The *Themedo triandrae - Setarietum incrassatae,* a new association from gabbro in the Manyeleti Game Reserve, Gazankulu, South Africa

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Previous studies identified a unique plant community on gabbro in the Manyeleti Game Reserve, but it was not formally described. From a Braun-Blanquet analysis of this vegetation, six syntaxa were recognised. These were classified as one association, two subassociations, five variants and one community without syntaxonomic rank. All these syntaxa are newly decribed, and ecologically interpreted by means of habitat data. A quantitive assessment of the woody component of each syntaxon is presented. Ordinations, based on floristic and habitat data, revealed the position of the syntaxa on environmental gradients.

Key words: classification, conservation area, new syntaxa, Transvaal Lowveld.

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Introduction

The vegetation of the Manyeleti Game Reserve was studied as part of a vegetation survey programme for conservation areas in South Africa. The floristic classification of vegetation forms the framework of detailed, regional, as well as local, plant ecological studies (Westhoff & Van der Maarel 1978), enabling the compilation of efficient wildlife management programmes and conservation policies (Bredenkamp & Theron 1978). It furthermore facilitates the basic data from which a formal syntaxonomy can be derived. Formal syntaxonomic studies from the Transvaal Lowveld are limited to those of Coetzee (1983), Bredenkamp & Theron (1990 & 1991) and Bredenkamp *et al.* (1993). Other relevant studies include those of Gertenbach (1987) and Van Rooyen (1978).

Bredenkamp (1987) distinguished seven major plant communities in the Manyeleti Game Reserve. The *Themeda triandra Setaria incrassata* shrubveld and grassland, which represents the vegetation of moist sites on the extensive gabbro dyke in the eastern Transvaal Lowveld, was considered by Bredenkamp (1987) as representing a new association, but it has never been analysed nor described.

In a phytosociological study of the gabbro dyke in the Kruger National Park by Gertenbach (1978), the *Themeda triandra - Setaria incrassata* community, although occurring in the Kruger National Park, has not been identified as a separate syntaxon. It was probably regarded as part of the closely related *Chloris virgata - Acacia nigrescens* shrub veld (Gertenbach 1978), situated to the north of the Manyeleti Game Reserve in the Kruger National Park. This latter shrub veld occurs on more sandy, shallower, distrophic, drier melanic soils on rock, representing the Milkwood soil form (MacVicar *et al.* 1977). The *Themeda triandra - Setaria incrassata* shrubveld and grassland, however, is situated on more clayey, eutrophic, deeper, vertic soils of the Arcadia and wetter Rensburg (G-horizon) soil forms in both the Manyeleti Game Reserve and the Kruger National Park (Bredenkamp 1987; Bredenkamp *et al.* 1983).

In this report the *Themedo triandrae - Setarietum incrassatae* is described as a new association. An analysis of total floristic

composition and a quantitative analysis of the woody component are given for the subordinate syntaxa recognised within this association.

Study area

The reserve is situated in the Arid Lowveld Veld Type (Acocks 1988) in the Gazankulu State, adjacent to the Kruger National Park, between 24°29′S to 24°42′S and 31°23′E to 31°36′E. The climate, topography and soils of the area have been described by Bredenkamp, *et al.* (1983) and Bredenkamp (1987).

Methods

By using 1:30 000 stereo areal photographs, the entire area of the Manyeleti Game Reserve was stratified into relatively homogeneous physiographic-physiognomic units. Sample plots were randomly located within these units. The number of sample plots per unit was determined, *pro rata*, on an area-size basis. In the unit representing the *Themedo triandrae - Setarietum incrassatae* 24 relevés were compiled. The vegetation survey included the following:

Cover-abundance values were recorded for all herbaceous species in 10 m x 20 m sample plots, using the Braun - Blanquet cover-abundance scale (Westhoff & Van der Maarel 1978). However, in accordance with Werger (1973), scale-unit 2 was divided as follows:

- 2A: covering 5 - 12% of the sample plot area and
- 2B: covering 12 - 25% of the sample area.

Quantitative cover and density data for all woody species were obtained by using the variable plot method of Coetzee & Gertenbach (1977). These cover values were converted to Braun-Blanquet cover/abundance values for the compilation of the phytosociological table. The quantitive data were used to analyse and describe the structure of the woody component (Van Rooyen et al. 1981; Bredenkamp & Theron 1985).

The habitat survey included geology, topography, altitude, aspect, slope, soil surface rock, soil type (MacVicar *et al.* 1977), soil depth and various soil properties (Bredenkamp 1982; Bredenkamp *et al.* 1983; Bredenkamp 1985; Bredenkamp & Theron 1988). The soil properties in the A and B horizons include (MacVicar *et al.* 1977):

- percentage gravel (>2 - 75 mm diameter)
- percentage sand (0,02 - 2 mm diameter) and clay (<0,002 mm diameter) after the gravel has been removed
- exchangeable K^+, Na^+, Mg^{2+} and Ca^{2+} (mg/100g soil)
- S-Value as sum of exchangeable K^+, Na^+, Mg^{2+} and Ca^{2+}
- soil conductivity (mS/m)
- soil pH (H_2O).

The results of a preliminary classification of relevés and species by using an agglomerative cluster analysis (Orloci 1967) produced a fairly ordered two-way table. This table was refined by application of Braun-Blanquet procedures (Bredenkamp *et al.* 1989). The results are given in a phytosociological table (Table 1). On the basis of the distribution of plant species within the reserve, the adjacent Kruger National Park and the Transvaal Lowveld in general, diagnostic species were distinguished. In Table 1 local character species (marked C) are more or less restricted to specific syntaxa, while differential species (marked D) have a wider distribution, but may be used to characterise specific syntaxa (Westhoff & Van der Maarel 1978). Names and authors of taxa are in accordance with Arnold & De Wet (1993).

From the quantitive cover and density data, and derived constancy values calculated from the phytosociological table, importance values were calculated for all woody species in each of the final communities (Table 2). Importance Value is the sum of the relative cover, relative density, and relative constancy (Bredenkamp & Theron 1985).

Gradients within the vegetation were determined by the application of the Principal Components Analysis (Orloci 1978) to the floristic data set. Corresponding gradients in individual habitat factors were obtained by superimposing the quantitative values of these factors onto the scatter diagram.

The Canonical Correspondence Analysis (Ter Braak 1986) was applied to the floristic and habitat data sets, to establish statistical relationships between plant communities and habitat variables.

Results

Classification

The analysis revealed six communities which can be classified as follows:

1. *Themedo triandrae - Setarietum incrassatae* on dark, vertic clayey soils derived from gabbro.

1.1 *Themedo triandrae - Setarietum incrassatae - sclerocaryetosum birreae* on relatively well drained soils of the Arca-

dia Form situated on gradual slopes in the undulating landscape;

a. *Heteropogon contortus* Variant on relatively sandy, self crumbling dark brown to black soils on gabbrogranite transitional areas;

b. *Aristida bipartita* Variant on relatively clayey, crust forming black soils;

1.2 *Themedo triandrae - Setarietum incrassatae - acalyphetosum segetalis* located in bottomland sites on poorly drained clayey soils of the Rensburg soil form;

a. *Acalypha segetalis* Variant situated in the transitional zone between the upland and bottomland

b. *Trachypogon spicatus* Variant occuring in bottomlands with poorly drained, hard, clayey soils

c. *Acacia nilotica* Variant situated along bottomland drainage lines.

2. The *Setaria incrassata* Grassland and Shrubveld on sodic, poorly drained soils situated in the flood plains along river courses in the transitional zone to granite (no syntaxonomical rank)

Description of the plant communities

1. The *Themedo triandrae - Setarietum incrassatae* ass. nov.

Nomenclature type: relevé 247

The *Themedo triandrae - Setarietum incrassatae* is restricted to the north-south extending gabbro dyke which occurs in the western part of the Manyeleti Game Reserve and the adjacent Kruger National Park.

In the slightly undulating landscape, the basic igneous gabbro weathers into a dark coloured alkaline vertic clay soil representative of the Arcadia soil form on the slopes, or the Rensburg soil form in bottomland situations. The physical and chemical properties of these alkaline soils differ considerably from the acid, more sandy soils derived from the adjacent extensive granite.

The clay content (average 51%) of the A-horizons of the gabbroic derived soils is the highest for the Manyeleti Game Reserve, consequently the relatively low sand content of the A-horizons (43%). The B-horizons contain less clay (38%) and more sand (57%) than the A-horizon. This is ascribed to the unconsolidated state of the shallow lying parent rock. The major clay mineral is montmorillonite, which causes the swelling of the soil under wet conditions and shrinking and cracking under dry conditions (MacVicar *et al.* 1977).

The A-horizons are usually very hard. The B-horizons are slightly softer and may sometimes represent a water saturated G-horizon. The blocky structure of the A-horizon is well developed whereas the structure of the B-horizon is intermediate blocky or granular.

The high magnesium content of these montmorillonitic clays is characteristic. The calcium and potassium contents are also relatively high but the average sodium content is less than that of the soils of the *Eucleo divinorii – Acacietum nigricentis* (Bredenkamp & Theron 1991) and *Albizio harveyi - Eucleetum divinorii* (Bredenkamp *et al.* 1993), both characteristically present on sodic soils. The S-values for both the A and B-horizons are high. Free carbonates are found frequently in these soils.

An analysis of the soil properties of the individual subordinate syntaxa of the association is given in Table 3.

The floristic composition of the *Themedo triandrae - Setarietum incrassatae* is given in Table 1, with the diagnostic species, all local character species, listed in species group A.

The grass layer is dense and well developed. The tufted rhizomatous and tall growing (1,5 m) *Setaria incrassata*, which is often associated with moist, black, clayey, vertic soils, is mostly dominant. Other prominent grass species include the co-dominant *Themeda triandra* and *Bothriochloa radicans*, both typically abundant on clayey soils in the Transvaal Lowveld area. *Panicum maximum* is often abundant in shady areas under bushes and trees. The wiry and variable *Eragrostis curvula*, though widespread in Highveld

Table 1

Phytosociological table of the Themedo triandrae - Setarietum incrassatae

C = Local character species; D = Differential species

		1				2
Community number		1.1a	1.1b	1.2a	1.2b	1.2c
Releve number		22112 44985 31281	00000 22111 10789	0120 2852 2763	22222 44445 27062	22 021 16 339 94 790
Species group A: Diagnostic species for the Themedo triandrae - Setarietum incrassatae.						
C	**Setaria incrassata**	1443	5BBB	5+ B	B445B	5B 413
C	**Indigofera spicata**	11+	11111	11+1	11++1	B1 +B+
C	**Tragia incisifolia**	++ ++	+++	++++	+ 1+1	1+ +
C	**Rhynchosia minima**	111A	+A11+	+11+	11 1	
C	**Vernonia fastigiata**	+++	+ +++	++ +	+++++	1
C	**Hybanthus enneaspermus**	+ +++	+ +++	+ +	+ +	++
C	**Merremia palmata**	1 1+	11+	+1	1+1++	
C	**Turbina robertsiana**	++	+ +++	++ 1	1 +	+
C	**Abutilon guineense**	+ ++	+	+1+	++1	++ +
C	**Eragrostis curvula**	A11	1+1++	1	1 111	+ 1
C	**Alysicarpus glumaceus**	+1+++			+++ +	
Species group B: Diagnostic species for the Themedo triandrae - Setarietum incrassatae - sclerocaryetosum birreae						
D	**Sclerocarya birrea**	++1 +	++ +1	1 1		
D	**Ipomoea obscura**	+++++	+++	++		
D	**Boophane disticha**	++++	+++			
D	**Phyllanthus maderaspatensis**	++	++ ++		++	
D	**Grewia monticola**	++1 +	+1	+		
D	**Pterocarpus rotundifolius**	+++	++			
D	**Plexipus hederaceum**	+ ++	+ +			
D	**Acacia gerrardii**	+ + +	++			+++
Species group C: Diagnostic species for the Heteropogon contortus Variant.						
D	**Heteropogon contortus**	1111	+			A
D	**Teramnus labialis**	+ +++	+			+
D	**Cucumis hirsutus**	++ +		+		
D	**Vernonia oligocephala**	+ ++	+			+
D	**Barleria oxyphylla**	++ +				
D	**Acacia exuvialis**	++ +	+	+		
D	**Maytenus senegalensis**	++ +			+	A

D	**Aeschynomene indica**	+ + +	+				
D	**Lannea discolor**	1+					
D	**Anthericum galpinii**	+ +					
D	**Combretum imberbe**	1 +			+		
D	**Brachiaria deflexa**	++					+

Species group D: Diagnostic species for the **Aristida bipartita** Variant.

C	**Aristida bipartita**		+++++				
D	**Lonchocarpus capassa**	1	+1+ 1	1		+	+
C	**Rhus pentheri**	+	+ +				
D	**Setaria sphacelata**	1	4 1				
C	**Commiphora edulis**		++				
D	**Lannea schweinfurthii**		11				

Species group E: Diagnostic species for the **Themedo triandrae-Setarietum incrassatae-acalyphetosum segetalis**

C	**Acalypha segetalis**	+	+	+1++	+++ +	+	
C	**Leucas glabrata**		+	+ 1+	++ ++	++	
C	**Ipomoea lapathifolia**			11 +	+ 1+	1	1 +
D	**Hibiscus pusillus**	+	+ +	++	+ +1	++	
C	**Securinega virosa**		1	1 +	1	++	+
D	**Tephrosia polystachya**	+	+	+	+ ++	+	

Species group F: Diagnostic species for the **Trachypogon spicatus** Variant

C	**Trachypogon spicatus**		4		4B4 1	B	
C	**Ipomoea coscinosperma**	+			111+1		

Species group G: Diagnostic species for the **Acacia nilotica** Variant

C	**Acacia nilotica**					33	
C	**Cyphostemma cirrhosum**					++	
C	**Ehretia rigida**					++	+
C	**Scolopia zeyheri**					++	
D	**Protasparagus retinervis**				+	++	
C	**Rhus guenzii**					++	
D	**Rhoicissus tridentata**					++	
D	**Cassine transvaalensis**					++	
C	**Schotia capitata**					++	
C	**Sorghum versicolor**					++	+
C	**Allophyllus decipiens**					++	
D	**Achyranthes aspera**					++	+
D	**Cocculus hirsutus**					++	

Species group H: species occuring on granite and gabbro, excluding hills and riverbanks

Corchorus asplenifolius	++++	+++++	++++	+++++	+	+++	
Bothriochloa radicans	1A+1A	1+++1	1 A1	111	+	11	
Commelina africana	+	+ +++	++ +	++++	++	++	
Solanum panduraeforme	++	++	+	+	+1	+ +	
Lantana rugosa	++ +	++ +	+ ++	+			
Ledebouria species	+	+++	+	+		+	
Ipomoea crassipes	+ +	+ +		+	+	+ +	

Species group I: General species

Themeda triandra	43333	B5B4+	14B	B11B1	+	413	
Dichrostachys cinerea	+++++	+ 1++	+1++	++1 +		+++	
Combretum hereroense	++1+	+1+11	A+++	+++ +	+	1+	
Panicum maximum	111 1	31+ 1	B4	11+1	1B	11+	
Albizia harveyi	+ ++	+++++	A +	+++ +	++	+11	
Ormocarpum trichocarpum	+11A1	+A11A	+1++	+1 +	+	++	
Dalbergia melanoxylon	+1+++	11A+	+++	11+11	++	1	
Sida dregei	+++++	++ +	++ +	++++		+ +	
Phyllanthus burchellii	++++	++	+ ++	++ +	++	++	
Acacia nigrescens	1111A	1 1+	B3	1 +	AB	++	
Digitaria eriantha	1+	+141+		+1+1B	1		
Ziziphus mucronata	++	11	+		++	+ +	
Neorautanenia amboense		++ +	+	++	+		
Kohautia virgata	+ +	+	+	+	+		
Euclea divinorum		+			++	++	
Talinum tenuissimum	+	+ +	+		+		
Eheretia amoena	+			+ +	1	1	
Eustachys paspaloides		+1				+1	
Pavonia burchellii		+ +				+ +	
Maytenus heterophylla	+ +	+			+		
Bolusanthus speciosus	1		+			+	
Melhania forbesii	+	+	+				

parts of southern Africa, is a local character species for this association, as it has a restricted distribution in the Transvaal Lowveld.

The canopy cover of the herbaceous layer is 95-100% with a height of 1-2 metres. This high canopy cover can be ascribed to the poor utilisation by game, probably due to inaccessibility caused by the density of the dwarfed woody species.

The dense, dominant grass layer shades out smaller herbaceous species, consequently many diagnostic species are scandent or twining herbaceous plants, for example *Tragia incisifolia*, *Rhynchosia minima*, *Merremia palmata*, *Turbina robertsiana* and *Alysicarpus glumaceus*.

Woody species are mostly dwarfed or stunted on the clayey, montmorrilonitic, vertic soils, due to poor drainage, poor root penetration and root breakage caused by swelling and shrinkage of the soil (MacVicar *et al.* 1977). The resulting vegetation is a dwarfed thicket or low shrubveld with a few locally scattered trees, where soil conditions are more favourable (Bredenkamp & Theron 1985). Tall trees (5-6 m) of *Albizia harveyi* and *Acacia nigrescens* occur scattered in this association, but most individuals of these two species are also dwarfed and are only 0,5 - 1,5 m tall. Other

Table 2
Analysis of the Importance Values (%) of the woody species of the Themedo triandrae - Setarietum incrassatae

Species	Syntaxa					
	1.1a	1.1b	1.2a	1.2b	1.2c	2
Acacia nigrescens	20,9	4,5	28,9	6,4	20,2	5,1
Albizia harveyi	2,4	5,1	16,1	10,0	4,1	21,6
Ormocarpum trichocarpum	36,8	40,0	19,1	11,9	–	8,2
Dichrostachys cinerea	5,1	4,2	9,4	11,0	–	10,1
Combretum hereroense	3,6	7,6	10,8	8,0	–	9,5
Dalbergia melanoxylon	5,9	22,4	6,6	49,4	–	–
Ziziphus mucronata	1,3	1,5	–	–	2,8	5,2
Sclerocarya birrea	3,4	5,0	4,6	–	–	–
Grewia monticola	2,9	1,5	–	–	–	–
Pterocarpus rotundifolius	2,8	1,5	–	–	–	–
Acacia gerrardii	2,2	1,5	–	–	–	7,1
Lannea discolor	1,2	–	–	–	–	–
Maytenus heterophylla	1,4	–	–	–	–	–
Acacia exuvialis	3,2	–	–	–	–	–
Combretum imberbe	2,7	–	–	–	–	–
Maytenus senegalensis	3,8	–	–	–	–	28,9
Securinega virosa	–	–	4,3	–	4,7	–
Rhus pentheri	–	1,8	–	–	–	–
Lannea schweinfurthii	–	1,5	–	–	–	–
Commiphora edulis	–	1,5	–	–	–	–
Lonchocarpus capassa	–	3,1	–	–	–	–
Schotia capitata	–	–	–	–	3,8	–
Cassine transvaalensis	–	–	–	–	2,8	–
Scolopia zeyheri	–	–	–	–	2,8	–
Allophyllus decipiens	–	–	–	–	2,8	–
Acacia nilotica	–	–	–	–	24,4	–
Ehretia rigida	–	–	–	–	3,1	–
Rhoicissus tridentata	–	–	–	–	2,8	–
Ehretia amoena	–	–	–	3,2	12,2	–
Euclea divinorum	–	–	–	–	7,1	4,4
Rhus guenzii	–	–	–	–	6,4	–

dwarfed woody species found frequently in this vegetation are *Dichrostachys cinerea*, *Combretum hereroense*, *Ormocarpum trichocarpum* and *Dalbergia melanoxylon*.

1.1 The *Themedo triandrae-Setarietum incrassatae - sclerocaryetosum birreae* subass. nov.

Nomenclature type: relevé 18

Larger trees and a greater variety of woody species occur on relatively better drained slopes in the slightly undulating landscape. Rocky gabbro ridges and outcrops occur scattered throughout this area and stones cover up to 10% of the soil surface. The adjacent granite also contributes to the development of a slightly more sandy soil. The A-horizon of the soil is self crumbling, a characteristic of the Arcadia soil series of the Arcadia soil form. All these factors cause a better drainage and more favourable conditions for development of a tree stratum. This vegetation occuring on these specific habitat conditions represents the *Themedo triandrae-Setarietum incrassatae - sclerocaryetosum birreae.*

Table 3
Soil characteristics of the A and B horizon of the subordinate syntaxa of the Themedo triandrae - Setarietum incrassatae

Soil property	Syntaxa					
	1.1a	1.1b	1.2a	1.2b	1.2c	2
Gravel A (%)	2	2	3	1	0	0
Gravel B (%)	16	19	18	12	0	2
Sand A (%)	56	45	39	35	34	43
Sand B (%)	63	60	71	49	34	52
Clay A (%)	39	52	55	57	58	49
Clay B (%)	30	35	26	47	57	44
Potassium A (mg/100g)	480	450	300	500	550	358
Potassium B (mg/100g)	260	190	125	290	500	192
Sodium A (mg/100g)	80	110	138	145	363	458
Sodium B (mg/100g)	105	130	131	180	425	1 867
Magnesium A (mg/100g)	2 475	2 775	4 875	5 025	4 375	2 875
Magnesium B (mg/100g)	2 000	2 825	4 438	5 425	4 625	3 167
Calsium A (mg/100g)	1 150	1 925	1 781	1 925	2 438	1 583
Calsium B (mg/100g)	3 075	2 350	2 031	4 000	3 188	1 333
S-Value A	4 185	5 260	7 094	8 195	7 725	5 283
S-Value B	6 015	5 495	6 725	9 890	8 738	5 892
Conductivity A (mS/m)	10,5	16,0	16,4	31,6	31,3	35,3
Conductivity B (mS/m)	17,8	20,5	28,0	51,0	55,0	2 42,5
pH A	7,4	6,9	7,4	7,2	8,0	7,1
pH B	8,0	7,8	8,2	8,0	8,3	8,5

The S-value, magnesium content as well as the electrical conductivety of the A and B-horizons are lower in the better drained soils of this subassociation, than in the case of the closely related *Themedo triandrae - Setarietum incrassatae - acalyphetosum segetalis* which occurs on the poorly drained Rensburg soil form situated in the bottomlands. The habitat of the *Themedo triandrae - Setarietum incrassatae - sclerocaryetosum birreae* also differs from the *Setaria incrassata* Grassland (no syntaxonomic rank), occurring on flood plains along drainage lines in the transitional zone between gabbro and granite. The sodic soils of the latter plant community are also poor in calcium but richer in sodium and have a high electrical conductivity, especially in the B-horizon (Table 3).

The floristic composition of the *Themedo triandrae - Setarietum incrassatae - sclerocaryetosum birreae* is given in Table 1.

Species group B characterises this subassociation, with all diagnostic species being differential, as they also occur abundantly on the vast granite areas on sandy, well drained, leached, acid soils (Bredenkamp 1987; Bredenkamp *et al.* 1983). These diagnostic species are also indicative of the better drainage conditions prevailing in the habitat of this subassociation. The diagnostic woody species include the tall (10 - 15 m) *Sclerocarya birrea*, and shorter (2 - 5 m) shrubby individuals of *Phyllanthus maderaspatensis*, *Grewia monticola*, *Pterocarpus rotundifolius* and *Acacia gerrardii*.

Two variants are recognised:

a. The *Heteropogon contortus* Variant is situated high up on the slopes in the undulating landscape, usually bordering the adjacent granite.

The vegetation is an open, low, shrubveld or a dense dwarfed thicket (Bredenkamp & Theron 1985). Trees are found in this community, though sparsly dispersed.

The influence of the granite on the soil is reflected by the relatively high percentage sand (56%) and low percentage clay (39%) in the A-horizon. Characteristic of the soils is the self crumbling quality found in the Arcadia soil series of the Arcadia soil form (MacVicar *et al.* 1977). The habitat of the *Heteropogon contortus* Variant differs furthermore from the related *Aristida bipartita* Variant in the higher potassium and lower sodium and magnesium contents of the soils of the first variant (Table 3).

The *Heteropogon contortus* Variant is characterised by the differential species listed in species group C (Table 1). The most conspicuous diagnostic species include the graminoids *Heteropogon contortus*, which can be locally sub- dominant, and *Brachiaria deflexa*, the woody shrubs *Acacia exuvialis* and *Maytenus senegalensis* and the trees *Lannea discolor* and *Combretum imberbe*.

Ormocarpum trichocarpum is by far the most important woody species with an Importance Value of 36,8% (Table 2). This high Importance Value can be ascribed to the high density of this species, usually a dwarf shrub in the 0,5 m height class. *Acacia nigrescens* is the most conspicuous woody species with the highest canopy cover and an Importance Value of 20,9%.

b. The *Aristida bipartita* Variant on the contrary is situated on the hard, black, clayey, crust-forming soils of the mid-slopes representing the Gelykvlakte series of the Arcadia soil form. The soils of these mid-slopes have a higher percentage clay in the A-horizon (52%) than those of the closely related *Heteropogon contortus* Variant on the higher slopes. These soils are also richer in sodium and magnesium (Table 3).

The dense closed dwarf shrubveld (Bredenkamp & Theron 1985) is characterised by species group D (Table 1). Local character and differential species include the sub-dominant grass species *Aristida bipartita* (C) and *Setaria sphacelata* (D) and stunted individuals of the woody *Lonchocarpus capassa* (D), *Rhus pentheri* (C), *Commiphora edulis* (C) and *Lannea schweinfurthii* (D)

The dwarfed shrub *Ormocarpum trichocarpum* (0,5 m tall) is also the most important species in this variant, with an Importance Value of 40,0% (Table 2). This species has a high density but a low canopy cover. Another dwarfed shrub, *Dalbergia melanoxylon* has the second highest Importance Value (22,4%), also caused by a high density but a low canopy cover. The increase of these two species in the *Aristida bipartita* Variant is alarming, resulting in the dense closed dwarf shrubveld. Scattered individuals of *Combretum hereroense* are the only woody plants in the 1 - 2 m height class.

1.2 The *Themedo triandrae - Setarietum incrassatae - acalyphetosum segetalis* subass. nov.

Nomenclatural type: relevé 247

This subassociation represents the typical form of the association. It is restricted to bottomland situations on the relatively poorly drained soils of the Rensburg soil form, typically with a vertic A-horizon over a water-saturated G-horizon (gley soil), but occasionaly also on soils of the Arcadia form. The clay, magnesium and sodium contents, as well as the S-value, electrical conductivity and pH are relatively high (Table 3).

The *Themedo triandrae - Setarietum incrassatae - acalyphetosum segetalis* is characterised by species group E (Table 1). The diagnostic species are mostly forbs, except for the differential small shrubby species *Securinega virosa*.

Three variants are recognised:

a. The *Acalypha segetalis* Variant is situated low down on the slopes, below the *Aristida bipartita* Variant of the mid-slopes. The clay content of the A-horizon is high (55%) where-as that of the B-horizon is low (26%), with the corresponding high sand content due to the shallow unconsolidated parent material (Table 3). These shallow soils, usually representing the Arcadia soil form, Gelykvlakte serie (MacVicar *et al.* 1977) are somewhat better drained than those of the *Trachypogon spicatus* Variant in the bottomlands. Crusts form typically on the soil surface. Gabbro outcrops occur scattered throughout this variant with stones covering aproximately 15% of the soil surface. The S-value and electrical conductivity of the soils of the *Acalypha segetalis* Variant are lower than those of the *Trachypogon spicatus* and *Acacia nilotica* Variants (Table 3), also indicating the transitional habitat of this variant to the *Themedo triandrae-Setarietum incrassatae - sclerocaryetosum birreae.*

In the vicinity of the prominent rocky outcrops, tall individuals of *Acacia nigrescens* and *Sclerocarya birrea* are found, forming an open to dense woodland. Generaly, however, the vegetation is an open, low thicket or dwarf shrub veld (Bredenkamp & Theron 1985).

An analysis of the woody component of the vegetation is given in Table 2. The tall tree *Acacia nigrescens* has the highest Importance Value (28,9%), ascribed mainly to the relative high canopy cover of larger trees. The Importance Values of the dwarfed shrubs *Ormocarpum trichocarpum* (19,1%) and *Albizia harveyi* (16,1%) are a result of their relative high densities and local bush incroachment. *Acacia nigrescens* is prominent in the 4-5 m height class, *Combretum hereroense* in the 1-2 m height class and *Ormocarpum trichocarpum* in the 0,5-1 m height class.

b. The *Trachypogon spicatus* Variant is restricted to poorly drained vertic gley soils of the Rensburg soil form, in the moist bottomlands. The calcium and magnesium contents, as well as the S-value are generally of the highest for the entire Reserve (Table 3).

The vegetation is an open, low shrubveld or sometimes a dense dwarfed brushveld (Bredenkamp & Theron 1985). This variant is characterised by species group F (Table 1). Local character species include the co-dominant grass *Trachypogon spicatus* and the herbaceous twining climber *Ipomoea coscinosperma.*

An analysis of the woody component is given in Table 2. In these bottomland sites the 0,5 - 1 m tall *Dalbergia melanoxylon* shrubs with a low canopy cover but high density have by far the highest Importance Value of 49,4%. This species, together with *Ormocarpum trichocarpum* and *Dichrostachys cinerea* are encroaching in this vegetation.

c. The *Acacia nilotica* Variant occupies narrow strips situated along the upper courses of drainage lines. The soils are clayey, poorly drained and of the Rensburg form. The clay content of these soils is 58% in the A-horizon. Besides the *Trachypogon spicatus* Variant, the S-Value, magnesium and calcium contents of the soil of this variant are the highest in the reserve (Table 3).

The vegetation of this variant can be described as a dense tall tree veld (Bredenkamp & Theron 1985). The *Acacia nilotica* Variant is characterised by species group G (Table 1). Many local character species are present, including the (2-3 m tall) but dominant tree *Acacia nilotica*, the woody shrubs *Ehretia rigida, Rhus guenzii, Schotia capitata, Scolopia zeyheri* and *Allophyllus decipiens*, the small succulent shrub *Cyphostemma cirrhosum* and the grass species *Sorghum versicolor*. The presence of many local character species may suggest that this variant could be considered as a separate association, but too little is presently known about this vegetation, due to its very limited distribution in the study area.

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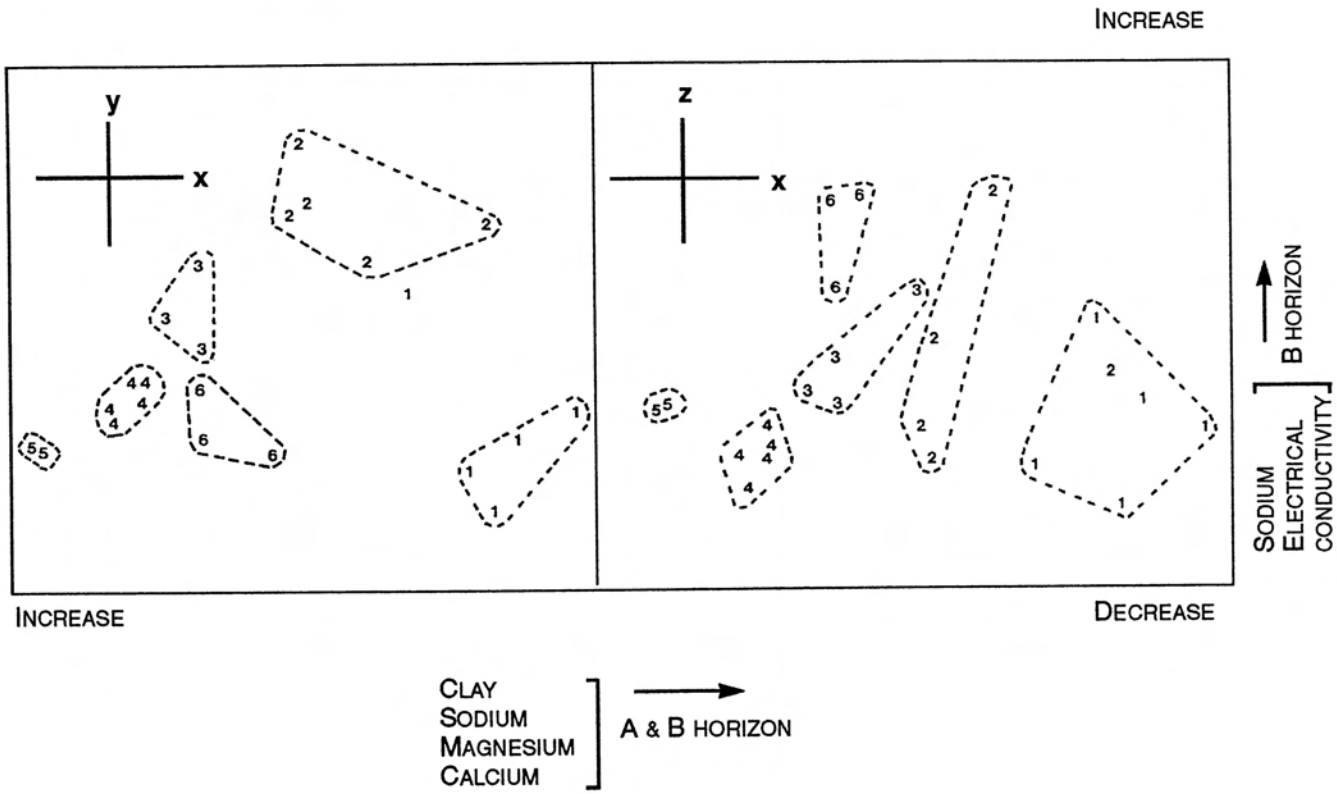

Fig. 1. The distribution of relevés along the first and second and the first and third axes of the ordination, based on floristic data. 1. *Heteropogon contortus* Variant; 2. *Aristida bipartita* Variant; 3. *Acalypha segetalis* Variant; 4. *Trachypogon spicatus* Variant; 5. *Acacia nilotica* Variant; 6. *Setaria incrassata* Grassland and Shrubveld.

An analysis of the woody component is given in Table 2. *Acacia nilotica* is the most important woody species with an Importance Value of 24,4%. In this case the average canopy cover is high (47,4%) and the density relatively low. *Acacia nigrescens* is also conspicious with a canopy cover of 22,9% and an Importance Value of 20,2%. The relative high Importance Value of *Ehretia amoena* can be ascribed to the high density of this species in the 0,5 - 1 m height class.

2. *Setaria incrassata* Grassland and Shrubveld

No syntaxonomical rank.

This community is usually situated on open, sodic flood plains adjacent to river courses on gabbro. The soils are clayey (49% in the A-horizon), with a high sodium (1 867 mg/100 g soil) content and electrical conductivity (242,5 mS/m) in the B-horizon.

The vegetation structure varies from a grassland to an open low shrub veld or a dense dwarf brush (Bredenkamp & Theron 1985). The woody species present are mostly dwarfed and dominated and overshadowed by the dense grass layer.

This community is distinguished from the other communities by the abscence of most species groups (Table 1).

Maytenus senegalensis and *Albizia harveyi* are the most important woody species with Importance Values of 28,9% and 21,6% respectively. These species are generally represented by a high density dwarfed individuals in the 0,5 - 1 m height class. In the height classes above 2 m only a few scattered individuals of *Euclea divinorum*, *Ziziphus mucronata* and *Combretum hereroense* occur here and there.

Ordination

The distribution of the 24 relevés along the first (X) and second (Y), and second and third (Z) axes of the ordination of floristic data is given in Figure 1.

In the scatter diagrams a distinct discontinuity in the distribution of the releve's of the six identified communities is noted (Figure 1). The distribution along the X-axis displays the position of the *Heteropogon contortus* (1) and *Aristida bipartita* (2) variants of the *Themedo triandrae - Setarietum incrassatae - sclerocaryetosum birreae* to the right of the scatter diagram and the *Acalypha segetalis* (3), *Trachypogon spicatus* (4) and *Acacia nilotica* (5) variants of the *Themedo triandrae - Setarietum incrassatae - acalyphetosum segetalis* to the left. The *Setaria incrassata* grassland and shrubveld (6) is also situated more to the left on the X-axis, indicating a possible inclusion of this community in the *Themedo triandrae - Setarietum incrassatae - acalyphetosum segetalis*.

The distribution along the X-axis follows a decrease in clay, sodium, magnesium and calcium contents of the soil from left to right in the diagrams. The *Acalypha segetalis* Variant (3) is transitional between the two subassociations, supporting the results of the classification.

From the ordination results, the *Setaria incrassata* Grassland and Shrubveld (6) and *Acalypha segetalis* Variant (3) are floristically closely related in spite of their geographical isolation. However, the affinity of the *Setaria incrassata* Grassland and Shrubveld to sodic soils with high electrical conductivity is confirmed by it's position to the top of the Z-axis.

Species with the highest eigen values in the first, second and third principal components are given in Table 4. Of the 11 species with high positive eigen values in the first principal component, four (*Grewia monticola*, *Boophane disticha*, *Plexipus hederaceum*

Table 4
Species with the highest eigen values in the first, second and third principal components

	Eigen values		
Principal components	1	2	3
Species			
Grewia monticola	1000	–	–
Boophane disticha	946	–	–
Aeschynomene indica	907	–	–
Acacia exuvialis	877	–	–
Teramnus labialis	875	–	–
Ipomoea lapathifolia	-798	–	–
Lantana rugosa	-786	–	–
Leucas glabrata	-782	–	–
Trachypogon spicatus	-746	–	–
Barleria oxyphylla	725	–	–
Anthericum galpinii	707	–	–
Lannea discolor	695	–	–
Heteropogon contortus	675	–	–
Plexipus hederaceum	617	–	–
Pterocarpus rotundifolius	617	–	-655
Eragrostis curvula	–	1000	-638
Abutilon guineense	–	947	–
Turbina robertsiana	–	842	–
Commiphora edulis	–	744	–
Alysicarpus glumaceus	–	-655	-617
Lannea schweinfurtii	–	639	–
Cucumis hirsutus	–	-601	–
Pavonia burchellii	–	–	1000
Merremia palmata	–	–	-912
Vernonia fastigiata	–	–	-848
Euclea divinorum	–	–	731
Hibiscus pusillus	–	–	-673
Combretum imberbe	–	–	-666
Tragia incisifolia	–	–	-629

and *Ptreocarpus rotundiffolius*) are diagnostic for the *Themedo triandrae - Setarietum incrassatae - sclerocaryetosum birreae* (1 & 2). The remaining seven species, namely *Aeschynomene indica*, *Acacia exuvialis*, *Teramnus labialis*, *Barleria oxyphylla*, *Anthericum galpinii*, *Lannea discolor* and *Heteropogon contortus* are diagnostic for the *Heteropogon contortus* Variant (1), situated to the right of the scatter diagram. Three of the four species with high negative eigen values in the first principal component are diagnostic for the *Themedo triandrae - Setarietum incrassatae - acalyphetosum segetalis* (3, 4 & 5) especially the *Trachypogon spicatus* Variant (4), situated to the left of the scatter diagram. These include *Ipomoea lapathifolia*, *Leucas glabrata* and *Trachypogon spicatus*. These results comfirm the suggested classification of the subordinate syntaxa within the association.

In the second and third principal components most of the seven species listed with high positive or negative eigen values, are diagnostic for the association, indicating that not much separation between subordinate syntaxa should be expected along the second and third axes. These diagnostic species include *Eragrostis curvula*, *Abutilon guineense*, *Turbina robertsiana*, *Alysicarpus glumaceus*, *Merremia palmata*, *Vernonia fastigiata* and *Tragia incisifolia*.

The Canonical Correspondence Analysis (Ter Braak 1986) did not reveal additional information regarding the gradients in vegetation or habitat. However, the results obtained indicate that percentage sand, potassium and sodium contents and the pH, all of the A-horizon are the environmental factors explaining most (29%, 22%, 16% and 9% respectively) of the variance in the data. Principal Components Analysis also showed that soil texture (percentage clay) and sodium contents are important habitat factors associated with vegetation gradients, but this could not be indicated for pH and potassium content. The importance placed by Principal Components Analysis on the soil variables of the B horizon for explaining vegetation gradients, was not confirmed by Canonical Correspondence Analysis.

Concluding remarks

The classification obtained by agglomerative cluster analysis (Orloci 1967) refined by Braun-Blanquet procedures resulted in vegetation units that can successfully be related to environmental factors. The classification is supported by the results of the Principal Components Analysis of floristic data, the latter providing an understanding of the vegetation gradients and associated habitat gradients

within the association. The Canonical Correspondence Analysis (Ter Braak 1986) did not reveal additional information regarding the gradients in vegetation or habitat.

The description of this association contributes to the scanty knowledge of the syntaxonomy and synecology of the Transvaal Lowveld Region in South Africa.

The Importance Values, calculated from cover, density and constancy values of woody species, indicate differences in the composition of the woody component among the recognised syntaxa. As a quantitative assessment of the structural data was given by Bredenkamp & Theron (1985), it is used in this report only to describe the woody strata quantitatively.

The results show that a reliable habitat interpretation of quantitative habitat variables can be made from ordinations of floristic and habitat data. The differences in quantitive habitat variables are however mostly associated with differences in qualitative habitat factors such as topographical position, soil form and soil series.

The new knowledge gained on the plant communities of the area concerned forms an important base for wildlife management of the Manyeleti Game Reserve, in that the communities represent homogeneous veld management units.

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