

The vegetation of the north-western Orange Free State, South Africa.

2. The D land type

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ABSTRACT

As part of a research programme on the synthesis of the vegetation of the western Grassland Biome, the plant communities of the D land type of the north-western Orange Free State were investigated. The results of a numerical classification (TWINSPAN) of 59 relevés were refined by Braun-Blanquet procedures. The analyses revealed eight plant communities which may be grouped into two major communities. A hierarchical classification, description and ecological interpretation of the plant communities, and an ordination (DECORANA) with associated environmental gradients, are presented.

UITTREKSEL

Die ondersoek na die plantgemeenskappe van die D-landtipe in die noordwestelike Oranje-Vrystaat vorm deel van 'n navorsingsprogram oor die sintese van die plantegroei van die westelike Grasveldbioom. Die resultate van 'n numeriese klassifikasie (TWINSPAN) van 59 relevés is met behulp van Braun-Blanquetprosedures verfyn. Agt plantgemeenskappe wat in twee hoofgemeenskappe gegroepeer kan word, is onderskei. 'n Hierargiese klassifikasie, beskrywing en ekologiese interpretasie van die plantgemeenskappe en 'n ordening (DECORANA) met geassosieerde omgewingsgradiënte, word verskaf.

INTRODUCTION

The necessity to identify and describe the major vegetation types and subtypes within the Grassland Biome was stated by Mentis & Huntley (1982) and Scheepers (1986). One of the major goals of the vegetation classification and mapping task group of the Grassland Biome Project is to produce a vegetation classification and to map the region on a 1:250 000 scale (Scheepers 1986). As mentioned by Bredenkamp, Joubert & Bezuidenhout (1989), the first step in the synthesis of the vegetation of the western Grassland Biome, is to create a phytosociological data base for the entire area. Little is known of the vegetation of the north-western Orange Free State. Scheepers (1975) conducted a semi-detailed survey of the vegetation in the Kroonstad area, and Du Preez (1987) described some woody plant communities from the Vredefort District. The north-western Orange Free State was therefore identified as a priority area for a phytosociological survey.

Extensive bottomland areas, representing the D land type (Land Type Survey Staff 1984) occur in the north-western Orange Free State. As the marginalitic, vertic, melanic or wet structured fersialitic soils of the D land type are often not ploughed and mainly used as pasture for sheep and game, this land type was chosen for the initial vegetation survey.

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 (Kooij *et al.* 1990: 234, fig. 1).

The Db and Dc map units accommodate land where duplex soils with gleycutanic, pedocutanic and prisma-

cutanic B horizons are predominant. These map units comprise approximately 280 000 ha of the study area, with approximately 35 700 ha unsuitable for agriculture (Land Type Survey Staff 1984). Soils that display a duplex character include the Estcourt, Sterkspruit, Swartland, Valsrivier and Kroonstad Forms (MacVicar *et al.* 1977). The Dc and Db map units are mostly located in bottomland situations, such as in the valleys of the Vaal, Vals and Renoster Rivers, as well as in the Pan Veld situated in the Wesselsbron and Welkom Districts. These map units are not suitable for agronomy, due to the high clay (> 35%) content of these bottomland soils, and land use is mainly restricted to sheep farming. The bottomlands are furthermore usually flooded during the rainy season.

The Db map unit refers to land where duplex soils with non-red B horizons comprise more than half of the area. The Dc map unit indicates land that qualifies for inclusion in the D land type but, in addition to the duplex soils, more than 10% of the land type comprise soil forms with one or more of the following diagnostic horizons: vertic, melanic or red-structured (Land Type Survey Staff 1984). The geology of the Db map unit consists mainly of Ecca sandstone, shale and mudstone with the sporadic intrusion of dolerite sills. Mudstone, shale and sandstone of the Tarkastad Subgroup occur in the eastern parts.

The Dc map unit representing the Pan Veld in the Wesselsbron District consists mainly of the Sterkspruit Form, whereas the soils of the Dc map unit in the vicinity of the Vredefort Dome, mainly represents the Bonheim Form. Pans occupy approximately 22% of this map unit. The predominant geology of the area is Ecca sandstone, mudstone and shale with the occasional intrusion of dolerite plates. Calcrete occurs sporadically in these bottomland pans. The plains between pans are mostly covered with aeolian sand.

The soils of the Dc map unit adjacent to the rivers are predominantly of the Bonheim and Mayo Forms. The

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TABLE 1.—A phytosociological table of the vegetation of the D land types of the north-western Orange Free State

Communities	1										2														
	1.1			1.2			1.3			1.4			1.5			1.6									
										1.4.1			1.4.2												
	101011	11	00011	100100000100	000000000100	121011112221	11001	00000	581874	33	58169	034157767067	445484443233	008899990000	42151	77667	585979	67	54652	198816491067	132577628456	349606890127	75237	53780	
Species group A																									
<i>Elionurus muticus</i>	2	++	+																						
<i>Setaria sphacelata</i>	++	+	+																						
<i>Hermannia depressa</i>	++	+																							
<i>Lippia scaberrima</i>	++		+	++																					
<i>Setaria nigrirostris</i>	+		+																						
<i>Haplocarpha scaposa</i>	++																								
Species group B																									
<i>Digitaria argyrograpta</i>				1+																					
<i>Barleria macrostegia</i>				++																					
<i>Trichoneura grandiglumis</i>				++																					
<i>Blepharis integrifolia</i>				++																					
<i>Vernonia oligocephala</i>				++																					
<i>Menodora africana</i>				++	++																				
Species group C																									
<i>Acacia karroo</i>				+																					
<i>Protasparagus laricinus</i>																									
<i>Ziziphus mucronata</i>																									
<i>Gomphrena celosioides</i>																									
<i>Commelina eckloniana</i>																									
<i>Ziziphus zeyheriana</i>																									
<i>Salvia sclarea</i>																									
<i>Teucrium trifidum</i>																									
Species group D																									
<i>Hibiscus trionum</i>																									
<i>Seddera capensis</i>																									
<i>Ophioglossum polyphyllum</i>																									
<i>Sporobolus ludwigii</i>																									
<i>Blepharis angustata</i>																									
Species group E																									
<i>Felicia filifolia</i>																									
<i>Tragus racemosus</i>																									
<i>Mariscus indecorus</i>																									
<i>Sporobolus fimbriatus</i>																									
<i>Sporobolus smutsii</i>																									
Species group F																									
<i>Geigeria burkei</i>																									
<i>Aristida bipartita</i>																									
<i>Berkheya onopordifolia</i>																									
<i>Indigofera sp.</i>																									
<i>Sporobolus sp.</i>																									
<i>Aptosimum lineare</i>																									
<i>Oenothera rosea</i>																									
Species group G																									
<i>Conyza sumatrensis</i>																									
<i>Halafria densiflora</i>																									
<i>Stoebe vulgaris</i>																									
<i>Stachys spathulata</i>																									
<i>Marsilea sp.</i>																									
<i>Eragrostis gummiflua</i>																									
<i>Echinochloa holubii</i>																									
<i>Chloris virgata</i>																									
Species group H																									
<i>Eragrostis plana</i>																									
<i>Setaria sphacelata</i>																									
<i>Schkuhria pinnata</i>																									
<i>Brachiaria serrata</i>																									
<i>Gazania krebsiana</i>																									
<i>Schoenoplectus muricinux</i>																									

Species with an occurrence of < 4 are omitted.

TABLE 1.—A phytosociological table of the vegetation of the D land types of the north-western Orange Free State

Communities	1								2					
	1.1	1.2	1.3	1.4		1.5	1.6							
				1.4.1	1.4.2									
	101011	11 00011	100100000100	000000000100	121011112221	11001	00000							
Relevés	581874	33 58169	034157767067	445484443233	008899990000	42151	77667	585979	67 54652	198816491067	132577628456	349606890127	75237	53780
Species group I														
<i>Themeda triandra</i>	444334	32 ++3+	4 2 221+23+2	1212+2222333	344++3+244	521	+							
<i>Felicia muricata</i>	+ + +	+ + + +	+ + + + +	+ + + + +	+ + + + +									
<i>Eragrostis superba</i>	+ + 1	+ + + +	+ + + + +	+ + + + +	1	+ + + + +	1							
<i>Cynodon dactylon</i>		+ 2 +	+ + + + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +							
<i>Oxalis sp.</i>	+ + +	+ + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +							
<i>Digitaria eriantha</i>	+ + +	1	+ + + + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +							
<i>Cymbopogon plurinodis</i>	+ + +	13 +	+ 2 + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +							
<i>Commelina africana</i>	+ + +	+ + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +							
<i>Chamaesyce prostrata</i>		+ +	+ + + + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +							
<i>Cirsium vulgare</i>		+ + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +							
<i>Crabbea acaulis</i>	+ + +	+ + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +							
<i>Kyllinga alba</i>		+ +	+ + + + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +							
Species group J														
<i>Aristida congesta</i>	+ + +	+ + + 2+	+ + + + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +							
<i>Corchorus asplenifolius</i>	+ + +	+ + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +							
<i>Heteropogon contortus</i>	+ + + 1	+ + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +							
<i>Hibiscus pusillus</i>	+ + + +	+ + + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +							
<i>Ledebouria marginata</i>	+ + +	+ + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +							
<i>Salvia radula</i>	+ + +	+ + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +							
Species group K														
<i>Lycium cinereum</i>			+ + + + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +							
<i>Sporobolus ioclados</i>			+ + + + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +							
<i>Pterodiscus speciosus</i>		+ + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +							
<i>Albica sp.</i>		+ + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +							
<i>Microchloa caffra</i>		+ + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +							
<i>Eragrostis lehmanniana</i>		1	+ + + + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +							
<i>Eragrostis stapfii</i>			+ + + + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +							
<i>Mollugo cerviana</i>			+ + + + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +							
Species group L														
<i>Panicum coloratum</i>	+ + + 1	+ + + + +	212 + + + + + 2 + +	+ 1 + 1 + 1 + + + + 1	5 +	+ + + + +	+ + + + +							
<i>Pentzia globosa</i>	+ 1 + +	+ + + + +	+ + + + + + + + + + +	+ + + + + + + + + + +	+ + + + + + + + + + +	+ + + + + + + + + + +	+ + + + + + + + + + +							
<i>Eragrostis curvula</i>	21 + + +	+ 3 + 4	32 3324 + 123	+ 2 + + + + 1 + 132 + 2	+ + + 2 + 2	+ 123 + + +	+ 3 2							
<i>Eragrostis obtusa</i>	+ + +	+ + + + +	+ + + + + + + + + + +	+ + + + + + + + + + +	+ + + + + + + + + + +	+ + + + + + + + + + +	+ + + + + + + + + + +							
<i>Bulbine narcissifolia</i>	+ + +	+ 1	+ + + + + + + + + + +	+ + + + + + + + + + +	+ + + + + + + + + + +	+ + + + + + + + + + +	+ + + + + + + + + + +							
Species group M														
<i>Berkheya radula</i>		1 +	+ + + + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +							
<i>Conyza podocephala</i>		+ + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +							
<i>Vahlia capensis</i>	+ + +	+ + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +							
<i>Anthericum galpinii</i>		+ + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +							
<i>Scabiosa columbaria</i>	+ + +	+ + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +							
<i>Crassula schimperi</i>		+ + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +							
<i>Solanum incanum</i>		+ + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +							
<i>Tragus berteronianus</i>		+ + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +							
<i>Salsola calluna</i>		+ + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +							
<i>Asclepias fruticosa</i>		+ + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +							

Species with an occurrence of < 4 are omitted.

geology in these areas consists of Ecce shale, sandstone and grit. In the vicinity of Kroonstad mudstone, shale and sandstone of the Adelaide Supergroup are predominant, with dolerite sills occurring here and there (Land Type Survey Staff 1984).

METHODS

Relevés were compiled in 59 stratified random sample plots. As geology and land type are relatively uniform, stratification was based on terrain units (De Beer 1988; Land Type Survey Staff 1984). In accordance with Scheepers (1975), plot sizes were fixed at 16 m² for grassland vegetation, while 100 m² plots were used for woody vegetation (Bredenkamp & Theron 1978). In each

sample plot total floristic composition, using the Braun-Blanquet cover-abundance scale (Mueller-Dombois & Ellenberg 1974) was noted. Taxon names generally conform to those of Gibbs Russell *et al.* (1985 & 1987), however, in accordance with Bredenkamp, Joubert & Bezuidenhout (1989), *Setaria flabellata* Stapf and *S. sphacelata* (Schumach.) Moss were treated as separate species. Environmental data included identification of terrain types, soil types and estimation of aspect, slope and rockiness of the soil surface. Other soil properties were obtained from Land Type Survey Staff (1984), Table 2.

Two way indicator species analysis (TWINSPAN) (Hill 1979b) 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 & Bredenkamp 1988; Bredenkamp, Joubert & 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 1979a) was applied to the floristic data set.

RESULTS

Classification

In general the vegetation of the D land type can be classified as a *Panicum coloratum-Eragrostis curvula* Grassland. Species constantly present include *Panicum coloratum*, *Pentzia globosa*, *Eragrostis curvula*, *Eragrostis obtusa* and *Bulbine narcissifolia* (Species group L, Table 1). The vegetation is generally poor in species, with an

average of 20 species per sample plot. The vegetation shows some similarity to certain bottomland communities described by Scheepers (1975). Direct comparisons are, however, difficult due to the differences in techniques applied and also due to differences in the scale of the surveys.

The greater part of the vegetation is utilized as pasture for sheep. The vegetation varies as a result of habitat variations, for example in the topography, soil type, drainage regime and vegetation management (grazing by animals).

A hierarchical classification of the plant communities is as follows:

1. *Themeda triandra-Panicum coloratum* Grassland
 - 1.1 *Themeda triandra-Elionurus muticus* Grassland
 - 1.2 *Themeda triandra-Digitaria argyrograptia* Grassland
 - 1.3 *Protasparagus laricinus-Acacia karroo* Woodland

TABLE 2. — An analysis of the soil properties of the A and B horizons of the plant communities in the D land type of the north-western Orange Free State (adapted from Land Type Survey Staff 1984)

Community No.		1.2	1.3	1.4.1	1.4.2	1.6	2
Soil form		Sterkspruit	Arcadia	Swartland	Bonheim	Bonheim	Arcadia
Soil series		Stanford	Gelykvlakte	Nyoka	Weenen	Weenen	Gelykvlakte
Soil depth							
mm	A	0–180	0–500	0–220	0–450	0–450	0–700
	B	181–360	501–750	221–440	451–1 200	451–800	701–900
% Sand	A	90	32	69	45	58	28
	B	69	24	41	31	27	29
% Silt	A	3	22	9	13	12	16
	B	7	30	8	15	11	19
% Clay	A	7	41	18	39	29	57
	B	24	47	50	49	58	47
H₂O retentivity %							
– 33 kPa	A	7.1	35.1	15.5	38.9	22.0	51.2
	B	25.9	38.7	33.7	41.2	39.8	53.8
– 1500 kPa	A	3.7	20.5	6.8	20.5	14.2	30.2
	B	12.3	21.0	19.6	23.3	–	34.4
Exchangeable cations (me/kg soil)							
Na	A	1	14	2	40	1	10
	B	32	24	32	45	12	22
K	A	3	3	4	2	12	3
	B	2	0	2	2	24	3
Ca	A	20	144	28	110	53	237
	B	61	186	87	114	146	292
Mg	A	12	71	24	98	25	212
	B	58	105	80	134	77	215
Total	A	36	232	58	250	91	264
	B	135	315	201	285	259	532
pH (H₂O)							
	A	7.4	6.9	6.5	9.0	6.2	7.4
	B	9.1	8.7	7.6	8.1	7.9	8.3
Resistance (ohm)							
	A	3 500	700	3 100	280	1 000	300
	B	600	350	490	120	960	220

- 1.4 *Themeda triandra*-*Hibiscus trionum* Grassland
 1.4.1 *Themeda triandra*-*Felicia filifolia* Grassland
 1.4.2 *Themeda triandra*-*Aristida bipartita* Grassland
 1.5 *Themeda triandra*-*Echinochloa holubii* Wetland
 1.6 *Setaria sphacelata*-*Eragrostis plana* Wetland
 2. *Sporobolus ioclados*-*Lycium cinereum* Pan Veld

Description of communities

1. *Themeda triandra*-*Panicum coloratum* Grassland

This major grassland type covers most of the D land type, excluding the pans which occur scattered throughout the area (Kooij *et al.* 1990: 234, fig. 1). The dominant species in almost all the plant communities within this major grassland type are *Themeda triandra* and *Eragrostis curvula*. Within the study area, species group I (Table 1) may be considered as diagnostic for this Grassland.

1.1 *Themeda triandra*-*Elionurus muticus* Grassland

This community is found in upland situations on relatively sandy and well drained soil, often with large exposed rocks (Figure 1). The predominant soil types are the Mispah and Glenrosa Forms and in non-rocky, sandy areas the deep (>1 200) Hutton Form. No soil analysis data on these soil types are available. The *Themeda triandra*-*Elionurus muticus* Grassland is characterised by species group A (Table 1). In typical situations *Themeda triandra* dominates entirely, with canopy cover values of up to 75%. Where *Themeda triandra* dominates, the occurrence of other species is limited, with an average of 20 species per relevé. Other grass species constantly (>50% of the relevés) found in this community are the diagnostic species *Elionurus muticus* and *Setaria sphacelata* and also *Aristida congesta*, *Eragrostis superba*, *Cymbopogon plurinodis*, *Heteropogon contortus*, *Panicum coloratum* and *Eragrostis curvula*. Non-grassy forbs occur only scattered, but *Commelina africana*, *Hermannia depressa*, *Salvia radula*, *Crabbea acaulis*, *Lippia scaberima*, *Oxalis* sp., *Hibiscus pusillus* and the karoo dwarf shrub *Pentzia globosa* occur constantly.

1.2 *Themeda triandra*-*Digitaria argyrograpta* Grassland

On slightly drier or overgrazed sites of the upland areas, the total cover, and especially the cover of the grass species, is less than in the general situation occupied by the *Themeda triandra*-*Elionurus muticus* Grassland. Although *Themeda triandra* is still dominant, *Cymbopogon plurinodis* is locally conspicuous. An average of 33 species was recorded per sample plot. This community is characterised by species group B (Table 1). Other species constantly present in the relevés representing the community, are the grasses *Aristida congesta*, *Eragrostis superba*, *Heteropogon contortus*, *Panicum coloratum* and the non-grassy forbs *Commelina africana*, *Hibiscus pusillus* and *Albuca* sp.

1.3 *Protasparagus laricinus*-*Acacia karroo* Woodland

This Woodland is a bottomland community which occurs along dry water courses or seasonal rivulets (Figure

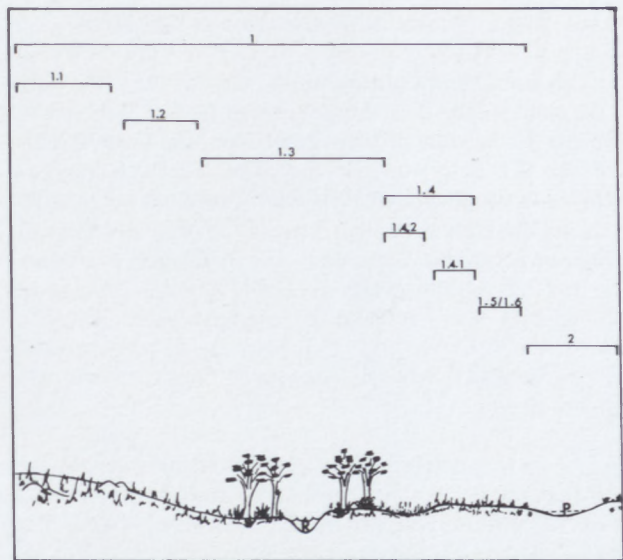


FIGURE 1.—A schematic representation of the identified plant communities in the Db and Dc map units. P, pan; R, river; 1, *Themeda triandra*-*Panicum coloratum* Grassland; 1.1, *Themeda triandra*-*Elionurus muticus* Grassland; 1.2, *Themeda triandra*-*Digitaria argyrograpta* Grassland; 1.3, *Protasparagus laricinus*-*Acacia karroo* Woodland; 1.4, *Themeda triandra*-*Hibiscus trionum* Grassland; 1.4.1, *Themeda triandra*-*Felicia muricata* Grassland; 1.4.2, *Themeda triandra*-*Aristida bipartita* Grassland; 1.5, *Themeda triandra*-*Echinochloa holubii* Wetland; 1.6, *Setaria sphacelata*-*Eragrostis plana* Wetland; 2, *Sporobolus ioclados*-*Lycium cinereum* Pan Veld.

1) on vertic Rensburg and Arcadia soil Forms, on duplex soils with clayey structured B horizons, e.g. the Sterkspruit, Valsrivier and Swartland Form, as well as on younger alluvial soils such as the Oakleaf and Dundee Forms (Table 2).

The vegetation is mostly severely overgrazed and in a poor condition. The grass cover is usually low, associated with an increase in density of *Acacia karroo*, *Protasparagus laricinus* and *Ziziphus zeyheriana* and an encroachment of the karoo shrub *Pentzia globosa*. An average of only 26 species was recorded per sample plot. The community is characterised by species group C (Table 1). Other constantly present species in the herbaceous layer are *Eragrostis superba*, *Corchorus asplenifolius*, *Ledebouria marginata*, *Panicum coloratum* and *Eragrostis obtusa*.

1.4 *Themeda triandra*-*Hibiscus trionum* Grassland

The extensive flat plains of the D land type are typically covered by the *Themeda triandra*-*Hibiscus trionum* Grassland which represents the largest part of the *Themeda triandra*-*Panicum coloratum* Grassland (Figure 1). The vegetation is characterised by species group D (Table 1). An average of 20 species was recorded per sample plot. The vegetation is mostly dominated by *Themeda triandra*, *Eragrostis curvula* and *Panicum coloratum*, with the karoo dwarf shrub *Pentzia globosa* conspicuously present. Two distinct communities were identified, namely the *Felicia filifolia*-*Themeda triandra* Grassland on the relatively drier slightly raised sites, mostly on duplex soils, and the *Aristida bipartita*-*Themeda triandra* Grassland on vertic or near vertic soils of moist bottomland sites.

1.4.1 *Themeda triandra-Felicia filifolia* Grassland

This community occurs on the slightly raised, extensive plains of the D land type (Figure 1). The Sterkspruit, Valsrivier, Swartland, Mayo and Hutton soil Forms (Table 2) are characteristic for the relatively well drained *Themeda triandra-Felicia filifolia* Grassland community and are therefore drier than those of the *Aristida bipartita-Themeda triandra* Grassland. The vegetation is characterised by species group E (Table 1). An average of 20 species was recorded per sample plot. *Themeda triandra* and *Eragrostis curvula* are mostly co-dominant. In overgrazed situations, however, *Eragrostis curvula* predominates.

The poor condition of the vegetation is indicated by the constant presence of the karroid shrubs *Felicia filifolia* and *Pentzia globosa*, and also pioneer species such as *Hibiscus trionum*, *Aristida congesta*, *Cirsium vulgare*, *Tragus racemosus* and *Cynodon dactylon*.

Other constantly present species include *Eragrostis superba*, *Eragrostis obtusa*, *Corchorus asplenifolius*, *Cymbopogon plurinodis*, *Oxalis* sp. and *Ledebouria marginata*.

1.4.2 *Themeda triandra-Aristida bipartita* Grassland

This Grassland is restricted to extensive bottomland plains and depressions, often on poorly drained and seasonally waterlogged vertic or near vertic soils (Figure 1). Soil types include the Arcadia, Rensburg, Willowbrook and Bonheim Form (Table 2). The vegetation is characterised by species group F (Table 1). Also of differential value is the simultaneous presence of the typical bottomland species *Eragrostis plana* and *Setaria sphacelata* and others (Species groups H and J, Table 1). An average of 21 species was recorded per sample plot.

1.5 *Themeda triandra-Echinochloa holubii* Wetland

This grassland is restricted to the wet, marshy conditions often found in the bottomland situations of the Db map unit west of Kroonstad. Some relevés were also compiled at the edges of wet pans in the Wesselsbron area. No soil analysis data are available for this community.

The vegetation is characterised by species group G (Table 1). Also of differential value is the occasional presence of species from species group H. An average of 16 species was recorded per sample plot. Dominants are *Themeda triandra* and *Eragrostis curvula*; other constantly present species include *Felicia muricata*, *Eragrostis superba*, *Cynodon dactylon*, *Oxalis* sp., *Commelina africana*, *Cirsium vulgare*, *Panicum coloratum*, *Eragrostis obtusa* and *Pentzia globosa*.

1.6 *Setaria sphacelata-Eragrostis plana* Wetland

This community is restricted to seasonally waterlogged soils of the wet vley areas which are abundant in the D land type (Figure 1). Soil types include the Katspruit, Willowbrook and Bonheim Forms (Table 2).

The vegetation is characterised by the presence of species group H and the absence of species groups F and

G (Table 1). An average of 14 species was recorded per sample plot.

The most prominent species are the diagnostic *Eragrostis plana* and also *Themeda triandra*, *Panicum coloratum* and *Eragrostis curvula*. Other species often present are *Setaria sphacelata*, *Aristida congesta*, *Cynodon dactylon* and *Cirsium vulgare*.

2. *Sporobolus ioclados-Lycium cinereum* Pan Veld

This community is restricted to the sodic and calcareous soils on the fringes of the pans within the area (Figure 1). These areas are severely overgrazed and the vegetation is scanty and typically karroid. The Willowbrook, Rensburg, Arcadia and Inhoek soil Forms are typical of this community.

This community is characterised by species group K (Table 1). An average of 18 species was recorded per sample plot. The vegetation is dominated by the karroid dwarf shrubs *Pentzia globosa*, *Lycium cinereum* and *Felicia filifolia*. Other constantly present prominent species are *Panicum coloratum*, *Eragrostis curvula* and *Eragrostis obtusa*.

Ordination

The distribution of relevés along the first and second axes of the ordination is given in Figure 2.

In this scatter diagram only a slight discontinuity in the distribution of the relevés can be observed. However, the syntaxa are more or less restricted to specific areas in the scatter diagram. Four classes of discontinuity were distinguished, namely:

- A, *Protasparagus laricinus-Acacia karroo* Woodland along riverbanks (community 1.3);
- G, The Grassland communities (communities 1.1, 1.2, 1.4 and 1.5);
- W, *Setaria sphacelata-Eragrostis plana* Wetland (community 1.6); and
- P, *Sporobolus ioclados-Lycium cinereum* Panveld (community 2).

The vegetation gradient on the first axis may be associated with a moisture/trophic gradient, from the relatively wet, leached, dystrophic conditions on the left to the relatively dry, eutrophic, sodic conditions on the right of the diagram. Grassland (G) relevés are located to the left, whereas the relevés of the *Sporobolus ioclados-Lycium cinereum* Panveld (P) are located on the right of the scatter diagram. The *Protasparagus laricinus-Acacia karroo* (A) Woodland is situated in an intermediate position. The second axis represents a moisture gradient with the wet *Setaria sphacelata-Eragrostis plana* Wetland (W) at the top, the drier Grassland (G) and Woodland (W) towards the bottom of the scatter diagram.

In Figure 3 the portion of the scatter diagram representing the Grassland is enlarged. The relevés of communities 1.1, 1.2, 1.4.1, 1.4.2 and 1.5 are more or less restricted to specific areas in this enlarged scatter diagram.

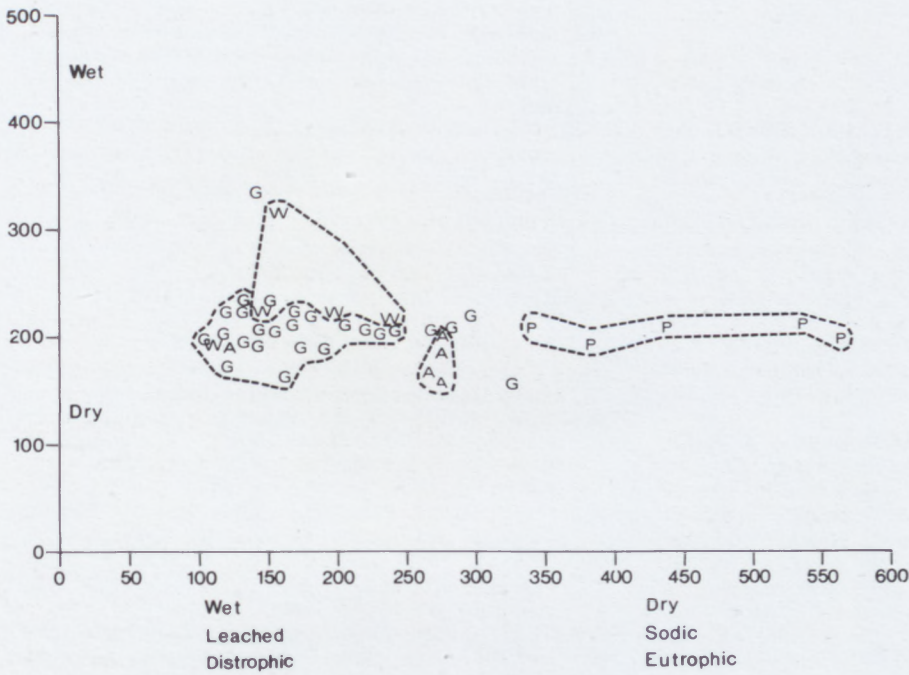


FIGURE 2.—A scatter diagram of the ordination of the vegetation on the D land type. A, *Protaspargus laricinus-Acacia karroo* Woodland community 1.3; G, Grassland communities; W, *Setaria sphacelata-Eragrostis plana* Wetland community 1.6; P, *Sporobolus ioclados-Lycium cinereum* Pan Veld community 2.

The vegetation gradient on the first axis, from community 1.5, via community 1.4.2 to community 1.4.1 can be explained by the general habitat gradient indicated in Figure 2. The position of communities 1.1 and 1.2 to the left of communities 1.4.1, 1.4.2 and 1.5 cannot be explained. However, their positions along the second axis indicate a drier habitat.

considered to be ecologically interpretable, as they relate to specific environmental conditions.

The results of the ordination suggest vegetation gradients which correlate with the moisture and trophic regimes of the soil. The results of this study, complemented by an additional phytosociological study of the B land type, should form the basis of a phytosociological synthesis of the north-western Orange Free State.

CONCLUSION

The methodology of refining the results of a TWIN-SPAN classification by Braun-Blanquet procedures (Bredenkamp & Behr 1988) was successfully applied in this study. The plant communities distinguished are

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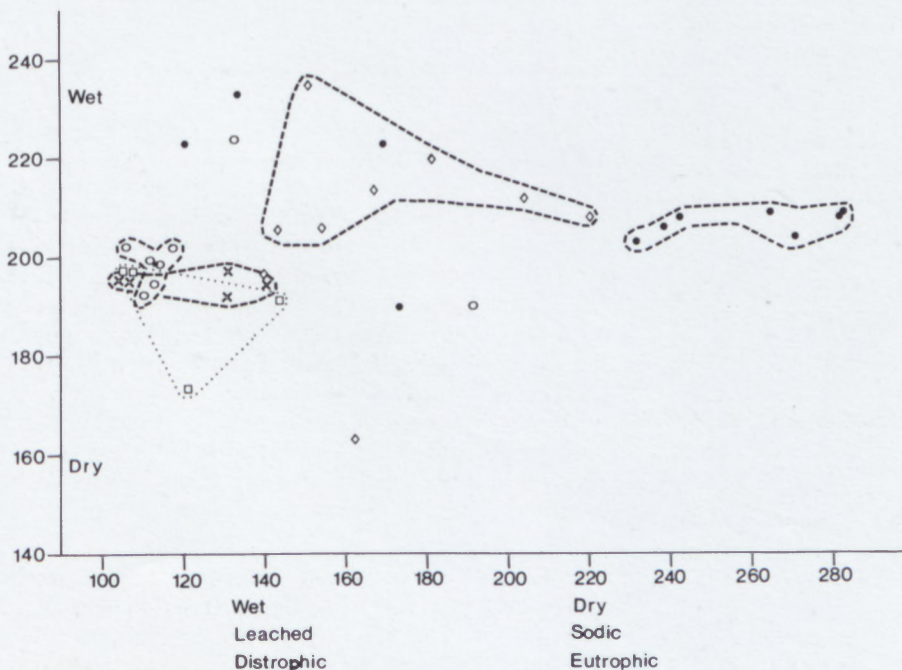


FIGURE 3.—An enlargement of a portion of the scatter diagram given in Figure 2. X, *Themeda triandra-Elionurus muticus* Grassland community 1.1; □, *Themeda triandra-Digitaria argyrograptia* Grassland community 1.2; ●, *Themeda triandra-Felicia filifolia* Grassland community 1.4.1; ◇, *Themeda triandra-Aristida bipartita* Grassland 1.4.2; ○, *Themeda triandra-Echinochloa holubii* Grassland community 1.5.

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