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THE VEGETATION OF THE FERSIALLITIC SOILS OF THE MANYELETI GAME RESERVE

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Abstract. As part of a vegetation survey programme for conserved areas in South Africa, a survey of the plant communities of the fersiallitic soils in the Manyeleti Game Reserve was undertaken. The Perotido patentis-Terminalietum sericeae is restricted to these soils. From a Braun-Blanquet analysis of the vegetation, two new subassociations, one with three variants, were identified and described. A quantitative assessment of the woody component of each syntaxon is presented. An ordination based on the floristic data revealed the position of the syntaxa on an environmental gradient.

Introduction

Vegetation and general ecological surveys of conserved areas are considered to have high priority (Nakor 1979), as a sound knowledge of the ecology of these areas is essential for the establishment of efficient wildlife management programmes and conservation policies (Bredenkamp and Theron 1978). For this reason and as part of a vegetation survey programme for conservation areas in South Africa, a study of the vegetation of the Manyeleti Game Reserve was undertaken. This Reserve is in the Gazankulu State, South Africa, adjacent to the Kruger National Park, between 24°29' and 24°42'S and 31°23' and 31°36'E. The location, climate, topography and soils of the area have been described by Bredenkamp, Theron and Van Vuuren (1983) and Bredenkamp (1987). Bredenkamp (1987) presented a general overview of the vegetation of the Reserve and distinguished seven major plant communities. One of these communities, the Perotido patentis-Terminalietum sericeae Coetzee 1983 (Dissertationes Botanicae 69: 92) was described in a report of the vegetation of the central district of the Kruger National Park. This association is classified under the Pogonarthrio sguarrosae-Combretion apiculati Coetzee 1983 (Dissertationes Botanicae 69: 90), an alliance which greatly represents the Broad-orthophyll Plains Bushveld (Werger and Coetzee 1978) in the eastern Transvaal Lowveld region. In the Manyeleti Game Reserve the association is restricted to deep, acid, dystrophic, sandy, mesic, fersiallitic soils derived from granite (Bredenkamp, Theron and Van Vuuren 1983, Bredenkamp 1987). Although the association is easily recognised by many diagnostic species, considerable variation was found both in floristic composition and in habitat (Coetzee 1983, Bredenkamp 1987). The present report is a phytosociological account of the Perotido patentis-Terminalietum sericeae within the Manyeleti Game Reserve.

Methods

The entire area of the Reserve was stratified into relatively homogeneous physiographic-physiognomic units. Sample plots were randomly located within these units. The number of plots per unit was determined *pro-rata*, on an area size basis. The Perotido patentis-Terminalietum sericeae is represented by 57 sample plots. Relevès were compiled for each sample plot. The vegetation survey included the following:

(a) Cover/abundance values were estimated for all herbaceous species in a 10 m×20 m sample plot, by using the Braun-Blanquet cover/abundance scale (Westhoff and Van der Maarel 1978). However, in accordance with Werger (1973), scale-unit 2 was divided as follows:

M: very numerous, covering <5% of the sample plot area,

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

B: covering 13-25% of the sample area.

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

The habitat survey included geology, topography, altitude, aspect, slope, soil surface rock, soil type (MacVicar *et al.* 1977) and various soil properties including physical and chemical analysis (Bredenkamp, Theron and Van Vuuren 1983, Bredenkamp and Theron 1985, Bredenkamp and Theron 1988).

Relevès and species were classified with an agglomerative cluster analysis (Orlóci 1967) and the table produced was refined by application of Braun-Blanquet procedures. On basis of the distribution of the species

Table 1. A phytosociological table of the Perotido patentis-Terminalietum sericeae.

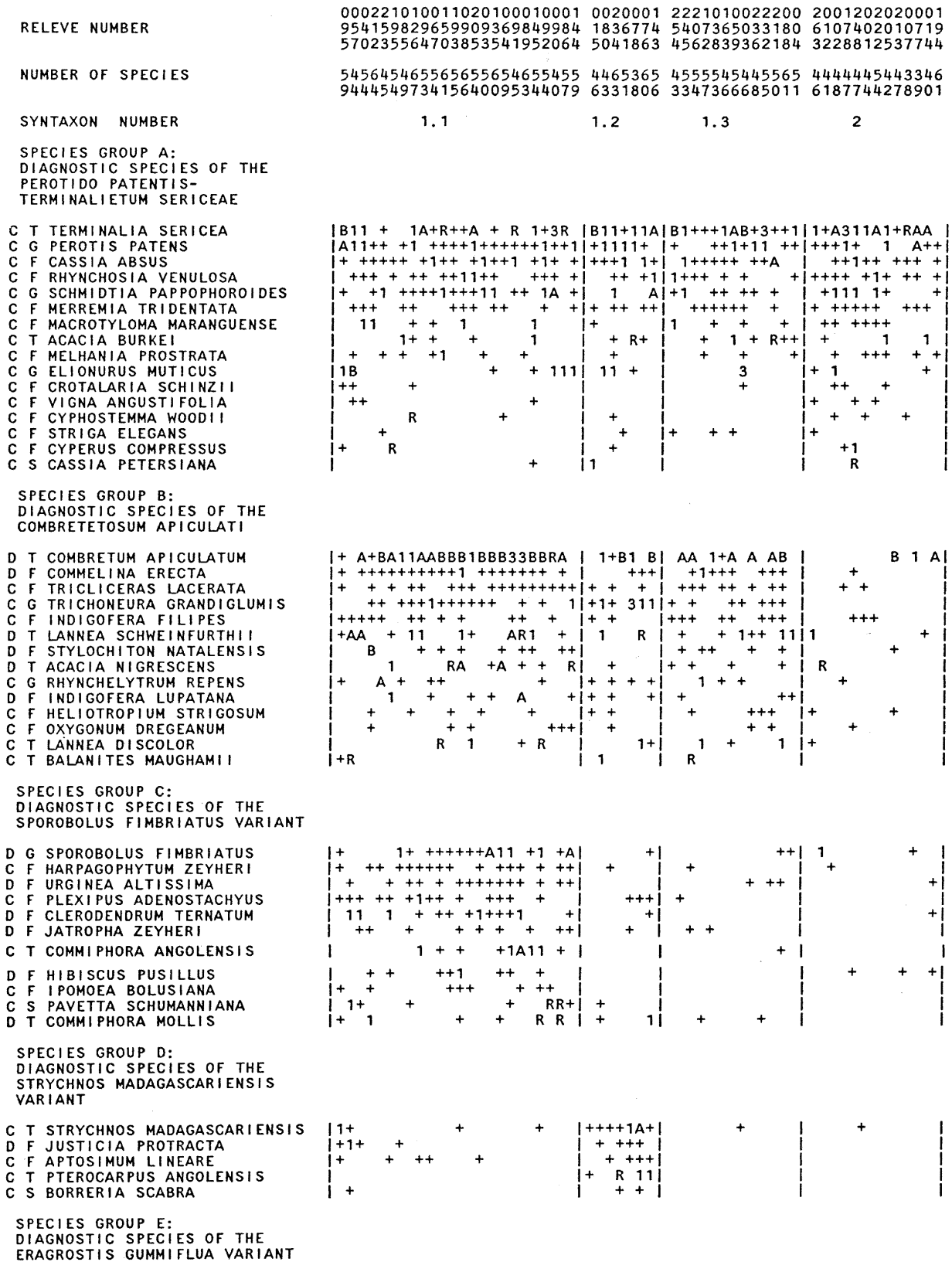


Table 1. Continued.

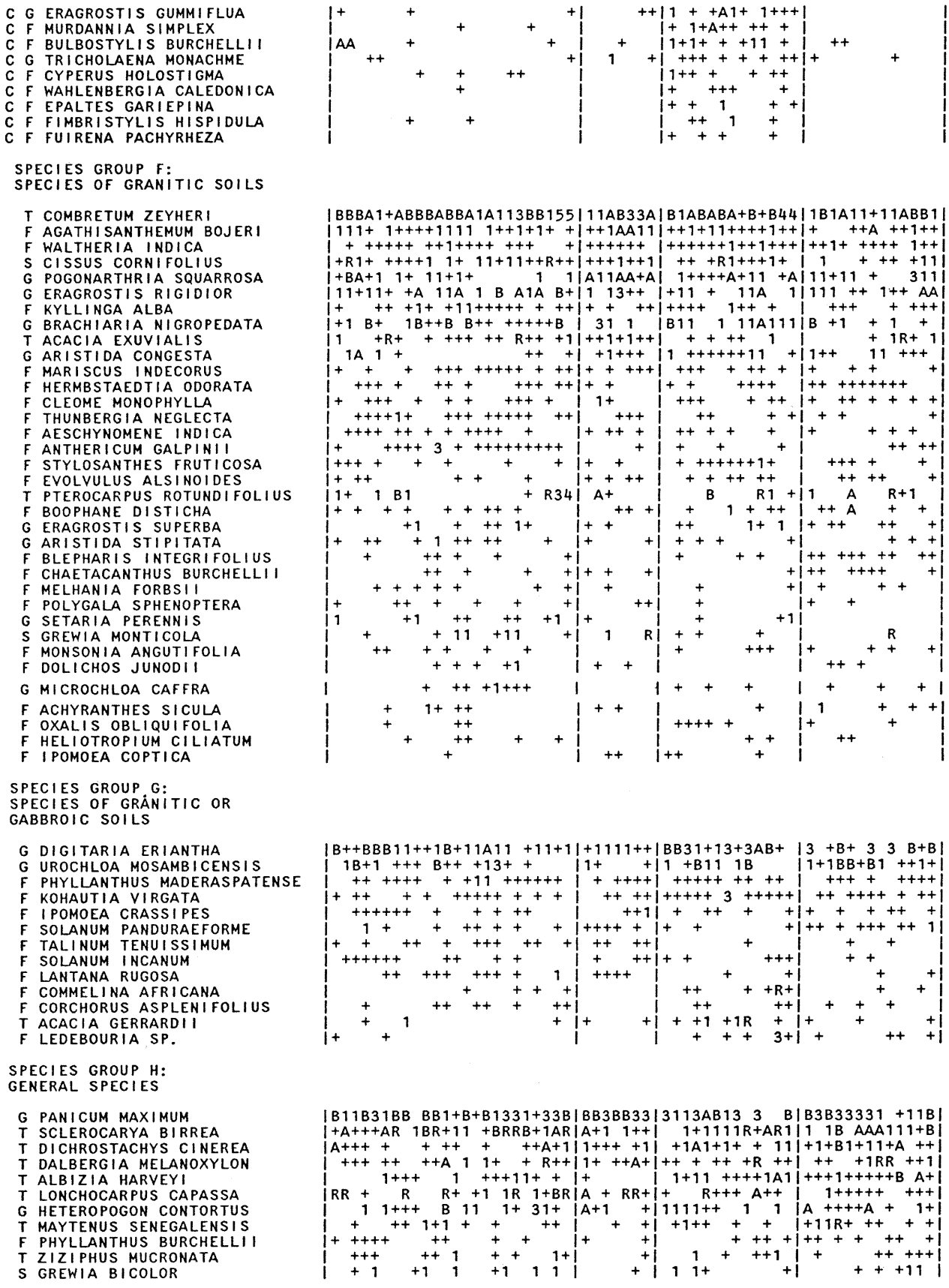
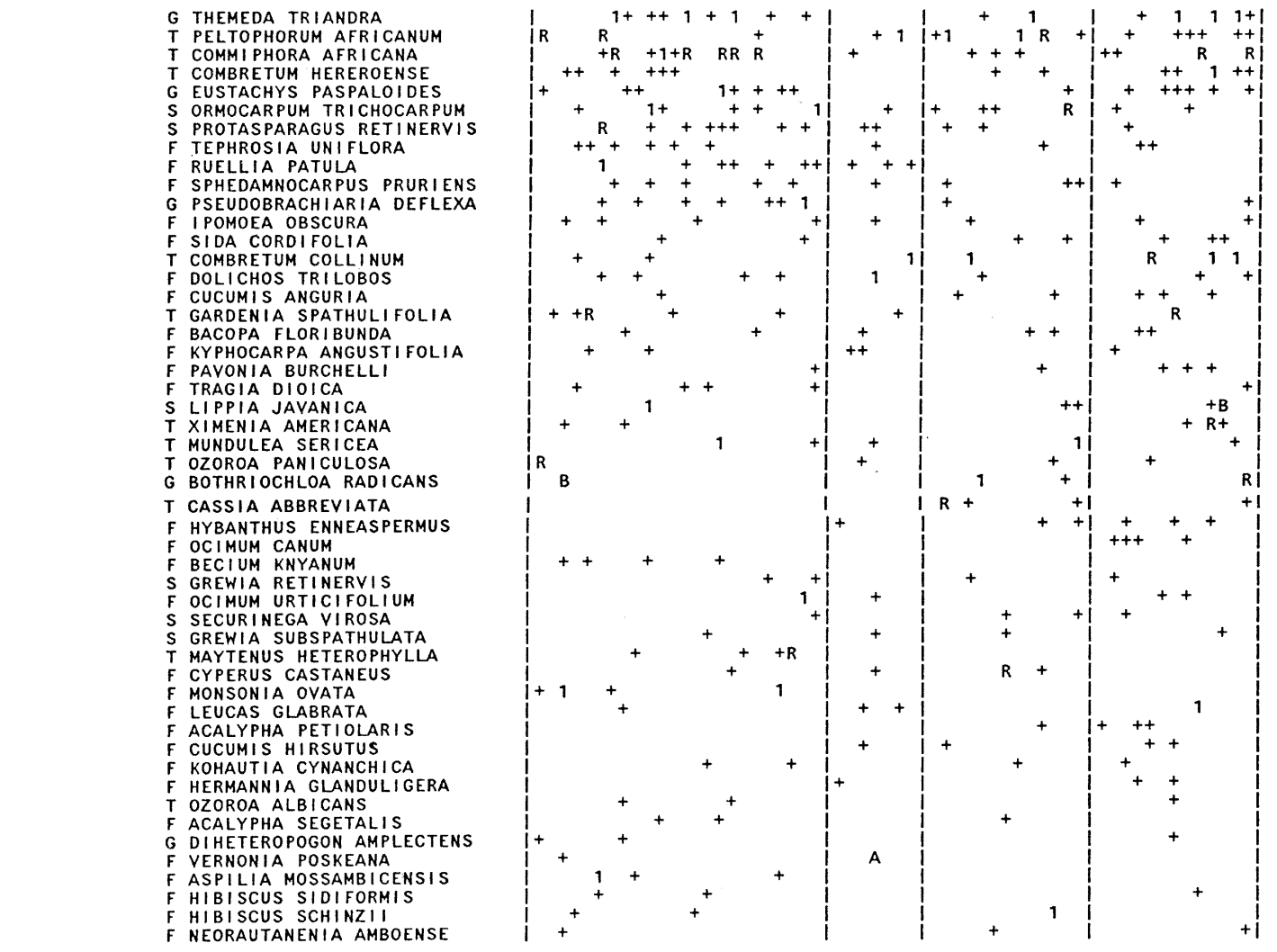


Table 1. Continued.



C = LOCAL CHARACTER SPECIES
D = DIFFERENTIAL SPECIES
T = TREE
S = SHRUB
F = FORB
G = GRASS
SPECIES WITH A FREQUENCY OF <3 ARE OMITTED FROM THE TABLE

within the Reserve, diagnostic species were distinguished. Local character species are more or less restricted to specific syntaxa while differential species have a wider distribution, but may be used to characterise specific syntaxa in a phytosociological table (Westhoff and Van der Maarel 1978). Names and descriptions of syntaxa are in accordance with Barkman *et al.* (1986). Names and authors of taxa are in accordance with Gibbs-Russell *et al.* (1984).

From the quantitative 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 distinguished communities. Importance value is the sum of the relative cover, relative density and the relative constancy, expressed as a percentage.

Gradients within the vegetation were determined by the application of Principal Components Analysis (Orlóci 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.

Results

Table 1 is the phytosociological table of the Perotido patentis-Terminalietum sericeae, produced by cluster analysis and refined with Braun-Blanquet procedures. The importance values of woody species in the different syntaxa are given in Table 2, and soil

Table 2. The Importance Values of the woody species in the subassociations and/or variants of the Perotido patentis-Terminalietum sericeae.

Species	Syntaxa			
	1.1	1.2	1.3	2
Combretum zeyheri	54,6	58,8	80,0	51,4
Combretum apiculatum	52,8	31,9	21,9	14,1
Terminalia sericea	19,8	38,3	42,6	45,9
Pterocarpus rotundifolius	16,6	5,0	12,6	13,3
Sclerocarya birrea	16,2	18,7	12,8	32,0
Acacia exuvialis	15,9	26,8	12,0	12,8
Cissus cornifolius	13,6	17,1	11,3	12,1
Dichrostachys cinerea	12,8	12,5	14,5	27,6
Dalbergia melanoxylon	12,2	14,3	8,2	21,1
Albizia harveyi	8,3	—	16,0	25,0
Lannea schweinfurthii	8,3	2,9	11,4	—
Commiphora africana	8,0	—	—	—
Acacia nigrescens	7,9	—	4,5	—
Lonchocarpus capassa	7,0	10,4	8,7	9,9
Maytenus senegalensis	6,2	2,9	6,8	22,1
Ziziphus mucronata	5,7	—	5,6	5,8
Ormocarpum trichocarpum	5,6	—	5,3	—
Grewia bicolor	5,6	—	4,6	5,6
Commiphora angolense	4,9	—	—	—
Grewia monticola	3,7	3,4	2,6	—
Pavetta schumanniana	3,5	—	—	—
Combretum hereroense	2,9	—	—	4,8
Acacia burkei	2,8	4,0	6,2	10,2
Commiphora mollis	2,5	6,3	—	—
Strychnos madagascariensis	—	26,7	—	—
Pterocarpus angolensis	—	7,8	—	—
Lannea discolor	—	4,3	—	—
Acacia gerrardii	—	3,4	8,4	3,0
Peltophorum africanum	—	3,0	5,3	5,1
Combretum collinum	—	—	—	5,1
Combretum molle	—	—	—	3,0
Ximenia americana	—	—	—	2,3

characteristics of the subassociations and variants are given in Table 3.

Classification

From the analysis results the following hierarchical classification of the Perotido patentis-Terminalietum sericeae:

1. The Perotido patentis-Terminalietum sericeae combretotosum apiculati subass. nov. on very acid, leached sandy soils

1.1. the *Sproobolus fimbriatus* Variant on moderately depp, relatively dry sandy soils,

1.2. the *Struchnos madagascariesis* Variant on very deep, leached, sandy soils,

1.3. the *Eragrostis gummiflua* Variant on shallower, strongly leached, wet sandy soils (seepage areas).

2. The Perotido patentis-Terminalietum sericeae urochloetosum mosambicensis subass. nov. on slightly less acid and less leached sandy soils with a slightly higher clay content.

Table 3. Soil characteristics of the A and B soil horizon of the lower syntaxa of the Perotido patentis-Terminalietum sericeae.

Soil characteristic	Syntaxon			
	1.1	1.2	1.3	2
Soil depth (m)	1,0	>1,2	0,4	0,6
Gravel A* (%)	12	7	9	10
Gravel B (%)	46	41	48	45
Sand A (%)	85	85	87	84
Sand B (%)	82	84	88	79
Clay A (%)	12	11	10	13
Clay B (%)	15	13	10	20
Potassium A (mg/100 g)	225	246	170	431
Potassium B (mg/100 g)	221	200	152	358
Sodium A (mg/100 g)	52	46	54	58
Sodium B (mg/100 g)	102	82	113	129
Magnesium A (mg/100 g)	223	179	166	270
Magnesium B (mg/100 g)	239	232	219	260
Calcium A (mg/100 g)	163	161	104	208
Calcium B (mg/100 g)	96	71	21	80
S-value A	663	632	494	967
S-value B	658	785	505	837
Conductivity A (umho/cm)	95	59	88	63
Conductivity B (umho/cm)	38	40	49	59
pH A	5,5	6,3	5,3	5,8
pHB	6,0	6,3	6,0	6,6

*A and B refer to the A and B soil horizon

Description of the plant communities

Within the Manyeleti Game Reserve the Perotido patentis-Terminalietum sericeae is mostly an open to dense, low to tall, tree veld (Bredenkamp and Theron 1985), representing the Broad Orthophyll Plains Bushveld of Werger and Coetzee (1978).

The association is restricted to deep, sandy, mesic fersiallitic, acid, dystrophic soils of upland sites on the gently undulating granite plains in the central parts of the Transvaal Lowveld (Bredenkamp, Theron and Van Vuuren 1983, Bredenkamp 1987).

Diagnostic species for this association within the Manyeleti Game Reserve were identified by Bredenkamp (1987). Local character species are those listed in group A, Table 1. The forbs *Crotalaria schinzii, Vigna angustifolia, Cyphostemma woodii, Striga elegans, Cyperus compressus* and *Cassia petersiana*, though restricted to this association, have low constancy values that restrict their diagnostic value.

Dominant and subdominant woody species include *Combretum zeyheri, Sclerocarya birrea, Terminalia sericea, Cissus cornifolius, Dichrostachys cinerea, Dalbergia melanoxylon, Albizia harveyi, Lonchocarpus capassa* and *Acacia exuvialis.*

The most prominent grass species on well preserved

sites are *Panicum maximum, Digitaria eriantha, Schmidtia pappophoroides* and *Brachiaria nigropedata*. On overgrazed and degraded sites the grasses *Urochloa mosambicensis, Eragrostis rigidior, Perotis patens, Aristida congesta* subsp. *congesta* and *Pogonarthria squarrosa* and the forbs *Agathisanthemum bojeri* and *Waltheria indica* become more prominent. Other prominent grass species are *Heteropogon contortus, Themeda triandra, Aristida stipitata, Setaria perennis*, and *Pseudobrachiaria deflexa*.

Many species restricted to soils derived from granite, are prominent in the Perotido patentis-Terminalietum sericeae. These are listed in species group F (Table 1). Species found on granite as well as on gabbro are listed in species group G, and widespread and other species in species group H (Table 1).

1. The Perotido patentis-Terminalietum sericeae combretetosum apiculati subass. nov.

Nomenclatural type: relevè 126.

The Perotido patentis-Terminalietum sericeae combretetosum apiculati occurs in the south-eastern parts of the Reserve, on the sandier, more acid and more leached soils of the association (Table 3). Diagnostic species for this subassociation are those of group B in Table 1.

1.1. The *Sporobolus fimbriatus* Variant is mostly restricted to the Glenrosa, Kusasa and Sandveld soil series. Generally, these moderately deep and relatively dry soils are slightly less sandy and have higher potassium, magnesium and calcium contents and S-values than those of the other variants (Table 3).

Diagnostic species of this Variant are those of group C in Table 1. It is clear that *Combretum zeyheri* and *C. apiculatum* are by far the most important species, however *Terminalia sericea, Pterocarpus rotundifolius, Sclerocarya birrea* and *Acacia exuvialis* can also be considered as relatively important species (Table 2).

The herbaceous layer has an average height of 0,7 m and a canopy cover of 74%. The most important grass species are *Panicum maximum, Perotis patens, Digitaria eriantha, Schmidtia pappophoroides, Eragrostis rigidior, Brachiaria nigropedata, Urochloa mosambicensis* and *Sporobolus fimbriatus*.

1.2 The *Strychnos madagascariensis* Variant is restricted to small local areas with very deep, more leached sands (lower sodium, potassium, magnesium and calcium contents, lower S-value and lower conductivity, Table 3) found scattered throughout the *Sporobolus fimbriatus* Variant.

Diagnostic species are those listed in group D in Table 1. The relatively high importance of *Strychnos madagascariensis* and presence of *Pterocarpus angolensis* (Table 2) should be emphasized. However, *Combretum zeyheri, C. apiculatum* and *Terminalia sericea* are still the most important woody species in this Variant.

The herbaceous layer is well developed, on average 1.1 m tall and with an average canopy cover of 82%. The most conspicuous species are the grasses *Panicum maximum, Digitaria eriantha, Pogonarthria squarrosa* and *Trichoneura grandiglumis* and the forb *Agathisanthemum bojeri*.

1.3 The *Eragrostis gummiflua* Variant is often situated lower down against the sandy slopes in the gently undulating landscape. Here the soils are mostly not as deep as in the case of the other variants of the *Perotido patentis-Terminalietum sericeae combretetosum apiculati*. The high water table, seepage of water and consequently extremely leached E-horizons of the Kusasa and Sandvlei soil series, are conspicuous features of the habitat. The extremely low clay content as well as low potassium, magnesium and calcium contents and low S-values (Table 3) are also characteristic.

Diagnostic species are those of group E in Table 1 and are mostly indicators of wet, water saturated conditions. *Combretum zeyheri* is the most important tree species, with *Terminalia sericea* conspicuously present (Table 2).

The herbaceous layer is 0.6 m tall and covers 74%. *Panicum maximum* is by far the dominant species, but *Eragrostis gummiflua, Brachiaria nigropedata, Urochloa mosambicensis, Pogonarthria squarrosa* and *Digitaria eriantha* are locally very prominent.

2. The Perotido patentis-Terminalietum sericeae urochloetosum mosambicensis subass. nov.

Nomenclatural type: relevè 222.

The Perotido patentis-Terminalietum sericeae urochloetosum mosambicensis occurs in the north-western parts of the Reserve. The soils of this subassociation are slightly less acid, have a slightly higher clay content, and have a higher potassium, sodium, magnesium and calcium content and higher S-value than the soils of the Perotido patentis-Terminalietum sericeae combretetosum apiculati (Table 3). The woody component of the Perotido patentis-Terminalietum sericeae urochloetosum mosambicensis is generally less dense than that of the Perotido patentis-Terminalietum sericeae combretetosum apiculati. Although no diagnostic species group could be identified, the Perotido patentis-Terminalietum sericeae urochloetosum mosambicensis can easily be distinguished by the absence of species group B (Table 1).

Combretum zeyheri, Terminalia sericea and *Sclerocarea birrea* are the most prominent trees in the woody component. However, in this subassociation, with the slightly more clayey and richer soils, the importance of *Dichrostachys cinerea, Albizia harveyi, Maytenus senegalensis* and *Dalbergia melanoxylon* is relatively high (Table 2). The preference of these species, especially of *Dichrostachys cinerea* and *Maytenus senegalensis*, to sandy, well drained but richer soils was also indicated by Werger and Coetzee (1978) and Bredenkamp and Theron (1985).

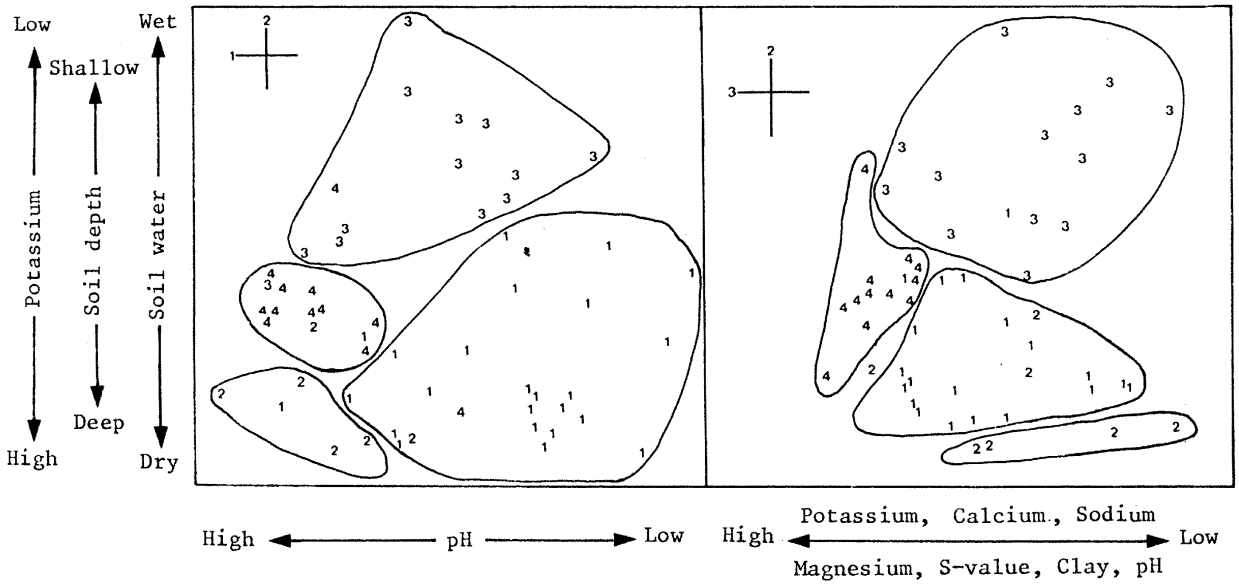


Fig. 1. The distribution of relevès along (a) the first and second and (b) the second and third axes of ordination. (1 = *Sporobolus fimbriatus* Variant, 2 = *Strychnos madagascariensis* Variant, 3 = *Eragrostis gummiflua* Variant, 4 = Perotido patentis-Terminalietum sericeae urochloetosum mosambicensis.

The vegetation of this subassociation is usually more intensely grazed than that of the Perotido patentis-Terminalietum sericeae combretetosum apiculati. The average height of the herbaceous layer is 0.70 m, and the average canopy cover is fairly low, namely 71%. *Panicum maximum, Urochloa mosambicensis* and *Digitaria eriantha* are the most important species in the herbaceous layer. Other species are those of the association (Table 1).

Ordination

The distribution of relevès along the first and second, and second and third axes of ordination are given in Figure 1. In the scatter diagrams (Figure 1a and b), no distinct discontinuity in the distribution of the relevès can be observed. However, the distinguished syntaxa are more or less restricted to specific areas in the scatter diagrams. Species with the highest eigenvalues in

Table 4. Species with high eigenvalues in the first three principal components of the ordination.

Principal Components					
1		2		3	
Species	Eigenvalues $\times 10^3$	Species	Eigenvalues $\times 10^3$	Species	Eigenvalues $\times 10^3$
*DV1 Urginea altissima	1000	KV3 Murdannia simplex	1000	KS1 Trichoneura grandiglumis	1000
KV1 Commiphora angolensis	967	DV3 Epaltes gariepina	873	KV3 Tricholaena monachme	896
DS1 Commelina erecta	788	DV3 Cyperus holostigma	864	KA Cyperus compressus	768
DS1 Combretum apiculatum	786	KV3 Wahlenbergia caledonica	857	KV3 Eragrostis gummiflua	755
KS1 Tricliceras lacerata	769	KV3 Fuirena pachyrrheza	817	KS1 Rhynchelytrum repens	750
DV1 Sporobolus fimbriatus	744	KV3 Eragrostis gummiflua	728	Microchloa caffra	−741
DV3 Cyperus holostigma	705	KS1 Rhynchelytrum repens	658	Dolichos tribolos	−635
DS1 Stylochiton natalensis	700	KV3 Fimbristylis hispidula	633	KS1 Heliotropium strigosum	599
DS1 Acacia nigrescens	665	DV1 CLerodendrum ternatum	−573	Combretum zeheri	583
KV1 Harpagophytum zeyheri	618	KA Terminalia sericea	556	Sclerocarya birrea	534
DV1 Jatropha zeyheri	596	KS1 Indigofera filipes	542	KS1 Oxygonum dregeanum	520
KV1 Strychnos madagascariensis	−592	KV1 Plexipus adenostachyus	−542	Ocimum urticifolium	−515
KV1 Ipomocea bolusiana	551	DV2 Justicia protracta	−540	DS1 Combretum apiculatum	505
KV 2 Borreria scabra	−498				
DV2 Justicia protractra	−432				

*K - local character species; D - differential species; V1 - *Sporobolus fimbriatus* Variant; V2 - *Strychnos madagascariensis* Variant; V3 - *Eragrostis gummiflua* Variant; S3 - *Combretetosum apiculati; A1 - Perotido patentis-Terminalietum sericeae.*

the first, second and third principal components are given in Table 4. From overlays of habitat data on the ordination diagrams it was determined that the gradient in vegetation in the first component may be associated with a gradient in soil pH, with relatively high pH-values to the left, and low values to the right of the diagram (Figure 1a). In this component the relevès of the *Strychnos madagascariensis* Variant and the Perotido patentis-Terminalietum sericeae urochloetosum mosambicensis, which both occur on slightly less acid soils, are located to the left, while the relevès of the *Eragrostis gummiflua* and *Sporobolus fimbriatus* Variants, which both occur on acid soils, are located to the right in the scatter diagram. Most species with high positive eigenvalues in the first principal component (Table 4), are diagnostic species of the *Sporobolus fimbriatus* Variant. Generally most relevès of the Perotido patentis-Terminalietum sericeae combretetosum apiculati are located to the right, and a few species with high eigenvalues in the first component are diagnostic for this subassociation. The species with high negative eigenvalues are diagnostic for the *Strychnos madagascariensis* Variant. This Variant is located in the bottom-left of the diagram (Figure 1a).

In the second component relevès of the *Eragrostis gummiflua* Variant are located at the top of the scatter diagram, followed downwards successively by relevès of the *Sporobolus fimbriatus* Variant and the *Strychnos madagascariensis* Variant. This sequence also represents gradients in soil depth, probably soil water regime and, as far as the Perotido patentis-Terminalietum sericeae combretetosum apiculati is concerned, also the potassium content. Relevès from shallow, wet, leached soils are located at the top and those from deep, dry, relatively richer soils at the bottom of the scatter diagram (Figure 1b). In the second principal component species with high positive eigenvalues are diagnostic species of the *Eragrostis gummiflua* Variant, the relevès of which are located at the top of the diagrams (Figure 1a and 1b). The few species with high negative eigenvalues are diagnostic for the *Sporobolus fimbriatus* Variant and *Strychnos madagascariensis* Variant, both located lower down in the diagrams.

In the third component the relevès of the Perotido patentis-Terminalietum sericeae urochloetosum mosambicensis, of less acid, richer and slightly more clayey soils, are located to the left, and those of the Perotido patentis-Terminalietum sericeae combretetosum apiculati of acid, leached, dystrophic, sandy soils, to the right in Figure 1b. Associated gradients in habitat are a decrease from left to right in the following soil properties: pH, clay content, potassium, magnesium, and calcium contents and S-value. A few of the species with high positive eigenvalues in the third principal component are diagnostic species of the Perotido patentis-Terminalietum sericeae combretetosum apiculati. Relevès of this subassociation are located to the right of the diagram.

Concluding remarks

The classification obtained by agglomerative cluster analysis (Orlóci 1967) refined by Braun-Blanquet procedures resulted in vegetation units that can be related to the environmental factors observed, and should therefore be considered as ecologically sound plant communities of the area concerned. The classification is supported by the results of the ordination, and the latter also provides an understanding of the vegetation gradients and the associated habitat gradients within the association.

The classification contributes to the present scanty knowledge of the synecology and syntaxonomy of the Transvaal Lowveld. More phytosociological data and classifications of this area are needed to construct a meaningful syntaxonomical classification for the entire Transvaal Lowveld Region in South Africa.

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