

An ecological study of the major vegetation communities of the Vaalbos National Park, Northern Cape. 1. The Than-Droogeveld section

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A detailed classification, description and mapping of the Than-Droogeveld section of the Vaalbos National Park, Northern Cape Province, were initiated. This classification is intended to serve as an ecological basis for the establishment of an efficient wildlife management programme as well as conservation policies for the Vaalbos National Park. Using a numerical classification technique (TWINSPAN) as a first approximation, the classification was refined by applying Braun-Blanquet procedures. A hierarchical classification, as well as description, ecological interpretation and a vegetation map are presented. In the phytosociological table 11 major plant communities are recognised.

Keywords: conservation, environmental data, Northern Cape, Vaalbos National Park, vegetation classification.

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Introduction

The Vaalbos National Park (VNP) is one of the most recently proclaimed national parks (September 1986). The necessity for an ecological classification, description and mapping of the vegetation of a conservation area was stated by Bredenkamp & Theron (1978), NACOR (1979) and Van Rooyen *et al.* (1981). A sound knowledge of the ecology will contribute considerably to the establishment of an efficient wildlife management programme and conservation policy for the VNP. Being a national park, it should also serve as a permanent reference area for wider reconnaissance surveys in the Northern Cape region. Apart from Gubb's (1989) broad-scale vegetation classification of the Northern Cape and Acocks' (1953) description of the veld types of South Africa, little is known about the vegetation of the area. Therefore, the main aim of this study was to classify, describe, interpret and map the vegetation of the VNP.

This project also forms part of a broader inventory of the diversity of plant species and

plant communities conserved in the different national parks, as already conducted for the Augrabies Falls National Park (Werger & Coetzee 1977), Mountain Zebra National Park (Van der Walt 1980), Zuurberg National Park (Van Wyk *et al.* 1988) and Golden Gate Highlands National Park (Kay *et al.* 1993).

In a floristic analysis of the VNP, 334 species were collected and identified, representing 211 genera and 65 families (Zietsman *et al.* 1992). The Dicotyledonae is represented by 55 families, which is 85.9% of the total number of families in the VNP. The largest plant family represented in the VNP is the Poaceae, with 57 species (17.1% of all species). According to Zietsman *et al.* (1992) the life form spectrum of the plants indicates that the VNP is a hemicryptophytic-therophytic area.

Study area

Location

The VNP consists of two sections, the largest one, the Than-Droogeveld section (18 120 ha)

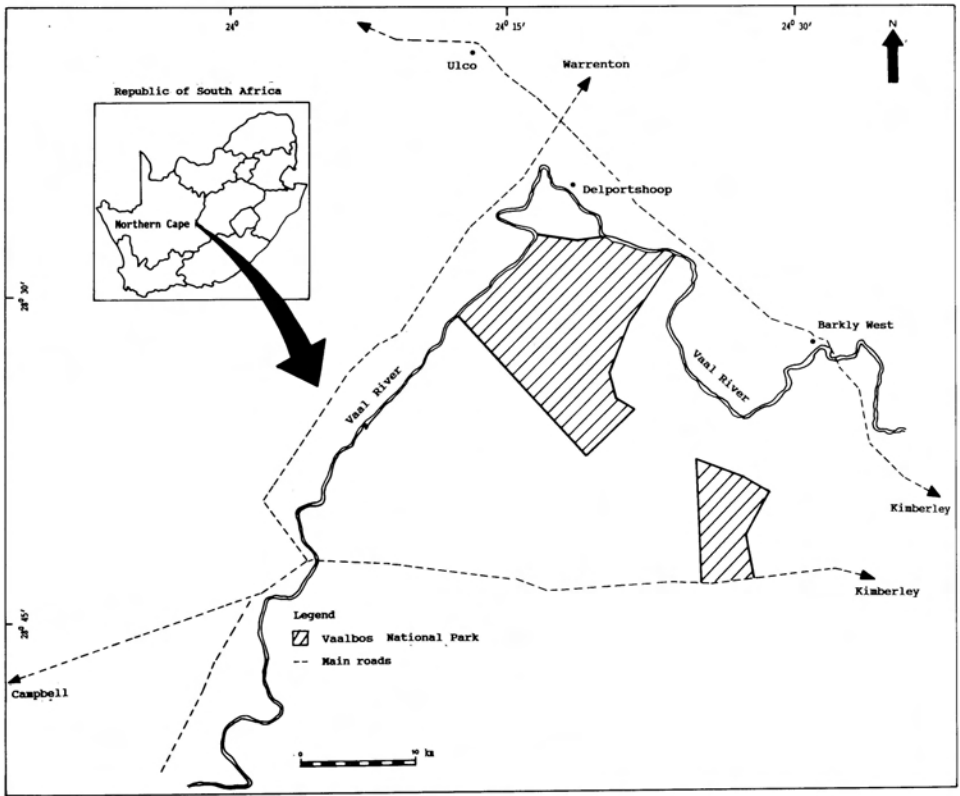
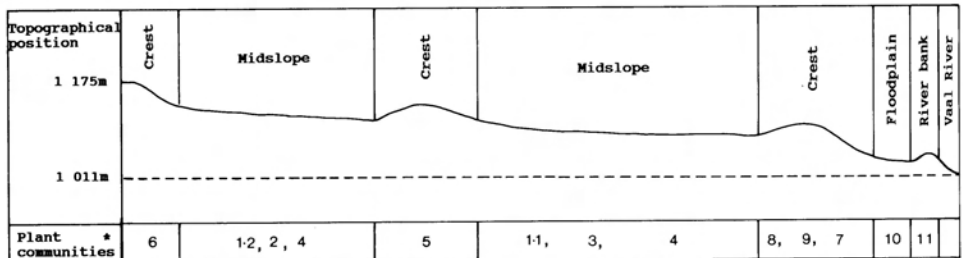


Fig. 1. The location of the Vaalbos National Park in relation to towns and the Vaal River.

is located approximately 61 km north-north-west of Kimberley, while the smaller one, the Gras-Holpan section (4 576 ha) is situated at about 25 km west of Kimberley (Fig. 1).

Unfortunately, these two sections are separated by private land and are being managed separately at this stage. The VNP extends from 28°25'S to 28°40'S and 24°12'E to



* Community numbers in text

Fig. 2. A simplified sketch of the landscape of the TD section, indicating the topographical positions of the plant communities.

24°26'E. The Than-Droogveld section is situated south of a bend in the Vaal River, which forms the north-western and north-northeastern boundaries (Fig. 1). This report deals with the vegetation of the Than-Droogveld section (TD section) only.

Physiography, geology, soils, land types and vegetation

The landscape varies from flat to gently undulating plains, with an altitude that varies from 1 011 m to 1 175 m. The following topographical positions are distinguished in the TD section: crest, midslope, floodplain and river bank (Fig. 2; adapted from the Land Type Survey Staff 1986). Small isolated patches of rocky outcrops occur in the north, west and southern parts of the TD section. The Vaal River, which is joined by the Harts River just outside the TD section, forms the core of the drainage system of the area.

The TD section is underlain by the following geological types. Outcrops of the andesitic lavas of the Ventersdorp Supergroup, which is mostly overlain by calcrete, occur in isolated patches as rocky hills (Spaggiari 1993). Outcrops of tillite of the Dwyka Formation and shale of the Prince Albert Formation (Karoo Sequence) occur in the north-north-western part of the TD section (Land Type Survey Staff 1986). The largest part of TD section is mainly underlain by aeolian sand and sometimes by alluvial gravels of Tertiary to Recent age covering Dwyka tillite (Helgren 1979). Surface limestone occurs sporadically in the area (Land Type Survey Staff 1986). During the 1920s, relatively rich diamond deposits were found in the ancient gravel-filled water courses of the Vaal River. This area, especially the TD section, was a hive of activity. It produced diamonds to the value of over £300 000 in 1913 (Wagner 1914). The heaps of mixed gravel still present in the area attest to the disturbance to which it was subjected.

The soil type varies from deep red and yellow sands (Hutton and Clovelly soil forms) to

shallow and stony (Mispah and Kimberley soil forms) while the soil in the north-western floodplain, is moderately deep and clayey (Valsrivier soil form). The banks of the Vaal River consist of silt-clayey soil (Oakleaf soil form) while the soil of debris of old diamond diggings is very disturbed. This soil type varies from a deep to a shallow Hutton form as well as a Mispah soil form.

Three land types, the Ah, Ae and Dc land types occur in the TD section. According to the Land Type Survey Staff (1986) "A land type denotes an area that can be shown at 1:250 000 scale and that displays a marked degree of uniformity with respect to terrain form, soil pattern and climate". The A-unit refers to yellow and red apedal, freely drained soil without water tables. The Ae land type refers to red, high base status soil, of which the depth varies from 0,1 m to > 0,3 m. The Ah land type varies from the Ae land type in that it also includes yellow soil and is consistently deeper than 0,3 m. The Dc land type indicates land where the soil has structure, such as prismatic, pedocutanic, vertic, melanic and red structured (Land Type Survey Staff 1986). The Land Type concept has frequently provided a useful basis for description of vegetation (Bezuidenhout 1988 and 1993, Kooij 1990, Breytenbach 1991, Smit 1992 and Myburgh 1993).

In terms of Acocks' (1953) the largest part of the vegetation of the TD section consists of Kalahari Thornveld invaded by Karoo (Veld Type 17), while a small section along the banks of the Vaal River, consists of the False Orange River Broken Veld (Veld Type 40). One of the interesting features of the VNP that is worth conserving, is the interface of two biomes, namely the Savanna Biome and the Nama-Karoo Biome that meet in the Gras-Holpan section (Rutherford & Westfall 1986).

Climate

The rainfall, mainly during summer, is erratic and can be as high as 700 mm per year (June

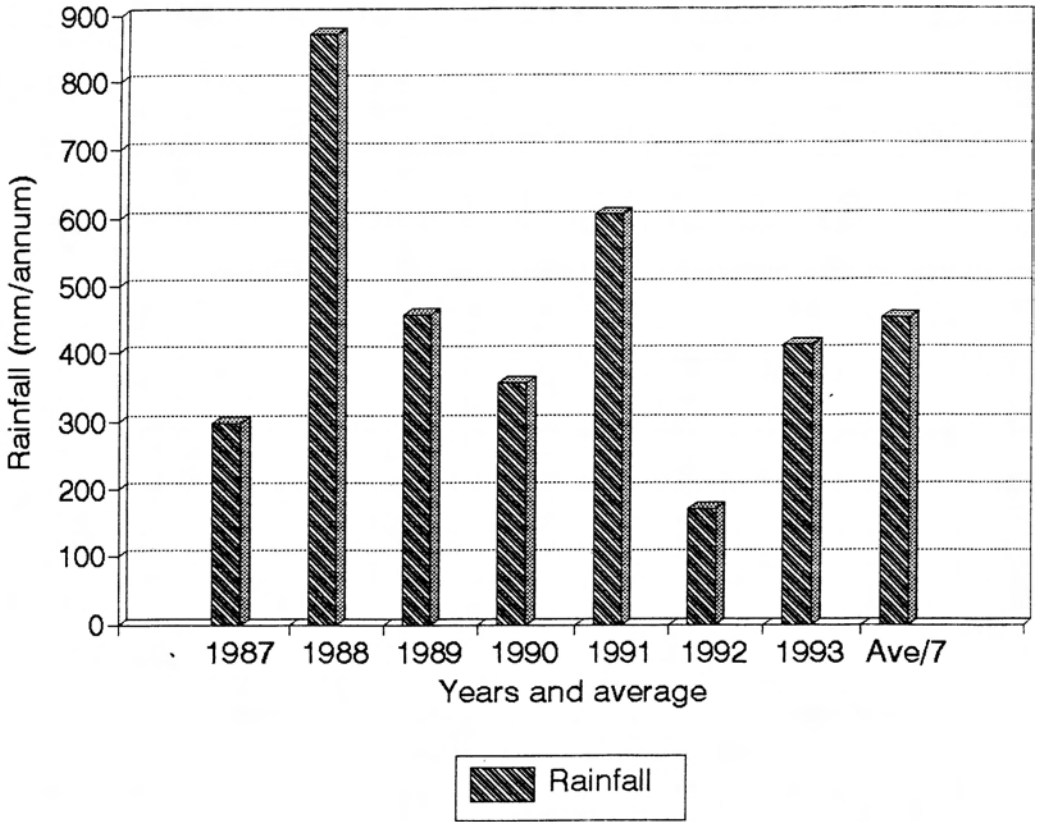


Fig. 3. The rainfall (mm/annum) statistics for the past seven years of the TD section, Vaalbos National Park.

to May), but also as low as 300 mm per year (June to May) (Fig. 3). The average annual rainfall for the TD section based on data from the past seven years (1987 - 1993), is just over 400 mm per annum. During February - April 1991, the year in which the fieldwork for this study was done, the rainfall was high (Fig. 4). The average rainfall for 1991, was higher than the average for this semi-arid region (Fig. 3). The temperature is less erratic than the rainfall with cold winters (coldest months June - July) as low as -4°C while the summer (warmest months December - January) is as high as 44°C . Frost occurs, with the earliest date recorded being 27 April and the latest date 23 September, while its duration can be as long as 107 days (Land Type Survey Staff 1986).

Methods

The stratification of the area into relatively homogeneous physiographic-physiognomic units was done on 1:50 000 aerial photographs. Sample plots were allocated to these units *pro rata* on the basis of the sizes of the areas. Relevés were compiled in 138 sample plots. After using the Nested Plot Technique as was described by Mueller-Dombois & Ellenberg (1974) to establish the minimum sample area, the plot size was fixed on 900 m^2 (30m x 30m). Fieldwork was done between February and the end of April 1991.

The cover-abundance for each species present in the sample plot was estimated according to the Braun-Blanquet scale (Mueller-Dombois & Ellenberg 1974). An estimated height and canopy cover average for the tree, shrub and herbaceous layers are given for each individual community (Bezuidenhout 1988). Environmental data include identification of rock, terrain and soil types as well as, soil depth, soil texture and an estimation of the rockiness of the soil surface (Fig. 5).

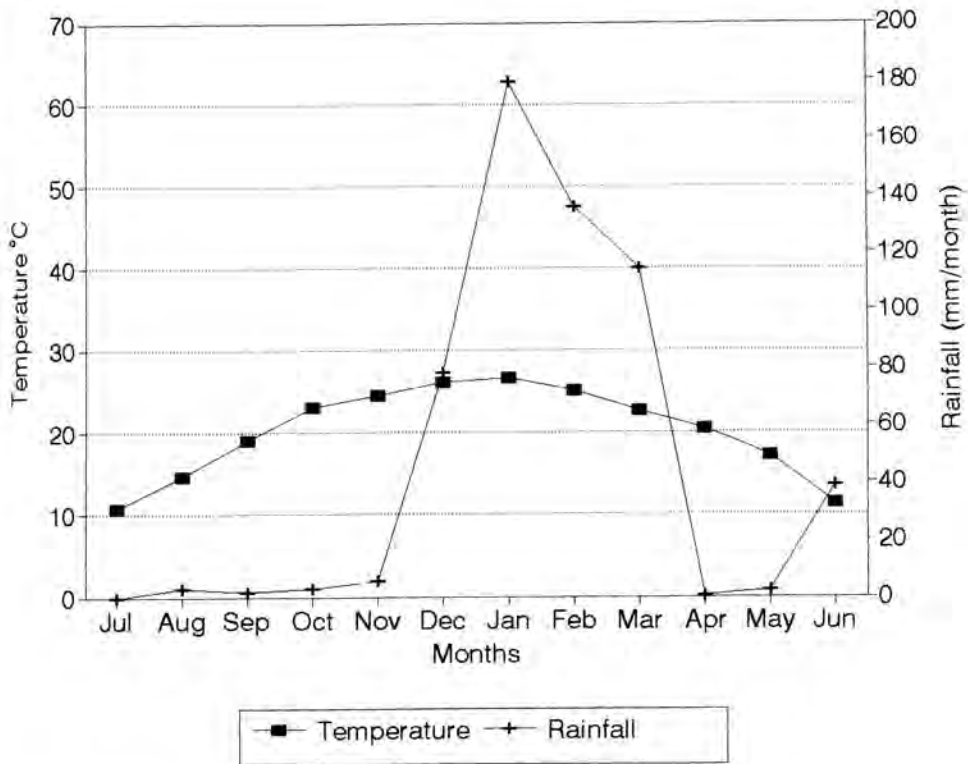


Fig. 4. A climate diagram for the TD section (July 1990 to June 1991).

The TWINSPLAN classification algorithm (Hill 1979a) was used for analysing the floristic data, as first approximation, and subsequently Braun-Blanquet procedures were used to refine these results. The final result of the classification procedure is a phytosociological table (Table 1). This approach proved to produce ecologically reliable results in many phytosociological studies (Bredenkamp & Bezuidenhout 1990; Kooij 1990; Breytenbach 1991; du Preez 1991; Bezuidenhout 1993; Eckhardt 1993; Fuls 1993; McDonald 1993; Mustart *et al.* 1993; Myburgh 1993). No attempt was made to formally fix syntax names as this is normally avoided in detailed local studies (Coetzee 1983).

An ordination algorithm, DECORANA (Hill 1979b) was also applied to the floristic data to illustrate floristic relationships between plant communities to detect possible gradients in and between communities and to detect possible habitat gradients associated with vegetation gradients (Fig. 6). Taxa names conform to those of Arnold & De Wet (1993). Soil

nomenclature follows the classification of the Soil Classification Working Group (1991). Edwards' (1983) broad-scale structural classification was used for describing the structure of the vegetation.

Results

Classification

In the phytosociological table (Table 1), 12 plant communities are recognised, which can be grouped into 11 major plant communities. The hierarchical classification and a brief habitat interpretation of these communities are summarised as follows:

1. *Schmidtia pappophoroides* - *Themeda triandra* Grassland of deep (> 1,2 m) to

moderately deep (0,3 m - 0,8 m), well-drained sandy soil.

1.1 *Themeda triandra* - *Eragrostis paltens* Variant not burnt.

1.2 *Themeda triandra* - *Elephantorrhiza elephantina* Variant burnt.

2. *Grewia flava* - *Acacia erioloba* Woodland of deep (> 1,2 m) well-drained red sandy soil of the western part of the TD section.
3. *Lycium hirsutum* - *Acacia erioloba* Woodland of deep (> 1,2 m) well-drained yellow sandy soil of the north-northeastern part of the TD section.
4. *Rhus ciliata* - *Tarchonanthus camphoratus* Shrubland of moderately deep (0,3 m - 0,8 m) sandy soil.
5. *Acacia erioloba* - *Acacia tortilis* Woodland of ancient gravel filled water courses.
6. *Boscia albitrunca* - *Acacia mellifera* Shrubland of the isolated rocky hills.
7. *Acacia tortilis* - *Acacia mellifera* Shrubland of shallow (< 0,3 m) stony soil with large rocks on the soil surface.
8. *Emeapogon cenchroides* - *Acacia tortilis* Woodland of relative recently deposited Vaal River gravel.
9. *Pentzia incana* - *Acacia mellifera* Shrubland of the shallow (< 0,3 m) stony soil with small stones on the soil surface.
10. *Eragrostis* species - *Chloris virgata* Grassland of the moderately deep (0,3 m - 0,8 m) clayey soil.
11. *Combretum erythrophyllum* - *Acacia karroo* Woodland of the deep (> 1,2 m) alluvial soil of the banks of the Vaal River.

Description of the vegetation

The vegetation is strongly related to soil type. Four major soil type/vegetation associations can be recognised: the plant species of rela-

tively deep sandy soil (species group G; Table 1), the plant species of the shallow stony soil (species group R; Table 1), the plant species of the moderately deep clayey soil (species group S; Table 1) and the plant species of the deep silt-clayey soil (species group V; Table 1) (Fig. 5). The plant species of species group BB (Table 1) are generally found in all of the vegetation communities.

1. *Schmidtia pappophoroides* - *Themeda triandra* Grassland

The *Schmidtia pappophoroides* - *Themeda triandra* Grassland occurs on the midslope (Fig. 2), mainly in the southern part of the study area (Fig. 7) and is strongly associated with very deep (> 1,2 m) to moderately deep (0,3 m - 0,8 m) well-drained sandy (clay-content < 10%) soil. This community is underlain by aeolian sand covering Dwyka tillite. Surface limestone occurs sporadically. No rocks or stones on the soil surface were recorded in the relevés of this community (Fig. 5). The dominant soil forms are Hutton and Clovelly, but the Mispah form can also occur. This grassland is situated in the Ah land type.

This community is characterised by species group A (Table 1) and the diagnostic species are the grass *Themeda triandra* and the forb *Solanum panduriforme*. The poorly developed tree stratum is 6 m tall, with a canopy cover of 2%. Sparsely distributed *Acacia erioloba* is the prominent tree in this community. The shrub stratum, with species such as *Grewia flava* and *Tarchonanthus camphoratus*, is poorly developed with a canopy cover of 3% and a height of 2 m. The herbaceous stratum is well developed, about 0,8 m tall with a canopy cover of 58%. The dominant grasses are *Schmidtia pappophoroides*, *Eragrostis lehmanniana* and *Aristida congesta*, while the most prominent forbs are *Indigofera daleoides*, *Hermannia tomentosa* and *Convolvulus multifidus* (Table 1).

Table 1
A phytosociological table of the vegetation of the Than-Droegeveld section, Vaalbos National Park

Sample numbers	1	2	3	4	5	6	7	8	9	10	11			
906	111	11	11,1	111	11	1111	11	11111	1,1,11	11	11	1	111	11
10694134697616584	590821234782	67689245166916803734752	78229346135	07133023603373958892190224808545	17905900	44561	59123223	7056768	145378	80457194	78			
Plant communities numbers (in text)	1.1	1.2												
Species Group A														
<i>Themeda triandra</i>	2+	+	R++1+	++++	+++	+								
<i>Solanum panduriforme</i>	+ R+++	+++	++	++	++	+	+	R + R	+				+	
Species Group B														
<i>LitospERMUM cinereum</i>	+++ +	+++												
<i>Barleria macrostegia</i>	+ R +	+	+	+	+	+	+							
Species Group C														
<i>Chamaesyce inaequilatera</i>	+ R+ ++	+	+	+	+	+	+							
<i>Cyperus margaritaceus</i>	+++ +	+	+	+	+	+	+							
Species Group D														
<i>Ipomoea obscura</i>	+	R	++	++	+	+	+	++					+	
<i>Merremia tridentata</i>			+	+++										
<i>Solanum nigrum</i>			++	+										
Species Group E														
<i>Setaria verticillata</i>			+++ +											++
Species Group F														
<i>Lycium hirsutum</i>	RR	+	++	+	++	+	++	++	+	+	+	+	+	++
<i>Pavonia burtonellii</i>	+	+	+++	+++	+++	+	+++	+++	+	+	+	+	+	

Table 1 (continued)

Species Group G									
<i>Eragrostis pallens</i>	+++	1+	++++	1	+				
<i>Requienia spiraerosperma</i>	+++	+++	+	+	++				
<i>Harpagophytum procumbens</i>	+	+	+	++	R++				
Species Group H									
<i>Barleria bechuanaensis</i>	++								
<i>Coccinia sessilifolia</i>		+							
<i>Hermannia eonii</i>		+							
<i>Pentarrhinum insipidum</i>									
Species Group I									
<i>Hibiscus pusillus</i>									
Species Group J									
<i>Boscia albitrunca</i>									
<i>Eragrostis echinochloidea</i>									
<i>Bulbine narcissifolia</i>									
<i>Sida dregei</i>									
<i>Sesamum alatum</i>									
<i>Protaspargus larinicus</i>									
<i>Anthephora pubescens</i>									
<i>Asclepias fruticosa</i>									
<i>Crassula species</i>									
<i>Eustachys paspaloidea</i>									
Species Group K									
<i>Rhus ciliata</i>									
<i>Rhyz'hosia totta</i>									
<i>Heteropogon contortus</i>									
<i>Brachiaria nigropedata</i>									
<i>Pegolettia retrofracta</i>									
<i>Dicoma macrocephala</i>									

Table 1 (continued)

Species Group L										
<i>Lepidium bonariense</i>										
<i>Hermania affinis</i>										
<i>Seddera capensis</i>										
<i>Alternanthera nodiflora</i>										
<i>Sporobolus coromandelianus</i>										
<i>Ptycholobium biflorum</i>										
<i>Barleria rigida</i>										
Species Group M										
<i>Plexipus pinnatifidus</i>										
<i>Hermania comosa</i>										
<i>Cleome rubella</i>										
<i>Cymbopogon pluzinodis</i>										
<i>Ehretia rigida</i>										
Species Group N										
<i>Rhigozum trichotomum</i>										
<i>Hermannia quartiana</i>										
<i>Corbichonia decumbens</i>										
<i>Cleome maculata</i>										
Species Group O										
<i>Digitaria eriantha</i>										
<i>Cenchrus ciliaris</i>										
Species Group P										
<i>Heliotropium ciliatum</i>										
<i>Amaranthus praetermissus</i>										
<i>Indigofera parvulus</i>										
<i>Zygophyllum pubescens</i>										

Table 1 (continued)

Species Group U										
<i>Sporobolus fimbriatus</i>										++ +
<i>Aristida barbicollis</i>										++ +
<i>Corchorus asplenifolius</i>										++ +
<i>Thesium lineatum</i>										++ +
Species Group V										
<i>Acacia karroo</i>										++ +
<i>Combretum erythrophyllum</i>										++ +
<i>Rhus pendulina</i>										++ +
<i>Salix micromata</i>										++ +
<i>Argemone ochroleuca</i>										++ +
<i>Datura stramonium</i>										++ +
<i>Verbena bonariensis</i>										++ +
<i>Phragmites australis</i>										++ +
<i>Nicotiana glauca</i>										++ +
<i>Nicotiana longiflora</i>										++ +
Species Group W										
<i>Hirpicium echinus</i>										++ +
<i>Helichrysum zeyheri</i>										++ +
<i>Striga gesnerioides</i>										++ +
Species Group X										
<i>Rhynchosia confusa</i>										++ +
<i>Cucumis africana</i>										++ +
<i>Commelina africana</i>										++ +
<i>Malafida densiflora</i>										++ +
<i>Chrysocoma ciliata</i>										++ +
<i>Loxomonis crumina</i>										++ +
<i>Lineum fenestratum</i>										++ +

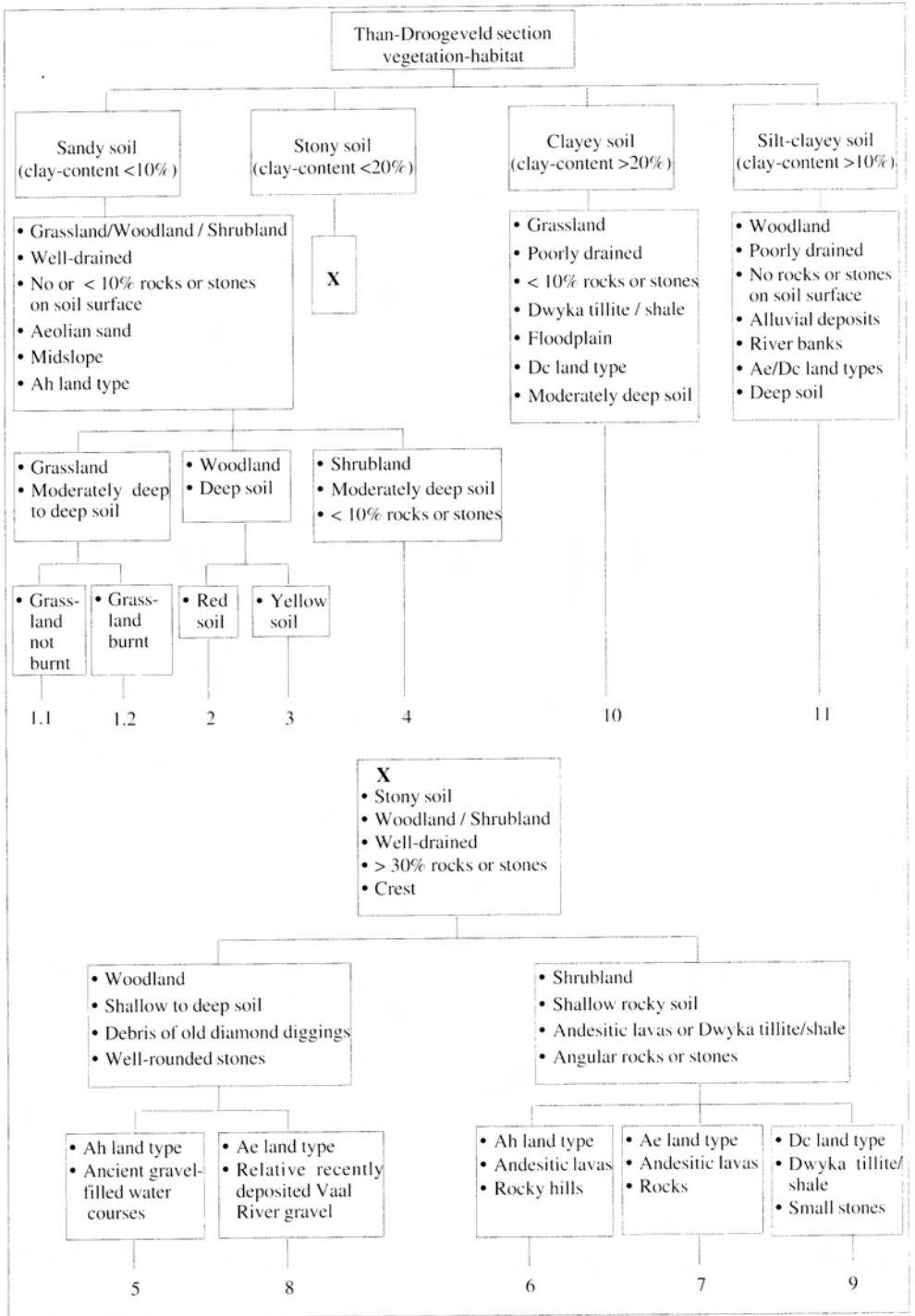


Fig. 5. A dendrogram to illustrate the habitat relationships of the plant communities of the TD section, Vaalbos National Park. Numbers used in this figure refer to community numbers in text.

A similar vegetation type, namely the Kalahari-Kuruman Sourveld Transitional Grasslands was described by Gubb (1989).

Two small (diameter of 5 m - 10 m) isolated pans occur in this grassland. No sampling was done in these areas because of the scale on which the classification was done. Dominant grasses occurring in these pans are *Hemarthria altissima*, *Diplachne fusca* and *Eragrostis bicolor*.

In December 1990 a management decision was made to burn a section of this grassland community as well as other communities in the southern part of TD section. Although the area received good rains, after the fire (Figs. 3 & 4), certain floristic differences were detected (species groups B and C; Table 1). Unfortunately no vegetation surveys were conducted before the fire so it is uncertain whether the observed floristic differences were due to the fire itself or some other factor. However there were no obvious topographic or soil factors associated with the two variants, so the fire may well have been the main cause of the difference (Fig. 5).

1.1 *Themeda triandra* - *Eragrostis pallens* Variant

This variant was not burnt and the diagnostic species which characterise it, are the inconspicuous forbs *Lithospermum cinereum* and *Barleria macrostegia* (species group B; Table 1). Plant species which are present in this unburnt grassland and which are noticeably fewer in the burnt grassland are the grass *Eragrostis pallens*, the tree *Acacia erioloba* and the shrub *Grewia flava* (Table 1).

1.2 *Themeda triandra* - *Elephantorrhiza elephantina* Variant

This variant occurs in the southern part of the study area where the grassland was burnt. The diagnostic species of species group C (Table 1) are the small forb *Chamaesyce inaequilatera* and the sedge *Cyperus marga-*

ritaceus. Apart from the diagnostic species, other species such as the grasses *Themeda triandra* and *Stipagrostis uniplumis* and the conspicuous forb *Elephantorrhiza elephantina* are more prominent in the burnt than the unburnt grassland (Table 1).

2. *Grewia flava* - *Acacia erioloba* Woodland

The *Grewia flava* - *Acacia erioloba* Woodland is found on the deep (> 1,2 m) well-drained red sandy soil, which mainly occurs in the western part of the TD section (Fig. 7). It is restricted to the midslope which is overlain by aeolian sand covering the Dwyka tillite (Fig. 2). Surface limestone occurs sporadically in this Ah land type woodland. No rocks or stones were noted on the soil surface in the relevés of this community (Fig. 5). The dominant soil form is the Hutton, while Shortlands, Clovelly and Mispah soil forms are also found in this community.

Diagnostic species (species group D; Table 1) are the non-conspicuous forbs *Ipomoea obscura*, *Merremia tridentata* and *Solanum nigrum*. The tree stratum, with a canopy cover of 7,5% and a height of 7 m is represented by the prominent tree *Acacia erioloba*. The prominent shrub species are *Grewia flava*, *Acacia mellifera*, *A. hebeclada*, *Tarchonanthus camphoratus* and *Protasparagus suaveolens*. The shrub layer has a canopy cover of 15% and is 2,5 m tall. These prominent woody species, along with the trees *Acacia tortilis* and *Ziziphus mucronata*, are widely distributed in this woodland. The herbaceous layer is 0,8 m tall and has a canopy cover of 68%. Prominent grasses are *Eragrostis pallens*, *E. lehmanniana*, *Pogonarthria squarrosa*, *Schmidtia pappophoroides*, *E. trichophora*, *Aristida congesta* and *Stipagrostis uniplumis*. Forbs that are constantly present are *Hirpicium echinus*, *Dicoma schinzii*, *Hermannia tomentosa* and *Indigofera daleoides*.

Gubb (1989) described a similar vegetation type in the Northern Cape, namely the Kalahari Thornveld Ecotonal Woodlands.

3. *Lycium hirsutum* - *Acacia erioloba* Woodland

This woodland community is associated with the midslope, on deep (> 1,2 m) well-drained yellow sandy soil, which mainly occurs in the north-northeastern part of the TD section (Fig. 7). The dominant soil form is Clovelly with other soil forms such as Hutton and Mispah also present. No rocks or stones were recorded in these aeolian sand relevés, although surface limestone may occur sporadically in this community. This woodland is also situated in the Ah land type (Fig. 5).

The grass *Setaria verticillata* is the only diagnostic species for this woodland (species group E; Table 1). The tree stratum is 8,5 m tall and the canopy cover is 8% while the shrub stratum is 1,7 m tall with the canopy cover 10%. The *Acacia erioloba* tree is very prominent being the dominant woody species. Other woody species which mainly grow beneath or around the *Acacia erioloba* trees are *Lycium hirsutum*, *Acacia mellifera*, *Ziziphus mucronata*, *Grewia flava* and to a lesser extent, *Tarchonanthus camphoratus* and *Acacia tortilis*. The shrub *Protaspargus suaveolens* is also strongly associated with the *Acacia erioloba* microhabitat. The herbaceous layer has a canopy cover of 77% and is 0,9 m tall. Forbs such as *Pavonia burchellii*, *Cucumis africana*, *Hermannia tomentosa*, *Dicoma schinzii*, *Elephantorrhiza elephantina*, *Plinthus sericeus*, *Harpagophytum procumbens*, *Indigofera daleoides* and *Chamaecrista biensis* are abundant. The grass species *Schmidtia pappophoroides*, *Eragrostis lehmanniana*, *E. trichophora*, *Aristida congesta* and *Stipagrostis uniplumis* are prominent in this woodland.

In the ordination of the vegetation of the TD section the two *Acacia erioloba* woodlands are very similar in habitat as well as in species composition (Fig. 6). However, the absence of species group W (Table 1) indicate a slightly different species composition. Apart from the floristic difference (Table 1) between the *Grewia flava* - *Acacia erioloba*

Woodland (2) and the *Lycium hirsutum* - *Acacia erioloba* Woodland (3), the colour of the soil is also different. The physiognomy of these two woodlands differ insofar that the *Grewia flava* - *Acacia erioloba* Woodland (2) is a closed mixed woodland, while the *Lycium hirsutum* - *Acacia erioloba* Woodland (3) is an open *Acacia erioloba* Woodland.

4. *Rhus ciliata* - *Tarchonanthus camphoratus* Shrubland

This midslope shrubland is associated with moderately deep (0,3 m - 0,8 m), well-drained sandy soil (Fig. 2). The parent material of the soil is aeolian sand of Tertiary to Recent age. Sporadic outcrops of limestone may occur. Less than 10% of the soil surface is covered by rocks or stones (Fig. 5). The shrubland is associated with the Ah land type. The dominant soil forms are the Hutton and Kimberley forms. The *Rhus ciliata* - *Tarchonanthus camphoratus* Shrubland is well distributed in the TD section (Fig. 7) especially the shrub *Tarchonanthus camphoratus* commonly known as 'vaalbos', from which the name of the park originated.

The diagnostic species are the non-conspicuous forbs *Barleria bechuanensis*, *Coccinia sessilifolia*, *Hermannia eenii* and *Pentarrhinum insipidum* (species group H; Table 1). The tall (average of 10 m) *Acacia erioloba* and *A. tortilis* trees are prominent in the poorly developed tree stratum with a canopy cover of 1%. The well-developed shrub stratum which is dominated by *Tarchonanthus camphoratus* is 2,9 m tall with a canopy cover of 40%. Three other prominent woody species in this stratum are *Rhus ciliata*, *Acacia mellifera* and *Grewia flava*. In isolated patches of this community, where the soil tends to become rocky and shallow, the shrub *Acacia mellifera* is more prominently present and is co-dominant with *Tarchonanthus camphoratus*. The herbaceous layer is 0,72 m tall and has a canopy cover of 53%. Apart from the diagnostic forbs for this community, other forbs such as *Rhynchosia toita*, *Plexipus pinnatifidus*, *Hermannia comosa*.

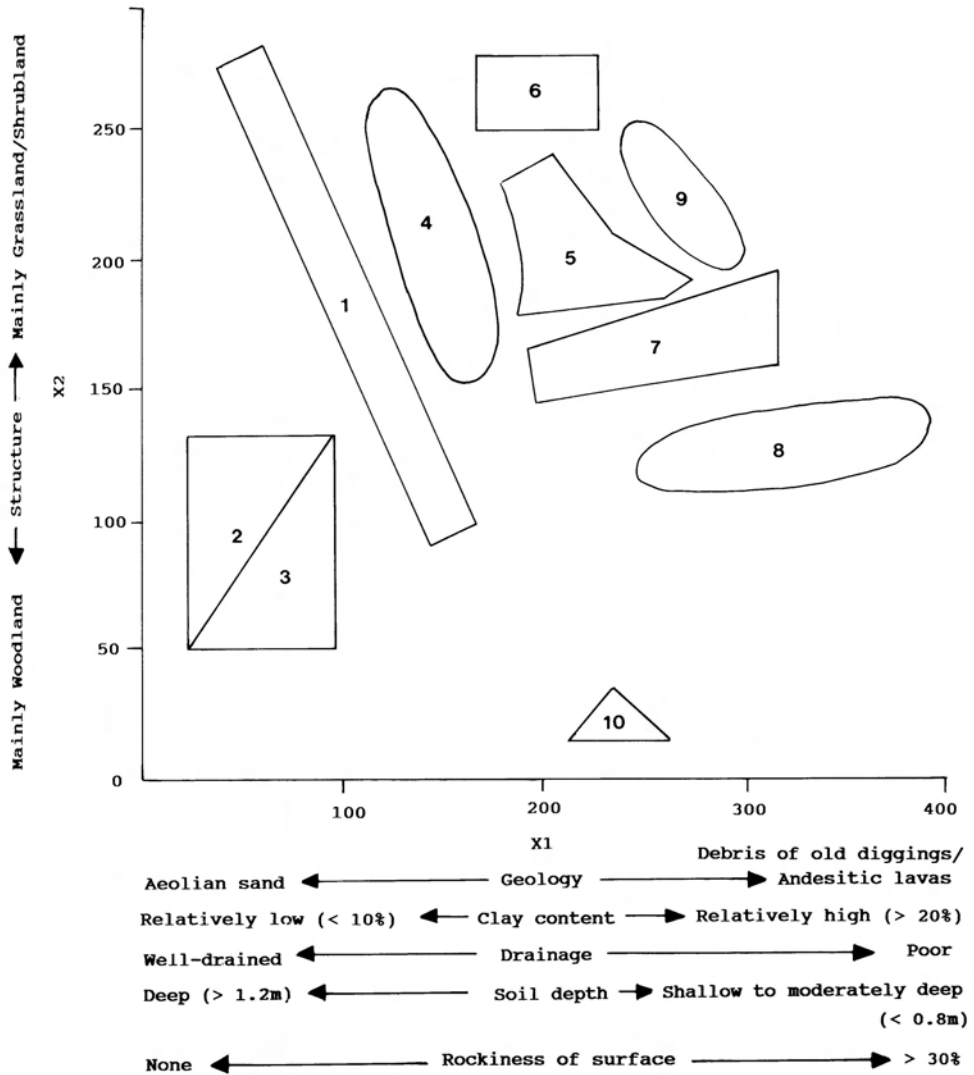


Fig. 6. The relative positions of the plant communities (numbers refer to text) along the first and second axes of the ordination

Indigofera daleoides, *Pollichia campestris*, *Felicia muricata* and *Lippia javanica* are present. The prominent grass species are *Cymbopogon plurinodis*, *Schmidtia pappophoroides*, *Eragrostis lehmanniana*, *Aristida congesta*, *A. stipitata* and *Stipagrostis uniplumis*.

5. *Acacia erioloba* - *Acacia tortilis*
Woodland

The *Acacia erioloba* - *Acacia tortilis* Woodland is strongly associated with the ancient gravel filled water courses of the Vaal River (Fig. 7). The well-drained, stony soil (clay-content < 20%) of this community varies in depth from shallow to deep (> 0,3 m). The debris of old diamond diggings are mostly found on the crests of the TD section landscape (Fig. 2). More than 30% well rounded rocks or stones occur on the soil surface of this community (Fig. 5). The dominant soil type of this Ah land type woodland are the Mispah and Hutton soil forms.

The diagnostic species for this woodland is the forb *Hibiscus pusillus* (species group I; Table 1). The dominant woody component is dense with the tree stratum 7 m tall and a canopy cover of 10%. The shrub stratum is 3 m tall with a canopy cover of 35%. The conspicuous woody species which are present in this woodland are the dominant trees *Acacia erioloba* and *A. tortilis* as well as the shrubs *A. mellifera*, *Rhus ciliata*, *Tarchonanthus camphoratus*, *Grewia flava* and *Protasparagus suaveolens*. The herbaceous layer is 0,8 m tall with a canopy cover of 55%. Apart from the common grasses of species group BB (Table 1), *Heteropogon contortus* and *Aristida meridionalis* are prominent in this community. The prominent forbs are *Gazania krebsiana*, *Elephanthorrhiza elephantina*, *Lippia javanica* and *Felicia muricata*.

6. *Boscia albitrunca* - *Acacia mellifera*
Shrubland

This shrubland is restricted to the isolated rocky hills of the TD section (Fig. 7). The

main geological type of these rocky hills is andesitic lavas. Angular rocks and stones cover more than 30% of the soil surface (Fig. 5). The *Boscia albitrunca* - *Acacia mellifera* Shrubland is associated with the non-characteristic shallow (< 0,3 m), rocky soil of the Ah land type which is restricted to the well-drained crests of the TD section landscape (Fig. 2). Rock and the Mispah soil form are the dominant soil-rock complex of this shrubland.

The *Boscia albitrunca* - *Acacia mellifera* Shrubland is characterised by species group J (Table 1) and the diagnostic species are the shrubs *Boscia albitrunca* and *Protasparagus laricinus*, the grasses *Eragrostis echinochloidea*, *Antheophora pubescens* and *Eustachys paspaloides* and the forbs *Bulbine narcissifolia*, *Sida dregei*, *Sesamum alatum*, *Asclepias fruticosa* and a *Crassula* species. A tree stratum is absent in this community while the shrub stratum is well-developed and is 1,5 m tall and has a canopy cover of 15%. The dominant shrubs are *Boscia albitrunca*, *Acacia mellifera*, *Ehretia rigida*, *Rhus ciliata*, *Tarchonanthus camphoratus* and *Grewia flava*. The poorly developed herbaceous layer is 0,8 m tall with a canopy cover of 40%. *Heteropogon contortus*, *Digitaria eriantha* and *Cenchrus ciliaris* as well as the grass species from species groups J (diagnostic for community) and BB (common species) are present in this community. Other prominent forbs than the diagnostic forbs which are present in this community are *Kyphocarpa angustifolia* and *Stachys hyssopoides*.

7. *Acacia tortilis* - *Acacia mellifera*
Shrubland

The *Acacia tortilis* - *Acacia mellifera* Shrubland which is strongly associated with the crest of the TD section near the Vaal River (Figs. 2 & 7). The habitat of this shrubland consists of well-drained, shallow (< 0,3 m), stony soil with large angular, andesitic lava rocks (more than 30%) on the soil surface (Fig 5). This shrubland is situated in the Ae land type. The soil-rock complex of this

shrubland consist of rock and Mispah soil form.

The diagnostic species for this shrubland are the forbs *Lepidium bonariense*, *Hermannia affinis*, *Seddera capensis*, *Alternanthera nodiflora*, *Ptychlobium biflorum* and *Barleria rigida* and the grass *Sporobolus coromandelianus* (species group L; Table 1). The poorly developed tree stratum is 4 m tall with a canopy cover of 2%. The only two trees that are prominent in this community are *Acacia tortilis* and *Ziziphus mucronata*. The well-developed shrub stratum, with dominant shrub species *Acacia mellifera*, *A. tortilis*, *Tarchonanthus camphoratus* and *Grewia flava*, is 1.5 m tall and has a canopy cover of 38%. The herbaceous layer is 0,7 m tall with a canopy cover of 48%. Except for the grasses *Aristida meridionalis* and *Eragrostis lehmanniana* no other grasses or forbs are prominent in this shrubland. The physiognomy of this shrubland sometimes change to impenetrable *Acacia tortilis* - *A. mellifera* Thickets.

8. *Enneapogon cenchroides* - *Acacia tortilis* Woodland

This woodland is restricted to the northern part of the TD section and is strongly associated with the relative recently deposited Vaal River gravel (Fig. 7). Because of the debris of the old diamond diggings the soil is very disturbed and the soil depth varies from shallow to deep (> 0,3 m) and two soil forms Mispah and Hutton are present. The landscape forms a crest next to the Vaal River and that is where this woodland occurs (Fig. 2). The soil is also well-drained and more than 30% well rounded rocks or stones were noted on the soil surface. This woodland is situated in the Ae land type (Fig. 5).

The *Enneapogon cenchroides* - *Acacia tortilis* Woodland is characterised by the diagnostic shrub *Rhigozum trichotomum* and the diagnostic forbs *Hermannia quartiniiana*, *Corbichonia decumbens* and *Cleome maculata* (species group N; Table 1). The tree

stratum is 4 m tall with a canopy cover of 5% while the dominant shrub stratum is well-developed with a canopy cover of 30% and a height of 1.5 m. The woody component is dominated by the tree/shrub *Acacia tortilis* while the tree *Ziziphus mucronata*, the shrubs *Acacia mellifera*, *Diospyros lycioides* and a *Lycium* species are also present. The herbaceous layer is 0,7 m tall and has a canopy cover of 68%. The prominent grasses are *Digitaria eriantha*, *Cenchrus ciliaris*, *Enneapogon cenchroides*, *Aristida adscensionis*, *A. congesta* subsp. *barbicollis*, *Eragrostis obtusa*, *E. lehmanniana* and *Cynodon dactylon*. Prominent forbs in this community are *Pentzia incana*, *Phyllanthus maderaspatensis*, *Pupalia lappacea*, *Pollichia campestris* and *Lippia javanica*.

9. *Pentzia incana* - *Acacia mellifera* Shrubland

The *Pentzia incana* - *Acacia mellifera* Shrubland is found on the crest in the north-north-western part of the TD section (Fig. 2 & 7). The main geological types that underly this area are Dwyka tillite and shale while surface limestone occurs sporadically. The *Pentzia incana* - *Acacia mellifera* Shrubland is situated in the De land type (Land Type Survey Staff 1986). The well-drained, shallow (< 0,3 m) stony soil (clay-content < 20%), with more than 30% small, angular stones on the soil surface is typical of the habitat of this community (Fig. 5). The dominant soil forms are Mispah and Glenrosa.

The diagnostic species of species group P (Table 1) are the forbs *Heliotropium ciliatum*, *Amaranthus praetermissus*, *Indigofera parvulus* and the succulent *Zygophyllum pubescens*. The tree stratum with *Acacia tortilis* and *Ziziphus mucronata* is poorly developed. It is 4 m tall and has a canopy cover of 2% while the shrub stratum is well-developed with a canopy cover of 45% and is 2,3 m tall.

The dominant shrub is *Acacia mellifera* while shrubs such as *A. tortilis*, *Tarchonanthus camphoratus* and *Grewia flava* are also pres-

ent. The herbaceous layer is 0,6 m tall with a canopy cover of 50%. Prominent grasses are *Enneapogon cenchroides*, *E. desvauxii*, *Eragrostis obtusa* and *E. lehmanniana*. Other prominent forbs than the diagnostic species are *Aptosimum albomarginatum*, *Pentzia incana*, *Monechma incanum*, *Stachys hyssopoides* and *Thesium lineatum*. On small isolated patches the succulent *Zygophyllum pubescens* tends to occur in a dense stand. Sometimes the *Pentzia incana* - *Acacia mellifera* community can form thickets.

10. *Eragrostis* species - *Chloris virgata* Grassland

This grassland is restricted to the floodplain along the north-westerly part of the TD section (Figs. 2 & 7). It is strongly associated with poorly drained, moderately deep (0,3 m - 0,8 m), clayey (> 20% clay-content) soil. The parent material is Dwyka tillite and shale. Less than 10% of the soil surface is covered by stones or rocks (Fig. 5). This grassland is situated in the Dc land type. The dominant soil form is the Valsrivier form while other soil forms such as Shortlands, Mispah and Glenrosa are also present.

Four grasses and one forb are the diagnostic species for the *Eragrostis* species - *Chloris virgata* Grassland (species group S; Table 1). The herbaceous layer is well developed with a canopy cover of 90% and is 0,8 m tall. The diagnostic grasses *Chloris virgata*, *Eragrostis* species, *E. porosa* and *Urochloa panicoides* and the diagnostic forb *Vahlia capensis* are prominent in this community while other prominent grasses such as *Aristida adscensionis*, *Eragrostis obtusa*, *Tragus berteronianus*, *Sporobolus fimbriatus*, *Panicum coloratum* and *Eragrostis lehmanniana* are also present. Other prominent forbs are *Salsola rabieana* and *Felicia muricata*. The tree and shrub strata are poorly developed with the tree stratum 7 m tall and a canopy cover of 1% while the shrub stratum is 2,5 m tall and has a canopy cover of 4%. The prominent woody species are the shrub/tree *Acacia tortilis*,

tree/shrub *A. karroo*, the tree/shrub *Ziziphus mucronata* and the shrub *Diospyros lycioides*.

11. *Combretum erythrophyllum* - *Acacia karroo* Woodland

The *Combretum erythrophyllum* - *Acacia karroo* Woodland is strongly associated with the poorly drained, deep (> 1,2 m), silt-clayey, alluvial soil (clay-content > 10%) of the Vaal River banks (Figs. 2 & 7). No rocks or stones were recorded on the soil surface (Fig. 5). This community associates strongly with the Vaal River system and can be related to the Dc as well as the Ae land types in the TD section. The dominant soil form is Oakleaf while other such as Dundee and Mispah soil forms are also present.

The tree stratum is very well-developed and is 10 m tall with a canopy cover of 35% while the shrub stratum is 2,5 m tall and has a canopy cover of 15%. The diagnostic woody species are the trees *Acacia karroo*, *Combretum erythrophyllum*, *Rhus pendulina*, *Salix mucronata* and the exotic shrub/tree *Nicotiana glauca* (Species Group V; Table 1). Other woody species present in this community are the trees *Ziziphus mucronata*, *Rhus lancea* and the shrub *Diospyros lycioides*. The herbaceous layer, which is very disturbed and is poorly developed, is 0,9 m tall with a canopy cover of 35%. The prominent grasses are *Setaria verticillata* and *Cynodon dactylon*. The diagnostic and also the prominent forbs are the exotics *Argemone ochroleuca*, *Datura stramonium*, *Nicotiana longiflora* and *Verbena bonariensis*. The diagnostic common reed *Phragmites australis* is also fairly abundant (Species Group V; Table 1).

Only two relevés are used to describe this woodland community. According to Barkman *et al.* (1986) one relevé could be used to describe a vegetation unit especially if this unit is homotoneous. At present the *Combretum erythrophyllum* - *Acacia karroo* Woodland is fenced from the inner part of the TD section

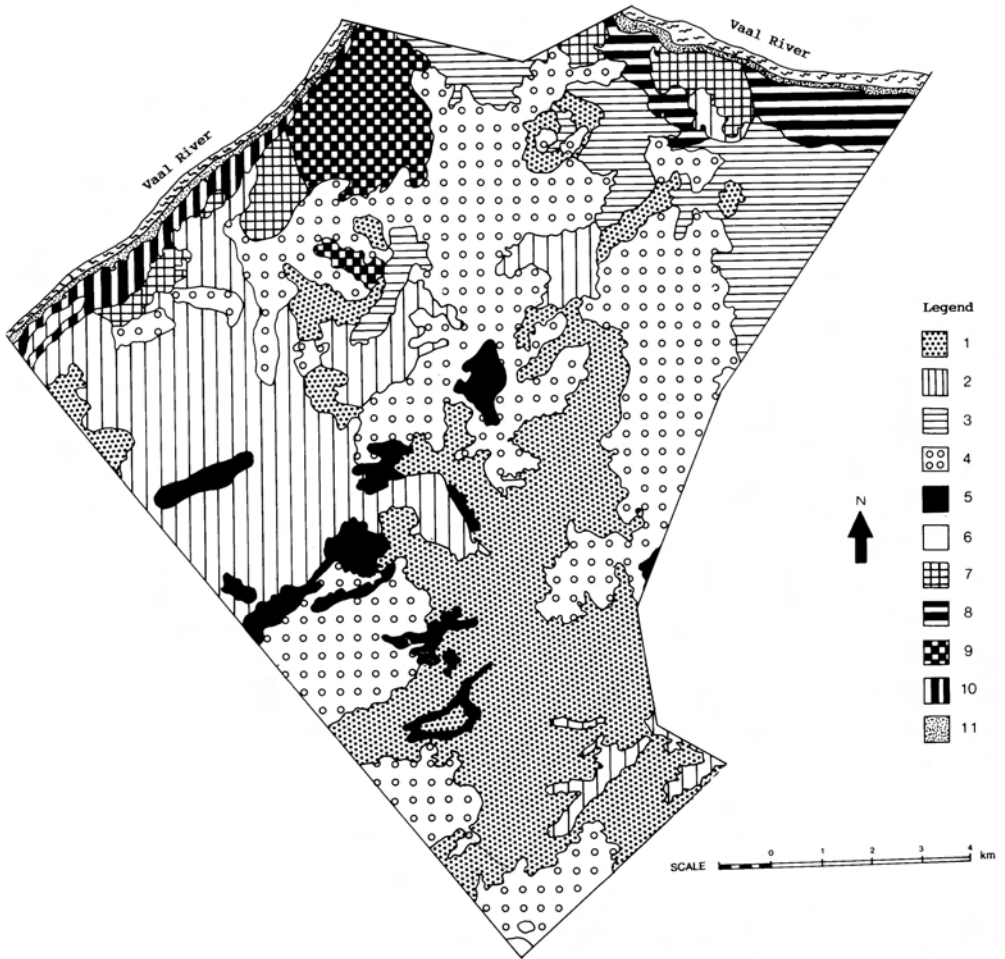


Fig. 7. A vegetation map of the TD section, Vaalbos National Park. (1) *Schmidia pappophoroides* - *Themeda triandra* Grassland, (2) *Grewia flava* - *Acacia erioloba* Woodland, (3) *Lycium hirsutum* - *Acacia erioloba* Woodland, (4) *Rhus ciliata* - *Tarchonanthus camphoratus* Shrubland, (5) *Acacia erioloba* - *Acacia tortilis* Woodland, (6) *Boscia albitrunca* - *Acacia mellifera* Shrubland, (7) *Acacia tortilis* - *Acacia mellifera* Shrubland, (8) *Enneapogon cenchroides* - *Acacia tortilis* Woodland, (9) *Pentzia incana* - *Acacia mellifera* Shrubland, (10) *Eragrostis species* - *Chloris virgata* Grassland, (11) *Combretum erythrophyllum* - *Acacia karroo* Woodland.

and is considered not to be important for the management of the TD section. However a more detailed study should be done of this riverine woodland community as it is currently under much pressure from dams (lowering the normal water level and less flooding) as well as chemical deposits from the intensive farming practices along the Vaal River.

Ordination

A clear discontinuity could be recognised between the *Combretum erythrophyllum* - *Acacia karroo* Woodland and the rest of the vegetation (Table 1). This was also verified by the ordination of the total data set which is not presented in this paper. The distribution of the plant communities, excluding the *Combretum erythrophyllum* - *Acacia karroo* Woodland is given along the first and second axes of the scatter diagram (Fig. 6). The plant communities are restricted to specific spatial areas in the diagram. Although the plant communities are floristically not totally different (Table 1), the ordination result clearly distinguished amongst the different plant communities except for the *Acacia erioloba* woodlands (2 & 3). The diagram illustrates a gradient along the first and second axes which could be related to the clay-content, drainage, geology, soil depth, presence of rocks and stones on the soil surface and vegetation structure.

Concluding remarks

The rich variety of the described vegetation types, which encompass or comprise some of the available habitats in the Northern Cape Province, is reflected in the TD section's faunal diversity, as was also noticed by Crowe *et al.* (1981) on the adjacent Rooipoort farm. Two of the so called big five are also inhabitants of the TD section, namely the endangered black rhino and the Cape buffalo (Table 2).

The vegetation of the TD section relates well to the *Acacia erioloba*-Savanna described by Acocks (1988). The Karoo species *Pentzia incana*, *P. globosa*, *Chrysocoma ciliata*, *Felicia muricata*, *Pegolettia retrofracta* and the grass *Enneapogon desvauxii*, which according to Acocks (1988) invade the Kalahari Thornveld (Veld Type 17) are present in most of the communities. There is no indication that above-mentioned species have increased since Acocks has made his notes in 1953. The habitat and floristic composition of the *Acacia tortilis* - *Acacia mellifera* Shrubland (7), *Enneapogon cenchroides* - *Acacia tortilis* Woodland (8) and *Pentzia incana* - *Acacia mellifera* Shrubland (9) relate to the False Orange River Broken Veld (Veld Type 40) as was described by Acocks (1988).

Table 2
The following animals occurred in the TD section at the time of the surveys (April 1991)

Common name	Scientific name
Cape hare	<i>Lepus capensis</i>
Striped ground squirrel	<i>Funisciurus congicus</i>
Porcupine	<i>Hystrix africaeaustralis</i>
Chacma baboon	<i>Papio ursinus</i>
Vervet monkey	<i>Cercopithecus aethiops</i>
Black-backed jackal	<i>Canis mesomelas</i>
Bat-eared fox	<i>Otocyon megalotis</i>
Small-spotted genet	<i>Genetta genetta</i>
Slender mongoose	<i>Galerella sanguinea</i>
Yellow mongoose	<i>Cynictis penicillata</i>
Suricate	<i>Suricata suricatta</i>
Brown hyaena	<i>Hyaena brunnea</i>
Black-footed cat	<i>Felis nigripes</i>
Caracal	<i>Felis caracal</i>
Aardvark	<i>Orycteropus afer</i>
Burchell's zebra	<i>Equus burchellii</i>
Warthog	<i>Phacochoerus aethiopicus</i>
Giraffe	<i>Giraffa camelopardalis</i>
Eland	<i>Taurotragus oryx</i>
Kudu	<i>Tragelaphus strepsiceros</i>
Gemsbok	<i>Oryx gazella</i>
Red hartebeest	<i>Alcelaphus buselaphus</i>
Springbok	<i>Antidorcas marsupialis</i>
Common duiker	<i>Sylvicapra grimmia</i>
Steenbok	<i>Raphicerus campestris</i>
Black rhinoceros	<i>Diceros bicornis</i>

The description of the plant communities, together with the vegetation map could serve as a basis to formulate a management programme for the TD section of the Vaalbos National Park. An understanding of the plant communities and their associated habitats is of fundamental importance for devising sound management and conservation strategies. The vegetation description and map were used by Pienaar (1992) as well as in starting a monitoring project for vegetation and animal-habitat relationships.

Reference to the relation between plant communities and land type is mentioned so that it could be used in other phytosociological studies in the Northern Cape Province.

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