Phytosociology of the north-eastern Transvaal high mountain grasslands

by

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Submitted in partial fulfilment of the requirements for the degree of

MAGISTER SCIENTIAE

In the Department of Botany
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"THE HIGHEST FUNCTION OF ECOLOGY
IS UNDERSTANDING CONSEQUENCES"

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The novel by Frank Herbert.

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ABSTRACT

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The vegetation of the high mountain grasslands of the north-eastern Transvaal was sampled by using stratification based on geology and land types. Data was classified by TWINSPAN procedures and refined by using the Braun-Blanquet method. This resulted in the recognition of three vegetation units namely wetlands, boulderies and grasslands which represent a moisture gradient. Wetlands comprised four major communities and ten minor plant communities while boulderies resulted in four major communities and seven minor communities. The grasslands comprised four major plant communities which were subdivided into twenty eight minor communities.

All identified communities were described and ecologically interpreted and a species list was compiled combining the data gathered in the area by other authors.

Due to the increased demands that man places on the natural habitat for the basic requirements of life, the natural resources are slowly but surely being depleted. If the current human population increases at the given rate it can be deduced that the natural pasturage will not be able to provide ample resources such as meat, dairy products, grain and timber for the population (Bayer 1970; Allen 1972; Scheepers 1975; Asibey 1977; Mentis & Huntley 1982). It is therefore vital that the natural resources providing these amenities be maintained if not improved to be able to cope with future pressures being placed upon them.

The Grassland Biome Project (Mentis & Huntley 1982) was initiated to address this problem of increased destruction of natural resources because the most suitable area for agriculture falls within the grasslands of this country.

The aims of the Grassland Biome Project, which covers research on the grassland ecosystems in South Africa, are to analyse and interpret the gradients of climate, geomorphology and soils associated with the grassland vegetation. Together, the results of all research done in this area will be compared. New insight into the management of this area should then be available to the farmers, who ultimately own most of this area, the future of which is in their hands.

The study of this particular area (see Chapter 2, page 3) will be incorporated into the Grassland Biome Project, and will be compared with those of the surrounding areas (Deall 1985 & 1986; Bloem 1988; Turner 1989 and Matthews 1991).

The objectives of this study are:

a) to conduct a study on the vegetation types occurring in the land types Fa and Ac within the specified area;

b) to study relationships between plant communities and environmental factors;

c) to obtain a vegetation map of the area; and

d) to compare the vegetation types to those classified by Acocks for the same area.

2.1 LOCALITY

The area upon which this study is based occurs in one of the most ecologicaly important wetland areas in the Transvaal. The reason for this is that this area is situated at the highest altitude in the Transvaal (the average altitude being above 1 800 m), as well as the fact that three large rivers originate here namely the Sabie, Elands and Crocodile Rivers. Major towns serving this area are Belfast, Machadodorp, Waterval Boven, Dullstroom, Lydenburg and Sabie (Figure 1).

The study area comprises two parts, the main part situated between the latitudes 25° and 25° 44' South, and longitudes 30° and 30° 20' East, and a smaller study area which is bounded by latitudes 25° 05' and 20° 15' South and 30° 30' and 30° 40' East. The portion studied however only comprises the Fa and Ac land types in this area (Land Type Survey Staff 1984). Other land types were not studied for the reason that they are not grassland but forest or savanna, as well as the fact that they are considered as lowlands. Limited sample sites however were placed in the adjacent land types to compare the study area with its surrounding areas.

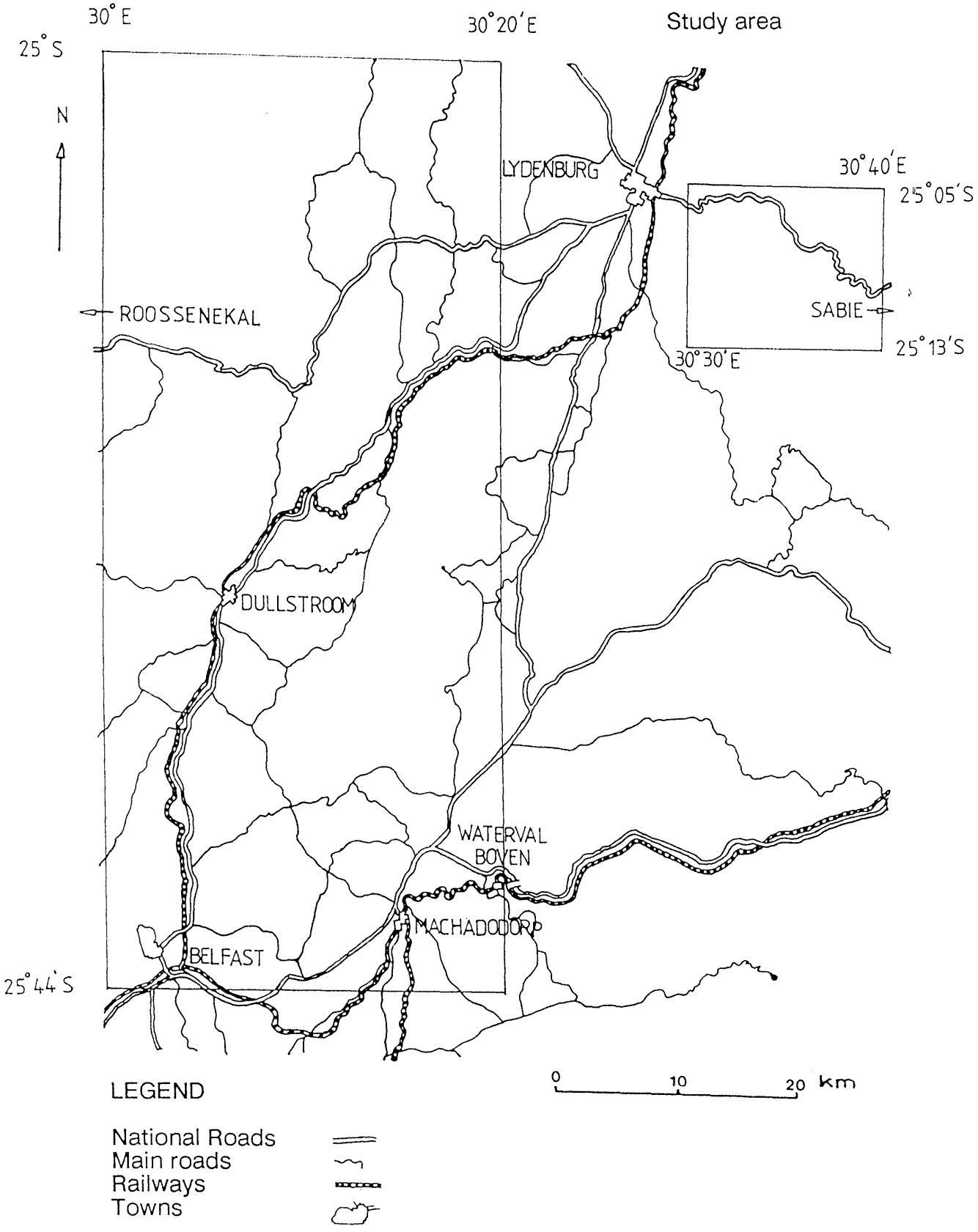


Figure 1. Location of the study area.

CHAPTER 3: PHYSICAL FACTORS AFFECTING THE VEGETATION

3.1 GEOLOGY

Geology is one of the environmental variables affecting the vegetation, physiography and ultimately the climate of the study area.

The geology is the principle factor determining the physiographic features of an area (Figure 2). These factors are then further modified by erosion over a period of time as determined by climatic processes.

Because the Magaliesberg Formation is more resistant to weathering than some of the other types of rock in the area the Escarpment comprises mainly this formation. This in turn causes the weather patterns to change from the lowlands to the highlands because of the altitude change (Figure 7). All these factors combined resulted in a significant change in the plant composition from the lowlands to the highlands.

All geological data described for this area follows the nomenclature of the South African Committee for Stratigraphy (SACS 1980).

Starting with the oldest, and proceeding to the youngest rocks (Figure 2), the stratigraphy of the study area will be described in the following contexts: Rocktypes comprising the groups, formations or series as well as the products of weathering.

3.1.1 Pretoria Group of the Transvaal Sequence.

The Transvaal Sequence forms the basis for the Bushveld Igneous Complex and dips beneath it, which indicates that the Bushveld Igneous Complex was formed after the Transvaal Sequence had been laid down (Figure 2). Due to ripple-marks, oolites and stromatolites it can be

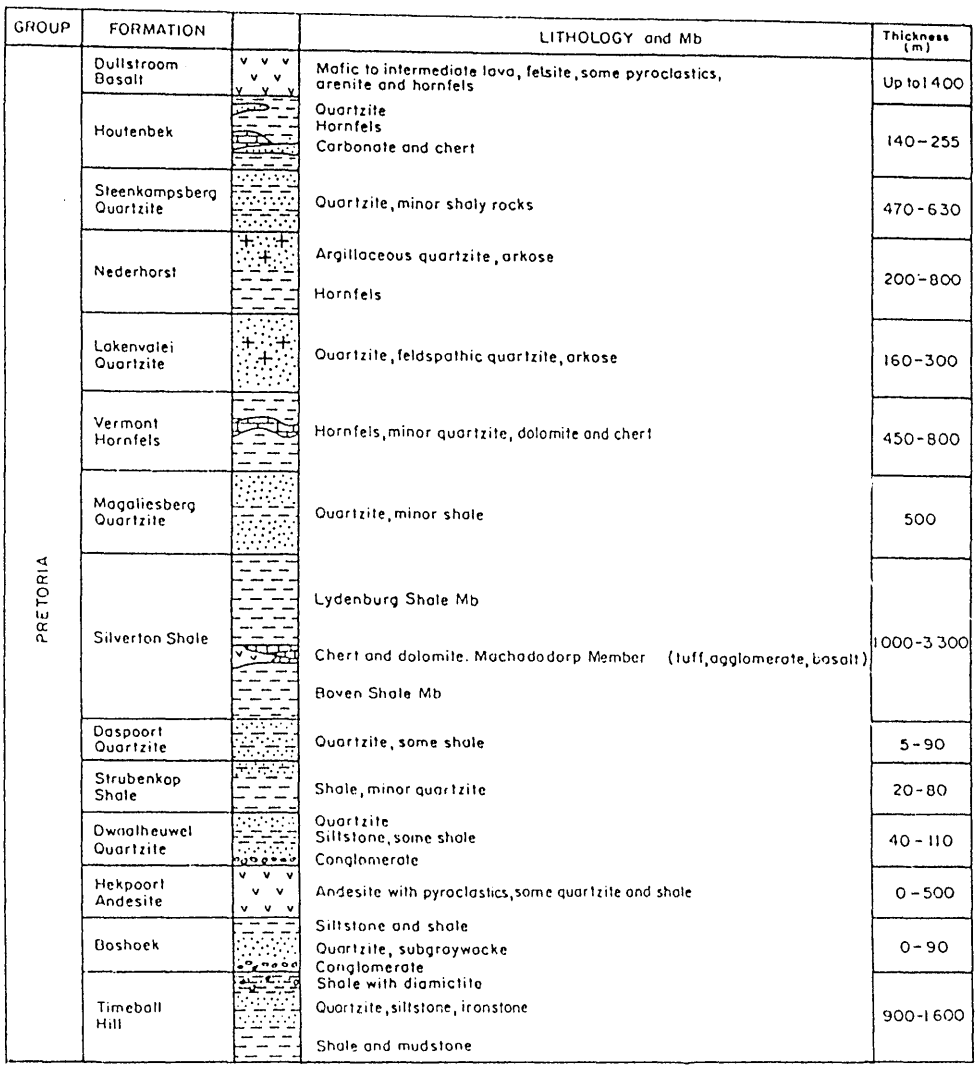


Figure 2. The deposition of the Pretoria Group in the eastern Transvaal.

assumed that these rocks were formed in shallow water. A large inland basin prevailed at the time, and rivers and streams running into this, had algae growing in their shallow still waters. The reason for the Pretoria Group being rich in metals is the fact that the algal structures trapped heavy particles (metals), thus forming a sedimentation bed through which the algae grew (Truswell 1970). The algae containing the metals as well as other deposits were later compressed due to the weight of the layers above them. Thus we have rocks with layers of metals in between them (eg. Timeball Hill ironstone, Figure 2).

The Pretoria Group (Figure 2) is dominated by quartzite and shale with a prominent volcanic unit combined with some conglomerate and also some chemical members.

Volcanic eruptions occurred intermittently and were normally localised. These eruptions were especialy prevalent in the Dullstroom and Hekpoort Formations.

In the eastern Transvaal the Pretoria Group is divided into fourteen formations, which will be discussed briefly.

Timeball Hill Formation: The lowest layer that is present in the study area as belonging to the Pretoria Group is this Formation. It is composed of laminated shale, mudstone and occasional diamictite, and quartzite layers occur above this and overlaying these are more shale and diamictite. This Formation is found in the smaller study area only (Figure 3). Soils originating from the mother-rock are not deep and vary in richness of minerals depending on the content of the mother-rock (SACS 1980).

Boshoek Formation: This Formation comprises medium-grained quartzite in the centre with subgreywacke and conglomerate at the base and siltstone at the top, and is present in the smaller study area only (Figure 3). The soils derived from this Formation are fine-grained, poor, sandy soils (SACS 1980).

Hekpoort Andesite Formation: This Formation is made up of fine to medium-grained andesitic lavas, brecciated at the top and having

amygdales in the centre. This Formation is found also only in the smaller study area, (Figure 3) and the soils that originate from it are normally rich loams (SACS 1980).

Dwaalheuwel Quartzite Formation: This Formation consists of medium-grained quartzite, interlayered with shale, and is also found only in the smaller study area (Figure 3). The quartzite weathers to a course sand, while the shale weathers to a fine loam or a clay loam (SACS 1980).

Strubenkop Shale Formation: This formation consists of fine-grained shale and interlayered shaly sandstone, with hornfels in places and is to be found in the smaller study area only (Figure 3). Soils are poor and shallow if conditions during weathering were dry, and are deeper and richer if conditions were moist during weathering (eg. dry hill tops and moist valleys).

Daspoort Quartzite Formation: This Formation is composed of medium-grained, current-bedded, quartzite with gritty layers and occasional conglomerate as well as shale. It occurs in the south-eastern corner of the larger study area, covering a very small area. It also occurs in the smaller study area (Figure 3). Soils derived from this Formation are generally sandy and can be rich or poor in nutrients depending on the weathering process (SACS 1980).

Silverton Shale Formation: This Formation is made up of three Members namely, the Boven Member, the Machadodorp Member and the Lydenburg Member.

The Boven Member consists of greenish, fine-grained shale and mudstones with tuff, and some layers of carbonatious rocks as well as hornfels in places. This Member is found in the area around Waterval Boven (Figure 3). Following on this is the Machadodorp Member consisting of two parts; a) a pale-green tuff with pyroclastic layers, which was formed by the deposition of ash from volcanoes in the area, and b) a course-grained, deeply weathered pillow lava. The pillow lava is formed by hot magma coming into contact with a large area of water. This Member is found east of Machadodorp and occupies an area in the south-eastern corner of

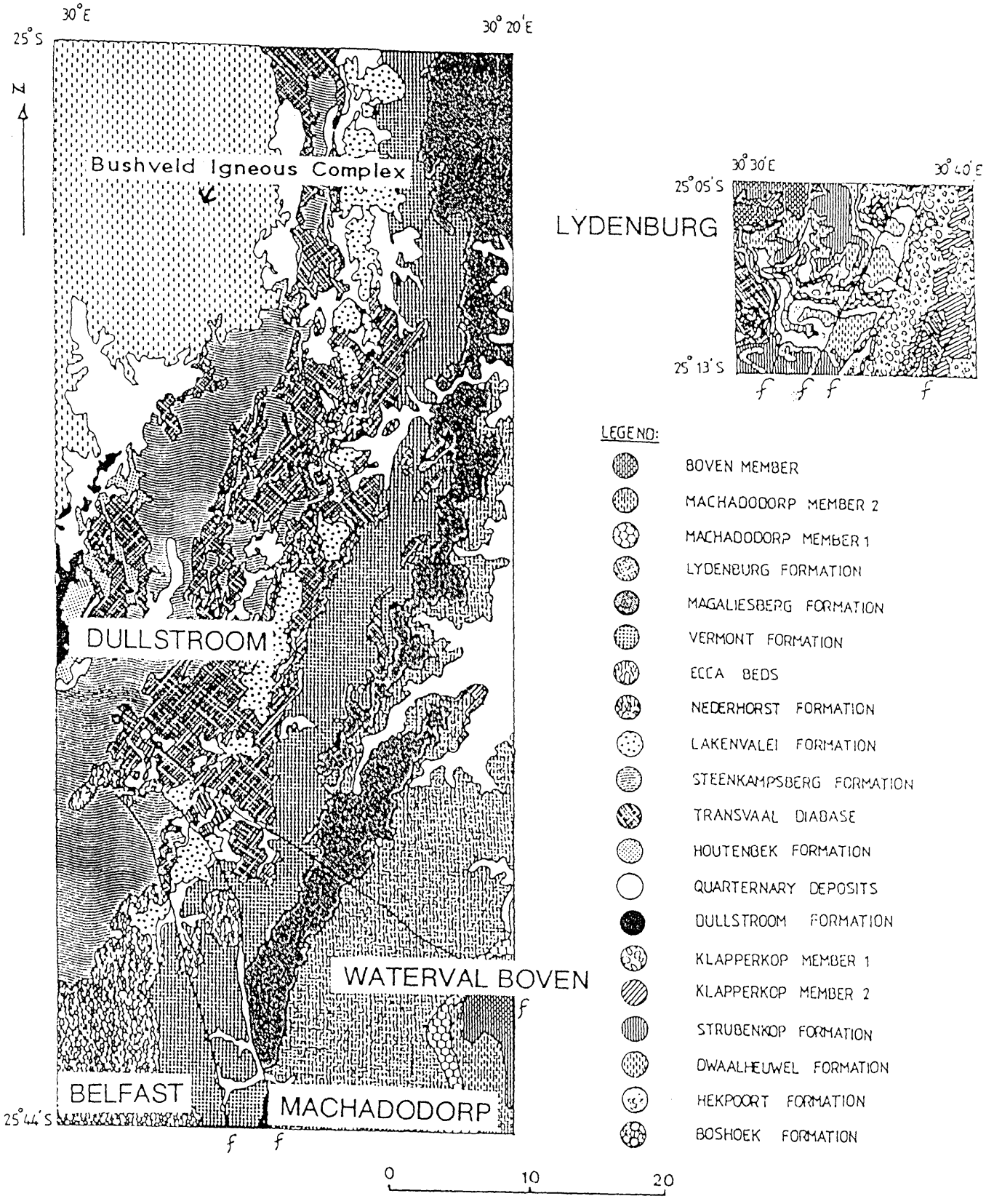


Figure 3. Geological Groups occurring in the study area.

the study area. The Lydenburg Member is the topmost Member and consists of a greenish fine-grained laminated shale with interlayered carbonate layers containing hornfels. This member is found near Machadodorp and extends over large areas of the eastern part of the study area.

The soils derived from these Members are generally very shallow and are poor in nutrients, except for the soils derived from the lavas which are richer in nutrients and are generally deeper (SACS 1980).

Magaliesberg Formation: This formation is made up of pure course-grained quartzite with scattered layers of shale in between. The upper part consists of siltstone, shale and quartzite, while the lower part consists mainly of shale. This Formation is to be found in a band extending from the north-eastern to the south-western part of the study area (SACS 1980), (Figure 3) and forms the Escarpment. Soils derived from this Formation are generally sandy but not deep, and are poor in mineral elements, the elements being leached to deeper layers (SACS 1980).

Vermont Formation: This Formation contains fine-grained hornfels together with silt and sandstone, with minor layers of carbonaceous (dolomite) and siliceous (chert) rocks, and is to be found throughout the study area in a broken, broad band from the north to the south (Figure 3). These rocktypes give rise to soils that are rich in minerals but the soils themselves are not deep.

Lakenvalei Formation: This Formation is made up of medium grained, cross-bedded, feldspathic quartzite with ripple marks, and has gritty lenses and thin conglomerate layers in between. This Formation is layed down in a broken band from the north-east to the south-western part of the study area (Figure 3), and gives rise to sandy loam or fine sand, depending on the mother material (SACS 1980).

Nederhorst Formation: This Formation consists of fine-grained hornfels with ripple marks, cross-bedding and mud cracks in the sedimentary layers and has medium- grained arenite at the top of the formation. It

is layed down in the vicinity of the highest point of the railway in the Transvaal, called Nederhorst (Figure 3), and gives rise to relatively rich soils (SACS 1980).

Steenkampsberg Formation: This formation consists of medium- to fine-grained, cross-bedded quartzite with intermediate layers of purple-weathering arenite and shale with very little conglomerate. Although this is the Formation situated at the highest altitude, it is third from the top in the sequence (the Dullstroom Formation being the topmost Formation of the Pretoria Group), and makes up the Steenkampsberg on the eastern side of the study area, which is the highest mountain-range in the Transvaal (Figure 3). This indicates just how resistant to weathering this rock-type is. Products of weathering are sandy soils that are easily leached and are relatively poor in mineral elements. The arenite and shale give rise to poor mauve-coloured soils.

Houtenbek Formation: This Formation consists of fine-grained hornfels with argillaceous quartzite and arkose (a blend of quartzite and plagioclase or orthoclase) at the top, and many sedimentary structures in between, with carbonate and chert interspersed between the hornfels. Weathered products of this rocktype are relatively rich soils with little or no structure and their colours may vary. This Formation is layed down in the area of the farm Houtenbek, north-east of Dullstroom (Figure 3).

Dullstroom Formation: This Formation consists of black to darkgreen, fine-grained andesitic lavas with amygdales, together with some felsite and pyroclasts, and is the result of local volcanic activity in this area.

Weathered products of this Formation are normally rich deep soils with a red colour, and the amygdales remain as small stones that do not weather as fast as the mother rock (SACS 1980).

This Formation commences at the Tonteldoos Post Office, south-west of Lydenburg and consists of a belt of lavas that extend along the western side of the Steenkampsberg and disappear under the Ecca beds.

3.1.2 Bushveld Igneous Complex

Before the main outflow of magma of the Bushveld Igneous Complex there were minor eruptions which formed diabase sills and dykes that can be found at intervals all over the study area (Figure 4).

These intrusions also caused metamorphosis of the adjoining rocks, for example soft shale turned into a hard crystalline type of rock. Some of these intrusions are made up of other types of rocks (norite) but the whole group together is termed Transvaal Diabase (SACS 1980).

The soils derived from this rock-type are normally rich in elements and form a dark coloured loam. These sills and dykes of diabase can sometimes be noted from aerial photographs by the difference in the vegetation growing on them. This is because there is more water and mineral elements present here than in the surrounding soils. These diabase intrusions are thus responsible for certain vegetation patterns.

Following these eruptions came the main outflow of magma (Truswell 1970) which flowed up and over the Pretoria Group of sediments. This magma cooled and formed a disc of rock (mainly norite) while the fisures between the weak spots were filled with diabase.

This placement of a huge volume of matter must have been a long continued process and not a single occurrence, thus giving rise to many varying rocktypes (Du Toit 1954). The reason that so many different types of rock are formed from the same magma is that different minerals crystalize in a specific order. This sometimes forms false stratifications (pseudostratifications). The sizes of the crystals depend on the temperature at which crystalization took place (Truswell 1970).

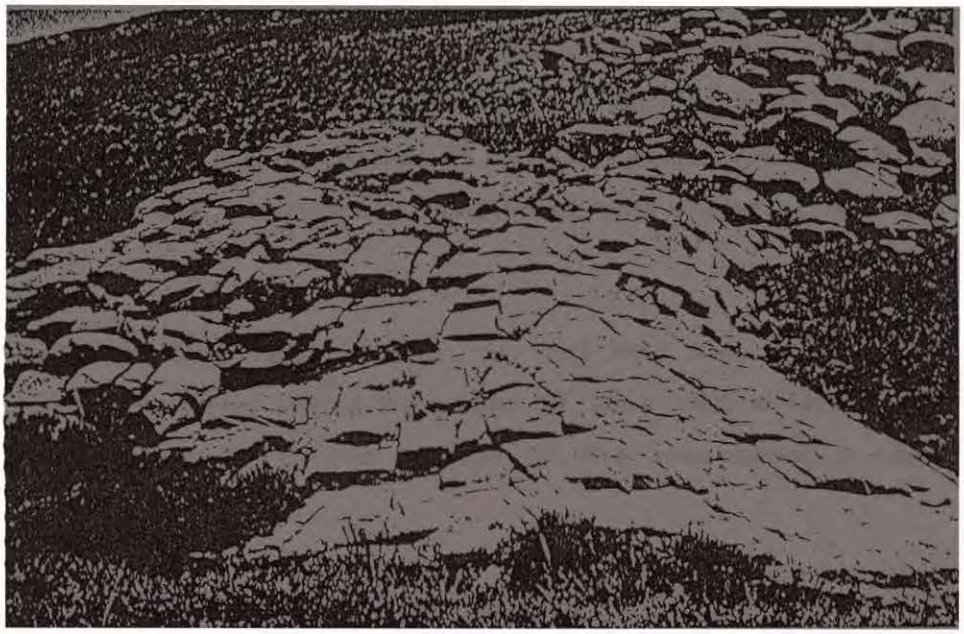


Figure 4. Example of a diabase intrusion near Dullstroom.

3.1.3 Ecca Series of the Karoo Supergroup

This series consists of sediments that were layed down in a fresh-water basin (Truswell 1970). Vegetation growing out into the swamps gave rise to the plant material being deposited thus forming coal. Shallow valleys were silted up by the deposition of material eroded from the higher areas giving rise to the sandstones, mudstones and shales of this Series (Du Toit 1954).

The most important fact however, is that coal was layed down in this area, and is normally mined by means of open cast mining. This way of mining is detrimental to the ecology of the area because much of the topsoil is lost or ruined.

This Series is found in the south-western parts of the study area around the town of Belfast (Figure 3).

3.1.4 Quarternary Deposits

These recent (Pleistocene) deposits occur in the study area in most of the river beds where the products of many years of erosion have been deposited. During their deposition there was a cooler climate present and glaciation was prevalent only as an enlarged Antarctica. The Drakensberg and Lesotho were not glaciated as has been determined from evidence found in caves (Truswell 1970). These deposits are loosely bound to each other due to the short time that sedimentation has taken place and occur in valleys and scree slopes of mountains and hills (SACS 1980)

3.2 MINING IN THE AREA

This aspect of the study is important because of the environmental impact that it could have on the region if mining practices were not of a conservative nature.

Platinum group metals

Platinum and the other metals in this group are mined from the Merensky Reef (Figure 5) of the Bushveld Igneous Complex. The Reef is a regularly layered band consisting of pyroxenite varying from 75 to 100 mm in thickness, interspersed with chromite seams. The pyroxenite layer is covered by a suite of norite and anorthosite which is overlain again by a pyroxenite band often called the "Bastard Reef" because of the low platinoid values (Coetzee 1976).

The Merensky Reef has been prospected in the eastern belt along a strike of 120 km, and boreholes indicate that it continues to a vertical depth of over 1 900 m. Chrome is mined extensively from chromite seams in the Merensky Reef, and nickel and copper are also mined from these seams. Chrome is mined on the farm De Kafferskraal in the north-western section of the study area (Coetzee 1976).

Gold

Gold is mined extensively in the study area (Figure 5) and occurs in the lowermost beds of the Timeball Hill Formation, as well as the higher beds of the Daspoort Formation, and the uppermost beds of the Dwaalheuwel Quartzite Formation. Gold occurs together with silver, copper and bismuth (Coetzee 1976). Small amounts of gold also occur in the pyroxenite of the Merensky Reef, in addition to the platinum-group metals found there (Coetzee 1976).

Silver

Silver is mined on the farm Slaaihoek (540 JT) near Waterval Boven (Figure 5) together with gold from this area (Coetzee 1976).

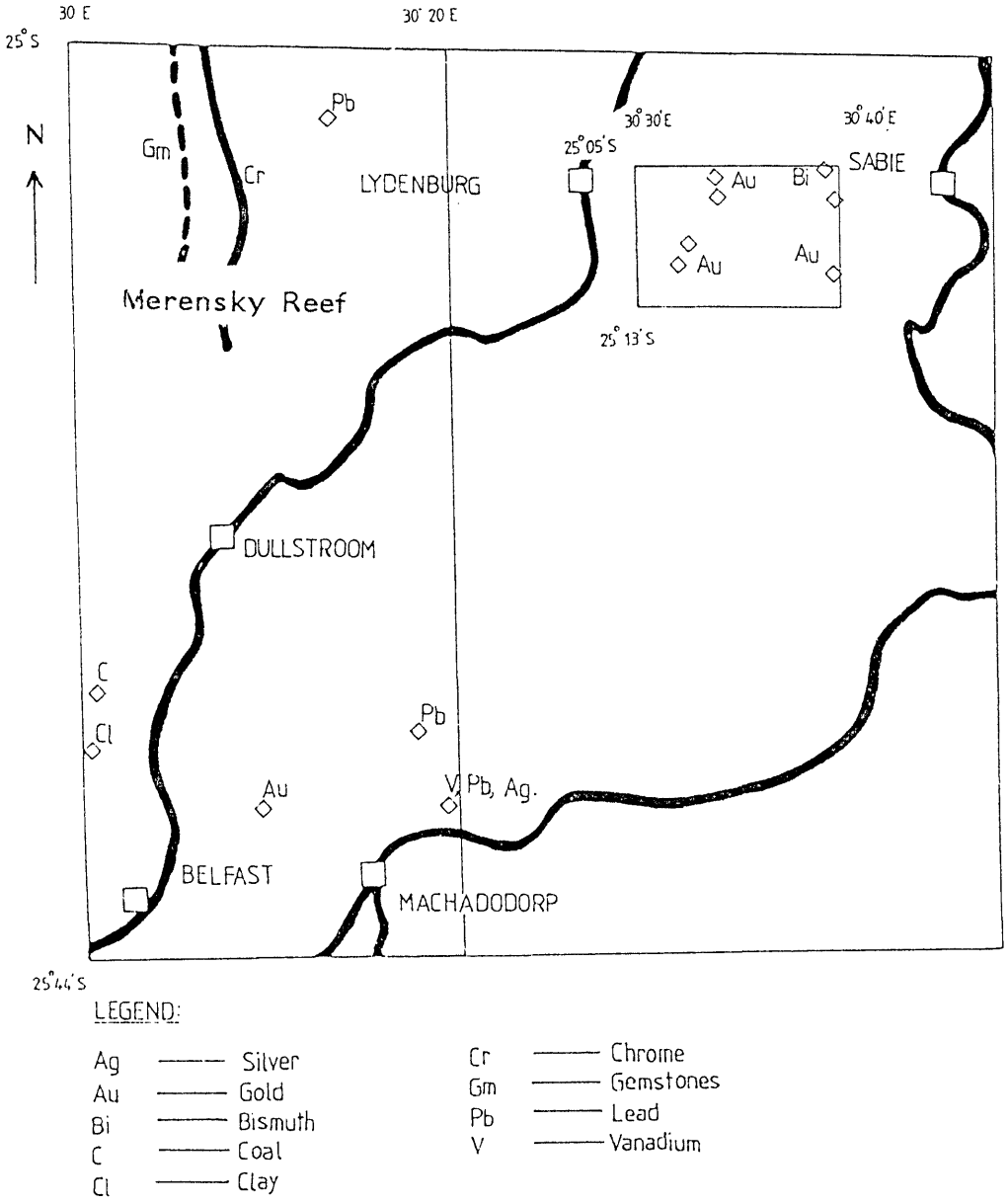


Figure 5. Mines and mining activities found in the study area.

Iron

Iron is found in the lower Timeball Hill Formation as magnetite- quartzite, and in the Daspoort Formation as hematite and limonite. Iron is mined on the farm Elandshoek (339 JT) and Slaaihoek (540 JT) which lie to the east (Figure 5) of the study area (Coetzee 1976).

Vanadium and lead

Vanadium and lead are mined in the north-western part of the study area and both are found in the Merensky Reef. An additional lead mine occurs on the farm Kennedy's Vale (361 KT) in the Lydenburg District (Coetzee 1976; Figure 5).

Coal

Coal is mined west and north of Belfast (Figure 5) and occurs in the Middle Ecca Stage of the Karoo Supergroup (Coetzee 1976).

Clays

Semi-flint fire clay is mined between Dullstroom and Belfast on the farm Zwartkoppies (316 JT), and is the result of the burning of a coal seam in the Lower Ecca Group in recent times (Coetzee 1976).

Dimensional stone

Dimensional stone used for building purposes, like gabbro, norite and dolerite are mined east of Dullstroom (Coetzee 1976).

Other

Diamonds are being mined from a kimberlite pipe between Dullstroom and Machadodorp (personal communication).(1)

Other developments in this field are the buying of farms by large mining companies in the area where the Merensky Reef occurs. This is being

(1) Mr. N. Venter P.O. Box 74 Machadodorp.

done to provide the larger mining companies with enough land for future expansion of their mining activities.

3.3 LAND TYPES

According to the land type maps of the Barberton area (2530) the Fa and Ac land types as shown in Figure 6 were studied.

Fa and Ac land types differ from each other in terms of microclimate, terrain form and geology (Land Type Survey Staff 1979).

Fa land types differ from each other in terms of their macroclimate while the same is true for different Ac land types.

Fa land types are found principally on Vermont sandstone, Magaliesberg shale and Steenkampsberg quartzite, while Ac land types occur on the shales of the various geological groups.

Each land type incorporates areas of similar geology and terrain forms (Land Type Survey Staff 1979) thus each land type is associated with specific landscapes. It would therefore follow that slope magnitudes and terrain units give an indication of the landscape associated with each land type (Land Type Survey Staff 1979).

Slopes of land type Ac are generally shallow and may reach considerable lengths. This may form systems of catenas giving rise to gently undulating landscapes in the southern part of the large study area.

Fa land types have steeper slopes and are to be found in the broken areas of both study areas (Figure 6). These land types give rise to the deep gorges and valleys and steep sloped mountains. Land type Fa, (Glenrosa and Mispah Forms) makes up approximately half of the study area and consists of relatively young soils. The main soil forming process is weathering of the parent material which results in the formation of orthic topsoils. The B horizons are formed by clay illuviation. Although Glenrosa and Mispah Forms are the most common Soil Forms, other Forms may also

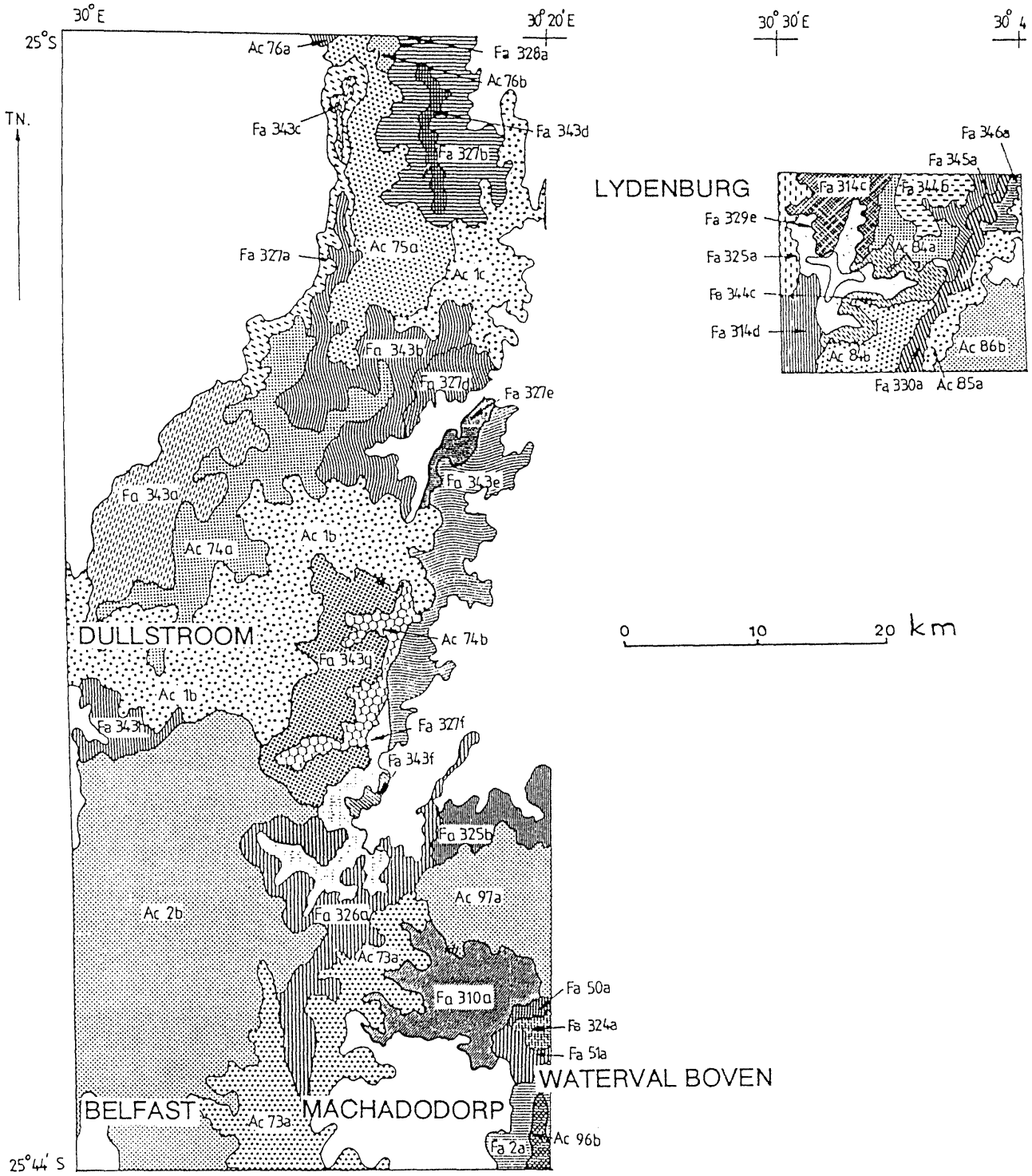


Figure 6. Land types occurring in the study area.

occur in this land type. The surface area covered by these other Forms is then minimal, being less than 7%.

The other half of the region is covered by the land type Ac. This Form is defined as red-yellow apedal soils having free drainage, and are dystrophic or mesotrophic, and have a high base status. Soil Forms Hutton, Griffin, Clovely and Inanda are frequent although others may be present to a lesser extent (Land Type Survey Staff 1979).

3.4 PHYSIOGRAPHY

3.4.1 TOPOGRAPHY

The study area is mountainous and rugged with deep ravines and steep cliffs in places and gently sloping plains in others. The altitude is mainly above 1 800 metres (Figure 8) and rises to 2 331 metres, the highest point in the Transvaal called Die Berg. Deep ravines are situated at altitudes below 900 metres, thus an extreme range of altitudes can be found in this area.

The deep ravines are relatively frost free and frost sensitive plant species are often found growing there. The high mountains are frequently wind blown as well as frost covered in winter and sparse vegetation is to be found growing on them.

The topography of the study area was divided into five groups according to Scheepers (1988) as can be seen in Figure 9.

3.4.2 DRAINAGE

The important rivers occurring in the eastern Transvaal originate in this area namely; the Elands, Crocodile and Sabie Rivers (Figure 7). All three of these rivers have their origins in rather undistinguished-looking wetlands at higher altitudes. These rivers are all fed by smaller rivers also originating from wetlands in and around the study area.

Wetlands in this area are thus important for maintaining the flow of rivers. Disturbing them in any way would eventually disturb, or possibly even cause some rivers to have a diminished flow.

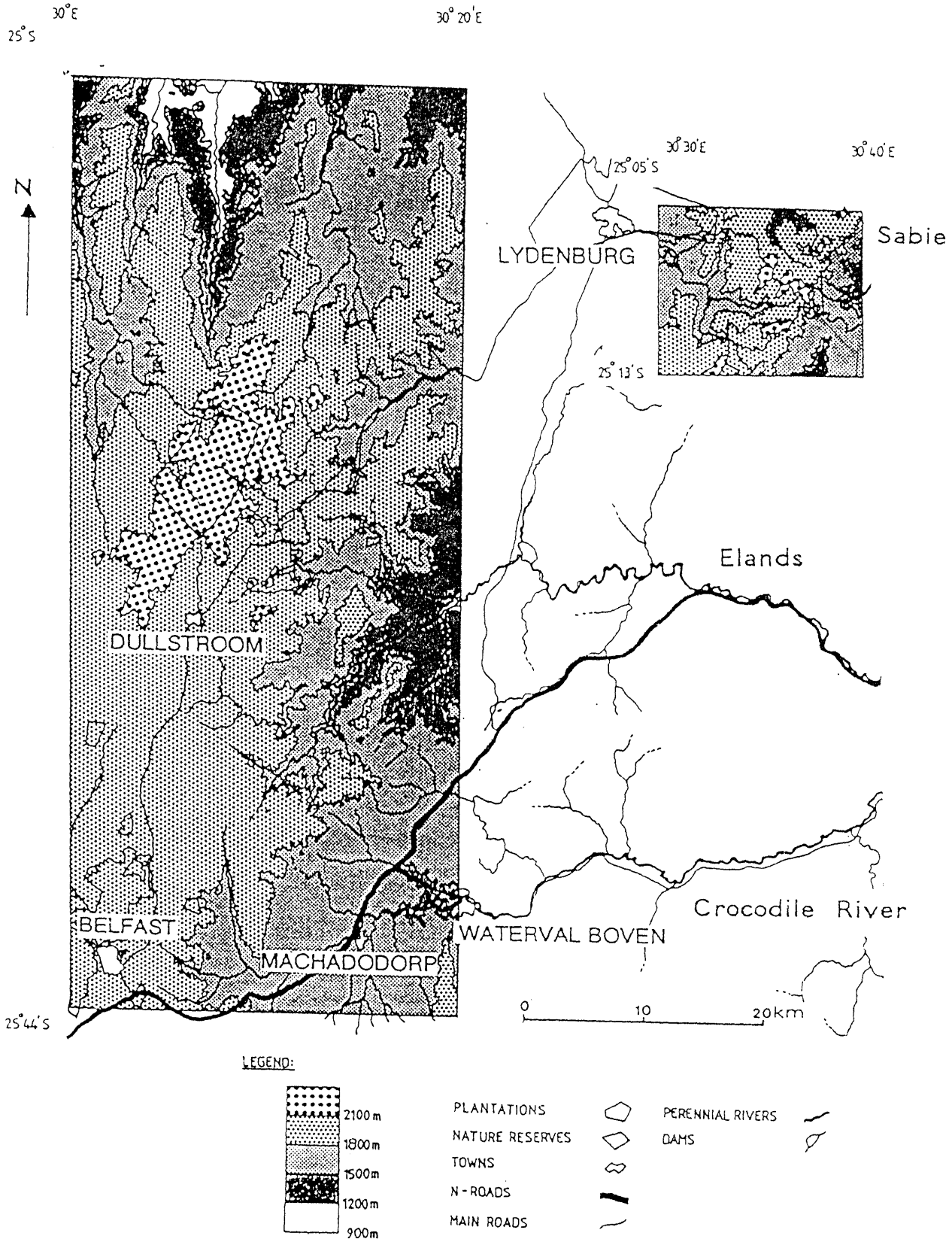


Figure 7. Map of the study area showing altitude and rivers.

The Steenkampsberg mountains form a deviding line between two watersheds in the larger study area. Thus rivers to the east of the Steenkampsberg flow eastwards, while rivers to the West of the Steenkampsberg flow in a north and north-westerly direction (Figure 7).

The rivers originating in the smaller study area originate from springs emerging from the heads of deep ravines and there are fewer wetlands due to the steeper gradients in this area. Rivers in this smaller study area flow predominantly eastwards (Figure 7).

3.4.3 ALTITUDE

This particular area is the highest part of the Transvaal and has a unique flora due to this fact (Stevens 1989), coupled with the rainfall (Figure 11) and temperature (Figure 16).

The altitude ranges from 900 metres (Figure 7), to 2 331 metres (Die Berg), which is the highest mountain in the Transvaal. Mount Anderson (2 284 m) is the second highest mountain in the Transvaal and lies just outside the bounds, to the north of the smaller study area (Figure 7). Gradients of up to 57° are not uncommon, and many vertical cliffs are to be found in the area. Differences in the topography and geology can be seen from the transect in Figures 8 and 9.

Plant species occurring at high altitudes such as those in this study area experience a great annual range of climatic conditions (Stevens 1989). This undoubtably has an effect on the plant communities found in this area.

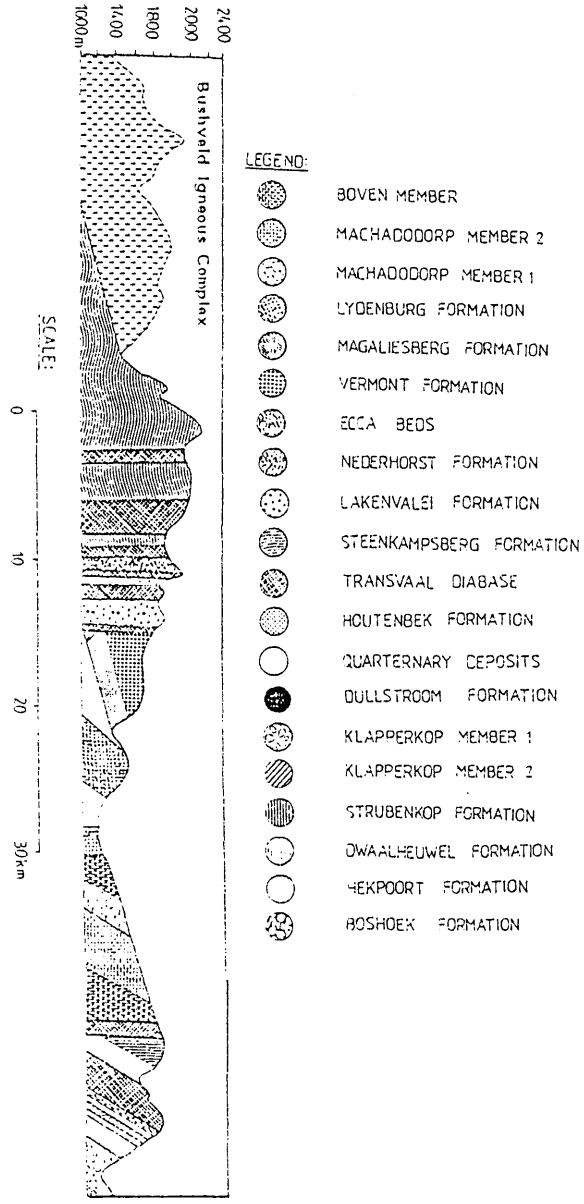


Figure 8. Transect of the study area including geological strata (this transect was taken from Figure 3).

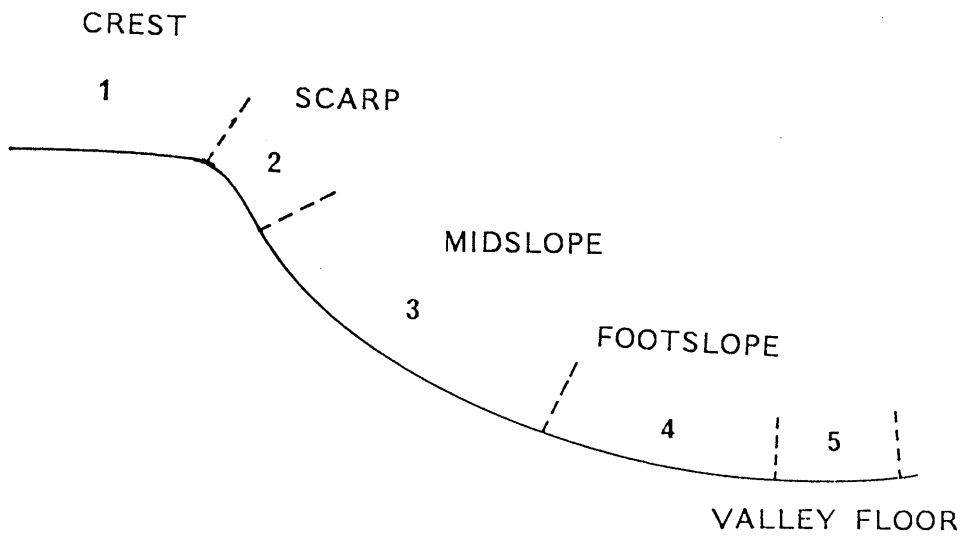


Figure 9. Different physiographical units occurring in the study area (Scheepers 1988).

3.5 CLIMATE

The climate of this region, according to the classification of Koppen (Schulze 1947), is a temperate, rainy climate with a dry winter season (summer rainfall). There is a C-type humidity province (sub-humid), with grassland as the characteristic vegetation, together with a precipitation (P) / evaporation (E) index of 32 to 63 (Schultze 1947). The area is also divided into subtypes of humidity provinces namely a w-type, which indicates a moisture deficiency in the winter.

3.5.1 INSOLATION

Incoming solar radiation is the most fundamental parameter present in the environment of the plant. Photosynthesis, photoperiodism and phototropism are all light dependent (Schulze & McGee 1978). Incoming radiation is subject to seasonal variation. Radiant flux densities during summer are higher than during winter (Granger & Schulze 1977). The presence and absence of cloud cover also affects the duration of bright sunlight during summer by 20-30% (Weather Bureau 1965 & Weather Bureau 1988).

Geographic variation of sunshine duration also occurs within the study area. Areas receiving mist (mistbelt) experience less than 60% of the possible sunshine, while areas in the lowlands (Low Country) experience 60 to 70% less sunshine. Summit areas experience a higher duration of daily sunshine due to rain-shaddow effects and the lack of mist (Weather Bureau 1965).

In addition to seasonal and geographic variability there exists also physiographic variation of insolation due to slope and aspect. Daily incoming radiant flux densities on sloping areas are a function of slope, aspect and season (Schulze 1975). In midsummer, steep slopes receive less radiation than do gentle slopes. This is true regardless of aspect (Weather Bureau 1988).

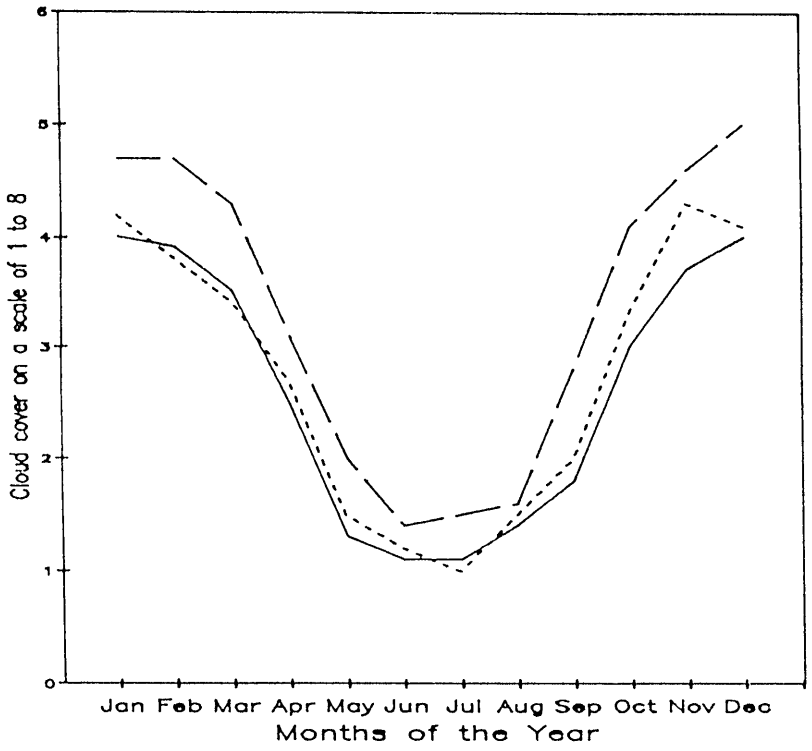


Figure 10. Line chart comparing the cloud cover of three weather stations in the area.

North-facing slopes receive a greater deal of radiation than those slopes with south-facing aspects. Incoming radiation on gentle slopes however is unaffected by aspect (Weather Bureau 1965 & Weather Bureau 1988).

Data from three stations given in Figure 10 shows that Waterval Boven has the most cloud cover possibly due to the clouds moving westwards from the escarpment. Belfast has the least cloud cover possibly due to the movement of the upper air masses at this high altitude.

3.5.2 TEMPERATURE

Temperature is a controlling factor in the presence or absence of a species because plants can only function within a certain temperature range. Certain species also only grow at certain temperatures (Larcher 1975).

Temperature affects the transpiration rate, evaporation rate and other processes of plants (Daubenmire 1974). These processes affect the germination rate, growth, maturation and reproduction as well as the vigour of the plant. Vigour in it's turn affects the plant's ability to compete and resist disease (Daubenmire 1974; Schulze & McGee 1978).

Temperature together with interactions of other climatic factors create environmental conditions which may limit the distribution of plant species (Krebs 1972). Severe frost and low minimum temperatures during winter, and high summer maximum temperatures together with the length of the frost-free period are possibly the most important direct temperature effects on plants (Daubenmire 1974; Schulze & McGee 1978).

Scheepers (1978) states that the temperature extremes (extreme maximum and extreme minimum temperature) plays a more important role in the presence or abscence of plants than does the average temperature.

Thus it can be seen from the following data for four stations in the study area that a great fluctuation in temperature occurs in this region (Weather Bureau 1988).

STATION	ALTITUDE	ABSOL. +	ABSOL. -	AVERAGE +	AVERAGE -
Belfast	1950m	32.2°C	-7.4°C	24.9°C	7.2°C
Lydenburg	1439m	34.5°C	-7.8°C	27.9°C	9.4°C
Sabie	1108m	37.5°C	-4.2°C	30.2°C	5.7°C
Waterval Boven	1430m	38.8°C	-6.7°C	29.2°C	9.4°C

This information was collected over a period of 40 years on average. Thus it is representative of the long-term weather fluctuations.

Comparisons show that Lydenburg is the coldest town in the study area with an extreme minimum of -7,4°C (Weather Bureau 1968b), while the highest maximum temperature is attained at Waterval Boven at 38,8°C. Sabie however has a maximum average of 30,2°C, which is higher than the other towns. The probable reason for this is that Sabie is in the Lowveld, while Lydenburg and Waterval Boven are at higher altitudes, but are surrounded by protective hills thus causing less air movement. The temperatures recorded for Belfast are lower due to the fact that Belfast is on an open, exposed, high-altitude plain where free airflow occurs.

Although Sabie is the warmest of the four stations it is not considerably warmer than the others. Lydenburg at an altitude of 1 439 metres above sea level is the coldest town with weather data recorded by the Weather Bureau but the town of Dullstroom at an altitude of 2 100 metres above sea level (no temperature data given) is considerably colder than the other towns in the area (personal observation of the author). Lydenburg and Waterval Boven have similar temperature ranges for the reason that

the two are situated at nearly the same altitudes (Lydenburg at 1 439 m, and Waterval Boven at 1 430 m).

Plant species in this area show a large degree of phenotypic plasticity due to the fact that the climatic variations experienced during their lifetimes vary so much. These species can thus tolerate temperatures below -6° C in the winter and above 30° C in the summer with ease. Thus the distribution of these species would be wider than for species adapted to lowland areas (Stevens 1989), due to their tolerance of adverse conditions.

3.5.3 PRECIPITATION

Water is vital to the physiological and chemical processes occurring within plants. It is also the medium by which nutrients in the soil are moved into the plant (Odum 1971; Daubenmire 1974).

Water is an important factor in the distribution of a species as water can be a limiting factor in their occurrence (Odum 1971; Walter 1971; Krebs 1972; Schulze & McGee 1978). Because of the high rainfall in the area there is a higher species diversity that in most other parts of the country (Huston 1979; MacArthur 1972; Stevens 1989).

Rainfall

The higher parts of the Steenkampsberg receive more rainfall than surrounding areas (Figure 11). This is partly due to the higher elevation coupled to the fact that these mountains act as a barrier against which the rain falls. The same can be observed of the Escarpment (north-eastern part, Figure 11) which receives a higher rainfall than the areas surrounding it. Lower rainfall at the centre (Figure 11) is caused by the valley running from north to

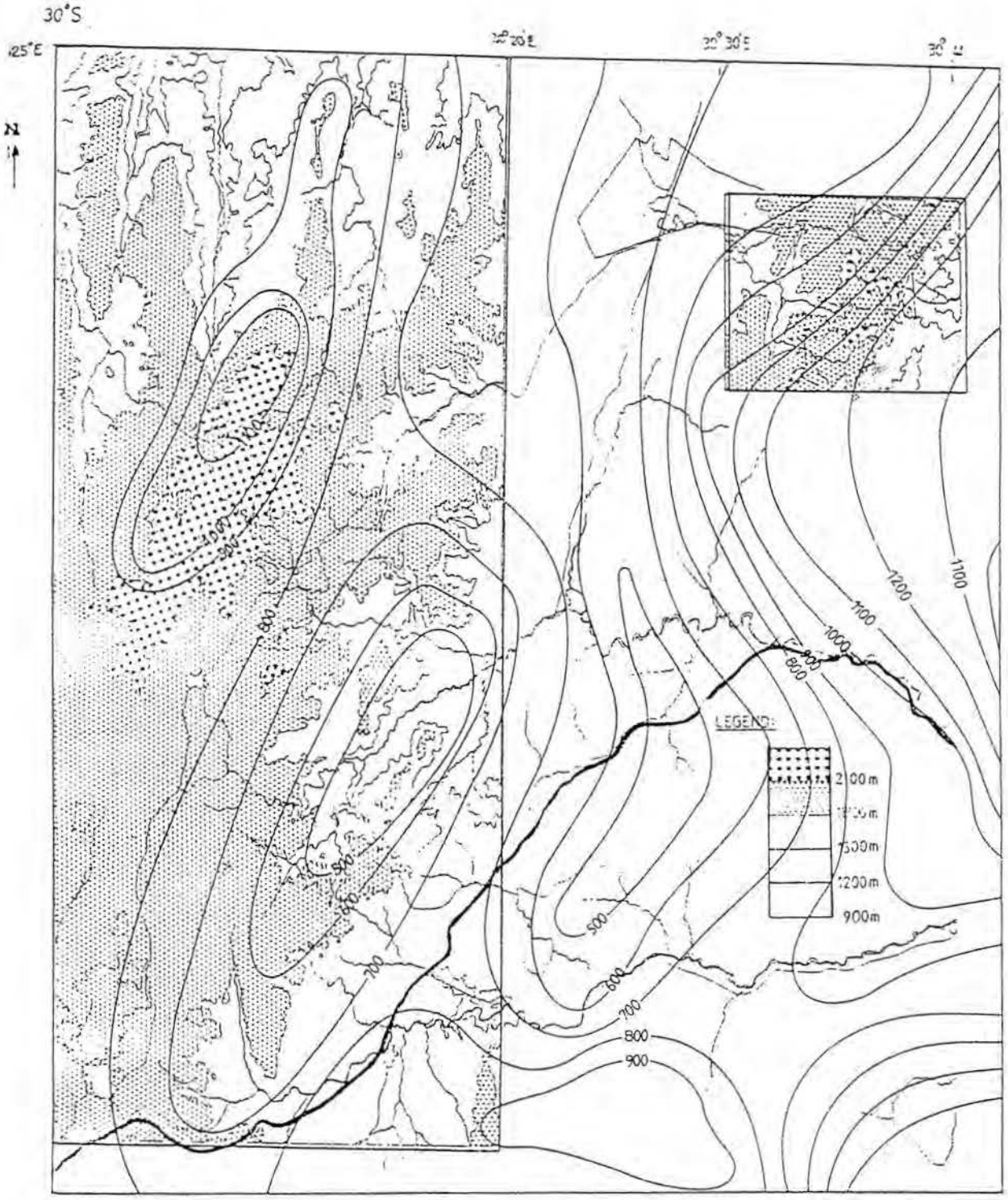


Figure 11. Rainfall map of the study area (Weather Bureau 1968a) underlain by topography.

south. The lack of rain here is caused by less convection currents in the valley as well as a rain-shadow formed by the escarpment.

From the Walter Climate Diagrams (Figure 16) it can be seen that Sabie undoubtably has a considerably higher rainfall than the other towns in the area. The other three towns receive more or less the same amount of rain, most of it occurring from October to April.

Fog or mist

Precipitation from mist and fog supplements the rainfall precipitation rather significantly in this area. Contributions to the soil moisture occur when mist or fog moves over the vegetation causing "fog-drip". The presence of fog or mist can also reduce evapotranspiration (Scheepers 1978). Mist occurring over most areas of the Transvaal is normally too neglegible to take into account, however this is not so in this case. Mist in this area is a common occurrence especialy during the months of October to February (Figure 12). The contribution made by mist to the total precipitation is quite considerable and many species probably cannot live without it (smaller forbs).

From the data (Figure 12) it can be seen that the most mist occurs in Belfast, but other areas that do not have ample weather stations for recording this phenomenon have much higher occurrences of mist. Areas above 2 000 m in altitude are shrouded in mist for most of the summer months, and mist can cover the entire escarpment area for three weeks at a time (personal observation of the author). The plants during this time are covered with small droplets and especialy species like *Tristachya leucothrix* which have hairy leaves are ideal traps for the mist.

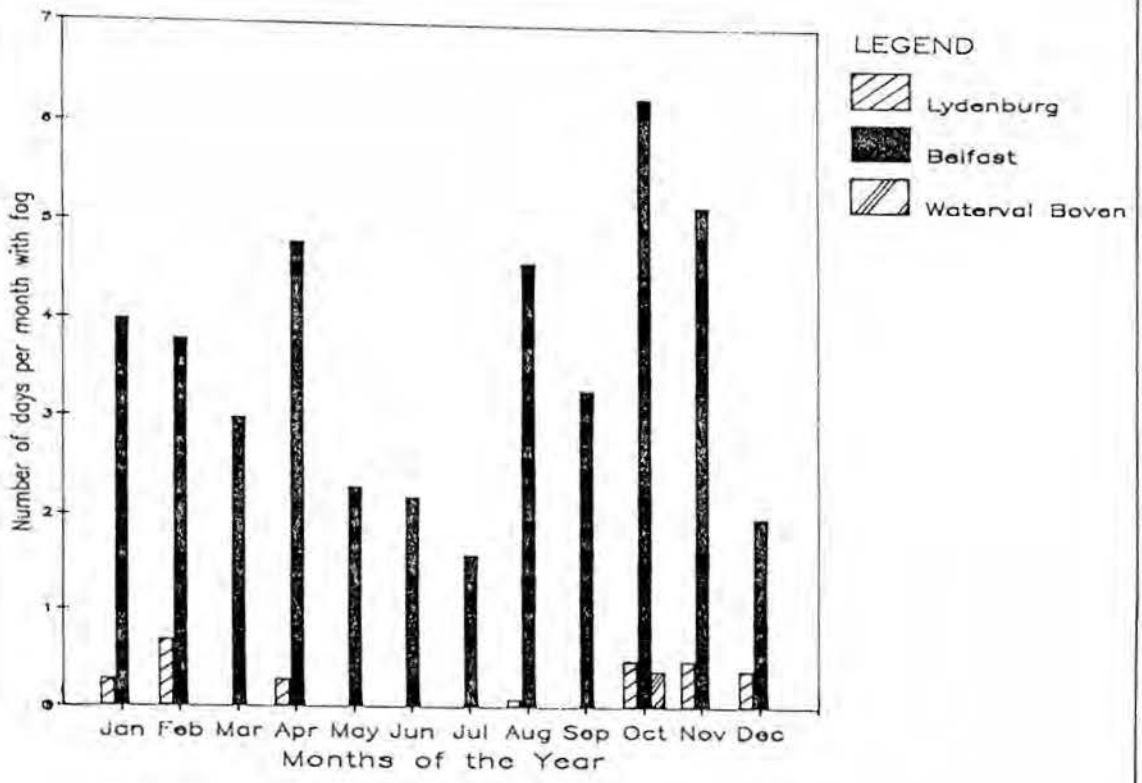


Figure 12. Line chart showing the monthly occurrence of mist at three weather stations in the area (Weather Bureau 1968b).

Hail

Hail frequently occurs in this area, Waterval Boven being prone to hail storms more than other weather stations in the area (Figure 13). The presence of hail is usually associated with convection thunderstorms and short periods of intense rain. Months that hail is most likely to fall are October, November, December and January which are the rainy months in this area. It must however be noted that the information from a weather station is only that data collected at one given spot, and the area in question is so heterogenous with regard to the patterns in weather, due to the broken nature of the terrain that it must not be accepted that this is the norm for surrounding areas (personal observation of the author).

Hail is of little ecological importance as it's effect on plant communities is unknown if any. Grasslands would be less affected than forest stands, as broad leaves offer a larger surface area for hail to strike upon than does grass (Deshmuhk 1984).

Frost

Frost occurs generally in the winter months in this area and is common on all slopes, crests, as well as in the valleys. Some areas may experience little or no frost due to the fact that they are sheltered by cliffs and deep valleys. Most plants in the area are frost resistant, or shed their leaves or die in the months when frost occurs, thus avoiding this phenomenon. Frost has been known to persist into the months of September and October in the southern parts of the study area (Figure 14). From Figure 14 it can be observed that Belfast has frost for a greater part of the year than does Waterval Boven.

The frost occurring in this area causes teracettes on slopes in this region (Van Zinderen Bakker & Werger 1974) by the daily frost-thaw process. These teracettes then are normally

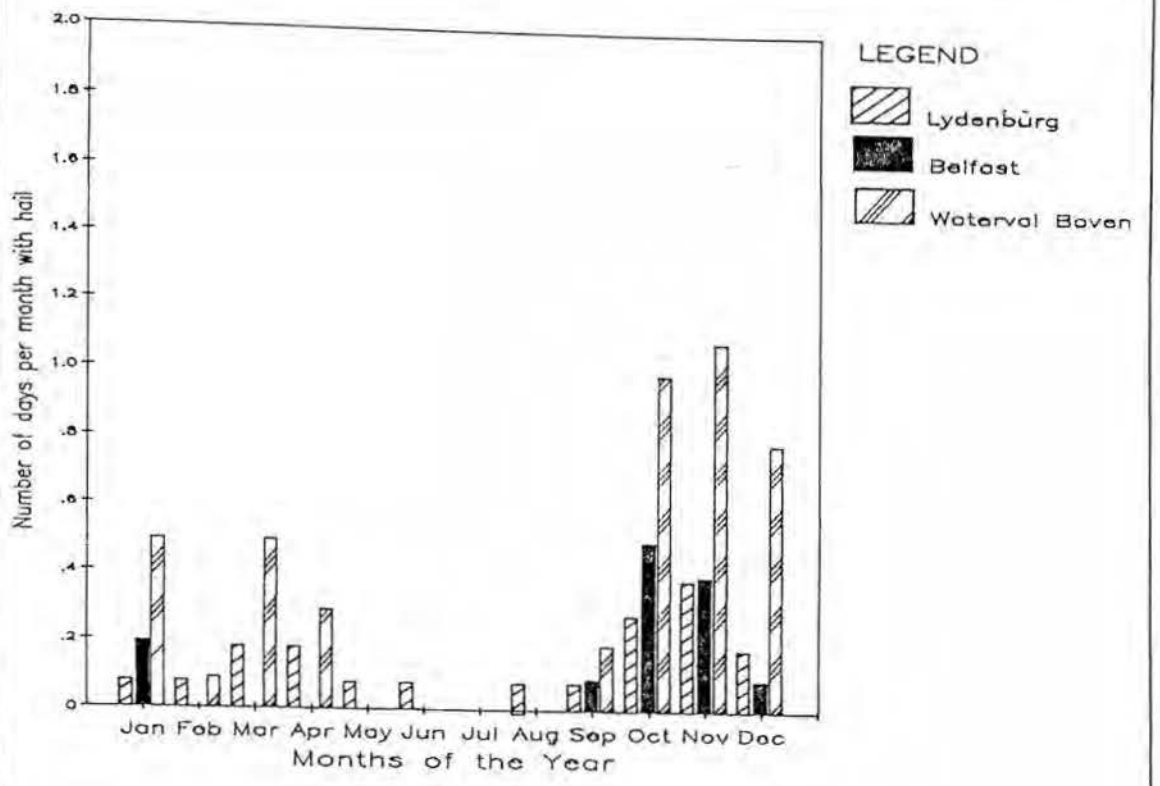
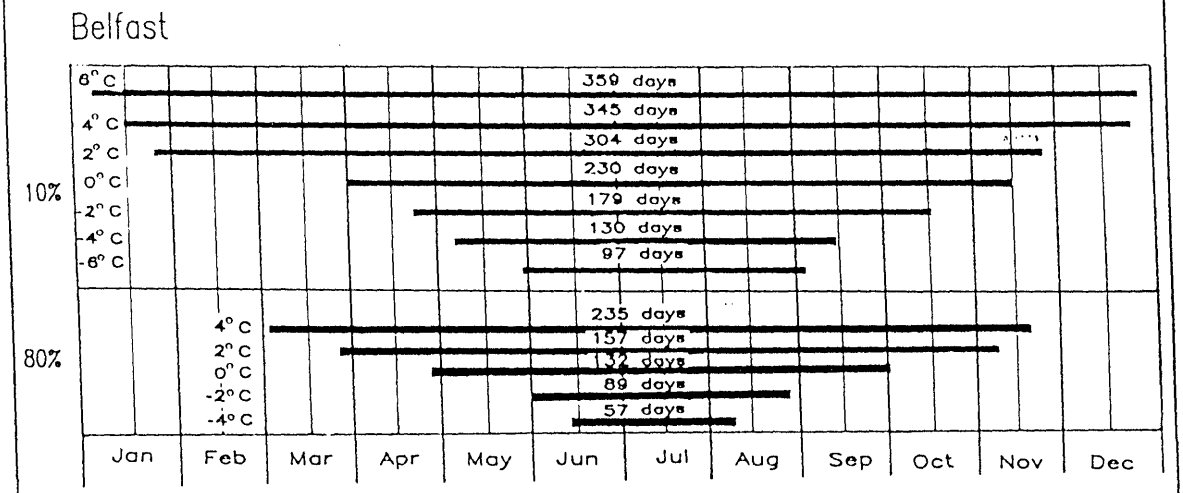


Figure 13. Line chart of the monthly occurrence of hail at four stations in the study area (Weather Bureau 1968b).



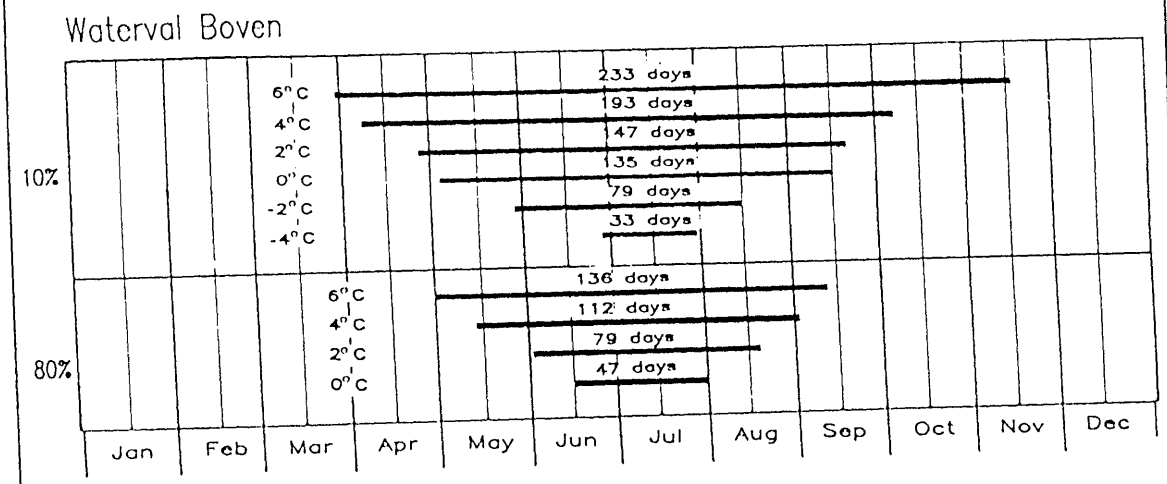


Figure 14. Duration of frost for two stations in the study area at 10% and 80% probabilities (Weather Bureau 1968b).

colonised by pioneers because they are basically disturbed areas. During rainy seasons these teracettes can be eroded thus losing valuable topsoil. The formation of frost-heaved tussocks is also an important process carried out by frost in this region (Sigafoos & Hopkins 1951; Hopkins & Sigafoos 1954).

Snow

Snow may increase soil moisture during winter and also act as an insulating blanket to protect plants from excessively low temperatures (Killick 1963).

Snow in this area is confined to the summits of the mountain ranges. The occurrence of snow in the late winter and early spring would then be beneficial to the high altitude plants whose soil moisture would be depleted at this stage of the year. Thus the increased soil moisture would enable these plants to commence seasonal growth before the first rains occurred.

Snowfalls are not uncommon in this area although the last falls at Dullstroom were in 1974 (personal communication). It must also be remembered that the Steenkampsberg Range are well above 2 000 m and that they form the tail-end of the Drakensberg Range, thus any extreme weather conditions caused by cold fronts moving northwards during winter months would cause snow on these mountains. The ecological importance of snow is little known in this area, and snow affecting the composition of plant communities has not been studied extensively in southern Africa as this phenomenon is very rare here.

From the following data it can be seen when the last snowfalls were received in the study area.

STATION	DATE	YEAR	PERIOD OF SNOW
LYDENBURG	20 JULY	1961	0,1 days

WATERVAL BOVEN	10 JULY	1956	0,2 days
BELFAST	30 SEPT.	1940	0,1 days
BELFAST	1 JUNE	1942	0,3 days
DULLSTROOM	JULY	1974	0,4 days

It is not recorded how deep the snowfalls were (Weather Bureau 1986).

Most species in the study area seem to have adapted to withstand the low temperatures associated with snow. Geophytes which are numerous simply lose their leaves and are not affected by snow. Other plants are dormant or die in the winter, leaving only seeds which are cold resistant, to grow when conditions become favourable again.

3.5.4 WIND

Wind is important in that it is one of the main mechanisms of seed dispersal for plants as well as the fact that grasses are pollinated by means of wind, and grasses are the dominant type of vegetation in this particular area. Wind influences the evaporation of water from the soil and strong winds can cause a water shortage in plants due to a high evapo-transpiration rate (Coupland 1979).

The plateau making up the interior of southern Africa has prevailing summer on-shore winds (south, south-east and east). These winds are normally moisture-laden and are associated with thunder storms (Jackson 1947), while prevailing winter winds are off-shore, (north, north-west and West) winds. Their moisture-content is low, thus causing wide temperature fluctuations due to the loss of radiation to the atmosphere (Jackson 1947).

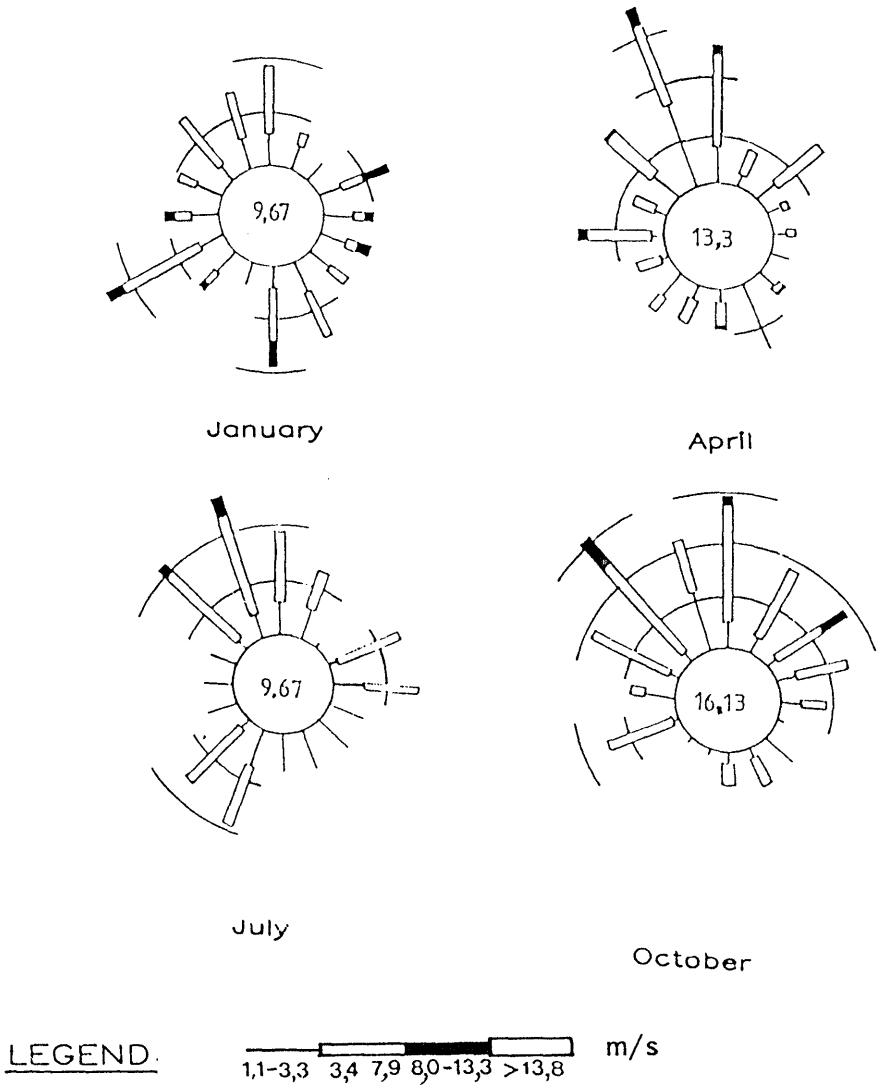


Figure 15. Wind roses for Lydenburg during four months of the year (Weather Bureau 1968b).

From Figure 15, it can be seen that at Lydenburg the wind is predominantly from the south and west-south-west as well as the north and north-West during the summer months, and from the north-west during the winter months. Winds occurring during the winter months seem to be generally less strong than those occurring during the summer months.

A tornado was spotted by the author in the month of October to the north-west of the town of Dullstroom.

CONCLUSION

From the Walter Climate Diagrams in Figure 16; it can be seen that the climate of the study area is very unique. It is situated at a high altitude which causes lower temperatures than what would normally be expected at this latitude (Schulze 1947). Snow and frost are thus common. The rainfall is relatively high (Weather Bureau 1988), and wind speeds are high all-year-round, contributing to many runaway fires. These combined factors give rise to a combination of species that is found only in this type of area. Geophytes flourish amongst the grasses and very few trees are present.

There also exists a relationship between precipitation and biomass production for grasslands (Deshmukh 1984). From the regression equation;

peak biomass (kg h) = 8.488 x precipitation (mm) - 195.768

(Deshmukh 1984), the peak (climax) biomass for any specific part of the study area can be determined. This equation was determined using data from grasslands (Deshmukh 1984), and is thus ideal for use in this study as this is pure grassland together with some forbs and no trees. Thus it can be seen that areas receiving a high rainfall could be expected to have a higher peak biomass than areas that receive less rain, as can be seen in the field. Peak biomass per for the grasslands surrounding Belfast would be 6 976.60 kg per hectare per year. Values for the grasslands surrounding Lydenburg, Waterval Boven and Sabie would be 5 822.23, 7 010.54, and 9 427.10 kg per hectare per year respectively. Thus the high rainfall around Sabie has a positive influence on the biomass production of the vegetation of this area. The low biomass production for the grasses around Lydenburg is caused mainly by the lower rainfall that this area receives.

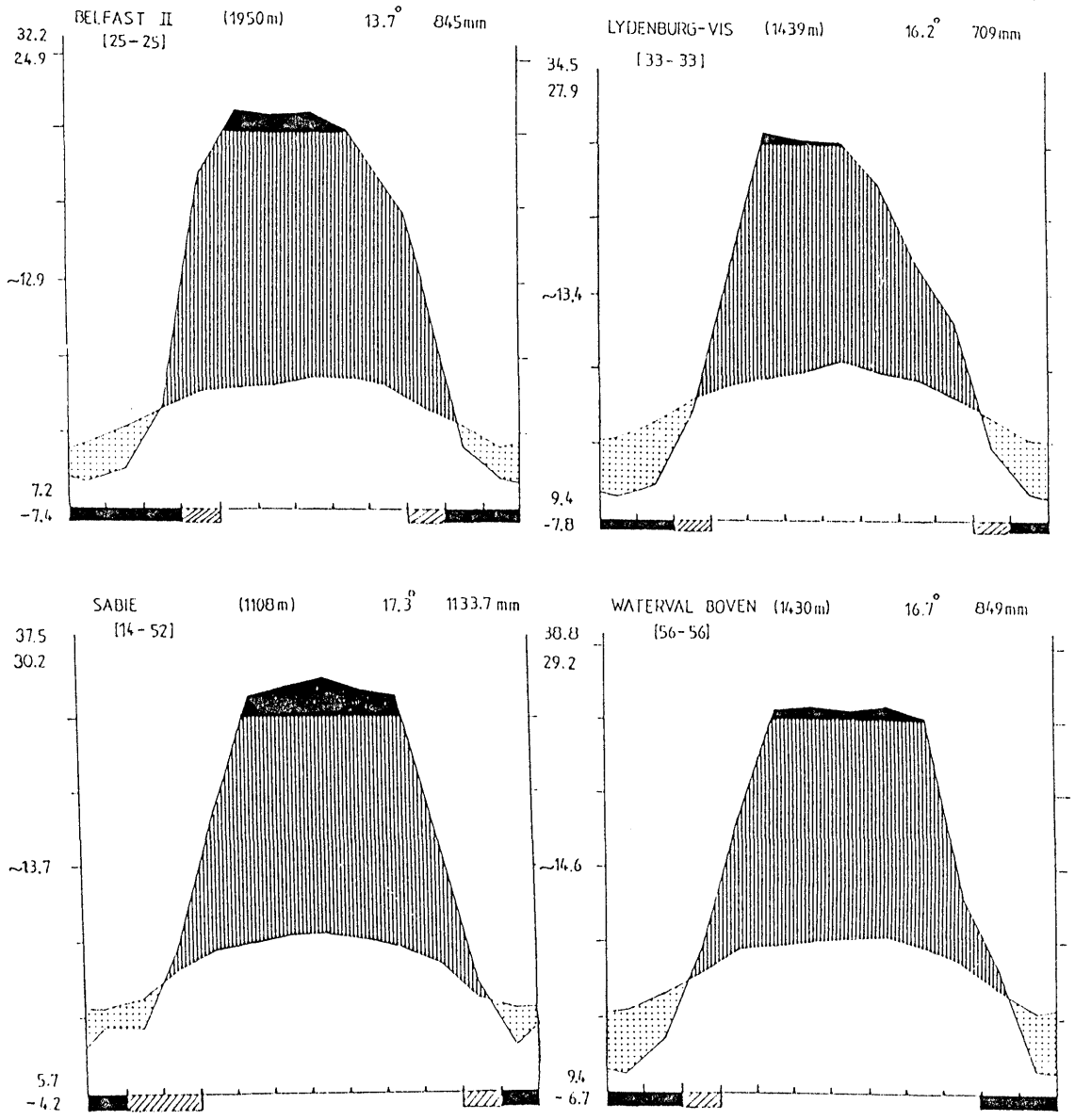


Figure 16. Walter Climate Diagrams for four weather stations in the study area.

These diagrams were compiled from data obtained from the Weather Bureau (Weather Bureau 1968b; Weather Bureau 1988).

4.1 HISTORY

The history of this area is included, as certain ecological units are explained by events that took place in the past. History also gives us an idea of how the land was managed in past years.

The earliest evidence of human habitation in this area are artifacts that were found in a rock shelter at Heuningneskrans in the Lydenburg district. These were dated as being of the Late Stone Age (Fage & Oliver 1982). It is presumed that the makers and users of these tools learned this from the tribes in Zimbabwe and eastern Africa, who traded with tribes in the northern and eastern Transvaal.

It is believed that the tribes in this area were not pasturalists because the pollen of *Acalypha* sp., a species common in abandoned gardens which are reverting to forest, is prevalent in this area (Fage & Oliver 1982). Settlement ruins can also be seen in many parts of this study area (Figure 17)

The tribe of Venda probably arrived during the Iron Age and they mined iron in this area as well as traded copper and gold, mined at Phalaborwa and Lydenburg respectively. Also tools that were found indicate that the cultivation of crop-foods must have dominated in this area in the Late Iron Age. It is also known that most of the pasturalists were situated in central Zambia and parts of Natal, and were rare in the study area until around the eighth century A.D.. Pottery has also been found in this area (Klapwyk 1973), which was used to store grain in.

A personal observation of the author is the presence of terraces, especially in the areas where there is Transvaal diabase present. These terraces are still visible, being constructed of Transvaal diabase, although there are also some terraces in areas where quartzite is present. These crop-planting tribes must therefore have known that soils derived from diabase are richer than soils derived from quartzite.

Figure 17. Ruins of an ancient settlement ± 2km east of Machadodorp.

Also in the Machadodorp area there are many strange stone structures (Figure 17), which, according to the local population, were studied by professor Raymond Dart, and were declared to be the same age as the Zimbabwe Ruins (personal communication). (2)

In the early nineteenth century the first European explorers and missionaries arrived in this area (Fage & Oliver 1976).

After the Great Trek in 1838-1850, the population of Ohrigstad moved to Lydenburg, which became the new settlement-centre in the eastern Transvaal. Later in 1856 because of political differences, Lydenburg formally declared itself a separate Republic (Fage & Oliver 1976).

There were repeated conflicts between the settlers and their African neighbours, and the Pedi chief, Sekwati entered into an agreement with the Lydenburg Republic in 1857, under which the Steelpoort River was recognised as the boundary of his kingdom (to the north-west of the study area). In 1860, Lydenburg rejoined the Transvaal Republic with Andries Pretorius as president.

Shortly after 1868, gold was found near Lydenburg and this brought hundreds of miners to the area. The excitement was short-lived however because there was very little gold and transport costs were enormous. This must have had a drastic effect on the ecology of the land around Sabie and Lydenburg because scars due to the mining activities can still be seen in this area. By 1874 most of the gold was depleted and most of the population had moved away. Lydenburg was still important to the transport-riders like Sir Percy Fitzpatrick, who made trips to the then "Delagoa Bay" (now Maputo) via Lydenburg, where they obtained supplies for trading purposes (Fage & Oliver 1976).

An interesting part of the study area is the legend of the Kruger Millions, which are believed to be in the study area somewhere near Machadodorp or Lydenburg. The facts about this treasure are these:

(2)Mrs A.V. Venter, P.O. Box 279 Machadodorp.

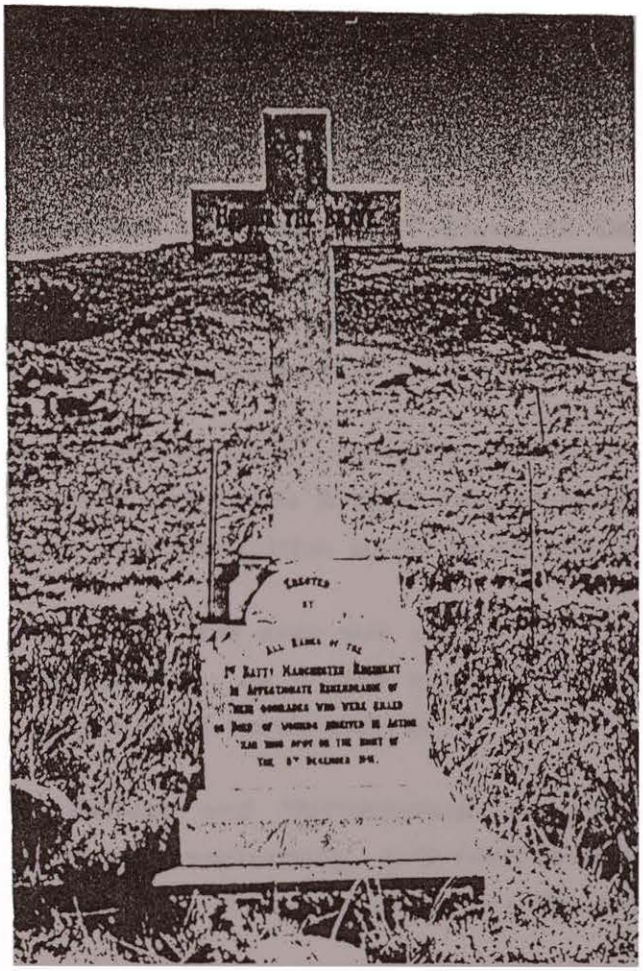


Figure 18. Graves from the Anglo-Boer war ±16 km north of Dullstroom on the road to Lydenburg.

On the 28th of May 1900, during the Anglo Boer War, Machadodorp was made the administrative capital of the Transvaal Republic after the British invasion of Pretoria. That very same day gold worth R 60 000 000 was moved from Pretoria and the East Rand, by rail to Machadodorp prior to the British invasion. In April 1901 General Botha announced that the "Staatskas" was empty due to debts that the government owed (Kruger 1979).

In June 1901 Lord Roberts marched from Pretoria to Delagoa Bay tearing up the railwayline as he went. In August the line up to Belfast was ripped up, and on the 26th and 27th of December 1901 the last great battle of the war was fought in this region, commemorated by a gravestone (Figure 18).

Whether the gold was used or went missing is still unknown, but no gold was moved out of the country due to the British that were monitoring all movements of gold, because arms and ammunition could be bought with it (Kruger 1979).

During the Anglo Boer War this area was utilized by farmers to breed horses used by the boer commandoes, as it is a particularly good area for breeding horses due to the abscence of horse-sickness.

Today Lydenburg, Belfast and Machadodorp are agricultural centres for farming practices such as sheepfarming, soft-fruit farming (especialy peaches) and cattle farming. It is also an important centre for trout- fishing.

4.2 PREVIOUS BOTANICAL AND VEGETATION SURVEYS IN THE AREA

From the PRECIS Data Bank of the National Herbarium it was found that well known collectors have collected many species in this area, however with regard to vegetation surveys in this area not much has been done.

Studies have been caried out in the Verlorenvalei Nature Reserve by Bloem (Bloem 1988), and the escarpment near Sabie has been studied by Deall (Deall 1985) and Matthews (Matthews 1991).

An important study was also performed by J.P.H. Acocks (Acocks 1988), who did a survey of veld types throughout the Republic of South Africa.

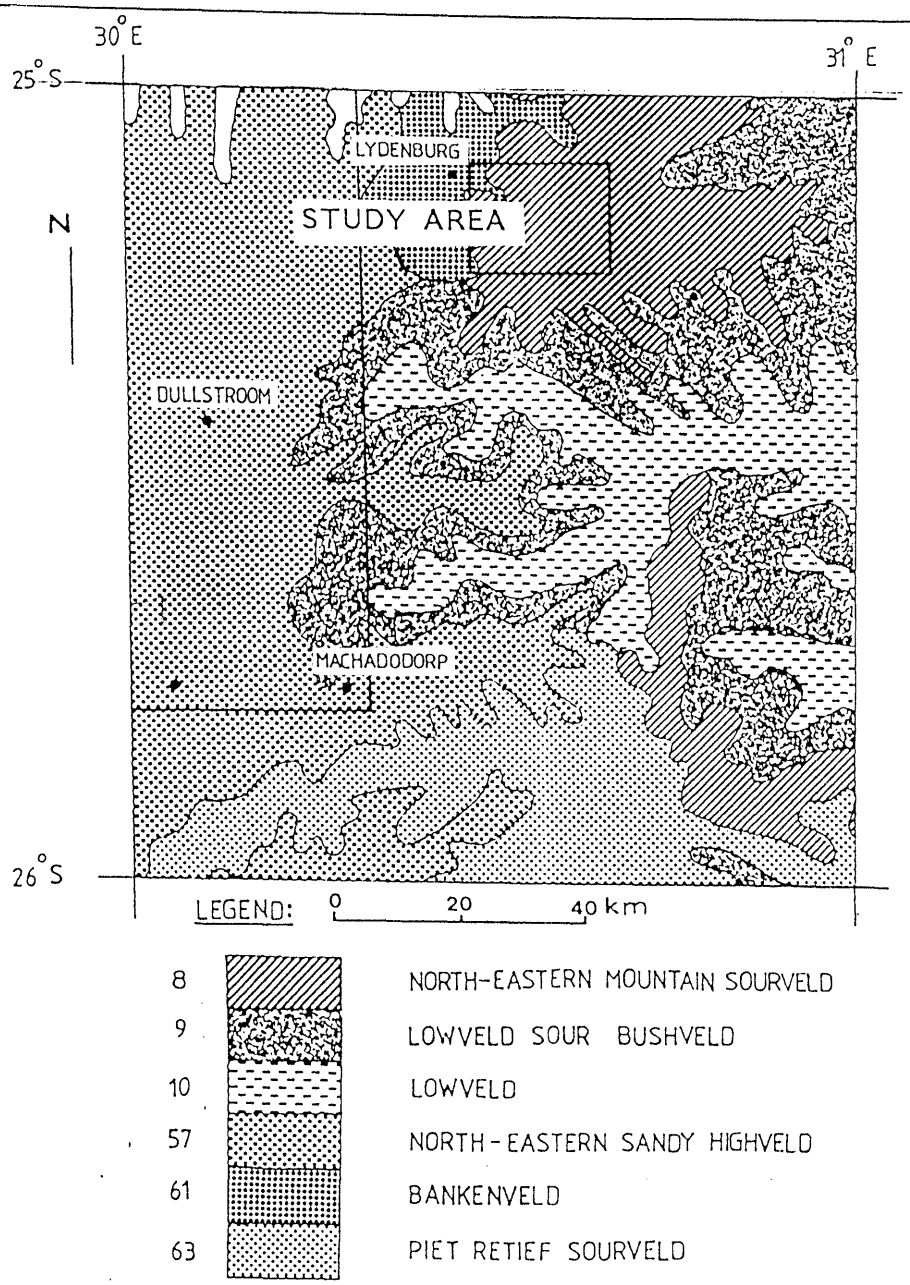


Figure 19. Acocks' classification of the eastern Transvaal (Taken from Acocks 1988).

This particular area according to Acocks falls into the North-eastern Sandy Highveld (Figure 19), which is sub-divided into the Near-Bankenveld Variation and the Near-Highland Sourveld Variation. The Near-Bankenveld Variation occurs more on the western sides of the watershed and does not include much *Themeda triandra*, it's ecological position being occupied by sourer species. Common grass species are *Tristachya leucothrix*, *Trachypogon spicatus*, *Heteropogon contortus*, *Eragrostis racemosa*, *Monocymbium ceresiiforme*, *Loudetia simplex*, *Ctenium concinnum* and *Microchloa caffra*.

The Near-Highland Sourveld Variation occurs more on the crests and eastern sides of the mountain ranges and *Themeda triandra* is dominant. Common species are much the same as the former variation however less *Loudetia simplex* and *Ctenium concinnum* are present.

Both these variations show affinities with the Bankenveld and form the transition between the *Cymbopogon - Themeda* Veld and the Highland Sourveld (Acocks 1988). A small area of isolated Bankenveld occurs near the town of Lydenburg and sample sites were placed in this area to determine it's affinity with the rest of the area.

4.3 EXPLOITATION AND LAND-USES

An estimated 30-35% of this study area is currently under cultivation (From aireal photographs of this area), with forestry being the most abundant practice. Other crops such as maize and fruit are important with crops such as sunflowers, flowers (tulips) and perrenial rye grass (*Lolium perenne*) being less important. Planted pastures of *Eragrostis curvula* are also common although most of the livestock is supported by the natural pasturage. Common domestic animals include cattle (dairy and beef), sheep and horses (which thrive here due to the apparent absence of horse sickness).

FAUNA.

Game is to be found on most of the farms in the area, while a private game reserve in the southern part of the larger study area abounds with blesbuck, black wildebeest, blue wildebeest, springbuck and ostriches.

Two nature reserves namely the Verlorenvalei Nature Reserve (VNR) and the Dullstroom Nature Reserve (DNR) are to be found in the larger study area, while the Lydenburg Nature Reserve (LNR) forms part of the smaller study area. These three Reserves have the following species residing in them (Batchelor *et al.* 1982) and according to Edwards (1974) more of this area should be conserved.

Common name	**Scientific name**	**Reserve**
Blesbuck	*Damaliscus dorcas phillipsi*	VNR, DNR & LNR
Wattled crane*	*Grus carunculata*	VNR & DNR
Crowned crane	*Balearica regulorum*	VNR, DNR & LNR
Blue crane	*Anthropoides paradisea*	VNR, DNR & LNR
Springbuck	*Antidorcas marsupialis*	DNR
Brown Hyaena	*Hyaena brunnea*	VNR & LNR
Blue wildebeest	*Connochaetes taurinus*	LNR
Duiker	*Sylvicapra grimmia*	VNR, DNR & LNR
Steenbuck	*Raphicerus campestris*	VNR, DNR & LNR
Oribi	*Ourebia ourebi*	VNR, DNR & LNR
Lynx	*Felis caracal*	VNR, DNR & LNR
Red rhebuck	*Redunca fulvorufula*	VNR, DNR & LNR
Grey rhebuck	*Pelea capreolus*	VNR, DNR & LNR

Other less conspicuous species are also to be found on all three nature reserves. The Verlorenvalei Nature Reserve is very special because it is the only Nature Reserve that has been set aside specifically as the breeding ground of wattled cranes, and is probably the Nature Reserve situated at the highest altitude in the Transvaal.

The wattled crane (*Grus carunculata*; Batchelor *et al.* 1982), which has it's breeding grounds in this area, is as yet still an endangered species.

The springbuck at the Dullstroom Nature Reserve were purchased by the Dullstroom Village Council and were re-introduced to the area. From the six originally sited there, one died and the remainder bred to reach a total of thirteen (personal communication).(3)

Various nature trails are also situated in these areas namely the Steenkampsberg Nature Trail, Elandskrans Nature Trail and a Nature Trail north of Lydenburg.

A large part of the study area consists of wetlands and plans are being made by the National Parks Board to conserve the Lakenvalei wetland, due to the wattled cranes that breed there, together with a few rare orchid species which are also to be found here.

FLORA

In addition to the naturally occurring species found in this area there are a number of alien species to be found. These include *Pinus sp.* found mainly in plantations. Other undesirable plant species are *Stoebe vulgaris* and *Pennisetum villosum* which have spread into natural grasslands.

Apart from the exotic plantations there is also a considerable problem with black wattle (*Acacia mearnsii*) in the drainage systems of the whole study area. This problem is being investigated by Mr. Johan Engelbrecht,(4) who together with his team are undertaking to chop some of these trees out especially in the area surrounding Lydenburg.

The removal ot these trees is vital to the recovery of the natural vegetation around the rivers (Mueller Dombois & Ellenberg 1974), however, the seed bank of seeds still remains viable for a long while after the trees have been removed. Other naturally occurring trees will be able to establish themselves after the removal of the wattles.

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(3) Dullstroom Village Council P.O. Box 1 Dullstroom.

(4) Mr. Johan Engelbrecht P.O. Box X 64 Pretoria, 0002.

Continued survival of a number of naturally occurring plant species in both study areas are threatened (Hall *et al.* 1980) due to the destruction of habitat resulting from agricultural and mining practices.

Endemics occurring in the area will be discussed later.

4.4 FIRE AND GRAZING

Grasslands found in the Belfast/Lydenburg/Dullstroom district are of fire climax vegetation as opposed to climatic climax vegetation (Tainton 1981). Here it can be seen that fire together with grazing maintains the grass cover (Burkhart 1975), and prevents the establishment of shrubs and trees. Thus fire started naturally (lightning) or by man, together with grazing, have created pressures with which the grasslands of Africa have co-evolved (Daubenmire 1974; Owen & Wiegert 1981; Tainton 1981; Mentis & Huntley 1982).

Fire has always been used by pasturalists for the management of the vegetation, but abuse by this tool can result in deterioration in the vegetation (Trollope 1989). Such misuse of fire is to be found in the study area where sheep farmers burn the veld out of season to obtain green growth for grazing. This causes a reduction of canopy cover, basal cover and a reduction of vigour (Tainton 1981; Trollope 1989) as well as an increased run-off area for rain. This then in turn causes soil erosion (Trollope 1989) which is most prevalent in the south-eastern part of the study area. This area is most susceptible to soil erosion because of the type of geology and soiltypes (Figure 3 and Figure 6) found there (Everson *et al.* 1989).

In areas of high rainfall such as this study area the biomass build-up is high per season (Roberts 1970). Build-up of old undesireable grazing material can then be removed by fire (Daubenmire 1968) thus preventing the grasses from becoming moribund (Trollope 1989).

Burning in the height of the summer months can have serious effects on the seed-banks of the grass seeds because the seeds themselves are burned before they can drop to the ground and form part of the seed-bank. Although the

effect of a loss of seeds is not immediately noticeable, it will cause a diminishing of the species in question later on (Edroma 1984; Knapp 1985).

Grazing shortly after burning can also have an extremely detrimental effect on the quality of the natural grasslands (Bakker 1987) especially if camps are too small or herds are too large. Grazing too soon after a burn can cause a mosiac pattern to develop in grasslands (Belsky 1986). The mosiac pattern consists of palatable grasses and unpalatable grasses in patches. The unpalatable grasses can take over due to the fact that they are not grazed (Grubb 1977), and are thus not stressed. Later these unpalatable grasses dominate completely.

Under-burning can have as serious an effect on the condition of the grassland as can over-burning (Trollope 1989). This is a very important factor in the breeding habits of the wattled crane (*Grus carunculata*). These birds breed in the wetlands and, according to some local farmers (5) (personal communication), breed only in wetlands that have been burned the previous season. Thus if wetlands are left unburned the cranes will either move to a more suitable spot or would simply not breed that year due to unfavourable conditions. Most cranes however return to their territories each year to breed and not burning the wetlands may be a possible explaination for their low numbers.

According to Heyns (1985) wetlands of the Verlorenvalei Nature Reserve should be burned every third year to remove dead plant material.

The condition of the veld in the study area appears to be relatively undamaged although the farmers graze their cattle and sheep extensively on the natural vegetation. The reason for this is that under high rainfall conditions the plants recover quickly from the effects of the grazing.

There are some examples of over-burning in certain areas resulting in a low species diversity. Burning twice a year is also a common practice for some farmers. This is done to remove the older grass which is high in cellulose. This is normally done by sheep-farmers because the sheep prefer softer younger grass.

(5) Mr. Daan Botha P.O. Box 164 Lydenburg

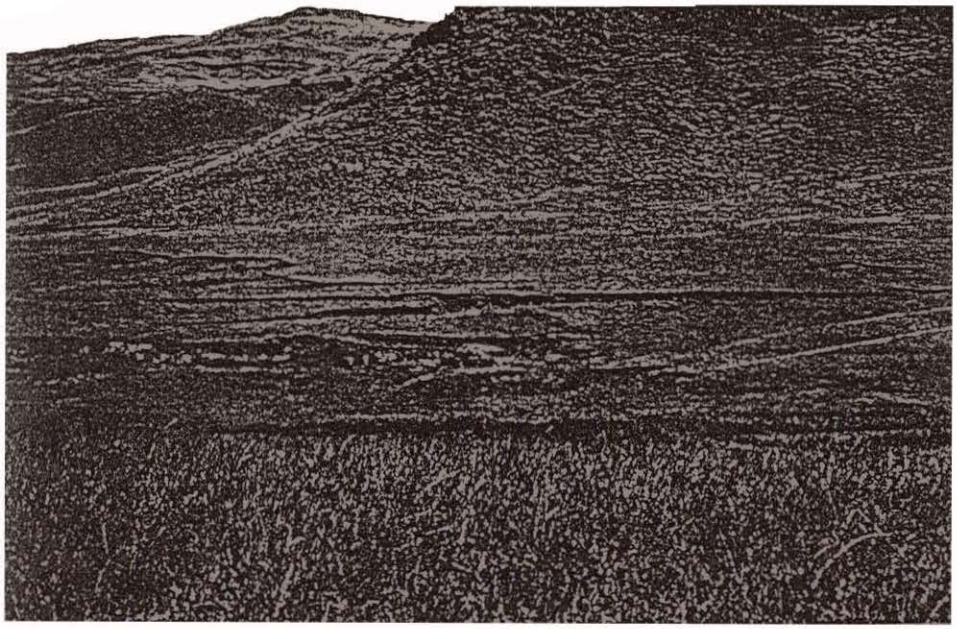

Figure 20. Sheet and donga erosion in the south-eastern part of the study area.

4.5 EROSION

Due to the steep gradients to be found in this area it is expected that there would be a high degree of erosion in this area. This however is not the case. Most of the area experiences sheet erosion which is not as serious as some other types of erosion. One exception however is the south-eastern areas where the Boven and the Machadodorp Members (Figures 3 and 20), are to be found. These are mainly shales and they are a type of rock that weathers and erodes very easily.

Thus if any degree of stress is placed on the soils derived from these rock types the result would be a high degree of erosion. This can be seen from Figure 20. Together with its's easily weathered nature, the soils derived from this type of rock are not very fertile, thus the plant cover is somewhat sparse, which in turn promotes a high degree of run-off, thus taking a great deal of topsoil with it.

Roads built on steep slopes also contribute to soil erosion, and can lead to the formation of dongas.

The movement of stock animals to and from watering points in this area also may lead to the formation of dongas.

Plants tend to grow together in groups and are seldom distributed in a random manner (Greig-Smith 1964; Daubenmire 1968).

Groups of species tend to occur in associations determined by their ecological tolerance of biotic factors, combined with interspecific and intraspecific interactions. Phytosociological classification seeks to investigate the interrelationships between species and their distribution patterns.

Classification as approached by the Braun-Blanquet (1932) method, and modified by Mueller-Dombois & Ellenberg (1974), Westhoff & Van der Maarel (1978) and Bredenkamp (1982), indicates that a correlation exists between specific environmental conditions and plant communities. Thus a sound ecological classification of the vegetation is produced (Bredenkamp & Theron 1978).

Two phases comprise this procedure of phytosociological classification namely; the analytical phase, where environmental and floristic data are collected during fieldwork. The second phase (synthetic phase) then results in a delimitation of communities derived from the classification of the data. These communities are then ordinated along environmental gradients (Moore *et al.* 1978; Westfall *et al.* 1982; Deall 1985 & Bloem 1988) to determine the most important environmental factor contributing towards the differentiation of each community.

5.1. ANALYTICAL PHASE

5.1.1 RECONNAISSANCE

As originally postulated in the Braun-Blanquet approach, sampling sites are chosen subjectively (Braun-Blanquet 1932). Thus a thorough reconnaissance

of the study area had to be done to enable the phytosociologist to choose the sample sites so that all communities represented in the area were sampled.

5.1.2 SAMPLING STRATEGY

Subjectively placed sampling sites versus objectively placed sample sites have been both criticised and endorsed (Coetzee & Werger 1973; Werger 1974a; Mueller-Dombois & Ellenberg 1974). The current trend in phytosociological work is towards using more objective methods (Coetzee 1974; Bredenkamp & Theron 1978; Deall 1985; Bloem 1988; Westfall 1992) such as random, or stratified-random sampling.

In this study a stratified-random sampling method was used since it is more precise than strictly random sampling (Cain & Castro 1959). This also excludes over-and under-sampling and the exclusion of certain vegetation types is less likely to occur. This stratified-random sampling method was combined with extra subjective sampling by the author to avoid the exclusion of any vegetation types in the area.

5.1.3 DISTRIBUTION OF SAMPLE SITES

The distribution of sites was based on the random stratification concept to ensure that all differing types of communities would be sampled (Daubenmire 1968).

Stratification

Stratification was carried out using the different geological types together with the different land types as strata. The geological map, 2530 Barberton (scale 1:250 000) was made into a transparancy and placed over the land type map 2530 Barberton (scale 1:250 000). Each of the different geological types per land type were then taken as a unit of statification.

The whole surface area of the study area was then determined using a Li Cor 3100 planimeter. The surface area of individual land types were then determined as a percentage of the area. The percentage of each area compared to the whole was then determined. Units of stratification comprising a larger percentage of area thus contained more sample sites than those units of stratification comprising smaller areas. It was decided to have approximately 200 sample sites in the main study area and 75 in the smaller study area. From this it was then determined how many sites were to be placed in each of the units of statification using the percentage-cover for each unit of stratification as compared to the whole.

Randomness

Before the site positions were located all areas under cultivation were delineated so as to be excluded from the sampling. This was done by observing cultivation on the most recent aerial photographs (1988) of the region, and plotting these areas onto the map used.

The placing of the sites in each unit of stratification was in a random fashion using a random number table. A grid with x and y co-ordinates was placed over the map and random number co-ordinates then formed the site positions.

Number of sample sites

Besides the 200 sample sites in the main study area and the 75 sample sites in the smaller area it was decided that extra sampling was necessary due to the fact that the physiognomy of the area does not form part of the strata and this aspect also had to be investigated. Therefore if a particular site was situated in the valley, an extra site would have to have been positioned on the crest as well as on the slope (this was done only if it was found that the vegetation of these sites obviously differed). Thus the total number of sites in the large study area was 239 and the number of sites in the smaller study area was 80 due to extra sampling.

Placing sites

Sites were located in the field using 1 : 50 000 aerial photographs upon which the sites had been stipulated previously from the maps. This method is relatively rough and not totaly accurate in placing the sites, but no better method

could be used. Finding the site-positions in the field from the aerial photographs is however very accurate and speeds up the process of sampling considerably.

An element of subjectivity was introduced as the sample site had to be placed in the most homogeneous area within the proximity of the site. This could only be done by means of personal observation to avoid ecotonal areas.

5.1.4 PHYTOSOCIOLOGICAL SAMPLING

Sample sites measuring 200 m^2 in area were sufficient to sample this vegetation type (Deall 1985; Bloem 1988). The square quadrat was not used because it is deemed less efficient than a rectangular quadrat (Cain & Castro 1959), and less variability is to be found between square quadrats (Greig-Smith 1964).

According to Mueller-Dombois & Ellenberg (1974) and Werger (1974a) size and shape have no influence on the effectiveness of the survey. There exists however a minimum area (Gleason 1925; Hopkins 1955) for sampling, determined by the vegetation (Werger 1974a). According to the species-area curve of the vegetation of the Verlorenvalei Nature Reserve (Bloem 1988) a sample site of 200 m^2 was recommended. This specific size of 200 m^2 was used due to the low species diversity of high mountain grassland (Bloem 1988). This is also the same size quadrat as recommended by Deall (1985) and used by Bloem (1988). Thus any correlation of data collected by these authors dan be done directly knowing all sample sites were of the same size.

For each quadrat the following data were gathered:

1. Location

Farm names or nearest beacons were used to specify the location of sample sites.

2. Stand co-ordinates

The co-ordinates of the sites were noted from a map (Land type series, 2530 Barberton 1979), eg. 2530 AA.

3. Relevé number and date

The site number and date when the data were collected, were noted.

4. Altitude

The altitude in metres was noted from the nearest contour on the topocadastral map (Land type series, 2530 Barberton 1979.)

5. Geology

The geological groups were noted for each site using the geological

6. Land types

The land types for each site were noted from the land type map (Land Type Series 2530 Barberton 1979).

7. Geomorphology

Slope positions are very important because they have an impact on the water run-off and water collection as well as the fact that soil depth is affected by the gradient of slopes (Munnik, Verster & Van Rooyen 1984).

The geomorphological classification system of Scheepers (1988) was followed. The landscape is divided into two major classes, namely facets (planes) and segments (curves). Further sub-divisions are made according to the position, the landscape (uplands and bottomlands) and the magnitude of the slope (flats, slopes and cliffs).

8. Aspect

The aspect of the sample sites was noted. Use was made of a compass to indicate the direction of strike of the slopes, in degrees. In addition directions (north clockwise to north-north-west) were noted for each slope. Measurements were corrected for an 18° West of true North magnetic declination.

9. Slope inclination

The inclination of each slope (if any) was noted using a clinometer.

10. Degree of exposure

The degree of exposure to the elements was noted according to the following scale:

0	Kloof	Very sheltered
1	Flat land enclosed by higher slopes	↓
2	Open flat land	
3	Intermediate slopes	
4	High land	
5	Summit	Highly exposed

11. Degree of disturbance

The degree of disturbance (if any) was noted and included disturbance due to road construction, exotic invaders, soil erosion, overgrazing, overburning, trampling and power line construction.

Different classes of grazing and erosion were scaled according to the following.

	Grazing		Erosion
0	No recent grazing	0	No visible erosion
1	Selectively grazed	1	Sheet erosion
2	Evenly grazed	2	Donga erosion
3	Heavily grazed	3	Sheet & donga erosion

12. Soil characteristics

a). Soil depth

The depth of the soil was measured in centimetres.

b). Soil texture

The texture of the soil was also noted using the method as prescribed by the F.S.S.A. (F.S.S.A. 1980).

c). Soil form and soil series

The soil form and soil series of the soils of the quadrats were noted following MacVicar *et al.* (1977).

5.1.5 FLORISTIC COMPOSITION

For the plant species that were present the following was noted;

a). Species name or number

The species that were present in the quadrat were noted. Unknown species were collected and numbered for later identification.

It will be noted that not all species occurring in the checklist (see attached checklist of species) are to be found in the phytosociological tables. This is due to the fact that the species were not collected only at the sample sites.

b). Cover-abundance scale

Cover-abundance values for every species present were recorded using the Braun-Blanquet cover-abundance scale (Mueller-Dombois & Ellenberg 1974)

r = individual with neglegible canopy cover
\+ = less than 1% canopy cover
1 = 1% - 5% canopy cover
2a = > 5% - 12% canopy cover
2b = >12% - 25% canopy cover
3 = >25% - 50% canopy cover
4 = >50% - 75% canopy cover
5 = >75% - 100% canopy cover

In most cases the canopy cover is over-estimated. Over-estimation is more common for larger plants than is under-estimation because over-estimation is correlated with the size of individuals (Floyd & Anderson 1987).

c). Height of vegetation

The height of the vegetation was noted. Most of the vegetation in the study area consisted of grasses although there were tree communities. Grasses were categorized into the following:

short	culms < 20 cm
medium	culms ± 40 cm
tall	culms > 60 cm

5.2 SYNTHETIC PHASE

5.2.1 CLASSIFICATION

The procedures of classification group floristically similar relevés together, forming units that are identified by diagnostic species. Diagnostic species are species occurring predominantly in one community, or species that are restricted to one community (Greig-Smith 1964; Whittaker 1978).

Classification of the field data was accomplished by using a TWINSPAN (TWo-way INdicator SPecies ANalysis) computer program (Hill 1979b). This program is a polythetic divisive technique where the entire set of field data is examined and successively divided into smaller groups. The divisions are based on floristic data (presence and abscence of species). Both the relevés and the species are grouped into a specific order (Noy-Meir 1973; Hill 1979b; Gauch & Whittaker 1981).

TWINSPAN performs a complete classification resulting in the smallest end-groups that can be distinguished by TWINSPAN. It is also possible for the user to stipulate a cut-off point for the level of divisions to be done by TWINSPAN (Hill 1979b).

TWINSPAN classification was carried out on the field data by using the BB NEW Programme Package, available at the University of Pretoria, and developed by Botes, Bredenkamp and Bezuidenhout.(6)

Running a TWINSPAN on the raw field data produced a rough table that was divided into three major communities by means of species and relevés falling into groups. The program classified these groups by ordinating the data by means of Reciprocal Averaging according to species presence and absence (Gauch 1982). This matrix was then refined by Braun-Blanquet procedures (Behr & Bredenkamp 1989).

Because of the size of the data set these communities were analysed seperately using TWINSPAN and refined by Braun-Blanquet procedures.

The syntaxonimic nomenclature of Barkman, Moravec & Rauschert (1986) was followed to obtain the names of the vegetation units, which involves the following:

The main vegetation unit has a single name, with the single name originating from a specific diagnostic species represented by the main vegetation unit.

The plant community (secondary unit) is represented by a binary name, where the first name is derived from the main vegetation unit (wherein the secondary unit occurs) and the second name from a dominant or diagnostic species present in the secondary vegetation unit.

Further subdivision of the secondary vegetation unit is characterised by a tri-nomial name of which the first and second part is the name of secondary vegetation unit, followed by the name of the dominant or diagnostic species of that specific vegetation unit, variant or zone.

No attempt however was made to fix formal syntaxon names. This will however will be possible when a synthesis of the vegetation of the eastern highland areas is made.

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Type relevés were chosen as the most representative relevé for a community. This was done subjectively by comparing relevés from the Braun-Blanquet tables (Tables 1, 2 and 3).

5.2.2 THE BRAUN-BLANQUET METHOD

This method (Werger 1974b) is also known as the Zurich-Montpellier school of phytosociology, the product of which is a two-way matrix (table) consisting of relevé numbers representing completed sample sites (x axis), and species names (y axis). The arrangement of this table is such that a completed table can at a glance divulge all the environmental data at each site, as well as the complete floristic data for each community. This includes dominant-, exclusive-, particular-, preferential-, constant- and character species. The stucture and affiliation of all communities can also be seen from this table. Environmental gradients responsible for the different communities usually run from one side of the table to the other.

The final product of this study is presented as three such tables (Tables 1, 2 and 3).

5.2.3 ORDINATION

With the many methods that are available to researchers in phytosociology today it must be decided which one would be most usefull for the specific type of work being done. Many papers have been published comparing different methods of ordination (Williams & Lambert 1959; Werger 1973; Kent 1977; Feoli 1977b; Hill & Gauch 1980; Allen & Shugart 1983; Oksanen 1983; Theron, Morris & Van Rooyen 1984; Dargie 1986).

It was found that Principal Component Analysis (hereafter PCA) done without previous data standardization delivered results that were determined mainly by the most abundant species, while Detrended Corespondence Analysis

(hereafter DCA) and Reciprocal Averaging (hereafter RA) gave more equal weight to all species (Oksanen 1983). Results of PCA matched those of RA and DCA when the species were standardized to roughly equal weights. Distortion can occur in ordinations however due to species richness (Dargie 1986), especialy in a region like the study area where there are many species per community. The species data were then standardised before ordination was carried out.

In this study, ordination was done only on the main communities produced by the TWINSPAN program plus further refinement by Braun-Blanquet procedures. This was done to investigate the plant-environment relationships within a community.

The field data was ordinated using the computer program DECORANA, (DEtrended CORrespondence ANAlysis; Hill 1979a) because of the superiority of DECORANA over other ordination techniques (Hill 1979a & Whittaker 1978). These being:

1. No relationship exist between any of the axes, since they are all formed independently (Hill 1979a; Hill & Gauch 1980; Whittaker 1987).

2. No distortion of axes occurs since the distances between stands or species, and distances along the axes correspond to differences in species composition along environmental gradients (Greig-Smith 1964; Whittaker 1978; Hill 1979a; Hill & Gauch 1980).

The procedure followed during data synthesis is as follows:

1. Species data were entered into a Raw-data file on the main-frame computer at the University of Pretoria. This data were then checked by running the programme attached to the BB NEW package to indicate any possible mistakes made while entering the data. Mistakes were corrected.

2. TWINSPAN was run to obtain a preliminary classification, resulting in three main groups.

3. Environmental data was then loaded and TWINSPAN was run again, thus incorporating floristic and environmental data. Upon examination of the

results of the TWINSPAN run, it was found that no correlation existed between the environmental parameters and their communities.

4. DECORANA was then run on the data to determine whether this program would group the relevés according to the same species that TWINSPAN did, therefore supporting the TWINSPAN, or if there existed any correlation between environmental data, species and relevés, and the DECORANA plot. The following environmental parameters were used: land type, altitude, geology, lithology and slope. DECORANA analysis did support the main divisions of three large groups but failed to correspond in any way with TWINSPAN on a more detailed level.

As the complete data set was too large to manage, it was split into three parts, corresponding to the three main divisions obtained by TWINSPAN.

These three data sets (wetlands, boulderies and grasslands) were then used for further computer analysis.

The computer programme package CANOCO (Ter Braak 1986) was then used to determine if environmental factors were coupled to plant communities.

The results of the CANOCO programme run on the floristic and environmental data of the wetlands did not reveal any of the environmental factors to be associated with any specific community or communities.

The TWINSPAN (Hill 1979b) classification of the relevés of the total data set revealed three clearly defined vegetation units, namely wetland communities (Table 1), communities of the boulderies (Table 2) and grassland communities (Table 3).

The communities which could be identified on a 1: 150 000 scale aerial photograph are given in map 1. Wetlands, boulderies and Grasslands can be identified. Only one community of the grasslands namely the *Bromus firmior* Grasslands could be distinguished from the other grasslands. This is possibly due to the size of the tussocks of this grass which are larger and more robust than other grass types.

6.1 WETLANDS.

The TWINSPAN classification (Hill 1979b) on the floristic data of the Wetlands produced results that could not be enterpreted ecologically. This classification was therefore refined by Braun-Blanquet procedures, and the results are given in Tables 1, 2 and 3.

Approximately fifteen percent of the study area comprises wetlands. The area covered by water depends on the season and the rainfall of any particular year. The formation of wetlands is associated closely with geological formation, lithology and soil types. Soils of certain geological formations are waterlogged due to the slope of the strata, thus causing wetlands to be formed. The wetlands have their own characteristic flora.

Wetlands in the study area occur at an altitude of 980 to 2 150 m above sea level and are represented by 39 relevés (Table 1).

The surface area of individual patches of wetlands can vary from 2 ha to 50 ha (Tarboton 1981).

No rocks and no trees occur in these communities.

The wetlands are burned regularly between two- and five-year intervals.

The floristic composition of the wetland plant communities is given in Table 1. Generally wetlands are characterised by the species group T.

Species group T (Table 1) are general species occurring throughout all wetland communities and are most flexible in their habitat requirements. These species are the grasses *Arundinella nepalensis*, *Alloteropsis* sp., *Aristida aquiglumis*, *Pennisetum thunbergii*, *Agrostis lachnantha*, *Hemarthria altissima* and *Setaria pallide-fusca*, the sedges *Fuirens pubescens*, *Mariscus congestus*, *Eleocharis palustris*, *Pycreus nitidus*, *Mariscus sumatrensis* and *Kyllinga erecta*, the forbs *Pycnostachys reticulata*, *Sebaea sedoides*, *Mentha aquatica*, *Lobelia flaccida*, *Helichrysum difficile* and *Helichrysum mundtii*, and the monocot *Eriocaulon dregei*.

The species with the highest constancy values are *Fuirena pubescens* (65,85 %) and *Arundinella nepalensis* (65,85 %) followed by *Mariscus congestus* (39,02 %) and *Schoenoplectus corymbosus* (31,71 %).

The analysis of the wetland vegetation resulted in the recognition of 4 major communities and 11 minor plant communities, which are classified as follows:

1 *Phragmites australis* deep wetlands

1.1 *Phragmites australis* - *Ficinia acuminata* wetlands
1.2 *Phragmites australis* - *Senecio microglossus* deep wetlands

2 *Miscanthus junceus* wetlands

2.1 *Alepidea amatymbica* - *Miscanthus junceus* moist river banks
2.2 *Agrostis gigantea* - *Miscanthus junceus* moist grassland.
2.3 *Panicum schinzii* - *Miscanthus junceus* shallow wetlands
2.4 *Carex cognata* - *Miscanthus junceus* wetlands
2.5 *Ischaemum fasciculatum* - *Miscanthus junceus* wetlands

3 *Eragrostis biflora* - *Stiburus allopecuroides* moist grassland

3.1 *Helichysum aureonitens* - *Eragrostis biflora* - *Stiburus allopecuroides* moist grassland
3.2 *Disa patula* - *Eragrostis biflora* - *Stiburus allopecuroides* moist grassland

4 *Arundinella nepalensis* moist turf grassland

4.1 *Hypericum hirtellum* - *Arundinella nepalensis* moist turf grassland
4.2 *Imperata cylindrica* - *Arundinella nepalensis* moist turf grassland

6.1.1 THE PHRAGMITES AUSTRALIS DEEP WETLANDS.

This wetland community occurs predominantly in deep water, mostly deeper than 0,20 m and often deeper than 1,10 m. The soils are high in organic matter, representing the Champagne form.

The vegetation is characterised by species group C (Table 1), with the diagnostic tall-growing reed, *Phragmites australis*, which can be seen in Figure 21 and *Typha capensis* also locally prominent. Other diagnostic species include hygrophylic forbs such as *Zantedeschia albomaculata*, *Berkheya speciosa* and the fern *Thelypteris confluens* which can grow in almost pure stands.

The *Phragmites australis* deep wetlands are subdivided into two communities namely the *Ficinia acuminata* - *Phragmites australis* wetlands in water 0,20 - 0,70 m deep, mostly at altitudes of 2 000 m and lower, the *Senecio microglossus* - *Phragmites australis* deep wetlands in water deeper than 1,10 m mostly at altitudes higher than 2 000 m above sea level.

6.1.1.1 Phragmites australis - Ficinia acuminata wetlands.

Type relevé - 307.

Average number of species per relevé - 32.

Maximum number of species per relevé - 47.

Minimum number of species per relevé - 10.

Stands of these deep wetlands may cover a surface area of up to 5 ha. This community is found where seasonal fluctuation of the water level occurs. Only in the most dry of seasons (as in the spring of 1992) does this community not have relatively deep surface water present. Water may vary in depth from 0,2 to 0,7 meters.

Altitudes vary greatly and mostly lie between 980 m and 2 000 m above sea level. The geology is predominantly from the Magaliesberg and the Steenkampsberg Formations although some shale from the Strubenkop and Lakenvalei Formations are also present. The soil form is Champagne and deep alluvial soils high in organic matter are found in these wetlands.

The reed *Phragmites australis* dominates the vegetation and the reed-beds form important bird breeding sites (Figure 21).

This community is characterised by species group A (Table 1), and the diagnostic species are the sedge *Ficinia acuminata*, the geophytes *Dierama pendulum*, *Ornithogallum monophyllum* and *Brunsvigia radulosa*, the forbs *Wahlenbergia sp.*, *Cycnium racemosum*, *Cyphia stenopetala*, *Asclepias dissona*, *Vigna vexillata*, *Vernonia hirsuta*, *Vernonia sutherlandii* and *Helichrysum pilosellum*.

The height of the vegetation in this community is approximately 2,60 m.

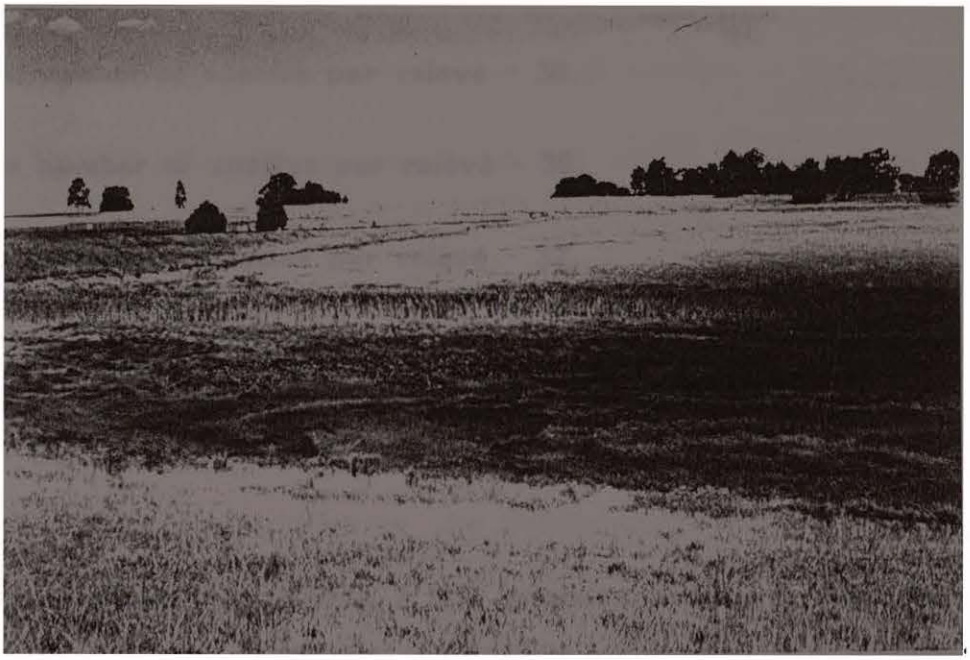

Figure 21. The Phragmites australis - Ficinia acuminata wetlands showing the dominant reed Phragmites australis.

6.1.1.2 Phragmites australis - Senecio microglossus deep wetlands.

Type relevé - 243.

Average number of species per relevé - 36.

Maximum number of species per relevé - 39.

Minimum number of species per relevé - 32.

This high altitude community occurs in the central parts of the deep wetlands and the surface area covered by these wetlands may be up to 15 ha. Lakenvalei between Belfast and Dullstroom is a good example of this community.

Altitudes are generally above 2 000 m above sea level and the geology is Steenkampsberg and Lakenvalei Formations. The soils are generally derived from quartzitic rocks and the soil form is Champagne. The water that is present is deeper than 1,10 m.

The height of the vegetation is approximately taller than 2,60 m, which is caused by the presence of the dominant tall-growing reed *Phragmites australis*.

This community is characterised by species group B (Table 1) and diagnostic species are the forbs *Senecio microglossus*, *Polygonum meisnerianum*, *Polygonum* sp. and the grass *Eragrostis cylindriflora*, together with the characteristic and conspicuous monocot *Kniphofia multiflora*, which can be seen from afar when flowering.

These wetlands are periodically burned and according to some of the farmers in the region this is beneficial to the breeding of birds like the wattled crane, who prefer open areas where they can clearly see any foes approaching.

6.1.2 MISCANTHUS JUNCEUS WETLANDS.

These wetlands are represented by communities that vary from moist river-bank communities to wet drainage lines. No trees occur in these wetlands and rockiness is confined to the presence of small pebbles in the sediments.

The moisture regime varies from moist soil which releases free water when trodden on, to surface water of a depth of 0,70 m.

The vegetation is characterised by species group K (Table 1). The diagnostic, robust grass *Miscanthus junceus* is dominant in this wetland community, and the forbs *Ranunculus meyeri* and *Ranunculus multifidus*, together with the sedge *Juncus exertus* are also diagnostic.

The *Miscanthus junceus* wetlands are divided into five communities (6.1.2.1. to 6.1.2.5. Table 1).

6.1.2.1 Alepidea amatymbica - Miscanthus junceus moist river-banks.

Type relevé - 172.

Average number of species per relevé - 18.

Maximum number of species per relevé - 30.

Minimum number of species per relevé - 9.

The *Alepidea amatymbica* - *Miscanthus junceus* wetlands of moist river banks are found on wet soils derived from granite and shale. No water is visible on the soil surface.

These moist river banks are found at altitudes lying between 1 200 and 2 000 m above sea level. The geological Formations are diverse but soils are mainly derived from quartzites and shales of the Pretora Group. The soils are deep,

dark and rich in organic content and belong to the Champagne soil form, allthough Arcadia soil forms may also be present.

The moisture status of this community is such that when trodden on water is released to the surface.

The height of the vegetation varies between 0,15 to 0,65 m.

The tall grass *Miscanthus junceus* is dominant but this community is characterised by species group D (Table 1) and diagnostic species are the forbs *Geranium multisectum, Alepidea amatymbica, Pelargonium alchemilloides, Diclis rotundifolium, Aeschynomene rehmannii, Asclepias dissona* and *Cephalaria attenuata,* together with the sedge *Kyllinga paucifolia,* the fern *Adiantum capillis-veneris* and the grass *Diheteropogon amplectens*.

6.1.2.2 Agrostis gigantea - Miscanthus junceus moist grassland.

Type relevé - 41.

Average number of species per relevé - 45.

Maximum number of species per relevé - 53.

Minimum number of species per relevé - 29.

This community is represented by numerous small patches of shallow wetlands that are a result of a raised water table caused by the lithological formations in the area. These wetlands are also formed by the drying up of larger wetlands through destructive use by man (See Figure 25).

The moisture status is such that visible water is present on the soil surface but never deeper than 0,05 m. The height of the vegetation is 0,4 m and may be extensively grazed especially in the dry season when the vegetation of this community is still green when compared to adjacent drier grassland vegetation.

Altitudes vary between 1 400 and 2 200 m above sea level and the lithology comprises shale and diabase from various geological Formations.

The soil is a deep, rich, dark loam, high in organic matter, thus being classified as belonging to the Champagne soil form.

This community is characterised by species group E (Table 1).

Species dominating the vegetation are the grasses *Scleria dieterlenii* and *Agrostis gigantea*.

Diagnostic species are the moss *Sphagnum africanum*, which grows in mats, the remains of which may form a peat bog. Diagnostic forbs of this community are *Senecio striatifolius*, *Rorippa nasturtium-aquaticum* (much eaten by cattle), *Commelina africana*, *Alepidea setifera* and *Peucedanum sp.*

The geophytes *Aristea* sp. *Hypoxis rigidula*, *Aloe ecklonis*, and *Tulbachia nutans* together with the orchid *Disperis cooperii*, the grass *Koeleria capensis* and the asteraceous forb *Helichrysum subglomeratum* are also diagnostic species for this community.

The species richness in this community is higher than in any other wetland community as can be seen from the maximum number of species which is 53.

6.1.2.3 Panicum schinzii - Miscanthus junceus shallow wetlands.

Type relevé - 207.

Average number of species per relevé - 22.

Maximum number of species per relevé - 34.

Minimum number of species per relevé - 9. These shallow wetlands occur on soils derived from shale, where the water depth is up to 0,8 m.

These wetlands cover a larger area than the *Agrostis gigantea* - *Miscanthus junceus* moist grasslands (6.1.2.2) and are also to be found along the periphery of the larger wetlands.

These wetlands are found between altitudes of 1 200 and 2 000 m above sea level. Surface water is visible and may be up to 0,8 m in depth.

Moisture levels in these wetlands vary greatly and can become quite dry especially in the winter when rainfall is low.

The geological formation varies greatly but quarternary deposits are dominant. The soil form is Champagne and the soil is a deep, rich loam, high in organic matter.

The height of the vegetation is 0,7 m and is selectively grazed.

This community is characterised by species group F (Table 1).

Diagnostic species of this community are the grasses *Panicum schinzii* and *Lolium multiflorum*, the semi-succulent forb *Crassula pellucida*, which may form mats of pure stands in patches, possibly due to it's seed dispersal mechanism, the orchid *Habenaria* sp. and the water plant *Aponogeton junceus*.

General species occurring in all the above-metioned *Miscanthus* communities (6.1.1.1. to 6.1.2.3.) are the forbs *Epilobium salignum*, *Sium repandum*, the geophytes *Eucomis comosa*, *Kniphophia linearifolia* and the grass *Holcus lanatus*.

6.1.2.4 Carex cognata - Miscanthus junceus wetlands.

Type relevé - 61.

Average number of species per relevé - 26.

Maximum number of species per relevé - 34.

Minimum number of species per relevé - 17.

Carex cognata - *Miscanthus junceus* wetlands are found on loose Quarternary deposits, where the water is up to 0,7 m deep.

These wetlands are large and are perennial in that water can be found in them all-year-round. The only time when they may have little or no water in them is during a severe drought. These wetlands are fed by fountains and form the beginnings of the river-systems of the Eastern Transvaal.

Altitudes vary between 1 600 and 1 900 m above sea level and the lithology is predominantly loose material from Quarternary deposits. The soil is once again deep, rich, dark loam, high in organic material, thus belonging to the Champagne soil form.

The moisture status of this community is visible water present, the depth being up to 0,7 m. The height of the vegetation is 0,6 m.

This community is characterised by species group H.

Diagnostic species for this community are the sedge *Carex cognata*, the orchids *Disa cooperii*, *Eulophia leontoglossa*, *Eulophia ovalis* and the geophytes *Nerine angustifolia* and *Bulbine abyssinica* (Figure 22).

The presence of these species throughout only one relevé (61) and not in others is an example of the seasonal appearance of geophytic species at the height of the growing season. These species, except for *Carex cognata*, are geophytes and from this it can be seen that these species were dormant when sampling relevés 173 and 310 was carried out just before the winter.

Figure 22. Carex cognata dominates the Carex cognata - Miscanthus junceus wetland (Nerine angustifolia in foreground).

Species group I represents general species occurring in communities 6.1.1.1. to 6.1.2.4. and include the sedge *Carex austro-africana*, the forbs *Rumex lanceolatus*, the conspicuous *Gunnera perpensa* with its round leaves, *Senecio serrulatuloides*, the orchid *Satyrium hallackii*, the monocot *Kniphofia fluviatilis* and the grasses *Festuca caprina* and *Leersia hexandra*.

6.1.2.5 Ischaemum fasciculatum - Miscanthus junceus wetlands.

Type relevé - 137.

Average number of species per relevé - 19.

Maximum number of species per relevé - 36.

Minimum number of species per relevé - 9.

Ischaemum fasciculatum - Miscanthus junceus wetlands occur where periodically dry soils are derived from quartzite.

These are wetlands that cover an area of less than 3 hectares and are subjected to periodic drying out spells. The water is also never as deep as the wetlands of the previous community (6.1.2.4) and is approximately 0,4 metres deep. The slopes occupied by these wetlands are also steep (ca. 12 degrees) as opposed to the wetlands in the previous community where a gradient of three degrees is the steepest noted. Thus running water is a feature of this community due to the gradient.

Altitudes vary between 1 200 and 2 000 m above sea level. Geologically this community is derived from quartzites from many formations of the the Pretoria Group.

The soil form is generally an Arcadia and the height of the vegetation is approximately 0,7 metres.

This community is characterised by species group J (Table 1) and include the grasses *Ischaemum fasciculatum, Digitaria flacida, Digitaria eyelsii, Pennisetum*

macrourum and *Eragrostis curvula*. Forbs in this community include *Dolichos falciformis*, *Conysa pinnata*, *Berkheya echinacea*, *Alysicarpus rugosus* and *Helchrysum opacum*. The orchid *Satyrium parviflorum*, and the sedge *Pycreus* sp. are also diagnostic species in this community.

Species group K (Table 1) are species that are found throughout the previously mentioned communities (6.1.1.1. to 6.1.2.5.) and include the sedges *Miscanthus junceus* and *Juncus exsertus*, together with the forbs *Ranunculus meyeri* and *Ranunculus multifidus*.

It is interesting to note that the robust grass *Miscanthus junceus* is relatively absent in the *Senecio microglossus* - *Phragmites australis* community whereas it is most dominant in all the other communities. The explaination for this may be that the abundant presence of species such as *Phragmites australis* and *Carex austro-africana* out-compete this species to such an extent that it cannot survive.

6.1.3 ERAGROSTIS BIFLORA - STIBURUS ALOPECUROIDES MOIST GRASSLAND.

These wetlands are found in poorly drained soils. In most cases the lithology is impenetrable to water giving rise to a raised water table. This community is charcterised by a high number of palatable grasses, giving rise to much grazing.

This wetland is characterised by species group O (Table 1) which includes the insect trapping plants *Drosera madagascariensis* and *Utricularia prehensilis*, the forbs *Polygala uncinata* and *Justicia petiolaris*, the sedge *Ascolepis capensis*, the geophyte *Dierama* sp. and the grass *Eragrostis biflora*. This grass is also visibly prominent due to its fine leaves and light pink, fluffy inflorescence.

The *Eragrostis biflora* - *Stiburus alopecuroides* moist grasslands are divided into two communities;

Helichrysum aureonitens - *Eragrostis biflora* - *Stiburus alopecuroides* moist grasslands which are found on soils of diabase origin; and

Disa patula - *Eragrostis alopecuroides* moist grasslands which are found on soils of sedimentary origin.

6.1.3.1 Helichrysum aureonitens - Eragrostis biflora - Stiburus

alopecuroides moist grassland (Figure 23).

Type relevé - 194.

Average number of species per relevé - 31.

Maximum number of species per relevé - 37.

Minimum number of species per relevé - 23.

This community is found on all aspects and slopes and the area covered by this community never exceeds 1,5 ha. They are thus small areas where the water is trapped by the geological strata.

No visible water is present but when trod on, water may seep out during the rainy season.

Altitudes vary between 950 and 2 200 m above sea level. The lithology is derived from igneous rock, particularly Transvaal diabase.

The soil is 0,3 metres deep and is relatively rich in organic matter thus belonging to the Champagne soil form. Stones may occur in this community but their size never exceeds 0,05 m in diameter.

The vegetation is 0,40 m in height and grazing is moderate to heavy due to the presence of palatable grasses in this community.

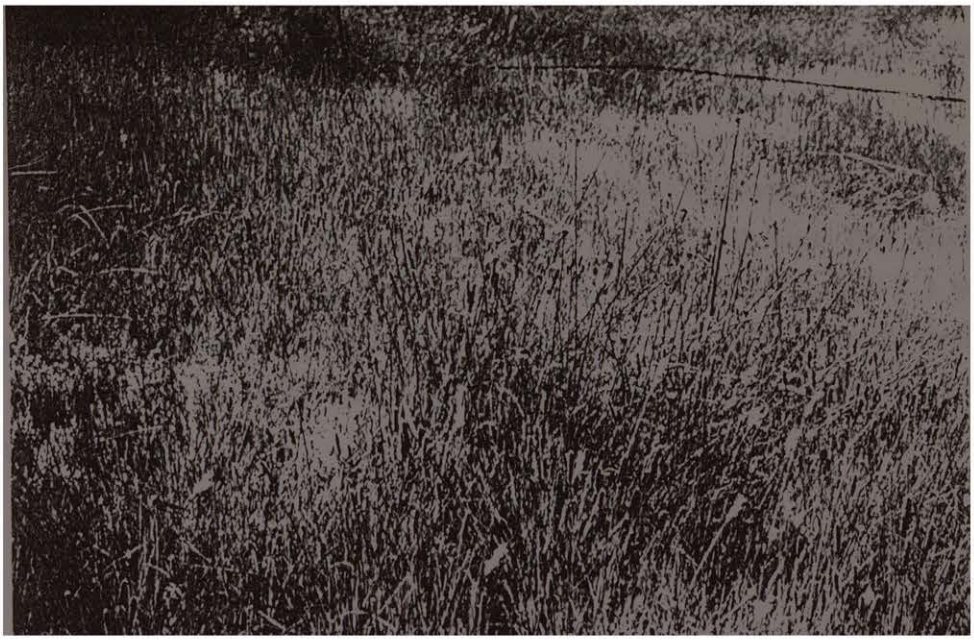

Figure 23. The Helichrysum aureonitens - Eragrostis biflora - Stiburus alopecuroides moist grassland.

This community is characterised by species group L (Table 1).

Diagnostic species of this community are the geophytes *Hypoxis filiformis* and *Oxalis obliquifolia*, the forbs *Helichrysum aureonitens*, *Sebaea leiostyla*, *Asclepias multicaulis* and *Anthericum cooperii*. The sedges *Juncus dregeanus* and *Ficinia sp.* together with the grass *Agrostis eriantha*.

Species group M represents a group of species common to the *Ischaemum fasciculatum* - *Miscanthus junceus* wetlands (6.1.2.5) and the *Helichrysum aureonitens* - *Eragrostis biflora* - *Stiburus alopecuroides* (6.1.3.1.) wetlands. These include the forbs *Buchnera glabrata* and *Chironia purpurescens*, the orchids *Habenaria clavata* and *Disa aconitodes* together with the grass *Andropogon eucomis*.

6.1.3.2 Disa patula - Eragrostis biflora - Stiburus alopecuroides

moist grassland.

Type relevé - 244.

Average number of species per relevé - 19.

Maximum number of species per relevé - 36.

Minimum number of species per relevé - 9.

The moisture status of this community is the following: depressions having poor drainage are periodically flooded in the wet seasons thus forming wetlands. These then dry out if further rainfall ceases or is insufficient. The soil is a dark, sandy loam, rich in organic material and is not deeper than 0,4 m, having a rock-base which is normally not penetrable to water, thus the water table is raised giving rise to moist conditions. These soils belong to the Champagne or Mispah soil forms. Rocks may be found in this community but are then not larger than 0,05 m in diameter.

Altitudes vary between 1 200 and 2 000 m above sea level. Geologically this community is derived from quartzites of diverse Formations of the Pretoria Group.

This community is characterised by species group N.

Diagnostic species are the orchid *Disa patula*, the forbs *Plectranthus* sp. and *Alepidea gracilis*, the bulb plant *Ornithogalum tenuifolium*, the sedge *Bulbostylis* sp. and the grasses *Helictotrichon turgidulum* and *Eragrostis capensis*.

An affinity exists between community number 6.1.3.1 and 6.1.3.2. through the common species shared in species group M.

The grass *Stiburus alopecuroides* dominates the vegetation and especially in the months when it flowers the light purple heads are prominently visible. Also when mist is present this community stands out visibly from those next to it due to the dew drops that are caught in the hairs of the leaves of this plant.

Species group P present in communities 6.1.1.2 through to 6.1.3.2 represents species common to these communities and include the following species: the sedges *Schoenoplectus corymbosus*, *Mariscus keniensis*, *Juncus oxycarpus* and *Bulbostylis burchellii*, the forbs *Denekia capensis* and *Oldenlandia herbacea*, the bulb plants *Ledebouria cooperii* and *Gladiolus longicollis* and the orchid *Satyrium longicauda*.

The presence of species in more than one community shows environmental affinities which exist between the communities in which the species are present. These environmental factors have yet to be ascertained and a combination of factors may be responsible for the distribution of species.

6.1.4 ARUNDINELLA NEPALENSIS MOIST TURF GRASSLAND.

This community is fairly poor in species composition, is often dominated by the widespread *Arundinella nepalensis* (species group T, Table 1). No diagnostic species group could be recognised.

This community is divided into two sub-communities namely the *Hypericum hirtellum - Arundinella nepalensis* moist turf grassland and the *Imperata cylindrica - Arundinella nepalensis* moist turf grassland. Both these sub-communities have in common the same soil type namely an Arcadia soil form, but the origins of the soil differ.

6.1.4.1 Hypericum hirtellum - Arundinella nepalensis moist turf grassland.

Type relevé - 311.

Average number of species per relevé - 20.

Maximum number of species per relevé - 30.

Minimum number of species per relevé - 10.

This community is found on all aspects and on slopes of moderate inclination (15° to 30°).

The moisture status gives rise to a semi-permanent soggy layer of soil underlain by an impenetrable layer of solid or weathered rock. During the dry season the soil may dry out completely.

Altitudes vary between 900 and 2 100 m above sea level and are spread over all aspects and slopes. The lithology comprises mainly Transvaal diabase.

Soils are rich, dark, clay-rich loams, belonging to the Arcadia soil form. There are rock-sheets present in this community and they may lie exposed at the surface or be covered by a thin (ca. 0,30 m) layer of soil. Because the soil

is not deep the roots of the plants in this community grow so closely together that a mat of roots is often found.

The height of the vegetation is 0,8 metres of higher due mainly to the presence of the robust grass *Arundinella nepalensis*.

This community is characterised by species group Q.

Diagnostic species are the succulent *Crassula sarcocaulon*, the forbs *Hypericum hirtellum* and *Senecio latifolius* and the geophytes *Ledebouria sp.* and *Gladiolus ecklonis*.

6.1.4.2 Imperata cylindrica - Arundinella nepalensis moist turf grassland.

Type relevé - 215.

Average number of species per relevé - 30.

Maximum number of species per relevé - 30.

Minimum number of species per relevé - 30.

This community is found on very gentle slopes normally in shallow valleys where the soil is derived from alluvial deposits of Quarternary origin. The soil form is an Arcadia with a high clay content giving rise to vertic conditions where most plants can not survive due to the swell and shrink of the soils, causing roots to be damaged.

The moisture status is such that during wet periods much water is held in the soil and during dry seasons the soil may be cracked and dry.

Altitudes vary between 900 and 1 900 m above sea level and are spread over all aspects and slopes. The height of the vegetation is 0,6 metres.

This community is characterised by species group R and diagnostic species are the grass *Imperata cylindrica* which may grow in nearly pure stands, the sedge *Pycreus macranthus* and the forb *Senecio latifolius*.

Species Group S present in communities 6.1.2.1. through to 6.1.4.2. but absent entirely in community 6.1.2.2 represents species that are flexible in their habitat requirements thus inhabiting a wide variety of environmental conditions within the parameters of the wetland. These include the grasses *Stiburus alopecuroides, Paspalum urvillei* and *Helictotrichon hirtelum,* the forbs *Monopsis decipiens, Wahlenbergia virgata, Hypericum lalandii* and *Cephalaria zeyheriana* and the sedge *Xyris capensis*

The wetlands are very fragile ecosystems and mismanaging them can result in a shrinkage of the area covered by the wetland or a total dissapearance of some species in the wetland. This can be seen in Figure 24, where it is schematically shown how malpractice can influence the size and composition of a wetland.

The degradation of wetlands in this area is a loss felt further along the river systems in the Eastern Transvaal and is important to the continued "health" of the river systems in the area for it is in the wetlands of this area that the rivers of the Eastern Transvaal originate.

Burning takes place at intervals of between one and five years and this may cause a serious depletion of the water in the wetland should burning be accompanied by other detrimental practises. The results of burning coupled to grazing during the dry season may increase evaporation in a wetland. This leads to the formation of a shallower wetland which then becomes accessable to cattle. The cattle then wade into the wetland to graze the tender green shoots emerging after the burn. This then causes the vegetation to be trampled which leads to the evaporation of more water from this wetland. Thus the surface area shrinks. Now the sheep can reach the green growth of the wetlands because the water has receded.

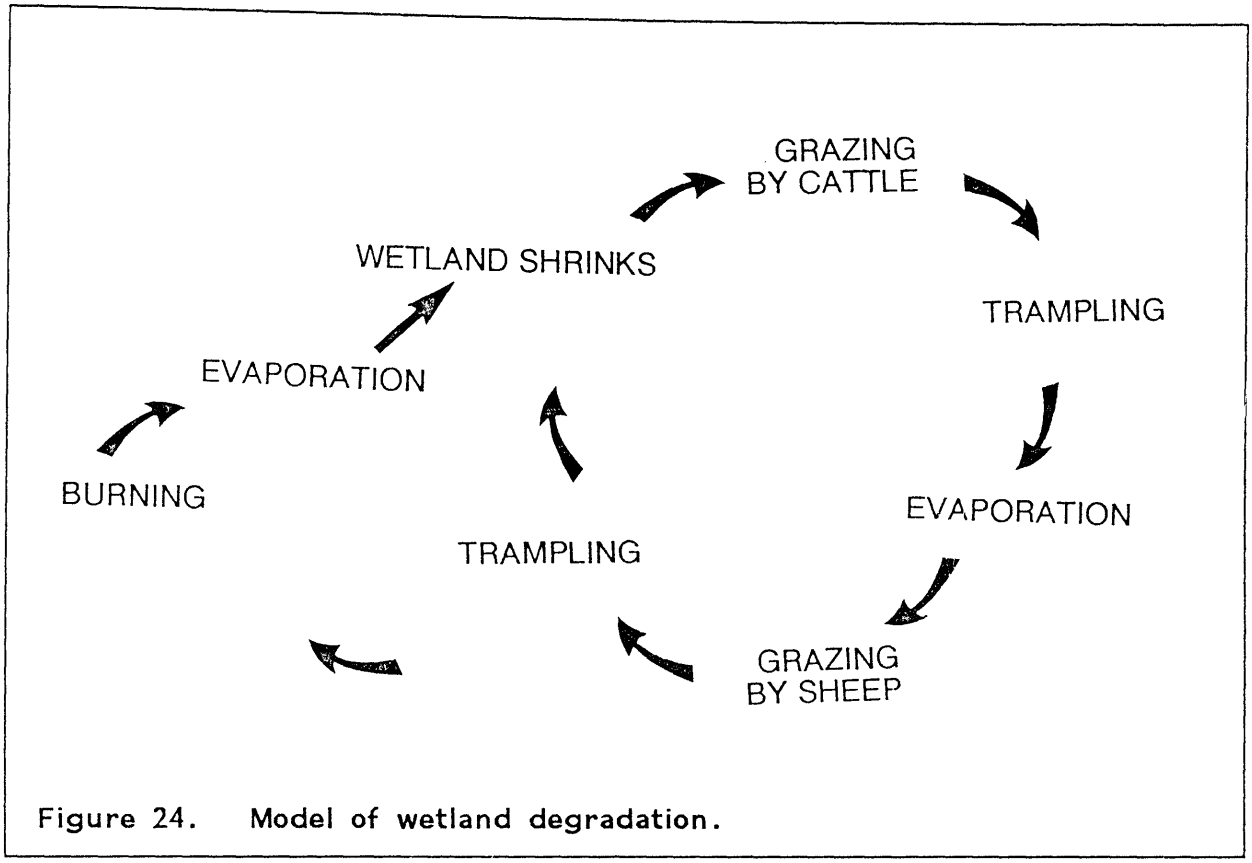

Figure 24. Model of wetland degradation.

This in turn causes more trampling of the vegetation and the whole cycle is repeated until only a moist grassland is left.

The shrinking of wetlands as illustrated in Figure 24 is prevalent in the *Miscanthus junceus* wetlands (2.1 to 2.5) as these wetlands include species that are highly desireable in the winter months when greens are scarce for grazing animals.

6.2 BOULDERIES.

The floristic composition of the boulderies is given in Table 2. Generally the boulderies are characterised by species group N (Table 2).

Species that occur throughout all the communities are the trees *Cussonia paniculata*, *Halleria lucida* and *Euclea crispa*, the grasses *Sporobolus pectinatus* and *Microchloa caffra*, the fern *Cheilanthes quadripinata* and the forb *Oxalis obliquifolia*.

The classification of the bouldery vegetation resulted in the recognition of 4 major plant communities, divided into drainage lines, woodland and grassland and is further divided into 7 minor communities as follows:

1. *Koeleria capensis* drainage lines
   1.1. *Diospyros whyteana* - *Koeleria capensis* steep wet woodlands.
   1.2. *Pentaschistis natalensis* - *Koeleria capensis* moist rocky grassland.

2. *Protea caffra* moist sparse woodland
   2.1. *Protea caffra* - *Senecio erubescens* sparse open woodland
   2.2. *Protea caffra* - *Themeda triandra* sparse open woodland

3. *Aristida junciformis* moist rocky grassland
   3.1. *Coleochloa setifera* - *Aristida junciformis* moist rocky grassland
   3.2. *Dicoma anomala* - *Aristida junciformis* moist rocky grassland

4. *Vernonia natalensis* - *Protea roupelliae* moist rocky woodland

Results obtained from the TWINSPAN computer programme (Hill 1979b) partially supported the cummunities found in the final table (Table 2).

6.2.1 KOELERIA CAPENSIS DRAINAGE LINES

These bouldery communities occur in drainage lines at high altitudes (higher than 1 800 m) and are limited to moist, rocky areas. The vegetation represents moist grassland or wet woodland and is characterised by species group C (Table 2) including species often present in moist montane situations, for example the grasses *Koeleria capensis* and *Bromus firmior*, the dwarf shrub *Erica cerinthoides* and the geophytes *Ledebouria cooperii*, *Aristea woodii*, the ferns *Cheilanthes multifida* and the forb *Pelargonium dispar*. Also characteristic is the absence of the many species of species group M (Table 2).

Two distinct communities can be recognised namely the *Diospyros whyteana* - *Koeleria capensis* steep wet woodland and the *Pentaschistis natalensis* - *Koeleria capensis* moist rocky grassland.

6.2.1.1 Diospyros whyteana - Koeleria capensis steep wet woodlands.

Type releve - 48.

Average number of species per relevé - 26.

Maximum number of species per relevé - 56.

Minimum number of species per relevé - 10.

These communities are found on all aspects. Rock cover is between 25 and 30 percent, and streams are normally found running through or close to these communities. Slopes vary between 15 and 30 degrees.

Altitudes vary between 1 800 and 2 000 m above sea level and the geology comprises mainly mafic intrusions such as diabase and norite.

This community represents isolated patches of wet woodlands found in high-altitude ravines and are characterised by species group A (Table 2). The tree and shrub canopy is well developed. Much leaf mold is present, and many ferns are found here. Mosses are also present but were not collected for this study.

Diagnostic species are the trees *Diospyros whyteana, Cyathea dregei, Erica drakensbergensis, Phylica* sp. and *Pittosporum viridiflorum*. Diagnostic ferns such as *Osmunda regalis, Hypolepis sparsisora, Pteris catoptera, Asplenium adiantum-nigrum,* and *Blechnum australe* are found growing in the moist shady spots, and the club mosses *Lycopodium clavatum* and *Lycopodium carolinianum* are found growing over rocks and other species. The forbs *Impatiens* sp. and *Scabiosa columbaria* and the grass *Agrostis lachnantha* are also found growing in this community.

6.2.1.2 Pentaschistis natalensis - Koeleria capensis moist rocky grassland.

Type releve - 297.

Average species per relevé - 16.

Maximum number of species per relevé - 19.

Minimum number of species per relevé - 11.

This community is found in rocky seepage lines where it is very moist. Altitudes are above 2 000 m and Steenkampsberg quartzite and Magaliesberg quartzite are the most prominent geological formations. Slopes are gentle (0 to 15 degrees) and rock cover is between 25 and 30 percent. The size of the rocks vary between 0,01 m and slabs of 5,0 m in diameter and pools of water accumulate between the rocks. Soil is not very deep as the soil form is Mispah, and the percentage of sand in the sandy loam soil is high as a result of the weathering of the quartzite that is present.

This community is found on western slopes of the Steenkampsberg and Magaliesberg quartzites and sandstones. This community shows signs of selective grazing by cattle and sheep and sheet erosion may occur. Burning takes place at regular intervals.

This community is a short grassland (culms approximately 0,25 m tall), characterised by species group B (Table 2).

Diagnostic species are the grasses *Pentaschistis natalensis* and *Eragrostis biflora*, the fern *Cheilanthes hirta*, the sedge *Rhynchospora brownii* together with the geophyte *Eriospermum porphyrovalve*, the forbs *Craterostigma wilmsii* and *Walafrida densiflora* and the monocot *Kniphofia splendida* which is found growing among the rocks.

6.2.2 PROTEA CAFFRA MOIST SPARSE WOODLAND

These woodlands are divided into two communities namely the *Protea caffra* - *Senecio erubescens* sparse, open woodland and the *Protea caffra* - *Themeda triandra* sparse, dry woodland. These communities are found on rocky slopes at altitudes above 1 800 m.

The trees also never grow very tall and seldom reach above 4 metres in height.

Species common to both the *Protea caffra* - *Senecio erubescens* sparse open woodland and the *Protea caffra* - *Themeda triandra* woodlands are represented by species group F (Tabel 2). This group of species thus shows the affinity

that exists between these two communities, and include the following: the grasses *Brachiaria bovonei*, *Tristachya rehmannii*, *Sporobolus stapfianus* and *Ctenium concinniun*, the forbs *Clerodendrum triphyllum*, *Senecio scitus*, *Raphionacme hirsuta*, *Acalypha caperonioides*, *Lippia javanica*, *Xysmalobium parviflorum*, *Berkheya echinacea*, *Pearsonia* sp. and *Raphionacme zeyheri*, the shrubby trees *Protea caffra*, *Acacia caffra*, *Englerophytum magalismontanum* and *Maytenus heterophylla* together with the monocots *Aloe transvaalensis*, *Xerophyta retinervis*, *Hypoxis rigidula* and *Ledebouria marginata*.

6.2.2.1 Protea caffra - Senecio erubescens sparse open woodland.

Type relevé - 30.

Average number of species per relevé - 34.

Maximum number of species per relevé - 38.

Minimum number of species per relevé - 29.

This community is to be found in rocky areas. The rocks are from the Magaliesberg and Steenkampsberg quartzites or sandstones and the sizes of the rocks are between 0,7 and 2,0 metres in diameter. Altitudes vary between 1 200 and 2 100 metres above sea level. Soils are high in organic matter and are sandy loams of the Mispah soil form. The moisture status is a slightly moist soil for most of the time except in extreme drought conditions. Precipitation that reaches the soil in this community is heightened by the fact that the moisture runs off the rocks and accumulates between them.

This community is characterised by species group D.

Diagnostic species are the shrubby forb *Senecio pentactinus*, the grass *Scleria dieterlenii*, the trees *Ziziphus mucronata* and *Celtis africana*, the forbs *Lotononis hirsuta*, *Callilepis leptophylla*, *Ipomoea papilio*, *Senecio latifolius*, *Tephrosia longipes* and *Castalis spectabilis*. The bulb plant *Nerine rehmannii* is also a diagnostic species for this community.

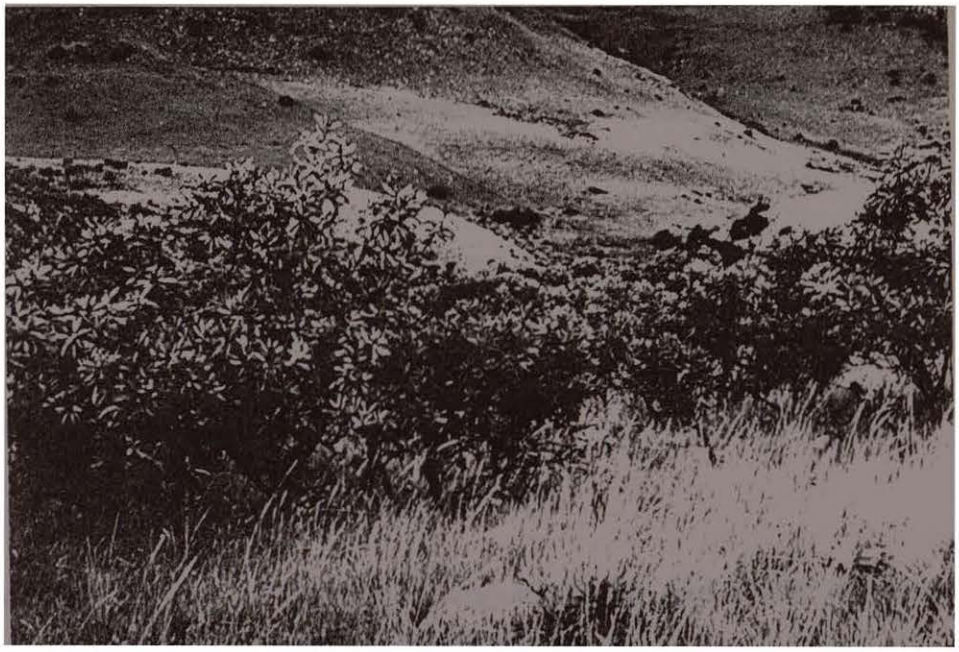

Figure 25. Protea caffra - Themeda triandra sparse open woodland showing Protea caffra.

This latter species being a geophyte may only be seen in summer months and will be absent from relevés if sampling takes place when too late in the season.

6.2.2.2 Protea caffra - Themeda triandra sparse open woodland.

Type relevé - 102.

Average number of species per relevé - 27.

Maximum number of species per relevé - 38.

Minimum number of species per relevé - 20.

This woodland occurs at altitudes between 1 800 and 2 200 m above sea level and the topography is generally heterogenous.

The geology varies but consists mainly of quartzites of the Magaliesberg Formation. The slope of the terrain is between 0 and 20 degrees.

The soil form is a Mispah and the soil type is generally a sandy loam.

Rock-cover is between 10 and 15 percent and is made up of small blocks approximately 0,30 m in diameter. The topographic positions occupied by this community are crests or topslopes. The community is well grazed by cattle and sheep. Burning occurs at regular intervals, and some sheet erosion is to be found possibly due to over-utilization.

This is a woodland with a well developed tree stratum which dominates the vegetation, however the trees are relatively far apart (Figure 25).

This community is characterised by species group E.

Diagnostic species are the grass *Themeda triandra*, the forbs *Helichrysum miconiifolium*, *Anthospermum rigidum*, *Leonotis ocymifolia*, *Tephrosia glomeruliflora*, *Helichrysum callicomum*, *Pentanisia angustifolia*, *Crabbea* sp. *Euphorbia guenzii*, *Gnidia kraussiana* and *Cyanotis pachyrrhiza*, together with

the dwarf shrub *Rhus discolor*, the tree *Faurea saligna* and the bulb plant *Cyrtanthus stenanthus*.

6.2.2.3 Aristida junciformis moist rocky grassland.

This grassland occurs at altitudes above 1 200 m having soils originating from sandstone and quartzite or from diabase rocks.

Species group I represents diagnostic species that occur generally in the *Aristida junciformis* moist rocky grasslands (6.2.3.1 and 6.2.3.2.). These include the grasses *Digitaria monodactyla, Aristida junciformis, Eragrostis scleranthа, Sporobolus discosporus* and *Eragrostis pseudoscleranthа*, the forbs *Selago lydenburgensis, Oldenlandia herbacea, Helichrysum lepidissimum*, the matt-like *Psammotropha myriantha, Silene burchellii, Indigofera hedyantha, Rhynchosia nervosa, Helichrysum rugulosum, Senecio oxyriifolia, Vernonia oligocephala* and the succulent forb *Crassula lanceolata* together with the monocots *Lapeirousia sandersonii, Eriospermum abyssinicum, Protasparagus laricinus, Gladiolus elliotii, Gladiolus calcaratus* and *Trachyandra asperata*.

This grassland is divided into two communities namely the *Coleochloa setifera - Aristida junciformis* moist rocky grassland and the *Dicoma anomala - Aristida junciformis* moist rocky grassland.

6.2.3 COLEOCHLOA SETIFERA - ARISTIDA JUNCIFORMIS MOIST ROCKY GRASSLAND.

Type relevé - 213.

Average number of species per relevé - 24.

Maximum number of species per relevé - 36.

Minimum number of species per relevé - 18.

Altitudes of this grassland vary between 1 900 and 2 100 metres above sea level and the geology is sandstone and quartzite of the Magaliesberg Formation. Some shales and diabase may also be included. The soils are relatively shallow, with sandy loam predominating.

This community is characterised by species group G (Table 2).

Diagnostic species found in this community are the fern *Selaginella kraussiana*, the forbs *Wahlenbergia lycopodioides*, *Wahlenbergia virgata*, *Helichrysum galpinii*, *Aeollanthus buchnerianus* and *Rumex acetosella* together with the grasses *Coleochloa setifera* and *Brachiaria brizantha* and the succulents *Crassula setulosa* and *Khadia* sp.

6.2.4 DICOMA ANOMALA - ARISTIDA JUNCIFORMIS MOIST ROCKY GRASSLAND

Type relevé - 195

Average number of species per relevé - 27.

Maximum number of species per relevé - 39.

Minimum number of species per relevé - 16.

Altitudes of this grassland vary between 1 200 and 2 200 m above sea level and the geology is mainly diabase dykes allthough some quartzite outcrops are included. Because of the diabase origin the soils are generaly rich red loams. The percentage rock-cover is between 10 and 15 and the sizes of the boulders are between 0,50 and 1,0 m in diameter.

The topographic position is heterogenous due to the diverse nature of dykes.

Figure 26. Dicoma anomala - Aristida junciformis moist rocky grassland showing the dominant grass Aristida junciformis.

Grazing is moderate and is utilised mainly by cattle. Some sheet erosion may be found due to the trampling by the cattle and generally burning takes place regularly. This resulted in the dominance of *Aristida junciformis* in many places (Figure 26).

This community is characterised by species group H (Table 2).

Diagnostic species are the forbs *Dicoma anomala, Stachys natalensis, Rabdosiella calycina* and *Lightfootia denticulata* together with the monocots *Hypoxis costata, Hypoxis gerrardii* and *Isolepis setacea*.

Species group J represents species that are generally found in the *Protea caffra* moist sparse woodland (6.2.2.1. and 6.2.2.2.) and the *Aristida junciformis* moist rocky grassland (6.2.3.1. and 6.2.3.2.), thus showing affinity between these communities. These include the grasses *Heteropogon contortus, Eragrostis nindensis* and *Monocymbium ceresiiforme*, the forbs *Richardia brasiliensis, Gazania krebsiana, Eriosema simulans, Pelargonium luridum, Monopsis decipiens, Hemizygia albiflora, Rhynchosia monophylla, Rhynchosia totta, Thesium lobeloides, Indigofera sanguinea, Helichrysum oreophilum* and *Justicia anagaloides*.

6.2.5 VERNONIA NATALENSIS - PROTEA ROUPELLIAE MOIST ROCKY WOODLAND.

Type relevé - 257.

Average species per relevé - 32.

Maximum number of species per relevé - 40.

Minimum number of species per relevé - 27.

A great variation in altitude occurs in this community as the height above sea level varies between 1 200 and 2 300 m.

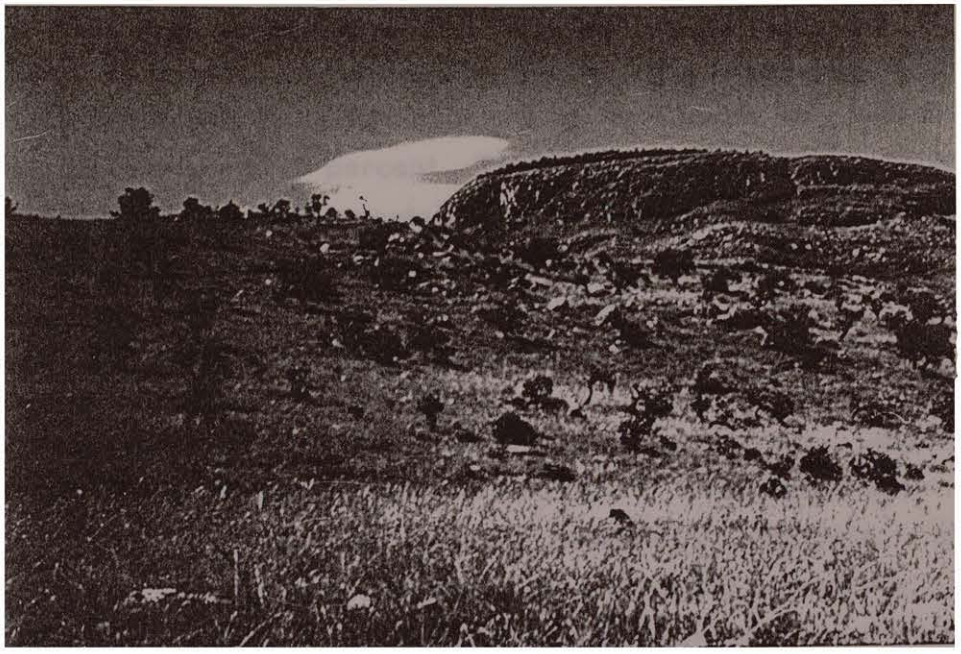

Figure 27. Vernonia natalensis - Protea roupelliae moist rocky woodland.

This community is present on east-facing slopes (receiving mist), the gradient being between 18 and 47 degrees. Topographic positions that these communities occupy are crests and upper slopes (Figure 27).

Geological groups are mainly quartzite interspersed with diabase. The soil form is predominantly Mispah, and soils are poor to rich sandy loams, all very well drained. The percentage of rocks covering the sample site is between 5 and 20 percent, averaging 17 percent. The rock size is between 0,40 and 0,90 meters in diameter. Natural vegetation is grazed predominantly by game thus it is very seldom over-utilized. No visible erosion occurs.

This community is characterised by species group K (Table 2).

Diagnostic species include the forbs *Vernonia natalensis, Geigeria burkei, Helichrysum albilinatum, Schistostephium crataegifolium, Acalypha peduncularis, Vernonia sutherlandii, Berkheya insignis, Helichrysum pilosellum, Peucedanum magalismontanum, Alepidea longifolia, Hypericum aethiopicum, Pimpinella transvaalensis, Vernonia hirsuta* and *Crabbea acaulis*, the succulent *Crassula vaginata*, the grass *Agrostis eriatha*, the shrub *Rhus montana* and the monocot *Crocosmia paniculata*.

A number of species (species group L) are common to both the *Vernonia natalensis - Protea roupelliae* and the *Coleochloa setifera - Aristida junciformis* communities. These are the forbs *Cyanotis speciosa, Hebenstretia angolensis, Helichrysum polycladum, Othonna natalensis, Gnidia spendens, Sutera caerulea, Pearsonia sessilifolia, Oxalis depressa, Zornia capensis, Lopholaena distacha* and *Wahlenbergia squamifolia*, together with the grasses *Cymbopogon validus* and *Aristida* sp., and the monocot *Ledebouria* sp.

Species common to all communities (species group M) except the *Koeleria capensis* drainage lines (6.2.1) are the fern *Pellaea calomelanos*, the grasses *Loudetia simplex, Panicum natalensis, Elionurus muticus, Eragrostis racemosa, Diheteropogon amplectens, Eulalia villosa, Bewsia biflora, Trachypogon spicatus, Eragrostis curvula* and *Brachiaria serrata*, the forbs *Commelina africana, Lannea edulis, Senecio venosus, Lopholaena coriifolia, Tetraselago wilmsii, Rhoicissis tridentata, Haplocarpha scaposa, Helichrysum chionosphaerum, Pentanisia prunelloides* and *Hermannia cristata* together with

the monocots *Bulbostylis oritrephes*, *Hypoxis iridifolia* and *Gladiolus crassifolius*.

6.3 GRASSLANDS.

Grassland occupy by far the largest part of the study area. Most plains, slopes and plateaux int he study area are covered by grassland, extensively used for grazing by livestock. Many grass species and non-grassy forbs occur constantly in these grasslands, as listed in species groups Z2 and Z3 (Table 3).

Species group Z2 (Table 3) are species occurring in the *Loudetia simplex*, *Tristachya leucothrix* and *Eragrostis chlorantha* grasslands (6.3.1 to 6.3.2.3)

These are the grasses *Tristachya leucothrix*, *Monocymbium ceressiforme*, *Eragrostis curvula*, *Aristida junciformis* and *Elionurus muticus*, the podplants *Rhynchosia totta* var. *totta*, *Zornia capensis*, *Tephrosia capensis* and *Rhynchosia monophylla*. The sedges *Bulbostyllis oritrephes* and *Schoenoxiphium sparteum* and the succulent forb *Crassula vaginata* are also species found throughout these grasslands. Other species include the forbs *Anthospermum rigidum*, *Scabiosa columbaria*, *Commelina africana*, *Crabaea acaulis*, *Acalypha angustata*, *Polygalla amatymbica*, *Wahlenbergia virgata*, *Wahlenbergia squamifolia*, *Acalypha shinzii*, *Hybiscus aethiopicus*, *Kohautia amatymbica*, *Crabbaea hirsuta*, *Gnidia caffra* and *Sebaea erosa*, the tuberous *Hypoxis costata*, *Cucumis hirsuta* and *Rhaphionacme galpinii* and the bulbs *Gladiolus crassifolius* and *Ledebouria marginata*. Also present are the asteraceous forbs, *Schistostephium crataegifolium Helichrysum pilosellum*, *Senecio coriifolia*, *Senecio erubescence*, *Haplocarpha scaposa* and *Gerbera ambigua*.

Species group Z3 are species that are adaptable in their habitat preferences and are found in all the communities, thus are general species. These include the grasses *Eragrostis racemosa*, *Themeda triandra*, *Heteropogon contortus*, *Alloteropsis semialata*, *Microchloa caffra*, *Diheteropogon amplectens*, *Eragrostis capensis* and *Trachypogon spicatus*, the tuberous *Hypoxis rigidula*, *Oxalis*

obliquifolia, *Pelargonium luridum*, *Pachycarpus transvaalensis* and *Raphionacme procumbens*, the asteraceous *Vernonia natalensis*, *Helichrysum miconiifolium*, *Berkheya setifera*, *Tolpis capensis*, *Helichrysum cephaloideum*, *Berkheya echinacea* subsp. *echinacea*, *Castalis spectabilis* and *Helichrysum appendiculatum*. The forbs *Acalypha caperonioides*, *Pentanisia prunelloides* subsp. *prunelloides*, *Justicia anagalloides*, *Hebenstretia angolensis* and *Monopsis decipiens* are also part of these general species. The orchids *Disa patula* and *Habenaria chlorotica*, together with the sedge *Fuirena pubescens* and the shrub *Rhus discolor* and podplant *Rhynchosia angulosa* are also species present in most relevés.

The classification of the grassland vegetation resulted in the recognition of 4 major plant communities and 28 minor plant communities, classified as follows:

1 *Loudetia simplex* grassland.

1.1 *Rabdosiella calycina* - *Loudetia simplex* moist rocky grasslands
1.1.1 *Rabdosiella calycina* - *Loudetia simplex* - *Rhus montana* moist rocky grassland
1.1.2 *Rabdosiella calycina* - *Loudetia simplex* - *Diheteropogon amplectens* moist rocky grassland
1.1.3 *Rabdosiella calycina* - *Loudetia simplex* - *Othonna natalensis*moist rocky grassland

1.2 *Koeleria capensis* - *Loudetia simplex* moist grassland

1.3 *Pteridium aquilinum* - *Loudetia simplex* bracken patches
1.4 *Harpochloa falx* - *Loudetia simplex* broken rocky grassland
1.4.1 *Harpochloa falx* - *Loudetia simplex* - *Digitaria tricholaenoides*broken rocky grassland
1.4.2 *Harpochloa falx* - *Loudetia simplex* - *Senecio polyodon* grassland

1.5 *Andropogon schirensis* - *Loudetia simplex* grassland

1.5.1 *Andropogon schirensis - Loudetia simplex - Panicum ecklonis* grassland

1.5.2 *Andropogon schirensis - Loudetia simplex - Protea gaguedii* grassland

1.5.3 *Andropogon schirensis - Loudetia simplex - Clerodendrum triphyllum* grassland

1.5.4 *Andropogon schirensis - Loudetia simplex - Indigofera sanguinea* grassland

1.5.5 *Andropogon schirensis - Loudetia simplex - Euryops laxus* grassland

2. *Eragrostis chloromelas* grassland

2.1 *Aristida aequiglumis - Eragrostis chloromelas* moist grassland

2.2 *Agrostis eriantha - Eragrostis chloromelas* moist grassland

2.3 *Phymaspermum acerosum - Eragrostis chloromelas* grassland

2.4 *Hyparrhenia anamesa - Eragrostis chloromelas* tall grassland

2.5 *Helichrysum rugulosum - Eragrostis chloromelas* grasssland

3 *Gladiolus ecklonii - Themeda triadra* grassland

3.1 *Crocosmia paniculata - Themeda triandra* grassland

3.2 *Cymbopogon validus - Themeda triandra* grassland

3.3 *Acacia karroo - Themeda triandra* open woodland

3.4 *Halleria lucida - Themeda triandra* rocky grassland

4 *Bromus firmior* mistbelt grassland

6.3.1 LOUDETIA SIMPLEX GRASSLAND.

These grasslands generally occur widely on shallow, rocky soils of crests or slopes, thus they occupy most of the study area.

The vegetation is characterised by species group P (Table 3), which includes as diagnostic species the prominent and often dominant grass *Loudetia simplex*. Diagnostic forbs include *Dicoma anomala, Helichrysum oreophilum, Ipomoea crassipes, Osteospermum striatum* and *Euphorbia guenzii,* the podplants *Eriosema simulans* and *Indigofera hedyantha*.

Loudetia simplex is very interesting in that two visually different forms are found growing together. One has very smooth awns with no hairs, while the other has awns covered with hairs. This is however one species.

These grasslands are divided into five communities namely:
1) *Rabdosiella calycina - Loudetia simplex* moist rocky grasslands
2) *Koeleria capensis - Loudetia simplex* moist grassland
3) *Pteridium aquilinum - Loudetia simplex* bracken patches
4) *Harpochloa falx - Loudetia simplex* broken rocky grassland
5) *Andropogon schirensis - Loudetia simplex* grassland

These communities are then subdivided into variants which will be discussed.

6.3.1.1 Rabdosiella calycina - Loudetia simplex moist rocky grassland.

The soils of these grasslands are derived from igneous rocks mainly diabase and are thus relatively deep and fertile.

The species generally occurring in the *Rabdosiella calycina - Loudetia simplex* rocky grassland community (species group E, Table 3) are the forbs *Rabdosiella calycina, Silene burchellii, Ajuga ophrydis,* and *Cephalaria zeyheriana,* together with the podplants *Pearsonia grandifolia, Rhynchosia repens* and *Tephrosia elongata* and the grass *Melinis repens*.

Figure 28. Rabdosiella calycina - Loudetia simplex - Rhus montana moist rocky grassland

The shrublet *Felicia filifolia* subsp. *filifolia* can be most prominently seen when flowering. The fern *Pellaea calomelanos* is also a diagnostic species and can be found growing between the rocks. This community is divided into three variants.

6.3.1.1.1 Rabdosiella calycina - Loudetia simplex - Rhus montana moist rocky grassland

Type relevé - 144.

Average species per relevé - 53.

Maximum number of species per relevé - 87.

Minimum number of species per relevé - 28.

This variant is characterised by the presence of diabase rocks ranging in size from 0,7 to 1,5 metres in diameter. The soils derived from this rock-type is a rich red colour and the texture is loamy. Slopes occupied by this community vary considerably and are never constant. Altitudes vary between 1 100 and 2 100 metres above sea level.

The vegetation is characterised by species group A (Table 3). Diagnostic species are the dwarf trees *Rhus montana* and *Diospyros lycioides*, the forbs *Protasparagus laricinus*, *Senecio oxyriifolius*, *Helichrysum albilinatum*, *Zaluzianskya elongata*, *Berkheya seminivea*, *Rhoicissis tridentata* and *Selago atherstonei*. The ferns *Cheilanthes viridis*, *Cheilanthes eckloniana* and *Dryopteris inequalis* are also diagnostic species. Bulb plants that are also diagnostic species are *Agapanthus inapterus*, *Gladiolus elliotii*, *Haemanthus humilis*, *Scilla natalensis*, *Gladiolus delenii* and *Anthericum transvaalensis*. The succulent *Crassula alba* and the bramble *Rubus rigidus* are also diagnostic for this community.

Although not a diagnostic species the conspicuous forb *Rabdosiella calycina* dominates the vegetation (Figure 28).

6.3.1.1.2 Rabdosiella calycina - Loudetia simplex - Diheteropogon amplectens moist rocky grassland.

Type relevé - 193.

Average species per relevé - 51.

Maximum number of species per relevé - 68.

Minimum number of species per relevé - 34.

This variant occurs in places where the moisture is contained in rock-pockets in the geological strata. Moisture content is thus higher than surrounding soils. The soils are derived from diabase and are rich in humus possibly due to the rotting of vegetation caused by the high moisture content of these pockets. The soil is never very deep and the rocky plates which underlie the soil are conspicuous. Altitudes vary between 1 800 and 2 100 metres above sea level.

This variant is characterised by species group B (Table 3) and the diagnostic species are the grass *Diheteropogon amplectens*, the succulent forb *Crassula lanceolata* which may cover large areas of these rocky patches and the bulbous *Trachyandra saltii*.

The *Rhus dentata* and the *Diheteropogon filifolia* variants have a number of species in common (species group C).

These are the grass *Sporobolus africanus*, the forbs *Alepidea setifera*, *Selago lydenburgensis*, *Acalypha peduncularis*, *Knowltonia transvaalensis*, *Helichrysum lepidissimum*, *Stachys natalensis*, *Pimpinella transvaalensis* and *Berkheya radulosa*. The shrubs *Rhus ernestii*, *Protea roupelliae* and *Erica drakensbergensis*, together with the fern *Cheilanthes quadripinata* and the succulent *Aloe ecklonis*, are also found in these communities.

6.3.1.1.3 Rabdosiella calycina - Loudetia simplex - Othonna natalensis moist rocky grassland

Type relevé - 170.

Average species per relevé - 25.

Maximum number of species per relevé - 37.

Minimum number of species per relevé - 17.

This variant of the *Rabdosiella calycina - Loudetia simplex* community is found on gentle slopes on all aspects. The soils are derived from igneous rocks (mainly diabase) and the rock-cover is approximately 30 % with the size of the rocks never larger than 0,7 metres. Soils are rich red loams. Altitudes vary between 1 200 and 2 000 metres above sea level. The moisture status of the soil is well-drained to moist.

This community is characterised by species group D. Diagnostic species of the variant are the forbs *Othonna natalensis* and *Leonotis ocymiifolia*.

6.3.1.2 Koeleria capensis - Loudetia simplex moist grassland.

Type relevé - 151.

Average number of species per relevé - 42.

Maximum number of species per relevé - 64.

Minimum number of species per relevé - 27.

This community occurs mainly on outcrops of quartzite. The soils are rich in humus, the moisture-content is high and drainage is poor. This community is found on all aspects and slopes. The rock-cover is not very high (approximately 20%) and sizes of the rocks are approximately 0,3 metres in diameter. Altitudes vary between 1 000 and 2 200 metres above sea level. This community is characterised by species group F.

Figure 29. Pteridium aquilinum - Loudetia simplex bracken patches showing almost pure stands of Pteridium.

Diagnostic species for this community are the grass *Koeleria capensis* the shrub *Protea welwitschii*, the forb *Ipomoea atherstonii* and the bulbous sedge *Bulbostylis humilis*. Other species occurring in this community are the grasses *Tristachya rehmannii*, *Digitaria monodactyla* and *Sporobolus pectinatus*.

6.3.1.3 Pteridium aquilinum - Loudetia simplex bracken patches.

Type relevé - 127.

Average number of species per relevé - 42.

Maximum number of species per relevé - 51.

Minimum number of species per relevé - 38.

This community is found on rich soils derived from igneous and sedimentary rocks. The percentage rock-cover varies. Soils are humus-rich loams, and slopes and aspects vary greatly. Altitudes vary from 1 600 to 2 000 metres above sea level. This community is characterised by species group G (Table 3).

The diagnostic species for this community is the bracken *Pteridium aqualinum*. This community is most conspicuous when seen in the field as the bracken *Pteridium aquilinum* stands out from other species. Also this species has a tendency to grow in almost pure stands (Figure 29).

Other conspicuous species occurring in this community are the purple-flowering bulb plant *Babiana hypogea*, the grasses *Digitaria tricholaenoides*, *Harpochloa falx* and *Tristachya rehmannii*.

6.3.1.4 Harpochloa falx - Loudetia simplex broken rocky grassland.

This grassland is found on topslopes and crests, on relatively deep soils, rich in humic matarial.

This community is characterised by species group I. Diagnostic species are the grasses *Harpochloa falx*, *Digitaria monodactyla* and *Eragrostis sclerantha*, the forbs *Helichrysum callicomum* and *Senecio polyodon* var. *subglaber*.

This community is subdivided into two variants namely the *Harpochloa falx* - *Loudetia simplex* - *Digitaria tricholaenoides* rocky grassland and the *Harpochloa falx* - *Loudetia simplex* rocky grassland. The latter has no diagnostic species present.

6.3.1.4.1 Harpochloa falx - Loudetia simplex - Digitaria tricholaenioides rocky grassland

Type relevé - 59.

Average number of species per relevé - 35.

Maximum number of species per relevé - 64.

Minimum number of species per relevé - 20.

This variant of the *Harpochloa falx* - *Loudetia simplex* community occurs on soils derived from igneous and sedimentary rocks. The soils are relatively deep (0,5 - 0,8 metres) and are rich in humic content, deep brown loams being the most common. The size of rocks varies, as does the aspect. This community is found mainly on top-slopes. The altitude varies between 900 and 1 800 metres above sea level. The moisture status is moist to dry but always well-drained.

This community is characterised by species group H (Table 3). Diagnostic species for this community are the grass *Digitaria tricholaenoides*, the forbs *Lightfootia paniculata*, *Pentanisia prunelliodes* subsp. *latifolia*, *Walafrida densiflora* and *Helichrysum adenocarpum*. The podplant *Indigofera hilaris* is

a diagnostic species and may be most conspicuous in this community when flowering.

6.3.1.4.2 Harpochloa falx - Loudetia simplex - Senecio polyodon grassland

Type relevé - 82.

Average number of species per relevé - 37.

Maximum number of species per relevé - 42.

Minimum number of species per relevé - 19.

This community is found on rocky, well-drained soils derived from sedimentary rocks. The soils are rich in humic material and are deep, rich, sandy loams. Altitudes vary between 900 and 2 100 metres above sea level. The size of the rocks vary but they are never larger than 0,3 metres in diameter. Aspects vary as do the slopes but this community is predominantly found on upper slopes and crests.

No diagnostic species occur and the community is characterised by the absence of species group H, while species group I is present (Table 3).

6.3.1.5 Andropogon schirensis - Loudetia simplex grassland.

These grasslands occur on poor, shallow soils derived from sedimentary rocks, usually on fairly flat areas or gentle slopes.

Species group O comprises the species that characterise the *Andropogon schirensis - Loudetia simplex* major community.

These species are the grasses *Brachiaria serrata, Andropogon schirensis, Eulalia villosa* and *Bewsia biflora,* the forbs *Hermannia cristata, Aster harveyanus, Felicia muricata, Clutia monticola, Chamaecrista comosa* and

Hypericum aethiopicum. The bulb plant *Aristea woodii* is also characteristic of this major community.

This community is divided into five variants namely the *Andropogon schirensis - Loudetia simplex - Panicum ecklonii* grassland, the *Andropogon schirensis - Loudetia simplex - Protea gaguedii* grassland, the *Andropogon schirensis - Loudetia simplex - Clerodendrum triphyllum* grassland, the *Andropogon schirensis - Loudetia simplex - Indigofera sanguinea* grassland and the *Andropogon schirensis - Loudetia simplex - Euryops laxus* grassland.

6.3.1.5.1 Andropogon schirensis - Loudetia simplex - Panicum ecklonii grassland

Type relevé - 262.

Average number of species per relevé - 24.

Maximum number of species per relevé - 36.

Minimum number of species per relevé - 21.

This community occurs on relatively poor soils derived from shales and quartzites of the Pretoria Group. The soil form is mainly Mispah. Aspects vary greatly but generally the slopes are gentle midslopes and altitudes are beween 1 200 and 2 100 meters above sea level.

This community is characterised by species group J (Table 3).

Diagnostic species are the grass *Panicum ecklonis*, the forb *Becium grandiflorum* and the tuberous *Eriospermum porphyrovalve*.

6.3.1.5.2 Andropogon schirensis - Loudetia simplex - Protea gaguedii grassland

Type relevé - 139.

Average number of species per relevé - 42.

Maximum number of species per relevé - 56.

Minimum number of species per relevé - 28.

This community originates in soils derived from sedimentary rocks. The slopes are nearly always level or so gentle as to be almost level. Soils are sandy loams. Aspects differ greatly and the altitude varies from 1 200 to 2 000 metres above sea level. The rocks present are no larger than 0,7 metres in diameter and deep soil is present between them.

This community is characterised by species group K (Table 3).

Diagnostic species are the shrub *Protea gaguedii*, the forb *Acalypha petiolaris* and the orchid *Eulophia clavicornis* var. *clavicornis*.

If this community is burned too frequently the presence of *Protea gaguedii* can be reduced as this species does not flourish when burned.

6.3.1.5.3 Andropogon schirensis - Loudetia simplex - Clerodendrum triphyllum grassland.

Type relevé - 267.

Average number of species per relevé - 35.

Maximum number of species per relevé - 53.

Minimum number of species per relevé - 20.

This community is found in soils derived from sedimentary rocks. The soils are relatively poor and shallow (0,4 metres deep) and drainage is good as the soils are loamy sands. Altitudes vary greatly as does the aspect. Slopes are gentle to moderate. Rocks are present but not plentiful and their size is smaller than 0,3 meters.

This community is represented by species group L (Table 3).

Diagnostic species are the forbs *Clerodendrum triphyllum*, prominent in Figure 30, *Triumfetta obtusicornis*, *Senecio pentactinus*, *Tetraselago wilmsii* and

Lopholaena coriifolia, the podplants *Lotononis hirsuta*, *Aeschynomene rehmannii*, *Pearsonia sp. nov.* and *Elaphantorrhiza elephantina*. The grasses *Tristachya rehmannii* and *Schizachyrium sanguineum* are also diagnostic for this community.

6.3.1.5.4 Andropogon schirensis - Loudetia simplex - Indigofera sanguinea grassland.

Type relevé - 175.

Average number of species per relevé - 39.

Maximum number of species per relevé - 57.

Minimum number of species per relevé - 24.

This plant community is found in soils derived from sedimentary rocks, mainly quartzites. the soils are shallow (0,4 metres deep) and relatively poor. Rocks are present only as small chips less than 0,1 metres in diameter. Altitudes range from 1 500 to 1 900 metres above sea level. Slopes vary as do the aspects. The moisture status is a well-drained sandy loam.

Diagnostic species are absent.

This community is characterised by the presence of species groups M and O, and the similtaneous absence of species groups J, K and L (Table 3).

Species occurring in species group M are the forbs *Cyanotis speciosa*, *Gnidia gymnostachya*, *Senecio scitus*, *Clutia natalensis*, *Helichrysum ceaspititium*, *Pygmaeothamnus zeyheri* and *Sutera caerulea*, the bulb plants *Eucomis montana* and *Hypoxis acuminata*, the grasses *Sporobolus pectinatus*, *Panicum natalense* and *Ctenium concinnum*. The podplant *Indigofera sanguinea* is also diagnostic for this community and when flowering can dominate the vegetation as can be seen in Figure 31.

Figure 30. Andropogon shirensis - Loudetia simplex - Clerodendrum triphyllum grassland showing Clerodendrum triphyllum.

6.3.1.5.5 Andropogon schirensis - Loudetia simplex - Euryops laxus grassland

Type relevé - 212.

Average number of species per relevé - 37.

Maximum number of species per relevé - 56.

Minimum number of species per relevé - 22.

This community is found on soils derived from sedimentary rocks. The soils are shallow sandy loams and are relatively poor in humic material. The rocks found are plates of quartzite. Aspects vary greatly and slopes occupied by this community are gentle midslopes. Altitudes vary between 900 and 1 900 metres above sea level. The moisture status of this community is badly drained, possibly due to the rock strata.

Figure 31. Andropogon schirensis - Loudetia simplex - Indigofera sanguinea grasslands showing Indigofera sanguinea when flowering.

This community is characterised by species group N (Table 3).

Diagnostic species are the forbs *Craterostigma wilmsii*, *Gazania krebsiana* and *Euryops laxus*, the grass *Setaria sphacelata* var. *torta* and the bulb plant

6.3.2 ERAGROSTIS CHLOROMELAS GRASSLAND.

These grasslands mostly occur on relatively non-rocky, deep soils of flat plains and gentle slopes.

This community is characterised by species group U (Table 3). Diagnostic species that occur generally are the grasses *Eragrostis chloromelas*, *Aristida congesta* and *Setaria sphacelata* var. *flabellata*, the

Figure 32. The blue-green leaves of Tristachya leucothrix are prominent in the Eragrostis chloromelas grasslands.

forbs *Helichrysum rugulosum, Hermannia transvaalensis, Lobelia flaccida* and *Vernonia oligicephala* and the bulb plants *Oxalis depressa* and *Dierama pendulata*.

These grasslands are divided into five minor communities namely the *Aristida aequiglumis - Eragrostis chloromelas* moist grasslands the *Agrostis eriantha - Eragrostis chloromelas* moist grassland, the *Phymaspermum acerosum - Eragrostis chloromelas* grassland,the *Hyparrhenia anamesa - Eragrostis chloromelas* tall grassland and the *Helichrysum rugulosum - Eragrostis chloromelas* grassland.

Tristachya leucothrix is often very prominent in all these grasslands (Figure 32).

6.3.2.1 Aristida aequiglumis - Eragrostis chloromelas moist grassland.

Type relevé - 242.

Average number of species per relevé - 28.

Maximum number of species per relevé - 52.

Minimum number of species per relevé - 16.

This community is found on soils originating from quartzites of the Steenkampsberg and Magaliesberg Formations. The soils are deep (0,9 m) sandy loams of the Mispah soil form. The humic content is relatively high. No rocks are found in this community. Aspects differ greatly and slopes are generally gentle midslopes. The moisture status is characterised by badly drained or water retaining patches. The size of these patches is never larger than 0,8 hectares and it would appear that these moist patches form the very beginnings of small wetlands. Altitudes vary between 1 000 and 1 800 metres above sea level.

This community is characterised by species group Q (Table 3).

The diagnostic species is the grass *Aristida aequiglumis* This grass is found in almost pure stands thus out-competing other species.

6.3.2.2 Agrostis eriantha - Eragrostis chloromelas moist grassland.

Type relevé - 64.

Average number of species per relevé - 34.

Maximum number of species per relevé - 47.

Minimum number of species per relevé - 15.

This community occurs on soils derived from sedimentary rocks of the Magaliesberg Formation. The soils are rich loamy sands high in organic material. The aspects and slopes vary greatly. Altitudes range from 900 to 2 100 metres above sea level. The moisture status of the soil is well-drained but moist due to the presence of a much organic matter.

This community is characterised by species group R (Table 3).

Diagnostic species are the grasses *Eragrostis aspera* and *Agrostis eriantha*, which is most characteristic in summer months when the soft pink inflorescence dominates the landscape. The forb *Sebaea sedoides* is also diagnostic for this community as it prefers a moist habitat.

6.3.2.3 Phymaspermum acerosum - Eragrostis chloromelas grassland.

Type relevé - 38.

Average number of species per relevé - 34.

Maximum number of species per relevé - 47.

Minimum number of species per relevé - 17.

Figure 33. Phymaspermum acerosum distinguishes the Phymaspermum acerosum - Eragrostis chloromelas grassland.

This community is found on soils derived from quartzites from the Magaliesberg Formation. Soils are sandy loams and the drainage is good. Aspects vary but the slopes occupied by this community are midslopes of a moderate degree of slope. Altitudes range from 1 500 to 1 800 metres above sea level. No rocks occur in this community.

This community is characterised by species group S (Table 3).

The diagnostic species for this community is the characteristic shrub-like forb *Phymaspermum acerosum* which, when flowering can be most spectacular in that it's yellow flowers can be seen from afar (Figure 33).

6.3.2.4 Hyparrhenia anamesa - Eragrostis chloromelas tall grassland.

Type relevé - 95.

Average number of species per relevé - 38.

Maximum number of species per relevé - 62.

Minimum number of species per relevé - 13.

This community is found on quarternary deposits. The soils derived from this rock type is a deep (1,2 metres) rich clay-loam. The moisture status of the soil is thus badly drained due to the soil texture. No rocks are found in this community. Altitudes vary from 1 000 to 1 300 metres above sea level. Aspects vary greatly and slopes are level or nearly level.

This community is found in shallow valleys and is characterised by species group T (Table 3).

Diagnostic species are the forbs *Helichrysum nudifolium* and *Conyza pinnata*, the bulb plants *Kniphofia rigidifolia* and *Moraea huttonii* and the tall and dominant grasses *Hyparrhenia anamesa* and *Hyparrhenia variabilis*.

6.3.2.5 Helichrysum rugulosum - Eragrostis chloromelas grassland.

Type relevé - 165.

Average munber of species per relevé - 38.

Maximum number of species per relevé - 62.

Minimum number of species per relevé - 22.

This community occurs on soils derived from Quarternary deposits. The soils are deep (1,2 metres) clay-loam, rich in organic matter. Aspects vary but slopes are consistently footslopes or valley floors. Altitudes range between 1 000 and 1 900 metres above sea level. The moisture status is badly drained, heavy soils, holding water.

There are no diagnostic species in this community.

6.3.3 GLADIOLUS ECKLONII - THEMEDA TRIANDRA GRASSLAND.

These grasslands are subdivided into four communities namely *Crocosmia paniculata - Gladiolus ecklonii - Themeda triandra* grassland, the *Cymbopogon validus - Gladiolus ecklonii - Themeda triandra* grassland, the *Acacia karroo - Gladiolus ecklonii - Themeda triandra* open woodland, and the *Halleria lucida - Gladiolus ecklonii - Themeda triandra* rocky grassland.

These communities have soil types in common that are all derived from Transvaal Diabase.

The vegetation is characterised by species group Y (Table 3) and the diagnostic species are *Gladiolus ecklonii* and *Polygala hottentotta*.

6.3.3.1 Crocosmia paniculata - Gladiolus ecklonii - Themeda triandra grassland.

Type relevé - 163.

Average number of species per relevé - 14.

Maximum number of species per relevé - 18.

Minimum number of species per relevé - 11.

This community is present on soils derived from diabase. This results in the formation of rich red deep soils. The aspect and slope varies greatly and altitudes range from 1 000 to 2 200 metres above sea level. The moisture status is such that the soils are moist without free water being available.

This community is characterised by species group V.

Diagnostic species are the tall geophyte *Crocosmia paniculata* which may become entirely dominant (Figure 34). The species poorness of this community can be ascribed to the fact that the corms of *Crocosmia paniculata* form a layer approximately 0,1 metres below the soil surface, these corms then multiply thus out-competing any other plants in this community. The more dense the *Crocosmia paniculata* the older the community is.

Figure 34. Crocosmia paniculata - Gladiolus ecklonii - Themeda triandra grassland.

6.3.3.2 Cymbopogon validus - Gladiolus ecklonii - Themeda triandra grassland.

Type relevé - 135.

Average number of species per relevé - 21.

Maximum number of species per relevé - 34.

Minimum number of species per relevé - 9.

This community is found on soils derived from diabase resulting in deep (0,9 metres) rich red soils. Aspects vary and slopes are gentle. No rocks are found in this community. Altitudes range between 900 and 1 200 metres above sea level. This community is found mainly in the northern areas of the study area at lower altitudes and warmer climatic conditions than the rest of the area.

This community is characterised by species group W.

Diagnostic species are the grasses *Cymbopogon validus*, which is often dominant and *Hyparrhenia hirta* together with the forb *Sebaea grandis*.

6.3.3.3 Acacia karroo - Gladiolus ecklonii - Themeda triandra open woodland.

Type relevé - 235.

Average number of species per relevé - 32.

Maximum number of species per relevé - 54.

Minimum number of species per relevé - 25.

This community is found on soils of diverse origins, mainly sediments of the Pretoria Group. This results in many different soils of differing depths, textures and water holding capacities. Aspects vary as do the slopes occupied by this community. Altitudes are lower and lie between 900 and

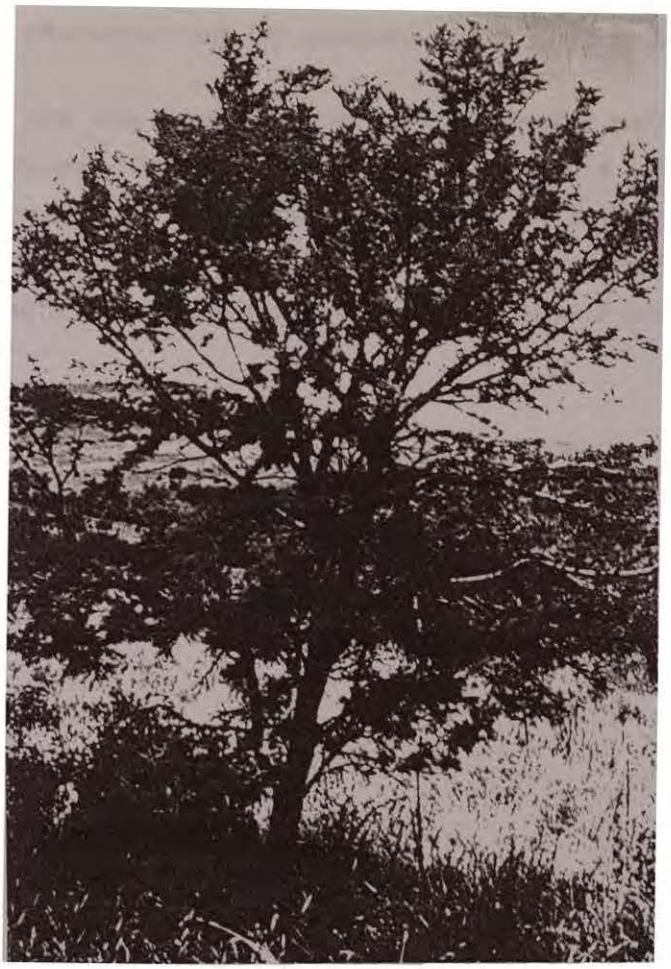

Figure 35. The Acacia karroo - Gladiolus ecklonii - Themeda triandra community.

1 100 metres above sea level. Rocks may be found in this community but most areas have no rocks. This is a grassland community where trees are the major component (Figure 35).

This community is characterised by species group X (Table 3).

Diagnostic species are the trees *Acacia karroo, Protea caffra, Acacia galpinii* and *Mundulea sericea*. Other diagnostic species are the forbs *Eriosema elipticifolium, Convolvulus sagittatus, Cycnium adonense* and *Polygala uncinata,* the grasses *Melinis nerviglumis, Setaria nigrirostis* and *Panicum maximum* and the bulb plants *Oxalis corniculata, Hypoxis galpinii* and *Scadoxus sp.*.

6.3.3.4 Halleria lucida - Gladiolus ecklonii - Themeda triandra rocky grassland.

Type relevé - 266.

Average number of species per relevé - 15.

Maximum number of species per relevé - 19

Minimum number of species per relevé - 12.

This community is found on soils originating from diabase or quartzitic origin. The soils are rich red loamy sand and belong to the Mispah soil form. The soil is never more than 0,8 metres deep. Aspects are mainly southerly slopes and the slope position is a crest or a topslope (Figure 36). The degree of slope is gentle to moderate (ca. 13 - 33°). The moisture status is dry to moist and the soil is always well-drained. Altitudes vary between 1 800 and 2 000 metres above sea level.

This community is characterised by species group Z (Table 3)

Figure 36. The Halleria lucida - Gladiolus ecklonii - Themeda triandra rocky grassland (Leucosidea sericea dominates the vegetation).

and the woody component is characteristic of this community as can be seen in Figure 36.

Diagnostic species are the trees *Halleria lucida* and *Leucosidea sericea* which both never get taller than approximatly four meters. The smaller diagnostic plants are the fern *Cheilanthes hirta* and the orchid *Eulophia foliosa*.

6.3.4 BROMUS FIRMIOR GRASSLAND.

Type relevé - 264.

Average number of species per relevé - 26.

Maximum number of species per relevé - 47.

Minimum number of species per relevé - 19.

This community is found at altitudes exceeding 1 900 metres above sea level. Because of the high altitudes this community is shrouded in mist for most of the wet season.

This community is found on quartzites and sandstones of the Steenkampsberg and Magaliesberg Formations. Soils originating from these rocks are dark, well-drained loamy sands, high in organic material. The depth of the soils may be as little as 0,05 metres or as deep as 1,1 metres. Rocks are present as slabs or boulders but the percentage covered by the rock is never higher than 15 %. Altitudes exceed 1 900 metres above sea level.

This community is characterised by species group Z1 (Table 3) and the diagnostic species is the dominant grass *Bromus firmior* as can be seen in Figure 37. The species poorness of this community is a result of the high cover values of the grass *Bromus firmior*, which is a very hardy unpalatable grass that grows in clumps. The root system of this grass is particularly robust and seems to thrive when burned.

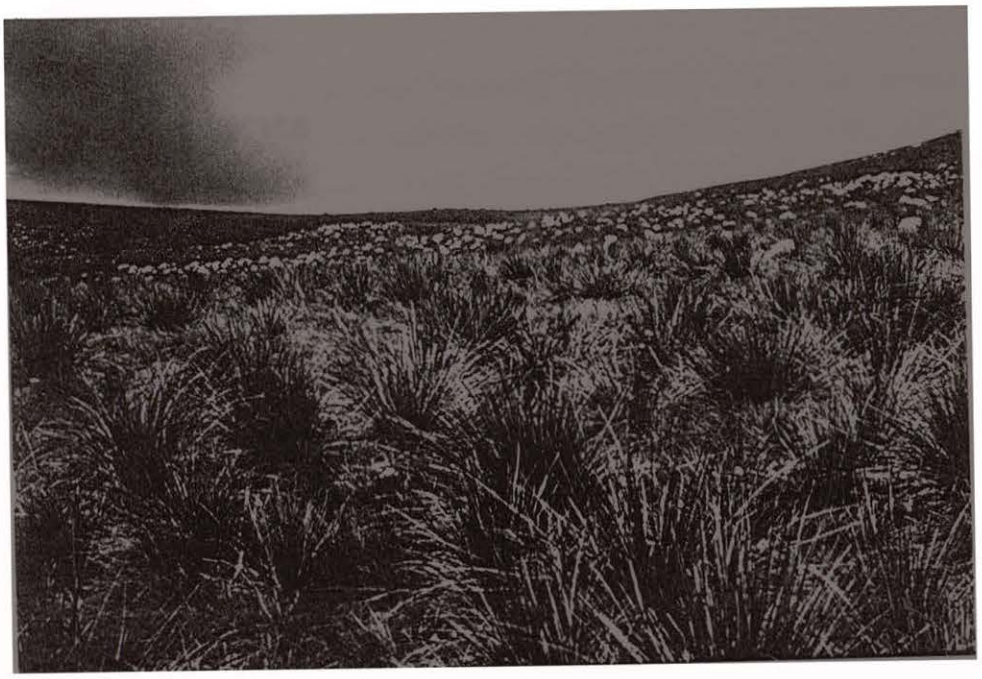

Figure 37. The Bromus firmior grassland showing the prominent grass Bromus firmior.

7.1 THREATENED SPECIES

Threatened species occurring in both study areas are classified into the following groups: extinct, endangered, vulnerable,rare, indeterminate, uncertain, endemic, and non-endemic Hall *et al.* (1980)

No extinct or endangered species occur in this area according to Hall *et al.* (1980). The following species occur in the study areas and are classified according to Hall *et al.* (1980).

SCIENTIFIC NAME	STATE	POSITION
Encephalartos humilis	vulnerable	endemic
Aloe graciliflora	rare	endemic
Clivia caulescens	rare	endemic
Cyrtanthus bicolor	rare	not endemic
Cyrtanthus huttonii	rare	not endemic
Eucomis montana	rare	not endemic
Eucomis vandermerwei	rare	endemic
Gladiolus calcaratus	rare	endemic
Gladiolus exiguus	rare	endemic
Kniphofia rigidifolia	rare	endemic
Kniphofia triangularis ssp. obtusiloba	rare	not endemic
Neobolusia tysonii	rare	not endemic
Ocotea kenyensis	rare	not endemic
Watsonia occulta	rare	not endemic
Aloe reitzii	uncertain	endemic
Disa rhodantha	uncertain	not endemic
Felicia fruticosa ssp. brevipedunculata		uncertain not endemic
Streptocarpus latens	uncertain	endemic

7.2 ENDEMISM

From the PRECIS database at the National Botanical Institute, Pretoria, a list of species unique to the grids 2430DC, DD and 2530 AA, AB, AC, AD, CA, CB, BB and BD were obtained. This resulted in the following list of species.

NAME	GRID
Thelypteris oppositiformis (C. Chr.) Ching	2530AA
Sphagnum fimbriatum Wils. in Hook.	2530CA
Rauiella subfilamentosa (Besch.) Wijk & Marg.	2530DC
Ectropothecium perrotii Ren. & Card	2530BA, BB
Zantedeschia elliottiana (Watson) Engl.	2530AA, AC & CB
Cyrtanthus junodii Beauv.	2530AD
Dierama formosum Hilliard	2530AC
Gladiolus calcaratus G.J. Lewis	2530AB, AC, BA, BB, &
Gladiolus cataractarum Oberm.	2530AD
Gladiolus rufomarginatus G.J. Lewis	2430DC & 2530AB
Radinosiphon lomatensis (N.E. Br.) N.E. Br.	2530BA
Disa alticola Linder	2530AA, AC & BA
Disa amoena Linder	2530BA
Disa clavicornis Linder	2530BA
Disa zimbabweensis Linder	2530AC & BA
Delosperma taylori (N.E. Br.) L. Bol. var. *albanense* L. Bol.	2530CA
Knowltonia transvaalensis Szyszyl. var. *filifolia* H. Rasm.	2530AC
Knowltonia transvaalensis Szyszyl. var. *pottiana* (Burtt Davy) H. Rasm.	2530AC
Pueraria lobata (Willd.) Ohwi var. *lobata*	2530AA
Alepidea basinuda Pott var. *subnuda* Weim.	2530BA & BB
Graderia linearifolia Codd	2530AA
Streptocarpus latens Hilliard & Burtt	2530AC
Dyschoriste perrottetii (Nees) Kuntze	2530AB
Helichrysum summo-montanum Verdoorn	2530AB, BA & BB

These species may occur outside the study area but no record of them has been found. It may be that they are more widespread but have not been collected.

The term endemic refers to a taxon which is limited in it's distribution to specific area or substrate. A near-endemic species is one that is found in a certain area but can also be found in fewer numbers in surrounding areas.

Biodiversity is generally regarded as the measure of richness of species in a region (fauna or flora). This is important to determine if areas are adequately conserved.

There are three factors that determine the species richness of a given system (Grubb 1977), namely;

1) the heterogeneity of the system;
2) the abundance of resources; and
3) the degree of disturbance.

The geology and altitude of this area are clearly major factors in causing heterogeneity in the system, while rainfall is plentiful and therefore organic matter is fed into the system continuously, there are abundant resources. The degree of disturbance in this area is relatively low due to a high rainfall, which causes the plants to recover from the excessive burning. Thus the three factors influencing species richness are plentiful in this study area. It would therfore follow that the results of the interactions between these factors would enhance the species richness even further.

7.3 PLANT SPECIES RICHNESS

Geology is an important factor influencing soil formation. From this the number of species per relevé on the different lithological groups was plotted (Figure

38). As can be seen the lithological group with the most species growing on it is Transvaal diabase.

This is as expected since sedimentary rocks are generally much older than igneous rocks thus the latter has more available elements for plants to utilise.

The factors influencing endemism and biodiversity may be more comlex to define due to the possibility of combined environmental factors influencing each other. Further studies using PATH ANALYSIS (Li 1989) may elucidate this problem.

From Figure 39 it can be seen that the number of species present in wetland communities vary between 18 and 46 species per community.

In Figure 40 it can be seen that the same values for the bouldery community lie between 16 and 34.

The number of species present in grassland communities as given in Figure 41 lie between 14 and 54.

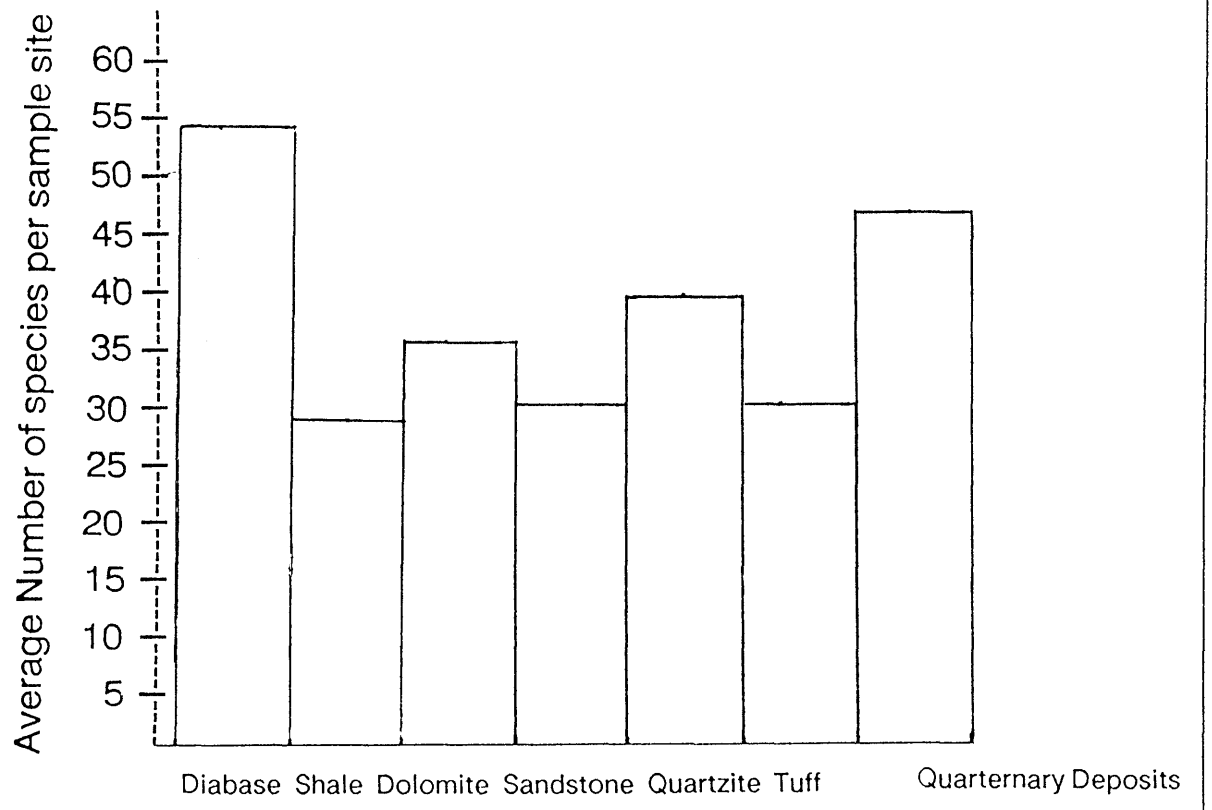

Figure 38. Plot of number of species against lithological groups.

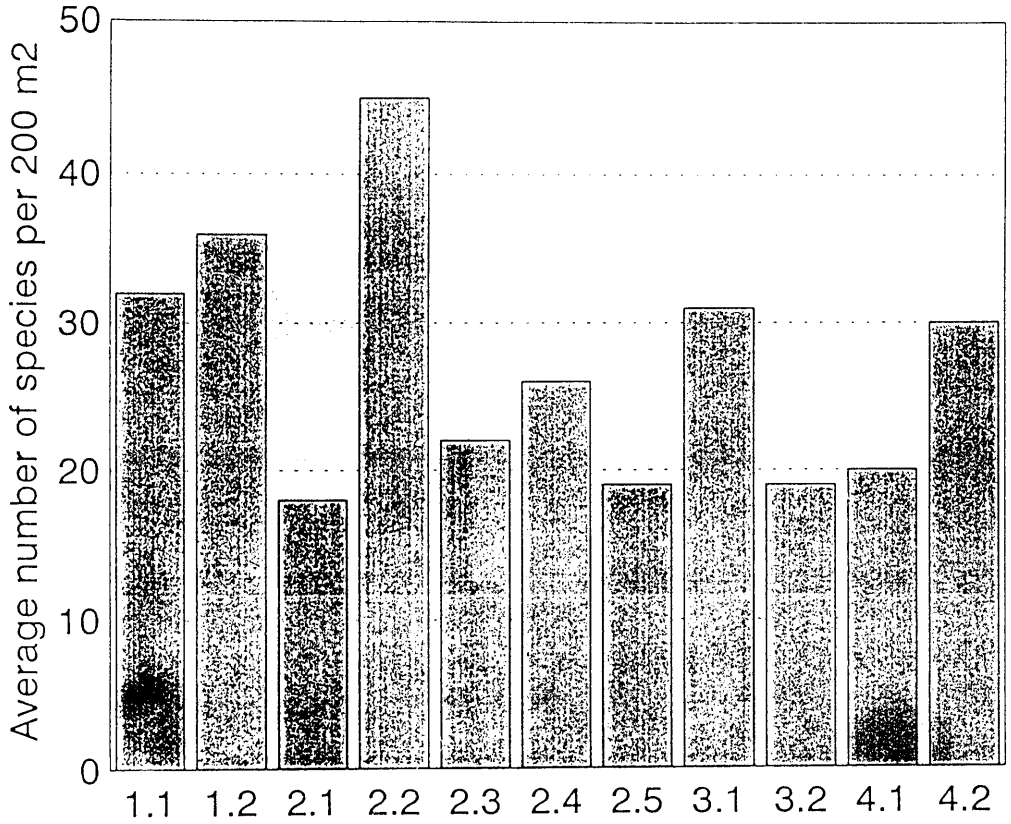

Figure 39. Line chart showing the species per 200 m^2 per community for the wetlands.

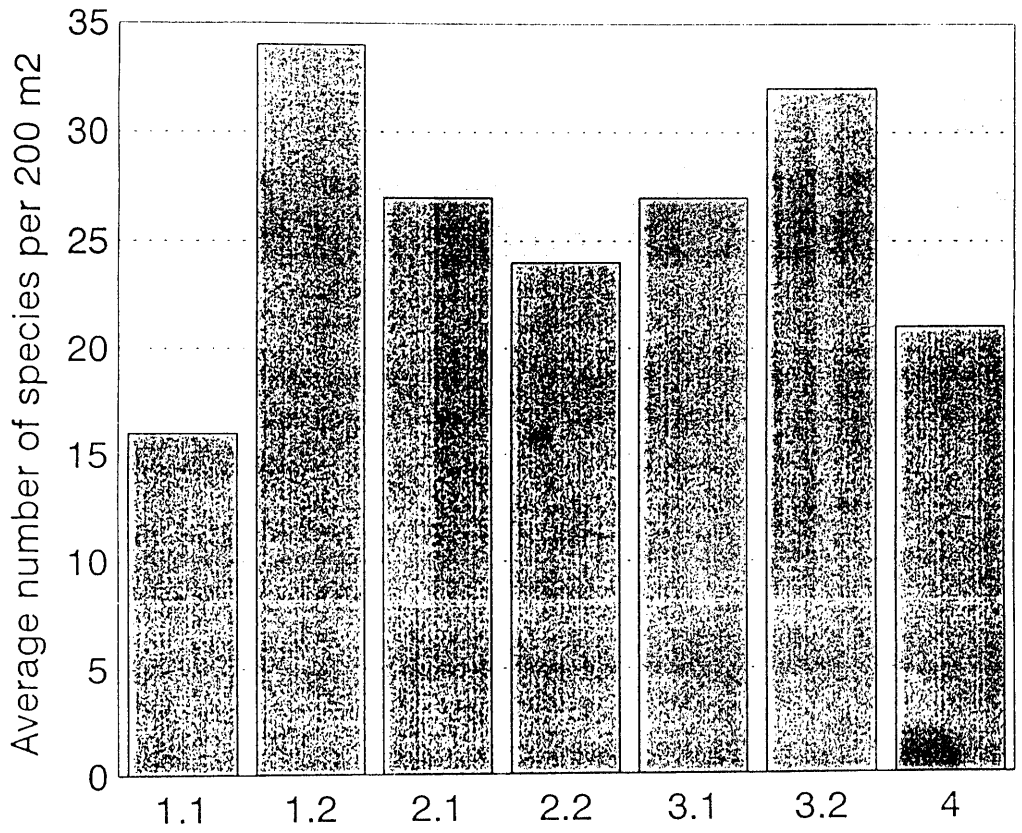

Figure 40. Line chart showing the species per 200 m^2 per community for the boulderies.

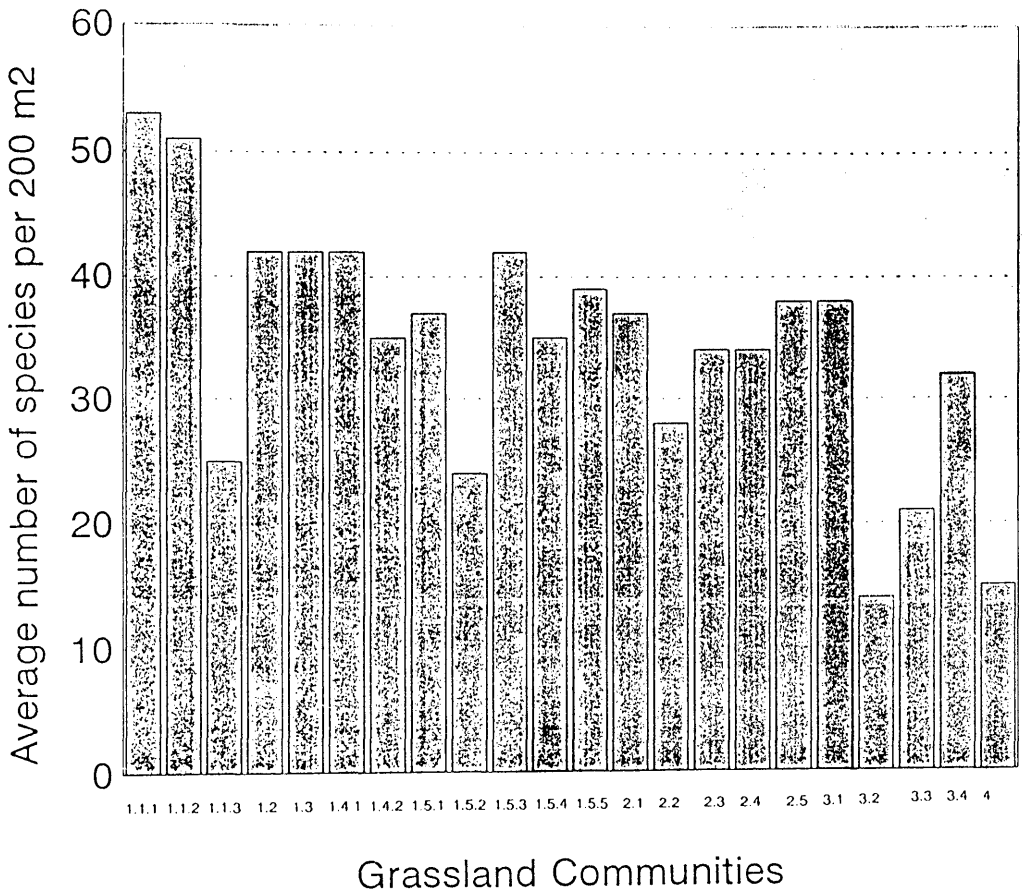

Figure 41. Line chart showing the species per 200 m^2 per community for the grasslands.

The study area is divided into three main vegetation types namely wetlands, boulderies and grasslands. The species found in each of these groups may also occur in the other groups. An example of this is the following species which occur in the wetlands, boulderies and grasslands *Agrostis lachnantha*, *Wahlenbergia virgata* and *Eragrostis racemosa*.

Some aspects of the methods of sampling will be discussed.

8.1 SITE SELECTION.

The selection of sites by means of the stratified-random process proved to be less than desireable in this area due to the broken character of the physiognomic units. This may be eliminated by a more subjective approach to placing sample sites. The geology aslo proved to be too diverse for it to be used as a general character in stratified-random sampling. Workers using this method to place sites should therefore study the terrain carefully before commencing studies or an alternative would be to have experienced workers. This eliminates the inclusion of ecotones where true representation of the communities is lost. This also implies that sample sites need not be square as this is not always possible for long narrow communities. An example of this is the *Coleochloa setifera - Aristida junciformis* moist rocky grassland and the *Dicoma anomala - Aristida junciformis* moist rocky grasslands (6.2.3.1 and 6.2.3.2) which occur in narrow strips approximately four metres in width and sometimes reaching one hundred metres in length. Placing 200 m&hu.2 sites is rather pointless in such a case as the community is dictated by the strata of the rock present.

The division of physiognomic-physiographic units is not a good reflection of habitat type as soil depth, -texture, -acidity, slope, aspect and moisture status (mist) also contribute to the physiographic units. An example of this is that units differing from the physiognomic-physiographic units were found

to occur in the field. Thus a stratified-random method of placing sites should be supplemented by the carefull examination of the terrain by the scientist sampling the area.

8.3 DATA ANALYSIS.

The aim of this study was to sample, classify, interpret and describe the vegetation of the study area. The Braun-Blanquet method whereby the raw data is tabulated and manipulated by hand and where the final table shows not only species occurring in all the relevés but also indicates the relationships between groups of species and relevés and includes environmental data for all releves and species. Thus at a glance it is possible to glean much more data from a Braun-Blanquet table than by any other method. For large data sets the Braun-Blanquet method however requires a classification method to be applied to it before rearranging can commence. The TWINSPAN method is most successful to achieve this.

It is also very important for the scientist to have a thorough knowledge of the study area as this is vital in the shifting of the data in the Braun-Blanquet Table. A good example is the arrangement of data in this study. The results of the first TWINSPAN run on the data were three tables, wetlands, boulderies and grasslands. The first two were complete using all species present in the study area. The grassland table however resulted in false communities resulting from the inclusion of wetland species. This wasted much time but was picked up early in the process avoiding a completely wrong description of the communities. The data of the grasslands were then processed with only the data resulting from the TWINSPAN results.

8.3 TIME AT WHICH SAMPLING TOOK PLACE.

There are two aspects to this point; the season at which sampling occurred and the year in which sampling was done. Both influence the outcome of the final communities. Comparing sample sites placed in September of one year (the commencement of the growing season) and April of the next year (end of the growing season) can give the wrong impression as in an area such as this where many geophytes become dormant just before the winter they will not be sampled at certain times.

The year in which sampling was done is also important as comparisons with later or earlier studies may have to be done. An example of this is comparing this study to that of Acocks's (Acocks 1988) study for the same area. It can thus be seen that the communities have changed over a period of time.

Data analysed by using the computer programme DECORANA did however support the main divisions obtained from the TWINSPAN analysis.

The programme package CANOCO needs to be used with more flair. This programme was run on the data entered using defaults for all factors, which resulted in a poor performance by this programme. The data should be entered and defaults should not be used. To do this more experience is needed when entering data and all the capabilities of this programme package need to be explored. If this is done CANOCO may prove to be a very succesfull method.

8.4 SIMILARITIES BETWEEN OTHER AREAS

From data collectd by Killick (1963) in the Drakensberg it can be seen that in many cases the genera occupying certain niches are the same for these areas but the species differ, depending on the environmental conditions of the areas.

This would be expected as the environmental factors of these two areas are very similar.

8.5 STATUS OF THE COMMUNITIES

All of the communities described can be ecologically interpreted by using habitat factors and are valid ecological units that may be utilized for management programmes.

The conservation status of some of these communities are a cause for concern. Some of these communities like the *Bromus firmior* Grasslands contain newly described succulent species that may be exploited by succulent lovers, coupled to the fact that they occur at such high altitudes and thus have to be conserved. Some rare geophytes also occur in these communities and deserve to be conserved.

Wetlands in this area tend to be green and attractive in the dry season and have a tendency to shrink in size during this season due to overutilization by farmers. Fortunately this is a temporary condition when rains in the summer season replenish the water in them. The vegetation recovers remarkably fast.

8.5 COMPARISON WITH ACOCK'S SURVEY.

According to the survey conducted by Acocks the larger study area is classified as North-eastern Sandy Highveld and the smaller study area is classified as North-eastern Moutain Sourveld. This difference however was not found in this survey but considering the lapse in time since the last suvey it is not unusual and could be ascribed to grazing and burning.

The distribution of *Loudetia simplex* which was confined in Acock's study to the North-eastern Sandy Highveld was found to be present in the whole study area in this survey. *Loudetia flavida* which was present in the Acock's study more in the North-eastern Mountain Sourveld was very seldomly found in the study area as a whole.

This species seems to have moved further North in it's distibution since Acock's survey was conducted.

8.6. SPECIFICS OF SPECIES

Classification of collected plants is according to Arnold & De Wet (1993) and the taxonomic nomenclature has been updated since 1990 when sampling was terminated. Unlike Scheepers (1978) the Poaceae constituted the largest family followed by the Fabaceae, the Asteraceae and the Cyperaceae.

FAMILIES	NUMBER OF GENERA	NUMBER OF SPECIES
Bryophyta	2	2
Pteridophyta	33	63
Gymnospermae	3	.ca 3
Angiospermae		
Monocotyledonae	167	477
Dicotyledonae	106	656

The flora of this region is represented by 1 101 species.

In comparison to Bloem (1988) where the monocots comprised 43,6% of the taxa the monocots in this study area (which is larger than that covered by Bloem) comprised 61% of the genera and 46% of the taxa. The dicots comprised 39% of the genera and 64% of the taxa.

Families with the most species:

FAMILY	GENERA	TAXA
Poaceae	67	161
Cyperaceae	19	69
Fabaceae	47	131
Asteraceae	27	146

Genera with the most taxa:

MONOCOTS	TAXA	DICOTS	TAXA
Digitaria	9	Crassula	14
Eragrostis	17	Indigofera	14
Cyperus	14	Eriosema	10
Aloe	10	Helichrysum	42
Hypoxis	13		
Moraea	10		
Gladiolus	14		
Disa	10		

As with Matthews *et al.* (1993) *Helichrysum* comprised the genus with the most taxa. This is possibly due to the dispersal mechanism coupled to the fact that many seeds are produced per head.

NOTE: Species numbers having the letters D and B preceding them have been collected by Deall (Deall 1985) and Bloem (Bloem 1988) respectively.

Exotic taxa are marked with an asterisk.

BRYOPHYTA
MUSCI

SPHAGNACEAE
1301 *Sphagnum* L.
Sphagnum truncatum Hornsch. (855)

POLYTRICHACEAE
1923 *Polytrichum* Hedw.
Polytrichum sp. (152)

PTERIDOPHYTA

LYCOPODIACEAE
20 *Lycopodium* L.
Lycopodium carolinianum L.
var.*grandifolium* Spring (1013)
L. clavatum L. (331)
L. gnidioides L. f. (D1194)

SELAGINELLACEAE
30 *Selaginella* Beauv.
Selaginella dregei (Presl) Hieron. (43)
Selaginella kraussiana (Kunze.) A. Br.

EQUISETACEAE
50 *Equisetum* L.
Equisetum ramosissimum Desf. (522)

OPHIOGLOSSACEAE
60 *Ophioglossum* L.
Ophioglossum polyphyllum A. Br. ex Seub. (26)

MARATTIACEAE
70 *Marattia* Swartz
Marattia fraxinea J.E. Sm. ex J.F. Gmel.
var. *salicifolia* (Schrad.) C. Chr.

OSMUNDACEAE
80 *Osmunda* L.
Osmunda regalis L. (768)

90 *Todea* Willd.

Todea barbara (L.) T. Moore (D1120)

SCHIZAEACEAE

120 *Mohria* Swartz
Mohria caffrorum (L.) Desv.
var. *caffrorum* (523)

130 *Schizaea* J.E. Sm.
Schizaea pectinata (L.) Swartz

GLEICHENIACEAE

140 *Dicranopteris* Bernh.
Dicranopteris linearis (Burm. f.) Underw. (D571)

150 *Gleichenia* J.E. Sm.
Gleichenia polypodioides (L.) J.E. Sm. (1010)

HYMENOPHYLLACEAE

170 *Trichomanes* L.
Trichomanes melanotrichum Schlechtd. (D1017)

CYATHEACEAE

180 *Cyathea* J.E. Sm.
Cyathea dregei Kunze

DENNSTAEDIACEAE

220 *Blotiella* A.F. Tryon
Blotiella glabra (Bory) A.F. Tryon (D1126)

240 *Hypolepis* Bernh.
Hypolepis sparsisora (Schrad.) Kuhn (D1123)

260 *Pteridium* Glad ex Scop.
Pteridium aquilinum (L.) Kuhn

ADIANTACEAE

300 *Adiantum* L.
Adiantum capillus-veneris L. (447)

340 *Cheilanthes* Swartz
Cheilanthes eckloniana (Kunze) Mett. (315)
C. hirta Swartz (179)
C. inaequalis (Kunze) Mett.
var. *buchananii*(Bak.) Schelpe (1017)
C. multifida (Swartz) Swartz
subsp. *lacerata* N.C. Anthony & Schelpe (548)
C. quadripinnata (Forssk.) Kuhn (115)
C. viridis (Forssk.)
var. *viridis* (534)
C. viridis (Forssk.) Swartz
var. *glauca* (Sim) Schelpe & N.C. Anthony (716)

350 *Doryopteris* J. Sm.

Doryopteris concolor (Langsd.& Fisch) Kuhn (D1846)

360 *Pellaea* Link
Pellaea calomelanos (Swartz) Link
var. *calomelanos* (169)
P. pectiniformis Bak. (D1391)

380 *Pteris* L.
Pteris catoptera Kunze (D1063)
P. cretica L. (D1572)
P. vittata L. (316)

POLYPODIACEAE

450 *Pleopeltis* H.B.K. ex Willd.
Pleopeltis macrocarpa (Bory ex Willd.) Kaulf. (D717)

460 *Polypodium* L.
Polypodium polypodioides (L.) Hitchc. (D704)

DAVALLIACEAE

480 *Arthopteris* J. Sm.
Arthopteris monocarpa (Cordem) C. Chr. (D1400)

ASPLENIACEAE
520 *Asplenium* L.
Asplenium adiantum-nigrum
var. *adiantum-nigrum* (550)
A. aethiopicum (Burm. f.) Becherer (189)
A. anisophyllum Kunze (D1065)
A. inaequilaterale Willd. (D1130a)
A. lobatum Pappe & Rawson (D1046a)
A. lunulatum Swartz (D1130)
A. rutifolium (Berg.) Kunze (D335)
A. splendens Kunze (D321)
A. varians Wall. ex Hook & Grev.
subsp. *fimbriatum* (Kunze) Schelpe (D1380)

THELYPTERIDACEAE
532 *Thelypteris* Schmidel
Thelypteris bergiana (Schlechtd.) Ching (D895)
T. confluens (Thunb.) Morton (402)
T. gueinziana (Mett.) Schelpe (D1909)
T. madigascariensis (Fee) Schelpe (D1122)
T. totta (Thunb.) Schelpe (D1923)

ATHYRIACEAE

540 *Anthyrium* Roth
Anthyrium scandicinum Willd. Presl (D1125)

LOMARIOPSIDACEAE
580 *Elaphoglossum* Schott ex J. Sm.
Elaphoglossum acrostichoides (Hook. & Grev.) Schelpe (567)

ASPIDIACEAE

605 *Cyrtomium* Presl
Cyrtomium caryotidea (Wall ex Hook. & Grev.) Presl
var. *micropterum* (Kunze) C. Chr.

620 *Dryopteris* Adans.
Dryopteris athamantica (Kunze) Kuntze (214)
D. inaequalis (Schlechtd.) Kuntze (451)

640 *Phanerophlebia* Presl
Phanerophlebia caryotidea Wall. ex Hook. & Grev.)
var. *micropteris* (Kunze) Tardieu (D1575)

650 *Polystichum* Roth
Polystichum luctuosum (Kunze) T. Moore (D1381)

660 *Rumohra* Raddi
Rumohra adiantiformis (G. Forst.) Ching (D1226)

670 *Tectaria* Cav.
Tectaria gemmifera (Fee) Alston (D1139)

BLECHNACEAE

690 *Blechnum* L.
Blechnum attenuatum (Swartz Mett.
var. *gigateum* (Kaulf.) Bonap.
B. australe L.
var. *australe* (1012)
B. giganteum (Kaulf.) Schlechtd. (D1121)
B. tubulare (Thunb.) Kuhn (D1146)

GYMNOSPERMAE

ZAMIACEAE

5 *Encephalartos* Lehm.
Encephalartos humilis Verdoorn

PODOCARPACEAE

13 *Podocarpus* L'Herit. ex Pers.
Podocarpus latifolius (Thunb.) R. Br. ex Mirb.

PINACEAE

Pinus L.
Pinus sp. *

ANGIOSPERMAE
MONOCOTYLEDONAE

TYPHACEAE

49 *Typha* L.
Typha capensis (Rohrb.) N.E. Br.

APONOGETONACEAE

65 *Aponogeton* L. f.
Aponogeton junceus Lehm. ex Schlechtd.
subsp. *junceus* (722)

POACEAE

K10 *Ischaemum* L.
Ischaemum fasciculatum Brongn. (143)

K17 *Urelytrum* Hack.
Urelytrum agropyroides (Hack.) Hack. (1241)

K21 *Hemarthria* R.Br.
Hemarthria altissima (Poir.) Stapf & C.E. Hubb. (942)

K28 *Elionurus* Kunth ex Willd.
Elionurus muticus (Spreng.) Kunth (546)

K37 *Imperata* Cirillo
Imperata cylindrica (L.) Raeuschel

K40 *Miscanthus* Anderss.
Miscanthus junceus (Stapf) Pilg. (78)

K42 *Eriochrysis* Beauv.
Eriochrysis brachypogon (Stapf) Stapf (939)
E. pallida Munro (915)

K48 *Cleistachne* Benth.
Cleistachne sorghoides Benth. (D684)

K53 *Eulalia* Kunth
Eulalia villosa (Thunb.) Nees (249)

K63 *Bothriocloa* Kuntze
Bothriocloa bladhii (Retz.) S.T. Blake (996)

K68 *Schizachyrium* Nees
Schizachyrium sanguineum (Retz.) Alst.

K71 *Andropogon* L.
Andropogon appendiculatus Nees (620)
A. chinensis (Nees) Merr. (D1919)
A. eucomus Nees (140)
A. huillensis Rendle (D1300)
A. lacunosus J.G. Anders.
A. mannii Hook. f. (383)
A. schirensis A. Rich. (313)

K72 *Cymbopogon* Spreng.
Cymbopogon dieterlenii Stapf ex Phill.
C. excavatus (Hochst.) Stapf ex Burtt Davy
C. marginatus (Steud.) Stapf ex Burtt Davy
C. plurinodis (Stapf) Stapf ex Burtt Davy
C. validus (Stapf) Stapf ex Burtt Davy (90)

K73 *Hyparrhenia* Anderss. ex Fourn.
Hyparrhenia anamesa Clayton (141)

H. cymbaria (L.) Stapf (D1601)
H. dregeana (Nees) Stapf (121)
H. filipendula (Hochst.) Stapf
var. *filipendula* (D1321f)
H. filipendula (Hochst.) Stapf
var. *pilosa* (Hochst.) Stapf (D1624a)
H. gazensis (Rendle) Stapf (D848)
H. hirta (L.) Stapf (D1321d)
H. newtonii (Hack.) Stapf
var. *macra* Stapf (D164)
H. variabilis Stapf (D3)
H. sp. (519)

K73 *Hyperthelia* Clayton
Hyperthelia dissoluta (Nees ex Steud.) Clayton (D2018)

K75 *Monocymbium* Stapf
Monocymbium ceresiiforme (Nees) Stapf (30)

K78 *Trachypogon* Nees
Trachypogon spicatus (L. F.) Kuntze (118)

K80 *Heteropogon* Pers.
Heteropogon contortus (L.) Roem. & Schult. (322)

K81 *Diheteropogon* (Hack.) Stapf
Diheteropogon amplectens (Nees) Clayton
D. filifolius (Nees) Clayton (274)

K83 *Themeda* Forssk.
Themeda triandra Forssk.

K89 *Digitaria* Haller
Digitaria diagonalis (Nees) Stapf (D1533)
D. eylesii C.E. Hubb. (964)
D. flaccida Stapf (744)
D. monodactyla (Nees) Stapf (171)
D. sanguinalis (L.) Scop. * (266)
D. setifolia Stapf (602)
D. ternata (A. Rich.) Stapf (222)
D. tricholaenoides Stap (329)

K94 *Alloteropsis* Presl
Alloteropsis semialata (R.Br.) Hitchc.
subsp. *eckloniana* (Nees) Gibbs Russell (119)
A. sp.

K104 *Brachiaria* (Trin.) Griseb.
Brachiaria bovonei (Chiov.) Robyns (328)
B. brizantha (A. Rich.) Stapf (D721)
B. nigropedata (Fical. & Hiern) Stapf
B. serrata (Thunb.) Stapf (246)
B. subulifolia (Mez) Clayton (D1320)

K107 *Paspalum* L.
Paspalum dilatatum Poir. *
P. scrobiculatum L. (1047)

P. urvillei Steud. * (96)

K115 *Oplismenus* Beauv.
Oplismenus hirtellus (L.) Beauv. (D682)

K116 *Panicum* L.
Panicum deustum Thunb. (D1695a)
P. ecklonii Nees (311)
P. maximum Jacq. (D847)
P. natalense Hochst. (765)
P. schinzii Hack. (851)
P. sp. (41)

K124 *Sacciolepis* Nash
Sacciolepis typhura (Stapf) Stapf (958)

K128 *Setaria* Beauv.
Setaria megaphylla (Steud.) Dur. & Shinz (D602)
S. nigrirostris (Nees) Dur. & Schinz (400)
S. pallide-fusca (Schumach.) Stapf & C.E. Hubb. (111)
S. sphacelata (Schumach.) Moss
var. *sphacelata* (823)
S. sphacelata (Schumach.) Moss
var. *torta* (Stapf) Clayton (209)
S. verticillata (L.) Beauv.

K134 *Melinis* Beauv.
Melinis minutiflora Beauv. (D1704)
M. nerviglumis (Franch.) Zizka (51)
M. repens (Willd.) Zizka
subsp. *repens*

K139 *Pennisetum* Rich.
Pennisetum macrourum Trin. (184)
P. sphacelatum (Nees) Dur. & Schinz
P. thunbergii Kunth (511)

K140 *Cenchrus* L.
Cenchrus ciliaris.L.

K159 *Leersia* Swartz
Leersia hexandra Swartz (109)

K160 *Ehrharta* Thunb.
Ehrharta erecta Lam.
var. *erecta* (D243)

K164 *Anthoxanthum* L.
Anthoxanthum ecklonii (Nees ex Trin.) Stapf

K173 *Arundinella* Raddi
Arundinella nepalensis Trin. (183)

K174 *Tristachya* Nees
Tristachya biseriata Stapf (34)
T. leucothrix Nees (268)

T. rehmannii Hack. (974)

K175 *Trichopterix* Nees
Trichopterix dregeana Nees (D1108)

K175b *Loudetia* Steud.
Loudetia densispica (Rendle) C.E. Hubb. (D1904)
L. simplex (Nees) C.E. Hubb. (206)
Type A * Hairs on seeds
Type B ** Smooth seeds

K192 *Holcus* L.
Holcus lanatus L. * (417)

K197 *Helictotrichon* Bess. ex Schult.
Helictotrichon hirtulum (Steud.) Schweick. (476)
H. turgidulum (Stapf) Schweick. (393)

K204c *Merxmuellera* Conert
Merxmuellera macowanii (Stapf) Conert

K205 *Pentaschistis* (Nees) Spach
Pentaschistis sp. (272)

K213 *Arundo* L.
Arundo donax L. *

K214 *Phragmites* Adanson
Phragmites australis (Cav.) Steud.
P. mauritianus Kunth (D1965)

K243 *Agrostis* L.
Agrostis barbuligera Stapf
var. *longipilosa* Goosens & Papendorf
A. continuata Stapf
A. eriantha Hack.
var. *eriantha* (62)
A. gigantea Roth (965)
A. lachnantha Nees
var. *lachnantha* (39)

K262 *Aristida* L.
Aristida aequiglumis Hack. (52)
A. congesta Roem. & Schult.
subsp. *barbicollis* (Trin. & Rupr.) De Winter (D1767)
A. congesta Roem. & Schult.
subsp. *congesta* (45)
A. junciformis Trin. & Rupr.
subsp. *junciformis* (327)
A. recta Franch.
A. sp.

K274 *Tragus* Haller
Tragus berteronianus Schult.

K280 *Perotis* Aiton
Perotis patens Gand.

K283 *Sporobolus* R. Br.
Sporobolus africanus (Poir.) Robyns & Tournay (95)
S. centrifugus (Trin.) Nees (D2088)
S. discosporus Nees (175)
S. pectinatus Hack. (210)
S. pyramidalis Beauv.
S. stapfianus Gand. (D1898)
S. subtilis Kunth (844)

K286 *Eragrostis* Wolf
Eragrostis aspera (Jacq.) Nees (264)
E. biflora Hack. ex Schinz (185)
E. caesia Stapf (267)
E. capensis (Thunb.) Trin. (227)
E. chloromelas Steud. (647)
E. curvula (Schrad.) Nees (207)
E. cylindriflora Hochst. (1085)
E. gummiflua Nees (265)
E. hieriana Rendle (D1920)
E. micrantha Hack. (981)
E. nindensis Fical. & Hiern (67)
E. patentissima Hack.
E. plana Nees (74)
E. planiculmis Nees (941)
E. pseudosclerantha Chiov. (217)
E. racemosa (Thunb.) Steud. (193)
E. sclerantha Nees
subsp. *sclerantha* (242

K294 *Microchloa* R. Br.
Microchloa caffra Nees (545)
M. kunthii Desv. (857)

K294 *Rendlia* Chiov.
Rendlia altera (Rendle) Chiov. (208)

K296 *Cynodon* Rich.
Cynodon dactylon (L.) Pers.

K298 *Harpochloa* Kunth
Harpochloa falx (L. f.) Kuntze (369)

K299 *Ctenium* Panzer.
Ctenium concinnum Nees (68)

K301 *Chloris* Swartz
Chloris gayana Kunth (1078)
C. virgata Swartz

K334 *Pogonarthria* Stapf
Pogonarthria squarrosa (Roem. & Schult.) Pilg. (232)

K344 *Bewsia* Goossens
Bewsia biflora (Hack.) Goossens (326)

K350 *Styppeiochloa* De Winter

Styppeiochloa gynoglossa (Goosens) De Winter (D110)2

K353 *Trichoneura* Anderss.
Trichoneura grandiglumis (Nees) Ekman
var. *grandiglumis* (D1759)

K374 *Koeleria* Pers.
Koeleria capensis (Steud.) Nees (49)

K398 *Dactylis* L.
Dactylis glomerata L. * (948)

K400 *Stiburus* Stapf
Stiburus alopecuroides (Hack.) Stapf (75)
S. conrathii Hack.

K407 *Poa* L.
Poa annua L. *
P. binata Nees (371)
P. pratensis L. * (420)

K417 *Festuca* L.
Festuca caprina Nees (394)
F. costata Nees (423)
F. scabra Vahl

K428 *Bromus* L.
Bromus firmior (Nees) Stapf (595)
B. speciosus Nees
B. sp.

K433 *Lolium* L.
Lolium multiflorum Lam. * (269)

CYPERACEAE

452 *Lipocarpha* R. Br.
Lipocarpha nana (A. Rich.) Cherm. (963)

454 *Ascolepis* Nees ex Steud.
Ascolepis capensis (Kunth) Ridley (85)

459 *Cyperus* L.
Cyperus albostriatus Schrad. (D1418)
C corymbosus Rottb.
C. denudatus L. f. (916)
C. esculentus L. (197)
C. fastigiatus Rottb. (748)
C. immensus C.B. Cl. (D1908)
C. leptocladus Kunth (908)
C. marginatus Thunb.
C. obtusiflorus Vahl
var. *sphaerocephalus* (Vahl) Kuekenth. (403)
C. pectinatus Vahl
C. psuedoleptocladus Kuekenth. (D1056)
C. rupestris Kunth
var. *rupestris*
C. semitrifidus Schrad.

var. *semitrifidus* (627)
C. sexangularis Nees (D1841)

459a *Pycreus* Beauv.
Pycreus cooperi C.B. Cl.
P. macranthus (Boeck.) C.B. Cl. (668)
P. nitidus (Lam.) J. Raynal (195)
P. rehmannianus C.B. Cl. (216)
P.unioloides (R. Br.) Urb.
P. sp. (509)

459c *Mariscus* Gaertn.
Mariscus capensis (Steud.) Schrad. (781)
M. congestus (Vahl) C.B. Cl.
M. dregeanus Kunth
M. keniensis (Kuekenth.) Hooper (769)
M. rehmannianus C.B. Cl.
M. sumatrensis (Retz.) J. Raynal * (1090)
M. uitenhagensis Steud. (910)

462 *Kyllinga* Rottb.
Kyllinga alba Nees
K. erecta Schumach. (796)
K. odorata Vahl
K. pauciflora Ridley (729)

465 *Ficinia* Schrad.
Ficinia acuminata (Nees) Nees
F. angustifolia (Schrad.) Levyns
F. bergiana Kunth (D1501)
F. tenuifolia Kunth
F. sp. (746)

467 *Fuirena* Rottb.
Fuirena pubescens (Poir.) Kunth (473)

468 *Scirpus* L.
Scirpus falsus C.B. Cl.
S. ficinioides Kunth (888)

468b *Schoenoplectus* Palla
Schoenoplectus corymbosus (Roth. ex Roem. & Schult.) J. Raynal
var *corymbosus* (223a)
S. muricinux (C.B. Cl.) J. Raynal

468 *Isolepis* R. Br.
Isolepis costata (Boeck.) A. Rich.
var. *macra* (Boeck.) B.L. Burtt (42)
I. fluitans (L.) R. Br. (867)
I. marginata (Thunb.) Dietr.
I. setacea (L.) R. Br. (77)

469 *Eleocharis* R. Br.
Eleocharis palustris R. Br. (384)

471 *Fimbristylis* Vahl
Fimbristylis complanata (Retz.) Link (248)

471a *Bulbostylis* Kunth
Bulbostylis burchellii (Fical. & Hiern) C.B. Cl. (237)
B. contexta (Nees) Bodard
B. humilis (Kunth) C.B. Cl.
B. oritrephes (Ridley) C.B. Cl.
subsp. *australis* B.L. Burtt (386)
B. oritrephes (Ridley) C.B. Cl.
subsp. *oritrephes*
B. scleropus C.B. Cl. (424)
B. schoenoides (Kunth) C.B. Cl. (653)
B. sp.

492 *Rhynchospora* Vahl
Rhynchospora brownii Roem. & Schult. (106)

512 *Coloechloa* Gilly
Coloechloa setifera (Ridley) Gilly (71)

515 *Scleria* Berg.
Scleria bulbifera Hochst. ex A. Rich. (D1335)
S. dieterlenii Turrill (168)
S. melanomphala Kunth (D1944)
S. woodii C.B. Cl. (934)

521 *Schoenoxiphium* Nees
Schoenoxiphium lehmannii (Nees) Steud. (D1582)
S. sparteum (Wahlenb.) C.B. Cl. (566)
S. sp. (601)

525 *Carex* L.
Carex aethiopica Schkuhr
C. austro-africana (Keukenth.) Raymond (440)
C. cognata Kunth
var. *drakensbergensis* (C.B. Cl.) Kuekenth. (280)
C. mossii Nelmes
C. spicato-paniculata C.B. Cl. (D595)

ARECACEA
528 *Phoenix* L.
Phoenix reclinata Jacq. (D1838)

ARACEAE
748 *Zantedeschia* Spreng.
Zantedeschia albomaculata (Hook.) Baill.
subsp. *albomaculata* (578)
Z. albomaculata (Hook.) Baill.
subsp. *macrocarpa* (Engl.) Letty
Z. pentlandii (Watson) Wittm. (1254)
Z. rehmannii Engl. (723)

764 *Stylochiton* Lepr.
Stylochiton natalense Schott (D702)

RESTIONACEAE

804c *Ischyrolepis* Steud.
Ischyrolepis schoenoides (Kunth) Linder (1011)

XYRIDACEAE
826 *Xyris* L.
Xyris capensis Thunb. (157)
X. gerrardii N.E. Br.
X. rehmannii Nilss.

ERIOCAULACEAE
828 *Eriocaulon* L.
Eriocaulon dregei Hochst.
var. *sonderanum* (Koern.) Oberm. (687)
E. sp. (854)

COMMELINACEAE
896 *Commelina* L.
Commelina africana L.
var. *africana* (133)
C. africana L.
var. *krebsiana* (Kunth) C.B. Cl.
C. africana L.
var. *lancispatha* C.B. Cl. (907)
C. bengalensis L. (202)
C. eckloniana Kunth (D1265)
C. livingstonii C.B. Cl. (D720)

899 *Aneilema* R. Br.
Aneilema aequinoctiale (Beauv.) Loudon (D1837)

904 *Cyanotis* D. Don
Cyanotis lanata Benth. (D1894)
C. lapidosa Phill. (D1409)
C. pachyrrhiza Oberm.
C. speciosa (L. f.) Hassk. (589)

908 *Floscopa* Lour.
Floscopa glomerata (Willd. ex Schult. & Schult. f.) Hassk.

911 *Tradescantia* L.
Tradescantia fluminensis Vell. *

JUNCACEAE
936 *Juncus* L.
Juncus dregeanus Kunth (1050)
J. exsertus Buchen. (187)
J. oxycarpus E. Mey. ex Kunth (172)

937 *Luzula* DC.
Luzula africana Drege ex Steud. (370)

COLCHICEACEAE
963 *Gloriosa* L.
Gloriosa superba L.

964 *Littonia* Hook.
Littonia modesta Hook.

969 *Androcymbium* Willd.
Androcymbium longipes Bak. (421)
A. melanthioides Willd.
var. *striatum* (Hochst.) Bak.
A. melanthioides Willd.
var. *subulatum* Bak. (886)

973 *Ornithoglossum* Salisb.
Ornithoglossum parviflorum B. Nord.
var. *parviflorum*

ASPHOLEDACEAE (Part A)

985 *Bulbine* Willd.
Bulbine abyssinica A. Rich. (442)
B. coetzeei Oberm.
B. filifolia Bak.

985a *Trachyandra* Kunth
Trachyandra asperata Kunth
var. *swaziensis* Oberm. (396)
T. saltii (Bak.) Oberm.
var. *saltii* (429)

989 *Anthericum* L.
Anthericum angulicaule Bak. (D1270)
A. cooperi Bak.
A. galpinii Bak.
var. *galpinii*
A. haygarthii (Wood & Evans) Kies ex Oberm. (690)
A. transvaalense Bak. (789)
A. sp. (411)

990 *Chlorophytum* Ker-Gawl.
Chlorophytum sp. (D1191a)

ERIOSPERMACEAE

1012 *Eriospermum* Jacq. ex Willd.
Eriospermum abyssinicum Bak. (279)
E. burchellii Bak. (D1030)
E. cooperi Bak. (D765)
E. hygrophilum Bak. (477)
E. porphyrovalve Bak. (593)
E. sp. (608)

ASPHODELACEAE (Part B)

1024 *Kniphofia* Moench
Kniphofia fluviatilis Codd
K. linearifolia Bak. (92)
K. multiflora Wood & Evans (1062)

K. rigidifolia E.A. Bruce
K. splendida E.A. Bruce
K. triangularis Kunth
subsp. *obtusiloba* (Berger) Codd (828)
K. sp. (314)

1026 *Aloe* L.
Aloe arborescens Mill.
A. boylei Bak.
A. ecklonis Salm-Dyck (733)
A. greatheadii Schol.
var. davyana (Schonl.) Glen & Hardy
A. minima Bak. (991)
A. modesta Reynolds
A. petricola Pole-Evans (D1992)
A. reitzii Reynolds
var. *reitzii*
A. reitzii Reynolds
var. *vernalis* Hardy
A. transvaalensis Kuntze

1029 *Haworthia* Duval
Haworthia angolensis Bak. (1084)

ALLIACEAE

1046 *Agapanthus* L' Herit.
Agapanthus inapertus Beauv.
subsp. *inapertus*
A. inapertus
subsp. *pendulus* (L. Bol.) Leighton

1047 *Tulbachia* L.
Tulbaghia acutiloba Harv. (359)
T. leucantha Bak. (224)
T. nutans Vosa (418)
T. simmleri Beauv.

HYACINTHACEAE (Part B)

1079 *Albuca* L.
Albuca glauca Bak.
A. setosa Jacq. (563)
A. shawii Bak.

1080 *Urginea* Steinh.
Urginea modesta Bak. (715)

1082 *Drimia* Jacq. ex Willd.
Drimia neriniformis Bak. (709)
D. robusta Bak. (293)
D. sp. (347)

1084 *Dipcadi* Medik.
Dipcadi marlothii Engl. (479)
D. viride (L.) Moench (636)

1086 *Scilla* L.
Scilla natalensis Planch. (438)
S. nervosa (Burch.) Jessop (454)

1088 *Eucomis* L'Herit.
Eucomis autumnalis (Mill.) Chitt. (262)
subsp. *clavata* (Bak.) Reyneke
E. comosa (Houtt.) Wehrh.
E. montana Compton (57)
E. pole-evansii N.E. Br. (816)
E. vandermerwei Verdoorn

1089 *Ornithogalum* L.
Ornithogalum monophyllum Bak. (597)
O. tenuifolium Delaroche
subsp. *tenuifolium* (444)

1090 *Drimiopsis* Lindl.
Drimiopsis burkei Bak. (507)
D. maculata Lindl.

1090a *Ledebouria* Roth.
Ledebouria cooperii (Hook. f.) Jessop (372)
L. marginata (Bak.) Jessop (357)
L. ovalifolia(Schrad.) Jessop
L. revoluta (L. f.) Jessop (D1554)
L. sp. (634)

DRACENACEAE

1109 *Dracaena* Vand. ex. L.
Dracaena hookerana K. Koch (D907)

ASPARAGACEAE

1113 *Protasparagus* Oberm.
Protasparagus aethiopicus (L.) Oberm.
P. africanus (Lam.) Oberm. (D516)
P. angusticladus (Jessop) Oberm. (D1850)
P. falcatus (L.) Oberm. (D93)
P. laricinus (Burch.) Oberm. (190)
P. plumosus (Bak.) Oberm. (D1062)
P. racemosus (Willd.) Oberm. (D1706a)
P. rigidus (Jessop) Oberm. (D1186)
P. virgatus (Bak.) Oberm. (70)

1113a *Myrsiphyllum* Willd.
Myrsiphyllum asparagoides (L.) Willd. (450)
M. ramosissimum (Bak.) Oberm. (674)

LUZURIGACEAE

1147 *Behnia* Didr.
Behnia reticulata (Thunb.) Didr. (D282)

SMILACEAE

1151 *Smilax* L.
Smilax anceps Willd. (D122)

AMARYLIDACEAE
1167 *Haemanthus* L.
Haemanthus albiflos Jacq.
H. humilis Jacq.
subsp. *hirsutus* (Bak.) Snijman (577)

1167a *Scadoxus* Raf.
Scadoxus multiflorus (Matyn) Raf.
subsp. *multiflorus* (D1728)
S. sp. (401)

1168 *Boophane* Herb.
Boophane disticha (L.f.) Herb.

1170 *Clivia* Lind.
Clivia caulescens R.A. Dyer

1175 *Nerine* Herb
Nerine angustifolia (Bak.) Bak. (1019)
N. rehmannii (Bak.) L. Bol.

1177 *Brunsvigia* Heist.
Brunsvigia radulosa Herb. (860)

1187 *Apodolirion* Bak.
Apodolirion buchananii Bak.

1189 *Crinum* L.
Crinum bulbispermum (Burm.f.) Milne-Redh. & Schweick. (1061)
C. lugardiae N.E. Br.
C. macowanii Bak. (426)

1191 *Cyrtanthus* L. f.
Cyrtanthus attenuatus R.A. Dyer
C. bicolor R.A. Dyer (D1161)
C. breviflorus Harv. (344)
C. flanniganii Bak.
C. huttonii Bak.
C. macowani Bak.
C. stenanthus Bak.
var. *major* R.A. Dyer (590)
C. tuckii Bak.
var. *transvaalensis* Verdoorn (352)

HYPOXIDACEAE
1230 *Hypoxis* L.
Hypoxis acuminata Bak. (459)
H. angustifolia Lam.
var. *angustifolia*
H. argentea Harv. ex Bak. (422)
var. *argentea*
H. costata Bak. (532)
H. filiformis Bak. (499)

H. galpinii Bak. (388)
H. gerrardii Bak. (772)
H. hemerocallidea Fisch. & C.A. Mey.
H. iridifolia Bak. (46)5
H. kraussiana Buchinger (7)03
H. multiceps Buchinger (D1317)
H. rigidula Bak.
var. *pilosissima* Bak. (672)
H. rigidula Bak.
var. *rigidula* (478)
H. sp. (678)

VELLOZIACEAE
1247 *Xerophyta* Juss.
Xerophyta retinervis Bak. (D2003)

DIOSCOREACEAE
1252 *Dioscorea* L.
Dioscorea cotinifolia Kunth (D655)
D. sylvatica (Kunth) Eckl.
D. sp.

IRIDACEAE
1265 *Moraea* Mill.
Moraea elliotii Bak. (29)
M. huttonii (Bak.) Oberm.
M. marionae N.E. Br.
M. modesta Killick
M. moggii N.E. Br.
subsp. *moggii* (881)
M. muddii N.E. Br.
M. pubiflora N.E. Br. (740)
M. robusta (Goldbl.) Goldbl. (368a)
M. thomsonii Bak.
M. sp. (727)

1265a *Dietes* Salisb. ex Klatt
Dietes iridioides (L.) Sweet ex Klatt

1265b *Gynandriris* Parl.
Gynandriris simulans (Bak.) R.C. Fost.

1277 *Homeria* Vent.
Homeria pallida Bak. (339)

1295 *Aristea* Ait.
Aristea angolensis Bak.
subsp. *angolensis*
A. woodii N. E. Br. (822)
A. sp. (697)

1299 *Schizostylis* Backh. & Harv.
Schizostylis coccinea Backh. & Harv. (146)

1301 *Hesperantha* Ker-Gawl.

Hesperantha baurii Bak. (158)
subsp. *baurii*
H. pauciflora (Bak.) G.J. Lewis
H. radiata (Jacq.) Ker-Gawl.
*H. rupestris*N.E. Br.ex R.C. Fost. (1065)
H. tysonii Bak. (712)

1303 *Dierama* K. Koch
Dierama insigne N.E. Br.
D. pendulum (L.f.) Bak.
D. robustum N.E. Br.
D. sp. (416)

1306 *Crocosmia* Planch.
Crocosmia aurea (Pappe ex Hook.) Planch. (D366)
C. paniculata (Klatt) Goldbl. (93)

1310 *Babiana* Ker-Gawl.
Babiana hypogea Burch.
var. *ensifolia* G.J. Lewis (47)
B. hypogea Burch.
var. *hypogea* (94)

1311 *Gladiolus* L.
Gladiolus appendiculatus G.J. Lewis
var. *appendiculatus*
G. atropurpureus Bak.
G. calcaratus G.J. Lewis (144)
G. cataractarum Oberm.
G. crassifolius Bak. (60)
G. dalenii Van Geel (745)
G. densiflorus Bak. (D1708)
G. ecklonii Lehm.
subsp. *ecklonii* (890)
G. elliotii Bak.
G. exiguus G.J. Lewis (D1482)
G. longicollis Bak.
var. *platypetalus* (Bak.) Oberm. (409)
G. papilio Hook. f.
G. permiabilis Delaroche
subsp. *edulis* (Burch. ex Ker-Gawl.) Oberm.
G. varius F. Bol.
var. *micranthus* (Bak.) Oberm.
G. woodii Bak. ** (This type has sky-blue flowers) (508)

1311d *Radinosiphon* N.E. Br.
Radinosiphon leptostachya (Bak.) N.E. Br. (955)

1314 *Lapeirousia* Pourret
Lapeirousia sandersonii Bak. (952)

1315 *Watsonia* Mill.
Watsonia bella N.E. Br. ex Goldbl. (734)
W densiflora Bak.
W. occulta L. Bol. (763)

1319 *Strelitzia* Ait.
Strelitzia caudata R.A. Dyer

ORCHIDACEAE
1407 *Stenoglottis* Lindl.
Stenoglottis fimbriata Lindl. (D1237)

1422 *Habenaria* Willd.
Habenaria chlorotica Reichb. f. (1087)
H. clavata (Lindl.) Reichb. f.
H. dives Reichb. f. (923)
H. dregeana Lindl.
H. falcicornis (Burch. ex (Lindl.) H. Bol.
subsp. *caffra* (Schltr.) J.C. Manning (147)
H. lithophila Schltr. (1063)
H. sp. (936)

1429 *Neobolusia* Schltr.
Neobolusia tysoniii (H. Bol.) Schltr. (918)

1430 *Satyrium* Swartz
Satyrium cristatum Sond.
var. *cristatum* (1248)
S. cristatum Sond.
var. *longilabiatum* A.V. Hall (818)
S. hallackii H. Bol.
subsp. *ocellatum* (H. Bol.) A.V. Hall (815)
S. longicauda Lindl.
var. *jacottetianum* (Kraenzl.) A.V. Hall (871)
Satyrium longicauda Lindl.
var. *longicauda* (705)
S. neglectum Schltr.
subsp. *neglectum*
S. parviflorum Swartz (1057)
S. trinerve Lindl. (956)

1431 *Schizochilus* Sond.
Schizochilus cecilii Rolfe
subsp. *transvaalensis* (Rolfe) Linder (1246)
S. zeyheri Sond.

1433 *Brownleea* Harv. ex Lindl.
Brownleea coerulea Harv. ex. Lindl (D830)
B. galpinii H. Bol.
subsp. *galpinii*
B. parviflora Harv. ex Lindl. (978)

1434 *Disa* Berg.
Disa aconitoides Sond. (760)
D. alticola Linder
D. chrysostachya Swartz
D. cooperi Reichb. f. (884)
D. nervosa Lindl.
D. patula Sond.
var. *transvaalensis* Summerh. (899)
D. rhodantha Schltr. (1247)
D. stachyoides Reichb. f. (742)

D. versicolor Reichb f. (887)
D. sp. (1043)

1435 *Herschelianthe* Rauschert
Herschelia baurii (H. Bol.) Rauschert

1437 *Disperis* Swartz
Disperis anthoceros Reichb. f. (1077)
D. cardiophora Harv.
D. cooperi Harv. (806)
D. fanniniae Harv. (D1239)
D. stenoplectron Reichb. f. (1095)
D. tysonii H. Bol. (949)

1440 *Corycium* Swartz
Corycium dracomontanum Parkman & Schelpe (1044)

1565 *Polystachya* Hook.
Polystachya cocreta (Jacq.) Garay & Sweet (D1622)
P. ottoniana Reichb. f. (D1201)
P. sp. (D1049)

1568 *Ansellia* Lindl.
Ansellia africana Lind. (D803)

1648 *Eulophia* R. Br. ex Lindl.
Eulophia aculeata (L. f.) Spreng.
subsp. *huttonii* (Rolfe) A.V. Hall (598)
E. clavicornis Lindl.
var. *clavicornis* (343)
E. foliosa (Lindl.) H. Bol. (560)
E. leontoglossa Reichb. f. (391)
E. ovalis Lindl.
subsp. *ovalis* (824)
E. streptopetala Lindl. (D1446)
E. welwitschii (Reichb. f.) Rolfe

1705 *Bulbophyllum* Thouars
Bulbophyllum sandersonii (Oliv.) Reichb. f. (D1198)

1828 *Tridactyle* Schltr.
Tridactyle tricuspis (H. Bol.) Schltr. (D658a)

DICOTYLEDONAE

CASUARINACEAE
1855 *Casuarina* Adans.
Casuarina equisetifolia L. *

PIPERACEAE
1862 *Piper* L.
Piper capense L. f.

1866 *Peperomia* Ruiz & Pav.
Peperomia blanda (Jacq.) H.B.K.
var. *leptostachya* (Hook. & Arn.) Deull (D708)

P. retusa (L. f.) Dietr. (D715)
P. tetraphylla (G. Forst.) Hook. & Arn. (D1192)

SALICACEAE
1873 *Salix* L.
Salix babylonica L. *
S. mucronata Thunb.
subsp. *capensis* (Thumb.) Immelman

MYRICACEAE
1874 *Myrica* L.
Myrica pilulifera Rendle (D960)
M. serrata Lam. (D897)

ULMACEAE
1898 *Celtis* L.
Celtis africana Burm. f. (D256)

1902 *Trema* Lour.
Trema orientalis (L.) Blume (D794)

MORACEAE
1961 *Ficus* L.
Ficus ingens (Miq.) Miq. (D811)
F. thonningii Blume

URTICACEAE
1980 *Laportea* Gaudich.
Laportea peduncularis (Wedd.) Chew
subsp. *peduncularis* (D1756)

PROTEACEAE
2034 *Faurea* Harv.
Faurea saligna Harv. (D1788)
F. speciosa (Welw.) Welw. (D644)

2035 *Protea* L.
Protea caffra Meisn.
subsp. *caffra*
P. gaguedi Gmel.
P. roupelliae Meisn.
subsp. *roupelliae* (181)
P. welwitschii Engl.
P. parvula Beard

LORANTHACEAE
2074f *Erianthemum* V. Tieghem
Erianthemum dregei (Eckl. & Zeyh.) v. Tieghem (D846)

SANTALACEAE

2116 *Osyridicarpos* A. DC.
Osyridicarpos schimperanus (Hochst. ex A. Rich) A. DC. (D701)

2118 *Thesium* L.
Thesium costatum A.W. Hill (D1216)
T. cytisoides A.W. Hill (D1268)
T. lobelioides A. DC. (829)
T. sp. (412)

OLACEAE
2136 *Ximenia* L.
Ximenia caffra Sond. (D1172)
var. *caffra*

POLYGONACEAE
2195 *Rumex* L.
Rumex acetosella L. (102)
subsp. *angiocarpus* (Murb.) Murb.
R. crispus L.
R. lanceolatus Thunb. (324)
R. sagittatus Thunb. (89)

2201 *Polygonum* L.
Polygonum meisnerianum Cham. & Schlechtd.
P. sp. (911)

2201c *Persicaria* Mill.
Persicaria lapathifolium (L.) S.F. Gray
P. serrulata (Lag.) Webb & Moq. (98)

2204 *Oxygonum* Burch. ex Campd.
Oxygonum dregeanum Meisn.
subsp. *canescens* (Sond.) Germishuizen
var. *canescens*
O. dregeanum Meisn.
subsp. *lanceolatum* Germishuizen (427)

AMARANTHACEAE
2312 *Cyathula* Blume.
Cyathula cylindrica Moq. (192)

2314 *Pupalia* A. Juss.
Pupalia lappaceae(L.) A. Juss.
var. *lappaceae* (D1757)

2328 *Achyranthes* L.
Achyranthes aspera L.
var. *sicula* L. (D1599)

AIZOACEAE
2376 *Limeum* L.
Limeum pauciflorum Moq. (1234)
L. viscosum (Gay) Fenzl

subsp. *viscosum*
var. *glomeratum* (Eckl. & Zeyh.) Friedr. (809)

2379 *Psammotropha* Eckl. & Zeyh.
Psammotropha myriantha Sond.
TYPE A # Single plants (48)
TYPE B ## Forms a colony

MESEMBRYANTHEMACEAE
2405 *Delosperma* N.E. Br.
Delosperma sutherlandii (Hook. f.) N.E. Br.

2405 *Khadia* N.E. Br.
Khadia carolensis (L. Bol.) L. Bol.
K. sp.

CARYOPHYLLACEAE
2430 *Cerastium* L.
Cerastium capense Sond. (735)

2450 *Spergula* L.
Spergula arvensis L. * (441)

ILLECEBRACEAE
2467 *Pollichia* Ait.
Pollichia campestris Ait. (297)

2490 *Silene* L.
Silene burchellii Otth
var. *angustifolia* Sond. (263)
Silene burchellii Otth
var. *burchellii*
S. clandestina Jacq.
S. undulata Ait. (1020)
S. sp. (831)

2502 *Dianthus* L.
Dianthus holopetalus Turcz.
D. mooiensis F.N. Williams
subsp. *kirkii* (Burtt Davy) Hooper
D. transvaalensis Burtt Davy (826)

RANUNCULACEAE
2541 *Knowltonia* Salisb.
Knowltonia transvaalensis Szyszyl.
var. *transvaalensis* (287)

2542 *Clematis* L.
Clematis brachiata Thunb. (167)

2546 *Ranunculus* L.
Ranunculus baurii Macowan (419)
R. meyeri Harv. (600)
R. multifidus Forssk. (501)

2548 *Thalictrum* L.
Thalictrum rhynchocarpum Dill. & Rich. (D1353a)

MENISPERMACEAE
2570 *Cocculus* DC.
Cocculus hirsutus (L.) Diels (D2027)

2572 *Stephania* Lour.
Stephania abyssinica (Dill. & Rich.) Walp.
var. *tomentalla* (Oliv.) Diels (D216)

2574 *Cissampelos* L.
Cissampelos torulosa E. Mey. ex. Harv. (D200)

ANNONACEAE
2692 *Monathotaxis* Baill.
Monathotaxis caffra (Sond.) Verdc.

2729 *Annona* L.
Annona senegalensis Pers.
subsp. *senegalensis* (D738)

TRIMENIACEAE
2759 *Xymalos* Baill.
Xymalos monospora (Harv.) Baill. (D1002)

LAURACEAE
2788 *Ocotea* Aubl.
Ocotea kenyensis (Chiov.) Robyns (D138)

PAPAVERACEAE
2853 *Papaver* L.
Papaver aculeatum Thunb. (710)

BRASSICACEAE
2875 *Heliophila* L.
Heliophila carnosa (Thunb.) Steud. (125)
H. rididiuscula Sond. (379)

2949 *Brassica* L.
Brassica rapa L. *

2965 *Rorippa* Scop.
Rorippa nasturtium-aquaticum (L.) Hayek * (521)

2986 *Capsella* Medik.
Capsella bursa-pastoris (L.) Medik. * (541)

CAPPARACEAE
3082 *Cleome* L.
Cleome maculata (Sond.) Szyszyl. (755)

3101 *Capparis* L.
Capparis brassii DC. (D896)
C. sepiaria L.
var. *subglabra* (Oliv.) Dewolf (D1874)

DROSERACEAE
3136 *Drosera* L.
Drosera burkeana Planch.
D. collinsiae N.E. Br. ex Burtt Davy (843)
D. madagascariensis DC. (83)

CRASSULACEAE
3164 *Cotyledon* L.
Cotyledon orbiculata L.
var. *orblonga* (Haw.) DC.
C. sp.

3166 *Kalanchoe* Adans.
Kalanchoe rotundifolia (Haw.) Haw. (301)
K. thyrsiflora Harv. (285)

3168 *Crassula* L.
Crassula alba Forssk.
var. *alba* (165)
Crassula alba Forssk.
var. *parvisepala* (Schonl.) Toelken (D71)
C. compacta Schonl. (390)
C. intermedia Schonl.
C. lanceolata (Eckl. & Zeyh.) Endl. ex Walp.
subsp. *lanceolata* (288)
C. natalensis Schonl. (D1521)
C. orbicularis L.
C. pellucida L.
subsp. *brachypetala* (Drege ex Harv.) Toelken (131)
C. sarcocaulis Eckl. & Zeyh.
subsp. *sarcocaulis* (64)
C. setulosa Harv.
var. *rubra* (N.E. Br.) Rowley (850)
C. setulosa Harv.
var. *setulosa* (849)
C. swaziensis Schonl. (D1232)
C. vaginata Eckl. & Zeyh.
var. *vaginata* (821)
C. sp. (336)

ESCALLONIACEAE
3241 *Choristylis* Harv.
Choristylis rhamnoides Harv. (D831)

PITTOSPORACEAE
3252 *Pittosporum* Banks ex Gaertn.
Pittosporum viridiflorum Sims (302)

MYROTHAMNACEAE
3282 *Myrothamnus* Welw.
Myrothamnus flabellifolius Welw. (D1853)

HAMAMELIDACEA
3311 *Trichocladus* Pers.
Trichocladus grandiflorus Oliv. (D1059)

ROSACEAE
3353 *Rubus* L.
Rubus ludwigii Eckl. & Zeyh.
subsp. *ludwigii*
R. pinnatus Willd. (D2023)
R. rigidus J.E. Sm.
R. transvaliensis C.E. Gust.
R. sp. (520)

3375 *Alchemilla* L.
Alchemilla elongata Eckl. & Zeyh.
var. *elongata*
A. woodii Kuntze (599)

3376 *Agrimonia* L.
Agrimonia procera Wallr. (D1596)

3379 *Leucosidea* Eckl. & Zeyh.
Leucosidea sericea Eckl. & Zeyh. (166)

3388 *Cliffortia* L.
Cliffortia linearifolia Eckl. Zeyh.
C. nitidula (Engl.) R.E. & Th. Fries Jr.
subsp. *pilosa* Weim. (1058)
C. repens Schltr. (D1082)

3396 *Prunus* L.
Prunus africana (Hook. f.) Kalkm. (D996)

CHRYSOBALANACEAE
3405 *Parinari* Aubl.
Parinari capensis Harv.
subsp. *capensis* (D1295)
P. curatellifolia Planch. ex Benth. (D7)

CONNARACEAE
3428 *Cnestis* Juss.
Cnestis natalensis (Hochst.) Planch. & Sond. (D908)

FABACEAE
3443 *Albizia* Durazz.
Albizia versicolor Welw. ex Oliv. (D2039)

3446 *Acacia* Mill.
Acacia ataxacantha DC. (D650)
A. baileyana F. Muell. *

A. caffra (Thunb.) Willd. (D818)
A. davyi N.E. Br. (D767)
A. dealbata Link *
A. decurrens Willd. *
A. mearnsii De Wild. *

3452 *Dichrostachys* (A. DC.) Wight & Arn.
Dichrostachys cinerea (L.) Wight & Arn.
subsp. *africana* Brenan & Brumm.
var. *africana* (D628)
Dichrostachys cinerea (L.) Wight & Arn.
subsp. *nyassana* (Taub.) Brenan (D723)

3467 *Elephantorrhiza* Benth.
Elephantorrhiza elephantina (Burch.) Skeels (1031)

3468 *Entada* Adans.
Entada spicata (E. Mey.) Druce (D1008)

3528 *Bauhinia* L.
Bauhinia galpinii N.E. Br. (D2030)

3528c *Tylosema* (Schweinf.) Torre & Hillc.
Tylosema esculentum (Burch.) A. Schreib.
T. fassoglensis (Schweinf.) Torre & Hillc. (D519)

3536 *Chamaecrista* Moench
Chamaecrista biensis (Stayaert) Locke (932)
C. plumosa E. Mey.
var. *erecta* (Schorn & Gordon-Gray) Lock. (D1552)
C. stricta E. Mey. (D599)

3536b *Senna* Mill.
Senna bicapsularis L. Roxb. (D1800)
S. petersiana (Bolle) Lock. (D738)

3561 *Peltophorum* (Vogel) Benth.
Peltophorum aficanum Sond. (D803a)

3607 *Calpurnea* E. Mey.
Calpurnia aurea (Ait.) Benth.
subsp. *aurea* (D295)

3657 *Lotononis* (D.C.) Eckl. & Zeyh.
Lotononis eriantha Benth.
L. foliosa H. Bol.
L. hirsuta (Thunb.) D. Dietr. (819)
L. lanceolata (E. Mey.) Benth. (75)0
L. mucronata Conrath
L. pulchra Duemmer (1072)

3657a *Pearsonia* Duemmer
Pearsonia aristata (Schinz) Duemmer (825)
P. cajanifolia (Harv.) Polhill
subsp. *cryptantha* (Bak.) Polhill (321)
P.grandifolia (H. Bol.) Polhill
subsp. *latibracteolata* (Duemmer) Polhill (592)

P. obovata (Schinz) Polhill (D1522)
P. sessilifolia (Harv.) Duemmer
subsp. *marginata* (Schinz) Polhill (D1452)
P. sessilifolia (Harv.) Duemmer
subsp. *sessilifolia* (979)
P. uniflora (Kensit) Polhill (D821)
P. sp.nov. (883)

3664 *Dichilus* DC.
Dichilus lebeckioides DC. (275)
D. strictus E. Mey. (711)

3669 *Crotalaria* L.
Crotalaria capensis Jacq. (D888)
C. recta Steud. ex A. Rich. (D1624)

3673 *Argyrolobium* Eckl. & Zeyh.
Argyrolobium speciosum Eckl. & Zeyh. (435)
A. transvaalense Schinz (D1840)
A. tuberosum Eckl. & Zeyh. (714)
A. wilmsii Harms. (413)
A. sp. (648)

3688 *Medicago* L.
Medicago lupulina L. (738)
M. sativa L.
subsp. *sativa* *

3690 *Trifolium* L.
Trifolium africanum Ser.
var. *africanum* (977)
T. repens L. *
var. *repens* (446)

3698 *Lotus* L.
Lotus discolor E. Mey.
subsp. *discolor* (D1946)

3702 *Indigofera* L.
Indigofera comosa N.E. Br. (D1883)
I. dimidiata Vogel ex Walp.
I. fastigiata E. Mey.
I. frondosa N.E. Br.
I. hedyantha Eckl. & Zeyh. (870)
I. heterotricha DC.
I. hilaris Eckl. & Zeyh. (784)
I. longebarbata Engl. (802)
I. melanadenia Benth. ex Harv. (982)
I. oxalidea Welw. ex Bak.
I. rostrata H. Bol.
I. sanguinea N.E. Br. (106)
I. swaziensis H. Bol.
var. *swaziensis* (D665)
I. tristoides N.E. Br. (D1939)

3703c *Otholobium* C.H. Stirton

Otholobium rotundifolium (L. f.) C.H. Stirton
O. wilmsii (Harms) C.H. Stirton (137)

3718 *Tephrosia* Pers.
Tephrosia elongata E. Mey.
var. *elongata* (813)
T. glomeruliflora Meisn.
subsp. *meisneri* (Hutch. & Burtt Davy) B.D. Schrire (D1009)

T. longipes Meisn.
subsp. *longipes* (1239)
T. macropoda (E. Mey.) Harv.
var. *macropoda* (759)
T. polystachya E. Mey.
var. *latifolia* Harv. (D765a)
T. semiglabra Sond. (D1553)
T. shiluwanensis Schinz (D765)

3747 *Sesbania* Scop.
Sesbania punicea (Cav.) Benth. *

3754 *Sutherlandia* R. Br. ex Ait. f.
Sutherlandia microphylla Burch. ex DC. (341)

3756 *Lessertia* DC.
Lessertia stricta L. Bol. (259)

3793 *Aeschynomene* L.
Aeschynomene nodulosa (Bak.) Bak. f.
var. *nodulosa* (139)
A. nyassana Taub. (D1182)
A. rehmannii Schinz
var. *leptobotrya* (Harms ex Bak.f.) J.B. Gillett (830)

3796 *Smithia* Ait.
Smithia erubescens (E. Mey.) Bak. f. (988)

3802 *Stylosanthes* Swartz
Stylosanthes fruticosa (Retz.) Alston (D604)

3804 *Zornia* J.F. Gmel.
Zornia capensis Pers. (877)
Z. milneana Mohlenbr. (D1298)
Z. sp. (771)

3807 *Desmodium* Desv.
Desmodium dregeanum Benth. (D737)
D. gangeticum (L.) DC. (D1288)
D. repandum (Vahl) DC. (D1002a)
D. setigerum(E. Mey.) Benth. ex Harv.

3808 *Pseudarthria* Wight & arn.
Pseudarthria hookerii Wight & Arn
var. *hookeri* (1001)

3810 *Alysicarpus* Desv.
Alysicarpus rugosus (Willd.) D.C.

subsp. *perennirufus* J. Leonard (257)

3821 *Dalbergia* L. f.
Dalbergia armata E. Mey. (D21)

3828 *Pterocarpus* Jacq.
Pterocarpus angolensis DC. (D248)
P. rotundifolius (Sond.) Druce
subsp. *rotundifolius* (D2040)
P. sp.

3852 *Vicia* L.
Vicia sativa L. * (481)

3856 *Abrus* Adans.
Abrus laevigatus E. Mey. (D713)

3861 *Dumasia* DC.
Dumasia villosa DC.
var. *villosa* (D1573)

3864 *Neonotonia* Lackey
Neonotonia wightii (Arn.) Lackey (D802)

3870 *Erythrina* L.
Erythrina latissima E. Mey.
E. lysistemon Hutch. (D874)
E. zeyheri Harv.

3877 *Macuna* Adans.
Macuna coriacea Bak.
subsp. *irritans* (Burtt Davy)

3897 *Rhynchosia* Lour.
Rhynchosia angulosa Schinz (D1485)
R. caribaea (Jacq.) DC. (D696)
R. hirta (Andrews) Meikle & Verdc. (D42)
R. komatiensis Harms (D620)
R. monophylla Schltr. (244)
R. nervosa Benth. & Harv.
var. *nervosa*
R. sordida (E. Mey.) Schinz (D1829)
R. thorncroftii (Bak. f.) Burtt Davy (D988)
R. totta (Thunb.) DC.
var. *totta* (698)
R. villosa (Meisn.) Druce (D1261)

3898 *Eriosema* (DC.) G. Don
Eriosema angustifolium Burtt Davy (D1244)
E. burkei Benth. (D1345)
E. cordatum E. Mey. (1030)
E. elipticifolium Schinz (557)
E. gunniae C.H. Stirton (D1544)
E. kraussianum Meisn. (348)
E. nutans Schinz (D1657)
E. psoraleoides (Lam.) G. Don. (D1768)
E. salignum E. Mey. (245)

E. simulans C.H. Stirton (666)

3899 *Flemingia* Roxb. ex Ait. f.
Flemingia grahamiana Wight & Arn (D2034)

3905 *Vigna* Savi
Vigna oblongifolia A. Rich.
var. *oblongifolia* (D1780)
V. nervosa Markoetter (D1481)
V. vexillata (L.) A. Rich.
var. *vexillata* (912)

3907 *Sphenostylis* E. Mey.
Sphenostylis angustifolia Sond. (D1334)
S. marginata E. Mey.
subsp. *marginata* (D692)

3909 *Lablab* Adans.
Lablab purpureus (L.) Sweet
subsp. *purpureus* (1033)

3910 *Dolichos* L.
Dolichos angustifolius Eckl. & Zeyh. (360)
D. falciformis E. Mey. (1034)
D. linearis E. Mey. (565)

GERANIACEAE
3924 *Geranium* L.
Geranium multisectum N.E. Br. (543)

3925 *Monsonia* L.
Monsonia attenuata Harv. (571)
M. brevirostrata Knuth

3928 *Pelargonium* L'Herit.
Pelargonium alchemilloides (L.) L'Herit. (349)
P. dispar N.E. Br. (134)
P. luridum (Andr.) Sweet (797)
P. sp. (893)

OXALIDACEAE
3936 *Oxalis* L.
Oxalis corniculata L. * (785)
O. depressa Eckl. & Zeyh. (D1507)
O. obliquifolia Steud. ex Rich. (100)
O. smithiana Eckl & Zeyh. (1023)

LINACEAE
3945 *Linum* L.
Linum thunbergii Eckl. & Zeyh. (191)

ZYGOPHYLLACEAE
3978 *Tribulus* L.

Tribulus terrestris L.

RUTACEAE

3991 *Zanthoxylum* L.
Zanthoxylum capense (Thunb.) Harv. (D334)
Z. davyi (Verdoorn) Waterm. (D694)
Z. thorncroftii (Verdoorn) Waterm.

4014 *Thamnosa* Torrey & Frem.
Thamnosa africana Engl. (754)

4077 *Toddalia* Juss.
Toddalia asiatica (L.) Lam. (D2025)

4091 *Clausena* Burm. f.
Clausena anisata (Willd.) Hook. f. ex Benth. (D875)

POLYGALACEAE

4237 *Polygala* L.
Polygala africana Chod. (176)
P. amatymbica Eckl. & Zeyh.
P. gerrardii Chod. (626)
P. hottentotta Presl (231)
P. leendertziae Burtt Davy (470)
P. ohlendorfiana Eckl. & Zeyh. (673)
P. uncinata E. Mey. ex Meisn. (495)
P. wilmsii Chod. (891)

DICHAPETALACEAE

4283 *Dichapetalum* Thouars
Dichapetalum cymosum (Hook.) Engl.

EUPHORBIACEAE

4299 *Phyllanthus* L.
Phyllanthus incurvus Thunb. (999)

4407 *Acalypha* L.
Acalypha angustata Sond.
var. *glabra* Sond. (505)
A. caperonioides Baill. (101)
A. glandulifolia Buchinger ex Meisn. (837)
A. peduncularis E. Mey. ex Meisn. (150)
A. petiolaris
A. schinzii Pax (973)
A. villicaulis Hochst. (753)
A. wilmsii Pax ex Prain & Hutch.

4448 *Clutia* L.
Clutia monticola S. Moore (350)
C. natalensis Bernh. ex Krauss (720)

4498 *Euphorbia* L.
Euphorbia clavarioides Boiss.
var. *truncata* (N.E. Br.) White, Dyer & Sloane

E. gueinzii Boiss.
var. *gueinzii* (547)
E. striata Thunb.
var. *striata* (365)

ANACARDIACEAE
4563 *Lannea* A. Rich.
Lannea discolor (Sond.) Engl.
L. edulis (Sond.) Engl.
var *edulis*

4594 *Rhus* L.
Rhus dentata Thunb. (669)
R. discolor E. Mey. ex Sond. (22)
R. ernestii Schonl. (296)
R. montana Diels
R. remanniana Engl. (1029)
R. tumulicola S. Moore

CELASTRACEAE
4626 *Maytenus* Molina
Maytenus heterophylla (Eckl. & Zeyh.) N.K.B. Robson

GREYIACEAE
4855 *Greyia* Hook. & Harv.
Greyia radlkoferi Szyszyl.(338)

BALSAMINACEAE
4856 *Impatiens* L.
Impatiens sp.

RHAMNACEAE
4861 *Ziziphus* Mill.
Ziziphus mucronata Willd.
subsp. *mucronata*

4886 *Phylica* L.
Phylica paniculata Willd. (66)
P. sp

VITACEAE
4917 *Rhoicissus* Planch.
Rhoisissus tridentata (L.F.) Willd. & Drum.
subsp. *cuneifolia* (Eckl. & Zeyh.) N.R. Urton (164)

4918a *Cyphostemma* (Planch.) Alston
Cyphostemma humile (N.E. Br.) Descoings ex Willd. & Drum.
subsp. *humile* (290)
C. simulans (C.A. Sm.) Wild & Drum. (1018)
C. sp.

TILIACEAE
4953 *Corchorus* L.
Corchorus confusus Wild (1000)

4975 *Triumfetta* L.
Triumfetta obtusicornis Sprague & Hutch. (839)
T. sp. (997)

MALVACEAE
5007 *Pavonia* Cav.
Pavonia columella Cav. (261)

5013 *Hibiscus* L.
Hibiscus aethiopicus L.
var. *ovatus* Harv. (464)
H. trionum L.

STERCULIACEAE
5056 *Hermannia* L.
Hermannia cristata H. Bol. (777)
H. depressa N.E. Br.
H. lancifolia Szyszyl. (364)
H. staurostemon K. Schum. (319)
H. transvaalensis Schinz (219)

CLUSIACEAE
5168 *Hypericum* L.
Hypericum aethiopicum Thunb.
subsp. *sonderi* (Bred.) N.K.B. Robson (498)
H. lalandii Choisy (618)

FLACOURTIACEAE
5296 *Kiggelaria* L.
Kiggelaria africana L.

THYMELAECEAE
5435 *Gnidia* L.
Gnidia caffra (Meisn.) Gilg (670)
G. capitata L. F.
G. gymnostachya (Meisn.) Gilg (80)
G. kraussiana Meisn.
var. *kraussiana* (356)
G. nodiflora Meisn. (862)
G. splendens Meisn. (243)
G. sp. (811)

5465 *Dais* L.
Dais cotinifolia L.

LYTHRACEAE
5486 *Nesaea* Comm. ex Juss.
Nesaea sagittifolia (Sond.) Koehne
var. *sagittifolia* (882)

MELASTOMATACEAE
5651 *Antherotoma* Hook. f.
Antherotoma naudinii Hook. f. (233)

5659 *Dissotis* Benth.
Dissotis canescens (E. Mey. ex R.A. Grah.) Hook. f. (885)

ONAGRACEAE
5795 *Epilobium* L.
Epilobium capense Buch. ex Hochst. (798)
E. salignum Hausskn. (130)

5804 *Oenothera* L.
Oenothera jamesii Torr. & Gray * (776)
O. rosea L'Herit. ex Ait. * (448)

HALORAGACEAE
5834 *Myriophyllum* L.
Myriophyllum aquaticum (Vell.) Verdc. *

5836 *Gunnera* L.
Gunnera perpensa L. (103)

ARALIACEAE
5872 *Cussonia* Thunb.
Cussonia paniculata Eckl. & Zeyh.
C. spicata Thunb.

APIACEAE
5894 *Centella* L.
Centella asiatica (L.) Urb. (800)
C. glabrata L.
var. *natalensis* Adamson

5922 *Alepidea* De La Roche
Alepidea amatymbica Eckl. & Zeyh.
var. *amatymbica* (155)
A. attenuata Weim.
A. gracilis Duemmer
A. longifolia E. Mey.
subsp. *angusta* (Duemmer) (878)
A. setifera N.E. Br. (947)
A. sp. (282)

5992 *Heteromorpha* Cham & Schlectd.
Heteromorpha involucrata Conr. (1036)
H. trifoliata (Wendl.) Eckl. & Zeyh. (953)

6033 *Pimpinella* L.
Pimpinella transvaalensis H. Wolff (159)

6038 *Sium* L.

Sium repandum Welw. ex Heirn (173)

6116 *Peucedanum* L.
Peucedanum magalismontanum Sond. (574)
P. sp. (1038)

ERICACEAE
6237 *Erica* L.
Erica alopecurus Harv.
var. *alopecuris* (200)
E. caffrorum H. Bol.
var. *caffrorum* (432)
E. cerinthoides L.
var. *cerinthoides* (439)
E. drakensbergensis Gunth. & Bol. (304)
E. holtii Schweick. (897)
E. leucopelta Tausch
var. *leucopelta* (239)
E. natalitia H. Bol.
var. *natalitia* (65)
E. woodii H. Bol.

MYRSINACEAE
6313 *Myrsine* L.
Myrsine africana L. (337)

6314 *Rapanea* Aubl.
Rapanea melanophloeos (L.) Mez

SAPOTACEAE
6377a *Englerophytum*
Englerophytum magalismontanum (Sond.)
Heine & J.H. Hemsl.

EBENACEAE
6404 *Euclea* Murray
Euclea crispa (Thunb.) Guerke
subsp. *crispa* (178)
E. undulata Thunb.
var. *undulata*

6406 *Diospyros* L.
Diospyros austro-africana De Winter
var. *austro-africana* (211)
D. lycioides Desf.
subsp. *sericea* (Bernh.) De Winter
D. whyteana (Hiern.) F. White (212)

OLEACEAE
6434 *Jasminum* L.
Jasminum quinatum Schinz (751)

LOGANACEAE

6470 *Gomphostigma* Turcz.
Gomphostigma virgatum (L.f.) Baill.

6473 *Buddleja* L.
Buddleja dysophylla (Benth.) Radlk.
B. salviifolia (L.) Lam.

GENTIANACEAE
6481 *Sebaea* Soland. ex R. Br.
Sebaea erosa Schinz (221)
S. grandis (E. Mey.) Steud. (120)
S. leiostyla Gilg
S. rehmannii Schinz
S. sedoides Gilg
var. *sedoides* (869)
S. sp. (649)

6503 *Chironia* L.
Chironia krebsii Griseb. (845)
C. palustris Burch.
subsp. *palustris*
C. purpurescens (E. Mey.) Benth. & Hook. f.
subsp. *humilis* (Gilg) Verdoorn (136)

6512 *Swertia* L.
Swertia welwitschii Engl. (63)

PERIPLOCACEAE
6747 *Raphionacme* Harv.
Raphionacme galpinii Schltr. (758)
R. hirsuta (E. Mey.) R.A. Dyer ex Phill. (351)
R. procumbens Schltr.
R. zeyheri Harv.

ASCLEPIDACEAE
6777 *Xysmalobium* R. Br.
Xysmalobium parviflorum Harv. ex Scott Elliot (374)
X. undulatum (L.) Ait. f. (840)

6778 *Schizoglossum* E. Mey.
Schizoglossum bidens E. Mey.
subsp. *galpinii* (Schltr.) Kupicha (874)
S. nitidum Schltr. (544)

6778a *Aspidoglossum* E. Mey.
Aspidoglossum glabrescens (Schltr.) Kupicha (53)
A. interruptum (E. Mey.) Bullock (126)
A. lamellatum (Schltr.) Kupicha (652)
A. ovalifolium (Schltr.) Kupicha (892)
A. validum Kupicha (539)

6778b *Miraglossum* Kupicha
Miraglossum pulchellum (Schltr.) Kupicha (704)

6782a *Periglossum* Decne.

Periglossum kassnerianum Schltr. (1064)

6787a *Pachycarpus* E. Mey.
Pachycarpus transvaalensis (Schltr.) N.E. Br. (761)
P. sp. (542)

6791 *Asclepias* L.
Asclepias albens (E. Mey.) Schltr. (814)
A. aurea (Schltr.) Schltr. (377)
A. cultriformis Harv. ex Schltr. (780)
A. dissona N.E. Br. (562)
A. lamellatum (Schltr.) Kupicha (652)
A. multicaulis (E. Mey.) Schltr.
A. sp. (972)

6861 *Sisyranthus* E. Mey.
Sisyranthus randii S. Moore (497)

6868 *Anisotoma* Fenzl
Anisotoma pedunculata N.E. Br. (588)

6870 *Brachystelma* R. Br.
Brachystelma coddii R.A. Dyer
B. foetidum Schltr.
B. remotum R.A. Dyer (576)
B. stellatum E.A. Bruce & R.A. Dyer

6874 *Ceropegia* L.
Ceropegia rendallii N.E. Br.

6875 *Riocreuxia* Decne.
Riocreuxia aberrans R.A. Dyer
R. picta Schltr. (1054)

6885 *Stapelia* L.
Stapelia sp.

6896 *Sphaerocodon* Benth.
Sphaerocodon natalense (Meisn.) Hook. f. (318)

6921 *Tenaris* E. Mey.
Tenaris rubella E. Mey. (20)
T. sp. nov.

CONVOLVULACEAE
6993 *Convolvulus* L.
Convolvulus natalensis Bernh. apud Krauss
var. *transvaalensis* (Schltr.) A. Meeuse (736)
C. sagittatus Thunb.
subsp. *sagittatus*
var. *phyllosepalus* (Hallier f.) A. Meeuse (1021)

6997 *Merremia* Dennst.
Merremia sp. (1055)

7003 *Ipomoea* L.
Ipomoea atherstonei Bak. (579)

I. crassipes Hook. (430)
I. ommaneyi Rendle
I. papilio Hallier f. (1005)
I. transvaalense A. Meeuse. (1026)

BORAGINACEAE

7056 *Trichodesma* R. Br.
Trichodesma physaloides (Fenzl.) A. DC. (408)

7064 *Cynoglossum* L.
Cynoglossum hispidum Thunb. (362)

7072a *Afrotysonia* Rauschert
Afrotysonia africana (H. Bol.) Rauschert

7100 *Myosotis* L.
Myosotis sp. (457)

7118 *Echium* L.
Echium vulgare L. * (971)

VERBENACEAE

7138 *Verbena* L. *
Verbena bonariesis L. * (749)
V. brasiliensis Vell. *
V. officinalis L. *

7144 *Lantana* L.
Lantana camara L. *

7145 *Lippia* L.
Lippia javanica (Burm f.) Spreng. (524)
L. remannii H. Pearson

7191 *Clerodendrum* L.
Clerodendrum triphyllum (Harv.) H. Pearson
var. *triphyllum* (404)

LAMIACEAE

7211 *Ajuga* L.
Ajuga ophrydis Burch. ex Benth. (514)

7212 *Teucrium* L.
Teucrium trifidum Retz. (230)

7264 *Leonotis* (Pers.) R. Br.
Leonotis leonurus (L.) R. Br. (205)
L. ocymifolia (Burm. f.) Iwarsson
var. *raineriana* (Visiani) Iwarsson

7281 *Stachys* L.
Stachys arachnoidea Codd (129)
S. natalensis Hochst.
var. *galpinii* (Briq.) Codd (236)
S. simplex Schltr. (832)

7328 *Mentha* L.
Mentha aquatica L. (151)
M. longifolia (L.) L.
subsp. *capensis* (Thunb.) Briq.

7345 *Aeollanthus* Mart. ex K. Spreng.
Aeollanthus buchnerianus Briq. (284)

7347 *Pycnostachys* Hook.
Pycnostachys reticulata (E. Mey.) Benth. (194)

7350 *Plectranthus* L'Herit.
Plectranthus sp.

7350c *Rabdosiella* Codd
Rabdosiella calycina (Benth.) Codd (88)

7359 *Syncolostemon* E.Mey. ex Benth.
Syncolostemon eriocephalus Verdoorn (1007)

7365 *Hemizygia* (Benth.) Briq.
Hemizygia albiflora (N.E. Br.) Ashby (820)
H. transvaalensis (Schltr.) Ashby (415)

7366a *Becium* Lindl.
Becium grandiflorum (Lam.) Pichi-Serm.
var. *obovatum* (E. Mey. ex Benth.) Sebald

SOLANACEAE
7407 *Solanum* L.
Solanum chenopoioides Lam. (859)

7415 *Datura* L.
Datura stramonium L. *

7420 *Cestrum* L.
Cestrum laevigatum Schlechtd. *

SCROPHULARIACEAE
7460 *Verbascum* L.
Verbascum virgatum Stokes * (1025)

7476 *Nemesia* Vent.
Nemesia fruticans (Thunb.) Benth. (254)

7477 *Diclis* Benth.
Diclis reptans Benth. (650)
D. rotundifolia (Hiern) Hilliard & Burtt (256)

7480 *Linaria* Mill.
Linaria vulgaris Mill. *

7493 *Halleria* L.
Halleria lucida L. (334)

7494 *Teedia* Rudopphi
Teedia lucida Rudophi (848)

7495 *Phygelius* E. Mey. ex Benth.
Phygelius aequalis Harv. ex Hiern (559)

7517 *Manulea* L.
Manulea bellidifolia Benth.
M. crassifolia Benth.
subsp. *crassifolia* (392)
M. paniculata Benth.

7519 *Sutera* Roth
Sutera caerulea (L. f.) Hiern (807)
S. campanulata (Benth.) Kuntze (114)
S. floribunda (Benth.) Kuntze (127)
S. neglecta (Wood & Evans) Hiern (782)
S. pinnatifida (Benth.) Kuntze (1091)
S. sp. (308)

7523 *Zaluzianskya* F.W. Schmidt
Zaluzianskya elongata Hilliard & Burtt (582)
Z. maritima (L.f) Walp.
Z. spathacea (Benth.) Walp.

7558 *Limosella* L.
Limosella maior Diels (937)

7560 *Craterostigma* Hochst.
Craterostigma wilmsii Engl. ex Diels (149)

7597 *Melasma* Berg.
Melasma scabrum Berg. (938)

7597a *Alectra* Thunb.
Alectra capensis Thunb. (286)
A. sissiliflora (Vahl) Kuntze
var. *sessiliflora*

7605 *Gerardiina* Engl.
Gerardiina angolensis Engl.

7614 *Graderia* Benth.
Graderia scabra (L. f.) Benth. (531)
G. subintegra Mast. (407)

7616 *Sopubia* Buch.-Ham. ex D. Don
Sopubia cana Harv.
var. *cana* (203)

7622 *Buchnera* L.
Buchnera glabrata Benth. (631)
B. longespicata Schinz (808)

7623 *Cycnium* Benth. emend. Engl.
Cycnium adonense E. Mey. ex Benth.
subsp. *adonense* (458)

C. racemosum Benth.

7625 *Striga* Lour.
Striga asiatica (L.) Kuntze
S. bilabiata (Thunb.) Kuntze (110)
S. elegans Benth.

SELAGINACEAE
7566 *Hebenstretia* L.
Hebenstretia angolensis Rolfe (61)
H. comosa Hochst. (537)
H. dura Choisy
H. oatesii Rolfe
subsp. *oatesii* (1022)
H. sp.

7568 *Selago* L.
Selago atherstonei Rolfe
S. capitellata Schltr.
S. lydenburgensis Rolfe (276)
S. muddii Rolfe (773)
S. villosa Rolfe

7568a *Walafrida* E. Mey.
Walafrida densiflora (Rolfe) Rolfe (107)

7568d *Tetraselago* Junell
Tetraselago wilmsii (Rolfe) Hilliard & Burtt (55)

BIGNONIACEAE
7725 *Jacaranda* Juss.
Jacaranda mimosifolia D. Don. *

GESNERIACEAE
7823 *Streptocarpus* Lindl.
Streptocarpus dunnii Hook. f.
S. latens Hilliard & Burtt
S. pentherianus Fritsch

LENTIBULARIACEAE
7899 *Genlisea* A. St-Hil.
Genlisea hispidula Stapf
subsp. *hispidula* (917)

7901 *Utricularia* L.
Utricularia livida E. Mey. (975)
U. prehensilis E. Mey. (153)

ACANTHACEAE
7914 *Thunbergia* Retz.
Thunbergia atriplicifolia E. Mey. ex Nees (414)

7941 *Chaetacanthus* Nees
Chaetacanthus setiger (Pers.) Lindl. (969)

C. sp. (196)

7972 *Crabbea* Harv.
Crabbea acaulis N.E. Br. (944)
C. hirsuta Harv.
C. sp.

7973 *Barleria* L.
Barleria sp.

8032 *Hypoestes* Soland. ex R. Br.
Hypoestes sp.

8094 *Justicia* L.
Justicia anagalloides (Nees) T. Anders. (605)
J. petiolaris (Nees) T. Anders. (577)
subsp. *petiolaris*

PLANTAGINACEAE
8116 *Plantago* L.
Plantago lanceolata L. * (518)
P. virginica L. * (252)

RUBIACEAE
8136/6 *Kohautia* Cham. & Schlechtd.
Kohautia amatymbica Eckl. & Zeyh. (378)

8136/7 *Conostomium* Cuf.
Conostomium natalense (Hochst.) Brem.
var. *natalense* (879)

8136/14 *Agathisanthemum* Klotzsch
Agathisanthemum bojeri Klotsch
var. *bojeri* (946)

8136/20 *Oldenlandia* L.
Oldenlandia herbacea (L.) Roxb.
var. *herbacea* (113)
O. rosulata K. Schum.
var. *rosulata* (914)

8230 *Cephalanthus* L.
Cephalanthus natalensis Oliv. (992)

8348 *Pentanisia* Harv.
Pentanisia angustifolia (Hochst.) Hochst. (204)
P. prunelloides (Klotzsch ex Eckl. & Zeyh.) Walp.
subsp. *latifolia* (Hochst.) Verdc. (506)
P. prunelloides (Klotzsch ex Eckl. & Zeyh.) Walp.
subsp. *prunelloides* (468)

8352 *Canthium* Lam.
Canthium sp.

8359 *Pachystigma* Hochst.

Pachystigma thamnus Robyns (655)

8359a *Fadogia* Schweinf.
Fadogia homblei De Wild.

8438 *Anthospermum* L.
Anthospermum herbaceum L. f. (985)
A. hispidulum E. Mey. ex Sond. (56)
A. rigidum Eckl. & Zeyh.
subsp. *pumilum* (Sond) Puff (624)
A. rigidum Eckl. & Zeyh.
subsp.*rigidum* (894)

8464 *Richardia* L.
Richardia brasiliensis Gomes *
R. scabra L. * (289)

8475 *Spermacoce* Gaertn.
Spermacoce natalensis Hochst. (841)

8486 *Galium* L.
Galium capense Thunb.
subsp. *garipense* (Sond.) Puff (707)
G. thunbergianum Eckl. & Zeyh.
var. *hirsutum* (Sond.) Verdc. (968)

VALERIANACEAE
8532 *Valeriana* L.
Valeriana capensis Thunb.
var. *capensis* (504)

DIPSACEAE
8541 *Cephalaria* Roem. & Schult.
Cephalaria attenuata (L. f.) Roem. & Schult.
C. petiolata Compton (156)
C. pungens Szabo
C. zeyheriana Szabo (661)

8546 *Scabiosa* L.
Scabiosa columbaria L. (583)

CUCURBITACEAE
8599 *Cucumis* L.
Cucumis hirsutus Sond. (292)

CAMPANULACEAE
8668 *Wahlenbergia* Schrad. ex Roth
Wahlenbergia epacridea Sond.
W. huttonii (Sond.) Thulin (926)
W. lycopodioides Schltr. & V. Brehm. (278)
W. squamifolia V. Brehm. (112)
W. undulata (L. f.) A. DC. (616)
W. virgata Engl. (373)
W. sp.

8668a *Craterocapsa* Hilliard & Burtt
Craterocapsa tarsodes Hilliard & Burtt (741)

8670 *Lightfootia* L'Herit.
Lightfootia denticulata (Burch.) Sond.
var. *transvaalensis* Adamson (309)
L. paniculata Sond. (154)

LOBELIACEAE
8681 *Cyphia* Berg.
Cyphia assimilis Sond.
var. *assimilis* (762)
C. bolusii Phillips (898)
C. elata Harv.
var *elata* (904)
C. elata Harv.
var. *glabra* Harv. (921)
C. stenopetala Diels (1059)

8694 *Lobelia* L.
Lobelia angolensis Engl. & Diels (853)
L. flaccida (Presl) A. DC.
subsp. *flaccida* (591)
L. flaccida (Presl) A. DC.
subsp. *mossiana* (R. Good) Thulin

8695 *Monopsis* Salisb.
Monopsis decipiens (Sond.) Thulin (174)

ASTERACEAE
8751 *Vernonia* Schreb.
Vernonia galpinii Klatt (372)
V. hirsuta (DC.) Sch. Bip. (606)
V. natalensis Sch. Bip. ex Walp. (323)
V. oligocephala (DC.) Sch. Bip. ex Walp.
V. steahelinoides Harv. (1238)
V. sutherlandii Harv. (1006)
V. thodei Phill. (847)

8816a *Stomatanthes* R.M. King & H. Robinson
Stomatanthes africanus (Oliv. & Hiern) R. M. King & H. Robinson

8900 *Aster* L.
Aster bakeranus Burtt Davy ex C.A. Sm. (399)
A. comptonii Lippert (718)
A. harveyanus Kuntze (371)

8919 *Felicia* Cass.
Felicia filifolia (Vent.) Burtt Davy
subsp. *filifolia*
F. fruticosa (L.) Nicholson
subsp. *brevipedunculata* (Hutch.) Grau (215)
F. muricata (Thunb.) Nees
subsp. *muricata* (294)
F. rosulata Yeo

8925 *Nidorella* Cass.
Nidorella auriculata DC. (986)
N. hottentotica DC. (863)

8926 *Conyza* Less.
Conyza aegyptiaca (L.) Ait. (1035)
C. attenuata DC.
C. bonariensis (L.) Cronq. *
C. pinnata (L. f.) Kuntze (643)

8949 *Denekia* Thunb.
Denekia capensis Thunb. (358)

8992 *Gnaphalium* L.
Gnaphalium coarctatum Willd. (970)

8994 *Tenrhynea* Hilliard & Burtt
Tenrhynea phylicifolia (DC.) Hilliard & Burtt (836)

8992e *Psaudognaphalium* Kirp.
Pseudognaphalium oligandrum (DC.) Hilliard & Burtt (1051)

9006 *Helichrysum* Mill.
Helichrysum acutatum DC. (834)
H. adenocarpum DC.
subsp. *adenocarpum* (271)
H. albilinatum Hilliard (148)
H. appendiculatum (L. f.) Less. (229)
H. argyrolepis MacOwan (866)
H. athrixiifolium (Kuntze) Moeser (526)
H. aureonitens Sch. Bip. (460)
H. aureum (Houtt.) Merr.
var. *monocephalum* (DC.) Hilliard (638)
H. caespititium (DC.) Harv. (363)
H. callicomum Harv. (163)
H. candolleanum Buek (752)
H. cephaloideum DC. (105)
H. chionosphaerum DC. (513)
H. cooperi Harv.
H. difficile Hilliard (160)
H. epapposum H. Bol. (99)
H. galpinii N.E. Br. (72)
H. glomeratum Klatt
H. herbaceum (Andr.) Sweet (994)
H. lepidissimum S. Moore (241)
H. malanacme DC.
H. miconiifolium DC. (492)
H. mimetes S. Moore
H. monticola Hilliard (827)
H. mundtii Harv. (201)
H. mutabile Hilliard (1014)
H. nudifolium (L.) Nees (529)
H. opacum Klatt (726)
H. oreophilum Klatt (428)
H. pallidum DC. (586)
H. pilosellum (L. f.) Less. (405)

H. platypterum DC. (1056)
H. polycladum Klatt (91)
H. reflexum N.E. Br. (128)
H. rugulosum Less.
H. setosum Harv.
H. spiralepis Hilliard & Burtt (1045)
H. splendidum (Thunb.) Less. (142)
H. subglomeratum Less. (273)
H. subluteum Burtt Davy (611)
H. truncatum Burtt Davy (32)
H. sp. (603)

9037 *Stoebe* L.
Stoebe vulgaris Levyns (812)

9053 *Macowania* Oliv.
Macowania tenuifolia M.D. Henderson

9055 *Athrixia* Ker-Gawl
Athrixia phylicoides DC. (1003)

9090 *Geigeria* Griesselich
Geigeria burkei Harv.
subsp *burkei*
var *elata* Merxm. (995)
G. burkei Harv.
subsp. *valida* Merxm. (1094)

9094 *Callilepis* DC.
Callilepis leptophylla Harv. (425)

9130 *Acanthospermum* Schrank
Acanthospermum hispidum DC. *

9148 *Xanthium* L.
Xanthium spinosum L. * (295)

9155 *Zinnia* L.
Zinnia peruviana (L.) L. *

9237 *Bidens* L.
Bidens formosa (Bonato) Sch. Bip. *
B. pilosa L. *

9311 *Tagetes* L.
Tagetes minuta L. *

9320 *Eriocephalus* L.
Eriocephalus sp.

9326a *Inulanthera* Kallersjo
Inulanthera calva (Hutch.) Kallersjo

9330 *Anthemis* L.
Anthemis cotula L. *

9336 *Phymaspermum* Less. emend. Kallersjo

Phymaspermum acerosum (DC.) Kallersjo (305)

9341d *Cymbopappus* B. Nord.
Cymbopappus piliferus (Thell.) B. Nord. (496)

9351 *Cotula* L.
Cotula hispida (DC.) Harv. (1015)

9356 *Schisostephium* Less.
Schisostephium crataegifolium (DC.) Fenzl ex Harv. (247)

9401 *Lopholaena* DC.
Lopholaena coriifolia (Sond.) Phill. & C.A. Sm. (240)
L. distacha (N.E. Br.) S. Moore (310)

9406 *Cineraria* L.
Cineraria parvifolia Burtt Davy (270)

9411 *Senecio* L.
Senecio albanensis DC.
var. *albanensis*
S. barbatus DC. (584)
S. caudatus DC.
S. conrathii N.E. Br.
S. coronatus (Thunb.) Harv. (376)
S. erubescens Ait.
var. *crepidifolius* DC. (779)
S. gerrardii Harv.
S. hieracioides DC. (226)
S. laevigatus Thunb.
var. *integrifolius* Harv.
S. latifolius DC. (987)
S. lygodes Hiern
S. macrocephalus DC. (368b)
S. microglossus DC. (431)
S. oxyriifolius DC. (449)
S. pentactinus Klatt (255)
S. polyodon DC.
var. *polyodon* (632)
S. polyodon DC.
var. *subglaber* (Kuntze) Hilliard & Burtt (361)
S. scitus Hutch. & Burtt Davy (258)
S. serratuliodes DC.
var. *seratuliodes*
S. speciosus Willd.
S. striatifolius DC. (787)
S. subcoriaceus Schltr.
S. venosus Harv.
S. sp.

9417 *Euryops* Cass.
Euryops laxus (Harv.) Burtt Davy (340)
E. pedunculatus N.E. Br. (558)

9420 *Othonna* L.
Othonna natalensis Sch. Bip. (332)
O. sp.

9425a *Castalis* Cass.
Castalis spectabilis (Schltr.) T. Norl. (406)

9427 *Osteospermum* L.
Osteospermum auriculatum (S. Moore) T. Norl. (300)
O. caulescens Harv. (535)
O. hispidum Harv.
var. *hispidum*
O. jacundum (Phill.) T. Norl. (345)
O. muricatum E. Mey. ex DC.
subsp. *muricatum* (410)
O. striatum Burtt Davy (905)

9431 *Ursinia* Gaertn.
Ursinia nana DC.
subsp. *leptophylla* Prassler (218)

9432b *Haplocarpha* Less.
Haplocarpha scaposa Harv. (251)

9434 *Gazania* Gaertn.
Gazania krebsiana Less.
subsp. *serrulata* (DC.) Roessl. (277)

9435 *Hirpicium* Cass.
Hirpicium armerioides (DC.) Roessl. (366)
H. linearifolium (H. Bol.) Roessl. (533)

9438 *Berkheya* Ehrh.
Berkheya echinacea (Harv.) O. Hoffm. ex Burtt Davy
subsp. *echinacea* (928)
B. insignis (Harv.) Thell. (437)
B. radula (Harv.) De Wild. (213)
B. seminivea Harv. & Sond. (291)
B. setifera DC. (671)
B. speciosa (DC.) O. Hoffm.
subsp. *lanceolata* Roessl. (966)

9501 *Dicoma* Cass.
Dicoma anomala Sond. (117)
D. zeyheri Sond.

9528 *Gerbera* L.
Gerbera ambigua (Cass.) Sch. Bip. (461)
G. galpinii Klatt
G. piloselloides (L.) Cass. (609)
G. viridifolia (DC.) Sch. Bip.
subsp. *natalensis* (Sch.) Bip.) H.V. Hansen
G. viridifolia (DC.) Sch. Bip.
subsp. *viridifolia* (436)

9561 *Tolpis* Adans.
Tolpis capensis (L.) Sch. Bip. (651)

9572 *Hypochoeris* L.
Hypochoeris radicata L. * (455)

9595 *Sonchus* L.
Sonchus intergrifolius Harv.
var. *intergrifolius* (644)
S. nanus Sond. ex Harv.

9596 *Lactuca* L.
Lactuca capensis Thunb. (250)

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MAP 1. Vegetation map of the study area

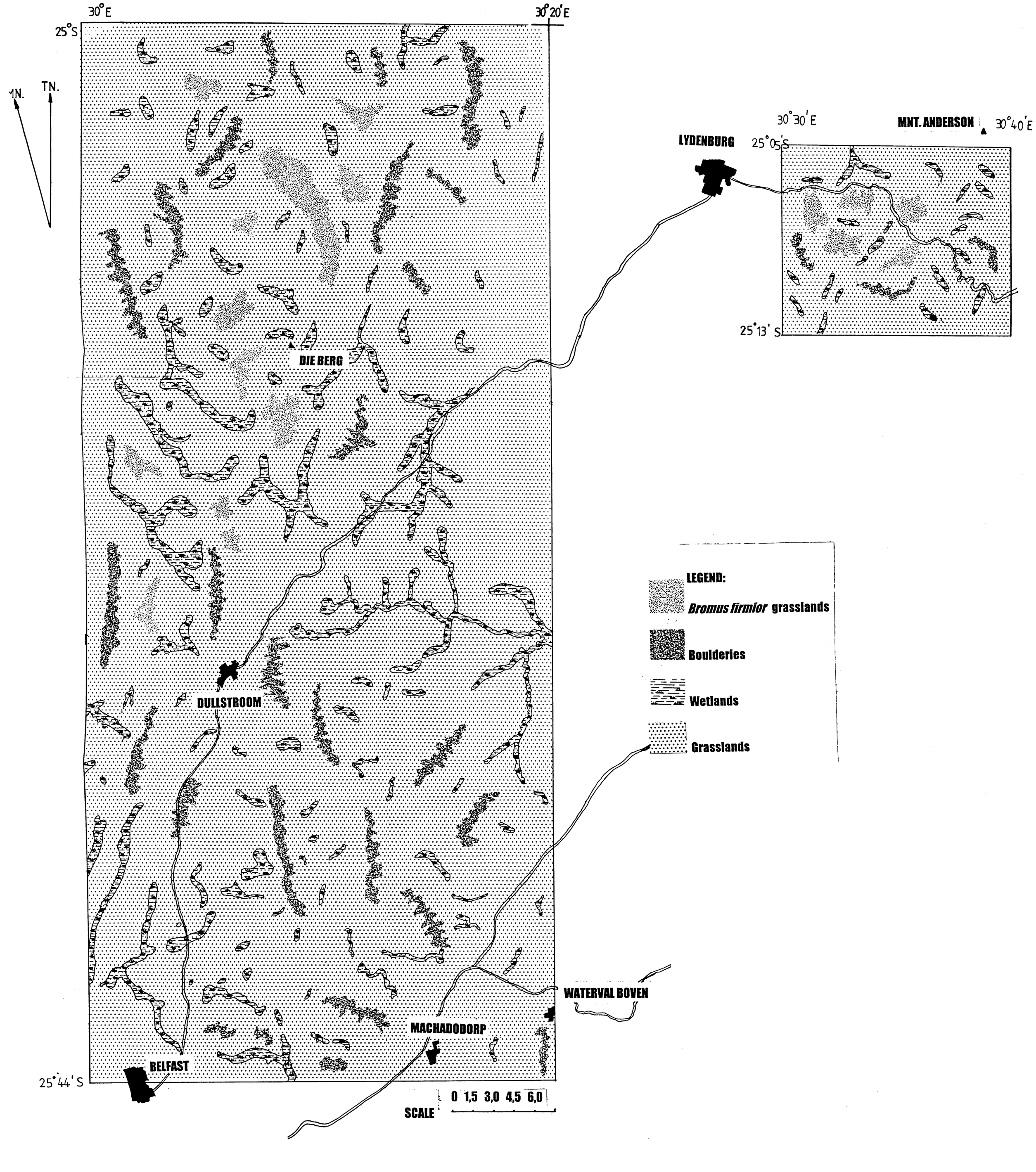

TABLE 1. Phytosociological table showing wetland communities

	1							2							3				4	
	1.1.	1.2		2.1	2.2	2.3	2.4	2.5	3.1		3.2	4.1	4.2	
	33111	23212???		130	03	32	130	3113	01321		23?21	30	?	
	00453	40524480		725	41	00	716	1311	59139		41454	11	1	
	75651	39417?0		206	19	87	301	3792	24591		48950	19	5	
Species Group A														
Ficinia acuminata	++	+												
Dierama pendulum	+++						R							
Wahlenbergia sp.	+++													
Cynium racemosum	++	+												
Cyphia stenopetala	++						+							
Brunsvigia radulosa	+	+					R							
Asclepias dissona	+	+												
Vigna vexillata	+	+					R							
Ornithogalum monophyllum	+				+									
Vernonia hirsuta	+	+												
Vernonia sutherlandii	+	+												
Helichrysum pilosellum	+	+												
Species Group B														
Senecio microglossus			+	1	+									
Polygonum meisnerianum			++											
Kniphofia multiflora			+	+										
Polygonum sp.					A									
Eragrostis cylindriflora			+			+				1				
Species Group C														
Phragmites australis	1B	1B		3A	1+	1								
Zantedeschia albomaculata	++	+		++	R			++						
Typha capensis	R	R		+	1R	R				R				
Thelypteris confluens	+	+		++										
Berkheya speciosa	R	R			+			RR						
Species Group D														
Geranium multisectum				+										+
Alepidea amatymbica			+											
Pelargonium alchemilloides								RR						
Dicliptera roundifolia										+				
Kyllinga pauciflora			+											
Adiantum capillus-veneris														
Diheteropogon amplectens														
Aeschynomene rehmannii														
Asclepias cultriformis														
Cephalaria attenuata														
Species Group E														
Scleria dieterlenii			+			+	11							
Agrostis gigantea							11							
Sphagnum truncatum							++							
Senecio striatifolius				+		+	++							
Rorippa nasturtium-aquaticum							++							
Aristea sp.							++							
Disperis cooperi							++		+					
Koeleria capensis							++							
Commelina africana							++							
Hypoxis rigidula							+	++						
Alepidea setifera							++							
Aloe ecklonis							++							
Tulbachia nutans	+						++	++						
Helichrysum subglomeratum							+	++		1				
Peucedanum sp.	+						+	++						
Species Group F														
Panicum schinzii				+				11						
Aponogeton junceus					+		+	++						
Crassula peltucida							+	R						
Ixilium multiflorum	+							++						
Habenaria sp.								++						
Species Group G														
Epilobium salignum	+	+	+	+++	1		+	++	++					
Sium repandum	+	+			+	+	+	++	++					
Kniphofia linearifolia	R		++				++		RR	+				
Holcus lanatus	1	1		1		1	1	11						
Eucomus comosa	+				+	1		RR						
Species Group H														
Merine angustifolia				+				+R						
Carex cognata								A						
Disa cooperi								+						
Eulophia ovalis								+						
Bulbine abyssinica								+						
Eulophia leontoglossa								+						
Species Group I														
Carex austro-africana	+	+	A	AAB	1		+	++	AA	1	A			
Rumex lanceolatus	+++++		+	1++		+++				+				
Gunnera perpensa	11	11	+	1 A+	BB		A		11	1				
Festuca caprina	+		+			+	1	++	++	++		A		
Satyrium hallackii		+	+	R+	R	+			RR	R				
Senecio serratuifodes	1	1				+	+	11	++	+1				
Kniphofia fluviatilis	+	+		+		+			++	++				
Leersia hexandra	+	+	1	+		1	++							
Species Group J														
Ischaemum fasciculatum									BB	11				
Dolichos falciformis									++	++				
Conyza pinnata	+	+				+			++	++	+			
Digitaria eylesii									11					
Pennisetum macrourum					+			+	++					
Digitaria flaccida									++					
Pycreus sp.									++					
Alysicarpus rugosus										++				
Satyrium parviflorum			+						++			+		
Helichysum opacum									++					
Habenria lithophila									RR				+	
Eragrostis curvula									RR					
Berkheya echinacea														
Species Group K														
Micanthus junceus	B+	BB+		4		4	B		AA	44		11	+	
Ranunculus meyeri	+	+	+		+		1	++	++		+	11		
Ranunculus multifidus	+	+	+					+	+			+	++	+
Juncus exsertus							+	++	++			++		
Species Group L														
Helichrysum sureonitens											11		+	
Hypoxis filiformis	1												++	1
Agrostis eriantha					+	1		++	+				1	A
Asclepias multicaulis									+				R	+
Sebaea leiostyla													++	+
Juncus dregeanus						++							++	+
Oxalis obliquifolia													+	+
Anthericum cooperi													R	R
Ficinia sp.													1	
Species Group M														
Buchnera glabrata											++	++	+	+
Habenaria clavata											RR		RR	R
Disa scaniodes			+				++				RR		+R	R
Andropogon eucomis					+				+		BB		+	+
Chironia purpurescens	+	+	+		+						++		R	
Species Group N														
Disa patula													+++	+
Helictotrichon turgidulum													++	+
Ornithogalum tenuifolium									++		+		+++	
Eragrostis capensis									++				+	
Bulbostylis sp.													++	
Plectranthus sp.													++	
Alepidea gracilis													++	
													11	
Species Group O														
Drosera madagascariensis				+		++		+			++	+	111	+
Eragrostis biflora				++							1B	B	++	B
Ascolepis capensis					+						1	1	1111	+
Dierama sp.										AA	+++	+		
Polygala uncinata											+	+	++	+
Utricularia prehensilis			+		R						+	+	R	+
Justicia petiolaris											+	B	A	
Species Group P														
Schoenoplectus corymbosus			1	1	+	+	++	11	+	++	A	A	+	+
Mariscus keniensis			A	+	A	1	++		A	+	++	+	BB	A
Juncus oxycarpus			+	+		+			+	++	+	1+	+	++
Bulbostylis burchellii			1		1	+			11	++	++	+	+	1
Ledebouria cooperi														
Gladiolus longicollis			R				++	RR	+		+	R+	+	
Denekia capensis					+		+	++			++	+	++	
Satyrium longicauda			+	R			++		+			+		
Oldenlandia herbacea			+									R	R	
Species Group Q														
Hypericum aethiopicum														33
Crassula sarcocaulis							++							11
Gladiolis ecklonis			+											++
Ledebouria sp.														++
Species Group R														
Pycreus macranthus														+
Imperata cylindrica														+
Senecio latifolius														+
Species Group s														
Stiburus alopecuroides	+	+				A	BB			A	44	B	1B	B
Monopsis decipiens	+						++				++	+	+++	+
Wahlenbergia virgata						+	++				++		+	+
Xyris capensis											AA		1R	1
Paspalum urvillei					++			++			11			
Hypericum lalandii	+						++					+		+
Helictotrichon hirtelum						+	++						+	
Cephalaria zeyheriana							++		+		+			
Species Group T														
Arundinella nepalensis	11	A	11	1++		1	A	11	11	11+	1	11	1	1
Fuirena pubescens	3	A	3A	+	B	3	113	AA	BB		3	BB	B+	3
Mariscus congestus	+		+		1			++	11	1		++	+	
Pycnostachys reticulata	+	1	+		+	+		1		++	1		+	+
Sebaea sedoides		++	+								+	++		+
Alloteropsis sp.	+		++			+		+	++		+			
Eleocharis palustris	+	++	+			+		++			+		1+	1
Pycreus nitidus	+	+				+		++	11	+	++			
Nemcha aquatica	1	1			+			++	+			+		+
Eriocaulon dregei	+	+					++			AA		++		
Lobelia flaccida					+	+			++	++				1
Aristida sequiglumis	+	+			++				+		+3			+
Helichrysum difficile	+	+			+++				+		+			
Helichrysum mundtii	+	+			+	++			+		+			
Pennisetum thunbergii			11		+	++			+		+	+		
Agrostis lachnantha		A	A		+			++				+	+	
Mariscus sumatrensis			1		1				+			1	4	
Kyllinga erecta	+	+						++				+		
Hemarthria altissima	+	+		B								+++		
Setaria pallide-fusca	+	+					++			++				
Ranunculis baurii				+		++			+		+			

TABLE 2. Phytosociological table showing bouldery communities

	1			2			3		4
	1.1	1.2	2.1	2.2			3.1	3.2	
	26120	222201	0000000	11101000110			2211	2012	222222
	24284	979986	5336415	30684976205			1180	0090	558955
	08929	760596	7603311	22441862558			3090	9155	717223
Species Group A									
Diospyros whyteana	AAAA1		+	1				+	
Cyathea dregei	B++1								
Osmunda regalis	++++								
Erica drakensbergensis	11 +			R			+		
Hypoxis sparsiflora	+++								
Pteris catoptera	+++								
Phylica sp.	1+								
Impatiens sp.	++								
Lycopodium carolinianum	+ +								
Asplenium adiantum-nigrum	+ +								
Agrostis lachnantha	+ ++								
Lycopodium clavatum	+ +	+							
Blechnum australe	+ +						+		
Scabiosa columbaria	+ +			+					
Pittosporum viridiflorum	+ +		+						
Species Group B									
Penteschistis natalensis		A A A						B	
Rhynchospora brownii		R++							
Cheilanthes hirta		+ ++	+		+			+	
Eragrostis biflora		B B							
Eriospermum porphyrovalve		+ 1	+						
Kniphofia splendida		+ +							
Craterostigma wilmsii		+ +					+ +		
Halafrida densiflora		+		+					+
Species Group C									
Kosteletzkya capensis	+ 1	1 1++						+	
Erica cerinthoides	+1 +	+					+	+	
Bromus pirmior	+	1 +						+	
Ledebouria cooperii	+	+ 1							
Aristea woodii	+	+							
Cheilanthes multifida	+	+	+ +						
Pelargonium dispar	+	+						+	
Species Group D									
Scleria dieterlenii			+ ++						
Senecio arubescens	+		11 1						
Lotononis hirsuta			+ ++				+		
Calilepis leptophylla			++ +					+	
Cassalis spectabilis			+++						
Ziziphus mucronata			+1						
Ipomoea papilio			+ +	+					
Senecio latifolius			++						
Celtis africana	+		++	+					
Tephrosia longipes			+ +						
Merine rehmannii			R +						
Kalachoe thyrsiflora			+						
Lantana camara			+						
Cleome maculata			+						+
Species Group E									
Helichrysum miconiifolium				++++	+				
Themeda triandra			+	A5 +1					
Rhus discolor				1 +1					
Anchospermum rigidum			++	+++			+		
Leonotis ocymifolia			+	++	+			+	
Faurea saligna				1 +					
Helichrysum callicomum				++			+		
Pentanisia angustifolia				+ +					
Crabbea sp.				+	+				
Euphorbia guienzii				++					
Gnidia kraussiana				+ +				+	
Tolpis capensis				+	+				
Cynanotis pachyrrhiza				++					+
Polygala hottentotta					R +				
Cyrtanthus stenanthus		+		+					
Tephrosia glomeruliflora			+ +	+					
Species Group F									
Brachiaria bovonei			+11	+ + 1 1 1					
Clerodendrum triphyllum			+ +++	+ + 1 +					
Senecio scitus			++ ++	+ + +					
Trisetachya rehmannii			+ 1A	A 3 A			B		1
Protea caffra			B 1 1	11A					
Acacia caffra			A+	1 B +					
Sporobolus stapfianus			A+	1 A 1					
Raphionacme hirsuta			+ +	+ ++			+		
Acalypha caperonioides			+	+ + +			+		
Lippia javanica			++	+ +					+
Aloe transvaalensis			+	+ + +					
Enneapogon scoparius				1A + +					
Xysmalobium parviflorum				+ +					
Berkheya echinacea				++ + +			+		
Pearsonia sp.			+	1					
Maytenus heterophylla			+	+ +					
Xerophyta retinervis			++	+				+	
Raphionacme zeyheri			+	+					
Hypoxis rigidula			+	++					
Ctenium concinnum			+	1			+	+	
Ledebouria marginata				+					
Species Group G									
Wahlenbergia lycopodioides		+	+				++1+	+	+
Selaginella kraussiana		+	++				1+A	A	
Wahlenbergia virgata				+			+++	+	
Helichrysum galpinii							+ 3A		
Coleochloa setifera		+ A					33		
Brachiaria brizantha		+					R +		
Aeollanthus buchnerianus		+					++		
Crassula setuzoa				+			+ +	1	
Rumex acetosella							+ ++		
Khadia sp.							+		
Species Group H									
Dicoma anomala			+	+			+ ++		
Hypoxis costata	+ +			+			++		
Stachys natalensis							++		
Rabdosiella calycina	+						B +		
Hypoxis gerrardii							+		
Isolepis setacea				+			+		
Lightfootia denticulata							+ +		
Species Group I									
Digitaria monodactyla				+			+ ++	1++	+
Aristida junciformis	+			A +			A+1	A11	+
Selago lydenburgensis	+			++			++	+++	+
Oldenlandia herbacea			+				++	+++	+
Laperousia sandersonii							R+1	++	
Eriospermum abyssinicum		+ +					+ ++	+ R	
Helichrysum lepidissimum			+	++			++	+ B	1
Psammotropha myriantha							+ 3A	+	
Silene burchellii			+				+	++	+
Indigofera hedyantha							++	+ +	+
Rhynchosia nervosa		+					++	++	
Eragrostis scleranthа							++	++	
Helichrysum rugulosum				+			+	++	
Protasparagus laricinus							++	+	+
Gladiolus gillotii							+	+ +	
Senecio oxyrriifolia				+			+	+	+
Gladiolus calcaratus							+ 3A	R	
Trachyandra asperata							++		
Sporobolus discosporus							+ R		
Eragrostis pseudoscleranthа							+ 1		
Vernonia oligocephala				+			+	+	
Crassula lanceolata							+	+	+
Species Group J									
Heteropogon contortus		+			1+	1+++	+	+	A
Eragrostis nindensis			+ ++		1	1 +	+	+	
Monocymbium ceresiiforme		+	1 A		++		1	1 1	
Richardia brasiliensis			+ +				+	++	
Gazania krebsiana		+	+	+			+	+	
Eriosema simulans				+ +				++	
Pelargomium luridum				+	+			+ +	
Monopsis decipiens				+				+ 1	+
Hemizygia albiflora	+				+		+	A	
Rhynchosia monophylla			+				+		+
Rhynchosia totta				++				+	
Thesium lobelioides			+	+			+		
Indigofera sanguinea	+			+			+		
Helichrysum oreophilum			+				+	+	
Justicia anagalloides				+			+		
Species Group K									
Vernonia natalensis			+					++	+
Helichysum albilinatum				+				++	+
Geigeria burkei								+	1
Rhus montana				1				+	+
Schistostephium crataegifolium								++	
Acalypha peduncularis								+	+
Vernonia suther landii								++	
Berkheya insignis				+ +				+	+
Helichysum pilosellum			+					+	+
Crassula vaginata		+						+	+
Peucedanum magalismontanum	+		+	+			+		++
Agrostis gigantea								+	+
Hypericum aethiopicum		+		R				+	
Pimpinella transvaalensis								+	+
Vernonia hirsuta			+	+				+	+
Eragrostis capensis	+								++
Alepidea longifolia		+						+	
Crocosmia paniculata	+							+	
Crabbea acaulis									+
Species Group L									
Cyanotis speciosa			+	+ +			+ ++	+ +	+
Hebenstretia angolensis				+		+	++ ++		+ +
Helichrysum polyciadum					+		++ +		+ +
Othonna natalensis		+						+	+
Gnidia splendens				+ ++			1		1 +
Cymbopogon validus			1					1	+ +
Aristida sp.							+	+	+
Sutera caerulea								++	+
Ledebouria sp.							+	R	+
Pearsonia sessilifolia				+				+	+
Oxalis depressa				+				+ +	
Zornia capensis								+	+
Lopholaena disscacha							+		1
Wahlenbergia squamifolia		+						+	+
Species Group M									
Pellaea calomelanos			+	+++++		+++ +	++	+++	+ +
Commelina africana				+++	+	+ +	++		++
Loudetia simplex			11	1 ++AB		+	13A		A +
Panicum natalense			1+	11	1	++1	111		+ +
Elionurus muticus			+ +	11	+	+	+		+
Bulbostylis oritrephes			+	++ + +			+	1	+
Hypoxis iridifolia			1+ +	+		++			+
Lannea edulis			1 +	+ +	+ +				+
Senecio venosus			++			++	+	++	
Lopholaena coriifolia			1	++	+				+B
Eragrostis racemosa			1 +			+	1		++
Diheterpogon amplectens			+	+	+		+	+1	
Tetraselago wilmsii			+	+1	+		+	+	
Rhoisissus tridentata	+		++	+ +	+ +			+	+
Haplocarpha scaposa		+		+			+	+	+
Eulalia villosa			A 1	1				+	
Protea roupelliae			B					A	
Bewsia biflora			++	+	+				+
Helichrysum chionosphaerum			+				+		A
Trachypogon spicatus			+				+		+
Eragrostis curvula				+				R	
Gladiolus crassifolius				+					+
Pentanisia prunelloides			+					+	
Brachiaria serrata				+					+
Hermannia crissata				+					+
Species Group N									
Sporobolus pectinatus		+ 1		1+ A		AA +	+	1 +3	A+A+
Oxalis obliquifolia		+	+	+	+	+ +	+ +	+	++ ++
Gussonia paniculata	++A		+	+	1	1 +A			A
Cheilanthes quadripinnata	+ + +	+					+	+ +	
Microchloa caffra		3		+			R	+	1 A
Haleria lucida	1 2	+	+	3					1
Eucles crispa			1	A	1			1	1

TABLE 3. Phytosociological table showing grassland communities

Species	1.1.1	1.1.2	1.1.3	1.2	1.3	1.4.1	1.4.2	1.5.1	1.5.2	1.5.3	1.5.4	1.5.5	2.1	2.2	2.3	2.4	2.5	3.1	3.2	3.3	3.4	4
SPECIES GROUP A																						
Rhus montana	[illegible]																					
Protasparagus laricinus	[illegible]																					
Agapanthus inapterus	[illegible]																					
Senecio oxyriifolius	[illegible]																					
Helichrysum albilinatum	[illegible]																					
Gladiolus elliotii	[illegible]																					
Crassula alba	[illegible]																					
Gladiolus dalenii	[illegible]																					
Zaluzianskya elongata	[illegible]																					
Rubus rigidus	[illegible]																					
Berkheya seminivea	[illegible]																					
Diospyros lycioides	[illegible]																					
Cheilanthes viridis	[illegible]																					
Cheilanthes eckloniana	[illegible]																					
Dryopteris inaequalis	[illegible]																					
Haemanthus humilis	[illegible]																					
Scilla natalensis	[illegible]																					
Anthericun transvaalense	[illegible]																					
Rhoisissus tridentata	[illegible]																					
Selago atherstonei	[illegible]																					
SPECIES GROUP B																						
Diheteropogon amplectens	[illegible]																					
Crassula laceolata	[illegible]																					
Trachyandra saltii	[illegible]																					
SPECIES GROUP C																						
Alepidea setifera	[illegible]																					
Selago lydenburgensis	[illegible]																					
Cheilanthes quadripinnata	[illegible]																					
Sporobolus africanus	[illegible]																					
Acalypha peduncularis	[illegible]																					
Knowltonia transvaalensis	[illegible]																					
Rhus ernestii	[illegible]																					
Helichysum lepidissimum	[illegible]																					
Stachys natalensis	[illegible]																					
Pimpinella transvaalensis	[illegible]																					
Protea roupelliae	[illegible]																					
Berkhyea radula	[illegible]																					
Aloe ecklonis	[illegible]																					
Erica drakensbergensis	[illegible]																					
SPECIES GROUP D																						
Othonna natalensis	[illegible]																					
Leonotis ocymifolia	[illegible]																					
SPECIES GROUP E																						
Rabdosiella calycina	[illegible]																					
Silene burchellii	[illegible]																					
Felicia filifolia	[illegible]																					
Melinis repens	[illegible]																					
Ajuga ophrydis	[illegible]																					
Pellaea calomelanos	[illegible]																					
Cephalaria zeyheriana	[illegible]																					
Tephrosia elongata	[illegible]																					
Pearsonia grandifolia	[illegible]																					
SPECIES GROUP F																						
Ipomoea atherstonei	[illegible]																					
Protea welwitschii	[illegible]																					
Koeleria capensis	[illegible]																					
Bulbostylis humilis	[illegible]																					
SPECIES GROUP G																						
Pteridium aquilinum	[illegible]																					
SPECIES GROUP H																						
Digitaria tricholaenoides	[illegible]																					
Babiana hypogea	[illegible]																					
Indigofera hilaris	[illegible]																					
Lightfootia paniculata	[illegible]																					
Pentanisia prunelloides	[illegible]																					
Halafrida densiflora	[illegible]																					
Helichysum adenocarpum	[illegible]																					
SPECIES GROUP I																						
Harpochloa falx	[illegible]																					
Helichrysum callicomum	[illegible]																					
Digitaria monodactyla	[illegible]																					
Eragrostis sclerantha	[illegible]																					
Senecio polyodon	[illegible]																					
SPECIES GROUP J																						
Panicum ecklonii	[illegible]																					
Eriospermum porphyrovalve	[illegible]																					
Becium grandiflorum	[illegible]																					
SPECIES GROUP K																						
Eulophia clavicornis	[illegible]																					
Protea gaguedii	[illegible]																					
Acalypha petiolaris	[illegible]																					
SPECIES GROUP L																						
Clerodendrum triphyllum	[illegible]																					
Triumfetta obtusicornis	[illegible]																					
Lotononis hirsuta	[illegible]																					
Aeschynomene rehmannii	[illegible]																					
Tristachya rehmannii	[illegible]																					
Pearsonia sp. nov.	[illegible]																					
Senecio pentactinus	[illegible]																					
Tetraselago wilmsii	[illegible]																					
Lopholaena coriifolia	[illegible]																					
Schizachyrium sanguineum	[illegible]																					
Elephantorrhiza elephantina	[illegible]																					
SPECIES GROUP M																						
Sporobolus pectinatus	[illegible]																					
Indigofera sanguinea	[illegible]																					
Eucomis montana	[illegible]																					
Panicum natalense	[illegible]																					
Cteniun concinnium	[illegible]																					
Cyanotis speciosa	[illegible]																					
Gnidia gymnostachya	[illegible]																					
Senecio scitus	[illegible]																					
Clutia natalensis	[illegible]																					
Helichrysum ceaspititium	[illegible]																					
Pygmaeothamnus zeyheri	[illegible]																					
Sutera caerulea	[illegible]																					
Hypoxis acuminata	[illegible]																					
SPECIES GROUP N																						
Craterostigma wilmsii	[illegible]																					
Gazania krebsiana	[illegible]																					
Euryops laxus	[illegible]																					
Setaria sphacelata var. *torta*	[illegible]																					
Ledebouria revoluta	[illegible]																					
SPECIES GROUP O																						
Brachiaria serrata	[illegible]																					
Hermannia cristata	[illegible]																					
Andropogon schirensis	[illegible]																					
Eulalia villosa	[illegible]																					
Aster harveyanus	[illegible]																					
Felicia muricata	[illegible]																					
Clutia monticola	[illegible]																					
Aristea woodii	[illegible]																					
Chamaecrista comosa	[illegible]																					
Hypericum aethiopicum	[illegible]																					
Bewsia biflora	[illegible]																					
SPECIES GROUP P																						
Loudetia simplex	[illegible]																					
Dicoma anomala	[illegible]																					
Helichrysum oreophilum	[illegible]																					
Eriosema simulans	[illegible]																					
Ipomoea crassipes	[illegible]																					
Osteospermum striatum	[illegible]																					
Euphorbia gueinzii	[illegible]																					
Indigofera hedyantha	[illegible]																					
SPECIES GROUP Q																						
Aristida aequiglumis	[illegible]																					
SPECIES GROUP R																						
Eragrostis aspera	[illegible]																					
Agrostis eriantha	[illegible]																					
Sebaea sedoides	[illegible]																					
SPECIES GROUP S																						
Phymaspermum acerosum	[illegible]																					
SPECIES GROUP T																						
Hyparrhenia anamesa	[illegible]																					
Hyparhenia variabilis	[illegible]																					
Helichrysum nudifolium	[illegible]																					
Conyza pinnata	[illegible]																					
Kniphofia rigidifolia	[illegible]																					
Moraea huttonii	[illegible]																					
SPECIES GROUP U																						
Helichrysum rugulosum	[illegible]																					
Eragrostis chloromelas	[illegible]																					
Hermannia transvaalensis	[illegible]																					
Lobelia flaccida	[illegible]																					
Oxalis depressa	[illegible]																					
Dierama pendulata	[illegible]																					
Vernonia oligocephala	[illegible]																					
Aristida congesta	[illegible]																					
Setaria sphacelata var. *flabellata*	[illegible]																					
SPECIES GROUP V																						
Crocosmia paniculata	[illegible]																					
SPECIES GROUP W																						
Cymbopogon validus	[illegible]																					
Hyparhenia hirta	[illegible]																					
Sebaea grandis	[illegible]																					
SPECIES GROUP X																						
Melinis nerviglumis	[illegible]																					
Acacia karoo	[illegible]																					
Oxalis corniculata	[illegible]																					
Setaria nigrirostis	[illegible]																					
Protea caffra	[illegible]																					
Acacia galpinii	[illegible]																					
Mundulea sericea	[illegible]																					
Panicum maximum	[illegible]																					
Eriosema ellipticifolium	[illegible]																					
Convolvulus sagittatus	[illegible]																					
Hypoxis galpinii	[illegible]																					
Cycnium adonense	[illegible]																					
Polygala uncinata	[illegible]																					
Scadoxus sp.	[illegible]																					
SPEC ES GROUP Y																						
Gladiolus ecklonii	[illegible]																					
Polygala hottentotta	[illegible]																					
Halleria lucida	[illegible]																					
Eulophia foliosa	[illegible]																					
Cheilanthes hirta	[illegible]																					
Leucosidea sericea	[illegible]																					
SPECIES GROUP Z1																						
Bromus firmior	[illegible]																					
SPECIES GROUP Z2																						
Tristachya leucothrix	[illegible]																					
Bulbostylis oritrephes	[illegible]																					
Anthospermum pumilum	[illegible]																					
Helichrysum pilosellum	[illegible]																					
Rhynchosia totta	[illegible]																					
Haplocarpha scaposa	[illegible]																					
Monocymbium ceresiiforme	[illegible]																					
Eragrostis curvula	[illegible]																					
Aristida junciformis	[illegible]																					
Gladiolus crassifolius	[illegible]																					
Scabiosa columbaria	[illegible]																					
Commelina africana	[illegible]																					
Crabbea acaulis	[illegible]																					
Ledebouria marginata	[illegible]																					
Acalypha angustata	[illegible]																					
Polygala amatymbica	[illegible]																					
Schizostephium crataegifolium	[illegible]																					
Crassula vaginata	[illegible]																					
Wahlenbergia virgata	[illegible]																					
Senecio coronatus	[illegible]																					
Wahlenbergia squamifolia	[illegible]																					
Schoenoxiphium sparteum	[illegible]																					
Acalypha schinzii	[illegible]																					
Hypochoeris radicata	[illegible]																					
Hibiscus aethiopicus	[illegible]																					
Kohautia amatymbica	[illegible]																					
Crabea hirsuta	[illegible]																					
Elionurus muticus	[illegible]																					
Cucumis hirsutus	[illegible]																					
Zornia capensis	[illegible]																					
Tephrosia capensis	[illegible]																					
Senecio erubescens	[illegible]																					
Rhynchosia monophylla	[illegible]																					
Hypoxis costata	[illegible]																					
Gnidia caffra	[illegible]																					
Gerbera ambigua	[illegible]																					
Sebaea erosa	[illegible]																					
Raphionacme galpinii	[illegible]																					
SPECIES GROUP Z3																						
Eragrostia racemosa	[illegible]																					
Themeda triandra	[illegible]																					
Heteropogon contortus	[illegible]																					
Alloteropsis semialata	[illegible]																					
Microchloa caffra	[illegible]																					
Hypoxis rigidula	[illegible]																					
Vernonia natalensis	[illegible]																					
Helichrusum miconiifolium	[illegible]																					
Oxalis obliquifolia	[illegible]																					
Acalypha caperonioides	[illegible]																					
Rhus discolor	[illegible]																					
Berkheya setifera	[illegible]																					
Tolpis capensis	[illegible]																					
Diheteropogon amplectens	[illegible]																					
Pentanisia prunelloides	[illegible]																					
Eragrostis capensis	[illegible]																					
Pelargonium luridum	[illegible]																					
Justicia angalloides	[illegible]																					
Trachypogon spicatus	[illegible]																					
Monopsis decipiens	[illegible]																					
Helichrysum cephaloideum	[illegible]																					
Pachycarpus transvaalensis	[illegible]																					
Berkheya echinacea	[illegible]																					
Rhynchosia angulosa	[illegible]																					
Raphionacme procumbens	[illegible]																					
Castalis spectabilis	[illegible]																					
Helichrysum appendiculatum	[illegible]																					
Disa patula	[illegible]																					
Fuirena pubescens	[illegible]																					
Habenaria chlorotica	[illegible]																					
Hebenstretia angolensis	[illegible]																					