

The plant communities of the hills and ridges in the north western Orange Free State, South Africa.

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Abstract. A phytosociological analysis of the vegetation of the hills and ridges in the north western Orange Free State, is presented. Relevés were compiled in only 15 sample plots due to the restricted area occupied by hills and ridges. A TWINSpan-classification refined by Braun-Blanquet procedures revealed five major communities. All communities are related to specific environmental conditions. Descriptions of the communities are given.

Key words: Braun-Blanquet method; Classification; Grassland Biome; Plant communities.

Introduction

The north western part of the Orange Free State is one of the most important agricultural regions in South Africa. The study area represents the south western part of the Highveld Agricultural Region. This Region produces 80% of the maize, 75% of the grain sorghum and 65% of the sunflower seed production in the Republic of South Africa (Scheepers, 1975). This part of the Grassland Biome also produces a large part of the Republic's animal products (Scheepers, 1975; Mentis and Huntley, 1982). Most of the land have been ploughed, mainly for maize cultivation. The remaining natural vegetation is restricted to non-arable shallow or rocky soils on hills, vertic clays in bottomland situations or seasonally waterlogged vleis and along drainage lines. The vegetation is often overgrazed by sheep and cattle.

Little is known about the vegetation of the north western Orange Free State. The relevance of plant ecological studies to land-use planning and management is well documented (Edwards, 1967; Walker, 1976; Bredenkamp and Theron, 1978; Müller, 1983). A more detailed

classification of the vegetation than that of Acocks (1988) is necessary to meet the present needs for regional and subregional planning (Deall *et al.*, 1989). It was therefore necessary to identify, classify and map the vegetation in order to enable efficient land-use planning and also the compilation of management programmes for optimal utilisation, without the degradation of vegetation.

The need to identify and describe the major vegetation types and subtypes within the Grassland Biome in southern Africa has also been emphasized by Mentis and Huntley (1982) and Scheepers (1986). Previous phytosociological studies in the north western Orange Free State, include only those of Scheepers (1975) in the Kroonstad area and Du Preez (1987) in the Vrededorst district. A comprehensive synecological and syntaxonomical investigation was therefore undertaken in the north western Orange Free State. The first step in this study was to create a phytosociological data base for the entire area to enable a synthesis of all available vegetation data (Bredenkamp *et al.*, 1989a). As part of a phytosociological survey of the north western Orange Free State such a data base has been compiled, and the plant communities of the A, B and D landtypes (Land Type Survey Staff, 1984) were described (Kooij *et al.*, 1990a, 1990b, 1990c & 1990d).

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The vegetation of the isolated rocky uplands and hills of the Ba, Fb and Ib land types, which are restricted to the north western parts of the study area, have not been classified yet. The aim of this study is to identify, characterise and describe the plant communities of these land types in the region. The incorporation of the results of this report with those of the vegetation surveys in the A, D and B land types (Kooij *et al.*, 1990b, 1990c, 1990d) as well as with the results of Scheepers (1975) and Du Preez (1987) will enable the compilation of an overall synthesis of the vegetation of this region, which could ultimately lead to the compilation of a formal syntaxonomical hierarchy.

The Study Area

The study area is situated between 26°00' and 26°23' E longitude and 27°00' and 28°00' S latitude, in the Grassland Biome of the north western Orange Free State, South Africa. A detailed description of the physical environment of the area is given by Kooij *et al.*, 1990a. The soil classification of MacVicar *et al.*, 1977 is followed. The soils of the Ba, Fb and Ib land types are seldomly ploughed due to the rockiness of the shallow soils. These land types are mainly utilized as natural pasture for cattle. Within these land types the Glenrosa and Mispah soil forms are predominant in the upland areas (terrain unit 2, Fig. 1) where-as the Arcadia, Rensburg, Bonheim, Valsrivier, Oakleaf and Dundee soil forms are predominant in the lowlands (terrain units 4 and 5, Fig. 1).

The geology of the Ba land type usually comprizes of Basement Complex granite. Plintic soils predominate in this land type where-as duplex, marginalitic soils are absent or occupy less than 10% of the area. This unit comprizes 18,000 hectares of the study area with approximately 1,500 hectares unsuitable for agronomy (Land Type Survey Staff, 1984). The upland plintic soils include the Hutton and Glenrosa soil forms and to a lesser extent the Westleigh soil form. In the very limited bottomlands the marginalitic, often waterlogged soils of the Estcourt, Sterkspruit, Willowbrook, Arcadia, Rensburg and Bonheim soil forms occur.

The geology of the Fb land type comprizes of Andesitic lavas of the Ventersdorp Supergroup with the sporadic occurrence of diorite, syenite, diabase and Post-Transvaal granite (Land Type Survey Staff, 1984).

The Fb land type accommodates pedologically

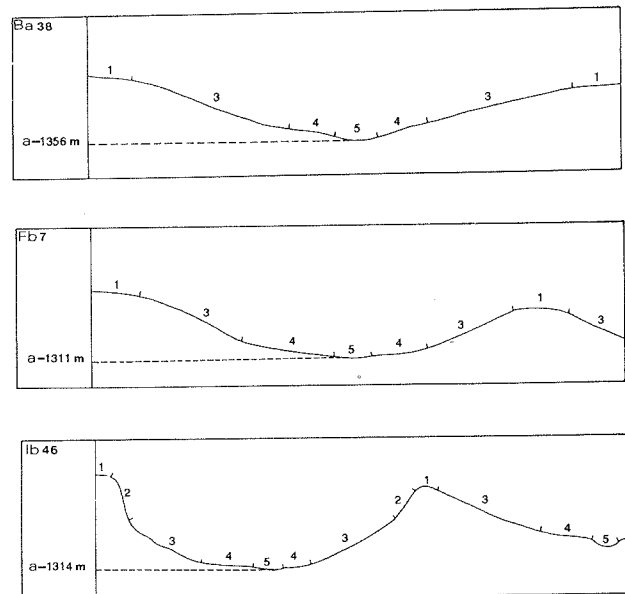


Fig. 1. A schematical representation of the different terrain units in the study area (Land Type Survey Staff, 1984). Terrain unit: 1-Crest; 2-Scarp; 3-Midslope; 4-Footslope; 5-Valley Bottomland or floodplain; a-Altitude.

young landscapes that are not predominantly rocky and not alluvial or aeolian, and in which the dominant soil forming processes have been rock weathering (Land Type Survey Staff, 1984). These lithocutanic soils include the Glenrosa and Mispah soil forms on upland situations. In bottomland situations the lime-rich Valsrivier, Arcadia, Oakleaf and Bonheim soil forms occur. This unit comprizes 10,000 hectares of the study area with approximately 800 hectares unsuitable for agronomy.

The geology of the Ib land type consists of quartzite, shale, slate and conglomerate of the Witwatersrand SuperGroup with the sporadic occurrence of diabase sills. The crests, scarps and midslopes are mainly situated on quartzite and conglomerate, whereas the footslopes and valley bottoms are situated on shale and diabase which may be covered by a mixed colluvium (Land Type Survey Staff, 1984).

In the Ib land type exposed rocks and boulders cover 60-80% of the area. The very shallow rocky soils of the upland areas are usually of the Mispah and Glenrosa soil forms (terrain units 1, 2 and 3, Fig. 1). Terrain unit 5 is often dominated by the Arcadia, Glenrosa and Bonheim soil forms (Land Type Survey

Staff, 1984).

This land type comprises approximately 3,000 hectares of the study area. The total study area comprises 1,437,000 hectares (Kooij *et al.*, 1990a).

Materials and Methods

The vegetation survey of the entire north western Orange Free State was done by means of 204 stratified sample plots. Stratification was based on land types and terrain units (Land Type Survey Staff, 1984 and De Beer, 1988). The number of sample plots per stratification unit was determined *pro rata* and on area basis. Due to a relatively restricted area occupied by the Ba, Fb and Ib land types, compared to the entire study area, only 15 sample plots were placed here. Plot sizes were fixed on 200 m for the woody vegetation (Du Preez, 1987).

In each sample plot all species identifiable at the time of survey (summer 1988) were noted, using the Braun-Blanquet cover-abundance scale (Mueller-Dombois and Ellenberg, 1974). Taxa names usually conform to those of Gibbs-Russell *et al.* (1985 & 1987), a list of species of the southern African plants, however in accordance with Bredenkamp and Bezuidenhout (1989) *Setaria flabellata* Stapf. and *S. sphacelata* (Schumach.) Moss were recognized as two separate taxa. Environmental information includes terrain types, geology, soil types, aspect, slope and rockiness of the soil surface. Other soil properties were obtained from Land Type Survey Staff (1984).

Two way indicator species analysis (TWINSPAN) (Hill, 1979) was applied to the floristic data set in order to derive a first approximation of the vegetation types of the area. Refinement of this classification was done by the application of Braun-Blanquet procedures (Behr and Bredenkamp, 1988; Bredenkamp and Bezuidenhout, 1989). The results are presented in a phytosociological table (Table 1). In order to determine probable vegetation gradients, an ordination algorithm, Detrended Correspondence Analysis (DECORANA) (Hill, 1979) was applied to the floristic data set.

Results

Classification

Generally the vegetation of the Ba, Fb and Ib land types can be described as a *Themeda triandra*-*Aristida*

congesta Grassland with scattered trees, shrubs and bush clumps. *Themeda triandra* is often the dominant grass species although others such as *Aristida congesta*, *Cymbopogon plurinodis* and *Eragrostis obtusa* are also abundant. Other species constantly present are *Eragrostis obtusa*, the forbs *Felicia muricata*, *Crabbea acaulis*, *Schkuhria pinnata* and *Chamaesyce prostrata* and the geophyte *Ledebouria marginata* (Species group K, Table 1). The number of species recorded per sample plot varies from 24 to 51, with an average of 32 species. The vegetation differs according to habitat, for example topography, soil type, drainage regime and vegetation management (grazing by animals), and consequently various plant communities can be recognized. These communities represent the outliers of Bankenveld vegetation from the Vredefort Dome area (Du Preez, 1987; Bezuidenhout, 1988). A schematical

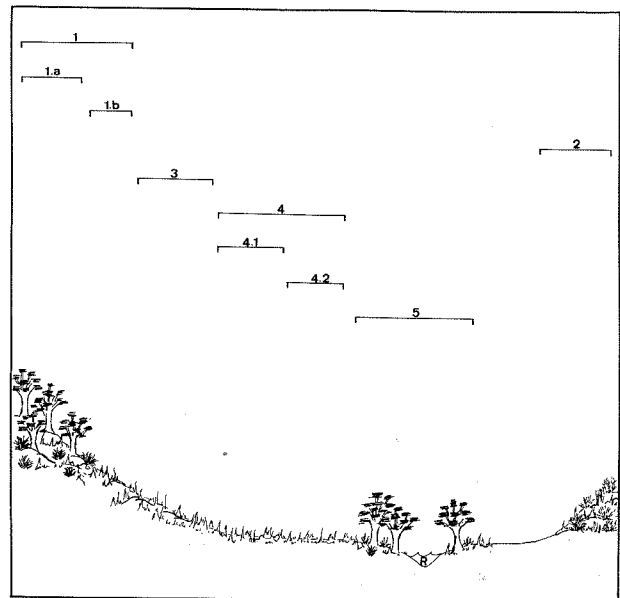


Fig. 2. A schematical representation of the topographical gradient and vegetation of the hills and ridges in the study area. R-River; 1.-*Maytenus heterophylla*-*Celtis africana* Shrubby Thorn Veld; 1.a-*Maytenus heterophylla*-*Euclea crispa* Shrubby Thorn Veld; 1.b-*Maytenus heterophylla*-*Protasparagus africanus* Shrubby Thorn Veld; 2.-*Ehretia rigida*-*Rhus magalismontanum* Shrub Veld; 3.-*Heteropogon contortus*-*Eragrostis racemosa* Grassland; 4.-*Panicum coloratum*-*Eragrostis curvula* Bottomland Grassland; 4.1-*Panicum coloratum*-*Aristida canescens* Variant; 4.2-*Panicum coloratum*-*Aristida bipartita* Variant; 5.-*Acacia karroo*-*Protasparagus suaveolens* River Thorn Veld.

Table 1. Continued

COMMUNITIES	1		2		3		4		5	
	A	B	A	B	A	B	A.1	4.2	A	B
RELEVÉS	0.1	1	0	0	0	0	1 0 1 1 0	1 1	0	0
	0.6	4	0	8.1	0	0	5 0 4 4 0	4 4	0	0
	6.4	5	2	5.0	5	0	8 3 3 4 9	1 2	5	5
<i>LIPPIA SCABERRIMA</i>			++		++		++			
<i>HETEROPOGON CONTORTUS</i>			++		++		++			
<i>ANTHOSPERMUM HESPIDULUM</i>			++		++		++			
<i>BARLERIA MACROSTEGIA</i>			+		+		++			
<i>SPOROBOLUS DISCOSPORUS</i>			+		+		++			
<i>HELICHRYSUM RUGILOSUM</i>			+		+		++			
<i>VERNONIA OLIGOCEPHALA</i>			+		+		++			
<i>SETARIA FLABELLATA</i>			+		+		++			
<i>GNIDIA CAPITATA</i>			+		+		++			
<i>CUCUMIS AFRICANUS</i>			+		+		++			
<i>PLEXIPUS ADENOSTACHYS</i>			+		+		++			
<i>LACTUCA SERRIOLA</i>			+		+		++			
SPECIES GROUP J										
<i>ACACIA KARROO</i>	1	+								
<i>PROTASPARAGUS SUA VEOLENS</i>	++									
<i>PROTASPARAGUS LARICINUS</i>	+									
<i>GREWIA FLAVA</i>	+									
<i>TEUCRIUM TRIFIDUM</i>							+			
SPECIES GROUP K										
<i>THEMEDA TRIANDRA</i>	++		2				3 1 4 2 4	3 3		
<i>ARISTIDA CONGESTA</i>	+		+				+	1		
<i>FELICIA MURICATA</i>	++		++				++	+		
<i>CYMOPOGON FLURINODIS</i>	++		++				++	+		
<i>CRABBEA ACAULIS</i>	+		+				+	+		
<i>SCHKUHRIA PINNATA</i>	+		+				++	+		
<i>ERAGROSTIS OBTUSA</i>			+				++	+		
<i>LEDEBOURIA MARGINATA</i>			+				++	+		
<i>CHAMAESYCE PROSTRATA</i>	+		+				+	++		
SPECIES GROUP L										
<i>ZIZIPHUS ZEYHERIANA</i>	++		+				+	++		
<i>BRACHIARIA SERRATA</i>	++		1				++	++		
<i>MICROCHLOA CAFFRA</i>			+				+	++		
<i>TRICHONEURA GRANDIGLUMIS</i>			+				+	++		
<i>DICOMA MACROCEPHALA</i>	+		+				++	++		
<i>SIDA CHRYSANTHA</i>			+				+	++		
COMMUNITIES	1		2		3		4		5	
	A	B	A	B	A	B	A.1	4.2	A	B
RELEVÉS	0.1	1	0	0	0	0	1 0 1 1 0	1 1	0	0
	0.6	4	0	8.1	0	0	5 0 4 4 0	4 4	0	0
	6.4	5	2	5.0	5	0	8 3 3 4 9	1 2	5	5
SPECIES GROUP M										
<i>ERAGROSTIS SUPERBA</i>	+		+				1			
<i>ELIONURUS MUTICUS</i>			++				+			
<i>CYNODON DACTYLON</i>			++				++			
<i>SOLANUM CAPENSIS</i>			+				+			
<i>GEIGERIA BURKEI</i>			+				+			
SPECIES GROUP N										
<i>TRAGUS BERTERONIANUS</i>	+									
<i>SOLANUM INCANUM</i>	++		+				+			
<i>RHYNCHELYTRUM REPENS</i>	+		+				+			
<i>MONSONIA ATTENUATA</i>	+		+				+			
<i>PHYLLANTHUS PARVULUS</i>										
SPECIES GROUP O										
<i>PENTZIA GLOBOSA</i>										
<i>HIBSCUS PUSILLUS</i>	+						+			
<i>BULBINE NARSICCIFOLIA</i>							+			
SPECIES GROUP P										
<i>GOMPHRENA CELOSIODES</i>										
<i>RHYNCHOSIA VENULOSA</i>	+		+							
<i>CASSIA ITALICA</i>										
<i>OXALIS SPECIES</i>										
<i>CLEMATIS BRACHATA</i>	+		+							
<i>INDIGOFERA SPECIES</i>	+		+							
<i>CYMOPOGON EXCAVATUS</i>	+		+							
<i>ERAGROSTIS PLANA</i>										
<i>COMMELINA BENGALENSIS</i>	+		+				1			
<i>LANTANA RUGOSA</i>										
<i>TRIRAPHIS ANDROPOGONOIDES</i>										
<i>ERAGROSTIS LEHMANNIANA</i>	+		+				++			
<i>SCABIOSA COLLUMBARIA</i>							+			
<i>HAPLOCARPHA SCAPOSA</i>	++		++				++			
<i>IPOMOEA OBSCURA</i>	+		+				+			

SPECIES WITH AN OCCURRENCE OF 1 HAVE BEEN OMITTED.

representation of the topographical gradient and vegetation of the hills and ridges in the study area is given in Fig. 3. A hierarchical classification of the recognized plant communities is the following:

1. *Maytenus heterophylla*-*Celtis africana* Shrubby Thorn Veld.
- 1.a *Maytenus heterophylla*-*Euclea crispa* Shrubby Thorn Veld.
- 1.b *Maytenus heterophylla*-*Protasparagus africanus* Shrubby Thorn Veld.
2. *Ehretia rigida*-*Rhus magalismsontanum* Shrub Veld.
3. *Heteropogon contortus*-*Eragrostis racemosa* Grassland.
4. *Panicum coloratum*-*Eragrostis curvula* Bottomland Grassland.
- 4.1 *Panicum coloratum*-*Aristida canescens* Variant.
- 4.2 *Panicum coloratum*-*Aristida bipartita* Variant.

5. *Acacia karroo*-*Protasparagus suaveolens* River Thorn Veld.

Description of communities

1. *Maytenus heterophylla*-*Celtis africana* Shrubby Thorn Veld.

This community is situated on the crests and scarps of the hills in the Ba, Ib and Fb land types. The predominant coarse sandy soils are shallow and usually of the Glenrosa or Mispah soil form, with rocks and boulders abundantly present on the soil surface (Land Type Survey Staff, 1984). The *Maytenus heterophylla*-*Celtis africana* Shrubby Thorn Veld shows relationships with other *Acacia caffra* communities from typical Bankenveld situations (Bredenkamp and Theron, 1980; Coetzee, 1974; Du Preez, 1987), and represents impoverished, temperate outliers of this vegetation type. The diagnostic species for this community are the trees

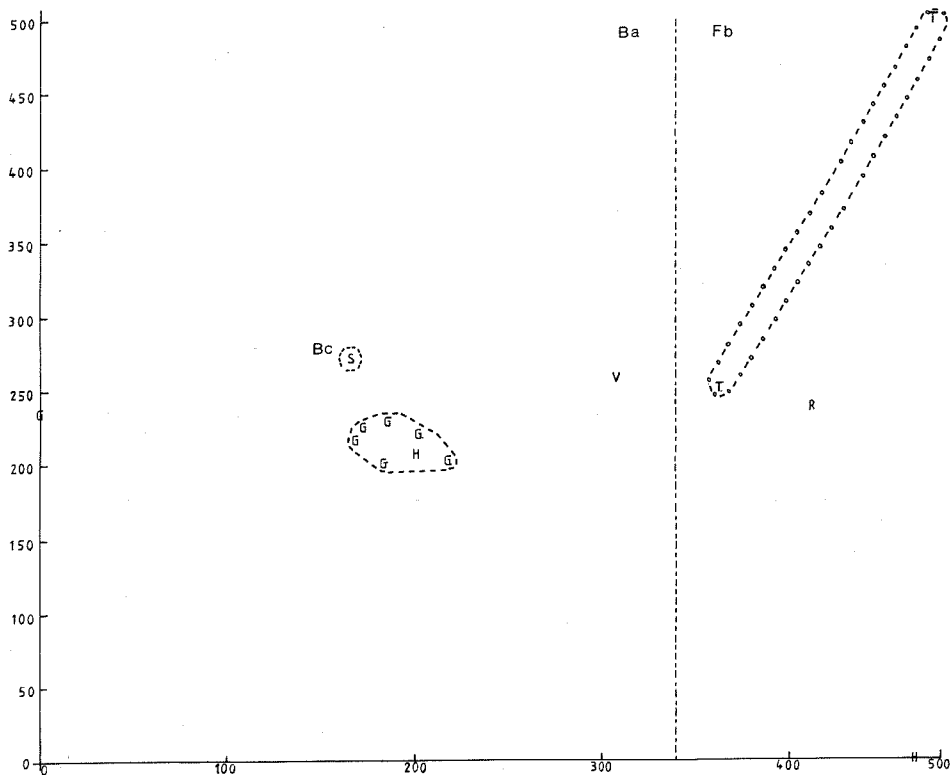


Fig. 3. An ordination of the vegetation on the hills and ridges in the study area. Community: T-1.a *Maytenus heterophylla*-*Euclea crispa* Shrubby Thornveld on the hills and ridges of the Fb land type; V-1.b *Maytenus heterophylla*-*Protasparagus africanus* Shrub Thornveld on the hills and ridges in the Ba land type; S-2 *Ehretia rigida*-*Rhus magalismsontanum* Shrub Veld on the hills in the Bc land type; H-3 *Heteropogon contortus*-*Eragrostis racemosa* Grassland; G-4 *Panicum coloratum*-*Eragrostis curvula* Bottomland Grassland; R-5 *Acacia karroo*-*Protasparagus suaveolens* River Thorn Veld.

and shrubs *Maytenus heterophylla*, *Celtis africana*, *Zanthoxylum capense*, *Acacia caffra*, *Olea europaea* subsp. *africana*, *Scolopia zeyherii* and *Diospyros lycioides* and the xerophytic ferns *Pellaea calomelanos* and *Cheilanthes hirta* (Species group A, Table 1). Other species prominently present are the grasses *Themeda triandra*, *Aristida congesta*, *Cymbopogon plurinodis* and the shrubs *Protasparagus suaveolens* and *Ziziphus zeyheriana*. An average of 38 species was recorded per sample plot. Variations of this community occur on different land types.

1a. *Maytenus heterophylla*-*Euclea crispa* Shrubby Thorn Veld.

This plant community is typically situated on the granite hills and ridges of the Fb land type. This Shrubby Thorn Veld is characterised by the diagnostic species *Euclea crispa* and *Rhus rigida* (Species group B, Table 1). *Acacia caffra* is often a dominant species but other prominent woody taxa include *Olea europaea* subsp. *africana*, *Scolopia zeyherii* and *Diospyros lycioides*. Grasses such as *Themeda triandra*, *Aristida congesta*, *Cymbopogon plurinodis* and *Rhynchelytrum repens* are prominent (Table 1).

1b. On the extremely disturbed, limited flat rocky granite outcrops within the Ba land type, a variant community *Maytenus heterophylla*-*Protasparagus africanus* Shrubby Thorn Veld occurs. This is characterised by species group C (Table 1) and diagnostic species include *Pavonia burchellii*, *Commelina africana*, *Protasparagus africanus*, *Sporobolus* species, *Ruschia hamata*, *Albuca* species and *Eragrostis gummiflua*. The dominant trees are *Celtis africana* and *Olea europaea* subsp. *africana*. Shrubs include *Diospyros lycioides*, *Ehretia rigida* and *Protasparagus suaveolens*, conspicuous grasses are *Sporobolus fimbriatus*, *Eragrostis curvula*, *Microchloa caffra*, *Trichoneura grandiglumis* and *Eragrostis superba*.

2. *Ehretia rigida*-*Rhus magalismsontanum* Shrub Veld.

This Shrub Veld has an extremely restricted occurrence in the Bc land type on isolated quartzite hills. Diagnostic species are *Ehretia rigida*, *Rhus magalismsontanum*, *Eustachys paspaloides*, *Hyparrhenia hirta*, *Pavetta zeyheri*, *Cleome rubella*, *Alectra sessiliflora*, *Indigofera sanguinea*, *Phyllanthus heterophyllus*, *Brachiaria nigropedata*, *Kohautia amatymbica* and *Stachys spatula* (Species group D, Table 1). Another diagnostic feature is the absence of the species of general occur-

rence, from species group K, which suggest the uniqueness and isolated syntaxonomic position of this community. The soils are shallow and usually of the Glenrosa and Mispah soil forms, with exposed quartzite rocks on the surface. The tree stratum is absent, but the shrub stratum is well developed, up to 2 m tall. The dominant shrubs are *Ehretia rigida*, *Pavetta zeyheri* and *Rhus magalismsontanum*, and the dominant grasses are *Brachiaria nigropedata*, *Hyparrhenia hirta*, *Rhynchelytrum repens*, *Eustachys paspaloides* and *Themeda triandra*. In the single sample plot 34 species were recorded.

3. *Heteropogon contortus*-*Eragrostis racemosa* Grassland.

This community is situated on the midslopes of the granitic hills in the Ba and Fb land types with an inclination of 10 to 15 (Terrain unit 3). The soils are usually shallow and rocky and of the Hutton or Glenrosa soil forms. *Eragrostis racemosa*, *Tephrosia* species, *Diheteropogon amplexens*, *Aristida diffusa*, *Helichrysum callicomum*, *Cassia biensis*, *Kyphocarpa angustifolia*, *Aristida stipitata*, *Amaranthus thunbergii*, *Helichrysum dregeanum* and *Schizachyrium sanguineum* are diagnostic species (Species group E, Table 1). Other prominent grass species include *Themeda triandra*, *Heteropogon contortus*, *Cymbopogon plurinodis*, *Elionurus muticus* and *Brachiaria serrata*. Other prominent and abundant non-grassy forbs include *Lippia scaberrima* and *Anthospermum hispidulum* (Table 1). An average of 36 species was recorded per sample plot. This Grassland community is related to certain Bankenveld communities from the Potchefstroom area (Bezuidenhout, 1988).

4. *Panicum coloratum*-*Eragrostis curvula* Bottomland Grassland.

This community occurs on the footslopes, valley floors and other bottomland situations in the Ba, Fb and Ib land types, where marginalitic, clayey Rensburg, Arcadia, Oakleaf, Bonheim and Valsrivier soil forms are found. The community is characterised by the diagnostic species *Panicum coloratum*, *Eragrostis curvula*, *Hibiscus trionum*, *Corchorus asplenifolius*, *Seddera capensis*, *Gazania krebsiana*, *Sporobolus ioclados*, *Walafrida densiflora*, *Setaria sphacelata* and *Setaria nigrirostris* (Species group F, Table 1). The dominant species are mostly *Themeda triandra*, *Panicum coloratum* and

Eragrostis curvula. An average of 29 species was recorded per sample plot. Two variants can be distinguished.

4.1 *Panicum coloratum*-*Aristida canescens* Variant.

This community occurs on the slightly raised, lower footslopes of the Ba, Fb and Ib land types (Terrain unit 4). The soils are usually of the Valsrivier, Swartland, Estcourt and Sterkspruit soil forms. These soils are better drained and drier than those of the *Panicum coloratum*-*Aristida bipartita* Variant. The diagnostic species for this community are *Aristida canescens*, *Hermannia depressa*, *Blepharis integrifolia*, *Lactuca* species, and *Antheophora pubescens* (Species group G, Table 1). The dominant species are *Themeda triandra* and *Aristida canescens*. Other prominent species are *Cymbopogon plurinodis*, *Felicia muricata*, *Ledebouria marginata* and *Crabbea acaulis*. The species of Species group I are situated on the mid- and footslopes of the Ba, Fb and Ib land types (Terrain units 3 & 4), and therefore occur in both the *Heteropogon contortus*-*Eragrostis racemosa* Grassland and the *Panicum coloratum*-*Aristida canescens* Variant. These species indicate the floristic relationship between the communities of the midslopes and the footslopes, and are also indicative of the well drained, relatively drier soils of these communities.

4.2 *Panicum coloratum*-*Aristida bipartita* Variant.

This occurs in the bottom of the valley floors. The soils are relatively moister than those of the *Panicum coloratum*-*Aristida canescens* Variant on the slightly raised footslopes. The soils are seasonally flooded, usually dark coloured (vertic or melanic) and clayey, representing the Rensburg, Arcadia and Bonheim soil forms. The diagnostic species for this community are *Berkheya radula*, *Aristida bipartita*, *Chloris virgata*, *Salvia radula*, *Aptosimum lineare*, *Setaria pallide-fusca*, *Hypoxis multiceps* and *Brachiaria euryciformis* (Species group H, Table 1). Also of diagnostic value is the absence of species groups I, L and N of better drained conditions.

The dominant species are *Themeda triandra*, *Eragrostis curvula* and *Panicum coloratum*. Other species occurring in this community are the pioneers *Geigeria burkei*, *Cynodon dactylon* and *Schkuhria pinnata*. The presence of the dwarf karroid shrubs *Felicia muricata* and *Pentzia globosa* as well as the presence of the annual weeds such as *Schkuhria pinnata* and *Chamaesyce prostrata* indicate the degraded condition of this community, and also relates to the karoo

encroachment (desertification) in the vegetation of the D land type (Kooij *et al.*, 1990a). An average of only 24 species was recorded per sample plot.

5. *Acacia karroo*-*Protasparagus suaveolens* River Thorn Veld.

This community occurs along banks of smaller, dry rivers and other floodplains. The soils vary from dark coloured vertic or melanic soils of the Arcadia, Rensburg and Bonheim soil forms to young or alluvial sandy soils of the Oakleaf and Dundee soil forms. The diagnostic species for this community are *Acacia karroo*, *Protasparagus suaveolens*, *Protasparagus laricinus*, *Grewia flava* and *Teucrium trifidum* (Species Group J, Table 1). Also of local diagnostic value is the absence of species group M in this community. The dominant species are the woody tree *Acacia karroo* and the semi-woody shrub *Protasparagus suaveolens*. The most abundant grasses are *Themeda triandra*, *Aristida congesta*, *Eragrostis curvula* and *Panicum coloratum*. An average of 30 species was recorded per sample plot. This community is clearly related to other widely distributed *Acacia karroo*-dominated communities from various parts of the south and western Transvaal (Bredenkamp and Theron, 1978; Bredenkamp and Bezuidenhout, 1989; Bredenkamp *et al.*, 1989a) and the north western Orange Free State (Scheepers, 1975; Kooij *et al.*, 1990b and 1990c).

Ordination

In the scatter diagram (Fig. 3) there is a distinct discontinuity in the distribution of the relevés. The recognized syntaxa are more or less restricted to specific areas in the scatter diagram. Different classes of discontinuity can be associated with the various land types, namely: The *Maytenus heterophylla*-*Euclea crispa* Shrubby Thorn Veld (T), the *Acacia karroo*-*Protasparagus suaveolens* River Thorn Veld (R) and the *Heteropogon contortus*-*Eragrostis racemosa* (H) Grassland, all on the Fb land type are located the right of the scatter diagram whereas the *Maytenus heterophylla*-*Euclea crispa* Shrubby Thorn Veld (V) and the *Panicum coloratum*-*Eragrostis curvula* Bottomland Grassland (G) is situated in the center of the scatter diagram (Fig. 3). Within the Fb land type a discontinuity between the *Maytenus heterophylla*-*Protasparagus africanus* Shrubby Thorn Veld (T) and the *Acacia karroo*-*Protasparagus suaveolens* River Thorn Veld (R) and the *Heteropogon*

contortus-Eragrostis racemosa Grassland (H) can also be seen along the second axis of this ordination. The uniqueness of the *Ehretia rigida-Rhus magalis-montanum* Shrubby Thorn Veld on the Bc land type is however indicated by the isolated position of this community along the third axis of ordination. The discontinuity between relevés of the *Heteropogon contortus-Eragrostis racemosa* community indicate some floristic variation within this Grassland. This floristic variation is associated with differences in land type.

Concluding Remarks

The methodology of refining the results of a TWINSPAN classification by Braun-Blanquet procedures (Behr and Bredenkamp, 1988) was successfully applied in this study. The plant communities recognized are considered as ecologically interpretable, as they relate to specific environmental conditions. The results obtained with the Detrended Correspondence Analysis (DECORANA) (Hill, 1979) indicates a distinct difference among the communities of the different land types.

The incorporation of the results of this phytosociological study with those of the A, D and B land types will enable a hierarchical syntaxonomy of the vegetation of the north western Orange Free State.

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南非 Orange Free 州西北部丘陵和山脈的植物群落

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本文係以植物社會學的方法分析 Orange Free 州西北部丘陵和山脈的植被。由於丘陵和山脈佔地的限制，僅以 15 個樣區收集樣分。以 TWINSpan 的方法分類後再用 Braun-Blanquet 的方法細加區分，結果顯示有 5 個主要的植物群落。所有的群落皆與特定的環境狀況有關，文中並提供這些群落的描述。