Introduction

Mentis & Huntley (1982) as well as Scheepers (1986) stated the necessity to determine the location and extent of the major vegetation types within the Grassland Biome. As part of a phytosociological research programme on the synthesis of the vegetation of the Grassland Biome in South Africa (Bezuidenhout, in prep); in this paper a description of the vegetation of the Fb land type in the study area is presented.

The gold-bearing quartzitic rock of the Witwatersrand Supergroup in the Fb land type is of great national importance (Coetzee 1976). Although mining activities have caused destruction and degradation of the vegetation of the Fb land type, large areas with relatively well-preserved vegetation can still be found on the rocky hills and ridges in the area. The need to classify and describe this vegetation can therefore not be over-emphasized. Habitat and floristic diversity of rocky quartzitic hills are known from other parts of the Grassland Biome (Bredenkamp & Theron 1978; Bredenkamp & Lam-
brochts 1979; Behr & Bredenkamp 1988). To formulate a management policy, proper land use should be emphasized, and for this purpose a classification of the vegetation is essential (van Rooyen et al. 1981). It will also provide scientific guidelines for conservation priorities. The results should contribute to the ultimate aim of a phytosociological and syn-taxonomical synthesis of the South African Grassland Biome.

Study area

The study area is situated in the western part of the Highveld Agricultural Region, Transvaal, and is bounded by latitudes 25°45' and 27°15' south and longitudes 24°45' and 28°00' east (Figure 1). Most of the Fb land type islands are situated to the eastern part of the study area with isolated parts in the central and western parts of the study area. The well-known Gatsrant hill range between Potchefstroom and Carletonville and the outer rim of the Vredefort Dome just south of Potchefstroom form the main core of the Fb land type in the western Transvaal. The Fb land type covers approximately 178 130 hectares, and although the Land Type Survey Staff (1984) estimated that between 5 and 10% is unsuitable for agronomy, very little of the Fb land type has been ploughed. Apart from the fact that mining companies own much of the Fb land type area, one of the main reasons for not ploughing it is that the dominant soil types are relatively shallow (between 100 and 350 mm) and rocky with the soil forms Glenrosa, Mispah and shallow Hutton predominant (Land Type Survey Staff 1984). The soil nomenclature follows the classification of MacVicar et al. (1977). The main rock types of the Fb land type are shale, slate and quartzite of the Pretoria Group with interlayered diabase sills and Hekpoort lava. Chert, dolomite and Black Reef quartzite are present in some places. The quartzite usually forms the crests and scarps in the terrain while the footslopes are usually covered by mixed colluvium. The mid-slopes and drainage lines are on the shales and slate (Land Type Survey Staff 1984). The Fb land type is drained by the tributaries of the Schoonspruit and the Mooi River.

The terrain is mostly high-lying and is situated at altitudes of 1372 – 1676 m above sea-level. The Fb land type represents the conspicuous parts in the study area and can easily be recognized while travelling through the western Transvaal. The average summer rainfall in the east exceeds 600 mm, with Potchefstroom receiving 625 mm and Carletonville 670 mm per year. However, in the west the rainfall is erratic and sometimes lower than 450 mm per annum. The mean minimum monthly winter temperatures are sometimes below -1°C whilst the mean maximum monthly summer temperatures are as high as 32°C (Weather Bureau 1988).

Methods

The broad stratification of the study area was based on land type, while terrain type was used within each land type for a more detailed stratification. The term 'land type' is used in a land-use classification system describing a homogeneous terrain with regard to soil pattern and climate (Land Type Survey Staff 1984). The following terrain types were recognized in the Fb land type: Plateau (1/0); Crest (1); Scarp (2); Midslope (3); Footslope (4); and Drainage line (5) (Figure 2). Releves were compiled in 96 stratified sample plots. Plot sizes were fixed at 16 m^2 for the grassland vegetation and 100 m^2 for the woody vegetation (Bredenkamp & Theron 1978). For every plant species present in the sample plot, a cover-abundance value was estimated according to the Braun-Blanquet scale (Mueller-Dombois & Ellenberg 1974). Height and canopy cover for the tree, shrub and herbaceous layers were additionally recorded in each sample plot, and average values calculated for each plant community. Environmental information such as rock type, terrain type and soil type, as well as soil depth and an estimation of rockiness of the soil surface, and also slope inclination, were noted (Figures 3 and 4). For analysing the raw floristic data an objective statistical classification technique, TWINSPAN (Hill 1979a), was used complementary to the Braun-Blanquet procedures. The final result of the classification procedure is represented in a phytosociological table (Table 1). An ordination technique, DECORANA (Hill 1979b), was also applied to the Braun-Blanquet procedures. The final result of the classification procedure is represented in a phytosociological table (Table 1). An ordination technique, DECORANA (Hill 1979b), was also applied to the floristic data (Figure 4). Taxa names conform to those of Arnold and De Wet (1993). This is the first comprehensive vegetation classification of the entire Fb land type of the western
Transvaal grassland and therefore new syntaxa are described and formal syntaxonomy, in accordance with the Code of Phytosociological Nomenclature (Barkman et al. 1986), is applied to the classification.

Results

Classification

In the phytosociological table (Table 1), two alliances, seven associations and two sub-associations are recognized. The hierarchical classification of these vegetation units is as follows:

1. **Rho d i e t d i t y o − Aca c i e m c a f f rae**
   1.1 **Acacietum karroo-caffrae**
   1.1.1 **Acacietum karroo-caffrae rhoetosum pyroidis**
   1.1.2 **Acacietum karroo-caffrae barlerietosum macrostegiae**

2. **Diheteropogono amplectentis-Schizachyrion sanguinei**
   2.1 **Monocymbio ceresiiformis − Schizachyrietums sanguinei**
   2.2 **Uryletro agropyroidis − Schizachyrietums sanguinei**

3. **Hyparrhenio hirtae − Eragrostidetum planae**

Description of the syntaxa

The vegetation of the Fb land type is strongly associated with the rocky outcrops and hills of the study area. Typical of the vegetation of the Western Transvaal, two broad phytosociological classes, namely woodland and grassland, can easily be distinguished (Bezuidenhout & Broedentamp 1990). The vegetation of the Fb land type differs from the rest of the study area in so far that woodland predominates in the study area, whereas grassland is normally the dominant vegetation type (Table 1).

In the Fb land type the grassland vegetation occurs as an upland grassland on the high-altitude plateaux/midslopes, or as bottomland grassland in narrow drainage lines.

1. **Rho d i e t d i t y o − Aca c i e m c a f f rae all. nov.**
   Nomenclatorial type: releve 98

This alliance represents a large part of the vegetation of the Fb land type and is characterized by species group H (Table 1). The diagnostic species are the trees *Acacia caffra*, *Rhus leptodictya*, and the shrubs *Ehretia rigida*, *Maytenus heterophylla*, *Euclea crispa* and *Zanthoxylum capense*. The small shrubby *Protasparagus suaveolens* and the grass *Eustachys paspaloides* are also diagnostic species of the **Rho d i e t d i t y o − Aca c i e m c a f f rae**. The **Rho d i e t d i t y o − Aca c i e m c a f f rae** occurs on the slopes of the hills and ridges. This alliance is represented by 53 relevés and four associations are recognized.

1.1 **Acacietum karroo-caffrae ass. nov.**
   Nomenclatorial type: releve 292

The **Acacietum karroo-caffrae** is found on the footslopes and midslopes (terrain units 3 and 4) of the rocky outcrops and hills of the Fb land type (Figures 2 and 3). This association represents the relatively low-altitude woodland. Related vegetation is present in some of the other land types in the study area (Bezuidenhout, in prep). There may be rocks and stones on the soil surface, but the rock cover is normally less than 10% (Figure 4). The diagnostic tree species *Acacia karroo*, *Ziziphus mucronata* and *Celtis africana* dominate this association. Other diagnostic species (Table 1, species group A) which also characterize the association are the grass species *Digitaria eriantha*, *Traqus berteroniansus* and *Eragrostis obtusa* as well as the pioneer forbs *Hibiscus pusillus*, *Blepharis angustifolia* and *Pavonia burchellii*. This vegetation is excellent for cattle- and sheep-farming and is often subjected to overgrazing, resulting in degradation and the subsequent presence of many pioneer species. Two sub-associations can be identified within this association.

1.1.1 **Acacietum karroo-caffrae rhoetosum pyroidis subass. nov.**
   Nomenclatorial type: releve 292

The **Acacietum karroo-caffrae** is found on the footslopes and midslopes (terrain units 3 and 4) of the rocky outcrops and hills of the Fb land type (Figures 2 and 3). This association represents the relatively low-altitude woodland. Related vegetation is present in some of the other land types in the study area (Bezuidenhout, in prep). There may be rocks and stones on the soil surface, but the rock cover is normally less than 10% (Figure 4). The diagnostic tree species *Acacia karroo*, *Ziziphus mucronata* and *Celtis africana* dominate this association. Other diagnostic species (Table 1, species group A) which also characterize the association are the grass species *Digitaria eriantha*, *Traqus berteroniansus* and *Eragrostis obtusa* as well as the pioneer forbs *Hibiscus pusillus*, *Blepharis angustifolia* and *Pavonia burchellii*. This vegetation is excellent for cattle- and sheep-farming and is often subjected to overgrazing, resulting in degradation and the subsequent presence of many pioneer species. Two sub-associations can be identified within this association.
This sub-association is strongly associated with the footslopes of the rocky outcrops and hills of the Fb land type (Figure 2). It occurs on slopes between 0 and 3% and the soil is deeper than 0.3 m. The Hutton (Hu) and Glenrosa (Gs) soil forms are the dominant forms in this sub-association (Figure 3). Less than 10% of the soil surface is covered by rocks and stones (Figure 4). The tree *Acacia robusta* and the shrubs *Rhus pyriodes* and *Maytenus polyacantha* and the grass *Sporobolus*
Table 1 A phytosociological table of the vegetation of the Fb land type in the western Transvaal, South Africa (all numbers are explained in the text)

| Sample plots | 1 1.1 | 1.1.1 | 1.2 | 1.3 | 1.4 | 2.1 | 2.2 | 2.3 |
|--------------|-------|-------|-----|-----|-----|-----|-----|-----|
| Syntaxa      | A     | B     | C   | D   | E   | F   | G   | H   |
| Species group A |       |       |     |     |     |     |     |     |
| Acacia karro  |       |       |     |     |     |     |     |     |
| Rhus pyrcides |       |       |     |     |     |     |     |     |
| Species group B |       |       |     |     |     |     |     |     |
| Species group C |       |       |     |     |     |     |     |     |
| Species group D |       |       |     |     |     |     |     |     |
| Species group E |       |       |     |     |     |     |     |     |
| Species group F |       |       |     |     |     |     |     |     |
| Species group G |       |       |     |     |     |     |     |     |
| Species group H |       |       |     |     |     |     |     |     |
Table 1 Continued

| System | 1.1.1 | 1.1.2 | 1.2 | 1.3 | 1.4 | 2.1 | 2.2 | 2.3 |
|--------|-------|-------|-----|-----|-----|-----|-----|-----|
| Species group C |       |       |     |     |     |     |     |     |
| Justicia angoloides | ++ | + | + | + | + | + | +++ | +++ |
| Stoebe vulgaris | + | - | + | + | + | ++ | + | +++ |
| Seseli cuminus | + | + | + | + | + | ++ | + | +++ |
| Plantago angustifolia | + | + | + | + | + | ++ | + | +++ |
| Polygala toxonotis | + | + | + | + | + | ++ | + | +++ |
| Locenion fulvous | + | + | + | + | + | ++ | + | +++ |
| Leucopogon superbus | + | + | + | + | + | ++ | + | +++ |
| Alloupopogon simplex | + | + | + | + | + | ++ | + | +++ |
| Cynisus speciosus | + | + | + | + | + | ++ | + | +++ |
| Nerium oleander | + | + | + | + | + | ++ | + | +++ |
| Byrketum gracilis | + | + | + | + | + | ++ | + | +++ |
| Ligularia ambractea | + | + | + | + | + | ++ | + | +++ |
| Tymosporum saxifraga | + | + | + | + | + | ++ | + | +++ |
| Indigofera raubidosca | + | + | + | + | + | ++ | + | +++ |
| Indigofera himalayensis | + | + | + | + | + | ++ | + | +++ |
| Gospera cinnaba | + | + | + | + | + | ++ | + | +++ |
| Leciga cepaesa | + | + | + | + | + | ++ | + | +++ |
| Hypericum anthostigma | + | + | + | + | + | ++ | + | +++ |
| Polanet cepaesa | + | + | + | + | + | ++ | + | +++ |
| Cyatella erubidea | + | + | + | + | + | ++ | + | +++ |
| Sporobolus spathulata | + | + | + | + | + | ++ | + | +++ |
| Species group K |       |       |     |     |     |     |     |     |
| Orthosperum angustifolium | + | + | + | + | + | ++ | + | +++ |
| Dicrasterum scopoletosum | + | + | + | + | + | ++ | + | +++ |
| Aristea dipteryx | + | + | + | + | + | ++ | + | +++ |
| Lepidopogon dematulata | + | + | + | + | + | ++ | + | +++ |
| Tristachya leucophylica | + | + | + | + | + | ++ | + | +++ |
| Stachys pectinata | + | + | + | + | + | ++ | + | +++ |
| Species group L |       |       |     |     |     |     |     |     |
| Lobelia cipularis | + | + | + | + | + | ++ | + | +++ |
| Indigofera ramosa | + | + | + | + | + | ++ | + | +++ |
| Scopularia latifolias | + | + | + | + | + | ++ | + | +++ |
| Mandula sericosa | + | + | + | + | + | ++ | + | +++ |
| Species group M |       |       |     |     |     |     |     |     |
| Disopyros rupinana | + | + | + | + | + | ++ | + | +++ |
| Vangueria rulaenta | + | + | + | + | + | ++ | + | +++ |
| Mini miquiamontana | + | + | + | + | + | ++ | + | +++ |
| Pella calomelanos | + | + | + | + | + | ++ | + | +++ |
| Species group N |       |       |     |     |     |     |     |     |
| Bulbosty bultelli | + | + | + | + | + | ++ | + | +++ |
| Tephrosia lancea | + | + | + | + | + | ++ | + | +++ |
| Bimbae ovata | + | + | + | + | + | ++ | + | +++ |
| Species group C |       |       |     |     |     |     |     |     |
| Brachyion saccata | + | + | + | + | + | ++ | + | +++ |
| Trachyabuctus scaphiaceus | + | + | + | + | + | ++ | + | +++ |
| Melinis cusene | + | + | + | + | + | ++ | + | +++ |
| Andropogon schinca | + | + | + | + | + | ++ | + | +++ |
| Scadoxus vanhems | + | + | + | + | + | ++ | + | +++ |
| Dicoma annulata | + | + | + | + | + | ++ | + | +++ |
| Tribocerus grandiplinum | + | + | + | + | + | ++ | + | +++ |
| Odina capilata | + | + | + | + | + | ++ | + | +++ |
| Anaphyllum angustifolium | + | + | + | + | + | ++ | + | +++ |
| Elephantorrhizus elephanta | + | + | + | + | + | ++ | + | +++ |
| Melinis neriiflora | + | + | + | + | + | ++ | + | +++ |
| Plaxisium reddingii | + | + | + | + | + | ++ | + | +++ |
| Tetraptis antropogonoides | + | + | + | + | + | ++ | + | +++ |
| Cameraria minorobus | + | + | + | + | + | ++ | + | +++ |
| Species group F |       |       |     |     |     |     |     |     |
| Hyparrhenia airta | + | + | + | + | + | ++ | + | +++ |
| Arrosatrix plana | + | + | + | + | + | ++ | + | +++ |
| Werena kemaniensis | + | + | + | + | + | ++ | + | +++ |
| Setaria laevisirta | + | + | + | + | + | ++ | + | +++ |
| Gomphio droopera | + | + | + | + | + | ++ | + | +++ |
| Sample plots | 8902613111412345 | 645551234512345 | 9876543210987654 | 09876543210987654 | 09876543210987654 | 09876543210987654 | 09876543210987654 |
|--------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| Species group 0 |                  |                  |                  |                  |                  |                  |                  |
| Eragrostis nervosa | +               | +                | +                | +                | +                | +                | +                |
| Eragrostis curvula | -               | -                | -                | -                | -                | -                | -                |
| Eragrostis compressa | -               | -                | -                | -                | -                | -                | -                |
| Helichrysum multiflora | +               | +                | +                | +                | +                | +                | +                |
| Lecanopsis stricta | -               | -                | -                | -                | -                | -                | -                |
| Linaria hirsuta | -               | -                | -                | -                | -                | -                | -                |
| Phlomis tomentosa | -               | -                | -                | -                | -                | -                | -                |
| Species group R |                  |                  |                  |                  |                  |                  |                  |
| Eragrostis nervosa | +               | +                | +                | +                | +                | +                | +                |
| Eragrostis curvula | -               | -                | -                | -                | -                | -                | -                |
| Eragrostis compressa | -               | -                | -                | -                | -                | -                | -                |
| Helichrysum multiflora | +               | +                | +                | +                | +                | +                | +                |
| Lecanopsis stricta | -               | -                | -                | -                | -                | -                | -                |
| Linaria hirsuta | -               | -                | -                | -                | -                | -                | -                |
| Phlomis tomentosa | -               | -                | -                | -                | -                | -                | -                |
Africanus are the diagnostic species (Table 1, species group B) which characterize the Acacia kaffr-coeffeae rheotomum pyroidis. Species from species groups A (diagnostic for the association), E and H (diagnostic for the alliance), as well as most of the more common species from species group R (Table 1), are present in this sub-association. An average of 30 species was recorded per sample plot.

The tree stratum is well developed and is 5.25 m tall with a canopy cover of 25.5%. The shrub stratum is 2.24 m tall and has a canopy cover of 19.2% while the herbaceous layer is 0.71 m tall with a fairly scanty canopy cover of 29.2%.

1.1.2 Acaciaum kaffr-coeffeae barterietosum macrostegiae subass. nov.
Nomenclatorial type: releve 245

The Acaciaum kaffr-coeffeae barterietosum macrostegiae is found on the midslopes and sometimes on the footslopes where the slope is between 3 and 6% (Figure 2). The soils are fairly shallow, representing the Mispaah (Ms), Glenrosa (Gs) and Hutton (Hu) soil forms. No tree species are diagnostic for this sub-association but the diagnostic species (Table 1, species group C) are the inconspicuous, though mostly perennial forbs Barleria macrostegia, Chamaesyce hirta and the small shrub Lantana rugosa. Other species which are also present in this sub-association are species from groups A (diagnostic for the association), E and H (diagnostic for the alliance), and the common species from species group R (Table 1). An average of 28 species per sample plot was noted.

The tree stratum is well developed and is 4.97 m tall with a canopy cover of 14.7%. The shrub stratum is 2.01 m tall with a canopy cover of 25.6%, while the herbaceous layer which is not very tall (average of 0.57 m) is relatively well developed with a canopy cover of 37.5%.

1.2 Rhus rigidae - Acaciuetum coeffae ass. nov.
Nomenclatorial type: releve 98

The Rhus rigidae - Acaciuetum coeffae is associated with the crest of the hills and rocky outcrops in the Fb land type (Figure 2). The soil surface is very rocky, with Mispaah (Ms) and Glenrosa (Gs) soil forms also present in this relatively high-altitude woodland (Figure 3). Although only one species, the dwarf shrub Rhus rigida (Table 1, species group D), was identified as diagnostic for this community, the vegetation is interpreted as to represent an association, as this specific species combination is typical for this particular habitat in the Fb land type. The presence of species group O (Table 1) in this association indicates that this vegetation is floristically related to the high-lying grasslands. Several grasses such as Andropogon schiren-sis, Trachypogon spectus and Triraphis andropogonoides which are typical of the relatively high-lying grassland areas in the Fb land type, are prominent in this association. The species of species groups E, H (diagnostic for the alliance) and R are also present in this association (Table 1). An average of 28 species was noted per sample plot.

The tree stratum, which is dominated by Acacia coeffae, is well developed, 5.43 m tall and has a canopy cover of 13.5%. The shrub stratum is also well developed and is 2.19 m tall with a canopy cover of 18.1%. The herbaceous layer is 0.83 m tall, well developed and has a canopy cover of 46.4%.

A related community was described by Bezuizenhout and Bredenkamp (1991) in the Bc land type.

1.3 Dombeyo rotundifoliae - Acaciuetum coeffae ass. nov.
Nomenclatorial type: releve 99

This relatively high-lying association occurs on the cooler and moister, but extremely rocky (70% rock on the soil surface) scarps of the Fb land type (Figure 2). The limited soil present in this association is exclusively represented by the shallow (< 0.2 m deep) Mispaah (Ms) soil form (Land Type Survey Staff 1984). The tree species Dombeyo rotundifolia, Oleae europeae subsp. africana and the shrub Grewia occidentalis are the diagnostic species (Table 1, species group F). Species from species group H (diagnostic for the alliance) (Table 1) are also prominent in this association. An average of 30 species per sample plot was recorded.

The tree stratum is well developed and is 6 m tall and has a canopy cover of 25%. Apart from the diagnostic trees which are present in this association, Acacia coeffea (Table 1, species group H) is also prominent. The shrub stratum is 1.97 m tall with a canopy cover of 31.3% and is dominated by the diagnostic shrub Grewia occidentalis. Relatively few species of the normally common grasses and forbs are present in this association, which is an indication of the dominance of the woody species. The herbaceous layer is 0.95 m tall and has a canopy cover of 30.5%.

The alien invaders Acacia mearnsii (Black wattle) (Henderson et al. 1987) and Eucalyptus species encroach the Dombeyo rotundifoliae - Acaciuetum coeffae.

A related community was described in the Fann Meinjes Nature Reserve (Bredenkamp & Bezuizenhout 1990).

1.4 Proteo coeffae - Acaciuetum coeffae ass. nov.
Nomenclatorial type: releve 63

The Proteo coeffae - Acaciuetum coeffae occurs on the relatively high-altitude midslopes of the Fb land type (Figure 2). Big boulders on the soil surface are associated with this association (Figure 3). The soil which is relatively shallow (< 0.3 m) is represented by the Glenrosa (Gs) and Mispaah (Ms) soil forms (Land Type Survey Staff 1984). The slope of this habitat is less than that of the Dombeyo rotundifoliae - Acaciuetum coeffae (1.2) and steeper than that of the Acaciuetum kaffr-coeffae barterietosum macrostegiae (1.1.2) (Figure 2). Species groups L, M, N, O and Q (Table 1) indicate the strong floristic relationship between the Proteo coeffae - Acaciuetum coeffae and Monocymbio cerasiformis - Schizachyrietum sanguinei (2.1). When the soil is too shallow for the Proteo coeffae - Acaciuetum coeffae, and big boulders are absent, the Monocymbio cerasiformis - Schizachyrietum sanguinei (2.1) might occur on this terrain type (Figure 3). The trees Protea coeffae and Combretum molle and the shrubs Pavetta zeyheri, Maytenus teniispina and Tupiphyllym parvifolium and the shrub-like forbs Helichrysum kraussii are the diagnostic species for this association (Table 1, species group G). An average of 32 species per sample plot was noted.

The tree stratum is 5.03 m tall and has a canopy cover of 28.5% while the shrub stratum is poorly developed, being 2.30 m tall with a canopy cover of 12.5%. The herbaceous layer is well developed and is 0.92 m tall and has a canopy cover of 47.5%.

2. Diheteropogono amplexicentis - Schizachyriion sanguinei aul. nov.
Nomenclatorial type: releve 487

This alliance occurs on the relatively high-lying plateaux and midslopes of the Fb land type (Figure 3). The shallow soil (< 0.3 m) has more than 10% rocks and stones on the surface (Figure 4). This habitat is drier than that of the Hyparrhenio hirtae - Eragrostidietum planae. This high-altitude grassland is characterized by species group K (Table 1). The diagnostic species are the grass species Schizachyrium sanguineum, Diheteropogono amplexicentis, Aristida diffusa, Tristachya leuco-thrix and Sporobolus pectinatus as well as the inconspicuous forbs Lighfiooia denticulata. This alliance is represented by 33 relevés and two associations can be distinguished.
2.1 Monocymbio ceresiformis – Schizachyrietum sanguinei ass. nov.

Nomenclatoral type: relevé 487

The Monocymbio ceresiformis – Schizachyrietum sanguinei is strongly associated with the high-lying plateaux of the Fb land type (Figure 2). The soil of this habitat is shallow (< 0.3 m) and very rocky with quartzite outcrops scattered about. The dominant soil forms are the Mispah (Ms) and Glenrosa (Gs) forms (Land Type Survey Staff 1984). The diagnostic species are the grasses Monocymbio ceresiformis and Microchloa caffra, the conspicuous forb Sphenostylis angustifolia, the inconspicuous forb Acratome hispida, the fern Chelidanthus hirta and the small succulent Crassula lanceolata subsp. transvaalensis (Table 1, species group 1). Species from species groups K (diagnostic for the alliance), L, M, N, O, Q and R (Table 1) are also present in this association. An average of 33 species per sample plot was noted.

A tree stratum is absent and a scanty low shrubby layer is present in only one sample plot. The herbaceous layer is well developed and has a canopy cover of 44.3% and is 0.76 m tall.

A related community was described by Bezuidenhout (1988) in the Mooi River catchment area, Transvaal.

2.2 Uletrichto agropyroides – Schizachyrietum sanguinei ass. nov.

Nomenclatoral type: relevé 547

This association occurs on the midslopes of the Fb land type. The dominant soil forms present in this association are the Glenrosa (Gs), Mispah (Ms) and Huston (Hs) forms. Large boulders are absent on the soil surface but more than 10% of the soil surface is covered with rocks and stones. The prominent diagnostic species of this association are the grasses Allo­teropsis semialata, Uletrichum agropyroides and Dicliagria monodactyla together with the forb Justicia anagalloides, Senecio coronatus, Pentanisia angustifolia, Polygala hothen­totta and the small bushy shrub Stoebe vulgaris (Table 1, species group J). The species from species groups I, K (diagnostic for the alliance), N, O, Q and R (Table 1) may also occur in this association. The vegetation is mostly dominated by grass species Themeda triandra and Elionurus muticus (Table 1, species group R). An average of 37 species per sample plot was recorded.

The tree stratum is absent, and the shrub stratum is poorly developed with a canopy cover of 9.5% and is 1.65 m tall. The herbaceous layer is well developed with a canopy cover of 57.7% and is 0.68 m tall.

A related community was described by Bezuidenhout (1988) in the Mooi River catchment area, Transvaal.

3. Hyparrhenio hirtae – Eragrostidetum planeae ass. nov.

Nomenclatoral type: relevé 76

This association is characteristic of the drainage lines of the Fb land type. More than 10% rocks and boulders occur on the soil surface of this relatively low-lying grassland. Where it occurs in water courses it is wetter than the Diheteropogono amplex ­tenis – Schizachryion sanguinei (2), and the dominant soil forms are the Rensburg (Rg), Arcadia (Ar) and Mispah (Ms) forms (Land Type Survey Staff 1984). The soil depth varies from 0.1 to 0.6 m. The diagnostic species are the grasses Hyparrhenia hirta, Eragrostis plana and Setaria nigrirostris and the forbs Verbena bonariensis and Oenothera tetrapetala (Table 1, species group P). Species from species groups Q and R (Table 1) are also present in this association. An average of 17 species per sample plot was noted.

The tree and shrub strata are absent. The herbaceous layer has a canopy cover of 60% and is 0.7 m tall.

Ordination

In the scatter diagram the distribution of the syntaxa along the first and second axes of the DECORANA ordination is given (Figure 4). Although no distinct discontinuity can be observed, the plant communities are restricted to specific spatial areas in the diagram. Along the first axis the grassland syntaxa are situated to the right side of the diagram while the woodland syn­taxa occur to the central and left sides of the diagram. Also illustrated on the first axis is a gradient which can be related to soil depth and rockiness of the soil surface. The second axis illustrates a gradient which may be related to altitude (Figure 4). This result confirms the result of the classification, and is not discussed further.

Conclusions

This is the first comprehensive syntaxonomical account of the grasslands of the Fb land type in the western Transvaal grass­land. New syntaxa described include two alliances, seven asso­ciations and two sub-associations.

According to Acocks (1988), the Bankenveld veld type is an open savanna with Acacia caffra. The presence of Acacia caffra, Cellis africana and Protea caffra and other bushveld taxa indicates a strong affinity to the Sour Bushveld and the Sour Mix Bushveld. However, this woodland occurs on rocky outcrops and hills and is unlikely to be found in the plains. However, the Acacia karroo woodland may occur in the plains. The plains are dominated by grassland and where fire and bad management practices have taken their toll, it often has changed only in species composition but not necessarily in physiognomic structure, thus remaining a grassland community.

In exceptional cases, Acacia karroo encroachment may occur on overgrazed grassland vegetation. As far as agriculture is concerned, the vegetation of the Fb land type is not able to support good farming prospects. However, due to great habitat and floristic diversity and for aesthetical reasons, the landscape of the Fb land type deserves to be conserved. The Faan Meintjes Nature Reserve, Suikerbos rand National Nature Reserve and Transvaal Protea Garden can serve as examples where small parts of these nature reserves are situated in the Fb land type (Bredenkamp & Bezuidenhout 1990; Bredenkamp & Theron 1978; Behr & Bredenkamp 1988).

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Comparison of two methods for estimating the size of the viable seed bank of two plant communities in the Strandveld of the west coast, South Africa

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Due to the important role of the soil seed bank in revegetation studies, the viable seed content of two sites at Brand se Baai (Strandveld of the west coast, South Africa) was estimated by means of the emergence and flotation methods. Most of the seeds were found to be small and only 'apparent viability' was determined after flotation had been completed. The average size of the seed bank differed significantly between the two sites and decreased with increased sampling depth. The flotation method yielded a significantly larger number of seeds per square metre than the emergence method. A combination of these two methods is, therefore, recommended for estimating the size of the germinable seed bank of the Strandveld of the west coast, South Africa.

As gevolg van die belangrike rol wat die saadbank in die grond speel in plantegroei-hervestigingsstudies, is die lewensvatbare seedbank van twee lokaliteite by Brand se Baai (Strandveld van die weskus, Suid-Afrika) deur middel van saalingopkomers en flotering bepaal. Die meeste sade was klein en slegs die 'apparent viability' was bepaal nadat flotering voltooi is. Die gemiddelde grootte van die saadbank het betekenisvol verskil tussen die twee lokaliteite en het afgeeneem met 'n toename in monsterdiepte. 'n Groter aantal sade per vierkante meter is deur die flotering.metode opgeweer as deur die saalingopkomsmetode. As gevolg van probleme was eraniere kombinasie van die twee metodes dus vir die bepaling van die grootte van die klarefaze saadbank van Brand se Baai gebied aanbeveel.

Keywords: Emergence, flotation, revegetation, seed bank.

The term 'soil-stored seed bank' has been widely adopted to denote the reserves of viable seeds present in the soil and on its surface (Roberts 1981). 'Seed bank' is used in the broad sense to describe both true seeds and fruits, but not spores or propagules that are produced vegetative.

The soil seed bank is composed of: (a) a transient component, made up mostly of seeds at the soil surface that are capable of immediate germination, a few of which remain viable for more than a year, and (b) a persistent component consisting of seeds that may remain viable for several years (Thompson & Grime 1979; Graham & Hutchings 1988).

Extracting seeds from the soil is both time and labour-consuming and the results are influenced by sampling techniques, the time of sampling and methods used to determine seed numbers (Bigwood & Inouye 1988; Benoit et al. 1989; Simpson et al. 1989; Gross 1990). Estimating the size of the viable seed bank is done either by placing the soil samples under conditions suitable for seed germination (Chippindale &