

KOOIJ M S

A PHYTOSOCIOLOGICAL SURVEY OF THE VEGETATION
OF THE NORTH WESTERN ORANGE FREE STATE

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**A PHYTOSOCIOLOGICAL SURVEY OF THE VEGETATION
OF THE NORTH WESTERN ORANGE FREE STATE.**

by

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Opgedra aan my ouers en Günter.

Wie het werklik wysheid?
Wie kan verklaar wat gebeur?

Pred. 8.1

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ABSTRACT

The vegetation of the north western Orange Free State was classified by means of the polythetic TWINSpan and Braun - Blanquet procedures. Stratification was done according to land type and terrain form to enable efficient sampling. The classification of the floristic data was done for the different land types separately, resulting in four different phytosociological tables, representing the A, B and D land types as well as the hills and ridges of the north western Orange Free State. All identified plant communities were ecologically interpreted, and described. The results of these classifications were incorporated with the Scheepers data from the Kroonstad area and the Du Preez data of the Vredefort Dome area into a synoptic table. The results obtained through this synthesis were successfully ecologically interpreted and forms the basis for a proposed syntaxonomical classification. Ecological / floristical gradients were interpreted by means of DECORANA ordination.

UITTREKSEL

Die plantegroei van die noordwestelike Oranje Vrystaat is geklassifiseer deur die toepassing van die politetiese TWINSPAN en Braun - Blanquet - prosedures. Stratifisering is gedoen op grond van landtipe en terreinvorm om sodoende doeltreffende monsterneming te verseker. Die klassifisering van die floristiese data is vir elke landtipe afsonderlik uitgevoer, gevolglik is vier fitososiologiese tabelle saamgestel wat die A, B en D land tipes sowel as die randte en koppies in die studie gebied verteenwoordig, is saamgestel. Al die geïdentifiseerde plantgemeenskappe is ekologies geïnterpreteer en beskryf. Die resultate van hierdie klassifikasies is met die Scheepers data en Du Preez data vanaf die Vredefortkoepel gebied geïnkorporeer in 'n sinoptiese tabel. Die resultate uit hierdie sintese is ekologies sinvol geïnterpreteer en vorm die basis vir 'n voorgestelde sintaksonomiese klassifikasie. Ekologies / floristiese gradiënte is met behulp van DECORANA ordening geïnterpreteer.

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CHAPTER 1

INTRODUCTION

Phytosociological research in the South African grassland biome arose largely in response to a report of the Drought Investigation Commission published in 1923. This Commission had been appointed in 1920 to investigate and report on certain matters connected with periodic droughts in South Africa , with the objective of identifying those factors which contributed to what was believed to be an increasing frequency and intensity of droughts. The Commission concluded that a number of factors appeared to contribute to the increase in drought incidence , but that in essence the drought problem was being aggravated by a man-induced deterioration of vegetal cover , leading in turn to an increased runoff and soil loss , and a reduced capacity of the soil to absorb and hold water during any rainfall event (Tainton 1984).

To facilitate land-use planning and management to prevent the deterioration of the veld , as well as the limitation of erosion in the north western Orange Free State , the scale of Acocks's (1988) veld types needed to be enlarged (Van der Meulen & Scheepers 1978). The vegetation of the north western Orange Free State was classified and described considering that floristic classifications express relationships between plant communities and their environment and are thus ecologically reliable units which are potentially suitable planning tools (Deall et al. 1989).

The north western Orange Free State is situated in the Grassland

Biome of southern Africa. According to Rutherford and Westfall (1986) the Grassland Biome occupies approximately 16,5% of Southern Africa. The Grassland Biome is situated on the central plateau, the Natal interior as well as the south eastern mountain ridges of the Cape Province. The topography varies from flat and undulating plains, to mountain ridges. The area lies between 300 and 2 850 m above sea level. The highveld is situated in the summer rainfall region with an average of 460 to 2 000 mm per annum (Mentis & Huntley 1982). The maximum temperature for January varies from 25°C in the southern parts to 30°C in the north western areas, where as the minimum temperature for July varies from 10°C at the coastal regions to -1°C inland. Frost occurs from April to October for a period from 30 up to 180 days (Mentis & Huntley 1982).

The Grassland Biome is the most suitable biome for agriculture. About half of all the cultivated land in the Republic of South Africa is situated in the Highveld Region, producing 80% of the maize, 75% of the grain sorghum, 65% of the sunflower seed, 58% of the dried beans, 52% of the potatoes, 37% of the groundnuts and 36% of the wheat in the Republic. Moreover, this region produces approximately 24% of the total value of the Republic's animal products (Scheepers 1975), as well as timber (Mentis & Huntley 1982). Furthermore a vast majority of mining and industrial activities take place in this biome, causing it to be the highest populated biome.

The vegetation of the Grassland Biome is physiognomically monoletic

and is dominated mainly by grass , especially Themeda triandra. The vegetation of the Grassland Biome correlates with a rainfall gradient , dividing the biome into two sections according to the availability of moisture , namely:

- 1) the wet grassveld occupying the greater part , consisting of unpalatable sour grasses and
- 2) the drier grassveld consisting of more palatable sweeter grasses (Rutherford & Westfall 1986).

The composition , stability and condition of the vegetation in the Grassland Biome are influenced by human activities for example mining , the misgoverning of veld , drought and erosion. The biome is maintained through abiotic factors such as fire , which prevents bush encroachment (Rutherford & Westfall 1986).

Besides the floristic richness of South Africa , it is poor in agricultural resources such as soil and water. Most of the arable land is cultivated , but the land that has not yet been cultivated can not compensate for the arable land lost to urbanisation. The high population increase causes a decrease in the available arable land per capita for food production (Mentis & Huntley 1982). This substantiates the necessity to:

- 1) identify and classify the major plant communities and variations in the Grassland Biome as well as the interpretation of the identified communities according to biotic and abiotic environmental factors and
- 2) the formulation of land-use planning and management measurements for optimal utilization without erosion and the degradation of the veld.

The necessity for describing and identifying plant communities and sub - communities in the Grassland Biome was already stated in 1923 by the Drought Investigation Commission , in 1982 by Mentis and Huntley and again in 1986 by Scheepers. Little information on the vegetation of the north western Orange Free State was available , therefore the urgent need for studying this area. A further benefit of such a vegetation study is that a formal hierarchical syntaxonomical classification could be compiled for the present time for the study area. This is considered a major advance in phytosociology in South Africa.

The purpose of this study was therefore to classify and describe the vegetation of the north western Orange Free State , and in doing so to incorporate all existing compatible data to enable a phytosociological and syntaxonomical synthesis of the area.

This thesis consists of a collection of contributaries on the phytosociology of the north western Orange Free State. All these studies were approached with an ultimate phytosociological and syntaxonomical synthesis of South African grassland in mind. Contributions are in the form of papers, which have either been accepted for publication , in various scientific journals or which have been prepared for publication. Although details of methods for the study area , results , discussions and references are presented in the individual contributions , a brief chapter on methods , a general discussion and a comprehensive list of references are also included. The papers presented show some stylistic irregularities. These are due to differences in layout

and style required by the various journals.

CHAPTER 2

METHODS

Terrain reconnoitring

All possible published environmental information of the study area were obtained , to enable efficient sampling of the representative vegetation types in limited time.

The actual reconnoitring of the study area was preceded by the demarcation of the specific locality of the study area on the 1 : 250 000 scale topographical map , of Kroonstad , 2627. Information concerning the geology , soil forms and topography was obtained from the Land Type Survey Staff (1984). The study area was further investigated by means of a reconnaissance trip through the study area , to form a basic idea of the topography , farming activities and the variation in vegetation. During the reconnaissance trip plant species were collected for identification at the Botanical Research Institute (now known as the National Botanical Institute)in Pretoria.

Number and distribution of sampling plots

According to Bredenkamp (1982) the number of sampling plots are influenced by various factors for example the scale of the survey, variation in the study area , and the accuracy necessary for the classification. The results should however give a clear reflection of the variation of the vegetation (Bredenkamp 1982) Variations in geology is limited in vast areas of the study area. The area could however be stratified on an ecological basis by using land types (Land Type Survey Staff 1984). This procedure is in accordance with Bezuidenhout (1988) , Bredenkamp,

Joubert & Bezuidenhout (1989) and Bredenkamp & Bezuidenhout (1990) , who stratified successfully by land types in phytosociological studies in the western Transvaal grasslands.

The area occupied by each land type represented in the study area , was calculated by means of a planimeter. The number of sampling plots allocated to each land type were calculated pro rata according to the area occupied by each land type to prevent over and under sampling of a specific land - and terrain type.

In each land type the sample plots were distributed in such a way to enable the adequate sampling of the different terrain types , eg. watercourses , flats , slopes , ridges and hills.

The Bc and Bd land types cover the largest region within the study area. These land types have been ploughed intensively , giving rise to a shortage of natural vegetation for sampling. The subjective method for the selection of sample plot sites has been criticized (Whittaker 1956). The subjective survey technique is however strongly recommended by Werger (1973) and Bredenkamp (1982) due to the fact that it enables efficient sampling in heterogeneous vegetation (Braun - Blanquet 1964). The subjective sampling method was applied in this study , because vast areas have been ploughed and used as grazing. Farmers also improve their veld by the planting of good meadow - grasses in their natural veld as well as the planting of grasses for pasture. Patches of natural veld were therefore selected for sampling. The location of a sample plot was plotted on the land type map.

The size of the sampling plots is similar to those used by

Scheepers (1975) , namely 16 m². The size used for the sampling sites in the Vredefort Dome coincide with the 100 m² used by Bredenkamp & Theron (1978). As far as possible , the shape of the sampling plots were square. It was however , sometimes necessary to adapt the shape to ensure that the vegetation sampled was homogeneous. A total of 204 sample plots were set out in the study area.

Sampling method

The Braun - Blanquet sampling technique was used , as it is considered to be a standardised method for vegetation surveys in South Africa (Bredenkamp 1982). A comprehensive floristic and habitat survey was done in each sampling plot.

Floristic analysis.

The floristic survey included the listing of all the species present in each sample plot. The cover - abundance of each species present was estimated according to the Braun - Blanquet cover-abundance scale (Mueller-Dombois & Ellenberg 1974 and van Wyk 1983).

r - one or a few individuals (rare).

+ - occasional and less than 1% of total plot area.

1 - abundant and with very low cover , or less abundant but with higher cover; in any case less than >5% cover of total plot area.

2 - very abundant and less than 5% cover , or >5 - 25% cover of total plot area.

3 - >25 - 50% cover of total plot area , irrespective of the

number of individuals.

4 - >50 - 75% cover of total plot area , irrespective of the number of individuals.

5 - >75 - 100% cover of total plot area , irrespective of the number of individuals.

Taxon names are in accordance to the genus and species names given in Gibbs-Russell 1985 and 1987.

Physiognomical Analysis

Three principal layers were distinguished namely the tree (>2m tall) , shrub (0,5 - 2m tall) and herbaceous , layers. The average height and total cover of each layer , as well as the dominant species in each layer were noted.

Habitat Analysis

According to Daubenmire (1968) the distribution of plant communities are influenced by environmental factors. The physical environment plays an important role in the ecological interpretation of the floristic data (Bezuidenhout 1988). The physical environment can be used as a criterion, but is not always the most important factor influencing the interpretation and classification of the vegetation (Theron 1973). The following habitat factors were investigated :

Geology

The geological descriptions of Harmse (1967) , of the geology of the study area were used as a guideline for the identification of the geological types.

Soil type

In each sample plot a provisional identification was made of the

soil form , according to the binomical soil classification system of MacVicar et al. (1977). Soil analitical data were however obtained from the Land Type Survey Staff (1984).

Topography

The topographical position , (terrain type) of each sample plot was noted using the following criteria.

1 crest

2 scarp

3 midslope

4 footslope

5 valley bottom , floodplain or drainage line.

The slope was also estimated.

Rockiness of soil surface.

The presence or absence of surface rock was noted as well as the percentage rock cover within the sample plot. The size in diametre of the surface rocks was estimated as follows :

gravel - < 20 mm

stones - 20 - 250 mm

rocks - 251 - 1000 mm

bolders > 1000 mm

General observations

General observations included the degree of erosion , trampling and grazing , as well as the presence of termites and standing water in or near the sampling plot.

Data processing

A relevè was compiled for each sample plot. A relevè is a list of all the observations made in a sample plot (Coetzee

1972). The data of each land type were classified separately, following the successful classification procedures of Bezuidenhout (1988), Bredenkamp, Bezuidenhout & Joubert (1989) and Bezuidenhout & Bredenkamp (1990). The floristic data were classified using the Two-step classification technique developed by Bredenkamp, Bezuidenhout & Van der Maarel (1990). This includes a TWINSpan (Hill 1979b) classification and subsequent refinement of the results by Braun-Blanquet procedures, by using the computer programme BBNEW, available at the Botany Department of the University of Pretoria. The data sets from the various land types were processed separately, as this procedure proved to be successful in the analysis of western Transvaal grasslands (Bezuidenhout 1988). The plant communities distinguished were described and interpreted ecologically.

Data of Scheepers (1975) from the Kroonstad area were reclassified using the TWINSpan classification and subsequent refinement by Braun-Blanquet procedures. The Kroonstad data set was subdivided into two smaller data sets representing Vlei and Bottomland communities and Grassland communities respectively. These plant communities recognised are described and interpreted ecologically. In analyzing some of the data sets, gradient analyses (DECORANA) (Hill 1979a) was applied to investigate possible gradients in vegetation and associated gradients in habitat. Those analyses were applied to obtain a better understanding of vegetation / habitat interrelationships.

The individual phytosociological tables were combined with the Vredefort data set of Du Preez (1987) in a synoptic table. This

synoptic table forms the basis for the hierarchical syntaxonomy of the vegetation. Although the principals and recommendations of the code for Syntaxonomy Nomenclature (Barkman et al. 1986) were followed, syntaxonomical names were not fixed, as the syntaxonomical status of the communities is presently being investigated .

As the resulting vegetation classification and plant ecological descriptions, as well as the proposed syntaxonomical classification are new contributions to phytosociological knowledge in South Africa , are most of the results presented in publication form.

CHAPTER 3

The vegetation of the north western Orange Free State , South Africa. 1. Physical environment

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ABSTRACT

The physiography , geology , soil , land types and climate of the north western Orange Free State are described. The description provides a contextual framework for the subsequent vegetation classification.

UITTREKSEL

Die fisiografie , geologie , grond , landtipes en klimaat van die noordwestelike Oranje-Vrystaat word beskryf. Die beskrywing verskaf 'n koördinerende raamwerk vir die daaropvolgende plantegroekklassifikasie.

INTRODUCTION

The north western part of the Orange Free State is one of the most important agricultural regions in South Africa. The study area represents the south western part of the Highveld Agricultural Region. This region produces 80% of the maize , 75% of the grain sorghum and 65% of the sunflower seed production in the Republic of South Africa (Scheepers 1975). This part of the Grassland Biome also produces a large part of the Republic's animal products (Scheepers 1975 , Mentis & Huntley 1982). Most of the land has been ploughed , mainly for maize cultivation.

The remaining natural vegetation is restricted to non-arable shallow or rocky soils , vertic clays in bottomland situations , seasonally waterlogged vlees and along drainage lines. The vegetation is often overgrazed by sheep and cattle.

Little is known about the vegetation of the north western Orange Free State. The relevance of plant ecological studies to land use planning and management is well documented (Edwards 1967 ; Walker 1976 ; Bredenkamp & Theron 1978 ; Muller 1983). A more detailed classification of vegetation than that of Acocks (1988) is necessary to meet the present needs for regional and subregional planning (Deall , Scheepers & Schutz 1989). It was therefore necessary to identify , classify and map the vegetation in order to enable efficient land use planning and also the compilation of management programmes for optimal utilisation , without the degradation of vegetation. In this account the fundamental physical environment of the study area is described.

STUDY AREA

The study area represents the western parts of the 2726 Kroonstad map (1 :250 000). The area is situated between 26°00' and 27°23' E longitude and 27°00' and 28°00' S latitude.

Towns situated in the study area are Kroonstad , Welkom , Bothaville, Hennenman , Viljoenskroon , Vredefort and Wesselsbron (Figure 1).

The area covers approximately 1 437 000 hectares and about 1 365 000 hectares is available for agriculture (Land Type Survey Staff 1984).

GEOLOGY

The geology of the study area is presented in Figure 2.

Archaic granite

Old Archaic granites are exposed in the vicinity of Vredefort where they form the central part of the Vredefort dome.

The round or castle-like koppies of stacked granite blocks are typical of this area. These granites occur only in the extreme north eastern part of the study area. They are grey-white in colour and consist of quartz , potassium feldspar , plagioclase and biotite. The Archaic granite weathers to form a coarse , sandy soil of the Glenrosa Form in the uplands and the Valsrivier and Sterkspruit Forms in the lowlands (Harmse 1967).

Witwatersrand Supergroup

Rocks of the Witwatersrand Supergroup are exposed in a small part of the study area. They occur adjacent to the Archaic granites and , together with the Ventersdorp Supergroup , represent the outer rim of the Vredefort dome.

The Witwatersrand Supergroup is of great economical value , seeing that it is the source of gold-bearing ore in South Africa.

The Supergroup consists of alternating groups of quartzite and shale or slate. The gold ore is situated in fine layers in conglomerate. The resistance to erosion of the various rock types differs greatly. Quartzite is very resistant and therefore forms predominant parallel ridges. It gives rise to coarse sandy shallow lithosols (<300 mm) and regosols represented by the Mispah Form (Harmse 1967). The softer shale and slate weather easily to form

the valleys between the quartzite ridges. The shale and slate erode to form dark clayey soils.

Ventersdorp Supergroup

This Supergroup is represented by outcrops along the Vaal River and the adjacent outer layers of the Vredefort Dome. A few outcrops are also found near Odendaalsrus.

The lavas of the Ventersdorp Supergroup cover the Witwatersrand Supergroup. The Ventersdorp Supergroup consists of dark blue-grey Andesitic lava with round amygdaloids. The Andesitic lava consists of plagioclase and pyroxene which weather easily, resulting in a flat landscape with dark coloured vertic soils with a high intrinsic fertility. This Supergroup is often covered with recent sand deposits.

Transvaal Sequence

Rocks of this Sequence are restricted to a small part in the north of the study area. It occurs between the Ventersdorp Supergroup outcrops adjacent to the Vaal River and the Vredefort dome (Figure 2). Two groups can be identified in this Sequence namely the Chuniespoort Group and the Pretoria Group.

Chuniespoort Group

This Group is situated between the Pretoria Group and the Ventersdorp lavas. It is represented by the Malmani Subgroup, previously known as the Dolomite Series. It mainly consists of dolomitic limestone and chert. Other minerals such as calcite and dolomite may be present. The rocks are also rich in

iron and magnesium (Truswell 1977). Chert is a hard , extremely compact , dull to semi-vitreous cryptocrystalline rock , consisting dominantly of cryptocrystalline silica (Harmse et al. 1984). These rocks were formed during a chemical deposition of silica in water (Kruger 1971). Dolomite and chert are both resistant to weathering. The result is a flat landscape with exposed dolomite and chert outcrops. The soils of this area are mostly very shallow and rocky , representing the Mispah , Glenrosa and shallow Hutton soil forms.

Pretoria Group

Within the study area this group is limited to a small area north of Viljoenskroon. It consists mainly of quartzite and shale. Igneous rock occurs regularly and two types are distinguished , namely Ongeluks lava that consists of a dark green to grey Andesitic lava with quartz amygdaloids and intrusive diabase plates. The soils derived from the shale , lavas and diabase are usually clayey and of the Bonheim , Arcadia or Rensburg soil forms , where as the sandy soils derived from the quartzite are mostly of the Mispah , Glenrosa and Hutton soil forms.

Karoo Sequence

This Sequence occupies about 80% of the study area. It comprises a thick shale layer , mudstone and sandstone with tillite at the base and basaltic lava as a canopy. These strata were not disturbed by earth movements. Four groups can be distinguished , but only two of the four occur in the study area , namely the Eccia and the Beaufort Groups.

Ecca Group

Sediments of this Group are approximately 200 - 300 m thick.

A considerable amount of fossils can be found in the sediments of this group. The Group can be subdivided into three subdivisions namely , the Lower Stage , consisting of soft dark-blue shales ; the Middle Stage , consisting of grit , shale and coal ; the Upper Stage , consisting of soft , dark shale , usually covered with recent aeolian sand deposits.

The grit and sandstone are resistant to weathering and form low hills and escarpments. These sediments are usually covered with recent , deep , fine aeolian sands.

Beaufort Group

The Beaufort Group covers the south eastern part of the study area. The sediments are a sequence of shale and mudstone with interbedded lenticular sandstone (Truswell 1977).

The Karoo sandstone is soft and easily weathered to form a variety of deep , red to yellow sandy soils. On the other hand mudstone , shale and dolerite weather rapidly to give rise to both sedentary and colluvial , base-rich , dark , margalitic clays.

Recent deposits

Aeolian sand

The colour of the aeolian sand of the north western Orange Free State varies from red to grey. The colours are a result of a fine layer of iron - oxide that covers the quartz and feldspar grains (Harmse 1963). The only difference between the sands of the Kalahari area and the north western Orange Free State is that the sands of the latter are covered with dense vegetation

and that no prominent dunes occur.

PHYSIOGRAPHY

The study area forms a part of the Highveld inland plateau region and consists of smoothly plained or gently rolling land surfaces of the Tertiary and Miocene age (Mentis & Huntley 1982).

The monotonous soft rolling landscape on Karoo sediments is situated between 1 200 and 1 400 m above sea level. This physiographic unit stretches from the Vaal River south eastwards to Theunissen and Ventersburg. Ventersdorp lavas are responsible for the formation of round hills whereas the uplands and mesas of Karoo dolerite are formed by relics of Tertiary erosion surfaces. Erosion within this physiographic unit is responsible for the formation of peneplains with vertic , impermeable , argillic soils of the Ecca Group. These clay peneplains are usually unsuitable for agronomy.

In areas covered with aeolian sand , most of the surface characteristics have been destroyed and therefore only an undulating landscape is visible. The presence of Acacia karroo is often the only indication of the existence of the dolerite sills. In the waterlogged areas of this landscape pans are a prominent characteristic. The pans can be subdivided according to their size and age.

The occurrence of large pans is restricted to clay flats situated on argillic sediment of the Upper Ecca. The form of the pans is uneven . These pans have an inflow but no outlet , and therefore the drainage is internal. The pan floors consist of

dark waterlogged alkaline soils. During desiccation these soils form block fragments with gypsum crystals. A sparse vegetation may cover the pan floor.

Small pans are situated on the grey sands with a high water table. Iron and lime concretions occur frequently on the pan floors. No vegetation is found on the floors of these pans.

In the northern parts of the study area the gently undulating landscape of the Vredefort Dome occurs. Rocky hills and ridges of quartzite , shale and lavas of the Witwatersrand Supergroup and Transvaal Sequence form the rim of the Vredefort Dome. This landscape is steeply dissected and the Vaal River cuts deeply through the rocky ridges.

Drainage

The study area is situated in the catchment area of the Vaal River. Drainage occurs along the Vaal , Renoster and Vals rivers and their tributaries , as well as flushes and seepages into pans. The Karoo Sequence is deeply incised by these rivers , gradually flattening towards the south east.

Due to the gradual slopes in the area , erosion is restricted to rivers and flushes. No marshy areas are formed in the aeolian sand with a high permeability , but the clayey flats usually form marshy areas during the rainy seasons. This gives rise to the formation of the large pans which are responsible for the internal drainage of the area (Harmse 1967).

LAND TYPES AND SOILS

A land type denotes an area that can be shown on a 1:250 000 scale map and that displays a marked degree of uniformity with respect to terrain form , soil pattern and climate. One land type differs from another in terms of one or more of the following: terrain form , soil pattern or climate (Land Type Survey Staff 1984).

Five different land types are distinguished in the study area namely the A , B , D , F and I land types (Figure 1). Each of these land types can be further subdivided. The following discussion is based on Land Type Survey Staff (1984). Nomenclature of soil forms follows MacVicar et al. (1977).

The Ae and Ai map units

Map units Ae and Ai refer to yellow and red soils without water tables and belonging to one or more of the following soil forms : Indanda , Kranskop , Magwa , Hutton , Griffin and Clovelly. Within the study area these map units comprise 198 780 hectares with approximately 6 000 hectares unsuitable for agronomy.

The Ae map unit refers to red , high base status soils which are deeper than 300 mm , with no dunes . The Ai map unit refers to yellow soils with a high base status.

The Bc and Bd map unit

A very large area of the South African interior is occupied by the B land type , represent a catena which in its perfect form is represented by the Hutton , Bainsvlei , Avalon and Longlands soil Forms. These map units occupy approximately 930 000 hectares of the study area with about 25 000 hectares unsuitable for

The valley bottomlands are occupied by gley soil types , for example the Rensburg , Katspruit or Willowbrook Forms. Depending on the extent to which water tables have been operative in a landscape , Longlands and Avalon and related grey and yellow soils may predominate. Where water tables have not extended far beyond the valley bottoms , red soils may predominate with plinthic soils restricted to narrow strips of land around valley bottoms or pans. Plinthic soils , however , cover more than 10 % of the B land type. Upland duplex and marginalitic soils are absent or occupy less than 10 % of the area in the B units. The Bc unit indicates land in which red and yellow apedal soils such as the Hutton , Bainsvlei , Avalon , Glencoe and Pinedene forms , are eutrophic. Red soils occupy more than a third of the area. The soils of the Bd unit are eutrophic , but yellow soils are widespread in the area (Land Type Survey Staff 1984).

The Db and Dc map units

Units Db and Dc accommodate land where duplex soils are dominant. Upland soils that display duplex character include the Escourt , Sterkspruit , Swartland , Valsrivier and Kroonstad Forms. The Db unit refers to land where duplex soils with non - red B horizons cover more than half of the area. Dc units indicate land that qualifies for inclusion in the D land type but , in addition to the duplex soils , more than 10% of the land type is covered with soil forms with vertic , melanic or red structured diagnostic horizons. These map units occupy approximately 280 000 hectares of the study area , with about 35 700 hectares unsuitable for

agronomy (Land Type Survey Staff 1984).

The Fb map unit

The Fb unit accommodates pedologically young landscapes that are not predominantly rock , alluvial or aeolian in nature. The dominant soil - forming processes have been rock weathering , and the formation of orthic topsoil horizons and lithocutanic B horizons. The soils of the Fb map unit are represented by the Glenrosa and Mispah Forms. The Fb unit indicates land where lime occurs regularly in valley bottom soils. Within the study area these land types comprise 9 890 hectares , with approximately 800 hectares unsuitable for agronomy (Land Type Survey Staff 1984).

The Ib map unit

This map unit occupies a very small part of the study area. The Ib unit includes land with exposed rock covering more than 60 - 80 % of the area. Within the study area this map unit comprises only 3 430 hectares (Land Type Survey Staff 1984).

Ba map unit

The Ba map unit accommodates land in which red and / or yellow apedal , dystrophic soils of the Hutton , Bainsvlei , Avalon , Glenco and Pinedene soil forms predominate over red and / or yellow eutrophic soils. Red soils mainly of the Hutton and Bainsvlei Forms occupy more than a third of the area. Upland marginalitic soils are absent or occupy less than 10 % of the area. This map unit comprises 17 830 hectares within the study area with approximately 1 500 hectares unsuitable for agronomy.

CLIMATE

The study area is situated in the H climate zone of the Highveld region , according to the classification of the South African Weather Bureau (1986). This region is characterised by thunderstorms during the summer months. The winter months are arid and cold.

Precipitation

Soil moisture is derived from precipitation mainly in the form of rainfall , and to a lesser degree from mist , dew , hail and snow (Deall , Scheepers & Schutz 1989).

Rainfall: the mean monthly rainfall for Balkfontein (33 yrs) , Kroonstad (33 yrs) , Plessisdraai (10 yrs) and Welkom (23 yrs) is presented in Table 1 and Figure 3 (Weather Bureau 1986). Mean monthly rainfall figures for a number of stations in the study area for the years 1987 / 1988 , are given in Table 1 (Weather Bureau 1989). Table 1 indicates the above average rainfall of the two years (1987 - 1988) in which the vegetation study took place. The study area clearly falls within the summer rainfall zone , with the heavier falls from October to March with an average of approximately 611 millimetres at Kroonstad in the eastern parts and 503 millimetres at Plessisdraai in the west. The rainfall also increases from south to north , with an average of 526 millimetres at Welkom in the south and an average of 611 millimetres at Kroonstad in the north. Thunderstorms are often violent and associated with strong south westerly gusting winds and hail.

Frost: frost is defined by the Weather Bureau as days with a minimum temperature of 2,5⁰ C and lower. Frost can be expected

from April to September in the study area (Table 2).

Snow: due to the dryness of the winter , snow does not often occur. Snowfalls were however , recorded during June and July in the study area in 1987 and 1988.

Temperature

Temperature alone may not be a significant factor in determining major regional vegetation formations , it does however play a part in the determination of floristic variations on a meso - and micro - scale (Schulze & McGee 1978). Such variations result from differential effects of temperature on plant growth rates , seed germination , seedling survival and flowering phenology (Deall et al. 1989). The average temperature is given in Figure 3 and the mean monthly maximum and minimum temperatures of the Plessisdraai , Welkom , Balkfontein and Kroonstad weather stations are represented in Table 3. There are no big differences between the maximum and minimum temperatures recorded at the different weather stations. The extreme maximum and minimum temperatures recorded at the four stations are represented in Table 4 (Weather Bureau 1986).

Wind

Wind directions and velocities for the Balkfontein , Plessisdraai , Welkom and Kroonstad weather stations are represented in Figure 4. The calmest days occur during May , June and July whereas August and September are the windiest months (Weather Bureau 1989).

CONCLUSION

A knowledge is necessary for the of the physical environment of the study area was understanding and ecological interpretation of

the abstract plant communities identified during a phytosociological survey. Environmental attributes largely determine the distribution of plant species and plant communities. These differences in distribution patterns makes the classification of vegetation into ecological zones possible.

ACKNOWLEDGEMENT

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TABLE 1 The mean monthly rainfall for weather stations in the study area.

Periode	Station	Month												Year Av.
		Jan	Feb	Mrh	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
#1951/84	B	99	83	72	52	20	7	6	8	17	52	73	75	564
+1987/88	B	33	158	45	81	9	2	4	13	57	118	71	**	
+1987/88	H	74	67	160	69	**	4	4	18	108	155	141	49	
#1951/84	K	105	83	82	53	23	6	8	12	25	66	74	74	611
+1887/88	K	57	85	146	88	8	6	2	16	108	91	100	**	
#1974/84	P	91	70	59	44	13	5	7	15	26	54	63	56	503
+1987/88	P	**	108	106	49	7	4	3	18	85	93	82	**	
+1987/88	Vk	69	101	104	82	**	4	2	10	**	95	104	149	
+1987/88	Vf	**	53	115	57	7	7	0	10	100	121	65	107	
#1955/78	W	99	67	67	49	23	8	7	5	17	49	63	72	526
+1987/88	W	35	148	122	61	10	6	4	16	**	99	84	98	

B = Balkfontein - Bothaville no 0399/894 4 ;
 H = Hennenman Police station no 0365/058 4 ;
 K = Kroonstad Municipality no 0365/430 8 ;
 P = Plessisdraai - Hoopstad no 0363/239 5 ;
 Vk = Viljoenskroon Municipality no 0400/792 9 ;
 Vf = Vredefort School no 0437/660 7 ;
 W = Welkom no 0364/300 1 ;
 ** Unreliable data ;
 # (Weather Bureau 1986) ;
 + (Weather Bureau 1989) .

TABLE 2. The monthly number of days with frost

Month	Weather Station							
	Plessisdraai		Balkfontein		Welkom		Kroonstad	
	1987	1988	1987	1988	1987	1988	1987	1988
Jan	0	0	0	0	0	0	0	0
Feb	0	0	0	0	0	0	0	0
Mar	0	0	0	0	0	0	0	0
Apr	0	4	0	0	0	1	0	5
May	15	7	8	5	4	3	12	8
Jun	27	16	23	21	14	17	27	25
Jul	29	27	27	23	25	20	29	27
Aug	21	15	12	13	6	6	14	17
Sep	0	3	0	0	0	1	0	3
Oct	0	0	0	0	0	0	0	0
Nov	0	0	0	0	0	0	0	0
Dec	0	0	0	0	0	0	0	0

The occurrence of frost is taken as days with a minimum temperature of $\leq 2,5$ (Weather Bureau 1989).

TABLE 3. The mean monthly maximum and minimum temperature (°C) for four weather stations in the study area

		Weather Stations							
		Balkfontein		Kroonstad		Plessisdraai		Welkom	
Year	Month	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1951 /84	Jan	30.2	16.7	29.5	15.8	30.4	15.5	29.4	16.6
	Feb	29.3	16.2	28.5	15.4	29.8	15.7	28.4	16.1
	Mar	27.9	14.2	26.9	13.2	27.7	12.7	27.0	14.7
	Apr	24.8	9.7	23.9	8.6	25.3	7.9	23.2	10.6
	May	21.8	4.8	20.9	3.5	21.7	2.6	20.1	5.7
	Jun	18.8	0.8	18.0	-0.7	18.6	-1.5	17.2	2.3
	Jul	19.4	0.7	18.6	-0.7	19.2	-1.2	17.9	2.4
	Aug	22.2	2.5	21.3	1.6	21.6	1.3	20.6	4.1
	Sep	26.1	7.8	25.0	6.6	25.6	6.3	25.1	8.8
	Oct	27.7	11.4	26.8	10.8	27.4	9.3	26.6	11.7
	Nov	28.9	13.9	27.9	12.9	29.4	12.1	27.9	14.0
	Dec	30.1	15.5	29.1	14.7	30.8	14.1	29.3	15.5
	Ave		25.6	9.5	24.7	8.4	25.6	7.9	24.3
1987 /88	Jan	33.1	17.6	31.8	16.4	34.2	15.9	32.8	16.6
	Feb	30.1	18.1	29.6	17.1	30.6	17.3	29.5	17.3
	Mar	28.4	15.6	27.7	14.5	28.3	14.5	27.5	14.9
	Apr	25.6	11.9	24.6	10.5	25.4	10.0	24.5	11.2
	May	23.6	5.4	22.7	3.9	23.5	3.7	22.7	6.4
	Jun	18.2	5.5	17.1	-4.1	17.8	-4.0	16.8	1.3
	Jul	19.7	-0.1	18.7	-2.0	19.1	-2.5	18.1	4.0
	Aug	22.3	3.9	21.3	2.3	21.9	1.6	20.8	4.9
	Sep	24.0	9.2	22.8	8.1	23.4	10.5	22.1	12.9
	Oct	26.3	11.9	24.9	10.8	26.2	9.9	24.9	10.9
	Nov	28.7	15.3	27.5	13.8	28.9	13.6	27.5	14.2
	Dec	31.4	17.6	28.5	15.1	30.4	14.8	28.8	14.9

TABLE 4. The extreme temperatures ($^{\circ}\text{C}$) recorded at four weather stations in the study area

Station	Temperature			
	Date	Maximum	Date	Minimum
Plessisdraai	26/02/83	39,0	05/08/77	-9,8
Balkfontein	12/01/81	39,5	01/08/74	-8,8
Welkom	18/01/73	38,3	23/07/75	-7,2
Kroonstad	19/01/73	39,6	23/07/75	-8,7

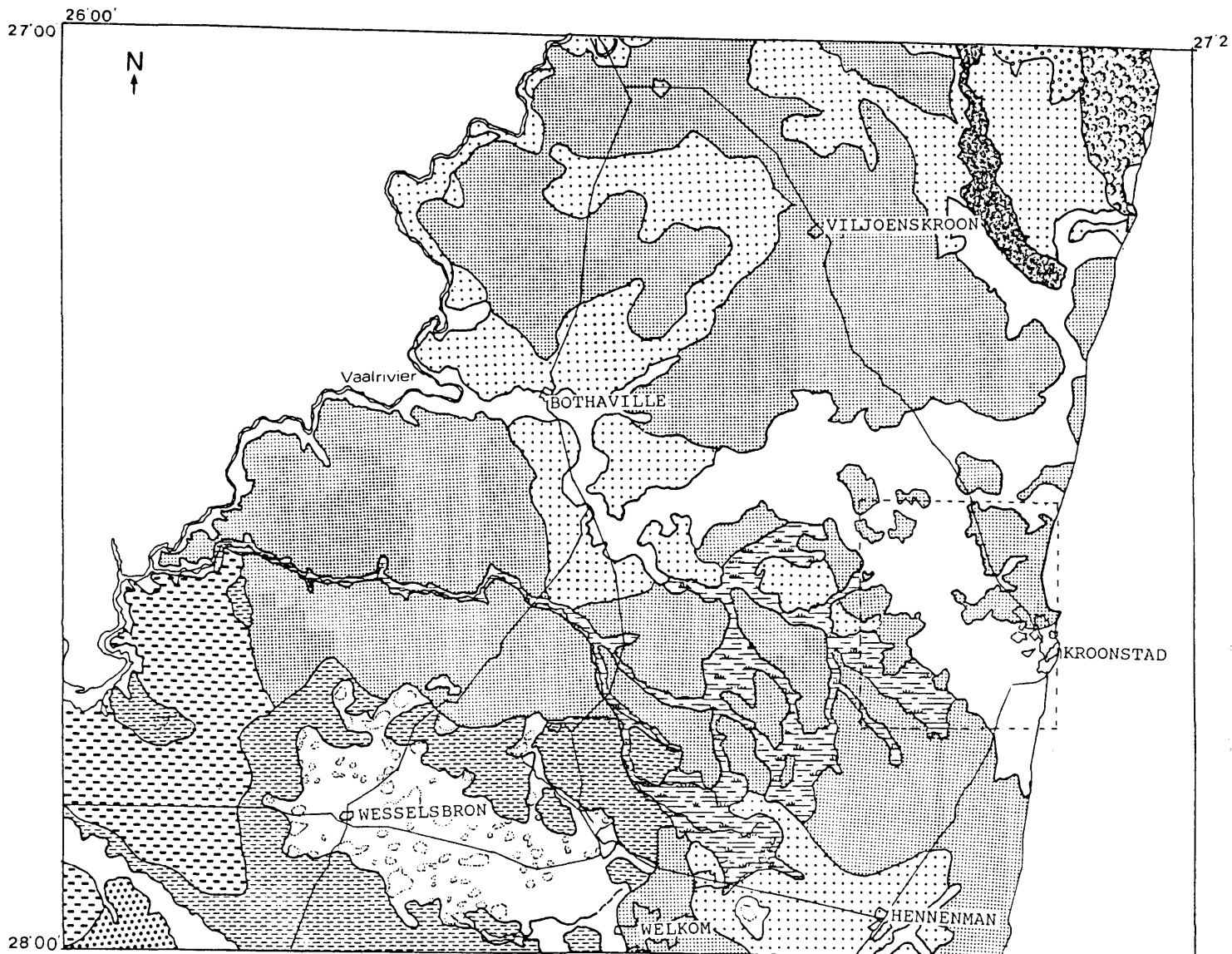












Figure 1. The distribution of the different land types in the study area (Land Type Survey Staff 1984).

Legend

-   A - Land Type = Ae and Ai
-    B - Land Type = Ba , Bc and Bd
-   D - Land Type = Db and Dc
-  F - Land Type = Fb
-  I - Land Type = Ib
-  - Portion studied by Scheepers (1975)

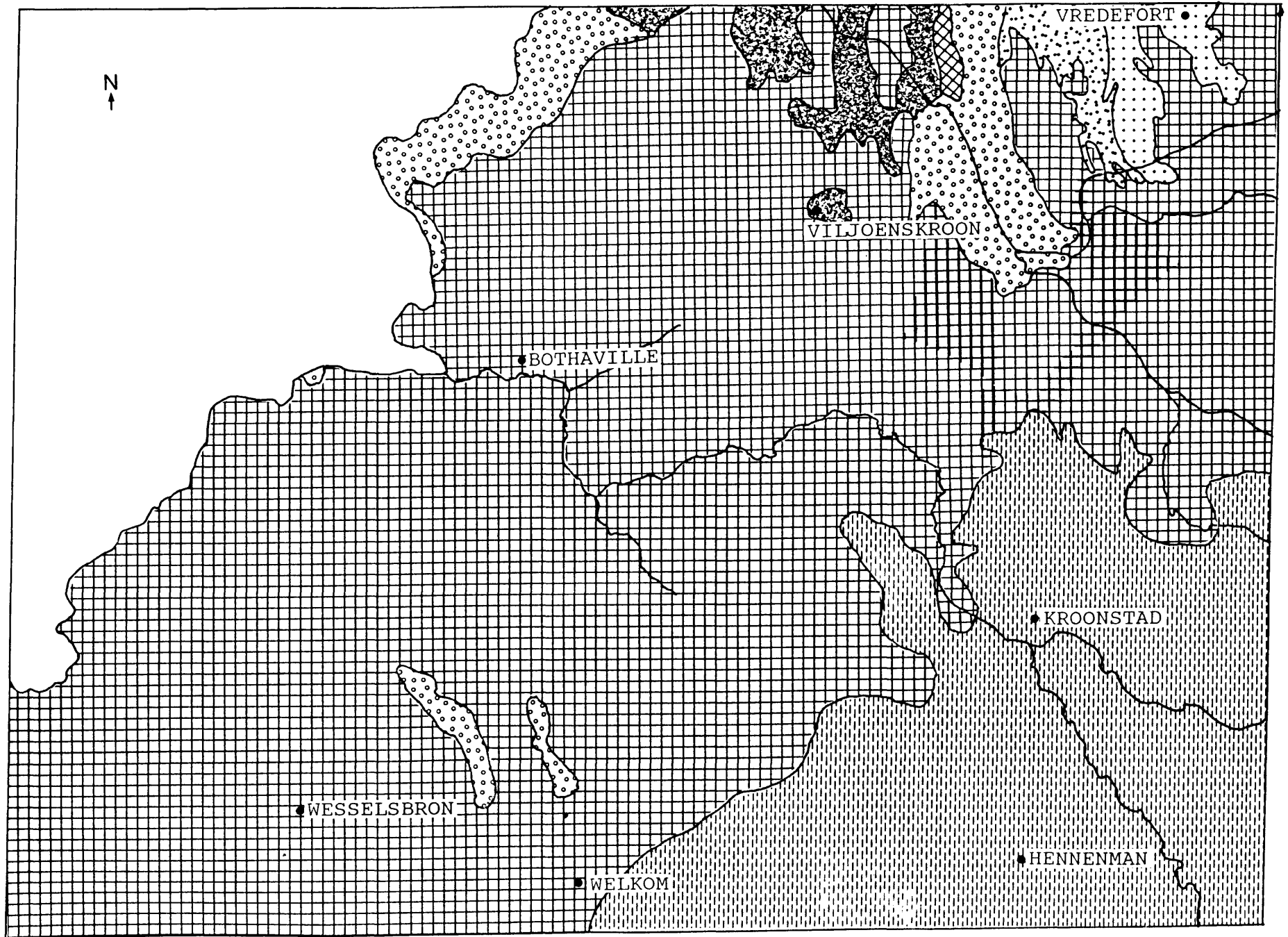









Figure 2. The geology of the study area (Harmse 1967).

Legend

	Beaufort Group	Shale , mudstone arenaceous shale immature sandstone ; extensively invaded by dolerite dykes and sheets.	
			Karoo Sequence
	Ecca Group	Shale and mudstone (carbonaceous and calcareous) , immature sandstone and coal seems; extensively invaded by dolerite sheets and dykes.	
	Pretoria Group	Quartzite , banded ironstone , subordinate shale and lava	
			Transvaal Sequence
	Chunniespoort Group	Dolomitic limestone , chert , thin band of quartzite and conglomerate at the base.	
		Andesitic lava , agglomerates and tuffaceous sediments.	Ventersdorp Supergroup
		Quartzite , conglomerate shale , lava , slate and tillite.	Witwatersrand Supergroup
		Granite	

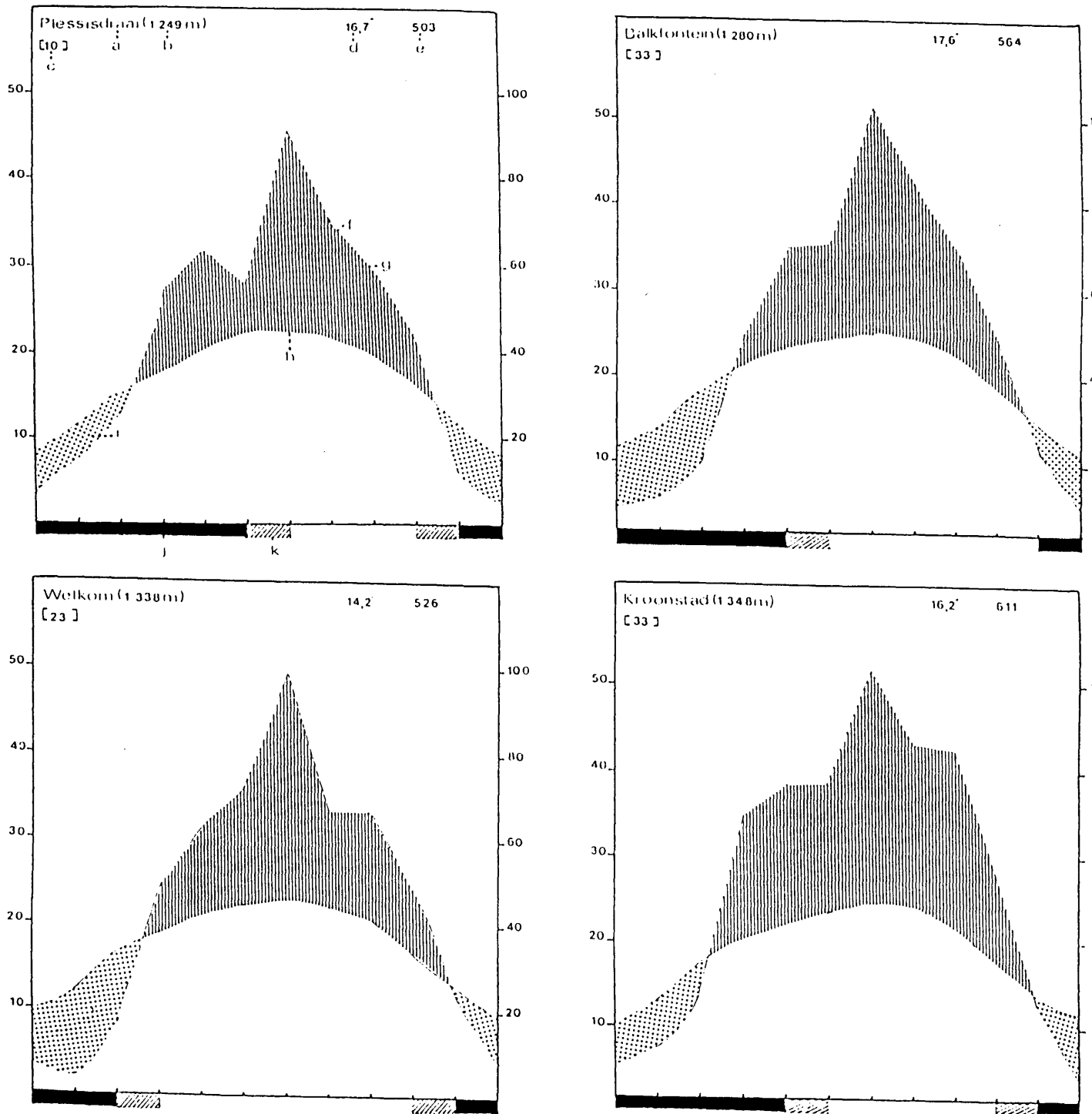
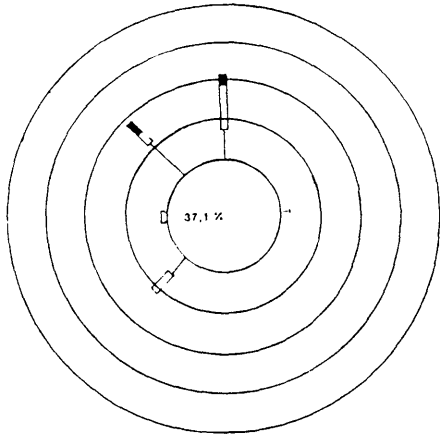


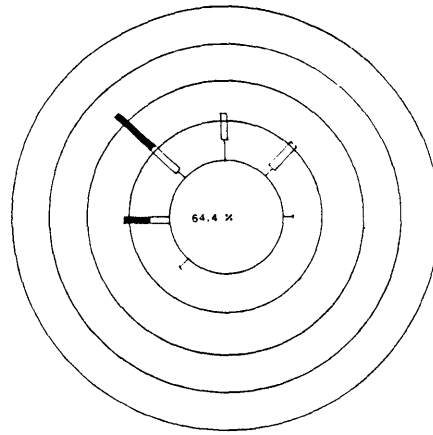
Figure 3. Climatic diagrams for the study area

- a) Station
- b) Height above sea level
- c) Duration of observations in years (First indicates temperature , the second precipitation)
- d) Mean annual temperature in °C
- e) Mean annual precipitation in mm
- f) Mean montly presipitation
- g) Wet period
- h) Mean montly temperature
- i) Dry period
- j) Cold season (months with mean daily minimum below 0°C).
- k) Months with absolute minimum below 0°C
- l) Frost - free period (Larcher 1975).

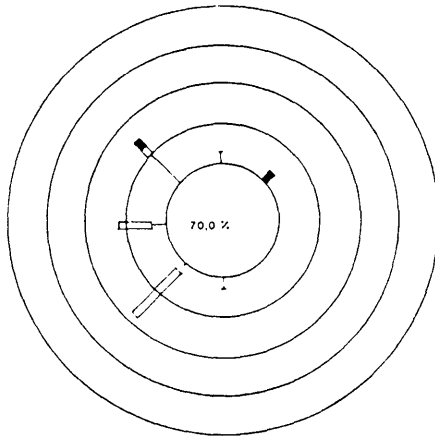
Bothaville



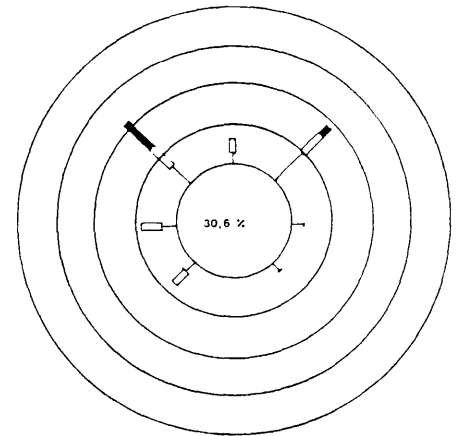
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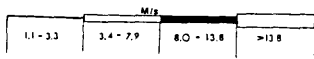
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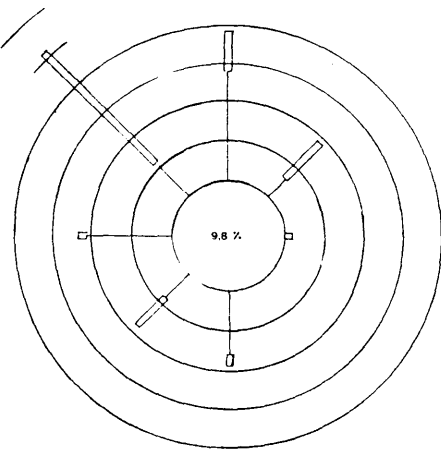
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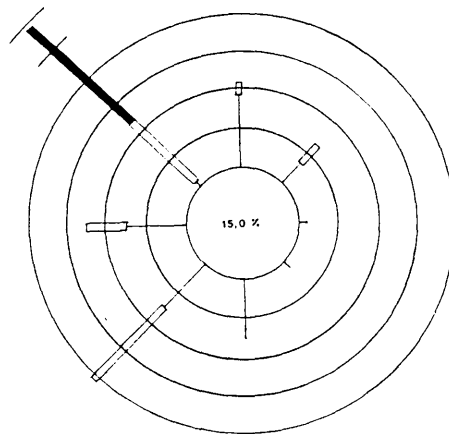
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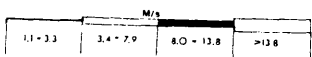
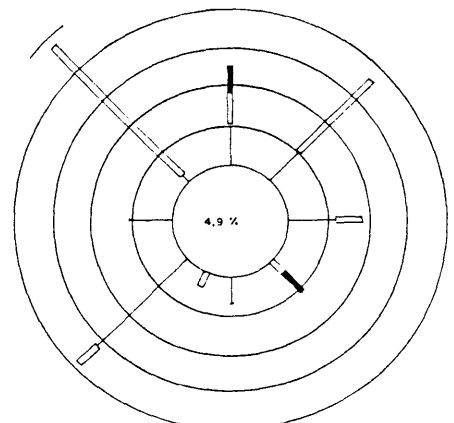
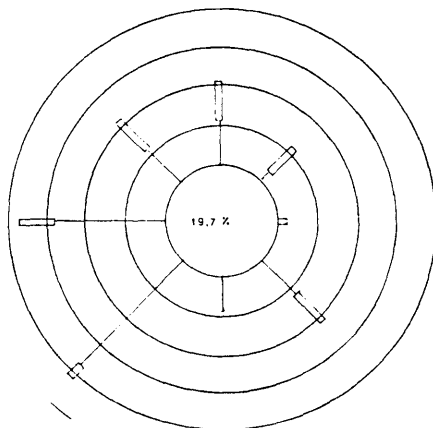
Kroonstad



JAN



APR



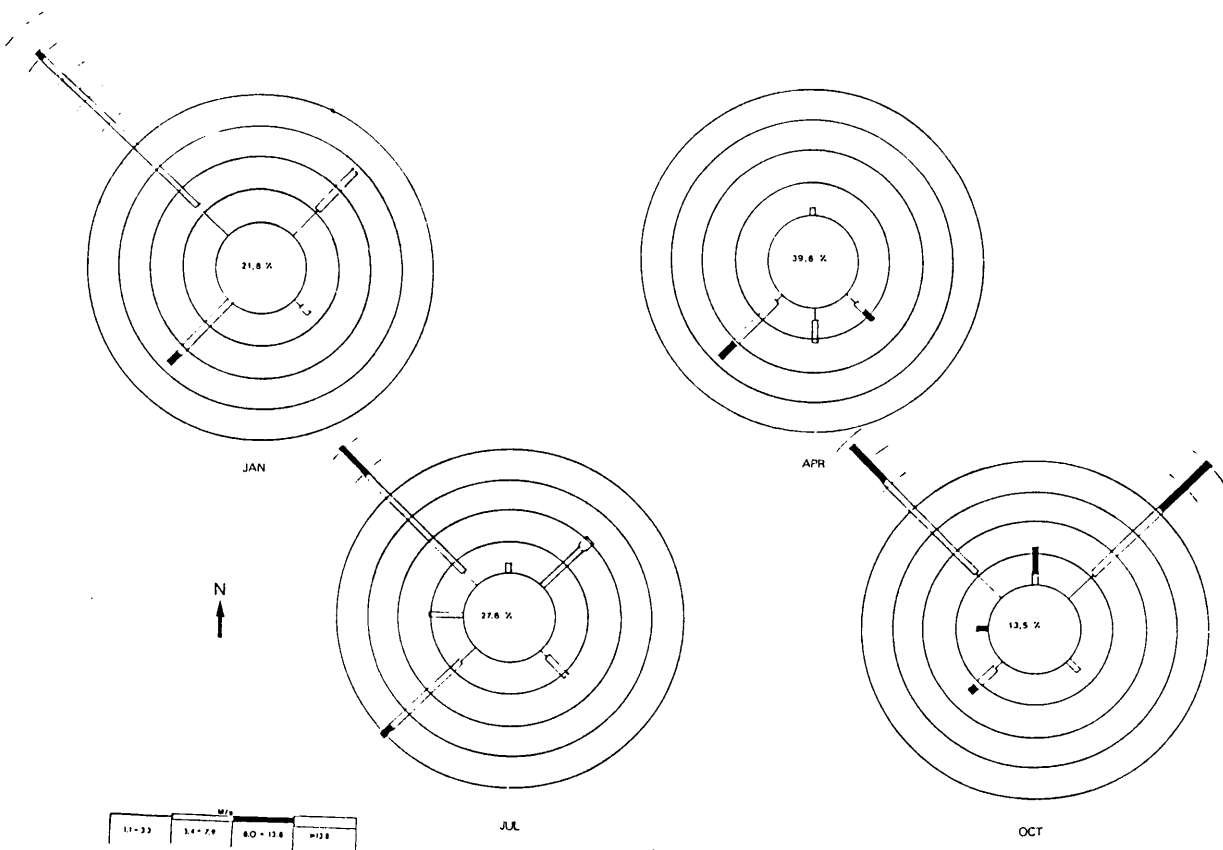
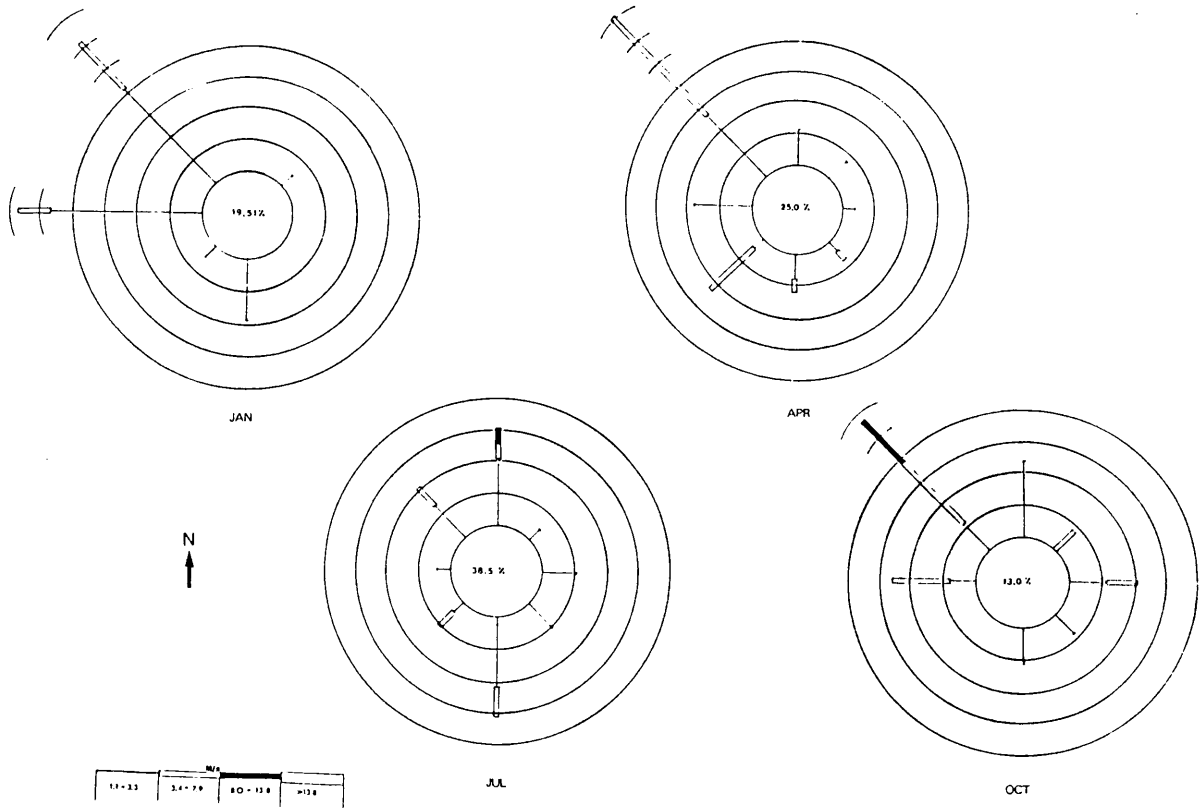


Figure 4. Wind roses for four weather stations in the study area , representing wind directions and speed intervals (m/s) for January , April , July and October (Weather Bureau 1988).
 a) 5% frequency intervals
 b) Percentage of calm in circle.

CHAPTER 4

The vegetation of the north western Orange Free State.

2. The D land types

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Keywords: classification , habitat interpretation , plant communities , western Grassland Biome.

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ABSTRACT

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

UITTREKSEL

Die ondersoek na die plantgemeenskappe van die D - landtipe in die noordwestelike Oranje - Vrystaat vorm deel van 'n navorsingsprogram oor die sintese van die plantegroei van die westelike Grasveldbiom. Die resultate van 'n numeriese klassifikasie (TWINSpan) van 59 relevés is met behulp van Braun-Blanquet prosedures verfyn. Agt plantgemeenskappe wat in

twee hoofgemeenskappe gegroepeer kan word , is onderskei. 'n Hierargiese klassifikasie , beskrywing en ekologiese interpretasie van die plantgemeenskappe en 'n ordening , (DECORANA) , met geassosieerde omgewingsgradiënte , word aangebied.

INTRODUCTION

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

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

The aim of the project was therefore to identify , characterise and describe the plant communities of the entire north western Orange Free State , as defined by Kooij , Bredenkamp & Theron 1990a. In this report the results of the vegetation survey of the D land type is presented.

THE STUDY AREA

The study area is situated between 26°00' and 26°23' E longitude and 27°00' and 28°00' S latitude , in the Grassland Biome of the north - western Orange Free State , South Africa (Figure 1). A detailed description of the physical environment of the area is given by Kooij , Bredenkamp & Theron (1990a). The location of the D land type are shown in Figure 1.

The Db and Dc map units accommodate land where duplex soils with gleycutanic , pedocutanic and prismacutanic B horizons are predominant. These map units comprise approximately 280 000 hectares of the study area , with approximately 35 700 hectares unsuitable for agriculture (Land Type Survey Staff 1984). Soils that display a duplex character include the Estcourt , Sterkspruit , Swartland , Valsrivier and Kroonstad Forms (MacVicar et al. 1977). The Dc and Db map units are mostly located in bottomland situations, such as in the valleys of the Vaal , Vals and Renoster rivers , as well as in the pan veld situated in the Wesselsbron and Welkom Districts. These map units are not suitable for agronomy , due to the high clay (> 35%) content

of these bottomland soils , and land use is mainly restricted to sheep farming. The bottomlands are furthermore usually flooded during the rainy season.

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

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

The soils of the Dc map unit adjacent to the rivers are predominantly of the Bonheim and Mayo Forms. The geology in these area consists of Eccca shale , sandstone and grit. In the vicinity of Kroonstad mudstone , shale and sandstone of the Adelaide

Supergroup are predominant , with dolerite sills occurring here and there (Land Type Survey Staff 1984).

METHODS

Relevés were compiled in 59 stratified random sample plots. As geology and land type are relatively uniform , stratification was based on terrain units (De Beer 1988 and Land Type Survey Staff 1984). In accordance with Scheepers (1975) , plot sizes were fixed at 16 m² for grassland vegetation , while 100 m² plots were used for woody vegetation (Bredenkamp & Theron 1978). In each sample plot total floristic composition , using the Braun-Blanquet cover-abundance scale (Mueller - Dombois & Ellenberg 1974) was noted. Taxon names generally conform to those of Gibbs Russell et al. (1985 & 1987) , however , in accordance with Bredenkamp , Joubert & Bezuidenhout (1989) Setaria flabellata Stapf. and S. sphacelata (Schumach.) Moss were treated as separate species. Environmental data included identification of terrain types , soil types and estimation of aspect , slope and rockiness of the soil surface. Other soil properties were obtained from Land Type Survey Staff (1984) (Table 2).

Two way indicator species analysis (TWINSpan) (Hill 1979) was applied to the floristic data set in order to derive a first approximation of the vegetation types of the area. Refinement of this classification was done by the application of Braun-Blanquet procedures (Behr & Bredenkamp 1988 ; Bredenkamp , Joubert & Bezuidenhout 1989). The results are presented in a phytosociological table (Table 1). In order to determine probable

vegetation gradients , an ordination algorithm , Detrended Correspondance Analysis (DECORANA) (Hill 1979) was applied to the floristic data set.

RESULTS

Classification

In general the vegetation of the D land type can be classified as a Panicum coloratum - Eragrostis curvula Grassland. Species constantly present include Panicum coloratum , Pentzia globosa , Eragrostis curvula , Eragrostis obtusa and Bulbine narcissifolia (Species group L , Table 1). The vegetation is generally poor in species , with an average of 20 species per sample plot. The vegetation shows some similarity to certain bottomland communities described by Scheepers (1975). Direct comparisons are , however , difficult due to the differences in techniques applied and also due to differences in the scale of the surveys.

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

A hierarchical classification of the distinguished plant communities is as follows:

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

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

Description of communities

- 1. Themeda triandra-Panicum coloratum Grassland

This major grassland type covers most of the D land type , excluding the pans which occur scattered throughout the area (Figure 1).

The dominant species in almost all the plant communities within this major grassland type are Themeda triandra and Eragrostis curvula. Within the study area , species group I (Table 1) may be considered as diagnostic for this Grassland.

- 1.1 Themeda triandra-Elionurus muticus Grassland

This community is found in upland situations on relatively sandy and well drained soil , often with large exposed rocks often (Figure 2). The predominant soil types are the Mispah and Glenrosa Forms and in non - rocky , sandy areas the deep (>1 200) Hutton Form. No soil analysis data on these soil types are available. The Themeda triandra-Elionurus muticus Grassland is characterised by species group A (Table 1). In typical situations Themeda triandra dominates entirely , with canopy cover values of up to 75%. Where Themeda triandra dominates , the occurrence of other species is limited , with an average of 20 species per relevé. Other grass species constantly (> 50% of the relevés) found in this community are the diagnostic species Elionurus muticus and Setaria sphacelata

and also Aristida congesta , Eragrostis superba , Cymbopogon plurinodis , Heteropogon contortus , Panicum coloratum and Eragrostis curvula. Non - grassy forbs occur only scattered , but Commelina africana , Hermannia depressa , Salvia radula , Crabbea accaulis , Lippia scaberrima , Oxalis species , Hibiscus pusillus and the karoo dwarf shrub Pentzia globosa occur constantly.

1.2 The Themeda triandra-Digitaria argyrograpta Grassland

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

1.3 The Protasparagus laricinus-Acacia karroo Woodland.

This Woodland is a bottomland community which occurs along dry water courses or seasonal rivulets (Figure 2) on vertic Rensburg and Arcadia soil Forms , on duplex soils with clayey structured B horizons e.g. the Sterkspruit , Valsrivier and Swartland Form , as well as on younger alluvial soils such as the Oakleaf and Dundee Forms (Table 2).

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

1.4 The Themeda triandra-Hibiscus trionum Grassland.

The extensive flat plains of the D land type are typically covered by the Themeda triandra-Hibiscus trionum Grassland which represents the largest part of the Themeda triandra-Panicum coloratum Grassland (Figure 2). The vegetation is characterised by species group D (Table 1). An average of 20 species was recorded per sample plot. The vegetation is mostly dominated by Themeda triandra, Eragrostis curvula and Panicum coloratum, with the karoo dwarf shrub Pentzia globosa conspicuously present.

Two distinct communities were identified namely the Felicia filifolia - Themeda triandra Grassland on the relatively drier slightly raised sites, mostly on duplex soils, and the Aristida bipartita - Themeda triandra Grassland on vertic or near vertic soils of moist bottomland sites.

1.4.1 The Themeda triandra-Felicia filifolia Grassland.

This community occurs on the slightly raised, extensive plains of the D land type (Figure 2). The Sterkspruit, Valsrivier, Swartland, Mayo and Hutton soil Forms (Table 2) are characteristic

for the relatively well drained Themeda triandra - Felicia filifolia Grassland community and are therefore drier than those of the Aristida bipartita - Themeda triandra Grassland. The vegetation is characterised by species group E (Table 1). An average of 20 species was recorded per sample plot. Themeda triandra and Eragrostis curvula are mostly co - dominant. In overgrazed situations , however , Eragrostis curvula predominates.

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

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

1.4.2 The Themeda triandra-Aristida bipartita Grassland.

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

1.5 The Themeda triandra-Echinochloa holubii Wetland

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

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

1.6 The Setaria sphacelata-Eragrostis plana Wetland

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

The vegetation is characterised by the presence of species group H and the absence of species groups F and G (Table 1). An average of 14 species was recorded per sample plot.

The most prominent species are the diagnostic Eragrostis plana and also Themeda triandra , Panicum coloratum and Eragrostis curvula. Other species often present are Setaria sphacelata ,

Aristida congesta , Cynodon dactylon and Cirsium vulgare.

2. The Sporobolus ioclados - Lycium cinereum Pan Veld.

This community is restricted to the sodic and calcareous soils on the fringes of the pans within the area (Figure 2). These areas are severely overgrazed and the vegetation is scanty and typically karroid. The Willowbrook , Rensburg , Arcadia and Inhoek soil Forms are typical of this community.

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

Ordination

The distribution of relevés along the first and second axes of the ordination is given in Figure 3.

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

A , Protasparagus laricinus - Acacia karroo Woodland along riverbanks (Community 1.3);

G , The Grassland Communities (Communities 1.1 , 1.2 , 1.4 and

1.5) ;

W , Setaria sphacelata - Eragrostis plana Wetland (Community 1.6) ; and

P , Sporobolus ioclados - Lycium cinereum Panveld (Community 2).

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

In Figure 4 the portion of the scatter diagram representing the Grassland is enlarged. The relevés of communities 1.1 , 1.2 , 1.4.1 , 1.4.2 and 1.5 are more or less restricted to specific areas in this enlarged scatter diagram. The vegetation gradient on the first axis , from community 1.5 , the Themeda triandra - Echinochloa holubii Wetland of wet marshy conditions , via community 1.4.2 the Themeda triandra - Aristida bipartita Grassland of poorly drained seasonally waterlogged , bottomland sites to community 1.4.1 the Themeda triandra-Felicia filifolia Grassland of well drained relatively drier sites can be explained

by the general habitat gradient indicated in Figure 3. The position of Communities 1.1 and 1.2 to the left of communities 1.4.1 , 1.4.2 and 1.5 cannot be explained , however , their positions along the second axis indicate a drier habitat.

CONCLUSION

The methodology of refining the results of a TWINSpan classification by Braun-Blanquet procedures (Bredenkamp & Behr 1988) was successfully applied in this study. The plant communities distinguished are considered to be ecologically interpretable , as they relate to specific environmental conditions.

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

ACKNOWLEDGMENT

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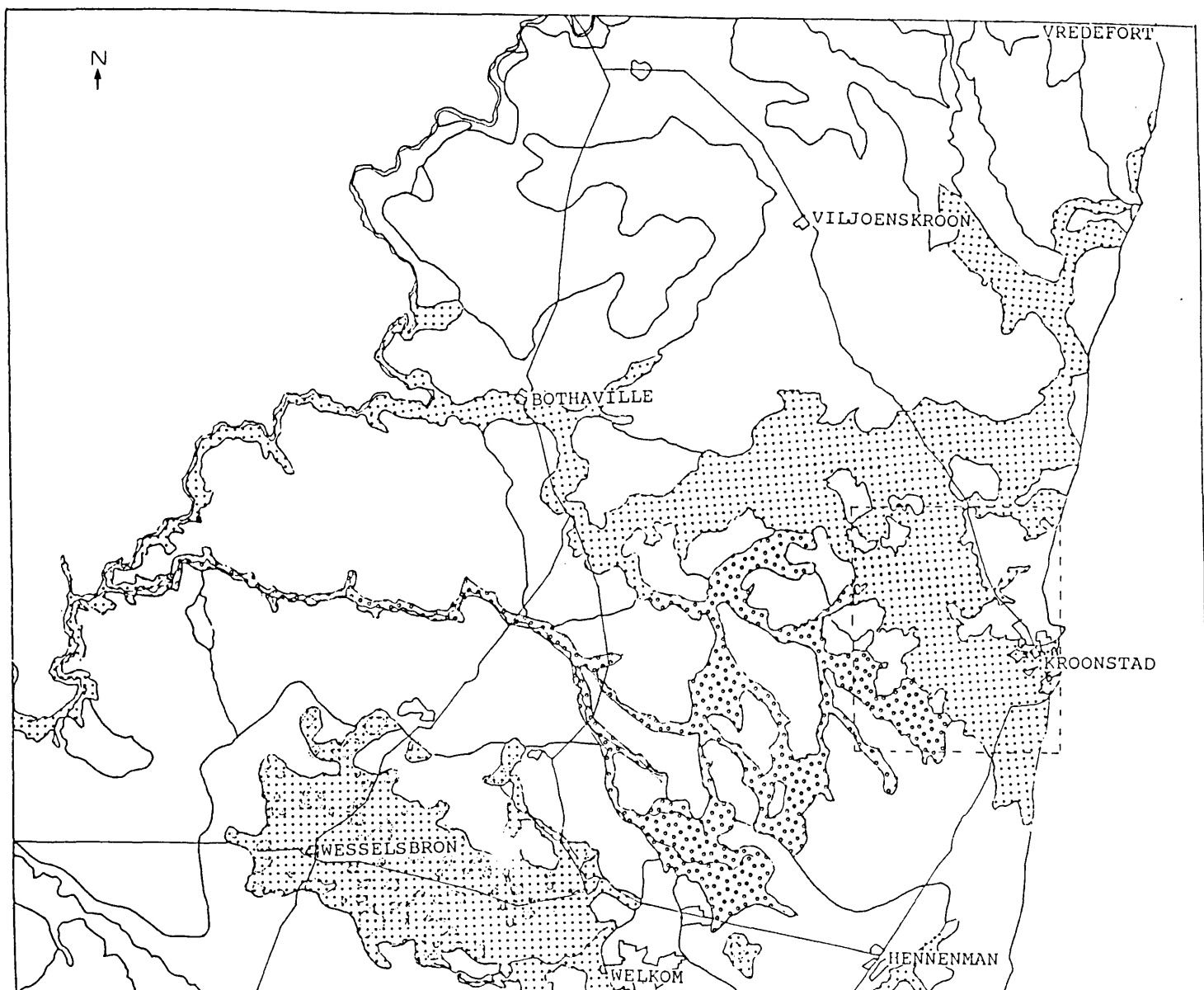





Figure 1. The location of the Db and Dc land types in the study area (Land Type Survey Staff 1984).

- Legend:
-  - Db land type
 -  - Dc land type
 -  - Portion studied by Scheepers (1975).

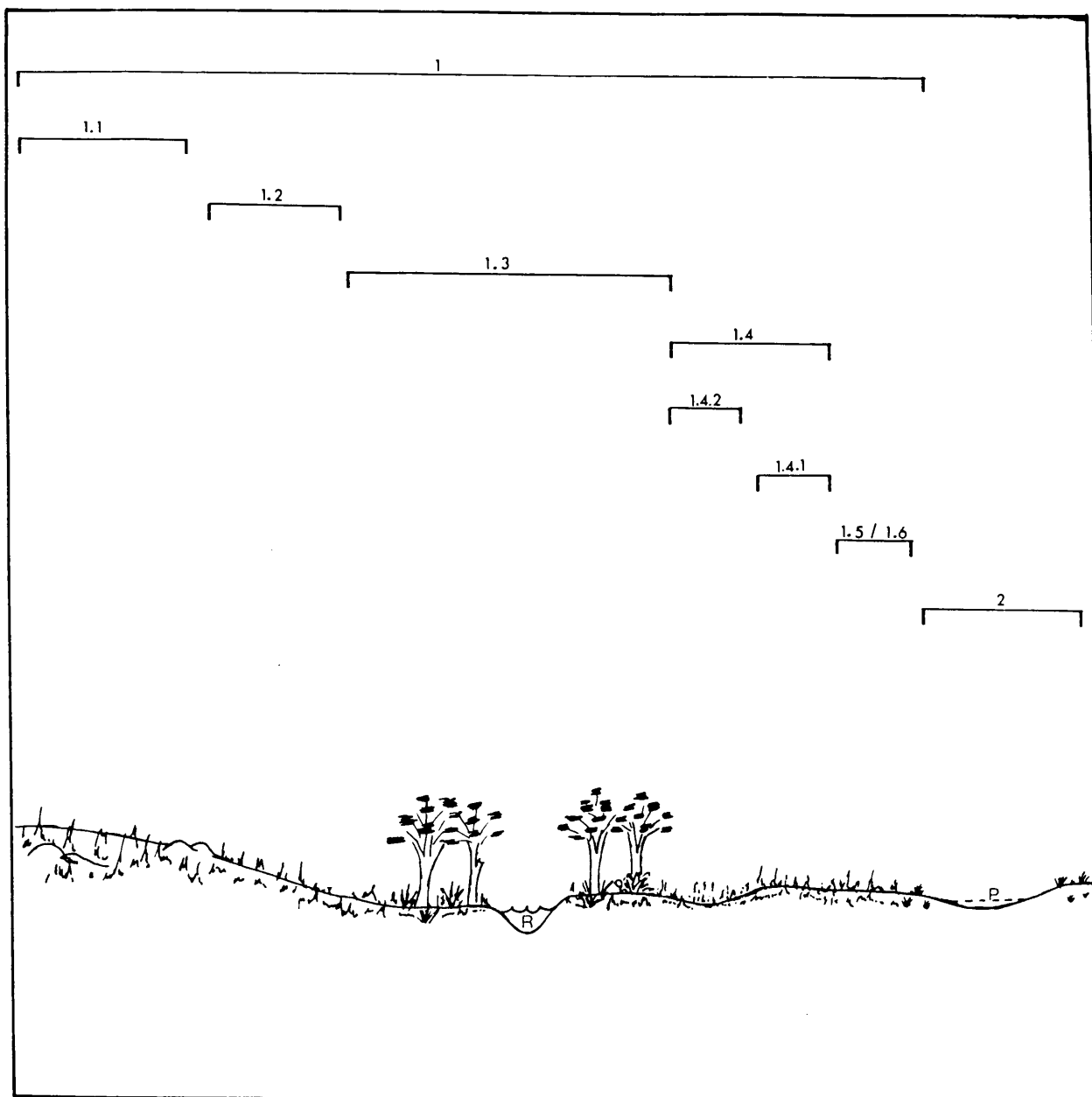


Figure 2. A schematic representation of the identified plant communities in the Db and Dc land types.

- Legend:
- P - pan
 - 1 - Themeda triandra - Panicum coloratum - Grassland
 - 1.1 - Themeda triandra - Elionurus muticus - Grassland
 - 1.2 - Themeda triandra - Digitaria argyrograpta - Grassland
 - 1.3 - Protasparagus laricinus - Acacia karroo - Woodlands
 - 1.4 - Themeda triandra - Hibiscus trionum - Grassland
 - 1.4.1 - Themeda triandra - Felicia muricata - Grassland
 - 1.4.2 - Themeda triandra - Aristida bipartita - Grassland
 - 1.5 - Themeda triandra - Echinochloa holubii - Wetland
 - 1.6 - Setaria sphacelata - Eragrostis plana - Wetland
 - 2 - Sporobolus ioclados - Lycium cinereum - Pan Veld

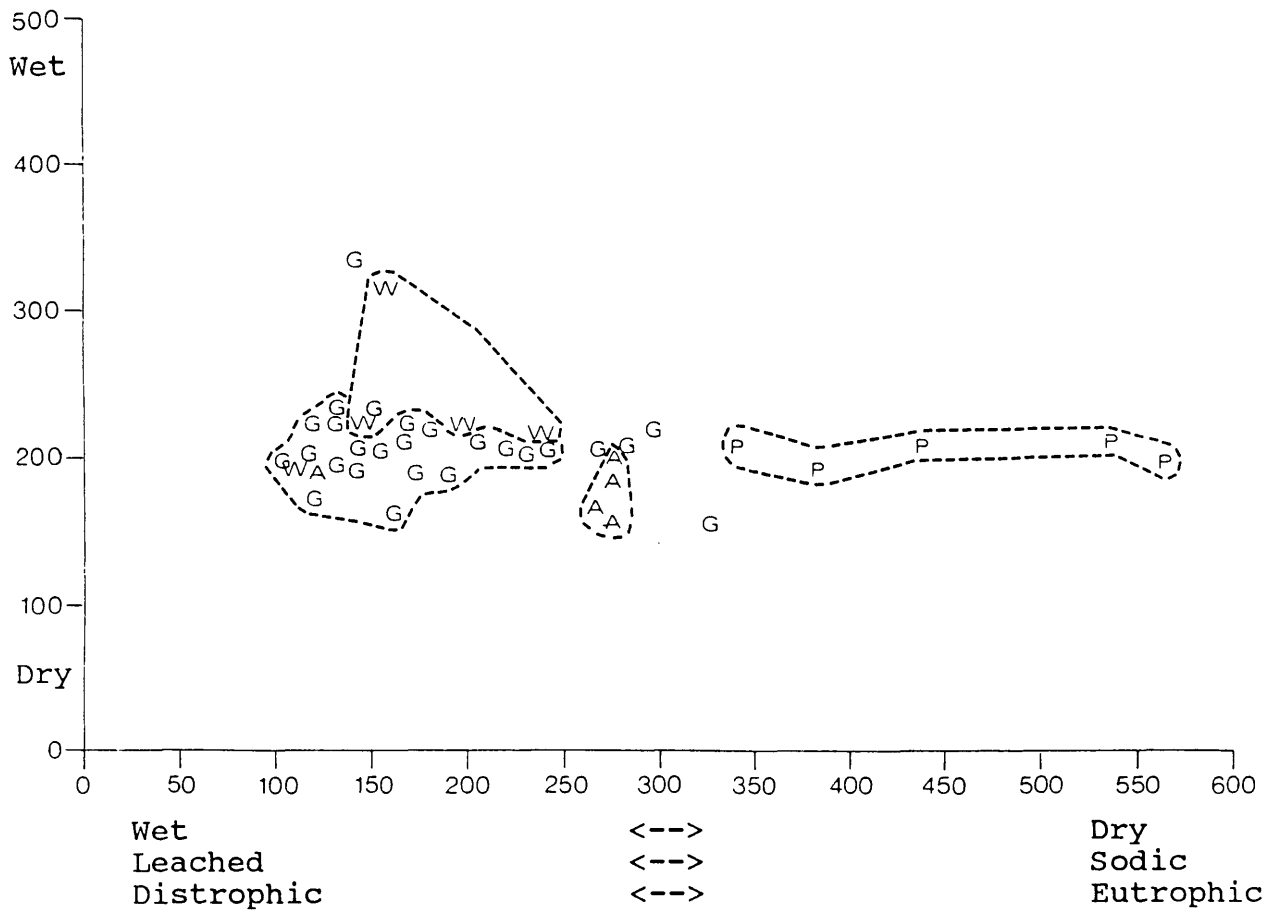


Figure 3. A scatter diagram of the ordination of the vegetation on the D land type.

Legend: A - Protasparagus laricinus - Acacia karroo Woodlands
 Community 1.6
 G - Grassland communities.
 Communities 1.1 , 1.2 , 1.4 and 1.5
 W - Setaria sphacelata - Eragrosti plana Wetlands
 Community 1.6
 P - Sporobolus ioclados - Lycium cinerium Pan Veld
 Community 2
 Enlarged portion

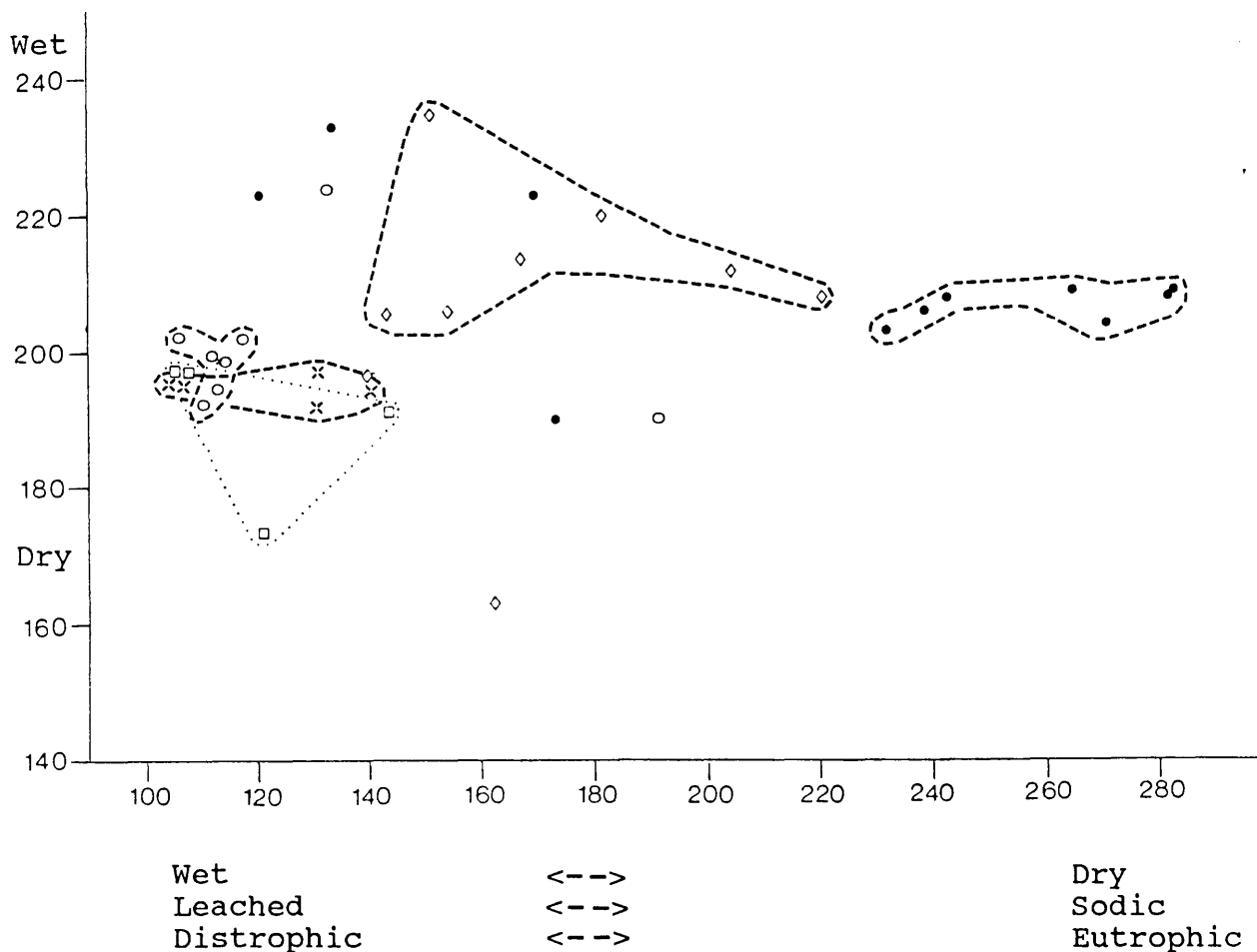


Figure 4. An enlargement of a portion of the scatter diagram given in figure 3.

- Legend: x - Themeda triandra - Elionurus muticus Grassland Community 1.1
 □ - Themeda triandra - Digitaria argyrograpta Grassland Community 1.2
 • - Themeda triandra - Felicia filifolia Grassland Community 1.4.1
 ◇ - Themeda triandra - Aristida bipartita Grassland Community 1.4.2
 ○ - Themeda triandra - Echinochloa holubii Grassland Community 1.5

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

Communities	1						2	
	1.1	1.2	1.3	1.4		1.5	1.6	
				1.4.1	1.4.2			
Relevés	101011	11 00011	100100000100	000000000100	121011112221	11001	00000	
	581874	33 58169	034157767067	445484443233	008899990000	42151	77667	
	585979	67 54652	198816491067	132577628456	349606890127	75237	53780	

-58-

Species group	1.1	1.2	1.3	1.4.1	1.4.2	1.5	1.6
Species group A							
<i>Elionurus muticus</i>	2 ++ +	+			+		+
<i>Setaria flabelata</i>	++ + +				+	+	
<i>Hermannia depressa</i>	++ +	+		+			
<i>Lippia scaberrima</i>	++	+	++				
<i>Setaria nigristrois</i>	+	+					
<i>Haplocarpha scaposa</i>	++						
Species group B							
<i>Digitaria argyrograpta</i>		1+			+	+	
<i>Barleria macrostegia</i>		++ +		+			+++
<i>Trichoneura grandiglumis</i>		++					
<i>Blepharis integrifolia</i>		++		+		+	
<i>Vernonia oligocephala</i>		++					
<i>Menodora africana</i>		++ ++ +					
Species group C							
<i>Acacia karroo</i>		+	32+21	+	+		+
<i>Protasparagus laricinus</i>			1+++	+			
<i>Ziziphus mucronata</i>			1+ +				
<i>Gomphrena celosioides</i>			++ +		+		
<i>Commelina eckloniana</i>		+	++				
<i>Ziziphus zeyheriana</i>		+	+1				
<i>Salvia sclarea</i>			++				
<i>Teucrium trifidum</i>			+++				
Species group D							
<i>Hibiscus trionum</i>			++	1++++++	++ +	+	+++
<i>Seddera capensis</i>		+		++ + + +	++ + + + + +		+
<i>Ophioglossum polyphyllum</i>				++ + +	+	+	++
<i>Sporobolus ludwigii</i>				+ ++			+
<i>Blepharia angustata</i>				+ +			+
Species group E							
<i>Felicia filifolia</i>		+		+ + + + + + +			+++++
<i>Tragus racemosus</i>			+	+++ ++			+
<i>Mariscus indecorus</i>		+	+	+ + + + +			+ +
<i>Sporobolus fimbriatus</i>				+ + + + +			+
<i>Sporobolus smutsii</i>				+ +			
Species group F							

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

<u>Community number</u>	1.2	1.3	1.4.1	1.4.2	1.6	
<u>Soil form</u>	Sterkspruit	Arcadia	Swartland	Bonheim	Bonheim	Arcadia
<u>Soil serie</u>	Stanford	Gelykvlakte	Nyoka	Wenen	Wenen	Gelykvlakte
<u>Soil depth mm</u>						
A	0 - 180	0 - 500	0 - 220	0 - 450	0 - 450	0 - 700
B	- 360	- 750	- 440	- 1 200	- 800	- 900
% Sand						
A	90	32	69	45	58	28
B	69	24	41	31	27	29
% Silt						
A	3	22	9	13	12	16
B	7	30	8	15	11	19
% Clay						
A	7	41	18	39	29	57
B	24	47	50	49	58	47
<u>H₂O retentivity %</u>						
-33kPa						
A	7,1	35,1	15,5	38,9	22,0	51,2
B	25,9	38,7	33,7	41,2	39,8	53,8
- 1500 kPa						
A	3,7	20,5	6,8	20,5	14,2	30,2
B	12,3	21,0	19,6	23,3	-	34,4
<u>Exchangeable cations (me / kg soil)</u>						
Na						
A	1	14	2	40	1	10
B	32	24	32	45	12	22
K						
A	3	3	4	2	12	3
B	2	0	2	2	24	3
Ca						
A	20	144	28	110	53	237
B	61	186	87	114	146	292
Mg						
A	12	71	24	98	25	212
B	58	105	80	134	77	215
Total						
A	36	232	58	250	91	264
B	135	315	201	285	259	532
<u>pH(H₂O)</u>						
A	7,4	6,9	6,5	9,0	6,2	7,4
B	9,1	8,7	7,6	8,1	7,9	8,3
<u>Resistance (ohm)</u>						
A	3 500	700	3 100	280	1 000	300
B	600	350	190	120	960	220

CHAPTER 5

Classification of the vegetation of the B land type in the north western Orange Free State.

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Abstract

An analysis of the vegetation of the B land type , covering 928 000 hectares in the north western Orange Free State is presented. More than 80 % of the area has been ploughed. Relève's were compiled in 105 stratified random sample plots in the remaining natural vegetation. A TWINSPAN - classification , refined by Braun - Blanquet procedures revealed seven plant communities , which may be classified under four major communities. All communities are related to specific environmental conditions. Descriptions of the communities are given.

Uittreksel

'n Analise van die plantegroei van die B landtipe , wat 928 000 hektaar van die westelike Oranje - Vrystaat beslaan , word aangebied. Meer as 80% van die gebied is geploeg. Relevés is in 105 gestratifiseerde ewekansig gekose monsterpersele saamgestel in die oorblywende natuurlike veld. 'n TWINSPAN - klassifikasie , verfyn deur die Braun - Blanquet tegnieke toon sewe plantgemeenskappe , wat in vier hoof - gemeenskappe gegroepeer kan word. Die geïdentifiseerde gemeenskappe kan verklaar word aan die hand van spesifieke omgewingsfaktore. Die plantgemeenskappe word beskryf.

Keywords: Braun - Blanquet method , classification , Grassland Biome , plant communities.

Introduction

The necessity to identify and describe the major vegetation types and subtypes within the Grassland Biome was stated by Mentis & Huntley (1982) and Scheepers (1986). One of the goals of the vegetation classification and mapping task group of the comprehensive Grassland Biome programme is to produce a vegetation classification and map on a 1 : 250 000 scale (Scheepers 1986). A synecological and syntaxonomical investigation was therefore undertaken in the north western Orange Free State (Figure 1). Land types (Landtype Survey Staff 1984) represented in this area include the A , B and D land types as well as small patches of the Fb and Ib map units. Previous phytosociological analyses in the north western Orange Free State , include those of Scheepers (1975) in the Kroonstad area and Du Preez (1987) in the Vredefort district. Within the present research project Kooij , Bredenkamp & Theron (1990b) classified and described the vegetation of the D land type in the study area. Little is known of the vegetation of the B land type of the north western Orange Free State.

The B land type represents the vast plains of the north western Orange Free State. Only 3% of this land type is unsuitable for agronomy . More than 80% of the soils of the B land type have been ploughed and the few relics of natural vegetation are often degraded due to grazing or other land use practices (Land Type

Survey Staff 1984). The natural vegetation of this area is clearly endangered by the existing farming practices in the area. The identification , description and classification of existing grassland plant communities of this area should have high priority , not only as a basis for efficient vegetation (grazing) management (Bosch et al. 1987) , but also to help identify areas suitable for conservation of these ecosystems in the future. The aim of this study was therefore to identify , characterise and describe the plant communities of the B land type in the north western Orange Free State. The results should contribute considerably to the knowledge of this vegetation type and to a phytosociological synthesis of the western Grassland Biome.

The study area

The study area is situated between 26°00' and 27°23' E longitude and 27°00' and 28°00' S latitude , in the Grassland Biome of the north western Orange Free State , South Africa (Figure 1). A detailed description of the physical environment of the area is given by Kooij , Bredenkamp & Theron (1990a). The area covered by the B land type in the study area is indicated in Figure 1.

Within the study area the B land type is subdivided into the Bc and Bd units . These two map units accommodate land where duplex and marginalitic soils occupy less than 10% of the area and plintic soils overlying sandstone are predominant (Land Type Survey Staff 1984). The Bc and Bd map units cover approximately 928 000 hectares within the study area , of which approximately 25 000 hectares are

unsuitable for agriculture. A perfect catena in the B land type is represented by a succession of the Hutton , Bainsvlei , Avalon and Longlands soil Forms , while valley bottoms are occupied by gley soils for example the Rensburg , Willowbrook or Katspruit Forms (Land Type Survey Staff 1984). The Bc land type refers to land where eutrophic , red soils are widespread , whereas the Bd map unit refers to land where eutrophic yellow soils are widespread. The soils of the B map unit are excellent for agronomy. Extensive areas have consequently been ploughed for the cultivation of maize , peanuts , potatoes and sunflowers.

The geology of the Bc map unit consists predominantly of Karoo sediments , consisting of Eccca sandstone , mudstone and shale with calcrete. Dolerite sills are abundant. Aeolian and colluvial sand overlies all rock types which are a conspicuous feature of this area. Pans occupy only 1 - 2% of this area. Soils of the Hutton , Avalon and Bainsvlei Forms predominate on the relatively raised plains. In the lowland situations Rensburg , Willowbrook , Katspruit and Sterkspruit soil Forms predominate.

As it is the case with the Bc map unit , the geology of the Bd map unit consists mainly of Eccca sandstone , shale and mudstone. Dolerite sills and diabase plates however occur only sporadically. Aeolian sand overlies most of the rocks. Pans occupy 0,5 - 2% of this land type (Land Type Survey Staff 1984). Soils of the Avalon , Hutton , Westleigh and Bainsvlei Forms predominate on the upland sites , while the Willowbrook , Katspruit , Dundee , Bonheim , Valsrivier and Swartland Forms are predominant

in bottomland situations (Land Type Survey Staff 1984).

Methods

Relevés were compiled in 105 stratified random sample plots. Within each map unit, stratification of sampling was based on five terrain units following De Beer (1988) and Land Type Survey Staff (1984) namely 1) crests, 2) scarp, 3) midslope, 4) footslope and 5) valley bottom or flood plain (Figure 2). In accordance with Scheepers (1975), plot size of 16 m² (4 x 4 m) was used to survey grassland vegetation, while 100 m² (10 x 10 m) plots were used for woody vegetation (Bredenkamp & Theron 1978).

In each sample plot all species recognisable at the time of the survey (summer 1988/1989) were noted. The cover - abundance of each species was estimated using the Braun - Blanquet cover - abundance scale as described by (Mueller - Dombois & Ellenberg 1974). Plants were named according to Gibbs Russell *et al.* (1985, 1987), except for Setaria flabellata Stapf. and S. sphacelata (Schumach.) Moss which were distinguished as two separate taxa as was done by Bredenkamp, Joubert & Bezuidenhout (1989). Environmental information collected includes terrain type, soil type, aspect, slope and rockiness of the soil surface.

Two way indicator species analysis (TWINSPAN) (Hill 1979) was applied to the floristic data set in order to derive a first approximation of the vegetation types of the area. Refinement of this classification was done by the application of Braun - Blanquet procedures (see also Behr & Bredenkamp 1988, Bredenkamp,

Joubert & Bezuidenhout 1989 , Kooij , Breidenkamp & Theron 1990b). The results are presented in a phytosociological table (Table 1). Soil properties for each community are given in Table 2.

Results

Classification

In general the vegetation of the B land type can be considered as a Themeda triandra - Eragrostis curvula Grassland. The vegetation is generally utilized as pasture for cattle and sheep. Themeda triandra is mostly the dominant species. However , in overgrazed or degraded situations Eragrostis curvula becomes dominant. Many of the grass species of Species group I (Table 1) are classified as Increasers 2 and 3 (Bosch & Van Rensburg 1988). These species increase , and are therefore abundantly present , in overgrazed or selectively grazed , degraded vegetation in the western Grassland Biome. The poor condition of these grasslands is emphasized by the presence of the karroid shrub Pentzia globosa and other pioneers such as Aristida congesta , Cynodon dactylon , Eragrostis obtusa , Walafrida densiflora , Chamaesyce prostrata , Hibiscus trionum and Blepharis integrifolia.

The number of species recorded per sample plot varies from 8 to 50 with an average number of 25.

The plant communities distinguished in the study area can be classified in a hierarchy as follows.

1. The Aristida bipartita - Eragrostis plana Vlei Grassland of wet , seasonally waterlogged depressions and vleis.

2. Berkheya radula - Microchloa caffra Grassland of flat lowland penepains and footslopes.
 - 2.1 Stachys spatula - Variant , representing a degraded phase. of 2.
3. Brachiaria serrata - Triraphis andropogonoides Grassland of sandy upland areas.
 - 3.1. Triraphis andropogonoides - Acacia karroo Woodland of river valleys or on dolerite - derived soils.
 - 3.2. Triraphis andropogonoides - Anthehora pubescens Grassland of moderately deep , yellow , sandy , rocky soils.
 - 3.3 Triraphis andropogonoides - Themeda triandra Grassland of deep yellow sandy soils.
4. Panicum coloratum - Themeda triandra Grassland of footslopes with sandy clay loam soils, towards bottomland situations.

Description of the communities.

1. The Aristida bipartita - Eragrostis plana Vlei Grassland. This Grassland is restricted to seasonally wet depressions , pans and vleis (occurring in terrain unit 5) of the Bd and to a lesser extent also the Bc map unit (Figure 3). The clayey soils of the Rensburg , Willowbrook , Katspruit or Bonheim Forms have a poor internal drainage regime and are therefore often waterlogged. Soil properties are given in Table 2. The vegetation is characterised by species group A (Table 1) and diagnostic species include the grasses Eragrostis plana , Chloris virgata , Setaria sphacelata , Aristida bipartita , Brachiaria eruciformis and the annual weed Sckhuhria pinnata. The vegetation is often

overgrazed and trampled. An average of 20 species was recorded per sample plot. The absence of the generally widespread species of species groups G and H is also characteristic. The vegetation is mostly dominated by Themeda triandra , Eragrostis curvula , Panicum coloratum , Setaria sphacelata , Eragrostis plana and Cynodon dactylon , with the general species of species group I also present.

2. The Berkheya radula - Microchloa caffra Grassland.

This Grassland is found in the Bd and to a lesser extent in the Bc map units and is situated on the flat lowland penneplains occurring in (terrain unit 4, Figure 2) adjacent to vleis , pans , water courses and depressions , (Figure 3). The clay - loam soils represent the Valsrivier , Swartland and Sterkspruit Forms , but the Hutton and Avalon , or Bonheim Forms may also occur in places. Soil properties are given in Table 2.

The vegetation is characterised by species group B (Table 1) with diagnostic species Oxalis depressa , Microchloa caffra and Berkheya radula and the absence of species group C (Table 1). An average of 25 species was recorded per sample plot. The vegetation is dominated by Themeda triandra , with Eragrostis curvula prominent in some degraded localities. Species of species groups G , H and I (Table 1) are usually present in this community. Other conspicuous and constantly present (>75%) species include the grasses Eragrostis superba , Heteropogon contortus , Aristida congesta , Panicum coloratum and Cynodon dactylon and the karroid shrub Felicia muricata and Pentzia globosa.

2.1 The Stachys spatula - Variant.

This Variant represents an overgrazed and degraded variation of the Berkheya radula - Microchloa caffra Grassland.

Although this vegetation occurs scattered throughout the range of the Berkheya radula - Microchloa caffra Grassland , it seems to predominate on slightly raised footslopes to midslopes (terrain unit 3 - 4) towards the upland situations in the undulating landscape (Figure 3). In this Variant the diagnostic weedy species Stachys spatula , Cirsium vulgare , Stoebe vulgaris and Sporobolus discosporus have encroached the area and are prominently present , while Eragrostis curvula often attains relatively high cover values. Other diagnostic species are Becium obovatum , Oenothera rosea and Lycium cinereum (Species group C , Table 1). An average of 24 species was recorded per sample plot.

3. Brachiaria serrata - Triraphis andropogonoides Grassland.

This major community occurs on sandy loam soils of upland situations on both the Bc and Bd map units. The community is represented by isolated relics of natural vegetation , as most of its habitat has been destroyed by ploughing for maize cultivation. The sandy soils are moderately deep , yellow to red sands , representing the Clovelly , Avalon , Westleigh , Hutton and Bainsvlei Forms. However , where dolomite sills or diabase plates occur , the soils are shallower , slightly more clayey and rocks or gravel may be found on the soil surface. Soil properties are given in Table 2. The vegetation is characterized by species group D (Table 1). Diagnostic species are the grasses Triraphis andropogonoides , Brachiaria serrata and Tragus

berteronianus , the geophytes Ledebouria marginata and Bulbine narcissifolia and the forb Barleria macrostegia.

Three distinct communities were identified

3.1 Triraphis andropogonoides - Acacia karroo Woodland.

This Woodland mostly occurs on the gradual slopes towards the Vaal and Renoster River valleys (terrain unit 3, 4, and 5) (Figure 3) on moderately deep , reddish , sandy loam soils of the Hutton and Glenrosa Forms. These soils are mostly derived from dolerite or diabase mainly on the Bc map unit. The community is characterised by species group E (Table 1) , which includes the diagnostic woody and semi - woody species Acacia karroo , Protasparagus laricinus , Protasparagus suaveolens and Ziziphus mucronata , and also the grass species Eragrostis trichophora. These areas are often severely overgrazed and here considerable increase of woody species has occurred (see also Friedel 1987 , Bredenkamp , Joubert & Bezuidenhout 1989 and Bredenkamp & Bezuidenhout 1989). In areas prone to bush encroachment , the vegetation is dominated by the diagnostic woody species and the herbaceous layer is mostly poorly developed , with patches of bare soil and considerable surface erosion. Despite the overgrazed nature of the vegetation , many species occur in this community and species groups D, E, F, G, H, and I are present (Table 1). An average of 35 species was recorded per sample plot. In addition to the diagnostic species mentioned from species group E , the following grass species are constantly (>50%) present Themeda triandra , Eragrostis curvula , Aristida congesta , Panicum coloratum , Cynodon

dactylon and Cymbopogon plurinodis , and forbs such as Hibiscus pusillus , Gomphrena celosioides and the dwarf shrub Felicia muricata.

3.2 Triraphis andropogonoides - Anthephora pubescens Grassland. This Grassland is typical for the moderately deep yellow sands of the Avalon , Westleigh and Clovelly soil Forms , found scattered throughout the vast area of the Bd map unit and to a lesser extent in the Bc unit. Although the sands overlaying Karoo sediments may be deep and without gravel or rocks on the soil surface , shallower soils with gravel or rock overlaying dolerite sills can also be found in this community.

Although no diagnostic species group could be identified , the community can be distinguished by the simultaneous presence of species groups D and F , and the absence of species group E (Table 1). A floristic relationship between this Grassland and the Triraphis andropogonoides - Acacia karroo Woodland , is indicated by species group F. Species from species groups G , H and I (Table 1) are also present in this community. The only floristic difference between these two communities , is the presence of mostly the woody and semi - woody species of species group E in the Triraphis andropogonoides - Acacia karroo Woodland. In the Triraphis andropogonoides - Anthephora pubescens Grassland the herbaceous layer is well developed , dominated by Themeda triandra and / or Eragrostis curvula , with Anthephora pubescens , Eragrostis lehmanniana and Eragrostis superba locally prominent. An average of 33 species was recorded per sample plot. Other constantly present

species (50%) include the grasses Brachiaria serrata , Aristida congesta , Cynodon dactylon the geophyte Ledebouria marginata and the dwarf shrub Felicia muricata.

3.3 The Triraphis andropogonoides - Themeda triandra Grassland.

This Grassland community is found on the vast plains of the Bc and Bd map unit on very deep , yellow , aeolian sands of the Avalon and Clovelly soil Forms. No diagnostic species group could be identified , but the community can be distinguished by the presence of species group D and the absence of species group F (Table 1). The vegetation is mostly well developed and is in a good condition , with Themeda triandra entirely dominant. On overgrazed sites , Eragrostis curvula is also prominent.

This Grassland is relatively poor in species composition , as is the case in many Themeda triandra - dominated communities. An average of only 23 species was recorded per sample plot. Other species constantly present (50%) include the grasses Eragrostis superba , Triraphis andropogonoides , Aristida congesta , Panicum coloratum and Cynodon dactylon and the forb Hibiscus pusillus and the karroid shrubs Pentzia globosa and Felicia muricata.

4. The Panicum coloratum - Themeda triandra Grassland.

This community mostly occurs on the shallower sandy clay loam soils of footslopes towards bottomland situations (terrain unit 4) (Figure 3) in the Bc map unit. Typical soils for these situations are of the Valsrivier , Sterkspruit or Westleigh Forms. The community also occurs in isolated patches on deeper yellow sands in the Bd map unit , but here the vegetation is degraded

due to overgrazing. Soil properties are given in Table 2. This Grassland is dominated by dense stands of Themeda triandra and is extremely poor in species composition. An average of only 18 species per sample plot was recorded. Only the general species (Species group I) occur constantly in this community, while species of species groups G and H are poorly represented.

Concluding remarks

The vegetation varies as a result of variations in habitat, for example topography, soil type, drainage regime and vegetation management (grazing by animals), and consequently various plant communities can be distinguished. The results of this phytosociological survey, together with the results of the phytosociological study of the vegetation of the D land type, (Kooij, Bredenkamp & Theron 1990b) form the basis for a phytosociological synthesis of the north western Orange Free State. The plant communities distinguished by the application of TWINSpan procedures refined by Braun - Blanquet procedures are considered as ecological interpretable, as it can be related to specific environmental conditions.

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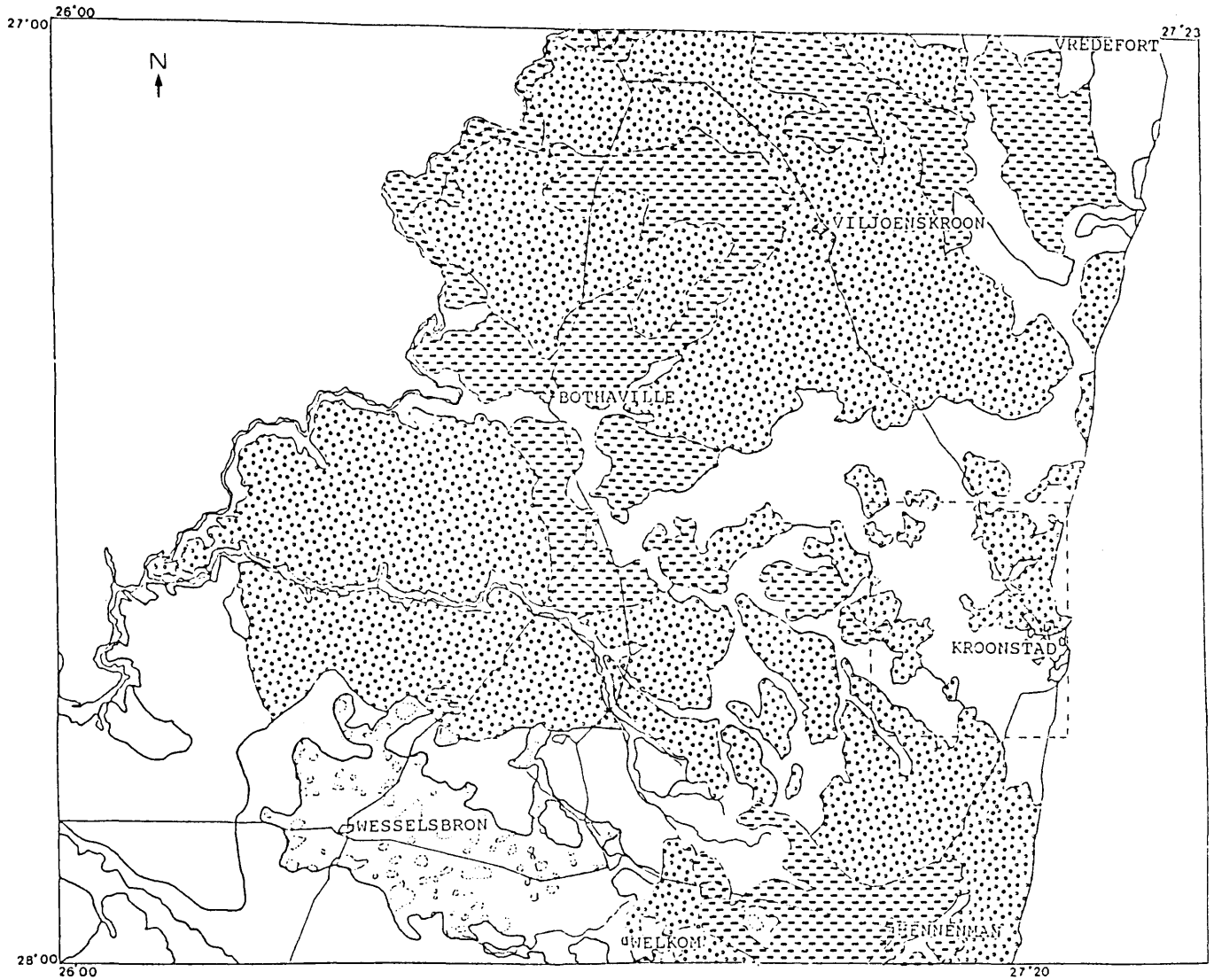





Figure 1. The location of the Bd and Bc land types in the study area (Land Type Survey Staff 1984).

- Legend: Land type Bd - 
 Bc - 
 Other - 

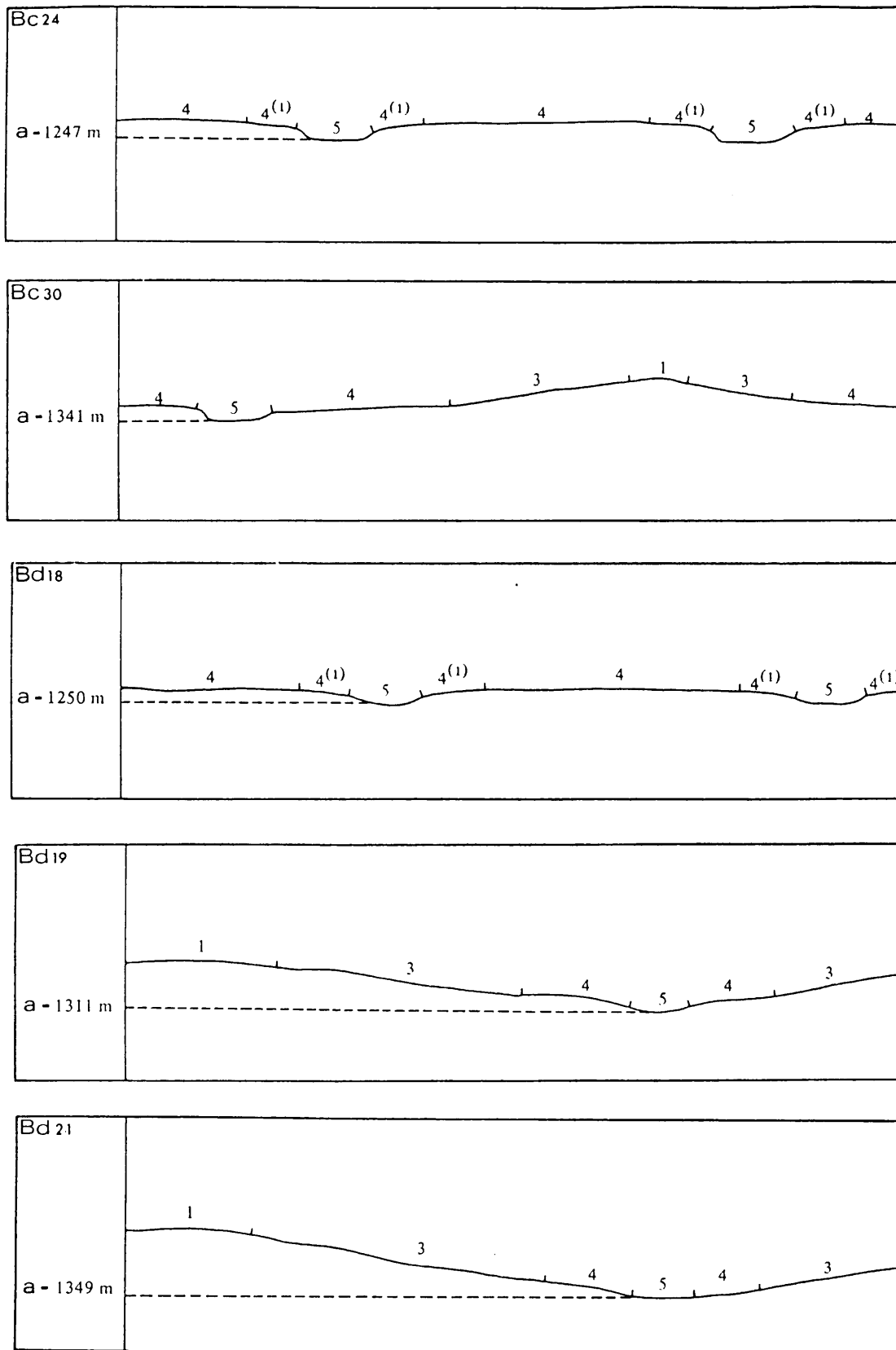


Figure 2. A schematical representation of the different terrain units in the B land type (Land Type Survey Staff 1984).

Legend: Terrain unit: 1 - Crest
 2 - Scarp
 3 - Midslope
 4 - Footslope
 5 - Valley Bottom or Flood plain
 a - Altitude

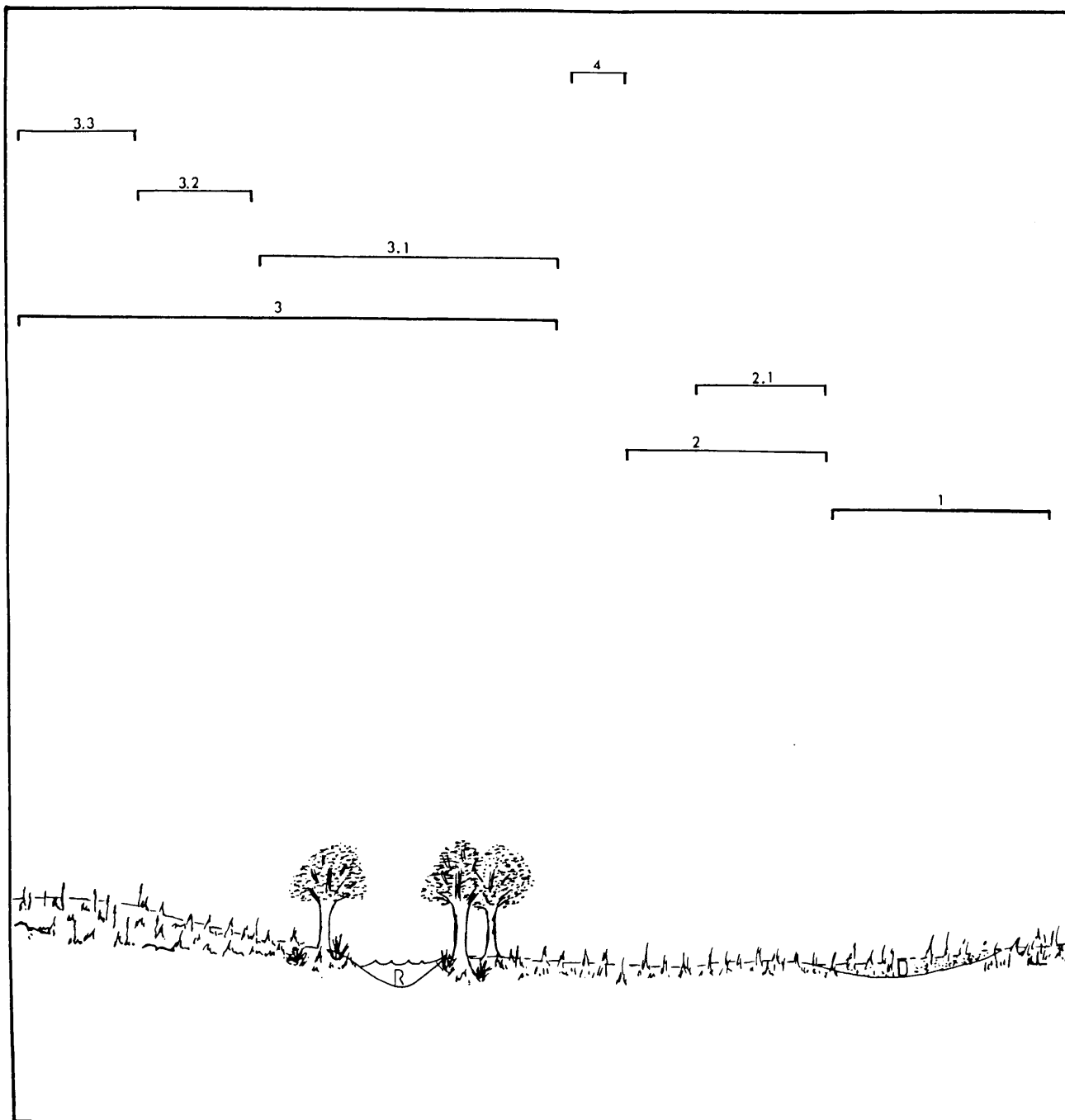


Figure 3. A schematic representation of the topographical gradient and vegetation of the Bd and Bc land types.

Legend : D - Depressions

R - River

- 1 - Aristida bipartita - Eragrostis plana Vlei
Grassland.
- 2 - Berkheya radula - Microchloa caffra - Grassland.
- 2.1 - Stachys spatula - Variant.
- 3 - Brachiaria serrata - Triraphis andropogonoides -
Grassland.
- 3.1 - Triraphis andropogonoides - Acacia karroo -
Woodland.
- 3.2 - Triraphis andropogonoides - Anthephora pubescens -
Grassland.
- 3.3 - Triraphis andropogonoides - Themeda triandra -
Grassland.
- 4 - Panicum coloratum - Themeda triandra - Grassland.

TABLE 1. A PHYTOSOCIOLOGICAL TABLE OF THE VEGETATION OF THE B LAND TYPE OF THE NORTH - WESTERN ORANGE FREE STATE SOUTH AFRICA

COMMUNITIES	1		2		3		4	
	2.1	2.2	3.1	3.2	3.3	3.3	3.3	4
RELEVES	10000000000	111010110	111010000100000101	001000011111	00101011100111111111101010100111	000001111	0111110110112	
	59113049535	555151347	780952399199994927	003201843089	024332223222233667883366828755679	041857665	2167111711250	
	62317804930	197930289	562742453061089768	131378009954	456251868477943230070106221278915	944363788	0116425437323	
SPECIES GROUP A								
<i>ERAGROSTIS PLANA</i>	++ + 1 3+1	+ +						
<i>SCHKUHRIA PINNATA</i>	+++ + ++	+ +						
<i>CHLORIS VIRGATA</i>	++++1+							
<i>SETARIA SPHACELATA</i>	12 31 +							
<i>ARISTIDA BIPARTITA</i>	++ 13	+ +						
<i>BRACHIARIA ERUCIFORMIS</i>	1 + +	+ +						
SPECIES GROUP B								
<i>OXALIS DEPRESSA</i>		+++++++						
<i>MICROCHLOA CAFFRA</i>		+ + ++ +						
<i>BERKHEYA RADULA</i>	+ +	+ + ++						
SPECIES GROUP C								
<i>STACHYS SPATULA</i>	+ + +	+ +	1++++ ++++++++ +					
<i>CIRSIUM VULGARE</i>	+ + +	+ +	+++ + + +++++					
<i>STOEBE VULGARIS</i>	+ +	+ +	+ 1 +++ 1++ +++					
<i>SPOROBOLUS DISCOSPORUS</i>		+ +	+++ ++ +					
<i>BECIUM OBOVATUM</i>		+ +	++ +					
<i>OENOTHERA ROSEA</i>		+ +	+ +					
<i>LYCIUM CINEREUM</i>			+++					
SPECIES GROUP D								
<i>TRIRAPHIS ANDROPOGONOIDES</i>	+ +	+ +	+ +					
<i>LEDEBOURIA MARGINATA</i>		+ +	+ +					
<i>BRACHIARIA SERRATA</i>		+ +	+ +					
<i>BARLERIA MACROSTEGIA</i>	+ +	+ +	+ +					
<i>TRAGUS BERTERONIANUS</i>		+ +	+ +					
<i>BULBINE NARCISSIFOLIA</i>		+ +	+ +					
SPECIES GROUP E								
<i>ACACIA KARROO</i>	+ +	+ +	2 +					
<i>PROTASPARAGUS LARICINUS</i>	+ +	+ +						
<i>PROTASPARAGUS SUAVEOLENS</i>	+ +	+ +						
<i>ZIZIPHUS MUCRONATA</i>								
<i>ERAGROSTIS TRICHOPHORA</i>			1					
SPECIES GROUP F								
<i>ERAGROSTIS LEHMANNIANA</i>		+ +	+ 1					
<i>ANTHEPHORA PUBESCENS</i>		+ +						
<i>KYPHOCARPHA ANGUSTATA</i>		+ +						
<i>CUCUMIS AFRICANA</i>	+ +	+ +	+ +					
<i>TURBINA OBLONGATA</i>		+ +	+ +					
<i>ARISTIDA CANESCENS</i>		+ +	+ +					
<i>RHYNCHELYTRUM REPENS</i>		+ +	+ +					
<i>ZIZIPHUS ZEYHERIANA</i>		+ +	+ +					
<i>LEDEBOURIA OVATIFOLIA</i>		+ +	+ +					

-08-

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

<u>Community number</u>	1	2	3.1	3.2	3.3	4
<u>Soil form</u>	Bonheim	Swartland	Hutton	Clovely	Avalon	Sterkspruit
<u>Soil serie</u>	Bonheim	Nyoka	Schorrocks	Blinkklip	Heidelberg	Stanford
<u>Soil depth mm</u>						
A	0 - 310	0 - 230	0 - 280	0 - 150	0 - 350	0 - 180
B	- 700	- 530	- 720	- 400	->1000	- 360
% Sand						
A	45	54	80	83	91	80
B	31	38	69	77	83	69
% Silt						
A	13	7	1	5	3	1
B	15	9	1	7	4	7
% Clay						
A	39	36	19	12	6	17
B	49	51	31	17	15	24
<u>H₂O retentivity %</u>						
-33kPa						
A	38,9	25,0	-	9,3	3,7	7,1
B	41,2	37,6	24,0	13	8,0	25,9
- 1500 kPa						
A	20,5	15,8	-	5,0	2,6	3,4
B	23,3	23,7	12,7	6,7	4,9	12,9
<u>Exchangeable catioons (me / kg soil)</u>						
Na						
A	40	2	1	1	0	1
B	45	9	2	1	4	32
K						
A	2	8	4	4	2	3
B	2	4	3	4	6	2
Ca						
A	110	83	62	18	14	20
B	114	121	93	30	12	61
Mg						
A	98	63	15	12	10	12
B	134	129	26	18	11	58
Total						
A	250	156	82	35	26	36
B	285	263	124	53	33	153
<u>pH(H₂O)</u>						
A	7,9	6,4	7,2	6,5	7,0	7,4
B	8,1	6,9	6,9	6,5	6,7	9,1
<u>Resistance</u>						
A	280	1 300	1 300	2 200	2 400	2 500
B	120	700	600	1 800	860	600

CHAPTER 6

The vegetation of the deep sandy soils of the A land type
in the north western Orange Free State , South Africa.

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Running title:

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Vegetation of A land type in the Orange Free State.

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A phytosociological analysis of the vegetation of the A land type , covering 199 000 hectares in the north western Orange Free State , South Africa , is presented. More than 80 % of the area has been ploughed. Relevés were compiled in 23 stratified random sample plots , representing the relics of natural vegetation. A TWINSpan classification , refined by Braun - Blanquet procedures revealed five communities. All communities are related to specific environmental conditions. Descriptions of the communities are given.

Keywords: Braun - Blanquet method , classification , Grassland Biome , plant communities.

Introduction

The necessity to identify and describe the major vegetation types and subtypes within the South African Grassland Biome was stated by Mentis & Huntley (1982) and Scheepers (1986). Previous phytosociological studies in the north western Orange Free State , only include those of Scheepers (1975) in the Kroonstad area and Du Preez (1987) in the Vredefort district. A comprehensive synecological and syntaxanomical investigation was therefore undertaken of the vegetation of the north western Orange Free State. Kooij et al. (1990b, 1990c) reported on the plant communities from various land types within the area. For the completion of the phytosociological study of the vegetation of the north western Orange Free State , it is necessary to classify and describe the until now unknown vegetation of the deep sandy soils of the A land type. The A land type refer to freely drained , yellow to red apedal soils with no water table. Within the study area the A land type includes the Ae and Ai map units. These two map units occur in the south western parts of the study area. By definition plinthic catenas do not occur in the Ae and Ai map units and one or more of the above soil forms occupy at least 40% of the area (Land Type Survey Staff , 1984). The entire A land type is very suitable for agronomy. More than 80% of the area has been ploughed for the cultivation of mainly maize , peanuts , potatoes and sunflowers. Natural vegetation is therefore extremely restricted , and only relics , often degraded due to grazing or other land - use practices , may be found scattered throughout the area.

The identification , classification and description of the remaining grassland communities of the A land type should have high priority as a basis for efficient vegetation (grazing) management and to identify suitable areas for probable conservation.

The aim of this project was therefore to identify , characterise and describe the plant communities of the A land type in the north western Orange Free State. The results should contribute to the knowledge of this vegetation type and therefore to a phytosociological synthesis of the western Grassland Biome.

The Study area

The study area is situated between 26°00' and 27°23' E longitude and 27°00' and 28°00' S latitude , in the Grassland Biome of the north western Orange Free State , South Africa . A detailed description of the physical environment of the area is given by Kooij et al. (1990a). Soil nomenclature follows that of MacVicar et al. 1977. The A land type occurs on approximately 199 000 hectares of the study area with approximately 193 000 hectares suitable for agronomy (Land Type Survey Staff , 1984).

The soils can be classified in one of the following soil forms : Indanda , Kranskop , Magwa , Hutton , Griffin and Clovelly. In the Ae map unit red soils with a high base status , deeper than 300 mm , with no visible predominating dunes , whereas yellow , high base status soils predominate in the Ai map unit.

The geology of the Ae map unit consists predominantly of Ecca sandstone , mudstone and shale with the sporadic occurrence of intrusive dolerite sills. Aeolian sand , derived from the Ecca sandstone , overlies all rocks. In depressions , pans occupy 4% of this map unit. The predominant soil forms in the Ae map unit are the Hutton Form on the slightly raised upland areas , the Valsrivier , Sterkspruit , Mispah and Oakleaf Forms , in the relatively low laying plains and the Willowbrook , Katspruit , Valsrivier , Rensburg and Sterkspruit Forms in the concave bottomland sites (Land Type Survey Staff , 1984).

The geology of the Ai map unit consists mainly of sandstone of the Ecca group. Intrusive dolerite sills occur sporadically throughout this map unit. Pans occupy 2% of the Ai map unit (Land Type Survey Staff , 1984). The predominant soil forms in this map unit are the Clovelly and Hutton Forms on the upland situations , the Oakleaf , Clovelly , Westleigh and Sterkspruit on the plains and the Oakleaf , Sterkspruit , Katspruit , Arcadia and Willowbrook Forms in depressions (Land Type Survey Staff , 1984).

Methods

Over the entire north western Orange Free State relevès were compiled in 204 stratified random sample plots. Due to the limited occurrence of natural vegetation in the A land type , only 23 relevès were compiled in this land type. As geology and land type were relatively uniform , stratification was based on the five terrain units , namely 1- crests , 2- scarp 3- midslope 4-

footslopes and 5- valley bottom or floodplain (Figure 1) (De Beer , 1988 , Land Type Survey Staff , 1984). In accordance with Scheepers (1975) , plot sizes were fixed on 16 m² for grassland vegetation , while 100 m² plots were used for woody vegetation (Bredenkamp & Theron , 1978).

In each sample plot all species present were noted , using the Braun - Blanquet cover - abundance scale (Mueller - Dombois & Ellenberg , 1974). Taxa names and taxon author names usually conform to those of Gibbs Russell et al. (1985 , 1987) , however in accordance with Bredenkamp et al. (1989) Setaria flabellata Stapf. and S. sphacelata (Schumach.) Moss were distinguished as two separate taxa. Environmental information includes terrain units , soil types , aspect , slope and rockiness of the soil surface. Other soil properties were obtained from Land Type Survey Staff (1984).

Two way indicator species analysis (TWINSPAN) (Hill , 1979) was applied to the floristic data set in order to derive a first approximation of the vegetation types of the area. Refinement of this classification was done by the application of Braun - Blanquet procedures (see also Behr & Bredenkamp , 1988 ; Bredenkamp , et al. , 1989 ; Kooij et al. 1990a , 1990b , 1990c). The results are presented in a phytosociological table (Table 1). In order to determine a probable vegetation gradient , an ordination algorithm , Detrended Correspondance Analysis (DECORANA) (Hill , 1979) was applied to the floristic data set.

Results

Classification

In general the vegetation of the A land type can be considered as a Pentzia globosa - Eragrostis curvula Grassland. Eragrostis curvula is mostly the dominant grass species. The grass species of species group G , (Table 1) are mostly classified as Increasers 2 and 3 (Bosch & Van Rensburg , 1988) as these species increase , and are therefore abundantly present , in overgrazed or selectively grazed , degraded grassland vegetation. The poor condition of these grasslands are emphasized by the presence of the karroid shrubs Felicia muricata and Pentzia globosa. Other pioneers such as Walafrida densiflora and Cirsium vulgare are constantly present. The number of species recorded per sample plot varies from 12 to 31 with an average of 22 species. The vegetation varies as a result of variations in habitat , for example topography , soil type , drainage regime and vegetation management (grazing by animals) , and consequently the various plant communities can easily be distinguished. A hierarchical classification of the distinguished plant communities is listed below:

1. The Oenothera indecorus - Conyza sumatrensis Secondary Grassland on severely disturbed sites.
 2. Acacia karroo - Hibiscus pusillus Thornveld along drainage lines.
 3. Eragrostis superba - Themeda triandra Grassland of the undulating plains.
- 3.1 Eragrostis lehmanniana Variant

3.2. Anthehora pubescens Variant

3.3. Eragrostis trichophora Variant

Description of the communities

1. The Oenothera indecorus - Conyza sumatrensis Secondary Grassland.

This Grassland community occurs on deep yellow sandy (90% sand) soils of the Clovelly Form, predominantly in the Ai map unit. Soil properties are given in Table 2. The pH - neutral sands have extremely low exchangeable cations and water retentivity, but a high electrical resistance. The sites are extremely disturbed and the poor condition of the vegetation in this community is emphasized by the weedy diagnostic species (Species group A, Table 1). The diagnostic species are Oenothera indecorus, Conyza sumatrensis, Schkuhria pinnata, Oenothera rosea, Aristida diffusa, Monandrus longicarpus and Coronopus integrifolius. The vegetation is dominated by Eragrostis curvula and Cynodon dactylon. An average of 15 species was recorded per sample plot.

2. The Acacia karroo - Hibiscus pusillus Thornveld.

This Thornveld is restricted to the water courses and drainage lines (terrain units 3 & 4) (Figures 1 and 2) in the A land type. The soils are usually deep, red to yellow sandy soils of the Hutton or Clovelly Forms. Soil properties are given in Table 2. These sandy soils tend to be alkaline especially in the A horizon. The soils are leached and have a low water retentivity. The soil resistance is however in the medium range (Table 2). The diagnostic species for this Thornveld (Species group B,

Table 1) includes the woody tree species Acacia karroo , Acacia hebeclada , the shrubby Protasparagus suaveolens , Protasparagus laricinus and Lycium cinereum , the grass Sporobolus fimbriatus , the forbs Hibiscus pusillus , Hibiscus trionum , Pollichia campestris and the succulent Portulaca kermesina. The herbaceous layer is dominated by Eragrostis curvula . The vegetation is generally overgrazed and in a degraded condition. Other species constantly present are Pentzia globosa , Cynodon dactylon , Bulbine narcissifolia , Felicia muricata , Solanum incanum , Eragrostis obtusa , Kyllinga alba , Barleria macrostegia , Ledebouria marginata and Walafrida densiflora . An average of 27 species was recorded per sample plot.

3. The Eragrostis superba - Themeda triandra Grassland.

The greater part of the natural vegetation of the A land type is represented by the Eragrostis superba - Themeda triandra Grassland. The diagnostic species for this community include the grasses Eragrostis superba , Themeda triandra and Digitaria eriantha and an Oxalis species (Species group C , Table 1). Other species generally present are the grasses Eragrostis curvula , Cynodon dactylon , Aristida congesta and Panicum coloratum , the forbs Solanum incanum , Kyllinga alba and Commelina africana , the geophytes Bulbine narcissifolius , Albuca species and Ledebouria marginata and the karroid dwarf shrubs Pentzia globosa and Felicia muricata. An average of 21 species was recorded per sample plot. This community can be sub - divided into three variants according to species composition and habitat differences.

3.1 The Eragrostis lehmanniana Variant.

The Eragrostis lehmanniana Variant is situated on the mid- and footslopes of the undulating plains (terrain units 3 - 4 , Figures 1 and 2). The soils are medium deep , predominantly red sands representing the Hutton Form. Soil properties are given in Table 2. Although sandy (86% sand in the A horizon) , the B horizon contains up to 24% clay , and therefore have slightly higher water retentivity , more exchangeable cations and a lower electric resistance than communities 1 and 2. This variant is characterised by species group D , which includes the diagnostic species Eragrostis lehmanniana , Commelina benegalensis , Cucumis africana , Sporobolus species , Setaria nigrirostris , Menodora africana and Brachiaria serrata. The dominant species are the grasses Eragrostis lehmanniana , Themeda triandra and Eragrostis curvula. Other constantly present species are the grasses Eragrostis superba , Digitaria eriantha , Cynodon dactylon and the forbs Cucumis africana , Menodora africana , and Kyllinga alba. The presence of Species group I (Table 1) as well as Pentzia globosa , Cynodon dactylon and Felicia muricata indicates the degraded state of the vegetation. This variation seems to represent a severely overgrazed and degraded stage of the Eragrostis superba - Themeda triandra grassland. Eragrostis lehmanniana seems to replace Antheophora pubescens with continuous overgrazing. Species group I indicates floristic similarities , probably caused by over - utilization , among communities 1 , 2 and 3.1 (Table 1). An average of 20 species was recorded per sample plot.

3.2 Anthehora pubescens Variant.

This Variant is also situated on the mid- and footslopes of the A land type , on similar but slightly deeper soils than the Eragrostis lehmanniana Variant. Soil properties are given in Table 2. The Anthehora pubescens Variant is characterised by species group E (Table 1). The diagnostic species are the grasses Anthehora pubescens , Aristida stipitata , Eragrostis gummiflua and the forbs Commelina eckloniana , Tephrosia species and Cyperus margaritaceus. Other species constantly present are Eragrostis superba , Themeda triandra , Heteropogon contortus , Pentzia globosa , Kyllinga alba , Commelina africana , and Mariscus indecorus. The presence of species group H indicates similarities between communities 1 , 2 , 3.1 and 3.2 (Table 1). An average of 20 species was recorded per sample plot.

3.3 The Eragrostis trichophora Variant

This Variant is situated in relatively wet depressions in the undulating landscape (terrain units 4(1) and 5 , Figures 1 and 2). Soil properties are given in Table 2. The clayey soils have a relatively high water retentivity , exchangeable cations , and a relatively low electrical resistance. The soils are usually more clayey (up to 35% clay) and represents the Sterkspruit , Swartland , Valsrivier and Willowbrook Forms. This Variant is characterised by species group F (Table 1). The diagnostic species are the dominant grass Eragrostis trichophora as well as Monsonia attenuata , Tragus racemosus , Stachys spatula and Salvia radula. Other prominent species are the grasses Eragrostis curvula , Themeda triandra , Heteropogon contortus , Eragrostis

superba , the karroid shrubs Pentzia globosa and Felicia muricata and the geophyte Bulbine narcissifolia. An average of 20 species was recorded per sample plot.

Ordination

The distribution of the relevés along the first and second axes of the ordination is given in Figure 3. A third axis of ordination contributes little to the interpretation of the plant communities and is therefore not included in this result.

In the scatter diagram a distinct discontinuity can be observed among some of the identified plant communities. Community 3.3 (the Eragrostis trichophora Variant) and 3.1 (the Eragrostis lehmanniana Variant) can clearly be distinguished as separate units. Communities 1 (the Oenothera indecorus - Conyza sumatrensis Grassland) , 2 (the Acacia karroo - Hibiscus pusillus Thornveld) and 3.2 (the Anthehora pubescens Variant) are situated to the right of the scatter diagram. The scatter diagram also illustrates the portion of the communities on a habitat gradient. A definite gradient in soil texture , water retentivity , exchangeable cations and electrical resistance of the soil is illustrated along the first axis. Communities situated to the left of the scatter diagram are associated with clayey soils with a high water retentivity and exchangeable cations and low electrical resistance , whereas the communities to the right are associated with sandy soils with a low water retentivity , exchangeable cations and a high electrical resistance.

Concluding remarks

The results of this phytosociological survey , together with the results of other phytosociological studies in the north western Orange Free State form the basis for the synecology and syntaxonomy of this area. The application of the TWINSPAN method refined by Braun - Blanquet procedures resulted in the successful delimitation of the plant communities which are related to specific environmental conditions. The results of the ordination suggest that the three Variants distinguished in the Eragrostis superba - Themeda triandra Grassland could be interpreted as syntaxa of the higher syntaxonomical rank. This should be considered in a synecological and syntaxonomical synthesis of the north western Orange Free State Grasslands. The dominant species in the three Variants of the Eragrostis superba - Themeda triandra Grassland namely the Eragrostis lehmanniana , Anthehora pubescens and Eragrostis trichophora indicate some floristic affinity to the vegetation of the deep sandy soils of the Kalahari Gemsbok National Park (Van Rooyen et al. , 1988).

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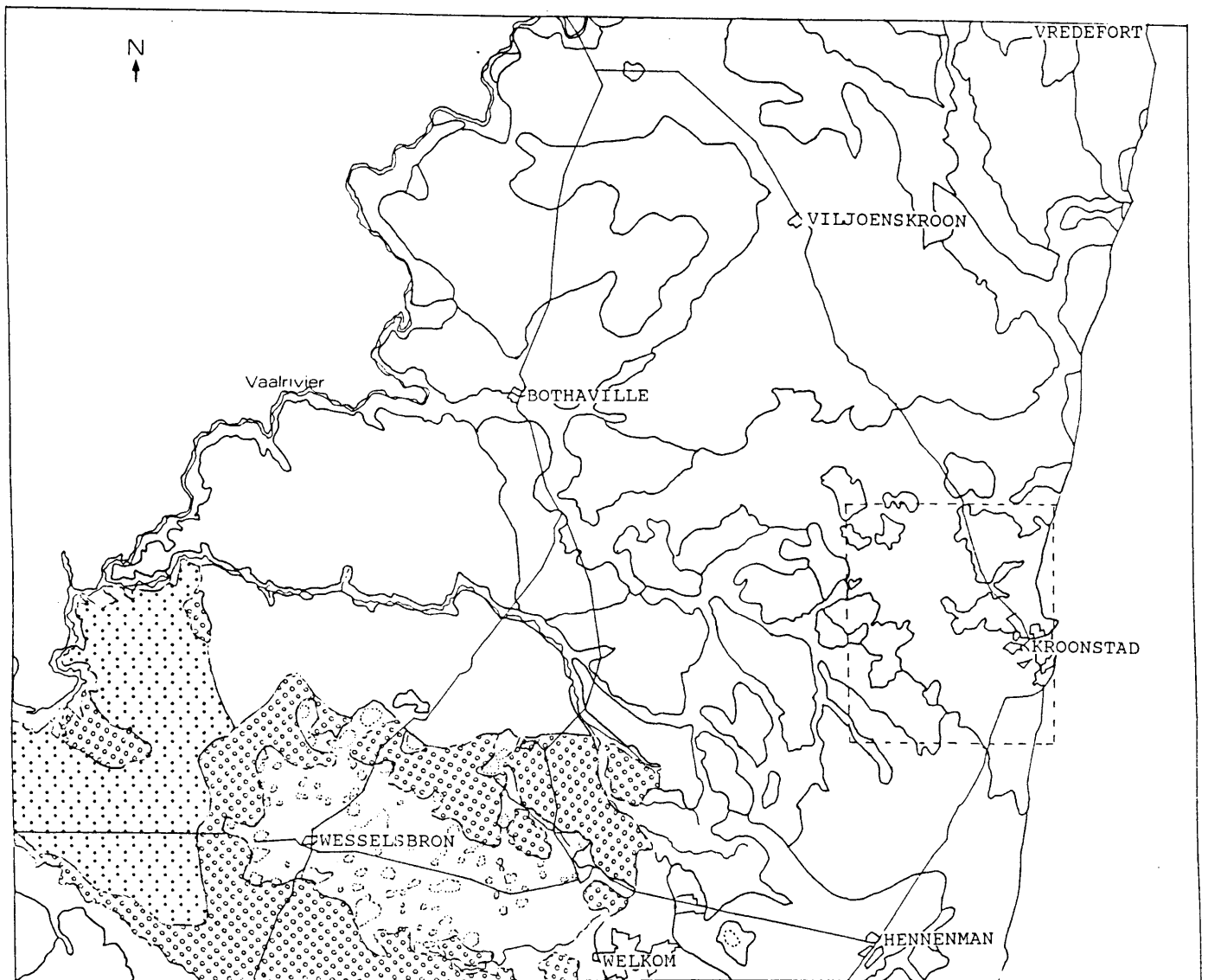





Figure 1. The location of the Ae and Ai land types in the study area (Land Type Survey Staff , 1984).

- Legend: Land type Ae - 
- Ai - 
- Others - 

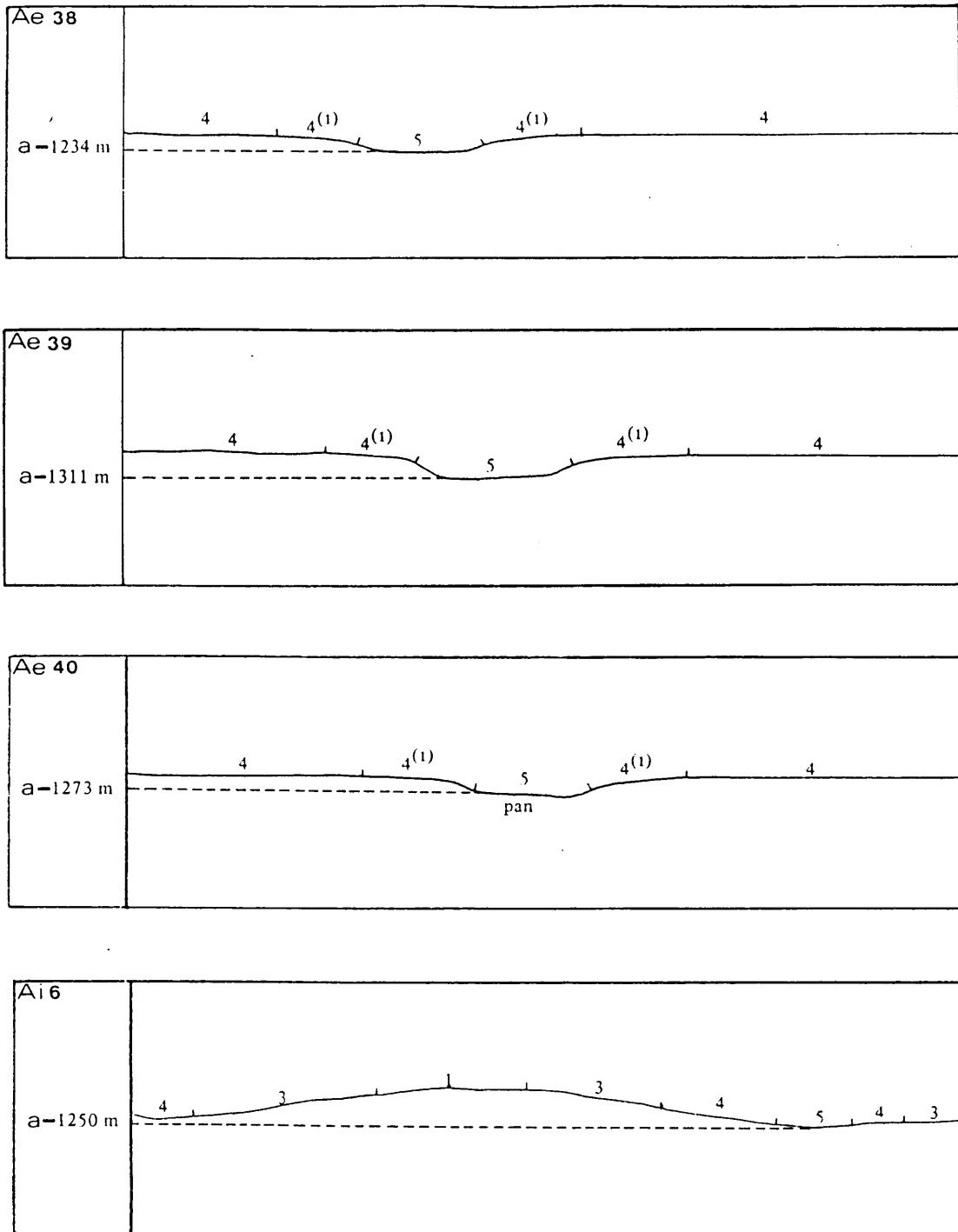


Figure 2. A schematic representation of the different terrain units in the A land type (Land Type Survey Staff, 1984).

Legend: Terrain unit: 1 - Crest
 2 - Scarp
 3 - Midslope
 4 - Footslope
 5 - Valley Bottom or floodplain
 a - Altitude

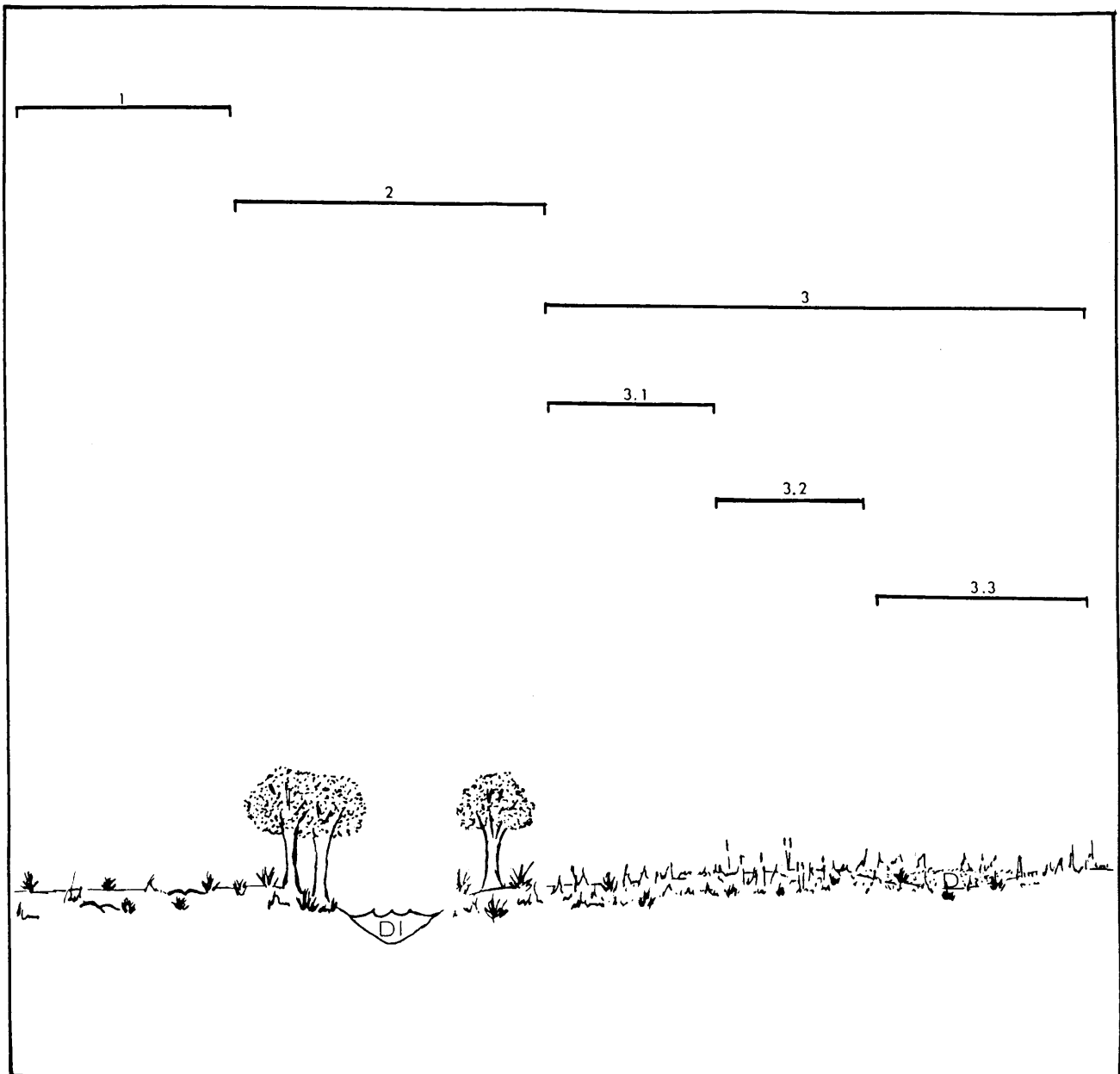
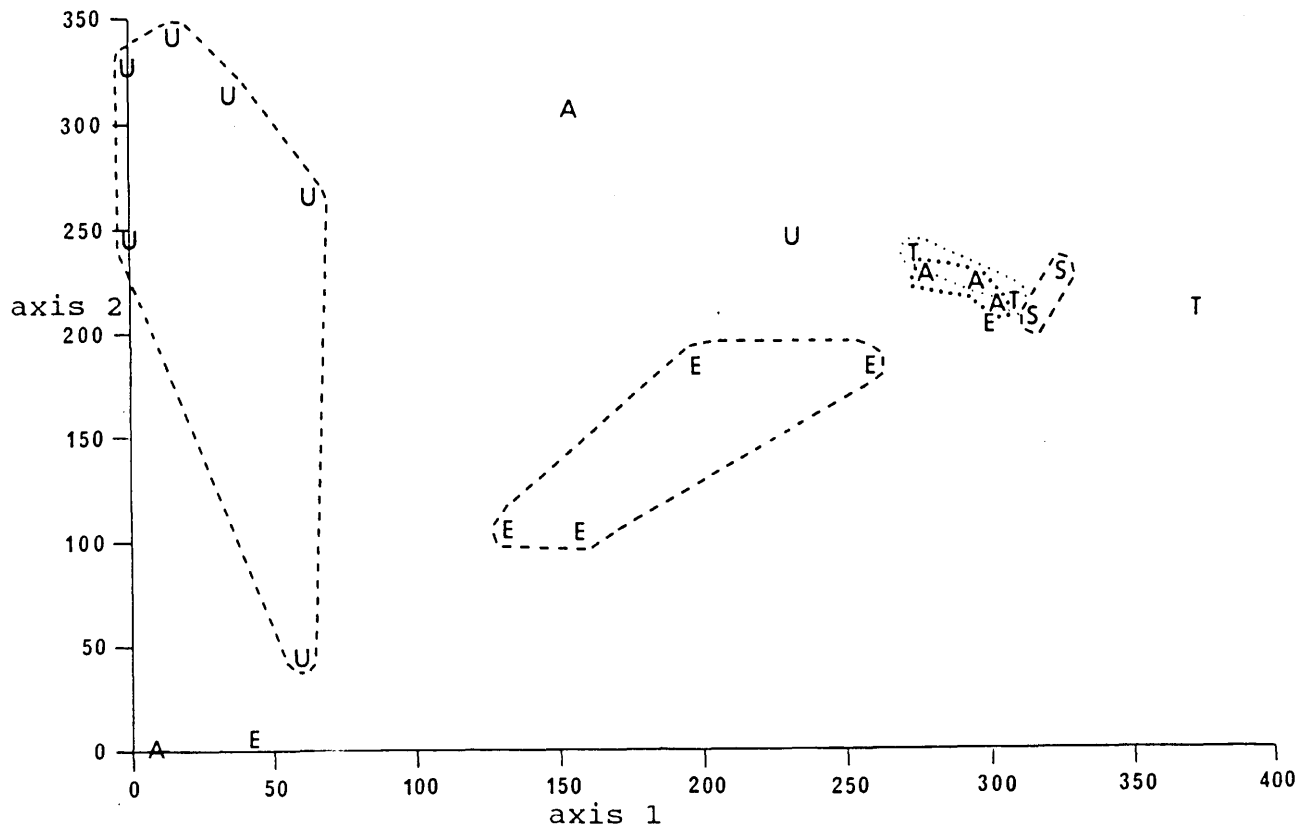


Figure 3. A schematical representation of the topographical gradient and vegetation of the Ae and Ai land type units.

Legend:

- D1 - Drainage line
- D - Depression
- 1 - Oenothera indecorus - Conyza sumatrensis Secondary Grassland severely disturbed sites.
- 2 - Acacia karroo - Hibiscus pusillus Thorn Veld along drainage lines.
- 3 - Eragrostis superba - Themeda triandra Grassland on the undulating plains.
- 3.1 - Eragrostis lehmanniana Variant.
- 3.2 - Anthephora pubescens Variant.
- 3.3 - Eragrostis trichopora Variant.



Clay	<-	soil texture	->	Sand
High	<-	H ₂ O retention	->	Low
High	<-	Cation exchange	->	Low
Low	<-	Resistance	->	High

Figure 4. An ordination of the vegetation of the A land type in the north - western Orange Free State , South Africa.

Legend:

Community

- S - Community 1 : Oenothera indecorus - Conyza sumatrensis
Secondary Grassland.
- T - Community 2 : Acacia karroo - Hibiscus pusillus
Thornveld.
- E - Community 3.1 : Eragrostis lehmanniana Variant.
- A - Community 3.2 : Anthephora pubescens Variant.
- U - Community 3.3 : Eragrostis trichophora Variant.

TABLE 1. A PHYTOSOCIOLOGICAL TABLE OF THE VEGETATION OF THE A LAND TYPE OF THE NORTH - WESTERN ORANGE FREE STATE.

COMMUNITIES	1		2		3	
	10	000	111111	00011	0111111	
RELEVES	96	666	888978	66720	5201001	
	31	534	423191	02818	4049566	
SPECIES GROUP A						
<i>OENOTHERA INDECORA</i>	1+					
<i>CONYZA SUMATRENSIS</i>	++					
<i>SCHKUHRIA PINNATA</i>	+					
<i>OENOTHERA ROSEA</i>	+					
<i>ARISTIDA DIFFUSA</i>	+					
<i>MONANDRUS LONGICARPUS</i>	+					
<i>CORONOPUS INTEGRIFOLIUS</i>	+					
SPECIES GROUP B						
<i>ACACIA KARROO</i>	3++		+			
<i>HIBISCUS TRIONUM</i>	++				+	+
<i>HIBISCUS PUSILLUS</i>	+++				+	
<i>SPOROBOLUS FIMBRIATUS</i>	1+			+		
<i>POLLICHIA CAMPESTRIS</i>	++			+	+	
<i>LYCIUM CINEREUM</i>	+					
<i>PORTULACA KERMESINA</i>	+					
<i>ACACIA HEBECLADA</i>	++					
<i>PROTASPARAGUS SUAVEOLENS</i>	+					
<i>PROTASPARAGUS LARICINUS</i>	+					
SPECIES GROUP C						
<i>ERAGROSTIS SUPERBA</i>			+++++	++++	++1++2	
<i>THEMEDA TRIANDRA</i>			+3+++34	+++3+	1 124	
<i>DIGITARIA ERIANTHA</i>			+ + + + +	+	++ +	
<i>OXALIS SPECIES</i>			+	+	+++ +	
SPECIES GROUP D						
<i>ERAGROSTIS LEHMANNIANA</i>	+	323		+	+	
<i>COMMELINA BENECALENSIS</i>		+	++ +			
<i>CUCUMIS AFRICANA</i>		++		+		
<i>SPOROBOLUS SPECIES</i>		+	+	+		
<i>SETARIA NIGRIROSTRIS</i>		++	+			
<i>MENODORA AFRICANA</i>	+	+				
<i>MARISCUS REHMANNIANUS</i>		++				
<i>WAHLENBERGIA CALEDONICA</i>		+	+			
<i>BRACHIARIA SERRATA</i>		++		+		
SPECIES GROUP E						
<i>ANTHEPHORA PUBESCENS</i>		+	+	+++4+	21	
<i>ARISTIDA STIPITATA</i>				+++ +	+	
<i>ERAGROSTIS GUMMIFLUA</i>				+++	+	
<i>COMMELINA ECKLONIANA</i>	+			++ +	+	
<i>TEHPROSIA SPECIES</i>	+			+	++	
<i>CYPERUS MARGARITACEUS</i>				+	++	
SPECIES GROUP F						
<i>ERAGROSTIS TRIGOPHORA</i>						++ 332322
<i>MONSONIA ATTENUATA</i>						++++ +
<i>TRAGUS RACEMOSUS</i>		+				++ +
<i>STACHYS SPATULA</i>						+ +
<i>SALVIA RADULA</i>						+ +
<i>CYMBOPOGON EXCAVATUS</i>						+ +
SPECIES GROUP G						
<i>PENTZIA GLOBOSA</i>		+	+++	++	+++	+++ + +++++ +
<i>ERAGROSTIS CURVULA</i>	22	424		33 3	2341+	+4++
<i>CYNODON DACTYLON</i>	11	+++		+++	22++	1 +
<i>BULBINE NARCISSIFOLIA</i>		+++		+	++	+1+++ +
<i>FELICIA MURICATA</i>		++		+++	+	++ +
<i>ARISTIDA CONGESTA</i>		+		+	+	++ +
<i>SOLANUM INCANUM</i>		++		+	++	+ +
<i>PANICUM COLORATUM</i>		+		+	+	+ +
<i>ERAGROSTIS OBTUSA</i>		++		+	+	+ +
<i>ALBUCA SPECIES</i>		+		+	+	+ +
SPECIES GROUP H						
<i>KYLLINGA ALBA</i>		++	+++	+	+++ +	++
<i>COMMELINA AFRICANA</i>		+	++		++++	++++
<i>MARISCUS INDICORUS</i>	+	++		+	+++	+++
<i>BARLERIA MACROSTEGIA</i>	+	+	+	+	++	++++
<i>LEDEBOURIA MARGINATA</i>		++		+	+	+
<i>HERMANNIA TOMENTOSA</i>		+		+	+	+
SPECIES GROUP I						
<i>CHLORIS VIRGATA</i>	++	+	++	+		
<i>WALAFRIDA DENSIFLORA</i>	+	++	+	++		+
<i>CIRSIMUM VULGARE</i>		+	++	+		
<i>SETARIA SPHACELATA</i>		+	+	++		
<i>CASSIA ITALICA</i>		+	+	+		
<i>TURBINA OBLONGATA</i>		+			++	
<i>CRASSULA SCHIMPARI</i>						++ +
<i>CYPERUS USITATUS</i>						++ +
<i>BLEPHARIS ANGUSTATA</i>						++
<i>POGONARTHRIA SQUARROSA</i>	+				++1	+
<i>HETEROPOGON CONTORTUS</i>					++	22
<i>CYMBOPOGON PLURINODIS</i>			+	+		+
<i>TRIRAPHIS ANDROPOGONOIDES</i>					++	++
<i>CHENOPODIUM ALBUM</i>	+	+				
<i>DICOMA MACROCEPHALA</i>					+	1
<i>CHAMAESYCE PROSTRATA</i>			+			+
<i>INDIGOFEA SPECIES</i>			+		+	
<i>GAZANIA KREBSIANA</i>			+		+	
<i>LACTUCA SERIOLA</i>			+		+	
<i>PTERODISCUS SPECIOSUS</i>		+				+

SPECIES WITH AN OCCURANCE OF 1 HAVE BEEN OMITTED.

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

<u>Community number</u>	1	2	3.1	3.2	3.3
<u>Soil form</u>	Clovelly	Hutton	Hutton	Hutton	Willowbrook
<u>Soil serie</u>	annandale	mangano	shorrocks	shorrocks	sarasdale
<u>Soil depth mm</u>					
A	0 - 400	270- 560	0 - 250	0 - 250	0 - 500
B	- 800	- 920	- 400	- 750	750 ->1000
% Sand					
A	90	90	85	75	61
B	90	85	75	73	61
% Silt					
A	1	3	2	3	5
B	1	2	3	4	6
% Clay					
A	7	8	13	25	33
B	10	18	24	25	35
<u>H₂O retentivity %</u>					
- 33kPa					
A	4,6	5,6	9,5	12,8	21,4
B	6,3	7,8	13,9	13,2	23,1
- 1500 kPa					
A	3,0	3,7	4,8	8,8	13,4
B	4,1	5,2	8,1	8,5	13,7
<u>Exchangeable cations (me / kg soil)</u>					
Na					
A	0	0	4	1	8
B	0	1	1	1	13
K					
A	3	4	5	3	2
B	4	4	2	1	1
Ca					
A	18	22	46	47	149
B	8	14	64	45	131
Mg					
A	6	15	5	22	53
B	12	17	17	30	56
Total					
A	27	41	60	73	212
B	24	36	84	77	201
<u>pH(H₂O)</u>					
A	7,6	8,5	8,2	7,6	7,4
B	7,4	6,5	6,9	7,4	8,3
<u>Resistance (ohm)</u>					
A	4 400	2 800	1 800	2 000	800
B	4 000	2 100	430	800	340

CHAPTER 7

The plant communities of the hills and ridges in the north western Orange Free State , South Africa.

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Abstract

A phytosociological analysis of the vegetation of the hills and ridges in the north western Orange Free State , is presented. Relevés were compiled in only 15 sample plots due to the restricted area occupied by hills and ridges. A TWINSpan - classification refined by Braun - Blanquet procedures revealed five major communities. All communities are related to specific environmental conditions. Descriptions of the communities are given.

Keywords : Braun - Blanquet method , classification , Grassland Biome , plant communities.

Introduction

The north western part of the Orange Free State is one of the most important agricultural regions in South Africa. The study area represents the south western part of the Highveld Agricultural Region. This Region produces 80% of the maize , 75% of the grain sorghum and 65% of the sunflower seed production in the Republic of South Africa (Scheepers , 1975). This part of the Grassland Biome also produces a large part of the Republic's animal products (Scheepers , 1975 , Mentis & Huntley , 1982). Most of the land have been ploughed , mainly for maize cultivation. The remaining natural vegetation is restricted to non - arable shallow or rocky soils on hills , vertic clays in bottomland situations or seasonaly waterlogged vleis and along drainage lines. The vegetation is often overgrazed by sheep and cattle.

Little is known about the vegetation of the north western Orange Free State. The relevance of plant ecological studies to land use planning and management is well documented (Edwards , 1967 , Walker , 1976 , Bredenkamp & Theron , 1978 and Muller , 1983). A more detailed classification of the vegetation than that of Acocks (1988) is necessary to meet the present needs for regional and subregional planning (Deall , Scheepers & Schultz , 1989). It was therefore necessary to identify , classify and map the vegetation in order to enable efficient land use planning and also the compilation of management programmes for optimal utilisation , without the degradation of vegetation.

The need to identify and describe the major vegetation types and subtypes within the Grassland Biome in southern Africa has

also been emphasized by Mentis & Huntley (1982) and Scheepers (1986). Previous phytosociological studies in the north western Orange Free State , include only those of Scheepers (1975) in the Kroonstad area and Du Preez (1987) in the Vredefort district. A comprehensive synecological and syntaxonomical investigation was therefore undertaken in the north western Orange Free State. The first step in this study was to create a phytosociological data base for the entire area to enable a synthesis of all available vegetation data (Bredenkamp et al. 1989a). As part of a phytosociological survey of the north western Orange Free State such a data base has been compiled , and the plant communities of the A , B and D land types (Land Type Survey Staff, 1984) were described (Kooij et al. , 1990a , 1990b , 1990c & 1990d).

The vegetation of the isolated rocky uplands and hills of the Ba , Fb and Ib map units , which are restricted to the north eastern parts of the study area , have not yet been classified. The aim of this study is to identify , characterise and describe the plant communities of these map units in the region. The incorporation of the results of this report with those of the vegetation surveys in the A , D and B land types (Kooij et al. 1990b , 1990c , 1990d) as well as with the results of Scheepers (1975) and Du Preez (1987) will enable the compilation of an overall synthesis of the vegetation of this region , which could ultimately lead to the compilation of a formal syntaxonomical hierarchy.

The Study area

The study area is situated between 26°00' and 26°23' E

longitude and 27°00' and 28°00' S latitude , in the Grassland Biome of the north - western Orange Free State , South Africa. A detailed description of the physical environment of the area is given by Kooij et al. (1990a). The soil classification of MacVicar et al. (1977) is followed. The soils of the Ba , Fb and Ib map units are seldomly ploughed due to the rockiness of the shallow soils. These land types are mainly utilized as natural pasture for cattle. Within these land types the Glenrosa and Mispah Forms are predominant in the upland areas (terrain unit 2 , Figure 1) whereas the Arcadia , Rensburg , Bonheim , Valsrivier , Oakleaf and Dundee Forms are predominant in the lowlands (terrain units 4 and 5 , Figure 1).

The geology of the Ba map unit usually comprizes of Basement Complex granite. Plintic soils predominate in this map unit where - as duplex , margalitic soils are absent or occupy less than 10% of the area. This unit comprizes 18 000 hectares of the study area with approximately 1 500 hectares unsuitable for agronomy. (Land Type Survey Staff , 1984). The upland plintic soils include the Hutton and Glenrosa Forms and to a lesser extent the Westleigh Form. In the very limited bottomlands the margalitic , often waterlogged soils of the Estcourt , Sterkspruit , Willowbrook , Arcadia , Rensburg and Bonheim Forms occur.

The geology of the Fb map unit comprizes of Andesitic lavas of the Ventersdorp Supergroup with the sporadic occurrence of diorite , syenite , diabase and Post - Transvaal granite (Land Type Survey Staff , 1984).

The Fb map unit accommodates pedologically young landscapes

which are not predominantly rocky and not alluvial or aeolian , and in which the dominant soil forming processes have been rock weathering (Land Type Survey Staff , 1984). These lithocutanic soils include the Glenrosa and Mispah Forms on upland situations. In bottomland situations the lime - rich Valsrivier , Arcadia , Oakleaf and Bonheim soil Forms occur. This unit comprises 10 000 hectares of the study area with approximately 800 hectares unsuitable for agronomy.

The geology of the Ib map unit consists of quartzite , shale , slate and conglomerate of the Witwatersrand Super Group with the sporadic occurrence of diabase sills. The crests , scarps and midslopes are mainly situated on quartzite and conglomerate , whereas the footslopes and valley bottoms are situated on shale and diabase which may be covered by a mixed colluvium (Land Type Survey Staff , 1984).

In the Ib map unit exposed rocks and boulders cover 60 - 80% of the area. The very shallow rocky soils of the upland areas are usually of the Mispah and Glenrosa Forms (terrain units 1 , 2 and 3 , Figure 1). Terrain unit 5 is often dominated by the Arcadia , Glenrosa and Bonheim soil Forms (Land Type Survey Staff , 1984).

This map unit comprises approximately 3 000 hectares of the study area. The total study area comprises 1 437 000 hectares (Kooij et al. , 1990a).

Methods

The vegetation survey of the entire north western Orange Free State was done by means of 204 stratified sample plots. Stratification was based on land types and terrain units (Land Type Survey Staff , 1984 and De Beer , 1988). The number of sample plots per stratification unit was determined pro rata and on area basis. Due to a relatively restricted area occupied by the Ba , Fb and Ib map unit , compared to the entire study area, only 15 sample plots were placed here. Plot sizes were fixed on 200 m for the woody vegetation (Du Preez , 1987).

In each sample plot all species identifiable at the time of the survey (summer 1988) were noted , using the Braun - Blanquet cover - abundance scale (Mueller - Dombois & Ellenberg , 1974). Taxa names usually conform to those of Gibbs Russell et al. (1985 & 1987) , a list of species of the southern African plants , however in accordance to Bredenkamp et al. (1989) Setaria flabellata Stapf. and S. sphacelata (Schumach.) Moss were recognized as two separate taxa. Environmental information includes terrain types , geology , soil types , aspect , slope and rockiness of the soil surface. Other soil properties were obtained from Land Type Survey Staff (1984).

Two way indicator species analysis (TWINSPAN) (Hill , 1979) was applied to the floristic data set in order to derive a first approximation of the vegetation types of the area. Refinement of this classification was done by the application of Braun - Blanquet procedures (Behr et al. , 1988 , Bredenkamp et al. , 1989). The results are presented in a phytosociological table (Table 1).

In order to determine probable vegetation gradients , an ordination algorithm , Detrended Correspondance Analysis (DECORANA) (Hill , 1979) was applied to the floristic data set.

Results

Classification

Generally the vegetation of the Ba , Fb and Ib map units can be described as a Themeda triandra - Aristida congesta Grassland with scattered trees , shrubs and bush clumps. Themeda triandra is often the dominant grass species although others such as Aristida congesta , Cymbopogon plurinodis and Eragrostis obtusa are also abundant. Other species constantly present are Eragrostis obtusa , the dwarf shrub Felicia muricata , Crabbea acaulis , Schkuhria pinnata and Chamaesyce prostrata and the geophyte Ledebouria marginata (Species group K , Table 1). The number of species recorded per sample plot varies from 24 to 51 , with an average of 32 species. The vegetation differs according to habitat , for example topography , soil type , drainage regime and vegetation management (grazing by animals) , and consequently various plant communities can be recognized. These communities represent the outliers of Bankenveld vegetation from the Vredefort Dome area (du Preez , 1987, Bezuidenhout et al. , 1988). A schematical representation of the topographical gradient and vegetation of the hills and ridges in the study area is given in Figure 3. A hierarchical classification of the recognized plant communities is the following:

1. Maytenus heterophylla - Celtis africana Shrubby Thorn Veld
- 1.a Maytenus heterophylla - Euclea crispa Shrubby Thorn Veld

- 1.b Maytenus heterophylla - Protasparagus africanus Shrubby Thorn Veld
2. Ehretia rigida - Rhus magalismsontanum Shrub Veld
3. Heteropogon contortus - Eragrostis racemosa Grassland
4. Panicum coloratum - Eragrostis curvula Bottomland Grassland
- 4.1 Panicum coloratum - Aristida canescens Variant
- 4.2 Panicum coloratum - Aristida bipartita Variant
5. Acacia karroo - Protasparagus suaveolens River Thorn Veld

Description of communities

1. Maytenus heterophylla - Celtis africana Shrubby Thorn Veld.

This community is situated on the crests and scarps of the hills in the Ba , Ib and Fb map units. The predominant coarse sandy soils are shallow and usually of the Glenrosa or Mispah Form , with rocks and bolders abundantly present on the soil surface (Land Type Survey Staff , 1984). The Maytenus heterophylla - Celtis africana Shrubby Thorn Veld shows relationships with other Acacia caffra communities from typical Bankenveld situations (Bredenkamp et al. , 1980 ; Coetzee , 1974 ; Du Preez , 1987) , and represents impoverished , temperate outliers of this vegetation type. The diagnostic species for this community are the trees and shrubs Maytenus heterophylla , Celtis africana , Zanthoxylum capense , Acacia caffra , Olea europea subsp. africana , Scolopia zeyherii and Diospyros lycioides and the xerophytic ferns Pellaea calomelanos and Cheilanthes hirta (Species group A , Table 1). Other species prominently present are the grasses Themeda triandra , Aristida congesta , Cymbopogon plurinodis and the shrubs Protasparagus suaveolens and Ziziphus zeyheriana. An average of 38 species was recorded

per sample plot. Variations of this community occur on different land types.

1a. Maytenus heterophylla - Euclea crispa Shrubby Thorn Veld

This plant community is typically situated on the granite hills and ridges of the Fb map unit. This Shrubby Thorn Veld is characterised by the diagnostic species Euclea crispa and Rhus rigida (Species group B , Table 1). Acacia caffra is often a dominant species but other prominent woody taxa include Olea europaea subsp. africana , Scolopia zeyheri and Diospyros lycioides. Grasses such as Themeda triandra , Aristida congesta , Cymbopogon plurinodis and Rhynchelytrum repens are prominent (Table 1).

1b. Maytenus heterophylla - Protasparagus africanus Shrubby Thorn Veld.

This variant occurs on the extremely disturbed , limited flat rocky granite outcrops within the Ba map unit. This Variant is characterised by species group C (Table 1) and diagnostic species include Pavonia burchellii , Commelina africana , Protasparagus africanus , Sporobolus species , Ruschia hamata , Albuca species and Eragrostis gummiflua. The dominant trees are Celtis africana and Olea europaea subsp. africana. Shrubs include Diospyros lycioides , Ehretia rigida and Protasparagus suaveolens , conspicuous grasses are Sporobolus fimbriatus , Eragrostis curvula , Microchloa caffra , Trichoneura grandiglumis and Eragrostis superba.

2. Ehretia rigida - Rhus magalismsontanum Shrub Veld

This Shrub Veld has an extremely restricted occurrence in the Bc map unit on isolated quartzite hills. Diagnostic species are

Ehretia rigida , Rhus magalismsontanum , Eustachys paspaloides ,
Hyparrhenia hirta , Pavetta zeyheri , Cleome rubella ,
Alectra sessiliflora , Indigofera sanguinea , Phyllanthus
heterophyllus , Brachiaria nigropedata , Kohautia amatymbica
and Stachys spatula (Species group D , Table 1). Another
diagnostic feature is the absence of the species of general
occurrence , from species group K , which suggest the uniqueness and
isolated syntaxonomic position of this community. The soils are
shallow and usually of the Glenrosa and Mispah soil forms , with
exposed quartzite rocks on the surface. The tree stratum is absent ,
but the shrub stratum is well developed , up to 2 m tall. The
dominant shrubs are Ehretia rigida , Pavetta zeyheri and
Rhus magalismsontanum , and the dominant grasses are Brachiaria
nigropedata , Hyparrhenia hirta , Rhynchelytrum repens ,
Eustachys paspaloides and Themeda triandra. In the single
sample plot 34 species were recorded.

3. Heteropogon contortus - Eragrostis racemosa Grassland

This community is situated on the midslopes of the granitic
hills in the Ba and Fb map units with an inclination of 10 to 15
(Terrain unit 3). The soils are usually shallow and rocky and
of the Hutton or Glenrosa Forms. Eragrostis racemosa , Tephrosia
species , Diheteropogon amplexans , Aristida diffusa ,
Helichrysum callicomum , Cassia biensis , Kyphocarpa angustifolia ,
Aristida stipitata , Amaranthus thunbergii , Helichrysum dregeanum
and Schizachyrium sanguineum are diagnostic species (Species group E
Table 1). Other prominent grass species include Themeda triandra ,
Heteropogon contortus , Cymbopogon plurinodis , Elionurus muticus

and Brachiaria serrata. Other prominent and abundant non - grassy forbs include Lippia scaberima and Anthospermum hispidulum (Table 1). An average of 36 species was recorded per sample plot. This Grassland community is related to certain Bankenveld communities from the Potchefstroom area (Bezuidenhout , 1987).

4. Panicum coloratum - Eragrostis curvula Bottomland Grassland

This community occurs on the footslopes , valley floors and other bottomland situations in the Ba , Fb and Ib map units , where marginalitic , clayey Rensburg , Arcadia , Oakleaf , Bonheim and Valsrivier soil Forms are found. The community is characterised by the diagnostic species Panicum coloratum , Eragrostis curvula , Hibiscus trionum , Corchorus asplenifolius , Seddera capensis , Gazania krebsiana , Sporobolus ioclodus , Walafrida densiflora , Setaria sphacelata and Setaria nigrirostris (Species group F , Table 1). The dominant species are mostly Themeda triandra , Panicum coloratum and Eragrostis curvula. An average of 29 species was recorded per sample plot. Two variants can be distinguished.

4.1 Panicum coloratum - Aristida canescens Variant

This community occurs on the slightly raised , lower footslopes of the Ba , Fb and Ib map units (Terrain unit 4). The soils are usually of the Valsrivier , Swartland , Estcourt and Sterkspruit Forms. These soils are better drained and drier than those of the Panicum coloratum - Aristida bipartita Variant. The diagnostic species for this community are Aristida canescens , Hermannia depressa , Blepharis integrifolia , Lactuca species , and Anthephora pubescens (Species group G , Table 1). The dominant

species are Themeda triandra and Aristida canescens. Other prominent species are Cymbopogon plurinodis , Felicia muricata , Ledebouria marginata and Crabbea acaulis.

The species of species group I are situated on the mid- and footslopes of the Ba , Fb and Ib map units (Terrain units 3 & 4) , and therefore occur in both the Heteropogon contortus - Eragrostis racemosa grassland and the Panicum coloratum - Aristida canescens Variant. These species indicate the floristic relationship between the communities of the midslopes and the footslopes , and are also indicative of the well drained , relatively drier soils of these communities.

4.2 Panicum coloratum - Aristida bipartita Variant

This occurs in the bottom of the valley floors. The soils are relatively more moist than those of the Panicum coloratum - Aristida canescens Variant on the slightly raised footslopes. The soils are seasonally flooded , usually dark coloured (vertic or melanic) and clayey , representing the Rensburg , Arcadia and Bonheim Forms. The diagnostic species for this community are Berkheya radula , Aristida bipartita , Chloris virgata , Salvia radula , Aptosimum lineare , Setaria pallide-fusca , Hypoxis multiceps and Brachiaria euriciformis (Species group H , Table 1). Also of diagnostic value is the absence of species groups I , L and N of better drained conditions.

The dominant species are Themeda triandra , Eragrostis curvula and Panicum coloratum. Other species occurring in this community are the pioneers Geigeria burkei , Cynodon dactylon and Schkuhria pinnata. The presence of the dwarf karroid shrubs Felicia

muricata and Pentzia globosa as well as the presence of the annual weeds such as Schkuhria pinnata and Chamaesyce prostrata indicate the degraded condition of this community, and also relates to the karroo encroachment (desertification) in the vegetation of the D land type (Kooij et al., 1990a). An average of only 24 species was recorded per sample plot.

5. Acacia karroo - Protasparagus suaveolens River Thorn Veld.

This community occurs along banks of smaller, dry rivers and on other floodplains. The soils vary from dark coloured vertic or melanic soils of the Arcadia, Rensburg and Bonheim Forms to young or alluvial sandy soils of the Oakleaf and Dundee Forms. The diagnostic species for this community are Acacia karroo, Protasparagus suaveolens, Protasparagus laricinus, Grewia flava and Teucrium trifidum (Species Group J, Table 1). Also of local diagnostic value is the absence of species group M in this community. The dominant species are the woody tree Acacia karroo and the semi-woody shrub Protasparagus suaveolens. The most abundant grasses are Themeda triandra, Aristida congesta, Eragrostis curvula and Panicum coloratum. An average of 30 species was recorded per sample plot. This community is clearly related to other widely distributed Acacia karroo - dominated communities from various parts of the south and western Transvaal (Bredenkamp et al., 1978; Bredenkamp et al., 1989; Bredenkamp et al., 1989a) and the north western Orange Free State (Scheepers, 1975; Kooij et al., 1990b and 1990c).

Ordination.

In the scatter diagram (Figure 3) there is a distinct discontinuity in the distribution of the relevés. The recognized syntaxa are more or less restricted to a specific area in the scatter diagram. Different classes of discontinuity can be associated with the various land types , namely: The Maytenus heterophylla - Euclea crispa Shrubby Thornveld (T) , the Acacia karroo - Protasparagus suaveolens River Thorn Veld(R) and the Heteropogon contortus - Eragrostis racemosa (H) Grassland , all on the Fb map unit are located to the right of the scatter diagram whereas the Maytenus heterophylla - Euclea crispa Shrubby Thorn Veld (V) and the Panicum coloratum - Eragrostis curvula Bottomland Grassland (G) is situated in the centre of the scatter diagram (Figure 3). Within the Fb map unit a discontinuity between the Maytenus heterophylla - Protasparagus africanus Shrubby Thorn Veld (T) and the Acacia karroo - Protasparagus suaveolens River Thorn Veld (R) and the Heteropogon contortus - Eragrostis racemosa Grassland (H) can also be seen along the second axis of this ordination. The uniqueness of the Ehretia rigida - Rhus magalismsontanum Shrubby Thorn Veld on the Bc map unit is however indicated by the isolated position of this community along the third axis of ordination. The discontinuity between relevés of the Heteropogon contortus - Eragrostis racemosa community indicate some floristic variation within this Grassland. This floristic variation is associated with differences in land type.

Concluding remarks

The methodology of refining the results of a TWINSpan

classification by Braun - Blanquet procedures (Behr et al. , 1988) was successfully applied in this study. The plant communities recognized are considered to be ecologically interpretable , as they relate to specific environmental conditions. The results obtained with the Detrended Correspondence Analysis (DECORANA) (Hill , 1979) indicates a distinct ecological difference among the communities of the different land types.

The incorporation of the results of this phytosociological study with those of the A , D and B land types will enable a hierarchical syntaxonomy of the vegetation of the north western Orange Free State.

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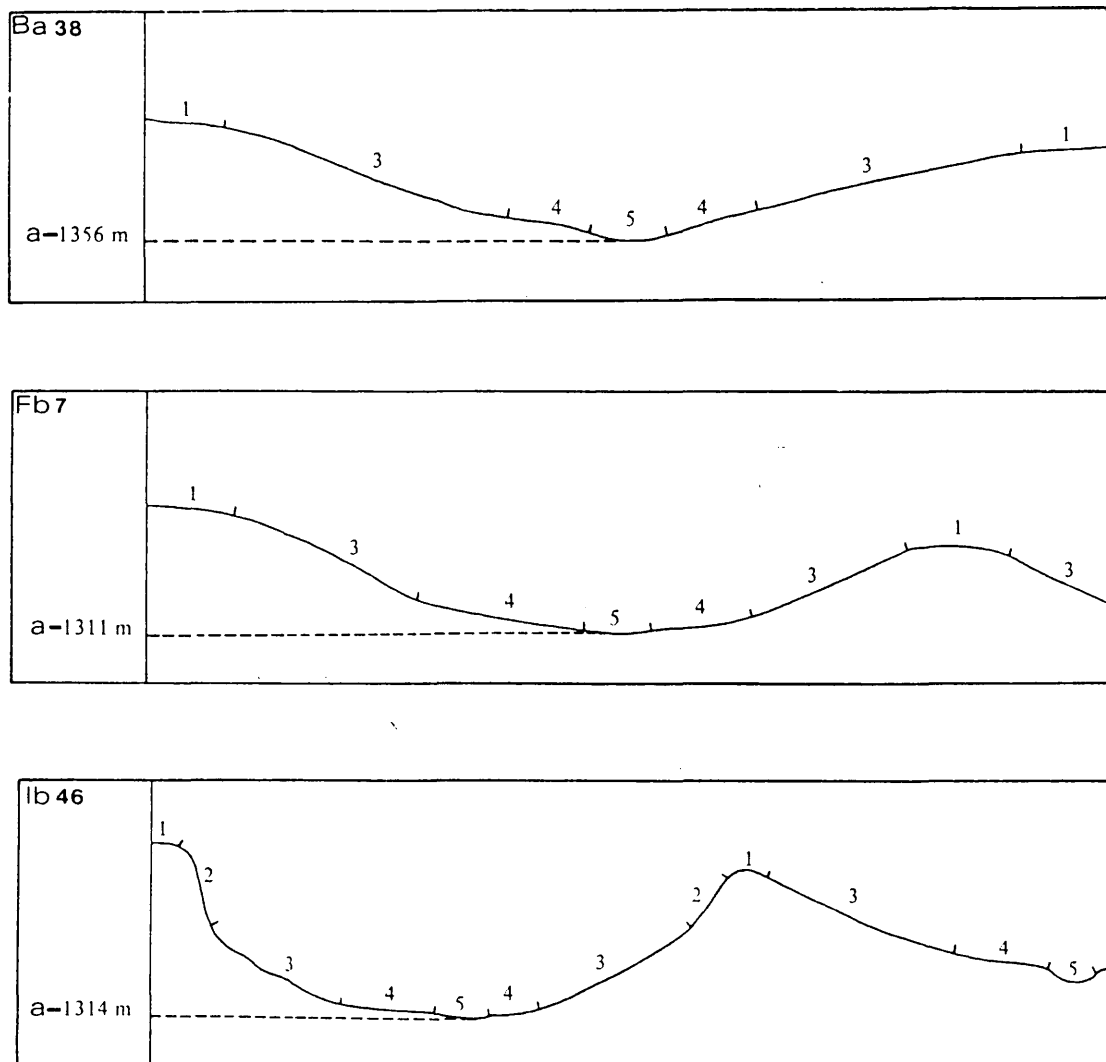


Figure 1. A schematical representation of the different terrain units in the study area (Land Type Survey Staff 1984).

- Legend: Terrain unit 1 - Crest
 2 - Scarp
 3 - Midslope
 4 - Footslope
 5 - Valley Bottomland or Floodplain
 a - Altitude

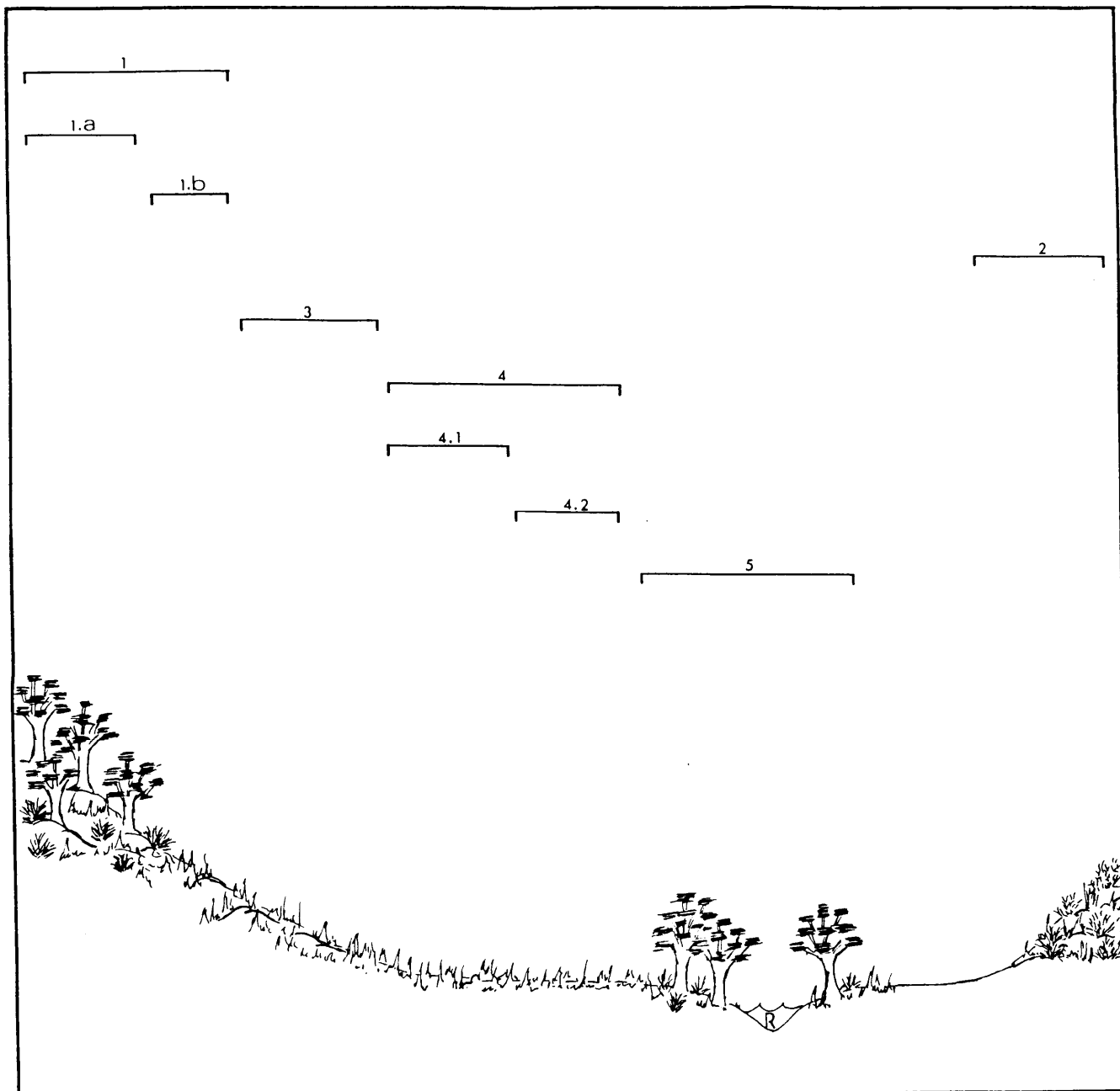


Figure 2. A schematic representation of the identified plant communities in the Ba , Fb and Ib land types.

Legend:

- R - River
- 1 - Maytenus heterophylla - Celtis africana Shrub Veld
- 1.a - Maytenus heterophylla - Euclea crispa Thorn Veld
- 1.b - Maytenus heterophylla - Protasparagus africanus Variation
- 2 - Ehretia rigida - Rhus magalismontanum Shrub Veld
- 3 - Heteropogon contortus - Eragrostis racemosa Grassland
- 4 - Panicum coloratum - Eragrostis curvula Bottomland Grassland
- 4.1 - Panicum coloratum - Aristida canescens Variant
- 4.2 - Panicum coloratum - Aristida bipartita Variant
- 5 - Acacia karroo - Protasparagus suaveolens River Thorn Veld

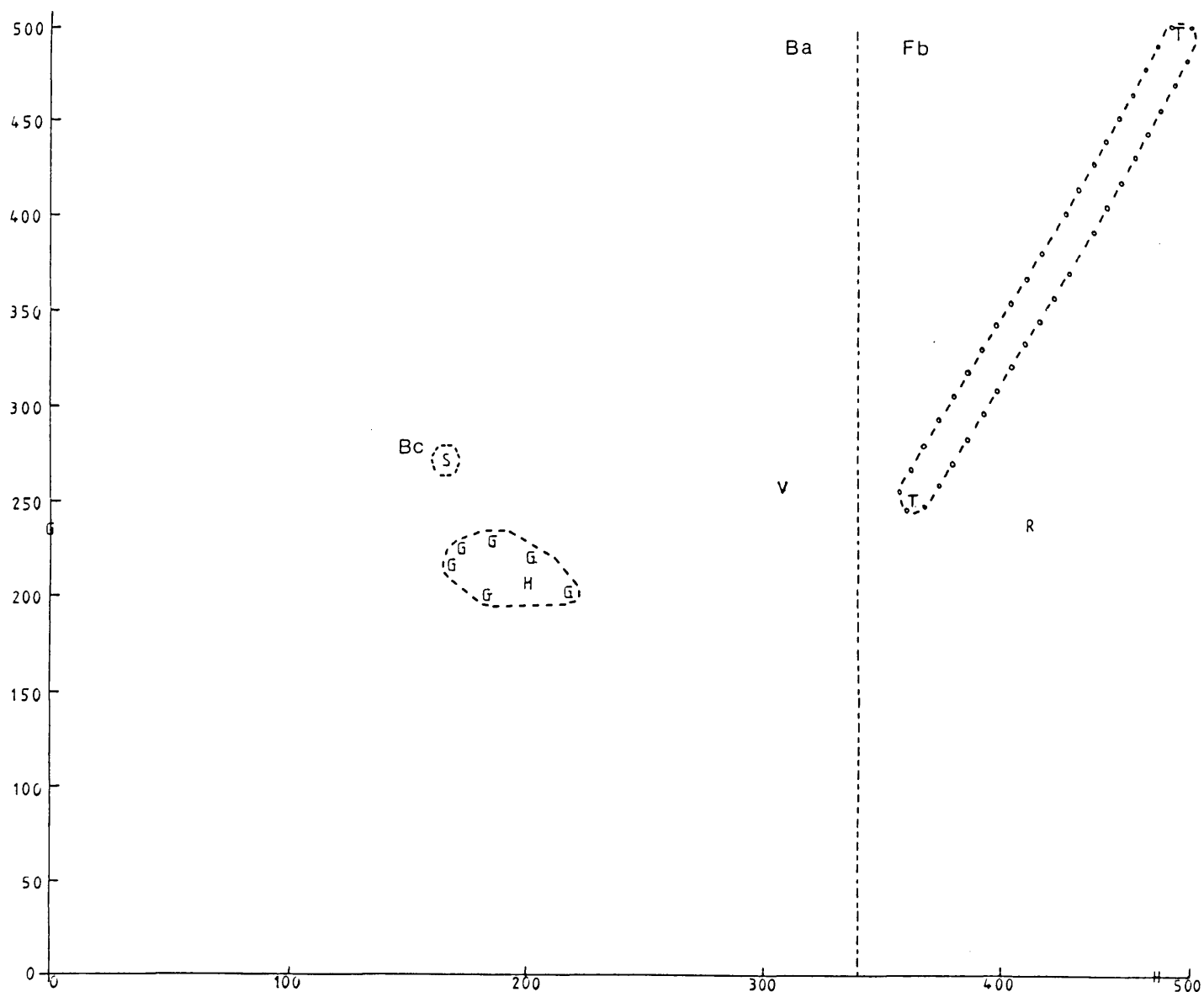


Figure 3 . An ordination of the vegetation on the hills and ridges in the study area.

Legend :

Community

- T - 1.a Maytenus heterophylla - Euclea crispa Shrubby Thornveld on the hills and ridges of the Fb map unit.
- V - 1.b Maytenus heterophylla - Protasparagus africanus Shrub Thornveld on the hills and ridges in the Ba map unit.
- S - 2 Ehretia rigida - Rhus magalismsontanum Shrub Veld On the hills in the Bc map unit.
- H - 3 Heteropogon contortus - Eragrostis racemosa Grassland.
- G - 4 Panicum coloratum - Eragrostis curvula Bottomland Grassland.
- R - 5 Acacia karroo - Protasparagus suaveolens River Thorn Veld.

CHAPTER 8

The plant communities of the Kroonstad area , Orange Free State 1 : Vlei and Bottomland communities.

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Abstract

Vegetation data from the Kroonstad area were analysed. The entire data set (235 relevés) was subdivided into two tabulation subsets by TWINSpan classification , followed by Braun - Blanquet procedures. One subset , representing the Vlei and Bottomland vegetation , was classified further by Braun - Blanquet procedures. Eight communities grouped into four major communities , were identified and described. The results can be integrated with existing phytosociological classifications of the north western Orange Free State.

Uittreksel

'n Ontleding van plantegroeidata vanaf die Kroonstad omgewing word aangebied. Die totale datastel (235 relevés) is in twee subdatastelle verdeel met behulp van 'n TWINSpan - klassifikasie , gevolg deur Braun - Blanquet prosedures . Een subdatastel wat die plantegroei van die Vleie en Laaglande verteenwoordig , is verder met behulp van Braun - Blanquet prosedures geklassifiseer. Agt plantgemeenskappe , wat vier hoofgemeenskappe verteenwoordig , is onderskei en bespreek. Die resultate kan geïntegreer word

met bestaande fitososiologiese klassifikasies van die noord - westelike Oranje Vrystaat.

Keywords: Braun - Blanquet , classification , Grassland Biome , plant communities.

Introduction

Scheepers (1975) classified the vegetation of the Kroonstad area by Association Analysis , a monothetic divisive classification technique (Gauch 1982). Association Analysis is based on the successive subdivision of vegetation samples into two groups according to the presence or absence of a single species. This process is repeated for a number of cycles in order to yield a hierarchy. The dividing species is that species having the maximum ability to separate one group or association of species from another association, implying the maximum sum of chi-squared values with all other species. Although Scheepers (1975) derived ecological interpretable vegetation types from the results of the Association Analysis , reconciliation of this classification with the comprehensive phytosociological classification of the north western Orange Free State (Kooij , Bredenkamp & Theron 1990b , c , d & e) is difficult if , not impossible , owing to major differences in the procedures and algorithms applied. Furthermore Coetzee & Werger (1975) showed that a polythetic Braun - Blanquet analysis of floristic data results in ecologically more reliable vegetation classes. Although the Association - Analysis algorithm utilises only presence / absence data , Scheeper's original data set comprised total floristic composition with Braun - Blanquet cover - abundance values for all identifiable species in the sample

plots. In order to utilize all existing compatible data in a phytosociological synthesis of the north western Orange Free State , a reclassification of Scheepers's data by Braun - Blanquet procedures was necessary. In this report the classification and description of the hygrophilous vlei and bottomland vegetation of the Kroonstad area are presented.

Study area

The study area is situated between 27°00' and 27°15'S latitude and 27°30' and 27°45'E longitude , in the Grassland Biome of the north western Orange Free State (Figure 1). This area comprises approximately 625 000 hectares. A detailed description of the physical environment of the area is given by Scheepers (1975), and is therefore not presented here.

Methods

In the semi - detailed ecological survey of the vegetation in the Kroonstad area , 235 relevès were made (Scheepers 1975). This inventory was intended to provide the basis for rational land use , larger scale planning and realization of the agricultural potential of the Highveld Region (Scheepers 1975). A 16m² quadrat was used and cover-abundance according to the standard Braun - Blanquet scale (Mueller - Dombois & Ellenberg 1974) of all species present were recorded. In the present study these data, were classified by means of a Two - Way Indicator Species Analysis (TWINSpan) (Hill 1979) and the resulting classification was refined by means of Braun - Blanquet procedures (Table 1). This procedure was shown to be effective by Behr & Bredenkamp

(1988) ; Bredenkamp et al. (1989) and Kooij et al. (1990b , c , d , e).

Results

Classification

General

On the basis of the major (first-level) division obtained by the above procedures, the entire phytosociological table was divided into two smaller tables , one containing 42 relevés (Table 1) , representing the vlei and bottomland communities , and the other containing 192 relevés (Kooij , Scheepers , Bredenkamp & Theron. 1990b) , representing grassland communities. A comparison of the classification of the total data set (Scheepers 1975) by Association Analysis and the present procedure is given in Table 2. The allocation of Scheepers's (1975) 13 major communities to these two tables is shown in Figure 2. The table representing the vlei and bottomland communities , includes 30 relevés from the Scheepers (1975) communities 2, 10, 11, 12, and 13 (Figure 3) while 12 relevés are from various other communities (Table 3). This table was refined by Braun - Blanquet procedure. A comparison of the classification of the 42 relevés representing vlei and bottomland communities by the present procedure and by Association Analysis is given in Table 3. In generally the vegetation can be considered as to be a Themeda triandra - Cynodon dactylon Grassland.

A hierarchical classification of the distinguished plant communities is the following:

1. The Echinochloa holubii - Cyperus longus Wetland
 - 1.1 The Echinochloa holubii - Diplachne fusca Vlei Grassland.

- 1.2 The Eragrostis plana Watercourse Grassland.
- 1.3 The Echinochloa holubii - Equisetum ramossissimum Riparian Grassland.
2. The Cynodon dactylon - Andropogon appendiculatus Dry Riparian Grassland.
3. The Acacia karroo - Protasparagus laricinus Thornveld.
 - 3.1 The Acacia karroo - Melica decumbens Bottomland Thornveld.
 - 3.1.1 The Acacia karroo - Celtis africana Ravine Thornveld.
 - 3.2 The Acacia karroo - Eragrostis chloromelas Upland Thornveld.
4. The Panicum coloratum - Pentzia globosa Disturbed Grassland.

Description of the communities.

1. The Echinochloa holubii - Cyperus longus Wetland.

This is a broad , major wetland community associated with permanently or seasonally wet watercourses , riverbanks , valley flats , flood plains and stream channels. The marginal soils vary from dark , vertic , clayey soils of the Rensburg Form to sandy , alluvial soils of the Oakleaf Form. The wet , marshy habitats are low in species composition. An average of 9 species was recorded per sample plot. The diagnostic species for this community are the hygrophilous Echinochloa holubii and Cyperus longus (Species group D , Table 1). The only other constantly present grass species is Cynodon dactylon , indicating the overgrazed and degraded state of the vegetation. The major community is divided into three communities , according to species composition and habitat differences.

- 1.1 Echinochloa holubii - Diplachne fusca Vlei Grassland

This Community relates to Community 12 of Scheepers (1975) (Table 3).

This community occurs on poorly drained , periodically inundated wetter parts of valley flats or flood plains of the Vals River and its tributaries. The soils are typically of the Rensburg Form , a hydromorphic vertic , black clay cracking deeply when dry. The basal cover usually varies from fairly good to poor , mostly rather poor (Scheepers 1975). This community is characterised by Species group A (Table 1) with the diagnostic species being Diplachne fusca , Senecio burchellii , Stachys hyssopoides and Crinum bulbispermum (Table 1). The vegetation is dominated by the grass species Diplachne fusca and Echinochloa holubii.

1.2 Eragrostis plana Watercourse Grassland

This community is identical to Community 13a of Scheepers (1975) (Table 3).

This community is associated with heterogeneous habitats on intermittently flowing watercourses or drainage lines , where the channel is choked with coarse to fine soil material. The substratum varies from sand to clay , but sandy alluvium of the Oakleaf Form predominates. The terrain is often disturbed because these areas are frequently used for artificial watering points and licks for cattle and sheep.

The diagnostic species for this community are the prominent grasses Eragrostis plana and Imperata cylindrica as well as the forbs Galium capense and Senecio inornatus (Species group B , Table 1). Other species conspicuous in this community include the dominant Cynodon dactylon and also Stachys hyssopoides , Crinum bulbispermum , Cyperus longus , Verbena officinalis and Andropogon

appendiculatus.

1.3 Echinochloa holubii - Equisetum ramossimum Riparian Grassland.
This community is identical to Community 13b of Scheepers (1975) (Table 3).

This community has a restricted distribution , being confined to the steep banks of the deeply incised Vals River and its tributary , the Blomspruit. The terrain is variously steep with slumped terraces. The Oakleaf Form of weakly stratified alluvial sandy soils is well drained at the upper surface layers and rather low in nutrients (Scheepers 1975). These sites are liable to periodic submersion , erosion , scouring and slumping , and deposition of fresh alluvium during floods. The vegetation is composed of species adapted to tolerate these conditions and to withstand the mechanical stress exerted by flood waters. The vegetation is heterogeneous and unstable owing to the instability of the habitat. The diagnostic species for this community are the prominent Hemarthria altissima and Equisetum ramosissimum and also Oenothera indecora , Polygonum lapathifolium , Verbena officinalis and Cyperus denudatus (Species group C, Table 1). Other species present are Echinochloa holubii and the dominant Cynodon dactylon.

2. Cynodon dactylon - Andropogon appendiculatus Dry Riparian Grassland.

This community relates to Community 11 (Cynodon dactylon - Setaria woodii Grassland) of Scheepers (1975) (Table 3).

This community occurs on drier riparian or bottomland situations.

The soils are typically the Rensburg Form with deeply cracking , vertic , calcareous and saline to alkaline dark clays , usually overwashed by sandy or silty material. Two communities occur from intermittent saturation to inundation conditions during wet periods to very dry conditions during the dry periods.

The diagnostic species for this community are Andropogon appendiculatus , Scabiosa columbaria , Berkheya radula , Haplocarpa scaposa and Falkia oblonga. Other species present are the tree Acacia karroo and the grasses Cynodon dactylon and Themeda triandra.

3. Acacia karroo - Protasparagus laricinus Thornveld.

In the Association Analysis hierarchy at the first division the dendrogram (Figure 3) was separated into two distinct communities , 2 and 10 , situated on upland and bottomlands respectively (Scheepers 1975). The present analysis indicates definite floristic relationships among these communities , and the Upland Thornveld (Scheepers 1975) is therefore included with the bottomlands in this phytosociological table. This major community is situated on the uplands as well as in the bottomlands along valley flats and steep streambanks. The Thornveld can be divided into three communities according to species composition and habitat differences. The diagnostic species for this community are Protasparagus laricinus , Acacia karroo and Teucrium trifidum (Species group F , Table 1). Other species constantly present are Melica decumbens , Maytenus heterophylla , Delosperma sutherlandii , Delosperma herbeum , Diospyros lycioides , Pentzia incana and Rhus pyroides and also Cynodon dactylon and Themeda triandra.

3.1 The Acacia karroo - Melica decumbens Bottomland Thornveld.

The Bottomland is Thornveld related to Community 10 of Scheepers (1975). This community is situated in the bottomlands along the valley flats , steep riverbanks or in ravines (see 3.1.1). The soils range from the vertic Rensburg Form to the Oakleaf Form via an intermediate Rensburg Form overlain with sand. These soils tend to be somewhat saline , especially the Rensburg soil Form. This bottomland thornveld also extends up the main tributary streams and minor drainage lines , and also in small kloofs and narrow ravines especially on the minor escarpment slopes facing south and east. The diagnostic species for this community are those of Species group G (Table 1) including Melica decumbens , Maytenus heterophylla , Delospermum sutherlandii , Delospermum herbeum , Diospyros lycioides , Pentzia incana and Rhus pyroides. Other species constantly present are Protasparagus laricinus , Acacia karroo , Teucrium trifidum , Cynodon dactylon and Themeda triandra. Species of Species group J occur in some relevés of this community. This species group, as well as Species group K , emphasizes the affinity , with the Acacia karroo - Eragrostis chloromelas Upland Thornveld (3.2).

3.1.1 The Acacia karroo - Celtis africana Ravine Thornveld.

This Variant of the Bottomland Thornveld is situated along narrow ravines and small kloofs. In the Scheeper's (1975) classification the relevés of the Ravine Thornveld are included in Community 10 , and not distinguished as a separate community. The diagnostic species for this community are (Species group H , Table 1) Celtis africana , Clematis brachiata , Achyranthes aspera , Ehretia rigida , Lycium oxycarpum , Coccinia sessilifolia

and Antizoma angustifolia. Other species constantly present include the woody Diospyros lycioides , Ziziphus mucronata , Rhus pyroides and Acacia karroo , Pentarrhinum insipidum , Melica decumbens , Protasparagus laricinus , Teucrium trifidum , Panicum coloratum , Atriplex semibaccata and Cynodon hirsutus.

3.2 Acacia karroo - Eragrostis chloromelas Upland Thornveld.

Association-Analysis (Scheepers 1975) classified most relevés of this Upland Thornveld under Community 2 (Corchorus asplenifolius - Cynodon hirsutus Thornveld , Table 3) , separated from the vlei and bottomland communities at the first division in the dendrogram (Figure 3).

This Thornveld is typically associated with extensive sheet and ledge outcrops of sandstone , and dolerite sills and dykes , on summits and structural terraces , plateaux , rocky ridges and koppies. The soils are generally shallow and rocky , black vertic clays of the Arcadia soil Form. This upland thornveld is generally used for beef - cattle farming. Under heavy stocking , the veld tends to break down and there is an invasion and increase of species such as Corchorus asplenifolius , Eragrostis obtusa , Sporobolus ioclados , Eragrostis barbinodis , Indigofera alternans , Aristida congesta and Digitaria argyrograpta. Reduction of the grass cover is accompanied by severe encroachment of Acacia karroo and Protasparagus laricinus as was found by Bredenkamp , Joubert & Bezuidenhout (1989) and Bredenkamp & Bezuidenhout (1990) in the western Transvaal (Table 1). The diagnostic species for this community are (Species group I , Table 1) Corchorus asplenifolius , Eragrostis

chloromelas , Aristida congesta , Sporobolus ioclados , Eragrostis barbinodis , Indigofera alternans , Anthericum fasciculatum and Hermannia coccocarpa. Species of Species group J are also mainly restricted to this community but may also occur in the bottomland thornveld. Other species constantly present are the grass species Panicum coloratum , Cynodon hirsutus , Eragrostis lehmanniana , Aristida congesta , Digitaria argyrograpta , Cynodon dactylon and Themeda triandra.

4. The Panicum coloratum - Pentzia globosa Disturbed Grassland. This community appears to be an outlier of the panveld vegetation of the north western Orange Free State (Kooij et al. 1990b.) , having strong floristic affinities with Acocks's (1988) Veld Type (51) "Pan Turf Veld" (Scheepers 1975). This community is not distinguished by Scheepers (1975) , the relevés are representative of his communities 2, 6 and 8. Of these Community 8 seems to be closely related to this disturbed grassland. The vegetation of this community has a distinct impoverished and somewhat specialized flora. The community occurs on brackish soils in bottomlands , pans and drier vleis between relic dunes. This community is characterised by the presence of fairly widely distributed individual of Species group K and the simultaneous absence of Species groups F, G, H, I, J and L. Constantly present species are the grass species Panicum coloratum , Cynodon hirsutus and Eragrostis lehmanianna and the halophytic and suffrutices karroid Atriplex semibaccata and Pentzia globosa. On these brackish to alkaline soils , the veld should provide highly palatable and nutritious grazing , but productivity is normally low , owing to the limiting effects of high salinity and alkalinity levels on the utilization of

soil moisture. There is a tendency to overstock this sweet bottomland grassland especially with sheep , which utilise the most palatable and nutritious grasses by opening up areas for encroachment by the dwarf halophytic shrub Atriplex semibaccata and the karroid shrub Pentzia globosa.

Conclusion

Using Association - Analysis , (Scheepers 1975) identified 13 major communities (Figure 3 , Table 3) that were subdivided into 25 sub-communities ("minor communities" of Scheepers 1975). Five of these major communities seven sub-communities) are characteristic of the vleis and bottomlands described in this report. In the present classification eight communities , grouped into four major communities were identified. In general , easily distinguishable major plant communities with unique species compositions were recognized by both the Association Analysis and the present procedures using TWINSpan and Braun - Blanquet analyses. However , in subdividing these , the polythetic methods gave ecologically better interpretable classes. The results of this classification of the Kroonstad data (Scheepers 1975) are reconcilable with that of Kooij , et al. (1990b , c , d , e & f) and incorporation will permit a synthesis and formal syntaxonomical classification of the vegetation of the north western Orange Free State.

Acknowledgement

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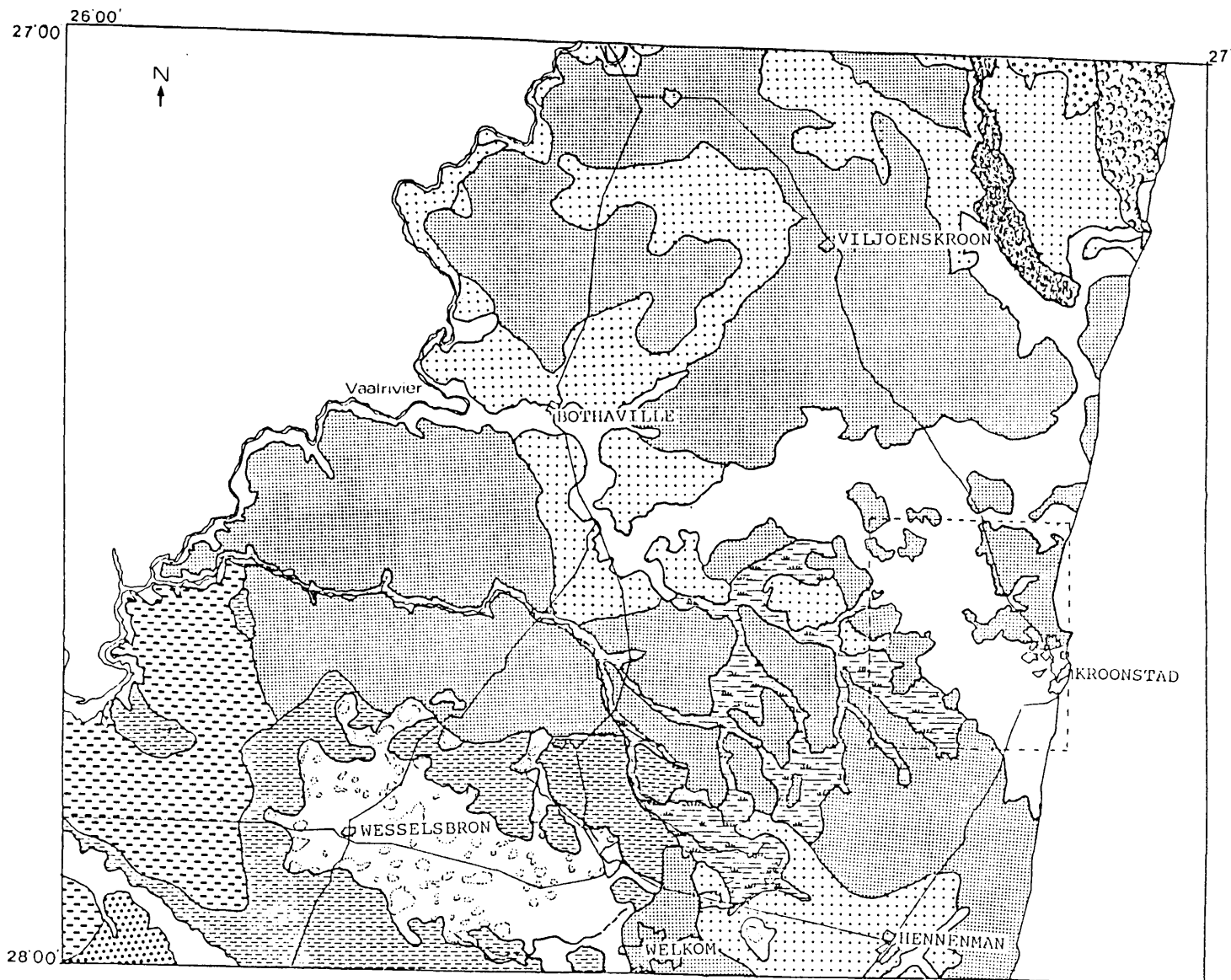











Figure 1. A map indicating the location of the Scheeper's study area (1975) in the north western Orange Free State.

Legend

-   A - Land Type = Ae and Ai
-   B - Land Type = Ba , Bc and Bd
-   D - Land Type = Db and Dc
-  F - Land Type = Fb
-  I - Land Type = Ib
-  - Portion studied by Scheepers (1975)

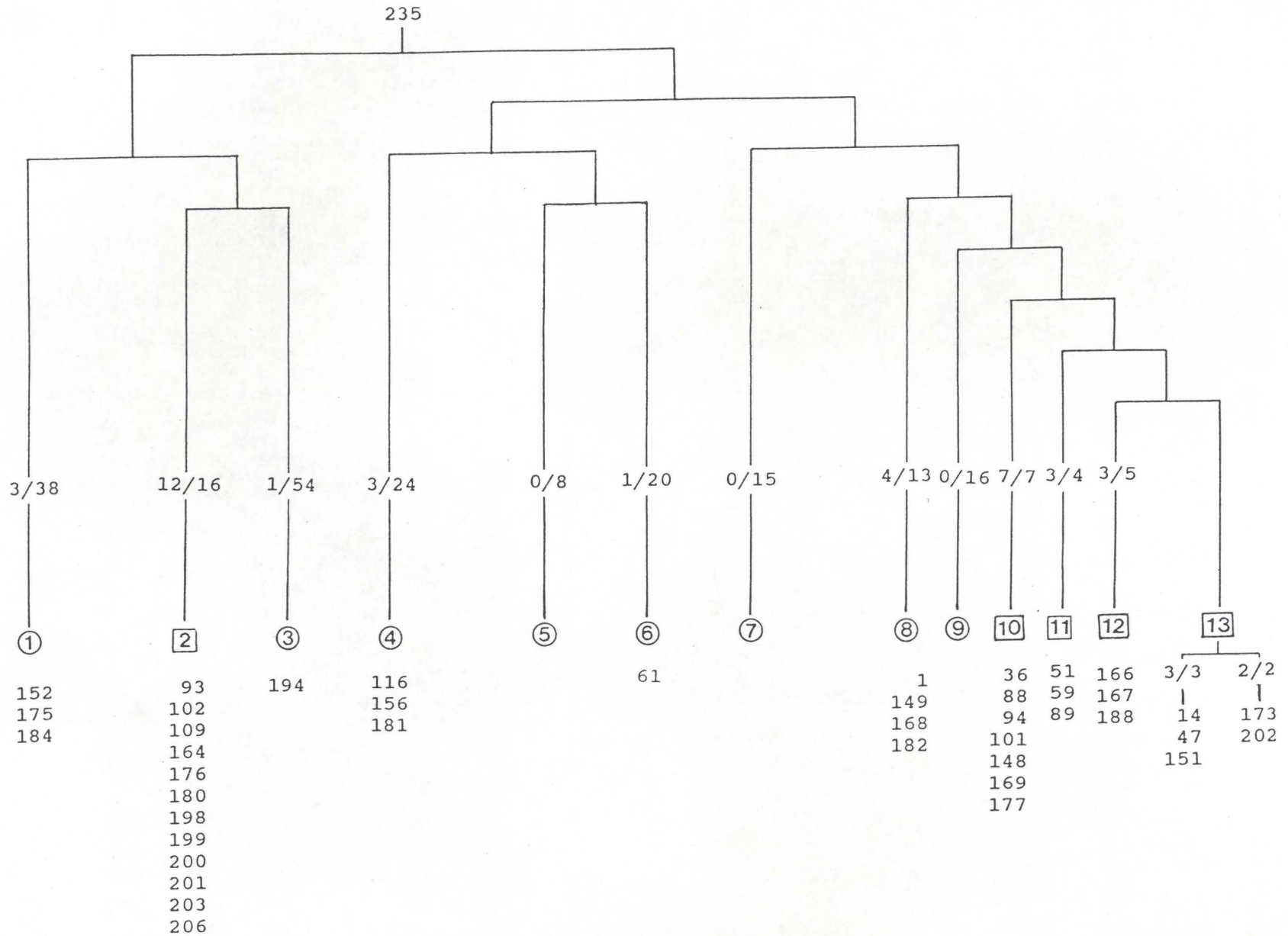


Figure 2. A dendrogram of the Association Analysis of the Kroonstad area vegetation described by Scheeper's 1975.

□ Table 1 - The Vlei and Bottomland Communities (Table 1)

○ Table 2 - The Grassland Communities (Table 1) (Kooij et al. 1990f)

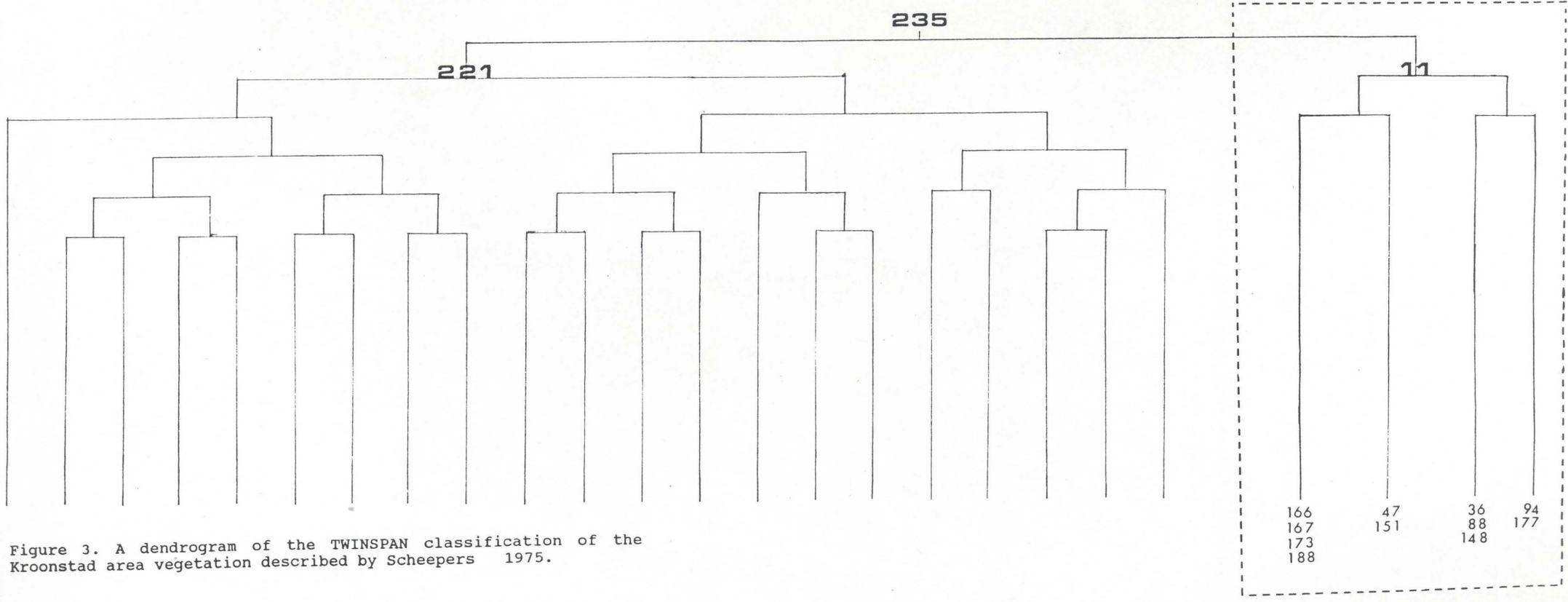


Figure 3. A dendrogram of the TWINSpan classification of the Kroonstad area vegetation described by Scheepers 1975.

Table 1. A phytosociological table of the vlei and bottomland communities of the Kroonstad area.

Communities	1			2			3			4				
	1.1	1.2	1.3	3.1			3.2							
				3.1.1										
	0111	12	001	00	01	01111211	21111112110111102	0011						
	8668	70	415	55	97	80468065	06899980703781590	0604						
	9678	32	741	19	47	81891186	04089443626526236	1199						

-143-

Species group A

Diplachne fusca 2454
Senecio burchellii 2 1
Stachys hyssopoides + 2 2
Crinum bulbispermum 31 1

Species group B

Eragrostis plana 2 33
Galium capense 1
Senecio inornatus 3
Imperata cylindrica 2

Species group C

Hemarthria altissima 2+1
Equisetum ramosissimum 1+2
Oenothera indecorus +++
Polygonum lapathifolium ++
Verbena officinalis 2 ++
Cyperus denudatus 4

Species group D

Echinochloa holubii 212
Cyperus longus 1+ ++ +

Species group E

Andropogon appendiculatus 3
Scabiosa columbaria 12
Berkheya radula 21
Haplocarpha scaposa 11
Falkia oblongata 1+
 ++

Species group F

Protasparagus laricinus 34 | 3534253 | +2232+12224+ 1++
Acacia karroo 2 | 42 | 13543342 | +52232 242+22
Teucrium trifidum + | +4 211 | + 2+ +

Species group G

Melica decumbens 2 | 1331213
Maytenus heterophylla 22 | 22
Delosperma sutherlandii | 21
Delosperma herbeum | 3 2 3+ +
Diospyros lycioides 33 | +2
Pentarrhinum insipidum + | 1 1

<i>Setaria flabellata</i>									+	2	1	+							1			
<i>Geigeria aspera</i>									+	+			+						++			
<i>Gazania krebsiana</i>																			+	+		+
<i>Pterodiscus speciosus</i>									+			++										
<i>Scilla species</i>									+		+											+
<i>Heteropogon contortus</i>												+							+	+		
<i>Solanum supinum</i>																						
<i>Pollichia campestris</i>										+												1
<i>Barleria macrostegia</i>												+	+									
<i>Lycium species</i>									+													
<i>Ruschia hamata</i>										+												+
<i>Commicarpus pentandrus</i>																						+
<i>Commelina africana</i>									+			++										+

Species with an occurrence of < 2 have been omitted.

Table 2. A statistical comparison of the present classification method and the Association Analysis.

	<u>Braun - Blanquet</u>				<u>Total</u>
	<u>Vlei & Bottomlands</u>		<u>Table</u>		
			<u>Grasslands</u>		
<u>Communities</u>					
<u>Association</u>	2 + 10 -13	30		13	43
<u>Analysis</u>	1 + 3 - 9	12		179	191
		42		192	234

$$\frac{30}{42} \times \frac{100}{1}$$

= 71,4%

Table 3. A comparison of the location of the relevés of the Association Analysis and the present classification method.

		<u>Association - Analysis</u>													<u>Total</u>	
<u>Community numbers</u>		1	2	3	4	5	6	7	8	9	10	11	12	13		a
<u>Braun-</u>	1.1	*	*	*	*	*	*	*	*	*	*	1	3	*	*	4
<u>Blanquet</u>	1 1.2	*	*	*	*	*	*	*	*	*	*	*	*	2	*	2
	1.3	*	*	*	*	*	*	*	*	*	*	*	*	*	3	3
	2	*	*	*	*	*	*	*	*	*	*	2	*	*	*	2
	3.1	*	1	*	2	*	*	*	1	*	6	*	*	*	*	10
	3	3.2	3	10	1	1	*	*	*	1	*	1	*	*	*	17
	4	*	1	*	*	*	1	*	2	*	*	*	*	*	*	4
<u>Total for this table.</u>		3	12	1	3	0	1	0	4	0	7	3	3	2	3	42
<u>Other communities</u>		35	4	53	21	8	19	25	9	16	0	2	1	0	0	192
<u>Total relevés</u>		38	16	54	24	8	20	25	13	16	7	5	4	2	3	235

CHAPTER 9

The vegetation of the Kroonstad area : A description of the Grassland communities.

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Abstract

A phytosociological analysis of the Grassland vegetation data from the Kroonstad area (Scheepers 1975) is presented. The data set (193 relevés) was classified by TWINSPAN , and refined by Braun - Blanquet procedures. Ten communities , grouped into four major communities , were identified and described.

Uittreksel

'n Fitososiologiese analise van grasveld data van Kroonstad omgewing (Scheepers 1975) word gegee. Die datastel bestaande uit 193 relevés is deur TWINSPAN - geklassifiseer en die resultaat deur Braun - Blanquet prosedures verfyn. Tien plantgemeenskappe , wat in vier hoofgemeenskappe gegroepeer kan word is geïdentifiseer en beskryf.

Keywords: Braun - Blanquet method, classification , Grassland Biome , phytosociology , plant communities.

Introduction

Association - Analysis , a monothetic divisive classification technique (Gauch 1982) , was used by Scheepers (1975) , to

classify the vegetation of the Kroonstad area. This technique is based on the subdivision of vegetation samples into two groups according to the presence or absence of a single species. This procedure is repeated for a number of cycles in order to yield a hierarchy. The division species chosen is that species with the maximum ability to separate one group or association of species from another, defined on the criterion that it is characterised the maximum sum of chi-squared values with all other species. Vegetation classes derived from Association Analysis are often not reconcilable with classes obtained from polythetic or Braun - Blanquet techniques, and inclusion of these classes in comprehensive phytosociological and syntaxonomic studies is difficult or impossible. Coetzee and Werger (1975) showed that polythetic Braun - Blanquet analyses of floristic data result in ecologically more reliable vegetation classes than those derived from monothetic techniques. Although the Association Analysis algorithm utilizes only presence-absence data, Scheepers's original data set comprized total floristic composition with Braun - Blanquet cover - abundance values for all identified species. The aim of this paper is to reclassify the floristic data from the Kroonstad area, by means of polythetic techniques and Braun - Blanquet procedures, to contribute towards a synthesis of all vegetation data from the north western Orange Free State (Kooij, Bredenkamp & Theron 1990b, c, d & e; Kooij, Scheepers, Bredenkamp & Theron 1990a).

Study area

The study area is situated between 27°00' and 27°15' S latitude and 27°30' and 27°45' E longitude, in the north western Orange

Free State in the Grassland Biome (Figure 1). This area comprises approximately 625 000 hectares. A detailed description of the physical environment of the area is given by Scheepers (1975).

Methods

A semi-detailed ecological survey of the vegetation of the Kroonstad area was undertaken by Scheepers (1975). This ecological survey was intended to provide a basis for rational land use, larger scale planning and realization of the agricultural potential of the region (Scheepers 1975). The vegetation was sampled by 235 relevés, each relevé being a 16m² quadrats. All species present were recorded and the data were analysed by Association - Analysis (Scheepers 1975). In the present study this data set was reclassified by using Two - Way Indicator Species Analysis (TWINSPAN) (Hill 1979) and the resulting classification was refined by means of Braun - Blanquet procedures (see also Behr & Bredenkamp 1988 ; Bredenkamp et al. 1989 ; Kooij et al. 1990b ,c ,d & e). Based on the major division obtained by this procedure, the entire phytosociological table was subdivided into two smaller phytosociological tables, one representing the vlei and bottomland communities being published elsewhere (Kooij, Scheepers, Bredenkamp & Theron 1990a). The other representing grassland communities, is presented here and a description of the grassland communities is given in this paper.

Results

A comparison of the classification of relevés by Association Analysis and the present classification is given in Table 2. From

Table 2 and Figure 2 it can be derived that the grassland communities are represented by Association Analysis group / combinations 1 , and 3 to 9. Vlei and bottomland communities are represented by Association Analysis groups 2 and 10 - 13 (Kooij, Scheepers , Bredenkamp & Theron 1990a). The allocation of relevés from the grassland communities to Association Analysis groups are given in Figure 2.

In general , the vegetation of the area can be considered to be a Themeda triandra - Panicum coloratum Grassland. A hierarchical classification of the grassland communities is the following:

1. Themeda triandra - Aristida bipartita Grassland
 - 1.1 Aristida bipartita - Trichoneura grandiglumis Variant
2. Nananthus transvaalensis - Panicum coloratum Grassland
 - 2.1 Panicum coloratum - Euphorbia pseudotuberosa Variant
3. Felicia muricata - Eragrostis chloromelas Disturbed Grassland
 - 3.1 Felicia muricata - Pentzia globosa Disturbed Grassland
 - 3.1.1 Felicia muricata - Eragrostis barbinodis Variant
 - 3.1.2 Felicia muricata - Eragrostis obtusa Variant
 - 3.1.3 Felicia muricata - Pentzia globosa Variant
 - 3.2 Felicia muricata - Setaria flabellata* Disturbed Grassland
 - 3.2.1 Felicia muricata - Elionurus muticus Variant
 - 3.2.2 Felicia muricata - Eragrostis trichophora Variant
4. Themeda triandra - Eragrostis chloromelas Valley Grassland
 1. The Themeda triandra - Aristida bipartita Grassland.

This community relates in part to Community 3 of Scheepers (1975) (Corchorus asplenifolius - Panicum coloratum Grassland)

* In this text the binomial Setaria flabellata is used to indicate Setaria sphacelata subsp. flabellata

and especially Community 3.2 Corchorus asplenifolius - Salvia burchellii Minor Community) (Table 2). However, this community of Scheepers is floristically heterogeneous, owing to heterogeneous habitat conditions. The 54 relevés of his Community 3 are dispersed among several communities identified by Braun - Blanquet procedures (Table 2).

The Themeda triandra-Aristida bipartita Grassland is associated with the dry plateau edges. These sites are usually situated on shallow, deeply cracking, blocky structured, black vertic, droughty soils of the Arcadia Form (Arcadia Series) often associated with dolerite. The veld is usually selectively and patchily overgrazed and trampled. The diagnostic species for this community are Hermannia depressa, Aristida bipartita, Osteospermum muricatum, Scabiosa columbaria, Anthospermum rigidum, Helichrysum rugulosum and Barleria macrostegia (species group A, Table 1). Prominent species are Themeda triandra, Panicum coloratum, Eragrostis chloromelas and Heteropogon contortus. Other prominent species, constantly present, are the grass species Elionurus muticus, Digitaria argyrograpta, Aristida congesta, Setaria flabellata, Cymbopogon plurinodis, Eragrostis superba, and Eragrostis lehmanniana and the karroid shrub Felicia muricata. Other species are listed mainly in species group G, H, I & J (Table 1). This veld evidently should be dominated by Themeda triandra with a high basal cover (Scheepers 1975). However, under a régime of light to selective overgrazing the basal cover has been lowered. Themeda triandra has yielded dominance to Cymbopogon plurinodis, Eragrostis chloromelas, Setaria flabellata and Aristida congesta

, and eventually to karroid species such as Pentzia globosa and Felicia muricata.

A variant of this community can be distinguished namely

1.1 The Aristida bipartita - Trichoneura grandiglumis Variant.

This Variant is akin to the Community 5 (Eragrostis superba - Trichoneura grandiglumis Grassland) concept of Scheepers (1975) (Table 2). This Variant occurs on moderately deep , leached , loose sandy soils of the Kroonstad Form , but it may also occur on reddish apedal soils of the Hutton Form as well as red structured soils of the Shortlands Form. Chimney-building termite species , typical of sandy soils , are commonly found in this habitat (Scheepers 1975).

The diagnostic species for this community are Tolpis capensis , Thesium species , Trichoneura grandiglumis , Hibiscus microcarpus and Mariscus capensis. Dominant species , constantly present , are the grass species Elionurus muticus , Setaria flabellata , Cymbopogon plurinodis , Eragrostis superba , Themeda triandra , Eragrostis chloromelas and Heteropogon contortus.

Other species are listed in Species Groups H, I, & J (Table 1). Owing to the sandier leached soils , the grazing is less sweet than that of the Themeda triandra - Aristida bipartita grassland and there is less overstocking (Scheepers 1975).

2. The Nananthus transvaalensis - Panicum coloratum Grassland.

This grassland community relates mainly to Community 1 (Corchorus asplenifolius - Nananthus transvaalensis Grassland) of Scheepers (1975). Some of the relevés classified under Scheepers's Communities 3 , 7 and 8 are also included in the Nananthus transvaalensis - Panicum coloratum Grassland.

This community covers extensive areas , occurring on the flat to slightly sloping peneplains and adjacent pediplains and lower pediment slopes within the study area. On upland , areas the soils vary from the Arcadia Form (Gelykvlakte Series) via the Estcourt to the Kroonstad Form. The Rensburg Form dominates in bottomland situations. In general , the soil environment is typified by droughty , calcareous , dark , vertic clays , commonly poorly drained (Scheepers 1975). Serious problems with veld deterioration on Arcadia Forms (Gelykvlakte Series) arise from the crusting properties of these soils. Compaction of Gelykvlakte Series soils under denudation and trampling cause serious deterioration , once this crust formation has passed beyond a certain threshold of severity. The veld has a great recovery potential if site degradation is not too far advanced. However ,if degradation continues beyond the critical threshold , crusting leads to the formation of a surface seal , resulting in minimal infiltration of water and therefore greatly reduced effectiveness of rainfall. These xeric conditions weaken the perennial grasses , especially under conditions of continuous grazing , leading to partial replacement by more drought-hardy grasses , forbs and karoo bushes. This process eventually leads to the formation of a secondary karoo type of vegetation characterised by low basal cover and prominence of Pentzia globosa , Pentzia incana , Pentzia calcarea , Felicia muricata and Chrysocoma ciliata.

The diagnostic species for this community are the grass Oropetium capense and the forbs Trachyandra asperata , Convolvulus sagittatus, Indigofera alternans, Lycium cinereum ,

Dipcadi viride , Gerbera ambigua and Duthiastrum linifolia , as well as the succulent Nananthus transvaalensis. Themeda triandra is often dominant. Other species conspicuously present are Eragrostis barbinodis , Corchorus asplenifolius , Albuca setosa and Geigeria aspera. Other species are listed mainly under species groups E , F , G , H , I and J (Table 1).

It would seem that with continued overgrazing and harvester termite infestation , especially on the more clayey soils of Arcadia Form (Gelykvlakte Series) , dominance shifts successively from Themeda triandra to Panicum coloratum , and to Eragrostis chloromelas and then to Sporobolus ioclados var. usitatus. These stages in the retrogression of originally good stands of Themeda veld are not , at first , accompanied by marked reduction in basal cover as prominence is assumed by one grass at the expense of another. However , the productivity and palatability of the pasture drops steadily with retrogression. Despite its high basal cover and palatability, Panicum coloratum produces a smaller mass of herbage than Themeda triandra. Eragrostis chloromelas produce relatively small quantities of forage of indifferent to poor quality. Sporobolus ioclados var. usitatus may have a high basal cover , but it produces little herbage. Together with grasses species of Cynodon and Aristida , dominance by Sporobolus ioclados var. usitatus represents the last perennial grass stage before the veld commences to break down to a critical level of denudation and degradation. This critical threshold level is heralded by the incursion of short-lived grasses , karoo bushes and weeds , such as Aristida

species , Chloris virgata , Tragus racemosus , Pentzia globosa , Chrysocoma ciliata , Chamaesycoides inaequilatera and Nidorella resedifolia. If site degradation continues beyond this critical threshold , it may be extremely difficult or impossible to reverse the trend , except by applying costly measures.

2.1 The Panicum coloratum - Euphorbia pseudotuberosa Variant.

This Variant represents a less degraded stage of the Nananthus transvaalensis - Panicum coloratum Grassland. Although degradation of the vegetation is also evident , Themeda triandra has high cover-abundance and constancy values , and karoo encroachment is less conspicuous. The diagnostic species for this variant are the grass species Sporobolus discosporus , the forbs' Euphorbia pseudotuberosa , Hermannia coccocarpa , Pterodiscus speciosus , Oxalis depressa and Hypoxis argenteus (Species Group D). Other species constantly present are the grass species Eragrostis barbinodis , Eragrostis obtusa and the dominant grass species Themeda triandra , Panicum coloratum , Eragrostis chloromelas and Heteropogon contortus.

3. Felicia muricata - Eragrostis chloromelas Disturbed Grassland.

This community shows affinities with Communities 3 , 4 , 6 , 7 and 9 of Scheepers (1975) (Table 2).

This major grassland community represents various stages of degradation of the grasslands in the north western Orange Free State. It is widespread , on summits , plateaux and pediment slopes. The soils vary from the red structured Shortlands to the vertic Arcadia Forms. The community is recognized by the presence

of Species Group I and simultaneous absence of Species Groups A and C (Table 1). The dominant species of this major community are the grass species Themeda triandra , Panicum coloratum and Eragrostis chloromelas but Digitaria agyrograpta , Aristida congesta , Setaria flabellata , Cymbopogon plurinodis , Eragrostis superba , and Cynodon dactylon and the forbs Hibiscus pusillus and Blepharis integrifolia as well as the karroid shrubs Felicia muricata and Pentzia globosa are conspicuously present.

3.1 Felicia muricata - Pentzia globosa Disturbed Grassland

This community relates mainly to Communities 3 (Corchorus asplenifolius - Panicum coloratum Grassland) and 4 (Eragrostis superba - Cynodon dactylon Grassland) of Scheepers (1975). This community is found over a wide range of habitat situations varying from pediment slopes , plains , structural terraces and plateaux. The vegetation of this community is usually lightly to selectively overgrazed. This community is distinguished from other communities by the absence of Species Groups A to D and the presence of species group G (Table 1). Three Variants can be recognized:

3.1.1 Felicia muricata - Eragrostis barbinodus Variant

This Variant relates partially to Community 3 (Corchorus asplenifolius - Panicum coloratum Grassland) and especially 4 (Eragrostis superba - Cynodon dactylon Grassland) of Scheepers (1975).

This community typically occurs on shallow , somewhat sandy soils of the Kroonstad Form (shallow phase of the Kroonstad Series) , Hutton Form (Shorrocks Serie) and Oakleaf Form (Jozini Serie). It may also be present on the Arcadia Form (Gelykvlakte Serie) where

a sandy topsoil is present. Although variations occur, the typical sites appear to lie in minor topographic depressions in the depositional sandy plain landscape. Particularly characteristic are sites where the sandy overburden is partially stripped by erosion and the underlying rock, stones or hard clayey subsoil is near the surface. The continued existence of grassland on these sites is owing to their being non-arable, because of the shallow stony soils.

Within the Felicia muricata - Eragrostis chloromelas Disturbed Grassland, this Variant is identified by the presence of Species Group E, the prominence of Cynodon dactylon, and the presence of Chrysocoma ciliata (Table 1). Cynodon dactylon is invariably present to dominant, suggesting enhanced nitrogen status owing to biotic factors, such as dung and urine effects and, possibly termite infestation (Scheepers 1975, Breznak et al. 1973, Lee & Wood 1971 and Murray 1938). Dominant species of this community are the grass species Panicum coloratum, Eragrostis chloromelas, with Cynodon dactylon, and, locally in patches, Themeda triandra. Other prominent species include Eragrostis barbinodis, Microchloa caffra, Eragrostis obtusa and Sporobolus ioclados and the karroid shrubs Pentzia incana and Atriplex semibaccata as well as the geophyte Bulbine narcissifolia. Other species constantly present are Corchorus asplenifolius, Pentzia globosa, Geigeria aspera, Aptosimum depressum, Felicia muricata, Hibiscus pusillus, Blepharis integrifolia, Anthericum fasciculatum, Eragrostis superba and Eragrostis trichophora.

3.1.2 Felicia muricata - Eragrostis obtusa Variant

This Variant relates partially to Community 3 (Corchorus asplenifolius - Panicum coloratum Grassland) of Scheepers (1975). This Variant is usually situated on the flat pediment slopes. The Arcadia Form predominates, often covered by a sandy layer. This Variant is slightly to severely overgrazed in places as well as being infested by termites. It is distinguished from the other variants by the presence of Species Group F and the absence of Species Group E (Table 1). Dominant species of this Variant are the grass species Themeda triandra, Panicum coloratum and Eragrostis chloromelas with Eragrostis obtusa and Sporobolus ioclados also prominent. Other species constantly present are Corchorus asplenifolius, Pentzia globosa, Geigeria aspera, Aptosimum depressum, Gazania krebsiana, Felicia muricata, Hibiscus pusillus, Blepharis integrifolia and Digitaria argyrograpta.

3.1.3 Felicia muricata - Pentzia globosa Variant

This Variant also relates mainly to Community 3 (Corchorus asplenifolius - Panicum coloratum Grassland) of Scheepers (1975). This Variant is also found over a wide range of habitat situations, varying from structural terraces, plateaux and pediment slopes. The black vertic soils of the Arcadia and Rensburg Forms are predominant. The veld is selectively and closely grazed to locally overgrazed, and is sometimes subjected to heavy trampling. This Variant is defined by the presence of Corchorus asplenifolius and Pentzia globosa (Species Group G) and the absence of species groups E and F. Dominant species are the grasses Themeda triandra, Panicum coloratum, Eragrostis

chloromelas and Heteropogon contortus. Other conspicuous species constantly present are the grass species Elionurus muticus , Digitaria argyrograpta , Aristida congesta , Setaria flabellata , Cymbopogon plurinodis , Eragrostis superba , the forbs Geigeria aspera , Aptosimum depressum , Hibiscus pusillus and Blepharis integrifolia as well as the karroid shrub Felicia muricata.

3.2 Felicia muricata - Setaria flabellata Disturbed Grassland.

This community relates mainly to Communities 6 (Eragrostis superba - Trichoneura grandiglumis Grassland) , 7 (Anthericum fasciculatum - Geigeria aspera Grassland) and 9 (Eragrostis chloromelas - Eragrostis plana Grassland) of Scheepers (1975). It is mainly situated on pediment slopes. The soils vary from black clayey soils of the Arcadia and Rensburg Forms to the Kroonstad Form as well as lithosols. Common physical factors of the environment are the shallowness , sandiness and relatively high base status of the surface soil. In respect of the physical factors , the habitats are similar to those of Community 1.1 (Aristida bipartita - Trichoneura grandiglumis Variant (from which , in some cases , this community appears to be derived) and Community 3.1.1 (Felicia muricata - Eragrostis barbinodis Variant). The veld condition of this community is poor owing to secondary disturbing factors. This Variant appears to have arisen on shallow or litholic soil sites unsuitable or marginal for cultivation and has , therefore , been used as grazing land for livestock. It is usually less overstocked , but sometimes understocked and selectively grazed (Scheepers 1975).

This community is characterised by the absence of species Group G

and the presence of Species Group I. Two variants are recognized:

3.2.1 Felicia muricata - Elionurus muticus Variant

This variant is mainly akin to Communities 6 (Eragrostis superba - Eragrostis chloromelas Grassland) and 7 (Anthericum fasciculatum - Geigeria aspera Grassland) of Scheepers (1975).

This variant is mainly situated on the upper pediment slopes. A common physical factor of the environment are the shallow , sandy nature and relatively high base status of the surface soil , usually of the Kroonstad Form or lithosols. The poor condition of this variant is mainly caused by secondary disturbing factors , including compaction due to trampling by livestock and game as well as by machinery and implements. Within the Felicia muricata - Setaria flabellata grassland this variant is recognized by the presence of Species Group H (Table 1) , including the prominent grass Elionurus muticus , the forbs Geigeria aspera and Aptosimum depressum. Other species prominently present are the grass species Digitaria argyrograpta , Setaria flabellata , Cymbopogon plurinodis , Eragrostis superba , Panicum coloratum and Heteropogon contortus , the forbs Hibiscus pusillus and Blepharis integrifolia , as well as the karroid shrub Felicia muricata.

3.2.2 Felicia muricata - Eragrostis trichophora Variant

This variant is related in part to Communities 6 (Eragrostis superba - Eragrostis chloromelas Grassland) , 7 (Anthericum fasciculatum - Geigeria aspera Grassland) and 9 (Eragrostis chloromelas - Eragrostis plana Grassland) of Scheepers (1975).

This variant is situated mainly on pediment slopes and plains. The soils vary from the black clayey soils of the Arcadia and

Rensburg Forms to the Kroonstad Form as well as lithosols. This variant is severely overgrazed and trampled owing to its restricted distribution near watering points. Within the Felicia muricata - Setaria flabellata Grassland, this variant is recognized by the absence of Species Group H (Table 1). Only the widespread species of Species Groups I and J are present. Dominant species are Themeda triandra, and Eragrostis chloromelas. Other prominent species for this variant are the grass species Setaria flabellata, Cymbopogon plurinodis, Panicum coloratum, Heteropogon contortus, Cynodon dactylon, Eragrostis superba, Eragrostis trichophora and Eragrostis lehmanniana and the forb Hibiscus pusillus.

4. The Themeda triandra - Eragrostis chloromelas Grassland.

This community relates to Community 9 (Eragrostis chloromelas - Eragrostis plana Grassland) of Scheepers (1975).

This community is associated with lower pediment slopes and valley flats. The habitats are relatively moist, disturbed bottomland situations along drainage lines, situated on black clayey soils of the Rensburg and Arcadia Forms. The soils are variously calcareous, to slightly saline or alkaline in places. Characteristic of this community is the low species richness as well as the absence of Species Group I (Table 1). Stands of Themeda triandra - Eragrostis chloromelas Grassland generally show marked internal heterogeneity at a large scale of pattern. They are normally restricted to relatively small areas - commonly portions of paddocks near water where animals tend to concentrate and where patchy overgrazing and trampling effects

are common. Prominent species of this community are Themeda triandra , Panicum coloratum , Eragrostis chloromelas , Cyperus usitatus , Cynodon dactylon and Eragrostis plana.

Conclusion

With Association - Analysis 13 major communities , divided into 25 sub - communities were identified (Table 2). Eight of the 13 major communities are represented in Table 1. The remaining five communities are included in the vlei and bottomland vegetation (Kooij , Scheepers , Bredenkamp & Theron 1990a). In the present classification ten communities grouped into four major communities. The results of this classification of the Kroonstad data (Scheepers 1975) can be arranged alongside those of Kooij , et al. 1990b , c , d & e ; and those of Kooij , Scheepers , Bredenkamp & Theron (1990a). This will permit a synthesis and formal syntaxonomic classification of the vegetation of the north western Orange Free State.

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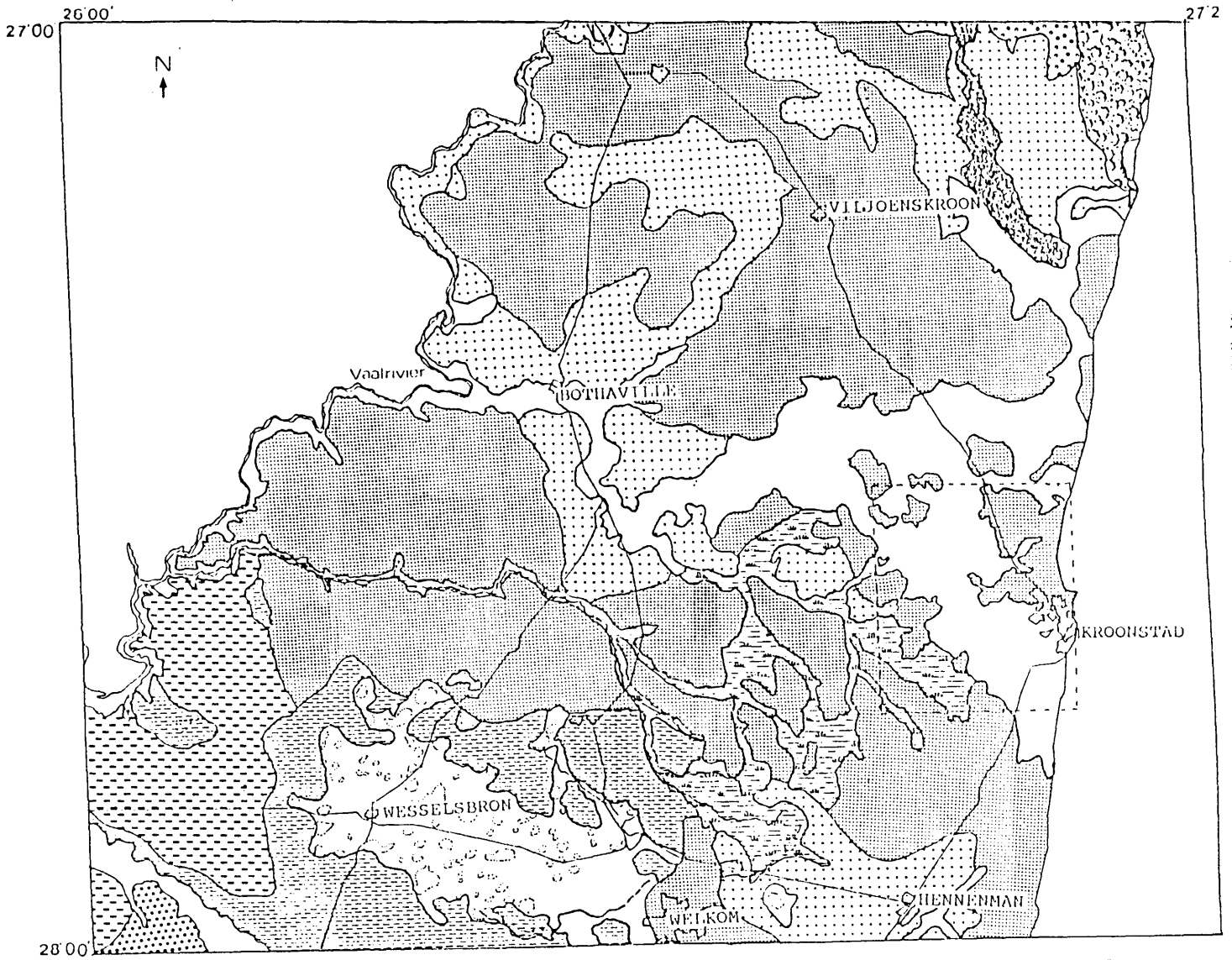


Figure 1. A map indicating the location of the Scheeper's study area (1975) in the north western Orange Free State.

Legend

- A - Land Type = Ae and Ai
- B - Land Type = Ba , Bc and Bd
- D - Land Type = Db and Dc
- F - Land Type = Fb
- I - Land Type = Ib
- Portion studied by Scheepers (1975)

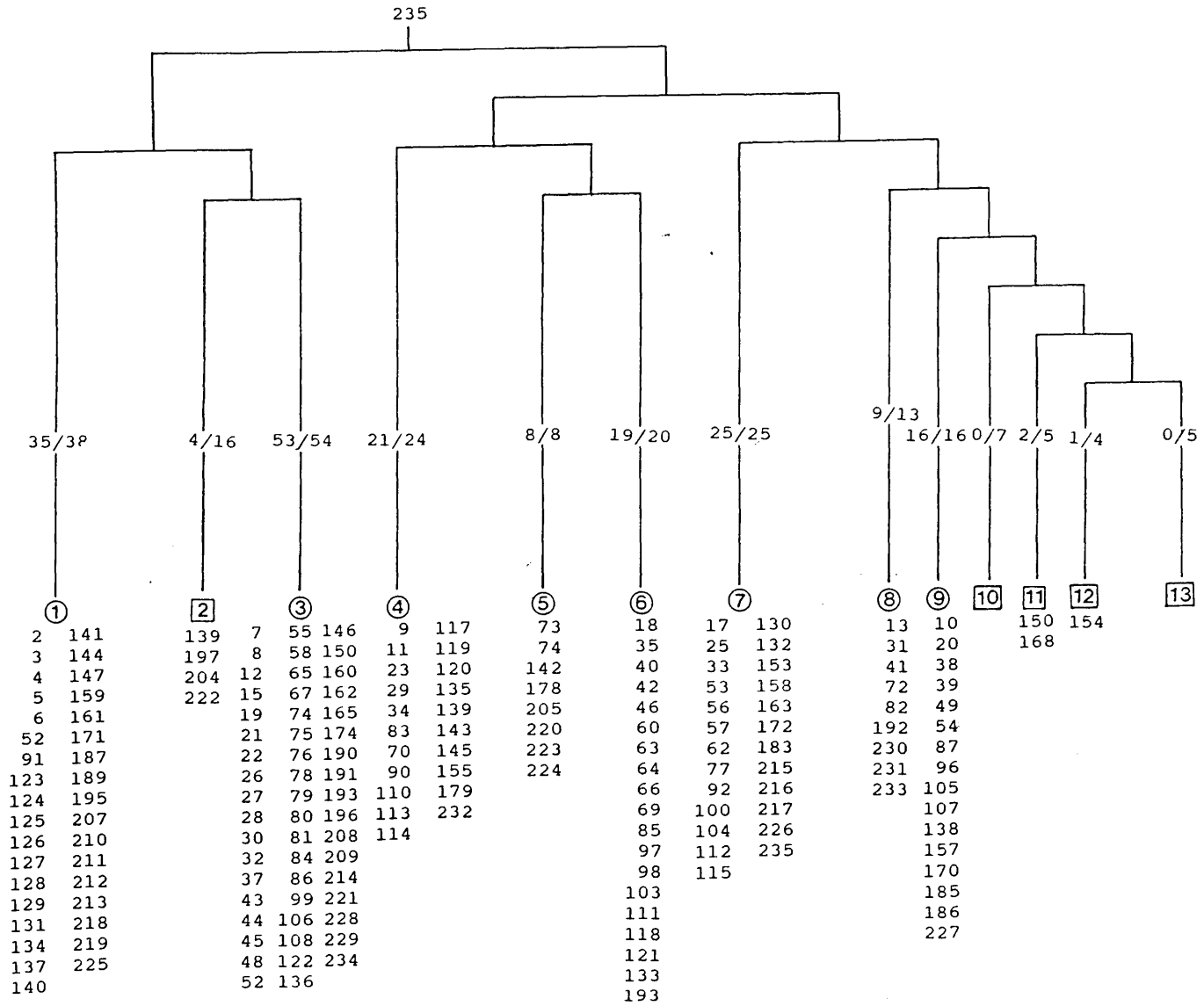


Figure 2. A dendrogram of the Association Analysis of the Kroonstad area vegetation described by Scheeper's 1975.

- Table 1 - The Vlei and Bottomland Communities (Table 1)
- Table 2 - The Grassland Communities (Table 1)(Kooij et al. 1990f)

TABLE 1. A PHYTOSOSIOLOGICAL TABLE OF THE GRASSLAND VEGETATION OF THE KROONSTAD AREA.

Communities	1		2		3.1		3		4	
	1.1		2.1		3.1.1		3.1.2		3.1.3	
	000000111100000010	21102111101121	00020111112210006222222010201121	21111111221212211122221101111122112221011111110	010000000010000001010	0200000000	0000000000011	100001100000000	001110000000010	112001
	433368001628776899	20530147061823	999207832252343171112233030224213	37459362310603326441123570224451179001302123880	9312702852104142851195	0124194454	7879199935701	674535269667233	161128621745205	782685
	017454030536567511	08535228437344	026661776981040524562913285523496	44507500344172582671832324570190295893138520597	0937088271754164153633	9765953881	4096278922861	332497122491985	808933600796570	067874
SPECIES GROUP A										
<i>Hermannia depressa</i>	+ 11	+11+	++++	+ 1+++111	+++ 12	+ +				
<i>Aristida bipartita</i>	+ 13	+ +	+++ +2	+ +	+ +					
<i>Osteospermum muricatum</i>	++	+++	+++ +	+ +	+++1					
<i>Scabiosa columbaria</i>	+ +	+++ +	+ +	++++++	+ +					
<i>Anthospermum pumilum</i>	+ +	1+	+ +	1 +	+1 +	+++				
<i>Helichrysum rugulosum</i>	+ +	1+	+ +	2 1	1 1	2				
<i>Barleria macrostegia</i>	+ +	++	+ +	+ +	+ +					
SPECIES GROUP B										
<i>Tolpis capensis</i>				1 +	+ 1+1	2+				
<i>Thesium species</i>		+		++++	+ +					
<i>Trichoneura grandiglumis</i>				1	1+2	11				
<i>Hibiscus miconifolium</i>		+			+ 1	++				
<i>Mariscus capensis</i>	++				+ ++	+				
SPECIES GROUP C										
<i>Trachyandra aspera</i>	+ +	+ +	+ +	+ 3	++	++++	+ +	++++++	+ +	
<i>Convolvulus sagittatus</i>				1++	1++11	+ +	+ +	1+	++	
<i>Nananthus transvaalensis</i>				+++	1+++	1	+ +	+++	++	
<i>Oropetium capense</i>				+ +	+ +	1+	+ +	+++	+++	
<i>Indigofera alternans</i>	+ +	+ +	+ +	+ 1	1+		+ +	+++	+++	
<i>Moraea trifida</i>				+ 1	+ +		1 112	+++	+++	
<i>Lycium cinereum</i>				2	3	1	2	1 1	+	
<i>Dipcadi viride</i>				+ +	++		+ +	++	++	
<i>Gerbera ambigua</i>				2	+		+ +	+	+	
<i>Duthiastrum linifolium</i>						1				
SPECIES GROUP D										
<i>Euphorbia pseudotuberosa</i>	++									
<i>Hermannia coccocharpa</i>										
<i>Pterodiscus speciosus</i>										
<i>Sporobolus discosporus</i>										
<i>Oxalis depressa</i>										
<i>Hypoxis argenteus</i>										
SPECIES GROUP E										
<i>Eragrostis barbinodis</i>		2		++	233	+++	++	+ +2	2 +	1
<i>Bulbine narcissifolia</i>					112+	1		+ +	+ +	1
<i>Eragrostis micrantha</i>				++				1+++2+2+1	+1+	
<i>Pentzia calcarea</i>				+1	2 +			+2	1 2	
<i>Atriplex semibacata</i>										
SPECIES GROUP F										
<i>Eragrostis obtusa</i>		++		+2	1+					
<i>Sporobolus loelados</i>	13+			2						

Table 2. A comparison of the classification of the relevés by Association Analysis (Scheepers 1975) and the present classification method.

		<u>Association - Analysis</u>													
	Community numbers	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
Braun- Blanquet	1	1	*	9	3	*	3	1	1	*	*	*	*	*	18
	1.1	1	*	1	2	5	1	3	*	*	*	*	*	*	14
	2	12	1	8	2	*	*	4	5	1	*	*	*	*	33
	2.1	19	2	12	5	1	1	6	*	1	*	*	*	*	47
	3.1.1	*	1	8	5	*	2	3	2	1	*	*	*	*	22
	3.1.2	*	*	7	1	*	*	1	1	*	*	*	*	*	10
	3.1.3	1	*	8	*	*	3	*	*	1	*	*	*	*	13
	3.2.1	*	*	*	1	2	5	4	*	3	*	*	*	*	15
	3.2.2	1	*	*	2	*	4	3	*	4	*	1	*	*	15
	4	*	*	*	*	*	*	*	*	*	4	*	1	1	*
Total for this table.		35	4	53	21	8	19	25	9	16	0	2	1	0	193
Other communities (Kooij, Scheepers, Bredenkamp & Theron 1990a)		3	12	1	3	0	1	0	4	0	7	3	3	5	42
Total relevés		38	16	54	24	8	20	25	13	16	7	5	4	5	235

CHAPTER 10

A syntaxonomical and synecological synthesis of the vegetation of the north western Orange Free State.

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Abstract

Vegetation data of the north western Orange Free State from various sources were analysed. A synthesis was made of phytosociological classifications of seven studies. Five classes and six orders have been identified and described. A total of 63 communities or subcommunities were classified.

Uittreksel

Die plantegroei van die noordwestelike Oranje - Vrystaat uit verskeie bronne is ontleed. 'n Sintese van fitososiologiese klassifikasies van sewe ondersoekte in die gebied is geanaliseer. Vyf klasse en ses ordes is geïdentifiseer en beskryf. 'n Totaal van 63 plantgemeenskappe of subgemeenskappe is geklassifiseer.

Keywords: syntaxonomical classification , TWINSPAN , Braun - Blanquet , north western Orange Free State, vegetation.

Introduction

To facilitate land use planning and management of vegetation on a regional and subregional basis , it is necessary to classify and describe the vegetation and to incorporate all available data in a synthesis (Deall 1989). This type of synthesis also enables the compilation of a formal classification and syntaxonomy of the vegetation. The necessity to identify and describe the major vegetation types and subtypes within the

Grassland Biome was stated by Mentis & Huntley (1982) and emphasized by Scheepers (1986). One of the goals of the vegetation classification and mapping task group of the comprehensive Grassland Biome Programme is to produce a vegetation classification and map on a 1 : 250 000 scale (Scheepers 1986). In the north western Orange Free State vegetation data have been collected , and compatible classifications produced by Du Preez (1987) , Kooij et al. (1990b , c, d & e) and Kooij , Scheepers , Bredenkamp & Theron (1990a , b). These phytosociological data sets and classifications provide a basis for the syntaxonomical synthesis presented here.

The study area

The area is situated between 26°00' and 27°23' E longitude and 27°00' and 28°00'S latitude , in the Grassland Biome of the north western Orange Free State. Part of the Vredefort Dome , situated between 27°00' and 27°30' E longitude and 26°45' and 27°30' S latitude (Figure 1) , is included in this study. Detailed descriptions of the physical environments of the areas are given by Scheepers (1975) , Du Preez (1987) and Kooij , Bredenkamp & Theron (1990a).

Methods

Floristic surveys were done in the A , B , D , F and I land types (Kooij , Bredenkamp and Theron 1990b , c , d , e). The results of these surveys were incorporated with the reclassified data (Kooij , Scheepers , Bredenkamp and Theron 1990a & b) of the Kroonstad area (Scheepers 1975) and also with data from the Vredefort Dome area (Du Preez 1987). A synoptic table was compiled for the entire

data set , consisting of 63 communities or subcommunities , using the Two-step classification technique developed by Bredenkamp , Bezuidenhout & Van der Maarel (1990). The 63 synoptic relevès were classified by means of the Two-Way Indicator Species Analysis (TWINSPAN) (Hill 1979) , and refined by means of Braun - Blanquet procedures.

Results and discussion

As none of the associations have yet been validly published , names of higher syntaxa cannot be published either (Article 8 of the Code) (Barkman 1986). A description of the recognised classes and orders are however presented. Although classes and orders have been established , the syntaxonomical rank and possible synonymy of the plant communities are presently being investigated. The results are presented in two synoptic tables.

Table 1 representing the grassland and associated vegetation , of the Dry Cymbopogon - Themeda Veld of Acocks (1989) as described by Kooij et al. (1990b , c , d & e) and Kooij , Scheepers , Bredenkamp & Theron (1990a & b.) whilst table 2 represents Bankenveld vegetation , as described by Du Preez (1987) , Kooij et al. (1990e) and Kooij , Scheepers , Bredenkamp & Theron (1990a).

In general the vegetation of the north western Orange Free State , including the vegetation in the Vredefort Dome can be considered as a Themeda triandra - Eragrostis curvula Grassland. This excludes the vegetation on the banks of the Vaal River and islands.

The following hierarchical classification is proposed in accordance to the International code for phytosociological nomenclature

(Barkman et al. 1986).

A: Grassland Vegetation.

Although a formal hierarchical classification was compiled for this table , the associations have not yet been formally classified. Three classes and four orders have been identified.

Class 1. The Andropogon appendiculatus Dry Riparian Grassland.

This class is restricted to dry riparian or bottomland situations. The soils are typically the Rensburg Form which are deeply cracked , vertic , calcareous and saline to alkaline , dark clays , usually covered by a layer of sand or silt.

Diagnostic species for this class are listed in species group A (Table 1).

Plant communities classified under this class :

1. Cynodon dactylon - Andropogon appendiculatus Dry Riparian Grassland (Kooij , Scheepers , Bredekamp & Theron 1990a)

Synonyms: Cynodon dactylon - Setaria woodii Grassland (Scheepers 1975).

Class 2. The Echinochloa holubii Vlei and Wetland.

This class is associated with permanently or seasonally wet watercourses , riverbanks , valley flats , flood plains and stream channels. The marginal soils vary from dark , vertic , clayey soils of the Rensburg Form to sandy , alluvial soils of the Oakleaf Form.

Diagnostic species for this class are listed in species group B (Table 1).

Communities classified under this class are the following :

1. Echinochloa holubii - Cyperus longus Wetland. (Kooij ,

Scheepers , Bredenkamp & Theron 1990a) , with the following variations :

2.1.Echinochloa holubii - Diplachne fusca Vlei Grassland

2.2.Eragrostis plana Watercourse Grassland

Synonyms: Cynodon dactylon - Eragrostis plana Watercourse Grassland (Scheepers 1975).

2.3.Echinochloa holubii - Equisetum ramosissimum Riparian Grassland.

Class 3. The Panicum coloratum - Pentzia globosa Grassland.

This class includes the extensive grassland communities of the north western Orange Free State. Diagnostic species for this class are listed in species group M (Table 1). Four orders can be distinguished in this class.

Order 1. The Eragrostis chloromelas order.

This order includes the upland grassland communities as well as communities situated in the bottomlands along valley flats and steep streambanks.

Diagnostic species for this order are listed in species group F (Table 1).

Communities classified under this order are :

3.1.1. Acacia karroo - Melica decumbens Bottomland Thornveld (Kooij, Scheepers , Bredenkamp & Theron 1990b).

Synonyms: Acacia karroo - Protasparagus laricinus Bottomland Thornveld (Scheepers 1975).

3.1.2. Acacia karroo - Eragrostis chloromelas Upland Thornveld (Kooij, Scheepers , Bredenkamp & Theron 1990b).

Synonyms: Chorchorus asplenifolius - Cynodon hirsutus Upland Thornveld (Scheepers 1975).

3.1.3. Panicum coloratum - Pentzia globosa Disturbed Grassland (Kooij , Scheepers , Bredenkamp & Theron , 1990b).

3.1.4. Themeda triandra - Panicum coloratum Grassland (Kooij , Scheepers Bredenkamp & Theron 1990b).

Order 2. The Lippia scaberrima Order.

The communities included in this order are situated on the flat lowland peneplains , adjacent to vleis , pans , watercoourses and depressions. The clay - loam soils represent the Valsrivier , Swartland and Sterkspruit Forms , but the Hutton and Avalon , or Bonheim Forms may also occur in places (Kooij et al. 1990c). This order also includes communities representing isolated relics of natural vegetation , situated on moderately deep , yellow to red sandy soils of the Clovelly , Avalon , Westleigh , Hutton and Bainsvlei Forms. However , where dolerite sills or diabase plates occur , the soils are shallower , slightly more clayey and rocks or gravel may be found on the soil surface (Kooij et al. 1990c).

Diagnostic species for this order are listed in species group I (Table 1).

Communities classified under this order are :

3.2.1. Heteropogon contortus - Eragrostis racemosa Grassland (Kooij et al. 1990e)

3.2.2. Panicum coloratum - Eragrostis curvula Bottomland Grassland

(Kooij et al. 1990e) with the variants

3.2.3.1. Panicum coloratum - Aristida canescens Variant

3.2.3.2. Panicum coloratum - Aristida bipartita Variant

3.2.4. Themeda triandra - Digitaria argyrograpta Grassland (Kooij et al. 1990b).

3.2.5. Berkheya radula - Microchloa caffra Grassland (Kooij et al. 1990c) with the

3.2.5.1. Stachys spatula Variant.

3.2.6. Brachiaria serrata - Triraphis andropogonoides Grassland (Kooij et al. 1990c) represented by

3.2.7. Triraphis andropogonoides - Acacia karroo Woodland

3.2.8. Triraphis andropogonoides - Anthephora pubescens Grassland

3.2.9. Triraphis andropogonoides - Themeda triandra Grassland.

Order 3. The Acacia karroo Order.

This order represents woodlands situated along drainage lines , riverbanks and dry water courses. In the A land type , those communities incorporated into this order are usually situated on deep , red to yellow sandy soils of the Hutton or Clovelly Forms. These sandy soils tend to be alkaline especially in the A horizon. The soils are leached and have a low water retentivity (Kooij et al. 1990d). In the D land type the woodland communities representing this order are situated along dry water courses or seasonal rivulets , on vertic Rensburg and Arcadia soil Forms , on duplex soils with clayey structured B horizons eg. the Sterkspruit, Valsrivier and Swartland Forms , as well as younger alluvial soils such as the Oakleaf and Dundee Forms (Kooij et al. 1990b). Along riverbanks the communities representing this order are situated on soils varying from dark coloured vertic or melanic soils of the Arcadia , Rensburg and Bonheim Forms to young or alluvial sandy soils of the Oakleaf and Dundee Forms (Kooij et al. 1990e).

Diagnostic species for this order are listed in species group K (Table 1).

Communities classified under this order are:

3.3.1. Protasparagus laricinus - Acacia karroo Woodland (Kooij et al. 1990b).

3.3.2. Acacia karroo - Protasparagus suaveolens River Thornveld (Kooij et al. 1990e).

3.3.3. Acacia karroo - Hibiscus pusillus Thornveld (Kooij et al. 1990d).

Order 4. Order unspecified

This order represents grassland communities that are usually severely overgrazed and disturbed, with a low species richness. The majority of the communities occurring on the A land type is classified under this order. These communities are usually situated on undulating plains. The soils are medium to deep red sands representing the Hutton Form or clayey with a relatively high water retentivity, representing the Sterkspruit, Swartland, Valsrivier, and Willowbrook Forms.

The communities of the D land type represented in this order are situated on the extensive bottomland plains of the D land type, varying from the slightly raised, relatively well drained positions to wet, marshy conditions in bottomland situations (Kooij et al. 1990b).

The B land type communities represented in this order are restricted to seasonally wet depressions, pans and vleis. The clayey soils of the Rensburg, Willowbrook, Katspruit or Bonheim Forms are predominant. These soils are poorly

drained and are therefore often waterlogged (Kooij et al.1990c). This order is characterised by the presence of species group L and the absence of species groups A - I and K (Table 1).

Communities classified under this order are:

4.1.Oenothera indecorus - Conyza sumatrensis Secondary Grassland (Kooij et al. 1990d).

3.4.2 Eragrostis superba - Themeda triandra Grassland (Kooij et al. 1990d) with the following variants:

3.4.2.1.Eragrostis lehmanniana Variant

3.4.2.2.Anthephora pubescens Variant

3.4.2.3.Eragrostis trichophora Variant

3.4.3.Aristida bipartita - Eragrostis plana Vlei Grassland (Kooij et al. 1990c).

3.4.4.Panicum coloratum - Themeda triandra Grassland (Kooij et al. 1990c).

3.4.5.Themeda triandra - Elionurus muticus Grassland (Kooij et al. 1990b).

3.4.6.Themeda triandra - Hibiscus trionum Grassland (Kooij et al. 1990b) with the subcommunities:

3.4.7.Themeda triandra - Felicia filifolia Grassland

3.4.8.Themeda triandra - Aristida bipartita Grassland.

3.4.9.Themeda triandra - Echinochloa holubii Wetland (Kooij et al. 1990b).

3.4.10. Setaria sphacelata - Eragrostis plana Wetland (Kooij et al. 1990b).

3.4.11.Sporobolus ioclados - Lycium cinereum Pan Veld (Kooij et al. 1990b).

B: Bankenveld Vegetation

This classification should be regarded as provisional as other communities from the Bankenveld , those described by Coetzee (1972) , Morris (1973) , Van Wyk & Bredenkamp (1986) , Behr & Bredenkamp (1988) , Bezuidenhout (1988) , Bredenkamp , Joubert & Bezuidenhout (1989) , Bezuidenhout & Bredenkamp (1989) and Bezuidenhout & Bredenkamp (1990) should also be incorporated in the synthesis. Some communities described by Kooij et al. (1990b , c , d & e) and Kooij , Scheepers , Bredenkamp & Theron (1990a, b) , have been classified under the Bankenveld vegetation , and therefore this provisional synthesis has been compiled. Two classes and two orders have been identified.

Class 1. The Acacia caffra - Pellaea calomelanos Hill and Ridge Thorn Veld.

This class is restricted to the hills and ridges situated to the north and north - eastern parts of the study area. These hills and ridges form part of the Vredefort Dome. The soils are usually of the Mishpa and Glenrosa Forms.

Diagnostic species for this class are listed in species group E (Table 2). Two orders can be recognised in this class namely:

Order 1. The Protea caffra Order.

The communities represented in this order are situated mainly on the south and south - easterly slopes of the quartzite ridges. Reddish brown soils of the Glenrosa Forms are predominant (Du Preez 1987).

Diagnostic species for this order are listed in species group A

(Table 2).

According to Du Preez (1987) communities classified in this order are:

1. Protea caffra Community including the following subcommunities and variants

1.1. Protea caffra - Loudetia simplex Subcommunity

1.1.1. Aloe davyana Variant

1.1.2. Eragrostis curvula Variant

1.2. Protea caffra - Rhus leptodictya Subcommunity

1.2.1 Phyllanthus parvulus Variant

Order 2. The Pappea capensis Order

The communities included into this order are situated on the granite and quartzite ridges in the area. The soils are mainly of the Hutton and Glenrosa Form (Du Preez , 1987). The possibility exist that this order may be subdivided into two suborders with species group C diagnostic for one of the suborders.

Diagnostic species for this order are listed in species group D (Table 2).

Communities classified under this order are :

2. Maytenus heterophylla - Celtis africana Shrubby Thornveld (Kooij et al. 1990e) with the variants

2.1. Maytenus heterophylla - Euclea crispa Shrubby Thornveld
and

2.2. Maytenus heterophylla - Protasparagus africanus Shrubby
Thornveld

3. Ehretia rigida - Rhus magalismsontanum Shrub Veld (Kooij et al. 1990e).

The following communities of du Preez (1987) are included in this order

4. Protea caffra - Rhus leptodictya Subcommunity with the
 - 4.1. Elionurus muticus Variant
5. Acacia hereroensis Community
6. Olea europaea subsp. africana - Pavetta zeyheri Community
 - 6.1. Olea europaea subsp. africana - Kalanchoe rotundifolia Subcommunity
 - 6.2. Olea europaea subsp. africana - Lantana rugosa Subcommunity
 - 6.3. Olea europaea subsp. africana - Setaria shpacelata Subcommunity
7. Combretum molle Community
 - 7.1. Combretum molle - Pavetta zeyheri Subcommunity
 - 7.2. Combretum molle - Acacia caffra Subcommunity
 - 7.3. Combretum molle - Plumbago auriculata - Pappea capensis Subcommunity
8. Buddleja saligna - Rhoicissus tridentata Community
 - 8.1 Buddleja saligna - Combretum molle Subcommunity
 - 8.2 Nuxia congesta - Buddleja saligna Subcommunity

Class 2. The Acacia karroo River Thornveld Class.

This class is restricted mainly to the riverbanks and islands of the Vaal River. The soils are usually of the Valsrivier Form varying from reddish brown to grey , and is 0,3 to 0,5 m deep (Du Preez , 1987).

Diagnostic species for this class are listed in species group F (Table 2).

Communities classified in this class are:

9. Acacia karroo - Celtis africana Ravine Thornveld (Kooij et al.

1990e).

Synonyms: Acacia karroo - Protea laricinus Bottomland Thornveld (Scheepers 1975).

10. Salix capensis Community (du Preez 1987).

10.1. Phragmites australis - Eichhornia crassipes Subcommunity

10.2. Verbena bonariensis - Tagetes minuta Subcommunity

11. Diospyros lycioides - Rhus pyroides Community (du Preez 1987)

11.1. Diospyros lycioides - Protasparagus africanus Subcommunity

12. Acacia karroo - Protasparagus suaveolens Community (du Preez 1987).

Conclusion

The syntaxonomical classification enables the identification and classification of many vegetation entities in the north western Orange Free State. All recognized classes and orders can easily be distinguished on basis of floristic composition and each is strongly associated with specific environmental conditions. This may contribute to an ecological basis for the compilation of management strategies for the judicious utilization and conservation of the natural vegetation. As the study of Müller (1986) is very local, including only the Willem Pretorius Nature Reserve, and Werger's (1973) study includes only fragmented grassland, transitional to karoo, this could be regarded as the first comprehensive syntaxonomical classification in South African grasslands.

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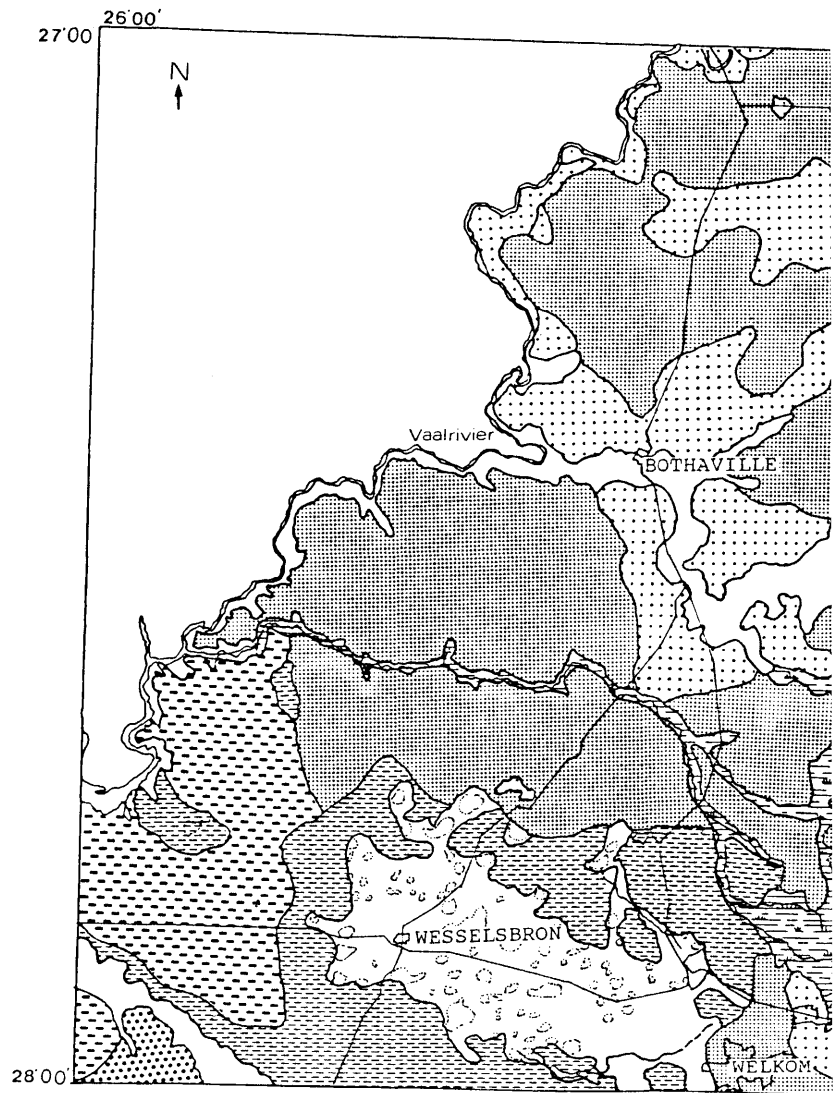













Figure 1. Location of the study area.

Legend:

-   A - Land Type = Ae & Ai.
-    B - Land Type = Ba , Bc & Bd.
-   D - Land Type = Dc & Db.
-  Fb - Land Type = Fb
-  I - Land Type = Ib
-  - Portion studied by Scheepers (1975)
-  - Portion studied by Du Preez (1987).

<i>Anthericum fasciculatum</i>	22	332	2 2332			
<i>Aptosimum depressum</i>	2	333	32332			
<i>Eragrostis trichophora</i>	22	2 2	22223			
<i>Geigeria aspera</i>	2	343	22433			
<i>Albuca setosa</i>	442	43	2 2 2			
<i>Scilla species</i>	2	2	32 2			
<i>Chrysocoma ciliata</i>	3	2	22			
Species group G						
<i>Elionurus muticus</i>		22	24244	3342 52		4
<i>Microchloa caffra</i>	222	33 3	33 2 33			3
<i>Brachiaria serrata</i>	2	2 2	323 3532		2	2
<i>Hermannia depressa</i>	2	45	3 322 32			3
<i>Helichrysum rugulosum</i>	2	22	2 33			
<i>Sporobolus species</i>	2	2	2 33			
<i>Aristida bipartita</i>	2	32	5 2		2	3
<i>Pterodiscus speciosus</i>	2	22	5	2		4
Species group H						
<i>Setaria flabellata</i>	2	22	442444	22323 3		2 4
<i>Blepharis integrifolia</i>	242	443	34443	52 2 22		
<i>Gazania krebsiana</i>	2	33	23422	3 222		2 22
<i>Sporobolus discosporus</i>	33	423	2	3 32		4
Species group I						
<i>Lippia scaberrima</i>				33222542	2	2
<i>Crabbea acaulis</i>				3332 2322	5	3 2
<i>Berkheya radula</i>	5			53332 2		
<i>Chamaesyce prostrata</i>				5332 23		2 3
<i>Trichoneura grandiglumis</i>		3		52 2 322		2
<i>Anthospermum hispidulum</i>				2 22522		
<i>Vernonia oligocephala</i>				5 2 322		
<i>Cucumis africana</i>				2 23 2		2
<i>Kyphocarpa angustifolia</i>				3 23 3		
<i>Solanum capense</i>				33 2 3	2	
<i>Triraphis andropogonoides</i>				22 3 4	22	
<i>Tragus berteronianus</i>				2323	25	2
<i>Aristida canescens</i>				3 22		
<i>Dicoma macrocephala</i>		2		3 33		
<i>Crassula lanceolata</i>				32 3		2
Species group J						
<i>Pogonarthria squarrosa</i>				2 2		3
<i>Barleria macrostegia</i>		22		5 3 3333	4 233	2
<i>Solanum incanum</i>				33 2322	42 32	
<i>Gomphrena celosioides</i>				22 23 3	35	2
<i>Albuca species</i>				5 222	2 22	4
<i>Turbina oblongata</i>				3 2 2	2 2	
<i>Antheophora pubescens</i>				2 2 2	52	
<i>Monsonia attenuata</i>				32 3	5 4	
<i>Tephrosia species</i>				2 5	2 3	
<i>Eragrostis gummiflua</i>				2 2 3	3	2
<i>Ziziphus zeyheriana</i>				3 2	2	
Species group K						
<i>Acacia karroo</i>	3	54		5 555		
<i>Protasparagus suaveolens</i>				4 225		
<i>Protasparagus laricinus</i>		55		5 245		

<i>Hermannia tomentosa</i>						2	2		
<i>Portulaca kermesina</i>						4	3		
<i>Chenopodium album</i>						2	3		
<i>Conyza podocephala</i>					2	2	2		
<i>Conyza sumatrensis</i>						2	5		4
<i>Hyparrhenia hirta</i>	2				2	2			
<i>Cassia italica</i>					3	2	2		
<i>Eragrostis racemosa</i>					2	5	5		
<i>Anthospermum pumilum</i>			23		2				
<i>Rhynchelytrum repens</i>						23			
<i>Aptosimum lineare</i>					5				2
<i>Digitaria argyrograpta</i>					52				
<i>Oenothera rosea</i>					2		3		2
<i>Osteospermum muricatum</i>		2	32		2				
<i>Seddera suffruticosa</i>			22						
<i>Menodora africana</i>					5		23	2	
<i>Cymbopogon excavatus</i>					2			2	
<i>Euphorbia pseudotuberosa</i>			3	2					
<i>Kyllinga erecta</i>	2		2	2					
<i>Mariscus rehmannianus</i>								2	
<i>Ruschia hamata</i>			2						2
<i>Aristida diffusa</i>						3		3	
<i>Aristida stipitata</i>						3		4	
<i>Delosperma sutherlandii</i>		2		2					
<i>Eragrostis micrantha</i>		2	3						
<i>Felicia filifolia</i>								3	5
<i>Gnidia capitata</i>						3	2		
<i>Hypoxis multiceps</i>					3	3			
<i>Indigofera heterophylla</i>					33				
<i>Lactuca species</i>						2		3	
<i>Lithospermum cinereum</i>			2			3			
<i>Lycium cinereum</i>							4		5
<i>Oenothera indecora</i>	5							5	
<i>Ophioglossum polyphyllum</i>									2 2
<i>Deverra burchellii</i>			2	2					
<i>Pollichia campestris</i>			2				4		
<i>Senecio burchellii</i>		3	3						
<i>Senecio species</i>					3			2	
<i>Solanum parduriforme</i>						2			2

Species with an occurrence of < 2 have been omitted.

Table 2. A synoptic table of the communities of the Bankenveld in the north - western Orange Free State.

class	1		2	
order	1		2	
	000	000	0000000000	000000
	000	222	0111111111	242212
	678	654	9267851304	361290

Species group A

<i>Conyza podocephala</i>	253			
<i>Hypoxis rigidula</i>	234			
<i>Senecio affinis</i>	323			
<i>Loudetia simplex</i>	442	5		
<i>Rhus magalismsontanum</i>	343	5		
<i>Acrotome hispida</i>	235			
<i>Eragrostis capensis</i>	435			
<i>Haemanthus humilis</i>	223			
<i>Indigofera setiflora</i>	444			
<i>Leonotis ocymifolia</i>	422			
<i>Protea caffra</i>	555			
<i>Schizoglossum glabrescens</i>	223			
<i>Scilla nervosa</i>	223			
<i>Senecio coronatus</i>	242			
<i>Tapinanthus rubromarginatus</i>	543			
<i>Tephrosia longipes</i>	443			
<i>Vernonia natalensis</i>	342			
<i>Pearsonia sessilifolia</i>	543			
<i>Helichrysum krausii</i>	533			
<i>Helichrysum nudifolium</i>	545			
<i>Asclepias burchellii</i>	322			
<i>Aster harveyanus</i>	555			
<i>Chaetachanthus costatus</i>	453			
<i>Boophane districha</i>	23			
<i>Dicoma anomala</i>	24			
<i>Hermania lancifolia</i>	33			
<i>Hypoxis rooperi</i>	24			
<i>Sonchus dregeanus</i>	33			
<i>Sytera caerulea</i>	44			
<i>Elephantorrhiza elephantina</i>	33			
<i>Cleome rubella</i>	33	5		
<i>Urelytrum agropyroides</i>	44			
<i>Xysmalobium parviflorum</i>	23			
<i>Brachiaria serrata</i>	445	3		
<i>Triraphis andropogonoides</i>	322			
<i>Vernonia oligocephala</i>	2	5		
<i>Commelina eckloniana</i>	24			
<i>Limeum viscosum</i>	44	5		

Species group B

<i>Rhynchosia venulosa</i>	5	3		
<i>Rhynchyletrum repens</i>	5	5		
<i>Commelina benegalensis</i>		53		
<i>Ziziphus zeyheriana</i>		55		
<i>Stachys spatula</i>	5			
<i>Bulbine narcissifolia</i>	5			
<i>Indigofera species</i>	5			
<i>kohautia cynanchica</i>	5			
<i>Schizachyrium sanguineum</i>	5			

<i>Alectra sessiliflora</i>	5		
<i>Andropogon chinensis</i>	5		
<i>Brachiaria nigropedata</i>	5		
<i>Indigofera sanguinea</i>	5		
<i>Phyllanthus heterophyllus</i>	5		
<i>Tephrosia lupinifolia</i>	5		
<i>Sida chrysantha</i>	5		
<i>Oxalis species</i>	5		
<i>Albuca species</i>	5		
<i>Solanum incanum</i>	5		
<i>Ledebouria marginata</i>	5		
<i>Salvia radula</i>	5		
<i>Eragrostis gummiflua</i>	5	5	
<i>Monsonia attenuata</i>	5		
<i>Solanum calense</i>	5		
<i>Gisekia africana</i>	5		
<i>Panicum coloratum</i>	5		
<i>Eragrostis lehmanniana</i>	5		
<i>Eragrostis plana</i>	5		
<i>Microchloa caffra</i>	5		
<i>Ruschia hamata</i>	5		
<i>Blepharis integrifolia</i>	5		
<i>Hermannia depressa</i>	3		
<i>Mariscus rehmannianus</i>	3		
<i>Lippia javanica</i>	3		
<i>Cheilanthes parviloba</i>	3		
<i>Helichrysum aureum</i>	3		
<i>Oxalis ambigua</i>	3		
<i>Pentanisia angustifolia</i>	3		
<i>Plexipus hederaceus</i>	3		
<i>Rhus burchellii</i>	3		
<i>Salvia verbenaca</i>	3		
<i>Trachypogon spicatus</i>	3		
<i>Plexipus pinnatifidus</i>	3		
<i>Chamaesyce prostrata</i>	3		
<i>Kyphocarpa angustata</i>	3		
<i>Geigeria burkei</i>	3		
<i>Cymbopogon plurinodis</i>	3		
<i>Ipomoea obscura</i>	3		
<i>Rhynchosia totta</i>	3		
<i>Hibiscus trionum</i>	3		
<i>Chloris viragata</i>	3		
<i>Tragus berteronianus</i>	3		
<i>Hibiscus pusillus</i>	3		
<i>Setaria flabellata</i>	3		
Species group C			
<i>Setaria lindenberghiana</i>	24	3332423	
<i>Dombeya rotundifolia</i>	44	42543 5	
<i>Solanum coccineum</i>		32334342	
<i>Pupalia lappacea</i>	35	3453 22	
<i>Abutilon sonneratianum</i>	34	3 33222	
<i>Tapiphyllum parvifolium</i>	3	22335 4	
<i>Vangeria infausta</i>	32	3 44 2	
<i>Stachys hysopiodes</i>	22	33 32	
<i>Opuntia vulgaris</i>	33	32 4	
<i>Enneapogon scoparius</i>	3	32 3 2	
<i>Hibiscus calyphyllus</i>	22	324	
<i>Sphedamnocarpus transvalicus</i>	22	22	
<i>Tragus koeleroides</i>	52	3 2	
<i>Viscum rotundifolium</i>	22	3 2	
<i>Oxalis corniculata</i>	52	2 2 2	
<i>Rhoicissus tridentata</i>	25	55	

<i>Thunbergia dregeana</i>	2	25	4
<i>Tragia rupestris</i>	5	2	3 2
<i>Buddleja salviifolia</i>	55	5	
<i>Dipcadi viride</i>	2	2	5
<i>Eriochloa parvispiculata</i>	5	2	3
<i>Heteromorpha arborescens</i>	33	3	
<i>Oldenlandia herbacea</i>	2	33	
<i>Coleochloa setifera</i>	2	3	
<i>Dichondra repens</i>	52		
<i>Ipomoea magnusiana</i>		53	
<i>Kalanchoe paniculata</i>	2	2	
<i>Kalanchoe rotundifolia</i>	2	5	
<i>Myrsine africana</i>	2	2 22	
<i>Combretum molle</i>	5	5 5 5	5
<i>Cussonia paniculata</i>	243	2	
<i>Eragrostis chloromelas</i>	3	32	
<i>Sporobolus discosporus</i>	32	2	
<i>Solanum supinum</i>	5	3	
<i>Brachylaena rotundata</i>	4	4	
<i>Anthospermum rigidum</i>	4	3	

Species group D

<i>Protasparagus suaveolens</i>	55	5233255	4 5
<i>Zanthoxylum capense</i>	55	554455544	
<i>Pappea capense</i>	5	553255442	
<i>Grewia occidentalis</i>	3	2532 5452	3
<i>Rhus undulata</i>	5	3345 5543	
<i>Euclea crispa</i>	5	355 345	
<i>Scolopia zeyheri</i>	53	5 3532	
<i>Pavetta zeyheri</i>	5	5 5552	
<i>Eustachys paspaloides</i>	5	352 2 2	
<i>Olea europaea</i>	53	5 545	
<i>Rhus rigida</i>	5	2 2 32	
<i>Grewia flava</i>	3	2 5 42	
<i>Zinnia peruviana</i>		2 2 5 4	
<i>Lantana rugosa</i>	3	3 35	
<i>Gomphrena celosioides</i>	5	32 3	
<i>Aristida congesta</i>	53	5343 33	5
<i>Felicia muricata</i>	53	3342 3	
<i>Eragrostis superba</i>	53	2 52	
<i>Cymbopogon plurinodis</i>	55	3 4	
<i>Eragrostis obtusa</i>	5	5 22	
<i>Pavonia burchellii</i>	53	32	
<i>Dicoma macrocephala</i>	3	522	
<i>Setaria sphacelata</i>	3	55	
<i>Teucrium trifidum</i>	3	52 2 5	
<i>Hyparrhenia hirta</i>	5	32 22	5
<i>Cynodon dactylon</i>	5	3 23 54	
<i>Digitaria eriantha</i>	5	5 23	

Species group E

<i>Commelina africana</i>	442	53 442 5534	
<i>Crabea acaulis</i>	245	53 53 324	
<i>Pellaea calomelanos</i>	553	555 443355553	
<i>Rhus leptodictia</i>	235	5 5445554455	
<i>Cheilanthes hirta</i>	24	53 43433435	
<i>Rhynchosia nervosa</i>	434	3 3542 5522	
<i>Acacia caltra</i>	43	53 32343 53	
<i>Clematis brachiata</i>	34	3 34 532	5
<i>Phylanthus parvulus</i>	23	3 22 524	
<i>Aloe davyana *</i>	5	3 3 4	
<i>Themeda triandra</i>	445	5 5 523 2 22	5

<i>Elionurus muticus</i>	335	5	53	2		
<i>Heteropogon contortus</i>	34		3	2	2	
<i>Eragrostis curvula</i>	553	5	54323	55	2	5
<i>Solanum sodomaeodes</i>	32		2335	432		
<i>Bulbostylis burchellii</i>	344		32	2	34	
<i>Barleria obtusa</i>	35		3	322		
<i>Cyperus obtusiflorus</i>	35		3	32		
Species group F						
<i>Acacia karroo</i>		3				555 54
<i>Ehrharta erecta</i>						35352
<i>Cyperus rotundus</i>						2 55
<i>Ipomoea purpurea</i>						55 4
<i>Phragmites australis</i>						352
<i>Cestrum laevigatum</i>						2 2
<i>Equisetum ramosissimum</i>						3 2
<i>Cineraria geifolia</i>						2 2
<i>Datura ferox</i>						3 5
<i>Panicum schinzii</i>						3 4
<i>Salix capensis</i>						55
<i>Oenothera rosea</i>						34
Species group G						
<i>Achranthus aspera</i>			32	335335		555 5
<i>Sida dregei</i>			55422	524	5	33 2
<i>Bidens pilosa</i>			322	5 55	5	2525
<i>Lepidium africanum</i>			52	2 3 4	5	324
<i>Rhus pyroides</i>			32	2		34555
<i>Chenopodium album</i>			5	5 4	3	45 5
<i>Setaria verticillata</i>			5	3 4		324
<i>Protasparagus laricinus</i>			52	3		5545 4
Species group H						
<i>Celtis africana</i>			55	53 235535		55 4
<i>Diospyros lyciodes</i>			53	42 5335		55522
<i>Ehretia rigida</i>			55	3344 55352		53
<i>Maytenus heterophylla</i>			55	4 23332		355542
<i>Protasparagus africanus</i>			5	2 2 2 2	5	4
<i>Schkuhria pinata</i>			53	52 2 35	5	22
Species group I						
<i>Ziziphus mucronata</i>	525		5454353353			3553 4
<i>Tagetes minuta</i>	2 4		543 3542			3 5535
Species group J						
<i>Berkheya radula</i>						5
<i>Haplocarpha scaposa</i>		3				
<i>Corchorus asplenifolius</i>			5			
<i>Lippia scaberrima</i>						5
<i>Trichoneura grandiglumis</i>		5	5			
<i>Atriplex semibaccata</i>						3
<i>Crassula lanceolata</i>			5			
<i>Cyanothus speciosus</i>			5			
<i>Melica decumbens</i>						3
<i>Pentarrhinum insipidum</i>						3
<i>Sporobolus species</i>		5				
<i>Acacia hebeclada</i>			5			
<i>Antizoma angustifolia</i>						3
<i>Argemone subfusiformis</i>						5

<i>Brayulinea densa</i>			5	.		
<i>Cleome monophylla</i>		5				3
<i>Coccinia sessilifolia</i>						
<i>Cyperus aristatus</i>		5				
<i>Dianthus mooiensis</i>	4					
<i>Eichhornia crassipes</i>						5
<i>Euphorbia inaequilatera</i>			5			
<i>Galium capense</i>						
<i>Pseudognaphalium oligandrum</i>			5			
<i>Helichrysum species</i>				4		
<i>Lycium oxycarpum</i>					3	
<i>Nuxia congesta</i>				4		
<i>Plumbago auriculata</i>				5		
<i>Rhus lancea</i>						2
<i>Rumex lanceolatus</i>						4
<i>Trachyandra saltii</i>			5			
<i>Turbina oenotheroides</i>						
<i>Urochloa panicoides</i>					5	
<i>Verbena bonariensis</i>						5

Species with an occurrence of < 2 have been omitted.

**Aloe davyana* is treated as *Aloe greatheadii* by some authors.

CHAPTER 11

GENERAL DISCUSSION

The purpose of this study was to classify the vegetation of the north western Orange Free State. The goals were:

- * to determine homogeneous vegetation - cum - habitat units for optimal use in management programmes and
- * to compile a synthesis of the grassland of this region as a part of the envisaged phytosociological synthesis of the entire western Grassland Biome.

The success and significance of this study can be measured by the meaningfulness of the results attained.

Sampling.

The greater part of the region has been ploughed and the natural vegetation is utilised as grazing for cattle and sheep. Furthermore , in trying to improve the grazing capacity of natural veld of some areas , better pasture grasses have been established in the natural vegetation. These farming practises however , hampered the random or systematic placing of sampling plots in the study area. The subjective stratified sampling method was found to be an effective and efficient method to use , especially due to the limited availability of natural vegetation. The successful classification of the vegetation , as well as the meaningful ecological interpretation of the recognized plant communities indicate that stratification by land type and terrain form , and the allocation of samples to land types pro rata on an area size basis , was applied successfully in this phytosociological study. This is in accordance to successful studies by Bezuidenhout (1988) , Bredenkamp , Joubert & Bezuidenhout (1989) and

Bezuidenhout & Bredenkamp (1990) , who also stratified by land type and terrain form to distribute vegetation samples efficiently. As the identified major community types of the different land types differ on a regional basis , the land types within the study area (the land type classification of the 2726 Kroonstad map) could be considered as ecologically sound. Futhermore , the repeating pattern of the plant community distribution on the various terrain forms within a particular land type could be useful for vegetation and grazing management planning of individual farms occuring within the land type.

The use of land types and terrain forms are therefore considered to be useful criteria for stratification to ensure efficient and effective sampling of the major variation in vegetation and environment in the grassland vegetation.

Floristic survey.

The Braun - Blanquet surveying methodology , of recording all recognizable species present in the sample plots is considered as successful , and reliable. Not only ecologically meaningful classifications resulted from the data , but from the ordinations (DECORANA) environmentally related vegetation gradients could also be identified. The vegetation - cum - habitat units thus identified could therefore form the basis for the planning of regional and local management strategies

Habitat survey.

Significant , ecological interpretations of each community could be made , due to the fact that adequate habitat data were collected in each sample plot. The importance of a thorough habitat survey

to interpret the plant communities obtained is also emphasized by Bredenkamp (1982). Habitat factors found to be of importance with regard to plant community distribution in the study area include geology , soil type , soil texture and rockiness of the soil surface as well as biotic factors such as grazing , presence of termites and the general condition (succesional stage) of the vegetation. Making use of land types enabled the extrapolation of soil analyses of the area by using information from the Land Type Survey Staff (1984). The habitat data collected and available from land type discriptions made it possible to determine environmental vegetation gradients through DECORANA ordinations. Data processing.

The process of using the TWINSpan classification algorithm (Hill 1979) to identify preliminary groups and communities , was found to be successfull and time saving. However the results obtained by using the TWINSpan classification only , was not always satisfactory and therefore refinement by Braun - Blanquet procedures was necessary. This procedure proved to be successful in view of the studies by Bredenkamp (1982) , Behr & Bredenkamp (1988) , Bezuidenhout (1988) and Bredenkamp , Joubert & Bezuidenhout (1989). In discussing the logic of intrinsic computer-based classifications , Williams and Lance (1965) emphasized that it is important to maintain a critical commonsense approach and to be wary of an exaggerated respect for the "absolute" nature of computer classification. Computer classification should be seen in their logical contents as an aid in the rapid classificatory processing of a cumbersome mass of data. This study emphasized the findings of Bredenkamp (1982) and

Bezuidenhout (1988) that it is difficult to demonstrate meaningful and ecologically justifiable variation in heterogeneous but related vegetation in a single large , phytosociological table . Comprehensive , major vegetation types , with many diagnostic species can easily be recognized in a single table. However , plant communities of a presumably lower syntaxonomical rank are often characterised by different species which may also occur in other floristically and environmentally related plant communities. The identification of these communities is difficult in a single large table , as grouping of relevès and species may be obscured by the total large data set.

The stratification by land type , as described above , and utilizing the experience of Bezuidenhout (1988) and Bezuidenhout and Bredenkamp (1990) , provided the opportunity to compile separate phytosociological tables of the vegetation of the various land types. The results (classification and community descriptions and ordinations) of the individual land types were published independantly (Kooij et al. 1990b , c , d & e ; Kooij , Scheepers , Bredenkamp & Theron 1990a & b). The classification of Scheepers (1975) by monothetic Association Analysis could not be incorporated in the synthesis of all available data from the study area , as results obtained by this technique are not compatible to classifications derived from polythetic TWINSpan or Braun - Blanquet procedures. A reclassification of the floristic data by Braun - Blanquet procedures was therefore necessary. The reclassification resulted in well defined ecologically sound plant communities. This emphasized the result of Coetzee & Werger

(1975) that polythetic Braun - Blanquet analyses of floristic data result in ecologically more reliable vegetation classes than those derived from monothetic techniques.

The necessity to compare the communities described in the independent studies has been emphasized by Werger (1973) and Bredenkamp (1975 & 1982). This comparison is mostly done in a synoptic table (Bredenkamp 1982). The two-step classification principle (Van der Maarel et al. 1987 and Bredenkamp et al. 1990) was applied successfully to create a synoptic table which included all phytosociological data sets of the study area (Scheepers 1975, Du Preez 1987 and Kooij et al. 1990b, c, d & e). The results obtained through this synthesis were successfully ecologically interpreted, and forms the basis for the syntaxonomical classification.

In general the success of the classification and integration of vegetation data of the north - western Orange Free State , can be ascribed to a total floristic survey done by each individual researcher as well as to the uniform use of the Braun - Blanquet cover/abundance scale. This enabled the compilation of a single synoptic table , containing various data sets of the different researchers. Major differences as well as similarities among all plant communities recognized by the different workers in the vegetation of the Bankenveld (Woody Communities of Du Preez (1987) and the Dry Cymbopogon - Themeda Veld (Acocks 1988) , could be recognized.

Hence a formal syntaxonomical classifications could be compiled for the Bankenveld (provisional) as well as for the Dry Cymbopogon -

Themeda Grassveld. The syntaxonomical classification of the dry Cymbopogon - Themeda Grassland is considered to be a major contribution to the knowledge of South African Grasslands. This classification also revealed the existance of synonyms for some communities. Although a formal hierarchical syntaxonomical classification was compiled , associations were not formally described. This is however the logical next step in the research programme , and recognised associations are presently being described.

Classification of the environment - vegetation complexes of a region into reasonably homogeneous mappable units greatly facilitates development and management planning and allows generalizations based on research findings. Recognition of eco-systems and mapping of their distrubution are fundamental pre-requisites for ecologically based rational land use and regional and subregional planning. This information is also essential to identify problem areas and to assess research priorities to meet the greatest needs (Scheepers 1975). The classification presented in this study provides the necessary ecologically based background for management planning.

SUMMARY

The vegetation of the north western Orange Free State was classified and described , to identify homogeneous mappable vegetation units to facilitate the development of management strategies. The identified units should serve as a fundamental ecological basis for the formulation of management strategies for effective utilization of vegetation. A further objective of the study was to compile a synthesis of all phytosociological data of the area in order to formulate a formal syntaxonomical classification of the vegetation. The study area was stratified according to land type and terrain form to enable efficient sampling , as well as variations in vegetation and habitat. The floristic data were classified by means of the TWINSpan classification technique and refined by Braun - Blanquet procedures. The classification of the floristic data according to the different land types resulted in four different phytosociological tables representing the A , B and D land types , as well as the hills and ridges of the north - western Orange Free State. All identified plant communities were ecologically interpreted and described. Data from the Kroonstad area were previously classified by monothetic Association Analysis. This data were reclassified by polythetic techniques to enable incorporation with the present classification. The results of the classifications of the A , B and D land types as well as the hills and ridges incorporated with the reclassified data of the Kroonstad area and the Vredefort Dome area enabled the compilation of a synoptic table. It was apparent from this synthesis that the synoptic

table could be divided into two separate tables based on the floristic composition as well as the habitat. The plant communities thus identified were ecologically interpreted and form the basis for a proposed syntaxonomical classification and the formal description of associations in future.

The Decorana ordination was used to identify gradients in vegetation as well as in the environment. These results contributed to a meaningful ecological interpretation of the plant communities.

OPSOMMING

Die plantegroei van die noordwestelike Oranje Vrystaat is geklassifiseer en beskryf met die doel om homogene plantegroei eenhede te identifiseer. Hierdie eenhede behoort as ekologies gefundeerde basis te dien vir die opstel van bestuursmaatreëls, vir die effektiewe benutting van die natuurlike veld.

'n Verdere doelstelling van die studie was die opstel van 'n sintese van alle fitososiologiese inligting van die gebied, om uiteindelik 'n formele sintaksonomiese klassifikasie op te stel. Die studiegebied is op grond van landtipe en terreinvorm gestratifiseer om sodoende doeltreffende monsterneming van soveel plantegroei/habitat variasies as moontlik te verseker. Die floristiese data is met behulp van TWINSPAN geklassifiseer en daarna verfyn deur gebruik te maak van Braun - Blanquet - prosedures.

Die floristiese data van die onderskeie landtipes is afsonderlik geklassifiseer, wat daartoe aanleiding gegee het, dat vier fitososiologiese tabelle saamgestel is, wat die A, B en D landtipes sowel as die randte en koppies in die studiegebied verteenwoordig. Al die geïdentifiseerde plantgemeenskappe is ekologies geïnterpreteer en beskryf.

Data vanaf die Kroonstad gebied is reeds voorheen met behulp van die monotetiese Assosiasie - Analise - tegniek geklassifiseer.

Die resultate van hierdie klassifikasie kon egter nie met die huidige klassifikasie geïntegreer word nie, met die gevolg dat 'n herklassifisering van die data deur politetiese tegnieke noodsaaklik was. Die resultate van die klassifikasies van die A, B en D landtipes sowel as die van die randjies en koppies is geïnkorporeer met die herklassifikasie van die data vanaf die

Kroonstadgebied en die data van die Vredefortkoepelgebied om sodoende 'n sinoptiese tabel saam te stel. Uit hierdie sintese het dit duidelik geblyk , dat die sinoptiese tabel in twee afsonderlike sinopties tabelle onderverdeel kon word , op grond van floristiese samestelling sowel as habitatsinligting. Die plantgemeenskappe wat in hierdie sintese geïdentifiseer is , is ekologies sinvol geïnterpreteer. Die resultate vorm die basis vir 'n voorgestelde sintaksonomiese klassifikasie en die toekomstige formele beskrywing van assosiasies.

Gradiënte in plantegroei en geassosieerde omgewingsgradiënte is met behulp van DECORANA - ordening geïdentifiseer. Die resultate van die ordenings dra by tot die sinvolle ekologiese interpretasie van die plantgemeenskappe.

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Appendix

CHECKLIST

A checklist of all species known to occur in the study area is presented in this appendix. The aim of this checklist is to provide an overview of the flora of the region and not to provide information on voucher species names or the distribution of the taxa.

The list was compiled by including all species collected by Scheepers (1975), Du Preez (1987) and Kooij et al. (1990b-e), while preparing this thesis. Additionally all species of the area which have been included in the PRECIS list (May 1990) were obtained from the National Botanical Institute in Pretoria. The PRECIS list include the following grid references:

2627 CC	2726 BA	2726 CA	2726 DA	2727 AA	2727 C
2627 CD	2726 BB	2726 CB	2726 DC	2727 AB	2727 CA
	2726 BC	2726 CC	2726 DD	2727 AC	2727 CB
	2726 BD	2726 CD		2727 AD	2727 CC

The nomenclature and author names conform to that of Gibbs - Russel et al. (1985 & 1987).

The flora of the region is represented by 1 203 species , including infra - specific taxa.

The relationship between the number of families , genera and species (including infra - specific taxa) of the Bryophyta , Pteridophyta , Gymnospermae , Monocotyledonae and Dicotyledonae are given in Table 1.

The Director of the Botanical Research Institute is thanked for the use of data produced by the Pretoria National Herbarium Computerized Information System (PRECIS).

Table 1. The relationship between the number of families ,
genera and species.

	Families		Genera		Species	
		%		%		%
Bryophyta	6	5.61	6	1.21	13	1.08
Pteridophyta	6	5.61	7	1.42	11	0.91
Gymnospermae	1	0.93	1	0.20	1	0.08
Monocotyledonae	16	14.95	131	26.52	354	29.43
Dicotyledonae	78	72.90	349	70.65	824	68.50
Total	107		494		1203	

SPECIES LIST

BRYOPHYTA

RICCIACEAE	0001016
Riccia	0001016
<u>R. albolimbata</u> S. Arnell	
<u>R. albovestita</u> Volk	
<u>R. atropurpurea</u> Sim	
<u>R. congoana</u> Steph.	
<u>R. okahandjana</u> S. Arnell	
<u>R. rosea</u> Volk & Perold	
<u>R. volkii</u> S. Arnell	
DICRANACEAE	0001356
Campylopus	0001359
<u>C. introflexus</u> (Hedw.) Brid.	
BRYACEAE	0001506
Bryum	0001508
<u>B. argenteum</u> Hedw.	
<u>B. bicolor</u> Dicks.	
ERPODIACEAE	0001601
Erpodium	0001602
<u>E. beccarii</u> C. Muell. ex Vent.	
FABRONIACEAE	0001801
Fabronia	0001802
<u>F. pilifera</u> Hornsc.	
LESKEACEAE	0001811
Pseudoleskeopsis	0001814
<u>P. claviramea</u> (C. Meull.) Ther.	

PTERIDOPHYTA

SELAGINELLACEAE	0000030
Selaginella	0000030
<u>S. dregei</u>	
EQUISETACEAE	0000050
Equisetum	0000050
<u>E. ramosissimum</u> Desf.	
OPHIOGLOSSACEAE	0000060
Ophioglossum	0000060
<u>O. polyphyllum</u> A. Br. ex Steub.	
<u>O. reticulatum</u> L.	
<u>O. species</u>	
SCHIZAEACEAE	0000100
Mohria	0000120
<u>M. caffrorum</u> (L.) Desv.	
MARSILEACEAE	0000190
Marsilea	0000190
<u>M. macrocarpa</u> Presl.	
<u>M. species</u>	
ADIANTHACEAE	0000280
Cheilanthes	0000340
<u>C. hirta</u> Swartz	
<u>C. parviloba</u> (Swartz) Swartz	
Pellaea	0000360
<u>P. calomelanos</u> (Swartz) Link	

GYMNOSPERMAE

CUPRESSACEAE	0037000
Widdringtonia	0038000
<u>W. nodiflora</u> (L.) Powrie	
ANGIOSPERMAE	
MONOCOTYLEDONAE	
TYPHACEAE	0049000
Typha	0049000
<u>T. capensis</u> (Rohrb.) N.E.Br.	
POTAMOGETONACEAE	0058000
Potamogeton	0058000
<u>P. crispus</u> L.	
<u>P. schweinfurthii</u> A.W. Benn.	
<u>P. pectinatus</u> L.	
<u>P. pusillus</u> L.	
APONOGETONACEAE	0065000
Aponogeton	0065000
<u>A. junceus</u> Lehm. ex Schlechtd. subsp. <u>junceus</u>	
Alisma	0070000
<u>A. plantago - aquatica</u> L. *	
HYDROCHARITACEAE	0085000
Lagarosiphon	0088000
<u>L. major</u> (Ridley) Moss ex Wager	
<u>L. muscoides</u> Harv.	
POACEAE	9900010
Urelytrum	9900170
<u>U. agropyroides</u> (Hack.) Hack.	
Hemarthria	9900210

<u>H. altissima</u> (Poir.) Staff & C.E. Hubb.	
Elionurus	9900280
<u>E. muticus</u> (Spreng.) Kunth	
Imperata	9900370
<u>I. cylindrica</u> (L.) Rauschel	
Sorgum	9900460
<u>S. bicolor</u> (L.) Moench subsp. <u>arundiaceum</u> (Desv.) De Wet & Harlan	
<u>S. halepense</u> (L.) Pers. *	
Dichanthium	9900640
<u>D. species</u>	
Schizachyrium	9900680
<u>S. sanguineum</u> (Retz.) Alst.	
Andropogon	9900710
<u>A. appendiculatus</u> Nees	
<u>A. chinensis</u> (Nees) Merr.	
<u>A. schirensis</u> A.Rich.	
Cymbopogon	9900720
<u>c. dieterlenii</u> Stapf ex Phill.	
<u>C. excavatus</u> (Hochst.) Stapf ex Burt Davy	
<u>C. plurinodis</u> (Stapf) ex Burt Davy	
<u>C. validus</u> (Stapf) Stapf ex Burt Davy	
Hyparrhenia	9900730
<u>H. dregeana</u> (Nees) Stapf	
<u>H. hirta</u> (L.) Stapf	
Hyperthelia	9900731
<u>H. dissoluta</u> (Nees ex Steud.) Clayton	
Trachypogon	9900780

<u>T. spicatus</u> (L.F.) Kuntze	
Heteropogon	9900800
<u>H. contortus</u> (L.) Roem. & Schult.	
Diheteropogon	9900810
<u>D. amplectens</u> (Nees) Clayton	
Themeda	9900830
<u>T. triandra</u> Forssk.	
Digitaria	9900890
<u>D. argyrograpta</u> (Nees) Stapf	
<u>D. ciliaris</u> (Retz.) Koeler	
<u>D. eriantha</u> Steud	
<u>D. milanjiana</u> (Rendle) Stapf	
<u>D. sanguinalis</u> (L.) Scop. *	
<u>D. species</u>	
<u>D. ternata</u> (A. Rich.) Stapf	
<u>D. tricholaenoides</u> Stapf	
<u>D. velutina</u> (Forssk.) Beauv.	
Tarigidia	9900891
<u>T. aequiglumis</u> (Goossens) Stent	
Alloteropsis	9900940
<u>A. semialata</u> (R.Br.) Hitchc.	
Eriochloa	9901020
<u>E. parvispiculata</u> C.E. Hubb	
Brachiaria	9901040
<u>B. brizantha</u> (A. Rich.) Stapf	
<u>B. eruciformis</u> (J.E. SM.) Griseb.	
<u>B. nigropedata</u> (Fical. & Hiern) Stapf	
<u>B. serrata</u> (Thunb.) Stapf	

Paspalum	9901070
<u>P. dilatatum</u> Poir. *	
<u>P. paspalodes</u> (Michx.) Scribn.	
<u>P. urvillei</u> Steud. *	
Urochloa	9901100
<u>U. mosambicensis</u> (Hack.) Dandy	
<u>U. panicoides</u> Beauv.	
Echinochloa	9901120
<u>E. colona</u> (L.) Link	
<u>E. crus - galli</u> (L.) Beauv.	
<u>E. crus - pavonis</u> (L.) Beauv.	
<u>E. holubii</u> (Stapf) Stapf	
Panicum	9901160
<u>P. coloratum</u> L. var <u>coloratum</u>	
<u>P. coloratum</u> L. var. <u>makarikariense</u> Goossens	
<u>P. impeditum</u> Launert	
<u>P. kalahareense</u> Mez	
<u>P. schinzii</u> Hack.	
<u>P. species</u>	
<u>P. stapfianum</u> Fourc.	
Setaria	9901280
<u>S. flabelata</u>	
<u>S. incrassata</u> (Hochst.) Hack.	
<u>S. italica</u> (L.) Beauv.	
<u>S. lindenberiana</u> (Nees) Stapf	
<u>S. nigrirostris</u> (Nees) Dur. & Schinz	
<u>S. pallide - fusca</u> (Schumach.) Stapf & C.E. Hubb.	

<u>S. sphacelata</u> (Schumach.) Moss var. <u>sphacelata</u>	
<u>S. sphacelata</u> (Schumach.) Moss var. <u>torta</u> (Stapf) Clayton	
<u>S. species</u>	
<u>S. verticillata</u> (L.) Beauv.	
Rhynchelytrum	9901321
<u>R. nerviglume</u> (Franch.) Chiov.	
<u>R. repens</u> (Willd.) C.E. Hubb.	
Melinis	9901340
<u>M. repens</u> (Willd.) Zizka subsp. <u>repens</u>	
Anthephora	9901380
<u>A. pubescens</u> Nees	
Pennisetum	9901390
<u>P. sphacelatum</u> (Nees.) Dur. & Schinz.	
<u>P. villosum</u> R. Br. ex Fresen. *	
Cenchrus	9901400
<u>C. incertus</u> M.A. Curtis *	
Leersia	9901590
<u>L. hexandra</u> Swartz	
Ehrharta	9901600
<u>E. erecta</u> Lam. var. <u>erecta</u>	
<u>E. erecta</u> Lam. var. <u>natalensis</u> Stapf	
Phalaris	9901630
<u>P. canariensis</u> L. *	
Tristachya	9901740
<u>T. leucothrix</u> Nees.	
<u>T. rehmannii</u> Hack.	
Loudetia	9901751

<u>L. simplex</u> (Nees) C.E. Hubb.	
Avena	9901950
<u>A. species</u>	
Helictotrichon	9901970
<u>H. trugidulum</u> (Stapf) Schweick.	
Phragmites	9902140
<u>P. australis</u> (Cav.) Steud	
Agrostis	9902430
<u>A. lachnantha</u> Nees var. <u>lachnantha</u>	
Polypogon	9902440
<u>P. monspeliensis</u> (L.) Desf.	
Stipagrostis	9902611
<u>S. obtusa</u> (Del.) Nees	
<u>S. uniplumis</u> (Licht.) De Winter var. <u>neesii</u> (Trin & Rupr.) De Winter	
<u>S. uniplumis</u> (Licht.) De Winter var. <u>uniplumis</u>	
Aristida	9902620
<u>A. adscensionis</u> L. subsp. <u>adscensionis</u>	
<u>A. bipartita</u> (Nees) Trin. & Rupr.	
<u>A. canescens</u> Henr. subsp. <u>canescens</u>	
<u>A. congesta</u> Roem. & Schult. subsp. <u>congesta</u>	
<u>A. diffusa</u> Trin. subsp. <u>burkei</u> (Stapf) Meld.	
<u>A. diffusa</u> Trin. subsp. <u>diffusa</u>	
<u>A. junciformis</u> Trin. & Rupr. subsp. <u>junciformis</u>	
<u>A. meridionalis</u> Henr.	
<u>A. mollissima</u> Pilg. subsp. <u>mollissima</u>	
<u>A. scabrivalvis</u> Hack subsp. <u>scabrivalvis</u>	
<u>A. species</u>	

A. stipitata Hack. subsp. graciliflora (Plig.) Meld.
A. stipitata Hack. subsp. stipitata
 Tragus 9902740
T. berteronianus Schult.
T. koeleroides Aschers.
T. racemosus (L.) All.
 Perotis 9902800
P. patens Gand.
 Sporobolus 9902830
S. africanus (Poir.) Robyns & Tournay
S. discosporus Nees
S. festivus A. Rich.
S. fimbriatus (Trin.) Nees var. fimbriatus
S. fimbriatus (Trin.) Nees var. latifolius Stent
S. ioclodus (Trin.) Nees
S. ludwigii Hochst.
S. smutsii Stent
S. stapfianus Grand
S. species
 Eragrostis 9902860
E. barbinodis Hack.
E. bicolor Nees
E. biflora Hack. ex Schinz
E. capensis (Thunb.) Trin.
E. chloromelas Steud.
E. cilianensis (All.) F.T. Hubb.
E. curvula (Schrad.) Nees
E. cylindriflora Hochst.

E. gummiflua Nees
E. lappula Nees var. lappula
E. lehmanniana Nees var. lehmanniana
E. micrantha Hack.
E. nindensis Fical. & Hiern
E. obtusa Munro ex Fical. & Hiern
E. pallens Hack.
E. pilosa (L.) Beauv. *
E. plana Nees
E. planiculmis Nees
E. x pseud - obtusa De Winter
E. pseudosclerantha Chiov.
E. racemosa (Thunb.) Steud.
E. rigidior Pilg.
E. stapfii De Winter
E. superba Peyr.
E. tef (Zucc.) Trotter *
E. trichophora Coss. & Dur.
E. species.
E. vicosa (Retz.) Trin.
Microchloa 9902940
M. caffra Nees
Cynodon 9902960
C. dactylon (L.) Pers.
C. hirsutus Stend
C. transvaalensis Burttt Davy
Harpochoa 9902980

<u>H. falx</u> (L.F.) Kuntze	
Chloris	9903010
<u>C. virgata</u> Swartz	
Eustachys	9903020
<u>E. paspaloides</u> (Vahl.) Lanza & Mattei	
Oropetium	9903200
<u>O. capense</u> Stapf	
Eleusine	9903310
<u>E. corcacana</u> (L.) Gaertn. subsp. <u>africana</u> (K.-O'Byrne) Hilu & De Wet	
<u>E. indica</u> (L.) Gaertn.	
Dactyloctenium	9903320
<u>D. aegyptium</u> (L.) Beauv.	
<u>P. squarrosa</u> (Roem. & Schult.) Pilg.	
Pogonarthria	9903340
<u>P. squarrosa</u> (Roem. & Schult.) Pilg.	
Bewsia	9903442
<u>B. biflora</u> (Hack.) Goossens	
Diplachne	9903450
<u>D. fusca</u> (L.) Stapf	
Triraphis	9903500
<u>T. andropogonoides</u> (Steud.) Phill	
Trichoneura	9903530
<u>T. grandiglumis</u> (Nees) Ekman var. <u>minor</u> Rendle	
Enneapogon	9903570
<u>E. cenchroides</u> (Roem. & Schult.) C.E. Hubb.	
<u>E. pretoriensis</u> Stent	
<u>E. scoparius</u> Stapf	

Fingerhuthia	9903710
<u>F. africana</u> Lehm.	
Melica	9903860
<u>M. decumbens</u> Thunb.	
Bromus	9904280
<u>B. leptoclados</u> Nees	
<u>B. species</u>	
<u>B. uniolooides</u> H.K.B.	
Lolium	9904330
<u>L. multiflorum</u> x L. Perenne	
<u>L. temulentum</u> L.	
CYPERACEAE	0452000
Cyperus	0459000
<u>C. bellus</u> Kunth	
<u>C. denudatus</u> L. F.	
<u>C. difformis</u> L.	
<u>C. eragrostis</u> Lam. *	
<u>C. esculentus</u> L.	
<u>C. fastigiatus</u> Rottb.	
<u>C. fulgens</u> C.B. Cl. var. <u>fulgens</u>	
<u>C. haematocephalus</u> Broeck. ex C.B.Cl.	
<u>C. longus</u> L. var. <u>longus</u>	
<u>C. margaritaceus</u> Vahl.	
<u>C. marginatus</u> Thunb.	
<u>C. obtusiflorus</u> Vahl. var. <u>flavissimus</u> Boeck.	
<u>C. obtusiflorus</u> Vahl var. <u>obtusiflorus</u>	
<u>C. obtusiflorus</u> Vahl var. <u>sphaerocephalus</u> (Vahl) Kuekenth.	
<u>C. rotundus</u> L. subsp. <u>rotundus</u> var. <u>rotundus</u> .	

C. rupestris Kunth var. rupestris
C. semitrifidus Schard.
C. sphaerospermus Schrad.
C. usitatus Burch. var. usitatus
C. species.
C. zollingeri Steud.
Pycneus 0459010
P. chrysanthus (Boeck.) C.B.Cl.
Mariscus 0459030
M. capensis (Steud.) Schrad.
M. congestus (Vahl.) C.B. Cl.
M. indicorus (Kunth) Podlech
M. marlothii (Boeck.) C.B. Cl.
M. rehmannianus C.B. Cl.
M. species
M. uitenhagensis Steud.
M. usitatus (Burch.) P.J. Vorster Ms. var. usitatus
Monandrus 0459040
M. longicarpus P.J. Voster Ms.
M. squarrosus (L.) P.J. Vorster MS. subsp. squarrosus
Kyllinga 0462000
K. alba Nees.
K. erecta Schumach.
K. species
Scirpus 0468000
S. burkei C.B. Cl.
S. dioecus (Kunth) Boeck.

Schoenoplectus	0468010
<u>S. decipiens</u> (Nees) J. Raynal	
<u>S. muricinux</u> (C.B. Cl.) J. Raynal	
Isolepis	0468020
<u>I. fluitans</u> (L.) R. Br.	
<u>I. sororia</u> Kunth	
Eleocharis	0469010
<u>E. atropurpurea</u> (Retz.) Presl	
<u>E. dregeana</u> Steud.	
<u>E. limosa</u> (Schrad.) Schult.	
Fimbristylis	0471000
<u>F. hispidula</u> (Vahl.) Kunth	
Bulbostylis	0471010
<u>B. burchelli</u> (Fiscal. & Hiern) C.B. CL.	
<u>B. densa</u> (Wall.) Hand - Mazz.	
Abildgaardia	0471020
<u>A. ovata</u> (Burm. F.) Kral	
Coleochloa	0512000
<u>C. setifera</u> (Ridley) Gilly	
LEMNACEAE	0794000
Spirodela	0794000
<u>S. polyrrhiza</u> (L.) Schleid.	
Lemna	0795000
<u>L. gibba</u> L.	
XYRIDACEAE	0826000
Xyris	0826000
<u>X. capensis</u> Thunb.	
COMMELINACEAE	0893000

Commelina	0896000
<u>C. africana</u> L. var. <u>africana</u>	
<u>C. africana</u> L. var. <u>lancispatha</u> C.B. Cl.	
<u>C. beneghalensis</u> L.	
<u>C. eckloniana</u> Kunth	
<u>C. erecta</u> L.	
<u>C. livingstonii</u> C.B. Cl.	
Cyanotis	0904000
<u>C. speciosa</u> (L.F.) Hassk.	
PONTEDERIACEAE	0920000
Eichhornia	0921000
<u>E. crassipes</u> (Mart.) Solms - Laub. *	
JUNCACEAE	0930000
Juncus	0936000
<u>J. dregeanus</u> Kunth	
<u>J. exsertus</u> Buchen.	
<u>J. rigidus</u> Desf.	
LILIACEAE	0942000
Androcymbium	0969000
<u>A. burkei</u> Bak.	
<u>A. melanthioides</u> Willd. var. <u>.melanthioides</u>	
Bulbine	0985000
<u>B. abyssinica</u> A. Rich.	
<u>B. capitata</u> V. Poelln.	
<u>B. frutescens</u> (L.) Willd.	
<u>B. lagopus</u> (Thunb.) N.E. Br.	
<u>B. narcissifolia</u> Salm - Dyck	

Trachyandra	0985010
<u>T. asperata</u> Kunth var. <u>asperata</u>	
<u>T. asperata</u> Kunth var. <u>basutoensis</u> (V. Poelln.) Oberm.	
<u>T. asperata</u> Kunth var. <u>macowanii</u> (Bak.) Oberm.	
<u>T. asperata</u> Kunth var. <u>nataglencoensis</u> (Kuntze.) Roessl.	
<u>T. burkei</u> (Bak.) Oberm.	
<u>T. laxa</u> (N.E.Br.) Oberm.	
<u>T. saltii</u> (Bak.) Oberm.	
<u>T. species</u>	
Anthericum	0989000
<u>A. angulicaule</u> Bak.	
<u>A. cooperi</u> Bak.	
<u>A. fasciculatum</u> Bak.	
<u>A. galpinii</u> Bak. var. <u>galpinii</u>	
<u>A. species</u>	
<u>A. trichophlebium</u> Bak.	
Schizobasis	1010000
<u>S. intricata</u> (Bak.) Bak.	
<u>S. species</u>	
Eriospermum	1012000
<u>E. burchellii</u> Bak.	
<u>E. cf. E galpinii</u> Schinz	
<u>E. pilosum</u> V. Poelln.	
<u>E. porphyrium</u> Archib.	
<u>E. species</u>	
Kniphofia	1024000
<u>K. ensifolia</u> Bak. subsp. <u>ensiflora</u>	

<u>K. typhoides</u> Codd	
Aloe	1026000
<u>A. davyana</u> Schonl. var. <u>davyana</u>	
<u>A. grandidentata</u> Salm - Dyck.	
<u>A. greatheadii</u> Schonl. var. <u>davyana</u> (Schonl.) Glen & Hardy	
<u>A. transvaalensis</u> Kuntze	
Haworthia	1029000
<u>H. angolensis</u> Bak.	
Tulbaghia	1047000
<u>T. acutiloba</u> Harv.	
<u>T. alliacea</u> L. F.	
<u>T. leucantha</u> Bak.	
Nothoscordum	1050000
<u>N. gracile</u> (Ait) Stearn *	
Albuca	1079000
<u>A. cooperi</u> Bak.	
<u>A. setosa</u> Jacq.	
<u>A. shawii</u> Bak.	
<u>A. species</u>	
Urginea	1080000
<u>U. capitata</u> (Hook.) Bak.	
<u>U. multisetosa</u> Bak.	
Drimia	1082000
<u>D. robusta</u> Bak.	
<u>D. species</u>	
Dipcadi	1084000
<u>D. ciliare</u> (Zeyh. ex Harv.) Bak	
<u>D. gracillimum</u> Bak.	

<u>D. marlothii</u> Engl.	
<u>D. species</u>	
<u>D. viride</u> (L.) Moench	
Scilla	1086000
<u>S. nervosa</u> (Burch.) Jessop.	
<u>S. species</u>	
Eucomis	1088000
<u>E. autumnalis</u> (Mill.) Chitt. subsp. <u>clavata</u> (Bak.) Reyneke	
<u>E. species</u>	
Ornithogalum	1089000
<u>O. graminifolium</u> Thunb.	
<u>O. juncifolium</u> Jacq.	
<u>O. ornithogaloides</u> Kunth) Oberm.	
<u>O. prasinum</u> Lindl.	
<u>O. tenuifolium</u> Delorache subsp. <u>tenuifolium</u>	
Drimiopsis	1090000
<u>D. cf. D. burkei</u> Bak.	
Ledebouria	1090010
<u>L. cooperi</u> (Hook. F.) Jessop	
<u>L. luteola</u> Jessop	
<u>L. marginata</u> (Bak.) Jessop	
<u>L. ovatifolia</u> (Bak.) Jessop	
<u>L. species</u>	
Polyxena	1099000
<u>P. odorata</u> (Hook. F.) Bak.	
Massonia	1101000
<u>M. jasminiflora</u> Burch. ex Bak.	

Protasparagus	1113000
<u>P. africanus</u> Lam.	
<u>P. bechuanicus</u> (Bak.) Oberm.	
<u>P. cooperi</u> (Bak.) Oberm.	
<u>P. flavicaulis</u> Obern. subsp. <u>flavicaulis</u>	
<u>P. laricinus</u> Burch.	
<u>P. setaceus</u> (Kunth) Oberm.	
<u>P. suaveolens</u> Burch.	
AMARYLLIDACEAE	1166000
Haemanthus	1167000
<u>H. amarylloides</u> Jacq. subsp. <u>amarylloides</u>	
<u>H. montanus</u> Bak.	
<u>H. nelsonii</u> Bak.	
Scadoxus	1167010
<u>S. puniceus</u> (L.) Feil. & Nordal	
Boophane	1168000
<u>B. disticha</u> (L.F.) Herb.	
Nerine	1175000
<u>N. frithii</u> L.	
<u>N. hesseodes</u> L. Bol.	
<u>N. laticoma</u> (Ker - Gawl.) Dur. & Schinz	
Brunsvigia	1177000
<u>B. radulosa</u> Herb.	
Gethyllis	1186000
<u>G. spiralis</u> L.F.	
Crinum	1189000
<u>C. bulbispermum</u> (Burm. F.) Milne-Redh. & Schweick.	
<u>C. graminicola</u> Verdoorn	

Ammocharis	1190000
<u>A. coranica</u> (Ker - Gawl.) Herb.	
HYPOXIDACEAE	1229010
Hypoxis	1230000
<u>H. argentea</u> Harv. ex Bak.	
<u>H. filiformis</u> Bak.	
<u>H. hemerocallidea</u> Fisch. & Mey.	
<u>H. iridifolia</u> Bak.	
<u>H. multiceps</u> Buchinger	
<u>H. rigidula</u> Bak. var. <u>rigidula</u>	
<u>H. rooperi</u> S. Moore	
<u>H. species</u>	
IRIDACEAE	1259000
Moraea	1265000
<u>M. polystachya</u> (Thunb.) Ker - Gawl.	
<u>M. species</u>	
<u>M. thomsonii</u> Bak.	
<u>M. trifida</u> R.C. Fost.	
Gynandriris	1265020
<u>G. simulans</u> (Bak.) R.C. Fost.	
Homeria	1277000
<u>H. cookii</u> L. Bol.	
<u>H. pallida</u> Bak.	
Duthiastrum	1306020
<u>D. linifolium</u> (Phill.) De Vos	
Gladiolus	1311000
<u>G. dalenii</u> Van Geel	

<u>G. ecklonii</u> Lehm. subsp. <u>ecklonii</u>	
<u>G. permeabilis</u> Delaroché subsp. <u>edulis</u> (Burch. ex Ker - Gawl.) Oberm.	
Lapeirousia	1314000
<u>L. plicata</u> (Jacq.) Diels subsp. <u>plicata</u>	
<u>L. species</u>	
Watsonia	1315000
<u>W. species</u>	
ORCHIDACEAE	1389000
Habenaria	1422000
<u>H. dregeana</u> Lindl.	
<u>H. epipactidea</u> Reichb. F.	
Bonatea	1422020
<u>B. speciosa</u> (L.F.) Willd.	
Eulophia	1648000
<u>E. ovalis</u> Lindl. subsp. <u>ovalis</u>	
DICOTYLEDONAE	
SALICACEAE	1872000
Salix	1873000
<u>S. babylonica</u> L. *	
<u>S. capensis</u> Thunb.	
<u>S. mucronata</u> Thunb. subsp. <u>capensis</u> (Thunb.) Immelman	
ULMACEAE	1894000
Celtis	1898000
<u>C. africana</u> Burn. F.	
PROTEACEAE	2016000
Protea	2035000
<u>P. caffra</u> Meisn.	

LORANTHACEAE	2070000
Tapinanthus	2074010
<u>T. rubromarginatus</u> (Engl.) Danser	
VISCACEAE	2093000
Viscum	2093000
<u>V. rotundifolium</u> L.f.	
SANTALACEAE	2096000
Osyris	2108000
<u>O. lanceolatus</u> Hochst. & Steud.	
Thesium	2118000
<u>T. costatum</u> A.W. Hill var. <u>costatum</u>	
<u>T. burkei</u> A.W. Hill	
<u>T. hirsutum</u> A.W. Hill	
<u>T. sp</u> cf. <u>T. resedoides</u> A.W. Hill	
<u>T. sp</u> cf. <u>T. spartioides</u> A.W. Hill	
<u>T. species</u>	
<u>T. transvaalense</u> Schltr.	
<u>T. utile</u> A.W. Hill	
POLYGONACEAE	2184000
Emex	2194000
<u>E. australis</u> Steinh. *	
Rumex	2195000
<u>R. angiocarpus</u> Murb.*	
<u>R. conglomeratus</u> Murb.	
<u>R. lanceolatus</u> Thunb.	
<u>R. sagittatus</u> Thunb.	
<u>R. steudelii</u> Hochst. ex A. Rich.	
Polygonum	2201000

<u>P. amphibium</u> L.	
<u>P. aviculare</u> L. *	
<u>P. hystriculum</u> Schuster	
<u>P. lapathifolium</u> L. subsp. <u>maculatum</u> (S.F. Gray) T.Dyer & Trim.	
<u>P. pulchrum</u> Blume	
<u>P. salicifolium</u> Willd.	
Oxygonum	2204000
<u>O. dregeanum</u> Meisn. var. <u>canescens</u> (Sond.) R.A. Grah.	
CHENOPODIACEAE	2214000
Chenopodium	2223000
<u>C. album</u> L.	
<u>C. ambrosioides</u> L.	
<u>C. botryodes</u> SM.	
<u>C. multifidum</u> L. *	
<u>C. murale</u> L.	
<u>C. phillipsianum</u> Aell.	
Atriplex	2229000
<u>A. semibaccata</u> R. Br. *	
Kochia	2240000
<u>K. indica</u> Wight	
Salsola	2269000
<u>S. aphylla</u> L.F.	
<u>S. calluna</u> Fenzl ex C. H. Wr.	
<u>S. glabrescense</u> Burttt Davy	
<u>S. kali</u> L.	
<u>S. rabieana</u> Verdoorn	
<u>S. species</u>	

AMARANTHACEAE	2289000
Hermbstaeditia	2293000
<u>H. odorata</u> (Burch.) T. Cooke var. <u>odorata</u>	
Amaranthus	2299000
<u>A. caudatus</u> L.	
<u>A. deflexus</u> L. *	
<u>A. hybridus</u> L.	
<u>A. thunbergii</u> Moq.	
<u>A. species</u>	
Sericorema	2307000
<u>S. remotiflora</u> (Hook. F.) Lopr.	
Kyphocarpa	2309000
<u>K. angustifolia</u> (Moq.) Lopr.	
Cyathula	2312000
<u>C. globulifera</u> Moq.	
Pupalia	2314000
<u>P. lappacea</u> (L.) Juss.	
Aerva	2317000
<u>A. leucura</u> Moq.	
Achyranthes	2328000
<u>A. aspera</u> L.	
Brayulinea	2330000
<u>B. densa</u> (Willd.) Small*	
Alternanthera	2335000
<u>A. nodiflora</u> R. Br	
<u>A. pungens</u> H.B.K. *	
<u>A. repens</u> (L.) O.Ktze.	

Gomphrena	2338000
<u>G. celosioides</u> Mart.	
NYCTAGINACEAE	2343000
Mirabilis	2347000
<u>M. jalapa</u> L.	
Commicarpus	2347010
<u>C. africanus</u> (Lour.) Dandy	
<u>C. pentandrus</u> (Burch.) Heimerl	
<u>C. species</u>	
AIZOACEAE	2374000
Limeum	2376000
<u>L. sulcatum</u> (Klotzsch) Hutch. var. <u>sulcatum</u>	
<u>L. viscosum</u> (Gay) Fenzl	
Psammotropha	2379000
<u>P. myriantha</u> Sond.	
PHYTOLACCACEAE	2380000
Phytolacca	2380000
<u>P. heptandra</u> Retz.	
Gisekia	2382000
<u>G. africana</u> (Lour.) Kuntze	
<u>G. pharnacioides</u> L.	
Mollugo	2387000
<u>M. cerviana</u> (L.) Ser. ex DC. var. <u>cerviana</u>	
Pharnaceum	2389000
<u>P. brevicaule</u> (DC.) Bartl.	
<u>P. verrucosum</u>	
Hypertelis	2390000
<u>H. salsoloides</u> (Burch.) Adamson	

Trianthema	2395000
<u>T. triquetra</u> Willd. subsp. <u>parvifolia</u> (Sond.) Jeffrey	
Galenia	2399000
<u>G. pubescens</u> (Eckl. & Zeyh.) Druce	
Aizoon	2401000
<u>A. canariense</u> L.	
MESEMBRYANTHEMACEAE	2405001
Aloinopsis	2405003
<u>A. species</u>	
Aptenia	2405009
<u>A. cordifolia</u> (L.F.) Schwant. var. <u>cordifolia</u>	
Braunsia	2405018
<u>B. apiculata</u> (Kensit) L. Bol.	
Chasmatophyllum	2405026
<u>C. musculinum</u> (Haw.) Dinter & Schwant.	
Delosperma	2405033
<u>D. cooperi</u> (Hook. f.) L. Bol.	
<u>D. herbeum</u> (N.E. Br.) (N.E.Br.)	
<u>D. imbricatum</u> L. Bol.	
<u>D. mahonii</u> (N.E. Br.) N.E. Br.	
<u>D. pontii</u> L. Bol.	
<u>D. species</u>	
<u>D. sutherlandii</u> (Hook. F.) N.E. Br.	
Herrea	2405056
<u>H. species</u>	
Lithops	2405069
<u>L. lesliei</u> (N.E. Br.) N.E. Br.	

<u>L. species</u>	
Mestoklema	2405074
<u>M. arboriforme</u> (Burch.) N.E. Br. ex Glen	
<u>M. tuberosum</u> (L.) N.E. Br. ex Glen	
Nananthus	2405084
<u>N. transvaalensis</u> (Rolf) L. Bol. var. <u>transvaalensis</u>	
Psilocaulon	2405101
<u>P. species</u>	
Rhuschia	2405105
<u>R. hamata</u> (L. Bol.) Schwant.	
<u>R. karrooica</u> (L. Bol. L. Bol.	
<u>R. putterillii</u> (L. Bol.) L. Bol.	
<u>R. species</u>	
<u>R. uncinata</u> (L.) Schwant.	
<u>R. unidens</u> (Haw.) Schwant.	
Stomatium	2405119
<u>S. erminimum</u> (Haw.) Schwant.	
PORTULACACEAE	2406000
Talinum	2406000
<u>T. arnotii</u> Hook. F.	
<u>T. caffrum</u> (Thunb.) Eckl. & Zeyh.	
<u>T. species</u>	
Anacampseros	2412000
<u>A. species</u>	
<u>A. subnuda</u> V. Poelln.	
Portulaca	2421000
<u>P. kermesina</u> N.E. Br.	

<u>P. oleracea</u> L.*	
<u>P. quadrifida</u> L.	
CARYOPHYLLACEAE	2429000
Cerastium	2430000
<u>C. capense</u> Sond.	
ILLECEBRACEAE	2467000
Pollichia	2467000
<u>P. campestris</u> Ait.	
<u>P. species</u>	
Herniaria	2476000
<u>H. erckertii</u> Herm. subsp. <u>erckertii</u>	
Silene	2490000
<u>S. burchellii</u> Otth	
<u>S. undulata</u> Ait.	
Dianthus	2502000
<u>D. micropetallus</u> Ser	
<u>D. mooiensis</u> I. Williams	
<u>D. species</u>	
CERATOPHYLLACEAE	2516000
Ceratophyllum	2516000
<u>C. demersum</u> L.	
RANUNCULACEAE	2521000
Clematis	2542000
<u>C. brachiata</u> Thunb.	
Ranunculus	2546000
<u>R. multifidus</u> Forssk.	
<u>R. trichophyllus</u> Chaix subsp. <u>drouetii</u> (Schultz) Clapham	
MENISPERMACEAE	2567000

Antizoma	2573000
<u>A. angustifolia</u> (Burch.) Miers ex Harv.	
Cissampelos	2547000
<u>C. capensis</u> L.F.	
PAPAVERACEAE	2833000
Argemone	2852000
<u>A. subfusiformis</u> G.B. Ownbey *	
Papaver	2853000
<u>P. aculeatum</u> Thunb.	
BRASSICACEAE	2863000
Lepidium	2883000
<u>L. africanum</u> (Burch.) DC.	
Coronopus	2884000
<u>C. integrifolius</u> (DC.) Spreng. *	
Sisymbrium	2917000
<u>S. burchellii</u> DC.	
<u>S. capense</u> Thunb.	
<u>S. orientale</u> L. *	
<u>S. species</u>	
<u>S. thellungii</u> O.E. Schulz	
Brassica	2949000
<u>B. species</u>	
Rorippa	2965000
<u>R. fluviatilis</u> (E. Mey. ex Sond.) Thell. var <u>fluviatilis</u>	
<u>R. nasturtium - aquaticum</u> (L.) Hayek	
<u>R. nudiuscula</u> Thell.	
Capsella	2986000

<u>C. bursa - pastoris</u> (L.) Medik.	
CAPPARACEAE	3082000
Cleome	3082000
<u>C. maculata</u> (Sond.) Szyszyl.	
<u>C. monophylla</u> L.	
<u>C. rubella</u> Burch.	
Boscia	3106000
<u>B. albitrunca</u> (Burch.) Gilg & Ben.	
RESEDACEAE	3122000
Oligomeris	3126000
<u>O. dregeana</u> (Muell. Arg.) Muell. Arg.	
CRASSULACEAE	3161000
Kalanchoe	3166000
<u>K. paniculata</u> Harv.	
<u>K. rotundifolia</u> (Haw.) Haw.	
Crassula	3168000
<u>C. capitella</u> Thunb.	
<u>C. capitella</u> Thunb. subsp. <u>nodulosa</u> (Schonl.) Toelken	
<u>C. corallina</u> Thunb. subsp. <u>corallina</u>	
<u>C. decumbens</u> Thunb.	
<u>C. deltoidea</u> Thunb.	
<u>C. lancoelata</u> (Eckl. & Zeyh.) endl ex. Walp. subsp. <u>lanceolata</u>	
<u>C. lanceolata</u> (Eckl. & Zeyh.) Endl. ex Walp. subsp. <u>transvaalensis</u> (Kuntze) Toelken	
<u>C. muscosa</u> L. var. <u>muscosa</u>	
<u>C. natalensis</u> Schonl.	
<u>C. nudicaulis</u> L. var. <u>nudicaulis</u>	
<u>C. obovata</u> Haw. var. <u>obovata</u>	

<u>C. setulosa</u> Harv.	
<u>C. schimpari</u> Fischer & C.A. Mey. var. <u>schimpari</u>	
<u>C. species</u>	
<u>C. transvaalensis</u> (Kuntze) K. Schum.	
Adromischus	3175000
<u>A. umbraticola</u> C.A. SM.	
VAHLIACEAE	3201000
Vahlia	3201000
<u>V. capensis</u> (L.F.) Thunb. subsp. <u>capensis</u>	
<u>V. capensis</u> Thunb. subsp. <u>vulgaris</u> Bridson var. <u>linearis</u> E. Mey. ex Bridson	
MYROTHAMANACEAE	3282000
Myrothamnus	3282000
<u>M. flabellifolia</u> (Sond.) Welw.	
FABACEAE	3443000
Acacia	3446000
<u>A. caffra</u> (Thunb.) Willd.	
<u>A. erioloba</u> E. Mey.	
<u>A. hebeclada</u> DC. subsp. <u>hebeclada</u>	
<u>A. hereroensis</u> Engl.	
<u>A. karroo</u> Hayne	
<u>A. mellifera</u> (Vahl) Benth. subsp. <u>detinens</u> (Burch.) Brenan	
<u>A. robusta</u> Burch.	
Elephantorrhiza	3467000
<u>E. elephantina</u> (Burch.) Skeels	
Cassia	3536000
<u>C. biensis</u> (Steyaert) Mendonca & Torre	
<u>C. mimosoides</u> L. Groep 1	

C. italica
C. guarrei (Ghesq.) Steyaert
Senna 3536020
S. italica Mill. subsp. arachoides (Burch.) Lock
Lotononis 3657000
L. bainesii Bak.
L. calycina (E.Mey.) Benth.
L. laxa Eckl. & Zeyh. var. laxa
L. listii Polhill
L. mucronata Conrath.
L. oocarpa Dinter ex Wilman
L. species
Pearsonia 3657010
P. cajanifolia (Harv.) Polhill subsp. cajanifolia
P. sessilifolia (Harv.) Duemmer
P. uniflora (Kensit) Polhill
Dichilus 3664000
D. strictus E. Mey.
Melolobium 3665000
M. candicans (E.Mey) Eckl. Zeyh.
Crotalaria 3669000
C. brachycarpa (Benth.) Burt Davy ex Verdoorn
C. burkeana Benth.
C. distans Benth.
C. orientalis Burt Davy ex Verdoorn subsp. orientalis
C. sphaerocarpha Perr. ex DC.
C. species

Argyrolobuim	3673000
<u>A. nanum</u> Schltr. ex Harms	
<u>A. pauciflorum</u> Eckl. & Zeyh. var. <u>pauciflorum</u>	
<u>A. rupestre</u> (Eckl. & Zeyh.) Walp.	
<u>A. species</u>	
Medicago	3688000
<u>M. laciniata</u> (L.) Mill.	
<u>M. polymorpha</u> L.	
<u>M. sativa</u> L. subsp. <u>sativa</u>	
Melilotus	3689000
<u>M. indica</u> (L.) All.	
Trifolium	3690000
<u>T. africanum</u> ser. var. <u>africanum</u>	
Indigofera	3702000
<u>I. acutisepala</u> Conrath	
<u>I. alternans</u> DC.	
<u>I. bainesii</u> Bak.	
<u>I. comosa</u> N.E. Br.	
<u>I. costata</u> Guill. & Perr. subsp. <u>macra</u> (E. Mey.) J.B. Gillett	
<u>I. cryptantha</u> Benth. ex Harv. var. <u>cryptantha</u>	
<u>I. daleoides</u> Benth. ex Harv. var. <u>daleoides</u>	
<u>I. filipes</u> Benth. ex Harv.	
<u>I. heterophylla</u> Thunb.	
<u>I. heterotricha</u> DC.	
<u>I. hilaris</u> Eckl. & Zeyh.	
<u>I. laxeracemosa</u> Bak. F.	
<u>I. longipes</u> N.E. Br.	

<u>I. melanadenia</u> Benth. ex Harv.	
<u>I. rhytidocarpa</u> Benth. ex Harv. subsp. <u>rhytidocarpa</u>	
<u>I. sanguinea</u> N.E. Br.	
<u>I. sessilifolia</u> DC.	
<u>I. setiflora</u> Bak.	
<u>I. species</u>	
<u>I. spinescens</u> E. Mey.	
<u>I. torulosa</u> E. Mey. var. <u>angustiloba</u> (Bak.F.) Gillett	
<u>I. tristis</u> E. Mey.	
<u>I. vicioides</u> Jaub. & Spach var. <u>vicioides</u>	
Psoralea	3703000
<u>P. pinnata</u>	
Tephrosia	3718000
<u>T. burchellii</u> Burt Davy	
<u>T. capensis</u> (Jacq.) pers. var. <u>capensis</u>	
<u>T. elongata</u> E. Mey.	
<u>T. longipes</u> Meisn.	
<u>T. lupinifolia</u> DC.	
<u>T. multijuga</u> R.G.N. Young	
<u>T. semiglabra</u> Sond.	
<u>T. sparsiflora</u> H.M. Forbes	
<u>T. species</u>	
Mundulea	3719000
<u>M. sericea</u> (Willd.) A. Chev.	
Sesbania	3747000
<u>S. punicea</u> (Cav.) Benth.	
<u>S. transvaalensis</u> J.B.Gillett	
Sutherlandia	3754000

<u>S. frutescens</u> R. Br.	
Lessertia	3756000
<u>L. depressa</u> Harv.	
<u>L. prostrata</u> DC.	
Zornia	3804000
<u>Z. capensis</u> Pers.	
<u>Z. milneana</u> Mohl.	
Neurautanenia	3865000
<u>N. ficifolius</u> (Benth.) C.A. Sm.	
Erythrina	3870000
<u>E. zeyheri</u> Harv.	
Rhynchosia	3897000
<u>R. caribaea</u> (Jacq.) DC.	
<u>R. confusa</u> Burttt Davy	
<u>R. holosericea</u> Schinz	
<u>R. minima</u> (L.) DC. var. <u>minima</u>	
<u>R. nervosa</u> Benth. & Harv. var. <u>nervosa</u>	
<u>R. totta</u> (Thunb.) DC. var. <u>totta</u>	
<u>R. venulosa</u> (Hiern) K. Schum.	
Eriosema	3898000
<u>E. cordatum</u> E. Mey.	
<u>E. salignum</u> E. Mey.	
Vigna	3905000
<u>V. angustifoliolata</u> Verdc.	
<u>V. oblongifolia</u> A. Rich. var. <u>oblongifolia</u>	
<u>V. oblongifolia</u> A. Rich. var. <u>parviflora</u> (Bak.) Verdc.	
<u>V. vexillata</u> (L.) A. Rich.	

Dolichos	3910000
<u>D. angustifolius</u> Eckl. & Zeyh.	
<u>D. linearis</u> E. Mey.	
GERANIACEAE	3924000
Monsonia	3925000
<u>M. angustifolia</u> E. Mey> ex A. Rich.	
<u>M. attenuata</u> Harv.	
<u>M. burkeana</u> Planch. ex Harv.	
Pelargonium	3928000
<u>P. luridum</u> (Andr.) Sweet	
<u>P. myrrhifolium</u> (L.) L'Herit.	
<u>P. sidifolium</u> (Thunb.) Knuth	
<u>P. species</u>	
OXALIDACEAE	3935000
Oxalis	3936000
<u>O. aurea</u> Schltr.	
<u>O. convexula</u> Jacq.	
<u>O. corniculata</u> L.*	
<u>O. depressa</u> Eckl. & Zeyh.	
<u>O. latifolia</u> H.B.K.	
<u>O. species</u>	
ZYGOPHYLLACEAE	3958000
Tribulus	3978000
<u>T. terrestris</u> L.	
RUTACEAE	3986000
Zanthoxylum	3991000
<u>Z. capense</u> (Thunb.) Harv.	
MALPIGHIACEAE	4201000

Sphedamnocarpus	4219000
<u>S. transvalicus</u> (Kuntze) Burt Davy	
POLYGALACEAE	4273000
Polygala	4273000
<u>P. amatymbica</u> ckl. & Zeyh.	
<u>P. gymnoclada</u> Macowan	
<u>P. hottentotta</u> Presl	
EUPHORBIACEAE	4286000
Phyllanthus	4299000
<u>P. glaucophyllus</u> Sond.	
<u>P. heterophyllus</u> E. Mey.	
<u>P. incurvus</u> Thunb.	
<u>P. maderaspatensis</u> L.	
<u>P. parvulus</u> Sond.	
Leidesia	4372000
<u>L. procumbens</u> (L.) Prain	
Acalypha	4407000
<u>A. angustata</u> Sond. var. <u>glabra</u> Sond.	
<u>A. caperonioides</u> Baill.	
<u>A. punctata</u> Meisn. var. <u>punctata</u>	
Tragia	4416000
<u>T. rupestris</u> Sond.	
Jatropha	4433000
<u>J. zeyheri</u> Sond. var. <u>zeyheri</u>	
Clutia	4448000
<u>C. natalensis</u> Bernh. ex Krauss	
<u>C. pulchella</u> L.	

Euphorbia	4498000
<u>E. clavarioides</u> Boiss var. <u>clavarioides</u>	
<u>E. clavarioides</u> Boiss var. <u>truncata</u> (N.E. Br.) White , Dyer & Sloane	
<u>E. mixta</u> N.E. Br.	
<u>E. pseudotuberosa</u> Pax	
<u>E. striata</u> Thunb.	
<u>E. species</u>	
Chamaesyce	4498010
<u>C. inequilatera</u> (Sond.) Sojak	
<u>C. prostrata</u> (Ait.) Small *	
ANACARDIACEAE	4543000
Smodingium	4588000
<u>S. argutum</u> E. Mey. ex Sond.	
Ozoroa	4589010
<u>O. paniculosa</u> (Sond.) R. & A. Fernandes var. <u>paniculosa</u>	
Rhus	4594000
<u>R. ciliata</u> Licht. ex Roem. & Schultes	
<u>R. eckloniana</u> Sond.	
<u>R. lancea</u> L.f.	
<u>R. leptodictya</u> Diels	
<u>R. magalismsontana</u> Sond.	
<u>R. pyroides</u> Burch.	
<u>R. rigida</u> Mill.	
<u>R. rehmanniana</u> Engl.	
<u>R. undulata</u> Jacq. var. <u>undulata</u>	
CELESTRACEAE	4618000

Maytenus	4626000
<u>M. heterophylla</u> (Eckl. Zeyh.) N.K.B. Robson*	
<u>M. polyacantha</u> (Sond.) Marias	
<u>M. tenuispina</u> (Sond.) Marias	
Cassine	4641000
<u>C. aethiopica</u> Thunb.	
SAPINDACEAE	4723000
Pappea	4784000
<u>P. capensis</u> Eckl. & Zeyh.	
RHAMNACEAE	4858000
Ziziphus	4861000
<u>Z. mucronata</u> Willd.	
<u>Z. zeyheriana</u> Sond.	
Bechemia	4868000
<u>B. zeyheri</u> (Sond.) Grubov	
Helinus	4905000
<u>H. integrifolius</u> (Lam.) Kuntze	
VITACEAE	4909000
Rhoicissus	4917000
<u>R. tridentata</u> (L.f.) Wild & Drum.	
Cyphostemma	4918010
<u>C. hereroense</u> (Schinz) Descoings ex Wild & Drum.	
<u>C. species</u>	
TILIACEAE	4937000
Corchorus	4953000
<u>C. asplenifolius</u> Burch.	
Grewia	4966000
<u>G. flava</u> DC.	

<u>G. monticola</u> Sond.	
<u>G. occidentalis</u> L.	
<u>G. species</u>	
Triumfetta	4975000
<u>T. sonderi</u> Fical. & Hiern	
MALVACEAE	4980000
Abutilon	4983000
<u>A. angulatum</u> (Guill. & Perr.) Mast.	
<u>A. sonneratianum</u> (CAV.) Sweet	
Sphaeralcea	4986000
<u>S. bonariensis</u> (Cav.) Griseb. *	
Malva	4992000
<u>M. neglecta</u> Wallr.	
<u>M. parviflora</u> L. *	
Sida	4998000
<u>S. cordifolia</u> L.	
<u>S. chrysantha</u> Ulbr.	
<u>S. dregei</u> Burt Davy	
<u>S. rhombifolia</u> L.	
<u>S. ternata</u> L. F.	
Pavonia	5007000
<u>P. burchellii</u> (DC.) R.A. Dyer	
Hibiscus	5013000
<u>H. calyphyllus</u> CAV.	
<u>H. engleri</u> K. Schum.	
<u>H. microcarpus</u> Garcke	
<u>H. pusillus</u> Thunb.	

<u>H. trionum</u> L.	
STERCULIACEAE	5044000
Melhania	5047000
<u>M. prostrata</u> DC.	
<u>M. rehmannii</u> Szyszyl.	
Dombeya	5053000
<u>D. rotundifolia</u> (Hochst.) Planch. var. <u>rotundifolia</u>	
Hermannia	5056000
<u>H. betonicifolia</u> Eckl. & Zeyh.	
<u>H. bicolor</u> Engl. & Dinter	
<u>H. coccocharpa</u> (Eckl. & Zeyh.) Kuntze	
<u>H. cordata</u> (E.Mey. ex Phill.) (Eckl. & Zeyh.) De Winter	
<u>H. depressa</u> N.E. Br.	
<u>H. floribunda</u> Harv.	
<u>H. grandistipula</u> (Buchinger ex Hochst.) K. Schum.	
<u>H. lancifolia</u> Sysyl.	
<u>H. oblongifolia</u> (Harv.) Hochr.	
<u>H. species</u> cf. <u>H. quartiniana</u> A. Rich.	
<u>H. species</u>	
<u>H. tomentosa</u> (Turcz.) ex Engl.	
CLUSIACEAE	5162000
Hypericum	5168000
<u>H. lalandii</u> Choisy	
ELATINACEAE	5230000
Bergia	5230000
<u>B. decumbens</u> Planch. ex Harv.	
<u>B. pentheriana</u> Keissl.	
<u>B. species</u>	

FRANKENIACEAE	5232000
Frankenia	5233000
<u>F. pulverulenta</u> L.	
FLACOURTIACEAE	5275000
Kiggelaria	5296000
<u>K. africana</u>	
Scolopia	5304000
<u>S. zeyheri</u> (Nees) Harv.	
CACTACEAE	5401000
Opuntia	5417000
<u>O. aurantiaca</u> Lindl.	
<u>O. ficus - indica</u> (L.) Mill. *	
<u>O. vulgaris</u> Mill.	
THYMELAEACEAE	5429000
Gnidia	5435000
<u>G. burchellii</u> (Meisn.) Gilg	
<u>G. caffra</u> Meisn.	
<u>G. capitata</u> L. F.	
<u>G. kraussiana</u> Meisn. var. <u>kraussiana</u>	
<u>G. sericocephala</u> (Meism.) Gilg. ex Engl.	
COMBRETACEAE	5536000
Combretum	5538000
<u>C. molle</u> R. Br. ex G. Don	
ONAGRACEAE	5791000
Ludwigia	5793000
<u>L. stolonifera</u> (Guill. & Perr.) Raven	
Epilobium	5795000

<u>E. species</u>	
Oenothera	5804000
<u>O. inecora</u> Cambess. subsp. <u>indecora</u> *	
<u>O. jamesii</u> Torr. & Gray *	
<u>O. rosea</u> L'Herit. ex Ait. *	
<u>O. tetraptera</u> Cav. *	
HALORAGACEAE	5830000
Myriophyllum	5834000
<u>M. aquaticum</u> (Vell.) Verdc. *	
<u>M. spicatum</u> L.	
ARALIACEAE	5839000
Cussonia	5872000
<u>C. paniculata</u>	
APIACEAE	5893000
Conium	5970000
<u>C. chaerophylloides</u> (Thunb.)Eckl. & Zeyh.	
Bupleurum	5994000
<u>B. mundtii</u> Cham. & Schlechtd.	
Heteromorpha	5992000
<u>H. trifoliata</u> (Wendl.) Eckl. & Zeyh.	
Apium	6004000
<u>A. leptophyllum</u> (Pers.) F. Muell.	
<u>A. species</u>	
Deverra	6013000
<u>D. burchellii</u> (DC.) Eckl. & Zeyh.	
Berula	6038010

<u>B. erecta</u> (Hudson) Cov.	
Choritaenia	6129000
<u>C. capensis</u> (Sond. & Harv.) Burt Davy	
MYRSINACEAE	6283000
Myrsine	6313000
<u>M. africana</u> L.	
PLUMBACINACEAE	6343000
Plumbago	6343000
<u>P. auriculata</u> Lam.	
EBENACEAE	6403000
Euclea	6404000
<u>E. crispa</u> (Thunb.) Guerke	
<u>E. undulata</u> Thunb. var. <u>myrtina</u> (Burch.) Hiern	
Diospyros	6406000
<u>D. astro - africana</u> De Wint. var. <u>microphylla</u> (Burch.) De Wint.	
<u>D. lycioides</u> Desf.	
<u>D. whyteana</u> Hiern) F. White	
OLEACEAE	6419000
Olea	6434000
<u>O. europaea</u> L. subsp. <u>africana</u> (Mill.) P.S. Green	
Menodora	6438000
<u>M. africana</u> Hook	
LOGANIACEAE	6447000
Nuxia	6469000
<u>N. congesta</u> R. Br. ex Fresen.	
Gomphostigma	6470000
<u>G. virgatum</u> (L.f.) Baill.	
Buddleja	6473000

<u>B. saligna</u> Willd.	
<u>B. salviifolia</u> (L.) Lam.	
GENTIANACEAE	6479000
Sebaea	6481000
<u>S. exigua</u> (Oliv.) Schinz	
<u>S. grandis</u> (E. Mey.) Steud.	
Chironia	6503000
<u>C. palustris</u> Burch.	
PERIPLOCACEAE	6729000
Cryptolepis	6740000
<u>C. oblongifolia</u> (Meisn.) Schltr.	
Raphionacme	6747000
<u>R. burkei</u> N.E. Br.	
<u>R. dyeri</u> Retief & Venter	
<u>R. galpinii</u> Schltr.	
<u>R. hirsuta</u> (E. Mey.) R.A. Dyer ex Phill.	
<u>R. species</u>	
<u>R. zeyheri</u> Harv.	
ASCLEPIADACEAE	6752000
Microloma	6752000
<u>M. hystericoides</u> Wanntorp	
Parapodium	6762000
<u>P. cstatum</u> E. Mey.o	
Araujia	6771000
<u>A. sericifera</u> Brot. *	
Xysmalobium	6777000
<u>X. brownianum</u> S. Moore	

<u>X. parviflorum</u> Harv. ex Scott Elliot	
<u>X undulatum</u> (L.) Ait. F.	
Schizoglossum	6778000
<u>S. aschersonianum</u> Schltr. var. <u>aschersonianum</u>	
<u>S. glabrescens</u> Schltr.	
<u>S. umbelluliferum</u> Schltr.	
Aspidoglossum	6778010
<u>A. interruptum</u> (E.Mey) Bullock	
<u>A. species</u>	
Cordylogyne	6783000
<u>C. globosa</u> E. Mey.	
Pachycarpus	6787010
<u>P. schinzianus</u> (Schltr.) N.E. Br.	
Asclepias	6791000
<u>A. adscendens</u> (Schltr.) Schltr.	
<u>A. affinis</u> (Schltr.) Schltr.	
<u>A. aurea</u> (Schltr.) Schltr.	
<u>A. burchellii</u> Schltr.	
<u>A. crispa</u> Berg.	
<u>A. decipiens</u> N.E. Br.	
<u>A. eminens</u> (Harv.) Schltr.	
<u>A. fruticosa</u> L.	
<u>A. gibba</u> (E. Mey.) Schltr. var. <u>gibba</u>	
<u>A. meyeriana</u> (Schltr.) Schltr.	
<u>A. multicaulis</u> (E. Mey.) Schltr.	
<u>A. species</u>	
<u>A. stellifera</u> Schltr.	
Pentarrhinum	6810000

<u>P. insipidum</u> E. Mey.	
Cynanchum	6834000
<u>C. virens</u> Dietr.	
Sarcostemma	6849000
<u>S. viminale</u> (L.) R. Br.	
Orthanthera	6862000
<u>O. jasminiflora</u> (Decne.) Schinz	
Brachystelma	6870000
<u>B. foetidum</u> Schltr.	
<u>B. gracile</u> E.A. Bruce	
<u>B. schinzii</u> (K. Schum.) N.E. Br.	
Riocreuxia	6875000
<u>R. torulosa</u> Decne.	
Orbeopsis	6885070
<u>O. lutea</u> (N.E.Br.) Leach subsp. <u>lutea</u>	
Tylophora	6899000
<u>T. anomala</u> N.E. Br.	
CONVOLVULACEAE	6968000
Cuscuta	6968000
<u>C. campestris</u> Yunck.	
Dichondra	6971000
<u>D. repens</u> J.R. & G. Frost.	
Falkia	6972000
<u>F. oblonga</u> Bernh. ex Krauss	
Evolvulus	6973000
<u>E. alsinoides</u> (L.) L. var. <u>linifolius</u> (L.) Bak.	
Seddera	6978000

BORAGINACEAE	7038000
Cordia	7038000
<u>C. ovalis</u> R. Br. ex DC.	
Ehretia	7043000
<u>E. rigida</u> (Thunb.) Druce	
Cynoglossum	7064000
<u>C. enerve</u> Turcz	
Heliotropium	7052000
<u>H. ciliatum</u> Kaplan	
<u>H. lineare</u> (A. DC.) C.H. Wr.	
Trichodesma	7056000
<u>T. angustifolium</u> Harv.	
Cynoglossum	7064000
<u>C. hispidum</u> Thunb.	
Lappula	7073000
<u>L. squarrosa</u> (L.) Dumort. subsp. <u>heteracantha</u> (Ledeb.) Chater *	
Anchusa	7093000
<u>A. azurea</u> Mill. *	
<u>A. capensis</u> Thunb.	
Lithospermum	7109000
<u>L. cinereum</u> DC.	
VERBENACEAE	7138000
Verbena	7138000
<u>V. bonariensis</u> L.*	
<u>V. brasiliensis</u> Vell. *	
<u>V. officinalis</u> L.*	
<u>V. tenuisecta</u> Briq. *	
Lantana	7144000

<u>L. rugosa</u> Thunb.	
Lippia	7145000
<u>L. javanica</u> (Burm. F.) Spreng.	
<u>L. rehmannii</u> H. Pearson	
<u>L. scaberrima</u> Sond.	
Plexipus	7148000
<u>P. adenostachyum</u> (Schauer) R. Fernandes	
<u>P. hederaceus</u> (Sond.) R. Fernandes var. <u>hederaceus</u>	
<u>P. pinnatifidus</u> (L.f.) var. <u>racemosus</u> (Schinz ex Moldenke) R. Fernandes	
Priva	7153000
<u>P. africana</u> Moldenke.	
Clerodendrum	7191000
<u>C. triphyllum</u> (Harv.) H. Pearson var. <u>triphyllum</u>	
LAMIACEAE	7210000
Ajuga	7211000
<u>A. ophrydis</u> Burch. ex Benth.	
Teucrium	7212000
<u>T. trifidum</u> Retz.	
Acrotome	7236000
<u>A. hispida</u> Benth.	
<u>A. inflata</u> Benth.	
Leonotis	7264000
<u>L. ocymifolia</u> (Burm. f.) Iwarsson var. <u>schinzii</u> (Geurke) Iwarsson	
Leucas	7268000
<u>L. capensis</u> (Benth.) Engl.	
<u>L. martinicensis</u> (Jacq.) R. Br.	

<u>L. neublizeana</u> Courb.	
Stachys	7281000
<u>S. hyssopoides</u> Burch. ex Benth.	
<u>S. rugosa</u> Ait.	
<u>S. spathulata</u> Burch. ex Benth.	
Salvia	7290000
<u>S. diserma</u> L.	
<u>S. namaensis</u> Schinz	
<u>S. radula</u> Benth.	
<u>S. repens</u> Burch. ex Benth. var. <u>repens</u>	
<u>S. runcinata</u> L.F.	
<u>S. sclarea</u> L. *	
<u>S. stenophylla</u> Burch. ex Benth.	
<u>S. verbenaca</u> L.	
<u>S. species</u>	
Mentha	7328000
<u>M. longifolia</u> (L.) Huds. subsp. <u>capensis</u> (Thunb.) Briq.	
<u>M. longifolia</u> (L.) Huds. subsp. <u>polyadena</u> (Briq.) Briq.	
Aeollanthus	7345000
<u>A. buchnerianus</u> Briq.	
Plectranthus	7350000
<u>P. madagascariensis</u> (Pers.) Benth. var. <u>madagascariensis</u>	
Becium	7366010
<u>B. angustifolium</u> (Benth.) N.E. Br.	
<u>B. obovatum</u> (E. Mey. ex Benth.) N.E. Br. var. <u>obovatum</u>	
SOLANACEAE	7377000
Lycium	7379000

<u>L. cinereum</u> Thunb. (Sens. Lat.)	
<u>L. ferocissimum</u> Miers	
<u>L. hirsutum</u> Dun.	
<u>L. oxycarpum</u> Dun.	
<u>L. species</u>	
Whithania	7400000
<u>W. somnifera</u> (L.) Dun.	
Physalis	7401000
<u>P. minima</u> L.	
<u>P. pubescens</u> L. *	
<u>P. viscosa</u> L. *	
Solanum	7407000
<u>S. capense</u> L.	
<u>S. coccineum</u> Jacq.	
<u>S. incanum</u> L.	
<u>S. leucophaeum</u> Dun.	
<u>S. nigrum</u> L.	
<u>S. panduriforme</u> E. Mey.	
<u>S. retroflexum</u> Dun.	
<u>S. sisymbriifolium</u> Lam. *	
<u>S. sodomaeodes</u> Kuntze	
<u>S. species</u>	
<u>S. supinum</u> Dun.	
Datura	7415000
<u>D. ferox</u> L. *	
<u>D. stramonium</u> L. *	
Cestrum	7420000

<u>C. laevigatum</u> Schlechtd. *	
Nicotiana	7434000
<u>N. glauca</u> R.C. Grah. *	
<u>N. longiflora</u> Cav. *	
SCROPHULARIACEAE	7460000
Aptosimum	7467000
<u>A. indivisum</u> Burch. ex Benth.	
<u>A. lineare</u> Marloth & Engl.	
<u>A. procumbens</u> (Lehm.) Steud. var. <u>procumbens</u>	
<u>A. procumbens</u> (Lehm.) Steud. var. <u>elongatum</u> (Hiern) Codd	
Nemesia	7476000
<u>N. fruticans</u> (Thunb.) Benth.	
Diclis	7477000
<u>D. reptans</u> Benth.	
Halleria	7493000
<u>H. lucida</u> L.	
Manulea	7517000
<u>M. paniculata</u> Benth.	
Sutera	7519000
<u>S. atropurpurea</u> (Benth.) Hiern	
<u>S. aurantiaca</u> (Burch.) Hiern	
<u>S. burkeana</u> (Benth.) Hiern	
<u>S. caerulea</u> (L.f.) Hiern	
<u>S. crassicaulis</u> (Benth.) Hiern	
<u>S. floribunda</u> (Benth.) Kuntze	
<u>S. palustris</u> Hiern	
Zaluzianskya	7523000

<u>Z. maritima</u> (L.f.) Walp.	
Mimulus	7524000
<u>M. gracilis</u> R. Br.	
Limosella	7558000
<u>L. africana</u> Gleuck	
Lindernia	7562000
<u>L. nana</u> (Engl.) Roessl.	
SELAGINACEAE	7566000
Selago	7568000
<u>S. albida</u> Choisy	
<u>S. burkei</u> Rolfe	
<u>S. welwitschii</u> Rolfe var. <u>holubii</u> (Rolfe) Brenan	
Walafrida	7568010
<u>W. densiflora</u> (Rolfe) Rolfe	
<u>W. paniculata</u> (Thunb.) Rolfe.	
<u>W. saxatilis</u> (E.Mey.) Rolfe	
<u>W. species</u>	
SCROPHULARIACEAE	7572000
Veronica	7579000
<u>V. anagallis</u> - <u>aquatica</u> L.	
Alectra	7597010
<u>A. sessiliflora</u> (Vahl) Kuntze var. <u>sessiliflora</u>	
Graderia	7614000
<u>G. subintegra</u> Mast.	
Cycnium	7623000
<u>C. tubulosa</u> (L.f.) Engl.	
Striga	7625000

<u>S. bilabiata</u> (Thunb.) Kuntze	
<u>S. elegans</u> Benth.	
PEDALIACEAE	7768000
Pterodiscus	7769000
<u>P. speciosus</u> Hook.	
Sesamum	7777000
<u>S. triphyllum</u> Welw. ex Aschers.	
ACANTHACEAE	7906000
Thunbergia	7914000
<u>T. dregeana</u> Nees	
<u>T. neglecta</u> Sond.	
Chaetacanthus	7941000
<u>C. burchellii</u> Nees	
<u>C. costatus</u> Nees	
<u>C. setiger</u> (Pers.) Lindl.	
<u>C. species</u>	
Crabbea	7972000
<u>C. acaulis</u> N.E. Br.	
<u>C. angustifolia</u> Nees	
<u>C. hirsuta</u> Harv.	
<u>C. nana</u> Nees	
<u>C. species</u>	
Barleria	7973000
<u>B. macrostegia</u> Nees	
<u>B. obtusa</u> Nees	
<u>B. pretoriensis</u> C.B. Cl.	
Blepharis	7980000
<u>B. angusta</u> (Nees) T. Anders.	

<u>B. integrifolia</u> (L.F.) E. Mey. ex Schinz var. <u>integrifolia</u>	
<u>B. squarrosa</u> (Nees) T. Anders.	
<u>B. subvolubilis</u> C.B. CL. var. <u>subvolubilis</u>	
<u>B. species</u>	
Dicliptera	8031000
<u>D. clinopodia</u> Nees	
Hypoestis	8032000
<u>H. aristata</u> (Vahl) Soland. ex Roem. & Schult. var. <u>aristata</u>	
<u>H. species</u>	
Justicia	8094000
<u>J. anagalloides</u> T. Anders.	
<u>J. orchiodes</u> L.F. subsp. <u>orchiodes</u>	
PLANTAGINACEAE	8116000
Plantago	8116000
<u>P. lanceolata</u> L.	
<u>P. major</u> L. *	
RUBIACEAE	8119000
Kohautia	8136060
<u>K. amatymbica</u> Eckl. & Zeyh.	
<u>K. amboensis</u> (Schinz) Brem.	
<u>K. aspera</u> (Heyne ex Roth) Brem.	
<u>K. brachyloba</u> (Sond.) Brem.	
<u>K. cynanchica</u> DC.	
<u>K. virgata</u> (Willd.) Brem.	
Oldenlandia	8136200
<u>O. herbacea</u> (L.) Roxb.	
Pentanisia	8348000

<u>P. angustifolia</u> (Hochst.) Hochst	
Vangueria	8351000
<u>V. infausta</u> Burch.	
Pygmaeothamnus	8351020
<u>P. zeyheri</u> (Sond.) Robyns	
Tapiphyllum	8351030
<u>T. parvifolium</u> (Sond.) Robyns	
Canthium	8352000
<u>C. ciliatum</u> (Klotzsch) Kuntze	
Pachystigma	8359000
<u>P. pygmaeum</u> (Schltr.) Robyns	
Pavetta	8383000
<u>P. zeyheri</u> Sond.	
Anthospermum	8438000
<u>A. galpinii</u> Schltr.	
<u>A. hispidulum</u> E. Mey. ex Harv. & Sond.	
<u>A. pumilum</u> Sond. subsp. <u>rigidum</u> (Eckl. & Zeth.) Puff	
Nenax	8439000
<u>N. microphylla</u> (Sond.) Salter.	
Richardia	8464000
<u>R. brasiliensis</u> Gomes *	
Galium	8486000
<u>G. capense</u> Thunb. subsp. <u>capense</u>	
Rubia	8489000
<u>R. horrida</u> (Thunb.) Puff	
<u>R. petiolaris</u> DC.	

DIPSACACEAE	8539000
Scabiosa	8546000
<u>S. columbaria</u> L.	
CUCURBITACEAE	8548000
Kedrostis	8568000
<u>K. africana</u> (L.) Cogn.	
<u>K. capensis</u> (Sond.) A. Meeuse	
<u>K. hirtella</u> (Naud.) Cogn.	
Acanthosicyos	8590000
<u>A. naudinianus</u> (Sond.) C. Jeffrey	
Citrullus	8598000
<u>C. lanatus</u> (Thunb.) Matsumura & Nakai	
Cucumis	8599000
<u>C. africanus</u> L. F.	
<u>C. myriocarpus</u> Naud.	
<u>C. zeyheri</u> Sond.	
Trochomeria	8608000
<u>T. debilis</u> (Sond.) Hook.f.	
Peponium	8612000
<u>P. caledonicum</u> (Sond.) Engl.	
Coccinia	8628000
<u>C. sessilifolia</u> (Sond.) Cogn.	
CAMPANULACEAE	8644000
Wahlenbergia	8668000
<u>W. androsacea</u> A. DC.	
<u>W. banksiana</u> A. DC.	
<u>W. caledonica</u> Sond.	
<u>W. denticulata</u> (Burch.) A. DC.	

<u>W. undulata</u> (L.F.) A. DC.	
Lightfootia	8670000
<u>L. denticulata</u> (Burch.) Sond. var. <u>transvaalensis</u>	
LOBELIACEAE	8681000
Cyphia	8681000
<u>C. assimilis</u> Sond. var. <u>assimilis</u>	
Lobelia	8694000
<u>L. angolensis</u> Engl. & Diels	
<u>L. tremalis</u> Thunb.	
<u>L. trullifolia</u> Hemsl. subsp. <u>delicatula</u> (Compton) Thulin	
Monopis	8695000
<u>M. decipiens</u> (Sond.) Thulin	
ASTERACEAE	8729000
Vernonia	8751000
<u>V. galpinii</u> Klatt	
<u>V. natalensis</u> Sch. Bip.	
<u>V. oligocephala</u> (DC.) Sch. Bip. ex Walp.	
<u>V. poskeana</u> Vatke & Hildebr. var. <u>poskeana</u>	
<u>V. staehelinoides</u> Harv.	
Aster	8900000
<u>A. harveyanus</u> Kuntze	
Felicia	8919000
<u>F. burkei</u> (Harv.) L. Bol.	
<u>F. fascicularis</u> DC.	
<u>F. filifolia</u> (Vent.) Burt Davy subsp. <u>filifolia</u>	
<u>F. muricata</u> (Thunb.) Nees subsp. <u>muricata</u>	
Nidorella	8925000

<u>N. anomala</u> Steetz	
<u>N. hottentotica</u> DC.	
<u>N. resedifolia</u> D.C. subsp. <u>resedifolia</u>	
Conyza	8926000
<u>C. bonariensis</u> (L.) Cronq. *	
<u>C. canadensis</u> (L.) Cronq. *	
<u>C. pinnata</u> (L.f.) Kuntze	
<u>C. podocephala</u> DC.	
<u>C. scabrida</u> D.C.	
<u>C. sumatrensis</u> (Retz.) E.H. Walker *	
Nolletia	8929000
<u>N. arenosa</u> O. Hoffm.	
<u>N. ciliaris</u> (DC.) Steetz	
<u>N. species</u>	
Chrysocoma	8930000
<u>C. ciliata</u> L.	
<u>C. obtusata</u> (Yhunb.) E. Bayer	
Brachylaena	8936000
<u>B. rotundata</u> S. Moore	
Tarchonanthus	8937000
<u>T. camphoratus</u> L.	
Blumea	8939000
<u>B. cafra</u> (DC.) O. Hoffm.	
Denekia	8949000
<u>D. capensis</u> Thunb.	
Epaltes	8953000
<u>E. gariepina</u> (DC.) Steetz	

Ifloga	8967000
<u>I. glomerata</u> (Harv.) Schltr.	
<u>I. verticillata</u> (L.F.) Fenzl	
Gnaphalium	8992000
<u>G. confine</u> Harv.	
<u>G. declinatum</u> L. f.	
<u>G. englerianum</u> (O. Hoffm.) Hilliard & Burt	
<u>G. filagopsis</u> Hillard & Burt	
Vellereophyton	8992010
<u>V. dealbatum</u> (Thunb.) Hillard & Burt	
Pseudognaphalium	8992050
<u>P. luteo-album</u> (L.) Hilliard & Burt	
<u>P. oligandrum</u> (DC.) Hilliard & Burt	
Helichrysum	9006000
<u>H. argyrosphaerum</u> DC.	
<u>H. asperum</u> (Thunb.) Hilliard & Burt var. <u>asperum</u>	
<u>H. caespititium</u> (DC.) Harv.	
<u>H. callicomum</u> Harv.	
<u>H. cerastioides</u> DC.	
<u>H. chionosphaerum</u> DC.	
<u>H. cylindriflorum</u> (L.) Hillard & Burt.	
<u>H. dregeanum</u> Sond. & Harv.	
<u>H. kraussii</u> Sch. Bip.	
<u>H. lineare</u> DC.	
<u>H. miconiifolium</u> DC.	
<u>H. nudifolium</u> (L.) Less.	
<u>H. paronycioides</u> DC.	
<u>H. rugulosum</u> ess.	

<u>H. setosum</u> Harv.	
<u>H. tenuifolium</u> Killick	
<u>H. tricostatum</u> (Thunb.) Less.	
<u>H. species</u>	
<u>H. zeyheri</u> Less.	
Stoebe	9037000
<u>S. vulgaris</u> Levyns	
Rosenia	9051000
<u>R. humulis</u> (Less.) Bremer	
Athrixia	9056000
<u>A. elata</u> Sond.	
Pulicaria	9078000
<u>P. scabra</u> (Thunb.) Druce	
Geigeria	9090000
<u>G. aspera</u> Harv. var. <u>aspera</u>	
<u>G. brevifo9lia</u> (DC.) Harv.	
<u>G. burkei</u> Harv.	
<u>G. filifolia</u> Mattf.	
Acanthospermum	9130000
<u>A. glabratum</u> (DC.) Wild *	
Ambrosia	9146000
<u>A. artemisiifolia</u> L. *	
Xanthium	9148000
<u>X. spinosum</u> L. *	
<u>X. strumarium</u> L. *	
Zinnia	9155000
<u>Z. peruviana</u> (L.) L. *	

Bidens	9237000
<u>B. bipinnata</u> L. *	
<u>B. formosa</u> (Bonato) Sch. Bip. *	
<u>B. pilosa</u> L. *	
Galinsoga	9246000
<u>G. parviflora</u> Cav. *	
Schkuhria	9291000
<u>S. pinnata</u> (Lam.) Cabr. *	
Tagetes	9311000
<u>T. minuta</u> L.	
Lasiospermum	9321000
<u>L. bipinnatum</u> (Thunb.) Druce	
Anthemis	9330000
<u>A. cotula</u> L. *	
Phymaspermum	9336000
<u>P. athanasioides</u> (S. Moore) Kallersjo	
<u>P. bolusii</u> (Hutch.) Kallersjo	
Cotula	9351000
<u>C. heterocarpa</u> DC.	
<u>C. species</u>	
Cenia	9351010
<u>C. microglossa</u> DC.	
Artemisia	9358000
<u>A. afra</u> Jacq. ex Willd.	
Pentzia	9366000
<u>P. calcarea</u> Kies	
<u>P. globosa</u> Less.	
<u>P. incana</u> (Thunb.) Kuntze	

P. pilulifera (L. F.) Fourc.
P. species
P. sphaerocephala DC.
P. spinescens Less.
P. viridis Kies
Hertia 9377000
H. ciliata (Harv.) Kuntze
H. cluytiifolia (DC.) Kuntze
Lopholaena 9401000
L. corrifolia (Sond.) Phill. & C.A. Sm
Cineraria 9406000
C. aspera Thunb.
C. geifolia (L.) L.
C. lobata L'Herit.
C. species
Senecio 9411000
S. affinis DC.
S. apiifolius (DC.) Benth. & Hook. f. ex O. Hoffm.
S. asperulus DC.
S. burchellii DC.
S. coronatus (Thunb.) Harv.
S. erubescens Ait.
S. harveianus Macowan
S. hieracioides DC.
S. inaequidens DC.
S. inornatus DC.
S. isatidioides Phill. & C.A. Sm.

<u>S. oxyriifolius</u> DC.	
<u>S. pentactinus</u> Klatt	
<u>S. reptans</u> Turcz.	
<u>S. ruwenzoriensis</u> S. Moore	
<u>S. species</u>	
<u>S. venosus</u> Harv.	
Euryops	9417000
<u>E. empetrifolius</u> DC.	
Dimorphotheca	9425000
<u>D. zeyheri</u> Sond.	
Osteospermum	9427000
<u>O. caulenscens</u> Harv.	
<u>O. leptolobum</u> (Harv.) T. Norl.	
<u>O. muricataum</u> E.Mey. ex DC. subsp. <u>muricatum</u>	
<u>O. scariosum</u> DC. var. <u>scariosum</u>	
<u>O. spinescens</u> Thunb.	
Ursinia	9431000
<u>U. nana</u> DC.	
Arctotis	9432000
<u>A. arctotooides</u> (L.f.) O. Hoffm.	
<u>A. fastuosa</u> Jacq.	
<u>A. microcephala</u> (DC.) Beauv.	
<u>A. venustra</u> T. Norl.	
Arctotheca	9432020
<u>A. calendula</u> (L.) Levyns	
Haplocarpha	9432020
<u>H. lyrata</u> Harv.	
<u>H. scaposa</u> Harv.	

Gazania	9434000
<u>G. krebsiana</u> Less.	
<u>G. krebsiana</u> Less. subsp. <u>arctotoides</u>	
<u>G. krebsiana</u> Less. subsp. <u>serrulata</u> (DC.) Roessl.	
Hirpicium	9435000
<u>H. bechuanense</u> (S. Moore) Roessl.	
<u>H. linearifolium</u> (H. Bol.) Roessl.	
Berkheya	9438000
<u>B. discolor</u> (DC.) O. Hoffm. & Muschl.	
<u>B. latifolia</u> Wood & Evans	
<u>B. montana</u> Wood & Evans	
<u>B. onopordifolia</u> (DC.) O. Hoffm. ex Burt Davy var. <u>onopordifolia</u>	
<u>B. pinnatifida</u> (Thunb.) Thell. subsp. <u>pinnatifida</u>	
<u>B. radula</u> (Harv.) De Willd	
<u>B. zeyheri</u> (Sond. & Harv.) Oliv. & Hiern subsp. <u>zeyheri</u>	
Platycarpha	9441000
<u>P. parvifolia</u> S. Moore	
Cirsium	9462000
<u>C. vulgare</u> (Savi) Ten.	
Dicoma	9501000
<u>D. anomala</u> Sond. subsp. <u>anomala</u>	
<u>D. macrocephala</u> DC.	
<u>D. schinzii</u> O. Hoffm.	
<u>D. species</u>	
<u>D. zeyheri</u> Sond.	
Gerbera	9528000
<u>G. ambigua</u> (Cass.) Sch. Bip.	

Tolpis	9561000
<u>T. capensis</u> (L.) Sch. Bip.	
Sonchus	9595000
<u>S. asper</u> (L.) Hill.	
<u>S. dregeanus</u> DC.	
<u>S. nanus</u> Sond. ex Harv.	
<u>S. oleraceus</u> L.	
<u>S. species</u>	
Lactuca	9596000
<u>L. capensis</u> Thunb.	
<u>L. serriola</u> L.	
<u>L. species</u>	

Curriculum Vitae

Miranda Susan Kooij was born on the 9 August 1965 in the Letaba district. She attended Hoërskool Riebeeck where she matriculated in 1983. In 1984 she enrolled at the Potchefstroom University for C.H.E. , and in 1986 was awarded a B.Sc degree with Botany and Zoology. This was followed by a B.Sc. (Hons.) in Botany in 1987 and she started the M.Sc. in 1988.

From 1988 she was appointed as technical assistant in the Department of Botany at the University of Pretoria where she is currently working. Miss Kooij has presented various posters at different congresses.

Toe het ek al die werk van God begryp;
die mens is nie in staat om wat in
hierdie wêreld gebeur , te verstaan nie.
Hoe hy hom ook al inspan en soek , hy
verstaan nie. Al sê die wyse hy weet ,
kan hy nie verstaan nie.

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