CHAPTER 4
CLASSIFICATION OF THE PLANT COMMUNITIES OF THE WATERBERG BIOSPHERE RESERVE

4.1. Introduction

The identification and classification of plant communities within large vegetation types in the South African savanna biome, as classified by Low & Rebelo (1996), have not been done in much detail. Although several studies have been done in the Waterberg area (Westfall, 1981; Newberry, 1998; Van Staden, in prep.), the need to have a more detailed though holistic view of the vegetation has become extremely important after the proclamation of the Waterberg Biosphere Reserve in 2001(Waterberg Newsletter, 2001).

Bredenkamp & Brown (2001) emphasized that the study of plant communities as fundamental units of ecosystems is basic to environmental planning and the compilation of environmental management plans. The identification of the plant communities in the Waterberg Biosphere Reserve might therefore be useful later in environmental management plans, and with the increase in tourism activities in the area, also in the promotion of tourism within the Biosphere Reserve.

The aim of this classification was to identify the major plant communities within the Biosphere Reserve that might provide specific habitats for tourist attractions such as mammals, birds and trees. These plant communities will represent ecohabitats, which combined, form large ecosystems, namely tourism ecozones (see Chapter 5). The level of classification was therefore aimed at identifying large areas within the Biosphere Reserve, which are relatively homogenous in terms of vegetation composition, and still represent plant communities.

4.2. Methods

4.2.1. Introduction

Bredenkamp & Bezuidenhout (1995) and Van der Maarel *et al.* (1987) described methodology used to classify large vegetation data sets. Winterbach (1998) and Du Plessis (2001) have successfully shown the how valuable these methods can be in the classification of large data sets in southern Africa. The following section provides a description of the methodology used in the classification procedures.

4.2.2. Data collection

Braun Blanquet data and descriptions of plant communities within phytosociological studies conducted by authors within the Biosphere Reserve, and in similar adjacent areas, were used for the creation of a database. Data consisted of unpublished and published data from B.Sc. Honors projects, M.Sc., Ph.D. studies and industry reports (Table 4.1). The locations where the studies were performed were visited and visual assessments were done to ensure the data sets were of an efficient standard to be included in the classification. Other studies included were data from floristic assessments for Ecological Management Plans performed by companies in the ecological field. However, although several studies have been conducted in the Waterberg Biosphere Reserve, in certain areas no data existed, and therefore field studies needed be done.

4.2.3 Field Surveys

Field surveys were performed within the Waterberg Biosphere Reserve in areas where data was found inadequate or not existing. These surveys in so-called "gaps" were done using standard Braun - Blanquet vegetation survey methods (Westhoff & Van der Maarel, 1982), using cover-abundance values given by Werger (1974). The areas in which the field surveys were performed are included in Table 4.1. It includes 58 relevés from the Wonderkop Nature Reserve, Masebe Nature Reserve, the Kwaggasvlakte plains at Marakele National Park and the vlei area in the Nylsvley Nature Reserve.

4.2.4. Database

After the data collected were found to be representative of the Waterberg Biosphere Reserve, a database was created on a vegetation database computer program, TURBOVEG (Hennekens, 1996[a]). A total number of 1419 relevés from 19 data sets were combined in the database file. The 58 additional relevés obtained from the field surveys were added to the original database. The data from the TURBOVEG database was classified using TWINSPAN (Hill, 1979), and refined by using Braun-Blanquet procedures in the programme MEGATAB (Hennekens, 1996[b]). The final classification consisted of 1477 relevés in total. Within each relevé, specific habitat data like altitude, soil type, geology, which plant community it belonged to in the original data set and vegetation structure were added as extra comments in TURBOVEG. This habitat data proved to be extremely useful during the identification of the vegetation types during classification. The authors, study areas and number of relevés used from each database are summarized in Table 4.1.

Table 4.1 Phytosociological datasets included in the TURBOVEG database of the Waterberg Biosphere Reserve vegetation

Author	Year		No. of Relevès
Botha	1991	Waterberg Game Centre, Melkrivier	59
Bredenkamp	1989	Touchstone Gale Lodge, Melkrivier	12
Brown & Bredenkamp	1999	Shambala Private Nature Reserve, Vaalwater	89
Brown (Ekotrust project)	2002	Kudu Canyon Game Lodge, Vaalwater	15
Centre for Wildlife Management, U.P	1991	Keta Private Nature Reserve, Marken	22
Coetzee et al.	1976	Nylsvley Nature Reserve, Modimolle	207
Du Plessis	1996	Duikerspan, Thabazimbi	17
Du Toit	1998	Entabeni Game Reserve, Sterkrivier	48
Field survey - present study	2002	Masebe Nature Reserve, Marken	16
Field survey - present study	2002	Wonderkop Nature Reserve, Steilloopbrug	27
Field survey - present study	2002	Nylsvley Nature Reserve (Vlei area)	3
Field survey - present study	2002	Marakele National Park (Plains)	10
Fourie	1994	Kwalata Game Ranch, Melkrivier	65
Furniss	1998	Emaweni Game Lodge, Melkrivier	82
Joubert	1998	Sambane Game Lodge	58
Kellerman & Steenkamp	1999	Nua Ranch, Melkrivier	36
Newberry	1998	Entabeni Game Reserve, Sterkrivier	67
Schmidt	1992	Rhino Ranch, Ellisras	46
Smit	1989	Lapalala, Melkrivier	82
Tuinder	1991	Waterberg Game Centre, Melkrivier	46
Turner	1991	Mokolo River Nature Reserve, Vaalwater	85
Van Rooyen & Bredenkamp	1999	Suikerboschplaat farm, Vaalwater	68
Van Staden	In prep.	Marakele National Park, Thabazimbi	130
Von Holdt	1995	Slangkuil Ranch, Vaalwater	48
Westfall	1981	Groothoek, Thabazimbi	170

4.2.5. Classification

The methods proposed for the classification of large datasets by Bredenkamp & Bezuidenhout (1995) and Van der Maarel *et al.* (1987) applies well to classification of large data sets, especially on a syntaxonomic level. For the aim of this study, similar steps were followed from the two-step method proposed by Van der Maarel *et al.* (1987). However, after initial classification certain closely related groups divided by TWINSPAN (Hill, 1979) were united together for the purpose of the identification of the tourism ecozones described in Chapter 5. An example is the sandy patches in between rocky areas on plateaus, terraces and footslopes. The vegetation composition was found to be related to those of the rocky terraces, plateaus and foothills described later in the chapter and therefore form geographically associated habitat types. The plant communities of the Biosphere Reserve described in this chapter will form the socalled "mosaic blocks" from which the ecozones (large, homogenous landscapes) will be identified in Chapter 5. The plant communities thus form part of a larger scale homogenous landscape. For the classification procedure the following steps were followed:

- The database in TURBOVEG was exported as a Cornell Condensed Species file (cc - file) to a directory created in MEGATAB (Hennekens, 1996[b]).
- The file was opened in MEGATAB as a table, and the 1477 relevés were classified by using a Two-Way-Species -Indicator-Analysis (TWINSPAN) (Hill, 1979). In TWINSPAN the following parameters were used during classification:
  - ◊ Cutlevels for cover abundance: 0 - 2 - 10 - 25 - 50
  - ◊ Maximum level of divisions: 3
  - ◊ Other parameters were left default although the option to visualize the cluster hierarchy was selected
- The first classification revealed 7 groups and after a closer investigation of the different groups, further refinement was applied. Certain groups were again subjected to a TWINSPAN classification procedure as stated above, using the same cutlevels but different levels of divisions as follows:
  - ◊ Group 1 represented all freshwater wetlands and was given 1 level of division to separate sponges and vleilands.

- ◊ Group 3 represented all the mountainous areas and was divided into 4 groups, using 2 maximum level of divisions. The group representing the rocky footslopes, terraces and plateaus was then combined with a similar sandy habitat, since these sandy habitats only represent patchy areas in between rocky areas. This revealed 3 three major habitat types according to plant communities: 1) Steep rocky slopes; 2) footslopes, terraces and plateaus; and 3) cooler higher areas and southern slopes.
- ◊ Group 4 was given 2 levels of divisions and revealed 3 different groups, namely 1) deep sandy areas, 2) old fields and 3) diabase- and dolerite dykes.

- A dendrogram was constructed from the TWINSPAN table to indicate the levels of division between the different vegetation type and show possible relationships.
- After the 12 groups were obtained, a synoptic table was created in MEGATAB as an option from TWINSPAN, and further refinement was done to cluster species groups together. Clusters were analyzed separately for species frequency values and characteristic species of a cluster were moved to the top. Species with a frequency value of less than 10% were ignored when species groups were formed, and discarded to the bottom of the table, except if such species was known to be an excellent indicator character species of the vegetation type (for example *Erica drakensbergensis* in the high mountainous vegetation type). Further refinement was done using Braun - Blanquet procedures. These procedures revealed 60 species groups with a total number of 1563 species.
- The fully formatted synoptic table was then exported to Microsoft Excel where it was opened. The species group at the bottom of the table, representing species with frequency values of less than 10%, was discarded which further refined the synoptic table to 59 species groups with 496 species. (Table 4.2).

After the classification, the 12 major plant communities were described according to species composition and habitat characteristics. These species compositions within plant communities better express their relationship with one another and environment than any other characteristic (Adriani & Van der Maarel, 1978).

4.3 Results and Discussion

4.3.1 Classification hierarchy

The cluster hierarchy showed by the TWINSPAN result was found quite useful to describe close relationships between clusters and provide an easier understanding of the division of vegetation groups (Du Plessis, 2001). The cluster hierarchy is shown in Figure 4.1.

- The vegetation of the Waterberg Biosphere Reserve was divided on a first level into two main groups. The first group is vegetation associated with the main Waterberg basin underlain by Waterberg Sandstone (Callaghan, 1987), while the second group consist of vegetation associated with marginal areas around the main basin, underlain by different Pre - and Post Waterbergrocks as classified by Jansen (1982). This level of division represents mostly represents the Sour Bushveld and Sourish Mixed Bushveld on the one hand, and the Arid Sweet Bushveld on the other (Acocks, 1988).
- The vegetation associated with the sweet vegetation group is divided on a second level into two groups, which consist of a group of vegetation associated with vertic clay soils,
- while the other group was divided on a third level into the arid sweet plains in the western and dry northern areas, and the termitaria vegetation that sometimes occur in clayey soils overlain by sand.
- The vegetation of the main basin was divided on a second level into vegetation associated with wet or moist areas and vegetation associated with drier areas.
- The moist areas group is divided on a third level into moist kloof areas and wetlands,
- while the wetlands divided on a fourth level into spongy marshes and vleiland areas.
- The drier areas, more common in the Waterberg is divided on a third level into rocky, rugged areas and more low-lying bottomlands.

- The rugged areas are divided on a fourth level into the higher parts of the escarpment and cool southern slopes, and the warmer northern and western slopes, including the higher parts of undulating plains.
- The warmer slopes are divided on a fifth level into steep rocky slopes that dominate most of the mountainous areas, and the rocky footslopes, hills and terraces, including the higher undulating plain areas. These two plant communities are closely related since rockiness would often determine species composition in the mountainous areas (Westfall, 1981).
- The other group of the drier areas is divided on a fourth level into sandy areas and sweet vegetation associated with diabase and dolerite dykes, as well as arid sweet mountainous vegetation on Waterberg Sandstone in the northern Biosphere Reserve.
- The sandy areas is further divided on a fifth level into the low-lying deep sandy areas, seepage lines and sandy plateaus, dominated by *Terminalia sericea* and *Eragrostis pallens*, and the old cultivated fields. The old fields and deep sandy areas are related since the old fields were cultivated on the same low-lying sandy areas where the deep sand vegetation type occurs currently, many years ago. The possible relatedness of the sweet dyke vegetation to the sandy areas could be due to the sandy areas forming a mosaic with the low-lying dykes, the same as previously stated by Winterbach (1998) for the *Terminalio sericeae-Combretetea apiculati* and *Panico maximi-Acacietea tortilis* classes.

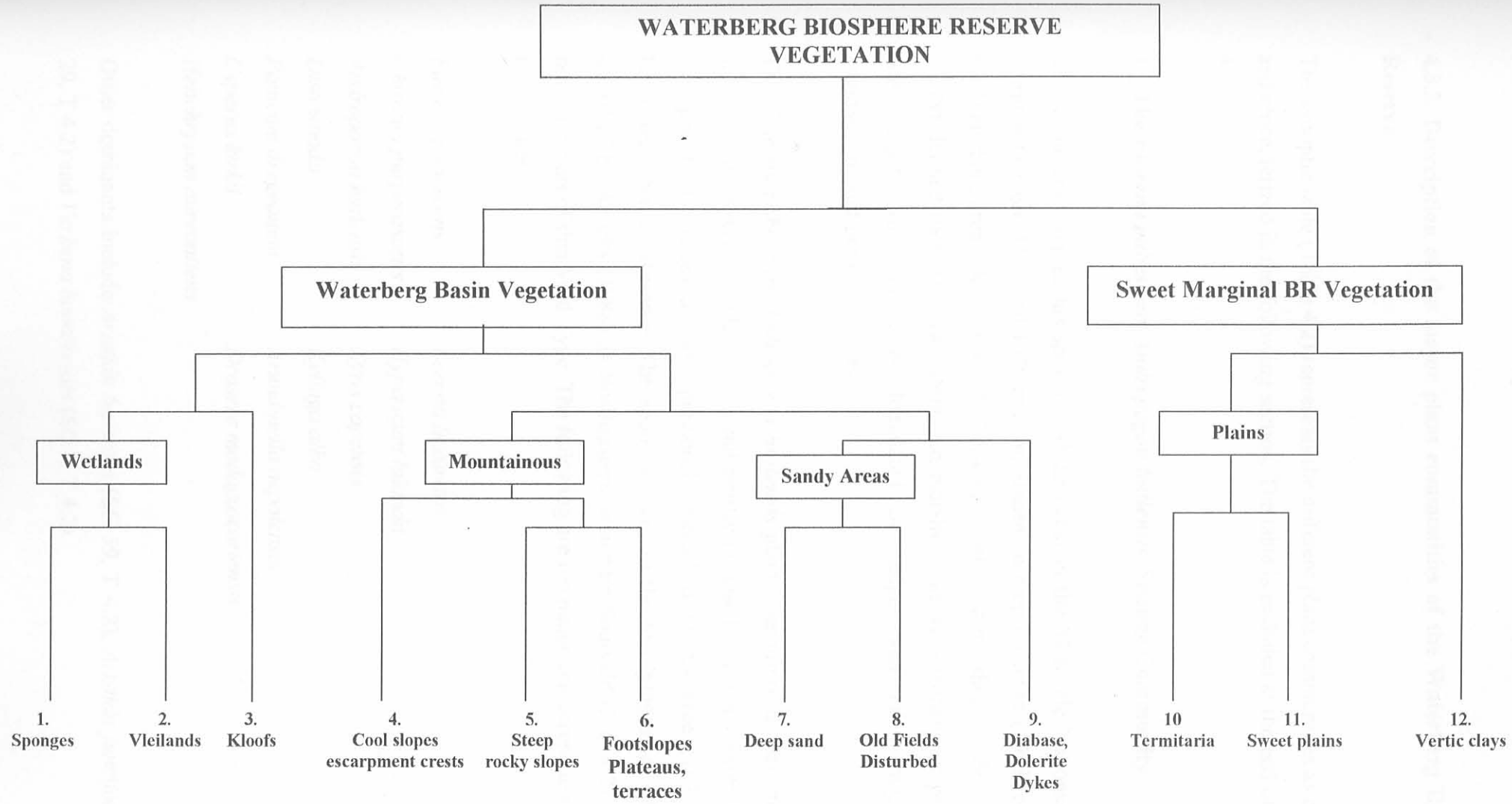

Figure 4.1 Dendrogram showing the hierarchy of the major plant communities of the Waterberg Biosphere Reserve (BR - Biosphere Reserve)

4.3.2. Description of the major plant communities of the Waterberg Biosphere Reserve

The synoptic table (Table 4.2) represents the different plant communities as described and characterized in the following section. The table is included at the end of Chapter 4.

1. The *Fuirena pubescens-Andropogon huilensis* Sponge Community

This community represents sponges, which occur in the Marakele National Park at altitudes between 1300 and 1420 m (Van Staden, in prep.). Cowan (1995) noted that the Waterberg area is known for it's seeps and small reed marshes. Noble & Hemens (1978) defined these shallow submerged marshy areas as seasonally or perennially waterlogged, with vegetation dominated by sedges and other hygrophilous angiosperms and perhaps mosses.

The ***Fuirena pubescens-Andropogon huilensis*** plant community is characterized by species group (SG) 1, Table (T) 4.2, and mostly include herbaceous waterplants and wet grassland species as also previously described by Coetzee (1975) in the Rustenburg Nature Reserve. The sponges occur in the low-lying areas of an area classified by Acocks (1988) as Northeastern Mountain Sourveld (Fig. 4.2), although not being part of this Veld Type. The following are the major characteristic species of the sponges:

Fuirena pubescens	*Leersia hexandra*
Chironia purperascens	*Hypericum lalandii*
Andropogon huilensis	*Xyris capensis*
Disa woodii	*Kylinga alba*
Panicum dregeanum	*Arundinella nepalensis*
Cyperus kirkii	*Drosera madagascariensis*
Helichrysum aureonitens	

Other dominants include *Aristida bipartita* (SG 59, T 4.2), *Aristida junciformis* (SG 29, T 4.2) and *Verbena bonariensis* (SG 3, T 4.2).

These sponges are the sources from where many streams and rivers arise (Noble & Hemens 1978). Van Staden (in prep.) described this community as the *Andropogon huilensis-Xyris capensis* major community occurring along streams and tributaries of the Matlabas-, Mamba and Sterkstroom Rivers. The plant community occurs on Avalon, Katspruit, Oakleaf and Westleigh soil forms, derived from sandstone of the Sandriviersberg formation (Van Staden, in prep). Figure 4.2 shows the sponges occurring in the Marakele National Park, Limpopo Province.

2. The *Phragmites australis-Persicaria serrulata* vlei community

This community represents vlei areas and floodplains which occur in the Nylsvley Nature Reserve and Emaweni Game Lodge. Cowan (1995) desribed this vegetation type as part of riverine floodplains under temporary riverine fresh water wetlands. These wetlands may occur on riverine floodplains, which include river flats, flooded river basins and seasonally flooded grasslands. Bloem *et al.* (1993) described a similar vegetation type as *Phragmites australis* vlei in the Verlorenvallei Nature Reserve on the Highveld, although the *Echinochloa holubii-Cyperus longus* wetland described by Kooij *et al.* (1991) from the western Free State, which is associated with permanent or seasonally wet watercourses, riverbanks, valley flats, flood plains and stream channels, is also closely related to this plant community. Various other authors also described *Phragmites australis* communities in different parts of South Africa, which indicated that it occurs quite widespread in different locations.

The characteristic species for this vegetation type are the typically water-associated species *Phragmites australis, Persicaria serrulata, Potamogeton* species, *Centella* species and *Juncus dregeanus* (SG 2, T 4.2). Other dominant species that occur are species of the Cyperaceae, *Verbena bonariensis* (SG 3, T 4.2), *Bulbostylis burchellii* (SG 22, T 4.2), *Senecio incornatus* and *Setaria incrassata* (SG 58, T 4.2).

This plant community type occurs in a wet zone of 500 mm and sometimes deeper (Bloem *et al.* 1993). Soil types on which this vegetation type occurs include the Katspruit form, Oakleaf form and Valsrivier form, mostly clayey soils as deep as 1 200 mm (Macvicar 1991).

The affinity that species like *Setaria incrassata,* and *Senecio incornatus* (SG 64, T 4.2) have with the plant community described on vertic clay soils in the adjacent area of the Nylsvley Nature Reserve, emphasize a problem encountered during classification of large datasets, namely intrazonal relevés occurring within original datasets. Bredenkamp & Bezuidenhout (1995) stated that intrazonal relevés should be excluded from a large data set before classification. However, the purpose of the study was not primarily to classify vegetation on a syntaxonomic level, rather to identify plant communities as probable habitat types for birds and mammals (Chapters 7, 8). Coetzee *et al.* (1976) classified the floodplain area at Nylsvley as the *Acacia nilotica-Acacia tortilis* variation of *Panicum maximum-Acacia tortilis* communities occurring on flat bottomlands and termitaria. However, during field surveys it was found that this variation rather occurs on a zone next to the main floodplain. Biggs (1979) showed in the Okavango Delta, Botswana, that floodplains should rather be divided into floodplain vegetation types (primary, secondary and grassland communities), marginal vegetation types and dryland vegetation types according to certain species that occur in these zones.

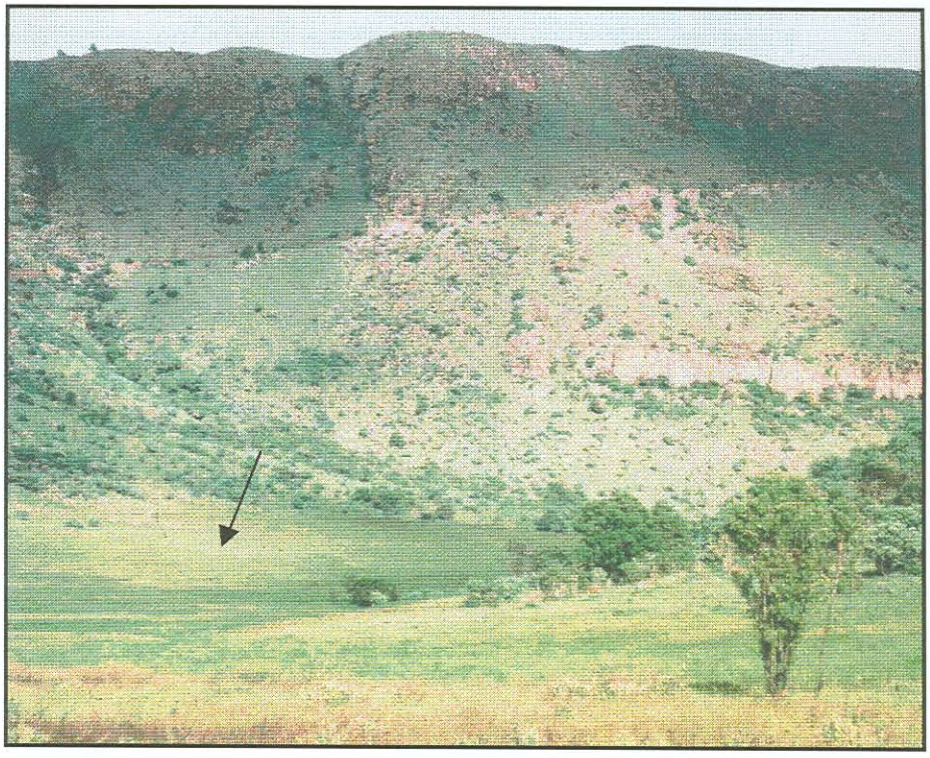

Figure 4.2 The *Fuirena pubescens-Andropogon huilensis* sponge community occurring in the Marakele National Park (arrow)

Figure 4.3. The *Phragmites australis-Persicaria serrulata* vlei community in the Nylsvlei Nature Reserve, showing *Phragmites australis* as a dominant species (arrow)

3. The *Podocarpus latifolius-Diospyros whyteana* Kloof Community

This major plant community is represented in the Marakele National Park, the Farm Groothoek and on the Shambala Private Nature Reserve within the Biosphere Reserve. Acocks (1988) described this plant community type as inland tropical forests, under the Northeastern Mountain Sourveld (A8) Veld Type. It represents the inland, isolated patches of Afromontane forests, although the open warm ravines described by Van Staden (in prep.) are also included. Several studies and floristic descriptions have been done on this Veld Type within different mountain ranges of South Africa (Cooper, 1982, Du Preez *et al.* 1991, Du Preez & Bredenkamp, 1991). Large tree species dominate within the forest ravines and the more prominent characteristic tree species are the following (SG 4, T 4.2):

Podocarpus latifolius	*Widdringtonia nodiflora*
Celtis africana	*Clutia pulchella*
Syzygium cordatum	*Syzygium guineense*
Curtisia dentata	*Ficus sur*
Ilex mitis	*Vepris lanceolata*

Other dominant woody species include *Diospyros whyteana, Olea europaea, Olea capensis* and *Ficus thoningii* (SG 36, T 4.2). Smaller trees or shrubs prominent and characteristic of this vegetation type include *Calpurnia aurea, Pterocelastrus echinatus, Osyris lanceolata, Ochna holstii, Grewia occidentalis, Acokanthera oppositifolia, Rothmannia capensis, Dovyalis zeyheri, Cussonia spicata, Canthium gilfillani* and *Cliffortia linearifolius* (SG 4, T 4.2). Herbaceous species and grasses occur patchy in the undergrowth due to the little sunlight penetrating the canopy. Some of these characteristic species include the fern *Blechnum attenuatum* and *Solanum giganteum, Setaria megaphylla, Ischaemum fasciculatum, Asparagus virgatus* and *Cyperus albostriatus* (SG 4, T 4.2). Other conspicuous species in the undergrowth include the fern *Pteridium aqulinium* (SG 7, T 4.2) and *Asparagus setaceus* (SG 44, T 4.2).

Characteristic species like *Buxus macowani* and *Kirkia wilmsii* (SG 4, T 4.2), and other species like *Olea europaea* subsp. *africana* (SG 36, T 4.2), *Rhus leptodictya* and

Pappea capensis (SG 44, T 4.2) represent the *Buxus macowanii-Kirkia wilmsii* low forest of warmer, drier and more open ravines in the Marakele National Park (Van Staden, in prep.).

The ravines within which this vegetation type occur were formed by the relatively rapid weathering of dolerite dykes within the sandstone (Groenewald, 1986). Soils within the ravines are mostly shallow Mispah form (<500mm), originating from sandstone of the Sandriviersberg formation. During the wet season (October to April; see description of study area), the water seeps through the sandstone forming the sides of ravines creating an ideal moist, sheltered habitat for the forest related species like *Podocarpus latifolius* to grow. Coetzee *et al.* (1981) stated that the ravine forests of the Sour Bushveld within the Kransberg range of the Waterberg vary according to temperature and soil water regime. There are for example dry warm (as described in previous paragraph), humid-warm, dry cool and humid-cool combinations (Van der Meulen, 1979). Du Preez *et al.* (1991) classified the afromontane forests of the Free State Province into two orders of the class *Scolopietea mundii*, namely the order *Podocarpetalia latifolii* and order *Pittosporetalea viridiflorum*. Figure 4.4 show a typical kloof community in the Kransberg Mountains in the Marakele National Park.

The first order, the *Podocarpetalia latifolii* (Du Preez *et al.* 1991) represent the moist afromontane communities, similarly described by Van Staden (in prep.) as the *Podocarpus latifolius-Widdringtonia nodiflora* or *Podocarpus latifolius-Rothmannia capensis* short forest, and by Westfall (1981) as *Celtis africana-Asplenium splendens* kloof forest within the study area. These forests occur at cooler, higher altitudes between 1400 and 1800 m above sea level. The rainfall at these altitudes are also considerably higher compared to lower altitudes of the same area (Acocks, 1988).

The *Pittosporetalea viridiflorum* order (Du Preez & Bredenkamp, 1991) occurs in the warmer, yet moist, western habitats of the Drakensberg range in the Eastern Orange Free State, South Africa. Similar, humid-warm kloof communities were described by Westfall (1981) (*Celtis africana-Erythrina lysistemon* kloof forest) and Van Staden (in prep.) (*Olea europaea-Calpurnea aurea* tall closed woodland) in the lower lying ravines of the Waterberg below 1200 m above sea level (Westfall, 1981).

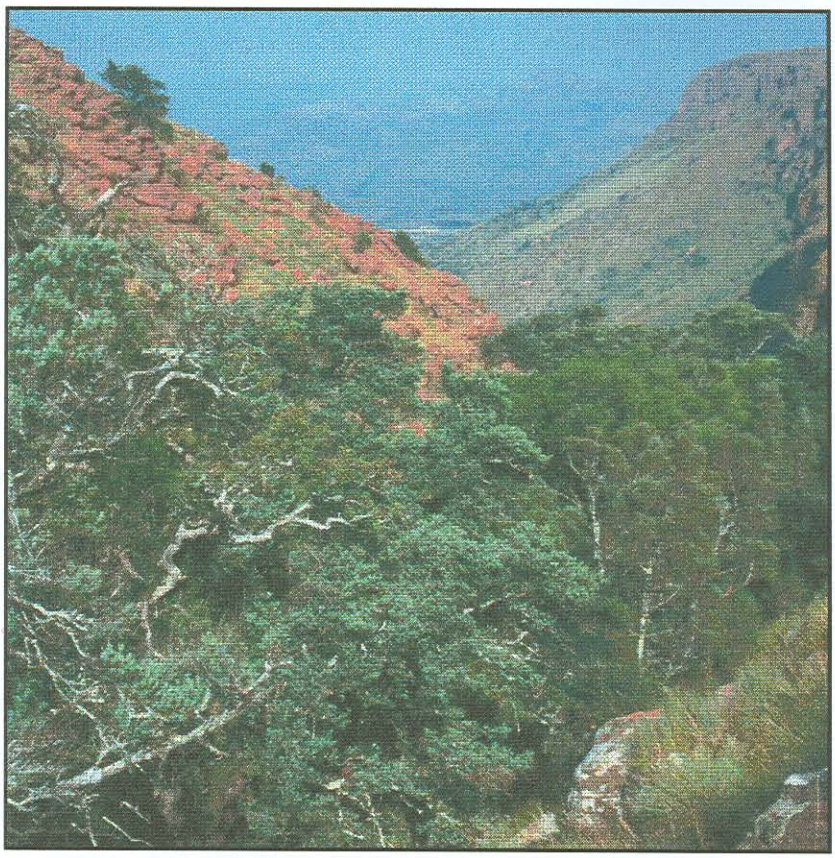

Figure 4.4 The *Podocarpus latifolius-Diospyros whyteana* kloof community occur in moist areas on the escarpment within the Marakele National Park.

4. The *Protea caffra-Loudetia simplex* Cool Slopes and Escarpment Crest Community

The higher part of the Waterberg mountain range, especially along the escarpment (well represented in the Marakele National Park, Groothoek farm, Suikerboshplaat Game farm and Entabeni Game Reserve), as well as the cool, protected southern slopes of other parts of the Waterberg mountain range (Emaweni Game Lodge, Shambala Private Game reserve) includes this plant community. Similar vegetation communities have been described in other localities which include high mountainous parts and southern slopes, such as the Magaliesberg Mountain range in the Rustenburg Nature Reserve (Coetzee *et al.* 1995), Jack Scott Nature Reserve (Coetzee, 1972) (Skurweberg near Magaliesburg), Suikerbosrand Nature Reserve (Bredenkamp, 1975) and the Eastern Transvaal Escarpment (Matthews *et al.* 1991). The vegetation type falls under the sourveld variation of Acock's (1988) Northeastern Mountain Sourveld (A8). Acocks (1988) describes this sourveld as a strongly sour *Themeda*-dominated veld, which replaces the forests, described in the previous section. It was stated that sometimes the breakdown of forest into grassveld or thornveld has never been completed, leaving dense thickets or bushclumps on the exposed slopes (Acocks, 1988), as described by Van Staden (in prep.) and Matthews *et al.* (1991).

This cool environment has few woody species, although small trees and shrubs like *Protea roupelliae, Rhus magalismontana* and, *Passerina montana* are diagnostic (SG 6, Table 4.2). Other dominant woody species in this vegetation type include *Protea caffra, Rhus dentata* (SG 15, T 4.2), *Vangueria infausta, Englerophytum magalismontanum, Combretum molle* and *Acacia caffra* SG 36, T 4.2). Several herbaceous and forb species are characteristic of this vegetation type. Some of the more dominant species are as follows (SG 6, T 4.2):

Coleochloa setifera	*Berkheya carlinopsis*
Helichrysum nudifolium	*Acalypha angustata*
Anthospermum hispidula	*Polygala hottentotta*
Vernonia galpinii	*Indigofera hedyantha*
Aeschynomene rehmannii	*Thesium utile*

This community includes different structures and variations, due to the varying aspect, slope, altitude and soil types. Coetzee *et al.* (1975) identified the major community of the mountain crests in Rustenburg Nature Reserve as *Loudetia simplex-Aristida aequiglumus* woodlands, shrublands and grasslands.

Within the study area the woodland variation is often dominated by a single woody species namely *Protea caffra* (Coetzee *et al.*1981). This variation dominates southern slopes and high slopes of the Marakele National Park, Entabeni Game Reserve and Groothoek farm as described by Van Staden (in prep.), Westfall (1981) and Newberry (1998) (Fig. 4.5). When altitude increases *Protea caffra* is often substituted by the frost-resistant species *Protea roupelliae* (Van Wyk *et al.* 2000). This community has been described as sparse woodland by Westfall (1981) and occurs at altitudes up to 1900 m in the Kransberg Mountains near Thabazimbi. The habitat is on shallow soils in moderately exposed habitats, whereas the *Protea caffra* variation occurs on moderately exposed lower altitude habitats (Westfall, 1981), with moderately deep soils of the Mispah, Glenrosa, Avalon and Clovelly soil forms. Van Staden (in prep.) described another very sensitive community within this variation as the *Protea caffra-Encephalartos eugene-maraisii* low open woodland, where the extremely rare and endemic cycad species *Encephalartos eugene-maraisii* can be found.

The shrublands common along the crests of the Waterberg escarpment were described by Newberry (1998) and Van Rooyen & Bredenkamp (1999). This variation is dominated by red milkplum *Englerophytum magalismontanum*, although other species like *Elephanthorrhiza burkei*, *Ancylobotrys capensis* and *Myrsine africana* are also frequent (Coetzee *et al.* 1981). Where this variation occurs along rocky areas other woody species like individuals of *Podocarpus latifolius* and *Vangueria infausta* may occur (Van Staden , in prep.). The general habitat is somewhat exposed yet on the warmer western and northern slopes of the escarpment, similarly described by Matthews *et al.* (1991) from the Drakensberg escarpment, on shallow rocky Mispah soils (Van Staden, in prep.).

Grassland communities often occur on the high, exposed mountain tops, and have been described by several authors in different localities (Coetzee *et al.* 1975, Rustenburg Nature Reserve; Bredenkamp, 1975, Suikerbosrand Nature Reserve;

Matthews *et al.* 1994, Drakensberg escarpment). Grasslands in the Waterberg Biosphere Reserve are confined to the Kransberg Mountain Range, where Northeastern Mountain Sourveld (Acocks, 1988) occur. Grass species common within the *Protea caffra-Loudetia simplex* vegetation type, sometimes dominating the grassland variation include the following typical cool grassland species:

Aristida transvaalensis (SG 11, T 4.2)
Panicum natalense (SG 15, T 4.2)
Monocymbium ceresiiforme (SG 17, T 4.2)
Diheteropogon amplectens (SG 21, T 4.2)
Schizachyrium sanguineum (SG 27, T 4.2)
Trachypogon spicatus (SG 35, T 4.2)
Tristachya biseriata (SG 15, T 4.2)
Andropogon schirensis (SG 15, T 4.2)
Tristachya rehmannii (SG 21, T 4.2)
Loudetia simplex (SG 27, T 4.2)
Eragrostis racemosa (SG 27, T 4.2)
Themeda triandra (SG 57, T 4.2)

The grasslands also include typical small shrubs and forbs such as *Rhynchosia totta* (SG 11, T 4.2), *Rhynchosia nitens* (SG 11, T 4.2), *Rhynchosia monophylla* (SG 15, T 4.2),. *Tephrosia longipes* (SG 35, T 4.2), *Xerophyta retinervis* (SG 21, T 4.2) and *Bulbostylis burchellii* (SG 22, T 4.2). The species *Erica drakensbergensis* (SG6, T 4.2) occurs at low frequency (6%), but was included due to it being a strong indicator of cold habitats, also occurring in the snowcovered peaks of the Drakensberg montain range. The general habitat is mostly at high altitude (up to 2100 m in the Kransberg mountain range) summits, and the geology of the Aasvoëlkop and Sandriviersberg formation. Soils are rocky, shallow and of the Mispah form derived from the sandstone of the described geological formations (Westfall, 1981). Figure 4.5 shows the woodland variation of the *Protea caffra-Loudetia simplex* community.

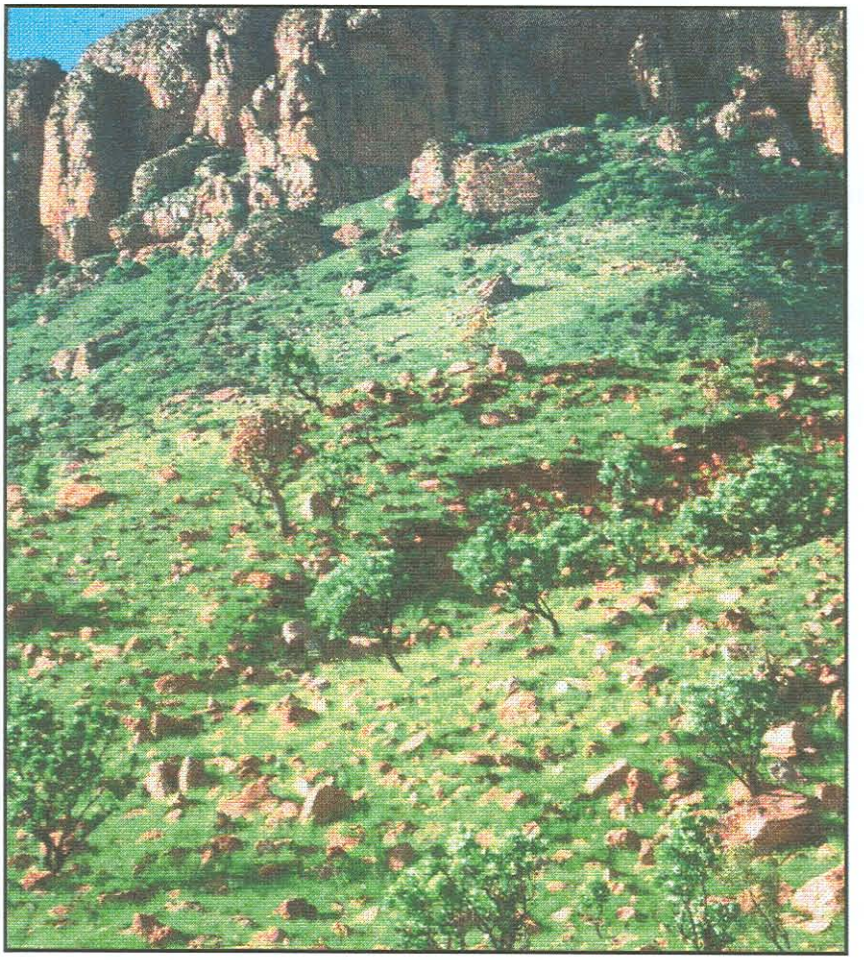

Figure 4.5 Slopes dominated by *Protea caffra* within the Marakele National Park representing the open woodland variation of the *Protea caffra-Loudetia simplex* community

5. The *Diplorhynchus condylocarpon-Englerophytum magalismontanum* Rocky Slope Community

This vegetation type is certainly the most widespread and most common community in the Waterberg Biosphere Reserve. Acocks (1988) classified it as Sour Bushveld (A20), while Van Rooyen & Bredenkamp (1996[a]) described it as Waterberg Moist Mountain Bushveld. The plant community is typical of moderately steep to steep warm western and northern rocky slopes within the Waterberg and the following species are characteristic (SG 10, T 4.2):

Hexalobus monopetalus	*Asparagus africanus*
Lantana rugosa	*Tylosemma fassoglense*
Commelina livingstonei	*Pavonia transvaalensis*
Polygala uncinata	*Aristida meridionalis*
Setaria lindenbergiana	*Bulbostylis hispidula*

Several woody species dominate this vegetation type and the combination thereof has been described by Ben-Shahar (1988) within the Lapalala Wilderness area as a specific association between certain species like *Diplorhynchus condylocarpon* (SG 34, T 4.2), *Croton gratissimus* (SG 36, T 4.2), *Combretum molle* (SG 36, T 4.2), *Elephanthorrhiza burkei* (SG 34, T 4.2) and *Pterocarpus rotundifolius* (SG 34, T 4.2). Other typical dominant mountainous species in this vegetation type include *Englerophytum magalismontanum* (SG 36, T 4.2), *Vitex rehmannii* (SG 35, T 4.2), *Pseudolachnostylis maprouneifolia* (SG 34, T 4.2), *Tapiphyllum parvifolium* (SG 14, T 4.2) and *Burkea africana* (SG 26, T 4.2). *Diplorhynchus condylocarpon* is the most dominant woody species within this vegetation type that stretches over a vast area of the Waterberg as seen in the several communities described by different authors (Table 4.3).

Acocks based his Sour Bushveld Veld Type on the low nutritious value of dominant grass species such as *Schizachyrium jeffreysii* (SG 26, T 4.2), *Andropogon schirensis* (SG 15, T 4.2), *Loudetia simplex* (SG 27, T 4.2), *Schizachyrium sanguineum* (SG 27, T 4.2), *Eragrostis racemosa* (SG 27, T 4.2), *Heteropogon contortus* (SG 51, T 4.2) and *Melionis repens sub. repens* (SG 56, T 4.2) (Van Oudtshoorn, 1999).

Table 4.3. Examples of *Diplorhynchus*-dominated communities described within the Waterberg Biosphere Reserve

Author	Place	Plant community name
Du Toit (1998)	Entabeni Game Reserve	*Diplorhynchus condylocarpon-Loudetia simplex*
Fourie (1994)	Kwalata Game Ranch	*Croton gratissimus-Diplorhynchus condylocarpon*
Joubert (1998)	Sambane Game Lodge	*Diplorhynchus condylocarpon-Burkea africana*
Tuinder (1991)	Jobedi Game Lodge	*Diplorhynchus condylocarpon*-savanna
Van Staden (in prep.)	Marakele NP*	*Diplorhynchus condylocarpon-Burkea africana*
Westfall (1981)	Groothoek farm	*Combretum molle-Aristida diffusa*

* NP - National Park

The habitat of this vegetation type is mostly on the northern to northwesterly slopes of the Waterberg. It is described as a deciduous broadleaf savanna of warm, low-lying hilly terrain and slopes (altitude 1250 - 1400 m above sea level) (Coetzee *et al.* 1981). Slopes on which it occurs vary in steepness from 4° to 40°, and it totally dominates the slopes of the Table- lands (see Fig. 3.3, Chapter 3) underlaid by the Mogalakwena and Sandriviersberg geological formations, Group Waterberg. The ground cover is usually very rocky, usually between 40 and 80 % as described by Joubert (1998) and Du Toit (1998) and therefore the herbaceous cover is low (Joubert, 1998). Soils are usually shallow and of the Mispah -, Glenrosa -, Clovelly and Hutton forms (Joubert, 1998; Van Staden, in prep). This specific vegetation type seem to be confined to mountainous terrain on warm, rocky slopes, with high precipitation, since similar vegetation communities were also described by Theron (1973) in the Loskopdam Nature Reserve, Coetzee *et al.* (1976) in the Nylsvley Nature Reserve and Brown *et al.* (1995) within the Borakalalo Nature Reserve, in warm, but wet areas outside the main Waterberg basin (Jansen, 1982). Figure 4.6 shows an example of the typical plant community on the rugged, rocky slopes dominating many parts of the Waterberg Biosphere Reserve.

Winterbach (1998) syntaxonomically classified the Mountain Bushveld of the Central Transvaal under the class *Englerophyto magalismontani-Acacietea caffrae*. However, this class seems to be more restricted to the higher sandstone plateaus and southern slopes of the Waterberg, while the class Terminalio sericeae-Combretetea apiculati seem to have more species belonging to the *Diplorhynchus condylocarpon-*

Englerophytum magalismontanum plant community described above. Winterbach (1998) stated that further studies within the Mountain Bushveld might reveal various different classes.

6. The *Burkea africana-Setaria sphacelata* Undulating Plains, Footslopes, Terraces and Plateaus Community

Although not occurring on quite as rocky and steep areas as the previous plant community, this major plant community is typical of the plateau areas, the footslopes and the undulating plains, all with a rock cover varying between 5 and 30%, which occur throughout the Waterberg Biosphere Reserve. Van der Meulen (1979) described this community as a transitional area between the bottomlands and the uplands, as the *Combretum apiculatum-Eragrostis nindensis* association. The communities occurring within this major plant community in smaller locations, varies greatly as several authors have described it within the Biosphere Reserve (Turner, 1995; Von Holdt, 1995; Furniss, 1998; Van Staden, in prep.). The characteristic species for the vegetation type are as follows (SG 13, T 4.2):

Tristachya leucothrix
Cymbopogon excavatus
Elephanthorhiza elephantina
Senecio barbertonicus
Crassula swaziensis
Euphorbia striata
Leonotis ocymifolia
Eragrostis nindensis
Hypoxis rigidula
Kalanchoe paniculata
Panicum schinzii
Setaria homonyma
Oxalis corniculata

Figure 4.7 show a typical example of the vegetation and surrounding landscape within this plant community.

Figure 4.6 The *Diplorhynchus condylocarpon-Englerophytum magalismontanum* plant community on Waterberg Sandstone within the Kwalata Game Lodge

Figure 4.7 A terrace representing the *Burkea africana-Setaria sphacelata* plant community, dominated by *Combretum apiculatum* (arrow)

The structure of the vegetation type is mostly an open woodland (Edwards, 1983) and woody species which occur frequently include the Waterberg endemic *Combretum nelsonii* (SG 14, T 4.2) (Van Wyk & Van Wyk, 1997), and others like *Burkea africana* (SG 26, T 4.2), *Combretum apiculatum* (SG 50, T 4.2), *Ochna pulchra* (SG 26, T 4.2), *Lannea discolor* (SG 34, T 4.2), *Pterocarpus rotundifolius* (SG 34, T 4.2) and *Combretum zeyheri* (SG 16, T 4.2). On the somewhat higher, cooler rocky plateaus and terraces, species like *Burkea africana, Faurea saligna* (SG 36, T 4.2), *Heteropyxis natalensis* (SG 36, T 4.2), *Protea caffra* (SG 15, T 4.2) (also on drainage lines), *Elephanthorrhiza burkei* (SG 34, T 4.2), *Acacia caffra* (SG 36, T 4.2) and *Combretum molle* (SG 36, T 4.2) are more prominent. The grassy layer consist of a combination of typical sour, low nutritious grasses (discussed in previous section), and other more palatable grasses like *Themeda triandra* (SG 57, T 4.2), *Setaria sphacelata* (SG 28, T 4.2) and *Digitaria eriantha* (SG 50, T 4.2) (Van Oudtshoorn, 1999). These decreaser species (Bredenkamp & Van Rooyen, 1991) increase the grazing capacity of this vegetation type and provide an extended grazing period for cattle and game during the winter in the Waterberg, when the sourveld species will be dry and unpalatable.

The plant communities of the undulating plains are well described throughout Southern Africa on different geological formations (Brown & Bredenkamp, 1994, Borakalalo Nature Reserve southern section; Brown *et al.* 1996, Borakalalo Nature Reserve northern section; Gertenbach, 1983, Kruger National Park) (Fig. 3.3, Chapter 3). The communities on the undulating plains fall within the Mixed Bushveld Veld Type and Vegetation Type in the Vaalwater valley as described by Acocks (1988) and Van Rooyen & Bredenkamp (1996[b]) respectively. The undulating areas are dominated by the species *Combretum apiculatum*, with the low lying areas dominated by *Terminalia sericea* (to be discussed in the *Terminalia sericea-Eragrostis pallens* plant community). Von Holdt (1995) described the vegetation of the undulating plains as the *Pterocarpus rotundifolius-Dombeya rotundifolia* woodland on shallow, sandy soils of the Mispah and Glenrosa forms, derived from sandstone of the Vaalwater and Cleremont geological formations within the Slangkuil Game Farm (Fig. 3.2, Chapter 3). Both *C. apiculatum* and *P. rotundifolius* are dominant over large areas of warm, low-lying hilly terrain, similar to the undulating plains in the Vaalwater valley (Coetzee *et al.* 1981).

The communities occurring on the rocky footslopes, terraces and plateaus occur within the Waterberg Moist Mountain Bushveld (Van Rooyen & Bredenkamp, 1996[a]) (Table-lands geomorphological formation, Fig. 3.3, Chapter 3). Furniss (1998) described the *Burkea africana-Aristida scabrivalis* closed woodland on foothills and plateaus of the Emaweni Game Lodge, as a typical example of this community. On the plateaus, the climate may be somewhat cooler than on the footslopes and terraces, Van Staden (in prep.) described a community on the cooler southern parts of plateaus in the Marakele National Park, as the *Faurea saligna-Setaria spaecelata* variation. Where the plateaus and footslopes are somewhat more sandy, species like *Eragrostis pallens* (SG 25, T 4.2), *Perotis patens* (SG 25, T 4.2), *Eragrostis gummiflua* (SG 26, T 4.2) and *Burkea africana* become more prominent. When a layer of clay occurs underneath a thin layer of sand species *like Combretum zeyheri* (SG 34, T 4.2) and *Gymnosporia tenuispina* (SG 15, T 4.2) dominate. The general habitat of footslopes, terraces and plateaus include moderately shallow to deeper sandy soils of the Mispah, Clovelly, Cartref and Constantia soil forms, derived from sandstone of the Mogalakwena and Sandriviersberg formations (Fig. 3.2, Chapter 3).

7. The *Terminalia sericea-Eragrostis pallens* Deep Sandy Lowlands Community

This plant community is typical of the lowland areas within the Waterberg Biosphere Reserve, excluding the northern, more arid parts like Wonderkop Nature Reserve. The typical dominant gras species is *Eragrostis pallens* (SG 25, T 4.2), which grows in association with the woody species *Terminalia sericea* (SG 42, T 4.2) and *Burkea africana* (SG 26, T 4.2) on deep sandy soils and and drainage lines (Van Oudtshoorn, 1999) (Fig. 4.8). Acocks classified this Veld Type under Mixed Bushveld (A18), as *Terminalia* Veld proper. It occurs within the Mixed Bushveld vegetation type (Van Rooyen & Bredenkamp, 1996[b]) on the lowland areas of the moderately undulating plains (Fig. 3.3, Chapter 3), as well as in the valley bottoms of the Table-Lands (Fig. 3.3, Ch. 3) in the Waterberg Moist Mountain Bushveld (Van Rooyen & Bredenkamp, 1996[a]). Several authors described similar specific vegetation communities in phytosociological studies within the Biosphere Reserve and elsewhere dominated by *Terminalia sericea* and *Eragrostis pallens* (Tuinder, 1991, Waterberg Game Centre; Brown & Bredenkamp, 1994, Borakalalo Nature Reserve southern section; Brown *et al.* 1995, Borakalalo Nature Reserve western section; Von Holdt, 1995, Slangkuil

Game Farm; Du Toit, 1998, Entabeni Nature Reserve). Van der Meulen (1979) describes the structure as a multi-layered, semi-closed to closed woodland (Edwards, 1983). The typical characteristic species include the following several dominant forbs, shrubs and grass species associated with sandy areas:

Melinis repens s. *grandiflora*
Cyperus margaritaceus
Strychnos cocculoides
Agathisanthemum bojeri
Pollichia campestris
Kohautia virgata
Aristida mollis
Securidaca longipedunculata
Nidorella hottentotica
Diheteropogon filifolius

Other typical sandveld dominants include *Bulbostylis burchellii* (SG 22, T 4.2), *Diheteropogon amplectens* (SG 21, T 4.2), *Chamaechrista mimisoides* (SG 24, T 4.2), *Perotis patens* (SG 25, T 4.2), *Ochna pulchra* (SG 26, T 4.2), *Eragrostis gummiflua* (drainage lines; SG 26, T 4.2), *Combretum zeyheri* (SG 34, T 4.2), *Commelina africana* (SG 43, T 4.2), *Waltheria indica* (SG 50, T 4.2) and *Melinis repens* s. *repens* (SG 51, T 4.2). Closer to footslopes and low lying areas close to dolerite dykes and streams, a sandy layer usually overlays a layer of clay. Sweetveld associated species (Acocks, 1988) like *Dichrostachys cinerea* (SG 55, T 4.2), *Digitaria eriantha* (SG 50, T 4.2), *Panicum maximum* (SG 50, T 4.2) and *Schmidtia papophoroides* (SG 54, T 4.2) become more conspicuous then. Von Holdt (1995) and Brown *et al.* (1996) described these variations as the *Terminalia sericea-Digitaria eriantha* woodland and *Terminalia sericea-Ozoroa paniculosa* tall closed woodland. Winterbach (1998) further stated that the syntaxonomic class *Terminalio sericae-Combretetea apiculati*, which is also represented by this plant community, forms a mosaic with the *Panico maximi-Acacietea tortilis* in the slightly undulating landscape of the Mixed Bushveld, explaining why certain sweet bushveld elements occur in this plant community.

Figure 4.8. A typical low-lying area dominated by *Terminalia sericea* (arrow) within the Emaweni Game Lodge, representative of the *Terminalia sericea-Eragrostis pallens* plant community

The habitat of this plant community is typically on deep sandy soils of the Cartref-, Clovelly and Constantia soil forms. The sandy soils of the Mixed Bushveld in the Vaalwater valley are derived from sandstone of the Vaalwater and Cleremont formations (Fig. 3.2, Ch. 3), while the sands of the valley bottoms in the Waterberg Moist mountain bushveld originates from weathering of the Sandriviersberg and Mogalakwena Sandstone formations (Fig. 3.2, Ch. 3). The sandy soils within this plant community are heavily leached due to the high rainfall (600 - 900 mm) which occurs in the area (Van Rooyen & Bredenkamp, 1996[a]). These low-lying sandy areas were previously used by farmers to cultivate crops. However, the costs involved for fertilizers on these poor soils were probably too high and these fields were later abandoned. The plant community associated with these old cultivated fields is discussed in the following section.

8. The *Cynodon dactylon-Dichrostachys cinerea* Old Fields and Disturbed Areas Community

This plant community is typical of old abandoned fields as well as disturbed sites within the Waterberg Biosphere Reserve. It occurs throughout Biosphere Reserve and was described by several authors in many phytosociological studies within the study area (Turner, 1995, Waterberg Game Centre; Von Holdt, 1995, Slangkuil Game Farm; Du Toit, 1998, Entabeni Nature Reserve Mmadikiri section; Furniss, 1998, Emaweni Game Lodge; Joubert, 1998, Sambane Game Lodge; Newberry, 1998, Entabeni Nature Reserve). It occurs especially in the sandy areas around Vaalwater and Melkrivier. Typical species of disturbed areas (Van Wyk & Malan, 1988; Van Oudtshoorn, 1999) characterize this community namely (SG 23, T 4.2):

Cynodon dactylon — *Hyperrhenia hirta*
Hyperthelia dissoluta — *Solanum incanum*
Terminalia brachystemma — *Eragrostis chloromelas*
Bidens pilosa

Other dominant disturbed-field associated species include *Oldenlandia herbacea* (SG 26, T 4.2), *Fadogia homblei* (SG 27, T 4.2), *Eragrostis curvula* (SG 33, T 4.2),

Solanum panduriforme (SG 39, T 4.2), *Pogonarthria squarrosa* (SG 49, T 4.2), *Digitaria eriantha* (SG 50, T 4.2) and *Dichrostachys cinerea* (SG 55, T 4.2).

When cultivated fields are left fallow, it results in a landscape mosaic of patches of secondary vegetation varying in age and dominated by various grass species (Moll, 1965). Different stages of succession occur in the old fields. The most common old fields in the Waterberg Biosphere Reserve are the young old fields of 1-5 years old (Smits *et al.* 1999, Transkei) dominated by the pioneer grass species of disturbed areas, *Cynodon dactylon* (Van Oudtshoorn, 1999). A syntaxonomic study in the old fields of the Transkei revealed this type of old field variation as the *Tageto minutae-Cynodonetum dactyli*. It has been studied extensively and described by Turner (1995), Joubert (1998) and Newberry (1998) in the study area. Although the species *Cynodon dactylon,* is not a very productive grass, it is palatable and a moderate to good grazing grass (Van Oudtshoorn, 1999). It is often heavily grazed by animals in game reserves and game farms in the Biosphere Reserve. The heavy grazing by game however, can cause trampling and erosion of these areas and the management of these areas are extremely important (Brown & Bredenkamp, 1994). Secondary grassland communities may develop from this old field variation as shown by Smits *et al.* (1999) in the old fields of the Transkei, dominated by the secondary grassland species directly related to man-made disturbances, *Hyparrhenia hirta* (Rivers-Moore, 1997). These fields are still in a early successional state, although somewhat older (older than 5 years) with several grass species like *Hyperthelia dissoluta, Aristida junciformis* (SG 29, T 4.2), *Aristida congesta* s. *congesta* (SG 56, T 4.2) and *Eragrostis rigidior* (SG 54, T 4.2). Furniss (1998) described this variation as the *Hyparrhenia hirta-Felicia muricata* short closed grassland on the Emaweni Game Lodge in the Waterberg Biosphere Reserve. This old field successional stage is often managed by fire for tourism purposes, to lure game to these areas. If left undisturbed and unmanaged, the unpalatable *Hyperrhenia hirta* (Van Oudtshoorn, 1999) will invade these old fields and game will flock to other areas where it is more difficult for tourists to view them.

The outer successional stage of old fields only starts after several years of abandonment when woody species start to invade. These secondary old fields are usually dominated by species such as *Dichrostachys cinerea, Terminalia sericea* (SG

42, T 4.2), *Acacia karoo* (SG 54, T 4.2) and *Ziziphus mucronata* (SG 56, T 4.2). Where overgrazing occurs the encroacher *Dichrostachys cinerea* becomes dominant (Bothma, 1995). These communities occur especially on areas on game farms previously overgrazed by cattle. Bell (1997) described a disturbed overgrazed community as *Dichrostachys cinerea-Hyperthelia dissoluta* tall closed grassland at Mabula Game Reserve in the foothills of the Waterberg, while Von Holdt (1995) classified a similar community as the *Dichrostachys cinerea-Eragrostis rigidior* encroached shrubland in the Slangkuil Game Farm. In sandy old fields (Cartref, Clovelly and Constantia soil forms) the dominant tree species to invade is usually *Terminalia sericea* (Brown *et al.* 1995), while the invasive species on clayey soils of the Hutton and Fernwood forms is *Acacia karoo* (Joubert, 1998).

As stated earlier, the habitat type of the old fields coincide with the habitat of the lowlands which is more suitable for agricultural practices. Other areas where old fields occur is on the sandy terraces and plateaus of the Table-lands geomorphological type (Fig. 3.3, Ch. 3). The value of these old fields to game farmers will be emphasized even more in the following chapter. Figure 4.9 shows a typical old field in an early successional stage within the Waterberg Biosphere Reserve

9. The *Dombeya rotundifolia-Panicum maximum* Sweet Rocky Community

This plant community is associated with the diabase and dolerite dykes within sheltered dykes and rocky outcrops within the Biosphere Reserve, as well as to the mountainous vegetation of the Arid Sweet Bushveld Veld Type (Acocks, 1988) of Wonderkop Nature Reserve in the northern part of the Waterberg Biosphere Reserve. The main geological formations of the Waterberg basin consist of sandstone (Jansen, 1982). However, the area has also been intruded by diabase (Pre - Karoo) and dolerite (Post - Karoo) dykes, as both irregular bodies and sheets (O'Connor, 1992) (Fig. 4.10). Vegetation associated with these intrusions usually has sweet bushveld-associated elements due to the rich soils derived from the geological formations (Smit *et al.* 1995).

Figure 4.9. An old field within the Entabeni Nature Reserve dominated by *Cynodon dactylon*

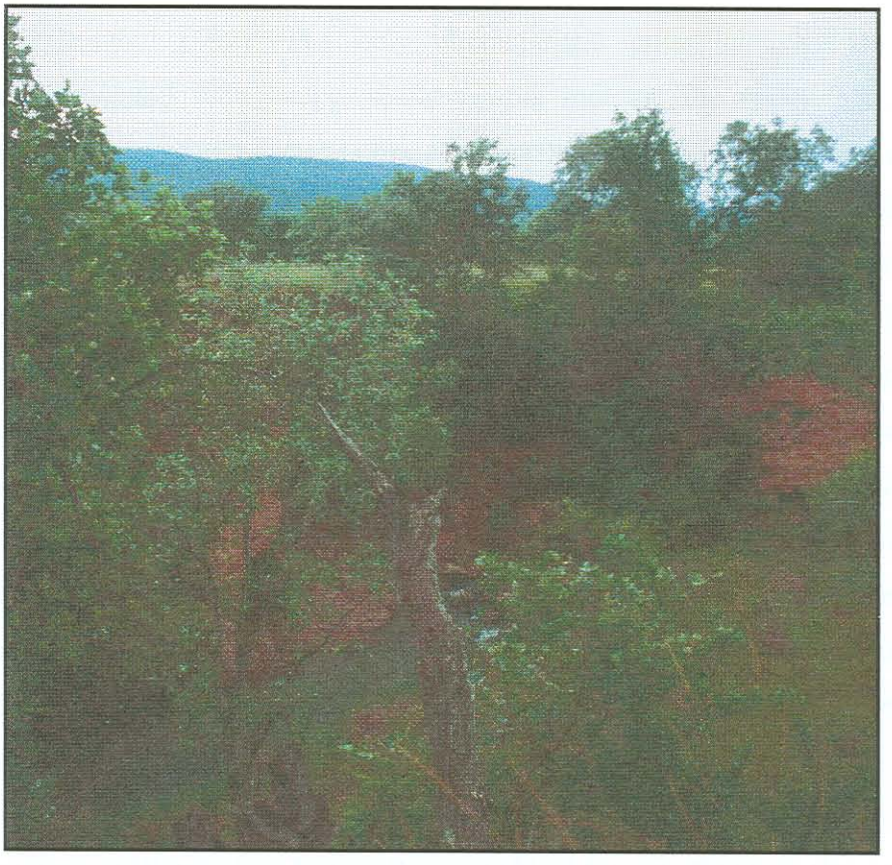

Figure 4.10. The *Dombeya rotundifolia-Panicum maximum* plant community represented within the Doorndraaidam Nature Reserve along a dolerite dyke

The most prominent characteristic species, mostly woodies, of this plant community is the following (SG 30, T 4.2):

Bridelia mollis
Kirkia acuminata
Ximenia americana
Enneapogon scoparius
Obetia tenax
Aloe marlothii
Schotia brachypetala
Spirostachys africana
Fluegga virosa
Euphorbia cooperi
Clerodendrum glabrum

Other dominant woody species also included in the *Diplorhynchus*-community of rocky slopes (SG 34, T 4.2; SG 36, T 4.2), that are typical Waterberg associated species, also occur in this sweet vegetation type of mountainous areas. Species similarly described characteristic of bouldery and broken areas of diabase geology are *Kirkia acuminata, Sclerocarya birrea* (SG 47, T 4.2) and *Acacia nigrescens* (SG 47, T 4.2) (O'Connor, 1992). The only characteristic grass species, *Enneapogon scoparius,* associated with rocky, shallow soils indicate the rocky, mountainous terrain, although sweet grass species like *Panicum maximum* (SG 50, T 4.2), *Digitaria eriantha* (SG 50, T 4.2) and *Schmidtia pappophoroides* (SG 54, T 4.2) indicate the richer soils (Van Oudtshoorn, 1999). The habitat is very rocky and the large rocks protect young trees against fire and frost (Smit *et al.* 1995). Furniss (1998) and Newberry (1998) have described the vegetation of rocky diabase outcrops in the Biosphere Reserve. The *Dombeya rotundifolia-Setaria homonyma* short closed woodland community at Entabeni Game Reserve (Newberry, 1998) and *Acacia nigrescens-Pavonia burchellii* low forest community on the slopes of Tafelkop at Entabeni Game Reserve represent good examples of this plant community in mountainous areas. These vegetation communities are directly related to geology and soil types (Van Rooyen & Theron, 1996). The soil type on which these communities occur are mostly the Hutton soil form.

The vegetation of Wonderkop Nature Reserve (Field Survey, 2002) in the Arid Sweet Bushveld (A14; Acocks, 1988), are not related to the diabase outcrops previously described. These vegetation communities are more exposed to drier conditions and therefore species like *Euphorbia cooperi, Aloe marlothii, Euphorbia ingens* (SG 36, T

4.2), *Boskia albitrunca* (SG 47, T 4.2) and *Commiphora mollis* (SG 47, T 4.2) are more dominant, with *Combretum apiculatum* dominating the plateaus and foothills on conglomerate of the Mogalakwena formation. The much lesser rainfall within this area (452 mm for Marken, Weather Bureau, 2000) may possibly cause the absence of typical Waterberg Sandstone species like *Diplorhynchus condylocarpon and Englerophytum magalismontanum;* while species like *Pseudolachnostylis maprouneifolia* and *Elephanthorrhiza burkei* indicate the strict association of certain species with Waterberg Sandstone (Mogalakwena formation), These species are thus able to survive under wet and dry conditions in the BR. Van Rooyen *et al.* (1981) and Du Plessis (2001) described communities under similar rainfall patterns on Waterberg Sandstone in the Punda Milia-Pafuri-Wambiya Sandveld area of the Kruger National Park.

The low-lying, sheltered vegetation variation along rocky dykes are similar to the *Spirostachys africana-Sporobolus ioclados* Woodland on granite described by Van der Meulen (1979) in the Central Bushveld. This variation occurs on more clayey soils (Oakleaf, Westleigh and Milkwood forms), sometimes with a rock layer underneath and varied rock cover above ground. Species like *Spirostachys africana, Schotia brachypetala, Euclea undulata, Olea europaea* SG 36, T 4.2), *Berchemia zeyheri* (SG 36, T 4.2), *Mimusops zeyheri* (SG 36, T 4.2), *Combretum hereroense* (SG 38, T 4.2), *Ziziphus mucronanta* (SG 56, T 4.2) and *Acacia karroo* (SG 54, T 4.2) are more associated with this heavier, clayey soils (Van Wyk & Van Wyk, 1997). The structure of this community is usually a tall closed woodland (Edwards, 1983), although Turner (1995) described the *Spirostachys africana* short forest community on the Mokolo River Nature Reserve. Van Rooyen & Bredenkamp (1999) described a dolerite dyke community in the Suikerboshplaat Game Farm as the *Dombeya rotundifolia-Acacia karroo* stream banks community, while von Holdt (1995) described a similar community as the *Euclea undulata - Panicum maximum* riverine thicket in the Slangkuil Game Farm.

10. The *Acacia tortilis-Panicum maximum-Ziziphus mucronata* Termitaria and Encroached Areas Community

This plant community occurs under specific conditions. It consist of two variations namely vegetation associated with termitaria throughout the Biosphere Reserve and vegetation associated with encroached areas, especially near Thabazimbi in the southwestern corner of the Biosphere Reserve. The encroached areas and termitaria are often closed, thicket-like woodland with a sparse ground cover. However, shade-loving grass species such as *Panicum maximum* often occurs (Van Oudtshoorn, 1999). Species composition of these vegetation variations tends to be variable, since specific species will thrive under different conditions. The characteristic species for this vegetation type include the following species (SG 37, T 4.2):

Acacia erioloba	*A. erubescens*
A. burkei	*Ehretia rigida*
Sporobolus iocladus	*S. fimbriatus*
Brachiaria eruciformis	*Eragrostis trichophora*
Tephrosia capensis	*Maytenus polyacantha*
Achyropsis avicularis	*Hibiscus pusillus*
Cyphostemma cirrhosum	*Kalanchoe lanceolata*
Justicia protracta	*Jasmium breviflorum*
Blepharis integrifolia	

Vegetation associated with termitaria has been studied and described by Coetzee *et al.* (1976) in the Nylsvley Nature Reserve and Van Staden (in prep.) in the Marakele National Park within the Biosphere Reserve. This variation often form impenetrable, thorny bushclumps on low mounds built by termites (Van der Meulen, 1979). The size of termitaria determines the structure of vegetation. Tall trees like *Pappea capensis* (SG 45, T 4.2), *Combretum imberbe* (SG 46, T 4.2) and *Ziziphus mucronata* are common, with several *Grewia* species also being part of the lower structure of the termitaria vegetation (Fig. 4.11). The *Acacia* species and other sweetveld associated vegetation occur on termitaria due to the depth and aeration, better drainage, as well as the finer texture and higher nutrient status of the soil (Lee & Wood, 1971). Coetzee *et al.* (1976) described termitaria within the Nylsvley Nature Reserve as communities

of flat bottomlands and of termitaria on alluvium. However, termitaria also occur on plateaus, terraces and lowlands on sandy to loamy soils without rocks, as termites need a certain depth of soil for their activities (Van der Meulen, 1979). Van Staden (in prep.) described the *Rhus leptodictya-Mimusops zeyheri* termitarium thickets in the Marakele National Park as an example. A typical termitaria community is shown in figure 4.11.

Vegetation associated with encroached areas usually occurs in previously disturbed or overgrazed sites (Van der Meulen, 1979). Werger (1977) showed that when severe and prolonged overgrazing in the semi-arid savanna ecosystem occurs, the grass component is severely restricted in growth, or in moisture usage. More moisture remains thus available in the soil to be used by the woody plants, and the result is bush encroachment, a structural change towards a more strongly woody vegetation (Werger, 1977). Typical examples occur in Marakele National Park near Thabazimbi, especially at sites where old cattle farms, where heavy grazing occurred and were later changed to be part of the park (Coetzee *et al.* 1981). Typical encroachers like *Dichrostachys cinerea* (SG 55, T 4.2), *Acacia erubescens* and *Acacia mellifera* (SG 46, T 4.2) occur in this vegetation variation, on somewhat deeper sandy to loamy soils compared to termitaria (Werger & Coetzee, 1978). Sometimes almost pure stands of these species might occur when conditions favour a certain species. Van der Meulen (1979) described it as one of the most seriously disturbed types of vegetation in the Central Bushveld, with overgrazing, trampling and erosion being common problems. Ecological management need therefore be implemented in these areas to adress the problem. The geology of the encroached areas at Thabazimbi is granite, granophyre, sandstone, shale and mudstone (Geological Survey, 1970). Other encroached areas also occur on diabase dykes in the Wonderkop Nature Reserve and other plain areas of the Biosphere reserve.

Figure 4.11. A typical termitaria with its associated vegetation within the Nylsvley Nature Reserve

11. The *Acacia nigrescens-Grewia flava* Plains Community

This plant community includes the vegetation of the northern plains (near Marken), classified by Acocks (1988) as Arid Sweet Bushveld, *Grewia flava* variation. However, Coetzee (1971) classified a similar vegetation type as *Acacia-Grewia* Veld due to it being on the transition zone of the Arid Sweet and Mixed Bushveld. Schmidt (1992) and Pauw (1988) described similar communities within the Rhino Ranch and Atherstone Nature Reserve outside the Biosphere Reserve respectively, and these communities are similar to the plains around Marken. The correlation between soil and vegetation is strong in this low rainfall areas (O'Connor, 1995). The most prominent characteristic species are the following, mostly dominated by forbs and grass species (SG 45, T 4.2):

Melhania acuminata	*Enneapogon cenchroides*
Achyrantes aspera	*Bothrichloa radicans*
Urochloa panicoides	*Tephrosia purparascens*
Melhania rehmannii	*Ehretia amoena*
Boscia foetida	*Commiphora africana*
Aristida rhinochloa	*Cenchrus ciliaris*

The landscape geomorphology within which the vegetation occurs consists of plains with slightly undulating areas where shallower, rocky soils occur. On the rockier areas, the soils are of the Mispah-, Hutton or Cartref soil forms. Schmidt (1992) and Pauw (1988) have described the vegetation variation as the *Combretum apiculatum-Acacia nigrescens* short closed woodland and the *Grewia bicolor-Combretum apiculatum* short open woodland communities, respectively. Species dominant within these communities are typically associated with rocky areas like *Enneapogon cenchroides, Combretum apiculatum* (SG 50, T 4.2), *Schmidtia papophoroides* (SG 54, T 4.2) and *Acacia nigrescens* (SG 47, T 4.2). The other variant of this vegetation type is typical of the low-lying plain areas with more typical thornveld (Fig. 4.12). Schmidt (1992) classified this variation as the *Acacia nigrescens - Grewia flava* tall open woodland on Hutton soils originated from anorthosite and gabroid rock. Typical species include *Acacia tortilis* (SG 53, T 4.2), *Grewia* species, *Acacia karroo* (SG 54, T 4.2), *Dichrostachys cinerea* (SG 55, T 4.2), *Panicum maximum* (SG 50, T 4.2) and

Chloris virgata (SG 53, T 4.2). The geology underlying this vegetation is variable, and it seems as though rainfall plays an overcoupling role in determining vegetation communities, as stated earlier. Again, the high and low lying areas form a mosaic as described by Winterbach (1998). The typical plains dominated by several woody species is shown in figure 4.12.

12. The *Setaria incrassata-Aristida bipartita* Vertic Clay Community

This community is restricted to the area adjacent to the floodplain (*Phragmites australis-Persicaria serrulata*) in the Nylsvley Nature Reserve. It forms part of the Clay Thorn Bushveld as described by Van Rooyen & Bredenkamp (1996[c]). Although specific herbaceous species from species group 52, like *Berkheya radula, Jamesbrittenia aurantiaca, Scilla dracomontana, Senecio apiifolius, Salvia repens* and *Falckia oblonga* characterize this vegetation type, the typical woody and grass species growing in clay soils are more prominent as discussed below. Figure 4.13 show the typical plant community in the Nylsvley Nature Reserve.

Grass species like *Aristida bipartita* (SG 59, T 4.2), *Setaria incrassata* (SG 58, T 4.2) and *Themeda triandrae* (SG 57, T 4.2) are typical grasses growing in vertic clays (Van Oudtshoorn, 1999). Coetzee *et al.* (1976) described this plant community mainly as grassland with an open stand of thorn savanna. The typical dominant scattered woody species growing in the clayey soils include *Acacia nilotica, A. tortilis* (SG 53, T 4.2), *A. karroo, Rhus pyroides* (SG 54, T 4.2) and *Ziziphus mucronata* (SG 56; T 4.2). The typical clayey soil is derived from basalt and of the Arcadia soil form. Habitat features as described by Coetzee *et al.* (1976) include a fluctuating water table, prolonged periods of inundation during heavy rainfall, swelling and contraction of the soil during wet and dry periods with considerable cracking when dry, a loose soil surface, a high calcium content in the soil and gilgai micro-relief. Bredenkamp & Deutschländer (1994) classified a similar vegetation association as the *Themedo triandrae-Setarietum incrassatae* in vertic clay soils on gabbro in the Manyeleti Game Reserve of the Eastern Transvaal Lowveld, while Van der Meulen (1979) classified it as woodland of vertic black clays (*Acacia tortilis-Aristida bipartita* woodland association) in the Central Bushveld.

Figure 4.12 Plains in the Wonderkop Nature Reserve representing the *Acacia nigrescens* - *Grewia flava* major plant community

Figure 4.13 The *Setaria incrassata-Aristida bipartita* community on the vertic clay soils in the Nylsvley Nature Reserve

4.4 Conclusion

The classification of the vegetation within the Waterberg Biosphere Reserve as represented by several datasets combined in a database revealed 12 different plant communities as follows:

- The *Fuirena pubescens-Andropogon huilensis* sponge community
- The *Phragmites australis-Persicaria serrulata* vlei community
- The *Protea caffra-Loudetia simplex* cool slopes and escarpment crest community
- The *Podocarpus latifolius-Diospyros whyteana* kloof community
- The *Diplorhynchus condylocarpon-Englerophyton magalismontanum* rocky slope community
- The *Burkea africana-Setaria sphacelata* undulating plains, footslopes, terraces and plateaus community
- The *Terminalia sericea-Eragrostis pallens* deep sandy lowlands community
- The *Cynodon dactylon-Dichrostachys cinerea* old fields and disturbed areas community
- The *Dombeya rotundifolia-Panicum maximum* sweet rocky community
- The *Acacia tortilis-Panicum maximum-Ziziphus mucronata* termitaria and encroached areas community
- The *Acacia nigrescens-Grewia flava* plains community
- The *Setaria incrassata-Aristida bipartita* vertic clay community

The plant communities are strongly correlated along environmental parameters. The main environmental factor to which the communities are correlated is the underlying geology. The last three vegetation types represent the sweet vegetation underlaid by Pre- and Post Waterberg rocks along the edges of the main Waterberg basin, while the other vegetation types are all underlain by Waterberg Sandstone, within the Waterberg Biosphere Reserve. Other factors, which played a role in distinguishing plant communities were rainfall, rockiness and soil type.

Each of the different plant communities would represent a specific habitat for mammals and birds, with specific trees growing in it, which are great attractions for

tourists visiting the area. The plant communities further fits into the landscape geomorphology to form ecosystems (ecozones). These ecozones will be identified, described and mapped within the Waterberg Biosphere Reserve in the following chapter.

Table 4.2 Synoptic Table of the plant communities of the Waterberg Biosphere Reserve

Vegetation type	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Number of releves	**11**	**3**	**43**	**90**	**387**	**156**	**182**	**432**	**44**	**76**	**48**	**5**
Species Group 1												
Fuirena pubescens	82											
Helichrysum aureonitens	73					8		1				
Monopsis decipiens	73					1		4		1		
Hypericum lalandii	64			2		6		2				
Andropogon huillensis	64		5									
Sebaea leiostyla	64											
Xyris capensis	55		5									
Cyperus kirkii	55											
Ascolepis capensis	55		2									
Arundinella nepalensis	46											
Drosera madagascariensis	46											
Chironia purpurascens	36			1		8						
Kyllinga alba	36							3				
Pycnostachys reticulata	36											
Aster species	36											
Lobelia erinus	36											
Eragrostis inamoena	36											
Leersia hexandra	27		5									
Disa woodii	27											
Eragrostis capensis	27		2	6				4				
Senecio affinis	27											
Senecio polyodon	27											
Panicum dregeanum	27		2									
Pennisetum sphacelatum	27											
Helichrysum epapposum	27											
Eriochrysis pallida	27											
Dierama medium	27											
Nemesia fruticans	27		2	6								
Sopubia simplex	18											
Asclepias brevipes	18											
Oldenlandia tenella	9											
Species Group 2												
Phragmites australis		100	5					2				
Persicaria serrulata		100										
Nymphoides species		33										
Juncus dregeanus		33										
Ceratophyllum species		33										
Centella species		33										
Species Group 3												
Verbena bonariensis	46	33	2					4				
Cyperus species	64	33			4			4		3		

Species Group 4									
Podocarpus latifolius		54	9		4				
Cyperus albostriatus		49	2		1				
Myrsine africana		44	1		8				
Celtis africana		40						7	1
Cheilanthes viridis	9	40	3	9	1	2		7	
Secamone alpini		37	1	2	1				
Asparagus virgatus		35				2			1
Osyris lanceolata		26		2	4			7	
Syzygium cordatum		26		1	5				
Ficus sur		26			1				
Acokanthera oppositifolia		23							
Buxus macowanii		23							3
Tricalysia lanceolata		23		1					
Curtisia dentata		21							
Cryptolepis transvaalensis		21		1				5	
Calpurnia aurea		21						7	
Clutia pulchella		19	3	4	1			2	
Rothmannia capensis		19	7	3	2				
Kirkia wilmsii		19		1				9	
Plectranthus fruticosus		19							
Ischaemum fasciculatum	9	19			2				
Canthium gilfillanii		19		8		2		5	
Widdringtonia nodiflora		16	6						
Solanum giganteum		16		1	5			5	8
Asplenium splendens		16							
Pittosporum viridiflorum		16		1					
Syzygium guineense	9	14		2					
Vepris lanceolata		14							
Setaria megaphylla		14		1				2	
Dovyalis zeyheri		14			3			5	1
Blechnum attenuatum		12							
Ochna holstii		12							
Grewia occidentalis		12		2				9	1
Pterocelastrus echinatus		12							
Abrus laevigatus		12		1				2	
Cussonia spicata		12	4	4					1
Species Group 5									
Miscanthus junceus	36	21		1			2		
Ilex mitis	9	21							
Cliffortia linearifolia	9	16							
Species Group 6									
Indigofera hedyantha			46						
Acalypha angustata			44		1				
Stachys natalensis		2	34	9	4				
Anthospermum hispidulum			32			1	2	7	
Vernonia galpinii			30	2	4	2			
Thesium utile			27	2		2	7		1
Polygala hottentotta			23	1	4	5	1		
Cheilanthes hirta		9	23	5					
Protea roupelliae			22						
Helichrysum nudifolium			21		3	3			
Aeschynomene rehmannii			21	2					

Berkheya carlinopsis			20	2					
Helichrysum mimetes			20						
Pentanisia angustifolia			19			1			
Gerbera viridifolia			17						
Indigofera mollicoma			16	7		2	1		
Gnidia capitata			16	1	5	4	2	2	
Eriospermum species			16	3	5				
Hypoxis iridifolia			16		6		2		5
Athrixia elata		2	16		1				
Gerbera piloselloides		7	14	1	1				
Scilla nervosa			13		1				
Cymbopogon validus		5	13	2	5				
Tephrosia elongata			13			1			
Helichrysum uninervium			13						
Phymaspermum bolusii			13						
Talinum caffrum			12	4	2			5	
Vernonia natalensis			12	1	4		3		1
Selago capitellata			12						
Pearsonia cajanifolia			12				2		
Helichrysum dasycephalum			12						
Berkheya zeyheri			12						
Passerina montana		7	11						
Cyperus rupestris			11	2	1		6	2	
Rhus magalismontana			10	4		1			
Digitaria brazzae	9		10	2		4			
Kohautia cynanchica		2	10	1	1				
Coleochloa setifera	9	7	10	3					
Mohria caffrorum		7	10	1					
Aristea woodii			10						
Senecio coronatus			10						
Dimorphotheca jucunda			9						
Erica drakensbergensis			6						
Species Group 7									
Pteridium aquilinum		26	14						
Species Group 8									
Helichrysum species	67	2	37		4				
Species Group 9									
Cyperus leptocladus	55	9	24	7	3				
Species Group 10									
Asparagus africanus			19			2	4	5	7
Hexalobus monopetalus			18	3				2	
Setaria lindenbergiana		9	4	17	2			9	
Lantana rugosa			2	16	5	8	8	9	1
Aristida meridionalis			2	14	2		6	9	4
Tylosema fassoglense				12				5	
Pavonia transvaalensis				12		6	1		
Bulbostylis hispidula			2	12		5	2	2	
Trichocladus grandiflora			2	11	10	2	6	2	
Commelina livingstonii				10	4		1		

Species Group 11									
Aristida transvaalensis	9		23	18		6	5		
Rhynchosia nitens			16	13	2	3			
Rhynchosia totta			26	11	4	3	1		
Sphenostylis angustifolia			26	11	3				
Species Group 12									
Polygala uncinata	27		9	14	2				
Species Group 13									
Tristachya leucothrix			7	6	36		2		
Cymbopogon excavatus			4	3	28	2	5	7	1
Eragrostis nindensis			1	3	22	3	5		
Hypoxis rigidula			9	3	22		2	2	
Setaria homonyma					15			5	
Hypericum aethiopicum			6		12				
Cymbopogon species			3		12				
Bulbostylis boeckeleri					12				
Kalanchoe paniculata				8	12	1	5	7	5
Stoebe vulgaris				1	11		7		
Eragrostis superba			1	2	11	7	5	5	4
Crassula swaziensis			6	3	10				
Euphorbia striata					10				
Species Group 14									
Indigofera melanadenia			1	24	35		10		
Rhus gracillima			8	18	25		4		
Tapiphyllum parvifolium			4	37	13			9	
Aristida scabrivalvis			1	10	12		4		
Combretum nelsonii				12	12	1	4	7	
Species Group 15									
Protea caffra			44	3	37		2	2	
Senecio venosus		5	18	7	33	5	3		
Panicum natalense		2	64	3	31	8	6		1
Ectadiopsis oblongifolius		2	10	23	24	6	2		
Bewsia biflora			12	3	22	7	3		
Vernonia staehelinoides			18	5	19	2	3	2	
Ancylobotrys capensis		2	10	11	18	3			
Melinis nerviglumis			24	17	18	8	5		
Scabiosa columbaria			16		17				1
Helichrysum kraussii			42	4	16		8		
Maytenus tenuispina		2	13	40	13	3	8	9	4
Rhynchosia monophylla			33	2	12	6			
Senecio conrathii			20		12				
Helichrysum cephaloides			31		12				
Oxalis depressa		7	11	3	11		4	5	1
Helichrysum setosum			12	1	11				
Andropogon schirensis			72	34	10	2	4	9	
Tristachya biseriata			16	2	7				
Species Group 16									
Apodytes dimidiata			12	4	8	19		2	
Rhus dentata			16	32	11	18		5	
Olea capensis			14			15		7	

Species Group 17										
Senecio erubescens	36			1		13				
Monocymbium ceresiiforme	46		2	48	3	11	4	1		
Species Group 18										
Melinis repens s grandiflora					1		81		2	
Cyperus margaritaceus					2		72	4		
Kohautia virgata	9		5		2		65		2	4
Justicia species				1	3		59			
Aristida mollis							52			
Lophiocarpus tenuissimus							42			
Diheteropogon filifolius							37			
Hermannia tomentosa				7	7		37	3		
Tephrosia burchellii							35			
Strychnos cocculoides					2	3	34	2	5	
Striga asiatica					2		34	2		
Tephrosia forbesii							32			
Ledebouria graminifolia							31			
Crabbea hirsuta					2		31			1
Dichapetalum cymosum					2	2	30	2		
Securidaca longepedunculata					1		29			1
Pollichia campestris					2	3	26	7		
Kohautia caespitosa				2			25			
Elephantorrhiza obliqua						3	25			
Ipomoea obscura				1	5	5	23	3	2	3
Nidorella hottentotica							22	1		
Rhynchosia longiflora							21			
Tragia rupestris				1	1		20		2	3
Pentarrhinum insipidum							20			
Phyllanthus maderaspatensis							20			
Vernonia oligocephala				7		6	19	2	2	
Justicia anagalloides							19			3
Agathisanthemum bojeri					9	5	19	8		3
Loudetia flavida					2		18		7	
Spermacoce senensis				2			18	1		2
Cleome rubella							15	2		
Hypoxis hemerocallidea					4		15			
Hibiscus engleri					7		13	1		9
Gomphocarpus fruticosus					1		13	5		
Crabbea angustifolia				1	1		13	1		
Cymbopogon plurinodis				4	4	1	12	7	5	1
Chamaecrista absus							11			
Chamaesyce inaequilatera							10			5
Species Group 19										
Triumfetta sonderi				1	6	16	18	5		
Lannea edulis				3	5	16	16	4		
Ximenia caffra					8	11	14	1	9	7
Digitaria monodactyla			2	6	5	14	13	2		1
Species Group 20										
Cleome maculata				4	16	7	59	5		
Limeum viscosum				2	16		54	4		
Strychnos pungens				3	46	10	48	9	9	

Aristida aequiglumis				3	16	5	34	2	2		
Aristida diffusa				3	18		17	3		3	
Indigofera filipes				6	10	2	16	3	2		
Vitex pooara					14	6	13	1	9		
Mundulea sericea				2	26	7	13	7	7	4	
Species Group 21											
Diheteropogon amplectens			5	46	38	60	62	9	2		
Elionurus muticus				16	12	17	48	7			
Brachiaria serrata				21	16	10	43	6	9	1	
Chaetacanthus costatus	9			41	2	3	34		2		
Urelytrum agropyroides				33	5	10	28	2			
Parinari capensis				17	15	29	26	6	2		
Pygmaeothamnus zeyheri				13	5	14	18	5			
Xerophyta retinervis				31	25	9	18	4	5		
Dicoma anomala				48	10	18	14	2			
Tristachya rehmannii				21	2	3	13	1			
Indigofera comosa				14	9	14	12	2			
Species Group 22											
Bulbostylis burchellii	9	67	2	77	13	12	69	7			2
Species Group 23											
Cynodon dactylon				3	2		3	27	9	5	2
Hyperthelia dissoluta	9				2	3	3	18	2		
Hyparrhenia hirta	9		2	3		7	3	16	2		
Terminalia brachystemma					4	1	2	16		5	
Bidens pilosa			2		7	5	2	14	7	3	
Solanum incanum			2	8	3	6	3	11	9	5	2
Eragrostis chloromelas			7	2	6	3		11	5		2
Species Group 24											
Indigofera daleoides					7	6	36	19	2		2
Trichoneura grandiglumus				1	8	2	19	18			
Chamaecrista mimosoides				9	5	5	52	10	5		
Species Group 25											
Aristida stipitata					8	19	35	32		1	
Perotis patens				3	5	10	78	28	2	1	
Eragrostis pallens				4	2	18	67	19		3	
Conyza bonariensis						11		14		3	
Lopholaena coriifolia				2	7	23	1	10			
Species Group 26											
Burkea africana			2	8	69	37	80	35	5		
Eragrostis gummiflua			2	6	18	17	16	32	2	1	
Oldenlandia herbacea				2	34	30	9	30	5	5	
Ochna pulchra				8	36	18	70	17			
Brachiaria nigropedata			2		31	4	41	13		4	
Schizachyrium jeffreysi				1	23	5	53	13			
Andropogon chinensis				1	28	39		10			4

Species Group 27											
Felicia muricata				11	1	13	3	18			
Schizachyrium sanguineum				27	40	52	43	14			
Fadogia homblei			2	42	35	54	19	11			
Loudetia simplex				84	59	41	3	10	2		
Eragrostis racemosa				83	20	49	17	10	2	3	
Species Group 28											
Setaria sphacelata	9	33	2	19	17	74	43	25	7	3	
Species Group 29											
Aristida junciformis	55		2		5	33	9	12		1	
Species Group 30											
Fluegga virosa			5				4	30	7	2	
Schotia brachypetala			9		1		1	27	5		
Enneapogon scoparius					8	4	6	27	9		
Bridelia mollis			2		5		3	25	1		
Scolopia zeyheri			7					23	3		
Zanthoxylum capense			9		1	5		23			
Kirkia acuminata					3		4	21	3	2	
Ximenia americana								21		8	
Clerodendrum glabrum			5		3	8	6	21			
Spirostachys africana			2					14	5		
Setaria pumila					1		5	14	4		
Psiadia punctulata								14			
Schistostephium heptalobum			5	4				14			
Obetia tenax			2					14			
Lippia rehmannii					3		3	11			
Hermannia floribunda								11	1		
Jatropha zeyheri					7	5		11	1		
Cassine aethiopica								11	1		
Tephrosia species					4		2	11	1		
Aloe marlothii					9	3	2	11	3		
Adenia glauca					3			11			
Euphorbia cooperi					1			9			
Euphorbia schinzii					1	1		7			
Species Group 31											
Tagetes minuta	9		2	2	3	8	7	10	11	5	
Species Group 32											
Sida cordifolia			2		3	4	20	22	25	8	2
Indigofera species					4		20	2	14	1	4
Species Group 33											
Eragrostis curvula				7	7	13	11	22	23	8	
Species Group 34											
Pseudolachnostylis maprouneifolia				1	36	6	3	5	23		
Commelina erecta				1	17	15	34	8	21	9	
Lannea discolor				3	51	25	36	15	18		
Elephantorrhiza burkei				3	40	36		7	18		4
Gardenia volkensii			5	1	15	11		4	18	4	

Diplorhynchus condylocarpon			1	56	5	9	8	14	
Pterocarpus rotundifolius				25	9	1	17	14	
Rhoicissus revoilii			4	37	21		7	14	7
Combretum zeyheri				25	12	44	20	14	1
Strychnos madagascariensis			1	15			4	14	
Species Group 35									
Vitex rehmannii		5	16	41	46	51	22	25	
Asparagus transvaalensis			24	4				23	
Trachypogon spicatus		9	59	21	51	43	14	16	1
Ozoroa paniculosa		2	10	40	28	32	12	11	
Tephrosia longipes			36	35	5	14	15	11	8
Species Group 36									
Dombeya rotundifolia			14	3	12	21	39	13	71	7
Euclea natalensis			12		16	4	34	8	36	9
Acacia caffra			16	10	5	26	6	16	36	1
Berchemia zeyheri			12	1	1	1		2	34	
Mimusops zeyheri			19		7	19		2	32	1
Olea europaea			30			2		2	30	
Euphorbia ingens			26		2				27	1
Combretum molle			12	12	87	60	55	21	27	1
Brachylaena rotundata			14	8	11	15			23	1
Pellaea calomelanos			47	42	49	16	14	7	23	
Cussonia paniculata			12	1	2				21	
Croton gratissimus			19		24	4	1	4	21	1
Englerophytum magalismontanum			14	36	66	35	1	4	21	1
Diospyros whyteana			58	1	7				16	
Vangueria infausta			14	49	39	42	2	5	16	
Rhoicissus tridentata			16	6	5	8		2	16	1
Ficus thonningii			21	1	2	4		4	14	
Maytenus undata			33	2	3	4			14	
Heteropyxis natalensis		9	19	11	15	22		3	14	1
Faurea saligna		9	16	13	13	42	4	10	11	
Species Group 37									
Ehretia rigida			9		9		7	7	9	33	
Sporobolus ioclados								8		30	
Acacia erubescens								7	2	29	4
Achyropsis avicularis							2		2	20	
Sporobolus fimbriatus							3	2	7	16	
Acacia erioloba								2		15	
Acacia burkei							2	4		15	
Phyllanthus reticulatus										15	
Eragrostis trichophora				1				2	2	15	
Brachiaria eruciformis										13	
Justicia protracta							4		5	13	2
Tephrosia capensis					1			2	7	12	
Jasminum breviflorum										12	
Gymnosporia polyacantha			9		1				7	11	
Hibiscus pusillus							3		2	11	
Cyphostemma cirrhosum										11	
Kalanchoe lanceolata					1		7			11	
Blepharis integrifolia					1					11	2
Opuntia species										11	

Species Group 38									
Carissa bispinosa	5				3		21	21	
Combretum hereroense			3		1	2	18	20	
Kalanchoe rotundifolia	2	2	4	3	3	1	11	18	
Elaeodendro transvaalensis	5				3		11	15	
Sida dregei			1	3	3	2	16	12	
Species Group 39									
Solanum panduriforme		2	5	8	2	21	25	38	
Chamaecrista comosa						10	5	16	
Species Group 40									
Grewia flavescens			8	4	55	24	36	43	8
Euclea undulata					13	2	9	29	
Aloe greatheadi v davyana			2		25		2	20	
Sida alba					15			11	
Solanum coccineum					26		2	11	
Species Group 41									
Gymnosporia buxifolia			5	14	8	7	39	18	2
Euclea crispa	9	2	5	22	3	23	57	13	
Asparagus laricinus			3	10		3	2	13	
Species Group 42									
Terminalia sericea			16	5	76	55	11	18	
Lippia javanica		3	15	39	19	30	21	13	
Species Group 43									
Commelina africana	5	42	42	16	69	19	5	16	
Species Group 44									
Rhus leptodictya	12		9	19	13	9	55	21	
Pappea capensis	19		3	4	3	4	68	15	
Asparagus setaceus	19		10	2		2	2	12	
Diospyros lycioides	12		3	12	12	7	11	11	
Species Group 45									
Enneapogon cenchroides			3			3	5	1	77
Melhania acuminata									67
Achyrantes aspera	2						2	1	63
Monechma debile									54
Hibiscus micranthus									52
Corbichonia decumbens									46
Urochloa panicoides									44
Bothriochloa radicans									42
Eragrostis species									42
Tephrosia purparascens									40
Seddera capensis									38
Carex austro-africana									33
Melhania rehmannii									31
Aristida rhiniochloa			6			3		1	29
Momordica repens									25
Aptosimum lineare									25
Tribulus species								1	25

Setaria verticillata								1	25
Cenchrus ciliaris							2	3	23
Indigofera nigromontan									21
Heliotropium steudneri									21
Leucas glabrata									21
Giseki africana									21
Commiphora africana							2	1	21
Boscia foetida									20
Sida chrysantha					8			3	19
Ehretia amoena									19
Geigeria ornativa							2		19
Dipcadi glaucum									15
Lycium cinereum								9	15
Dicoma tomentosa									15
Indigofera alternata									15
Blechnum australe									13
Abutilon austro-africanum								5	13
Mariscus rehmannianus									13
Chenopodium album									13
Asparagus nelsii									13
Cissus fragilis									13
Clerodendrum ternatum									13
Ceratotheca triloba						4		5	10
Geigeria burkei			1	7			2		10
Dicliptera fruticosa									10
Ornithoglossum species									10
Digitaria velutina									10
Ledebouria viscosa									10

Species Group 46

Tragus berteronianus						8		11	54
Pupalia lappacea							2	11	46
Acacia mellifera					2	2	7	21	21
Euclea divinorum						2		15	21
Justicia flava					2		5	29	15
Combretum imberbe	2						5	12	13

Species Group 47

Acacia nigrescens						2	30	16	69
Pavonia burchellii	2					1	21	12	27
Commiphora mollis			3			3	14	3	21
Sclerocarya birrea			2		2	4	21	4	17
Boscia albitrunca					1		14	4	17
Acacia robusta	5					2	14	5	15

Species Group 48

Grewia bicolor			5			14	16	34	77
Grewia flava	2	1	2	1	4	15	39	36	75
Aristida adscensionis		2	2	2	6	13	5		73
Aristida congesta s barbicollis		2		3		26	5	18	40
Urochloa mosambicensis						10		11	19

Species Group 49										
Kyphocarpa angustifolia			4		47	3		18	67	
Ruellia patula					18		2	3	38	
Pogonarthria squarrosa		4	5	8	31	45	11	7	23	
Peltophorum africanum			3	3	20	23	23	15	19	
Commelina benghalensis			2		12	2	5		13	
Species Group 50										
Grewia monticola			11	3	9	10	30	18	58	
Panicum maximum		1	25	9	28	38	73	65	56	
Combretum apiculatum			19	9	19	27	48	18	38	
Waltheria indica		3	17	3	74	33	16	18	35	
Phyllanthus parvulus		8	33	3	43	6	2	1	19	
Asparagus suaveolens		6	30	21	23	6	9	25	19	
Digitaria eriantha			44	19	81	63	23	33	17	
Species Group 51										
Melinis repens s repens	7	21	55	41	7	69	28	11	50	
Heteropogon contortus	2	40	20	37	46	38	21	9	15	
Species Group 52										
Jamesbrittenia aurantiaca								4		80
Senecio apiifolius								1		80
Salvia repens								3		80
Falckia oblonga								3		80
Berkheya radula								3		80
Scilla dracomontana								1		60
Aspilia species										60
Dichanthium annulatum					1	2		3	6	60
Crotalaria sphaerocarpa					2	2		1	2	20
Leucas neuflizeana					2				4	20
Cullen holubii					1					20
Litogyne gariepina								1		20
Mariscus species										20
Nesaea schinzii								4		20
Species Group 53										
Acacia nilotica					4	2	2	12	6	60
Acacia tortilis					5	4	7	49	75	20
Chloris virgata						2		30	54	20
Species Group 54										
Rhus pyroides	2		1	8	3	12	7	17		20
Monsonia angustifolia			3	3	3	10				20
Schmidtia pappophoroides			7		2	22	21	25	25	20
Schkuhria pinnata			2		2	11	9	5	31	20
Eragrostis rigidior			3	2	7	35	23	26	33	20
Acacia karroo				3	3	16	27	40	25	20
Species Group 55										
Solanum delagoense					14			4	63	20
Dichrostachys cinerea			5	5	48	35	32	66	67	20
Achyranthes aspera	2	1	2	5	26	4	9	30	2	20
Evolvulus alsinoides		2	5	3	72	6	2	1	8	20
Hibiscus cannabinus					19			4		20

Portulaca pilosa						19					20
Hermbstaedtia linearis						14				40	20
Eragrostis lehmanniana			1	2	7	21	19	14	18	10	20
Species Group 56											
Aristida congesta s congesta			7	35	23	83	65	22	30	8	20
Ziziphus mucronata		5		10	10	4	21	80	41		20
Vernonia poskeana		2	2	16	6	61	16		3	2	20
Species Group 57											
Themeda triandra			56	24	57	46	16	18	11	2	60
Species Group 58											
Setaria incrassata	9	67	2						4	2	80
Senecio inornatus		67			2		4		4		20
Species Group 59											
Aristida bipartita	36								3		80

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