at the boundaries thus leading to a larger species pool being available in these zones. Although phytochorological complexity was not examined here, perusal of a vegetation map (e.g. Low & Rebelo 1996) shows clearly that from the Amatola / Winterberg mountain region southwards there are more different vegetation types than elsewhere in the study area. There was high gamma diversity in the study area, but especially between the Amatola / Winterberg region and other parts of the study area. The reasons for the presence of this complexity may be linked to rainfall — some of the highest rainfall figures for the country are from the Amatola Mountains — thus creating a strong moisture gradient over very short distances. This region also had grasslands with the highest internal heterogeneity, although mean alpha diversity was amongst the lowest in the study area. The vegetation communities here appear to change rapidly from one place to another due to strong environmental pressures.

It is hypothesised here that the low alpha diversity in the grasslands of the Amatola / Winterberg mountains is due to overgrazing. The common species of the grassland associations here were indicators of disturbance or overgrazing (see Chapter 3). It is generally accepted that disturbance is a factor maintaining diversity in species-rich communities (Connell 1978; Grassle 1989) and that intermediate intensity disturbance has the most positive influence (Huston 1979; Denslow 1985). However, the utilisation disturbance in the Amatola / Winterberg mountains

was fairly heavy and constant, which tends to lead to a situation in which only those species capable of reproducing under the heavy disturbance regime will persist. Data comparing stands of vegetation of known management regime are required to test this hypothesis.

In the grassy fynbos species richness is high, but heterogeneity is fairly low. The low heterogeneity figures obtained may be due to the geographically restricted region sampled for grassy fynbos. Samples were not widespread enough in this study area to determine whether species turnover along gradients and between geographical regions were high for grassy fynbos. A comparison between grassy fynbos in the Humansdorp region (Cowling 1984), the Baviaanskloof Mountains (Euston-Brown 1995), the Zuurberg Mountains (Van Wyk *et al.* 1988) and data from the present study indicate large differences in the species composition of local floras, which would suggest that gamma diversity is high between these localities. Alpha diversity may be high in the grassy fynbos because of the structural complexity of grassy fynbos compared to grassland. Cody (1989) suggests that there is a positive relationship between growth form richness and species richness. The mean species richness of grassy fynbos compares well with that obtained for the Humansdorp region (between 34 and 47 species per relevé for grassy fynbos communities, Cowling 1983b). Cowling (1983b) also observed that heterogeneity within grassy fynbos communities was lower than for dune grassland and south-coast renosterveld. Finally, grassy fynbos was not dominated by a single species, thus giving other species an opportunity to appear in the vegetation.

Grassland vegetation generally had slightly lower alpha diversity than shrublands, but was comparable to grasslands in other parts of the country. In northern Kwazulu-Natal, Eckhardt *et al.* (1996a) obtained mean species richness values ranging from nine to 30 in lowland grasslands and Eckhardt *et al.* (1996b) values of 18 to 39 in high altitude grasslands as compared to values of 21 to 37 in the Eastern Cape. This low species richness for grasslands may have a structural and a dominance explanation. Grassland vegetation structure is not very variable, graminoids being the dominant life-form. Herbaceous species form an important component of grasslands and dwarf and small shrubs may be present to varying degrees, but neither dominate to any degree. Such limited complexity does not induce strong overstorey-understorey interactions and, therefore, has a limited influence on alpha diversity. The pattern

of species dominance obtained for grassland vegetation in the Eastern Cape indicates a strong degree of dominance in a few species. For importance-value curves, as presented in this chapter, the steeper the curve the lower the overall diversity and the greater the dominance by one or few species (Whittaker 1970; Odum 1983). Whittaker (1975) states that lognormal pattern, as observed for the data from the Eastern Cape, indicates a situation in which the extent of resource space occupied by a species is determined by a large number of factors. The flat sigmoid curve obtained indicates a non-overlapping, random niche pattern, often exhibited by groups exhibiting intense interspecific competition (Odum 1983). The data from the grasslands of the Eastern Cape suggest a complex pattern of niche differentiation and overlap. Although a similar pattern was obtained for shrublands, there was a tendency for species in the shrublands to be less overwhelmingly dominant and for a greater number of species to contribute towards the overall dominance.

Diversity along environmental gradients appeared to be high for both rainfall and surface rockiness. There was also a fairly constant rate of turnover along these gradients although there were insufficient data to establish this with certainty. Data across a wider range of rainfall classes are required and it may be necessary to produce an artificial topo-moisture gradient (e.g. Palmer & Cowling 1994) in order to examine this gradient more effectively.

There was similar species turnover between regimes of low and high rock cover as between rainfall classes. This is due to there being many woody species which establish in rocky areas which do not occur in open grasslands. The introduction of woody species in these rocky regions increases structural diversity, thus promoting species richness. Woody species have more extensive root systems which enable them to utilise deep water sources more effectively than herbaceous species. Species turnover between rocky and non-rocky areas is therefore related to there being different suites of species capable of most effectively utilising the environmental conditions in the opposing habitat types.

6. General discussion

In this project standard Braun-Blanquet procedures were used as a means of describing the grassland vegetation of the Eastern Cape. The process was successful from this descriptive point of view since vegetation units could be described on the basis of both vegetation structure and floristic elements. This addresses the main criticism of Acocks's (1953, 1988) Veld Type approach (Cowling 1984; Taylor 1996). Remarkable variability was apparent in the grasslands and grassland-related vegetation of the Eastern Cape. The transitional nature of the Eastern Cape (Goldblatt 1978; Werger 1978; Gibbs-Russell & Robinson 1981; White 1983; Cowling 1983a, 1983b; Lubke *et al.* 1986; Lubke 1988) and the diversity of vegetation types (Acocks 1988; Low & Rebelo 1996) has led to a mosaic of communities in the region (Cowling 1983a). The collection of good floristic and ecological data enabled the production of a good classification of the grassland vegetation. This classification contained four dry grassland associations, five mesic grassland associations, two shrubland associations, two savanna associations, one grassy fynbos association, five karroid vegetation associations and six wetland and drainage line associations.

Striking variability has been observed within grassland and grassland related communities. Excluding karroo, fynbos, pure wetland and savanna related vegetation, 12 associations and 17 subassociations have been described in this study. This does not seem to be the full range of existing associations. For dry grasslands alone an ordination was not interpretable due to the variability of the data: seven axes were required to explain 52% of the variability in the data. Whittaker's beta diversity index for the same data gave a value of 12.3. Taking $\beta+1$ as the number of completely distinct community units (Wilson & Shmida 1984) we would expect there to be 13 complete vegetation units for this data set. Only four associations and four subassociations (six units altogether) could be described using standard Braun-Blanquet classification techniques. Similarly, for shrublands, seven units were described of an expected 15. It is therefore unlikely that all the variability in the sub-region has been encompassed in this study, but at least a gap which previously existed for this type of data in the study area (Lubke *et al.* 1986) has been filled.

This is the first detailed study of this type covering the grasslands of the Eastern Cape, although Bester (1997) has studied the grasslands in small part of the north-eastern region of the study area and Judd (1997, Ph.D. in progress) is currently describing the coastal grasslands for the region. Werger (1980) has used Braun-Blanquet techniques to describe the vegetation of the upper Orange River Valley which included some grassland and shrubland associations which overlapped with the present study. Other vegetation types described in the study area using similar methods are valley thicket (Everard 1987), grassy fynbos (Cowling 1984; Van Wyk *et al.* 1988) and karroid dwarf shrublands (Palmer 1989, 1991a; Rubin & Palmer 1996). With the current data set it should now be possible to produce a full syntaxanomic synthesis of the vegetation of this region. This will, in turn, enable more detailed research on the floristics of the region (Lubke *et al.* 1986).

The associations described in the present study appear to be distributed according to a limited number of environmental factors which could be used to predict their distribution. The most important of these factors appeared to be the variable topography and the strong rainfall gradients. The main geological substrates which meet in the study area appear to affect vegetation distribution by influencing soil nutrient status (Cowling 1992).

Environmental factors are manifested at different scales in the landscape. For example, mean annual precipitation and elevation appear to govern vegetation patterns on a subcontinental scale. At the biome level the equivalent scale could be used to describe overall vegetation types and subtypes. At a local scale substrate characteristics, aspect and slope play an important role in distinguishing between communities, and precipitation and elevation lose resolution. At the level of the individual plant, biological interactions play in important role in determining the distribution of individuals. It is very difficult for a phytosociologist to determine at which point to terminate divisive processing, since pattern exists as gradients in time, space and across different scales.

Environmental factors provide the framework within which floristic communities occur. Shrublands were found on moderate to steep slopes with a high surface rock cover; grasslands were found on flat to gently sloping landscapes with low surface rock cover; wetlands and

drainage line grassland were found in valley bottoms and along drainage lines; and grassy fynbos occurred on Cape geology with moderate to steep slopes. Steep slopes associated with grassy fynbos are an indication that the region is mountainous. Wetland and drainage line communities were azonal to a large extent and depended on local moisture and drainage conditions to effect their character.

The inability to obtain meaningful results from an ordination in this study may be attributed to the floristic and environmental variability in the study area. The manner in which environmental factors manifest themselves is fairly complex and occasionally non-linear. Gradients seldom parallel each other as, for example, in a transect up a sandy beach. There is also not always a linear response between the vegetation and the environment. Finally, the environmental gradients themselves do not always display a linear gradient.

It is possible to use the Braun-Blanquet data from this study for purposes other than vegetation description. These range from mapping to producing historical and ecological explanations for vegetation patterns. Classified data with known positions can be used for detailed vegetation mapping. This process is presently being undertaken on the Vegmap project (NBI in prep.). It was possible to apply various presence / absence diversity indices to the data in order to establish patterns of diversity in the Eastern Cape grasslands. Good ecological data and / or latitude / longitude positions of relevés were required for establishing diversity patterns along environmental or geographical gradients. A good initial classification was required for some aspects of diversity, but this was not necessary for analysis along gradients. Mean alpha diversity for the study area was not high but was equivalent to other grasslands in South Africa with which comparisons could be made (Eckhardt *et al.* 1996a, 1996b; Perkins 1997).

A checklist was produced of the species found in the grassland vegetation for which voucher specimens exist. The checklist and voucher specimens provide a documented reference to validate the classification and a means of confirming species identities.

In addition to the applications above, the Braun-Blanquet data from this study has the potential to be used in the following ways:

1. Data for which information such as the vegetation structure is known may be used to ground-proof digital satellite imagery such as land coverage maps. Braun-Blanquet data would only be useful if sampling intensity is high enough. The original image would be stratified and specific points in the landscape would be visited for confirmation.
2. The data could be used to establish phytochorological patterns in the grassland vegetation since the species composition of any unit of vegetation is known. This is important in establishing the biogeographical origins of the vegetation. The total distribution of each species is required for this process to be successful, which requires a thorough examination of relevant literature and voucher specimens.

7. Concluding remarks

- Standard Braun-Blanquet procedures were successfully used to produce a classification of the grassland and grassland-related vegetation of the Eastern Cape. Braun-Blanquet data has once again been found to be useful in describing vegetation pattern in South Africa. The data is also compatible with similar studies done in other vegetation types and, in the Eastern Cape, can form the basis of a syntaxanomic synthesis of the vegetation.
- Floristic patterns were found to be linked to environmental variables. These were manifested at different scales in the landscape and were correlated with broad-scale vegetation patterns as well as patterns of species turnover. The establishment of vegetation / environment relationships by methods of correlation provided an insight into the processes defining vegetation patterns in the region.
- The success of modelling the relationship between floristic units and environmental variables was limited by the fact that associations described in this thesis did not correspond in distribution to Acocks's Veld Type boundaries, and the latter could, therefore, not be used to validate the defined statistical model.
- The establishment of diversity patterns provided insight into ecological and environmental processes defining the co-existence of species in the grassland and grassland-related vegetation of the Eastern Cape. Available information suggests that species richness is similar to other grasslands in the country.

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Summary

This study in the Eastern Cape was part of ongoing research on the Grassland Biome Project. The aims of the study were to produce a formal phytosociological inventory of the grassland communities of the Eastern Cape, relate the identified floristic units to environmental factors, predict the distribution of these based on linear modelling techniques and analyse the floristic data to determine biogeographic relationships and establish diversity patterns.

As an introduction the physiography, geology, climate, soils and land use of the region were described. This environmental framework highlights the transitional nature of the sub-region and the habitat diversity. For the phytosociological study standard Braun-Blanquet procedures were followed, which resulted in a classification containing 4 dry grassland associations, 5 mesic grassland associations, 2 shrubland associations, 2 savanna associations, 1 grassy fynbos association, 5 karroid vegetation associations and 6 wetland and drainage line associations. These syntaxa were characterised on the basis of constituent floristic elements, habitat and distribution criteria and the relationship to other (published and unpublished) descriptions. Where names of syntaxa were formalised, type relevés were identified. The study revealed remarkable variability in the described vegetation, but in many cases the floristic units showed a strong relationship to those from neighbouring regions. Gradients between floristic units were strong and were attributed to strong environmental gradients. These were strong altitude and precipitation-related gradients to explain floristic variability within grasslands, substrate and geomorphological gradients between grassland and woody vegetation, geological and rainfall season gradients to grassy fynbos, and precipitation, altitude and rainfall seasonality gradients to karoo vegetation. Wetland and drainage line communities were azonal to a large extent and depended on local moisture and drainage conditions to effect their character.

Linear modelling techniques were used to predict the distribution of some of the main associations based on classes of median annual rainfall and elevation. Diversity patterns were established by examining species richness and dominance, within-association heterogeneity, species turnover along rainfall and surface rockiness gradients, and species turnover between geographical regions within the study area. Diversity in the grasslands and grassland-related

vegetation of the Eastern Cape could be attributed to ecological factors (rainfall and surface rockiness gradients), disturbance (e.g. grazing), structural complexity in some vegetation types, and high species turnover between geographical regions. In addition, high dominance by a low number of species appeared to restrict diversity to a large extent.

Appendices

Appendix 1: Infrequent species occurring in the relevés of Table 4 (dry grassland)

Acacia karroo : 56,1; 252,+; 218,+; 262,+; 279,+
Acacia mearnsii : 342,+
Agapanthus praecox : 165,+
Albuca fastigiata : 161,+; 162,+
Albuca setosa : 205,+; 218,+; 221,+; 260,+; 174,+; 177,+
Aloe sp. : 52,+
Amaranthus thunbergii : 312,+; 358,+
Amellus strigosus : 174,+
Andropogon appendiculatus : 353,1; 383,+; 306,+; 319,+; 358,+; 152,+; 334,+; 338,1
Anthospermum sp. : 281,+; 313,+; 275,+
Aptosimum procumbens : 389,+; 311,+
Arctotis microcephala : 92,+
Argyrolobium lanceolatum : 174,+
Argyrolobium pauciflorum : 271,r
Argyrolobium sp. : 218,+; 319,+; 217,+; 152,+; 333,+
Aristida canescens : 271,b
Aristida junciformis : 385,a
Artemisia afra : 349,+
Asclepias meyeriana : 262,+
Asclepias multicaulis : 161,+; 334,+
Aspalathus chortophila : 168,+; 208,+; 212,+; 221,+; 355,+; 333,+
Asparagus burchellii : 52,+; 53,+; 129,+
Asparagus cooperi : 306,+; 362,+
Asparagus denudatus : 156,+; 165,+
Asparagus sp. : 389,+
Asparagus striatus : 53,+
Asparagus suaveolens : 70,+
Berkheya buphthalmoides : 174,+
Berkheya carduoides : 174,+
Berkheya decurrens : 368,+
Berkheya discolor : 230,+; 281,+; 316,+; 321,+; 261,+; 271,+; 275,+; 177,+
Berkheya glabrata : 129,+
Berkheya heterophylla : 253,+
Boophane disticha : 52,+; 278,r
Brachiaria serrata : 306,+; 315,+; 312,+; 275,+
Bromus catharticus : 165,+; 174,+; 193,+
Bulbine abyssinica : 55,+; 230,+; 342,+
Bulbine frutescens : 321,+
Bulbine sp. : 52,+
Bulbostylis humilis : 57,1; 381,+; 388,+; 391,3; 392,+; 320,+; 368,+; 358,+; 334,+
Catalepis gracilis : 349,+
Cerastium capense : 162,+
Cheilanthes marlothii : 162,+
Chenopodium album : 233,+; 388,+; 389,+; 392,+; 207,+; 338,+
Chenopodium mucronatum : 253,+
Chloris virgata : 312,+
Chlorophytum sp. : 70,+
Ciclospermum leptophyllum : 174,+
Cineraria sp. : 165,+
Cirsium vulgare : 174,+
Clutia alaternoides : 311,+
Convolvulus thunbergii : 162,+; 281,+; 306,+; 277,r; 311,+; 271,+; 174,+
Conyza bonariensis : 281,+
Conyza podocephala : 233,+; 190,+; 205,+; 362,+
Cotula heterocarpa : 388,+; 152,+; 177,+; 333,+; 338,+
Cotyledon orbiculata : 156,+; 161,+; 162,+
Crassula capitella s. capitella : 119,+; 281,+; 343,+; 275,+
Crassula campestris : 316,+; 312,+; 262,+

Crassula dependens : 161,+; 162,+; 152,+
Crassula lanceolata : 315,+; 311,+
Crassula muscosa : 207,+; 162,+
Crassula sp. : 230,+
Cucumis heptadactylus : 343,+; 70,+
Cucumis myriocarpus : 358,+
Cyanotis speciosa : 52,+; 129,+; 218,+; 281,+; 92,+; 260,+; 262,+; 271,+
Cymbopogon validus : 385,1
Cynodon incompletus : 165,+; 321,+; 322,+; 312,+; 338,a
Cynoglossum austroafricanus : 281,+
Cyphia sylvatica : 129,+
Denekia capensis : 174,+
Dianthus basuticus : 252,+; 253,+; 221,+; 277,+; 278,+; 174,+
Dicoma anomala : 311,+
Dimorphotheca cuneata : 220,1; 221,+
Diospyros austro-africanus v. a : 306,+
Diospyros lycioides : 306,1; 343,+
Dolichos sp. : 271,+
Eragrostis racemosa : 129,a; 277,+; 368,+; 275,a; 333,+
Eriocephalus spinescens : 70,+
Erodium cicutarium : 391,+; 165,+; 166,+; 208,+; 174,+
Erythrina sp. : 271,+
Euphorbia clavarioides : 275,+
Euphorbia rhombifolia : 52,+; 161,+
Euphorbia sp. : 220,+; 221,+; 162,+; 226,+; 312,+
Eustachys paspaloides : 52,+; 53,+; 54,1; 55,+; 253,+; 70,+; 226,3; 260,+; 279,+
Falckia repens : 271,+
Festuca scabra : 152,+
Ficinia gracilis : 172,+; 319,+; 321,+; 355,+; 277,+
Ficinia sp. : 358,+
Ficinia stolonifera : 262,+
Galenia pubescens : 252,+
Galium capense : 353,+; 166,+; 168,+; 221,+; 152,+; 174,+; 177,+; 334,+; 338,+
Geigeria filifolia : 381,+; 311,+
Geranium harveyi : 162,+
Gerbera ambigua : 333,+
Gerbera piloselloides : 261,+; 174,+
Gladiolus permeabilis : 358,+
Gnidia sericea : 358,+; 349,+
Gnidia sp. : 271,+
Gomphocarpus fruticosus : 384,+; 165,+; 211,+; 306,+; 322,+; 358,+; 152,+; 334,+
Haplocarpha scaposa : 320,+; 193,+
Harpochloa falx : 353,a; 156,+; 172,+; 221,+; 334,+
Hebenstretia integrifo : 220,+; 230,+
Helichrysum anomalum : 70,+
Helichrysum callicomum : 353,+; 156,+; 164,+; 212,+; 161,+; 358,+; 152,+; 174,+
Helichrysum dasymallum : 168,+; 277,+; 278,+
Helichrysum mixtum : 315,+; 320,+
Helichrysum montis-cati : 157,+; 161,+
Helichrysum nudifolium : 161,+; 162,+; 281,+; 174,+
Helichrysum psilolepis : 157,+; 281,+; 275,+; 174,+
Helichrysum rutilans : 306,+; 316,+; 319,+
Helichrysum sp. : 7,+
Helichrysum splendidum : 193,+
Helichrysum zeyheri : 376,+; 381,+
Heliophila carnosa : 161,+
Hermannia erodioides : 174,+
Hermannia parviflora : 174,+
Hertia pallens : 218,+; 311,+; 279,+
Hibiscus aethiopicus : 54,+; 129,+; 271,+
Hibiscus microcarpus : 277,+; 70,+
Hibiscus pusillus : 311,+; 262,+
Hordeum capense : 349,+
Hyparrhenia hirta : 57,+; 319,+; 368,b; 362,3
Hypochaeris radicata : 172,+; 162,+; 193,+
Hypoxis costata : 334,+
Indigofera alternans : 252,+; 260,+; 261,+
Indigofera burchellii : 162,+
Indigofera heterophylla : 129,+; 368,+; 271,+
Indigofera sessilifolia : 129,+

Indigofera zeyheri : 119,+; 362,+
Ipomoea crispa : 319,+; 343,+
Jamesbrittenia atropurpurea : 253,+; 218,+
Jamesbrittenia aurantiacea : 343,+
Kedrostis capensis : 162,+
Kniphofia sp. : 358,+
Koeleria capensis : 52,+; 156,+; 164,+; 190,+; 220,+; 162,+; 152,+; 177,+; 338,+
Kyllinga alba : 311,1
Lachenalia sp. : 271,+; 275,+
Lappula squarrosa : 279,+
Lasiospermum bipinnatus : 233,+; 156,+; 221,+; 177,+; 338,+
Lepidium africanum : 52,+; 53,+; 57,+; 253,+; 388,+; 119,+; 207,+
Lessertia inflata : 168,+
Leucosidea sericea : 349,+
Leysera gnaphalodes : 221,+; 161,+; 162,+; 275,+; 362,+
Limeum aethiopicum : 129,+; 368,+
Lobelia flaccida : 362,+; 333,+; 349,+
Lobelia sp. : 52,r
Lotononis laxa : 129,+; 218,+; 162,+; 312,+
Mariscus capensis : 271,+
Mariscus congestus : 57,+; 306,+
Mariscus uitenhagensis : 275,+
Medicago laciniata : 56,+; 164,+; 166,+; 207,+; 209,+; 217,+; 174,+
Mentha longifolia : 349,+
Mesembryanthemum sp. : 311,+
Monsonia angustifolia : 368,+; 311,+
Moraea polystachya : 221,+; 161,+
Nassella neesiana : 233,+
Nenax microphylla : 381,1; 389,+; 205,+; 207,+; 230,+; 226,1; 260,+; 261,+
Nidorella resedifolia s. resedif. : 281,+
Nolletia ciliaris : 253,+
Ophioglossum polyphyllum : 70,+; 92,+; 261,+
Ornithogalum juncifolium : 212,+; 161,+; 162,+
Ornithogalum secundum : 243,+
Oxalis corniculata : 226,+
Pachycarpus sp. : 385,+
Panicum coloratum : 52,+
Panicum maximum : 388,1; 389,+; 262,+
Passerina montana : 164,+; 349,+
Pelargonium minimum : 311,+
Pelargonium ranunculophyllum : 162,+
Pelargonium reniforme : 52,+
Pennisetum sphacelatum : 383,+; 333,+; 338,b; 349,+
Pentaschistis setifolia : 221,+; 230,+; 174,+; 176,+
Pentzia cooperi : 383,+; 157,+; 174,+
Pentzia incana : 166,1; 230,+
Pentzia sphaerocephala : 388,1
Pentzia viridis : 251,+; 253,+; 261,+
Peucedanum capense : 7,+
Phymaspermum parvifolia : 376,+; 174,+
Picris hieracioides : 174,+
Polygala amatymbica : 172,+; 281,+; 271,+; 275,+
Polygala fruticosa : 368,+
Polygala ohlendorfiana : 212,+
Pseudognaphalium luteo-album : 315,+; 333,+; 338,+
Rabiea sp. : 161,+
Rhamnus prinoides : 306,1
Rhus erosa : 306,1; 315,+
Rhus pyroides : 306,+
Rhynchosia totta v. totta : 271,r
Rhynchosia adenodes : 156,+; 355,+; 243,+; 362,+
Rhynchosia nervosa : 362,+
Rhynchosia reptabunda : 174,+
Rhynchosia sp. : 271,+
Rosa eglanteria : 349,+
Rubus ludwigii : 162,+
Salvia repens v. repens : 251,+; 384,+; 322,+; 271,+
Salvia runcinata : 92,+
Salvia verbenaca : 209,+
Scabiosa columbaria : 209,+; 281,+; 277,+; 271,+; 362,+; 174,+; 188,+; 334,+

Schoenoxiphium sparteum : 383,+; 362,+; 349,+
Sebaea filiformis : 353,+; 349,+
Sebaea natalensis : 353,+; 358,+; 334,+
Senecio conrathii : 343,+; 355,+; 312,+
Senecio coronatus : 277,+; 174,+
Senecio inaequidens : 381,+; 156,+; 208,+; 212,+; 321,+; 226,+; 311,+; 261,+; 362,+
Senecio reptans : 174,+
Silene sp. : 162,+; 306,+
Sisymbrium sp. : 213,+
Sisymbrium thellungii : 252,+
Sisymbrium turczaninowii : 174,+
Solanum sp. : 324,+
Solanum tomentosum : 271,+
Sonchus asper : 209,+
Sporobolus africanus : 56,b; 281,+; 306,+; 316,+; 386,+; 311,+
Sporobolus fimbriatus : 389,+
Stachys cuneata : 174,+
Stipagrostis zeyheri : 277,+
Sutera pinnatifida : 52,+; 54,+; 57,+; 253,+; 221,+; 230,+; 161,+; 260,+; 271,+; 174,+
Sutera sp. : 315,+; 338,+
Tagetes minuta : 56,+; 57,+; 358,+
Taraxacum officinale : 177,+; 188,+
Thesium sp. : 157,+; 230,+; 161,+; 312,+; 174,+
Tolpis capensis : 316,+
Trachyandra saltii : 168,+; 172,+; 209,+; 211,+; 226,+; 271,r; 152,+; 174,+; 177,+
Tragopogon dubius : 193,+
Tragus berteronianus : 322,a
Tragus racemosus : 358,+
Tribolium hispidum : 233,+
Tribulus terrestris : 251,+
Trifolium africanum : 279,+; 349,+
Trifolium burchellianum : 56,+
Triraphis andropogonoides : 315,1; 316,+
Turbina oblongata : 271,+
Ursinia nana : 172,+; 212,+; 358,+
Vernonia capensis : 362,+
Vulpia myuros : 207,+
Wahlenbergia albens : 381,+; 306,+
Wahlenbergia juncea : 54,+; 56,+; 57,+; 119,+; 230,+; 226,+; 271,+
Wahlenbergia nodosa : 129,+
Wahlenbergia sp. : 281,+; 349,+
Wahlenbergia stellarioides : 324,+; 281,+; 316,+; 342,+; 355,+; 358,+; 333,+
Wahlenbergia undulata : 165,+; 217,+; 261,+; 174,+; 177,+
Walafrida densiflora : 7,+; 205,1; 278,+
Walafrida geniculata : 54,+; 55,+; 324,+
Walafrida paniculata : 353,+

Appendix 2: Infrequent species occurring in the relevés of Table 5 (mesic grassland)

Acacia mearnsii : 84,+; 297,+; 369,+
Acalypha peduncularis : 2,+
Adenocline pauciflora : 83,+; 84,1; 284,1; 308,+; 60,+
Agrostis lachnantha : 235,+
Ajuga ophrydis : 286,+; 357,+; 310,+; 237,+; 240,+
Albuca fastigiata : 1,+; 4,+; 3,r
Albuca setosa : 189,+; 237,+
Albuca sp. : 255,+; 254,+
Alchemilla woodii : 16,+; 366,+; 96,+; 106,+; 235,+
Alepidea capensis : 20,+; 96,+; 106,+; 294,+; 296,+; 237,+; 240,+
Alepidea serrata : 4,+
Aloe ecklonis : 4,+
Annesorhiza nuda : 295,+
Anthospermum aethiopicum : 2,1
Anthospermum herbaceum : 37,+; 16,+; 96,+; 104,+; 109,+; 294,+; 296,+
Anthospermum sp. : 273,+; 283,+; 298,+; 60,+; 117,+; 64,+
Apium sp. : 237,+
Argyrolobium amplexical : 96,+
Argyrolobium molle : 234,+
Argyrolobium sp. : 189,+; 4,+; 366,+; 254,+
Argyrolobium speciosum : 4,+; 98,+
Aristea abyssinica : 26,+; 107,+
Aristida congesta ssp. *congesta* : 273,+; 282,+; 317,+; 82,+
Aristida canescens : 41,+
Aristida junciformis : 282,+; 283,1; 297,3; 298,a; 337,+; 28,+; 29,+; 309,+
Arrowsmithia styphelioides : 106,+
Artemisia afra : 350,+; 307,+; 196,+
Arundinella nepalensis : 96,+
Asclepias brevicuspis : 10,r
Asclepias gibba : 37,+
Asclepias multicaulis : 282,r; 285,+; 298,+; 308,+
Asclepias stellifera : 286,+; 348,+
Aspalathus frankenioides : 96,+
Asparagus burchellii : 83,+
Asparagus capensis : 237,+
Asparagus denudatus : 299,+; 1,+
Asparagus laricinus : 20,+; 82,+
Asparagus sp. : 96,a
Aspidoglossum carinatum : 3,+
Athrixia fontana : 295,+
Bartsia trixago : 294,+
Berkheya acanthopoda : 62,1
Berkheya buphthalmoides : 255,+; 201,+; 202,+
Berkheya carduoides : 297,+; 100,+
Berkheya cirsiifolia : 295,+; 237,+
Berkheya decurrens : 100,+
Berkheya macrocephala : 295,+
Berkheya onopordifolia : 274,+; 280,+; 20,+; 32,+; 34,+; 254,+
Berkheya purpurea : 291,+; 294,+
Bromus catharticus : 23,+; 40,+; 63,+; 112,+; 239,+; 255,+; 235,+; 214,+
Brunsvigia sp. : 37,+
Bulbine abyssinica : 30,+
Bulbine frutescens : 10,+
Bulbine narcissifolia : 189,+; 8,+; 40,+; 65,+; 237,+
Bulbine sp. : 63,+
Bulbostylis humilis : 335,+; 357,+; 75,+
Bulbostylis oritrephes : 3,1
Carex cognata : 295,+
Catalepis gracilis : 110,+
Centella asiatica : 282,+; 283,+; 297,+; 299,+; 308,+; 42,+; 60,+; 75,+; 105,+; 96,+; 107,+; 109,+; 64,+
Cerastium arabidis : 254,+; 295,+; 199,+
Chamaecrista capensis : 78,+
Chamaecrista stricta : 78,+; 83,+; 84,+; 88,+
Cheilanthes involuta : 237,+

Chenopodium album : 340,+
Chironia krebsii : 295,+
Chlorophytum fasciculatum : 340,+
Ciclospermum leptophyllum : 299,+; 340,+
Cineraria canescens : 11,+
Cineraria lyrata : 96,+
Cirsium vulgare : 299,+; 73,+
Cliffortia ramosissima : 16,+
Cliffortia sp. : 295,+
Convolvulus natalensis : 1,+
Convolvulus thunbergii : 83,+; 348,+; 41,+
Conyza albida : 283,+
Conyza bonariensis : 299,+
Conyza obscura : 308,+; 73,+; 117,+
Conyza pinnata : 11,+
Conyza podocephala : 274,+; 283,+; 286,+; 290,+; 348,+; 350,+; 29,+; 34,+; 96,+; 307,+
Cotula heterocarpa : 340,+; 30,+; 2,+; 106,+; 254,+; 235,+
Cotula hispida : 242,+; 96,+; 103,+; 295,+; 296,+; 309,+
Crabbea acaulis : 299,+
Crassula sarcocaulis : 106,+; 107,+
Crassula dependens : 295,+; 296,+; 202,+; 237,+
Crassula hirtipes : 37,+
Crassula lanceolata : 30,+; 295,+
Crassula pellucida : 106,+; 107,+; 309,+
Crassula vaginata : 96,+
Cyanotis speciosa : 299,+; 32,+; 45,+
Cynodon incompletus : 273,1; 75,+
Cynoglossum austroafricana : 299,+; 295,+
Cynoglossum hispidum : 45,+
Cyperus semitrifidus : 356,+
Cyperus sphaerospermus : 369,+
Cyphia triphylla : 340,+
Daucus carota : 366,+
Delosperma crassuloides : 4,+
Delosperma sp. : 83,+
Dianthus basuticus : 286,+; 255,+; 254,+; 200,+; 237,+; 240,+
Dicoma anomala : 298,+
Dierama igneum : 234,+
Dierama pendulum : 98,a; 96,+
Dierama sp. : 78,+; 42,+; 106,+; 109,+; 295,+; 235,+; 201,+
Digitaria argyrograpta : 20,+; 65,1; 82,+
Digitaria monodactyla : 83,+; 285,1
Diospyros lycioides : 37,+
Disparago sp. : 309,+
Dolichos decumbens : 11,+
Dolichos linearis : 63,+; 37,+; 64,+
Echium plantagineum : 299,+
Ehrharta calycina : 242,+; 2,+; 255,+; 254,+
Elytropappus gnaphaloides : 109,+
Elytropappus rhinocerotis : 64,+
Empodium elongatum : 254,+
Eragrostis caesia : 103,+; 295,+
Eragrostis gummiflua : 282,+; 297,+
Eragrostis lehmanniana : 290,+; 295,+
Eragrostis planiculmis : 85,1
Eragrostis superba : 8,+; 10,+
Erica peltata : 96,+
Eriocephalus ericoides : 189,+
Eriosema squarrosum : 1,+
Erodium cicutarium : 240,+
Eulalia villosa : 297,+; 298,+; 34,+; 73,1; 88,+
Euryops annae : 189,+; 195,1
Euryops floribundus : 45,+
Euryops oligoglossus : 18,+
Euryops tysonii : 201,+
Eustachys paspaloides : 105,+
Falckia repens : 273,+; 282,+; 299,+
Felicia hyssopifolia : 189,+
Festuca longipes : 40,+
Ficinia nigrescens : 282,+

Ficinia sp. : 91,+; 8,+; 10,+; 29,1; 72,+; 93,+; 110,+; 112,+; 106,+; 107,+; 109,+; 309,+
Ficinia stolonifera : 83,+; 234,+; 273,+; 298,+; 254,+; 235,+; 202,+; 237,+
Ficinia tristachya : 98,+
Fingerhuthia sesleriiformis : 235,+; 202,+
Foeniculum vulgare : 295,+
Fuirena coerulescens : 295,+
Galium capense : 337,+; 184,+; 239,+; 37,+; 254,+; 201,+
Galium sp. : 1,+
Geranium amatolicum : 18,+; 98,+
Geranium baurianum : 2,+; 235,+
Geranium caffrum : 42,+
Geranium contortum : 234,+; 42,+; 37,+; 1,+; 100,+; 109,+; 235,+
Geranium grandistipulatum : 63,+
Geranium incanum : 30,+; 295,+; 235,+
Geranium robustum : 239,+
Gerbera piloselloides : 1,+; 255,+; 254,+; 235,+; 237,+; 214,+
Gerbera sp. : 239,+
Gerbera viridifolia : 45,+; 237,+
Gladiolus longicollis : 239,+
Gladiolus ochroleucus : 296,+
Gladiolus permeabilis : 335,+
Gladiolus saundersii : 291,r
Gnidia burchellii : 158,1
Gnidia nodiflora : 105,+; 18,+
Gnidia sericea : 189,+; 290,+; 335,+; 104,+; 107,+
Gomphocarpus fruticosus : 350,+; 357,+; 88,+; 202,+
Graderia sp. : 2,+
Grewia tenax : 37,1
Habenaria dregeana : 109,r
Habenaria lithophila : 366,+
Harveya sp. : 202,+
Harveya speciosa : 42,+
Helichrysum adenocarpum : 96,+; 103,+; 106,+; 309,+
Helichrysum ammitophillum : 366,+
Helichrysum argyrophyllum : 107,a
Helichrysum chionosphaerum : 285,+
Helichrysum dasymallum : 285,+
Helichrysum griseum : 309,+; 196,+; 214,+
Helichrysum herbaceum : 298,+; 296,+
Helichrysum isolepis : 103,+; 235,+
Helichrysum mixtum : 234,+; 286,+; 26,+; 16,+; 98,+; 3,1; 96,+; 103,+; 106,+; 109,+; 294,+; 235,+
Helichrysum montis-cati : 117,+; 294,+; 296,+; 235,+; 214,a; 199,+
Helichrysum psilolepis : 234,+; 280,+; 282,+; 284,+; 299,+; 28,+; 18,+; 241,+
Helichrysum rutilans : 317,+; 310,+; 294,+; 307,+
Helichrysum sp. : 23,+
Helichrysum spiralepis : 3,+; 109,+; 294,+
Helichrysum splendidum : 290,1; 291,a; 299,+; 340,+; 50,+; 82,+; 18,+; 104,+; 310,+; 307,a; 240,+; 241,+
Helichrysum subglomeratum : 109,+
Helichrysum umbraculigerum : 42,+; 62,+; 110,+; 30,+; 100,+; 107,+; 295,+
Helictotrichon hirtulum : 85,+
Heliophila carnosa : 285,+
Hermannia depressa : 273,+; 317,+
Hermannia parviflora : 175,+; 283,+
Hermannia sp. : 280,+
Herniaria erckertii : 242,+; 107,+; 255,+
Hesperantha tysonii : 235,+
Hibiscus aethiopicus : 280,+; 282,+; 283,+; 1,+
Hibiscus microcarpus : 83,+
Holothrix scopularia : 294,r; 235,+
Homeria sp. : 200,+; 195,+
Hordeum capense : 299,+
Hyparrhenia anamesa : 75,+
Hyparrhenia hirta : 280,+; 60,1; 68,a; 88,1
Hypericum aethiopicum : 28,+; 1,+; 18,+
Hypericum lalandii : 4,+
Hypericum wilmsii : 340,+
Hypertelis salsoloides : 98,+
Hypochaeris brasiliens : 8,+
Hypochaeris radicata : 40,+; 41,+; 37,+; 2,+; 16,+; 64,+; 235,+; 240,+
Hypoxis acuminata : 26,+; 40,+; 41,+

Hypoxis costata : 284,+; 299,+; 41,+; 4,+; 310,+; 296,+; 240,+
Hypoxis hemerocallidea : 280,+
Hypoxis multiceps : 78,+
Hypoxis rigidula : 280,+; 297,+; 298,+
Hypoxis villosa : 285,+
Ifloga glomerata : 255,+
Indigofera burchellii : 254,+
Indigofera dimidiata : 350,+; 37,+; 254,+
Indigofera hedyantha : 234,+; 72,1; 1,+; 2,+; 4,+
Indigofera heterophylla : 8,+; 82,+; 88,+
Indigofera monostachya : 234,+; 366,+
Indigofera obscura : 96,+
Indigofera sessilifolia : 11,+; 68,+
Indigofera sp. : 28,+; 235,+
Indigofera woodii : 4,+
Indigofera zeyheri : 84,+; 15,+; 82,+
Ipomoea crispa : 83,+; 273,+; 317,+; 82,+
Jamesbrittenia aurantiacea : 286,+
Karroochloa curva : 63,+
Kniphofia parviflora : 296,r
Kniphofia sp. : 107,+
Kniphofia stricta : 295,+
Kniphofia triangularis : 37,+; 309,+
Kohautia amatymbica : 2,+
Kyllinga pulchella : 309,+
Lachenalia sp. : 282,+; 284,+; 65,r
Lantana rugosa : 299,+
Leonotis sp. : 63,+
Lepidium africanum : 10,+; 20,+; 63,+; 68,+; 72,+; 117,+
Linum thunbergii : 348,+; 26,+; 110,+; 296,+; 237,+
Lotononis caerulescens : 4,+
Lotononis laxa : 348,+; 357,+; 41,+; 72,+; 4,+; 106,+
Lotononis sp. : 45,+
Lycium prunus-spinosa : 10,+
Lycium sp. : 280,+; 340,+; 15,+
Malva neglecta : 290,+
Manulea crassifolia : 335,+
Mariscus dregeanus : 10,+
Mariscus indecorus : 8,+
Mariscus sp. : 11,r; 369,+
Mariscus tabularis : 84,1
Melica decumbens : 340,+; 356,+; 20,+; 23,+; 61,+; 62,+; 63,a; 85,+; 112,1
Melolobium burchelli : 189,1; 37,+
Merxmuellera disticha : 189,1; 242,3; 60,b; 61,3; 109,3
Merxmuellera drakensbergensis : 295,3; 202,1
Mesembryanthemum sp. : 285,+; 107,+
Metalasia sp. : 2,1; 3,+
Miscanthus capensis : 200,1; 195,+
Mohria caffrorum v. *caffrorum* : 237,+
Monopsis decipiens : 3,+
Monopsis scabra : 18,+; 96,+
Monopsis unidentata : 308,+; 2,+; 366,+; 64,+; 235,+
Monsonia brevirostrata : 1,+
Moraea albicuspa : 296,+
Moraea polystachya : 234,+; 242,+; 273,+; 64,+; 200,+; 195,+; 235,+
Moraea sp. : 285,+; 202,+
Myrica brevifolia : 103,+; 109,+
Nassella trichotoma : 8,+; 20,+
Nidorella undulata : 100,+; 96,+; 106,+; 295,+; 294,+; 309,+
Oenothera indecora s. *bonar.* : 308,+; 295,+; 307,+
Oenothera tetraptera : 299,+; 88,+; 184,+
Ophioglossum polyphyllum : 82,+; 88,+
Ornithogalum juncifolium : 201,+
Ornithogalum secundum : 254,+
Ornithogalum sp. : 83,+; 10,+
Ornithogalum tenuifolium : 43,+
Orthanthera jasminiflorum : 16,+
Oxalis depressa : 274,+; 282,+; 285,+; 290,+; 40,+; 41,r; 310,+; 254,+; 307,+; 235,+
Oxalis obliquifolia : 298,+
Pachycarpus concolor : 1,+

Panicum aequinerve : 96,+; 309,+
Panicum ecklonii : 96,+
Paspalum dilatatum : 32,1; 30,+; 4,+
Pelargonium capitatum : 237,+
Pelargonium grossularioides : 106,+
Pelargonium reniforme : 10,+; 11,+; 23,1; 42,+; 37,+
Pelargonium sp. : 16,+
Pellaea calomelanos : 1,+
Pellaea pteroides : 82,+
Pennisetum sphacelatum : 84,+; 290,1; 291,+; 340,a; 73,1; 110,+; 112,+; 117,+; 366,+; 307,1; 235,+; 214,+
Pentanisia angustifolia : 1,+
Pentaschistis microphyllum : 158,+
Pentaschistis setifolia : 234,+; 290,1; 255,1; 254,1; 307,+; 202,+; 237,+; 240,+
Pentaschistis oreodoxa : 78,+; 239,+; 295,+
Pentzia cooperi : 189,+; 256,+; 291,a; 337,+; 356,+; 307,a; 214,+
Pentzia globosa : 317,+; 239,+
Peucedanum capense : 11,+; 23,a; 34,+; 37,+; 18,+
Peucedanum platycarpum : 105,+; 96,+
Phymaspermum parvifolium : 350,+
Picris hieracioides : 175,+
Plantago lanceolata : 112,+; 37,+; 16,+; 235,+
Pollichia campestris : 68,+
Polygala amatymbica : 273,+; 340,+; 23,+; 41,+
Polygala gracilenta : 72,+; 96,+; 106,+; 107,+
Polygala gymnoclada : 84,+; 286,+; 350,+; 88,+; 200,+
Polygala hottentotta : 83,+; 356,+; 37,+
Polygala ohlendorfiana : 234,+; 28,+; 310,+; 235,+
Polygala serpentaria : 4,+
Polygala sp. : 357,+
Psammotropha mucronata : 4,+
Pseudognaphalium luteo-album : 242,+; 286,+; 291,+; 350,+; 357,+; 295,+; 294,+; 307,+
Ptycholobium sp. : 273,+
Ranunculus multifidus : 42,+; 117,+; 16,+; 235,+
Relhania acerosa : 285,+; 202,+
Rendlia altera : 297,+; 298,+
Rhus dentata : 82,+
Rhus discolor : 298,r; 299,+; 1,+
Rhus lucida : 273,+
Rhus pyroides : 299,+; 11,1; 239,+; 200,1; 237,+; 240,+
Rhynchosia ciliata : 357,+
Rhynchosia reptabunda : 91,+; 280,+; 284,+; 1,+
Rhynchosia sp. : 83,+; 75,+
Richardia humistrata : 297,+; 75,+; 82,+; 3,+
Romulea macowanii : 110,+; 103,+
Rosa eglanteria : 290,1; 195,+
Rubus fruticosus : 16,+
Rubus ludwigii : 299,+; 37,+; 2,1
Rubus sp. : 96,+
Rumex acetosella : 2,+; 100,+
Rumex pulcher : 10,+
Rumex spathulatus : 290,+
Rumex woodii : 2,+
Ruschia centrocapsula : 202,+; 237,+
Salvia aurita : 37,+
Salvia repens v. repens : 273,+; 317,+; 340,+; 10,+; 50,+; 1,+
Salvia stenophylla : 242,+; 307,+
Schistostephium crataegifolium : 42,+; 96,+
Schoenoxiphium schweickerdtii : 189,+; 195,+
Schoenoxiphium sp. : 200,+; 201,+
Selago corymbosa : 62,+; 88,+; 18,+
Selago galpinii : 285,+
Senecio affinis : 3,+
Senecio arabidifolius : 285,+
Senecio barbatus : 241,+
Senecio conrathii : 286,+; 356,+
Senecio coronatus : 175,+; 184,+
Senecio erubescens : 280,+; 308,+; 335,+; 348,+; 357,+; 184,+; 2,+; 366,+; 310,+; 254,+; 200,+; 196,+; 241,+
Senecio latifolius : 256,+
Senecio macrocephalus : 234,+
Senecio monticola : 237,+

Senecio polelensis : 4,+; 98,+; 103,+
Senecio pterophorus : 1,+; 3,+
Senecio sp. : 200,+
Senecio speciosus : 307,+
Setaria sphacelata : 283,+; 317,+; 310,+; 295,+; 309,+; 307,+; 195,1
Silene bellidioides : 290,+; 29,+; 307,+; 235,+; 237,+
Silene pilosellifolia : 37,+
Silene sp. : 189,+; 285,+; 299,+; 335,+; 82,+; 103,+; 310,+; 200,+; 237,+
Sisymbrium thellungii : 91,+; 175,+; 286,+; 117,+; 214,+
Sisymbrium turczaninowii : 20,+; 240,+
Sisyranthus barbatus : 3,+; 109,+
Solanum rigescens : 75,+
Solanum supinum : 273,+; 283,+; 299,+
Sonchus asper : 299,+
Sonchus oleraceus : 274,+
Species indet. : 274,+; 200,+; 237,+
Spermacoce sp. : 96,+
Sporobolus discosporus : 282,+; 298,+; 357,+
Sporobolus nitens : 285,1
Sporobolus sp. : 295,+
Stachys cuneata : 214,+
Stachys malacophylla : 37,+; 1,+
Stachys rugosa : 237,+
Stiburus alopecuroides : 285,+
Stipagrostis zeyheri : 335,3
Struthiola sp. : 273,+
Sutera calycina : 286,+
Sutera campanulata : 237,+
Sutera halimifolia : 285,+; 254,+
Sutera pinnatifida : 83,+; 91,+; 273,+; 40,+; 82,+; 93,+; 37,+
Sutera sp. : 72,+; 75,+; 110,+
Tagetes minuta : 274,+; 280,+; 283,+; 65,+; 75,+
Taraxacum officinale : 335,+; 350,+; 105,+
Tephrosia capensis : 283,+; 299,+; 11,+; 29,+; 82,+; 4,1; 64,+
Tetraria cuspidata : 96,+
Tolpis capensis : 285,+; 4,+; 3,+
Trachyandra asperata : 8,+; 2,+; 4,+; 240,+
Trachyandra saltii : 235,+
Tribolium hispidum : 98,+; 254,+
Tribulus terrestris : 20,+
Trifolium africanum : 158,+; 290,+; 299,+; 350,+; 310,+; 295,+; 309,+; 195,+; 214,+
Trifolium burchellianum : 84,+; 42,+; 30,+; 2,+; 235,+
Tritonia lineata : 234,+
Turbina oblongata : 308,+; 11,+
Ursinia montana : 106,+; 107,+
Vernonia capensis : 83,+; 11,+
Vernonia dregeana : 3,+
Wahlenbergia albens : 72,+
Wahlenbergia huttonii : 96,+
Wahlenbergia juncea : 91,+; 274,+; 10,+; 11,r; 20,+; 28,+; 32,+; 72,+; 37,+; 18,+
Wahlenbergia sp. : 34,+
Wahlenbergia undulata : 91,+; 234,+; 286,+; 350,+; 73,+; 37,+; 4,+; 310,+; 295,+
Walafrida geniculata : 184,+; 96,+
Walafrida gracilis : 20,+; 21,a; 23,a; 72,+; 112,+
Walafrida paniculata : 350,+
Walafrida saxatilis : 158,+; 242,+; 256,+; 290,+; 291,+; 317,+; 340,+; 356,+; 357,+; 20,+; 255,+; 254,1; 307,+; 214,+; 241,r
Walafrida sp. : 189,+; 274,+; 282,+; 283,+; 286,+; 299,+; 45,+; 105,+; 110,+; 104,+; 307,+; 196,+; 240,+
Watsonia pillansii : 96,+
Watsonia sp. : 18,+; 98,+; 107,+
Withania somnifera : 105,+
Wurmbea elatior : 73,r; 295,+
Xysmalobium parviflorum : 2,+; 106,+; 109,+
Zaluzianskya angustifolia : 98,+
Zaluzianskya capensis : 295,+
Zaluzianskya schmitzia : 285,r; 106,+; 107,+
Zaluzianskya sp. : 296,+; 199,+
Zornia capensis : 83,+; 273,+; 82,+
Zornia sp. : 83,+; 82,+

Appendix 3: Infrequent species occurring in the relevés of Table 6 (Rhoetae erosae Werger)

Acalypha caperonioides : 370,+
Acalypha peduncularis : 372,+
Adenocline pauciflora : 38,+; 370,+; 87,+
Adromischus sp. : 87,+
Agapanthus praecox : 44,+; 97,+
Agapanthus sp. : 154,+
Ajuga ophrydis : 181,+; 236,+; 318,+; 344,+
Albuca exuviata : 258,+
Albuca fastigiata : 167,+
Albuca setosa : 150,+
Alepidea capensis : 326,+; 328,+; 336,+; 351,+
Alloteropsis semialata : 36,+; 372,1
Aloe africana : 314,b
Aloe ecklonis : 44,+
Aloe sp. : 36,+; 151,+
Aloe striata : 44,+
Amaranthus thunbergii : 138,+
Amellus strigosus : 289,+; 204,+
Annesorhiza nuda : 318,+
Anthospermum monticola : 351,+
Anthospermum paniculatum : 370,+
Anthospermum rigidum : 372,+; 289,+; 301,+; 325,+; 330,+; 287,+; 306,+; 323,+; 125,+
Anthospermum sp. : 354,+; 326,+
Antimima sp. : 87,+
Arctotis arctotoides : 339,+; 204,+; 138,+
Argyrolobium lanceolatum : 301,+
Argyrolobium molle : 86,+; 94,+; 330,+
Argyrolobium pauciflorum : 345,+; 204,+; 125,+; 137,+; 148,+; 149,+
Argyrolobium sp. : 163,+; 178,+
Argyrolobium speciosum : 77,+
Argyrolobium tuberosum : 301,+
Aristea abyssinica : 341,+
Aristida canescens : 71,+; 127,1
Aristida junciformis : 301,+; 323,+
Arrowsmithia stypheliodes : 151,+
Artemisia afra : 167,+; 289,+; 344,+; 347,1
Arundinella nepalensis : 97,+
Asclepias stellifera : 153,+; 258,r
Aspalathus chortophila : 163,+; 258,+; 160,+; 323,+; 155,+
Asparagus aethiopicus : 151,+
Asparagus burchellii : 115,+; 71,+; 127,+
Asparagus capensis : 25,1; 36,+; 44,+; 267,+; 375,+; 125,+
Asparagus cooperi : 36,+; 167,+; 115,+; 306,+
Asparagus retrofractus : 125,1; 137,+
Asparagus setaceus : 138,+
Asparagus sp. : 336,+
Asparagus suaveolens : 163,+
Aspidoglossum gracile : 344,+
Aster bakeranus : 17,+; 77,+; 87,+; 94,+; 163,+; 314,+
Azima tetracantha : 370,+
Berkheya decurrens : 97,+
Berkheya heterophylla : 125,+
Berkheya onopordifolia : 370,+; 372,+; 325,+; 306,+; 323,+; 314,+
Berkheya sp. : 24,+; 38,+; 86,+; 167,+; 318,+; 179,+; 351,+; 47,+; 154,+; 155,+; 180,+; 71,+
Bidens pilosa : 138,+
Blechnum australe : 36,+; 38,+; 167,+; 258,+
Blepharis mitrata : 267,+
Brachiaria serrata : 77,+; 372,+; 86,+; 94,+; 258,+; 301,1; 318,+; 325,+; 326,+; 330,+; 341,+; 306,+; 180,+; 71,+
Bromus catharticus : 287,+; 155,+
Bromus leptoclados : 204,+
Brunsvigia sp. : 44,+
Buddleja salviifolia : 151,1; 179,+; 351,+; 210,+
Bulbine abyssinica : 36,+; 336,+; 160,+; 382,+
Bulbine narcissifolia : 44,+

Bupleurum mundii : 328,+
Ceterach cordatum : 345,+; 351,+
Chamaecrista capensis : 77,+
Cheilanthes involuta : 347,+
Cheilanthes marlothii : 151,+; 163,+; 150,a
Cheilanthes quadripinnata : 44,+; 216,+; 351,+
Chenopodium album : 326,+; 267,+
Chloris virgata : 125,+; 138,+
Cineraria aspera : 150,+
Cineraria saxifraga : 36,1
Cineraria sp. : 339,+
Cliffortia ramosissima : 341,+
Cliffortia sp. : 167,+; 236,+; 336,1; 71,+; 125,+
Clutia alaternoides : 87,+
Clutia natalensis : 347,+
Clutia pulchella : 138,+
Commelina africana : 36,+; 94,+; 354,+; 181,+; 325,+; 336,+; 204,+; 306,+; 180,+; 382,+; 71,+
Convolvulus galpinii : 44,+
Convolvulus thunbergii : 301,+; 179,+; 326,+; 327,+; 330,+; 287,+; 306,+; 331,+
Conyza obscura : 370,+; 351,+
Conyza podocephala : 179,+; 344,+; 287,+; 331,+; 180,+; 138,+
Cotula heterocarpa : 372,+; 153,+; 354,+; 339,+; 125,+
Crassula capitella s. capitella : 323,+
Crassula subulata v. fastigiata : 17,+
Crassula dependens : 236,+; 289,+; 327,+; 336,1
Crassula expansa : 44,+
Crassula hirtipes : 44,+; 86,+; 327,+; 328,+
Crassula lanceolata : 36,+; 38,+; 44,+; 326,+; 351,+; 149,+; 390,+
Crassula muscosa : 351,+
Crassula obovata : 38,+; 17,+; 94,+; 301,+; 130,+
Crassula orbicularis : 327,+; 328,+
Crassula pellucida : 97,+
Crassula sp. : 236,+; 289,+; 130,+; 148,+
Crassula tetragona : 301,+
Crassula tomentosa : 328,+; 329,+
Cussonia paniculata : 25,1; 36,+; 151,+; 137,1; 138,+; 149,+; 314,+
Cynodon dactylon : 258,1; 179,+; 267,1; 374,+
Cynodon incompletus : 325,+; 287,+; 323,+
Cynoglossum austroafricanum : 150,+; 204,+
Cyperus obtusiflorus : 236,+
Cyperus rupestris : 180,+
Cyrtanthus contractus : 163,+
Diascia rigescens : 77,+
Dicoma anomala : 326,+; 330,+
Dierama pendulum : 97,1
Dierama sp. : 36,+; 44,+; 372,+
Digitaria diagonalis : 77,+
Digitaria argyrograpta : 24,1; 306,1; 374,+; 375,+; 382,+; 125,1
Diospyros lycioides : 306,1; 375,+; 314,1
Dolichos angustifolius : 138,+
Dolichos linearis : 36,+; 115,+
Echium plantagineum : 47,+
Ehrharta calycina : 216,+; 339,+; 374,1
Encephalartos friderici-guil. : 301,+
Eragrostis gummiflua : 306,3
Eragrostis lehmanniana : 330,+; 382,1; 71,+; 125,1; 138,+
Eragrostis planiculmis : 77,+
Eragrostis racemosa : 17,+; 86,+; 94,+; 153,+; 301,+; 325,+; 330,1; 336,+; 341,+; 344,+; 345,+; 127,+
Eragrostis trichophora : 232,+
Eriocephalus aspalathoides : 87,+; 94,+; 115,1; 289,+; 329,+
Eriocephalus ericoides : 36,1; 204,+; 127,+; 149,+
Erodium cicutarium : 160,+
Euclea crispa : 36,+; 115,1
Eucomis autumnalis : 97,+
Eulalia villosa : 17,+; 86,+
Euphorbia clavarioides : 327,+; 328,+; 329,+
Euphorbia pulvinata : 86,+
Euphorbia sclerophylla : 94,+
Euphorbia sp. : 163,+; 182,+; 374,+; 125,+

Euphorbia striata : 38,+; 97,+; 86,+; 87,+; 94,+; 167,+; 354,+; 115,+; 182,+; 301,+; 318,+; 330,+; 336,+; 344,+; 154,+; 306,+; 331,+; 155,+; 127,r; 138,+
Euryops galpinii : 181,+; 179,+
Euryops oligoglossus : 47,1
Euryops spathaceus : 17,+
Eustachys paspaloides : 375,+; 127,+; 137,+; 390,1
Felicia hirsuta : 236,+; 289,+
Felicia rosulata : 151,+
Felicia zeyheri : 86,+
Festuca caprina : 216,+; 289,a; 339,1; 347,+
Festuca scabra : 153,+; 181,1; 179,+
Ficinia sp. : 97,+; 258,+; 180,+
Ficinia stolonifera : 94,+
Fingerhuthia africana : 12,+
Galium capense : 38,+; 301,+; 339,+; 331,+; 137,+
Geigeria filifolia : 382,+
Geranium amatolicum : 77,+
Geranium contortum : 44,+; 370,+
Geranium grandistipulatum : 87,+
Geranium sp. : 151,+
Geranium wakkerstroomianum : 258,+
Gerbera piloselloides : 17,+; 167,+; 115,1; 181,+; 258,+; 318,+; 351,+; 154,+; 382,+; 138,+
Gerbera sp. : 236,+
Gladiolus permeabilis : 94,+; 318,+; 325,+; 328,+; 339,+
Gnidia nodiflora : 87,+
Gnidia sericea : 97,+; 354,+; 289,+
Grewia occidentalis : 17,+; 77,+; 115,a; 71,b
Grewia tenax : 36,+; 137,+; 149,+; 314,1
Habenaria lithophila : 370,+
Haplocarpha nervosa : 151,+
Harveya sp. : 351,+
Haworthia sp. : 36,+; 38,+; 86,+; 155,+
Helichrysum allioides : 17,+
Helichrysum anomalum : 44,+; 17,+; 370,+; 372,+; 86,+; 87,+; 94,+; 115,+; 301,+
Helichrysum asperum : 354,+; 181,+; 179,+; 344,+; 345,+; 160,+; 306,+; 155,+; 180,+
Helichrysum chionosphaerum : 153,+; 167,+; 325,1; 336,+; 339,+; 154,+; 160,+; 323,+
Helichrysum cymosum : 148,1
Helichrysum dasymallum : 180,+
Helichrysum glomeratum : 370,+
Helichrysum hamulosum : 374,+; 149,+
Helichrysum herbaceum : 24,+; 17,+
Helichrysum lineare : 47,+
Helichrysum mixtum : 354,+
Helichrysum montis-cati : 354,+; 178,+
Helichrysum odoratissimum : 24,+; 77,+; 345,+; 148,+
Helichrysum psilolepis : 24,+
Helichrysum rugulosum : 17,+; 86,+; 153,+; 178,+; 236,+; 301,+; 326,+; 330,+; 336,+; 339,+; 341,+; 47,+; 154,+; 331,+; 155,+; 180,+; 71,+; 125,+; 127,+; 130,+; 138,+; 232,+
Helichrysum rutilans : 354,+; 318,+; 325,+; 154,+; 306,+; 323,1; 155,+
Helichrysum simillimum : 24,+; 370,+; 372,+
Helichrysum sphaeroideum : 326,+
Helichrysum splendidum : 17,+; 289,+; 344,+; 345,+; 351,+; 47,+; 287,+
Helichrysum trilineatum : 258,+; 345,+; 351,+
Helichrysum umbraculigerum : 77,+; 372,+; 347,+
Helichrysum zeyheri : 382,+; 130,+; 137,1; 138,+; 390,+
Heliophila carnosa : 289,+
Hermannia althaeifolia : 374,+; 378,+
Hermannia coccocarpa : 38,+; 354,+; 301,+; 179,+; 327,+; 336,+; 47,+; 154,+; 160,+; 125,+; 127,+; 137,+; 138,+
Hermannia cordata : 370,+; 86,+; 181,+; 301,+; 341,+; 154,+
Hermannia depressa : 354,+; 330,+; 306,+; 314,+
Hermannia parviflora : 24,+; 341,1; 154,+
Herniaria erckertii : 344,+
Hibiscus aethiopicus : 372,+; 149,+; 314,+
Holcus lanatus : 17,+
Homeria sp. : 216,+
Hyparrhenia hirta : 86,+; 94,1; 236,+; 150,1; 267,1; 382,+; 127,+; 149,+; 314,b; 390,+
Hypericum lalandii : 148,+
Hypertelis salsoloides : 160,+; 329,+
Hypochaeris radicata : 153,1; 163,+
Hypoxis argentea : 12,1; 163,+; 236,+; 160,+; 267,+; 71,+; 127,+; 314,+

Hypoxis costata : 336,+
Hypoxis iridifolia : 167,+
Hypoxis multiceps : 86,+
Hypoxis sp. : 36,+; 94,+
Ifloga glomerata : 354,+; 326,+; 306,+; 323,+; 180,+
Indigofera alternans : 341,+; 204,+; 267,+
Indigofera burchellii : 351,+
Indigofera hedyantha : 370,+; 130,+
Indigofera heterophylla : 12,r; 17,1; 148,+
Indigofera sessilifolia : 115,+; 180,+; 149,+; 314,+
Indigofera tenuissima : 301,+
Indigofera woodii : 17,+
Indigofera zeyheri : 87,+; 94,+; 181,+
Ipomoea crispa : 94,+
Jamesbrittenia atropurpurea : 267,+; 125,+; 137,+
Jamesbrittenia aurantiacea : 151,+
Kedrostis africana : 71,+
Kiggelaria africana : 258,1
Kniphofia sp. : 380,+
Kniphofia stricta : 325,+; 326,+; 328,+; 339,1; 351,+
Kniphofia triangularis : 130,a; 148,1
Kniphofia uvaria : 77,+
Koeleria capensis : 44,+; 344,+; 155,+
Kyllinga alata : 336,+; 306,+; 323,+; 331,+
Lachenalia sp. : 287,+
Lactuca inermis : 178,+; 181,+; 236,+; 326,+; 154,+; 203,+; 287,+; 323,+; 331,+
Lantana rugosa : 149,+; 314,+
Lappula squarrosa : 204,+
Lasiospermum bipinnatum : 31,+; 155,+
Leipoldtia sp. : 94,+
Leonotis ocymifolia : 38,+
Leonotis sp. : 77,+
Lepidium africanum : 326,+; 327,+; 47,+; 204,+; 323,+; 374,+
Lessertia inflata : 318,+
Leucosidea sericea : 38,1; 236,+; 289,+; 336,1; 47,1; 287,+
Leysera gnaphalodes : 38,+; 163,+
Limeum aethiopicum : 374,+
Linum thunbergii : 97,+; 86,+; 94,+; 301,+; 325,+; 351,+
Lithospermum papillosum : 370,+; 301,+; 351,+
Lobelia flaccida : 38,+; 372,+; 87,+; 94,+; 301,+; 330,+; 339,+; 137,+; 148,+
Lotononis divaricata : 138,+
Lotononis sericophylla : 351,+
Manulea sp. : 326,+
Mariscus capensis : 94,+; 301,+; 314,+
Mariscus congestus : 306,+
Mariscus indecorus : 71,+
Mariscus uitenhagensis : 86,+
Massonia grandiflora : 148,+
Maytenus heterophylla : 36,+; 167,+; 318,+; 210,1; 138,+
Melinis nerviglumis : 17,+; 86,+; 94,+; 325,+; 150,+
Melinis repens : 382,+
Melolobium sp. : 318,+
Mesembryanthemum sp. : 87,+; 289,+; 326,+; 345,+; 203,+
Metalasia densa : 87,1; 236,1
Microchloa kunthii : 38,+; 372,1; 94,+; 181,+; 325,+; 327,+; 330,+; 336,+; 306,1; 323,1; 155,+; 329,+
Miscanthus capensis : 151,+; 347,+; 149,+
Mohria sp. : 347,+
Monsonia emarginata : 370,+
Moraea polystachya : 341,+
Moraea spathulata : 258,+
Moraea sp. : 179,+; 160,+; 155,+
Muraltia alticola : 236,+; 130,+
Myrica brevifolia : 44,+
Myrsine africana : 36,+; 44,1; 151,+; 370,+; 178,+; 301,+; 179,+; 180,+; 210,+
Nemesia fruticans : 36,+
Nenax microphylla : 160,+; 204,+; 155,+; 382,+; 232,+
Oenothera indecorus : 154,+
Olea sp. : 314,+
Ornithogalum secundum : 258,+
Othonna patula : 329,+

Oxalis depressa : 289,+; 339,+; 323,+
Oxalis obliquifolia : 127,+; 148,+
Oxalis smithiana : 125,+
Pachycarpus sp. : 181,+; 258,r
Pachycarpus vexillaris : 86,+; 301,+; 326,+; 327,+
Panicum coloratum : 127,+; 138,+
Paspalum dilatatum : 167,+; 181,+; 180,+
Pegolettia retrofracta : 149,+
Pelargonium elongatum : 36,+; 44,+
Pelargonium laxum : 149,+
Pelargonium reniforme : 24,+; 25,+; 38,+; 370,+; 150,+; 127,+; 148,+
Pelargonium sidoides : 31,+; 181,+; 327,1; 336,+; 345,+; 47,+; 154,+; 204,+; 71,+; 137,+; 138,+
Pellaea calomelanos : 36,+; 44,+; 151,+; 153,+; 167,+; 182,+; 216,+; 339,+; 150,+; 210,+; 382,+; 71,r; 149,+
Pennisetum sphacelatum : 77,+; 289,+; 339,1; 287,+; 331,+; 390,+
Pentanisia angustifolia : 17,+
Pentaschistis setifolia : 153,+; 178,+; 216,+; 236,+; 351,+; 150,+
Pentaschistis airoides : 153,+
Pentaschistis oreodoxa : 258,+; 318,+
Pentzia sphaerocephala : 71,+
Peucedanum capense : 12,+; 31,+; 351,+
Peucedanum platycarpum : 301,+
Phylica sp. : 330,a
Pimpinella caffra : 351,+
Pollichia campestris : 86,+
Polygala amatymbica : 236,+; 301,+; 179,+; 154,+; 323,+; 155,+; 180,+
Polygala ephedroides : 289,+
Polygala fruticosa : 301,+
Polygala gracilenta : 86,+; 71,+
Polygala gymnoclada : 24,+; 17,+; 344,+
Polygala hottentotta : 347,+
Printzia pyrifolia : 347,+; 351,+
Psammotropha mucronata : 36,+
Pseudognaphalium luteo-album : 289,+; 180,+
Pseudognaphalium oligandrum : 354,+; 339,+; 347,+; 203,+; 204,+; 287,+; 306,+; 375,+; 382,+
Pterothrix spinescens : 289,+; 203,+; 287,+; 232,+; 390,+
Ptycholobium sp. : 370,+; 306,+; 323,+; 155,+
Rabiea sp. : 382,+
Raphionacme sp. : 153,+
Relhania pungens : 151,+; 97,+; 87,+; 301,+
Rhamnus prinoides : 167,1; 216,+; 301,+; 341,+; 345,+; 150,+; 306,1
Rhoicissus tridentata : 125,1
Rhus divaricata : 326,+; 351,+
Rhus dregeana : 378,+; 148,1
Rhus glauca : 148,+
Rhus krebsiana : 149,+
Rhus refracta : 38,1; 87,1; 326,+; 327,+; 330,+
Rhus sp. : 318,+; 336,+; 331,1; 380,+
Rhynchosia totta v. totta : 24,+; 25,+; 370,+; 372,+; 86,+; 94,+; 301,+; 325,+; 314,+
Rhynchosia adenodes : 24,1; 25,+; 178,+; 216,+; 301,+; 330,+; 341,+; 331,+
Rhynchosia ciliata : 167,+; 339,+; 154,+
Rhynchosia nervosa : 370,+; 314,+
Rhynchosia pauciflora : 130,+
Rhynchosia reptabunda : 77,+; 372,+; 153,+; 130,+; 137,+
Richardia humistrata : 370,+; 372,+
Rosa eglanteria : 301,+; 325,+; 339,+; 347,+; 331,+
Rubia petiolaris : 181,+; 301,+; 351,+; 130,+; 137,+; 138,1
Rubus ludwigii : 372,+; 87,+; 163,+; 216,+; 318,+; 339,+; 345,+; 347,+; 154,+; 331,+; 380,+
Rubus rigidus : 347,+
Rubus sp. : 97,+
Rumex spathulatus : 287,+
Ruschia centrocapsula : 236,+; 327,+
Ruschia sp. : 44,+
Salvia repens v. repens : 370,+; 236,+; 339,+; 341,+; 331,+
Salvia verbenaca : 204,+
Sarcocaulon camdeboensis : 382,+
Sarcocaulon vanderietiae : 71,+
Sarcostemma viminale : 382,+
Schistostephium crataegifolium : 77,+; 97,+; 87,+; 301,+
Schizoglossum linifolium : 179,+; 330,+
Schkuhria pinnata : 327,+; 323,+

Schoenoxiphium schweickerdtii : 216,+
Sebaea natalensis : 370,+; 372,+; 354,+; 330,+; 336,+; 344,+; 345,+; 347,+; 351,+
Selago albida : 354,+; 327,1; 330,+
Selago corymbosa : 370,+; 94,+; 380,+
Selago galpinii : 325,+
Selago sp. : 336,+; 351,+
Senecio affinis : 17,+
Senecio conrathii : 347,+
Senecio coronatus : 354,+; 181,+; 325,+
Senecio erubescens : 289,+; 344,+; 160,+; 306,+; 180,+
Senecio inornatus : 351,+
Senecio juniperinus : 24,+; 44,+; 17,+; 77,+; 97,+; 372,+; 94,+; 163,+; 150,+; 127,+; 130,+; 137,+; 148,+
Senecio oxyodontus : 44,+
Senecio polelensis : 351,+
Senecio radicans : 327,+; 329,+; 374,+
Senecio ruwenzoriensis : 137,+
Setaria sphacelata : 370,+; 347,+; 150,+; 306,1; 314,+
Silene bellidioides : 38,+
Silene sp. : 153,+; 258,+; 326,+; 339,+; 351,+; 306,+; 378,+
Sisymbrium thellungii : 287,+
Sisymbrium turczaninowii : 47,+
Sisyranthus barbatus : 17,+
Solanum nigrum : 378,+
Solanum rigescens : 77,+
Solanum supinum : 326,+; 327,+; 330,+; 306,+; 267,+; 137,+; 138,+
Sonchus asper : 204,+; 138,+
Sporobolus africanus : 31,+; 370,1; 372,1; 306,+; 125,+
Sporobolus discosporus : 354,+; 155,+
Stachys aethiopica : 25,+; 167,+
Stachys graciliflora : 87,+
Stachys linearis : 71,+
Stachys malacophylla : 36,r
Striga elegans : 354,+; 289,+; 301,+; 325,+; 330,+; 345,+; 287,+
Sutera sp. : 77,+; 86,+; 87,+; 289,+; 71,+
Sutherlandia frutescens : 216,+; 378,+
Tagetes minuta : 44,+; 154,+
Taraxacum officinale : 301,+; 154,+
Tephrosia capensis : 17,+; 86,+; 94,+; 115,+; 301,+; 330,+; 125,+; 137,+; 138,+
Tetrachne dregei : 204,+; 331,1
Thesium sp. : 38,+; 97,+; 153,+; 167,1; 216,+; 179,+; 326,+; 330,+; 344,+; 160,+; 210,+; 378,+; 127,+
Trachyandra asperata : 38,+
Trachyandra saltii : 153,+; 178,+; 181,+; 327,+; 328,+; 154,+
Tribolium hispidum : 216,+; 258,+; 326,+
Tribulus terrestris : 47,+; 267,+
Trichodiadema sp. : 204,+; 375,+; 137,+
Trichoneura grandiglumis : 325,+; 323,+
Trifolium africanum : 339,+
Trifolium burchellianum : 38,+; 71,r
Turbina oblongata : 12,1
Ursinia montana : 154,+
Ursinia nana : 153,+; 180,+
Vernonia capensis : 301,+; 341,+
Vicia sp. : 351,+
Wahlenbergia capensis : 97,+
Wahlenbergia denticulata : 287,+
Wahlenbergia juncea : 12,1; 24,+; 17,+; 326,+; 127,+
Wahlenbergia sp. : 372,+; 86,+; 94,+; 115,+; 301,+; 345,+; 347,+; 148,+
Wahlenbergia stellariodes : 326,+; 339,+; 323,+; 331,+
Wahlenbergia undulata : 370,+; 354,+; 289,+; 179,+; 328,+; 344,+; 351,+; 287,+; 380,+; 148,+
Walafrida densiflora : 87,+; 354,+; 47,+; 150,1; 380,+
Walafrida gracilis : 24,+; 38,+; 370,+; 86,+; 287,+; 323,1; 331,+
Walafrida sp. : 372,+; 326,+; 330,+; 341,+; 323,+
Watsonia pillansii : 97,+
Watsonia sp. : 25,+; 17,+; 94,+
Withania somnifera : 25,+; 86,+; 267,+
Zaluzianskya schmitzia : 318,+; 326,+; 336,+
Zaluzianskya sp. : 289,+; 328,+; 345,+; 154,+
Zantedeschia albomaculata : 36,+; 372,+; 154,+

Appendix 4: Infrequent species occurring in the relevés of Table 7 (savanna)

Acacia mearnsii : 264,1
Adenocline pauciflora : 264,+
Agapanthus praecox : 132,+
Agrostis lachnantha : 361,+
Albuca sp. : 245,+; 246,+
Aloe sp. : 90,a; 225,+
Anacampseros arachnoides : 245,+
Andropogon appendicula : 229,1; 219,1
Anthospermum aethiopicum : 265,+
Anthospermum sp. : 304,+
Aptosimum procumbens : 143,+; 229,+
Argyrolobium pauciflorum : 246,+; 264,+
Argyrolobium sp. : 225,+; 263,+
Aristida canescens : 133,+
Asparagus burchellii : 59,+
Asparagus capensis : 246,+
Asparagus cooperi : 58,1
Asparagus setaceus : 132,+
Asparagus suaveolens : 14,1; 90,+
Azima tetracantha : 359,+
Berkheya pinnatifida : 143,+; 219,+
Berkheya sp. : 90,+
Berula erecta : 264,+
Bidens bipinnata : 249,+
Blepharis mitrata : 245,1
Bulbine frutescens : 244,+; 272,+
Bulbostylis humilis : 265,+
Carissa haematocarpa : 132,+
Cenchrus ciliaris : 133,+
Cheilanthes eckloniana : 132,+
Chenopodium album : 224,+
Chenopodium carinatum : 249,+
Chloris virgata : 272,+
Cliffortia sp. : 219,+
Convolvulus thunbergii : 361,+
Crassula capitella s. capitella : 245,+
Crassula ericoides : 265,+
Crassula muscosa : 245,+
Crassula setulosa : 14,+
Cucumis zeyheri : 360,+
Cussonia paniculata : 132,+; 225,+
Cymbopogon excavatus : 244,3; 263,+
Cynodon incompletus : 245,1; 90,+
Cyperus rupestris : 265,+
Cyphia sp. : 224,+; 304,+
Delosperma sp. : 59,+; 244,+
Dierama sp. : 132,+
Diospyros scabrida : 132,+
Dipcadi ciliare : 224,+
Elytropappus rhinocerotis : 219,+; 249,r
Enneapogon scoparius : 245,+
Eragrostis gummiflua : 360,1
Euphorbia micracantha : 246,+
Euphorbia sp. : 229,+
Euryops floribundus : 132,+
Falckia repens : 360,+
Felicia hyssopifolia : 244,+
Festuca scabra : 219,+
Ficinia stolonifera : 304,+
Galenia prostrata : 272,+
Geranium grandistipulatum : 304,+
Geranium incanum : 229,+
Gnaphalium vestitum : 304,1
Gnidia capitata : 225,1
Gnidia myrtifolia : 265,+
Gnidia sp. : 359,+

Gomphocarpus fruticosus : 360,+
Gomphrena celosioides : 272,+
Grewia occidentalis : 14,+
Grewia tenax : 132,+; 359,+
Guilleminea densa : 360,+
Harpochloa falx : 359,+; 219,+
Helichrysum anomalum : 304,+
Helichrysum callicomum : 219,+
Helichrysum odoratissimum : 219,+
Helichrysum pentzioideum : 249,+
Helichrysum zeyheri : 132,+
Heliophila carnosa : 265,+
Hermannia cordata : 272,+
Hermannia parviflora : 272,+
Hertia pallens : 249,+
Hibiscus pusillus : 90,+; 263,+
Hypertelis salsoloides : 245,+; 272,+
Hypochaeris radicata : 265,+
Hypoxis costata : 225,+
Hypoxis iridifolia : 219,+
Hypoxis longifolia : 265,+
Hypoxis multiceps : 90,+
Hypoxis sp. : 14,+; 244,+
Ifloga glomerata : 249,+
Indigofera alternans : 224,+
Indigofera heterophylla : 263,+
Indigofera sessilifolia : 90,+; 359,+
Indigofera torulosa : 272,r
Indigofera zeyheri : 14,+
Koeleria capensis : 225,+
Lantana rugosa : 244,+
Ledebouria sp. : 244,+
Lepidium africanum : 59,+; 66,+
Lobelia tomentosa : 263,+
Manulea burchellii : 249,+
Mariscus capensis : 272,+; 263,1
Mariscus uitenhagensis : 245,+; 90,+
Melinis nerviglumis : 90,+
Melolobium burchelli : 59,+; 132,+
Merxmuellera disticha : 143,1
Mesembryanthemum sp. : 272,+; 304,+
Mestoklema elatum : 133,+
Monopsis unidentata : 265,+
Monsonia angustifolia : 359,+
Olea europaea : 132,1
Opuntia aurantiaca : 245,+
Ornithogalum juncifolium : 244,+; 228,+
Oxalis depressa : 272,+
Panicum coloratum : 90,+; 359,a
Panicum stapfianum : 59,+; 272,+
Paspalum dilatatum : 272,+; 304,+
Passerina montana : 219,+
Pelargonium multicaulum : 245,+
Pelargonium abrotanifolium : 143,+
Pelargonium alchemilloides : 263,+
Pennisetum sphacelatum : 132,+; 263,1
Pentaschisti setifolia : 219,+
Pentzia lanata : 249,+
Plantago lanceolata : 272,+
Polygala gracilenta : 90,+; 219,+
Polygala gymnoclada : 363,+
Polygala leptophylla : 246,+
Polygala uncinata : 245,+
Pseudognaphalium oligandrum : 249,+
Pteronia staehelinoides : 133,+
Rabiea sp. : 246,+
Rhus erosa : 132,a; 219,+
Rhus lancea : 132,1; 58,1
Rhus refracta : 133,a
Rhus sp. : 244,a

Rhynchosia totta v. totta : 225,+
Salvia stenophylla : 224,+; 249,+
Sansevieria sp. : 359,+
Sebaea natalensis : 265,+
Senecio asperulus : 219,+
Senecio conrathii : 304,+
Senecio juniperinus : 264,+
Senecio radicans : 246,+; 250,+
Sida ovata : 361,+
Sisymbrium turczaninowii : 90,+; 359,+
Solanum incanum : 224,+
Sonchus dregeanus : 249,+
Stachys linearis : 250,+; 219,+
Stoebe vulgaris : 219,+
Sutera halimifolia : 359,+
Sutera pinnatifida : 59,+; 219,+
Tagetes minuta : 66,+
Talinum caffrum : 250,+; 249,+
Taraxacum officinale : 264,+
Tephrosia sp. : 304,+
Thunbergia capensis : 360,+; 361,+
Trachyandra saltii : 246,+; 225,+
Tragus racemosus : 224,+
Tribolium hispidum : 219,+; 304,+
Tristachya leucothrix : 219,+; 264,+
Turbina oblongata : 224,+
Urochloa panicoides : 90,+; 361,+
Ursinia nana : 249,+
Verbena venosa : 265,+
Vernonia capensis : 225,+; 263,+
Viscum rotundifolium : 359,+
Wahlenbergia albens : 59,+
Walafrida geniculata : 59,+; 272,+
Walafrida gracilis : 304,+
Walafrida sp. : 363,+
Species indet. : 304,+
Withania somnifera : 360,+
Zornia capensis : 263,+

Appendix 5: Infrequent species occurring in relevés of Table 8 (grassy fynbos)

Acacia longifolia : 268,+
Acalypha ambigua : 398,+
Acalypha caperonioides : 303,+
Acalypha peduncularis : 268,+
Acalypha sp. : 398,+
Alloteropsis semialata : 303,+; 123,+; 398,a
Aloe pluridens : 269,a
Aloe sp. : 302,+; 124,r
Anthospermum aethiopicum : 302,+; 398,+
Anthospermum prostratum : 270,+
Asparagus denudatus : 302,+; 124,+
Aster bakeranus : 302,+; 303,+
Athanasia dentata : 268,+; 270,+
Athanasia pinnata : 268,+
Becium sp. : 398,+
Berkheya carduoides : 270,+
Berkheya decurrens : 270,+; 303,+
Berkheya heterophylla : 303,+
Berkheya rhapontica : 268,+; 270,+
Boophane disticha : 302,+
Brunsvigia sp. : 302,+
Buchnera dura : 268,+
Bulbine abyssinica : 302,+
Bulbine frutescens : 398,+
Bulbostylis humilis : 303,+; 124,+
Bulbostylis oritrephes : 268,+
Carpobrotus sp. : 303,+; 124,+
Cassytha filiformis : 270,+
Centella asiatica : 270,+; 303,+
Chironia melampyrifolia : 270,+
Chironia peglerae : 268,+
Chrysanthemodes monilifera : 302,+
Chrysocoma ciliata : 124,+
Cineraria saxifraga : 269,1; 124,+
Cliffortia nitidula : 270,a
Cliffortia sp. : 303,+
Clutia heterophylla : 268,+; 302,+
Cotyledon orbiculata : 302,+; 124,+
Crassula cotyledonis : 269,+
Crassula latibracteata : 302,+
Cussonia paniculata : 269,+
Cussonia sp. : 398,r
Cymbopogon plurinodis : 302,+
Cymbopogon validus : 123,+; 124,+
Cyphia sylvatica : 123,+
Cyrtanthus obrienii : 303,+
Disa sp. : 398,+
Ehrharta calycina : 302,+; 303,+
Ehrharta erecta : 124,+
Elionurus muticus : 302,+; 303,+
Eragrostis obtusa : 302,+
Euclea crispa : 302,+
Euclea racemosa : 123,+
Eulalia villosa : 303,1
Euryops brachypodus : 302,+; 124,+
Euryops sp. : 398,+
Felicia muricata : 123,+
Ficinia acuminata : 303,+
Ficinia nigrescens : 124,+
Ficinia stolonifera : 302,+; 303,+
Gerbera piloselloides : 124,r
Gladiolus ochroleucus : 302,+
Gnidia myrtifolia : 268,+; 270,+
Gnidia sp. : 398,+
Hakea sericea : 398,r
Halleria lucida : 268,+; 398,+

Haworthia sp. : 302,+
Helichrysum acutatum : 398,+
Helichrysum felinum : 268,+; 303,+
Helichrysum herbaceum : 302,+
Helichrysum pilosellum : 303,+
Helichrysum rosum : 302,+
Helichrysum spiralepis : 303,+
Helichrysum teretifolium : 268,1
Heliophila sp. : 398,+
Hibiscus aethiopicus : 268,+; 270,+
Hibiscus sp. : 398,+
Hypericum lalandii : 123,+
Hypoxis argentea : 303,+
Hypoxis costata : 303,+
Hypoxis hemerocallidea : 269,+; 302,+
Hypoxis sp. : 398,1
Hypoxis villosa : 302,+; 303,+
Indigofera burchellii : 303,+
Indigofera hedyantha : 268,+
Indigofera poliotes : 270,+
Indigofera sp. : 398,+
Indigofera verrucosa : 123,1
Knowltonia cordata : 124,+
Lachenalia sp. : 398,+
Lactuca inermis : 268,+; 302,+
Lantana rugosa : 302,+
Leucadendron salignum : 268,+
Linum acuticarpum : 270,+
Linum thunbergii : 268,+; 302,+
Lithospermum papillosum : 303,+
Mariscus uitenhagensis : 302,+
Maytenus heterophylla : 398,+; 124,+
Melinis nerviglumis : 302,+
Mesembryanthemum sp. : 302,+
Metalasia trivialis : 124,+
Mohria caffrorum v. caffrorum : 123,+
Monopsis unidentata : 270,r; 303,+
Moraea polystachya : 302,+
Moraea sp. : 398,+
Myrica serrata : 302,+
Myrica sp. : 398,+
Myrsine africana : 124,+
Nidorella auriculata : 303,+
Olea exasperata : 124,+
Osteospermum bidens : 302,+
Oxalis sp. : 303,+; 123,+
Panicum stapfianum : 268,+; 302,+
Passerina vulgaris : 268,+; 302,+
Pavetta capensis : 269,+
Pellae calome v. leuco : 269,+; 302,+
Pennisetum sphacelatum : 303,+
Pentaschistis oreodoxa : 302,+; 303,+
Pentaschistis sp. : 398,1
Poa sp. : 398,+
Polygala hottentotta : 268,+
Pteridium aquilinum : 303,+
Pterocelastrus sp. : 398,+
Pterocelastrus tricuspidatus : 302,+
Pteronia teretifolia : 268,+
Rapanea sp. : 269,+
Relhania pungens : 268,+; 303,+
Restio sejunctus : 123,1
Rhodocoma fruticosa : 124,+
Rhoicissus tridentata : 302,+; 124,+
Rhus crenata : 124,+
Rhus dentata : 270,+
Rhus glauca : 124,+
Rhynchosia sp. : 398,+
Rhynchosia totta : 398,+
Richardia humistrata : 270,+

Rubus pinnatus	: 303,+; 124,+
Rumohra adiantiformis	: 124,+
Satyrium parviflorum	: 303,+
Satyrium sp.	: 398,r
Scabiosa columbaria	: 303,+
Scabiosa tysonii	: 124,+
Solanum tomentosum	: 269,+
Sonchus dregeanus	: 124,+
Species indet.	: 302,+
Sporobolus africanus	: 398,+
Sutera pinnatifida	: 123,+
Sutera sp.	: 269,+
Tarchonanthus camphoratus	: 124,1
Tephrosia sp.	: 302,+; 303,+
Tetraria cuspidata	: 398,+; 124,+
Thunbergia capensis	: 302,+
Trachyandra asperata	: 303,+
Viscum sp.	: 268,+
Watsonia sp.	: 124,+
Zornia capensis	: 268,+; 270,+

Appendix 6: Infrequent species occurring in the relevés of Table 9 (karroid vegetation)

Acacia karroo : 143,+
Agapanthus praecox : 131,+
Aloe broomii : 146,+
Amaranthus sp. : 126,+
Amaranthus thunbergii : 146,+
Anthospermum sp. : 134,+
Argyrolobium pauciflorum : 140,+; 266,+
Aristida adscensionis : 131,+
Asclepias compressidens : 126,+
Asparagus burchellii : 128,1
Asparagus striatus : 95,+; 131,+
Berkheya onopordifolia : 126,+
Berkheya pinnatifida : 143,+
Bidens pilosa : 126,+
Blepharis dilatata : 95,+
Boophane disticha : 147,+
Brunsvigia sp. : 126,+; 128,+
Buddleja glomerata : 128,+
Bulbine abyssinica : 126,+; 135,+
Bulbostylis humilis : 397,+
Carissa haematocarpa : 131,+
Chascanum pinnatifidum : 131,+
Cotyledon orbiculata : 141,+
Crassula muscosa : 140,+; 95,+
Crassula pellucida : 95,+
Crassula sp. : 141,+; 147,+
Crassula tabularis : 140,+
Cucumis myriocarpus : 147,+
Cymbopogon plurinodis : 126,+; 128,+
Cyperus longus : 140,+
Dianthus basuticus : 126,+; 146,+; 266,+
Dierama sp. : 135,+
Diospyros austroafricanus : 128,+; 266,+
Dolichos sp. : 126,+
Ehrharta calycina : 146,+; 147,+
Elytropappus rhinocerotis : 397,+
Eragrostis plana : 146,+
Eriocephalus africanus : 147,+
Eriocephalus sp. : 140,+; 95,+
Euphorbia micracantha : 247,+
Euryops annae : 397,+
Exomis microphylla : 140,+
Felicia filifolia : 143,1
Felicia hirsuta : 266,+
Felicia hyssopifolia : 248,+
Felicia ovata : 248,+
Fingerhuthia sesleriiformis : 131,+
Galium capense : 248,+
Helichrysum asperum : 95,+
Helichrysum rugulosum : 128,+; 266,+
Helichrysum zeyheri : 126,1; 134,+
Helictotrichon turgidulum : 146,+
Hermannia cuneifolia : 95,+
Hermannia filifolia : 126,+
Hibiscus aethiopicus : 143,+; 147,+
Hypoxis argentea : 126,+
Indigofera sessilifolia : 146,+; 147,+
Karroochloa purpurea : 397,+
Kyllinga alata : 126,+
Lactuca inermis : 126,+
Lasiospermum bipinnatum : 135,+
Limeum aethiopicum : 248,+; 131,+
Lotononis laxa : 126,+
Lycium cinereum : 95,+

Lycium sp. : 248,1; 266,+
Mariscus capensis : 95,+
Maytenus heterophylla : 131,+
Moraea polystachya : 131,+
Oxalis depressa : 140,+; 266,+
Oxalis sp. : 128,+; 141,+
Pelargonium abrotanifolium : 143,+
Pelargonium pulverulen. : 126,+
Pelargonium reniforme : 140,+
Pennisetum sphacelatum : 147,+
Polygala ephedroides : 266,+
Pteronia staehelinoides : 147,+
Pterothrix spinescens : 397,+
Rhus pyroides : 128,+
Ruschia spinescens : 248,+
Sarcostemma viminale : 266,+
Senecio inaequidens : 128,+
Senecio radicans : 126,+
Senecio reptans : 248,+
Senecio retrorsus : 140,+
Silene sp. : 126,+
Solanum supinum : 126,+; 146,+; 147,+
Solanum tomentosum : 146,+; 131,+
Sonchus dregeanus : 140,+
Sutera pinnatifida : 247,+; 397,+
Trachyandra affinis : 95,r
Trachyandra asperata : 266,+
Tribulus terrestris : 248,+
Trichodiadema setuliferum : 140,1
Tripteris aghillana : 142,+
Ursinia nana : 248,+
Wahlenbergia juncea : 126,+
Walafrida densiflora : 134,+
Walafrida gracilis : 266,1

Appendix 7: Infrequent species occurring in the relevés of Table 10 (wetlands and drainage lines)

Agrostis lachnantha : 80,+; 288,+
Alchemilla woodii : 101,+
Amaranthus thunbergii : 288,+
Amellus strigosus : 215,+; 169,+
Anisodontea julii : 346,+
Annesorhiza nuda : 295,+
Argyrolobium pauciflorum : 27,+
Aristida congesta : 145,+; 288,+
Aristida diffusa : 346,+
Aster bakeranus : 238,+
Athrixia fontana : 295,+
Berkheya discolor : 293,+
Berkheya heterophylla : 27,+
Berkheya onopordifolia : 215,+
Bidens bipinnata : 89,+; 169,+
Bulbine narcissifolia : 187,+
Centella asiatica : 80,+; 101,+
Cerastium arabidis : 295,+
Chironia krebsii : 295,+
Cliffortia sp. : 295,+
Clutia natalensis : 293,+; 346,+
Convolvulus natalensis : 27,+
Convolvulus sagittatus : 288,+; 9,1
Conyza podocephala : 145,+; 288,+; 215,+
Conyza scabrida : 145,+
Cotula hispida : 295,+
Crassula dependens : 295,+
Crassula lanceolata : 295,+
Cymbopogon plurinodis : 288,+
Cynoglossum austroafricana : 295,+
Dierama sp. : 295,+; 187,+
Digitaria eriantha : 288,+; 187,1
Dimorphotheca cuneata : 288,+
Diospyros austroafricanus : 288,+
Elionurus muticus : 288,+; 215,+
Eragrostis caesia : 295,+
Eragrostis lehmanniana : 295,+; 215,+; 101,1
Eragrostis planiculmis : 80,1
Erodium cicutarium : 238,+; 169,+
Euphorbia striata : 13,r; 9,+
Felicia filifolia : 371,+
Fingerhuthia sesleriiformis : 288,+; 9,a
Foeniculum vulgare : 295,+; 293,+
Galium capense : 169,+
Geranium baurianum : 293,+
Geranium contortum : 215,+
Geranium incanum : 295,+
Gnidia sericea : 187,+
Gomphocarpus fruticosus : 89,+; 169,+; 183,+
Guilleminea densa : 89,+
Haplocarpha scaposa : 293,+
Hebenstretia integrifolia : 346,+
Helichrysum anomalum : 101,+
Helichrysum mixtum : 80,+
Helichrysum rugulosum : 293,+; 99,+
Helichrysum simillimum : 27,1; 215,+
Helichrysum umbraculigerum : 295,+
Heteromorpha arborescens : 288,+
Hibiscus trionum : 89,+; 288,+
Holcus lanatus : 27,+
Hordeum capense : 288,+
Indigofera sessilifolium : 68,+
Karroochloa purpurea : 215,1
Kniphofia sp. : 89,+

Kniphofia stricta : 295,+
Koeleria capensis : 215,+
Lepidium africanum : 89,+; 68,+
Lithospermum papillosum : 169,+
Lycium sp. : 169,1; 183,1
Malva neglecta : 215,+
Medicago laciniata : 169,+
Medicago lupulina : 288,+
Melica decumbens : 187,+
Merxmuellera disticha : 101,+
Monopsis unidentata : 101,+
Moraea sp. : 183,+
Myosotis graminifolia : 238,+
Nassella trichotoma : 9,1
Nidorella undulata : 295,+
Oxalis depressa : 288,+; 293,+
Oxalis sp. : 89,+; 101,+
Panicum aequinerve : 145,+
Panicum coloratum : 145,+
Pentaschistis oreodoxa : 295,+
Pentzia cooperi : 238,+; 169,+
Peucedanum capense : 13,+
Plantago lanceolata : 27,+
Poa pratensis : 238,+; 215,+
Pollichia campestris : 68,+
Pseudognaphalium oligandrum : 27,+; 215,+
Ranunculus multifidus : 27,+; 238,+
Rhus pyroides : 145,1; 238,1
Rhynchosia totta v. totta : 371,+
Richardia humistrata : 238,+; 371,+
Rosa eglanteria : 169,+; 183,+
Rubus fruticosus : 27,1
Rubus ludwigii : 238,+
Rumex pulcher : 13,+
Rumex spathulatus : 238,+
Salvia stenophylla : 288,+
Scabiosa columbaria : 187,+
Sebaea natalensis : 295,+; 346,+
Setaria sphacelata : 295,+; 215,+; 371,+
Silene bellidioides : 99,+
Sisymbrium turczaninowii : 238,+; 9,+
Sonchus dregeanus : 145,+
Sporobolus fimbriatus : 288,1
Sporobolus sp. : 295,+
Stachys aethiopica : 145,+
Stachys dregeana : 238,+
Stachys rugosa : 238,+
Sutherlandia microphyllum : 288,+
Tagetes minuta : 169,+
Trifolium africanum : 295,+; 215,+; 101,+
Trifolium burchellianum : 99,+
Tristachya leucothrix : 68,+
Verbena brasiliensis : 89,+
Wahlenbergia sp. : 346,+
Wahlenbergia undulata : 295,+; 288,+
Walafrida gracilis : 288,+
Walafrida saxatilis : 293,+; 169,+
Walafrida sp. : 89,+; 187,+; 101,+
Wurmbea elatior : 295,+
Zaluzianskya capensis : 295,+
Species indet. : 238,+; 13,+

Appendix 8: Checklist of plant species occurring in the grassland vegetation of the Eastern Cape

This checklist was compiled from the following sources:
1. Collections by the author, the author's wife and joint collections during 1995/1996 (numbers prefixed by the letters DBH, JEV and V&H respectively);
2. Records of plants observed during the survey not recorded from other sources (cited as 'Hoare sight records').

An asterisk (*) in front of a species name indicates a naturalized exotic or alien invader. Specimens are housed at PRE. Nomenclature follows Arnold & De Wet (1993) or more recent revisions as accepted by PRE. The checklist was as up to date as possible in April 1997.

BRYOPHYTA
MUSCI

AYTONIACEAE
0971 *Plagiochasme rupestre* (G.Forst.) Steph. var. *rupestre* (JEV 1749)

RICCIACEAE
0971 *Riccia bullosa* Link ex. Lindenb. (JEV 1750)

BRYACEAE
0975 *Bryum pycnophyllum* (Dixon) Mohamed (JEV 1740)

ENCALYPTACEAE
1396 *Encalypta vulgaris* Hedw. (JEV 1541)

GRIMMIACEAE
1441 *Grimmia pulvinata* (Hedw.) Sm. (JEV 1542)

BARTRAMIACEAE
1585 *Anacolia breutelii* (C.Mull.) Magill. var. *breutelii* (JEV 1543)

PTERIDOPHYTA

OPHIOGLOSSACEAE
0060 *Ophioglossum polyphyllum* A.Br. in Seub. (JEV 870)

SCHIZAEACEAE
0120 *Mohria caffrorum* (L.) Desv. var. *caffrorum* (JEV 1332)
0120 *Mohria vestita* Baker (DBH 327, JEV 1755)

DENNSTAEDTIACEAE
0260 *Pteridium aquilinum* (L.) Kuhn. (Hoare site record)

ADIANTACEAE
0340 *Cheilanthes eckloniana* (Kunze) Mett.(JEV 696, JEV 1712, JEV 1752)
0340 *Cheilanthes involuta* (Swartz) Schelpe & N.C.Anthony (DBH 338) var. *obscura* (N.C.Anthony) N.C.Anthony (JEV 1754)
0340 *Cheilanthes quadripinnata* (Forssk.) Kuhn (JEV 1493, JEV 1548, V&H 382)
0360 *Pellaea calomelanos* (Swartz) Link var. *calomelanos* (JEV732)
0360 *Pellaea pteroides* (L.) Prantl (Hoare site record)

POLYPODIACEAE
0460 *Polypodium vulgare* L. (JEV 1572)

ASPLENIACEAE
0530 *Ceterarch cordatum* (Thunb.) Desv. (JEV 1282, JEV 1742, JEV 1793)

ASPIDIACEAE
0650 *Polystichum* sp. (JEV 1168)

BLECHNACEAE
0690 cf. *Blechnum australe* L. var. *australe* (V&H 315)

GYMNOSPERMAE

ZAMIACEAE
0005 *Encephalartus friderici-guilielmi* Lehm. (Hoare site record)

PODOCARPACEAE
0013 *Podocarpus latifolius* (Thunb.) R.Br. ex Mirb. (Hoare site record)

ANGIOSPERMAE
MONOCOTYLEDONAE

TYPHACEAE
0049 *Typha capensis* (Rohrb.) N.E.Br. (Hoare site record)

POACEAE
9900280 *Elionurus muticus* (Spreng.) Kunth (DBH 257, JEV 774, JEV 1046, JEV 1849)
9900380 *Miscanthus capensis* (Nees) Anderss. (JEV 1031)
9900530 *Eulalia villosa* (Thunb.) Nees (Hoare site record)
9900710 *Andropogon appendiculatus* Nees (DBH 590, DBH 710, JEV 788, JEV 914, JEV 1067, JEV 1823)
9900720 *Cymbopogon excavatus* (Hochst.) Stapf ex Burtt Davy (JEV 876)
9900720 *Cymbopogon plurinodis* (Stapf) Stapf ex Burtt Davy (JEV 701, JEV 900, JEV 1500, JEV 1628, JEV 1668, JEV 1707, JEV 1839)
9900720 *Cymbopogon validus* (Stapf) Stapf ex Burtt Davy (JEV 1333)
9900730 *Hyparrhenia anamesa* Clayton (JEV 916)
9900730 *Hyparrhenia hirta* (L.) Stapf (JEV 683, JEV 706)
9900800 *Heteropogon contortus* (L.) Roem. & Schult. (JEV 790, JEV 796, JEV 899, JEV 1039, JEV 1610)
9900830 *Themeda triandra* Forssk. (JEV 684, JEV 698, JEV 1783, JEV 1847)
9900890 *Digitaria argyrograpta* (Nees) Stapf. (Hoare site record)
9900890 *Digitaria diagonalis* (Nees) Stapf var. *diagonalis* (JEV 926
9900890 *Digitaria erianthe* Steud. (DBH 554, JEV 881, JEV 915, JEV 1054, JEV 1624, JEV 1882)
9900890 *Digitaria monodactyla* (Nees) Stapf (DBH 588, JEV 983)
9900890 *Digitaria setifolia* Stapf (JEV 913)
9900940 *Alloteropsis semialata* (R.Br.) Hitchc. subsp. *eckloniana* (Nees) Gibbs Russell (JEV 723, JEV 794)
9901040 *Brachiaria eruciformis* (J.E.Sm.) Griseb. (Hoare site record)
9901040 *Brachiaria serrata* (Thunb.) Stapf (JEV 874, JEV 924, JEV 1035, JEV 1225, JEV 1674, JEV 1885)
9901070 *Paspalum distichum* L. (JEV 957)
9901070 **Paspalum dilatatum* Poir. (Hoare site record)
9901070 **Paspalum notatum* Fluegge (Hoare site record)
9901100 *Urochloa panicoides* Beauv. (Hoare site record)
9901160 *Panicum aequinerve* Nees (JEV 925, JEV 1094)
9901160 *Panicum coloratum* L. (JEV 1636)
9901160 *Panicum coloratum* L. var. *coloratum* (JEV 1034, JEV 1277, JEV 1883)
9901160 *Panicum ecklonii* Nees (JEV 1088)
9901160 *Panicum maximum* Jacq. (DBH 278)

9901160 *Panicum stapfianum* Fourc. (JEV 1729)
9901280 *Setaria sphacelata* (Schumach.) Moss var. *torta* (Stapf) Clayton (JEV 912)
9901280 *Setaria sphacelata* (Schumach.) Moss var. *sphacelata* (JEV 1295)
9901340 *Melinis nerviglumis* (Franch.) Zizka (V&H 304, JEV 963, JEV 1033)
9901340 *Melinis repens* Zizka (Hoare site record)
9901390 *Pennisetum macrourum* Trin. (JEV 954)
9901390 *Pennisetum sphacelatum* (Nees) Dur. & Schinz (DBH 550, JEV 812, JEV 903, JEV 1244, JEV 1782)
9901400 *Cenchrus ciliaris* L. (Hoare site record)
9901600 *Ehrharta calycina* J.E.Sm. (JEV 743, JEV 920, JEV 1655)
9901600 *Ehrharta erecta* Lam. (Hoare site record)
9901730 *Arundinella nepalensis* Trin. (JEV 1128)
9901740 *Tristachya leucothrix* Nees (JEV 722, JEV 1673)
9901920 *Holcus lanatus* L. (JEV 811)
9901970 *Helictotrichon hirtulum* (Steud.) Schweick. (DBH 619, JEV 995)
9901970 *Helictotrichon turgidulum* (Stapf) Schweick. (DBH 404, DBH 700, V&H 363, JEV 764, JEV 960, JEV 1472, JEV 1625, JEV 1791)
9902043 *Merxmuellera disticha* (Nees) Conert (JEV 1403)
9902043 *Merxmuellera drakensbergensis* (Schweick.) Conert (Hoare site record)
9902043 *Merxmuellera macowanii* (Stapf) Conert (JEV 1481)
9902044 *Karroochloa curva* (Nees) Conert & Tuerpe (Hoare site record)
9902044 *Karroochloa purpurea* (L.f.) Conert & Türpe (DBH 254, JEV 1471, JEV 1647)
9902050 *Pentaschistis airoides* (Nees) Stapf (DBH 264)
9902050 *Pentaschistis galpinii* (Stapf) McClean (JEV 1648)
9902050 *Pentaschistis microphylla* (Nees) McClean (DBH 527)
9902050 *Pentaschistis* cf. *oreodoxa* Schweick. (DBH 672, JEV 938)
9902050 *Pentaschistis setifolia* (Thunb.) McClean (DBH 326, DBH 544, DBH 618, DBH 784, JEV 1660)
9902140 *Phragmites australis* (Cav.) Steud. (Hoare site record)
9902430 *Agrostis lachnantha* Nees var. *lachnantha* (DBH 576, JEV 962, JEV 1163)
9902611 *Stipagrostis zeyheri* (Nees) De Winter subsp. *sericans* (Hack.) De Winter (JEV 1717)
9902620 *Aristida adscensionis* L. (JEV 1757)
9902620 *Aristida canescens* Henr. subsp. *ramosa* De Winter (DBH 559, JEV 880)
9902620 *Aristida congesta* Roem. & Schult. subsp. *congesta* (JEV 1038, JEV 1322, JEV 1850)
9902620 *Aristida diffusa* Trin. (JEV 1427, JEV 1612)
subsp. *burkei* (Stapf) Meld. (JEV 692, JEV 868, JEV949)
9902620 *Aristida junciformis* Trin. & Rupr. (DBH 731)
9902650 *Nassella neesiana* (Trin. & Rupr.) Barkworth (DBH 295)
9902650 **Nassella trichotoma* (Nees) Hack. ex Arech. (JEV 792)
9902740 *Tragus berteronianus* Schult. (DBH 746, JEV 1070)
9902740 *Tragus koelerioides* Aschers. (DBH 455, V&H 389, JEV 878, JEV 1037, JEV 1302, JEV 1688)
9902740 *Tragus racemosus* (L.) All. (Hoare site record)
9902830 *Sporobolus africanus* (Poir.) Robyns & Tournay (JEV 937, JEV 1026, JEV 1159, JEV 1184)
9902830 *Sporobolus centrifugus* (Trin.) Nees (JEV 797, JEV 1198)
9902830 *Sporobolus discosporus* Nees (DBH 581, JEV 1852)
9902830 *Sporobolus fimbriatus* (Trin.) Nees (JEV 882, JEV 1081, JEV 1881)
9902830 *Sporobolus nitens* Stent (DBH 382)
9902830 *Sporobolus subulatus* Hack. (JEV 1229)
9902860 *Eragrostis caesia* Stapf (DBH 635, JEV 1182)
9902860 *Eragrostis capensis* (Thunb.) Trin. (JEV 716, JEV 820, JEV 919, JEV 1228, JEV 1524)
9902860 *Eragrostis chloromelas* Steud. (JEV 968, JEV 1059)
9902860 *Eragrostis curvula* (Schrad.) Nees (DBH 577, V&H 338, JEV 682, JEV 699, JEV 703, JEV 773, JEV 859, JEV 1224, JEV 1336, JEV 1408, JEV 1409, JEV 1474, JEV 1477, JEV 1496, JEV 1611, JEV 1632, JEV 1669, JEV 1848)
9902860 *Eragrostis gummiflua* Nees (DBH 709, JEV 1050, JEV 1838)
9902860 *Eragrostis lehmanniana* Nees var. *lehmanniana* (JEV 872, JEV 875, JEV 1684, JEV 1880)
9902860 *Eragrostis obtusa* Munro ex Fical. & Hiern (JEV 1036)
9902860 *Eragrostis plana* Nees (Hoare site record)

9902860 *Eragrostis planiculmis* Nees (JEV 952)
9902860 *Eragrostis racemosa* (Thunb.) Steud. (JEV 798, JEV 991, JEV 901, JEV 1739)
9902860 *Eragrostis superba* Peyr. (Hoare site record)
9902860 *Eragrostis trichophora* Coss. & Dur. (DBH 281)
9902940 *Michrochloa caffra* Nees (DBH 766, JEV 1043, JEV 1773)
9902940 *Michrochloa kunthii* Desv. (JEV 966)
9902941 *Rendlia altera* (Rendle) Chiov. (DBH 654)
9902942 *Catalepsis gracilis* Stapf & Stent (JEV 1245, JEV 1772)
9902960 *Cynodon dactylon* (L.) Pers. (JEV 961, JEV 1140)
9902960 *Cynodon incompletus* Nees (JEV 1040, JEV 1253)
9902980 *Harpochloa falx* (L.f.) Kuntze (JEV 724)
9903101 *Polevansia rigida* De Winter (Hoare site record)
9903010 *Chloris virgata* Swartz (Hoare site record)
9903020 *Eustachys paspaloides* (Vahl) Lanza & Mattei (Hoare site record)
9903270 *Tetrachne dregei* Nees (JEV 1627)
9903500 *Triraphis andropogonoides* (Steud.) Phill. (JEV 1691, JEV 1694)
9903530 *Trichoneura grandiglumis* (Nees) Ekman (DBH 575)
var. *grandiglumis* (JEV 1867)
9903570 *Enneapogon desvauxii* Beauv. (JEV 1071)
9903570 *Enneapogon scoparius* Stapf (DBH 383, DBH 387)
9903710 *Fingerhuthia africana* Lehm. (Hoare site record)
9903710 *Fingerhuthia sesleriiformis* Nees (DBH 318, JEV 702)
9903740 *Koeleria capensis* (Steud.) Nees (DBH 331, DBH 403, DBH 405, DBH 541, JEV 765)
9903860 *Melica decumbens* Thunb. (JEV 1407)
9904000 *Stiburus alopecuroides* (Hack.) Stapf (DBH 587)
9904021 *Tribolium hispidum* (Thunb.) Desv. (DBH 757, JEV 1649, JEV 1658)
9904070 *Poa pratensis* L. (DBH 545, JEV 1504, JEV 1536, JEV 1653)
9904150 **Puccinellia fasciculata* (Torr.) Beickn. (Hoare site record)
9904170 *Festuca caprina* Nees (DBH 270, DBH 339, DBH 615, JEV 1478)
var. *irrasa* (DBH 315)
9904170 *Festuca costata* Nees (JEV 739)
9904170 *Festuca longipes* Stapf (V&H 362)
9904170 *Festuca scabra* Vahl. (JEV 1458)
9904180 *Vulpia myurus* (L.) C.C.Gmel. (JEV 791)
9904280 **Bromus catharticus* Vahl. (JEV 789, JEV 1439)
9904280 **Bromus commutatus* Schrad. (Hoare site record)
9904280 *Bromus leptocladus* Nees (Hoare site record)
9904280 *Bromus pectinatus* Thunb. (JEV 1629)
9904330 *Lolium multiflorum* Lam. (JEV 1651)
9904510 *Hordeum capense* Thunb. (DBH 701, JEV 1626)

CYPERACEAE
0459 *Cyperus longus* L. (DBH 624)
0459 *Cyperus marginatus* Thunb. (DBH 697, JEV 1438, JEV 1447)
0459 *Cyperus obtusiflorus* Vahl (DBH 325, DBH 653)
var. *sphaerocephalus* (Vahl) Kuekenth. (JEV 988)
0459 *Cyperus rupestris* Kunth var. *rupestris* (DBH 450, V&H 307)
0459 *Cyperus semitrifidus* Schrad. (DBH 757)
0459 *Cyperus sexangularis* Nees (JEV 1027)
0459 *Cyperus* cf. *sphaerospermus* Schrad. (JEV 1922)
0459 *Cyperus usitatus* Burch. var. *usitatus* (DBH 454, DBH 708, JEV 877, JEV 978, JEV 1000, JEV 1053, JEV 1076, JEV 1264, JEV 1270, JEV 1287, JEV 1305, JEV 1747, JEV 1866, JEV 1876)
0459 *Mariscus capensis* (Steud.) Schrad. (DBH 558, DBH 660, JEV 1058, JEV 1068)
0459 *Mariscus congestus* (Vahl) C.B.Cl. (DBH 610, DBH 717, JEV 1023)
0459 *Mariscus dregeanus* Kunth. (Hoare site record)
0459 *Mariscus* cf. *indecorus* (Kunth) Podlech (JEV 879)

0459 *Mariscus rehmannianus* (C.B.Clarke (JEV 1875)
0459 *Mariscus tabularis* (Schrad.) C.B.Clarke subsp. *major* (Nees) P.J.Vorster c.n.ined. (JEV 994, JEV 1901)
0459 *Mariscus uitenhagensis* Steud. (DBH 381, JEV 998, JEV 1041)
0462 *Kyllinga alata* Nees (V&H 357, JEV 950, JEV 979, JEV 984, JEV 996, JEV 1045, JEV 1052)
0462 *Kyllinga alba* Nees (Hoare site record)
0462 *Kyllinga erecta* Schumach. (Hoare site record)
0462 *Kyllinga pulchella* Kunth. (DBH 727)
0465 *Ficinia acuminata* (Nees) Nees (Hoare site record)
0465 *Ficinia* cf. *gracilis* (Poir.) Schrad. (DBH 474, DBH 531, DBH 617, DBH 661, DBH 743)
0465 *Ficinia nigrescens* (Schrad.) J.Raynal (JEV 1348)
0465 *Ficinia stolonifera* Boeck. (DBH 309, DBH 316, DBH 317, DBH 333, DBH 406, DBH 676, DBH 690, V&H 398, JEV 967, JEV 1066)
0465 *Ficinia* cf. *tristachya* (Rottb.) Nees (JEV 1133, JEV 1227)
0465 *Ficinia* spp. (DBH 689, JEV 821, JEV 892, JEV 1048, JEV 1055, JEV 1123, JEV 1125, JEV 1236, JEV1268, JEV 1296, JEV 1406, JEV 1552, JEV 1558, JEV 1646, JEV 1840)
0467 *Fuirena coerulescens* Steud (DBH 636)
0468 *Schoenoplectus corymbosus* (Roth. ex Roem. & Schult.) J. Raynal (Hoare site record)
0468 *Schoenoplectus decipiens* (Nees) J.Raynal (JEV 1022)
0468 *Schoenoplectus lacustris* (L.) Palla (Hoare site record)
0468 *Schoenoplectus paludicola* (Kunth) Palla ex J.Raynal (JEV 953)
0468 *Isolepis costata* (Boeck.) A. Rich. (Hoare site record)
0468 *Isolepis setacea* (L.) R.Br. (JEV 1167)
0469 *Eleocharis palustris* R.Br. (JEV 955)
0471 *Fimbrostylis fascicularis* Nees (JEV 1169)
0471 *Bulbostylis contexta* (nees) Bodard (JEV 907)
0471 *Bulbostylis humilis* (Kunth) C.B.Cl. (DBH 449b, DBH 744, DBH 750, JEV 918, JEV 1352)
0471 *Bulbostylis oritrephes* (Ridley) C.B.Clarke. (DBH 467)
0471 *Bulbostylis oritrephes* (Ridley) C.B.Clarke. ssp. *australis* B.L.Burtt (JEV 815)
0471 *Abildgaardia ovata* (Burm.f.) Kral (JEV 985, JEV 992)
0494 *Tetraria cuspidata* (Rottb.) C.B.Cl. (JEV 1089, JEV 1350)
0521 *Schoenoxiphium schweickerdtii* Merxm. & Podlech (Hoare site record)
0521 *Schoenoxiphium sparteum* (Wahlenb.) C.B. Clarke (JEV 1146, JEV 1787)
0521 *Schoenoxiphium* sp. (JEV 1514, JEV 1459)
0525 *Carex cognata* Kunth var. *drakensbergensis* (C.B.Cl.) Kuekenth. (DBH 641)

ARACEAE
0748 *Zantedeschia albomaculata* (Hook.) Baill. (Hoare site record)

RESTIONACEAE
0804 *Restio sejunctus* Mast. (JEV 1335, JEV 1342)
0804 *Restio triticeus* Rottb. (DBH 466, DBH 671, JEV 1339)
0804 *Rhodocoma fruticosa* (Rottb.) C.B.Cl. (JEV 1349)

COMMELINACEAE
0896 *Commelina africana* L. var. *lancispatha* C.B.Cl. (V&H 306, JEV 887, JEV 948)
var. *krebsiana* (Kunth) C.B.Clarke (JEV 1872)
0904 *Cyanotis speciosa* (L.f.) Hassk. (V&H 305)

JUNCACEAE
0936 *Juncus dregeanus* Kunth (JEV 1164)
0936 *Juncus inflexus* L. (JEV 1160, JEV 1437, JEV 1448, JEV 1650)
0936 *Juncus effusus* L. (Hoare site record)

COLCHICACEAE
0972 *Wurmbea elatior* B. Nord. (DBH 638, JEV 904)

ASPHODELACEAE
0985 *Bulbine abyssinica* A.Rich. (JEV 921, JEV 1299, JEV 1311)
0985 *Bulbine asphoeloides* (L.) Willd. (JEV 1676, JEV 1682)
0985 *Bulbine frutescens* (L.) Willd. (Hoare site record)
0985 *Bulbine narcissifolia* Salm-Dyck (V&H 359, V&H 386, JEV 1297)
0985 *Trachyandra affinis* Kunth (JEV 1074)
0985 *Trachyandra asperata* Kunth
0985 *Trachyandra asperata* Kunth (DBH 348, JEV 1587, JEV 1638, JEV 1659, JEV 1670, JEV 1681)
var. *macowanii* (Bak.) Oberm. (JEV 740, JEV 848)
0985 *Trachyandra gerrardii* (Bak.) Oberm. (V&H 377)
0985 *Trachyandra saltii* (Bak.) Oberm. var. *saltii* (DBH 258, DBH287, DBH762, V&H 344, JEV 1491)
0990 *Chlorophytum fasciculatum* (Baker) Kativu (JEV 1723)
0990 *Chlorophytum* sp. (JEV 873)
1012 *Eriospermum cooperi* Bak. (V&H 353)
1024 *Kniphofia parviflora* Kunth (DBH 649)
1024 *Kniphofia triangularis* Kunth subsp. *triangularis* (DBH 728, V&H 329)
1024 *Kniphofia stricta* Codd (DBH 639, JEV 1703, JEV 1808, JEV 1860)
1024 *Kniphofia* cf. *uvaria* (L.) Oken (JEV 933)
1024 *Kniphofia* sp. (JEV 1201)
1026 *Aloe africana* Mill. (Hoare site record)
1026 *Aloe aristata* Haw. (JEV 1405, JEV 1516)
1026 *Aloe broomii* Schonl. (Hoare site record)
1026 *Aloe ecklonis* Salm-Dyck (JEV 852)
1026 *Aloe pluridens* Haw.(Hoare site record)
1026 *Aloe striata* Haw. (Hoare site record)
1029 *Haworthia* sp. (Hoare site record)

ALLIACEAE
1046 *Agapanthus praecox* Willd. (Hoare site record)
1046 *Agapanthus* sp. (Hoare site record)
1047 *Tulbaghia verdoornia* Vosa & Burb. (JEV 1522)
1047 *Tulbaghia* sp. (V&H 352)

HYACINTHACEAE (PART B)
1079 *Albuca exuviata* Bak. (Hoare site record)
1079 *Albuca* cf. *fastigiata* (L.f.) Dryand. (JEV 719, JEV 842)
1079 *Albuca setosa* Jacq. (DBH 269)
1084 *Dipcadi* cf. *ciliare* (Zeyh. ex Harv.) Bak. (DBH 277)
1088 *Eucomis autumnalis* (Mill.) Chitt. (Hoare site record)
1089 *Ornithogalum graminifolium* Thunb. (JEV 1551, JEV 1556)
1089 *Ornithogalum juncifolium* Jacq. (DBH 357, V&H 303, JEV 1642)
1089 *Ornithogalum tenuifolium* Delaroche subsp. *tenuifolium* (V&H 380)
1090 *Ledebouria* sp. (*L. ensifolia* (Eckl.) S.Venter, C.Archer in ed.) (DBH 354)
1098 *Lachenalia* sp. (Hoare site record)
1110 *Massonia grandiflora* Lindl. (Hoare site record)

DRACAENACEAE
1110 *Sansevieria* sp. (Hoare site record)

ASPARAGACEAE
1113 *Asparagus aethiopicus* (L.) Oberm. (Hoare site record)
1113 *Asparagus capensis* (L.) Oberm. (DBH 187, DBH 375)
1113 *Asparagus cooperi* (Bak.) Oberm. (Hoare site record)
1113 *Asparagus densiflorus* (Kunth) Oberm. (JEV 733)
1113 *Asparagus denudatus* (Kunth.) Oberm. (DBH 268)
1113 *Asparagus glaucus* Kies (JEV 1419)

1113 *Asparagus krebsianus* (Kunth) Oberm. (V&H 309)
1113 *Asparagus laricinus* (Burch.) Oberm. (JEV 858)
1113 *Asparagus microraphis* (Kunth) Oberm. (JEV 1266)
1113 *Asparagus retrofractus* (L.) Oberm. (DBH 186)
1113 *Asparagus setaceus* (Kunth) Oberm. (Hoare site record)
1113 *Asparagus striatus* (L.f.) Oberm. (Hoare site record)
1113 *Asparagus suaveolens* (Burch.) Oberm. (JEV 871, JEV 1042)
1113 *Asparagus subulatus* (Thunb.) Oberm. (V&H 308)
1113 *Myrsiphyllum asparagoides* (L.) Willd. (Hoare site record)

AMARYLLIDACEAE
1168 *Boophane disticha* (L.f.) Herb. (Hoare site record)
1177 *Brunsvigia* sp. (Hoare site record)
1191 *Cyrtanthus tuckii* Bak. var. *tuckii* (DBH 306)
1191 *Cyrtanthus contractus* N.E.Br. (DBH 528)
1191 *Cyrtanthus* cf. *obrienii* Bak. (DBH 692)

HYPOXIDACEAE
1229 *Empodium elongatum* (Nel) B.L.Burtt (Hoare site record)
1230 *Hypoxis* cf. *acuminata* Bak. (JEV 795)
1230 *Hypoxis argentea* Harv. ex Bak. var. *argentea* (DBH 546, JEV 750, JEV 827, JEV 857, JEV 886, JEV 895)
1230 *Hypoxis costata* Bak. (DBH 350, V&H 364, JEV 840)
1230 *Hypoxis hemerocallidea* Fisch. & C.A.Mey (DBH 476)
1230 *Hypoxis iridifolia* Bak. (DBH 358)
1230 *Hypoxis longifolia* Bak. (DBH 444)
1230 *Hypoxis* cf. *multiceps* Buchinger ex Bak. (JEV 1351)
1230 *Hypoxis rigidula* Baker (JEV 1425)
1230 *Hypoxis villosa* L.f. (DBH 683)

IRIDACEAE
1261 *Romulea autumnalis* L.Bol. (JEV 1208)
1261 *Romulea macowanii* Bak. var. *oreophila* De Vos (JEV 1174)
1261 *Romulea macowanii* Bak. var. *macowanii* (JEV 1248)
1265 *Moraea albicuspa* Goldbl. (DBH 650)
1265 *Moraea brevistyla* (Goldblatt) Goldblatt (JEV 1573, JEV 1578)
1265 *Moraea elliotii* Baker (JEV 1469)
1265 *Moraea polystachya* (Thunb.) Ker-Gawl. (DBH 448)
1265 *Moraea spathulata* (L.f.) Klatt (JEV 1521)
1277 *Homeria* sp. (Hoare site record)
1284 *Bobartia orientalis* J.B.Gillet subsp. *orientalis* (JEV 1337)
1295 *Aristea abyssinica* Pax (JEV 969, JEV 1915)
1295 *Aristea schizolaena* Harv. ex Bak. (Hoare site record)
1301 *Hesperantha tysonii* Baker (DBH 311, JEV 1540)
1303 *Dierama igneum* Klatt (DBH 298)
1303 *Dierama pendulum* (L.f.) Bak. (Hoare site record)
1303 *Dierama pulcherrimum* (Hook. f.) Bak. (V&H 314)
1303 *Dierama* sp. (JEV 1122, JEV 1130)
1306 *Tritonia lineata* (Salisb.) Ker-Gawl. var. *lineata* (DBH 299)
1311 *Gladiolus permeabilis* D.Delaroche subsp. *edulis* (Burch. ex Ker Gawl.) Oberm. (DBH 503, DBH 504, JEV 1064, JEV 1698, JEV 1706, JEV 1861)
1311 *Gladiolus longicollis* Baker (DBH 551, JEV 1467, JEV 1557)
1311 *Gladiolus ochroleucus* Bak. (Hoare site record)
1311 *Gladiolus saundersii* Hook. f. (DBH 620)
1315 *Watsonia pilansii* L.Bol. (Hoare site record)
1315 *Watsonia* sp. (Hoare site record)

ORCHIDACEAE
1408 *Holothrix burchellii* (Lindl.) Rchb.f. (JEV 1643)
1408 *Holothrix scopularia* (Lindl.) Reichb.f. (DBH 314, DBH 630)
1422 *Habenaria dregeana* Lindl. (JEV 1240)
1422 *Habenaria lithophila* Schltr. (DBH 793, JEV 1905)
1430 *Satyrium parviflorum* Swartz (DBH 687)
1648 *Eulophia ovalis* Lindl. subsp. *ovalis* (V&H 319)

DICOTYLEDONAE

SALICACEAE
1873 **Salix babylonica* L. (Hoare site record)

MYRICACEAE
1874 *Myrica brevifolia* E.Mey. ex C.DC. (Hoare site record)
1874 *Myrica serrata* Lam. (DBH 680)

PROTEACEAE
2035 *Protea* sp. (Hoare site record)
2037 *Leucadendron salignum* Berg. (DBH 465)

LORANTHACEAE
2074 *Moquinella rubra* (A.Spreng) Balle (JEV 1888)

VISCACEAE
2093 *Viscum rotundifolium* L.f. (JEV 1877)

SANTALACEAE
2104 *Colpoon compressum* Berg. (Hoare site record)
2118 *Thesium accutissimum* A.DC. (DBH 451)
2118 *Thesium durum* Hilliard & Burtt (V&H 345)
2118 *Thesium gnidiaceum* A.DC. var. *gnidiaceum* (DBH 460)
2118 *Thesium junceum* Bernh. var. *junceum* (JEV 1910)
2118 *Thesium* spp. (DBH 263, DBH 290, DBH 438, JEV 838, JEV 1090, JEV 1126, JEV 1511)

POLYGONACEAE
2195 *Rumex acetosella* L. subsp. *angiocarpus* (Murb.) Murb. (JEV 757, JEV 1150)
2195 *Rumex pulcher* L. (Hoare site record)
2195 *Rumex lanceolatus* Thunb. (JEV 1813)
2195 *Rumex spathulatus* Thunb. (Hoare site record)
2195 *Rumex woodii* N.E.Br. (JEV 753)

CHENOPODIACEAE
2223 **Chenopodium* cf. *album* L. (DBH 696)
2223 **Chenopodium carinatum* R.Br. (Hoare site record)
2223 *Chenopodium mucronatum* Thunb. (JEV 1307)
2226 *Exomis microphylla* (Thunb.) Aell. (Hoare site record)
2269 *Salsola* sp. (Hoare site record)

AMARANTHACEAE
2299 *Amaranthus thunbergii* Moq. (DBH 738)
var. *thunbergii* (JEV 1864)
2330 *Guilleminea densa* (Willd.) Moq. (JEV 1013, JEV 1891)
2338 **Gomphrena celasoides* Mart. (Hoare site record)

AIZOACEAE
2376 *Limeum aethiopicum* Burm. (DBH 211)

2379 *Psammotropha mucronata* (Thunb.) Fenzl. (JEV 1549)
2379 *Psammotropha mucronata* (Thunb.) Fenzl. var. *marginata* Adamson (JEV 831)
2390 *Hypertelis salsoloides* (Burch.) Adamson (DBH 796)
2390 *Hypertelis* sp. (Hoare site record)
2399 *Galenia prostrata* Schellenb. (Hoare site record)
2399 *Galenia pubescens* (Eckl. & Zeyh.) Druce (Hoare site record)
2401 *Aizoon glinioides* L.f. (Hoare site record)

MESEMBRYANTHEMACEAE
2405 *Carpobrotus* sp. (Hoare site record)
2405026 *Chasmatophyllum musculinum* (Haw.) Dinter & Schwant. (DBH *s.n.*)
2405033 *Delosperma crassuloides* (Haw.) L.Bol. (JEV 836)
2405033 *Delosperma katbergense* L.Bol. var. *katbergense* (V&H 346)
2405033 *Delosperma monanthemum* Lavis (JEV 1510)
2405033 *Delosperma* spp. (V&H 312, JEV 1763)
2405 *Drosanthemum* sp. (Hoare site record)
2405 *Faucaria* cf. *subintegra* L.Bol. (JEV 772)
2405068 *Leipoldtia* sp. (Hoare site record)
2405074 *Mestoklema elatum* N.E.Br. (Hoare site record)
2405102 *Rabiea* sp. (Hoare site record)
2405 *Ruschia intricata* H.E.K.Hartmann & Stüber (JEV 1618)
2405 *Ruschia orientalis* L.Bol. (JEV 770)
2405 *Ruschia spinescens* L.Bol. (Hoare site record)
2405 *Ruschia* sp. (V&H 384)
2405 *Antimima* sp. (Hoare site record)
2405 *Trichodiadema setuliferum* (N.E.Br.) Schwant. (Hoare site record)
2405 *Trichodiadema* spp. (DBH 367, DBH 399, DBH 795, JEV 856, JEV 1080, JEV 1358, JEV 1414)

PORTULACACEAE
2406 *Talinum caffrum* (Thunb.) Eckl. & Zeyh. (Hoare site record)
2412 *Anacampseros arachnoides* (Harv.) Sims. (Hoare site record)

CARYOPHYLLACEAE (PART A)
2430 *Cerastium capense* Sond. (JEV 1550)
2430 *Cerastium arabidis* E.Mey ex Fenzl (DBH 540, JEV 1577)

ILLECEBRACEAE
2467 *Pollichia campestris* Ait. (Hoare site record)
2476 *Herniaria eckertia* Hermann subsp. *eckertii* var. *eckertii* (JEV 1777)

CARYOPHYLLACEAE (PART B)
2490 *Silene australis* D.Masson (DBH 261, DBH 343, DBH 591, JEV 970, JEV 1183)
2490 *Silene bellidioides* Sond. (DBH 340, JEV 1143)
2490 *Silene pilosellifolia* Cham. & Schltdl. (JEV 1538, V&H 324, V&H 376)
2490 *Silene undulata* Ait. (V&H 335)
2490 *Silene* spp. (DBH 734, JEV 1656)
2502 *Dianthus basuticus* Burtt Davy (DBH 330, DBH 756, JEV 1584)
subsp. *basuticus* var. *basuticus* (JEV 1304)

RANUNCULACEAE
2541 *Anemone fanninii* Harv. ex Mast. (JEV 1591)
2541 *Knowltonia cordata* H.Rasm. (Hoare site record)
2546 *Ranunculus multifidus* Forssk. (V&H 369)

LAURACEAE
2825 *Cassytha filiformis* L. (DBH 484)

PAPAVERACEAE
2852 *Argemone ochroleuca* Sweet (JEV 1599)
2853 *Papaver aculeatum* Thunb. (JEV 1534)

BRASSICACEAE
2875 *Heliophila carnosa (Thunb.) Steud.* (DBH 391, DBH 499, JEV 1555, JEV 1505)
2875 *Heliophila crithmifolia* Willd. (JEV 1418, JEV 1606)
2875 *Heliophila deserticola* Schltr. (JEV 1613)
2875 *Heliophila rigidiuscula* Sond. (JEV 850)
2875 *Heliophila* spp. (DBH 556, JEV 1331)
2883 *Lepidium africanum* (Burm.f.) DC. (DBH 702, DBH 754)
subsp. *divaricatum* (Ait.) Jonsell (JEV 1017)
2883 *Lepidium* sp. (JEV 1257)
2917 *Sisymbrium burchellii* DC. var. *burchellii* (JEV 1254)
2917 *Sisymbrium capense* Thunb. x *S. turczaninowii* Sond. (JEV 1468)
2917 *Sisymbrium thellungii* O.E.Schulz (JEV 1312)
2917 *Sisymbrium turczaninowii* Sond. (JEV 1271)
2949 *Brassica* sp. (JEV 1845)
3042 *Matthiola torulosa* (Thunb.) DC. (JEV 1619)

CRASSULACEAE
3164 *Cotyledon orbiculata* L. var. *oblonga* (Haw.) DC. (JEV 680)
3168 *Crassula* sp. (JEV 1562, DBH 398)
3168 *Crassula atropurpurea* (Haw.) Dietr. var *atropurpurea* (JEV 688)
3168 *Crassula bergioides* Harv. (Hoare site record)
3168 *Crassula campestris* (Eckl. & Zeyh.) Endl. ex Walp. (DBH 751, JEV 1743, JEV 1753)
3168 *Crassula capitella* Thunb. subsp. *capitella* (DBH 776)
3168 *Crassula cotyledonis* Thunb. (Hoare site record)
3168 *Crassula* cf. *dependans* L.Bol. (DBH 369, DBH 398, DBH 496)
3168 *Crassula ericoides* Haw subsp. *ericoides* (DBH 441)
3168 *Crassula expansa* Dryand. (Hoare site record)
3168 *Crassula hirtipes* Harv. (Hoare site record)
3168 *Crassula lanceolata* (Eckl. & Zeyh.) Endl. ex Walp. subsp. *lanceolata* (V&H 397)
3168 *Crassula lanceolata* (Eckl. & Zeyh.) Endl. ex Walp. subsp *transvaalensis* (Kuntze) Tolken (JEV 1689)
3168 *Crassula lanuginosa* Harv. var. *lanuginosa* (JEV 1744)
3168 *Crassula latibracteata* Tölken (DBH 675)
3168 *Crassula mollis* Thunb. (JEV 1340)
3168 *Crassula montana* Thunb. subsp.*quadrangularis* (Schonl.) Toelken (JEV 860)
3168 *Crassula muscosa* L. (Hoare site record)
3168 *Crassula nudicaulis* L. (JEV 1515)
3168 *Crassula obovata* Haw. var. *obovata* (JEV 1923)
3168 *Crassula orbicularis* L. (Hoare site record)
3168 *Crassula pellucida* L. subsp. *brachypetala* (Drege ex Harv.) Toelken (JEV 1072, 1202)
3168 *Crassula sarcocaulis* Eckl. & Zeyh. subsp. sarcocaulis (JEV 1200)
3168 *Crassula setulosa* Harv. var. *rubra* (N.E.Br.) Rowley (V&H 387, JEV 1764)
3168 *Crassula setulosa* Harv. var. *setulosa* (JEV 1797)
3168 *Crassula subulata* L. var. *fastiata* (Schonl.) Tölken (Hoare site record)
3168 *Crassula tabularis* Dinter (Hoare site record)
3168 *Crassula tetragona* L. (DBH 431)
3168 *Crassula tomentosa* Thunb. (Hoare site record)
3168 *Crassula vaginata* Eckl. & Zeyh. subsp. *vaginata* (DBH 609, JEV 1096)
3168 *Crassula* sp. (DBH 498)
3175 *Adromischus trigynus* (Burch.) V. Poelln. (JEV 689)

ROSACEAE
3353 *Rubus fruticosus* L. (Hoare site record)

3353 *Rubus ludwigii* Eckl. & Zeyh. (Hoare site record)
3353 *Rubus pinnatus* Willd. (Hoare site record)
3353 *Rubus rigidus* J.E.Sm. (Hoare site record)
3353 *Rubus* sp. (Hoare site record)
3365 *Geum capense* Thunb. (JEV 1583)
3375 *Alchemilla woodii* Kuntze (JEV 1087, JEV 1197)
3379 *Leucosidea sericea* Eckl. & Zeyh. (Hoare site record)
3388 *Cliffortia nitidula* (Engl.) R.E. & Th. Fries. Jr. subsp. *pilosa* Weim (DBH 479)
3388 *Cliffortia paucistaminea* Weim. (JEV 767, JEV 1092, JEV 1097, JEV 1238)
3388 *Cliffortia ramosissima* Schltr. (JEV 1725)
3388 *Cliffortia* sp. (DBH 634)
3389 *Rosa eglanteria* L. (JEV 1432, JEV 1519)

FABACEAE
3446 *Acacia karroo* Hayne (Hoare site record)
3446 **Acacia longifolia* (Andr.) Willd. (Hoare site record)
3446 **Acacia mearnsii* De Wild. (Hoare site record)
3536 *Chamaecrista capensis* (Thunb.) E.Mey. var. *capensis* (JEV 922, JEV 932)
3536 *Chamaecrista stricta* E.Mey. (DBH 428, JEV 776)
3657 *Lotononis alpina* (Eckl. & Zeyh.) B.-E. van Wyk (Hoare site record)
3657 *Lotononis caerulescens* (E.Mey.) B-E. Van Wyk (JEV 839)
3657 *Lotononis divaricata* (Eckl. & Zeyh.) Benth. (JEV 1614)
3657 *Lotononis jacottetii* (Schinz) B.-E. van Wyk (JEV 1501, JEV 1528)
3657 *Lotononis laxa* Eckl. & Zeyh. (DBH 736, DBH 752, V&H 347, JEV 832, JEV 1205, JEV 1482, JEV 1858)
3657 *Lotononis pulchella* (E.Mey.) B.-E.van Wyk (JEV 1678)
3657 *Lotononis sericophylla* Benth. (JEV 1801)
3657 *Lotononis* sp. (V&H 396)
3662 *Aspalathus chortophila* Eckl. & Zeyh. (DBH 679, JEV 1338)
3662 *Aspalathus frankenioides* DC. (Hoare site record)
3662 *Aspalathus setacea* Eckl. & Zeyh. (JEV 1919)
3662 *Aspalathus* spp. (DBH 686, JEV 1404, JEV 1424)
3665 *Melolobium burchelli* N.E.Br. (DBH 296, V&H 332, JEV 686, cf. JEV 1265, JEV 1594)
3665 *Melolobium* sp. (JEV 1298, JEV 1802)
3673 *Argyrolobium harveyanum* Oliv. (JEV 1523)
3673 *Argyrolobium humile* Philips (JEV 1811)
3673 *Argyrolobium lanceolatum* Eckl. & Zeyh. (Hoare site record)
3673 *Argyrolobium* cf. *molle* Eckl. & Zeyh. (DBH 523)
3673 *Argyrolobium pauciflorum* Eckl. & Zeyh. (Hoare site record)
3673 *Argyrolobium pilosum* Harv. (JEV 1085)
3673 *Argyrolobium speciosum* Eckl. & Zeyh. (JEV 844, JEV 930)
3673 *Argyrolobium tuberosum* Eckl. & Zeyh. (V&H 318, JEV 964)
3673 *Argyrolobium* sp. (V&H 337, V&H 367, JEV 847, JEV 849, JEV 1494)
3688 *Medicago laciniata* (L.) Mill. (Hoare site record)
3688 *Medicago lupulina* L. (Hoare site record)
3688 *Medicago sativa* L. subsp. *sativa* (JEV 687)
3690 *Trifolium africanum* Ser. var. *africanum* (JEV 1162)
3690 *Trifolium burchellianum* Ser. subsp. *burchellianum* (V&H 336, JEV 763, JEV 1141)
3702 *Indigofera alpina* Eckl. & Zeyh. (V&H 350)
3702 *Indigofera alternans* DC. (DBH 273, DBH 390, DBH 522)
3702 *Indigofera burchellii* DC. (JEV 1421, JEV 1492, JEV 1526)
3702 *Indigofera dimidiata* Vogel ex Walp. (DBH 401, V&H 328)
3702 *Indigofera hedyantha* Eckl. & Zeyh. (DBH 301, JEV 713, JEV 749, JEV 851, JEV 894)
3702 *Indigofera heterophylla* Thunb. (JEV867, JEV 863)
3702 *Indigofera monostachya* Eckl. &Zeyh. (DBH 303, V&H 378)
3702 *Indigofera obscura* N.E.Br. (JEV 1091)

3702 *Indigofera poliotes* Eckl. & Zeyh. (DBH 486)
3702 *Indigofera sessilifolia* DC. (Hoare site record)
3702 *Indigofera tenuissima* E.Mey (DBH 667)
3702 *Indigofera torulosa* E.Mey. (Hoare site record)
3702 *Indigofera verrucosa* Eckl. & Zeyh. (JEV 1327)
3702 *Indigofera woodii* H. Bol. var. *woodii* (JEV 825)
3702 *Indigofera zeyheri* Spreng. ex Eckl. & Zeyh. (JEV 945, JEV 1281)
3703 *Psoralea pinnata* L. (Hoare site record)
3718 *Tephrosia capensis* (Jacqu.) Pers. var. *capensis* (DBH 430, JEV 824, JEV 975, JEV 1210, JEV 1292, JEV 1895)
3718 *Tephrosia* sp. (Hoare site record)
3754 *Sutherlandia frutescens* (L.) R.Br. (Hoare site record)
3754 *Sutherlandia microphylla* Burch. ex DC. (Hoare site record)
3756 *Lessertia carnosa* Eckl. & Zeyh. (JEV 1318, JEV 1595)
3756 *Lessertia depressa* Harv. (JEV 1508)
3756 *Lessertia inflata* Harv. (DBH 698)
3804 *Zornia capensis* Pers. (DBH 432, DBH 485, DBH 569, JEV 990, JEV 1916)
3804 *Zornia* sp. (JEV 974)
3852 *Vicia benghalensis* L. (JEV 1436, JEV 1738)
3852 *Vicia sativa* L. (JEV 1537)
3852 *Vicia* sp. (JEV 1803)
3870 *Erythrina* sp. (Hoare site record)
3897 *Rhynchosia adenodes* Eckl. &Zeyh. (DBH 353, DBH 532, V&H 331, V&H 395, JEV 1663)
3897 *Rhynchosia ciliata* (Thunb.) Schinz. (Hoare site record)
3897 *Rhynchosia nervosa* Benth. & Harv. var. *nervosa* (JEV 1925)
3897 *Rhynchosia pauciflora* H.Bol. (Hoare site record)
3897 *Rhynchosia reptabunda* N.E.Br. (JEV 731, JEV 786, JEV 929)
3897 *Rhynchosia totta* (Thunb.) D.C. (JEV 846, V&H 300, V&H 317, JEV 965, JEV 1101) var. *totta* (JEV 1222, JEV 1904, JEV 1917, JEV 1924)
3897 *Rhynchosia* sp. (JEV 908, JEV 989, JEV 935, JEV 943, JEV 1221, JEV 1288)
3898 *Eriosema squarrosum* (Thunb.) Walp. (JEV 730)
3910 *Dolichos angustifolius* Eckl. & Zeyh. (JEV 1401)
3910 *Dolichos decumbens* Thunb. (Hoare site record)
3910 *Dolichos linearis* E. Mey. (V&H 330)

GERANIACEAE
3924 *Geranium amatolicum* Hilliard & Burtt (Hoare site record)
3924 *Geranium baurianum* Knuth (DBH 313a, JEV 745)
3924 *Geranium caffrum* Eckl. & Zeyh. (V&H 381)
3924 *Geranium contortum* Eckl. & Zeyh. (DBH 300, DBH 313b, V&H 326, JEV 728)
3924 *Geranium grandistipulatum* Hilliard & Burtt (Hoare site record)
3924 *Geranium harveyi* Briq. (JEV 1665)
3924 *Geranium incanum* Burm. var. *multifidum* (Sweet) Hilliard & Burtt (DBH 312, DBH 642)
3924 *Geranium robustum* Kuntze (DBH 797)
3924 *Geranium wakkerstroomianum* Knuth (DBH 419, JEV 1433
3925 *Monsonia angustifolia* E.Mey. ex A.Rich. (DBH 790, JEV 1886)
3925 *Monsonia brevirostrata* Knuth (JEV 729)
3925 *Monsonia emarginata* (L.f.) L'Herit. (DBH 791)
3926 *Sarcocaulon cambdeboense* Moffett (Hoare site record)
3926 *Sarcocaulon vanderietiae* L.Bol. (Hoare site record)
3927 *Erodium cicutarium* (L.)L.Her. (JEV 1410)
3928 *Pelargonium abrotanifolium* (L.f.) Jacq. (Hoare site record)
3928 *Pelargonium alchemilloides* (L.) L'Herit. (Hoare site record)
3928 *Pelargonium capitatum* (L.) L'Herit. (Hoare site record)
3928 *Pelargonium elongatum* (Cav.) Salisb. (V&H 302)
3928 *Pelargonium grossularioides* (L.) L'Herit. (JEV 1194)

3928 *Pelargonium laxum* (Sweet) G>Don. (Hoare site record)
3928 *Pelargonium minimum* (Cav.) Willd. (JEV 1601)
3928 *Pelargonium multicaule* Jacq. subsp. *multicaule* (Hoare site record)
3928 *Pelargonium* cf. *pulverulentrum* Colv. ex Sweet (Hoare site record)
3928 *Pelargonium ranunculophyllum* (Eckl. & Zeyh.) Bak. (DBH 509)
3928 *Pelargonium reniforme* Curtis (JEV 1278)
3928 *Pelargonium sidoides* DC. (JEV 816, JEV 1868)
3928 *Pelargonium tragacanthoides* Burch. (JEV 691)

OXALIDACEAE
3936 **Oxalis corniculata* L. (DBH 291)
3936 *Oxalis depressa* L. (DBH 408, DBH 747, JEV 1716)
3936 *Oxalis obliquifolia* Steud. ex Rich. (Hoare site record)
3936 *Oxalis smithiana* Eckl. & Zeyh. (Hoare site record)
3936 *Oxalis* sp. (Sect. Oppositifolia) (DBH 304)
3936 *Oxalis* sp. (V&H 341)
3936 *Oxalis* sp. (DBH 364)

LINACEAE
3945 *Linum acuticarpum* Rogers (DBH 477)
3945 *Linum africanum* L. (V&H 374)
3945 *Linum quadrifolium* L. (JEV 1767)
3945 *Linum thunbergii* Eckl. &Zeyh. (DBH 336, JEV 1118, JEV 1662)

ZYGOPHYLLACEAE
3978 *Tribulus terrestris* L. (Hoare site record)

RUTACEAE
4037 *Agathosma ovata* (Thunb.) Pillans. (Hoare site record)

POLYGALACEAE
4273 *Polygala amatymbica* Eckl. & Zeyh. (V&H 366)
4273 *Polygala ephedroides* Burch. (DBH 616)
4273 *Polygala fruticosa* Berg. (DBH 668, JEV 1920)
4273 *Polygala garcini* DC. (JEV 1918)
4273 *Polygala gracilienta* Burtt Davy (JEV 897, JEV 1206, JEV 1506)
4273 *Polygala gymnoclada* MacOwan (DBH 605, DBH 779, JEV 817, JEV 1531, JEV 1785, JEV 1842)
4273 *Polygala hottentotta* Presl (V&H 325, JEV 942)
4273 *Polygala leptophylla* Burch. (Hoare site record)
4273 *Polygala ohlendorfiana* Eckl. & Zeyh. (DBH 307)
4273 *Polygala serpentaria* Eckl. A Zeyh. (JEV 829)
4273 *Polygala uncinata* E.Mey ex Meisn. (DBH 380)
4273 *Polygala* sp. (DBH 735)
4278 *Muraltia alticola* Schltr. (Hoare site record)

EUPHORBIACEAE
4370 *Adenocline pauciflora* Turcz. (Hoare site record)
4407 *Acalypha capensis* (L.f.) Prain & Hutch (Hoare site record)
4407 *Acalypha peduncularis* E.Mey. ex Meisn. (JEV 768b)
4448 *Clutia alaternoides* L. (Hoare site record)
4448 *Clutia heterophylla* Thunb. (Hoare site record)
4448 *Clutia natalensis* Bernh. ex Krauss (DBH 623, DBH 500)
4448 *Clutia pulchella* L. (Hoare site record)
4448 *Clutia rubricaulis* Eckl. ex Sond. (JEV 1644)
4498 *Euphorbia clavarioides* Boiss. (Hoare site record)
4498 *Euphorbia epicyparissias* E.Mey. ex Boiss. (DBH 247)

4498 *Euphorbia micracantha* Boiss. (DBH 365)
4498 *Euphorbia pulvinata* Marloth (Hoare site record)
4498 *Euphorbia rhombifolia* Boiss. (Hoare site record)
4498 *Euphorbia sclerophylla* Boiss. (Hoare site record)
4498 *Euphorbia striata* Thunb. (JEV 1456)
var. *striata* (JEV 756, JEV 1120, V&H 355)
var. *brachyphylla* (DBH 256)
4498 *Euphorbia* sp. (JEV 1420)

ANACARDIACEAE
4594 *Rhus burchellii* Sond. ex Engl. (JEV 1598)
4594 *Rhus crenata* Thunb. (Hoare site record)
4594 *Rhus dentata* Thunb. (DBH 246, JEV 1061)
4594 *Rhus discolor* E.Mey. ex Sond. (DBH 655, JEV 737)
4594 *Rhus divaricata* Eckl. & Zeyh. (JEV 1499, JEV 1710, JEV 1796, V&H 351)
4594 *Rhus dregeana* Sond. (Hoare site record)
4594 *Rhus erosa* Thunb. (JEV 681, JEV 891, JEV 1616)
4594 *Rhus glauca* Thunb. (Hoare site record)
4594 *Rhus incisa* L.f. (JEV 1423)
4594 *Rhus krebsiana* Presl. ex Engl. (Hoare site record)
4594 *Rhus lancea* L.F. (Hoare site record)
4594 *Rhus longispina* Eckl. & Zeyh. (Hoare site record)
4594 *Rhus lucida* L. var. *lucida* (DBH 456, DBH 681)
4594 *Rhus pallens* Eckl. & Zeyh. (Hoare site record)
4594 *Rhus pyroides* Burch. (Hoare site record)
4594 *Rhus refracta* Eckl. & Zeyh. (DBH 760)
4594 *Rhus* spp. (DBH 538, DBH 718, DBH 769, JEV 1487)

CELASTRACEAE
4626 *Maytenus heterophylla* (Eckl. & Zeyh.) N.K.B.Robson (Hoare site record)
4626 *Maytenus* sp. (JEV 1889)
4630 *Pterocelastrus tricuspidatus* (Lam.) Sond. (Hoare site record)

MELIANTHACEAE
4854 *Melianthus comosus* Vahl (DBH 251)

RHAMNACEAE
4875 *Rhamnus prinoides* L'Herit (DBH 525, DBH 711)
4886 *Phylica gnidioides* Eckl. & Zeyh. (JEV 1212, JEV 1341)

VITACEAE
4917 *Rhoicissus microphylla* (Turcz.) Gilg & Brandt (V&H 310)
4917 *Rhoicissus tridentata* (L.f.) Wild & Drum. (Hoare site record)
4917 *Rhoicissus* sp. (JEV 1344, JEV 1345)

TILLIACEAE
4966 *Grewia occidentalis* L. (JEV 1887)
4966 *Grewia robusta* Burch. (Hoare site record)
4966 *Grewia tenax* (Forssk.) Fiori (Hoare site record)

MALVACEAE
4986 *Anisodontea julii* (Burch. ex DC.) Bates (Hoare site record)
4992 **Malva neglecta* Wallr. (Hoare site record)
4998 *Sida ovata* Forssk. (JEV 1894)
5013 *Hibiscus aethiopicus* L. var. *ovatus* Harv. (JEV 710)
5013 *Hibiscus microcarpus* Garcke (DBH 578, JEV 981)

5013 *Hibiscus* cf. *pusillus* Thunb. (DBH 433)
5013 *Hibiscus trionum* L. (JEV 1025)

STERCULIACEAE
5056 *Hermannia althaefolia* L. (Hoare site record)
5056 *Hermannia althaeoides* Link (DBH 359, DBH 373, JEV 1284)
5056 *Hermannia coccocarpa* (Eckl. & Zeyh.) Kuntze (DBH 529, JEV 1473, JEV 1690, JEV 1728)
5056 *Hermannia cordata* (E.Mey. ex E.Phillips) De Winter (JEV 944, JEV 1671)
5056 *Hermannia cuneifolia* Jacq. var. *glabrescens* (Harv.) Verdoorn (JEV 1078)
5056 *Hermannia depressa* N.E.Br. (DBH 393, JEV 1667)
5056 *Hermannia erodioides* (Burch. ex DC.) Kuntze (DBH 535)
5056 *Hermannia filifolia* L.f. (Hoare site record)
5056 *Hermannia flammula* Harv. (JEV 1280)
5056 *Hermannia geniculata* Eckl. & Zeyh. (JEV 1897)
5056 *Hermannia linearifolia* Harv. (JEV 1593)
5056 *Hermannia parviflora* Eckl. & Zeyh. (DBH 562, DBH 506, JEV 1714, JEV 1727)
5056 *Hermannia quartiniana* A.Rich. subsp. *stellulata* (K.Schum.) (V&H 334)

CLUSIACEAE
5168 *Hypericum aethiopicum* Thunb. subsp. *aethiopicum* (JEV 711)
5168 *Hypericum lalandii* Choisy (JEV 835, JEV 1234)
5168 *Hypericum wilmsii* R.Keller (Hoare site record)

FLACOURTIACEAE
5296 *Kiggelaria africana* L. (Hoare site record)

CACTACEAE
5417 **Opuntia aurantiaca* Lindl. (Hoare site record)
5417 **Opuntia ficus-indica* (L.) Mill. (Hoare site record)

ACHARIACEAE
5376 *Guthriea capensis* Bolus (JEV 1581)

THYMELAEACEAE
5435 *Gnidia burchellii* (Meisn.) Gilg (JEV 1411)
5435 *Gnidia capitata* L.f. (DBH 288)
5435 *Gnidia kraussiana* Meisn. (Hoare site record)
5435 *Gnidia* cf. *myrtifolia* C.H.Wr. (DBH 458)
5435 *Gnidia nodiflora* Meisn. (Hoare site record)
5435 *Gnidia sericea* L. var. *hirsuta* Meisn. (JEV 1124, JEV 1190)
5436 *Struthiola* sp. (Hoare site record)
5461 *Passerina montana* Thoday (DBH 725, JEV 905, JEV 1007, JEV 1008, JEV 1145, JEV 1267, JEV 1413, JEV 1483, JEV 1546)
5461 *Passerina vulgaris* Thoday

ONAGRACEAE
5795 *Epilobium* sp. (Hoare site record)
5804 *Oenothera indecora* Cambess. subsp. *indecora* (JEV 779, JEV 1455)
5804 **Oenothera rosea* L.Her. ex Aiton (JEV 1018, JEV 1144, JEV 1442, JEV 1821)
5804 **Oenothera tetraptera* Cav. (Hoare site record)

HALORAGACEAE
5836 *Gunnera perpensa* L. (DBH 625)

ARALIACEAE
5872 *Cussonia paniculata* Eckl. & Zeyh. (Hoare site record)

5872 *Cussonia spicata* Thunb. (Hoare site record)

APIACEAE
5894 *Centella asiatica* (L.) Urb. (DBH 447, DBH 483)
5922 *Alepidea capensis* (Berb.) R.A.Dyer var. *capensis* (JEV 1196)
5922 *Alepidea* cf. *galpinii* Dümmer (DBH 764)
5922 *Alepidea serrata* Eckl. & Zeyh. var. *serrata* (JEV 834, JEV 1708)
5992 *Heteromorpha arborescens* (Thunb.) Cham. & Schlechtd. (DBH 613)
5994 *Bupleurum mundtii* Cham. & Schlechtd. (DBH 763, V&H 348)
6004 **Ciclospermum leptophyllum*(Pers.) Eichler (DBH 502, DBH 533, DBH 775)
6033 *Pimpinella caffra* (Eckl. & Zeyhr.) D.Dietr. (JEV 1805)
6038 *Berula erecta* (Hudson) Cov. subsp. *thunbergii* (DC.) B.L.Burtt. (Hoare site record)
6062 **Foeniculum vulgare* Mill. (DBH 501, DBH 644)
6078 *Annesorhiza montana* (DBH 645, DBH 742)
6116 *Peucadanum capense* (Thunb.) Sond. (Hoare site record)
6116 *Peucadanum* cf. *platycarpa* E.Mey. (JEV 1103)
6116 *Peucadanum* sp. (V&H 320)
6142 *Daucus carota* L. (JEV 1906)

ERICACEAE
6237 *Erica algida* Bolus (JEV 1547)
6237 *Erica cerinthoides* L. var. *cerinthoides* (JEV 1325)
6237 *Erica dracomontana* E.G.H.Oliv.(JEV 1566)
6237 *Erica peltata* Andr. (JEV 1095)
6237 *Erica sparsa* Lodd. var. *sparsa* (JEV 1217)
6237 *Erica* sp. (DBH 494)
6237 *Erica* sp. (DBH 495)
6237 *Erica* spp. (DBH 457, DBH 542, DBH 695)

MYRSINACEAE
6313 *Myrsine africana* L. (V&H 316, V&H 383)
6314 *Rapanea* sp. (Hoare site record)

EBENACEAE
6404 *Euclea crispa* (Thunb.) Guerke (Hoare site record)
6404 *Euclea racemosa* Murray (Hoare site record)
6406 *Diospyros austro-africana* De Winter (JEV 1597)
6406 *Diospyros austro-africana* De Winter var. *microphylla* (Burch.) De Winter (JEV 999)
var. *rubriflora* (De Winter) De Winter (JEV 1736)
6406 *Diospyros dichrophylla* (Gand.) De Winter (Hoare site record)
6406 *Diospyros lycioides* Desf. subsp. *lycioides* (JEV690, JEV 1892)
6406 *Diospyros scabrida* (Harv. ex Hiern.) De Winter (Hoare site record)

OLEACEAE
6434 *Olea europea* L. (Hoare site record)
6434 *Olea exasperata* Jacqu. (Hoare site record)

SALVADORACEAE
6444 cf. *Azima tetracantha* Lam. (Hoare site record)

LOGANIACEAE
6470 *Gomphostigma virgatum* (L.f.) Baill. (DBH 626)
6473 *Buddleja glomerata* Wendl. f. (Hoare site record)
6473 *Buddleja saligna* Willd. (Hoare site record)
6473 *Buddleja salviifolia* (L.) Lam. (Hoare site record)

GENTIANACEAE
6481 *Sebaea filiformis* Schinz. (JEV 1771, JEV 1776, JEV 1831)
6481 *Sebaea leiostyla* Gilg (JEV 1786)
6481 *Sebaea natalensis* Schinz. (JEV 1117, JEV 1239, JEV 1756, JEV 1909)
6481 *Sebaea thomasii* (S.Moore) Schinz (JEV 1580)
6503 *Chironia krebsii* Griseb. (DBH 637)
6503 *Chironia melampyrifolia* Lam. (Hoare site record)
6503 *Chironia peglerae* Prain (DBH 468)

APOCYNACEAE
6559 *Carissa bispinosa* (L.) Desf. ex Brenan (Hoare site record)
6559 *Carissa haematocarpa* (Eckl. & Zeyh.) A.DC. (Hoare site record)

PERIPLOCACEAE
6747 *Raphionacme* sp. (DBH 259)

ASCLEPIADACEAE
6777 *Xysmalobium parviflorum* Harv. ex Scott Elliot (JEV 754)
6778 *Schizoglossum linifolium* Schltr. (DBH 767)
6787 *Pachycarpus concolor* E.Mey. (JEV 707)
6787 *Pachycarpus vexillaris* E.Mey. (JEV 1002, JEV 1711)
6787 *Gomphocarpus fruticosus* (L.) Aiton f. (JEV 853, JEV 1012, JEV 1032, JEV 1770, JEV 1869)
6778 *Aspidoglossum carinatum* (Schltr.) Kupicha (JEV 804)
6791 *Asclepias brevicuspus* (E.Mey.) Schltr. (Hoare site record)
6791 *Asclepias gibba* (E.Mey.) Schltr. var. *gibba* (V&H 327, JEV 818)
6791 *Asclepias meyeriana* (Schltr.) Schltr. (Hoare site record)
6791 *Asclepias multicaulis* (E.Mey.) Schltr. (DBH 424)
6791 *Asclepias stellifera* Schltr. (DBH 260, DBH 602, JEV 1446)
6849 *Sarcostemma viminale* (L.) R.Br. (Hoare site record)
6861 *Sisyranthus barbatus* (Turcz.) N.E.Br. (JEV814)
6862 *Orthanthera jasminiflora* (Decne.) Schinz (Hoare site record)

CONVOLVULACEAE
6972 *Falckia repens* L.f. (Hoare site record)
6993 *Convolvulus dregeanus* Choisy (DBH 420, JEV 697, JEV 1631))
6993 *Convolvulus galpinii* C.H.Wr. (V&H 388)
6993 *Convolvulus natalensis* Bernh. apaud C.Krauss (JEV 1430)
6993 *Convolvulus natalensis* Bernh. apaud C.Krauss var. *transvaalensis* (Schltr.) A.Meeuse (JEV 708)
6993 *Convolvulus sagittatus* Thunb. (Hoare site record)
6993 *Convolvulus thunbergii* Roem. & Schult. (V&H 365, JEV 1450)
6997 *Merremia verecunda* Rendle (Hoare site record)
7003 *Ipomoea crispa* (Thunb.) Hallier f. (DBH 377, JEV 976)
7008 *Turbina oblongata* (E.Mey. ex Choisy) A.Meeuse. (Hoare site record)
7008 *Turbina oenotheroides* (L.f.) A.Meeuse (JEV 1672)

BORAGINACEAE
7064 *Cynoglossum austro-africanum* Hilliard & Burtt (DBH 508, DBH 657)
7064 *Cynoglossum hispidum* Thunb. (V&H 392)
7073 **Lappula squarrosa* (L.) Dumort. (DBH 394, DBH 543)
subsp. *heteracantha* (Ledeb.) Chater (JEV 1502)
7100 *Myosotis graminifolia* DC. (Hoare site record)
7109 *Lithospermum papillosum* Thunb. (DBH 306)
7118 **Echium plantagineum* L. (DBH 658, JEV 1792)
7118 **Echium vulgare* L. (Hoare site record)

VERBENACEAE
7144 *Lantana rugosa* Thunb. (Hoare site record)
7138 **Verbena brasiliensis* Vell. (Hoare site record)
7138 **Verbena venosa* Gill. & Hook. (Hoare site record)
7148 *Chascanum pinnatifidum* (L.f.) E.Mey. ( )

LAMIACEAE
7211 *Ajuga ophrydis* Burch. ex Benth. (DBH 549, JEV 1461, JEV 1592)
7212 *Teucrium africanum* Thunb. (JEV 866)
7281 *Stachys aethiopica* L. (JEV 1291)
7281 *Stachys cuneata* Banks ex Benth. (Hoare site record)
7281 *Stachys dregeana* Benth. (Hoare site record)
7281 *Stachys graciliflora* Presl. (Hoare site record)
7281 *Stachys linearis* Burch. ex Benth. (Hoare site record)
7281 *Stachys malacophylla* Skan (JEV 714)
7281 *Stachys rugosa* Ait. (Hoare site record)
7281 *Stachys* sp. (JEV 1434, JEV 1664)
7290 *Salvia africana-lutea* L. (Hoare site record)
7290 *Salvia aurita* L.f. (Hoare site record)
7290 *Salvia repens* Burch. ex Benth. (JEV 1400)
var. *repens* (DBH 547, V&H 323, JEV 712, JEV 1726, JEV 1851)
7290 *Salvia runcinata* L.f. (JEV 700, JEV 1051, JEV 1635)
7290 *Salvia stenophylla* Burch. ex Benth. (JEV 1778)
7290 *Salvia verbenaca* L. (Hoare site record)
7328 *Mentha longifolia* (L.) L. subsp. *capensis* (Thunb.) Briq. (JEV 1029)

SOLANACEAE
7379 *Lycium cinereum* Thunb. *sensu lato* (JEV 1069, JEV 1321, JEV 1633, JEV 1666)
7379 *Lycium prunus-spinosa* Dun. (Hoare site record)
7379 *Lycium* sp. (DBH 282)
7400 *Withania somnifera* (L.) Dun. (Hoare site record)
7407 *Solanum incanum* L. (DBH 272)
7407 **Solanum nigrum* L. (Hoare site record)
7407 *Solanum rigescens* Jacq. (Hoare site record)
7407 *Solanum supinum* Dun. (Hoare site record)
7407 *Solanum tomentosum* L. (Hoare site record)
7407 *Solanum* sp.
7415 *Datura stramonium* L. (JEV 1030)

SCROPHULARIACEAE (PART A)
7467 *Aptosimum procumbens* (Lehm.) Steud.
7471 *Diascia capsularis* Benth. (JEV 1279)
7471 *Diascia integerrima* Benth.(JEV 1465, JEV 1530, JEV 1733, JEV 1765)
7471 *Diascia rigescens* Benth. (JEV 927)
7476 *Nemesia denticulata* (Benth.) Fourc. (V&H 301, JEV 1259)
7476 *Nemesia foetens* Vent. (JEV 855)
7476 *Nemesia fruticans* (Thunb.) Benth. (Hoare site record)
7476 *Nemesia linearis* Vent. (JEV 693)
7476 *Nemesia* sp. (JEV 1874)
7493 *Halleria lucida* L. (Hoare site record)
7495 *Phygelius capensis* E.Mey. ex Benth. (JEV 1761)
7517 *Manulea burchellii* Hiern (Hoare site record)
7517 *Manulea crassifolia* Benth. (DBH 505)
7517 *Manulea dregei* Hilliard & B.L.Burtt (JEV 1561, JEV 1871, JEV 1913)
7517 *Manulea rhodantha* Hilliard subsp. *rhodantha* (JEV 1709)
7519 *Sutera campanulata* (Benth.) Kuntze (DBH 342)

7519 *Sutera halimifolia* (Benth.) Kuntze (DBH 507, DBH 669, DBH 703, DBH 745)
7519 *Sutera patriotica* Hiern. (JEV 1751)
7519 *Sutera pinnatifida* (Benth.) Kuntze (Hoare site record)
7519 *Sutera* spp. (JEV 889, JEV 893, JEV 917, JEV 940, JEV 947, JEV 997, JEV 1004, JEV 1242, JEV 1260, JEV1290, JEV 1306, JEV 1317, JEV 1328, JEV 1507, JEV 1604, V&H 342, V&H 349)
7519 *Jamesbrittenia (Sutera) aurantiaca* (Burch.) Hilliard (DBH 606, JEV 1639)
7519 *Jamesbrittenia (Sutera) atropurpurea* (Benth.) Hilliard subsp. *atropurpurea* (JEV 694)
7523 *Zaluzianskya* cf. *angustifolia* Hilliard & Burtt (JEV 1132)
7523 *Zaluzianskya* cf. *capensis* (L.) Walp. (DBH 647)
7523 *Zaluzianskya ovata* (Benth.) Walp. (JEV 1582)
7523 *Zaluzianskya pulvinata* Killick (JEV 1565)
7523 *Zaluzianskya rubrostellata* Hilliard & Burtt (JEV 1560)
7523 *Zaluzianskya schmitziae* Hilliard & Burtt (DBH 592, DBH 741, JEV 1203, JEV 1741)
7558 *Limosella grandiflora* Benth. (JEV 1718a)

SELAGINACEAE
7566 *Hebenstretia dura* Choisy (JEV 1100, JEV 1121, JEV 1422, JEV 1564, JEV 1677, JEV 1859)
7566 *Hebenstretia comosa* Hochst. (JEV 1590)
7566 *Hebenstretia* cf. *integrifolia* L. (DBH 245, DBH 265, JEV 1804)
7568 *Selago albida* Choisy (DBH 758)
7568 *Selago corymbosa* L. (DBH 439, DBH 440, DBH 462, JEV 1057, JEV 1223, JEV 1329)
7568 *Selago galpinii* Schltr. (JEV 1705, JEV 1818)
7568 *Selago melliodora* Hilliard (JEV 1795)
7568 *Selago speciosa* Rolfe (JEV 1466, JEV 1509, JEV 1675)
7568 *Walafrida densiflora* (Rolfe) Rolfe (Hoare site record)
7568 *Walafrida geniculata* (L.f.) Rolfe (JEV 1308)
7568 *Walafrida gracilis* Rolfe (Hoare site record)
7568 *Walafrida paniculata* (Thunb.) Rolfe (JEV 1720)
7568 *Walafrida saxatalis* (E.Mey.) Rolfe (DBH 321, DBH 396, V&H 343, JEV 1454, JEV 1775, JEV 1784a, JEV 1837)
7568 *Walafrida witbergensis* (E.Mey.) Rolfe (JEV 1553)
7568 *Walafrida* spp. (DBH 352, DBH 293, V&H 360, JEV 783, JEV 865, JEV 1028, JEV 1161, JEV 1191, JEV 1193, JEV 1249, JEV 1732, JEV 1832, JEV 1784b)

SCROPHULARIACEAE (PART B)
7614 *Graderia scabra* (L.f.) Benth. (JEV 744, JEV 782)
7622 *Buchnera dura* Benth. (DBH 469)
7625 *Striga bilabiata* (Thunb.) Kuntze (JEV 1746, JEV 1817)
7625 *Striga elegans* Benth. (DBH 568, DBH 584, JEV 1857)
7627 *Harveya speciosa* Bernh. ex Krauss (JEV 1800, V&H 375)
7629 *Hyobanche rubra* N.E.Br. (JEV 1568)
7645 *Bartsia trixago* L. (DBH 633)

ACANTHACEAE
7914 *Thunbergia capensis* Retz. (JEV 1893)
7972 *Crabbea acaulis* N.E.Br. (Hoare site record)
7980 *Blepharis dilatata* C.B.Cl. (JEV 862, JEV 1075)
7980 *Blepharis integrifolia* (L.f.) E.Mey. var. *integrifolia* (DBH 360, DBH 739, DBH 789)
7980 *Blepharis mitrata* C.B.Cl. (DBH 385)

PLANTAGINACEAE
8116 **Plantago lanceolata* L. (Hoare site record)

RUBIACEAE
8136 *Kohautia amatymbica* Eckl. & Zeyh. (JEV 751)
8281 *Burchellia bubalina* (L.f.) Sims (Hoare site record)

8348 *Pentanisia angustifolia* (Hochst.) Hochst. (JEV 709)
8383 *Pavetta capensis* (Houtt.) Brem. subsp. *capensis* (DBH 473)
8438 *Anthospermum aethiopicum* L. (Hoare site record)
8438 *Anthospermum herbaceum* L.f. (DBH 632, JEV 1187)
8438 *Anthospermum montocola* Puff. (JEV 1608, JEV 1806)
8438 *Anthospermum paniculatum* Cruse (V&H 372, JEV 715, JEV 828, JEV 1135, JEV 1199, JEV 1911)
8438 *Anthospermum rigidum* Eckl. & Zeyh. (DBH 656, DBH 782, JEV 1513)
subsp. *pumilum* (Sond.) Puff (DBH 434, DBH 561, JEV 1686)
subsp. *rigidum* (Sond.) Puff (JEV 1898, JEV 1921)
8438 *Anthospermum* sp. cf. *A. prostratum* Sond. (DBH 480)
8439 *Nenax microphylla* (Sond.) Salter (DBH 292, JEV 1323)
8464 *Richardia humistrata* (Cham. & Schlechtd.) Steud. (JEV 799)
8486 *Galium capense* Thunb. (DBH 421, DBH 768, JEV 1443)
subsp. cap*ense* (JEV 784)
subsp. *garipense* (Sond.) Puff (JEV 718, JEV 1830)
8489 *Rubia petiolare* DC. (Hoare site record)

DIPSACACEAE
8541 *Cephalaria oblongifolia* (Kuntze) Szabo (JEV 1084, JEV 1099)
8546 *Scabiosa albanensis* R.A.Dyer (JEV 1490)
8546 *Scabiosa columbaria* L. (JEV 717, JEV 736, JEV 833, JEV 1062, JEV 1657, JEV 1735, JEV 1766, JEV 1807)
8546 *Scabiosa tysonii* L.Bol. (JEV 1353)

CUCURBITACEAE
8568 *Kedrostis africana* (L.) Cogn. (JEV 885, JEV 1870)
8568 *Kedrostis capensis* (Sond.) A.Meeuse (Hoare site record)
8599 *Cucumis heptadactylus* Naud. (JEV 869)
8599 *Cucumis myriocarpus* Naud. subsp. *leptodermis* (Schweick.) C.Jeffrey & P.Halliday (JEV 1865)
8599 *Cucumis zeyheri* Sond. (Hoare site record)

CAMPANULACEAE
8668 *Wahlenbergia albens* (Spreng. ex A.DC.) Lammers (JEV 1428, JEV 1607)
8668 *Wahlenbergia androsacea* A.DC. (JEV 1453, JEV 1603, JEV 1645)
8668 *Wahlenbergia capillacea* (L.f.) A.DC. subsp. *capillacea* (JEV 1116, JEV 1119, JEV 1185, JEV 1211, JEV 1914)
8668 *Wahlenbergia denticulata* (Burch.) A.DC. (DBH 608, JEV 1460, JEV 1464, JEV 1596)
8668 *Wahlenbergia dilatata* Brehmer (JEV 1602)
8668 *Wahlenbergia huttonii* (Sond.) Thulin (JEV 1098)
8668 *Wahlenbergia krebsii* Cham. subsp. *krebsii* (V&H 322, JEV 761)
8668 *Wahlenbergia paucidentata* Schinz (JEV 1585)
8668 *Wahlenbergia stellarioides* Cham. & Schlechtd. (DBH 570, DBH 582, DBH 774, V&H 361, JEV 977, JEV 1702, JEV 1836)
8668 *Wahlenbergia undulata* (L.f.) A.DC. (DBH 192, DBH 643, DBH 765, V&H 321, JEV 823, JEV 923, JEV 941, JEV 1044, JEV 1258, JEV 1748, JEV 1789, JEV 1822)
8670 *Lightfootia albens* Spreng. ex A.DC. (JEV 883)
8670 *Lightfootia juncea* (Buek) Sond. (DBH 753, JEV 898)
8670 *Lightfootia nodosa* Buek (Hoare site record)
8670 *Lightfootia* sp. (Hoare site record)

LOBELIACEAE
8681 *Cyphia longifolia* N.E.Br. var. *longifolia* (JEV 1902)
8681 *Cyphia sylvatica* Eckl. var. *sylvatica* (DBH 189, V&H 354, JEV 1073, JEV 1082, JEV 1324)
8681 *Cyphia triphylla* Phill. (JEV 1722)
8681 *Cyphia* sp. (DBH 283)

8694 *Lobelia flaccida* (Presl) A.DC. subsp. *flaccida* (DBH 221, DBH 308, DBH 437, DBH 446, JEV 760, JEV 780, JEV 843, JEV 911, JEV 951, JEV 1156, JEV 1213, JEV 1780, JEV 1896)
8694 *Lobelia tomentosa* L.f. (DBH 673, JEV 1326)
8695 *Monopsis decipiens* (Sond.) Thulin (JEV 813)
8695 *Monopsis scabra* (Thunb.) Urb. (JEV 1112)
8695 *Monopsis unidentata* (Dryand.) E.Wimm. (DBH 445, DBH 481)
subsp. *intermedia* P.B.Phillipson Ined. (JEV 748)

ASTERACEAE
8751 *Vernonia brasiliensis* Vell. (JEV 1021)
8751 *Vernonia capensis* (Houtt.) Druce (DBH 285, JEV 986)
8751 *Vernonia dregeana* Sch. Bip. (JEV 803)
8751 *Vernonia meiostephana* C. Jeffrey (Hoare site record)
8862 *Pteronia staehelinoides* DC. (Hoare site record)
8862 *Pteronia teretifolia* (Thunb.) Fourcade (DBH 470)
8887 *Amellus strigosus* (Thunb.) Less. (DBH 537, JEV 1621)
8887 *Amellus tridactylus* DC. (JEV 1652)
8900 *Aster bakeranus* Burtt Davy ex C.A.Sm. (V&H 370, JEV 738, JEV 747, JEV 807, JEV 826)
8919 *Felicia fascicularis* DC. (JEV 1289)
8919 *Felicia filifolia* (Vent.) Burtt Davy subsp. *filifolia* (JEV 1301, JEV 1856)
8919 *Felicia hirsuta* DC. (DBH 614)
8919 *Felicia hyssopifolia* (Berg.) Nees (DBH 362)
8919 *Felicia muricata* (Thunb.) Ness (JEV 1488, JEV 1527, JEV 1529, DBH 705)
subsp. *muricata* (JEV 896, JEV 1209, JEV 1256, JEV 1316, JEV 1788, JEV 1855)
8919 *Felicia ovata* (Thunb.) Compton (DBH 392)
8919 *Felicia petiolata* (Harv.) N.E.Br. (JEV 1554)
8919 *Felicia rosulata* Yeo (JEV 1574)
8919 *Felicia zeyheri* (Less.) Nees subsp. *linifolia* (Harv.) Grau (JEV 1001)
8925 *Nidorella agria* Hilliard (JEV 1810)
8925 *Nidorella auriculata* DC. (DBH 694)
8925 *Nidorella resedifolia* DC. subsp. *resedifolia* (DBH 580)
8925 *Nidorella undulata* (Thunb.) Sond. ex Harv. (DBH 627, DBH 646, DBH 726, JEV 1083, JEV 1107, JEV 1149, JEV 1151)
8926 **Conyza albida* Spreng (DBH 586)
8926 **Conyza bonariensis* (L.) Cronq. (Hoare site record)
8926 *Conyza obscura* DC. (cf. JEV 906, JEV 1313)
8926 *Conyza pinnata* (L.f.) Kuntze (Hoare site record)
8926 *Conyza podocephala* DC. (DBH 572, DBH 585, JEV 704, JEV 1319, JEV 1731, JEV 1790, JEV 1828)
8926 *Conyza scabrida* DC. (Hoare site record)
8929 *Nolletia ciliaris* (DC.) Steetz (DBH 555, JEV 1700)
8930 *Chrysocoma ciliata* L. (V&H 339, JEV 777, JEV 1063, JEV 1138, JEV 1147, JEV 1155, JEV 1186, JEV 1235, JEV 1273, JEV 1346, JEV 1485)
8937 *Tarchonanthus camphoratus* L. (JEV 1452)
8949 *Denekia capensis* Thunb. (Hoare site record)
8967 *Ifloga glomerata* (Harv.) Schltr. (JEV 1692, JEV 1862)
8992 *Gnaphalium confine* Harv. (JEV 1637)
8992 *Gnaphalium vestitum* Thunb. (DBH 688, JEV 1233)
8992 *Pseudognaphalium luteo-album* (L.) Hilliard & Burtt (DBH 599, DBH 612, JEV 958, JEV 1016, JEV 1165)
8992 *Pseudognaphalium oligandrum* (DC.) Hilliard & Burtt (DBH 571, DBH 600, DBH 699, DBH 707, JEV 902, JEV 1251, JEV 1699)
8992 *Pseudognaphalium undulatum* (L.) Hilliard & Burtt (JEV 1824)
9006 *Helichrysum adenocarpum* DC. subsp. *adenocarpum* (DBH 730, JEV 1114, JEV 1177)
9006 *Helichrysum albanense* Hilliard (JEV 1220)
9006 *Helichrysum allioides* Less. (Hoare site record)
9006 *Helichrysum ammitophilum* Hilliard (JEV 1715)

9006 *Helichrysum anomalum* Less. (DBH 459, DBH 594, DBH 720, JEV 1010, JEV 1047, JEV 1108, JEV 1157, JEV 1172, JEV 1216, JEV 1286, JEV 1334, JEV 1899)
9006 *Helichrysum appendiculatum* (L.f.) Less. (JEV 746, JEV 800)
9006 *Helichrysum argyrophyllum* DC. (JEV 1207)
9006 *Helichrysum asperum* (Thunb.) Hilliard & Burtt var. *albidulum* (DC.) Hilliard (JEV 775)
var. *appressifolium* (Moeser) Hilliard (DBH 255)
9006 *Helichrysum aureum* (Houtt.) Merr. (JEV 1463)
var. *monocephalum* (DC.) Hilliard (JEV 726, JEV 741, JEV 759, JEV 841)
var. *serotinum* Hilliard (JEV 1178)
9006 *Helichrysum aureonitens* Sch.Bip. (JEV 1475)
9006 *Helichrysum callicomum* Harv. (DBH 589, DBH 601, DBH 755, JEV 936, JEV 1719, JEV 1815, JEV 1841)
9006 *Helichrysum cephaloideum* DC. (DBH 794, JEV 1215, JEV 1696, JEV 1825, JEV 1907)
9006 *Helichrysum chionosphaerum* DC. (Hoare site record)
9006 *Helichrysum cymosum* (L.) D.Don. var. *cymosum* (DBH 524)
9006 *Helichrysum dasycephalum* O.Hoffm. (DBH 579)
9006 *Helichrysum dregeanum* Sond. & Harv. (JEV 1444, JEV 1462, JEV 1826, JEV 1900)
9006 *Helichrysum felinum* Less. (DBH 463)
9006 *Helichrysum glomeratum* Klatt (DBH 593, DBH 724, JEV 733, JEV 993, JEV 993, JEV 1109, JEV 1171, JEV 1908b)
9006 *Helichrysum griseolanatum* Sond. ()DBH 729
9006 *Helichrysum hamulosum* E. Mey ex DC. (JEV 854)
9006 *Helichrysum herbaceum* (Andr.) Sweet (DBH 648, DBH 674, DBH 693)
9006 *Helichrysum isolepis* H.Bol. (DBH 310) Katberg/Winterberg - rare
9006 *Helichrysum krebsianum* Less. (JEV 810, JEV 1195)
9006 *Helichrysum lineare* DC. (V&H 394, JEV 1480, JEV 1495, JEV 1834)
9006 *Helichrysum melanacme* DC. (JEV 1713)
9006 *Helichrysum miciniifolium* DC. (DBH 677, JEV 1230)
9006 *Helichrysum mixtum* (Kuntze) Moeser var. *mixtum* (JEV 808, JEV 1106, JEV 1113, JEV 1180)
9006 *Helichrysum monticola* Hilliard (DBH 631)
9006 *Helichrysum nudifolium* (L.) Less. (JEV 1231, JEV 1294)
9006 *Helichrysum odoratissimum* (L.) Sweet (JEV 742, JEV 802, JEV1105, JEV 1181, JEV 1188, JEV 1697, JEV 1724, JEV 1737, JEV 1759, JEV 1774, JEV 1794, JEV 1819, JEV 1827)
9006 *Helichrysum pentzioides* Less. (Hoare site record)
9006 *Helichrysum pilosellum* (L.f.) Less. (DBH 435, JEV 734, JEV 793, JEV 1486)
9006 *Helichrysum psilolepis* Harv. (JEV 1272).
9006 *Helichrysum rosum* (Berg.) Less. var. *arcuatum* Hilliard (JEV 890, JEV 1262, JEV 1285)
9006 *Helichrysum rugulosum* Less. (DBH 284, DBH 412, JEV 560, JEV 781, JEV 720, JEV 721, JEV 778, JV 787, JEV 819, JEV 1009, JEV1049, JEV 1232, JEV 1303, JEV 1779, JEV 1816, JEV 1833)
9006 *Helichrysum rutilans* (L.) D.Don. (DBH 713, DBH 628, JEV 1685)
9006 *Helichrysum scitulum* Hilliard & B.L.Burtt (JEV 1679)
9006 *Helichrysum sessilioides* Hilliard (JEV 1559)
9006 *Helichrysum simillimum* DC. (DBH 583, JEV 1148, JEV 1189, JEV 1192, JEV 1908a)
9006 *Helichrysum sphaeroideum* Moeser (Hoare site record)
9006 *Helichrysum spiralepsis* Hilliard & Burtt (DBH 629, JEV 805, JEV1237)
9006 *Helichrysum splendidum* (Thund.) Less. (DBH 607, DBH 722, DBH 732, JEV 1497, JEV 1275)
9006 *Helichrysum subglomeratum* Less. (JEV 1241, JEV 1843)
9006 *Helichrysum teretifolium* (L.) D.Don. (Hoare site record)
9006 *Helichrysum trilineatum* DC. (DBH 332, DBH 410, DBH 719, JEV 1426, JEV 1498, JEV 1512, JEV 1520, JEV 1745)
9006 *Helichrysum umbraculigerum* Less. (JEV 931, JEV 1166)
9006 *Helichrysum xerochrysum* DC. (Hoare site record)
9006 *Helichrysum zeyheri* Less. (JEV 861)
9006 *Helichrysum* sp. (DBH 557)
9037 *Stoebe vulgaris* Levyns (JEV 1006, JEV 1093)
9039 *Disparago tortilis* (DC.) Sch. Bip. (JEV 1219, JEV 1343)

9041 *Elytropappus gnaphaloides* (L.) Levyns (Hoare site record)
9041 *Elytropappus rhinocerotis* (L.f.) Less (Hoare site record)
9042 *Pterothrix spinescens* DC. (Hoare site record)
9043 *Metalasia densa* (Lam.) P.O.Karis (DBH 252, DBH 322, DBH 475, DBH 670, DBH 691, JEV 1005, JEV 1086, JEV 1218, JEV 1525)
9043 *Metalasia trivialis* Karis (Hoare site record)
9050 *Relhania acerosa* (DC.) Bremer (Hoare site record)
9050 *Relhania dieterlenii* (Phill.) Bremer (JEV 1798)
9050 *Relhania pungens* L'Herit (DBH 478, DBH 659, DBH 663)
9052 *Leysera gnaphalodes* (L.) L. (JEV 973, JEV 1246)
9053 *Macowania pulvinaris* N.E.Br. (JEV 1569)
9055 *Athrixia fontana* MacOwan (Hoare site record)
9058 *Arrowsmithia styphelioides* DC. (Hoare site record)
9059 *Printzia pyrifolia* Less. (Hoare site record)
9073 *Pegolettia retrofracta* (Thunb.) Kies (Hoare site record)
9078 *Pulicaria scabra* (Thunb.) Druce (JEV 1024)
9090 *Geigeria filifolia* Mattf. (Hoare site record)
9237 *Bidens bipinnata* L. (JEV 1014)
9237 **Bidens pilosa* L.
9291 **Schkuhria pinnata* (Lam.) Cabr. (DBH 565, JEV 1890)
9311 **Tagetes minuta* L. (JEV 1768)
9320 *Eriocephalus africanus* L. (Hoare site record)
9320 *Eriocephalus aspalathoides* DC. (Hoare site record)
9320 *Eriocephalus ericoides* (L.f.) Druce (Hoare site record)
9320 *Eriocephalus spinescens* Burch. (Hoare site record)
9320 *Eriocephalus* sp. (Hoare site record)
9321 *Lasiospermum bipinnatum* (Thunb.) Druce (DBH 788, V&H 356, V&H 393, JEV 762, JEV 766, JEV 1019, JEV 1136, JEV 1139, JEV1158, JEV 1263)
9326 *Athanasia dentata* (L.) L. (DBH 464)
9326 *Athanasia pinnata* L.f. (DBH 461)
9336 *Phymaspermum parvifolium* DC. Benth. & Hook. ex Jacks. (JEV 1415, JEV 1622)
9351 *Cotula heterocarpa* DC. (DBH 402, JEV 755, JEV 959)
9351 *Cotula hispida* (DC.) Harv. (DBH 651, V&H 371, JEV 1115, JEV 1176)
9351 *Cotula* cf. *lineariloba* (DC.) Hilliard (JEV 1252)
9356 *Schistostephium crataegifolium* (DC.) Fenzl. (DBH 664, JEV 928, JEV 1102, JEV 1127, JEV 1129)
9358 *Artemisia afra* Jacq. ex Willd. (Hoare site record)
9366 *Pentzia cooperi* Harv. (DBH 721, JEV 1730, JEV 1812, JEV 1846)
9366 *Pentzia globosa* Less. (DBH 266, DBH 271, DBH 770, JEV 1615, JEV 1634, JEV 1863)
9366 *Pentzia incana* (Thunb.) Kuntze (DBH 388, JEV 1077)
9366 *Pentzia lanata* Hutch. (DBH 395, JEV 685)
9366 *Pentzia sphaerocephala* DC. (JEV 884)
9366 *Pentzia viridis* Kies (Hoare site record)
9370 *Luzula africana* Drege ex Steud. (JEV 1563)
9377 *Hertia pallens* (DC.) Kuntze (Hoare site record)
9406 *Cineraria aspera* Thunb. (Hoare site record)
9406 *Cineraria canescens* Wendl. ex Link (Hoare site record)
9406 *Cineraria lyrata* DC. (JEV 1110, JEV 1835)
9406 *Cineraria mollis* E.Mey. ex DC. (JEV 1579)
9406 *Cineraria platycarpa* DC. (Hoare site record)
9406 *Cineraria saxifraga* DC. (JEV 1354)
9411 *Senecio affinis* DC. (JEV 809)
9411 *Senecio arabidifolius* O.Hoffm. (DBH 595)
9411 *Senecio asperulus* DC. (JEV 1269, JEV 1441)
9411 *Senecio barbatus* DC. (Hoare site record)
9411 *Senecio consangineus* DC. (DBH 604)
9411 *Senecio coronatus* (Thunb.) Harv. (Hoare site record)

9411 *Senecio erubescens* Ait. (DBH 530, DBH 777)
var. *crepidifolius* DC. (JEV 768)
var. *erubescens* (DBH 712)
9411 *Senecio harveianus* MacOwan (JEV 1605, JEV 1762, JEV 1829)
9411 *Senecio hastatus* L. (V&H 340, JEV 1853)
9411 *Senecio heiracioides* DC. (JEV 1440, JEV 1412, JEV 1489, JEV 1814)
9411 *Senecio hypochoerideus* DC. (JEV 1320)
9411 *Senecio inaequidens* DC. (DBH 778, JEV 946, JEV 1142, JEV 1154, JEV 1175, JEV 1243, JEV 1255)
9411 *Senecio inornatus* DC. (DBH 783)
9411 *Senecio juniperinus* L.f. var. *epitrachys* (DC.) Harv. (JEV 1015, JEV 1111)
9411 *Senecio latifolius* DC. (DBH 413)
9411 *Senecio macrocephalus* DC. (DBH 305, JEV 1214)
9411 *Senecio* cf. *monticola* DC. (DBH 335)
9411 *Senecio oxydontus* DC. (V&H 311)
9411 *Senecio polyodon* DC. var. *polyodon* (JEV 845, JEV 1134, JEV 1173, JEV 1799)
9411 *Senecio pterophorus* DC. (JEV 727, JEV 801)
9411 *Senecio radicans* (L.f.) Sch. Bip. (DBH 368, DBH 761)
9411 *Senecio reptans* Turcz. (DBH 536, DBH 706)
9411 *Senecio retrorsus* DC. (JEV 725, JEV 785, JEV 1011, JEV 1274, JEV 1854)
9411 *Senecio ruwenzoriensis* S.Moore (JEV 1283)
9411 *Senecio scaposus* DC. (JEV 771)
9411 *Senecio speciosus* Willd. (DBH 471, JEV 1170, JEV 1330)
9411 *Senecio tanacetopsis* Hilliard (JEV 1314)
9411 *Senecio* sp. (DBH 704)
9417 *Euryops annae* Phill. (JEV 1701)
9417 *Euryops brachypodus* (DC.) B.Nord. (DBH 678, JEV 1347)
9417 *Euryops floribundus* N.E.Br. (V&H 390)
9417 *Euryops galpinii* H.Bol. (Hoare site record)
9417 *Euryops oligoglossus* DC. (JEV 1435, JEV 1484, JEV 1609)
subsp. *oliglossus* (JEV 1276, JEV 1769)
9417 *Euryops spathaceus* DC. (Hoare site record)
9417 *Euryops tysonii* E.Phillips (JEV 1571)
9420 *Othonna pavonia* E.Mey. (JEV 1451)
9420 *Othonna patula* Schltr. (Hoare site record)
9425 *Dimorphotheca caulescens* Harv. (JEV 1640)
9425 *Dimorphotheca cuneata* (Thunb.) Less. (JEV 1402, JEV 1470)
9425 *Dimorphotheca jucunda* E.Phillips (JEV 1575)
9427 *Chrysanthemoides monilifera* (L.) T.Norl. (Hoare site record)
9427 *Osteospermum bidens* Thunb. (DBH 682)
9427 *Osteospermum scariosum* DC. (Hoare site record)
9431 *Ursinia montana* DC. subsp. *montana* (JEV 1204, JEV 1315)
subsp. *apiculata* (DC.) Prassler (DBH 526)
9431 *Ursinia nana* DC. (JEV 1620)
9431 *Ursinia tenuiloba* DC. (JEV 1310)
9432 *Arctotis arctotoides* (L.f.) O.Hoffm. (JEV 1250, JEV 1300)
9432 *Arctotis microcephala* (DC.) Beauv. (JEV 705, JEV 1056, JEV 1247, JEV 1630, JEV 1873)
9432 *Arctotis venusta* T.Norl. (JEV 1683, JEV 1844)
9432 *Haplocarpha lyrata* Harv. (JEV 1226)
9432 *Haplocarpha nervosa* (Thunb.) Beauv. (Hoare site record)
9432 *Haplocarpha scaposa* Harv. (DBH 349, DBH 567, DBH 598, DBH 740, JEV 781, JEV 1820)
9434 *Gazania krebsiana* Less. (DBH 279, DBH 426, DBH 786, JEV 1503, JEV 1654)
subsp. *serrulata* (DC.) Roessl. (JEV 837, JEV 1809)
subsp. *krebsiana* (JEV 1760)
9434 *Gazania linearis* (Thunb.) Druce var. *linearis* (JEV 987, JEV 1060, JEV 1261)
9438 *Berkheya acanthopoda* (DC.) Rössl. (Hoare site record)
9438 *Berkheya buphthalmoides* (DC.) Schltr. (DBH 411, JEV 1445, JEV 1680)

9438 *Berkheya carduoides* (Less.) Hutch. (DBH 487, DBH 652, DBH 792, JEV 910, JEV 934, JEV 1153)
9438 *Berkheya cirsiifolia* (DC.) Rössl. (DBH 345)
9438 *Berkheya decurrens* (Thunb.) Willd. (DBH 482, DBH 684, V&H 333)
9438 *Berkheya discolor* (DC.) O.Hoffm. & Muschl. (DBH 294, DBH 427, DBH 563, DBH 573, DBH 622, DBH 666, DBH 715, DBH 749, JEV 909, JEV 982, JEV 1695, JEV 1721, JEV 1879)
9438 *Berkheya glabrata* (Thunb.) Fourc. (Hoare site record)
9438 *Berkheya heterophylla* (Thunb.) O.Hoffm. (DBH 370, DBH 553, DBH 685, JEV 1416, JEV 1617)
9438 *Berkheya macrocephala* J.M.Wood (DBH 640)
9438 *Berkheya onopordifolia* (DC.) O.Hoffm. ex Burtt Davy (DBH 564, DBH 574, DBH 714, DBH 748, DBH 772, DBH 773)
9438 *Berkheya pinnatifida* (Thunb.) Thell. (DBH 422, DBH 771)
9438 *Berkheya purpurea* (DC.) Mast. (DBH 347, DBH 621, V&H 379)
9438 *Berkheya rhapontica* (DC.) Hutch. & Burtt Davy subsp. *aristosa* (DC.) Roessl. var. *exalata* Roessl. (JEV 1179)
9438 *Berkheya* sp. (V&H 373, JEV 1020, JEV 1152)
9462 **Cirsium vulgare* (Savi) Ten. (Hoare site record)
9500 *Oldenburgia grandis* (Thunb.) Baill. (Hoare site record)
9501 *Dicoma anomala* Sond. (JEV 1687, JEV 1704)
9528 *Gerbera ambigua* (Cass.) Sch. Bip. (V&H 358)
9528 *Gerbera piloselloides* (L.) Cass. (JEV 735, JEV 1355)
9528 *Gerbera viridifolia* (DC.) Sch.Bip. subsp. *viridifolia* (DBH 341, JEV 1539, V&H 391)
9553 *Cichorium intybus* L. (JEV 695)
9561 *Tolpis capensis* (L.) Sch. Bip. (DBH 597, JEV 806, JEV 830)
9572 *Hypochoeris radicata* L. (DBH 443, JEV 752, JEV 822, JEV 956, JEV 1912)
9574 **Picris heiracioides* L. (DBH 534)
9579 *Tragopogon dubius* Scop. (JEV 1449, JEV 1535)
9592 *Taraxacum officinale* Weber *sens. Lat.* (JEV 1137)
9595 *Sonchus dregeanus* DC. (JEV 939, JEV 980)
9596 *Lactuca capensis* Thunb. (DBH 737)
9596 *Lactuca inermis* Forssk. (JEV 1431, JEV 1589)

Appendix 9: Environmental factors for relevés in Tables 4–10

Table 4 (dry grassland):

Relevé number	556666	222233313334444	11111111112222222222211	233333333333332	739222332222222233	1111113333
	890123	355558933880000	32667777791111111222366	811222222446998	678234116667888866	5888993445
		978999050271245	5230124861345789467678	729125678891213	4 329786787124548	8023499045
Turboveg relevé number	999999	999999999999999	99999999999999999999999	999999999999999	999999999999999999	9999999999
	000000	000000000000000	00000000000000000000000	000000000000000	000000000000000000	0000000000
	000000	222234413444444	01111111122222222222211	333333333333443	031222332222233333	1122223333
	777788	577770054001111	34888899912333333444588	0333444444667100	991456338889900088	7900115567
	678901	756777838052356	13018902649123567245456	507903456679091	426107564565902326	6801277823
Altitude (m)	000000	111111111111 11	1111111 11111111111111	111111111111111	111111111111111111	1111111112
	867698	333596847556 56	8988557 85666778366598	343454534445465	312535334222455252	6765875560
	132601	525328677060 00	9296394 39885473858626	5484346244734 23	510689284909439669	5429679321
	000000	000000000000 00	0000000 00000000000000	000000000000000	000000000000000000	0000000000
Median annual rainfall	433333	444655 3	54544444 44445554444 4	554566655456554	45546555344455555	54665556
	287879	412401 3	19079998 04261134564 7	647718196866107	80080423739931333	08395788
	305369	862139 0	09656986 00995309579 2	666248337094028	92707398876153403	67568531
Aspect (degrees)		21 2	3 11 2 3 11	1331 3 131 3 31	33 2	23 322 2 2 3 3 1 3	133332 32
	449197	9 6 339 726 33	866894 991 368 4464 13	4669 9 90	719677 247 69693 1	861617 967
	552200	0 0 550 020 55	000005 005 500 5505 55	5000 0 02	050000 550 00005 5	005050 000
	005500	0 0 000 050 00	000000 000 000 0000 00	0000 0 05	000000 000 00000 0	000000 000
Slope (degrees)		2	1 13		1
	322314	3.1.324.322..32	306322.242..423.2446.18	2332.....3..32	237242.433.43244.3	507234.633
Topographic position	TTTTBS	B.T.MMSSS.T....MMSMTMBT...FMMMTMMMMMTSS	MMMS..TF..MB..M	.FM.S.TSMM.FMMFF.F	MMMM.MTSMT
Cover bare rock (%)		5 2	1 15	2	1 1 2	1 1
	53...1	5...52.0.50....	4.5..1.55....111.304.50	25.....0....	.5251.155..022..0.	5.0...02..
Number of species	212222	123232122223222	11222222221222131323233	443343332232213	122322342224323243	2512113313
	832021	941409776071704	45433894219937825044652	790624622348054	931092989848750648	6607993886

Table 5 (mesic grasslands):

Relevé number	889911122222222222222333333333333	1112222333344444556666777788999111111234	1282211363	111111	32273 | 333 | 232222222222
	490768904467888899999000124445566	467617924580678916678914891814911129463	24007 7	001111	16600 | 001 | 010400402440
	4154082906890126734543136 4623	168305	462 5	290235	610 1 | 025 | 631178320675
Turboveg relevé number	99999999999999999999999999999999	999999999999999999999999999999999999	9999999999	999999	99999 | 999 | 999999999999
	00000000000000000000000000000000	000000000000000000000000000000000000	0000000000	000000	00000 | 000 | 000000000000
	11111122222223333333333333333333	000000000000000000000000000111111112200	0000011303	111111	32203 | 333 | 232222222222
	000189125689900000111222345667788	333434455555666667888889999001123340656	2224422929	222333	37781 | 123 | 231522623662
	27852932860784678904512321914 2401	245495702368456794456792679692794618341	5680224073	078013	49889 | 803 | 419956108453
Altitude (m)	11111122111111111111111111112111111	11111111111111111111111001111111111111111	11111 0	111111	21112 | 211 | 11122221221
	21538731598455332888843456176896 7	33333434544344665633337857013236778595 3	42673 8	776766	09951 | 198 | 96803109209
	31050416089163253993215492645628 1	58255427077541820555852731878058140686 8	49878 4	445155	75890 | 056 | 58917612545
	00000000000000000000000000000000	00000000000000000000000000000000000000	00000 0	000000	00000 | 000 | 00000000000
Median annual rainfall	65555666665655675666687 6 6556666	6 5566 7 5667 546 64646 555586455865	0556 6	8 88	75 58 | 997 | 7768886 778
	03102258969370805865827 8 0865941	5 8103 4 7550 655 15182 054213942688	6927 2	9 89	56 99 | 156 | 0343220 431
	21670682425099993291702 2 1204696	0 0625 2 9445 982 54729 703782598590	5863 5	6 06	14 55 | 184 | 1667030 782
Aspect (degrees)	223 3113232 3333323 2 2 233 2	233 22 332 312 1 3 1 3 113313313 12	3 2 2	1 2332	21 3 | 212 | 22 12 222 3
	226968862674466611264 9479 76149	016 779667 968798 69984693361861569 87	46 74 7	8 7664	92196 | 982 | 42980 772 6
	550000005005500055505 2500 00552	250 000000 000000 00005005505005700 00	50 05 0	0 0007	05200 | 205 | 75002 005 0
	00000000000000000000 5000 00005	500 000000 000000 00000000000000500 00	00 00 0	0 0005	00500 | 500 | 50005 000 0
Slope (degrees)	5511161851122253145191781 41782	0010 0110105212354 111333118246125 2341	00 31 1	3 3514	21525 | 222 | 15163 31133
	50 5 20 5 1 0 7 00	5550 255550 025 24 0 5 2 55	52 30 0	0 5 0	00 | 228 | 5 0 0 532
Topographic position	SMMTMMMTMTMFBMMMMMSSFMTFMFMTSMFMS	MMS.TTB.MFMTMMMTMBSTSSSSMBSMTSMSMMTMMBM	MMTTMSTST.	MTMSMS	MMMTB | MMS | MFFMMTMFSTMM
Cover bare rock (%)	1 2 5	1 1 3	11	5	5 | | 1 1 1
	02012050000300000007000100000 2013	00505000001020000100000000 5200000000028	2000030000	101000	02000 | 005 | 005000450000
Number of species	13322131322433332433223532232232 4	22221122211233312 211211211422223212224	3332331321	522333	33434 | 233 | 331522423321
	89142732422225595659287518783618 1	55224342791511167932226442851872066095 3	2528619656	787826	19615 | 659 | 129006705751

Table 6 (shrubland):

Relevé number	13334451	28133	991111311112	222331333333333333	511122233311	22333333	71111111	234
	80172405	33077	230567628882	469028333334445555	356601912368	71388888	73334455	320
	7	368	0993014782	245745123462570137	60690329716	36501468	1363445	803
Turboveg relevé number	99999999	99999	999999999999	9999999999999999	999999999999	99999999	99999999	999
	00000000	00000	000000000000	0000000000000000	000000000000	00000000	00000000	000
	00000001	01133	111111312222	223332333333333333	011122333312	22333444	01111111	234
	34456667	40299	111789730004	6812404555566666677	777822134570	93599000	94556677	531
	68950285	11146	018771892560	023523901240358915	148478107594	14389246	59141223	684
Altitude (m)	1111111	11111	11 111111111	1111 1111111111112	111111111111	11111111	11111111	111
	3445335	31711	35 666736776	8862 5777757688851	866654847576	55688999	32433232	335
	0713559	84617	23 582185445	0320 9777004596693	922567347615	39566082	53122056	850
	0000000	00000	00 000000000	0000 0000000000000	000000000000	00000000	00000000	000
Median annual rainfall	5 5 67	07990	555444535 55	7465655 5 5 67	655444 5 554	34 3 34	344 3	45
	0 9 00	83640	774977971 01	3852110 5 6 43	331531 4 109	38 3 50	721 4	31
	1 6 35	10525	004929806 36	8909575 1 3 96	043940 6 187	53 9 68	706 6	39
Aspect (degrees)	332 3223	311 2	12 3 11332	32231 2211 2 1112	3 223 3 2	22 2231	2123113	333
	617 6473	11897	487 69483662	62218479334 743339	64776 96 947	7744413	2321581	661
	050 0707	52000	500 00505005	05550502555 055552	05000 00 050	0057755	5555705	005
	000 0505	05000	000 00000000	00000005000 000005	00000 00 000	0005500	0000500	000
Slope (degrees)	1 1534	43411	342 2 2 43	3121 1231 122133	2 1	31 2 32	1 11 33	32
	582.5055	05502	005.97150450	55243568405.500530	25114.73.335	05.0.05.	55350505	105
Topographic position	SMMMMMMM	MMSMM	MMMMMMSMMTSM	MTMMMFMSSMFSMMMMMM	TMMTMFFMTFSM	MMMMTMMS	MFFFFFMM	MMM
Cover bare rock	555265	1 5 1	333726 73 5	44253522355 1 47	3 3 1 43	44943426	43533624	44
	.5005000	5.555	555505850501	500500050500355505	503085255555	00055500	05050050	.00
Number of species	12115342	33244	435333423423	434734564354543335	234423444544	32122223	34434533	132
	04830587	82981	625267387108	1794641668572445 74	677033499163	32998775	64270654	468

Table 7 (savanna):

Relevé number	2	61112222	79222333362	2222	2223
	0	53343555	26333666645	2357	6771
		8995012	0345679 6	5158	9010
Turboveg relevé number	9	99999999	99999999999	9999	9999
	0	00000000	00000000000	0000	0000
	0	01112222	01222333302	2222	2223
	3	85565667	91455888887	4479	8882
	8	36773890	04812345724	3936	7898
Altitude (m)	1	0101 000	01111100001	1111	0000
	2	6192 467	72122199963	7102	6646
	9	9199 595	50169196932	4189	0053
	0	0000 000	00000000000	0000	0000
Median annual rainfall	4	4 335433	45544544433	5444	6556
	9	5 770198	52640436479	3348	7880
	2	6 501657	89158479885	1961	1587
Aspect (degrees)	2	22 13331	11 33 1 1	1 2	23
	7	72986668	85 16 3 8	39 7	96
	0	05000000	07 50 5 0	50 0	20
	0	00000000	05 00 0 0	00 0	50
Slope (degrees)		1 1		23	
	8	35613310	16.11.1...1	50.1	22
Topographic position	M	TMMMFMTM	MS...T...B.	MFMB	MSTT
Cover bare rock (%)	1	53 1 3	1 1	45	
	5	300.5545	.2...335.0.	00..	....
Number of species	1	23221343	13312422211	5445	3333
	8	24745507	53501696418	1502	2405

Table 8 (grassy fynbos):

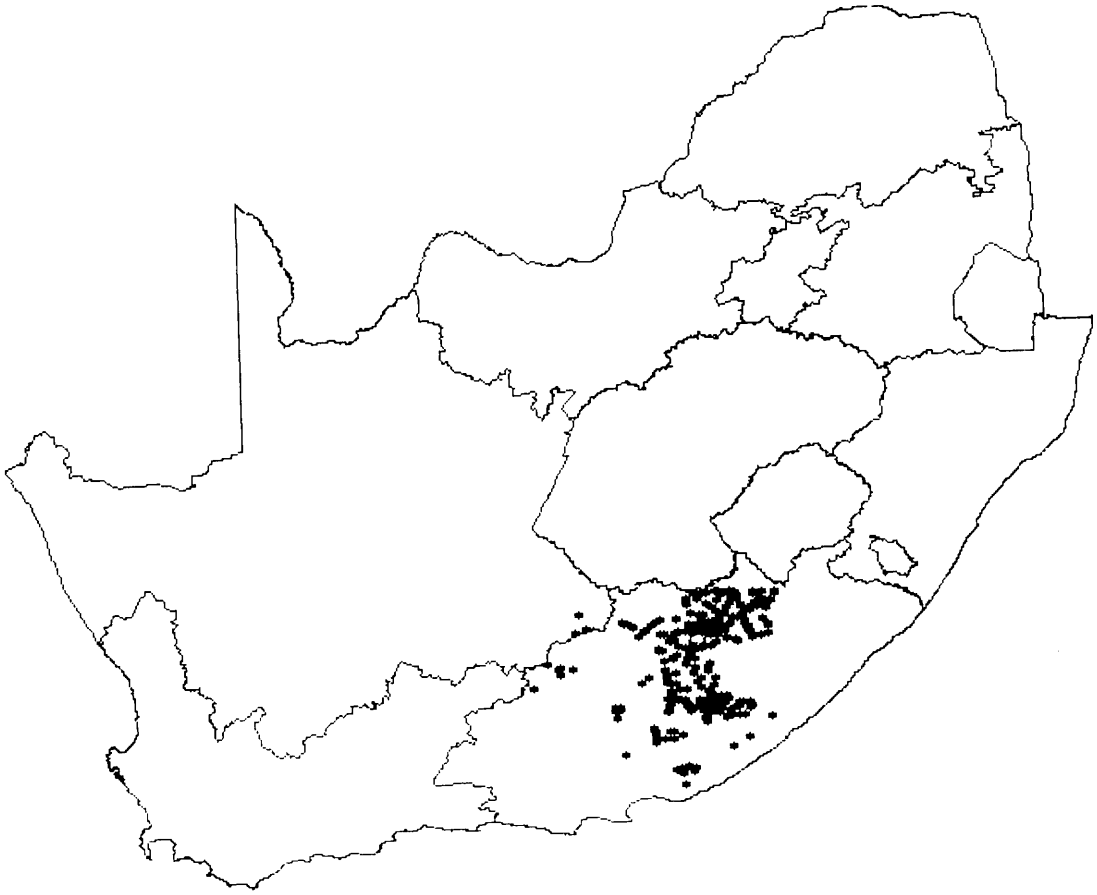
Relevé number	22233	11
	77700	23
	45689	90
Turboveg relevé number	99999	99
	00000	00
	22233	11
	99922	44
	23467	78
Altitude (m)	00000	00
	66659	66
	00370	96
	00000	00
Median annual rainfall	658	7
	550	4
	430	1
Aspect (degrees)	2 22	21
	79922	08
	00055	20
	00000	50
Slope (degrees)	34113	21
	0555	55
Topographic position	MMMST	SS
Cover bare rock (%)	14 1	5
	00.55	25
Number of species	53376	35
	21735	90

Table 9 (karroid vegetation):

Relevé number	111111111	1222	1	4 1
	334444445	5557	0	1 3
	240167892	3342	1	0 7
Turboveg relevé number	999999999	9999	9	9 9
	000000000	0000	0	0 0
	111111111	1222	1	4 1
	555566667	7779	1	2 5
	028945670	1120	9	1 5
Altitude (m)	111111111	1111	0	1 1
	333433325	4115	5	7 0
	228482290	1416	4	0 5
	000000000	0000	0	0 0
Median annual rainfall	4 3	3333	3	
	1 7	4243	1	
	6 0	6136	5	
Aspect (degrees)	21221331	2		3
	21923118	97		1
	52255550	00		5
	05500000	00		0
Slope (degrees)				
	32221111.	.22.	.	. 5
Topographic position	FBFFBMMMT	TSSF	.	. .
Cover bare rock (%)	1 1 4	4		1 2
	8.5.0...0	05.5	1	5 5
Number of species	422122222	3223	2	2 2
	344671147	1161	0	3 5

Table 10 (wetlands and drainage lines):

```
     Relevé number         1|8|3|9|3|2221233|1111117
                           5|6|3|5|0|4999257|7890054
                           1| | | |1|4493127|59 57

Turboveg relevé number     9|9|9|9|9|9999999|9999999
                           0|0|0|0|0|0000000|0000000
                           1|1|0|1|3|2332233|1201100
                           6|0|5|1|1|6111379|9032239
                           9|4|1|3|9|2271905|3773532

     Altitude (m)          1|1|1|1|2|21 12 1|1111110
                           1|0|4|2|1|07 80 1|6717738
                           7|8|7|0|0|77 31 1|8447787
                           0|0|0|0|0|00 00 0|0000000

 Median annual rainfall    3|6|6|5|8|767656 |544 5 6
                           4|3|8|4|9|760844 |088 9 1
                           6|5|4|4|5|304285 |977 8 7

     Aspect (degrees)       |3| |3|3|  3 313|2  1
                            |6| |6|6|9969636|7  89 4
                            |0| |0|0|0000050|0  00 5
                            |0| |0|0|0000000|0  00 0

     Slope (degrees)        | | | | |     12|
                           .|2|.|2|5|4322550|1..28.3

   Topographic position    .|.|.|.|.|BBBBBBB|BBBTBBT

     Cover bare rock (%)    | | | |5| 4    1|
                           .|.|.|.|0|.0....0|.......

     Number of species     1|1|1|3|4|332221 |2111211
                           7|8|9|0|5|3540958|3003154
---------------------------------------------------
```



Appendix 10: Distribution of relevés for this study.