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The plant ecology of the farm Groothoek, Thabazimbi District. II. Classification

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Keywords: floristic classification, phytosociology, savanna, structural classificaton, vegetation

ABSTRACT

The vegetation of the farm Groothoek, Thabazimbi District, situated in the Sour Bushveld of the Waterberg, Transvaal, is classified according to the Braun-Blanquet method, using the PHYTOTAB-program package. Five major vegetation types with 18 communities are described with reference to the main environmental factors influencing vegetation composition and structure.

INTRODUCTION

The plant ecology of the farm Groothoek, Thabazimbi District, was studied in order to supply data on the Sour Bushveld (Acocks, 1975) for the natural resource classification of the Department of Agriculture & Water Supply. This veld type is found mainly in the Waterberg of the Transvaal and little is known about the vegetation. The study included classification of the vegetation in terms of both floristics and structure, as well as correlation of the vegetation classification with the environment to facilitate later study of the entire Waterberg area.

STUDY AREA

The study area consists of the farm Groothoek 278 KQ situated between 24°28′ and 24°31′ south latitude and 27°32′ and 27°39′ east longitude. The farm covers approximately 4 000 ha over an altitudinal range of 1 200 m to 2 100 m. The summit of Kransberg forms the northern boundary with the greatest farm area consisting of two plateaux at approximately 1 500 m and 1 200 m altitude to the south. Bakker's Pass lies to the west allowing vehicular access to the upper plateau.

The Kransberg Massif consists of sandstone from the Kransberg Series of the Waterberg System. Outcrops of sandstone, shale and conglomerate from the Nylstroom Series of the Waterberg System, are found on the upper plateau while sandstone outcrops are found on the lower plateau. A diabase dyke, of post-Waterberg age, is exposed in Bakker's Pass. The soils arising from these parent materials are mainly of the Mispah Form, Mispah Series. The topography and a north-south profile of the study area are shown in Figs 1 & 2.

The study area is representative of Acock's (1975) Sour Bushveld in a relatively undisturbed condition with sufficient variation in vegetation and environment for observations to be relevant to other areas in the Waterberg where this veld type occurs.

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CLIMATE

The Waterberg is classified as **Cwa** according to Köppen's classification (Schulze, 1947) although this is not supported by direct evidence as no full climatological station has ever been maintained in the area. Rainfall statistics indicate the area as falling under the category **Cw**, warm temperate with summer rainfall, while the high probability that the January mean exceeds 22°C indicates the **Cwa** classification (Schulze, 1947). Rainfall records for the ten-year period July 1963 to June 1973 on the upper plateau suggest a mean annual rainfall of 680 mm. The consensus of local opinion, however, is that this period was unusually dry.

METHODS

The Braun-Blanquet method of sampling and synthesis followed in the study is described by Westhoff & Van der Maarel (1973), Mueller-Dombois & Ellenberg (1974) and Werger (1974).

The study area was stratified into physiognomic-physiographic units determined by interpretation of 1: 33 000 aerial photographs. Sampling sites were located by means of random co-ordinates within each physiognomic-physiographic unit. This procedure is accommodated within the flexible Braun-Blanquet method (Coetzee, 1975). 170 quadrats, 10 × 20 m, were sited in homogeneous stands representing the different physiognomic-physiographic units. The 10 m × 20 m quadrat size used is considered adequate for bushveld vegetation (Coetzee *et al.*, 1976; Van der Meulen, 1979).

Data recorded at each sampling site include the species present in each quadrat with estimated canopy cover-abundance according to the Domin-Krajina scale (Mueller-Dombois & Ellenberg, 1974), vegetation formation, altitude, slope, aspect, soil form and series, soil depth, water-table depth, chemical soil characteristics of the A-horizon, lithology and estimated percentage rock cover.

The vegetation was classified according to the Braun-Blanquet method using the PHYTOTAB program package (Westfall *et al.*, 1982a). The main environmental factors influencing the communities were ordinated on floristic data by detrended corre-

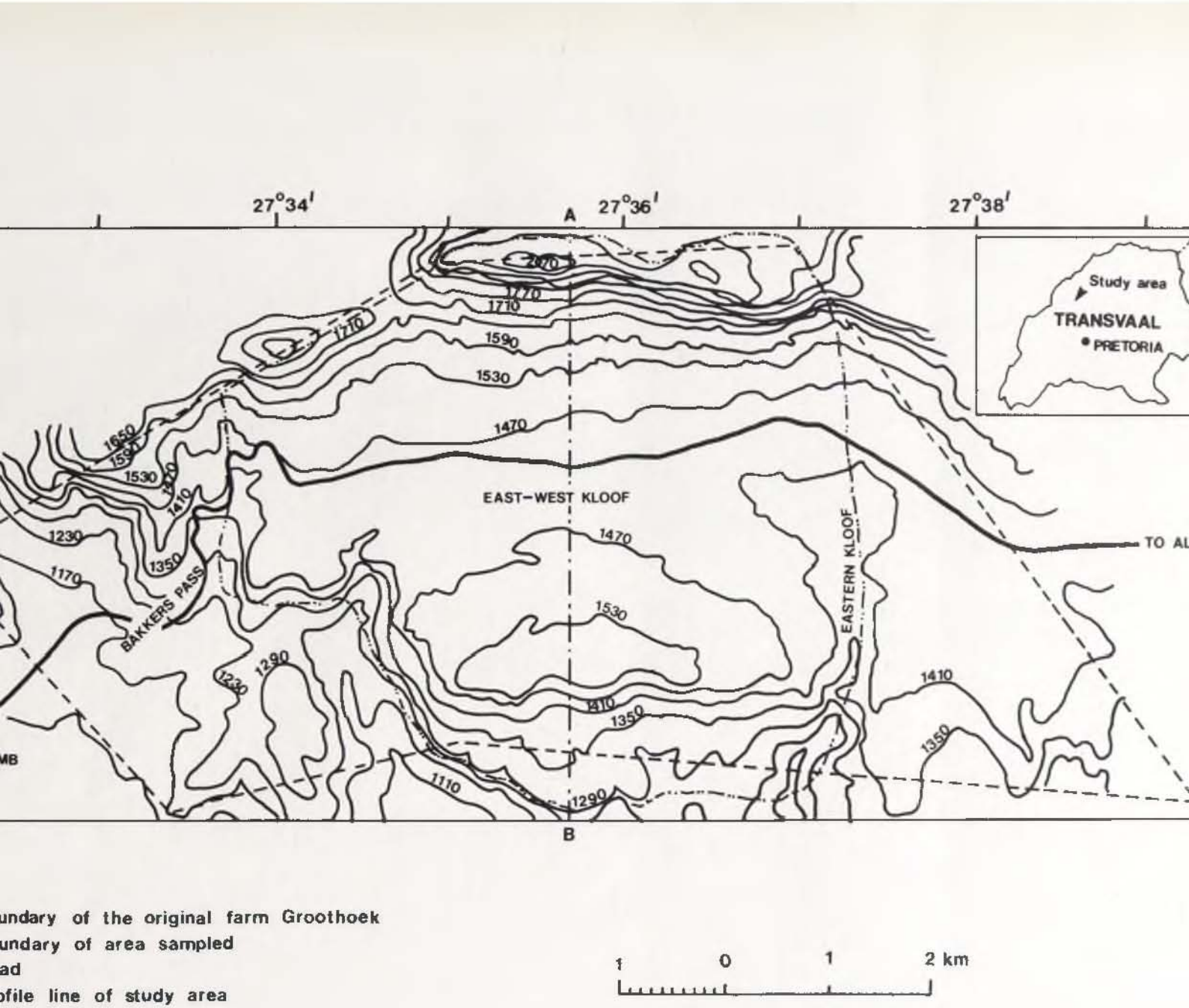
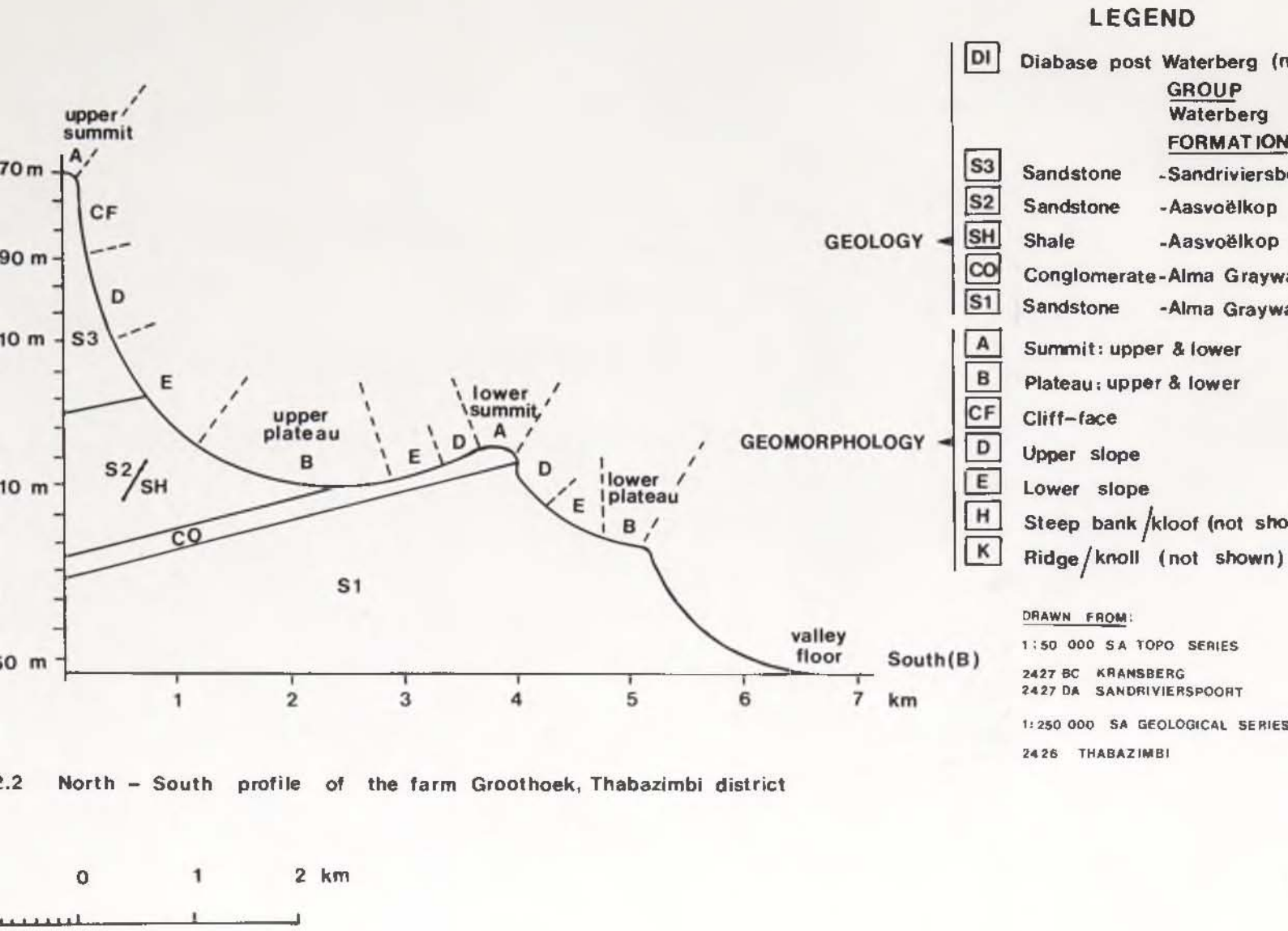


FIG. 1. — Topographic map of the farm Groothoek, Thabazimbi District showing boundary of the study area.



2.2 North – South profile of the farm Groothoek, Thabazimbi district

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FIG. 2. — A North-South profile of the farm Groothoek, Thabazimbi District.

TABLE 1.—A classification of the plant communities of the farm Groothoek, Thabazimbi District

A.		Kloof Forest communities on moderately deep soil in moist sheltered habitats.
	1	*Erythrina lysistemon–Celtis africana* Kloof Forest
	2	*Osyris lanceolata–Celtis africana* Kloof Forest
	3	*Asplenium splendens–Celtis africana* Kloof Forest
B.		Woodland Phase of Acocks's (1975) Sour Bushveld, on moderately deep to deep soils, in moderately exposed habitats.
	4	*Panicum maximum–Combretum molle* Closed Woodland
	5	*Euclea crispa–Combretum molle* Closed Woodland
	6	*Setaria megaphylla–Combretum molle* Closed Woodland
	7	*Terminalia sericea–Combretum molle* Closed Woodland
	8	*Aristida diffusa–Combretum molle* Open Woodland
	8.1	*Strychnos madagascariensis–Aristida diffusa–Combretum molle* Variation
	8.2	*Vitex rehmannii–Aristida diffusa–Combretum molle* Variation
	9	*Landolphia capensis–Combretum molle* Closed Woodland
	9.1	*Burkea africana–Landolphia capensis–Combretum molle* Variation
	9.2	*Tapiphyllum parvifolium–Landolphia capensis–Combretum molle* Variation
	10	*Coleochloa setifera–Combretum molle* Open Woodland
	11	*Heteropogon contortus–Combretum molle* Closed and Open Woodlands
	11.1	*Rhus dentata–Heteropogon contortus–Combretum molle* Closed Woodland Variation
	11.2	*Chaetacanthus costatus–Heteropogon contortus–Combretum molle* Open Woodland Variation
	12	*Themeda triandra–Combretum molle* Open Woodland
	13	*Argyrolobium transvaalense–Combretum molle* Open Woodland
	14	*Pachycarpus schinzianus–Combretum molle* Open Woodland
	15	*Protea caffra–Combretum molle* Open Woodland
C.		Grassland Phase of Acocks's (1975) Sour Bushveld on moderately deep soils in exposed dry habitats.
	16	*Eragrostis pallens–Andropogon appendiculatus* Grassland
D.		Woodland Phase of Acocks's (1975) North-Eastern Mountain Sourveld on moderately shallow soils in moderately exposed habitats.
	17	*Helichrysum nudifolium–Protea roupelliae* Sparse Woodland
E.		Grassland Phase of Acocks's (1975) North-Eastern Mountain Sourveld on shallow rocky soils in exposed habitats.
	18	*Eragrostis racemosa–Trachypogon spicatus* Grassland

spondence analysis (DCA) (Hill & Gauch, 1980) using the DECORANA program (Hill, 1979; Westfall *et al.*, 1983). Syntaxonomic nomenclature is according to the preliminary rules and recommendations of the South African Syntaxonomic Nomenclature Committee.

Total canopy cover was estimated for each quadrat within the eight height classes used by Van der Meulen & Westfall (1980) for bushveld vegetation. The height classes are independent of vegetation height. Structure is illustrated by means of layer diagrams (Ito, 1979) giving mean percentage cover within each height class. The structural features are summarized according to Ito (1979) by grouping the eight height classes into three strata, namely a herb/grass stratum (0–1 m), a shrub stratum (>1–5 m) and a tree stratum (>5 m), and determining the highest mean percentage cover in each stratum. The following symbols, determined by the highest mean cover in a stratum, are used to classify each layer diagram type:

Layer diagram type	*Cover of strata*
L – type	herb > shrub > tree
rL – type	herb < shrub < tree
D – type	herb < shrub > tree
C – type	herb > shrub < tree
I – type	herb = shrub = tree

RESULTS

Classification of the vegetation, according to the Braun-Blanquet method, revealed 21 (possibly 22) plant communities within five major vegetation types (Table 1). The North-Eastern Mountain Sourveld Communities (Acocks, 1975) are outliers of this veld type and are found above 1 500 m altitude on the Kransberg massif. The phytosociological classification of communities is shown in Tables 2 & 3 with Table 2 showing the diagnostic species and Table 3 showing the general and infrequent species. Symbols denoting environmental parameters are shown above the matrix in Table 2 and explained in Appendix A. Species with the highest mean percentage cover per community are shown above the matrix in Table 3. Percentage constancy and mean percentage cover together with the densities of trees greater than 2 m tall per relevé and per hectare, are shown to the right of the matrix in both tables. The taxa on the left of the matrix, in both tables, are grouped into simplified life-form classes to facilitate the veld condition assessment of the vegetation (Westfall *et al.*, 1983).

The spatial relationships of the communities are shown in the form of a vegetation map (Fig. 3).

The structural classification together with each layer diagram type is shown in Fig. 4.

DESCRIPTION OF THE PLANT COMMUNITIES

In the community descriptions woody and herbaceous species are both listed in order of constancy followed by mean percentage cover, with the respective values indicated next to each species. Species characteristics of each community are omitted from the descriptions because they are directly apparent from Table 2.

A. Kloof forest communities on moderately deep soils in moist sheltered habitats

The kloof forest communities are found in kloofs in the east (Communities 1 & 3) and in the west (Community 2) of the study area (Fig. 3) at altitudes of 1 050 m to 1 850 m (Table 2). The vegetation is represented by three communities, namely Communities 1 to 3 (Tables 2 & 3).

Habitat

The soils are mainly of the Mispah Form, Mispah Series, and Shortlands Form, Bokuil Series, derived from sandstone and diabase respectively. The soil depth varies from 140 mm to 470 mm. The kloofs are the least exposed of the landform classes (Appendix A) found in the study area and as a result probably have the narrowest temperature range and highest humidity of the communities in the study area. Streamflow in the kloof communities is seasonal

Floristics

Although the kloof vegetation is physiognomically homogeneous, the communities have few species in common, viz the species of the *Diospyros whyteana* species-group (Table 2F). The *Olea europaea* species-group (Table 2 C) is common to the first and second communities (Communities 1 & 2) and the *Myrsine africana* species-group (Table 2 E) is common to the second and third communities (Communities 2 & 3) (Table 2)

The *Cyperus albostriatus* species-group (Table 2 H) is the only species-group the kloof communities (Communities 2 & 3) have in common with the other main vegetation types in the study area. This species-group contains only two large woody plants viz *Secamone alpinii*, a shrubby climber, and *Pterocelastrus rostratus* whose ecological amplitudes suggest that they occur on forest margins. *Celtis africana* is diagnostic and physiognomically conspicuous in the kloof communities. *Podocarpus latifolius* is non-diagnostic (Table 3) but physiognomically conspicuous in all the kloof communities and also in portions of the main vegetation type B and occasionally in types D and E. An example of kloof forest vegetation in the west of the study area (Community 2) is shown in Fig. 5.

In the phytosociological classification, the kloof forest communities are classified as follows (Tables 1, 2 & 3):

1. *Erythrina lysistemon – Celtis africana* Kloof Forest, found below 1 101 m altitude on sandstone,
2. *Osyris lanceolata–Celtis africana* Kloof Forest, found at altitudes of 1 300 to 1 400 m on diabase,
3. *Asplenium splendens – Celtis africana* Kloof Forest, found at altitudes of 1 600 to 1 850 m on sandstone.

1. Erythrina lysistemon – Celtis africana *Kloof Forest*

This forest is found below 1 101 m in a deep kloof in the south-east of the study area (Fig. 3). It is represented by relevés 98 and 100 with 17 and 21 species per relevé respectively. This forest community (Edwards, 1983) has an rL structure (Ito, 1979; Fig. 4a) with the greatest average cover of 65% in the upper height classes higher than eight metres. The kloof is subjected to cold air drainage (Coetzee, 1975) and being situated lower than the other two kloof forest communities, is not only cooler at night but can probably reach higher day temperatures resulting in a greater temperature range than the other kloof forest communities in the study area.

Habitat

The soils are of the Mispah Form, Mispah Series, derived from sandstone of the Alma Graywacke Formation. The average soil depth varies from 190 mm to 450 mm and the surface rock cover averages 50%. The kloof slopes from 3° to 6° in a south to south-west direction. The electrical resistance of the soil is the highest in relation to the other kloof communities and the T-value is the lowest (Table 2), indicating nutrient-poor soils. This may be attributed to the low altitude with consequent greater streamflow than the high-lying kloofs. The nutrient-poor soils may also be attributed to periodic flooding as the quadrats were placed below the observable floodline when sampling. The soils are strongly acid (MacVicar *et al.*, 1977) with a pH of 4,8 when saturated with water.

Floristics

The community is diagnosed by the *Plectranthus verticillatus* species-group (Table 2A). The species diversity per unit area is low for the study area with an average of 4 species/m² for this community.

Trees and shrubs

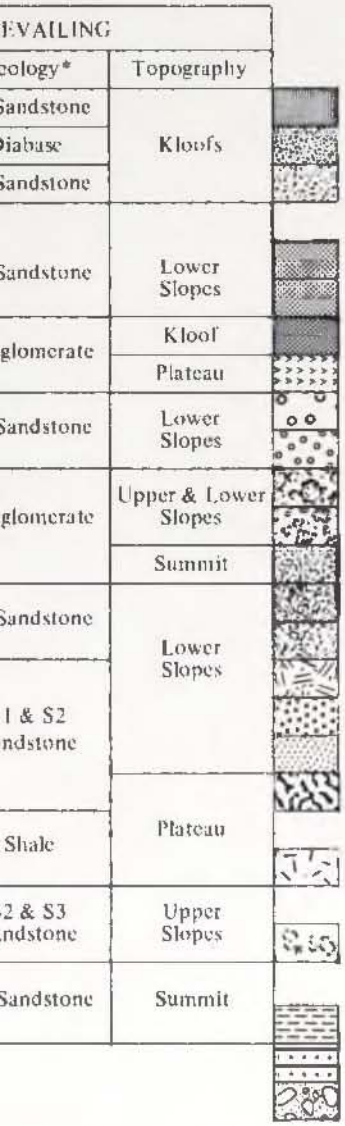
Conspicuous woody species with more than 5% mean cover and occurring in more than 50% of the relevés representing this community are:

Podocarpus latifolius (tree)	100%	53%
Celtis africana (tree)	100%	46%
Buxus macowanii (shrub)	100%	18%
Diospyros whyteana (shrub)	100%	6%
Ficus sur (tree)	100%	6%

Magnetic N
Average magnetic declination 6° West
N True
TO THABAZIMBI
0
1
2
KILOMETRES
24°31'
27°33'
24°28'
24°31'
27°37'
24°28'
TO RANKIN'S PASS

FIG. 3 — Vegetation map of the farm Groothoek, Thabazimbi District.

LEGEND



Kloof Forest communities on moderately deep soils in moist, sheltered habitats

1 *Erythrina lysistemon–Celtis africana* Kloof Forest

2 *Osyris lanceolata–Celtis africana* Kloof Forest

3 *Asplenium splendens–Celtis africana* Kloof Forest

Woodland Phase of Acocks's (1975) Sour Bushveld on moderately deep to deep soils in moderately exposed habitats

4 *Panicum maximum–Combretum molle* Closed Woodland

5 *Euclea crispa–Combretum molle* Closed Woodland

6 *Setaria megaphylla–Combretum molle* Closed Woodland

7 *Terminalia sericea–Combretum molle* Closed Woodland

8.1 *Strychnos madagascariensis–Aristida diffusa–Combretum molle* Open Woodland Variation

8.2 *Vitex rehmannii–Aristida diffusa–Combretum molle* Open Woodland Variation

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10 *Coleochloa setifera–Combretum molle* Open Woodland

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Grassland Phase of Acocks's (1975) Sour Bushveld on moderately deep soils in exposed dry habitats

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Woodland Phase of Acocks's (1975) North-Eastern Mountain Sourveld on moderately shallow soils in moderately exposed habi

17 *Helichrysum nudifolium–Protea roupelliae* Sparse Woodland

Grassland Phase of Acocks's (1975) North-Eastern Mountain Sourveld on shallow rocky soil in exposed habitats

18 *Eragrostis racemosa–Trachypogon spicatus* Grassland

Cultivated lands

Cliff face

terberg Group, Waterberg Group: S3, Sandriviersberg Formation; S2 & shale, Aasvoëlkop Formation; S1 & Conglomerate, Alma Graywacke Formation.

Herbs

Herb species occurring in more than 50% of the relevés representing the community are:

Plectranthus verticillatus (forb)	100%	0,50%
Glycine wightii (forb)	100%	0,28%
Mohria caffrorum (fern)	100%	0,05%

General

Communities 1 & 2 are related to each other through the common presence of the *Olea europaea* species-group (Table 2C) and Communities 1, 2 & 3 are related to each other through the shared presence of the *Diospyros whyteana* species-group (Table 2F). Community 1 has no species-group in common with the other main vegetation types found in the study area, which may be attributed to the low altitude of Community 1 and the surrounding vegetation not having been sampled. It is, therefore, suggested that this community could have a higher occurrence of species in common with the low-lying valley vegetation.

2. Osyris lanceolata – Celtis africana *Kloof Forest*

This forest is found at altitudes of 1 300 m to 1 400 m in Bakker's Pass, on the escarpment in the west of the study area (Fig. 3). It is represented by eight relevés (Table 2) with 13 to 23 species per relevé. This forest community (Edwards, 1983) has an rL structure (Ito, 1979; Fig. 4b) with the greatest average cover of 50% in the > 5–8 m height class. There are several non-perennial streams in the community which, in area, is the largest of the other kloof communities (Fig. 3). The community is sheltered and is situated at an altitude between that of the other kloof communities (Table 2), probably resulting in the narrowest temperature range and highest humidity of the kloof forest communities.

Habitat

The soils are of the Shortlands Form, Bokuil Series, derived from diabase of the post-Waterberg Group. The average soil depth varies from 140 mm to 470 mm and the surface rock cover varies from 15 to 40%. The kloof slopes from 3° to 17° in a southerly to westerly direction. The electrical resistance of the soil is the lowest recorded for all the communities in the study area, whereas the T-value is amongst the highest (Table 2), indicating nutrient-rich soils. The soils are moderately acid (MacVicar *et al.*, 1977) with a pH of 6,5 when saturated with water.

Floristics

This community is distinguished by the *Osyris lanceolata* species-group (Table 2 B). The species diversity per unit area is the lowest for the kloof communities with an average of 2,6 species/m^2 for the eight relevés.

Trees and shrubs

Conspicuous woody species with more than 5% mean cover and occurring in more than 50% of the relevés representing the community are:

Osyris lanceolata (shrub)	100%	35%
Maytenus undata (shrub)	88%	16%
Olea europaea subsp. *africana* (shrub)	88%	9%
Tricalysia lanceolata (shrub)	45%	12%

Herbs

The only herb species occurring in more than 50% of the relevés representing the community is:

Cyperus albostriatus (sedge)	63%	0,8%

The presence of a sedge as the most conspicuous species in the herb stratum is indicative of the mesic conditions in this community.

General

Communities 1 & 2 are related to each other through the common presence of the *Olea europaea* species-group (Table 2C) and Communities 2 & 3 are related to each other through the shared presence of the *Myrsine africana* species-group (Table 2E), whereas the *Diospyros whyteana* species-group (Table 2F) is common to Communities 1, 2 & 3. The *Cyperus albostriatus* species-group (Table 2H) shows affinities with the main vegetation type B, but as the affinity is limited to Communities 4 & 5 this species-group may be regarded as representing forest-margin species.

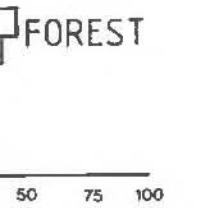
The community is accessible to grazing in places and the area represented by these relevés contain grass patches as forest incursors.

3. Asplenium splendens – Celtis africana *Kloof Forest*

This forest is found at altitudes of 1 600 m to 1 850 m in two kloofs in the north and north-east of the study area (Fig. 3) and is represented by six relevés (Table 2) with 13 to 24 species per relevé. It (Edwards, 1983) has an rL structure (Ito, 1979; Fig. 4c) with the greatest average cover of over 50% in the higher than twelve metres height class. It is found at the highest altitude for the kloof forest communities in the study area and is consequently influenced by mist which occurs frequently on the Kransberg massif, but because the kloofs are generally shallow the community is more exposed than the other kloof communities and should, therefore, experience a greater amplitude in temperature.

Habitat

The soils are of the Mispah Form, Mispah Series, derived from sandstone of the Sandriviersberg Formation. The average soil depth varies from 170 mm



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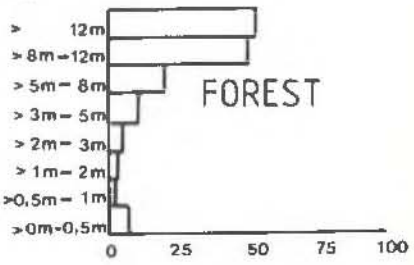

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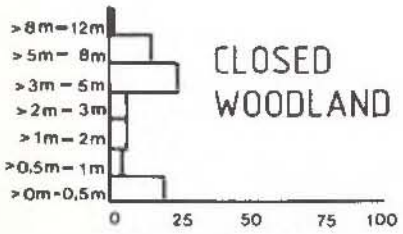

Community 4 Type D

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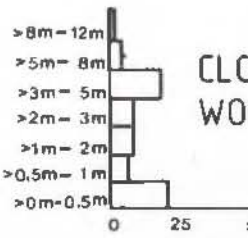

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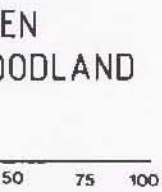

y 8.1 Type L

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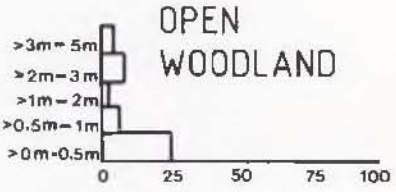

Community 8.2 Type L

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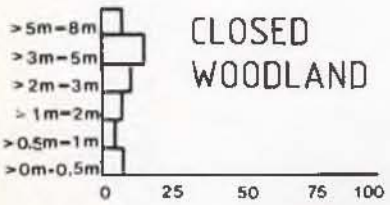

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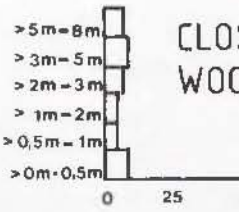

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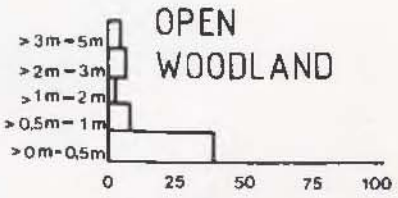
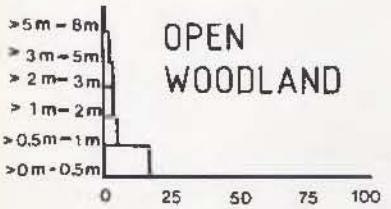


Community 12 Type L

p)



Community 13 Type L

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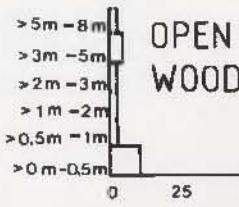

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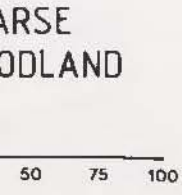
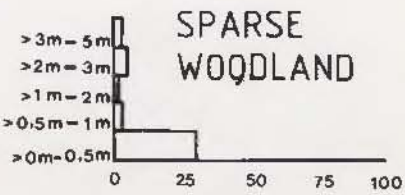


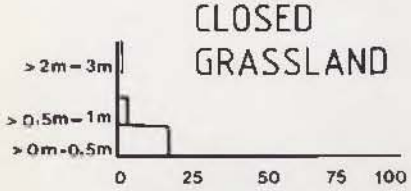
ity 17.1 Type L

u)



Community 17.2 Type L

v)



Community 18 Type L

munity structure of the vegetation of the farm Groothoek, Thabazimbi District, showing formation classes, height classes, strata, mean percentage cover and layer-di

FIG. 5. — An example of kloof forest vegetation in the west of the study area with *Faurea saligna – Combretum molle* Open Woodland in the foreground.

to 390 mm and the surface rock cover varies from 40 to 95%.

The kloofs slope from 17° to 30° in a southerly to south-easterly direction. The electrical resistance of the soil is low at 2 200 ohms with a high T-value of 22,0 me/100 g indicating a richer nutrient status than for Community 1. This may be attributed to the protection afforded to the soil, found mostly in pockets between boulders, by the large rocks and boulders found in this community. The effect of streamflow on the leaching of nutrients from the soil should therefore be minimized. Furthermore, the streamflow in these two kloofs is considerably less than in the other kloofs because these two kloofs are situated at a high altitude and do not have feeder streams. It is also suggested that this community is not subjected to flooding as severe as in the other kloof communities. The soils are strongly acid (MacVicar *et al.*, 1977) with a pH of 4,1 when saturated with water.

Floristics

The community is differentiated by the *Asplenium splendens* species-group (Table 2D). The species diversity per unit area averages 2,8 species/m² for the six relevés.

Trees and shrubs

Conspicuous woody species, with more than 5% mean cover and occurring in more than 50% of the relevés representing this community are:

Celtis africana (tree)	100%	52%
Podocarpus latifolius (tree)	83%	47%

Myrsine africana and *Diospyros whyteana* both occur with 100% constancy but with 2,5% and 2,2% mean cover respectively. *Widdringtonia nodiflora* occurs with 33% constancy and 1,3% cover but also occurs in the grassland Community 18 as a forest initial (Edwards, 1967).

The smaller kloof represented by relevé number 113 has a high cover-abundance (11%–25%) of the tree fern *Cyathea dregei* (Table 2). This smaller kloof is relatively inaccessible, while the larger kloof is more accessible, being the most used route to the top of Kransberg. There are, however, isolated stumps of *Cyathea dregei* in the larger kloof, suggesting that the habitat is suitable for growth of the tree fern. It is suggested, therefore, that were it not for the removal of *Cyathea dregei* this species would be a character species for Community 3 with a high cover-abundance.

Herbs

Herb species occurring in more than 50% of the relevés representing the community are:

Plectranthus fruticosus (forb)	100%	2,3%
Cyperus albostriatus (sedge)	100%	8,0%
Pteridium aquilinum (fern)	83%	0,4%
Asplenium splendens (fern)	83%	0,2%
Pellaea calomelanos (fern)	83%	0,4%
Carex spicato-paniculata (sedge)	67%	0,7%

General

Communities 2 & 3 are related to each other through the common presence of the *Myrsine africana* species-group (Table 2E) and the *Diospyros whyteana* species-group (Table 2F) is common to the three kloof forest communities. The *Cyperus albostriatus* species-group (Table 2H) shows affinities with the main vegetation type B but only as regards forest-margin species. Community 3 is similar to Community 2 in respect of common species-groups, however, unlike Community 2, Community 3 does not have the *Olea europaea* species-group (Table 2C) in common with Community 1. This difference may be attributed to the higher altitude in which Community 3 occurs indicating that the *Olea eu-*

ropaea species-group (Table 2C) does not occur above 1 400 m altitude.

B. Woodland phase of Acocks's (1975) Sour Bushveld, on moderately deep to deep soils in moderately exposed habitats

The woodland communities representing Acocks's (1975) Sour Bushveld are found south of the Kransberg massif in the study area (Fig. 3) below 1 600 m altitude.

Habitat

The soils are mainly of the Mispah Form (Mispah Series) with the Hutton Form (Middelburg Series), Shortlands Form (Bokuil Series) and the Westleigh Form (Sibasa Series) also occurring. Soil depth varies from 40 mm to more than 1 000 mm with 57% of the soil depths recorded being greater than 130 mm. The communities are more exposed than the kloof communities, but more sheltered than the communities on the upper slopes of the Kransberg massif and on the upper summit (Fig. 2), being sheltered by the Kransberg massif.

Floristics

The vegetation is structurally heterogeneous, varying from closed woodland to open woodland and occasionally sparse woodland (Table 2). The *Combretum molle* species-group (Table 2 AC) is differentiating for the woodland communities representing Acocks's (1975) Sour Bushveld (main vegetation type B). The grasslands of Acocks's (1975) Sour Bushveld (main vegetation type C) are related to the main vegetation type B through the common presence of the *Schizachyrium sanguineum* species-group (Table 2W). The *Aristida aequiglumis* species-group (Table 2Q), which contains species such as *Burkea africana* and *Ochna pulchra*, has a narrower ecological amplitude than the *Combretum molle* species-group (Table 2AC) and is common to Communities 5 to 11. An example of the vegetation is shown in Fig. 6.

In the phytosociological classification, the communities of the main vegetation type B are classified as follows (Tables 1, 2 & 3):

4. *Panicum maximum – Combretum molle* Closed Woodland
5. *Euclea crispa – Combretum molle* Closed Woodland
6. *Setaria megaphylla – Combretum molle* Closed Woodland
7. *Terminalia sericea – Combretum molle* Closed Woodland
8. *Aristida diffusa – Combretum molle* Open Woodland
8.1 *Strychnos madagascariensis – Aristida diffusa – Combretum molle* Variation
8.2 *Vitex rehmannii – Aristida diffusa – Combretum molle* Variation
9. *Landolphia capensis – Combretum molle* Closed Woodland
9.1 *Burkea africana – Landolphia capensis – Combretum molle* Variation
9.2 *Tapiphyllum parvifolium – Landolphia capensis – Combretum molle* Variation
10. *Coleochloa setifera – Combretum molle* Open Woodland
11. *Heteropogon contortus – Combretum molle* Closed and Open Woodlands
11.1 *Rhus dentata – Heteropogon contortus – Combretum molle* Closed Woodland Variation
11.2 *Chaetacanthus costatus – Heteropogon contortus – Combretum molle* Open Woodland Variation
12. *Themeda triandra – Combretum molle* Open Woodland
13. *Argyrolobium transvaalense – Combretum molle* Open Woodland
14. *Pachycarpus schinzianus – Combretum molle* Open Woodland
15. *Protea caffra – Combretum molle* Open Woodland.

4. Panicum maximum – Combretum molle *Closed Woodland*

This woodland is found at altitudes of 1 450 m–1 600 m on the lower slopes of the Kransberg massif in the north of the study area (Fig. 3). It is represented by ten relevés with 21 to 33 species

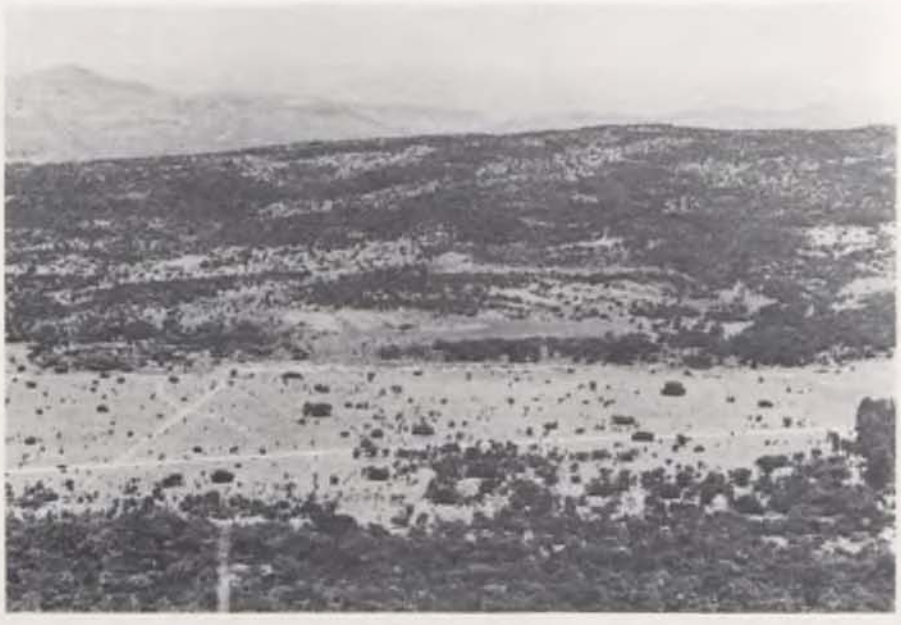


FIG. 6. — Woodland representative of Acocks's (1975) Sour Bushveld with the *Panicum maximum – Combretum molle* Closed Woodland and *Euclea crispa – Combretum molle* Closed Woodland in the foreground and the *Landolphia capensis – Combretum molle* Closed Woodland in the background.

per relevé. This closed-woodland community (Edwards, 1983) has a D structure (Ito, 1979; Fig. 4d) with the greatest average cover of about 27% in the > 3 m–5 m height class. Because the slopes on which this community is found are south facing, the temperature is likely to be lower than that of the north-facing slopes (Theron, 1973) and if night temperatures are equal, should have a smaller temperature range than that of the north-facing slopes.

Habitat

The soils are of the Mispah Form, Mispah Series, derived from sandstone of the Aasvoëlkop Formation. The average soil depth varies from 150 mm to 500 mm and the surface rock cover varies from 1% to 40%. The terrain slopes from 3° to 25° in a southerly direction. The electrical resistance of the soil is 4 700 ohms and the T-value is 8,5 me/100 g which is moderate for the study area indicating a moderate nutrient status. As the community is situated on the lower slopes, nutrient accumulation from run-off is greater than for the upper slopes (Russell, 1961), where greater leaching can be expected. The soils are strongly acid (MacVicar *et al.*, 1977) with a pH of 4,8 when saturated with water.

Floristics

This community is differentiated by the *Achyranthes aspera* species-group (Table 2G). The species diversity per unit area averages 5,8 species/m² for the Community. The character species for the species-group are mainly pioneer forbs, which could have a wider presence than that indicated on Table 2. However, at the time of sampling they were characteristic of Community 4 in the study area and are, therefore, classified accordingly.

Trees and shrubs

Conspicuous woody species with more than 5% mean cover and occurring in more than 50% of the relevés representing this community are:

Combretum molle (tree/shrub)	90%	7,1%
Rhus leptodictya (tree/shrub)	80%	5,1%
Faurea saligna (tree/shrub)	60%	6,2%

Herbs

Herb species occurring in more than 50% of the relevés representing the Community are:

Achyranthes aspera (forb)	100%	1,2%
Tagetes minuta (forb)	80%	2,8%
Oxalis depressa (forb)	70%	0,2%
Cymbopogon validus (grass)	60%	0,9%
Bidens pilosa (forb)	60%	0,3%

General

Communities 2, 3, 4 & 5 are related to each other through the shared presence of the *Cyperus albostriatus* species-group (Table 2H). Communities 4 & 5 are structurally similar (Figs 4d & 4e) and, because they occur next to each other in the study area, cannot be separated on aerial photographs. They are, therefore, mapped as a single unit in Fig. 3. These two communities represent a transitional vegetation zone between the main vegetation types A and B because they do not have perennial character species which are at present apparent (Table 2). If the *Achyranthes aspera* species-group (Table 2G) were possibly eliminated by reduced grazing pressure, then this community would be floristically more similar to Community 5 than is indicated on Table 2.

5. Euclea crispa – Combretum molle *Closed Woodland*

This woodland is found at altitudes of 1 500 m to 1 550 m on the lower slopes of the Kransberg massif in the north of the study area (Fig. 3). It is represented by relevés 145, 153 and 134 with 25, 30 and 34 species per relevé respectively. This closed-woodland community (Edwards, 1983) has a D structure (Ito, 1979; Fig. 4e) with the greatest average cover of 23% in the > 3 m–5 m height class. Because the community is adjacent to Community 4, their temperature and moisture regimes should be similar.

Habitat

The soils are of the Mispah Form, Mispah Series, derived from sandstone of the Aasvoëlkop Formation. The average soil depth varies from 150 mm to 240 mm and the surface rock cover varies from 20% to 60%. The terrain slopes from 8° to 16° in a southerly to south-easterly direction. The electrical resistance of the soil is 4 700 ohms and the T-value is 8,5 me/100 g which is similar to that of Community 4. The soils are strongly acid (MacVicar *et al.*, 1977) with a pH of 4,8 when saturated with water.

Floristics

The community is differentiated by the absence of character species, as well as the absence of the *Achyranthes aspera* species-group (Table 2G), and the presence of the *Aristida aequiglumis* species-group (Table 2Q) and the *Cyperus albostriatus* species-group (Table 2H). The species diversity per unit area averages 4,7 species/m² for the Community which is less than for Community 4, possibly as a result of the high surface rock cover in Community 5 with consequently less soil area for vegetation as well as fewer annual and pioneer species.

Trees and shrubs

Conspicuous woody species with more than 5% mean cover and occurring in more than 50% of the relevés representing the Community are:

Combretum molle (tree/shrub)	100%	5,8%
Burkea africana (tree/shrub)	67%	6,8%

Herbs

Herb species occurring in more than 50% of the relevés representing this community are:

Heteropogon contortus (grass)	100%	4,2%
Andropogon schirensis (grass)	100%	1,8%
Cyperus leptocladus (sedge)	100%	0,5%
Pellaea calomelanos (fern)	100%	0,05%
Eragrostis racemosa (grass)	67%	1,7%
Loudetia simplex (grass)	67%	1,7%
Rhynchosia spectabilis (forb)	67%	1,0%
Bulbostylis burchellii (sedge)	67%	0,1%
Commelina africana (forb)	67%	0,05%
Oxalis depressa (forb)	67%	0,03%

General

Communities 2, 3, 4 & 5 are related to each other through the shared presence of the *Cyperus albostriatus* species-group (Table 2H) and Communities 5 to 11 are related to each other through the shared presence of the *Aristida aequiglumis* species-group (Table 2Q). Community 5 together with Community 4 forms a transitional vegetation zone between the main vegetation types A and B. The pioneer forbs present in Community 4 (Table 2G) are absent in Community 5. *Selaginella dregei* is present in two of the three relevés representing Community 5 indicating the high surface rock cover found in this community. Although this community is accessible to cattle, the high surface rock cover may possibly result in a grazing preference for Community 4.

6. Setaria megaphylla — Combretum molle *Closed Woodland*

This woodland is found at altitudes of 1 075 m to 1 375 m in an open kloof in the east of the study area (Fig. 3). It is represented by relevés 103, 101, 102 and 99 with 27, 26, 27 and 21 species per relevé respectively. This closed woodland community (Edwards, 1983) has a D structure (Ito, 1979; Fig. 4f) with the greatest average cover of about 22% in the > 3 m–5 m height class. Although this community is situated in a kloof, the kloof is very broad and shallow so that the vegetation is more exposed with a consequently greater temperature range and is less moist than the kloof forest communities. The vegetation is, therefore, a closed woodland and not a forest as could be expected from the landform class H (Table 2).

Habitat

The soils are of the Mispah form, Mispah Series derived from conglomerate of the Alma Graywacke Formation in the case of relevés 103, 101 and 102 and sandstone of the Alma Graywacke Formation in the case of relevé 99. The average soil depth varies from 150 mm to 210 mm and the surface rock cover varies from 30% to 70%. The kloof slopes from 3° to 5° in a southerly to south-westerly direction. The electrical resistance of the soil is 4 300 ohms with a T-value of 9,3 me/100 g indicating soils of a moderate nutrient status for the study area. The soils are strongly acid (MacVicar *et al.*, 1977) with a pH of 4,8 when saturated with water.

Floristics

This community is differentiated by the *Setaria megaphylla* species-group (Table 2I). *Setaria megaphylla* is also found in Community 1 with 100% constancy but with a lower mean percentage cover (Table 2). The species diversity per unit area averages 5,3 species/m² for the community.

Trees and Shrubs

The only conspicuous woody species with more than 5% mean cover and occurring in more than 50% of the relevés representing the community is:

Elephantorrhiza burkei (shrub)	75%	7%

Herbs

Herb species occurring in more than 50% of the relevés representing the community are:

Setaria megaphylla (grass)	100%	13,1%
Cyperus leptocladus (sedge)	75%	0,9%
Hypoestes verticillaris (forb)	75%	0,9%
Cheilanthes hirta (fern)	75%	0,01%
Commelina africana (forb)	75%	0,01%

General

Communities 5 to 11 are related to each other through the shared presence of the *Aristida aequiglumis* species-group (Table 2Q). The vegetation represented by relevé numbers 103 and 101 is on the same side of the stream as that used by cattle for drinking and the grazing pressure on *Setaria megaphylla*, a palatable grass, is high, hence the low cover-abundance values of this species in relevé numbers 103 and 101.

7. Terminalia sericea — Combretum molle *Closed Woodland*

This woodland is found at altitudes of 1 415 m to 1 425 m in the eastern central part of the study area on the upper plateau (Fig. 3). It is represented by relevés 79, 80 and 77 with 30, 30 and 22 species per relevé respectively. This closed-woodland community (Edwards, 1983) has an rL structure (Ito, 1979; Fig. 4g) with the greatest average cover of about 37% in the upper height class of > 5 m – 8 m. The community is probably subjected to temperature inversion at night because it is situated near a stream in a depression. The temperature range should, therefore, be wide for the study area.

Habitat

The soils are of the Hutton Form, Middelburg Series, derived from conglomerate of the Alma Graywacke Formation. The average soil depth varies from 150 mm to 650 mm and the surface rock cover varies from 1% to 2%. The terrain slopes from 1° to 2° in a northerly direction. The electrical resistance of the soil is 6 400 ohms and the T-value is 5,9 me/100 g indicating a poor nutrient status for the soils, which may be attributed to leaching. The soils are strongly acid (MacVicar *et al.*, 1977) with a pH of 4,1 when saturated with water.

Floristics

The community is distinguished by the *Terminalia sericea* species-group (Table 2J). The species diversity per unit area averages 7 species/m² for the community which is relatively high for the study area.

Trees and shrubs

Conspicuous woody species with more than 5% mean cover and occurring in more than 50% of the relevés representing the community are:

Terminalia sericea (tree)	100%	28,0%
Burkea africana (tree/shrub)	67%	8,5%

Herbs

Herb species occurring in more than 50% of the relevés representing the community are:

Aristida aequiglumis (grass)	100%	0,5%
Digitaria eriantha 'subspecies *transvaalensis*' (grass)	67%	1,0%
Perotis patens (grass)	67%	1,0%
Rhynchelytrum repens (grass)	67%	1,0%
Richardia brasiliensis (forb)	67%	1,0%
Anthospermum rigidum (forb)	67%	0,3%
Bulbostylis burchellii (sedge)	67%	0,3%
Cyperus denudatus (sedge)	67%	0,3%
Heteropogon contortus (grass)	67%	0,3%
Indigofera filipes (forb)	67%	0,3%

General

Communities 5 to 11 are related to each other through the common presence of the *Aristida aequiglumis* species-group (Table 2Q). This community is restricted to the moderately deep soils of the upper plateau which are well drained, but as these soils are limited in extent, the community is consequently small in area. On the northern side of the stream, opposite Community 7, there is much cultivated land on moderately deep soils, which could support the same vegetation as that of Community 7.

8. Aristida diffusa — Combretum molle *Open Woodland*

This woodland is found at altitudes of 1 250 m to 1 400 m on the lower slopes of the lower plateau in the south of the study area with an outlier of the community above the eastern kloof on the upper plateau (Fig. 3). This community is differentiated by the *Aristida diffusa* species-group (Table 2K) which only has one character species, namely *Aristida diffusa*. The community is separated into the following two variations, based on floristics:

8.1 *Strychnos madagascariensis – Aristida diffusa – Combretum molle* Variation found at, or below 1 325 m altitude,

8.2 *Vitex rehmannii – Aristida diffusa – Combretum molle* Variation found at or above 1 325 m altitude.

8.1 Strychnos madagascariensis – Aristida diffusa – Combretum molle *Variation*

This variation is found at altitudes of 1 250 m to 1 325 m, being the lowest altitude of the communities on the lower plateau in the south of the study area (Fig. 3). It is represented by six relevés with 23 to 38 species per relevé. This open-woodland variation (Edwards, 1983) has an L structure (Ito, 1979; Fig. 4h) with the greatest average cover of about 20 per cent in the lowest height class of 0,0 m – 0,5 m. The lower plateau is exposed and a wide temperature range could be expected, while the open vegetation indicates a low moisture status for this variation.

Habitat

The soils are of the Mispah Form, Mispah Series, derived from sandstone of the Alma Graywacke Formation. The average soil depth varies from 120 mm to 170 mm and the surface rock cover varies from 50% to 70%. The terrain slopes from 1° to 9° in a southerly to south-westerly direction. The electrical resistance of the soil is 3 500 ohms and the T-value is 7,1 me/100 g indicating a moderate nutrient status. The soils are strongly acid (MacVicar *et al.*, 1977) with a pH of 5,4 when saturated with water.

Floristics

This variation is distinguished by the *Schrebera alata* species-group (Table 2L). The species diversity per unit area averages 5,5 species/m² for the Variation.

Trees and shrubs

Conspicuous woody species with a 2,5% or more mean cover and occurring in more than 50% of the relevés representing this variation are:

Pseudolachnostylis maprouneifolia (tree/shrub)	100%	2,6%
Diplorhynchus condylocarpon (tree/shrub)	100%	2,5%

The value of 2,5 % or more mean cover for the conspicuous woody plants has been reduced from the arbitrarily selected 5% used for the previous communities because Community 8 is the first community with an open formation class. The 5% mean cover value is too high for open formation and no woody species would be detected.

Herbs

Herb species occurring in more than 50% of the relevés representing the variation are:

Aristida diffusa (grass)	100%	5,0%
Schizachyrium sanguineum (grass)	100%	2,2%
Commelina africana (forb)	100%	0,2%
Diheteropogon amplectens (grass)	83%	2,9%
Aristida aequiglumis (grass)	83%	1,8%
Heteropogon contortus (grass)	67%	3,0%
Brachiaria nigropedata (grass)	67%	1,0%
Elionurus muticus (grass)	67%	1,0%
Rhynchelytrum nerviglume (grass)	67%	0,7%
Loudetia simplex (grass)	67%	0,5%
Vernonia staehelinoides (forb)	67%	0,3%
Tephrosia longipes (forb)	67%	0,03%

General

Communities 8 & 9 are related to each other through the common presence of the *Diplorhynchus condylocarpon* species-group (Table 2N) and Communities 5 to 11 are related to each other through the shared presence of the *Aristida aequiglumis* species-group (Table 2Q), while Communities 8 to 16 are related to each other through the shared presence of the *Schizachyrium sanguineum* species-group (Table 2W).

8.2 Vitex rehmannii – Aristida diffusa – Combretum molle *Variation*

This variation is found at altitudes of 1 325 m to 1 400 m upslope of variation 8.1 on the lower plateau in the south of the study area and on the slopes leading to a kloof on the upper plateau in the east of the study area (Fig. 3). It is represented by six relevés with 20 to 30 species per relevé. This open-woodland Variation (Edwards, 1983) has an L structure (Ito, 1979; Fig. 4i) with the greatest average cover of 25% in the lowest height class of 0,0 m – 0,5 m, which is greater than that for Variation 8.1. The

temperature and moisture regimes should be similar to that of Variation 8.1.

Habitat

The soils are of the Mispah Form, Mispah Series, derived from sandstone in the case of relevés 86, 89, 90, 87 and 96 and conglomerate in the case of relevé 104, both of the Alma Graywacke Formation. The average soil depth varies from 100 mm to 190 mm and the surface rock cover varies from 60% to 70%. The terrain slopes up to 28° in a southerly to southeasterly direction in the case of relevés 86, 89, 90, 87 and 96 and in a northerly direction in the case of relevé 104. The electrical resistance varies from 3 500 ohms to 6 700 ohms and the T-value varies from 7,1 me/100 g to 10,5 me/100 g, indicating soils of a moderate nutrient status. The soils are strongly acid (MacVicar *et al.*, 1977) with a pH range of 4,5 to 5,4 when saturated with water.

The difference in the soil factors found in this variation may be attributed to the difference in parent materials in the case of relevé 104 and possibly to the leaching effect of a seasonal stream which causes periodic flooding in the vicinity of relevé 96, with increased runoff and consequent leaching.

Floristics

This variation is differentiated by the absence of character species and notably the absence of the species of the *Schrebera alata* species-group (Table 2L) which differentiates this variation from the *Strychnos madagascariensis – Aristida diffusa – Combretum molle* Variation. The species diversity per unit area averages 4,8 species/m² for this variation which is lower than for Variation 8.1.

Trees and shrubs

Conspicuous woody species with 2,5% or more mean cover and occurring in more than 50% of the relevés representing the variation are:

Combretum molle (tree/shrub)	100%	2,9%
Diplorhynchus condylocarpon (tree/shrub)	83%	4,6%

Vitex rehmannii is present with 83% constancy and 1,4% mean cover.

Herbs

Herb species occurring in more than 50% of the relevés representing the variation are:

Aristida diffusa (grass)	83%	3,8%
Andropogon schirensis (grass)	83%	2,9%
Aristida aequiglumis (grass)	83%	1,4%
Commelina africana (forb)	83%	0,4%
Tristachya biseriata (grass)	67%	4,2%
Diheteropogon amplectens (grass)	67%	1,7%
Bulbostylis burchellii (sedge)	67%	1,0%

General

Variation 8.2 has the same affinities with other communities as that described for Variation 8.1

9. Combretum molle – Landolphia capensis *Closed Woodland*

This woodland is found at altitudes of 1 425 m to 1 550 m south of the upper plateau in the southern half of the study area (Fig. 3). The community is diagnosed by the *Landolphia capensis* species-group (Table 2M).

This community is differentiated into the following two variations, based on floristics:

9.1 *Burkea africana – Landolphia capensis – Combretum molle* Variation found on soils with a moderate surface rock cover,

9.2 *Tapiphyllum parvifolium – Landolphia capensis – Combretum molle* Variation found on soils with a moderate to high surface rock cover.

9.1 Burkea africana – Landolphia capensis – Combretum molle *Variation*

This variation is found at altitudes of 1 425 m to 1 550 m south of the upper plateau in the southern half of the study area (Fig. 3). It is represented by eight relevés with 19 to 31 species per relevé. This closed-woodland variation (Edwards, 1983) has a D structure (Ito, 1979; Fig. 4j) with the greatest average cover of 15% in the > 3 m – 5 m height class. The variation occurs on north-facing slopes (Theron, 1973) and should therefore have a greater temperature range than the south-facing slopes, if night temperatures are the same.

Habitat

The soils are of the Mispah Form, Mispah Series, derived from conglomerate of the Alma Graywacke Formation. The average soil depth varies from 40 mm to 250 mm and the surface rock cover varies from 5% to 25%. The terrain slopes up to 6° in a northerly to easterly direction. The electrical resistance is 6 700 ohms and the T-value is 10,5 me/100 g indicating soils of a moderate nutrient status for the study area. The soils are strongly acid (MacVicar *et al.*, 1977) with a pH of 4,5 when saturated with water.

Floristics

The Variation is differentiated by the absence of character species as well as the absence of the *Selaginella dregei* species-group (Table 2P) which differentiates this variation from the *Tapiphyllum parvifolium – Landolphia capensis – Combretum molle* Variation. The species diversity per unit area averages 5 species/m² for the variation.

Trees and Shrubs

Conspicuous woody species with more than 5% mean cover and occurring in more than 50% of the relevés representing the variation are:

Burkea africana (tree/shrub)	100%	15,9%
Combretum molle (tree/shrub)	100%	6,0%
Ochna pulchra (tree/shrub)	88%	7,6%

Burkea africana has the highest constancy value in the study area in Variation 9.1.

Herbs

Herb species occurring in more than 50 per cent of the relevés representing the variation are:

Bulbostylis burchellii (sedge)	100%	1,0%
Schizachyrium sanguineum (grass)	88%	2,1%
Aristida aequiglumis (grass)	88%	1,4%
Andropogon schirensis (grass)	75%	0,5%
Elionurus muticus (grass)	63%	0,8%

General

Communities 8 & 9 are related to each other through the joint occurrence of the *Diplorhynchus condylocarpon* species-group (Table 2N) and Communities 5 to 11 are related to each other through the shared presence of the *Aristida aequiglumis* species-group (Table 2Q) while Communities 8 to 16 are related to each other through having the *Schizachyrium sanguineum* species-group (Table 2W) in common.

9.2 Tapiphyllum parvifolium – Landolphia capensis – Combretum molle *Variation*

This variation is found at altitudes 1 425 m to 1 525 m south of the upper plateau in the southern half of the study area (Fig. 3). It is represented by twelve relevés with 21 to 34 species per relevé. This closed-woodland variation (Edwards, 1983) has a D structure (Ito, 1979; Fig. 4k) with the greatest average cover of 10% in the > 3 m – 5 m height class. This variation can, therefore, be considered to be more open than Variation 9.1 which could indicate a drier moisture regime than for Variation 9.1. The temperature regime should be similar to that of Variation 9.1.

Habitat

The soils are of the Mispah Form, Mispah Series, derived from conglomerate of the Alma Graywacke Formation. The average soil depth varies from 50 mm to 230 mm and the surface rock cover varies from 5% to 80%. The terrain slopes from 1° to 8° in a north-easterly direction. The electrical resistance of the soil is 6 700 ohms and the T-value is 10,5 me/100 g indicating a moderate nutrient status for the study area. The soils are strongly acid (MacVicar *et al.*, 1977) with a pH of 4,5 when saturated with water.

Floristics

This variation is differentiated by the absence of character species and is differentiated from the *Burkea africana – Landolphia capensis – Combretum molle* Variation by the presence of the *Selaginella dregei* species-group (Table 2P). The species diversity per unit area averages 4,4 species/m² for this variation, which is lower than for Variation 9.1.

Trees and shrubs

The only conspicuous woody species with more than 5% mean cover and occurring in more than 50% of the relevés representing the variation is:

Burkea africana (tree/shrub)	67%	7,35%

Combretum molle has a 100% constancy in Variation 9.2, but only 4,4% mean cover, whereas *Ochna pulchra* has 83% constancy and only 4,1% mean cover indicating the lesser cover of these two species in this variation compared with Variation 9.1.

Herbs

Herb species occurring in more than 50% of the relevés representing this variation are:

Bulbostylis burchelli (sedge)	100%	1,1%
Aristida aequiglumis (grass)	83%	1,4%
Selaginella dregei (fern)	75%	1,3%
Eragrostis curvula (grass)	75%	1,0%
Andropogon schirensis (grass)	67%	1,3%
Indigofera egens (forb)	67%	0,1%

General

Communities 8 to 9, 5 to 11 and 8 to 16 are related to each other through the shared presence of the *Diplorhynchus condylocarpon* species-group (Table 2N), the *Aristida aequiglumis* species-group (Table 2Q) and the *Schizachyrium sanguineum* species-group (Table 2W) respectively which corresponds to that for the *Burkea africana – Landolphia capensis – Combretum molle* Variation. The *Selaginella dregei* species-group (Table 2P) is common to Community 10 and Variation 9.2, but is absent in Variation 9.1. *Selaginella dregei* has a 75% constancy which is high for the study area and is indicative of the high surface rock cover for Variation 9.2 because *Selaginella dregei* only occurs where there are sheet outcrops. The high surface rock cover is a possible reason for the structural differences between the two variations of Community 9 and can also contribute to the floristic differences between the two variations.

10. Coleochloa setifera – Combretum molle *Open Woodland*

This woodland is found at altitudes of 1 525 m to 1 550 m south of the upper plateau in the southern half of the study area (Fig. 3). It is represented by eight relevés with 26 to 33 species per relevé. This open-woodland community (Edwards, 1983) has an L structure (Ito, 1979; Fig. 4l) with the greatest average cover of 5% in the lowest height class of 0,0 m–0,5 m. Because the vegetation occurs on the lower summit, this community is more exposed than the adjacent communities (Communities 8 & 9), and a greater temperature range and a drier moisture regime than in Communities 8 & 9 could be expected.

Habitat

The soils are of the Mispah Form, Mispah Series, derived from conglomerate of the Alma Graywacke Formation. The average soil depth varies from 40 mm to 80 mm and the surface rock cover varies from 60% to 80%. The terrain slopes from 18° to 25° in a southerly direction. The electrical resistance is 6 700 ohms and the T-value is 10,5 me/100 g indicating soils of a moderate nutrient status for the study area. The soils are strongly acid (MacVicar *et al.*, 1977) with a pH of 4,5 when saturated with water.

Floristics

The community is distinguished by the *Coleochloa setifera* species-group (Table 2O). The species diversity per unit area averages 5,3 species/m² for the community.

Trees and shrubs

The only conspicuous woody species with 2,5% or more mean cover and occurring in more than 50% of the relevés representing the community is:

Heteropyxis natalensis (shrub)	100%	2,5%

Combretum molle, *Vitex rehmannii*, *Bequaertiodendron magalismontanum* and *Brachylaena rotundata* occur in all the relevés representing the community, but have a mean cover of less than 2,5%.

Herbs

Herb species occurring in 50% of the relevés representing the community are:

Bulbostylis burchellii (sedge)	100%	2,0 %
Coleochloa setifera (sedge)	100%	1,8 %
Pellaea calomelanos (fern)	100%	0,05%
Selaginella dregei (fern)	88%	1,2 %
Elionurus muticus (grass)	75%	1,4 %
Andropogon schirensis (grass)	75%	0,9 %
Indigofera comosa (forb)	75%	0,2 %
Stachys natalensis var. *natalensis* (forb)	75%	0,04%
Aristida aequiglumis (grass)	63%	0,8 %
Digitaria eriantha 'subsp. *transvaalensis*' (grass)	63%	0,6 %
Xerophyta retinervis (forb)	63%	0,09%
Cheilanthes hirta (fern)	63%	0,03%

General

Variation 9.2 and Community 10 are related to each other through the common presence of the *Selaginella dregei* species-group (Table 2P) while Communities 5 to 11 and 8 to 16 are related to each other through the shared presence of the *Aristida aequiglumis* species-group (Table 2Q) and the *Schizachyrium sanguineum* species-group (Table 2W) respectively. The condition of the grass layer is poor with respect to cover (Fig. 4l). The high surface rock cover, caused by conglomerate sheet outcrop, is reflected in the relatively high proportion of *Selaginella dregei* in Table 2.

11. Heteropogon contortus – Combretum molle *Closed and Open Woodlands*

These woodlands are found at altitudes of 1 400 m to 1 600 m in the north, south-east and south-west of the study area (Fig. 3). This community is differentiated by the absence of character species as well as the absence of the *Cyperus albostriatus* species-group (Table 2H), the *Setaria megaphylla* species-group (Table 2I), the *Terminalia sericea* species-group (Table 2J), the *Diplorhynchus condylocarpon* species-group (Table 2N), the *Selaginella dregei* species-group (Table 2P), the *Stoebe vulgaris* species group (Table 2U) and the *Senecio erubescens* species-group (Table 2V) in the main vegetation type B, as well as the presence of the *Aristida aequiglumis* species-group (Table 2Q). This community is separated into the following two variations, based on floristics:

11.1 *Rhus dentata – Heteropogon contortus – Combretum molle* Closed Woodland Variation on predominantly nutrient-rich soils,

11.2 *Chaetacanthus costatus – Heteropogon contortus – Combretum molle* Open Woodland Variation on predominantly nutrient-poor soils.

11.1 Rhus dentata – Heteropogon contortus – Combretum molle *Closed Woodland Variation*

This variation is found at altitudes of 1 400 m to 1 575 m on the lower slopes of the Kransberg massif in the north as well as in the south-west and south-east of the study area (Fig. 3). It is represented by ten relevés with 19 to 32 species per relevé. This closed-woodland variation (Edwards, 1983) has a D structure (Ito, 1979; Fig. 4m) with the greatest average cover of 20% in the > 3 m – 5 m height class. Because the variation has a closed-woodland structure, the temperature range is likely to have a narrower amplitude and the moisture regime is likely to be higher than for Variation 11.2.

Habitat

The soils are of the Mispah Form, Mispah Series, derived from sandstone of the Aasvoëlkop Formation, in the case of relevés 154, 151, 143, 139, 146, 147 and 24, and conglomerate of the Alma Graywacke Formation in the case of relevés 59, 49 and 50. The average soil depth varies from 40 mm to 230 mm and the surface rock cover varies from 20% to 60%. The terrain slopes up to 25° in a southerly direction. The electrical resistance of the soils varies from 2 100 ohms to 6 700 ohms. The T-value varies from 7,4 me/100 g to 15,8 me/100 g indicating soils of a predominantly high nutrient status. The soils are strongly acid (MacVicar *et al.*, 1977) with a pH of 4,1 to 4,5 except for relevé 24 which has a pH of 6,0 when saturated with water and is, therefore, moderately acid. The habitat factors for this variation have a wide range which may be attributed to the distribution of this variation which occurs as small areas, widely dispersed through the study area (Fig. 3).

Floristics

This variation is differentiated by the absence of character species as well as the absence of the *Helichrysum* sp. species-group (Table 2 AB), which distinguishes it from the *Chaetacanthus costatus – Heteropogon contortus – Combretum molle* Variation. The species diversity per unit area averages 4,8 species/m² for this variation.

Trees and shrubs

The only conspicuous woody species with more than 5% mean cover and occurring in more than 50% of the relevés representing this variation is:

Burkea africana (tree/shrub)	70%	13%

Rhus dentata (shrub) occurs in 70% of the relevés and has a mean cover of 1,4%.

Herbs

Herb species occurring in more than 50% of the relevés representing this variation are:

Indigofera comosa (forb)	90%	0,9 %
Heteropogon contortus (grass)	80%	4,9 %
Loudetia simplex (grass)	80%	1,6 %
Schizachyrium sanguineum (grass)	80%	0,8 %
Cyperus leptocladus (sedge)	80%	0,3 %
Pellaea calomelanos (fern)	70%	0,03%
Aristida aequiglumis (grass)	60%	1,2 %
Bulbostylis burchellii (sedge)	60%	0,3 %

General

Communities 5 to 11 are related to each other through the shared presence of the *Aristida diffusa* species-group (Table 2Q) and Communities 8 to 16 are related to each other through the shared presence of the *Schizachyrium sanguineum* species-group (Table 2W).

11.2 Chaetacanthus costatus – Heteropogon contortus – Combretum molle *Open Woodland Variation*

This variation is found at altitudes of 1 500 m to 1 600 m on the lower slopes of the Kransberg massif in the northern half of the study area (Fig. 3). It is represented by eight relevés with 20 to 27 species per relevé. This open-woodland variation (Edwards, 1983) has an L structure (Ito, 1979; Fig. 4n) with the greatest cover of 25% in the 0,0 m–0,5 m height class. Because the Variation is generally situated upslope of Variation 11.1, it is probably more exposed with a consequently greater temperature amplitude and a drier moisture regime than Variation 11.1.

Habitat

The soils are of the Mispah Form, Mispah Series, derived from sandstone of the Aasvoëlkop Formation. The average soil depth varies from 110 mm to 210 mm and the surface rock cover varies from 15% to 60%. The terrain slopes from 3° to 21° in a southerly direction. The electrical resistance is 4 400 ohms to 5 100 ohms for the soils and the T-value varies from 6,3 me/100 g to 8,5 me/100 g which is generally lower than that for Variation 11.1 indicating soils of a lower nutrient status. This may be as a result of Variation 11.2 being generally upslope of Variation 11.1 with nutrients lost by runoff from Variation 11.2 to 11.1. The soils are strongly acid (MacVicar *et al.*, 1977) with a pH range of 4,3 to 4,8 when saturated with water.

Floristics

This variation is marked by the absence of character species and is distinguished from Variation 11.1 in Community 11 by the presence of the *Helichrysum* sp. (Westfall 921) species-group (Table 2AB). The species diversity per unit area averages 5,4 species/m^2 for this variation which is higher than that for Variation 11.1.

Trees and shrubs

Conspicuous woody species with 2,5% or more mean cover and occurring in more than 50% of the relevés representing the variation are:

Combretum molle (tree/shrub)	88%	2,9%
Burkea africana (tree/shrub)	75%	7,1%
Protea caffra (tree/shrub)	63%	2,8%

Bequaertiodendron magalismontanum has 100% constancy in Variation 11.2 but only 2,1% mean cover.

Herbs

Herbaceous species occurring in more than 50% of the relevés representing this variation are:

Heteropogon contortus (grass)	100%	15,0%
Chaetacanthus costatus (forb)	88%	0,1%
Bulbostylis burchellii (sedge)	75%	0,4%
Commelina africana (forb)	75%	0,4%
Schizachyrium sanguineum (grass)	63%	1,6%
Loudetia simplex (grass)	63%	1,4%
Sphenostylis angustifolia (forb)	63%	0,4%
Indigofera comosa (forb)	63%	0,3%
Vernonia staehelinoides (forb)	63%	0,3%

General

Communities 5 to 11 and 8 to 16 are related to each other through the shared presence of the *Aristida aequiglumis* species-group (Table 2Q) and the *Schizachyrium sanguineum* species-group (Table 2W) respectively. Variation 11.2 and Communities 12, 17 and 18 are related to each other through the shared presence of the *Helichrysum* species-group (Table 2AB).

12. Themeda triandra – Combretum molle *Open Woodland*

This woodland is found at altitudes of 1 400 m to 1 600 m in the south, north and west of the study area (Fig. 3). It is represented by thirteen relevés with 21 to 29 species per relevé. This open-woodland community (Edwards, 1983) has an L structure (Ito, 1979; Fig. 4o) with the greatest average cover of 38% in the 0,0 m–0,5 m height class. The temperature range should be wide and the moisture regime should be dry, because of the relatively exposed situation of this community.

Habitat

The soils are mainly of the Mispah Form, Mispah Series, derived from sandstone of Aasvoëlkop and Alma Graywacke Formations and shale of the Aasvoëlkop Formation. Soils of Shortlands Form, Bokuil Series, derived from diabase of the post-Waterberg Group, are also found in this community (relevés 165 and 164). The class limits set for the soil classification used in this study (MacVicar *et al.*, 1977) are not necessarily the same as the limits influencing the vegetation (D. Edwards, pers. comm.), hence the variation of soil within this community. The Shortlands Form recorded for this community can, furthermore, be regarded as atypical because of the shallow soil depth of 80 mm recorded (Table 2). The average soil depth varies from 80 mm to 300 mm and the surface rock cover varies from 5% to 60%. The terrain slopes from 3° to 24° in a south-easterly to westerly direction. The electrical resistance of the soils varies from 3 200 ohms to 6 000 ohms and the T-value varies from 4,4 me/100 g to 7,4 me/100 g, indicating soils with a moderate nutrient status. The soils are strongly acid (MacVicar *et al.*, 1977) with a pH range of 4,5 to 5,0 when saturated with water.

Floristics

The Community is diagnosed by the absence of character species as well as the absence of the *Aris-*

tida aequiglumis species-group (Table 2Q) and the *Senecio erubescens* species-group (Table 2V) and the presence of the *Helichrysum* sp. species-group (Table 2AB) in the main vegetation type B, distinguished by the *Combretum molle* species-group (Table 2AC). The species diversity per unit area averages 5,8 species/m² for this community.

Trees and shrubs

Conspicuous woody species with 2,5% or more mean cover and occurring in 50% of the relevés representing this community are:

Protea caffra (tree/shrub)	69%	2,5%
Faurea saligna (tree/shrub)	62%	3,4%

Faurea saligna occurs in eleven of the twelve communities of the main vegetation type B represented by species-group AC (Table 2), but has the highest mean percentage cover of its range in the study area in Community 12.

Herbs

Herb species occurring in more than 50% of the relevés representing this community are:

Heteropogon contortus (grass)	92%	9,8 %
Themeda triandra (grass)	85%	4,4 %
Setaria sphacelata [= *S. perennis*] (grass)	85%	1,3 %
Diheteropogon amplectens (grass)	62%	1,1 %
Rhynchelytrum nerviglume (grass)	62%	1,0 %
Eragrostis racemosa (grass)	62%	0,9 %
Indigofera egens (forb)	62%	0,2 %
Helichrysum sp. (Westfall 921) (forb)	54%	0,2 %
Senecio conrathii (forb)	54%	0,06%

General

Communities 8 to 16 are related to each other through the shared presence of the *Schizachyrium sanguineum* species-group (Table 2W) and Variation 11.2 and Communities 12, 17 and 18 are related to each other through the shared presence of the *Helichrysum* sp. species-group (Table 2AB).

13. Argyrolobium transvaalense – Combretum molle *Open Woodland*

This woodland is found at altitudes of 1 435 m to 1 575 m on the lower slopes of the Kransberg massif in the north-west of the study area (Fig. 3). It is represented by five relevés with 22 to 31 species per relevé. This open-woodland community (Edwards, 1983) has an L structure (Ito, 1979; Fig. 4p) with the greatest average cover of 20% in the 0,0 m–0,5 m height class. This community is more exposed, as a result of its situation on prominent ridges, than the other communities of the lower slopes and large temperature fluctuations and a dry moisture regime can consequently be expected.

Habitat

The soils are of the Mispah Form, Mispah Series, derived from sandstone of the Aasvoëlkop Formation. The average soil depth varies from 120 mm to 150 mm and the surface rock cover varies from 7% to 15%. The terrain slopes up to 27° in a south-easterly to south-westerly direction. The electrical resistance of the soils is 2 100 ohms indicating a moderate nutrient status. The soils are moderately acid (MacVicar *et al.*, 1977) with a pH of 6,0 when saturated with water.

Floristics

This community is distinguished by the *Vernonia oligocephala* species-group (Table 2R). The species diversity per unit area averages 7,8 species/m² for this community which is relatively high for the study area.

Trees and shrubs

There are no woody species with a mean cover of 2,5% or more. Woody species occurring in more than 50% of the relevés representing this community are:

Argyrolobium transvaalense (shrub)	100%	0,2%
Faurea saligna (tree/shrub)	80%	2,6%
Acacia caffra (tree/shrub)	80%	1,2%
Protea caffra (tree/shrub)	60%	1,2%
Vitex rehmannii (tree/shrub)	60%	1,2%
Combretum molle (tree/shrub)	60%	1,1%

Herbs

Herb species occurring in more than 50% of the relevés representing this community, are:

Themeda triandra (grass)	100%	13,0%
Setaria sphacelata [= *S. perennis*] (grass)	100%	2,5%
Elionurus muticus (grass)	100%	2,1%
Eragrostis racemosa (grass)	100%	2,1%
Cymbopogon sp. (grass)	100%	1,7%
Vernonia oligocephala (forb)	100%	0,2%
Ruellia cordata (forb)	100%	0,05%
Senecio erubescens (forb)	100%	0,05%
Eragrostis capensis (grass)	80%	1,6%
Diheteropogon amplectens (grass)	80%	0,8%
Scabiosa columbaria (forb)	80%	0,4%
Hypericum aethiopicum (forb)	80%	0,04%
Tristachya biseriata (grass)	60%	0,7%
Bulbostylis boeckeleriana (sedge)	60%	0,2%
Senecio venosus (forb)	60%	0,2%
Indigofera comosa (forb)	60%	0,1%
Hypoxis angustifolia (geophyte)	60%	0,03%
Gazania krebsiana (forb)	60%	0,03%

General

Communities 13 to 16 are related to each other through the shared presence of the *Senecio erubescens* species-group (Table 2V) and Communities 8 to 16 are related to each other through the shared presence of the *Schizachyrium sanguineum* species-group (Table 2W).

14. Pachycarpus schinzianus – Combretum molle *Open Woodland*

This woodland is found at altitudes 1 425 m to 1 465 m on the upper plateau and adjacent south-facing lower slopes in the centre of the study area

(Fig. 3). It is represented by six relevés with 24 to 27 species per relevé. This open-woodland variation (Edwards, 1983) has an L structure (Ito, 1979; Fig. 4q) with the greatest average cover of 10% in the 0,0 m–0,5 m height class. Being situated adjacent to the upper plateau, probably subjected to marked temperature inversion at night, this community can be expected to have a wide temperature range and relatively dry moisture status.

Habitat

The soils are mainly of the Mispah Form, Mispah Series, derived from sandstone of the Aasvoëlkop Formation but relevés 22 and 23 represent soils of the Westleigh Form, Sibasa Series, also derived from sandstone of the Aasvoëlkop Formation. The soils of the Westleigh Form appear in isolated pockets and are not large in extent, resulting in no apparent vegetation change at the scale of this study. The average soil depth varies from 80 mm to deeper than 1 000 mm and the surface rock cover is 4% or less. The terrain slopes up to 5° in a southerly direction with one relevé (17) representing a 2° slope in a northerly direction. The electrical resistance of the soils is 2 100 ohms to 2 800 ohms and the T-value varies from 3,4 me/100 g to 9,3 me/100 g indicating a moderate nutrient status for the Mispah Form soils and a low nutrient status for the Westleigh Form soils. The soils are moderately acid (MacVicar *et al.*, 1977) with a pH of 6,0 when saturated with water.

Floristics

This community is distinguished by the *Pachycarpus schinzianus* species-group (Table 2S). The species diversity per unit area averages 7,3 species/m² for the Community.

Trees and shrubs

The only conspicuous woody species with 2,5% or more mean cover and occurring in 50% of the relevés representing this community is:

Combretum molle (tree/shrub)	67%	2,5%

Herbs

Herb species occurring in more than 50% of the relevés representing the community are:

Eragrostis racemosa (grass)	100%	5,8%
Setaria sphacelata [= *S. perennis*] (grass)	100%	4,2%
Indigofera comosa (forb)	100%	0,7%
Pachycarpus schinzianus (forb)	83%	0,1%
Eragrostis pallens (grass)	67%	7,5%
Elionurus muticus (grass)	67%	1,7%
Scabiosa columbaria (forb)	67%	0,7%
Hypericum aethiopicum (forb)	67%	0,03%

General

Communities 13 to 16 are related to each other through the shared presence of the *Senecio erubescens* species-group (Table 2V) and Communities 8 to 16 are related to each other through the shared presence of the *Schizachyrium sanguineum* species-group (Table 2W).

15. Protea caffra – Combretum molle *Open Woodland*

This woodland is found at altitudes of 1 425 m to 1 575 m on the upper plateau and the adjacent south-facing lower slopes in the northern half of the study area (Fig. 3). It is represented by eight relevés with 18 to 30 species per relevé. This open-woodland community (Edwards, 1983) has an L structure (Ito, 1979; Fig. 4r) with the greatest cover of 20% in the 0,0m–0,5 m height class. Being situated adjacent to the upper plateau, this community can be expected to have a wide temperature range and dry moisture status.

Habitat

The soils are mainly of the Mispah Form, Mispah Series, derived mainly from sandstone of the Aasvoëlkop Formation but also conglomerate, in the case of relevé 78, of the Alma Graywacke Formation. Relevé 14 represents soils of the Westleigh Form, Sibasa Series, derived from sandstone of the Aasvoëlkop Formation. The average soil depth varies from 80 mm to deeper than 1 000 mm and the surface rock cover varies from 1% to 15%. The terrain slopes from 1° to 19° in a south to south-easterly direction with relevé 78 on the upper plateau representing a slope of 2° in a northerly direction. The electrical resistance of the soils varies from 2 100 ohms to 4 700 ohms and the T-value varies from 3,4 me/100g to 9,3 me/100 g, indicating soils with a low to moderate nutrient status. The soils are moderately to strongly acid (MacVicar *et al.*,1977) with a pH range of 5,0 to 6,0, when saturated with water.

Floristics

This community is distinguished by the absence of character species and the absence of the *Vernonia oligocephala* species-group (Table 2R), the *Pachycarpus schinzianus* species-group (Table 2S) and the *Cyperus denudatus* species-group (Table 2T) together with the presence of the *Senecio erubescens* species-group (Table 2V). The species diversity per unit area averages 6,5 species/m² for this community.

Trees and shrubs

All woody species have less than 2,5% mean cover. Woody species occurring in more than 50% of the relevés representing this community are:

Protea caffra (tree/shrub)	75%	1,9%
Rhus dentata (shrub)	63%	0,5%

Herbs

Herb species occurring in more than 50% of the relevés representing this community are:

Eragrostis racemosa (grass)	100%	4,3%
Setaria sphacelata [= *S. perennis*] (grass)	75%	2,9%
Indigofera comosa (forb)	63%	0,2%
Bulbostylis boeckeleriana (sedge)	63%	0,08%

General

Communities 13 to 16 are related to each other through the shared presence of the *Senecio erubes-*

cens species-group (Table 2V) and Communities 8 to 16 are related to each other through the shared presence of the *Schizachyrium sanguineum* species-group (Table 2W). The *Stoebe vulgaris* species-group (Table 2U) indicates a partial affinity between Communities 15 & 16.

C. Grassland phase of Acocks's (1975) Sour Bushveld on moderately deep soils, in exposed dry habitats

The grassland phase of Acocks's (1975) Sour Bushveld is represented by one community in the study area, viz the *Eragrostis pallens – Andropogon appendiculatus* Grassland.

16. Eragrostis pallens – Andropogon appendiculatus *Grassland*

This grassland is found at altitudes of 1 400 m to 1 465 m on the upper plateau (Fig. 7) in the central part of the study area (Fig. 3). It is represented by twelve relevés with 12 to 28 species per relevé. This grassland community (Edwards, 1983) has an L structure (Ito, 1979; Fig. 4s) with the greatest average cover of 23% in the 0,0 m–0,5 m height class. However, relevé 1 represents vegetation classified as dwarf shrubland (Edwards, 1983) because of the presence of *Stoebe vulgaris* which has a mean cover of 42% in this relevé (Fig. 8). The upper plateau is possibly subjected to temperature inversion at night because of the slopes to the north and south, resulting in wide temperature fluctuations. Except for the rainy season, when the water table is high or at the soil surface for large areas of the upper plateau, this community is very dry, possibly because of the exposed nature of the habitat and lack of high vegetation cover.

Habitat

The soils are mainly of the Mispah Form, Mispah Series, derived from shale of the Aasvoëlkop Formation and the Kroonstad Form, Sibasa Series, derived from shale of the Aasvoëlkop Formation and conglomerate of the Alma Graywacke Formation.

FIG. 7. — The *Eragrostis pallens – Andropogon appendiculatus* Grassland in the foreground with the north-facing slopes in the background.

FIG. 8. — *Stoebe vulgaris* Closed Dwarf Shrubland in the foreground, represented by relevé 1.

The average soil depth varies from 150 mm to deeper than 1 000 mm but the impermeable shale causes a high water table, varying from 150 mm to deeper than 1 000 mm at the time of sampling, that could have a limiting effect on maximum root depth. No surface rocks were recorded for this community. The terrain slopes up to 3° mainly in a south-easterly to south-westerly direction but also northerly in the case of relevé 8. The electrical resistance varies from 3 100 ohms to 4 800 ohms and the T-value varies from 5,9 me/100 g 11,8 me/100 g indicating soils of a predominantly high nutrient status, possibly owing to cation adsorption by the clay fraction derived from the shale. The soils are strongly acid (MacVicar *et al.*, 1977) with a pH of 4,5 to 4,7 when saturated with water.

Floristics

The community is diagnosed by the *Cyperus denudatus* species-group (Table 2T). The species diversity per unit area averages 6,1 species/m² for the Community.

Trees and shrubs

Only an isolated *Protea caffra* tree was recorded for this community. The dwarf shrub *Stoebe vulgaris* with a constancy of 53% has a mean cover of 4% for the relevés representing this community. However, in relevé 1, *Stoebe vulgaris* has a mean cover of 42%, resulting in this relevé being classified as closed dwarf shrubland. If relevé 1 is not taken into account, the mean cover of *Stoebe vulgaris* is less than 1% for the community as a whole, hence the community is classified as grassland. The floristic composition of relevé 1 is such that it forms a part of Community 16 (Table 2). *Stoebe vulgaris* can be regarded as an invader species, without which relevé 1 would have potentially closer floristic affinities with Community 16. The presence of *Stoebe vulgaris* causes much concern amongst the local farmers because of its encroachment upon grassland used for grazing.

Herbs

Herb species occurring in more than 50% of the relevés representing this community are:

Cyperus denudatus (sedge)	100%	0,8%
Eragrostis racemosa (grass)	92%	5,9%
Eragrostis pallens (grass)	92%	4,6%
Bulbostylis boeckeleriana (sedge)	92%	0,9%
Senecio erubescens (forb)	92%	0,2%
Andropogon appendiculatus (grass)	67%	1,7%
Alloteropsis semialata (grass)	67%	0,2%
Bergia decumbens (forb)	67%	0,2%
Panicum natalense (grass)	58%	5,7%
Aristida junciformis (grass)	58%	2,7%
Eragrostis capensis (grass)	58%	2,2%

General

Communities 13 to 16 are related to each other through the shared presence of the *Senecio erubescens* species-group (Table 2V) and Communities 8 to 16 are related to each other through the shared presence of the *Schizachyrium sanguineum* species-group (Table 2W). The *Stoebe vulgaris* species-group (Table 2U) indicates a partial affinity between Communities 15 & 16. Roux (1969) suggests that selective grazing of grass results in grass tufts often being left ungrazed, which provides essential shade for *Stoebe vulgaris* seed germination. Where grass is grazed short and species composition is not affected, i.e. non-selective grazing (Acocks, 1966), *Stoebe vulgaris* will be unable to germinate for lack of shade.

D. Woodland phase of Acocks's (1975) North-Eastern Mountain Sourveld on moderately shallow soils, in moderately exposed habitats

The woodland phase of Acocks's (1975) North-Eastern Mountain Sourveld is represented by one community in the study area, viz the *Helichrysum nudifolium – Protea roupelliae* Sparse Woodland.

17. Helichrysum nudifolium – Protea roupelliae *Sparse Woodland*

This woodland (Fig. 9) is found at altitudes of 1 600 m to 1 900 m in the northern part of the study area (Fig. 3). It is represented by 17 relevés with 17 to 32 species per relevé. Relevés 120 and 118, although floristically different from the rest of the community, are not regarded as a separate variation because of the lack of character species and because only two relevés are different. In order to ascertain whether structural differences exist, the two different floristic units were illustrated separately as Fig. 4t, for relevés 120 and 118, and Fig. 4u for the rest of the community. This sparse-woodland community (Edwards, 1983) has an L structure (Ito, 1979; Figs 4t and 4u) with the greatest average cover of 36% for relevés 120 and 118, and 30% for the other relevés in the community, in the 0,0 m to 0,5 m height class. This community is exposed, being situated at a high altitude and considerable temperature fluctuation could be expected. The moisture regime, however, should not be the driest in the study area although this community is much exposed, because of the frequent occurrence of mist on the upper reaches of the Kransberg massif, as observed during the course of fieldwork.

Habitat

The soils are of the Mispah Form, Mispah Series, derived from sandstone of the Aasvoëlkop and Sandriviersberg Formations. The average soil depth varies from 70 mm to 180 mm and the surface rock cover varies from 50% to 80%. The terrain slopes up to 38° in a south-easterly to westerly direction. Relevé 122 representing the 0° slope is situated on a flat area at 1 750 m altitude. The electrical resistance of the soils varies from 4 300 ohms to 8 300 ohms and the T-value varies from 6,0 me/100 g to 11,8 me/100 g indicating a low to high nutrient status. It is suggested that the high nutrient status occurs in bottomlands where runoff from the interfluves causes depletion of nutrients on the interfluves and accumulation of nutrients in the bottomlands. The soils are strongly acid (MacVicar *et al.*, 1977) with pH from 4,4 to 4,9 when saturated with water.

Floristics

This community is differentiated by the *Helichrysum nudifolium* species-group (Table 2X) which

FIG. 9. — The *Helichrysum nudifolium – Protea roupelliae* Sparse Woodland on the upper slopes of the Kransberg massif.

does not occur in relevés 120 and 118. The species diversity per unit area averages 6,2 species/m² for this community. It appears from aerial photographs of the study area that the vegetation represented by relevés 120 and 118 falls into an apparent permanent shadow caused by the Kransberg cliffs and with additional sampling could prove to be a variation of Community 17.

Trees and shrubs

The only conspicuous woody species occurring in 50 per cent of the relevés representing this community is:

Protea caffra (tree/shrub)	71%	2,8%

The mean percentage cover for *Protea caffra* is higher than indicated for a sparse woodland (Edwards, 1983). However, the high cover can be attributed to individual plants, under 2 m tall, as is also the case with *Protea roupelliae* which has a 47% constancy and 1,3% mean cover.

Herbs

Herb species occurring in more than 50% of the relevés representing this community are:

Heteropogon contortus (grass)	100%	25,6%
Eragrostis racemosa (grass)	94%	1,8%
Panicum natalense (grass)	88%	2,6%
Bulbostylis burchellii (sedge)	88%	0,2%
Loudetia simplex (grass)	82%	2,9%
Monocymbium ceresiiforme (grass)	82%	2,4%
Helichrysum sp. (forb)	71%	0,1%
Indigofera hedyantha (forb)	71%	0,1%
Helichrysum nudifolium (forb)	65%	0,09%
Andropogon schirensis (grass)	59%	1,1%
Brachymeris bolusii (forb)	59%	0,8%
Chaetacanthus costatus (forb)	59%	0,3%
Helichrysum kraussii (forb)	59%	0,3%
Stachys natalensis var. *natalensis* (forb)	59%	0,06%
Themeda triandra (grass)	53%	3,2%
Dicoma anomala (forb)	53%	0,03%

General

Communities 17 & 18 are related to each other through the common presence of the *Protea roupelliae* species-group (Table 2Z) and the *Helichrysum kraussii* species-group (Table 2AA), but the former species-group is not represented in relevés 120 and 118, whereas the latter is represented in these two relevés. Variation 11.2 and Communities 12, 17 and 18 are related to each other through the shared presence of the *Helichrysum* sp. *Westfall* 921 species group (Table 2AB).

The high altitude and steep slope on which this community is found, together with the high surface rock cover make accessibility and hence grazing by cattle difficult. The grass is not moribund, however, probably owing to periodic accidental fires.

E. Grassland phase of Acocks's (1975) North-Eastern Mountain Sourveld on shallow rocky soils in exposed habitats.

The grassland phase of Acocks's (1975) North-Eastern Mountain Sourveld is represented by one community in the study area, viz the *Eragrostis racemosa – Trachypogon spicatus* Grassland.

18. Eragrostis racemosa – Trachypogon spicatus *Grassland.*

This grassland (Fig. 10) is found at altitudes of 1 900 m to 2 080 m in the extreme north of the study area (Fig. 3). It is represented by 15 relevés with 19 to 35 species per relevé. This grassland community (Edwards, 1983) has an L structure (Ito, 1979; Fig. 4V) with the greatest average cover of 18% in the 0,0 to 0,5 m height class. The community is exposed, being situated on the upper summit, and a wide temperature range could be expected. As in the case of Community 17, the moisture regime should not be the lowest in the study area, although the community is exposed, because of frequent mists, as observed during the course of fieldwork.

Habitat

The soils are of the Mispah Form, Mispah Series, derived from sandstone of the Sandriviersberg Formation. The average soil depth varies from 40 mm to

FIG. 10. — The *Eragrostis racemosa – Trachypogon spicatus* Grassland with an isolated *Podocarpus latifolius* in the centre.

100 mm and the surface rock cover varies from 60% to 90%. The terrain slopes up to 14° mainly in a south-westerly through northerly to south-easterly direction. The absence of a southerly aspect may be attributed to the cliff face to the south of the upper summit. The electrical resistance of the soils is 4 200 ohms and the T-value is 11,0 me/100 g indicating soils of a high nutrient status which may be attributed to the predominantly flat nature of the upper summit which inhibits runoff and consequent loss of nutrients. The soils are strongly acid (MacVicar *et al.*, 1977) with a pH of 5,2 when saturated with water.

Floristics

This community is distinguished by the *Trachypogon spicatus* species-group (Table 2Y). The species diversity per unit area averages 6,0 species/m² for this community.

Trees and shrubs

Isolated *Protea roupelliae* trees and shrubs occur in 60% of the relevés representing this community and the shrublet *Fadogia monticola* occurs with 60% constancy. Isolated *Podocarpus latifolius* trees are found in boulder clumps and the shrub *Widdringtonia nodiflora* occurs in 33% of the relevés. The canopy cover of the woody species is, however, less than 0,1 per cent, resulting in this community being classified as a grassland (Edwards, 1983).

Herbs

Herb species occurring in more than 50% of the relevés representing this Community are:

Trachypogon spicatus (grass)	100%	8,6%
Loudetia simplex (grass)	100%	7,2%
Andropogon schirensis (grass)	100%	2,2%
Acalypha angustata (forb)	100%	0,3%
Bulbostylis burchellii (sedge)	93%	0,9%
Helichrysum kraussii (forb)	93%	0,4%
Helichrysum sp. (forb)	93%	0,3%
Dicoma anomala (forb)	93%	0,2%
Eragrostis racemosa (grass)	80%	0,4%
Helichrysum mimetes (forb)	73%	0,2%
Selago capitellata (forb)	67%	1,0%
Helichrysum uninervium (forb)	67%	0,2%
Helichrysum cephaloideum (forb)	60%	0,2%
Indigofera hedyantha (forb)	60%	0,06%
Senecio conrathii (forb)	60%	0,06%
Mohria caffrorum (fern)	60%	0,03%
Cyperus leptocladus (sedge)	53%	0,2%
Berkheya carlinopsis (forb)	53%	0,2%
Tephrosia elongata (forb)	53%	0,09%
Xerophyta retinervis (forb)	53%	0,06%

General

Communities 17 & 18 are related to each other through the common presence of the *Protea roupelliae* species-group (Table 2Z) and the *Helichrysum kraussii* species-group (Table 2AA). Variation 11.2 and Communities 12, 17 and 18 are related to each other through the shared presence of the *Helichrysum* sp. species-group (Table 2AB).

DISCUSSION AND CONCLUSIONS

The present study has resulted in a classification of the vegetation and a correlation of the main environmental factors influencing the vegetation (Westfall *et al.*, 1983). Although the vegetation is predominantly open woodland, the formation classes found in the study area range from forests to grasslands, with a diversity of communities, along a temperature/moisture gradient. Soil depth also appears to play an important role in community differentiation. The kloof forest communities are diagnosed by the species *Celtis africana* and *Diospyros whyteana*, whereas the woodland communities representing Acocks's (1975) Sour Bushveld are distinguished by species such as *Combretum molle*, *Faurea saligna*, *Ozoroa paniculosa* and *Heteropyxis natalensis*. Species such as *Burkea africana*, *Ochna pulchra* and *Strychnos pungens* represent the *Aristida aequiglumis* species-group (Table 2Q) and have a more restricted range than the species that distinguish the woodland phase of Acocks's (1975) Sour Bushveld. The ordination of communities (Westfall *et al.*, 1983) shows that the communities characterized by the *Aristida aequiglumis* species-group (Table 2Q) occupy a central position on the temperature/moisture gradient. It can,

therefore, be inferred that the extremes of the temperature/moisture gradient are limiting factors for the species of the *Aristida aequiglumis* species-group (Table 2Q). The grassland phase of Acocks's (1975) Sour Bushveld, in the study area, appears to be related to the reduced effective soil depth resulting from seasonally high water tables. If the drainage were to improve, it is possible that an open-woodland formation could become established. Tinley (1977 & 1982) also attributes the occurrence of grasslands in dambos to seasonal waterlogging.

The communities representing Acocks's (1975) North-Eastern Mountain Sourveld are found above 1 501 m altitude in the study area. Acocks (1975) describes North-Eastern Mountain Sourveld as having had a high-forest climax. Isolated *Podocarpus latifolius* trees are found in Community 17, amongst boulder clumps (Fig. 11). The boulders probably afford protection from fire. Edwards (1967) describes the occurrence of *Podocarpus latifolius* amongst boulder clumps in the Protea savanna in Natal as developing forest clumps. It is likely that *Podocarpus latifolius* could have a higher mean percentage cover, than at present, if protected from fire in Community 17, with the possibility of forest as a climax.

A comparison of communities described by Theron (1973), Coetzee (1975), Coetzee *et al.*, (1976) and Van der Meulen (1979), who all worked in Transvaal Bushveld, shows that none of the communities are similar to communities described in this study, in terms of character species for the communities. A complete floristic comparison of the communities described by the aforementioned authors and those in this study would entail joint synthesis of all the communities involved.

It would appear from the community descriptions that in an open bushveld situation, woody species encroachment could become a problem for grazing management, when the canopy cover of the woody species is less than two crown diameters apart or more than 9% canopy cover forming a closed woodland. Although the floristic composition of the grass stratum appears different in Acocks's (1975) Sour Bushveld as represented in the study area, when the canopy cover of the tree stratum is greater than 20% for any height class (Fig. 4), it is likely that floristic change could take place before a 20% canopy cover is achieved.

The removal of the tree ferns, *Cyathea dregei*, from the larger kloof in which Community 3 is found, emphasizes the need for protection of the smaller kloof in which *Cyathea dregei* still occurs, if the species is to be conserved in its natural habitat in the study area. Although there is an abundance of streams in the study area, none are perennial. The experience gained at the Thabamhlope Research Station, near Estcourt in Natal (Westfall *et al.*, 1982b) indicates that protection of kloofs from grazing and fire should prolong the periods in which streams flow, which would be of benefit to the farms south of Kransberg.

The agricultural potential of the study area appears to be limited because of the limited extent of deep soils, generally high surface-rock cover and lack of perennial free water. Furthermore, the grass cover is not suited to year-round grazing because of its sour nature (Booysen, 1967). That potential for agriculture appears limited, is supported by the many part-time farmers in the study area. Paddock fences generally do not follow natural community boundaries. This results in portions of camps being selected for grazing far more than others. Fences should be erected so that the enclosed vegetation is as homogeneous as possible to encourage uniform grazing. Where communities, such as Community 16, have local differences in veld condition with respect to grazing, these could also be separated by fences to ensure uniform grazing.

Recommendations based on this study may be summarized as follows:

1. Species requiring conservation in their natural habitats include *Cyathea dregei* as well as *Encephalartos eugene-maraisii* which has been reported in the

FIG. 11. — An isolated *Podocarpus latifolius* in a boulder clump in the *Helichrysum nudifolium – Protea roupelliae* Sparse Woodland.

Waterberg (Coates Palgrave, 1977) and on the upper north-facing slopes of the Kransberg massif by local farmers, but not observed during the course of this study.

2. Protection of the catchment areas, from grazing by means of fences and from fire by means of firebreaks, to improve the water supply.

3. Improvement of species composition of the veld to enhance its grazing value and to overcome problems caused by invader species such as *Stoebe vulgaris* by ensuring that paddock fences coincide with community boundaries where feasible and adjusting grazing pressure as the proportion of Increaser species and Decreaser species dictates.

4. Provision of facilities for, and control of activities of sightseers, so that the landscape is not littered and species such as *Cyathea dregei* are not removed.

Conservation of the entire study area could achieve the abovementioned recommendations and might be feasible because of the apparently low agricultural potential of the study area. Furthermore, conservation would ensure that Acocks's Sour Bushveld, which is poorly conserved (Edwards, 1974), could be represented in the Waterberg where the greatest area of this veld type is found (Acocks, 1975). The study area includes the Kransberg massif which is frequently visited by members of mountain clubs, as witnessed during the course of fieldwork, and is considered by mountain-club members to be probably the best rock-climbing facility in the Transvaal. The study area is approximately 200 km from Pretoria which is an accessible range for visitors from Pretoria, Johannesburg and vicinity. Introduction of grazing game into the area would not improve the grass species composition without a grazing policy being implemented. Several private game reserves in the Waterberg area have a woody species canopy cover, including *Dichrostachys cinerea* thickets which, from cursory observation, appear to be impenetrable. A grazing policy in which the species composition is frequently monitored and grazing pressure adjusted accordingly is, therefore, essential. A further advantage of conservation of the study area is that the area could provide emergency grazing for farms in the Mixed and Sourish Mixed Bushveld (Acocks, 1975), in times of drought, but not on a permanent basis.

In conclusion, the classification of the farm Groothoek, Thabazimbi District, has revealed a diversity of plant communities and habitats requiring continual surveillance by farmers and conservation authorities if the full potential of the area is to be realized.

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UITTREKSEL

Die plantegroei van die plaas Groothoek, Thabazimbi-distrik wat in die Suurbosveld van die Transvaalse Waterberg geleë is, is volgens die Braun-Blanquet metode, met gebruik van die FITOTAB programme, geklassifiseer. Vyf hoof plantegroei-tipes met agtien gemeenskappe is beskryf met verwysing na die hoof omgewingsfaktore wat die plantegroei beïnvloed, asook na plantegroeistruktuur.

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APPENDIX: EXPLANATION OF CLASS SYMBOLS USED IN TABLE 2

Vegetation Formation

Feature	Symbol	Class
Canopy cover (classes, according to Edwards, 1983)	C	Closed (0–2 canopy diameters apart)
	O	Open (> 2–8 canopy diameters apart)
	S	Sparse (> 8–27 canopy diameters apart)
Formation (classes, according to Edwards, 1983)	F	Forest (< 0 canopy diameters apart)
	W	Woodland
	S	Shrubland
	D	Dwarf shrubland
	G	Grassland

Habitat Data

Landform			
	A	Summit: upper lower	
	B	Plateau: upper lower	
	CF	Cliff face	
	D	Upper slope	
	E	Lower slope	
	H	Steep bank/kloof	
	K	Ridge/knoll	
Altitude (arbitrary 100 m class intervals except for class 0 which has a 200 m class interval, to the nearest 1 m)	1	1 001–1 100 m low	
	2	1 101–1 200 m low	
	3	1 201–1 300 m low	
	4	1 301–1 400 m moderate	
	5	1 401–1 500 m moderate	
	6	1 501–1 600 m moderate	
	7	1 601–1 700 m high	
	8	1 701–1 800 m high	
	9	1 801–1 900 m high	
	0	1 901–2 100 m high	
			Description
Slope (classes used by the Botanical Research Institute, Private Bag X101, Pretoria)	L	Level	0–3,49°
	G	Gentle	3,50–17,62°
	M	Moderate	17,63–36,39°
	S	Steep	≥ 36,4°
Aspect (classes according to an eight-point rosette, to the nearest 1°)	1	North	338–360;0–22°
	2	North-east	23– 67°
	3	East	68–112°
	4	South-east	113–157°
	5	South	158–202°
	6	South-west	203–247°
	7	West	248–292°
	8	North-west	293–337°
		Soil Form	**Soil Series**
Soil Form and Series (MacVicar *et al.*, 1977)	MM	Mispah	Mispah
	SB	Shortlands	Bokuil
	HM	Hutton	Middelburg
	WS	Westleigh	Sibasa
	KS	Kroonstad	Slangkop
		Soil depth	
Soil Depth (Arbitrary class intervals, to the nearest 10 mm)	A	0– 120 mm shallow	
	B	130– 240 mm moderate	
	C	250– 480 mm moderate	
	D	490– 1 000 mm moderate	
	E	> 1 000 mm deep	
		Water table depth	
Water table Depth (Arbitrary class intervals, to the nearest 10 mm)	H	0– 250 mm high	
	M	260– 500 mm moderate	
	L	510– 1 000 mm low	
	O	Not observable	

Chemical analysis of the A-Horizon

Feature	Symbol	Class
Carbon		
(Arbitrary class intervals)	1	0–1% low
	2	> 1–2% low
	3	> 2–3% moderate
	4	> 3–4% moderate
	5	10,4% high (only one sample)
Aluminium		
(arbitrary class intervals,	0	0,0 me % low
to the nearest 0,1 me % soil)	1	0,1 me % low
	2	0,2 me % low
	3	0,3 me % low
	4	0,4–0,5 me % low
	5	0,6–0,7 me % moderate
	6	0,8–0,9 me % moderate
	7	1,0–1,1 me % moderate
	8	1,2–1,4 me % high
	9	1,5–2,0 me % high
Soil pH (in distilled water solution)		
(classes according to	M	pH 5,5–6,5 moderately acid
MacVicar *et al.*, 1977)	S	pH <5,5 strongly acid
Buffer Capacity		
(arbitrary class intervals	1	0,1 low
of 0,1 to the nearest 0,1	2	0,2 low
being difference in pH in	3	0,3 low
H_2O and $CaCl_2$, see Russell,	4	0,4 moderate
1961)	5	0,5 moderate
	6	0,6 moderate
	7	0,7 high
	8	0,8 high
	9	0,9 high
Titratable acidity		
(arbitrary class intervals, to	1	≤ 2,9 low
the nearest 0,1 me/100g soil)	2	3,0– 3,9 low
	3	4,0– 4,9 low
	4	5,0– 5,9 moderate
	5	6,0– 6,9 moderate
	6	7,0– 7,9 moderate
	7	8,0– 8,9 moderate
	8	9,0–11,9 moderate
	9	12,0–14,9 high
	0	15,0–29,9 high
Electrical Resistance		
(arbitrary class intervals	1	≤ 1900 ohms low
to the nearest 100 ohms)	2	2000–2900 ohms low
	3	3000–3900 ohms moderate
	4	4000–4900 ohms moderate
	5	5000–5900 ohms moderate
	6	6000–6900 ohms high
	7	7000–7900 ohms high
	8	8000–8900 ohms high
T-Value (cation exchange capacity)		
(arbitrary class intervals	1	<5 me/100 g low
to the nearest 0,1 me/100g)	2	5,0– 5,9 me/100 g low
	3	6,0– 6,9 me/100 g low
	4	7,0– 7,9 me/100 g moderate
	5	8,0– 8,9 me/100 g moderate
	6	9,0– 9,9 me/100 g moderate
	7	10,0–11,0 me/100 g high
	8	12,0–14,9 me/100 g high
	9	15,0–22,0 me/100 g high

			Description
Surface Rock Cover			
(classes according to	O	< 1%	No limitation on mechanical utilization
Van der Meulen, 1979, to the nearest 1%)	L	1– 4%	Low limitation on mechanical utilization
	M	5– 34%	Moderate limitation on mechanical utilization
	H	35– 84%	High limitation on mechanical utilization
	V	85–100%	No mechanical utilization possible