A phytosociological synthesis of Mopaneveld

by

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Dedicated to Stefan, my parents and to Him, who guides me along my journey

ABSTRACT

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Mopaneveld, a vegetation type dominated by *Colophospermum mopane*, covers an area of approximately 550 000 km^2 over eight countries in southern Africa. A phytosociological synthesis of this extensive vegetation type is presented. TWINSPAN classification was based on existing, adequate, raw vegetation data of southern African Mopaneveld, which included fifteen data sets. Despite the limitations in sound vegetation data, 2 298 relevés contributed to the identification of seven vegetation types and six major plant communities by the application of TWINSPAN. A new method to treat large vegetation data sets is also presented. The wealth of adequate vegetation data from the South African Lowveld Mopaneveld motivated further analysis of this vegetation type. Four major plant communities were identified of which two are discussed in this dissertation. Apart from the phytosociological contribution of this study, TWINSPAN results revealed motivation for the southern African Mopaneveld being an event-driven system which follows non-equilibrial models to explain vegetation change.

Keywords: Mopaneveld, Mopani Veld, *Colophospermum mopane*, TWINSPAN, DECORANA, large vegetation data sets, savanna, phytosociology, synthesis, vegetation dynamics, non-equilibrium, South African Lowveld, southern Africa

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CHAPTER 1

INTRODUCTION

1.1 Background

The environmental heterogeneity of southern African savannas is expressed in diverse ecosystems, each comprising a complex combination of specific organisms, objects, structures and processes. Maintenance of this notable biological wealth depends on the understanding of the ecosystems that underlie this rich biodiversity. Vegetation is a complex phenomenon, which largely reflects ecological processes and therefore, for various practical and academic reasons, deserves to be described and classified (Mucina 1997). Plant communities as a result of vegetation classification, provide baseline information on all ecological processes and consequently provide knowledge on variability, distribution and dynamics of vegetation. Hence, plant communities are generally treated as environmental management units. There is a growing concern in applying phytosociological knowledge in nature conservation and natural resource management. Although such studies are generally of local interest, they provide essential knowledge to holistic focus in vegetation classification.

Why the need for holistic focus on vegetation classification?

Vegetation is more of a continuum than a set of distinct units. Holistic knowledge on vegetation heterogeneity, distribution patterns and dynamics is therefore an indispensable prerequisite for identifying and understanding ecological processes and hence, providing subsequent insight for managing ecological systems and the highly valued renewable resources. It is, for instance, often difficult to explain ecosystem functioning within a small study area in the savannas of southern Africa. When the emphasis is however put on complete integration of vegetation knowledge of southern African savannas, complexity is dispersed, resulting in a simplified view of the same ecosystem.

In southern African savannas little has been done to present plant communities on a scale larger than regional. Mapping and description of large vegetation types are however abundant (e.g. Boughey 1961; Rattray 1962; Wild & Barbosa 1967; Fanshawe 1969; Barbosa 1970; Weare &

Yalala 1971; White 1983; Acocks 1988; Timberlake & Mapaure 1992; Timberlake *et al.* 1993; Giess 1998). Although such descriptions contribute to a better knowledge of southern African savannas, attempts should be made to analyse plant communities documented by recent and historical vegetation relevés (=phytosociological synthesis) to constitute a proper basis for evaluating the consequences of environmental changes, both on regional as well as on international scale (Schaminée & Stortelder 1996).

Why are such studies being avoided in southern Africa?

1) Vegetation sampling in southern Africa is still in its growing stage due to limitations in vegetation knowledge on the regional scale. It is, however also true that botanists eluded vegetation sampling for classification purposes in parts of southern Africa, leaving gaps in sound vegetation knowledge.

2) Considering the high plant species diversity in southern Africa (Cowling & Hilton-Taylor 1994; Davis *et al.* 1994), vegetation studies on a local scale are complex themselves, which consequently suppress interests in large-scale studies.

3) The Zürich-Montpellier or Braun-Blanquet approach for the study of vegetation has proved to be efficient and reliable method for vegetation surveying and classification in most countries (Whittaker 1962; Werger 1974). Since 1969 this approach became popular in southern Africa, however, criticisms on the method (e.g. Egler 1954; Poore 1956; Kent & Coker 1995) evoked uncertainties. Since then, several alternative multivariate methods for vegetation classification evolved (Whittaker 1980; Gaugh 1982), resulting in growing knowledge on vegetation in southern Africa, but lacking consistency between authors.

4) Many vegetation data sets, which are of valuable contribution to vegetation knowledge, were never analysed and described, which consequently hampers phytosociological syntheses.

5) Local/regional vegetation surveying often constitutes biased conclusions due to ignorance of system functioning on a larger scale.

6) A major constraint in phytosociological syntheses is inadequate and inconsistent methods to treat large vegetation data sets containing high species diversity, as in the case of southern African vegetation studies.

1.2 Motivation

Vegetation classification in the Savanna Biome of South Africa has received attention in recent years (e.g. Van der Meulen 1979; Van Rooyen *et al.* 1981a; Van Rooyen *et al.* 1981b; Van Rooyen *et al.* 1981c; Westfall *et al.* 1985; Bredenkamp & Theron 1990; Bredenkamp & Theron 1991; Bredenkamp *et al.* 1993; Coetzee 1983; Nel *et al.* 1993; Schmidt *et al.* 1993; Bredenkamp & Deutschländer 1994; Bredenkamp & Deutschländer 1995; Brown *et al.* 1995a; Brown *et al.* 1995b; Brown *et al.* 1996; Dekker & Van Rooyen 1995; Bezuidenhout 1996; Visser *et al.* 1996). These studies definitely contributed to the knowledge of variability, distribution and dynamics of vegetation, resulting in better natural resource management. It is however evident that little is known at the level beyond the superior vegetation unit.

The study of Winterbach (1998) was one of the first attempts to synthesise knowledge on South African savanna vegetation. This synthesis revealed four major groups of communities, interpreted as zonal vegetation classes, of which the Commiphoro mollis – Colophospermetea mopani evoked further interest. This proposed vegetation class represents Mopaneveld (=Mopani Veld) of the Central Savanna Biome in South Africa, although it is known to cover large areas of savanna vegetation in southern Africa (Mapaure 1994).

The savannas of southern Africa are comprised of various vegetation types of which some, e.g. the Mopaneveld, traverse environmental extremes. Although variability within Mopaneveld vegetation is recognised, no attempt has ever been made to synthesise existing vegetation knowledge. This need can be ascribed to (a) scarcity in adequate methods for synthesising large data sets as well as (b) the priority given to local/regional vegetation studies since the Mopaneveld crosses the borders of several countries.

1.3 Objectives

The **primary goals** of this study include significant contributions to the knowledge on Mopaneveld vegetation in southern Africa by means of classification procedures as well as literature studies. Furthermore the study aims to present a better understanding of the ecological processes within Mopaneveld. The **secondary goal** is to identify the viability of a proposed new method for treating large vegetation data sets by analysing the outcome: e.g. do results reflect speculations on large vegetation types within Mopaneveld?

1.4 Rationale

In order to accomplish the above goals, an investigation was initialised with the following rationale:

- **Problem identification:**
  - (i) The understanding of Mopaneveld vegetation needs assessment.
  - (ii) Scientists strive towards holistic approaches in vegetation studies, but are limited in adequate methods to treat large data sets in regions of high species diversity, e.g. the Mopaneveld.
- **Attempts to solve problem:**
  - (i) A phytosociological synthesis of Mopaneveld.
  - (ii) The proposal of a new method for treating adequate phytosociological data from several studies undertaken in the Mopaneveld of southern Africa.
- **Hypotheses:**
  - (i) Mopaneveld comprises different major vegetation types, which vary along environmental gradients.
  - (ii) Ecological processes within Mopaneveld are reflected by vegetation patterns.
  - (iii) Large data sets can be synthesised by basic phytosociological procedures.
- **Key question:**

  If results could not support the above hypotheses, could it be explained by limitations in the methodology used, or by variance in vegetation that eluded Botanists in previous studies?

This dissertation should be seen as a first attempt to synthesise the vegetation of Mopaneveld over its entire distribution range in southern Africa. The proposed method was developed in coincidence with many constraints encountered in data analysis.

CHAPTER 2

LITERATURE REVIEW

2.1 Phytosociological syntheses

2.1.1 Introduction

A phytosociological synthesis can be described as a study of which the main aim is to compile a synthesis of vegetation information based on phytosociological data collected by various researchers at various times in a particular study area. Large vegetation data sets are generally encountered with in phytosociological syntheses, due to the accumulation of information in the form of vegetation relevés. Knowledge on phytosociological syntheses and the treatment of large vegetation data sets are limited in southern Africa. Identification of basic vegetation units still needs attention, lowering general concern of syntheses and vegetation classification on higher ranks.

2.1.2 Previous attempts to treat large vegetation data sets

One of the first attempts to analise large phytosociological data sets in South Africa, was the three-step method proposed by Bredenkamp and Bezuidenhout (1995). Winterbach (1998) also performed this method in a synthesis of *Acacia*-dominated vegetation of the Central Bushveld of South Africa. The three-step method for a phytosociological synthesis of grasslands in South Africa (Bredenkamp & Bezuidenhout 1995) was based on the two-step procedure proposed by Van der Maarel *et al.* (1987).

a) Van der Maarel *et al.* (1987)

The first step of the method of Van der Maarel *et al.* (1987) is preceded by stratification of the data set. Stratification is suggested either by area (in the case of a large and geographically heterogeneous region), or by vegetation type in the case where all plant communities of an area are covered. Cluster analysis is performed on each stratified unit, resulting in basic clusters (first step). These clusters are then summarised by calculating a "synoptic cover abundance value" for each species in each cluster. The resulting clusters are called synrelevés or synclusters. The second step of this approach is to perform cluster analysis and ordination to synclusters resulting from the first step (Van der Maarel *et al.* 1987).

b) Bredenkamp and Bezuidenhout (1995)

The method of Bredenkamp and Bezuidenhout (1995) is an elaboration of the two-step method of Van der Maarel *et al.* (1987) to a three-step approach. The first step also involves stratification of the complete data set under examination by area or project or, where applicable, to vegetation type, followed by a numerical classification and refinement of the resulting clusters. Resulting plant communities are then summarised in a single synoptic table by means of synoptic values calculated for each species in each community. The second step involves numerical classification of all communities in the synoptic table resulted from step 1 as well as refinement procedures in accordance with the Braun-Blanquet approach. According to Bredenkamp and Bezuidenhout (1995) these two steps result in desirable identification of broad vegetation types within the study area. The extra step includes the compilation of phytosociological tables for each identified broad vegetation type as well as the arrangement of comprehensive hierarchy. This step is considered necessary, as plant communities identified from local studies only, are often inadequate to formally describe syntaxa.

Considering the growing need for vegetation classification on a level higher than the association for conservation and land-use purposes, a clear view on methodology of treating large vegetation data sets is needed. An objective evaluation of both methods is presented below.

Advantages

The attempts of Van der Maarel *et al.* (1987) and Bredenkamp and Bezuidenhout (1995) are of great value for holistic views on existing plant communities. Considering limitations within methods used for numerical classification, consolidating fragments of identified plant communities were at the time of these studies the best way to express variation within larger types. New computer tools have however been developed in the meantime, e.g. JUICE (Tichý 2001) to treat large vegetation data sets.

Criticism

The "holistic picture" resulting from studies based on the above methods, is not necessarily truly representative of the vegetation over its distribution range as a type since only fragments of the vegetation may be included in the analysis. Vegetation classification on a small scale, e.g. plant community identification for management purposes on a game farm, cause marginal relevés, that do not fit well into a known plant community. These marginal relevés, which might assist to express a syntaxon on a higher level of classification, are usually forced into plant communities. This manipulation of data creates the overlooking of transition zones or ecotone vegetation identification. Van der Maarel (1990) emphasised the great ecological interest of ecotones and stressed that it deserves more attention in research. Ecotone plant communities are abstract units on paper, although they do exist in the physical environment. Such plant communities need to be classified since they may require a different management approach.

Certain plant communities receive higher rank than deserved during classification of a small study area since it seems, on a small scale, as if they represent a large type. However, looking holistically, they often fade out as plant communities of much lower rank interrupting large vegetation types.

During a synthesis of vegetation classifications, seral communities are easily overlooked. Although seral communities are often of short duration, they might be useful as classified units since rehabilitation projects and other management practices need information on vegetation change and structure over time.

The proposed methods under discussion require well-sampled, well-discussed plant communities for a realistic outcome. In southern Africa, it is most often experienced that areas of great value to vegetation classification are under-sampled or if sampled, data are often not classified or documented. It therefore seems that well-classified and well-documented data are needed for meaningful synoptic clusters to be used in the second step of the analysis. If not, the synrelevés used have little syntaxonomic or synecological value.

2.1.3 The possibility to apply these methods to the Mopaneveld study

Mopaneveld occurs along a distinctive environmental gradient (mostly declining rainfall from East to West): from arid environments (Damaraland, Namibia, Angola), crossing semi-arid areas (Owamboland, Namibia, Caprivi, Namibia, Botswana, southern and western Zimbabwe, southwestern Zambia, north of the Soutpansberg, South Africa) to semi-moist areas (South African Lowveld, northern and eastern Zimbabwe, eastern Zambia, Malawi & Mozambique) (Mapaure 1994). Because of its distribution over environmental extremes, high α-ánd β-diversity is expected. The major constraint in studying Mopaneveld vegetation is the limitations in vegetation studies with adequate phytosociological data over its entire distribution range (Chapter 4). If vegetation classification in the Mopaneveld was adequate, diversity within vegetation patterns would also have been captured, making the discussed methods applicable.

It is however needed to synthesise existing vegetation knowledge and therefore a method is proposed to classify the vegetation of Mopaneveld, with its limitations in available vegetation data. It is important to note that the outcome of the method does not represent a clear picture of Mopaneveld vegetation along its distribution, since many areas of great significance to the classification are undersampled.

2.1.4 New trends in the syntheses of large vegetation data sets

A new computer package, JUICE (Tichý 2001), was recently developed to challenge the international problem of dealing with the classification and analysis of large vegetation data sets. JUICE is an expert system, which comprises analytical methods such as COCKTAIL (Bruelheide 1995, Bruelheide 2000) and TWINSPAN (Hill 1979b). After the analytical phase, synoptic tables can be created in the program using user-defined fidelity measures. The classification results can be exported to WORD, EXCEL, DMAP and IDRISI.

Chytrý *et al.* (in press) proposed a new method for structuring phytosociological synoptic tables in large vegetation data sets and defining diagnostic species using fidelity calculation. According to Chytrý *et al.* (in press), synoptic tables being constructed using the statistical measure of fidelity, have several peculiarities if compared with the traditional synoptic tables widely used in current phytosociological literature. In the traditional synoptic tables, diagnostic value is given to species simply according to frequency difference, as in the case of the Mopaneveld phytosociological synthesis. It is therefore likely for certain species to be labeled as diagnostics within the vegetation type or major plant community of Mopaneveld. Although, with the new proposed method, these species would not necessarily be regarded diagnostic. It is therefore important to note that, although the term "diagnostic species" is used in the description of the major vegetation units within Mopaneveld vegetation (Chapters 5 and 6), it may not express diagnostic (character) species in the true sence of the word. In southern African vegetation studies, little attempts have been made to classify vegetation according to their position in the higher vegetation rank. Therefore, when referring to diagnostic species in the Mopaneveld, it comprises those species most frequently present in that vegetation unit, and based on the present knowledge, they can be used to differentiate between types. The approach of Chytrý *et al.* (in press) attaches diagnostic value only to the species whose diagnostic capacity is valid over many different vegetation types in this wider area.

2.2 Mopaneveld in southern Africa

2.2.1 Definition of Mopaneveld

The identification of a vegetation class where *Colophospermum mopane* is the most conspicuous character species, namely the Commiphoro mollis – Colophospermetea mopani (Winterbach 1998) engendered further analysis on this vegetation class. The proposed Commiphoro mollis – Colophospermetea mopani (class name still to be typified) was identified according to a phytosociological synthesis of the Central Savanna Biome, South Africa. It is speculated that this vegetation class extends along the distribution of the character species, *Colophospermum mopane*. The name Mopaneveld is the suggested common name for this vegetation class. It is derived from a name given to the South African Veld Type, Mopani Veld (Acocks 1953). Acocks (1953) defined a veld type as "a unit of vegetation whose range of variation is small enough to permit the whole of it to have the same farming potentialities". Since the focus of this study does not directly include agricultural potential and because the study area extends across South African borders, the Acocks' proposed Mopani Veld was not considered being used. Low and Rebelo (1998) identified the Vegetation Type which can be described as a vegetation unit representing a coherent array of communities which shares common species (or abundance of species), possesses a similar vegetation structure (vertical profile) and shares the same set of ecological processes. Along the distribution range of *Colophospermum mopane*, vegetation structure and ecological processes vary considerably (Timberlake 1999). Therefore neither the Veld Ttype nor the Vegetation Type is a true reflection of *C. mopane* vegetation in southern Africa. **The Mopaneveld is therefore defined as a vegetation unit where *Colophospermum mopane* generally dominates or co-dominates the woody component**. Although it is apparent that where *C. mopane* occurs it generally forms the sole dominant in the tree layer of a savanna type, Mopaneveld does not necessarily have to be dominated by *Colophospermum mopane*. Data selection criteria (Chapter 4) state amongst others that data should be sampled in areas where *Colophospermum mopane* at least forms a major component of the vegetation. Mopaneveld is however interrupted by vegetation not clearly representative of the Commiphoro mollis – Colophospermetea mopani vegetation class. These units were easily identified as azonal or intrazonal vegetation during analysis (Chapter 4). The remaining vegetation data, after azonal types had been separated and removed, were regarded as representing Mopaneveld, whether the relevé, or combination of relevés contains *Colophospermum mopane* or not. Mopaneveld, as referred to in this study, could only be identified after the first approximation of vegetation analysis. **The definition of Mopaneveld is therefore suggested as a vegetation class where *Colophospermum mopane* forms at least the major component in the woody vegetation on a scale larger than the basic plant community (association)**. Mopaneveld is furthermore often characterised by the typical herbaceous component rather than only by the mere presence of *Colophospermum mop*ane. It is rather a prevalent phenomenon in savanna vegetation that herbaceous species express relations between vegetation units, which in turn exhibit resemblance in vegetation dynamic processes (e.g. O'Connor & Roux 1995; Du Plessis *et al.* 1998). Therefore Mopaneveld does not always have to contain *Colophospermum mopane* in a specific relevé.

2.2.2 The species *Colophospermum mopane*

Colophospermum mopane, often refered to as "mopane", has extensively been reviewed in terms of its biology and ecology (eg. Thompson 1960; Jarman & Thomas 1969; Henning & White 1974; Van Voorthuizen 1976; Scholes 1990; Madams 1990; Choinski & Tuohy 1991; Malan &

Van Wyk 1993; Mapaure 1994; Smit *et al.* 1994; Timberlake 1995; Timberlake 1996; Timberlake 1999; Smit & Rethman 1998a; Smit & Rethman 1998b). These review papers were studied to produce a brief discussion on the species *C. mopane* since this study focuses mainly on the vegetation of Mopaneveld and not on the species itself. The discussion of the species will be in accordance with published reviews from the above-mentioned authors.

2.2.2.1 Taxonomy

Colophospermum mopane (Kirk ex Benth.) Kirk ex J. Léonard is a monotypic genus which belongs to the Detarieae tribe of the sub-family Caesalpinioidae, family Leguminosae or Fabaceae (Lock 1989; Timberlake 1996). The generic name "*Colophospermum*" refers to its seeds and is the Greek for "resinous seed" (Ross 1977). Van Voorthuizen (1976) states that it is derived from the Greek for "seed inhibiting the light". The genus *Colophospermum* was described in 1949 by J. Léonard. *Colophospermum mopane* was previously placed in the genus *Copaifera* L. (*Copaifera mopane* Kirk ex Benth.) along with *Copaifera conjugata* (Bolle) Milne-Redh. (now *Guibourtia conjugata* (Bolle) J. Léonard) and *Copaifera coleosperma* Benth. (now *Guibourtia coleosperma* (Benth.) J. Léonard) (Timberlake 1995). *Colophospermum* is congeneric with the monotypic *Hardwickia*, described from India in 1811 (Breteler *et al.* 1997). Breteler *et al.* (1997) proposed a new combination, namely *Hardwickia mopane*. Supported by various botanists in southern Africa, Smith *et al.* (1998) suggested conserving the name *Colophospermum*, as it is commonly known today. Léonard (1999) responded to the team of researchers (Breteler *et al.* 1997) who proposed to sink *Colophospermum* under *Hardwickia*. According to the author of this montypic genus, *Colophospermum* differs macromorphological more extensively to *Hardwickia* than mentioned by Breteler *et al.* (1997). Léonard (1999) re-established the genus *Colophospermum* with the species *C. mopane* and provided a detailed key in order to distinguish it from the genus *Hardwickia*.

2.2.2.2 General description

The deciduous, leguminous small to medium-sized tree, *Colophospermum mopane* (mopane) constitutes a major component of the main river basins of sub-tropical southern Africa (Werger & Coetzee 1978; White 1983; Madams 1990; Henning & White 1974; Mapaure 1994;

Timberlake 1996). The crown of *C. mopane* is usually erect and narrow, although it often occurs as a low shrub (1–2 m). Leaves are distinctively "butterfly-shaped" (Palgrave 1983; Timberlake 1995; Timberlake 1996; Van Wyk & Van Wyk 1997) consisting of two leathery leaflets (Madams 1990; Timberlake 1995; Van Wyk & Van Wyk 1997). These leaflets are usually open, but in hot, dry conditions they fold together, presumably reducing transpirational water loss (Madams 1990; Timberlake 1995). Leaves fall in the dry season, determined mainly by soil moisture status, wind and exposure (Timberlake 1996). Trees are leafless for approximately five months south of the Zambezi Valley, whilst leafless for only three months (August to October) in the Luangwa Valley, Zambia (White 1983; Madams 1990).

The inconspicuous pale yellowish-green flowers (less than 1.3 cm across) appear in short axillary racemes or sprays (Van Voorthuizen 1976; Van Wyk & Van Wyk 1997) from December to March, after the leaves have developed (Madams 1990; Timberlake 1995; Timberlake 1996). *C. mopane* is wind-pollinated, which is rather an unusual phenomenon in the Caesalpinioidae (Ross 1977). Fruits are thin, kidney-shaped, light brown, papery pods and ripen around May (Van Voorthuizen 1976; Madams 1990; Timberlake 1995; Timberlake 1996; Jordaan & Wessels 1999). Pods are wind-dispersed, indehiscent with numerous scattered resin glands on the surface. Seeds also contain small, sticky, resin glands (Van Voorthuizen 1976; Thompson 1960; Madams 1990; Timberlake 1995). Both the seed and fruit are short-lived which seldom remain viable for more than a year probably because of the thin testa being highly permeable to water (Jordaan & Wessels 1999). Brophy *et al.* (1992) identified significant amounts of essential oils in the leaves, bark and seeds of mopane. Seeds germinate under a wide range of conditions. According to Thompson (1960) seeds of *C. mopane* will germinate on moist, bare soil with only a sparse grass cover. Seedling-survival under these conditions is good, revealing competition with grass species. Seedling-growth increases with increased soil nitrogen and potassium and on soils with less than 7 % moisture (Chionski & Tuohy 1991; Henning & White 1974). Smith (1972) found that seedling growth leads to a reduction in soil pH due to selective uptake of cations.

The bark of *C. mopane* is fibrous, dark grey or brown (Van Voorthuizen 1976) and is strong and tough due to concentric zones of abundant crystalliferous strands with very thin, lignified secondary cell walls (Malan & Van Wyk 1993). It also accommodates secretory ducts or cells, which contain a diversity of secondary compounds. Furthermore, the bark of *C. mopane* is also the habitat of ants (Van Voorthuizen 1976).

Colophospermum mopane is known for extensively utilising moisture in the upper soil horizons (Mapaure 1994) by its shallow, aggressive (30–120 cm deep) root system (Thompson 1960; Madams 1990; Smit & Rethman 1998a). When occurring on deep soil, roots of *C. mopane* are found to penetrate to a depth up to 2 m. A well-developed, vertically growing tap-root is produced during the seedling phase followed by the development of radial roots near the soil surface. At maturity the tap-roots gradually disappear to leave a dense network of roots near the soil surface (Henning & White 1974; Madams 1990; Smit & Rethman 1998a) where soil moisture content and water-holding capacity are optimal. Fine roots (0–1 mm) are concentrated in the top 200 mm of the soil surface and decline linearly with increased soil depth, while coarse roots (100 mm) increase in biomass up to a depth of 400–600 mm, whereafter they also decline (Le Roux *et al.* 1994; Smit *et al.* 1994). Total root biomass in an area covered by dense stands of *Colophospermum mopane*, ranges from 9 760 kg/ha up to 29 790 kg/ha with a mean value of 17 354 kg/ha (Smit & Rethman 1998a). It was also found that root biomass well exceeds leaf biomass (Smit *et al.* 1994; Smit & Rethman 1998a) which consequently implies a high competitive potential with herbaceous plants.

For a long time it was believed that *C. mopane* roots do not nodulate and fix atmospheric nitrogen (Henning & White 1974). In a recent study, bacteria that resemble rhizobia were found to infect roots of *C. mopane* (Jordaan *et al.* 2000). It is however not clear if nitrogen-fixing symbiosis is indeed present. The relation between bacteria and roots of *C. mopane* might be beneficial to tree growth as it seems to induce continuous development of new roots resulting in better mineral uptake (Jordaan *et al.* 2000).

High leaf production of *Colophospermum mopane*, especially in vegetation types dominated by this savanna tree (Dekker & Smit 1996) is of significant value for available browsing material for livestock- or game farmers. It is however not only leaves on the trees that animals feed on, but also fallen leaf litter that provide important food reserves (Owen-Smith *et al.* 1983; Styles & Skinner 1997). In some Mopaneveld plant communities new season leaves *of C. mopane*, often appear as early as September while leaf senescence often starts in June. This long leaf carriage of the dominant tree species of the semi-arid mopane savanna stresses its value as a fodder resource in the Mopaneveld. De la Hunt (1954) already recognised the value of *Colophospermum mopane* as a browser. *C. mopane* leaves have an extremely high feeding value throughout the year, especially during drought conditions and it retains a high feeding value, even when fallen (De la Hunt 1954).

As an adaptation to periodic drought conditions in Mopaneveld systems, *Colophospermum mopane* readily coppices (Henning & White 1974; Timberlake 1996; Timberlake 1999). This property of the species improves fodder production, but is of great concern in the sustainability of the herbaceous layer since higher above-ground biomass reduces grass species production. This also probably enables *C. mopane* to outcompete most other woody species.

Mopane was successfully introduced from Zimbabwe to the arid regions of India in 1963 (Sharma *et al.* 1989). The introduction of *C. mopane* to India was motivated since it was found to grow fast in relation to indigenous trees, tolerates aridity and, according to Sharma *et al.* (1989) improves the fertility of soil. Furthermore it provides good fodder and firewood. Mopane is even found to be effective in sand dune stabilisation (Sharma *et al.* 1989). It however showed poor establishment and survival (Timberlake 1995).

2.2.2.3 Adaptations of *Colophospermum mopane*

Considering its wide distribution, *Colophospermum mopane* has to be adapted to an extreme set of environmental conditions. According to Timberlake (1995) the distribution of *C. mopane* is obviously determined by different ecological factors in different parts of its range. Therefore a continuous range does not exist. Frost incidence and/or minimum temperatures along with minimum annual rainfall may play an important role in the southern and western distribution of *C. mopane*, whilst the higher altitude with an increase in annual rainfall determines its distribution in the north and the east (Werger & Coetzee 1978; Mapaure 1994). In addition to these factors, soil texture was also found to be of influence in the distribution of the species. Henning and White (1974) found *C. mopane* to be highly tolerant of adverse soil conditions, in particular, poor availability of soil water, which explains its wide distribution pattern. It is generally believed that *C. mopane* can tolerate the poorest soil conditions over its distribution range. However, as soon as conditions are more favourable to other woody species, often associated with soil moisture availability, mopane is competed out. Apart from its tolerance towards soil conditions, *Colophospermum mopane* appears to be physiologically adapted to xeric conditions, being able to grow at a matric water potential below -15.2 bar (Henning & White 1974). *C. mopane* is also capable of internal osmotic adjustment. High magnesium levels in the soil tend to favour moisture uptake by *C. mopane* whilst increasing levels of potassium and sodium result in a production decline probably due to increased soil osmotic suction (Timberlake 1995).

2.2.2.4 Uses of *Colophospermum mopane*

Colophospermum mopane is an economically important species to the rural communities of southern African savannas due to its variety of uses.

The long leaf carriage period of *Colophospermum mopane* in the semi-arid areas of its distribution range underlies its value as a fodder resource (Dekker & Smit 1996). Wood is harvested mainly for construction poles and firewood (Timberlake 1995; Chikuni 1996; Madzibane & Potgieter 1999; Van Wyk & Gericke 2000). *Colophospermum mopane* accounts for more than 90 percent of the timber used for living- and storing huts in southern Africa (Van Wyk & Gericke 2000). Mopane is especially popular for its high quality firewood (Timberlake 1995; Chikuni 1996; Van Wyk & Gericke 2000). The remaining ash contains high percentages of phosphorus, calcium and lime, which makes it a suitable fertilizer for small holder farmers (Timberlake 1995; Madzibane & Potgieter 1999). The Herero-speaking people of Namibia use only the wood of *C. mopane* for the sacred fire and for the ceremonial removal of teeth (Van Wyk & Gericke 2000). The inner bark is often used to tie poles together for hut construction (Madzibane & Potgieter 1999; Van Wyk & Gericke 2000). One of the best known uses of the mopane tree is its association with the mopane-worm, an important and popular source of protein for the human diet in rural areas. *Colophospermum mopane* is the major source of food for mopane worms, which are the larvae of the mopane emperor moth (*Imbrasia belina*) (Styles & Skinner 1996; Wiggens 1997; Motshegwe *et al.* 1998; Klok & Chown 1999; Van Wyk & Gericke 2000; Potgieter *et al.* 2001).

C. mopane also has a medicinal value, although of lower significance. Bark decoctions are taken for diarrhoea and stomach pains (Madzibane & Potgieter 1999; Van Wyk & Gericke 2000), constipation is treated by leaf infusions whilst chewed leaves are applied to fresh wounds to stop bleeding. Furthermore, twigs are used as chewing sticks to clean teeth (Van Wyk & Gericke 2000). The Vhavenda in South Africa use mopane roots for gum bleeding, to treat kidney stones and for impotence in a mixture with *Wrightia natalensis*, *Securidaca longipedunculata* and mutshalimela (scientific name unknown) (Madzibane & Potgieter 1999).

2.2.2.5 Management and conservation of the Mopaneveld

Mopaneveld is surely one of southern Africa's most valuable vegetation types. Apart from the different uses of the species, Mopaneveld is commonly associated with specific agricultural practices. Over the last few decades, landowners in the Mopaneveld have switched from livestock farming to game farming. Pressure on the indigenous vegetation due to artificial pasture production has declined consequently. The survival of certain rare animal species, such as the roan antelope, is to a great extent related to successful breeding programmes, which are conducted in conservancies within their natural habitat (Joubert 1976). These usually include Mopaneveld vegetation.

Species cannot necessarily only live in the area to which it is presently confined. It may not have completed its natural migrations and may still be in the process of extending its range (Rattray 1963). Therefore, great concerns have arose involving increasing densities of *Colophospermum mopane* and the resulted decreasing of grass cover, especially in the areas north of the Soutpansberg, South Africa (Donaldson 1979; Smit *et al.* 1994; Smit & Rethman 1998b). Ironically, due to the multiple uses of *Colophospermum mopane* (2.2.2.4) by the growing population of southern Africa and consequently the growing need for natural resources, Mopaneveld in some parts of southern Africa suffers from deterioration and need to be protected. (Anderson & Walker 1974; Lewis 1987; Coe 1991; Ben-Shahar 1996; Bhima & Bredenkamp 1999; Styles & Skinner 1997; Prior & Cutter 1999). These differences between livestock owners and nature conservationists revealed controversy over the management of the Mopaneveld.

Management of Mopaneveld has been reviewed extensively, especially in terms of pasture management. Regarding the conservation of Mopaneveld, the impact of large herbivores (especially the impact of elephants) on the vegetation structure, has received attention. For the scope of this dissertation, no attempt will be made to discuss the different management regimes and conservation attempts. Studies involving the management and/or conservation of Mopaneveld include Rattray (1963), Anderson and Walker (1974), Donaldson (1979), Guy (1981), Lewis (1987), Madams (1990), Lewis (1991), Coe (1991), Coe (1992), O'Connor (1992), O'Connor (1999), Ben-Shahar (1993), Ben-Shahar (1996), Chikuni (1996), Dekker *et al.* (1996), Smit *et al.* (1996), Smit & Rethman (1998), Bhima and Bredenkamp (1999), Bhima and Bredenkamp (in press), Kennedy (2000), and Styles and Skinner (2000).

2.2.3 Review of previous vegetation studies in the Mopaneveld

2.2.3.1 Described communities in the Mopaneveld

A list of most plant communities that have been identified within the southern African Mopaneveld is compiled for future reference (Appendix 1). According to the definition of Mopaneveld all described communities (zonal vegetation) of a certain study are listed and not only those where *Colophospermum mopane* dominates. Although many of the described communities were never published, they are also included in the provided list. The list is however not complete since more vegetation classification studies are presently being undertaken. Listed names of communities are in accordance with the names given by authors. Species names are subjected to change. Where the study was documented in Afrikaans, names were translated into English where applicable.

2.2.3.2 Vegetation types containing Mopaneveld

It is also important to list all vegetation types dominated by *Colophospermum mopane*. Timberlake stated in 1995 that a full list of vegetation types in which *Colophospermum mopane* is found is not available. Appendix 2 represents an attempt to list most of the vegetation types where *C. mo*pane is at least prominent. Vegetation types, as referred to in the provided list, present vegetation mapping units as described in several vegetation maps of countries in southern Africa.

2.2.4 Mopaneveld vegetation

2.2.4.1 Introduction

Covering 54 percent of southern Africa, savanna vegetation is generally characterised by the co-dominance of woody plants and grasses. Small trees or shrubs form an intermediate layer whilst the grass layer may be temporarily absent or replaced by dicotyledonous herbs during periods of drought or disturbance (Scholes 1997). Savannas include plant communities of diverse floristic composition and varying physiognomy from pure grasslands, parklands and low tree and shrub savannas to open deciduous woodlands, thicket and scrub (Cole 1986).

Mopaneveld is an extensive vegetation type (Figure 1) within the savannas of southern Africa, dominated by a well-known, economically and ecologically important tree species, *Colophospermum mopane*. Mopaneveld is abundant in eight different countries in southern Africa covering an area of approximately 550 000 km^2 (Mapaure 1994). The species however ranges further than the distribution of the vegetation type (Timberlake 1999). Individuals of mopane are often well represented outside the vegetation type, where it occurs on termite mounds or on patches where conditions tend to favour its presence (Timberlake 1995; Timberlake 1999). According to Werger and Coetzee (1978), pure stands of *Colophospermum mopane* are often associated with insufficiently drained soils.

2.2.4.2 Physiognomy

The variety of factors influencing the distribution of Mopaneveld vegetation constitutes variance in physiognomical structure over its distribution in southern Africa. However, large areas with locally equal environmental conditions are covered with structurally even and homogenous stands of tree or shrub savanna. In some savanna types gradual floristic and physiognomic changes mark the transition from one type of savanna to another as in the case of Mopaneveld, whilst in others changes are abrupt presenting sharp boundaries (Cole 1986).

C. mopane has four definite growth forms: (i) a tall tree form growing up to 20 m high; (ii) a small to medium sized tree usually from 5–12 m tall (Figure 2a); (iii) a shrubby form up to 6 m tall (Figure 2b), differing from (i) and (ii) in that the bole is not well developed, and (iv) a bushy scrub form usually less than 3 m tall (Figure 2c) (Madams 1990; Timberlake 1995; Timberlake 1996). The closed mopane woodlands (type i) occur in the semi-moist northern parts of its distribution range with trees up to 25 m in height (Werger & Coetzee 1978). This physiognomical structure of Mopaneveld vegetation is often referred to as "cathedral mopane" (Timberlake 1995) and is associated with deeper, less compacted soils, such as alluvium, and higher annual rainfall patterns (Werger & Coetzee 1978; White 1983; Timberlake 1995). The majority of Mopaneveld vegetation is presented with the woodland/savanna tree physiognomical structure (type ii) where it is predominantly found on shallow, sodic, heavier textured solonetzes (Werger & Coetzee 1978; Timberlake 1995). The shrubby, multi-stemmed type (type iv) is associated with heavy clays, often of vertic character (Figure 2c) (Werger & Coetzee 1978; Cole 1986; Van Rooyen & Bredenkamp 1998).

The difference in physiognomy of the species depends upon local environmental conditions, of which soil conditions are usually found to be the most influential. In many parts of Mopaneveld, the physiognomical structure has been modified by fire, herbivory or harvesting, most often leaving dense stands of multi-stemmed shrubs.

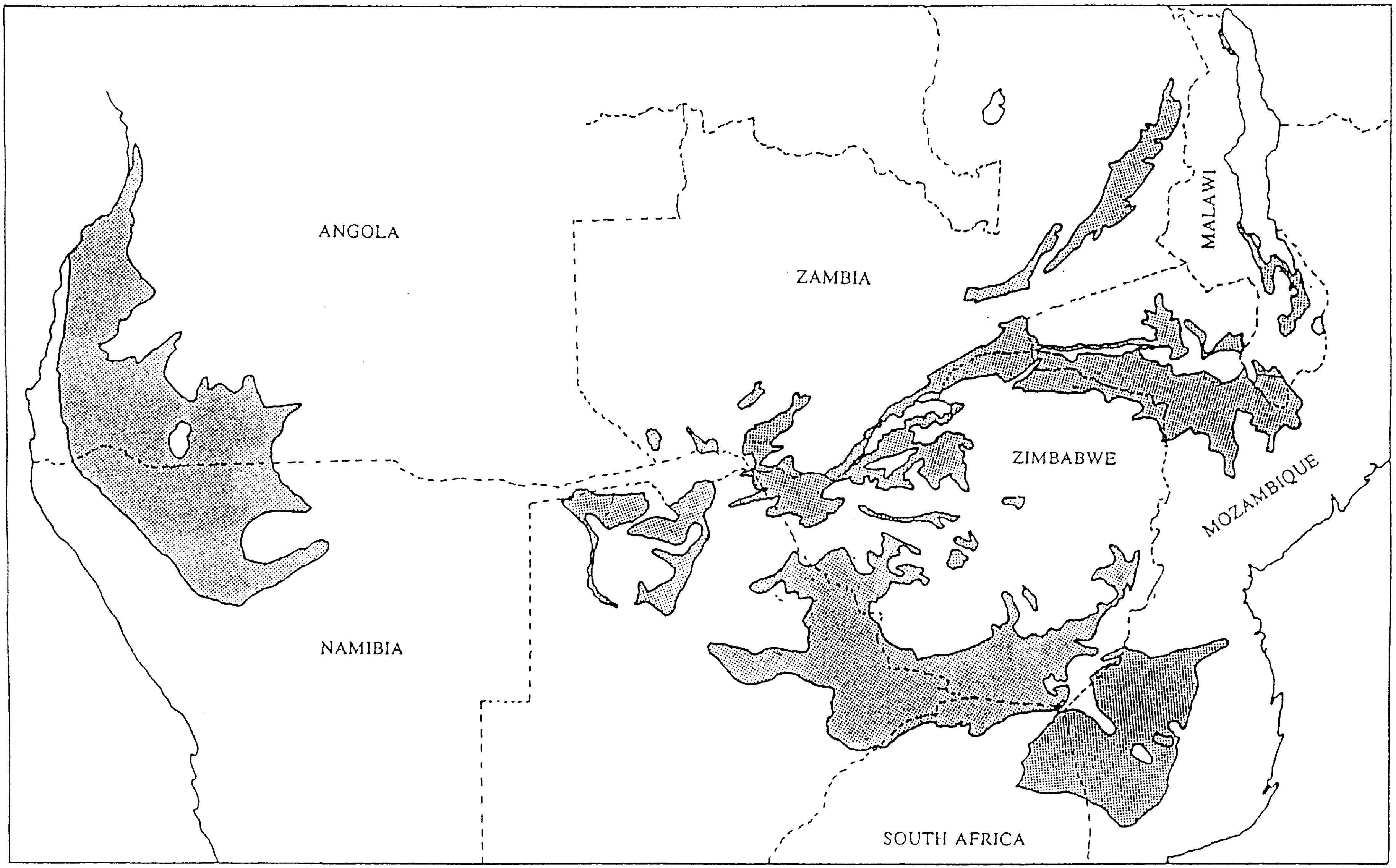


Figure 1 Distribution of Mopaneveld (adapted from Mapaure 1994)

a)
b)
c)

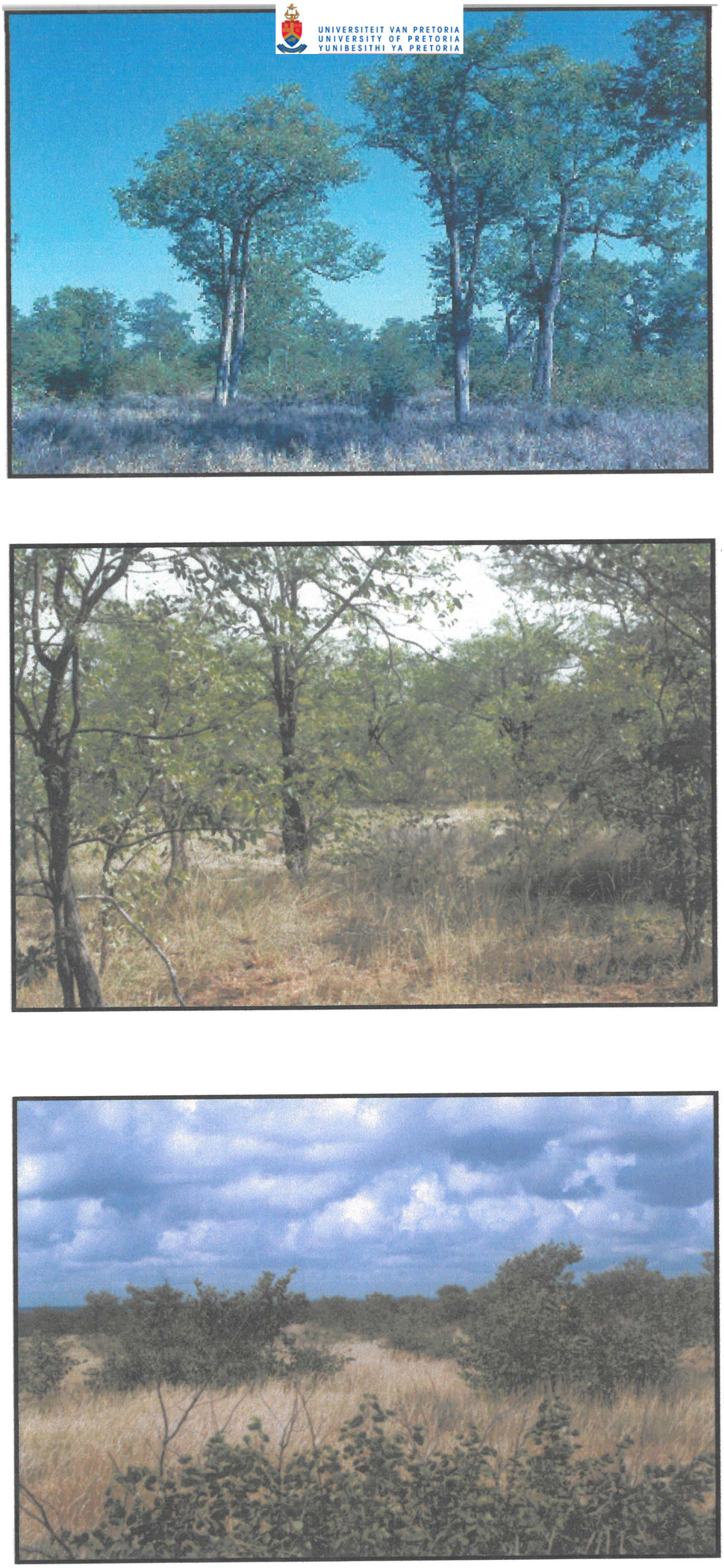


Figure 2 The different growth forms of *Colophospermum mopane*: (a) high trees of 5–12 m in height (b) high mopane shrubs and (c) multi-stemmed bushy shrubs.

2.2.4.3 Distribution of Mopaneveld

One of the most basic elements of plant ecology is the general study of the various factors influencing the distribution of plants (Rattray 1963; Woodward 1986, Madams 1990). Yet, the causes of particular limits in the distribution of a species, with a few exceptions, are poorly understood (Madams 1990). It is universally believed that plant species occur where environmental conditions favour them (Rattray 1963; Carter & Prince 1988; Dekker & Van Rooyen 1995). The ecological amplitude of a species is mainly set by climatic conditions in the small-scale distribution of a species whilst edaphic, topographic and/or biotic factors play an important part in determining the distribution of species at the larger scale (Woodward 1986).

Colophospermum mopane is certainly one of the most extensive plant species in Africa due to its character to dominate the woody layer of a plant community if conditions are favourable. Considering the vast areas occupied by Mopaneveld in the savannas of southern Africa (Figure 1), factors influencing its distribution are not easily detectable. As already mentioned, the distribution of Mopaneveld generally follows the distribution of *Colophospermum mopane* although the species often occurs as individuals outside the range of *C. mopane*-dominated vegetation (Timberlake *et al.* 1993). Distribution limits of *Colophospermum mopane*, hence Mopaneveld, is obviously determined by different ecological factors over different parts of its range. The distribution of *Colophospermum mopane* is principally influenced by moisture availability expressed through altitude, rainfall and soil texture (Cole 1986; Mapaure 1994). *Colophospermum mopane* generally occupies areas where moisture accumulates at shallow depth. It is therefore often found on impervious bedrock (e.g. granite) overlain by shallow soils or on an impervious layer of transported clay (e.g. riverine silt). Where there is a combination of low rainfall and severe heat, as a result of clay being dispersed by exchangeable sodium, *C. mopane* also occurs (Cole 1986). The shallow rooting system of *Colophospermum mopane* places it in a competitive advantage in areas where conditions lead to the development of a zone of maximum water retention near the surface. Such zones are commonly found in semi-arid savannas due to low rainfall and great heat, which consequently lead to moisture retention near the soil surface.

The general distribution of Mopaneveld is associated with heavier-textured soils in the wide, flat valley bottoms of river valleys such as the Limpopo (Botswana, South Africa, Zimbabwe & Mozambique), Zambezi (Botswana, Zimbabwe, Zambia & Mozambique), Chobe (Botswana), Okavango (Botswana), Cunene (Namibia & Angola), Shire (Malawi) and Luangwa (Zambia & Malawi) (Werger & Coetzee 1978; Cole 1986; Mapaure 1994). *Colophospermum mopane* is profoundly found in the 400 m and 700 m altitudinal range. Following a strongly seasonal summer rainfall regime, it receives between 200 mm and 800 mm annually, coinciding with high temperatures (Mapaure 1994). Low winter temperature is found to be an important distribution determinant to the southernmost distribution of the species. The 5°C isotherm for daily minimum temperatures is thought to coincide largely with the southern distribution boundary of *Colophospermum mopane* (Henning & White 1974; Cole 1986).

Colophospermum mopane is one of several species of the Zambezian Region (White 1983) which penetrates far into the western desert along watercourses. It is however found not to be the dominant woody species in areas receiving less than 300 mm rainfall annually (Timberlake 1995), but rather occurring in the form of bushy trees. *Colophospermum mopane* can tolerate extreme environmental conditions, e.g. surviving on as little as 125 mm rainfall per year in the Kaokoland of Namibia, whilst in the Luangwa Valley in Zambia and central Malawi, it experiences up to 1 000 mm rainfall annually. The majority of plant communities dominated by *Colophospermum mopane* are distributed between the *Brachystegia - Isoberlinia - Julbernardia* savanna woodlands (miombo) and the *Acacia*-dominated low tree and shrub savanna (Kalahari vegetation). According to Cole (1986) this alternation of different savanna types provides important evidence of the interacting influences of factors and processes affecting the distribution of all categories of savanna and of the plant communities within them.

The distribution of Mopaneveld as well as the vegetation associations and plant communities within, are related not only to the prevailing climatic and edaphic conditions but also to the geomorphological evolution of the landscape, to bedrock geology and to geological events and changes of climate.

The distribution of *C. mopane*-dominated vegetation types has been reviewed by Mapaure (1994) according to vegetation maps from the different hosting countries (e.g. Acocks (1988) for

South Africa, Weare & Yalala (1971) for Botswana, Rattray (1962) for Zimbabwe, Barbosa (1970) for Angola, Giess (1971) for Namibia and Wild & Barbosa (1967) for the Flora Zambesiaca area).

2.2.4.4 Floristic evaluation

According to the floristic map of White (1983) which indicates the main phytochoria of Africa and Madagascar, the Mopaneveld is located within the Sudano-Zambezian Region, or more precisely, its Zambezian domain (Zambezian Regional Centre of Endemism). The Sudano-Zambezian Region comprises vast stretches of woodland, savanna and grassland with occasional dry forests and thickets as well as swampy vegetation (Werger & Coetzee 1978). In the arid regions of Namibia and Angola, Mopaneveld crosses the borders of the Sudano-Zambezian Region into the Karoo-Namib Region (Werger & Coetzee 1978), a region of extensive desert and semi-desert areas. The boundary between the Sudano-Zambezian Region and the adjacent Karoo-Namib Region to the West is however not clear-cut (Werger & Coetzee 1978), explaining the transition of *Colophospermum mopane*-dominated vegetation into the desert Region. White (1983) acknowledges this transition between Zambezian and Karoo-Namib species in his mapping unit 36 (The Zambezian/Kaokoveld-Mossamedes transition in the XIVth phytochoria: Kalahari-Highveld Regional Transition Zone). Mopaneveld of these arid regions is a transition from *Colophospermum mopane* scrub woodland to a Karoo-Namib shrubland (White 1983).

Colophospermum mopane can tolerate extremely dry conditions. In areas where *C. mopane* is subjected to moisture stress, it predominantly occurs along drainage lines (Figure 3). In its western distribution limits, *Colophospermum mopane* occurs as stunted trees (up to 3 m tall) in association with the well-known desert species, *Welwitschia mirabilis* (Figure 4) (White 1983; Werger & Coetzee 1978).

Although *C. mopane* and miombo woodlands are found adjacent to each other over much of its range, they rarely occur together, as their associated floras are dissimilar (White 1983; Timberlake 1995). Vegetation types of alternated dominance of miombo and *C. mopane* are however apparent in the Zambezi Valley (Timberlake & Mapaure 1992; Timberlake *et al.* 1993). Where they occur together, *Colophospermum mopane* is restricted to depositional clay-rich soils in the lower parts of the catena or on termitaria whilst miombo woodlands inhabit the upper parts on lighter-textured soils on rocky outcrops (White 1983; Timberlake & Mapaure 1992; Timberlake *et al.* 1993). Mopaneveld also often shares dominance with *Combretum*-dominated woodlands. In general Mopaneveld possesses fewer species and a poorly-developed grass layer in comparison with miombo and *Combretum* woodlands. The alternation of *Combretum*-dominated vegetation and Mopaneveld vegetation is well-known in South Africa (e.g. Van Rooyen 1981c; Gertenbach 1983; Venter & Gertenbach 1986; Gertenbach 1987) and follows the exact pattern as that of the miombo-mopane association.

Mopaneveld often has a low alpha-diversity due to the almost monospecific stands of *Colophospermum mopane* over much of its distribution range. Beta-diversity is low in comparison to miombo woodlands, and can be altered with infrequent rainfall and grazing events. Variability in rainfall, as well as grazing history in most parts of the Mopaneveld constitutes sporadic responses of especially the herbaceous stratum, which consequently constitute a rapidly changing species composition (O'Connor 1985). Species richness in Mopaneveld is most often dependent on the cover of *Colophospermum mopane*. High cover of *C. mopane* results in low species richness whereas a higher species richness is noted in areas of low *C. mopane* cover (O'Connor 1992). According to Timberlake (1995) Mopaneveld has a low gamma diversity due to typical associated species being similar across much of its range. These typical tree species include *Acacia nigrescens*, *A. nilotica*, *Adansonia digitata*, *Albizia harveyi*, *Balanites* spp., *Combretum apiculatum*, *C. hereroense*, *Commiphora* spp., *Dalbergia melanoxylon*, *Diospyros quiloensis*, *Erythroxylum zambesiacum*, *Kirkia acuminata*, *Sclerocarya birrea*, *Terminalia prunioides*, *T. stuhlmannii* and *Ziziphus mucronata*. Shrubs include *Combretum elaeagnoides*, *Dichrostachys cinerea*, *Gardenia resiniflua*, *Grewia* spp., *Ximenia americana* and species of the family Capparidaceae. The herbaceous layer predominantly contains species of the Acanthaceae. The grass layer is generally poor and often dominated by annuals such as *Aristida*, *Enneapogon* and *Eragrostis* species (Timberlake 1995).

2.2.5 Discussion of Mopaneveld vegetation in the eight hosting countries

Mopaneveld vegetation is discussed according to the eight different countries hosting this extensive savanna type. The vegetation of certain countries is discussed in more detail. These countries contributed to the phytosociological synthesis in terms of adequate, electronic vegetation data and are therefore investigated in more detail. General physiognomy and species composition is discussed in coherence with environmental factors influencing its distribution and general character. The discussion of the vegetation follows species names as published in the literature.

2.2.5.1 Angola

"Angola presents the paradox of possessing one of the richest and most varied, yet least well known wildlife resources in Africa" (Huntley 1974). Although only a drop in the wildlife kingdom of Angola is contributed by Mopaneveld vegetation, it represents the largest expanse of Mopaneveld in southern Africa (112 500 km^2) (Mapaure 1994). It is restricted to the south-western part of the country between Lobito in the north and the Cunene River, bordering Namibia in the south. Angolian Mopaneveld occurs on a variety of soil types mainly derived from granite. Rainfall seems to be the major determinant in its distribution in Angola (Mapaure 1994). The Mopaneveld vegetation represented in Angola continues into the north-western Mopaneveld of Namibia.

Inland from the desert areas along the Atlantic coast, Mopaneveld dominates the savanna on areas where rainfall exceeds 300 mm. In these savanna woodlands Mopaneveld is alternates with *Baikiaea* woodlands which are predominantly located on the Kalahari sands, whereas Mopaneveld inhabits the clayey substrates (Huntley 1974). Further westwards to the Kaokoland (Namibia) and Chela (Angola) escarpments, at an altitude of approximately 250 m, low shrubs of *Colophospermum mopane* together with *Balanites welwitschii* occur predominantly in dry riverbeds under a rainfall of sometimes less than 100 mm annually. Other species associated with 3 m tall *C. mopane* shrubs in these arid-western region, include *Catophractes alexandri*, *Rhigozum virgatum* and *Phaeoptilum spinosum* on dry, often rocky soils (Werger & Coetzee 1978). It is in this region that Mopaneveld crosses the border of the Sudano-Zambezian Region into the Karoo-Namib Region (Werger & Coetzee 1978). On sites with locally more water available, *Spirostachys africana* becomes subdominant or even dominant. Tree species associated with this type include *Pteleopsis diptera*, *Pterocarpus lucens* subsp. *antunesii*, *Commiphora angolensis*, *C. mollis*, *Combretum psidioides*, *C. zeyheri* and several *Acacia* species (Werger & Coetzee 1978).

At the foot of the Chela escarpment (800–1 100 m altitude) and near Ngiva (1 000–1 200 m altitude) mopane woodlands prevail with *Colophospermum mopane* trees varying from 7 m to 15 m in height. Woody species accompanying *C. mopane* include *Terminalia prunioides*, *Commiphora angolensis*, *Combretum oxystachyum*, *Acacia erubescens*, *Balanites angolensis*, *Cordia ovalis*, *Hexalobus monopelatus*, *Croton* spp., *Ximenia caffra*, *Grewia bicolor* and *Euclea* spp. (Werger & Coetzee 1978). In the herbaceous layer species such as *Schmidtia pappophoroides*, *Aristida rhiniochloa*, *A. adscensionis*, *Anthephora pubescens*, *Eragrostis annulata*, *E. porosa*, *E. superba* and *Pegolettia senegalensis* dominate (Werger & Coetzee 1978).

A well-defined mopane shrubland is abundant south of Lubango on predominantly impermeable black clays. This shrubland is associated with several *Acacia* species including *A. kirkii*, *A. nilotica* subsp. *subalata*, *A. hebaclada* subsp. *tristis* and other woody species such as *Flueggea virosa*, *Spirostachys africana*, *Peltophorum africanum* and *Dichrostachys cinerea* (Werger & Coetzee 1978).

2.2.5.2 Botswana

From the Limpopo River in the east to the Makgadikgadi pans in the north as well as surrounding the Okavango swamps, 85 000 km^2 area are covered with mopane woodland and savanna. Its distribution is mainly determined by rainfall, which varies from 400 mm to 600 mm annually (Mapaure 1994). Sands, silts, clay loams and clays support mixed tree and bushland savanna whilst mopane woodlands are associated with fersiallitic soils on uplands and siallitic colluvial soils with impeded drainage in the valleys (Mapaure 1994).

Mopaneveld of Botswana can be subdivided into dry deciduous forest, riparian forest, woodland, thicket, tree or shrub savanna or shrub steppe (Weare & Yalala 1971), therefore hosting most of the physiognomic forms of Mopaneveld. Woody species associated with *Colophospermum mopane* vary in distribution, but generally *Acacia nigrescens*, *Sclerocarya birrea*, *Terminalia prunioides*, *Commiphora mossambicensis*, *Combretum apiculatum*, *C. imberbe*, *Dichrostachys cinerea*, *Maytenus heterophylla* and *Adansonia digitata* are the most prominent ones (Wild & Barbosa 1967; Weare & Yalala 1971; Werger & Coetzee 1978). The grass cover is generally sparse including species such as *Eragrostis lehmanniana*, *E. superba*, *E. rigidior*, *Digitaria eriantha*, *Aristida congesta*, *Brachiaria nigropedata*, *Cenchrus ciliaris* and *Urochloa oligotricha* (Weare & Yalala 1971).

The predominant type in Botswana Mopaneveld is the tree and bush savanna (mopane bushveld) (Weare and Yalala 1971). This broad vegetation type however encompasses several types of *C. mopane* vegetation, that can be differentiated by density and physiognomy of *C. mopane* itself, rather than by differences in its associated species. In the Limpopo River Valley (annual rainfall 400 mm or less), the Mopaneveld is shrubby (maximum 5 m in height) or it occurs as a low treeveld with individuals of *Colophospermum mopane* approximately 8 m tall (Wild & Barbosa 1967; Werger & Coetzee 1978). *Colophospermum mopane* woodlands of lower or even dwarf stature occupy large areas on calcrete in eastern, northern and western Botswana and in the Transvaal Lowveld. A moderately undulating landscape is commonly associated with this tree/shrub savanna. Tree and shrub savanna occurs on reddish and loamy sands underlain by shallow alluvium or colluvium derived from Palapye shales (Timberlake 1980). Species in association include *Terminalia sericea* and *Acacia fleckii*. On more calcareous areas *Tarchonanthus camphoratus*, *Rhigozum brevispinosum* and *Combretum hereroense* are conspicuous. Where it occurs on light sandy soil, *Colophospermum mopane* dominates the woody layer with accompanying trees such as *Terminalia sericea*, *Burkea africana*, *Combretum imberbe* and scattered *Lonchocarpus capassa* and *Commiphora* spp. (Weare & Yalala 1971). A common character of Mopaneveld in Sandveld areas is its varying physiognomy in relation to sand depth. Where alluvium and other "mopane-favouring" soils are close to the surface, density of *C. mopane* is higher whilst *C. mopane* occurs in low densities prevail on a thick cover of sand (Timberlake 1980). A mopane thicket woodland prevails on sandy, impenetrable soils. This low tree savanna is often associated with overgrazing and erosion. Prominent woody species include

Combretum apiculatum, *Acacia erubescens* and scattered individuals of *Terminalia prunioides*, *Acacia mellifera* and *A. tortilis* subsp. *detinens* along smaller watercourses (Weare & Yalala 1971). The Mopaneveld along the Makgadikgadi grassy plains occurs on sands, silt and clays. *Colophospermum mopane* grows as trees in association with *Acacia nigrescens*, *Terminalia prunioides*, *Sclerocarya birrea*, *Combretum imberbe*, *Dichrostachys cinerea* and *Maytenus heterophylla* (Werger & Coetzee 1978). On the silty soils, especially near salt pans such as the Makarikari, a low open mopane bushveld or mixed veld is found with some species of *Acacia* and *Grewia* (3–5 m high) being prominent (Werger & Coetzee 1978).

One of the most interesting Mopaneveld features is located along the Okavango delta (500 mm rainfall annually). *Colophospermum mopane* forms open woodlands over riverine silts in the Okavango delta (Cole 1986). Not only does *Colophospermum mopane* reach heights of over 20 m on these alluvial floodplains, but isolated individuals may also be found on termitaria of the central delta areas (Biggs 1979). A *Colophospermum mopane* woodland and pyrophytic scrub savanna occurs on some of the larger islands within the delta area (Biggs 1979). Woody species associated with these communities include amongst others *Croton megalobotrys*, *Grewia bicolor*, *G. flava*, *G. villosa*, *Commiphora africana* and *Boscia mossambicensis*. Although poorly developed, the following species dominate the herbaceous layer: *Eragrostis curvula*, *Setaria verticillata*, *Aristida stipitata*, *Chloris virgata*, *Achyranthes sicula*, *Tribulus terrestris*, *Sesuvium nyasicum*, *Ruellia patula*, *Acanthosicyos naudinianus*, *Harpagophytum* sp. and *Bidens schimperi* (Biggs 1979).

Further inland of the delta the vegetation is dominated by mopane treeveld in association with *Burkea africana* on shallow east-west valleys. In the Moremi Wildlife Reserve and the Mababe Depression the tall mopane woodlands are interrupted by shrub mopane and a broad-sclerophyll arid bushveld type. Broad orthophyll *Terminalia sericea* bushveld alternates with Mopaneveld in these areas (Werger & Coetzee 1978). Due to impervious clay soils being associated with Mopaneveld, rain pans are common in mopane woodlands. These pans are bordered by microphyllous thorny *Acacia* bushveld (Werger & Coetzee 1978; Biggs 1979) with *Acacia* spp. such as *A. tortilis* and *Albizia harveyi* (Biggs 1979).

Mopaneveld along rivers in Botswana are characterised by a mopane woodland in association with *Acacia nigrescens* in the tree layer and *Grewia flavescens* and *Grewia flava* dominating the shrub layer (Werger & Coetzee 1978). On waterlogged soils *Colophospermum mopane* is alternated by *Acacia xanthophloea* and *Hyphaene petersiana* (Werger & Coetzee 1978).

2.2.5.3 Malawi

The smallest area of Mopaneveld in southern Africa (10 000km^2) is hosted in Malawi where it occurs on altitudes between 450 m and 500 m receiving 800 mm or less rainfall annually (Mapaure 1994). It is these two environmental factors (rainfall and altitude) that is believed to determine the distribution of Mopaneveld in Malawi (Mapaure 1994). Werger and Coetzee (1978) stated that Mopaneveld in Malawi is rarely encountered with and if present, it is not as extensive as in the other hosting countries. Mopaneveld occurs in Liwonde National Park, Lengwe National Park, Majete, Mwabvi and Vwaza Marsh Wildlife Reserves as well as in the mid-Shire Valley in Chingale (Namatunu Forest) in Zomba and Mua-Tsanya Forest Reserve in Dedza (Chikuni 1996). In the mid-Shire Valley, deep soils produce *C. mopane* woodland. In the lower Shire Valley and along the southern shores of Lake Malawi, Mopaneveld is found on compact, alkaline, dark grey sandy clays with free calcium carbonate (Wild & Barbosa 1967; Werger & Coetzee 1978) supporting a tree savanna (Mapaure 1994). This dry deciduous woodland savanna is dominated by *Colophospermum mopane* on deep sandy clay where individuals reach 30–31 m, considerably higher than recorded elsewhere (Dudley 1994). The Malawian Mopaneveld is almost uniform in woody species dominance (Wild & Barbosa 1967). In Liwonde National Park, *Colophospermum mopane* usually forms monotypic stands, although on termite hills *C. mopane* individuals are accompanied by species of *Drypetes*, *Markhamia*, *Cassia*, *Euphorbia*, *Tamarindus*, *Acacia*, *Commiphora*, *Ziziphus*, *Croton*, *Salvadora* and *Dalbergia* (Dudley 1994). The mopane clump savanna is widely distributed in the Liwonde National Park with Mopaneveld restricted to the regularly spaced termite hills. These termite-Mopaneveld communities are surrounded by grassy glades, often seasonally waterlogged (Dudley 1994; Bhima & Bredenkamp in press).

2.2.5.4 Mozambique

The Limpopo, Save and Zambezi rivers, all three being associated with extended Mopaneveld along their valleys, flow through Mozambique to enter the sea. Receiving between 400 mm and 700 mm rainfall annually, the Mopaneveld of Mozambique is principally dominated by woodlands and savanna of which their distribution is thought to be influenced by rainfall (Mapaure 1994). Approximately 98 000 km^2 area is covered by Mopaneveld vegetation in Mozambique (Mapaure 1994). The Save and Limpopo valleys contain calcareous alluvium on which mopane savanna predominates, whilst both mopane woodland and savanna is found in the Zambezi valley, mainly composed of relatively deep, compact, clayey and calcareous soils derived from Karoo formations (Mapaure 1994).

Mopaneveld vegetation in the valleys of the Save- and Limpopo River occurs as a mixed tree and shrub savanna (Werger & Coetzee 1978). Soils are lacustrine, calcareous formations with several alluvial depressions. Rainfall in this region is irregular and less than 400 mm annually, decreasing inland (Wild & Barbosa 1967). The vegetation varies according to variance in soil types, but also according to changes in topography. Generally *Colophospermum mopane* is accompanied by species such as *Ximenia americana*, *Salvadora angustifolia*, *Azima tetracantha*, *Adenium multiflorum*, *Boscia albitrunca*, *Pachypodium saundersii*, *Dombeya kirkii*, *Sanseveria* spp., *Euphorbia* spp., *Maerua edulis* etc. (Werger & Coetzee 1978).

A major contribution to Mopaneveld is located in the Zambezi River valley. Mopaneveld of this valley, stretching from the Caprivi (Namibia) in the West to the Tete district (Mozambique) in the East, consists of almost pure *Colophospermum mopane* woodlands, with scattered *Adansonia digitata* trees. Soils are generally deep, clayey and often contain calcareous material. Annual rainfall measures between 500 mm and 700 mm. Altitude varies from 200 m to 500 m (Werger & Coetzee 1978). A mixed Mopaneveld occurs where the soils are stonier. Species associated with this type include *Commiphora* spp., *Combretum* spp., *Acacia nigrescens*, *Albizia* spp., *Ximenia americana*, *Dalbergia melanoxylon* and several more. The undergrowth is generally sparse and contains species of *Andropogon* and *Setaria* and also *Cenchrus ciliaris* (Werger & Coetzee 1978).

2.2.5.5 Namibia

The distribution of Mopaneveld in Namibia stretches from the Cunene River in the north towards the Ugab in the south and north-eastwards towards Namutoni, as well as occupying patches in the Caprivi strip (Mapaure 1994). Mopaneveld in Namibia covers approximately 77 000 km^2. A variety of soil types accompany the distribution of Mopaneveld in Namibia. Variance in soil type in combination with erratic, variable rainfall patterns probably determine the distribution of Mopaneveld in Namibia (Mapaure 1994).

Colophospermum mopane often makes up a spaced woodland with a shrubby understorey in Namibia. Its southern distribution boundary follows the 5°C isotherm of mean daily minimum temperature for the coldest month, July. This explains why *C. mopane* does not exist either in the eastern part of Owamboland or in the Kavango. Close to its southern boundary, frost damage is frequent. The height of *C. mopane* trees decreases from north to south and west where the weather is cooler and drier. The more alcaline the soil, the poorer the growth of the trees. Soils under *Colophospermum mopane* tend to have poor permeability and high susceptibility to erosion (Erkkilä & Siiskonen 1992).

Colophospermum mopane occupies the arid lands along the Kaokòland escarpment in Namibia and the Chela escarpment in Angola. It is in these arid regions where *Colophospermum mopane* crosses the border of the Sudano-Zambezian Region into the Karoo-Namib region (Werger & Coetzee 1978) (see also 2.2.5.1). Receiving an annual rainfall of 50–100 mm (250 m altitude), the western limits of Namibian Mopaneveld along the Kaokoland escarpment toward the Namib Desert is characterised by a low shrub savanna type. Although still dominating the woody layer, *Colophospermum mopane* is confined to depressions and small riverbeds (Figure 3) (Werger & Coetzee 1978; Giess 1998). Vegetation associated with *Colophospermum mopane* in these arid areas include species such as *Balanites welwitschii*, *Sesamothamnus benguellensis*, *S. guerichii*, *Commiphora* spp. including *Commiphora africana*, *C. angolensis*, *C. anacardiifolia*, *C. crenato-serrata*, *C. discolor*, *C. giessii*, *C. glaucescens*, *C. kraeseliana*, *C. mollis*, *C. multijuga*, *C. pyracanthoides*, *C. tenuipetiolata*, *C. virgata*, *C. wildtii* and many species of the Acanthaceae in the herabceous stratum (Werger & Coetzee 1978; Giess 1998). What is of particular interest, is the occurrence of Mopaneveld on arid lands in the western part of the country, often being associated with the well-known desert species, *Welwitschia mirabilis* (Figure 4).

The Kaokoland lies between the 0–300 mm rainfall isohyets and produces only desert or semi-desert soils and corresponding vegetation. The vegetation of the Kaokoland can be divided into two major components, being arid savanna and desert and sub-desert (Joubert 1971).

In the study of Becker and Jürgens (2000) the vegetation of Kaokoland was examined by analyzing three transects through the study area by means of phytosociological criteria. Although presenting a description of the vegetation of Kaokoland 20 years after the study of Viljoen (1980), the results corresponded to a large extend. For the purpose of an overview of the vegetation of Kaokoland in Namibia, the discussion mainly follows the descriptions by Viljoen (1980).

In the dry, central parts of the Kaokoland escarpment, an open tree savanna predominates on an altitude between 700 m and 1 100 m. Being the dominant woody species for this open savanna, *Colophospermum mopane* reaches a height of 2.5 m (Viljoen 1980). Species accompanying mopane in this savanna type include *Catophractes alexandri*, *Terminalia prunioides*, *Combretum apiculatum*, *Euphorbia damarana*, *Ceraria longipedunculata*, *Commiphora multijuga*, *C. virgata*, *C. africana*, *Maerua schinzii* and *Sesamothamnus guerichii*. The herbaceous stratum is poorly developed with *Schmidtia kalahariensis* being the dominant grass species (Viljoen 1980). In the long, undulating valley of the Hoarusib River, bordered by the Tonnesen- and Girraffen Mountains, a dwarf mopane savanna predominates in association with *Terminalia prunioides* (Viljoen 1980). The annual rainfall of the Hoarusib Valley ranges between 150 mm and 250 mm. Shallow, calcareous, stony soils (Figure 5), interrupted by deep, sandy loamy soils on colluvial and alluvial plains, characterise this arid area (Viljoen 1980). The tree layer is dominated by *Colophospermum mopane* in association with *Terminalia prunioides*. Other species with lesser dominance include *Sesamothamnus guerichii* (Figure 6), *Maerua schinzi*, *Boscia foetida*, *Commiphora pyracanthoides*, *Acacia reficiens*, *A. senegal* var. *rostrata*, *Salvadora persica*, *Petalidium rossmannianum*, *Monechma genistifolia* and *M. arenicola* (Viljoen 1980; Becker & Jürgens 2000). The herbaceous layer is heavily utilised with scattered tussocks of *Schmidtia kalahariensis*, *Enneapogon cenchroides* and *Stipagrostis uniplumis* (Viljoen 1980).

Another open tree savanna, a typical Kaokoland valley Mopaneveld, prevails in the Sesfontein and Warmquelle valleys. This savanna type receives between 72 mm and 164 mm rainfall per year and inhabits calcareous, as well as colluvial and alluvial soils varying in soil moisture content (Viljoen 1980). Trees in this type reach heights of more than 12 m despite the low rainfall patterns (Viljoen 1980). *Acacia tortilis* is in strong association with *Colophospermum mopane* in this valley bushveld. They do occur together, however *Colophospermum mopane* tends to grow denser but lower with scattered individuals of *Maerua schinzii*, whilst *Acacia tortilis* forms an open treeveld with *Salvadora persica* occupying the shrub stratum (Viljoen 1980). Due to over-utilisation no perennial species occur in the herbaceous stratum. Instead, annuals such as *Chloris virgata*, *Setaria verticillata*, *Eragrostis denudata*, *Monelytrum luederitzianum*, *Enneapogon brachystachyus*, *Tribulus* sp. and *Heliotropium ovalifolium* dominate (Viljoen 1980).

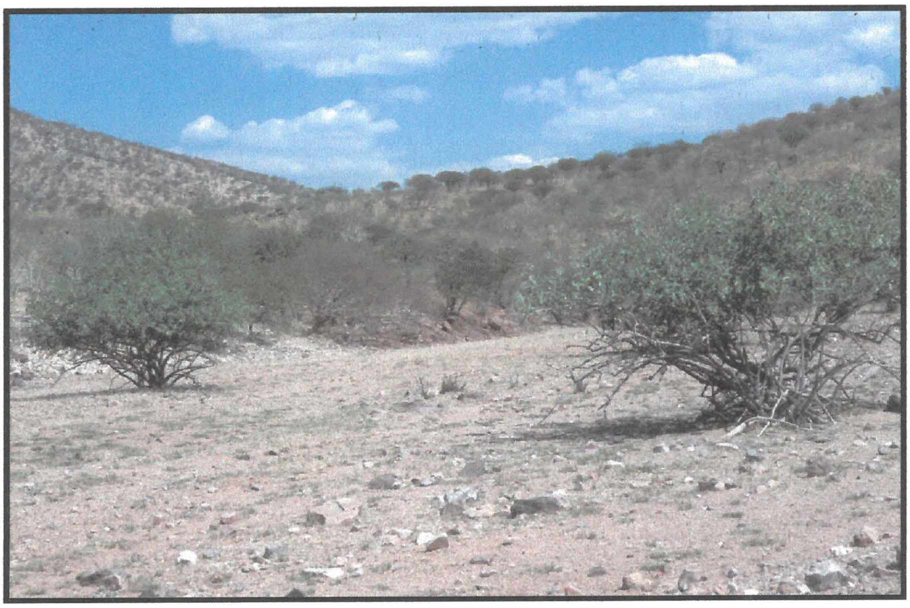


Figure 3 *Colophospermum mopane* often inhabits dry washes in the arid Kaokoland.

Figure 4 One of the most spectacular combinations: *Colophospermum mopane* and *Welwitschia mirabilis* in the Namibian desert.

Figure 5 Shallow, calcareous soils in Namibian Mopaneveld.

Figure 6 *Sesamothamnus guierichii* in a *Colophospermum mopane* community on calcareous soils.

A *Colophospermum mopane – Terminalia prunioides – Combretum apiculatum* tree savanna occurs on an altitude between 850 m and 1 500 m in the undulating, broad valleys of the northeastern Kaokoland (Viljoen 1980). Rainfall figures of this area near 350 mm annually (Viljoen 1980). The vegetation however does not reflect this relatively high rainfall pattern. It is suggested to be ascribed to poor soil moisture availability in the predominant shallow, rocky soils (Viljoen 1980). The most conspicuous tree species of this area include *Colophospermum mopane*, *Terminalia prunioides* and *Combretum apiculatum*. The co-dominance of these species is interrupted by dominance by several *Commiphora* spp. on the mountain slopes and rocky outcrops, whilst on the granitic outcrops *Cissus nymphaeifolia* and *Hexalobus monopetalus* predominate. On the more sandy soils dominance by *Hippocratea africana* and *Pterocarpus lucens* subsp. *antunesii* characterise the vegetation (Viljoen 1980).

From Opuwo and further south the vegetation is also characterised by the co-dominance of *Colophospermum mopane* and *Terminalia prunioides* (Viljoen 1980). On deeper soils however, *Terminalia prunioides* is replaced by *Spirostachys africana* and in the lower-lying valleys of alluvium, *Acacia tortilis* and *Ziziphus mucronata* dominate the tree stratum. On the mountains and hills *Sterculia africana* and several *Commiphora* species predominate. On calcareous plains a dwarf shrubveld occur with the most conspicuous species being *Petalidium rossmannianum* and *Hirpicium gorteroides* (Viljoen 1980).

In the Etosha National Park, Kaokoland vegetation is represented in the western regions of the park on calcrete, rhiolite, andesite and granite of the Damara supergroup (Le Roux *et al.* 1988). Receiving approximately 300 mm rainfall annually, this Kaokoland vegetation type is presented by Mopaneveld type vegetation. On very shallow lithosols on a calcrete substrate *Colophospermum mopane* is accompanied by *Acacia reficiens*, *Terminalia prunioides* in the tree stratum and *Gossypium triphyllum*, *Boscia foetida*, *Monechma genisitifolium*, *Petalidium englerianum* and *Leucosphaera bainesii* in the shrub stratum (Le Roux *et al.* 1988). On sites where aeolian sands cover calcrete boulders, *Sesamothamnus guerichii*, *Catophractes alexandri*, *Otoptera burchellii* and *Mundulea sericea* also become prominent with the herbaceous layer being well-developed and including species such as *Anthephora schinzii*, *Enneapogon desvauxii*, *Stipagrostis hirtigluma* and *Enneapogon cenchroides* (Le Roux *et al.* 1988). Lithosolic soils derived from the andesites are relatively fertile and produce a heterogenic vegetation type on this hilly landscape. The herbaceous stratum is perennial with *Eragrostis nindensis* being very prominent (Le Roux *et al.* 1988).

Mopaneveld vegetation occurring on calcareous substrates in Etosha National Park is furthermore abundant south of the Etosha Pan, extending westwards. Le Roux *et al.* (1988) refers to this vegetation type as Karst woodlands, although it does not represent woodlands in the true sense of the word. Adjoining the sweet grassland, which in turn borders the southern edges of the pan, the vegetation is characterised by the dominance of *Colophospermum mopane* on calcareous lithosols. In some areas *C. mopane* forms homogeneous stands, but generally the woody stratum comprises species such as *Catophractes alexandri*, *Acacia reficiens*, *Acacia mellifera*, *Grewia* spp., *Commiphora pyracanthoides*, *Montinia caryophyllaceae*, *Acacia senegal*, *Boscia foetida*, *B. albitrunca*, *Acacia nebrownii* and *Gossypium triphyllum*. The herbaceous stratum is fairly well developed including species such as *Stipagrostis hochstetteriana*, *Cenchrus ciliaris* and several annual species of *Enneapogon* and *Aristida* (Le Roux *et al.* 1988). On shallower soils *Combretum apiculatum* and *Terminalia prunioides* become more prominent. On areas receiving slightly higher rainfall, although still being Karstveld vegetation, *Colophospermum mopane* and *Terminalia prunioides* are the most prominent trees on boulder calcrete. The soils are very shallow and overlie a calcified dolomite or a low-grade marble. The soils are however fertile and heavy clayey soil often erupts on the surface. *Spirostachys africana* becomes prominent on soils containing higher moisture levels.

Mopaneveld in Namibia is not only restricted to calcareous substrates and alluvium, but also on Kalahari-type sand (Joubert 1971). The dry western sandveld of the Etosha National Park (Le Roux *et al.* 1988) is characterised by shrub Mopaneveld where the sand is shallow and calcretes are exposed. *Leucosphaera bainesii*, *Seddera suffruticosa*, *Rhigozum brevispinosum* and *Commiphora angolensis* are often accompanying mopane in the woody layer whereas *Anthephora pubescens*, *Pogonarthria fleckii* and *Eragrostis dinteri* dominate the grassy layer (Le Roux *et al.* 1988). On deeper Kalahari sand *Terminalia sericea* becomes prominent with *Acacia erioloba, Dichrostachys cinerea* and *Croton gratissimus* also present (Le Roux *et al.* 1988).

In small depressions in the Etosha National Park shrub Mopaneveld predominates on loamy soils with a high clay content (Le Roux *et al.* 1988). Species associated with *C. mopane* in this shrub savanna include *Catophractes alexandri*, *Dichrostachys cinerea*, *Leucosphaera bainesii* and *Grewia flava* (Le Roux *et al.* 1988).

Further eastwards from the escarpment, Mopaneveld turns from a predominant shrubland to an open tree savanna in Owamboland of the Cuvelai Delta. Owamboland, a broad plain about 1 100 m above sea level, is located in the northern parts of Namibia. Aeolian Kalahari sands of varying depth cover the area with scattered patches of calcareous concretes. Oshanas, being seasonally flooded water courses, dissect the Cuvelai Delta in Owamboland (Figure 7). This area receives between 350 mm rainfall per year in the southwest, while the northeastern parts receive 550 mm annually. Rainfall patterns are however unpredictable, but generally precipitation peaks in February (Erkkilä & Siiskonen 1992). The western part of Owamboland belongs to Mopaneveld where this extensive vegetation type occurs as interfaces on slightly elevated terraces or sand dunes between the seasonally flooded Oshanas. Due to the availability of water in the semi-arid region of the Cuvelai Delta, the area is densely populated and, at least most of the area is converted to agricultural fields and grazing land (Erkkilä & Siiskonen 1992). Wood harvesting, especially of *C. mopane* is also common along the Oshanas (Figure 8). Trees dominating the vegetation of this area include *Colophospermum mopane*, several species of *Acacia*, *Combretum* and *Commiphora*, *Diospyros mespiliformis*, *Hyphaene petersiana* (Figure 9), *Adansonia digitata* and *Terminalia sericea* (Erkkilä & Siiskonen 1992).

Even more eastwards in the Kavango, *Colophospermum mopane* occurs as scattered individuals but never dominates the woody stratum (Erkkilä & Siiskonen 1992). The three major zonal Mopaneveld vegetation types in the Caprivi (Mendelsohn & Roberts 1997) relate to a large extent the soil types. The Mopaneveld type is restricted to the heavy, poorly-drained clay soils interrupting deep Kalahari sands inhabited by *Baikiaea plurijuga*, *Burkea africana*, *Pterocarpus angolensis*, *Ricinodendron rautanenii* and *Guibourtia coleosperma*. On the light clay soils, *Acacia erioloba*, *Combretum imberbe* and *Acacia nigrescens* are common (Mendelsohn & Roberts 1997). *Colophospermum mopane* occurs as the only large tree in the *C. mopane–Aristida* woodland on heavy clay loams (Mendelsohn & Roberts 1997). Mopane is however accompanied by *Acacia erioloba* and *Albizia harveyi* where the soils are better drained. A mosaic of Mopaneveld and Sandveld often occurs where pockets of Kalahari sands interrupt the "mopane soils" (being heavier-textured clays or clayey loam soils). In this mosaic vegetation type, *C. mopane* occurs with tree species which are usually not associates of mopane, e.g. *Burkea africana*, *Erythrophleum africanum*, *Terminalia sericea* and *Combretum collinum* (Mendelsohn & Roberts 1997).

Figure 7 Oshanas in Owamboland. Mopaneveld occurs on the interfaces within the flooded areas.

Figure 8 Wood harvesting has a pronounce effect on the structure of *Colophospermum mopane* trees in Owamboland, Namibia.

Figure 9 *Hyphaene petersiana* (arrow) is a common associate of *Colophospermum mopane* in Owamboland, Namibia.

2.2.5.6 South Africa

The South African Mopaneveld is distributed along the Limpopo River Valley in the north where it extends towards its affinities in the neighbouring Zimbabwe and Botswana. The Soutpansberg forms the southern distribution limit in the wide, gently undulating landscapes of Limpopo River Valley (Acocks 1988). A broad plain of Mopaneveld extends from the northern border of the Kruger National Park along the eastern end of the Soutpansberg in Venda, to its most southern distribution limit just south of the Olifants River in the Kruger National Park where the annual rainfall is slightly higher (Gertenbach 1987).

Mopaneveld in South Africa covers a total area of 23 00 km^2. Generally it follows areas of altitudes ranging from 400–750 m, rainfall varying between 250 mm and 400 mm annually and high temperatures (15–31°C) (Acocks 1988; Mapaure 1994). Rainfall and altitude seem to influence the distribution of mopane in South Africa, while physiognomy is determined by soil type (Mapaure 1994). Mopaneveld physiognomy is a striking feature in the Mopaneveld of South Africa. Extensive areas of multi-stemmed, shrubby Mopaneveld cover the basaltic plains in the Kruger National Park (Figure 2c) whereas mopane woodlands is associated with soils derived from shale and a mixed mopane treeveld covering granitic and calcareous substrates.

Acocks (1953) did not separate the two distinct physiognomical units of Mopaneveld in South Africa, namely shrubveld and treeveld. Low and Rebelo (1998) distinguished between Mopane Shrubveld and Mopane Bushveld (Van Rooyen & Bredenkamp 1998). Mopane Shrubveld is commonly associated with heavy clayey soils often with vertic or near-vertic properties derived from basalt and gabbro. A stunted, multi-stemmed shrubby growth of fairly dense mopane (1–2 m in height) characterises this type occurring in the broad basaltic plains along the eastern distribution of Mopaneveld in the Kruger National Park (Figure 2c). Individuals of *Combretum imberbe*, *C. hereroense*, *C. apiculatum*, *Sclerocarya birrea*, *Lonchorcapus capassa*, *Acacia nigrescens*, *A. exuvialis*, *Commiphora glandulosa*, *C. africana*, *Grewia bicolor*, *Dalbergia melanoxylon*, *Flueggea virosa*, *Ehretia rigida*, *Maerua parvifolia*, *Dichrostachys cinerea* and *Cissus cornifolia* is commonly associated with this type (Gertenbach 1978; Gertenbach 1983; Van Rooyen & Bredenkamp 1998). Gertenbach (1983) distinguished three variations of mopane shrubveld on basalt and gabbro according to the herbaceous layer. They include the open shrubveld of the *Bothriochloa radicans* variation on Milkwood soils, the mopane shrubveld containing scattered individuals of *Colophospermum mopane* and *Combretum apiculatum* trees of the *Themeda triandra* variation on deeper soils of, either Bonheim, Swartland and Mayo types. The last variation is the *Setaria woodii* (=*S. incrassata*) occurring on concave terrain where soils are very clayey with a vertic character. *Colophospermum mopane* is more sparsely dispersed while species such as *Acacia nigrescens*, *Albizia harveyi* and *Lonchocarpus capassa* become more prominent in the woody stratum (Gertenbach 1983). The herbaceous layer of the mopane shrubveld includes dense stands of *Themeda triandra*, *Setaria incrassata*, *Bothriochloa radicans*, *Panicum coloratum*, and *Digitaria eriantha* (Gertenbach 1978; Van Rooyen & Bredenkamp 1998), whilst others such as *Enneapogon cenchroides*, *Aristida congesta*, *Eragrostis superba*, *Schmidtia pappophoroides*, *Cenchrus ciliaris*, *Urochloa mosambicensis* and *Panicum maximum* occur frequently (Gertenbach 1983).

The mopane shrubveld is however not restricted to the heavy clays derived form basalt and gabbro, but also occurs in the Limpopo River Valley on calcareous soils of an intersected to undulating landscape (Gertenbach 1983; Mapaure 1994). This unique landscape (Gertenbach 1983) is underlain by the Malvernia Formation, which decomposes to give rise to soil with many lime concretions (Gertenbach 1983). The vegetation of this shrub savanna consists of *Colophospermum mopane*, *Maytenus heterophylla*, *Euclea schimperi*, *Grewia bicolor*, *Acacia nigrescens*, *Combretum apiculatum*, *Terminalia prunioides*, *Euclea divinorum*, *Sterculia rogersii*, *Commiphora mollis*, *Zanthoxylum humilis* and *Dalbergia melanoxylon* in the woody layer. Grasses such as *Enneapogon scoparius* and *Aristida congesta* characterise the herbaceous stratum while *Seddera capensis* occurs frequently as a forb (Gertenbach 1983).

Another less common Mopaneveld type is the Olifants River Rugged Veld on metamorphic rock (Gertenbach 1983). The vegetation shows xerophytic characteristics with a field layer being very sparse. *Colophospermum mopane* occurs not as a sole dominant, but the mixed relatively high species diversity open savanna is comprised of individuals of which *Combretum apiculatum*, *C. hereroense*, *Colophospermum mopane*, *Commiphora mollis*, *Commiphora africana*, *Terminalia prunioides*, *Grewia villosa*, *G. bicolor*, *Boscia albitrunca*, *Acacia nigrescens*, *Dalbergia melanoxylon*, *Dichrostachys cinerea* are the most conspicuous (Gertenbach 1983).

Mopane Bushveld (Van Rooyen & Bredenkamp 1998) is commonly associated with deeper soils. Although monotypic stands of *Colophospermum mopane* occur in Mopane Bushveld it is in general more a mixed savanna than the Mopane Shrubveld. In the main river valleys Mopaneveld is more mixed and a striking feature is the scattered individuals of *Adansonia digitata* in the open treeveld (Figure 15) (Acocks 1988).

A familiar Mopaneveld type is the open to closed mopane treeveld savanna in association with *Combretum apiculatum*. This vegetation type is commonly underlain by amphibolite of the Swaziland System, granite and gneiss intersected with dolerite intrusions (Gertenbach 1983). The undulating landscape derived from the Swaziland System constitutes sandy uplands and more clayey bottomlands. *Combretum*-dominated vegetation is confined to the more sandy uplands whilst *Colophospermum mopane* vegetation inhabits the clayey bottomlands. The upland *Combretum*-dominated vegetation includes odd individuals of *Colophospermum mopane* whilst species such as *Combretum apiculatum*, *C. zeyheri*, *Terminalia sericea*, *Albizia harveyi*, *Dalbergia melanoxylon*, *Sclerocarya birrea*, *Cissus cornifolia*, *Acacia exuvialis*, *A. burkei*, *Dichrostachys cinerea*, *Commiphora africana* and *Lannea schweinfurthii* dominate (Gertenbach 1983). In the middle-and footslopes *Colophospermum mopane* occurs in association with *Combretum apiculatum* accompanied by other species including *Ormocarpum trichocarpum*, *Acacia gerrardii*, *A. nigrescens*, *Ozoroa engleri*, *Euclea divinorum*, *Bolusanthus speciosus*, *Combretum hereroense*, *C. imberbe*, *Terminalia prunioides*, *Grewia bicolor*, *Maerua parvifolia* and *Ximenia caffra* in the woody layer (Gertenbach 1983).

The herbaceous layer of both the uplands and bottomlands is well developed with dominant grass species being *Pogonarthria squarrosa*, *Eragrostis rigidior*, *Aristida congesta*, *Digitaria eriantha*, *Panicum maximum*, *Enneapogon cenchroides*, *Heteropogon contortus*, *Schmidtia pappophoroides*, *Bothriochloa radicans*, *Themeda triandra* and *Urochloa mosambicensis* (Gertenbach 1983). Forb species characterising the *Combretum*-mopane type include *Indigofera floribunda*, *Kyphocarpa angustifolia*, *Rhynchosia totta*, *Indigofera bainesii*, *Tephrosia polystachya*, *Ruellia patula*, *Asparagus plumosus*, *Corchorus asplenifolius*, *Seddera capensis*, *Phyllanthus asperulatus*, *Cucumis hirsutus* and *Hibiscus micranthus* (Gertenbach 1983).
Mopaneveld occurring on sands is not to be overlooked. Although it usually does not form the sole dominant of a community in sandveld areas, *Colophospermum mopane* occurs as scattered

individuals on, either termitaria, or clayey soils overlain by a shallow sandy sheet (Chapter 6). The Sandveld occurring in the Kruger National Park is derived from, either the Waterberg System, the Phalaborwa Igneous Complex and the Swaziland System. Sandveld derived from the Swaziland System and the Phalaborwa Igneous Complex gives rise to undulating landscapes, generally granitic of origin. The vegetation coincides with the *Combretum*-mopane type associated with granite, although this type is sandier with tree species such as *Peltophorum africanum* and *Pseudolachnostylis maprouneifolia* occurring on heavily leached sandy uplands as a result of a higher rainfall in the area (Gertenbach 1983). The Tsende Sandveld (Gertenbach 1983) is dominated by *Colophospermum mopane*, although not alternated by *Combretum* vegetation according to distinct topography, but *Combretum*-dominated vegetation occurring rather as interrupting strips on sandier plains in the moderately high shrub savanna (Gertenbach 1983). In the northern parts of the Kruger National Park, an ecotone type of Mopaneveld occurs as a border between proper Mopaneveld and Sandveld (Chapter 6). Although conditions do not reflect the typical distribution of *C. mopane* in this area, scattered patches of *C. mopane*-dominated vegetation occurs between deep sandy plains of the Waterberg System, where vegetation is totally atypical of Mopaneveld.

Mopane forests occur in isolated patches of Mopaneveld on deep alluvium (mostly along watercourses) or loamy soils derived from Ecca-shales. The vegetation of these woodlands is mixed with high *Colophospermum mopane* trees (10–15 m in height) and others including *Spirostachys africana*, *Acacia nigrescens*, *Euclea divinorum*, *Grewia bicolor*, *Ximenia americana*, *Maerua parvifolia*, *Zanthoxylum humilis*, *Thilachium africanum*, *Acacia grandicornuta*, *A. tortilis*, *Combretum imberbe*, *C. hereroense*, *Dichrostachys cinerea*, *Boscia albitrunca* and *Dalbergia melanoxylon* (Gertenbach 1983). In the herbaceous layer *Enteropogon macrostachyus*, *Enneapogon cenchroides*, *Chloris roxburghiana*, *Panicum maximum*, *Aristida congesta*, *Digitaria eriantha*, *Bothriochloa radicans* and *Schmidtia pappophoroides* dominate the grassy layer while *Amaranthus thunbergii*, *Hibiscus micranthus*, *Seddera capensis*, *Abutilon fruticosum*, *Crotalaria virgulata*, *Indigofera vicioides* and *Neuracanthus africanus* are conspicuous forbs (Gertenbach 1983). Along drainage lines tall mopane trees in association with tall *Acacia karroo* trees occur with sparse undergrowth, predominantly *Panicum maximum* cover (Acocks 1988). In the Limpopo Valley, a closed canopy of mopane forest occurs with little undergrowth (Acocks 1988). The vegetation is striking, containing, apart from high *C. mopane* trees, large individuals of *Kirkia acuminata*, *Adansonia digitata*, *Acacia nigrescens*, *Sclerocarya birrea*, and *Sterculia rogersii*.

The Mopaneveld north of the Soutpansberg is in general drier as a result of moisture retention by calcareous substrates. Altitude varies between 300 m and 700 m with annual rainfall being approximately 350 mm. The vegetation of this area is related to the eastern belt Mopaneveld in the Kruger National Park, but generally comprises elements typical of drier habitats, even relating Namibian types (Chapter 5). Species significant of this type include *Boscia foetida* subsp. *rehmanniana*, *B. albitrunca*, several *Commiphora* species, *Grewia* spp. *Terminalia prunioides*, *Acacia mellifera* subsp. *detinens*, *A. erubescens*, *A. senegal*, *Adansonia digitata*, *Sesamothamnus lugardii*, *Anisotes rogersii* and *Catophractes alexandri*. The herbaceous layer is poorly developed, containing many annual species such as *Enneapogon* spp., *Aristida* spp. and *Schmidtia pappophoroides* (Louw 1970; Acocks 1988).

2.2.5.7 Zambia

Covering an area of approximately 43 500 km^2, Mopaneveld in Zambia is generally associated with extended, often one-storeyed woodlands, found in the valleys of the Luangwa, Luano, Kafue as far north as Mofu in the Kafue National Park, Zambezi west to Katima and the Mashi to just north of the Sesheke-Senanga border (Fanshawe 1969). According to Mapaure (1994) it is particularly the soil type that determines the distribution of Mopaneveld in Zambia. *Colophospermum mopane* forms the sole dominant woody species with scattered individuals of *Acacia nigrescens*, *Adansonia digitata*, *Combretum imberbe*, *Kirkia acuminata* and *Lannea schweinfurthii*. The understorey is often absent, but if it does exist *Balanites aegyptiaca* and *Ximenia americana* is often encountered with (Fanshawe 1969).

The Luangwa Valley receives approximately 900 mm rainfall annually and lies in a wide, flat-bottomed trough bounded by steep, dissected escarpments that rise to 700 m and 800 m above its floor (Werger & Coetzee 1978). Extensive stands of *Colophospermum mopane* trees from 10 m to 17 m in height inhabit the alkaline soils of the valley alluvium (Fanshawe 1969; Werger & Coetzee 1978). These poor fluvisol-vertisol soils, impregnated with nodular concretions, are normally flooded during the wet season and almost completely dried out during the dry season, which coincides with high temperatures (Fanshawe 1969; Cole 1986; Mapaure 1994). The ability of *C. mopane* to withstand these extreme conditions results in being a good competitor, which explains the almost monotypic stands of the species in parts of the Luangwa Valley. Woody species that are interspersed through the woodland include *Adansonia digitata*, *Combretum elaeagnoides*, *C. obovatum*, *Diospyros quiloensis*, *Holarrhena pubescens*, *Ximenia americana* and *Markhamia obtusifolia*. The undergrowth is sparse with dominant species including *Eragrostis viscosa*, *Andropogon gayanus*, *Aristida adscensionis*, *Chloris virgata*, *Brachiaria eruciformis*, *Echinochloa colona*, *Urochloa mosambicensis*, *Kyllinga alba* and several more (Werger & Coetzee 1978). Mopaneveld in the Luangwa Valley is however also frequently interrupted by patches of *Acacia* savanna and *Combretum-Terminalia sericea* woodland where conditions tend towards lower extremes (Werger & Coetzee 1978). On soils types where a sandy sheet overlays a hard and compact, alkaline sandy loam with a columnar structure, mopane woodlands with trees reaching heights of 25 m is found. A shrub Mopaneveld interrupts this woodland type (Werger & Coetzee 1978; Mapaure 1994).

Mopaneveld in the Zambezi River Valley of the Lake Kariba region differs from the Luangwa and associated valleys. The former is a bit drier, although still receiving more or less 700 mm rainfall per annum.

Termite mound building on the fluvisol-vertisol soils in the Luangwa Valley and the physiognomy of Mopaneveld on these soils depend on the depth and duration of flooding during the rainy season. Slight and temporary, or even absent floods result in the absence of termite mounds with *Balanites* shrubs occurring throughout the woodland. Scattered termite mounds accompanied by species not being able to withstand the floods follow the increase in flood duration and depth. A pure stand of "cathedral" mopane prevails on areas where flood duration and depth went beyond a certain point. Termite mounds are absent from these sites (Fanshawe 1969).

In "The Vegetation of Zambia", Fanshawe (1969) describes two ecotone types involving mopane woodlands. The first, an ecotone of Mopaneveld with miombo woodland, occurs on the colluvial soils of scarp slopes, on basalt soils around Livingstone and on schist ridges in the Gwembe Valley. On basalt around Livingstone, a low, open woodland with a deciduous canopy is characterised by *Colophospermum mopane*, *Acacia nigrescens*, *Adansonia digitata*, *Julbernardia globiflora*, *Kirkia acuminata*, *Peltophorum africanum*, *Pterocarpus lucens* subsp. *antunesii*, *Sclerocarya birrea* and *Sterculia* species (Fanshawe 1969). An ecotone of Mopaneveld with munga woodland occurs on alluvial flats and damboes, Karoo sandstones, alluvial mudstones not being flooded, skeletal mudstones and pebble beds (Fanshawe 1969). The ecotone with munga on sandstone and mudstone is a rich, tall, open deciduous woodland characterised by *Colophospermum mopane*, *Acacia nigrescens* and *Combretum apiculatum*. The understorey is well developed in the shrubby layer where species such as *Acacia nilotica*, *Albizia anthelmintica*, *Boscia matabelensis*, *Combretum elaeagnoides*, *Croton gratissimus*, *Dalbergia melanoxylon*, *Diospyros quiloensis* and *Grewia bicolor* are among the dominants (Fanshawe 1969). Another Mopaneveld-munga ecotone type exists as a broken, low open scrub Mopaneveld accompanied by *Terminalia randii* and *T. stuhlmannii*.

2.2.5.8 Zimbabwe

Zimbabwean Mopaneveld is commonly associated with the Zambezi, Limpopo, Sabi and Shangani valleys with medium size *Colophospermum mopane* trees to tall mopane woodlands (Werger & Coetzee 1978; Mapaure 1994). The distribution of Mopaneveld in Zimbabwe is thought to be determined by rainfall, which ranges between 500 mm and 700 mm annually, and altitude (being approximately 400 m) (Mapaure 1994).

Mopaneveld covers 101 500 km^2 in Zimbabwe (Mapaure 1994) and seems to represent approximately twelve major types. These types can be distinguished according to general physiognomical appearance and species composition, which follow the variance of a combination of factors, of which substrate type, soil depth, altitude and annual rainfall are probably the most important determinants for their distribution (Guy 1975; Timberlake *et al.* 1993; Mapaure 1994). Differences in soils account for the very heterogenous structure of Mopaneveld in Zimbabwe (Guy 1975), and probably in the rest of its distribution range.

Mopaneveld vegetation types in Zimbabwe are discussed according to three major physiognomical structures, which include *Colophospermum mopane* woodlands, tree savannas and shrub savannas. The variance within physiognomical structures is also addressed.

Mopane woodlands

There is great variance in *Colophospermum mopane*-dominated woodlands. They often grade into other woodland types or even into woodland thicket types. It is often difficult to determine where the *Colophospermum mopane* woodland types change to woodland savannas due to the variation in tree density along the valleys of the large rivers dissecting Zimbabwe. In the higher rainfall areas, e.g. in the northern Zambezi Valley in Zimbabwe, Mopaneveld varies between woodland and woodland savanna whereas in the drier south, woodland savanna, tree savanna and tree/bush savanna prevails. As a result of partial clearing for cultivation or cutting for timber, many woodlands have been degraded to more open savanna types (Rattray 1962).

The first *Colophospermum mopane* woodland type is identified as a pure *C. mopane* woodland generally occuring on the valley floors of large rivers dissecting Zimbabwe. In the Zambezi Valley this deciduous woodland occurs as the most extensive vegetation type of the valley floor (Guy 1975). According to Rattray & Wild (1961) this woodland is, as far as tree size and density is concerned, much better developed than those from the Sabi and Limpopo systems. This pure *C. mopane* woodland type occurs on soils which are generally derived from Karoo sediments, particularly mudstone and often sandstone, or old alluvium. These sediments produce deep, well-drained, fertile, sandy clay loam to clay, or often calcareous soils, on which pure stands of *Colophospermum mopane* trees between 10 m and 18 m high predominate (Rattray 1962; Wild & Barbosa 1967; Farrell 1968a; Timberlake & Mapaure 1992; Timberlake *et al.* 1993). Tree species such as *Adansonia digitata*, *Acacia nigrescens*, *Kirkia acuminata*, *Sterculia africana* and several *Commiphora* and *Combretum* species however often interrupt the monotypic appearance of the *Colophospermum mopane* woodland (Rattray & Wild 1961; Wild & Barbosa 1967; Du Toit 1993). On the more sandy soils *C. mopane* trees are typically associated with *Combretum apiculatum*, *C. collinum*, *Diospyros quiloensis*, *Acacia nigrescens*, *Commiphora mollis*, *Erythroxylum zambesiacum*, *Lannea schweinfurthii*, *Schrebera trichoclada*, *Strychnos madagascariensis* and *Xeroderris stuhlmannii* (Timberlake *et al.* 1993). The shrub layer is also better developed on the sandier soils (Timberlake *et al.* 1993). In areas where the *C. mopane* woodlands are tall and well developed with an almost closed canopy, the herb layer is poorly developed with scattered shrubs and a very poor, or even no grass cover is produced (Guy 1975; Timberlake & Mapaure 1992; Timberlake *et al.* 1993). Although not common, *Chloris* *virgata* and species of *Aristida*, *Digitaria*, *Eragrostis* and *Sporobolus* dominate the grass layer (Guy 1975; Timberlake *et al.* 1993). Where the canopy cover is less dense, a good cover of *Andropogon gayanus* occurs (Timberlake & Mapaure 1992). In areas where the canopy is sparser *Acacia nilotica*, *Dichrostachys cinerea*, *Dalbergia melanoxylon*, *Diospyros quiloensis*, *Erythroxylum zambesiacum*, *Ximenia americana*, *Gardenia resiniflua*, *Commiphora glandulosa*, *C. africana*, *Vepris zambesiaca*, *Maerua* spp., *Boscia* spp. and *Grewia bicolor* may occur (Timberlake & Mapaure 1992; Du Toit 1993; Timberlake *et al.* 1993). In the Sabi Valley a shrubby *Grewia bicolor* understorey occurs (Rattray 1962).

Occasionally *C. mopane* woodlands occur on old alluvium or colluvium. On these substrates *C. mopane* trees reach heights of 18 m or more and are termed "cathedral mopane". Trees of *Acacia nigrescens*, *A. robusta* subsp. *clavigera*, *Albizia anthelmintica* and *Balanites aegyptiaca* is often associates in this woodland type. This unique woodland type also produces a poorly developed understorey (Timberlake *et al.* 1993).

Although not very common and occuring in small patches, a *Colophospermum mopane* woodland type exists on a gently undulating expanse of sandy terrain along the border of Mozambique in the Zambezi Valley (Du Toit 1993). An open stand of tall, thin *Colophospermum mopane* trees and occasionally accompanied by also tall, scraggly *Combretum apiculatum* trees characterise this type (Du Toit 1993).

Colophospermum mopane often occurs in a woodland type of alternating dominance of *Kirkia acuminata* and *Acacia nigrescens* on shallower lithosols or skeletal soils, mainly derived from basalt (Rattray 1962; Du Toit 1993; Timberlake *et al.* 1993). In this woodland type, *C. mopane* is confined to the slightly deeper soils with *Kirkia acuminata* being predominant on shallow soils and rocky rises (Timberlake *et al.* 1993). *Combretum apiculatum*, *Diospyros quiloensis*, *Erythroxylum zambesiacum*, *Sclerocarya birrea*, *Commiphora mollis*, *C. mossambicensis* and *C. glandulosa* are common associates in the tree layer (Timberlake *et al.* 1993). The shrub layer is well developed with, amongst others, *Carphalea pubescens* and *Dalbergia melanoxylon*, while the grass layer is poorly developed (Timberlake *et al.* 1993). On heavier-textured soils, associated with *C. mopane* dominance, *Terminalia stuhlmannii*, *Combretum hereroense*, *Ximenia americana* and *Commiphora africana* become more important in the woody stratum

(Timberlake *et al.* 1993). *C. mopane* often shares dominance with *Terminalia stuhlmannii* on this undulating, slightly raised terrain. Extensively covered by rounded pebbles, the soils are usually sandy clay loam at medium depths derived from sandstones and siltstones (Timberlake & Mapaure 1992). Species being associated with the *C. mopane – T. stuhlmannii* woodland include *Kirkia acuminata*, *Sclerocarya birrea*, *Erythroxylum zambesiacum*, *Commiphora glandulosa*, *C. mossambicensis*, *C. mollis*, *Acacia nilotica*, *A. nigrescens* and *Ximenia americana* (Timberlake & Mapaure 1992; Timberlake *et al.* 1993). On shallower soils, this type is strongly associated with a *C. mopane – Combretum apiculatum* woodland (Timberlake & Mapaure 1992). The latter type includes an open woodland on medium to light textured soils formed from Karoo sandstone. *C. mopane* trees of 6–8 m characterise this type with additional major trees being *Combretum apiculatum* and *Diospyros kirkii*. The *Colophospermum–Diospyros kirkii* open woodland on shallow soils forms a type of its own and represents an open woodland with *C. mopane*, *D. kirkii* and *C. apiculatum* being the major components. The soils are generally shallow, light-textured lithosols with a shallow layer of brown loamy sand to clay loam derived from Karoo sandstone or from basalt (Timberlake *et al.* 1993). On sandier soils miombo elements such *as Pseudolachnostylis maprouneifolia*, *Diplorhynchus condylocarpon* and *Terminalia stenostachya* occasionally occur (Timberlake & Mapaure 1992).

Colophospermum mopane woodlands also occur along fringing rivers or major watercourses. On heavier-textured, fertile soils, a well-developed closed woodland thicket or an open woodland type occurs with trees between 12 m and 20 m high. Conspicuous species in the tree layer include *Colophospermum mopane*, *Diospyros quiloensis*, *Acacia robusta* subsp. *clavigera*, *A. nigrescens*, *Piliostigma thonningii*, *Lonchocarpus capassa*, *Combretum imberbe* and *Lannea schweinfurthii*, whereas *Combretum elaeagnoides*, *C. obovatum*, *C. mossambicense*, *Acacia ataxacantha*, *A. nilotica*, *Friesodielsia obovata* and *Markhamia zanzibarica* are amongst the dominants in the shrub layer. Species such as *Heteropogon melanocarpus* and *Digitaria* spp. define the poorly-developed grass layer (Guy 1975; Timberlake *et al.* 1993; Du Toit 1993).

Although not being a miombo species, *Colophospermum mopane* often interrupts miombo woodlands in northern Zimbabwe expressing ecotone woodlands (Rattray 1962; Farrell 1968b; Timberlake & Mapaure 1992; Du Toit 1993; Timberlake *et al.* 1993). The miombo-mopane association in Zimbabwe coincides with the *Combretum*-mopane association where Mopaneveld tends to inhabit the less sandy, heavier soil types usually on the foothills of an undulating landscape, or in the lower-lying valley floors, whereas miombo and *Combretum*-dominated vegetation (=Combretumveld) are more or less confined to the rocky, sandy soils on the hill crests and middle slopes (Timberlake & Mapaure 1992). Three major miombo-mopane woodland types are recognised in Zimbabwe. The *Brachystegia allenii*–mopane woodland is found at the foot of the Zambezi escarpment on colluvium (Timberlake & Mapaure 1992). The vegetation forms a mosaic with *Colophospermum mopane* being dominant on heavier-textured soils while *Brachystegia allenii* is dominant on coarser-textured soils (Timberlake & Mapaure 1992). The *Brachystegia glaucescens* woodland on hills follows almost the same pattern as the *B. allenii–C. mopane* woodland with *C. mopane* becoming more important towards the heavier-textured, slightly deeper bottomland soils (Timberlake *et al.* 1993). The second type is the *Brachystegia boehmii – Colophospermum mopane* woodland and is associated with heavy, often shallow sandy loam colluvial soils (Rattray 1962; Timberlake & Mapaure 1992; Timberlake *et al.* 1993). The *Brachystegia boehmii–Colophospermum mopane* woodland is open in some areas and closed in others. It can even present a clumped woodland or woodland thicket. The height of the dominant trees varies between 8 m and 16 m (Timberlake *et al.* 1993). Prominent tree species, generally being associated with this type, include *Colophospermum mopane*, *Brachystegia boehmii*, *Julbernardia globiflora* and *Kirkia acuminata*. Timberlake *et al.* (1993) distinguished three subtypes within the *B. boehmii–C. mopane* woodland being separated by species composition following substrate differences. A subtype on Cretaceous and Karoo sandstones represents a woodland to open woodland. A second subtype represents an alternating dominance of *C. mopane*, *B. boehmii*, *Julbernardia globiflora* and *Kirkia acuminata* on paragneiss, gneiss and granite whereas the third subtype is associated with termitaria and rocky outcrops (Timberlake *et al.* 1993). The *Julbernardia globiflora–Colophospermum mopane* woodland (type 3) is commonly associated with shallow, skeletal soils and with rocky, hilly areas derived from Karoo sandstones or associated with large termitaria (Rattray 1962; Du Toit 1993; Timberlake *et al.* 1993). In this woodland type *Julbernardia globiflora* and *Colophospermum mopane* alternate dominance with the miombo element (*J. globiflora* and associates) being confined to the sandier patches on slopes of rocky hills, and *Colophospermum mopane* to the heavier textured soils in the bottomlands (Timberlake *et al.* 1993). Trees accompanying *Julbernardia globiflora* dominance include amongst others *Diplorhynchus condylocarpon*, *Combretum zeyheri*, *Pseudolachnostylis maprouneifolia* and *Burkea africana*.

In the shrub layer *Baphia massaiensis* predominates. The grass layer of this type is generally tall with species such as *Aristida meridionalis*, *Pogonarthria squarrosa*, *Heteropogon melanocarpus* and *Stereochlaena cameronii* (Timberlake *et al.* 1993). Associates of *C. mopane* in the tree layer include *Terminalia stuhlmannii*, *Diospyros quiloensis* and *Terminalia prunioides*. The shrub layer is not well developed, but species such as *Acacia nilotica*, *Mundulea sericea*, *Erythroxylum zambesiacum*, *Boscia mossambicensis* and *B. matabalensis* may occur. In contrast with the *Julbernardia* vegetation, the grass layer of the *C. mopane* type in the bottomlands is not well developed and sparse individuals of *Hyparrhenia* spp., *Loudetia* spp., *Aristida* spp., *Brachiaria* spp. and *Heteropogon melanocarpus* occur (Timberlake *et al.* 1993).

Julbernardia globiflora has in general a wider altitudinal range comparing to the *Brachystegia* species. Pure *Julbernardia globiflora* communities are often found at lower altitudes where climatic conditions are less favourable to *Brachystegia* species. It is under these warm, dry conditions that *Julbernardia* woodlands are associated with *Colophospermum mopane* in ecotone types, as been described above (Rattray 1962). The woodland stature becomes somewhat opened and changes towards a savanna type (Rattray 1962).

Within a miombo type on intercalated sandstone (Du Toit 1993), small patches on deep white sands derived from coarse arkose sandstone represent a *Combretum-Strychnos* woodland in which *Colophospermum mopane* is one of the major components in the tree layer (Du Toit 1993). Other include *Kirkia acuminata*, *Burkea africana*, *Commiphora ugogensis*, *Pteleopsis anisoptera* and *Lonchocarpus bussei* with *Combretum apiculatum* and *Strychnos madagascariensis* being the dominants (Du Toit 1993).

The grass cover of the miombo-mopane associations is in general sparse but on heavy red soils derived from dolerite and epidiorite it is better developed. Perrenial grass species such as *Themeda triandra*, *Heteropogon contortus* and *Setaria sphacelata* tend to dominate on these soil types (Rattray 1962; Timberlake *et al.* 1993).

The Mopaneveld in Zimbabwe also covers semi-arid areas (400–600 mm rainfall annually) in the Limpopo Valley and its larger tributaries. *Colophospermum mopane* woodlands are not as common as in the Zambezi Valley, although large *C. mopane* trees can be found on the deeper alluvium soils along large watercourses (Farrell 1968a; Rogers 1993; Campbell & Du Toit 1994; O'Connor & Campbell 1986).

In Hwange National Park where the Madumabisa mudstones produce sandy clay to clayey soils, *C. mopane* often dominates the tree layer forming an almost uniform woodland type of 8–10 m in height (Rogers 1993). Trees such as *Erythroxylum zambesiacum*, *Acacia nigrescens* and *Diospyros quiloensis* occur as scattered individuals through the gregarious mopane. The understorey is well developed, consisting of *Combretum elaeagnoides*, *Terminalia prunioides*, *Commiphora pyracanthoides*, *C. africana*, *Grewia monticola* and *Vepris zambesiaca* (Rogers 1993). On seasonally inundated areas, *Colophospermum mopane* occurs in a woodland or wooded grassland type in association with woody species such as *Combretum imberbe*, *C. hereroense*, *Lonchocarpus capassa*, *Dichrostachys cinerea*, *Acacia nigrescens*, *Ziziphus mucronata* and *Hyphaene petersiana*.

A *Colophospermum mopane* woodland and mixed shrub woodland occurs on the north bank of the Lundi River on soils of granophytic origin (O'Connor & Campbell 1986). *C. mopane* dominates the tree layer in association with *Adansonia digitata* (O'Connor & Campbell 1986). A *Colophospermum mopane– Markhamia acuminata* (now *M. zanzibarica*) type occurs on the north bank of the Lundi River. Associated species include *Combretum imberbe*, *C. mossambicense*, *Thilachium africanum* and *Vitex* spp. (O'Connor & Campbell 1986). Mopaneveld in the Sabi-Lundi basin occurs on almost all soil types at lower altitudes, being dominant or sub-dominant on alcaline clays (Farrell 1968a). Short thickets or short closed *C. mopane* woodlands occur in the Save Valley on clayey soils derived from granite, gneiss, conglomerate, lava, shale, quartzite, limestone, grits and alluvium (Hin 2000). *Colophospermum mopane* in this region generally dominates the woody layer on flat or slightly rolling topography. The herbaceous layer is generally sparse in the closed woodland whereas a dense herbaceous layer is apparent along drainage lines (Hin 2000).

A mopane woodland on mudstone is found along the watercourses of the Lukosi River and its tributaries in the Hwange National Park (Rogers 1993). The woody component mainly comprises *Diospyros quiloensis*, *Dichrostachys cinerea*, *Combretum mossambicense*, *Terminalia prunioides*, *Erythroxylum zambesiacum*, *Acacia robusta* and *A. ataxacantha* (Rogers 1993).

Mosaic patches of Mopaneveld within other vegetation types are a general phenomenon (e.g. patches of Mopaneveld often interrupt miombo woodlands and woodland thickets on deep sand). Although miombo-type vegetation generally occurs on substrates atypical of Mopaneveld, individuals of *C. mopane* however inhabit the heavier-textured soils. On elevated areas of unconsolidated sand *Colophospermum mopane* occurs as an associate in dry forests and thickets, and not as a sole dominant in the woody component (Timberlake *et al.* 1993). *C. mopane* is however still a major component of the vegetation, therefore being discussed under Mopaneveld vegetation. In contrast to woodlands dominated by *Colophospermum mopane*, these dry forests and thickets contain a well-developed shrub layer, but the grass layer is still of poor condition (Timberlake *et al.* 1993). *C. mopane* occasionally occurs as an associated species in the *Terminalia brachystemma* bushed woodland, the *Combretum* woodland thicket on colluvium and sandstone, the *Combretum collinum* low open woodland on sand, the *Baikiaea* woodland on Kalahari sands and lastly in the *Baikiaea–Acacia* bushed woodland on sand dunes (Timberlake *et al.* 1993). In the *Terminalia brachystemma* bushed woodland on slightly elevated areas of unconsolidated, medium-textured brownish sands, probably remnants of aeolian Kalahari sand, *C. mopane* is amongst the main emergent trees accompanied by *Kirkia acuminata* and *Xeroderris stuhlmannii*. This bushed woodland to wooded bushland is characterised by trees of *Terminalia brachystemma* (6–8 m high) (Timberlake *et al.* 1993). Close to the shores of Lake Kariba the *C. mopane* individuals occasionally occur in a *Combretum* woodland thicket on colluvium and sandstone, usually in association with *Lannea schweinfurthii* (Timberlake *et al.* 1993). In the *Combretum collinum* low open woodland no clear catenary sequence exists, but species such as *C. mopane*, *Combretum apiculatum* and *Lonchocarpus nelsii* seem to occur on patches where the sands are thinner and there is some influence of heavier sub-soils (Timberlake *et al.* 1993). *C. mopane* occasionally occurs on heavier-textured soils in the *Baikiaea* woodlands on Kalahari sand. Patches of atypical miombo interrupt this type by the presence of *C. mopane*, *Combretum apiculatum*, *Boscia albitrunca*, *Grewia flavescens* and *Dichrostachys cinerea* (Timberlake *et al.* 1993). In areas where *C. mopane* occurs as a single species rather than forming pure stands, it is often accompanied by *Kirkia acuminata* and *Acacia nigrescens*.

Colophospermum mopane vegetation on termitaria is certainly a Mopaneveld type that can not be denied. This type is especially associated with Miombo. Deep, well-drained soils are not typical habitat for Mopaneveld, but termitaria within this habitat type provide habitat for

Colophospermum mopane and its associates. Woodland types where *Colophospermum mopane* is confined to termitaria include *Combretum* woodlands in a somewhat sloped landscape on deep, unconsolidated, generally coarse sands derived from Karoo sandstone (Timberlake *et al.* 1993). Termitaria in the *Brachystegia spiciformis–B. boehmii* woodland on deep, redeposited, unconsolidated Kalahari sand, the *Brachystegia boehmii–Pterocapus angolensis* open woodland on unconsolidated, medium to loamy sands derived from Karoo or Chizaira sandstone on a sandstone plateaux, and the *B. boehmii–Julbernardia* woodland on shallow soils, are inhabited by Mopaneveld-type vegetation with *Colophospermum mopane* dominating the tree layer (Timberlake *et al.* 1993).

Tree savanna

South of the Kalahari Sand areas and the main plateau in Zimbabwe, *Colophospermum mopane* woodlands are replaced by open tree savanna vegetation (Wild & Barbosa 1967). Where *C. mopane* is fairly pure and the grass cover is good, perennial grasses include *Eragrostis rigidior*, *Cenchrus ciliaris*, *Schmidtia pappophoroides* and *Urochloa* spp., while annual grasses are represented by *Enneapogon cenchroides*, *Aristida adscensionis*, *Eragrostis viscosa* and *Dactyloctenium aegyptium* (Wild & Barbosa 1967).

One of the most common vegetation types in the Mopaneveld of southern Africa is the *Colophospermum mopane–Combretum apiculatum* mosaic savanna. In Zimbabwe, as in other countries hosting this type, the tree layer is dominated by species of the Combretaceae on sandy rises and dominated by *C. mopane* in the lower areas on heavier soils (Timberlake *et al.* 1993). Trees of 5–10 m high define the open woodland with species such as *Combretum apiculatum*, *C. zeyheri*, *C. collinum*, *Terminalia sericea* and *Lonchocarpus nelsii* being prominent. Scattered large trees of *Sclerocarya birrea* and *Ricinodendron rautanenii* occurs with only a few individuals of *C. mopane* (Timberlake *et al.* 1993). In Hwange National Park, the *C. mopane–Combretum* type is described as one of the more diverse types of the park (Rogers 1993). As in most parts of its distribution, the *C. mopane–Combretum* tree savanna in Hwange National Park is underlain by granitic gneiss producing rocky ground on undulating landscapes of the Basement Complex (Rogers 1993). Several *Combretum* species characterise this type in combination with species such as *Xeroderris stuhlmannii*, *Markhamia acuminata* (=*M.*

zanzibarica), *Commiphora mollis*, *Terminalia randii*, *Cissus cornifolia*, *Dichrostahys cinerea* and *Grewia monticola* (Rogers 1993). Mopaneveld and Combretumveld are not restricted to granitic substrates, but often occur together on basalt. The soils are in general rocky, gravelly clay and sandy clay. *C. mopane* occurs in the tree- and shrublayer in association with, amongst others, *Combretum apiculatum*, *C. hereroense*, *Commiphora pyracanthoides*, *Acacia nigrescens* and *Dalbergia melanoxylon* (Rogers 1993). Where this type approximates Kalahari sand, species such as *Commiphora angolensis*, *Croton gratissimus* and *Bauhinia petersiana* are added to the list, prefering the sandier soils (Rogers 1993).

A second *C. mopane-Combretum* type exists as one being found on very shallow soils overlying basalt (Timberlake & Mapaure 1992). Growing as 6 m high trees, *Combretum apiculatum*, *Acacia senegal* var. *leiorhachis* and *Diplorhynchus condylocarpon* are the most prominent trees for this type whereas *Pterocarpus rotundifolius* subsp. *polyanthus* var. *martinii* and *Colophospermum mopane* occur on deeper soils and *Kirkia acuminata* on the ridges. The grass layer is particularly well developed in this *C. mopane-Combretum* woodland (Timberlake & Mapaure 1992).

C. mopane–Combretum apiculatum associations are especially apparent on granitic substrates, not only in Zimbabwe, but also in the other Mopaneveld-hosting countries (Rattray 1962; Gertenbach 1983; Campbell & Du Toit 1994; Hin 2000). In Zimbabwe this type is a rather mixed dry woodland mosaic ranging from woodland, through open woodland to tree/bush savanna (Rattray 1962; Campbell & Du Toit 1994; Timberlake *et al.* 1993; Hin 2000). Typical species include *Kirkia acuminata*, *Acacia nigrescens*, *A. erubescens*, *Terminalia stuhlmannii*, *Ziziphus mucronata*, *Combretum imberbe*, *C. apiculatum*, *Colophospermum mopane* and *Sclerocarya birrea*. On sandier patches *Peltophorum africanum*, *Afzelia quanzensis* and *Terminalia sericea* occur. The shrub layer is well developed with *Phyllanthus reticulatus* and several *Grewia* species being the dominants, while the grass cover is poor and mainly consists of *Aristida* and *Eragrostis* species and accasionally *Pogonarthria squarrosa* and *Cynodon dactylon* (Rattray 1962; Timberlake *et al.* 1993; Hin 2000). On fine-textured soils derived from greenstone and dolerite, *Colophospermum mopane* forms a major component in the vegetation of a *Combretum apiculatum–Acacia nigrescens* community on mountains and hills (Campbell & Du Toit 1994). Prominent woody species include *Colophospermum mopane*, *Dalbergia* *melanoxylon*, *Combretum adenogonium* and *Julbernardia globiflora*. On sloped terrain, tree species accompanying *C. mopane* include *Julbernardia globiflora*, *Dalbergia melanoxylon*, *Grewia monticola* and *Strychnos madagascariensis* whereas *Ziziphus mucronata* and *Peltophorum africanum* become more important along drainage lines on gneiss (Campbell & Du Toit 1994). In Hwange National Park, a similar type occurs on Basement Complex geology of undulating terrain (Rogers 1993). *Julbernardia globiflora* is also a common associated species, while other prominent tree species include *Combretum apiculatum*, *C. zeyheri*, *Terminalia sericea*, *Diplorhynchus condylocarpon* and *Commiphora mossambicensis* (Rogers 1993). These *Julbernardia globiflora* types resemble miombo vegetation and share dominance with typical miombo species such as *Strychnos madagascariensis*, *Brachystegia boehmii*, *Lannea discolor* and *Pseudolachnostylis maprouneifolia* (Rogers 1993). Another miombo-mopane woodland type occurs on sandy clay soils produced by the Kalahari Group. *Baikiaea plurijuga* and *Colophospermum mopane* are representative of the deep sandy soils and the shallow clayey soils respectively. Other conspicuous species include *Combretum apiculatum*, *Acacia fleckii*, *Boscia albitrunca* and *Terminalia sericea* (Rogers 1993).

On low, elevated, dome-shaped sandstone ridges in Hwange National Park, a *Combretum–Boscia angustifolia* open scrub or thicket occurs (Rogers 1993). *Combretum elaeagnoides*, *C. apiculatum*, *C. celastroides* and *C. collinum* dominate with scattered *Lonchocarpus eriocalyx* trees. *Colophospermum mopane*, although not dominant, is a common species in association with, amongst others, *Diospyros quiloensis*, *Canthium pseudorandii*, *Combretum collinum* and *Boscia angustifolia* (Rogers 1993).

Kalahari sand often produces inter-dune troughs dominated by grassland, but interrupted by clumps of trees, of which *Colophospermum mopane* is one of the major contributors (Rogers 1993). This unique mixed savanna type is associated with calcareous soils and comprises, despite *C. mopane*, many woody species including *Acacia erioloba*, *A. luederitzii*, *A. erubescens*, *Combretum imberbe*, *C. hereroense*, *C. apiculatum*, *Grewia flavescens*, *Boscia albitrunca* and several more (Rogers 1993).

Over most of the tree savanna in the Limpopo Valley and its larger tributaries, trees such as *Sclerocarya birrea*, *Acacia nigrescens*, *Kirkia acuminata*, *Terminalia prunioides*, *Adansonia* *digitata* and species of *Grewia* and *Commiphora* is typically associated with the sloped, stony landscapes (Rattray 1962; Farrell 1968a; Werger & Coetzee 1978; Hin 2000). *Colophospermum mopane* rarely dominates the woody component on steep ridges. Where it occurs, it is often associated with less sandy patches, often along seasonal drainage lines where the terrain is also less sloped (Campbell & Du Toit 1994). In such cases, *C. mopane* is often associated with species such as *Combretum hereroense*, *Euclea divinorum* and *Bolusanthus speciosus* (Campbell & Du Toit 1994). Du Toit (1993) identified a *Kirkia–Colophospermum* ridge vegetation type on crests or steep-sided sandstone ridges. Medium-grained sandy clays evident in shallow soils, underly the vegetation dominated by *Kirkia acuminata* and *Colophospermum mopane* trees. Other conspicuous tree species include *Adansonia digitata*, *Pterocarpus lucens*, *Terminalia prunioides*, *Sterculia africana*, *Diospyros quiloensis*, *Xeroderris stuhlmannii* and *Commiphora karibensis*. The shrub layer is densely dominated by *Combretum elaeagnoides* accompanied by *Combretum apiculatum*, *Acacia ataxacantha*, *A. erubescens*, *Dichrostachys cinerea*, *Gardenia resiniflua* and several more (Du Toit 1993). A *Colophospermum mopane–Commiphora marlothii* mixed woodland or thicket on scree slopes occurs on lithosols of the escarpments of Karoo formations in the Hwange National Park (Rogers 1993). For the purpose of this discussion, this type would rather be regarded as a tree savanna type. *Colophospermum mopane*, *Markhamia zanzibarica*, *Canthium glaucum*, *Combretum elaeagnoides*, *Grewia flavescens* and *Diospyros quiloensis* are the most common woody species (Rogers 1993). The abundance of several *Commiphora* species are characteristic for sloped, rocky areas in Mopaneveld landscapes.

In the Sabi Valley on deep, sandy soils derived from sandstones, a moderate tree savanna to a tree/bush savanna is dominated by *Acacia nigrescens* with other conspicuous woody species being *Colophospermum mopane*, *Sclerocarya birrea* and several *Commiphora* species (Rattray 1962).

Mopaneveld ecotone types occur between Kalahari sands and more clayey soils derived from basalt. These ecotone types are especially apparent in Hwange National Park where *Colophospermum mopane* dominates patches of heavier-textured soils, whereas *Combretum apiculatum*, *C. hereroense*, *C. collinum* and *Acacia nigrescens* inhabit the clayey soils, also derived from basalt, but overlain by a fairly deep strip of Kalahari-type sand (Rogers 1993).

Shrub savanna

On soils derived from basalt, mainly in the southeastern border of Zimbabwe, Mopaneveld occurs as extensive patches of open shrubland or bushveld (Wild & Barbosa 1967; Rattray 1962; Werger & Coetzee 1978; Rogers 1993). In the tree layer, *Acacia* species (e.g. *A. sieberiana*, *A. robusta*, *A. nilotica*) and *Commiphora* species (e.g. *C. africana*, *C. pyracanthoides*) become important (Rattray 1962; Werger & Coetzee 1978; Rogers 1993). Other conspicuous woody species include *Dichrostachys cinerea*, *Dalbergia melanoxylon*, *Ximenia americana*, *Grewia monticola* and *G. bicolor* (Rogers 1993). The grass layer is well developed with *Schmidtia pappophoroides*, *Cenchrus ciliaris*, *Enneapogon cenchroides*, *Eragrostis viscosa* and several *Aristida* species being the most conspicuous contributors (Rattray 1962; Werger & Coetzee 1978). Where the soils are heavy and badly drained with compacted base-rich subsoil, *C. mopane* becomes stunted (Farrell 1968b; Werger & Coetzee 1978) and relates the shrubmopaneveld in the Kruger National Park on vertic clays derived from basalt or gabbro. In some areas the stunted *C. mopane* shrubland is associated with almost bare soil. *Craterostigma plantagineum* and *Portulaca hereroensis* are of the only species being able to inhabit these "Sikwakwa", patches (Wild & Barbosa 1967). On the south bank of the Lundi River, a *Colophospermum mopane–Spirostachys africana* shrub woodland occurs on black montmorillonitic clay. In this type, stunted individuals of *C. mopane* occur in association with *Salvadora angustifolia* and *Spirostachys africana* (O'Connor & Campbell 1986). On lighter-textured, better-drained soils species such as *Combretum apiculatum*, *Acacia nigrescens* and *Spirostachys africana* interrupt the stunted, monotypic Mopaneveld (Farrell 1968). On gravelly basalt soils near the Sabi River a low Mopaneveld type exists with woodies including *Commiphora mollis*, *Terminalia prunioides*, *Acacia borleae*, *Dichrostachys cinerea* and *Dalbergia melanoxylon* (Farrell 1968a). On basalt-sandstone contact soils *Boscia mossambicensis* and *B. albitrunca* occur in the shrublayer, whereas *Sesamothamnus lugardii* is more or less confined to the sandstone areas and *Catophractes alexandri* particularly dominating the shrublayer on calcrete soils (Rattray 1962; Werger & Coetzee 1978).

On heavy degraded soils near the Chewore mouth, a scrub form of *Colophospermum mopane*, seldom higher than 3 m, is apparent (Guy 1975). On deeper soils near the base of the *ridges C.*

mopane is accompanied by *Adansonia digitata*, *Terminalia prunioides*, *Afzelia quanzensis* and *Gardenia resiniflua*. The grass layer is in general poorly developed (Guy 1975).

2.2.6 Conclusions

From the discussion of Mopaneveld vegetation over its distribution in southern Africa, it is evident that the Mopaneveld is a complex of many vegetation units (plant communities), of which some are related despite their geographical isolation, and others represent distinct, unique communities. With this in mind, it was thought valuable to look holistically at Mopaneveld vegetation by means of a phytosociological synthesis.

CHAPTER 3

STUDY AREA

3.1 Introduction

The distribution of savannas is correlated with many environmental factors, including geomorphology, climate, soils, vegetation, fauna and fire (Bourlière 1983; Cole 1986). Mopaneveld is no exception to the rule. The distribution of *Colophospermum mopane*, hence to a great extent the distribution of Mopaneveld (see section 2.2.1, Chapter 2) is principally influenced by moisture availability expressed through altitude, rainfall and soil texture (Mapaure 1994). The study area will therefore be discussed according to these determinants, although others will not be eluded, for it is rather a combination of factors than a specific set of conditions that influence the distribution of the Mopaneveld (Timberlake 1995).

In most environmental studies, scale is often the most hazardous factor to deal with. Considering the large geographical region of the Mopaneveld over its distribution range, the discussion on the environmental determinants is broad, rather than detailed.

3.2 Locality

For the purpose of this study, Mopaneveld is used to describe the demarcated areas on Figure 1, which was adapted from Mapaure (1994). Although the map of Mapaure (1994) follows the distribution of *Colophospermum mopane*-dominated vegetation types, it serves a good indication of the distribution of Mopaneveld.

The Mopaneveld lies across several political borders stretching from Mozambique and South Africa along the East Coast of Africa to Angola and Namibia along the dry West Coast, crossing areas of Zimbabwe, Zambia, Malawi and Botswana. The longitudinal boundaries of the study area lie between 11°00′ and 24°30′ E. Mopaneveld covers approximately 550 500 km^2 over its distribution range (Mapaure 1994).

Although the discussion of Mopaneveld vegetation (Chapter 2) and the discussion of environmental parameters (Chapter 3) follow the distribution of Mopaneveld over its entire distribution range, the study area applicable to vegetation analysis and synthesis (Chapter 4) were narrowed according to the availability of adequate phytosociological data.

3.3 Topography and Geomorphology

Mopaneveld is associated with large river valleys and their tributaries where it inhabits the deep, clayey to loamy clayey soils in the valley bottoms (Werger & Coetzee 1978; Cole 1986; Mapaure 1994). Well-known African features such as the Cunene, Chobe, Limpopo, Luangwa, Okavango, Shire and Zambezi Rivers dissect the study area. Physiographically the study area can be described as flat to undulating terrain with scattered inselbergs (koppies or rocky outcrops). On these steep-sloped inselbergs, *Colophospermum mopane* rarely forms the dominant species in the tree layer since it is usually confined to the deeper, more clayey soils (see Chapter 2).

The western limit of Mopaneveld stretches along the Chela escarpment in the North (Angola) and the Kaokoland escarpment in the South (Namibia). The Kalahari Basin in Botswana is in general level or slightly raised. The escarpment in Zimbabwe does not form a definite separation of Mopaneveld vegetation since the Mopaneveld in the Limpopo River Valley below the Zimbabwean escarpment leads Northeast (Figure 1). Further downstream of Lake Kariba (Zimbabwe), Mopaneveld however covers the slopes of the escarpment (Werger & Coetzee 1978). The topography along the Zambezi Valley varies from level (especially on the valley bottom) to slightly raised terrain, to an undulating landscape characterised by the alternate dominance of Mopaneveld and Miombo. The topography on the Kalahari sands is in general level. Mopaneveld in Zambia is characterised by a wide, flat-bottomed trough bounded by steep, dissected escarpments that rise from 700 m to 800 m above its floor (Werger & Coetzee 1978). Malawian Mopaneveld is not bounded by any escarpments, but occurs as isolated patches on broken topography. At its northern distribution limit in Malawi, Mopaneveld occurs on the flat to slightly raised valley floor of the Shire, whereas its southern limit in Malawi is associated with stony hills (Werger & Coetzee 1978). Landscapes in the Mopaneveld of Mozambique are not very diverse. A slightly undulating landscape is the predominant landscape type in this part of the study area. In South Africa Mopaneveld is characterised by level or slightly raised terrain along the Lebombo range in the northern Kruger National Park. The Mopaneveld in the northwestern parts of its range covers undulating landscapes with scattered rocky outcrops. The Soutpansberg forms a definite southern border of Mopaneveld in the northern parts of the country. The southern-most limit of Mopaneveld in South Africa is south of the Olifants River in the Kruger National Park (Gertenbach 1987).

Apart from the large rivers (mentioned above) dissecting the study area, other conspicuous water bodies in the Mopaneveld include the Cuvelai Delta and Etosha Pan in Namibia, the Makgadikgadi Pan and the Okavango Delta in Botswana, Lake Kariba in Zimbabwe and Zambia and Lake Malawi in Malawi.

The study area varies greatly in terms of altitude, which ranges between 100 m to 1 000 m above sea level. Despite its wide range, altitude plays a major role in the distribution of the Mopaneveld (Mapaure 1994) since moisture availability is often expressed through altitude. Approximate altitudinal range for Mopaneveld in all different hosting African countries are summarised in Table 1.

3.4 Climate

3.4.1 Introduction

The central thesis for plant ecology is that climate exerts the dominant control on the distribution of the major vegetation types of the world. Within a vegetation type smaller-scale variations in distribution may be controlled by smaller-scale features of the environment, such as soil types, human activity or topography (Woodward 1986).

The Mopaneveld occurs in hot regions with a highly seasonal rainfall distribution. The warm, dry season lasts for five to eight months followed by the hot, wet season for the remainder of the year. Of all the factors involved, climate has a dominating influence on all other environmental factors and is therefore considered to be the most important from the point of view of their effect on plant-life (Rattray 1963). The understanding and recognition of climate variability in the Mopaneveld will provide in the understanding of ecosystem functioning.

3.4.2 Rainfall

In the savannas, high irradiance, heat and low humidity combine to create a high evaporative demand, which ensures that savannas are in net water deficit for most of the year, including much of the 'rainy season' (Scholes & Walker 1993). Considering this, rainfall is of utmost importance for the subsistence of Mopaneveld vegetation.

Rainfall patterns within the study area vary significantly. Mopaneveld is therefore regarded as a vegetation type which can tolerate the most extreme environmental, especially rainfall conditions. Approximate annual rainfall figures for Mopaneveld in all different hosting African countries are summarised in Table 1. Without considering the extremes, the general range of annual rainfall in which Mopaneveld predominate is approximately 250 mm – 400 mm. If an index of soil moisture availability could be examined for all areas hosting Mopaneveld, it is speculated that the range would not express such extremes as for annual rainfall. These speculations are based on the limited soil moisture availability in high rainfall areas of high rainfall intensities, heavy vertisols as well as fluvisols. Despite high annual rainfall, the vegetation in these areas are exposed to prolonged drought conditions due to low soil moisture availability as a result of high run-off or as a result of soil moisture retention by vertisols and fluvisols.

In the Luangwa Valley, Zambia, annual rainfall exceeds 800 mm. Nonetheless is the vegetation exposed to extremely hot and dry conditions during the period prior to rainfall events. Figure 10 represents a simplified explanation of a high rainfall area in Mopaneveld (Luangwa Valley, Zambia) which survive under low soil moisture availability for a significant time period.

3.4.3 Temperature

The whole study area has a fairly drawn-out warm summer, with a short mild to warm winter. January and February are generally the warmest months and July the coolest. Approximate mean temperature ranges for Mopaneveld in all different hosting African countries are summarised in Table 1. It is evident that Namibian Mopaneveld survives most extreme temperatures (12 – 31°C).

Temperature on its own is not a major determinant of vegetation patterns. In combination with annual rainfall and altitude it however has a profound influence on vegetation, also evident in the Mopaneveld. Periods of low rainfall conditions and high temperatures, such as illustrated in Figure 10 have a definite effect on vegetation. This phenomenon prevails especially in semi-arid savannas which consequently explains why non-equilibrium models are often used to explain vegetation change in these chapters (Chapter 7).

Table 1 A summary of mean annual rainfall and temperature values as well as altitudinal range for the southern African Mopaneveld

Mopaneveld-hosting African country	Mean annual rainfall (mm)	Mean temperature range (°C)	Altitudinal range (m)
Angola	100 – 400	16 – 25	100 – 400
Botswana	400 – 600	13 – 30	800 – 900
Malawi	700 – 800	19 – 28	450 – 500
Mozambique	400 – 700	20 – 29	200 – 500
Namibia	100 – 550	12 – 31	150 – 1 000
South Africa	250 – 400	15 – 31	400 – 700
Zambia	700 – 1 000	14 – 30	400 – 800
Zimbabwe	500 – 700	16 – 30	400 – 950

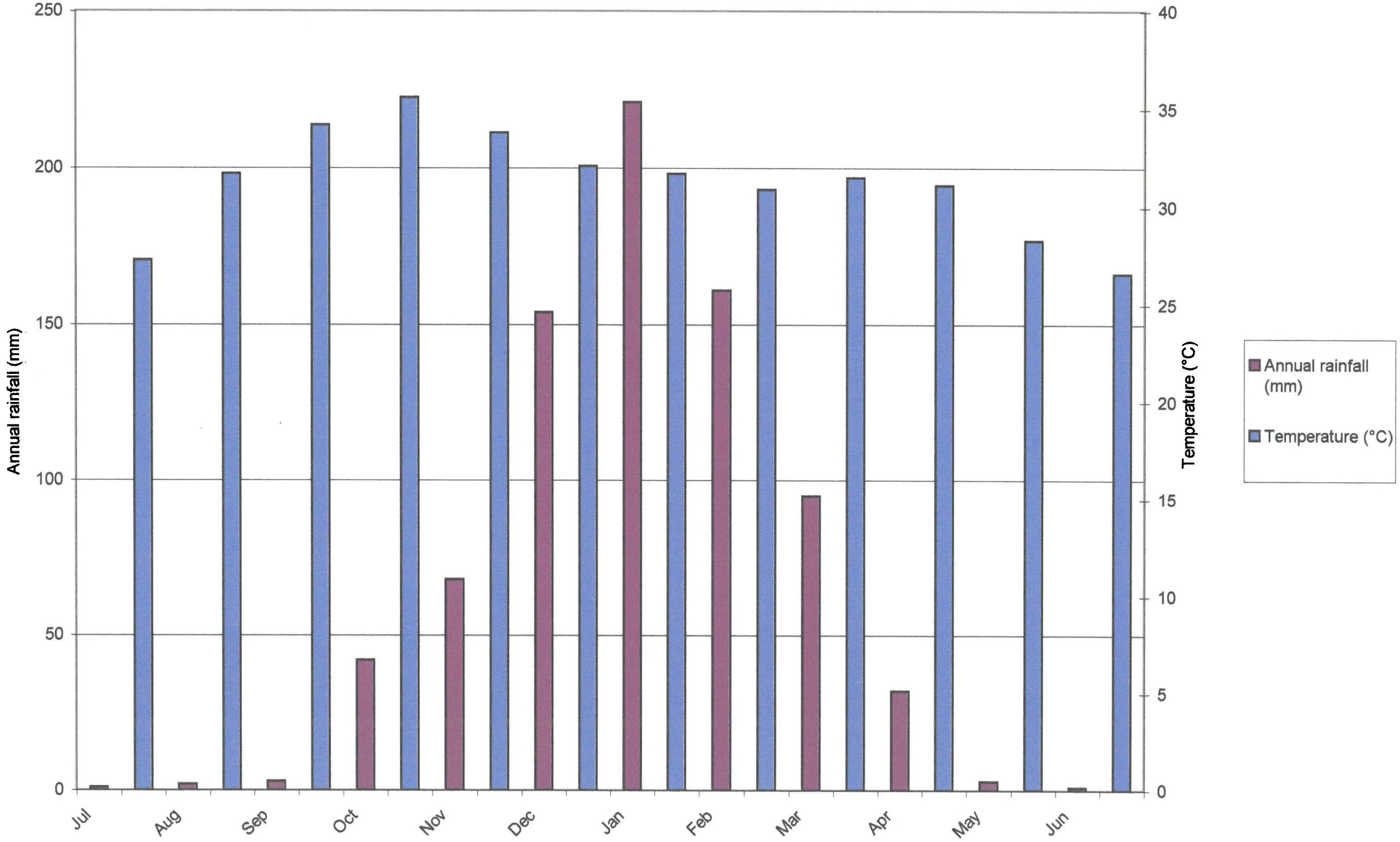


Figure 10 Monthly mean annual rainfall and mean temperature measures in Zambian Mopaneveld

3.5 Geology

The geology underlying southern African Mopaneveld is discussed only in broad terms since a detailed inventory of the complex geology over such a large area is beyond the scope of this study. A simplified geology map overlain by the distribution of *Colophospermum mopane* is presented in Figure 11 to illustrate variation in geological parent material in Mopaneveld.

The majority of geological substrates underlying the study area are from the Precambrian, dissected with various intrusive, extrusive and metamorphic rocks of undetermined nature and age. Small proportions of Mopaneveld cover recent deposits, such as the Kalahari Sand from the Quaternary (Figure 11). Limited areas of Mopaneveld are underlain by the Mesozoic of the Carboniferous, Jurassic to Triassic periods. Most of the Eastern Mopaneveld covers areas of alkaline black clay soils derived from Karoo (Triassic) basalt, granite and shale.

The lithology of the Mopaneveld can basically be divided into basic rocks, acidic rocks and recent deposits such as the Kalahari Sand. The difference between basic- and acidic rocks lies in their mineral content. Ultrabasic (ultramafic) rocks contain, for example, MgO, FeO and CaO, and acidic rocks contain mineral oxides such as SiO_2, K_2O and Na_2O (Krauskopf 1967). Basic rocks are usually referred to as basalt. Granite and shale are acidic rocks. Granite is known for its low mineral content and shale is formed from sediments derived from weathered rocks. Sediments derived from weathered rocks such as shale, cover about 70% of the world's surface lithology (Krauskopf 1967).

The geology of the South African Lowveld shows definite associations with vegetation distribution and therefore a simplified explanation of its geological history is included for possible reference to most parts of the Eastern Mopaneveld. Approximately 3 500 – 200 million years ago gabbro intruded granite and gneiss, which formed the major rocks of the Lowveld, as we know it today. Ecca-shales covered the granite-gneiss layer with gabbro intrusions after the marshy period. As Gondwanaland broke apart (200 milion years ago), volcanic rocks, first basalt then rhiolite, covered the earth's surface. The granite, gneiss and shale layers eventually ripped to expose a sequence, from West to East, of granite and gneiss, shale, basalt and rhiolite as the new continental coastline developed. After extended periods of wind and water erosion, the erosion-tolerant granite, gneiss and rhiolite remained to form the Eastern Escarpment and the Lebombo Mountain range respectively.

3.6 Soils

Soils are a distinct and important factor in plant ecology (Fraser *et al.* 1987). The close relationship between soils and vegetation is a useful aid in studying ecosystems (Witkowski & O'Connor 1996).

The scale of this study however does not allow a detailed soil inventory. More information on the relevant correlations between vegetation and soil is provided in the discussion of the different vegetation types (Results: Chapters 5 & 6) as well as the literature review on Mopaneveld vegetation (Chapter 2). General comments on the soils underlying the southern African Mopaneveld are provided in this section for sufficient background to understand the variation in vegetation types along the extensive Mopaneveld of southern Africa.

A variety of soils are found under savanna vegetation. This is attributed to the interaction of varied plant material with weathering regimes of different duration and intensities. The vegetation itself does not have a profound effect on pedogenesis in savannas, although there is often a close relationship between soil and vegetation type (Scholes & Walker 1993). The soils of dry savannas are base-rich, especially in the Mopaneveld where large areas are underlain by basic igneous rocks such as basalt, or fine-grained sediments such as shale or mudstone. High concentration of bases in dry savannas causes alkaline soils and the accumulation of free salts in the profile. Where the parent material is basalt or related basic lavas, vertic clayey soils occur (Scholes & Walker 1993).

Acid igneous parent materials such as granites result in a landscape with sandy, infertile uplands (typically *Combretum*-dominated vegetation) and clayey, fertile bottomlands, which are inhabited by *Colophospermum mopane*-dominated vegetation throughout large parts of the study area.

The relationship between geology, soils and plants are well stated by Fraser *et al.* (1987). The study was conducted in the Mooiplaas-Mahlangeni district in the Kruger National Park, South Afruca. These relationships are partially addressed in the discussion of the plant communities of the South African Lowveld Mopaneveld (Chapter 6).

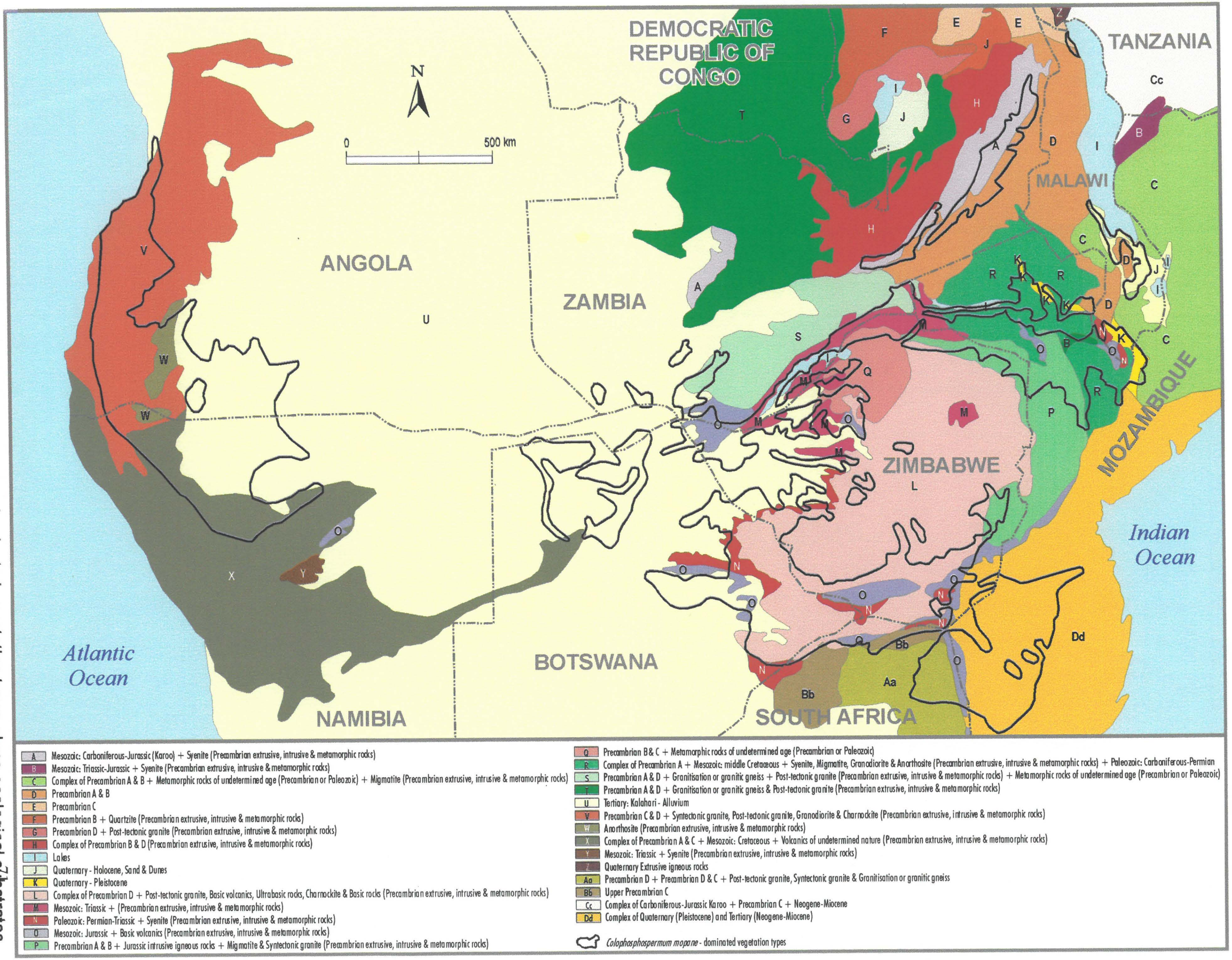


Figure 11 Distribution of *Colophospermum mopane*-dominated vegetation types along geological substrates (distribution of *C.mopane* adapted from Mapaure, 1994).

CHAPTER 4

METHODS

4.1 Introduction

One of the objectives of this study is to propose a revised methodology on analysing large vegetation data sets. The methodology is also directly in accordance with the primary goals of this study, which includes an attempt to classify the vegetation of the southern African Mopaneveld.

A step-by-step outlay of the procedures is presented as they were tested upon a large database, which includes all adequate vegetation data from the southern African Mopaneveld. The procedures for proposing the new method however involve many other facets of a vegetation study as well. Procedures for treating some of these facets are presented (4.2), followed by the actual procedures for vegetation analysis presented in a step-by-step approach (4.3).

In addition to the synthesis of the entire Mopaneveld, a further synthesis was undertaken on the South African Lowveld Mopaneveld due to special interest in the area and due to adequate vegetation data available from the area. The methods for the synthesis of the South African Lowveld Mopaneveld follow the same procedures as for the synthesis of the entire Mopaneveld. Only the differences in the approach are discussed in this chapter.

Please note that all names of taxa follow Arnold & De Wet (1993). A list of all taxa included in the TURBOVEG database is presented in Appendix 3.

4.2 Steps preceding computer-based procedures

4.2.1 Study area selection

As to propose a method for treating large vegetation data sets, not only was a study area selected according to the availability of phytosociological data, but also according to the contribution such a study would make to vegetation knowledge of that area. The Mopaneveld of southern Africa was selected as the study area. The selection was motivated by the lack of comprehensive phytosociological knowledge of this extensive vegetation type in spite of relevé data available from several local studies (Chapter 2).

4.2.2 Literature surveying

This dissertation includes an extensive literature survey. Literature on Mopaneveld, including vegetation descriptions, management recommendations, taxonomy, ecology and plant uses were collected. The main function of the literature assessment was to become familiar with the field of study and to present a brief overview on the species *Colophospermum mopane* and on Mopaneveld vegetation over its entire distribution range (Literature Review presented in Chapter 2).

4.2.3 Vegetation data surveying

Applicable and suitable data sets on Mopaneveld vegetation are limited and not freely accessible. A search on vegetation data from studies conducted in any part of the Mopaneveld was undertaken for possible contribution to vegetation classification. Since the study is based on existing data of Mopaneveld vegetation, only a few field surveys were made to complement the existing data.

For existing vegetation data sets to be included in the computer database of Mopaneveld vegetation, the data had to conform to specific criteria as indicated below (4.2.3.1).

4.2.3.1 Criteria for vegetation data inclusion

Data could only be included for analysis if it conformed to the following criteria:

1. Vegetation data had to be sampled in Mopaneveld savanna.
2. Vegetation data had to consist of total floristic composition (therefore including a detailed survey of the woody- **and** herbaceous strata).

3. Published data with vegetation descriptions should preferably be used, although unpublished data from M.Sc.– or Ph.D studies were also included. Studies undertaken for the fulfilment of lower degrees were only used if the data set could contribute to a relatively undersampled- or an unknown area and after the data were assessed thoroughly for corrections and comprehensiveness.
4. Unpublished data from studies still in progress were included (with agreement with the recorders), especially where the study could contribute to an area where no other adequate vegetation data sets exist.

Adequate habitat data of each vegetation sample should have been a criterion but due to a general lack of habitat data in most of the conducted studies, this criterion could not be included. Suitable, compatible data from the Mopaneveld that conformed to the above criteria were obtained from 15 vegetation studies, listed in Table 2. These were the only compatible phytosociological data available at time of data acquisition.

4.3 Computer-based procedures

Step 1

Data sets that conformed to the above criteria were selected and consequently used to compile a database on Mopaneveld vegetation. The database was created in the computer program TURBOVEG (Hennekens 1996a) and is currently stored at the University of Pretoria, Botany Department, African Vegetation and Plant Diversity Research Centre.

Data were captured in the following ways, depending on the format in which data were accessible:

- imported from CEP-files stored in the University of Pretoria main frame database
- captured from field sheets
- captured from published tables
- directly retrieved from existing TURBOVEG files

Step 2

The complete Mopaneveld database (2 298 relevés stored in TURBOVEG) was exported as a Cornell Condensed species file (cc-file) to a working directory in MEGATAB (Hennekens 1996b). The option in TURBOVEG to distinguish between different vegetation layers a single species occupy, was made inapplicable by combining all layers into one (no layer).

4.3.1 Classification

Step 3

The cc-file was opened in MEGATAB. The option in MEGATAB to change the order of the table was applied using Two-Way-Indicator-Species-Analysis (TWINSPAN) (Hill 1979b). In order to identify relevés representing azonal vegetation, TWINSPAN was applied on a single division level (default cutlevels). After each separation of the table in two parts, the azonal relevés were exported as a cc-file and saved for further analysis in future. This procedure was repeated until the separation revealed two parts containing zonal vegetation in Mopaneveld. A total of 2 246 relevés remained as relevés probably representing zonal vegetation in Mopaneveld.

Step 4

Due to the inconsistency between authors considering species identification (especially lower than the species level), most subspecies and variations were combined into the relevant species name. This option was carried out in MEGATAB.

Step 5

TWINSPAN classification was applied to the 2 246 zonal relevés on cutlevels 0-5-25-50 and on 6 levels of division. The rest of the parameters were left default. TWINSPAN revealed the identification of 43 clusters.

Step 6

The 43 clusters contained various numbers of relevés. Clusters containing less than 5 relevés were omitted from the TWINSPAN table for refinement purposes. During the identification of large vegetation units for the phytosociological synthesis, clusters containing small numbers of relevés were considered not being clearly representative of a large vegetation unit and were therefore ignored for refinement. After refinement, those clusters were examined and if they contained valuable contributions to the table, they were moved into a suitable position in the table. A total of 29 clusters were considered for refinement.

Step 7

To facilitate the immense task of refining a phytosociological table containing more than 2 000 relevés and almost 1 500 species, a synoptic table was constructed directly from the TWINSPAN table as an option in MEGATAB.

4.3.2 Refinement procedures

Step 8

1. The order of the species in the synoptic table was changed according to the frequency values of species in each cluster. Species fidelity was not calculated statistically (e.g. Chytrý *et al.* in press). However, all species being more-or-less confined to the same cluster were selected and concurrently moved to the top. These species were then sorted on order of the highest frequency to lowest frequency. All clusters were separately examined for fidelity and frequency after which they were moved into positions where they would compliment diagnostic species groups in the TWINSPAN table.
2. Many species have a wider distribution range, not being confined to only one cluster (i.e. differential species). After diagnostic species groups were identified according to step 8, differential species groups were identified according to high frequency values being shared by different clusters. These species groups were moved into positions where they are most likely to represent relations between clusters (Table 3).

After refinement, the synoptic table was closed. Changes to the order of species in the synoptic table were directly saved to the TWINSPAN table (a very valuable option in MEGATAB). It would however be impractical to present the full table as explanation to the results. Results of the large data set were best expressed in the synoptic table. Although the synoptic table contained only 29 clusters, the number of species still resulted in a very long table (a total of 105 species groups in Table 3!).

Step 9

Vegetation types and major plant communities within the Mopaneveld were identified according to the synoptic table (Table 3) and relevant habitat information. A vegetation type is suggested to represent a superior plant community containing different major plant communities. Diagnostic species groups for a vegetation type were moved to the top position, followed by its lower-rank diagnostic species groups.

Step 10

The hierarchy of the TWINSPAN classification was examined in MEGATAB. A dendrogram following TWINSPAN classification was created to present probable explanation of the results (Figure 12).

Step 11

The synoptic table, containing 29 clusters and 1 465 species, were further reduced to 10 clusters and 329 species (Table 4). Each major vegetation unit (vegetation types and major plant communities) was reduced to a single cluster, in which the frequency of each species to the major plant community or vegetation type was summarised. Frequency values for the larger vegetation units were calculated as follow:

- Each species was treated separately
- Example: *Cyathula uncinulata* (Species group 1, Table 3)
- x = vegetation type/major plant community

  x_1 would be the very first major plant community/vegetation type (i.e. Zimbabwean Mopaneveld, vegetation type 1, major plant community 1.1 (Table 3))

  x_2 would be the second major plant community/vegetation type (i.e. Zimbabwean Mopaneveld, vegetation type 1, major plant community 1.2 (Table 3))
- r = number of relevés

  r_a would be the total number of relevés in cluster a (Table 3)

  $r_{(x1)}$ would be the total number of relevés in the first vegetation type/major plant community

  e.g. $r_{(x1)}$ = total number of relevés in 1.1 (Table 3)

  $= r_a + r_b + r_c + r_d$

  $= 11+17+30+13 =$ **71**
- y = % frequency of plant species

- y_1 = % frequency of plant species 1

  y_{1a} would be the frequency of plant species 1 in cluster a

  e.g. consider *Cyathula uncinulata* species 1

  $y_{1a} = 18$

  $y_{1b} = 35$ etc.

- r_{a1} = number of relevés in which species 1 occur in cluster a

  $= y_{1a}/100 \times r_a$

  $= 18/100 \times 11$

  $= 1.98$

  ~2 relevés

- $y_{1(x1)}$ = % frequency of species one (e.g *Cyathula uncinulata*) in major plant community/vegetation type 1

  $y_{1(x1)} = r_{a1} + r_{b1} + r_{c1} + r_{d1}/r_{(x1)}$

  $= 2+6+30+12 / 71$

  $= 50/71 \times 100$

  $= 70\%$ (Table 4)

The above calculations reduced the synoptic table in terms of clusters representing major vegetation units, although the number of species in the table remained high. In order to decrease the number of species to present a short, yet valuable expression of the major vegetation units in the Mopaneveld of southern Africa, species were selected according to their fidelity to, and their frequency in the vegetation unit they occur in. Species of frequency lower than 10 % in a syncluster (e.g. *Hermstaedtia linearis* in Species group 3, Table 4 were not selected for the reduced table (Table 5) although it is 18 % frequent in cluster b in Table 3. This selection and elimination of species resulted in a 10 cluster synoptic table containing 329 species being representative of the major vegetation units in the Mopaneveld being studied (Table 5).

Step 12

This reduced synoptic table (Table 5) was used to describe the vegetation types and major plant communities within the study area. Diagnostic species for each vegetation type and major plant community were identified according to their fidelity. Species being diagnostic for two and more vegetation units were regarded indicators of similarity between vegetation units.

4.3.3 Ordination

Species composition may be a more informative indicator of environment than any set of measured environmental variables (Ter Braak 1995). Considering the importance of environmental conditions on the distribution of Mopaneveld vegetation types, the ordination algorithm DECORANA (Detrended Correspondence Analysis) (Hill 1979a) was applied to the floristic data to relate the distribution of the major types along environmental gradients. The ordination algorithm was applied to the synrelevés rather than to all 2 246 relevés, due to the enormous dimensions of the data set.

The synoptic table created in MEGATAB was exported as a Cornell Condensed Species File. DECORANA was then applied to the exported synrelevés. No transformation of the data was carried out and all parameters were set to defaults during the application of DECORANA to the 29 clusters (synrelevés). A scatter diagram was created to present DECORANA results (Figure 19). Habitat data for each cluster were traced from the published literature and accordingly environmental gradients were fitted to the diagram.

4.4 Synthesis of the South African Lowveld Mopaneveld

For the synthesis of the South African Lowveld Mopaneveld, results of the complete synthesis of the southern African Mopaneveld were needed. After the South African Lowveld Mopaneveld (SALM) was identified as the *Cissus cornifolia* - *Colophospermum mopane* major vegetation type, all relevés representing this vegetation type were exported as a cc-file to a separate working directory in MEGATAB. The data of the SALM were therefore presented in a raw data matrix prior to further analysis. All procedures for the synthesis of the SALM were undertaken in that directory. Since the SALM vegetation data comprises more than 1 000 relevés itself, it was thought useful to apply the same method for data analysis **(4.3)** as was proposed for the analysis of the data set containing data from 15 studies undertaken in the Mopaneveld.

TWINSPAN classification was applied to the 1 375 relevés, firstly on a single division level. Since the scale in this part of the study narrowed, it was necessary to identify and discard all relevés representing azonal vegetation. The Sandveld communities of the Punda Milia-Pafuri-

Wambiya (Van Rooyen 1981b) were thought to be clearly separated by this procedure. However, many relevés representing those communities remained within the scope of Mopaneveld vegetation. After a division within the Mopaneveld resulted, TWINSPAN was applied to the remaining relevés on default cutlevels and default levels of division. A synoptic table was constructed in order to identify the major plant communities within the SALM. The same procedures were followed as in *Step 11* to present a reduced synoptic table of the four major plant communities of the SALM (Table 6).

The procedures following the identification of the major plant communities in the SALM differ somewhat from the entire synthesis. Four major plant communities were identified and were further analysed separately to identify the plant communities within each. Each major plant community was therefore exported as a separate file for further analysis. TWINSPAN classification at default cutlevels and two levels of division were regarded the most effective procedure in which plant communities, which probably represent alliances, could be identified for each of the four major plant communities. Since the study did not aim to identify plant communities below the alliance level, only several relevés in "oversampled" areas (regarded oversampled only for the purpose of this study) were included in the final tables. The relevés to be included in the final tables were selected randomly within each cluster for the results to be easily presented in Braun-Blanquet tables (Tables 7 & 8).

Refinement procedures followed the Braun-Blanquet approach (Westhoff & Van der Maarel 1982), which were proved to be successful in several phytosociological studies (e.g. Behr & Bredenkamp 1988; Dekker & Van Rooyen 1995; Brown 1997; Eckhardt *et al.* 1996; Visser *et al.* 1996; Smit *et al.* 1997). The phytosociological tables contain total floristic composition of the major plant communities. Species abundance is presented at the Braun-Blanquet cover-abundance scale.

The discussion on two of the four major plant communities within the SALM is presented in Chapter 6. Although analysis and refinement of all four major plant communities have been completed, only two are included in this study because the description actually falls beyond the objectives of this study. The complete synthesis of the SALM will however be presented in subsequent papers.

Table 2 Data sets used for a phytosociological synthesis on Mopaneveld vegetation

	Author	Year	Location	No. of Relevés
1.	Beck, N.G.	1998	Foskor, mine, Phalaborwa, South Africa	114
2.	Dekker, B.	1995	Messina Experimental Farm, South Africa	148
3.	Du Plessis, F.	1998	Kruger National Park & North of the Soutpansberg, South Africa	19
4.	Du Plessis, F.	1998	Botswana Mopaneveld & Cuvelai Delta, Namibia	31
5.	Gertenbach, W.P.D.	1987	Southern distribution of Mopaneveld, Kruger National Park, South Africa	250
6.	Gertenbach, W.P.D.	1976	Mopaneveld north of the Olifants River in the Kruger National Park, South Africa	380
7.	Hinn, C.	2000	Save River Valley, Zimbabwe	230
8.	Kelly, L.	1996	Pylkop, Louis Trichardt, South Africa	62
9	Le Roux, C.	1976	Etosha National Park, Namibia	204
10.	NOLIDEP	1998	Kaokoland, Namibia	34
11.	Purchase, A.	1997	Hoedspruit-Klaserie-Timbavati-Umbabat Nature Reserves, South Africa	374
12.	Ströhbach, B.	1998	Cuvelai Delta, Namibia	40
13.	Swart, H.B.	1998	Letaba Ranch, South Africa	200
14.	Van Rooyen, N.	1978	Punda Maria-Pafuri-Wambiya, Kruger National Park, South Africa	196
15.	Visser, N.	1996	Honnet Nature Reserve, Tshipise, South Africa	57

Table 3 Complete synoptic table of the Mopaneveld

	1								2		3					4			5			6							
Cluster	a	b	c	d	e	f	g	h	I	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z	aa	bb	cc
Number of relevés	11	17	30	13	13	44	64	10	44	48	257	471	405	49	193	8	132	17	31	18	19	51	93	109	18	20	37	14	10
	1.1				1.2				2		3					4			5			6.1		6.2			7.1		7.2
Species group 1																													
Cyathula uncinulata	18	35	100	92	15	66	47	20	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Digitaria milanjiana	91	35	23	62	23	86	88	10	.	.	0.4	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.
Cucumis zeyheri	9	71	57	8	23	50	23	10	.	.	0.4	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Abutilon grandiflorum	9	24	47	.	31	5	5	50	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cucumis metuliferus	.	18	7	.	39	16	6	60	.	.	0.4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7	.
Cucumis anguria	.	18	7	.	39	16	6	60	.	.	0.4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7	.
Cucumis zeyheri	9	71	57	8	23	50	23	10	.	.	0.4	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species group 2																													
Boscia mossambicensis	46	12	13	23	.	.	17	.	.	2	1	.	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cissus rotundifolia	27	6	67	31	.	2	11	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species group 3																													
Senecio species	9	18	7	.	.	5	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hermbstaedtia linearis	.	18	7	.	.	5	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	8	.	.
Echinochloa colona	.	12	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acacia nilotica subsp. kraussia	.	12	3	.	.	.	.	.	.	.	.	.	0.2	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.
Species group 4																													
Cyperus species	.	6	63	.	.	.	.	.	.	.	1	.	0.5	.	.	.	.	.	.	.	.	2	1	11	.	.	.	7	.
Plectranthus caninus	.	.	33	.	23	.	.	10	.	.	0.4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Balanites maughamii	.	.	10	.	.	.	.	.	.	2	2	1	0.2	8	.	.	.	.	7	.	.	.	.	.	.	.	.	7	.
Eragrostis heteromera	9	.	10	.	.	.	5	.	5	2	5	2	3	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species group 5																													
Dactyloctenium australe	9	18	13	.	.	2	2	.	.	.	.	0.6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dactyloctenium giganteum	64	53	27	.	.	9	17	.	.	2	8	0.8	0.2	.	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species group 6																													
Plectranthus neochilus	.	.	23	46	.	.	2	.	.	.	0.4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Thilachium africanum	18	.	43	15	.	.	9	.	.	.	4	0.2	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Zanthoxylum capense	.	.	37	31	.	.	3	.	.	.	0.8	.	2	.	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Maytenus procumbens	.	.	3	15	.	2	3	10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species group 7																													
Boscia mossambicensis	46	12	13	23	.	.	17	.	.	2	1	.	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cissus rotundifolia	27	6	67	31	.	2	11	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species group 8																													
Millettia sutherlandii	.	.	.	.	62	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Grewia caffra	.	.	.	.	39	7	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Monodora junodii	.	.	.	.	31	2	2	.	.	.	2	0.4	.	20	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Artabotrys brachypetala	.	.	.	.	23	.	.	10	.	.	2	0.4	.	10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Melinis nerviglumis	.	.	7	.	23	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	7	.	.	8	21	.
Strychnos potatorum	.	.	.	.	23	7	2	.	.	.	0.8	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Combretum microphyllum	.	.	.	.	23	2	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Vitex buchananii	.	.	.	.	15	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cyphostemma species	.	6	.	.	15	2	.	.	.	.	.	.	.	.	0.5	.	8	6	.	.	.	2	.	.	.	.	.	.	.
Millettia grandis	.	.	.	.	15	.	.	10	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species group 9																													
Vigna frutescens	.	6	.	.	62	30	3	.	.	.	.	.	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Phyllanthus reticulatus	.	.	7	.	39	21	6	.	.	2	4	1	0.2	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tragia okanyua	.	.	.	.	15	14	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Justicia kirkiana	.	.	.	.	8	23	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.9	.	.	.	.	.
Ceratotheca sesamoides	.	.	.	.	8	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species group 10																													
Stylochiton natalensis	.	6	23	39	23	9	2	.	.	.	5	4	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Vernonia lundiensis	9	12	3	.	46	7	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	6	.	5	27	.	.
Eragrostis cilianensis	.	18	10	.	15	5	.	.	.	.	.	.	0.2	.	.	.	.	.	.	.	.	2	.	0.9	.	.	.	.	.
Enteropogon monostachys	.	.	47	.	46	9	.	.	.	.	.	.	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Crotalaria species	.	6	23	.	23	23	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	.	.	5	.	.
Setaria sphacelata	.	12	.	.	15	64	2	.	.	4	1	0.4	2	.	1	.	.	12	.	.	.	.	.	.	.	.	.	.	.
Species group 11																													
Diospyros quiloensis	.	12	50	62	15	48	31	.	.	.	0.4	.	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Indigofera varia	.	77	63	.	31	32	13	.	.	4	0.4	.	0.7	.	0.5	.	.	.	3	.	.	16	.	3	.	.	.	7	.
Species group 12																													
Acacia schweinfurthii	.	.	.	.	15	2	.	70	.	2	0.8	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Grewia inaequilatera	.	6	.	.	8	2	.	40	.	.	0.4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Capparis tomentosa	9	6	.	.	8	.	3	30	.	10	5	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Maerua edulis	.	.	3	.	.	.	3	20	.	.	0.8	.	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Panicum species	.	.	.	.	.	.	.	10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cardamine africana	.	.	.	.	.	.	2	10	.	.	0.4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cordia monoica	.	6	.	.	8	9	9	10	.	.	4	2	0.5	.	.	13	2	.	.	.	.	.	.	.	.	.	.	.	.
Kalanchoe lanceolata	.	.	7	.	.	.	9	10	.	.	2	0.8	0.5	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Abutilon hirtum	.	.	3	.	.	5	2	10	.	.	0.4	.	.	.	.	.	.	.	.	.	.	.	.	0.9	.	.	.	.	.
Species group 13																													
Sporobolus fimbriatus	.	.	.	.	.	.	.	.	82	48	9	9	7	.	.	.	.	6	.	83	.	.	2	.	.	.	.	.	.
Flaveria bidentis	.	.	.	.	.	.	.	.	11	29	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species group 14																													
Acacia burkei	.	.	.	.	.	.	.	10	14	4	9	6	1	.	.	.	.	.	.	6	.	.	.	.	.	.	.	.	.
Hyparrhenia hirta	.	.	.	.	.	.	.	.	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Cluster	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z	aa	bb	cc
				1					2				3				4			5				6					
Number of relevés	11	17	30	13	13	44	64	10	44	48	257	471	405	49	193	8	132	17	31	18	19	51	93	109	18	20	37	14	10
		1.1				1.2			2				3				4			5		6.1			6.2		7.1		7.2
Species group 15																													
Croton megalobotrys	.	.	.	.	.	2	.	.	5	60	1	.	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ficus sycomorus	.	.	.	.	.	.	.	.	2	38	0.8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Phragmites australis	.	.	.	.	.	.	.	.	2	35	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hyphaene coriacea	.	.	.	.	.	.	.	.	.	15	0.4	0.2	0.7	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.
Phoenix reclinata	.	.	.	.	.	.	.	.	.	15	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cynodon dactylon	.	.	.	.	.	.	.	.	2	13	2	0.6	.	.	1	.	.	.	.	.	.	.	7	.	.	.	.	.	10
Sporobolus consimilis	.	.	.	.	.	.	.	.	.	10	.	.	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sesbania sesban	.	.	.	.	.	.	.	.	.	10	0.4	.	1	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Nuxia oppositifolia	.	.	.	.	.	.	.	.	.	10	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species group 16																													
Limeum fenestratum	.	.	.	.	.	.	.	.	.	.	14	24	4	2	86	.	.	.	.	.	.	6	.	.	.	.	5	.	.
Cissus cornifolia	.	.	.	.	.	.	.	.	.	.	14	78	50	29	60	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cassia abbreviata	.	.	.	.	.	2	.	.	5	25	5	12	6	12	24	.	2	6	.	6	5	.	.	.	.	.	.	.	.
Dalbergia melanoxylon	9	.	3	.	.	16	8	.	.	2	15	28	38	31	17	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Grewia hexamita	.	.	.	.	.	.	.	.	.	.	13	15	2	4	29	13	.	.	.	.	5	8	.	.	.	.	.	.	.
Species group 17																													
Dactylocteni aegyptium	.	18	13	.	.	5	.	.	.	2	18	6	0.5	4	2	.	.	.	.	.	.	.	9	.	.	.	.	.	.
Enteropogon macrostachys	.	.	.	31	.	.	9	.	.	.	15	3	2	2	.	.	2	.	3	.	.	.	.	2	.	.	.	.	.
Abutilon guineense	.	.	.	.	.	.	.	.	.	8	15	2	4	2	.	.	0.8	.	.	.	.	.	.	.	.	.	.	.	.
Urochloa panicoides	.	.	7	.	.	.	2	.	.	.	13	4	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sida rhombifolia	.	.	.	.	.	.	.	.	.	4	13	3	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Orthosiphon suffrutescens	.	.	.	.	.	.	.	.	.	4	13	9	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Trianthema salsoloides	.	.	.	.	.	.	.	.	.	.	11	1	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Boerhavia diffusa	.	.	.	.	.	.	.	.	.	2	12	9	4	.	0.5	.	.	.	.	.	.	20	.	2	.	.	.	.	.
Achyropsis leptostachys	.	.	.	.	.	.	.	.	.	.	10	0.6	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species group 18																													
Maytenus senegalensis	.	.	.	.	.	.	.	.	.	17	15	2	0.5	2	4	.	.	.	.	.	.	.	5	13	6	.	.	14	.
Species group 19																													
Spirostachys africana	.	.	.	.	.	.	.	.	32	48	16	4	2	10	0.5	.	.	.	3	17	.	.	1	11	.	.	.	.	.
Species group 20																													
Diospyros mespiliformis	.	.	.	.	8	.	.	10	2	15	10	2	1	.	6	.	.	.	.	.	.	.	9	.	.	.	.	.	.
Species group 21																													
Ceratotheca triloba	.	.	.	.	.	.	.	.	.	.	6	40	5	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.
Crabbea velutina	.	.	.	.	.	.	.	.	.	.	6	30	5	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chamaesyce neopolycnemoides	.	.	.	.	.	.	.	.	.	.	4	30	7	2	0.5	.	.	.	.	.	.	6	.	.	.	.	.	.	.
Indigofera filipes	.	.	.	.	.	.	.	.	.	.	0.8	26	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Polygala sphenoptera	.	.	.	.	.	.	.	.	.	2	4	23	7	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Grewia subspathulata	.	.	.	.	.	.	.	.	.	.	5	21	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hibiscus sidiformis	.	.	.	.	.	.	.	.	.	.	7	21	8	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Melhania didyma	.	.	.	.	.	.	.	.	.	.	9	22	4	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aristida scabrivalvis	.	.	.	.	.	.	.	.	.	.	7	21	0.7	.	3	.	2	.	.	.	.	.	.	6	.	.	3	.	.
Leucas neuflizeana	.	.	.	.	.	.	.	.	.	.	7	20	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ornithogalum seineri	.	.	.	.	.	.	.	.	.	.	4	18	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aristida stipitata s. graciliflora	.	.	.	.	.	.	.	.	.	.	0.4	16	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10
Trichoneura grandigluma	.	.	.	.	.	.	.	.	.	.	0.4	16	5	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Crotalaria virgulata	.	.	.	.	.	.	.	.	.	.	3	16	9	6	3	.	0.8	.	.	.	.	.	.	.	.	.	.	7	.
Limeum viscosum	.	.	.	.	.	.	.	.	.	.	7	14	.	.	.	.	.	.	.	.	.	.	7	.	.	.	.	.	.
Coccinia rehmannii	.	.	.	.	.	.	.	.	.	.	6	14	2	.	7	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Crotalaria schinzii	.	.	.	.	.	.	.	.	.	.	4	14	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Triumfetta pentandra	.	.	.	.	.	.	.	.	2	0.6	.	14	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rhinacanthus xerophilus	.	.	.	.	.	.	.	.	.	2	8	13	0.5	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chlorophytum galpinii	.	.	.	.	.	.	.	.	.	.	6	13	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tricliceras laceratum	.	.	.	.	.	.	.	.	.	.	0.8	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Justicia anagalloides	.	.	.	.	.	.	.	.	.	.	8	11	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Phyllanthus incurvus	.	.	.	.	.	.	.	.	.	.	7	11	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Indigofera lupatana	.	.	.	.	.	.	.	.	.	.	8	12	4	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Monsonia burkeana	.	.	.	.	.	.	.	.	.	.	2	10	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Monsonia angustifolia	.	.	.	.	.	.	.	.	.	.	5	10	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Fimbristylis complanata	.	.	.	.	.	.	.	.	.	.	1	11	4	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Stylosanthes fruticosa	.	.	.	.	.	.	.	.	.	.	2	10	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sporobolus panicoides	.	.	.	.	.	.	.	.	.	.	3	10	0.2	.	1	.	0.8	.	.	.	.	.	.	.	.	.	3	.	.
Chascanum hederaceum	.	.	.	.	.	.	.	.	.	.	2	10	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species group 22																													
Acalypha indica	.	.	.	.	.	.	.	.	.	8	25	41	7	8	.	.	0.8	.	.	.	.	.	.	3	.	5	.	.	.
Asparagus setaceus	.	.	.	.	.	.	.	.	.	.	25	39	7	6	.	.	.	6	.	.	.	.	1	.	.	.	.	.	.
Cyperus rupestris	.	.	.	.	.	.	.	.	.	.	12	31	4	2	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Endostemon tereticauli	.	.	.	.	.	.	.	.	.	.	15	37	0.5	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Talinum caffrum	.	.	.	.	.	.	.	.	.	.	18	26	6	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.
Melhania prostrata	.	.	.	.	.	.	.	.	.	.	10	25	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Phyllanthus asperulatus	.	.	.	.	.	.	.	.	.	.	14	22	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ehretia amoena	.	.	.	.	.	.	.	.	.	.	14	11	3	.	0.5	.	.	.	.	.	.	6	.	.	.	.	.	.	.
Hibiscus pusillus	.	.	.	.	.	.	.	.	.	2	10	11	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cucumis africanus	.	.	.	.	.	.	.	.	.	6	16	17	6	2	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
Portulaca kermesina	.	12	27	.	.	.	.	.	.	2	23	18	.	.	.	13	.	.	.	.	.	.	.	2	.	.	.	.	.
Species group 23																													
Setaria incrassata	.	.	.	.	.	.	.	.	2	6	3	0.6	19	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Neorautanenia amboensis	.	.	.	.	.	.	.	.	.	.	.	.	15	.	.	.	.	.	.	.	.	.	.	0.9	.	.	3	.	.
Sorghum versicolor	.	.	.	.	.	5	2	.	.	.	1	0.4	12	.	.	.	.	.	.	.	.	.	.	0.9	.	.	.	.	.
Hybanthus enneaspermus	.	.	.	.	.	.	.	.	.	.	1	2	10	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.

Cluster	a	b	c	d	e	f	g	h	I	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z	aa	bb	cc
				1						2			3				4			5				6					
Number of relevés	11	17	30	13	13	44	64	10	44	48	257	471	405	49	193	8	132	17	31	18	19	51	93	109	18	20	37	14	10
		1.1				1.2			2				3				4			5		6.1			6.2		7.1		7.2
Tephrosia multijuga	.	.	.	.	.	.	.	.	.	4	2	1	10	.	0.5	.	.	.	.	.	.	.	.	0.9	.	.	.	.	.
Pterocarpus rotundifolius	.	.	.	.	.	.	.	.	.	.	2	5	10	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rhynchosia minima	.	.	.	.	.	.	.	.	.	6	5	3	10	2	.	.	.	.	.	.	.	.	.	8	.	5	3	.	.
Species group 24																													
Chamaecrista mimosoides	.	.	.	.	.	.	.	.	.	.	9	29	24	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ipomoea crassipes	.	.	.	.	.	.	.	.	.	.	9	20	18	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Indigofera bainesii	.	.	.	.	.	.	.	.	.	.	7	24	11	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.
Bothriochloa insculpta	.	.	.	.	.	.	.	.	.	4	7	10	38	.	2	.	2	.	3	.	.	.	.	.	.	.	.	.	.
Ozoroa engleri	.	.	.	.	.	.	.	.	.	.	0.4	16	16	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Kohautia virgata	.	.	.	.	.	.	.	.	.	.	5	27	15	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Brachiaria xantholeuca	.	.	.	.	.	.	.	.	.	2	8	16	12	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species group 25																													
Aristida congesta s. barbicollis	.	.	.	.	.	.	.	.	.	2	46	64	41	2	.	.	59	.	3	.	.	.	2	.	.	.	.	.	.
Corchorus asplenifolius	.	.	.	.	.	.	.	.	.	.	32	58	26	6	.	.	.	.	.	.	.	.	.	2	.	5	.	.	.
Acacia exuvialis	.	.	.	.	.	.	.	.	.	.	17	44	22	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Themeda triandra	.	.	.	.	.	.	.	.	9	.	23	17	44	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ruellia patula	.	.	.	.	.	.	.	.	.	.	39	37	14	.	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ormocarpum trichocarpum	.	.	.	.	.	.	.	.	.	2	18	21	12	.	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sida dregei	.	.	.	.	.	.	.	.	.	2	14	18	11	.	1	.	.	.	.	.	.	4	.	.	.	.	.	.	.
Bothriochloa radicans	.	.	.	.	.	.	.	.	.	2	26	24	13	.	37	.	.	.	.	.	.	.	.	16	.	.	.	.	.
Blepharis integrifolia	.	.	.	.	.	.	.	.	.	.	25	19	10	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.
Lantana rugosa	.	.	7	.	.	.	2	.	.	.	22	29	19	6	.	.	.	.	.	.	.	8	.	.	.	.	.	.	.
Tragia dioica	.	.	.	.	.	.	.	.	.	.	21	19	18	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ipomoea obscura	.	.	.	.	.	.	.	.	.	2	14	18	20	4	.	.	.	.	.	.	.	.	.	3	6	.	35	14	.
Phyllanthus pentandrus	.	.	.	.	.	.	.	.	.	.	14	16	10	8	0.5	.	.	.	.	.	.	.	.	4	.	.	8	.	.
Maytenus heterophylla	.	.	.	.	8	2	2	.	.	.	19	21	13	4	1	.	.	.	3	.	.	.	.	0.9	.	.	.	.	.
Species group 26																													
Panicum coloratum	.	.	.	.	.	.	.	.	.	21	16	9	31	.	10	.	.	.	3	.	.	24	7	3	.	5	.	.	.
Chloris virgata	.	.	.	.	.	.	.	.	.	25	33	12	4	.	8	.	2	.	.	.	.	2	14	15	.	15	.	.	.
Species group 27																													
Cymbopogon plurinodis	.	.	.	.	.	.	.	.	41	.	11	27	24	.	.	.	.	6	.	61	58	.	.	0.9	.	.	.	.	.
Combretum hereroense	.	.	.	.	.	5	5	.	46	44	27	25	24	.	2	.	.	6	.	17	.	.	7	10	.	5	.	.	.
Euclea divinorum	.	.	.	.	.	2	.	.	21	25	45	17	13	2	2	.	.	.	.	.	.	.	3	8	.	.	.	.	.
Species group 28																													
Eragrostis rigidior	36	18	30	85	.	36	41	.	9	2	31	60	29	6	4	.	.	.	.	.	11	.	2	.	.	.	.	7	.
Justicia flava	27	12	90	85	.	.	8	.	.	4	32	7	4	4	.	.	0.8	.	.	.	.	2	.	.	.	.	.	.	.
Sporobolus nitens	64	82	37	39	.	7	11	.	.	.	33	10	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7	.
Species group 29																													
Vitex ferruginea	.	.	.	.	.	.	.	.	.	.	0.8	0.2	.	12	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Guibourtia conjugata	.	.	.	.	.	.	.	.	.	.	0.8	1	0.2	27	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Holarrhena pubescens	.	.	.	.	.	.	.	.	.	.	.	.	.	16	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Indigofera inhambanens	.	.	.	.	.	.	.	.	.	.	.	.	.	12	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Xeroderris stuhlmannii	.	.	.	.	.	2	3	.	.	.	.	.	.	10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Burkea africana	.	.	.	.	.	.	.	.	.	.	.	.	0.2	25	.	.	.	.	.	.	32	.	.	.	.	.	.	.	20
Cheilanthes viridis	.	.	.	.	.	.	.	.	.	.	1	1	.	16	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hermannia glanduligera	.	.	.	.	.	.	.	.	2	.	4	3	4	33	.	.	0.8	.	.	.	.	.	.	.	.	.	.	.	.
Zornia species	.	.	.	.	.	.	.	.	.	.	0.8	5	1	10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tephrosia longipes	.	.	.	.	.	.	.	.	.	.	0.8	5	3	14	.	.	.	.	.	.	.	8	.	.	.	.	.	.	.
Pseudolachnostylis maprouneif	.	.	.	.	.	.	.	.	.	.	0.4	0.2	1	43	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pellaea calomelanos	.	.	.	.	.	.	.	.	.	.	0.8	0.4	0.2	10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eragrostis pallens	.	.	.	.	.	.	.	.	2	.	0.4	0.6	0.2	27	.	.	.	.	.	.	.	.	.	.	.	.	.	7	.
Chamaesyce tettensis	.	.	.	.	.	.	.	.	.	.	0.8	0.6	3	25	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Diplorhynchus condylocarpon	.	.	.	.	.	.	.	.	.	.	2	0.6	0.5	20	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Phyllanthus burchellii	.	.	.	.	.	.	.	.	.	.	3	2	3	27	2	.	0.8	.	.	.	.	.	.	.	.	.	.	.	.
Bauhinia galpinii	.	.	.	.	.	.	.	.	.	.	0.4	0.2	0.7	12	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pteleopsis myrtifolia	.	.	.	.	.	.	.	.	.	.	0.4	0.2	.	37	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hymenocardia ulmoides	.	.	.	.	.	.	.	.	.	.	2	0.6	.	16	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Alchornea laxiflora	.	.	.	.	.	.	.	.	.	.	0.8	0.6	0.2	14	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Strychnos decussata	.	.	.	.	.	.	.	.	.	.	1	0.4	0.2	10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rhynchosia resinosa	.	.	.	.	.	.	.	.	.	.	0.4	0.6	.	18	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Celosia trigyna	.	.	.	.	.	.	.	.	.	.	0.8	0.2	0.5	10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Vangueria infausta	.	.	.	.	.	.	.	.	.	2	0.8	1	0.5	16	0.5	.	.	6	.	.	.	.	1	.	.	.	3	14	.
Hibiscus engleri	.	.	.	.	.	2	8	.	.	4	4	5	3	25	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hexalobus monopetalus	.	.	.	.	.	.	.	.	.	2	0.4	2	0.5	25	.	.	.	12	.	.	.	.	.	.	.	.	.	.	.
Corchorus kirkii	.	.	.	.	.	.	.	.	.	6	0.4	0.4	1	18	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tragia rupestris	.	.	.	.	.	.	.	.	.	4	0.4	0.2	2	10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Senna petersiana	.	.	.	.	.	.	.	.	.	2	.	1	2	10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tephrosia elongata	.	.	.	.	.	.	.	.	.	.	0.8	.	.	18	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rhynchosia venulosa	.	.	.	.	.	.	.	.	.	.	.	0.4	0.7	10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aristida mollissima	.	.	.	.	.	.	.	.	.	.	.	9	3	20	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Spermacoce senensis	.	.	.	.	.	.	.	.	.	.	.	2	0.5	22	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tarenna zygoon	.	.	.	.	.	.	.	.	.	.	.	0.2	0.2	27	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Striga asiatica	.	.	.	.	.	.	.	.	.	.	.	0.6	2	12	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species group 30																													
Vernonia fastigiata	.	.	.	.	.	.	.	.	.	.	5	16	24	35	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Clerodendrum ternatum	.	.	.	.	.	.	.	.	.	.	3	45	36	10	.	.	.	.	.	.	.	.	2	10	.	.	22	.	.
Crotalaria sphaerocarp	.	.	.	.	.	.	.	.	.	.	9	17	5	20	.	.	.	.	.	.	.	.	1	2	.	.	3	.	.
Brachiaria nigropedata	.	.	.	.	.	.	.	.	.	.	2	11	13	35	.	.	2	6	.	.	.	.	.	.	.	.	11	7	.
Merremia tridentata	.	.	.	.	.	.	.	.	.	.	1	10	5	51	.	.	.	.	.	.	.	.	.	2	.	.	51	43	.
Strychnos madagascariensis	.	.	.	.	.	5	2	.	.	.	2	14	6	47	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Perotis patens	.	.	.	.	.	.	.	.	2	.	2	20	3	37	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Vigna unguiculata	.	.	.	.	.	.	.	.	.	.	4	16	18	53	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Cluster	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z	aa	bb	cc
	1								2		3					4			5			6							
Number of relevés	11	17	30	13	13	44	64	10	44	48	257	471	405	49	193	8	132	17	31	18	19	51	93	109	18	20	37	14	10
	1.1				1.2				2		3					4			5			6.1		6.2			7.1		7.2
Andropogon gayanus	.	.	.	.	.	.	.	.	.	.	2	19	14	16	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Agathisanthemum bojeri	.	.	.	.	.	.	.	.	.	.	2	14	5	18	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Combretum zeyheri	.	.	.	.	8	2	2	.	.	.	2	12	3	47	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species group 31																													
Commelina erecta	.	.	.	.	.	.	.	.	.	2	15	14	3	20	.	.	.	.	.	.	.	.	.	0.9	.	.	5	7	.
Tephrosia polystachya	.	.	.	.	.	.	.	.	.	.	39	80	40	33	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.
Waltheria indica	.	.	.	.	.	.	.	.	.	.	20	64	5	20	1	.	.	.	.	.	.	2	2	.	.	.	.	.	.
Peltophorum africanum	.	.	.	.	.	.	.	.	9	.	13	18	7	12	6	.	.	.	.	.	.	.	3	.	.	.	5	.	20
Indigofera rhytidocarpa	.	.	.	.	.	.	.	.	.	.	19	29	8	10	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aristida congesta s. congesta	.	.	.	.	.	.	.	.	.	4	22	43	41	33	1	.	2	.	.	.	.	.	12	.	.	.	.	.	.
Indigofera vicioides	.	.	.	.	.	.	.	.	.	.	15	36	23	12	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Solanum panduriforme	.	.	.	.	.	11	3	.	.	13	43	34	26	12	0.5	.	.	.	.	.	.	26	1	.	.	.	.	.	.
Species group 32																													
Hemizygia bracteosa	18	35	37	.	.	11	8	.	.	.	0.4	9	2	10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Melhania forbesii	.	6	30	.	8	18	3	.	.	6	36	51	12	18	0.5	.	.	.	.	.	.	12	.	4	.	20	11	29	.
Aristida junciformis	.	18	70	.	31	14	2	.	.	.	.	.	0.5	10	.	.	.	.	.	.	.	.	3	0.9	.	.	.	.	.
Species group 33																													
Aristida rhiniochloa	.	.	.	.	.	.	.	.	.	.	2	0.2	1	.	37	.	.	.	3	.	.	.	9	22	.	.	.	.	.
Eragrostis curvula	.	.	3	.	.	.	.	.	.	.	0.4	0.2	0.2	.	15	.	.	.	.	.	5	.	.	.	.	.	.	.	.
Sesamum alatum	.	.	.	.	.	.	.	.	.	.	7	16	.	.	55	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lannea discolor	.	.	.	.	.	.	.	.	.	.	.	0.6	1	.	34	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Asparagus africanus	.	.	.	.	.	.	.	.	.	2	0.4	2	0.5	.	30	.	.	.	.	.	.	4	2	.	.	.	.	.	.
Melolobium glandulifera	.	.	.	.	.	.	.	.	.	.	0.4	.	.	.	30	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aristida bipartita	.	.	.	.	.	.	.	.	.	.	.	0.6	.	.	16	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hyparrhenia anamesa	.	.	.	.	.	.	.	.	.	.	0.4	.	.	.	12	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Microchloa caffra	.	.	.	.	.	.	.	.	.	.	2	10	0.2	.	52	.	.	.	.	.	.	.	1	.	.	.	.	.	.
Species group 34																													
Acalypha villicaulis	.	.	.	.	.	.	.	.	.	.	.	.	0.7	.	0.5	63	63	65	.	.	.	20	1	.	.	.	.	.	.
Priva africana	.	.	.	.	.	.	.	.	.	.	.	.	0.2	.	.	25	10	18	.	.	.	.	.	.	.	.	.	.	.
Indigofera trita	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	75	30	24	.	.	.	.	.	2	6	.	.	7	.
Ptycholobium contortum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	50	85	35	.	.	.	.	.	.	.	.	.	.	.
Acrachne racemosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.5	13	11	12	.	.	.	.	.	.	.	.	.	.	.
Amaranthus schinzianus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	63	64	41	.	.	.	.	.	.	.	.	.	.	.
Asparagus suaveolens	.	.	.	.	.	.	.	.	.	.	0.8	.	.	.	.	25	33	35	.	.	.	.	.	.	.	.	.	.	.
Calostephane divaricatata	.	.	.	.	.	.	.	.	.	2	0.8	5	6	.	.	13	52	24	3	.	.	.	.	5	.	.	.	7	.
Tephrosia purpurea	.	.	.	.	.	.	.	.	.	.	0.8	.	0.2	.	.	13	82	35	.	.	.	.	1	3	.	.	8	.	.
Commicarpus fallacissimus	.	.	.	.	.	.	.	.	.	.	0.8	0.2	0.5	.	.	63	73	29	.	.	.	.	.	2	.	.	.	.	.
Species group 35																													
Heliotropium strigosum	.	.	.	.	.	.	.	.	.	.	4	17	4	8	0.5	13	.	.	.	.	.	2	.	.	.	.	.	.	.
Ximenia caffra	.	.	.	.	.	.	.	.	5	.	3	7	4	6	2	13	.	.	.	.	.	2	.	.	.	.	.	.	.
Justicia betonica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	13	.	.	.	.	.	2	.	.	.	.	.	.	.
Limeum aethiopicum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.5	25	.	.	.	.	.	4	.	.	.	.	.	.	.
Senecio harveianus	.	.	.	.	.	.	.	.	.	.	0.4	.	.	.	0.5	13	.	.	.	.	.	4	.	.	.	.	.	.	.
Tribulus zeyheri	.	.	.	.	.	.	.	.	.	.	0.4	.	.	.	.	13	.	.	.	.	.	2	.	.	.	.	.	.	.
Cardiospermum halicacabum	.	.	.	.	.	.	.	.	.	.	2	0.8	0.5	2	.	13	.	.	.	.	.	2	.	.	.	.	.	.	.
Barleria senensis	.	.	.	.	.	.	.	.	.	.	2	1	2	.	.	25	5	6	.	.	.	.	.	0.9	.	.	.	.	.
Species group 36																													
Kohautia cynanchica	.	.	.	.	.	.	.	.	.	.	0.4	.	0.2	.	.	.	39	.	.	.	.	.	.	.	.	.	.	.	.
Indigofera nebrowniana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	39	.	.	.	.	.	.	.	.	.	.	.	.
Geigeria acaulis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	30	.	.	.	.	.	5	10	.	5	.	.	.
Pavonia columella	.	.	.	.	.	.	.	.	.	2	2	0.8	.	.	.	.	21	.	.	.	.	.	.	.	.	.	.	.	.
Boerhavia coccinea	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	11	6	3	.	.	.	.	.	.	.	.	.	.
Blepharis diversispina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	15	6	.	.	.	.	.	.	.	.	8	.	.
Barleria species	.	.	10	.	8	.	.	10	.	.	.	.	.	.	0.5	.	14	6	.	.	.	.	.	.	.	.	.	.	.
Limeum sulcatum	.	.	.	.	.	.	.	.	.	.	2	4	.	2	.	.	33	6	.	.	.	.	1	3	.	10	.	.	.
Adansonia digitata	.	.	.	8	.	.	.	.	.	.	0.8	0.2	0.2	.	.	.	17	6	.	.	.	.	.	.	.	.	.	.	.
Sericorema remotiflora	.	.	.	.	.	.	.	.	.	.	2	0.2	7	.	.	.	10	6	.	.	.	2	.	.	.	.	.	.	.
Species group 37																													
Leucas sexdentata	.	.	.	.	.	.	.	.	.	.	.	.	0.2	.	0.5	25	23	.	.	.	.	.	.	.	.	.	.	.	.
Ocimum americanum	.	.	.	.	.	.	.	.	.	.	16	9	4	.	.	25	32	.	.	.	.	20	.	.	.	.	.	.	.
Cleome angustifolia	.	.	.	.	.	.	.	.	.	.	2	3	0.2	.	8	63	56	6	.	.	.	4	.	.	.	.	.	.	.
Species group 38																													
Hermbstaedtia odorata	.	.	.	.	.	.	.	.	.	2	18	20	4	4	0.5	63	21	.	.	.	.	26	.	.	.	.	.	.	.
Phyllanthus maderaspatensis	.	.	.	.	.	.	.	.	.	.	13	25	25	.	2	.	30	6	.	.	.	.	.	14	.	.	5	.	.
Mariscus rehmannianus	.	.	.	.	.	.	.	.	.	.	20	24	6	.	.	.	24	6	.	.	.	.	.	.	.	.	.	.	.
Chamaecrista absus	.	.	.	.	.	.	.	.	.	.	2	30	11	14	1	.	36	.	.	.	.	.	.	3	.	.	5	.	.
Species group 39																													
Heliotropium steudneri	.	24	3	.	.	5	2	.	.	2	31	46	25	.	.	.	33	.	.	.	.	4	.	.	.	.	.	.	.
Digitaria velutina	.	6	3	.	31	11	2	.	.	.	0.4	.	.	.	0.5	.	17	6	3	.	.	.	1	.	.	.	.	.	.
Species group 40																													
Eleusine coracana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	18	.	.	.	.	.	.	.	.	.	.	.
Steganotaenia araliacea	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	18	.	.	.	.	.	0.9	.	.	.	.	.
Berchemia discolor	.	.	.	.	.	.	.	10	.	4	3	2	0.2	.	.	.	.	18	.	.	.	2	2	6	.	.	.	.	.
Ficus tettensis	.	.	.	.	8	.	.	.	.	.	.	.	.	.	.	.	.	41	.	.	.	.	.	.	.	.	.	.	.
Dombeya rotundifolia	.	.	.	.	.	.	.	.	7	.	0.4	0.8	2	.	.	.	.	18	.	.	.	.	.	0.9	.	.	.	.	.
Albizia brevifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	18	7	.	.	.	2	.	.	.	.	.	.
Commiphora merkeri	.	.	7	31	.	.	.	.	.	.	0.4	.	.	.	.	.	5	18	.	.	.	4	1	.	.	.	.	.	.
Xanthocercis zambesiaca	.	.	.	.	.	.	.	.	5	8	2	.	.	.	.	.	.	12	.	.	.	.	.	.	.	.	.	.	.
Danthoniopsis dinteri	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	41	.	.	.	2	.	2	.	.	.	.	.
Bridelia mollis	.	.	.	.	.	.	.	.	.	.	0.8	1	1	4	.	.	.	12	.	.	.	.	.	.	.	.	.	.	.
Bidens pilosa	.	.	.	.	.	.	.	.	.	2	3	6	0.2	.	.	.	5	35	.	.	.	.	.	.	.	.	.	.	.

Cluster	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z	aa	bb	cc
	1								2		3					4			5			6							
Number of relevés	11	17	30	13	13	44	64	10	44	48	257	471	405	49	193	8	132	17	31	18	19	51	93	109	18	20	37	14	10
			1.1				1.2		2				3				4			5		6.1			6.2		7.1		7.2
Rhoicissus revoilii	.	.	.	.	.	2	2	.	.	.	0.8	0.6	0.5	6	1	.	4	18	.	.	.	.	.	.	.	.	.	.	.
Markhamia zanzibarica	.	.	.	.	23	5	.	.	.	.	0.8	0.4	2	4	.	.	4	29	.	.	.	.	.	.	.	.	.	.	.
Species group 41																													
Jatropha spicata	.	.	.	.	.	.	.	.	.	.	0.4	1	.	.	.	.	30	12	.	.	.	.	.	.	.	.	.	.	.
Megalochlamys kenyensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	14	12	.	.	.	.	.	.	.	.	.	.	.
Eragrostis biflora	.	.	.	.	.	.	.	.	.	.	.	0.4	.	.	.	.	17	12	.	.	.	.	.	.	.	5	.	.	.
Lantana species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	36	24	.	.	.	.	.	0.9	.	.	.	.	.
Sesamum triphyllum	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	22	29	.	.	.	.	3	2	.	.	.	.	.
Commiphora tenuipetiol	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	24	29	.	.	.	.	.	.	.	.	.	.	.
Acacia erubescens	.	6	.	.	.	11	6	.	.	.	1	4	0.2	2	.	.	13	35	.	.	.	4	.	.	.	.	.	.	.
Sterculia rogersii	.	.	.	.	8	2	.	.	.	.	0.8	4	2	2	1	.	20	35	.	.	.	.	.	.	.	.	.	.	.
Justicia protracta	.	.	.	.	.	.	.	.	.	.	3	7	4	2	0.5	.	27	18	.	.	.	.	.	.	.	.	.	.	.
Gardenia resiniflua	.	.	.	.	8	18	6	.	.	.	2	0.4	0.5	.	0.5	.	14	53	.	.	.	2	.	.	.	.	.	.	.
Monechma debile	.	.	.	.	.	.	.	.	.	.	3	6	5	20	0.5	.	37	18	.	.	.	.	.	.	.	.	.	14	.
Species group 42																													
Indigofera heterotricha	.	.	.	.	.	.	.	.	.	.	2	5	13	.	.	13	47	35	.	.	.	.	.	.	.	.	.	.	.
Neuracanthus africanus	.	.	.	.	.	.	.	.	.	2	5	0.6	12	.	.	13	36	29	.	.	.	.	.	.	.	.	.	.	.
Species group 43																													
Ipomoea magnusiana	.	.	.	.	.	.	.	.	.	.	5	27	6	37	.	13	62	12	.	.	.	.	.	.	.	.	3	.	.
Species group 44																													
Seddera capensis	.	.	.	.	.	.	.	.	.	.	29	21	31	.	.	75	67	47	.	.	.	.	.	.	.	.	.	.	.
Grewia villosa	.	.	7	.	.	.	3	.	.	.	14	17	2	.	2	63	25	18	.	.	.	6	1	20	6	.	.	.	.
Hermannia boraginiflora	.	.	.	.	.	.	.	.	.	.	13	50	11	.	.	.	67	24	.	.	.	2	.	.	.	.	.	.	.
Corbichonia decumbens	.	.	.	.	.	.	.	.	.	.	13	16	6	.	.	.	22	29	.	.	.	.	.	.	.	.	.	.	.
Phyllanthus species	.	.	.	.	.	.	.	.	.	2	13	22	20	2	0.5	25	57	53	.	.	.	.	.	.	.	.	.	.	.
Pupalia lappacea	.	.	.	.	.	.	.	.	.	6	40	18	3	10	.	.	13	29	.	.	.	4	.	10	.	.	.	7	.
Solanum coccineum	.	.	.	.	.	.	.	.	.	2	17	15	3	.	.	.	25	41	.	.	.	.	1	.	.	.	.	.	.
Flueggea virosa	.	.	.	.	.	5	.	.	.	4	25	27	20	10	1	13	4	24	.	.	.	6	.	12	.	.	.	.	.
Abutilon austro-africanum	.	.	.	.	.	.	.	.	.	8	48	25	4	.	.	.	11	24	.	.	.	.	.	.	.	.	.	.	.
Pavonia burchellii	.	.	.	.	.	.	.	.	.	.	26	23	9	6	.	13	33	18	.	.	.	14	1	5	.	.	.	7	.
Leucas glabrata	.	.	.	.	.	.	.	.	.	4	19	38	7	10	.	.	35	29	.	.	.	.	.	.	.	.	.	.	.
Species group 45																													
Achyranthes aspera	.	.	.	.	.	.	.	.	.	10	14	11	3	4	0.5	25	64	71	3	.	.	10	7	7	.	.	.	21	.
Species group 46																													
Commiphora mollis	.	.	.	.	8	16	3	.	5	.	3	20	5	4	61	.	64	41	.	6	.	2	5	4	.	.	.	.	.
Tricholaena monachne	.	.	.	.	.	16	6	.	.	2	10	53	11	27	2	.	7	18	7	.	.	.	2	3	.	.	.	.	.
Species group 47																													
Commelina benghalensis	.	71	73	.	77	71	9	40	.	6	35	44	13	4	.	13	43	53	.	.	.	2	.	3	6	.	3	7	.
Lannea schweinfurthii	.	6	.	8	8	5	19	10	5	2	12	32	22	8	18	.	31	35	13	.	.	.	.	.	.	.	.	.	.
Species group 48																													
Combretum mossambicense	.	.	.	.	39	2	.	10	.	6	16	15	12	16	8	13	7	41	.	.	.	20	.	0.9	.	.	.	.	.
Setaria sagittifolia	.	6	3	.	46	36	2	10	.	8	1	0.8	.	2	.	.	11	24	.	.	.	.	.	.	.	.	.	.	.
Kirkia acuminata	.	.	.	.	15	18	5	.	.	.	2	2	2	10	.	.	42	47	3	.	.	.	2	6	.	.	.	.	.
Commiphora edulis	.	.	.	.	23	16	2	10	.	.	0.4	0.4	0.2	.	.	.	21	29	.	.	.	.	.	.	.	.	.	.	.
Species group 49																													
Oropetium capense	9	.	93	62	.	.	3	.	.	.	12	21	5	.	.	13	35	29	.	.	.	.	.	18	.	.	.	.	.
Species group 50																													
Lonchocarpus capassa	.	12	.	.	8	7	5	30	46	92	16	16	23	16	6	.	2	24	.	6	5	.	.	.	.	.	.	.	.
Kyllinga alba	.	29	70	.	.	7	2	.	.	.	3	20	4	2	.	.	30	12	.	.	.	.	4	0.9	.	.	5	7	.
Rhigozum zambesiacum	.	18	10	.	.	.	.	.	.	.	0.8	2	2	2	.	13	23	12	.	.	.	.	.	.	.	.	.	.	.
Species group 51																													
Urochloa mosambicensis	100	100	33	69	.	66	91	10	.	29	67	58	54	2	39	13	2	.	.	.	.	.	.	.	.	.	.	7	.
Grewia monticola	18	24	23	62	15	61	45	10	.	.	6	16	9	10	10	.	35	24	.	.	.	2	2	.	.	.	.	.	.
Maerua parvifolia	46	12	43	46	.	.	33	10	.	4	34	34	19	6	16	25	27	6	.	.	.	.	.	.	.	.	.	.	.
Species group 52																													
Dicoma anomala	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	29	.	.	.	7	.	.	.	.	.	.
Leonotis ocymifolia	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	13	.	.	.	7	.	.	.	.	.	.
Coelachyrum yemenicum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10	.	.	.	1	.	.	.	.	.	.
Thesium utile	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	29	.	.	.	4	.	.	.	.	7	.
Indigofera comosa	.	.	.	.	.	.	.	.	.	.	0.4	.	.	.	.	.	.	.	16	.	.	.	3	.	.	.	.	.	.
Species group 53																													
Euphorbia cooperi	.	.	.	.	.	.	.	.	5	.	.	.	.	2	.	.	.	.	.	17	.	.	.	.	.	.	.	.	.
Panicum deustum	.	.	.	.	.	.	.	.	41	.	7	0.8	1	.	1	.	.	.	.	22	.	.	.	.	.	.	.	.	.
Xerophyta retinervis	.	.	.	.	.	.	.	.	18	.	0.4	14	1	2	8	.	.	.	.	28	5	.	.	.	.	.	.	.	.
Digitaria argyrograpta	.	.	.	.	.	.	.	.	14	.	.	0.2	.	.	.	.	.	6	.	28	.	.	.	.	.	.	.	.	.
Berchemia zeyheri	.	6	.	.	.	2	.	.	11	6	0.4	0.2	.	.	.	.	.	24	.	28	.	.	.	.	.	.	.	.	.
Sporobolus pyramidalis	.	.	.	.	.	.	.	.	11	.	0.4	.	.	.	.	.	.	.	.	17	.	.	.	.	.	.	.	.	.
Trachypogon spicatus	.	.	.	.	.	.	.	.	11	.	.	.	.	.	.	.	.	.	.	22	5	.	.	.	.	.	.	.	.
Cymbopogon excavatus	.	.	.	.	.	.	.	.	11	2	.	0.2	4	.	.	.	.	.	.	11	5	.	.	0.9	.	.	.	.	.
Species group 54																													
Pogonarthria squarrosa	.	.	.	8	.	5	3	.	18	.	7	61	24	51	11	.	.	.	.	6	68	.	7	0.9	.	.	.	.	.
Sansevieria hyacinthoides	.	.	.	.	.	.	.	.	36	.	11	8	1	.	.	.	.	18	.	61	47	.	.	.	.	.	.	.	.
Eragrostis chloromelas	.	.	.	.	.	.	.	.	14	4	0.4	.	.	.	.	.	.	6	.	22	21	.	.	.	.	.	.	.	.
Panicum natalense	.	.	.	.	.	.	.	.	14	2	0.4	.	0.7	.	.	.	.	.	.	11	95	.	.	.	.	.	.	.	.
Eragrostis superba	.	.	.	8	.	5	8	.	25	6	19	22	46	.	8	.	.	.	.	17	74	.	2	5	.	5	3	.	.
Aristida congesta	.	.	.	.	.	.	.	.	14	6	.	.	.	.	78	.	92	29	74	56	100	.	17	0.9	.	.	.	.	.
Acacia gerrardii	.	6	.	.	.	2	2	.	46	.	11	9	8	.	2	.	.	12	.	67	95	.	.	.	.	.	3	.	.
Albizia harveyi	.	.	.	.	8	.	3	10	23	13	22	29	25	2	11	.	0.8	12	.	6	11	.	.	.	.	.	.	.	.
Species group 55																													
Acacia nigrescens	.	.	.	.	.	27	16	.	84	10	42	52	50	4	0.5	38	27	53	19	83	79	.	1	.	.	.	.	.	.

				1					2				3				4			5				6				
Cluster	a	b	c	d	e	f	g	h	I	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z	aa	bb	cc
Number of relevés	11	17	30	13	13	44	64	10	44	48	257	471	405	49	193	8	132	17	31	18	19	51	93	109	18	20	37	14	10
		1.1				1.2			2				3				4			5		6.1			6.2		7.1		7.2
Indigofera flavicans	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	21	.
Species group 80																													
Grewia retinervis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8	.	19	6	.	38	79	.
Vigna species	.	.	3	.	.	18	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acacia reficiens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	33	6	5	49	29	.
Ehretia rigida	.	.	.	.	.	.	.	.	.	2	9	6	18	.	.	.	.	.	.	.	.	4	.	18	.	.	22	36	.
Helinus integrifolius	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	29	6	5	3	36	.
Acacia mellifera	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	17	6	5	32	43	.
Anthephora pubescens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	44	11	.	70	21	.
Blepharis obmitrata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	19	.	10	3	29	.
Heliotropium ovalifolium	.	.	.	.	.	.	.	.	.	.	1	0.4	.	.	.	.	.	.	.	.	.	.	5	16	11	30	19	14	.
Species group 81																													
Anthephora schinzii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	20	30	11	15	.	21	.
Species group 82																													
Aristida meridionalis	.	.	.	.	.	.	.	.	.	.	.	6	2	2	.	.	5	41	.	.	.	4	.	10	.	.	70	36	.
Species group 83																													
Monechma divaricatum	.	.	.	.	.	.	.	.	.	.	3	3	.	4	0.5	63	10	.	3	.	.	53	1	26	33	30	14	21	.
Stipagrostis uniplumis	.	.	.	.	.	.	.	.	2	.	2	0.4	1	8	3	38	64	18	71	6	5	39	15	54	61	.	78	79	.
Species group 84																													
Boscia albitrunca	.	.	3	.	.	.	.	.	.	.	3	5	5	27	0.5	25	74	29	7	.	.	22	22	40	6	.	60	64	.
Species group 85																													
Commiphora pyracanthoides	.	.	.	.	.	.	.	.	.	.	3	14	0.2	.	.	.	7	.	10	.	.	8	5	43	6	.	14	57	.
Species group 86																													
Hibiscus micranthus	.	.	.	.	.	.	.	.	.	.	53	74	36	18	0.5	50	72	53	.	.	.	.	.	16	.	.	3	36	.
Schmidtia pappophoroides	.	.	.	.	.	.	.	.	.	.	32	66	59	53	41	.	11	12	10	.	.	12	17	18	17	.	84	50	.
Brachiaria deflexa	.	.	.	.	.	.	.	.	7	2	22	37	3	4	84	50	98	71	7	56	.	.	5	0.9	.	5	.	7	.
Species group 87																													
Digitaria eriantha	.	.	.	.	.	.	.	.	21	4	42	71	76	94	27	.	5	53	39	6	5	2	1	.	.	.	.	21	.
Terminalia prunioides	.	.	3	.	.	.	3	.	39	13	14	27	10	.	22	75	90	18	10	17	32	61	33	55	.	.	14	50	.
Eragrostis lehmanniana	.	.	.	.	.	.	.	.	48	25	13	8	0.7	.	7	38	61	18	.	89	5	71	1	7	17	.	81	64	.
Melinis repens	.	.	.	.	.	.	.	.	32	.	4	52	17	6	39	13	50	59	52	67	5	8	10	62	.	10	41	.	.
Ozoroa paniculosa	.	.	.	.	.	.	.	.	14	.	.	0.6	0.5	8	7	.	.	6	10	28	21	.	3	2	.	.	14	43	.
Species group 88																													
Grewia species	.	.	.	.	.	.	.	20	.	2	1	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	3	21	.
Species group 89																													
Grewia flava	.	.	.	15	.	.	2	.	.	.	0.4	0.6	0.2	.	.	38	82	59	13	.	.	.	7	24	6	.	38	79	.
Species group 90																													
Albizia anthelmintica	36	12	.	.	.	7	14	10	.	.	2	0.2	0.7	.	.	.	.	.	.	.	.	.	11	9	.	.	16	71	.
Species group 91																													
Hyphaene petersiana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8	.	.	.	.	7	20
Harpagophytum zeyheri	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.	20
Requienia pseudosphaerosper	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	40
Scilla nervosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	10
Salacia luebbertii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10
Basananthe pedata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10
Ophioglossum polyphyllum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	10
Pentarrhinum insipidum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	10
Tragus racemosus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10	.	.	.	.	.	20
Tavaresia barklyi	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	10
Stipagrostis uniplumis v. unipl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9	.	.	.	.	.	30
Dichapetalum cymosum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	20
Ozoroa schinzii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	50
Cyperus margaritaceus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	20
Asparagus nelsii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10	.	.	.	.	.	60
Hermannia eenii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10
Tephrosia dregeana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	3	.	5	35	.	40
Talinum arnotii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	.	3	.	40
Cleome rubella	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	2	.	.	.	.	20
Dicoma schinzii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	.	5	.	60
Lantana angolensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.9	.	.	.	.	10
Solanum delagoense	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	10
Acrotome inflata	.	.	.	.	.	.	.	.	.	.	.	0.6	.	4	.	.	.	.	.	.	.	.	4	.	.	.	.	7	20
Psydrax livida	.	.	.	.	.	.	.	.	.	.	0.4	0.2	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	20
Species group 92																													
Ochna pulchra	.	.	.	.	.	.	.	.	.	.	.	.	.	12	.	.	.	.	.	.	.	.	.	.	.	.	.	14	30
Bauhinia petersiana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	57	20
Aristida stipoides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	23	.	.	.	.	21	40
Combretum engleri	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	29	10
Combretum collinum	.	.	.	.	.	.	.	.	.	.	0.4	5	8	45	.	.	.	.	.	.	.	.	1	.	.	.	.	36	60
Species group 93																													
Rhus tenuinervis	.	.	.	.	.	.	.	.	.	.	.	.	0.2	.	.	.	.	.	.	.	.	.	4	0.9	.	.	19	21	50
Species group 94																													
Rhigozum brevispinosum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.5	.	.	.	.	.	.	2	5	24	11	.	84	43	10
Urochloa brachyura	.	.	.	.	.	.	.	.	.	.	.	2	11	.	.	.	.	.	.	.	.	.	9	22	33	20	8	14	10
Species group 95																													
Croton gratissimus	.	.	.	.	.	.	.	.	.	.	3	0.4	.	8	.	.	.	18	.	.	.	4	11	30	.	.	38	71	70
Pechuel-Loeschea leubnitziae	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	26	6	17	15	5	.	30
Schmidtia kalihariensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	18	17	6	.	35	14	60
Acacia erioloba	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	10	0.9	.	.	54	43	30
Pogonarthria fleckii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	22	26	.	.	19	14	10

				1						2			3				4			5				6					
Cluster	a	b	c	d	e	f	g	h	I	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z	aa	bb	cc
Number of relevés	11	17	30	13	13	44	64	10	44	48	257	471	405	49	193	8	132	17	31	18	19	51	93	109	18	20	37	14	10
		1.1					**1.2**			**2**			**3**				**4**			**5**			**6.1**		**6.2**		**7.1**		**7.2**
Species group 96																													
Eragrostis trichophora	.	.	.	.	.	.	.	.	.	2	7	1	0.7	.	.	.	72	12	77	.	.	4	65	16	11	.	5	7	90
Species group 97																													
Aristida stipitata	.	.	.	.	.	.	.	.	.	.	0.8	0.6	.	20	.	.	4	.	13	.	.	2	5	.	.	.	.	7	10
Species group 98																													
Mundulea sericea	.	.	.	.	.	.	.	.	.	.	2	10	8	12	0.5	.	.	.	.	.	.	.	5	14	17	.	8	14	80
Ximenia americana	.	.	3	.	.	.	.	.	.	.	7	10	4	6	6	13	8	12	.	.	.	2	5	3	.	.	.	14	10
Bulbostylis hispidula	.	.	.	.	.	.	.	.	.	.	5	19	0.5	16	40	.	45	12	.	.	.	.	15	.	.	.	5	.	10
Terminalia sericea	.	.	.	.	.	.	.	.	2	.	2	23	7	57	0.5	.	.	.	10	.	.	.	7	2	.	.	43	57	100
Species group 99																													
Gisekia africana	.	.	.	.	.	.	.	.	.	2	15	13	0.7	2	.	63	64	53	.	.	.	4	17	0.9	.	5	3	7	20
Rhynchosia totta	.	.	.	.	.	.	.	.	.	.	10	44	38	20	0.5	38	20	35	.	.	.	.	2	10	.	.	3	.	30
Tribulus terrestris	.	6	3	.	.	.	.	.	.	2	16	9	1	.	.	63	69	.	.	.	.	24	9	9	11	30	.	.	20
Species group 100																													
Aristida adscensionis	.	.	.	.	.	.	.	.	50	15	27	51	4	.	1	38	84	71	.	28	100	24	11	75	72	70	11	14	10
Sclerocarya birrea	.	.	.	.	.	5	3	.	34	13	12	51	29	16	22	.	39	53	13	50	32	4	3	3	.	.	.	.	10
Species group 101																													
Enneapogon cenchroides	.	.	.	.	.	14	2	.	48	13	42	64	40	12	68	100	98	88	81	39	84	69	24	72	61	.	27	43	.
Commiphora glandulosa	.	.	7	.	.	21	2	.	.	2	9	7	12	.	23	.	0.8	.	.	.	.	6	14	2	.	5	.	.	20
Species group 102																													
Commelina africana	.	.	.	.	15	27	2	.	.	.	16	36	10	18	0.5	13	.	.	.	.	.	4	8	2	.	.	.	.	10
Ziziphus mucronata	.	.	.	.	15	11	3	10	23	8	14	20	12	2	12	.	.	6	.	44	16	2	5	11	.	.	.	7	10
Species group 103																													
Asparagus species	.	.	30	.	8	9	2	.	.	2	.	.	0.5	2	.	.	.	.	3	.	.	2	5	25	11	.	62	50	.
Evolvulus alsinoides	.	.	20	.	.	2	8	.	.	.	41	65	12	14	0.5	.	80	24	.	.	.	20	7	8	.	.	11	.	10
Grewia flavescens	.	6	10	8	8	36	44	40	.	2	21	24	2	2	9	.	.	.	65	.	.	.	18	5	.	.	14	.	40
Kyphocarpa angustifolia	.	6	13	39	.	9	9	.	.	.	48	78	6	6	35	50	84	41	3	.	.	26	.	.	.	.	3	7	.
Species group 104																													
Colophospermum mopane	.	35	100	100	.	21	27	.	80	33	28	43	85	8	93	88	98	41	55	83	100	35	84	80	6	5	60	7	80
Grewia bicolor	.	18	70	31	.	23	6	.	.	.	62	74	42	14	67	100	89	41	.	.	.	49	9	52	6	5	35	50	30
Commiphora africana	.	12	7	15	.	5	5	.	.	.	14	35	26	2	.	.	11	.	29	.	.	6	7	6	11	.	19	57	10
Species group 105																													
Dichrostachys cinerea	18	29	20	39	.	32	25	80	27	17	37	64	51	33	52	13	60	18	45	50	84	8	25	55	.	.	68	79	10
Tragus berteronianus	27	77	97	23	.	5	6	.	.	4	58	69	10	2	87	50	89	12	94	.	.	4	30	10	17	40	.	7	20
Panicum maximum	27	12	27	39	69	82	63	90	23	48	83	86	67	86	5	.	14	65	36	17	.	.	8	.	.	.	.	50	.
Acacia tortilis	73	35	.	.	.	2	33	70	2	17	25	7	9	.	5	13	22	6	13	.	.	22	3	.	.	25	3	7	.
Sida ovata	27	35	7	.	.	7	13	.	.	.	.	0.4	0.2	2	1	.	.	.	.	.	.	24	.	2	.	.	3	57	.

Table 4 Reduced synoptic table indicating species selected for final table (Table 5)

	Zimbabwe		Rivers	SA Lowv.	N.Soutp	Trans.	Nambia		Sand	
Major vegetation type	**1.1**	**1.2**	**2**	**3**	**4**	**5**	**6.1**	**6.2**	**7.1**	**7**
Number of relevés	*71*	*131*	*92*	*1375*	*157*	*68*	*144*	*147*	*51*	*10*
Species group 1										
Cucumis metuliferus	7	17							2	
Cucumis zeyheri	44	31								
Abutilon grandiflorum	27	11			1					
Digitaria milanjiana	44	75					1			
Cyathula uncinulata	70	48								
Species group 2										
Boscia mossambicensis	20	8	1							
Cissus rotundifolia	40	6		1						
Species group 3										
Senecio species	9	3								
Hermbstaedtia linearis	7	3						2	6	
Echinochloa colona	3									
Acacia nilotica s. kraussiana	4					1				
Species group 4										
Cyperus species	28						1	8	2	
Plectranthus caninus	14	3								
Balanites maughamii	4		1	1		3			2	
Eragrostis heteromera	6	2	3	3						
Species group 5										
Dactyloctenium australe	11	2								
Dactyloctenium giganteum	34	11	1	3						
Species group 6										
Plectranthus neochilus	18	1								
Thilachium africanum	24	4		1						
Zanthoxylum capense	21	1		1						
Maytenus procumbens	4	3								
Species group 7										
Millettia sutherlandii		7								
Grewia caffra		8								
Monodora junodii		5		1						
Artabotrys brachypetala		3		1						
Melinis nerviglumis	3	5					1	5	12	
Strychnos potatorum		6								
Combretum microphyllum		3								
Vitex buchananii		1								
Cyphostemma species	1	2			7		1			
Millettia grandis		2								
Species group 8										
Justicia kirkiana		9						1		
Ceratotheca sesamoides		4								
Vigna frutescens	1	18								
Phyllanthus reticulatus	3	14	1	1						
Tragia okanyua		6								
Species group 9										
Stylochiton natalensis	18	6		3						
Vernonia lundiensis	6	8					1	5	20	
Eragrostis cilianensis	9	3					1	1		

	Zimbabwe		Rivers	SA Lowv.	N.Soutp	Trans.	Nambia		Sand	
Major vegetation type	**1.1**	**1.2**	**2**	**3**	**4**	**5**	**6.1**	**6.2**	**7.1**	**7**
Number of relevés	*71*	*131*	*92*	*1375*	*157*	*68*	*144*	*147*	*51*	*10*
Enteropogon monostachys	20	8								
Crotalaria species	11	11						4	4	
Setaria sphacelata	3	24	2	1	1					
Species group 10										
Diospyros quiloensis	35	33								
Indigofera varia	45	20	2			1	6	2	2	
Species group 11										
Acacia schweinfurthii		8	1							
Grewia inaequilatera	1	5								
Capparis tomentosa	3	5	5	1						
Maerua edulis	1	3								
Panicum species		1								
Cardamine africana		2								
Cordia monoica	1	9		2	2					
Kalanchoe lanceolata	3	5		1						
Abutilon hirtum	1	3						1		
Species group 12										
Sporobolus fimbriatus			64	7	1	22	1			
Flaveria bidentis			20							
Species group 13										
Acacia burkei		1	9	4		2				
Hyparrhenia hirta			5							
Species group 14										
Croton megalobotrys		1	34							
Ficus sycomorus			21							
Phragmites australis			19							
Hyphaene coriacea			8		3					
Phoenix reclinata			8							
Cynodon dactylon			8	1			5			10
Sporobolus consimilis			5							
Sesbania sesban			5	1						
Nuxia oppositifolia			5							
Species group 15										
Limeum fenestratum				24			2		4	
Cissus cornifolia				54						
Cassia abbreviata		1	15	11	2	3				
Dalbergia melanoxylon		9	1	27						
Grewia hexamita				12	1	1	3			
Species group 16										
Dactyloctenium aegyptium	10	2	1	6			6			
Enteropogon macrostachys	6	4		4	2	1		1		
Abutilon guineense			4	5	1					
Urochloa panicoides	3	1		4						
Sida rhombifolia			2	5						
Orthosiphon suffrutescens			2	7						
Trianthema salsoloides				2						
Boerhavia diffusa			1	7			7	1		
Achyropsis leptostachys				2						
Species group 17										
Maytenus senegalensis			9	4			3	10	4	

	Zimbabwe		Rivers	SA Lowv.	N.Soutp	Trans.	Nambia		Sand	
Major vegetation type	**1.1**	**1.2**	**2**	**3**	**4**	**5**	**6.1**	**6.2**	**7.1**	**7**
Number of relevés	***71***	***131***	***92***	***1375***	***157***	***68***	***144***	***147***	***51***	***10***
Species group 18										
Spirostachys africana			40	5		6	1	8		
Species group 19										
Diospyros mespiliformis		2	9	4			6			
Species group 20										
Ceratotheca triloba				16			1			
Crabbea velutina				13						
Chamaesyce neopolycnemoides				13			2			
Indigofera filipes				9						
Polygala sphenoptera			1	11						
Grewia subspathulata				8						
Hibiscus sidiformis				11						
Melhania didyma				10						
Aristida scabrivalvis				9	2			4	2	
Leucas neuflizeana				8						
Ornithogalum seineri				8						
Aristi stipitata s. graciloflora				6						10
Trichoneura grandigluma				7						
Crotalaria virgulata				9	1				2	
Limeum viscosum				6			5			
Coccinia rehmannii				7						
Crotalaria schinzii				6						
Triumfetta pentandra			1	5						
Rhinacanthus xerophilus			1	6						
Chlorophytum galpinii				6						
Tricliceras laceratum				4						
Justicia anagalloides				6						
Phyllanthus incurvus				5						
Indigofera lupatana				7						
Monsonia burkeana				4						
Monsonia angustifolia				6						
Fimbristylis complanata				5						
Stylosanthes fruticosa				4						
Sporobolus panicoides				4	1				2	
Chascanum hederaceum				4						
Species group 21										
Acalypha indica			4	21	1			3		
Asparagus setaceus				20	1		1			
Cyperus rupestris				15						
Endostemon tereticauli				16						
Talinum caffrum				14			2			
Melhania prostrata				11						
Phyllanthus asperulatus				10						
Ehretia amoena				7			2			
Hibiscus pusillus			1	8						
Cucumis africanus			3	11			1			
Portulaca kermesina	14		1	10	1			1		
Species group 22										
Setaria incrassata			4	6						
Neorautanenia amboensis				4				1	2	
Sorghum versicolor		3		4				1		

	Zimbabwe		Rivers	SA Lowv.	N.Soutp	Trans.	Nambia		Sand	
Major vegetation type	**1.1**	**1.2**	**2**	**3**	**4**	**5**	**6.1**	**6.2**	**7.1**	**7**
Number of relevés	*71*	*131*	*92*	*1375*	*157*	*68*	*144*	*147*	*51*	*10*
Hybanthus enneaspermus				4	3					
Tephrosia multijuga			2	4				1		
Pterocarpus rotundifolius				5						
Rhynchosia minima			3	5				7	2	
Species group 23										
Chamaecrista mimosoides				19						
Ipomoea crassipes				14						
Indigofera bainesii				13					2	
Bothriochloa insculpta			2	16	2	1				
Ozoroa engleri				10						
Kohautia virgata				15						
Brachiaria xantholeuca			1	11						
Species group 24										
Aristi congesta s. barbicollis			1	43	50	1	1			
Corchorus asplenifolius				34				2		
Acacia exuvialis				25						
Themeda triandra			4	23						
Ruellia patula				24						
Ormocarpum trichocarpum			1	16						
Sida dregei			1	12			1			
Bothriochloa radicans			1	22				12		
Blepharis integrifolia				14				1		
Lantana rugosa	3	1		20			3			
Tragia dioica				16						
Ipomoea obscura			1	15				3	29	
Phyllanthus pentandrus				11				3	6	
Maytenus heterophylla		2		15		1		1		
Species group 25										
Panicum coloratum			11	17		1	13	3		
Chloris virgata			13	13	2		10	13		
Species group 26										
Cymbopogon plurinodis			20	18	1	32		1		
Combretum hereroense		4	45	21	1	5	5	8		
Euclea divinorum		1	23	18			2	6		
Species group 27										
Eragrostis rigidior	38	32	5	36		3	1		2	
Justicia flava	61	4	2	10	1		1			
Sporobolus nitens	52	8		10					2	
Species group 28										
Vitex ferruginea				1						
Guibourtia conjugata				2						
Holarrhena pubescens				1						
Indigofera inhambanens				0						
Xeroderris stuhlmannii		2		0						
Burkea africana				1		9				20
Cheilanthes viridis				1						
Hermannia glanduligera			1	4	1					
Zornia species				3						
Tephrosia longipes				3			3			
Pseudolachno maprounei				2						
Pellaea calomelanos				1						

	Zimbabwe		Rivers	SA Lowv.	N.Soutp	Trans.	Nambia		Sand	
Major vegetation type	**1.1**	**1.2**	**2**	**3**	**4**	**5**	**6.1**	**6.2**	**7.1**	**7**
Number of relevés	*71*	*131*	*92*	*1375*	*157*	*68*	*144*	*147*	*51*	*10*
Eragrostis pallens			1	1					2	
Chamaesyce tettensis				2						
Diplorhynchu condyloca				1						
Phyllanthus burchellii				3	1					
Bauhinia galpinii				1						
Pteleopsis myrtifolia				1						
Hymenocardia ulmoides				1						
Alchornea laxiflora				1						
Strychnos decussata				1						
Rhynchosia resinosa				1						
Celosia trigyna				1						
Vangueria infausta			1	1	1		1		6	
Hibiscus engleri		5	2	4						
Hexalobus monopetalus			1	2	1					
Corchorus kirkii			3	1						
Tragia rupestris			2	1						
Senna petersiana			1	1						
Tephrosia elongata				1						
Rhynchosia venulosa				1						
Aristida mollissima				5						
Spermacoce senensis				2						
Tarenna zygoon				1						
Striga asiatica				1						
Species group 29				0						
Vernonia fastigiata				15						
Clerodendrum ternatum				27			1	7	16	
Crotalaria sphaerocarpa				10			1	1	2	
Brachiaria nigropedata				9	2				10	
Merremia tridentata				7				1	49	
Strychnos madagascariensis		3		9						
Perotis patens			1	10						
Vigna unguiculata				13						
Andropogon gayanus				12						
Agathisanthemum bojeri				7						
Combretum zeyheri		2		7						
Species group 30										
Commelina erecta			1	9				1	6	
Tephrosia polystachya				48			1			
Waltheria indica				28			2			
Peltophorum africanum			4	12			2		4	20
Indigofera rhytidocarpa				16						
Aristi congesta s. congesta			2	32	2		8			
Indigofera vicioides				22						
Solanum panduriforme		5	7	28			10			
Species group 31										
Hemizygia bracteosa	27	8		4						
Melhania forbesii	14	8	3	28			4	6	16	
Aristida junciformis	34	9					2	1		
Species group 32										
Aristida rhiniochloa				6		1	6	16		
Eragrostis curvula				2		1				

	Zimbabwe		Rivers	SA Lowv.	N.Soutp	Trans.	Nambia		Sand	
Major vegetation type	**1.1**	**1.2**	**2**	**3**	**4**	**5**	**6.1**	**6.2**	**7.1**	**7**
Number of relevés	*71*	*131*	*92*	*1375*	*157*	*68*	*144*	*147*	*51*	*10*
Sesamum alatum				15						
Lannea discolor				5						
Asparagus africanus			1	5			3			
Melolobium glandulifera				4						
Aristida bipartita				2						
Hyparrhenia anamesa				2						
Microchloa caffra				11			1			
Species group 33										
Acalypha villicaulis					63		8			
Priva africana					12					
Indigofera trita					32			2	2	
Ptycholobium contortum					78					
Acrachne racemosa					11					
Amaranthus schinzianus					61					
Asparagus suaveolens					33					
Calostephane divaricata			1	4	47	1		4	2	
Tephrosia purpurea					73		1	2	6	
Commicarpus fallacissimus					68			1		
Species group 34										
Heliotropium strigosum				8	1		1			
Ximenia caffra			2	5	1		1			
Justicia betonica					1		1			
Limeum aethiopicum					1		1			
Senecio harveianus					1		1			
Tribulus zeyheri					1		1			
Cardiospermum halicacabum				1	1		1			
Barleria senensis				1	6			1		
Species group 35										
Kohautia cynanchica					33					
Indigofera nebrowniana					33					
Geigeria acaulis					25		3	8		
Pavonia columella			1	1	18					
Boerhavia coccinea			1		10	1				
Blepharis diversispina					13				6	
Barleria species	4	2			12					
Limeum sulcatum				2	28		1	4		
Adansonia digitata	1				15					
Sericorema remotiflora				3	9		1			
Species group 36										
Leucas sexdentata					21					
Ocimum americanum				7	28		7			
Cleome angustifolia				3	51		1			
Species group 37										
Hermbstaedtia odorata			1	12	21		9			
Phyllanthus maderaspatensis				19	26			10	4	
Mariscus rehmannianus				14	21					
Chamaecrista absus				15	30			2	4	
Species group 38										
Heliotropium steudneri	7	3	1	29	28		1			
Digitaria velutina	1	7			15	1	1			

	Zimbabwe		Rivers	SA Lowv.	N.Soutp	Trans.	Nambia		Sand	
Major vegetation type	**1.1**	**1.2**	**2**	**3**	**4**	**5**	**6.1**	**6.2**	**7.1**	**7**
Number of relevés	*71*	*131*	*92*	*1375*	*157*	*68*	*144*	*147*	*51*	*10*
Species group 39										
Eleusine coracana					2					
Steganotaenia araliacea			1		2			1		
Berchemia discolor		1	2	1	2		2	4		
Ficus tettensis		1			4					
Dombeya rotundifolia			3	1	2			1		
Albizia brevifolia					2	3	1			
Commiphora merkeri					6		2			
Xanthocercis zambesiaca			7		1					
Danthoniopsis dinteri					8		1	1		
Bridelia mollis				1	1					
Bidens pilosa			1	3	8					
Rhoicissus revoilii		2		1	5					
Markhamia zanzibarica		4		1	7					
Species group 40										
Jatropha spicata					27					
Megalochlamys kenyensis					13					
Eragrostis biflora					16			1		
Lantana species					33			1		
Sesamum triphyllum		1			22		2	1		
Commiphora tenuipetiolata					23					
Acacia erubescens	1	7		2	15		1			
Sterculia rogersii		1		2	21					
Justicia protracta				4	25					
Gardenia resiniflua		10		1	18		1			
Monechma debile				5	33				4	
Species group 41										
Indigofera heterotricha				6	44					
Neuracanthus africanus			1	5	34					
Species group 42										
Ipomoea magnusiana				13	54				2	
Species group 43										
Seddera capensis				22	65					
Grewia villosa	3	1		9	26		3	16		
Hermannia boraginiflora				23	59		1			
Corbichonia decumbens				10	22					
Phyllanthus species			1	16	55					
Pupalia lappacea			3	15	14		1	7	2	
Solanum coccineum			1	9	25		1			
Flueggea virosa		2	2	20	7		2	9		
Abutilon austro-africanum			4	19	12					
Pavonia burchellii				16	30		6	4	2	
Leucas glabrata			2	19	33					
Species group 44										
Achyranthes aspera			5	7	63	1	8	5	6	
Species group 45										
Commiphora mollis		8	2	18	58	2	4	3		
Tricholaena monachne		8	1	25	8	3	1	2		
Species group 46										
Lannea schweinfurthii	3	13	3	22	30	6				
Commelina benghalensis	48	39	3	26	43		1	3	4	

	Zimbabwe		Rivers	SA Lowv.	N.Soutp	Trans.	Nambia		Sand	
Major vegetation type	**1.1**	**1.2**	**2**	**3**	**4**	**5**	**6.1**	**6.2**	**7.1**	**7**
Number of relevés	*71*	*131*	*92*	*1375*	*157*	*68*	*144*	*147*	*51*	*10*
Combretum mossambicense		5	3	13	11		7	1		
Setaria sagittifolia	3	18	4	1	12					
Kirkia acuminata		10		2	40	1	1	4		
Commiphora edulis		9			21					
Species group 48										
Oropetium capense	52	1		11	33			13		
Species group 49										
Lonchocarpus capassa	3	8	70	17	4	3				
Kyllinga alba	37	3		9	27		3	1	6	
Rhigozum zambesiacum	9			1	21					
Species group 50										
Urochloa mosambicensis	66	67	15	54	2				2	
Grewia monticola	30	45		11	32		2			
Maerua parvifolia	37	17	2	26	25					
Species group 51										
Dicoma anomala						13	5			
Leonotis ocymifolia			1			6	5			
Coelachyrum yemenicum						5	1			
Thesium utile						13	3		2	
Indigofera comosa						7	2			
Species group 52										
Euphorbia cooperi			2			5				
Panicum deustum			20	2		6				
Xerophyta retinervis			9	6		9				
Digitaria argyrograpta			7		1	7				
Berchemia zeyheri	1	1	8		3	7				
Sporobolus pyramidalis			5			5				
Trachypogon spicatus			5			7				
Cymbopogon excavatus			6	1		4		1		
Species group 53										
Pogonarthria squarrosa	1	3	9	33		21	5	1		
Sansevieria hyacinthoides			17	5	2	29				
Eragrostis chloromelas			9		1	12				
Panicum natalense			8			29				
Eragrostis superba	1	6	15	26		25	1	4	2	
Aristida congesta			10	11	80	77	11	1		
Acacia gerrardii	1	2	22	8	1	44			2	
Albizia harveyi		3	18	23	2	5				
Species group 54										
Acacia nigrescens		17	45	41	30	53	1			
Species group 55										
Anisotes rogersii				1			4			
Triraphis ramisissima							9			
Acalypha glabrata							4			
Ipomoea cairica							7	1		
Indigofera melanadenia							4			
Indigofera daleoides							6	1	8	
Sida cordifolia			2	3		1	6		2	
Abutilon angulatum			3		1		15	6	4	
Heliotropium ciliatum	3				1		9	3		

	Zimbabwe		Rivers	SA Lowv.	N.Soutp	Trans.	Nambia		Sand	
Major vegetation type	**1.1**	**1.2**	**2**	**3**	**4**	**5**	**6.1**	**6.2**	**7.1**	**7**
Number of relevés	*71*	*131*	*92*	*1375*	*157*	*68*	*144*	*147*	*51*	*10*
Species group 56										
Eragrostis viscosa							15			
Willkommia sarmentosa							12	1		
Species group 57										
Enneapogon desvauxii								39	4	
Eragrostis echinochloidea							3	34		
Eragrostis porosa							5	16		
Leucosphaera bainesii								62		
Monelytrum luederitzia								25		
Solanum species		1	1					12	2	
Hibiscus caesius								23	2	
Indigofera charlierian					1		1	18	4	
Eragrostis nindensis							7	36	2	
Species group 58										
Boscia foetida			2		1		10	21	2	
Helichrysum tomentosulum								15	2	
Commiphora glaucescens							5	7		
Lantana dinteri								10	2	
Gossypium triphyllum								13		
Melinis longiseta								9	4	
Aristida hordeacea								7		
Cyperus fulgens							1	10	2	
Vernonia cinerascens								9		
Seddera suffruticosa				4			1	18	2	
Triaspis hypericoides								11		
Abutilon fruticosum				2	1		1	20		
Nidorella resedifolia								10		
Aptosimum angustifolium							1	8	2	
Species group 59										
Acacia nilotica			9	4			22	13	2	
Species group 60										
Acacia senegal				1	11		8	11	2	
Species group 61										
Fingerhuthia africana			2	10		9		18		
Species group 62										
Dicoma tomentosa				25	69		8	7	2	
Species group 63										
Enneapogon scoparius			49	10	3	52	6	10		
Species group 64										
Heteropogon contortus		11	4	31	2		1	22		
Species group 65										
Combretum imberbe	3	5	56	14	5	6	9	7		
Species group 66										
Combretum apiculatum	4	44	27	64	85	84	9	33	6	
Species group 67										
Monechma tonsum								4	2	
Felicia clavipilosa								1		
Aizoanthemum dinteri								2		
Stipagrostis hochstetteriana							3	6		
Dipcadi species								4	4	
Stipagrostis hirtigluma							2	6		

	Zimbabwe		Rivers	SA Lowv.	N.Soutp	Trans.	Nambia		Sand	
Major vegetation type	**1.1**	**1.2**	**2**	**3**	**4**	**5**	**6.1**	**6.2**	**7.1**	**7**
Number of relevés	*71*	*131*	*92*	*1375*	*157*	*68*	*144*	*147*	*51*	*10*
Melhania damarana							1	6	2	
Species group 68										
Stipag hirtigluma s. pearsonii								15		
Stipag hirtigluma s. patula							1	15		
Ptycholobium biflorum								11		
Fockea angustifolia			1	2				10	2	
Pegolettia senegalensis			1	2			1	15	4	
Monechma genistifolium								14	4	
Species group 69										
Gisekia species								1		
Sporobolus acinifolius								3	2	
Crotalaria damarensis							1	2		
Ipomoea sinensis				1				5		
Trianthema triquetra								3		
Senna italica				2			3	2		
Sporobolus spicatus								3	2	
Heliotropium species			2					1		
Brachiaria malacodes							1	7		
Heliotropium giessii							1	2		
Sporobolus salsus								1		
Panicum novemnerve								4	2	
Panicum lanipes							1	2		
Salsola tuberculata								2		
Eragrostis sabinae								2		
Kohautia azurea								9		
Blepharis leendertziae								8		
Lycium bosciifolium								3		
Erucastrum arabicum								2		
Acalypha segetalis			1					11		
Setaria verticillata			1		6	1	4	10		
Species group 70										
Chamaesyce inaequilatera							3	17	2	
Geigeria odontoptera								10		
Aizoon virgatum								11		
Ruelliopsis setosa								13		
Eragrostis annulata							2	13		
Eragrostis glandulosipedata								11		
Acacia nebrownii								12		
Heliotropium lineare							1	8	2	
Odyssea paucinervis							5	11	2	10
Hirpicium gazanioides							1	12	2	
Species group 71										
Triraphis purpurea						1	17	14		
Species group 72										
Aptosimum lineare				14	75			22		
Melhania rehmannii			1	10	70			12	6	
Species group 73										
Cyathula lanceolata			2	2			3	12		
Geigeria ornativa				3			12	18	2	
Species group 74										
Cenchrus ciliaris		1	28	11	11	24	6	50		

	Zimbabwe		Rivers	SA Lowv.	N.Soutp	Trans.	Nambia		Sand	
Major vegetation type	**1.1**	**1.2**	**2**	**3**	**4**	**5**	**6.1**	**6.2**	**7.1**	**7**
Number of relevés	*71*	*131*	*92*	*1375*	*157*	*68*	*144*	*147*	*51*	*10*
Species group 75										
Eragrostis dinteri							1	4	12	
Indigofera colutea								2	23	
Acanthosicyo naudinian							3		43	
Acacia ataxacantha							3	1	31	
Lonchocarpus nelsii								4	49	
Hermannia species	3							4	18	
Acacia fleckii							3	7	49	
Species group 76										
Oxygonum dregeanum									12	
Helichrysum candolleanum				2			3	1	8	
Dicoma species								1	12	
Requienia sphaerosperma							1		41	
Commiphora species					1		2	5	14	
Blepharis species					1		4		10	
Petalidium coccineum								1	14	
Merremia palmata				3			2	4	22	
Elephantorrh suffruticosa								6	45	
Neorautanenia species								5	36	
Kohautia caespitosa				1			1	1	17	
Hiernia angolensis								5	8	
Kohautia species							1	2	8	
Harpagophytum procumbens									18	
Ipomoea verbascoidea								1	18	
Vernonia poskeana				5			3	6	14	
Commiphora angolensis							1	7	31	
Species group 77										
Maerua juncea			3	1			1	8	29	
Cephalocroton mollis				1				16	10	
Montinia caryophyllaceae							1	25	25	
Chascanum pinnatifidum				1			1	22	8	
Otoptera burchellii							1	25	57	
Catophractes alexandri						1	5	45	16	
Barleria lancifolia				3	18		1	13	20	
Hermannia modesta				2			3	15	22	
Petalidium engleranum								14	8	
Species group 78										
Triraphis schinzii								4	14	
Cucumella species									6	
Croton menyhartii							5	1	4	
Bidens biternata		2					1	10	4	
Baissea wulfhorstii									4	
Tricalysia species									4	
Blepharis maderaspatensis				1					6	
Digitaria seriata							1		6	
Leucas martinicensis							1	5	6	
Pergularia daemia								2	4	
Clerodendrum dekindtii								1	16	
Tylosema esculentum									7	
Indigofera flavicans									8	

	Zimbabwe		Rivers	SA Lowv.	N.Soutp	Trans.	Nambia		Sand	
Major vegetation type	**1.1**	**1.2**	**2**	**3**	**4**	**5**	**6.1**	**6.2**	**7.1**	**7**
Number of relevés	***71***	***131***	***92***	***1375***	***157***	***68***	***144***	***147***	***51***	***10***
Species group 79										
Grewia retinervis							3	15	49	
Vigna species	1							8	35	
Acacia reficiens							3	26	44	
Ehretia rigida			1	9			1	13	26	
Helinus integrifolius								23	12	
Acacia mellifera							1	14	35	
Anthephora pubescens							3	34	57	
Blepharis obmitrata								15	10	
Heliotropium ovalifolium							3	17	18	
Species group 80										
Anthephora schinzii							13	26	6	
Species group 81										
Aristida meridionalis				3	9		1	7	61	
Species group 82										
Monechma divaricatum				2	12	1	19	27	16	
Stipagrostis uniplumis			1	2	58	35	24	48	78	
Species group 83										
Boscia albitrunca	1			5	67	3	22	30	61	
Species group 84										
Commiphora pyracanthoides				5	6	5	6	33	26	
Species group 85										
Hibiscus micranthus				47	69			12	12	
Schmidtia pappophoroides				54	11	5	15	15	75	
Brachiaria deflexa			4	30	93	18	3	1	2	
Species group 86										
Digitaria eriantha			12	62	10	21	1		6	
Terminalia prunioides	1		25	18	81	18	43	41	24	
Eragrostis lehmanniana			36	6	55	25	26	7	76	
Melinis repens			15	29	49	43	9	47	30	
Ozoroa paniculosa			7	2	1	18	2	1	22	
Species group 87										
Grewia species			1				1		8	
Species group 88										
Grewia flava	3				77	6	3	19	49	
Species group 89										
Albizia anthelmintica	8			1			7	7	31	
Species group 90										
Hyphaene petersiana							5		2	20
Harpagophytum zeyheri				1			3			20
Requienia pseudosphaerma							1			40
Scilla nervosa							1			10
Salacia luebbertii										10
Basananthe pedata										10
Ophioglossum polyphyllum							1			10
Pentarrhinum insipidum							1			10
Tragus racemosus							6			20
Tavaresia barklyi							3			10
Stipag uniplumis var. uniplumis							6			30
Dichapetalum cymosum										20
Ozoroa schinzii							1			50

	Zimbabwe		Rivers	SA Lowv.	N.Soutp	Trans.	Nambia		Sand	
Major vegetation type	**1.1**	**1.2**	**2**	**3**	**4**	**5**	**6.1**	**6.2**	**7.1**	**7**
Number of relevés	*71*	*131*	*92*	*1375*	*157*	*68*	*144*	*147*	*51*	*10*
Cyperus margaritaceus							1			20
Asparagus nelsii							6			60
Hermannia eenii										10
Tephrosia dregeana							2	3	25	40
Talinum arnotii							3		2	40
Cleome rubella							3	1		20
Dicoma schinzii							3		4	60
Lantana angolensis							0	1		10
Solanum delagoense							0	3		10
Acrotome inflata							3		2	20
Psydrax livida							1			20
Species group 91										
Ochna pulchra							0		4	30
Bauhinia petersiana							0		19	20
Aristida stipoides							15		6	40
Combretum engleri									8	10
Combretum collinum				6			1		10	60
Species group 92										
Rhus tenuinervis							3	1	20	50
Species group 93										
Rhigozum brevispinosum							4	19	73	10
Urochloa brachyura				4			6	23	10	10
Species group 94										
Croton gratissimus				1	2		9	22	47	70
Pechuel-Loeshea leubnitziae							17	9	4	30
Schmidtia kalihariensi							13	13	29	60
Acacia erioloba						1	6	1	51	30
Pogonarthria fleckii							14	19	18	10
Species group 95										
Eragrostis trichophora			1	2	62	35	43	13	6	90
Species group 96										
Aristida stipitata				1	3	6	4		2	10
Species group 97										
Mundulea sericea				7			3	12	10	80
Ximenia americana	1			7	9		4	2	4	10
Bulbostylis hispidula				14	39		10		4	10
Terminalia sericea			1	12		5	5	1	47	100
Species group 98										
Gisekia africana			1	8	63		12	1	4	20
Rhynchosia totta				29	23		1	7	2	30
Tribulus terrestris			1	6	61		14	12		20
Species group 99										
Aristida adscensionis			32	24	80	35	16	74	12	10
Sclerocarya birrea		3	23	32	39	28	3	2		10
Species group 100										
Enneapogon cenchroides		6	30	52	97	71	40	61	31	
Commiphora glandulosa		8	1	11	1	0	11	2		20

	Zimbabwe		Rivers	SA Lowv.	N.Soutp	Trans.	Nambia		Sand	
Major vegetation type	**1.1**	**1.2**	**2**	**3**	**4**	**5**	**6.1**	**6.2**	**7.1**	**7**
Number of relevés	***71***	***131***	***92***	***1375***	***157***	***68***	***144***	***147***	***51***	***10***
Species group 101										
Commelina africana		12		19	1		7	1		10
Ziziphus mucronata		7	15	15	1	16	4	8	2	10
Species group 102										
Asparagus species	13	5	1			1	4	20	59	
Evolvulus alsinoides	8	5		34	70		12	6	8	10
Grewia flavescens	7	37	1	14		30	12	4	10	40
Kyphocarpa angustifolia	14	7		43	78	1	9		4	
Species group 103										
Colophospermum mopane	69	20	55	58	91	75	67	61	45	80
Grewia bicolor	40	11		59	84		23	40	39	30
Commiphora africana	9	4		22	9	13	7	6	29	10
Species group 104										
Acacia tortilis	20	22	10	10	20	6	10	3	4	
Panicum maximum	26	72	36	68	19	21	5		14	
Tragus berteronianus	68	5	2	50	79	43	21	15	2	20
Dichrostachys cinerea	25	29	22	52	53	57	19	41	71	10
Sida ovata	16	9					9	1	18	

CHAPTER 5

RESULTS

PHYTOSOCIOLOGY OF THE COMPLETE DATA SET

5.1 Introduction

As already mentioned, the vegetation of all available, adequate and compatible phytosociological data in the Mopaneveld of southern Africa were classified using basic phytosociological procedures (Chapter 4). The major aim of this classification was to identify major vegetation units within the Mopaneveld. These major vegetation units are referred to as vegetation types. For the purpose of this study, a vegetation type is defined as a vegetation unit of high rank in the Mopaneveld of southern Africa. Since Mopaneveld vegetation is suggested to be a vegetation class (Winterbach 1998), a vegetation type within Mopaneveld probably represents a vegetation order. If TWINSPAN distinctly separated a vegetation type into vegetation units, these vegetation units are termed major plant communities. A major plant community within the Mopaneveld therefore represents vegetation on a level lower than vegetation type, probably an alliance.

5.2 Classification hierarchy

A dendrogram was constructed to indicate the hierarchical levels into which TWINSPAN separated the zonal Mopaneveld vegetation (Figure 12). Possible determinants for the separations within the data set include annual rainfall and geology, as indicated in Figure 12. This dendrogram is presented up to the fourth level of division in the TWINSPAN classification. The first TWINSPAN division separated the semi-arid to arid Mopaneveld communities from Namibia (i.e. Western Mopaneveld) from the higher rainfall Eastern Mopaneveld (Figure 12). The second division within the Eastern Mopaneveld, separated communities of the semi-arid and degraded areas from the higher rainfall South African Lowveld Mopaneveld, the riverbank Mopaneveld and the Zimbabwean Mopaneveld.

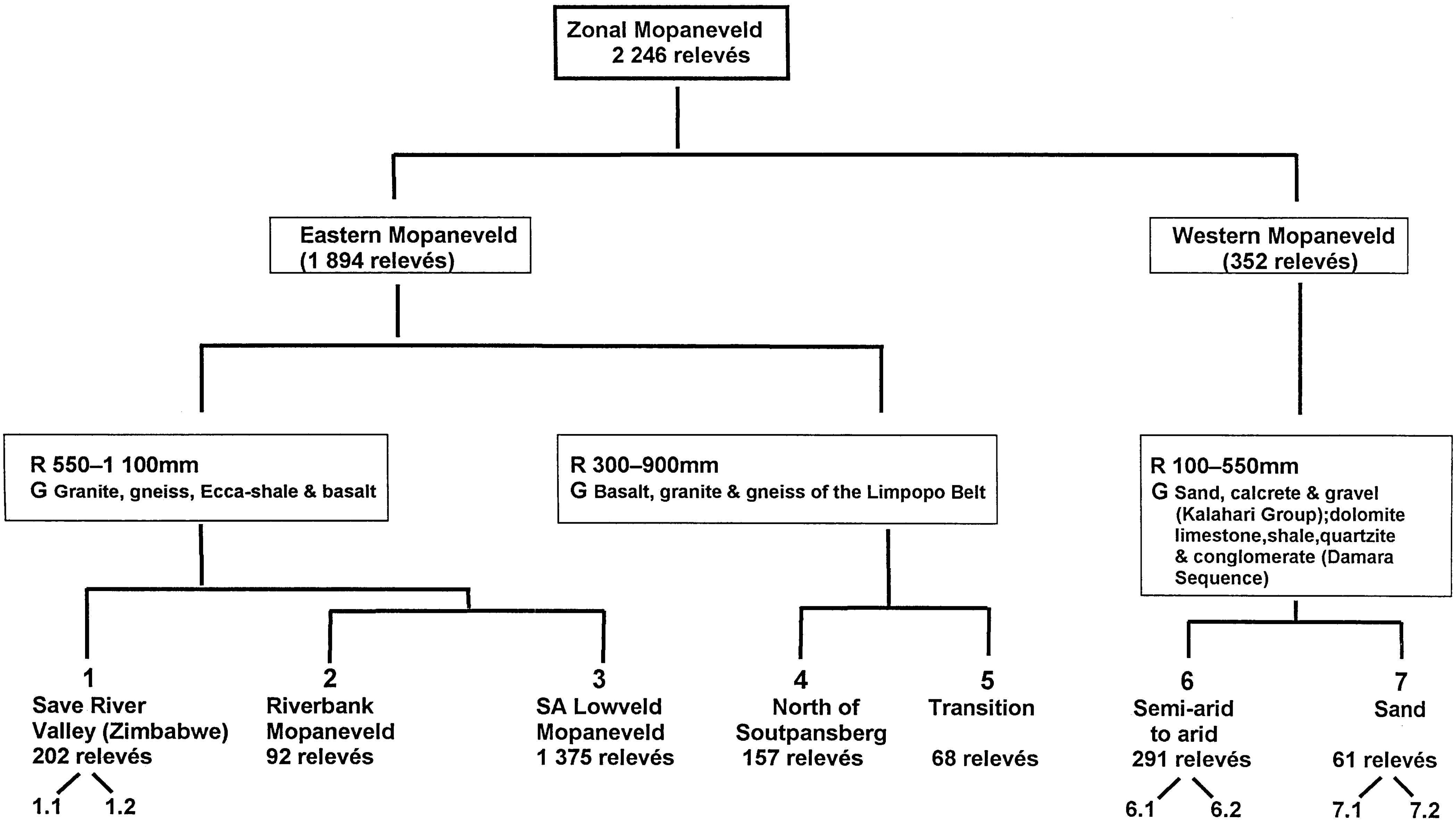


Figure 12 Dendrogram presenting TWINSPAN hierarchy (R=annual rainfall; G= Major rocks)

In the Western Mopaneveld, communities occurring on sandy soils were separated from the semi-arid to arid Mopaneveld on the second level of division (Figure 12). The third level of division within the Eastern Mopaneveld revealed the separation of the Zimbabwean Mopaneveld from the rest of the communities (i.e. riverbank Mopaneveld as well as South African Lowveld Mopaneveld). TWINSPAN also separated the semi-arid Mopaneveld north of the Soutpansberg in South Africa from those communities, which probably represent a transition between the Eastern- and the Western Mopaneveld. The third level of division in the Eastern Mopaneveld and the second level of division in the Western Mopaneveld therefore revealed in the identification of seven different vegetation units, regarded as vegetation types for the purpose of this study (Figure 12). On the fourth level of division, the Mopaneveld in the Save River Valley in Zimbabwe was subdivided into two major plant communities. Likewise did TWINSPAN separate the semi-arid to arid harsh Mopaneveld (6.1 & 6.2) and the Mopaneveld on sandy soils (7.1 & 7.2) in the Western Mopaneveld (Figure 12).

Application of TWINSPAN (Hill 1979a) to the data set, which comprises fifteen pre-selected studies containing Mopaneveld vegetation (Table 2), therefore resulted in the identification of 7 vegetation types and 6 major plant communities. They include the following:

1 *Digitaria milanjiana – Colophospermum mopane* vegetation type
  1.1 *Justicia flava – Colophospermum mopane* major plant community
  1.2 *Setaria sphacelata – Colophospermum mopane* major plant community
2 *Croton megalobotrys – Colophospermum mopane* vegetation type
3 *Cissus cornifolia – Colophospermum mopane* vegetation type
4 *Ptycholobium contortum – Colophospermum mopane* vegetation type
5 *Enneapogon scoparius – Colophospermum mopane* vegetation type
6 *Boscia foetida – Colophospermum mopane* vegetation type
  6.1 *Eragrostis viscosa – Colophospermum mopane* major plant community
  6.2 *Leucosphaera bainesii – Colophospermum mopane* major plant community
7 *Bauhinia petersiana – Colophospermum mopane* vegetation type
  7.1 *Lonchocarpus nelsii – Colophospermum mopane* major plant community
  7.2 *Asparagus nelsii – Colophospermum mopane* major plant community

5.3 Description of the major vegetation units

Mopaneveld is characterised mainly by the constant presence, mostly with high abundance values, of *Colophospermum mopane*, *Dichrostachys cinerea*, *Tragus berteronianus*, *Grewia bicolor* and *Commiphora africana* (species group DD, Table 5). Character species of the Commiphoro mollis – Colophospermetea mopani, a suggested vegetation class in the Central Savanna Biome, South Africa (Winterbach 1998), include woody species such as *Colophospermum mopane*, *Combretum mossambicense*, *Boscia albitrunca*, *Acacia senegal*, *A. nigrescens*, *A. erubescens*, *Terminalia prunioides*, *Grewia bicolor* and *Kirkia acuminata* (Winterbach 1998). Since the study of Winterbach (1998) was restricted to the South African Mopaneveld North of the Soutpansberg, it was however expected that some of these species would lose their character status over the entire distribution area of Mopaneveld. Classification results of the expanded view of Mopaneveld vegetation (Table 5) indicate that, of the character species listed by Winterbach (1998), only *C. mopane* and *G. bicolor* (species group DD, Table 5) remained constantly present over the somewhat broader view of Mopaneveld vegetation.

Since *C. mopane* determines to a large extent the distribution of Mopaneveld vegetation, it is evident that it is a character species in the Mopaneveld of southern Africa. Although it is difficult to comment on the character status of *Grewia bicolor*, it is apparent that this species generally follows the distribution of *Colophospermum mopane*. In the description of *G. bicolor* by Van Wyk & Van Wyk (1997) its association with *C. mopane* is also noted. The distribution of *Kirkia acuminata* and *Acacia erubescens* (species group H, Table 5) seems to be narrower in the expanded view of Mopaneveld vegetation. Although *Combretum mossambicense* occurs along the East (moist)-West (arid) gradient, it is profoundly found in the Mopaneveld north of the Soutpansberg (South Africa) and in the South African Lowveld (species group I, Table 5). *Boscia albitrunca* (species group V) and *Acacia senegal* (species group P) are mainly confined to semi–arid to arid areas, whereas *Acacia nigrescens*, when associated with *Colophospermum mopane*, is profoundly found in the eastern, semi-moist regions (species group L).

A discussion on the seven identified vegetation types within Mopaneveld, southern Africa, follows as an amplification of the suggested Commiphoro mollis – Colophospermetea mopani (Winterbach 1998) of the Central Savanna Biome, South Africa. Table 5 is a reference to all species groups in this section. Data set numbers in brackets refer to those listed in Table 2.

1. *Digitaria milanjiana – Colophospermum mopane* vegetation type (Data set 7)

The *Digitaria milanjiana - Colophospermum mopane* vegetation type is situated in the Sango Ranch, Zimbabwe. A classification and description of this vegetation type was prepared by Hin (2000).

Sango Ranch is situated in the Save Valley Conservancy, Masvingo Province in the southeastern Lowveld of Zimbabwe. It stretches from southern latitudes 20° 10' and 20° 23' and eastern longitudes 32° 00' and 32° 20' covering an area of 443,48 km^2. Mean annual rainfall for Sango Ranch is 526.5 mm between 400 m and 800 m above sealevel (Hin 2000). The major geological material underlying Sango Ranch includes alluvium, granite and gneiss (Hin 2000).

The study of Hin (2000) revealed nine different plant communities in the Sango Ranch, Save Valley Conservancy. Four of the nine communities relate either azonal vegetation and were therefore omitted from the data set during the first step of classification (Chapter 4), or they are interspersed in the *Croton megalobotrys – Colophospermum mopane* vegetation type (type 2). The remaining five plant communities (communities 1 to 5, Hin 2000) represent the *Digitaria milanjiana - Colophospermum mopane* vegetation type.

TWINSPAN markedly separated the vegetation of the Zimbabwean Save River Valley from the riverbank Mopaneveld, the southern Mopaneveld of the Limpopo River Valley in South Africa, and western Mopaneveld of the Cunene River Valley in Namibia (Table 5).

Diagnostic species for the *Digitaria milanjiana – Colophospermum mopane* vegetation type are listed in species group A, Table 5. High frequency values in species group B and C resulted in the expression of two major plant communities within the *Digitaria milanjiana – Colophospermum mopane* vegetation type, namely the *Justicia flava – Colophospermum mopane* major plant community (1.1), and the *Setaria sphacelata – Colophospermum mopane* major plant community (1.2).

1.1 *Justicia flava – Colophospermum mopane* major plant community

Vegetation representing the *Justicia flava – Colophospermum mopane* major community is confined to the valleys and depressions, typically found in the Sango Ranch Conservancy, Zimbabwe. These low-lying areas are covered with sandy outwash and clayey midslope soils derived from alluvium, gneiss, lava, shale, quartzite and limestone. The soil surface in this major community contains no rock cover (Hin 2000).

Individuals of *Colophospermum mopane* (species group DD) reach heights of 16–20 m on deep alluvial soils. Herbaceous species in these mopane woodlands are in general sparse, but grass species such as *Sporobolus nitens*, *Enteropogon monostachys* (species group B), *Eragrostis rigidior* (species group G), *Urochloa mosambicensis* (species group J) and *Panicum maximum* (species group Y) are prominently present. Hin (2000) noted that the two plant communities, which express the *Justicia flava - Colophospermum mopane* major plant community, are overutilised resulting in high percentage cover of annual species such as *Aristida junciformis* (species group B) and *Tragus berteronianus* (species group DD). Conspicuous woody species in this major plant community other than *C. mopane* include *Zanthoxylum capense*, *Boscia mossambicensis* (species group B), *Grewia monticola*, *Maerua parvifolia* (specis group J) *Acacia tortilis* (species group Y) and *Dichrostachys cinerea* (species group DD).

1.2 *Setaria sphacelata – Colophospermum mopane* major plant community

This closed woodland to thicket, varying from short to tall, is found on broken and rocky terrain with scattered castle koppies and inselbergs (Hin 2000). Soils are in general shallow, coarsely grained, leached and sandy, derived from gneiss, granite and conglomerate (Hin 2000). This major community is often associated with overutilised, trampled areas.

Diagnostic species for the *Setaria spacelata - Colophospermum mopane* major plant community are listed in species group C. The perennial grass *Setaria sphacelata* (species group C) tolerates a wide range of habitat types, which include riverine habitats as well as rocky midslopes (Van Oudtshoorn 1994). Species composition for this rocky hill community is controversial as several diagnostic species are indicative of riverine habitats, e.g. the shrub *Phyllanthus reticulatus* (species group C) (Van Wyk & Van Wyk 1997). Bredenkamp & Deutschländer (1995) mentioned the floristic relationship between vegetation of rocky hills and rivers from arid Lowveld vegetation in South Africa, Savanna Biome, which implies that both rocky hills and river banks should be considered as relatively moist habitats.

In general the *Setaria sphacelata - Colophospermum mopane* major plant community is associated with the well-known *Combretum apiculatum - Colophospermum mopane* combination in the Mopaneveld. The frequency of *C. mopane* (species group DD) is markedly lower in this major community due to the habitat, which favours *Combretum apiculatum* (species group R). *C. apiculatum* is the most conspicuous woody species of this major community in association with *Grewia monticola*, *Lannea schweinfurthii* (species group J), *Acacia nigrescens* (species group L), *Dichrostachys cinerea* and *Grewia flavescens* (species group DD). *Kirkia acuminata* (species group H) is associated with the steep, shallow side slopes of the inselbergs. The grass species *Setaria sphacelata* (species group C), *Eragristis rigidior* (species group G), *Urochloa mosambicensis*, *Setaria sagittifolia* (species group J) and *Panicum maximum* (species group Y) are important contributions to the herbaceous component of the *Setaria sphacelata - Colophospermum mopane* major plant community.

2. *Croton megalobotrys – Colophospermum mopane* vegetation type (Data sets 1, 3, 4, 6, 7, 11 & 14)

Figure 13

Data sets from which this vegetation type was identified cover mainly the Mopaneveld along the Olifants-, Save- and Limpopo Rivers.

The *Croton megalobotrys – Colophospermum mopane* vegetation type represents floodplain and upper riverbank vegetation of the Eastern Mopaneveld. A variety of woody plant species indicative of floodplains and riverbanks, characterise this community of which *Croton* *megalobotrys*, *Ficus sycomorus*, *Hyphaene coriaceae*, *Phoenix reclinata*, *Spirostachys africana* (species group D) and *Lonchocarpus capassa* (species group J) are abundant. Grass species adapted to wet conditions, such as *Sporobolus fimbriatus* (species group D) contribute to the characterisation of this vegetation type. Other conspicuous grass species include *Panicum deustum* (species group D), *Cymbopogon plurinodis* (species group F), *Cenchrus ciliaris*, *Enneapogon scoparius* (species group Q), *Enneapogon cenchroides*, *Eragrostis lehmanniana* (species group X), *Panicum maximum* (species group Y) and *Aristida adscensionis* (species group CC).

Although *Colophospermum mopane* is known to grow on a wide variety of soils, including "wet" soils of alluvial origin (Van Rooyen 1978; Biggs 1979; O'Connor & Campbell 1986), the high abundance of *Colophospermum mopane* (species group DD) in this community is controversial. This vegetation type however does not represent typical azonal vegetation since those relevés were omitted from the data set (Chapter 4). High frequency values of other terrestrial plant species such as *Combretum hereroense*, *Euclea divinorum* (species group F), *Acacia nigrescens*, *Acacia gerrardii* (species group L), *Combretum imberbe* (species group Q), *Combretum apiculatum* (species group R), *Terminalia prunioides* (species group X), *Sclerocarya birrea* (species group CC) *Colophospermum mopane* and *Dichrostachys cinerea* (species group DD) express its inland, terrestrial affinity.

The *Croton megalobotrys - Colophsopermum mopane* vegetation type may therefore probably represent an intrazonal vegetation zone between terrestrial and riparian vegetation (also apparent from the ordination, Figure 19 and discussion in Chapter 8).

Figure 13 The *Croton megalobotrys* - *Colophospermum mopane* vegetation type.

Figure 14 The *Cissus cornifolia* - *Colophospermum mopane* vegetation type (Mopane Bushveld).

3. *Cissus cornifolia – Colophospermum mopane* vegetation type (Data sets 1, 3, 5, 6, 8, 11, 13 & 14)

Figures 2 & 14

A large number of relevés (1 375) were classified under the *Cissus cornifolia – Colophospermum mopane* vegetation type, profoundly found in the South African Lowveld Mopaneveld. Data sets from which this vegetation type was derived are mainly from the Kruger National Park and the adjacent Hoedspruit-Klaserie-Timbavati-Umbabat Nature Reserves. It is bordered by the Limpopo River in the north and in the south by the most southern distribution limit of *Colophospermum mopane* in South Africa as identified by Gertenbach (1987) (approximately 24°21'32'' latitude). The *Cissus cornifolia – Colophospermum mopane* vegetation type receives above 400 mm rainfall annually on an altitude varying between 200 m along the floodplains and 500 m on undulating landscapes (Gertenbach 1983).

This vegetation type covers approximately 20 000 km^2. The majority of the area is protected as National Parks and Nature Reserves.

The *Cissus cornifolia - Colophospermum mopane* vegetation type is characterised by species group E, Table 5. Diagnostic woody species include *Dalbergia melanoxylon*, *Clerodendrum ternatum* and *Acacia exuvialis* (species group E). Other than *C. mopane*, species such as *Combretum hereroense* (species group F), *Maerua parvifolia*, *Lannea schweinfurthii* (species group J), *Acacia nigrescens*, *Albizia harveyi* (species group L), *Combretum apiculatum* (species group R), *Sclerocarya birrea* (species group CC), *Dichrostachys cinerea*, *Grewia bicolor* and *Commiphora africana* (species group DD) are the most common woody species. Many forbs species are diagnostic for this vegetation type of which *Cissus* cornifolia, *Tephrosia polystachya*, *Corchorus asplenifolius*, *Melhania forbesii* and *Walteria indica* (species group E) are the most conspicuous. Important grass species are, amongst others, *Eragrostis rigidior* (species group G), *Urochloa mosambicensis* (species group J), *Eragrostis superba* (species group L), *Schmidtia pappophoroides*, *Brachiaria deflexa* (species group W), *Enneapogon cenchroides* (species group X) and *Panicum maximum* (species group Y).

Differentiation in geological parent material is responsible for the distinct physiognomical variance that is characteristic of the South African Lowveld Mopaneveld: Mopane Shrubveld and Mopane Bushveld (Low & Rebelo 1996, types 9 & 10). Mopane Shrubveld occurs on flat plains of vertic or near-vertic clays derived mainly from igneous gabbro and basalt (Fraser *et al.* 1987). Vegetation of the shrubveld type is generally dominated by a stunted and multi-stemmed shrubby growth of *Colophospermum mopane* (Figure 2c). In contrast with Mopane Shrubveld, Mopane Bushveld is characterised by a fairly dense growth of *Colophospermum mopane* trees occuring on undulating landscapes derived from basalt, shale, solonetzes and coarse sandy soils derived from granite (Figure 2a & 14) (Fraser *et al.* 1987; Van Rooyen & Bredenkamp 1998).

Most of the relevés representing this vegetation type are from phytosociological studies from the Kruger National Park (e.g. data sets 3, 5, 6 & 14, Table 2). TWINSPAN did not clearly separate the *Cissus cornifolia – Colophospermum mopane* vegetation type into major plant communities during classification of the entire data set. A study on the Lowveld Mopaneveld however revealed the identification of four major plant communities within the *Cissus cornifolia – Colophospermum mopane* vegetation type (Chapter 6). These four distinct plant communities cover approximately 7 250 km^2 of the southern African Mopaneveld (Gertenbach 1987) and represent Broad–sclerophyll arid bushveld (Werger & Coetzee 1978).

A brief discussion on the four major communities follows. A more detailed description of the four major communities appears in Chapter 6.

1) The *Colophospermum mopane* communities on sandy soils

The Punda Maria-Pafuri-Wambiya Sandveld (PPW) in the northern section of the Kruger National Park, South Africa, forms a distinct vegetation unit, as indicated by Van Rooyen (1978). However, Acocks (1988) included this area in the Mopani Veld veld type, although it is evident that the PPW Sandveld does not represent true Mopaneveld vegetation. Patches of *Colophospermum mopane*-dominated communities however interrupt the PPW Sandveld (Figure 20). These patches of Mopaneveld, identified as the *Terminalia sericea – Colophospermum mopane* major plant community, represent the first of four major communities within the Lowveld Mopaneveld. It is speculated that the PPW Sandveld, and probably other Sandveld areas in the Savanna Biome, represents a separate vegetation class whereas the *Terminalia* *sericea* – *Colophospermum mopane* major community represents a transition between two vegetation classes (Chapter 6).

The *Terminalia sericea* – *Colophospermum mopane* major plant community of the Punda Maria-Pafuri-Wambiya Sandveld area is confined to deep, sandy clay loam to clayey soils derived from alluvium, shale, basalt, andesite and the Malvernia Formation on undulating plains (Van Rooyen 1981b). Species specifically associated with deep, sandy, leached soils, characterise this major community of which *Combretum zeyheri*, *C. collinum*, *Terminalia sericea*, *Mundulea sericea*, *Pteleopsis myrtifolia*, *Guibourtia conjugata*, *Pseudolachnostylis maprouneifolia* (species group A, Table 6), *Diplorhynchus condylocarpon* (species group S, Table 7) and *Afzelia quanzensis* (species group T, Table 7) are some of the prominent trees.

2) The *Colophospermum mopane* communities on clayey soils

The second major community within the *Cissus cornifolia* – *Colophospermum mopane* is identified as the *Acacia nigrescens* – *Colophospermum mopane*, a stunted community spreading over Lowveld bottomlands on heavy clays derived mainly from igneous basalt and gabbro. On these gabbroic vertic clays south of the Olifants River in the Kruger National Park, South Africa, *C. mopane* reaches its southern-most distribution in South Africa (Gertenbach 1987). Shrubmopaneveld is most renowned in the northeastern Kruger National Park on the bottomlands of the Lebombo Mountains. These extensive mopane bushes are confined to fine–textured vertic clays derived from basalt (Fraser *et al.* 1987) as well as clays from the Malvernia Formation (Van Rooyen 1978). Prominent woody species (e.g. *Colophospermum mopane*, *Maytenus heterophylla*, and *Dalbergia melanoxylon*) within these communities are suppressed to a height of 3 m to a maximum of 6 m (Van Rooyen 1978).

3) *Colophospermum mopane* communities on shale

Loamy sand to clayey soils derived from shale of the Ecca Group create habitat for a tall Mopane woodland in which the tallest individuals reach up to 22 m (Van Rooyen 1981c). In the synthesis of the *Cissus cornifolia* – *Colophospermum mopane* vegetation type, this vegetation unit was identified as the *Euclea divinorum* – *Colophospermum mopane* major community. Diagnostic species for this major plant community are listed in species group D (Table 6).

4) *Colophospermum mopane* communities on granite and gneiss

On slightly undulating granitic landscapes, *Combretum apiculatum*-dominated vegetation (in association with trees such as *Terminalia sericea*, *Combretum zeyheri* and *Strychnos madagascariensis*) is confined to the summits on coarse, well-drained soils, while *Colophospermum mopane*–dominated vegetation occurs in the depressions on fine-textured and poorly-drained clays (Fraser *et al.* 1987; Gertenbach 1987). This simultaneous occurrence of two vegetation types is identified as the *Combretum apiculatum* – *Colophospermum mopane* major community within the *Cissus cornifolia* – *Colophospermum mopane* vegetation type.

4. *Ptycholobium contortum* – *Colophospermum mopane* vegetation type (Data sets 1, 2, 3 & 15)

Figure 15

This vegetation type is confined to the Mopaneveld north of the Soutpansberg in the Limpopo River Valley, South Africa. The vegetation of the Messina Experimental Farm (Dekker & Van Rooyen 1995, Data set 2) mostly represents this vegetation type. The *Ptycholobium contortum* – *Colophospermum mopane* vegetation type stretches from 28°40'–30°40'E and 22°07'– 22°52'S (300–780 m altitude) and covers an area of 2 037 km^2 (Louw 1970). The geology of this area forms mosaic formations of metamorphic types belonging to the Archaean complex (Louw 1970). This vegetation type is characterised by species group H (Table 5).

Several *Commiphora* species are known to be diagnostic for the Mopaneveld north of the Soutpansberg (Louw 1970) of which *Commiphora tenuipetiolata*, *C. edulis* (species group H), *C. mollis* (species group I) and *C. africana* (species group DD) are abundant. Another characteristic feature of this community is the scattered stands of *Adansonia digitata* (species group H) (Figure 15) on sandy, undulating plains derived from granite and gneiss (Dekker & Van Rooyen 1995).

The *Ptycholobium contortum* – *Colophospermum mopane* vegetation type is floristically related to the *Cissus cornifolia* – *Colophospermum mopane* vegetation type as indicated by species group I.

5. *Enneapogon scoparius – Colophospermum mopane* vegetation type (Data sets 1 & 8)

Figure 16

The distribution of the *Enneapogon scoparius – Colophospermum mopane* vegetation type is uncertain. No specific set of habitat conditions could support the separation in TWINSPAN. Its existence can however be explained by the following:

1) Vegetation data, which contributed to the identification of this vegetation type, were sampled from degraded areas. According to Beck (1998) some of the areas were overutilised by animals or used for training by the defense force (SANDF) and also served as dumping sites during vegetation surveying. Other areas were sampled during dry periods of sustained droughty conditions. The degraded patches are, however interrupted by more pristine areas, which cause the presence of climax, as well as pioneer species in the vegetation type (e.g. pioneer grass species, such as *Enneapogon scoparius*, species group Q Table 5; *E. cenchroides*, species group X; climax grass species, such as *Digitaria eriantha*, species group X; *Panicum maximum*, species group Y).

2) As this vegetation type is defined from sample plots mostly located in the moister Eastern Mopaneveld (Data sets 1 & 8, Table 2), it is expected that many plant species should indicate affinity to these regions. Species group L, and to a lesser degree species group F confirm this relation. The presence of species group V, and to a lesser degree species group W also indicates some affinity to the drier western regions in Namibia. This may indicate that degradation is an event that changes the more mesic vegetation via the proposed State-and-Transition model (Westoby *et al.* 1989) to show similarities to vegetation of much drier areas. It can therefore be postulated that degradation of moist Mopaneveld will change the vegetation composition to reflect properties of the climax vegetation composition of drier Mopaneveld (Chapter 7).

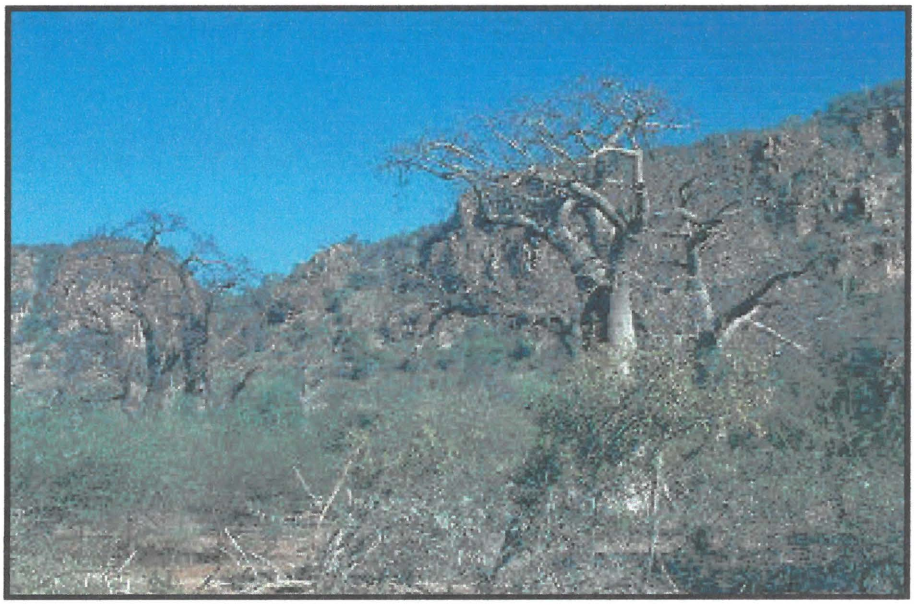


Figure 15 Scattered individuals of *Adansonia digitata* in the *Ptycholobium contortum - Colophospermum mopane* vegetation type.

Figure 16 Bare soil under mopane shrubs in the *Enneapogon scoparius - Colophospermum mopane* vegetation type.

6. *Boscia foetida – Colophospermum mopane* vegetation type

This vegetation type represents the semi–arid to arid Mopaneveld of Namibia (<100 mm up to 500 mm rainfall annually). The *Boscia foetida – Colophospermum mopane* vegetation type occurs on altitudes between 1 000 m and 1 500 m above sea level (Van der Merwe 1983). It is strongly associated with harsh environments on mainly shallow sand, gravel and calcrete of the Kalahari Group and dolomites, limestone, shale, quartzite and conglomerate of the Damara sequence. The *Boscia foetida - Colophospermum mopane* vegetation type occurs from Etosha National Park in the south to the Kunene River in Kaokoland in the north, excluding deep sandy soils on which the *Bauhinia peresiana - Colophospermum mopane* vegetation type (vegetation type 7) is confined.

The *Boscia foetida - Colophospermum mopane* vegetation type is characterised by species group M. The conspicuous tree *Boscia foetida*, also known for its association with arid environments, is diagnostic for this community. Prominent woody species for this vegetation type, other than *Colophospermum mopane*, include *Boscia albitrunca* (species group V), *Terminalia prunioides* (species group X) and *Grewia bicolor* (species group DD). Grass species such as *Stipagrostis uniplumis* (species group V), *Enneapogon cenchroides* (species group X), *Pogonarthria fleckii* (species group BB) and *Eragrostis trichopora* (species group CC) are of the most common contributors to the herbaceous layer.

Two major communities were recognised within the *Boscia foetida – Colophospermum mopane* vegetation type.

6.1 *Eragrostis viscosa – Colophospermum mopane* major plant community (Data sets 3, 4, 8, 9, 10, 12 & 15)

Figure 17

Although this community is characterised only by three species (species group N), it comprises elements of extreme habitats. The semi–arid Mopaneveld north of the Soutpansberg (South Africa), the Cuvelai Delta on aeolian sands of the Kalahari Group as well as the arid Koakoland are represented in the *Eragrostis viscosa – Colophospermum mopane* major community. Shallow soils with a moderately clay content as well as moderate sandy soils overlying calcrete characterise this major community. Vegetation data of the Honnet Nature Reserve, north of the Soutpansberg, South Africa (Visser *et al.* 1996) is however stronger related to this major community than to the *Ptycholobium contortum – Colophospermum mopane* vegetation type. This result can be ascribed to the extreme droughty conditions under which data were sampled, which consequently supports speculations on Mopaneveld being an event–driven system (Chapter 7). The diagnostic grass species, *Eragrostis viscosa* (species group N, Table 5) is known to be associated with Mopaneveld (Van Oudtshoorn 1999). Species of significant value include grasses such as *Stipagrostis uniplumis* (species group V), *Schmidtia pappophoroides* (species group W), *Enneapogon cenchroides*, *Eragrostis lehmanniana* (species group X) and *Eragrostis trichophora* (species group CC) and trees such as *Boscia albitrunca* (species group V), *Terminalia prunioides* (species group X), *Colophospermum mopane* and *Grewia bicolor* (species group DD).

6.2 *Leucosphaera bainesii – Colophospermum mopane* major plant community (Data sets 9 & 10)

Figures 6 & 18

This major community is prevalently found in the Etosha National Park, Namibia. This mixed dry deciduous tree savanna and grassland occurs on calcareous ridges and plains of the Kalahari Group. *Leucosphaera bainesii*, a prominent diagnostic species of this community (species group O, Table 5) is known to be associated with calcareous soils. *Colophospermum mopane* individuals on these sodium rich soils are usually only 2–6 m tall with a very poor–developed herbaceous layer (Le Roux 1980; Timberlake 1995). Calcareous habitats are known to produce high species diversity in southern Africa. This phenomenon can be supported in the number of diagnostic species listed in species group O, Table 5. The most significant species include grasses such as *Enneapogon desvauxii*, *Eragrostis nindensis*, *E. echinochloidea* (species group O), *Cenchrus ciliaris* (species group Q), *Anthephora pubescens* (species group U), *Stipagrostis uniplumis* (species group V), *Enneapogon cenchroides* (species group X), *Urochloa brachyura* (species group AA) and *Aristida adscensionis* (species group CC) and trees such as *Combretum* *apiculatum* (species group R), *Catophractes alexandri*, *Acacia reficiens* (species group U), *Boscia albitrunca*, *Commiphora pyracanthoides* (species group V), *Rhigozum brevispinosum* (species group AA), *Colophospermum mopane*, *Dichrostcahys cinerea* and *Grewia bicolor* (species group DD). Prominent forb species include *Leucosphaera bainesii*, *Monelytrum luederitziana*, *Hibiscua caesius*, *Chascanum pinnatifidum* (species group O), *Montinia caryophyllaceae*, *Otoptera burchellii*, *Helinis integrifolius* (species group U) and *Monechma divaricatum* (species group V).

7. *Bauhinia petersiana– Colophospermum mopane* vegetation type

This vegetation type is confined to deep Kalahari-type sands mainly of aeolian origin. The *Bauhinia petersiana – Colophospermum mopane* sandy dry bushveld is best represented in the Etosha National Park (Namibia) on the sandveld areas. Diagnostic species for this major community are listed in species group S. Although *C. mopane* is often associated with heavier, clayey soils in slightly higher rainfall conditions, it is well represented within this vegetation type (species group DD, Table 5). A few odd relevés from Kaokoland, northern Botswana and Zimbabwe are also present in this community, probably due to the sandy soils they occur on. Two communities within the *Bauhinia petersiana – Colophospermum mopane* vegetation type are distinguished. These communities represent dry mopane woodland on deep, sandy soils or mopane shrubveld on shallower sand overlying calcrete (7.1), and moister mopane woodland on deep sandy soils (7.2).

7.1 *Lonchocarpus nelsii – Colophospermum mopane* major plant community (Data sets 4, 7 & 9)

This community represents vegetation associated with Kalahari-type sands of aeolian origin mainly within the arid Namibian Mopaneveld (annual rainfall varying between 200 mm and 350 mm). Several species indicative to soils containing a high sandy content characterise this community. Among them are *Lonchocarpus nelsii*, *Acanthosicyos naudinianus*, *Requienia sphaerosperma* and *Harpagophytum procumbens* (species group T). Habitats representing this community include the Kowares sandy mopane shrubveld (Kaokoland section of the Etosha National Park) and Sandveld areas of the Etosha National park producing sandy shrub

Mopaneveld, often overlying calcrete (Le Roux 1980). The *Lonchocarpus nelsii – Colophospermum mopane* major plant community is related to the *Leucosphaera bainesii – Colophospermum mopane* major community probably due to the calcareous component within both. Conspicuous woody species in the *Lonchocarpus nelsii - Colophospermum mopane* major plant community include *Acacia fleckii*, *Lonchocarpus nelsii*, *Elephantorrhiza suffruticosa* (species group T), *Acacia reficiens*, *A. mellifera*, *Grewia retinervis* (species group U), *Boscia albitrunca*, *Grewia flava*, *Commiphora pyracanthoides* (species group V), *Terminalia prunioides* (specis group X), *Rhigozum brevispinosum* (species group AA), *Acacia erioloba* (species group BB), *Colophospospermum mopane*, *Dichrostachys cinerea*, *Grewia bicolor* and *Commiphora africana* (species group DD). *Stipagrostis uniplumis* (species group V) and *Eragrostis lehmanniana* (species group X) are important grass species.

7.2 *Asparagus nelsii – Colophospermum mopane* major community (Data sets 10 & 12)

This unique community of only 10 relevés represents the moister northeastern Namibian Mopaneveld, adjacent to the Caprivi (annual rainfall ranging between 500 mm and 650 mm). Diagnostic species are shown in species group Z, Table 5. These Mopane woodlands lie in an area of old river drainage lines which are covered by aeolian sand deposits (Mendelsohn & Roberts 1997). Vegetation associated with the *Asparagus nelsii – Colophospermum mopane* dry early–deciduous savanna woodland include species preferably growing on deep sandy soils, such as *Requienia pseudosphaerosperma*, *Hyphaene petersiana*, *Harpagophytum zeyheri* and *Dichapetalum cymosum* (species group Z). Other important species include the small tree *Mudulea sericea* (species group BB), and the grass *Eragrostis trichophora* (species group CC).

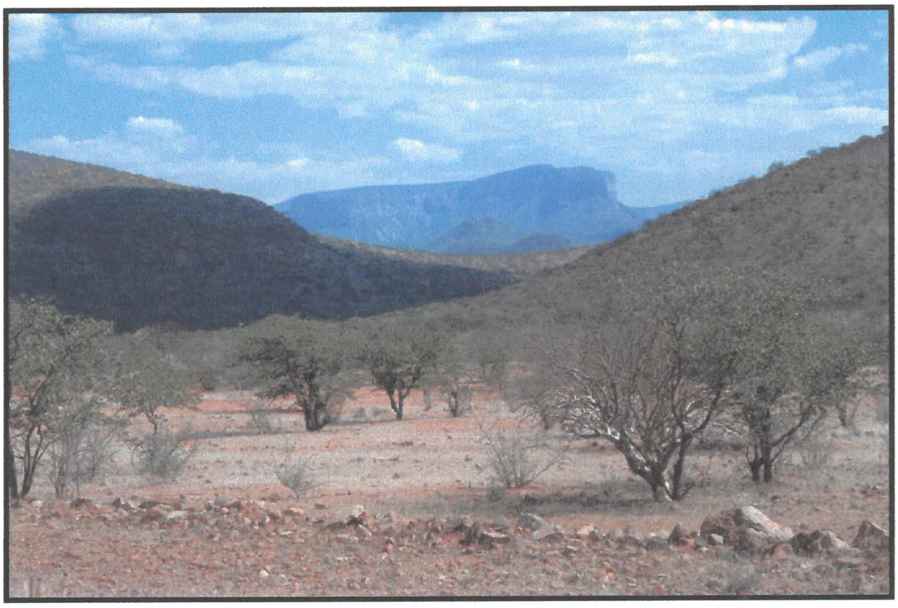


Figure 17 The *Boscia foetida - Colophospermum mopane* is a widespread vegetation type in Namibia. This figure represents the Kaokoland Mopaneveld in this vegetation type.

Figure 18 The *Leucosphaera bainesii - Colophospermum mopane* vegetation type occurs on calcareous soils and is often associated with *Terminalia prunioides* (arrow).

5.4 Ordination

The distribution of the vegetation types and major plant communities along the first and third axes of a Detrended Correspondence Analysis (DECORANA) scatter diagram is presented in Figure 19. The distribution of vegetation types and major plant communities along Axis 1 (Eigenvalue = 0.682) follows a gradient of decreasing soil moisture availability. The far right location of the *Leucosphaera bainesii - Colophospermum mopane* major plant community (6.2) in the scatter diagram can be explained by the high calcrete content of the soil associated with this major plant community. Although the annual rainfall in this community is higher than in the Kaokoland Mopaneveld, which was grouped to the *Eragrostis viscosa - Colophospermum mopane* major plant community (6.1) by TWINSPAN, conditions seem to be harsh in the *Leucosphaera bainesii - Colophospermum mopane* due to soil moisture retention in calcareous soils. It is therefore specualted that, although annual rainfall is a major determinant in the separation of the Eastern Mopaneveld (vegetation types 1,2,3,4 and 5) from the Western Mopaneveld (vegetation types 6 & 7) according to TWINSPAN results (Figure12), vegetation types 6 and 7 are not separated according to annual rainfall, but rather by soil moisture availability. In general vegetation types situated to the left of the diagram are associated with a mean annual rainfall above 600 mm, while vegetation types from the middle of the scatter diagram to the right receive between 150 mm and 500 mm annually. Although not as distinct as was expected, the diagram also supports the sequence of vegetation types along a geographical East-West gradient (Axis 1).

Another environmental factor associated with the distribution of vegetation types along Axis 1 of the DECORANA scatter diagram, is probably a decrease in soil nutrients. Poor, leached, calcareous soils are associated with the *Leucosphaera bainesii - Colophospermum mopane* major plant community (6.2) whilst soils of the Eastern Mopaneveld are more nutrient-rich.

The distribution of vegetation types and major plant communities along Axis 3 (Eigenvalue = 0.324) follows a decrease in soil depth and an increase in rockiness (Figure 19).

From Figure 19, it seems as if the Mopaneveld in the semi-arid areas of South Africa, namely the Mopaneveld north of the Soutpansberg, is to some extent related to the Namibian Mopaneveld.

The uncertainty of the distribution of the *Enneapogon scoparius* – *Colophospermum mopane* vegetation type (vegetation type no. 5) can be explained by its position in the scattered diagram along Axis 1. This vegetation type represents a transition between semi-moist to moist Mopaneveld to the left, and arid Mopaneveld to the right (Figure 19). Due to degradation effects, this vegetation type is not clearly situated in the semi-moist Lowveld Mopaneveld (to the left). The vegetation is driven by degradation towards floristic affinities with semi-arid Mopaneveld north of the Soutpansberg (synrelevés 16, 17 & 18).

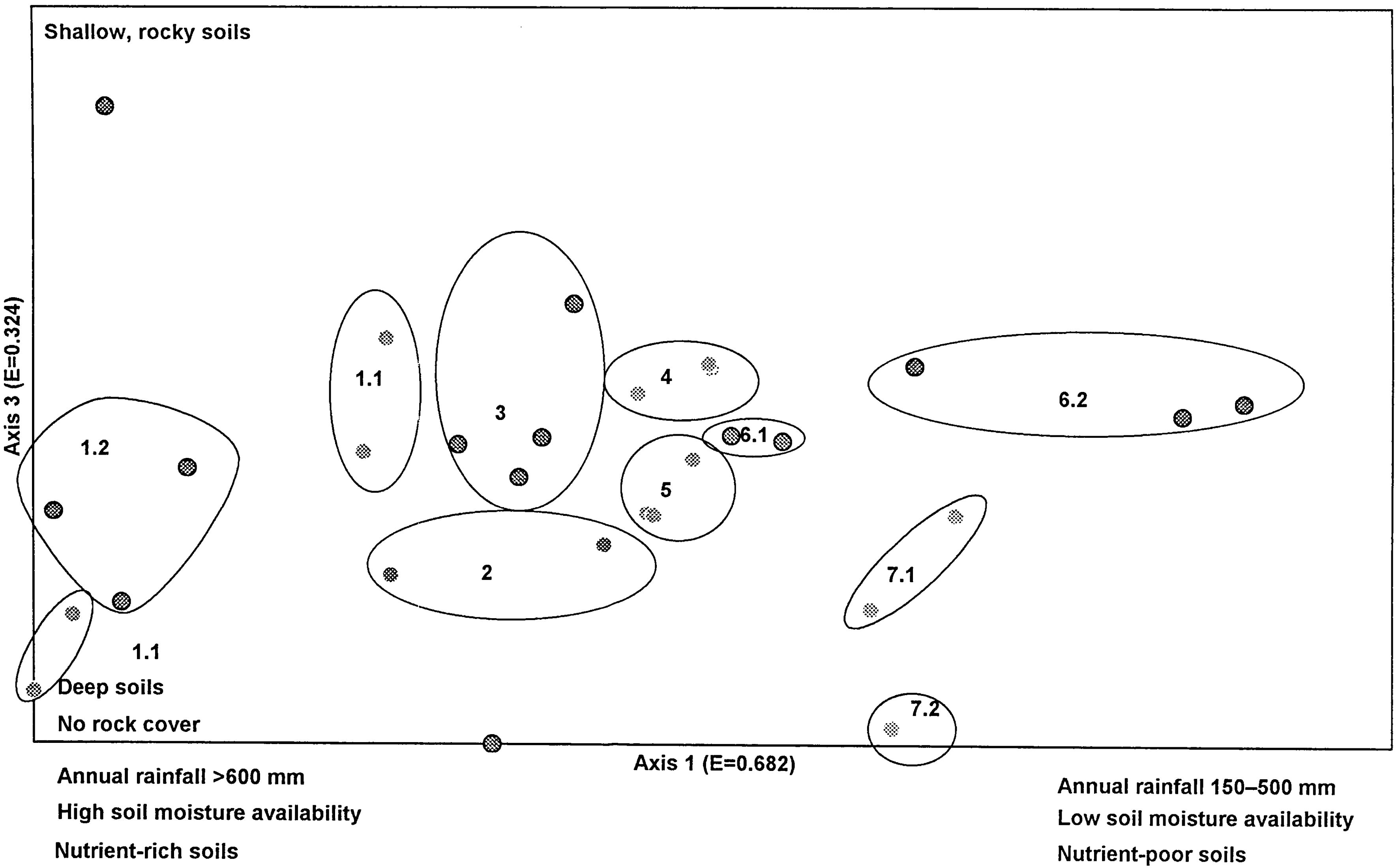


Figure 19 Ordination diagram of axes 1 and 3 illustrating the distribution of Mopaneveld vegetation types along environmental gradients.

Table 5 Synoptic table of the southern African Mopaneveld

	Zimbabwe		Rivers	Lowv.	N.Soutp	Trans.	Semi-arid		Sandy	
Major vegetation type	**1.1**	**1.2**	**2**	**3**	**4**	**5**	**6.1**	**6.2**	**7.1**	**7.2**
Number of relevés	***71***	***131***	***92***	***1375***	***157***	***68***	***144***	***147***	***51***	***10***
Species group A										
Cyathula uncinulata	70	48								
Indigofera varia	45	20	2			1	6	2	2	
Cucumis zeyheri	44	31								
Digitaria milanjiana	44	75					1			
Diospyros quiloensis	35	33								
Dactylocteni giganteum	34	11	1	3						
Abutilon grandiflorum	27	11			1					
Crotalaria species	11	11						4	4	
Species group B										
Justicia flava	61	4	2	10	1		1			
Sporobolus nitens	52	8		10					2	
Oropetium capense	52	1		11	33			13		
Cissus rotundifolia	40	6		1						
Aristida junciformis	34	9					2	1		
Cyperus species	28						1	8	2	
Hemizygia bracteosa	27	8		4						
Thilachium africanum	24	4		1						
Zanthoxylum capense	21	1		1						
Boscia mossambicensis	20	8	1							
Enteropogon monostachys	20	8								
Stylochiton natalensis	18	6		3						
Plectranthus neochilus	18	1								
Plectranthus caninus	14	3								
Dactyloctenium australe	11	2								
Species group C										
Setaria sphacelata	3	24	2	1	1					
Vigna frutescens	1	18								
Cucumis metuliferus	7	17							2	
Phyllanthus reticulatus	3	14	1	1						
Species group D										
Sporobolus fimbriatus			64	7	1	22	1			
Spirostachys africana			40	5		6	1	8		
Croton megalobotrys		1	34							
Ficus sycomorus			21							
Flaveria bidentis			20							
Panicum deustum			20	2		6				
Phragmites australis			19							
Hyphaene coriacea			8		3					
Phoenix reclinata			8							

	Zimbabwe		Rivers	Lowv.	N.Soutp	Trans.	Semi-arid		Sandy	
Major vegetation type	**1.1**	**1.2**	**2**	**3**	**4**	**5**	**6.1**	**6.2**	**7.1**	**7.2**
Number of relevés	***71***	***131***	***92***	***1375***	***157***	***68***	***144***	***147***	***51***	***10***
Species group E										
Cissus cornifolia				54						
Tephrosia polystachya				48			1			
Corchorus asplenifolius				34				2		
Aristida congesta s. congeta			2	32	2		8			
Melhania forbesii	14	8	3	28			4	6	16	
Waltheria indica				28			2			
Solanum panduriforme		5	7	28			10			
Dalbergia melanoxylon		9	1	27						
Clerodendrum ternatum				27			1	7	16	
Acacia exuvialis				25						
Limeum fenestratum				24			2		4	
Ruellia patula				24						
Themeda triandra			4	23						
Indigofera vicioides				22						
Bothriochloa radicans			1	22				12		
Acalypha indica			4	21	1			3		
Flueggea virosa		2	2	20	7		2	9		
Asparagus setaceus				20	1		1			
Lantana rugosa	3	1		20			3			
Chamaecrista mimosoides				19						
Ceratotheca triloba				16			1			
Indigofera rhytidocarpa				16						
Bothriochloa insculpta			2	16	2	1				
Tragia dioica				16						
Endostemon tereticauli				16						
Ormocarpum trichocarpum			1	16						
Cyperus rupestris				15						
Kohautia virgata				15						
Maytenus heterophylla		2		15		1		1		
Vernonia fastigiata				15						
Sesamum alatum				15						
Blepharis integrifolia				14				1		
Talinum caffrum				14			2			
Ipomoea crassipes				14						
Vigna unguiculata				13						
Chamaesyce neopolycnemoides				13			2			
Crabbea velutina				13						
Indigofera bainesii				13					2	
Grewia hexamita				12	1	1	3			
Sida dregei			1	12			1			
Andropogon gayanus				12						
Phyllanthus pentandrus				11				3	6	
Microchloa caffra				11			1			
Hibiscus sidiformis				11						
Polygala sphenoptera			1	11						
Cucumis africanus			3	11			1			
Melhania prostrata				11						
Brachiaria xantholeuca			1	11						
Melhania didyma				10						
Ozoroa engleri				10						

	Zimbabwe		Rivers	Lowv.	N.Soutp	Trans.	Semi-arid		Sandy	
Major vegetation type	**1.1**	**1.2**	**2**	**3**	**4**	**5**	**6.1**	**6.2**	**7.1**	**7.2**
Number of relevés	***71***	***131***	***92***	***1375***	***157***	***68***	***144***	***147***	***51***	***10***
Phyllanthus asperulatus				10						
Perotis patens			1	10						
Crotalaria sphaerocarpa				10			1	1	2	
Species group F										
Combretum hereroense		4	45	21	1	5	5	8		
Euclea divinorum		1	23	18			2	6		
Cymbopogon plurinodis			20	18	1	32		1		
Cassia abbreviata		1	15	11	2	3				
Species group G										
Eragrostis rigidior	38	32	5	36		3	1		2	
Species group H										
Ptycholobium contortum					78					
Tephrosia purpurea					73		1	2	6	
Commicarpus fallacissimus					68			1		
Acalypha villicaulis					63		8			
Achyranthes aspera			5	7	63	1	8	5	6	
Amaranthus schinzianus					61					
Cleome angustifolia				3	51		1			
Calostephane divaricata			1	4	47	1		4	2	
Indigofera heterotricha				6	44					
Kirkia acuminata		10		2	40	1	1	4		
Neuracanthus africanus			1	5	34					
Monechma debile				5	33				4	
Lantana species					33			1		
Asparagus suaveolens					33					
Kohautia cynanchica					33					
Indigofera nebrowniana					33					
Indigofera trita					32			2	2	
Limeum sulcatum				2	28		1	4		
Ocimum americanum				7	28		7			
Jatropha spicata					27					
Grewia villosa	3	1		9	26		3	16		
Solanum coccineum			1	9	25		1			
Geigeria acaulis					25		3	8		
Justicia protracta				4	25					
Commiphora tenuipetiolata					23					
Sesamum triphyllum		1			22		2	1		
Commiphora edulis		9			21					
Leucas sexdentata					21					
Sterculia rogersii		1		2	21					
Pavonia columella			1	1	18					
Gardenia resiniflua		10		1	18		1			
Eragrostis biflora					16			1		
Digitaria velutina					15	1	1			
Adansonia digitata	1				15					
Acacia erubescens	1	7		2	15		1			
Blepharis diversispina					13				6	
Megalochlamys kenyensis					13					
Barleria species	4	2			12					
Priva africana					12					

	Zimbabwe		Rivers	Lowv.	N.Soutp	Trans.	Semi-arid		Sandy	
Major vegetation type	**1.1**	**1.2**	**2**	**3**	**4**	**5**	**6.1**	**6.2**	**7.1**	**7.2**
Number of relevés	***71***	***131***	***92***	***1375***	***157***	***68***	***144***	***147***	***51***	***10***
Acrachne racemosa					11					
Boerhavia coccinea			1		10	1				
Species group I										
Bulbostylis hispidula				14	39		10		4	10
Hibiscus micranthus				47	69			12	12	
Aristida congesta s. barbicollis			1	43	50	1	1			
Heliotropium steudneri	7	3	1	29	28		1			
Dicoma tomentosa				25	69		8	7	2	
Hermannia boraginiflora				23	59		1			
Seddera capensis				22	65					
Leucas glabrata			2	19	33					
Abutilon austro-africanum			4	19	12					
Phyllanthus maderaspatensis				19	26			10	4	
Commiphora mollis		8	2	18	58	2	4	3		
Phyllanthus species			1	16	55					
Pavonia burchellii				16	30		6	4	2	
Pupalia lappacea			3	15	14		1	7	2	
Chamaecrista absus				15	30			2	4	
Mariscus rehmannianus				14	21					
Ipomoea magnusiana				13	54				2	
Hermbstaedtia odorata			1	12	21		9			
Corbichonia decumbens				10	22					
Combretum mossambicense		5	3	13	11		7	1		
Species group J										
Urochloa mosambicensis	66	67	15	54	2				2	
Maerua parvifolia	37	17	2	26	25					
Commelina benghalensis	48	39	3	26	43		1	3	4	
Kyllinga alba	37	3		9	27		3	1	6	
Grewia monticola	30	45		11	32		2			
Lannea schweinfurthii	3	13	3	22	30	6				
Lonchocarpus capassa	3	8	70	17	4	3				
Setaria sagittifolia	3	18	4	1	12					
Species group K										
Panicum natalense			8			29				
Sansevieria hyacinthoides			17	5	2	29				
Dicoma anomala						13	5			
Thesium utile						13	3		2	
Species group L										
Acacia nigrescens		17	45	41	30	53	1			
Eragrostis superba	1	6	15	26		25	1	4	2	
Albizia harveyi		3	18	23	2	5				
Acacia gerrardii	1	2	22	8	1	44			2	
Species group M										
Triraphis purpurea						1	17	26		
Acacia nilotica			9	4			22	14	2	
Anthephora schinzii							13	21	6	
Boscia foetida			2		1		10	13	2	
Species group N										
Abutilon angulatum			3		1		15	6	4	
Eragrostis viscosa							15			
Willkommia sarmentosa							12	1		

	Zimbabwe		Rivers	Lowv.	N.Soutp	Trans.	Semi-arid		Sandy	
Major vegetation type	**1.1**	**1.2**	**2**	**3**	**4**	**5**	**6.1**	**6.2**	**7.1**	**7.2**
Number of relevés	*71*	*131*	*92*	*1375*	*157*	*68*	*144*	*147*	*51*	*10*
Species group O										
Leucosphaera bainesii								62		
Enneapogon desvauxii								39	4	
Eragrostis nindensis							7	36	2	
Eragrostis echinochloidea							3	34		
Monelytrum luederitziana								25		
Hibiscus caesius								23	2	
Chascanum pinnatifidum				1			1	22	8	
Abutilon fruticosum				2	1		1	20		
Seddera suffruticosa				4			1	18	2	
Indigofera charlieriana					1		1	18	4	
Chamaesyce inaequilatera							3	17	2	
Aristida rhiniochloa				6		1	6	16		
Eragrostis porosa							5	16		
Stipagrostis hirtigluma s. patula							1	15		
Helichrysum tomentosulum								15	2	
Pegolettia senegalensis			1	2			1	15	4	
Stipagrostis hirtigluma s. pearsonii								15		
Petalidium engleranum								14	8	
Monechma genistifolium								14	4	
Gossypium triphyllum								13		
Ruelliopsis setosa								13		
Eragrostis annulata							2	13		
Hirpicium gazanioides							1	12	2	
Acacia nebrownii								12		
Solanum species		1	1					12	2	
Aizoon virgatum								11		
Eragrostis glandulosipedata								11		
Triaspis hypericoides								11		
Ptycholobium biflorum								11		
Acalypha segetalis			1					11		
Lantana dinteri								10	2	
Cyperus fulgens							1	10	2	
Nidorella resedifolia								10		
Setaria verticillata			1		6	1	4	10		
Geigeria odontoptera								10		
Fockea angustifolia			1	2				10	2	
Species group P										
Acacia senegal				1	11		8	11	2	
Species group Q										
Cenchrus ciliaris		1	28	11	11	24	6	50		
Enneapogon scoparius			49	10	3	52	6	10		
Combretum imberbe	3	5	56	14	5	6	9	7		
Species group R										
Combretum apiculatum	4	44	27	64	85	84	9	33	6	

	Zimbabwe		Rivers	Lowv.	N.Soutp	Trans.	Semi-arid		Sandy	
Major vegetation type	**1.1**	**1.2**	**2**	**3**	**4**	**5**	**6.1**	**6.2**	**7.1**	**7.2**
Number of relevés	***71***	***131***	***92***	***1375***	***157***	***68***	***144***	***147***	***51***	***10***
Species group S										
Terminalia sericea			1	12		5	5	1	47	100
Tephrosia dregeana							2	3	25	40
Rhus tenuinervis							3	1	20	50
Bauhinia petersiana							0		19	20
Combretum collinum				6			1		10	60
Species group T										
Acacia fleckii							3	7	49	
Lonchocarpus nelsii								4	49	
Merremia tridentata				7				1	49	
Elephantorrhiza suffruticosa								6	45	
Acanthosicyos naudinianus							3		43	
Requienia sphaerosperma							1		41	
Neorautanenia species								5	36	
Acacia ataxacantha							3	1	31	
Commiphora angolensis							1	7	31	
Albizia anthelmintica	8			1			7	7	31	
Maerua juncea			3	1			1	8	29	
Indigofera colutea								2	23	
Merremia palmata				3			2	4	22	
Vernonia species	6	8					1	5	20	
Harpagophytum procumbens									18	
Ipomoea verbascoidea								1	18	
Hermannia species	3							4	18	
Kohautia caespitosa				1			1	1	17	
Clerodendrum dekindtii								1	16	
Commiphora species					1		2	5	14	
Petalidium coccineum								1	14	
Triraphis schinzii								4	14	
Vernonia poskeana				5			3	6	14	
Oxygonum dregeanum									12	
Dicoma species								1	12	
Eragrostis dinteri							1	4	12	
Melinis nerviglumis	3	5					1	5	12	
Blepharis species					1		4		10	
Species group U										
Catophractes alexandri						1	5	45	16	
Anthephora pubescens							3	34	57	
Acacia reficiens							3	26	44	
Montinia caryophyllacea							1	25	25	
Otoptera burchellii							1	25	57	
Helinus integrifolius								23	12	
Heliotropium ovalifolium							3	17	18	
Cephalocroton mollis				1				16	10	
Hermannia modesta				2			3	15	22	
Blepharis obmitrata								15	10	
Grewia retinervis							3	15	49	
Acacia mellifera							1	14	35	
Ehretia rigida			1	9			1	13	26	
Barleria lancifolia				3	18		1	13	20	

	Zimbabwe		Rivers	Lowv.	N.Soutp	Trans.	Semi-arid		Sandy	
Major vegetation type	**1.1**	**1.2**	**2**	**3**	**4**	**5**	**6.1**	**6.2**	**7.1**	**7.2**
Number of relevés	***71***	***131***	***92***	***1375***	***157***	***68***	***144***	***147***	***51***	***10***
Species group V										
Stipagrostis uniplumis			1	2	58	35	24	48	78	
Boscia albitrunca	1			5	67	3	22	30	61	
Grewia flava	3				77	6	5	19	49	
Monechma divaricatum				2	12	1	19	27	16	
Commiphora pyracanthoides				5	6	5	6	33	26	
Species group W										
Schmidtia pappophoroides				54	11	5	15	15	75	
Brachiaria deflexa			4	30	93	18	3	1	2	
Species group X										
Enneapogon cenchroides		6	30	52	97	71	40	61	31	
Terminalia prunioides	1		25	18	81	18	43	41	24	
Eragrostis lehmanniana			36	6	55	25	26	7	76	
Melinis repens			15	29	49	43	9	47	30	
Digitaria eriantha			12	62	10	21	1		6	
Ozoroa paniculosa			7	2	1	18	2	1	22	
Species group Y										
Panicum maximum	26	72	36	68	19	21	5		14	
Acacia tortilis	20	22	10	10	20	6	10	3	4	
Species group Z										
Asparagus nelsii							6			60
Dicoma schinzii							3		4	60
Ozoroa schinzii							1			50
Requienia pseudosphaerosperma							1			40
Talinum arnotii							3		2	40
Aristida stipoides							15		6	40
Stipagrostis uniplumis v. uniplumis							6			30
Ochna pulchra							0		4	30
Hyphaene petersiana							5		2	20
Peltophorum africanum			4	12			2		4	20
Harpagophytum zeyheri				1			3			20
Tragus racemosus							6			20
Dichapetalum cymosum										20
Cyperus margaritaceus							1			20
Cleome rubella							3	1		20
Acrotome inflata							3		2	20
Psydrax livida							1			20
Aristi stipitata s. graciliflora				6						10
Scilla nervosa							1			10
Salacia luebbertii										10
Basananthe pedata										10
Ophioglossum polyphyllum							1			10
Pentarrhinum insipidum							1			10
Tavaresia barklyi							3			10
Hermannia eenii										10
Lantana angolensis							0	1		10
Solanum delagoense							0	3		10
Combretum engleri									8	10

	Zimbabwe		Rivers	Lowv.	N.Soutp	Trans.	Semi-arid		Sandy	
Major vegetation type	**1.1**	**1.2**	**2**	**3**	**4**	**5**	**6.1**	**6.2**	**7.1**	**7.2**
Number of relevés	***71***	***131***	***92***	***1375***	***157***	***68***	***144***	***147***	***51***	***10***
Species group AA										
Rhigozum brevispinosum							4	19	73	10
Croton gratissimus				1	2		9	22	47	70
Urochloa brachyura				4			6	23	10	10
Species group BB										
Schmidtia kalihariensis							13	13	29	60
Pogonarthria fleckii							14	19	18	10
Pechuel-Loeschea leubnitziae							17	9	4	30
Acacia erioloba						1	6	1	51	30
Mundulea sericea				7			3	12	10	80
Species group CC										
Aristida adscensionis			32	24	80	35	16	74	12	10
Sclerocarya birrea		3	23	32	39	28	3	2		10
Eragrostis trichophora			1	2	62	35	43	13	6	90
Species group DD										
Colophospermum mopane	69	20	55	58	91	75	67	61	45	80
Dichrostachys cinerea	25	29	22	52	53	57	19	41	71	10
Tragus berteronianus	68	5	2	50	79	43	21	15	2	20
Grewia bicolor	40	11		59	84		23	40	39	30
Commiphora africana	9	4		22	9	13	7	6	29	10
Grewia flavescens	7	37	1	14		30	12	4	10	40
Evolvulus alsinoides	8	5		34	70		12	6	8	10

CHAPTER 6

RESULTS

PHYTOSOCIOLOGY OF THE SOUTH AFRICAN LOWVELD MOPANEVELD

6.1 Introduction

The South African Lowveld Mopaneveld was identified as the *Cissus cornifolia - Colophospermum mopane* vegetation type during classification of the southern African Mopaneveld (Chapter 5). General interest in the South African Lowveld vegetation and the availability of adequate vegetation data from this area engendered further analysis of this Mopaneveld type. Classification of the *Cissus cornifolia – Colophospermum mopane* vegetation type revealed the identification of 4 distinct major plant communities:

1. The *Terminalia sericea – Colophospermum mopane* major plant community on sandy soil.
2. The *Acacia nigrescens – Colophospermum mopane* major plant community on clayey soil.
3. The *Euclea divinorum – Colophospermum mopane* major plant community on deep clayey soils, mainly derived from shale.
4. The *Combretum apiculatum – Colophospermum mopane* major plant community on granite and gneiss.

These four major plant communities are distributed mainly in accordance with geological material and consequently soil types varying from sandy soils derived from sandstone to vertic, black clays derived from igneous basalt and gabbro.

The first two major plant communities, namely the *Terminalia sericea – Colophospermum mopane* and the *Acacia nigrescens – Colophospermum mopane* are discussed. The *Euclea* *divinorum – Colophospermum mopane* and the *Combretum apiculatum – Colophospermum mopane* major communities will be discussed in subsequent papers.

6.2 Description of the major plant communities within the South African Lowveld Mopaneveld

6.2.1 The *Terminalia sericea – Colophospermum mopane* major plant community

Tables 6 & 7 are relevant in the description of this major plant community

Figure 20

Over its distribution range, *Colophospermum mopane* usually forms the sole dominant woody component in plant communities occurring on fine-textured, deep sandy clay loam to clay soils on flat or slightly undulating topography (Werger & Coetzee 1978; Madams 1990; Timberlake *et al.* 1993; Timberlake 1995). Mosaic patches of Sandveld, however occur within the Lowveld Mopaneveld, e.g. the Punda Maria Sandveld, Wambiya Sandveld, Phalaborwa Sandveld, Tsende Sandveld, and sandy patches on granitic hillcrests (Van Rooyen *et al.* 1981b; Gertenbach 1983). Although not formally described yet, it is suggested that these Sandveld communities represent a vegetation class. The separation of azonal and intrazonal types from the zonal types during the procedure of analyzing Lowveld Mopaneveld (Chapter 4) was expected to separate all relevés of these Sandveld areas. Certain relevés remained within the scope of Mopaneveld vegetation, hence the identification of the *Terminalia sericea – Colophospermum mopane* major plant community. This major community can probably be explained as an ecotone between intrazonal Sandveld communities and the proper Mopaneveld Veld Type (Acocks 1988). The name of this major community may be controversial, suggesting that *C. mopane* and *T. sericea* occur simultaneously in the same community. It rarely happens however that these species, which occupy totally different soil types, will occur together. Where the sandy content is high, *Terminalia sericea* (species group R, Table 7) is dominant over *C. mopane* which, if present, is of very low significance (species group V, Table 7). If conditions favour *C. mopane*, *T. sericea* tends to fade. *Colophospermum mopane* is not present in all communities of the

Terminalia sericea – C. mopane major plant community (species group V, Table 7) and where it occurs it is not necessarily the dominant woody species. The question evolves whether Mopaneveld necessarily have to contain *Colophospermum mopane*, and whether total species composition is more important then a single dominant to determine to which vegetation unit a specific plant (stand) belongs.

The *Terminalia sericea – Colophospermum mopane* major plant community is confined to course-grained, sandy soils derived from either Archaean granite or Sandstone of the Clarens Formation and the Waterberg Group and to a lesser extent sandy soils derived from rhiolite. The soils are usually shallow, well drained, stony and with a very low or no clay content. In its northern distribution on the Waterberg Sandstone the *Terminalia sericea – Colophospermum mopane* major community is associated with deep, fine-textured, well-drained sand or loamy sand (Van Rooyen *et al.* 1981b).

This major plant community occurs on plains, slightly undulating landscapes to hilly terrain. On the granitic landscapes, the *Terminalia sericea – Colophospermum mopane* major community mostly occurs on flat crests or slightly sloped midslopes, whereas on sandstone, it generally occurs in sandy plains, footslopes, middleslopes and plateaus.

The annual rainfall of this major plant community varies considerable due to its discontinuous distribution. In the northern parts of the study area (in the vicinity of Punda Maria in the Kruger National Park), the annual rainfall can reach up to 1 000 mm (Gertenbach 1980), but generally rainfall ranges between 450 and 550 mm per annum (Van Rooyen *et al.* 1981a; Weather Bureau Statistics, 1961 – 1990). In the southern distribution limit of the *Terminalia sericea - Colophospermum mopane* major plant community the annual rainfall varies between 450 mm and 600 mm.

The *Terminalia sericea – C. mopane* major plant community on sandy soils is characterised by the high abundance values of woody species such as *Terminalia sericea*, *Combretum zeyheri*, *C. collinum*, *Mundulea sericea*, *Strychnos madagascariensis* and *Pseudolachnostylis maprouneifolia* (species group A, Table 6). Herbaceous species of diagnostic value include *Agathisanthemum bojeri*, *Hibiscus engleri*, *Hermannia glanduligera*, *Tephrosia longipes*, *Fimbristylis complanatus* and *Xenostegia tridentata* subsp. *angustifolia* (species group A, Table 6).

The *Terminalia sericea* – *Colophospermum mopane* major plant community is subdivided into 2 communities, probably on alliance level in the syntaxonomical rank, and 4 subcommunities, probably on association level:

1 The *Clerodendrum ternatum* – *Combretum apiculatum* community

1.1 The *Indigofera filipes* – *Digitaria eriantha* subcommunity

1.2 The *Sclerocarya birrea* – *Colophospermum mopane* subcommunity

2 The *Pseudolachnostylis maprouneifolia* – *Guibourtia conjugata* community

2.1 The *Combretum collinum* – *Hermannia glanduligera* subcommunity

a) The *Eragrostis pallens* variant

b) The *Hymenocardia ulmoides* variant

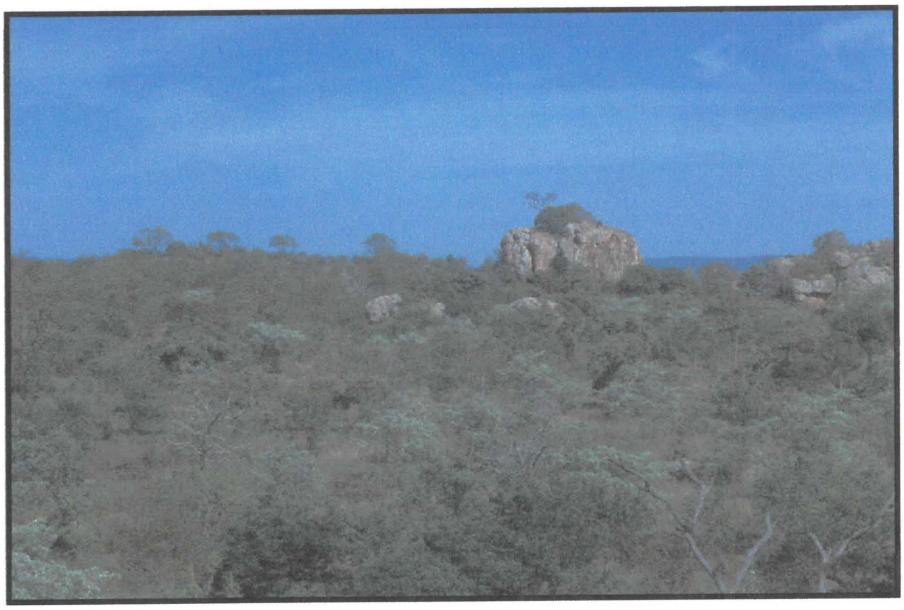
2.2 The *Diplorhynchus condylocarpon* – *Andropogon gayanus* subcommunity

a) The *Combretum apiculatum* variant

b) The *Andropogon gayanus* variant

The major differentiation between the two communities can be ascribed to differences in geological substrates they occur on. The *Clerodendrum ternatum* – *Combretum apiculatum* community occurs on sandy ridges derived from Archaean granite or Sandstone of the Clarens Formation, whereas the *Pseudolachnostylis maprouneifolia* – *Guibourtia conjugata* community is confined to Sandstone derived from the Waterberg Group.

a)



b)

Figure 20 The *Terminalia sericea* - *Colophospermum mopane* major plant community in the Kruger National Park. The silver leaves of *T. sericea* interrupt the *C. mopane* dominated vegetation (a). Individuals of *T. sericea* and *C. mopane*(b).

Table 7 has relevance to the discussion of the plant communities, unless indicated different.

1. The *Clerodendrum ternatum* – *Combretum apiculatum* community (Data of Gertenbach 1976 & Gertenbach 1987)

This community occurs on sandy soils derived from Arachaean granite as well as Clarens Sandstone. It is well represented towards the southern distribution of the Mopaneveld in the Kruger National Park (Gertenbach 1987). Landscapes assosiated with granitic substrates are characterised by undulating hills of which the convex crests and midslopes are occasionally inhabited by the *Clerodendrum ternatum* – *Combretum apiculatum* community. Soils vary in depth, but in general the relatively shallow (300 – 600 mm) soils are derived from granite whereas deeper soils originate from Clarens Sandstone. The A-horizon contains more than 80 % sand and an average of 7 % clay. The B-horizon, if present, can be lutocutanic or a deeper apedal and contains higher percentages clay (Gertenbach 1987). Soils are leached and poor in nutrients probably also due to the low clay contents in the soil.

Mean annual rainfall within the *Clerodendrum ternatum* – *Combretum apiculatum* community vary from less than 500 mm up to 600 mm (Gertenbach 1983; Gertenbach 1987).

The *Clerodendrum ternatum* – *Combretum apiculatum* community can structurally be classified as a moderate open to dense bush savanna (Gertenbach 1987) and diagnostic species of this community are listed in species group A. Prominent woody species include amongst others *Clerodendrum ternatum* (species group A) and *Colophospermum mopane* (species group V). Herbaceous species such as *Cissus cornifolia* (species group O), *Tephrosia polystachya* and *Chamaecrista absus* (species group W), and grasses such as *Heteropogon contortus* (species group A) are prominent in this community. Dominant woody species include *Terminalia sericea* (species group R) and *Combretum apiculatum* (species group Z). Other dominant species are mostly grasses, such as *Perotis patens*, *Schmidtia pappophoroides* (species group R), *Aristida congesta* (species group W), *Digitaria eriantha*, *Panicum maximum* and *Pogonarthria squarrosa* (species group Z). The *Clerodendrum ternatum* – *Combretum apiculatum* community is strongly related to the Perotido patentis – Terminalietum sericeae combretotosum apiculati subass. nov. in the Perotido patentis –

Terminalietum sericeae (Bredenkamp & Theron 1990). This association occurs on very acid, leached sandy soils (Bredenkamp & Theron 1990).

Two subcommunities were distinguished in the *Clerodendrum ternatum – Combretum apiculatum* community:

1.1 The *Indigofera filipes – Digitaria eriantha* subcommunity

This moderate- to dense bush savanna mainly occurs on granite of which the soils are shallow, sandy and well-drained. Dominant soil series include Mispah and Glenrosa.
Diagnostic species for the *Indigofera filipes – Digitaria eriantha* subcommunity are listed in species group B. *Clerodendrum ternatum* (species group A) and *Combretum zeyheri* (species group Z) are prominent woody species, whereas *Commelina benghalensis* (species group A) is a prominent forb. Grass species such as *Urochloa mosambicensis* (species group A) and *Perotis patens* (species group R), are prominent. Dominent species for this community include amongst others woody species such as *Terminalia sericea* (species group R) and *Combretum apiculatum* (species group Z), forbs such as *Cissus cornifolia* (species group O) and grass species including *Schmidtia pappophoroides* (species group R), *Aristida congesta* (species group W), *Pogonarthria squarrosa*, *Digitaria eriantha* and *Panicum maximum* (species group Z).

1.2 The *Sclerocarya birrea – Colophospermum mopane* subcommunity

Within the Lowveld Mopaneveld the *Sclerocarya birrea – Colophospermum mopane* subcommunity is mostly a moderately dense to an open shrubveld with occasionally higher trees such as *Sclerocarya birrea* (Gertenbach 1976; Gertenbach 1987). This subcommunity is restricted to deeper sandy soils derived from granite where it inhabits the crests of undulating hills in a typical granitic landscape. The slope of the area is moderate to steep, with almost no rock cover. Termite heaps are abundant on which tree species such as *Colophospermum mopane* and *Diospyros mespiliformis* often occur (Gertenbach 1976).

Diagnostic species for the *Sclerocarya birrea – Colophospermum mopane* subcommunity are listed in species group E. Several prominent species characterise this subcommunity, of which *Sclerocarya birrea*, *Lannea schweinfurthii* (species group N), *Terminalia sericea* (species group R) and *Grewia bicolor* (species group W) characterise the woody component. Prominent herbaceous species include forbs such as *Indigofera vicioides* (species group E), *Fimbristylis complanata* (species group I), *Limeum fenestratum* (species group A), *Chamaecrista absus* (species group W) and *Vernonia fastigiata* (species group Z). Prominent grass species are *Heteropogon contortus*, *Eragrostis rigidior* (species group A), *Aristida mollissima* (species group N), *Melinis repens* (species group V), *Panicum maximum*, and *Brachiaria nigropedata* (species group Z). A few species are considerably dominant in this subcommunity of which *Colophospermum mopane* (species group V) and *Combretum apiculatum* (species group Z) cover the woody component. *Cissus cornifolia* (species group O) and *Tephrosia polystachya* (species group W) are dominant forbs whilst *Digitaria eriantha* and *Pogonarthria squarrosa* (species group Z) dominate the herbaceous layer.

2. The *Pseudolachnostylis maprouneifolia – Guibourtia conjugata* community

This tree savanna (Van Rooyen *et al.* 1981b) is confined to deep sand in areas underlain by Waterberg Sandstone. It is well represented in the northern parts of the study area (Punda Maria region, Kruger National Park). The topography varies from broken terrain to plains and small mountains where the *Pseudolachnostylis maprouneifolia – Guibourtia conjugata* community is restricted to plains and sandy plateaus. It sometimes also occurs on steep footslopes (Van Rooyen *et al.* 1981b). Mostly deep, but also shallow and stony at places, fine-textured sand, loamy sand, sandy clay loam or sandy loam underlies this community. The Sandveld communities are often associated with poor, leached soils. These soil characteristics are adapted from the description by Van Rooyen (1978) on the Sandveld communities. According to data analysis, the *Pseudolachnostylis maprouneifolia – Guibourtia conjugata* community comprises only small patches within the *Burkea africana – Pseudolachnostylis maprouneifolia* tree savanna, the *Xeroderris stuhlmannii – Combretum apiculatum* tree savanna and the *Kirkia acuminata – Afzelia quansensis – Combretum apiculatum* tree savanna (Van Rooyen *et al.* 1981b). Soil characteristics may therefore vary on a smaller scale.

Rainfall for the Punda Maria region varies between 450 mm and 550 mm per annum (Van Rooyen *et al.* 1981b; Weather Bureau Statistics, 1961 – 1990).

The vegetation of this community is not representative of typical Mopaneveld vegetation due to the influence of the Sandveld communities, which probably represent a separate vegetation class. Many diagnostic species for this community will in the outermost exception concurrently be present with *Colophospermum mopane*. These diagnostic species are listed in species group J, of which *Pseudolachnostylis maprouneifolia* (species group J) and *Combretum zeyheri* (species group Z) are prominent in the woody layer. Other prominent species include grasses such as *Pogonarthria squarrosa* and *Andropogon gayanus* (species group Z). Dominant species are mostly grasses of which *Digitaria eriantha* and *Panicum maximum* (species group Z) are the most conspicuous.

Two subcommunities were distinguished:

2.1 The *Combretum collinum – Hermannia glanduligera* subcommunity

The *Combretum collinum – Hermannia glanduligera* tree savanna is associated with sandy plains (Van Rooyen *et al.* 1981b). Soils are in general leached, deep and contain high percentages of finely grained sand with a low pH. Diagnostic species for this subcommunity are listed in species group K. None of the diagnostic species are prominent or dominant, although they are locally characteristic for this subcommunity. Prominent species include amongst others woody species such as *Terminalia sericea* (species group R), *Pseudolachnostylis maprouneifolia* (species group J) and *Combretum zeyheri* (species group Z), forbs such as *Hermannia glanduligera* (species group K) and grass species such as *Schmidtia pappophoroides*, *Perotis patens* (species group R) and *Pogonarthria squarrosa* (species group Z). Although *Combretum apiculatum* and *Combretum zeyheri* frequently occur (species group Z), they are not dominant in this subcommunity.

Two variants were distinguished:

a) *Eragrostis pallens* variant

The *Eragrostis pallens* tree savanna comprises elements of all four communities within the *Terminalia sericea* – *Pteleopsis myrtifolia* tree savanna (Van Rooyen *et al.* 1981b). It is mainly associated with sandy plains containing leached, deep sandy soils with a low pH. Diagnostic species for this variant are listed in species group L of which the grass *Eragrostis pallens* is the most conspicuous. Other prominent grass species include *Schmidtia pappophoroides* and *Perotis patens* (species group R). Although not highly abundant, *Terminalia sericea* is frequently present in this variant.

b) *Hymenocardia ulmoides* variant

The *Hymenocardia ulmoides* variant comprises elements of both the *Terminalia sericea* – *Pteleopsis myrtifolia* tree savanna and the *Croton gratissimus* – *Phyllanthus reticulatus* tree savanna (Van Rooyen *et al.* 1981b). In general this variant inhabits small patches in the ecotone between Mopaneveld and the Sandveld where soils are rocky, shallow and sandy. Diagnostic species of this variant are listed in species group P. Species such as the tree *Manilkara mochista* (species group P) is a local character species and also prominent in this variant. Other prominent woody species include the tree *Combretum zeyheri* (species group Z), shrubs such as *Hymenocardia ulmoides* (species group P) and *Hexalobus monopetalus* (species group Y) and grasses such as *Schmidtia pappophoroides*, *Perotis patens* (species group R), *Pogonarthria squarrosa* and *Andropogon gayanus* (species group Z). *Digitaria eriantha* and *Panicum maximum* (species group Z) are the only dominant species for this variant.

2.2 The *Diplorhynchus condylocarpon* – *Andropogon gayanus* subcommunity

The habitat of this tree savanna varies from deep, sandy plains to steep, shallow, rocky slopes (Van Rooyen *et al.* 1981b). Soils are in some places strongly leached and contain high percentages of finely grained sand. The soil surface is 40 – 60 % covered with stones (Van

Rooyen *et al.* 1981b). The *Diplorhynchus condylocarpon* – *Andropogon gayanus* subcommunity occurs as patches between the *Burkea africana* – *Pseudolachnostylis maprouneifolia* tree savanna and the *Kirkia acuminata* – *Afzelia quanzensis* – *Combretum apiculatum* tree savanna (Van Rooyen *et al.* 1981b). Diagnostic species for this subcommunity are listed in species group S. *Diplorhynchus condylocarpon* (species group S) is the most prominent woody species for this subcommunity. Woody species of less importance include *Pseudolachnostylis maprouneifolia*, *Pteleopsis myrtifolia*, *Guibourtia conjugata* (species group J), *Combretum apiculatum*, *Combretum zeyheri* and *Strychnos madagascariensis* (species group Z). Forbs such as *Vernonia fastigiata* and *Waltheria indica* (species group Z) and grass species such as *Digitaria eriantha*, *Panicum maximum*, *Pogonarthria squarrosa*, *Andropogon gayanus* and *Brachiaria nigropedata* (species group Z) are prominent in the herbaceous layer.

Two variants were distinguished:

a) *Combretum apiculatum* variant

The *Combretum apiculatum* variant is associated with the *Kirkia acuminata* – *Afzelia quanzensis* – *Combretum apiculatum* tree savanna identified by Van Rooyen *et al.* (1981b). According to comparisons made with the *Kirkia acuminata* – *Afzelia quanzensis* – *Combretum apiculatum* tree savanna (Van Rooyen *et al.* 1981b) this variant occurs mainly on steep south-facing slopes on soils originated from the weathering of the Waterberg and Cave Sandstone. Soils are in general shallow and dark red-brown fine-textured loamy sand to sandy clay loam. Diagnostic species for this variant are listed in species group T. Conspicuous woody species include *Diplorhynchus condylocarpon* (species group S), *Afzelia quanzensis*, *Commiphora glandulosa*, *Kirkia acuminata* (species group T) and *Combretum apiculatum* (species group Z), which is also the dominant woody species for this variant. Prominent forb species include *Waltheria indica* and *Vernonia fastigiata* (species group Z) and grasses such as *Aristida congesta* (species group W), *Panicum maximum* and *Pogonarthria squarrosa* (species group Z). *Digitaria eriantha* is the dominant grass species for this community (species group Z).

b) *Andropogon gayanus* variant

The *Andropogon gayanus* variant is associated with the *Burkea africana – Pseudolachnostylis maprouneifolia* tree savanna identified by Van Rooyen *et al.* (1981b). According to comparisons made with these communities identified by Van Rooyen *et al.* (1981b), this variant occurs mainly on drier plains and on south-facing slopes on broken landscapes around Punda Maria in the Kruger National Park on Waterberg Sandstone. Soils originated from the weathering of the Waterberg Sandstone are in general red brown to dark red brown fine textured sand or loamy sand. Diagnostic species for this variant are listed in species group X. Although none of the diagnostic species are frequently present in this variant, the absence of species groups L, P and T is diagnostic for this variant in the Punda Maria Sandveld area. Conspicuous woody species include *Diplorhynchus condylocarpon* (species group S), *Pseudolachnostylis maprouneifolia*, *Burkea africana* (species group J) and *Combretum zeyheri* (species group Z), which is also the dominant woody species for this variant. Prominent forb species include *Tephrosia elongata* (species group J) and *Vernonia fastigiata* (species group Z), and grasses such as *Panicum maximum* and *Pogonarthria squarrosa* (species group Z). *Digitaria eriantha* and *Andropogon gayanus* are the dominant grass species for this community (species group Z).

6.2.2 The *Acacia nigrescens – Colophospermum mopane* major plant community

Tables 6 & 8 are relevant for the discussion of this major plant community

Figure 21

The *Acacia nigrescens – Colophospermum mopane* major plant community, the largest major community within the South African Lowveld Mopaneveld, represents Mopaneveld on clayey soils. It is a well-known vegetation unit, not only to scientists, but also to tourists. This extensive, almost monotonous vegetation unit (as tourists often refer to) is often associated with long stretches of shrubmopaneveld (Figure 21 a). Although it seems to be homogenous and low in species diversity, TWINSPAN results revealed that this extensive vegetation unit comprises four different plant communities, probably on a level higher than the association.

Among the few diagnostic species (species group B, Table 6) are species significantly characteristic of clayey habitats, such as *Setaria incrassata*, an indicator of wet, heavy black clay (Van Oudtshoorn 1994). All diagnostic species are herbaceous although many woody species occur within the *Acacia nigrescens – Colophospermum mopane* major community. Prominent woody species present in this major community include *Clerodendrum ternatum*, *Lonchocarpus capassa* (species group E, Table 6), *Maerua parvifolia*, *Combretum hereroense*, *Combretum imberbe* (species group I, Table 6), *Colophospermum mopane*, *Combretum apiculatum*, *Grewia bicolor*, *Sclerocarya birrea*, *Dichrostachys cinerea*, *Acacia nigrescens*, *Dalbergia melanoxylon* and *Commiphora africana* (species group K, Table 6). Woody species are often stunted (Figure 21b) due to the vertic character of the heavy clays derived from igneous rocks (Fraser *et al.* 1987). Isolated high trees of *Combretum imberbe*, *Acacia nigrescens* and *Sclerocarya birrea* in this community is however diagnostic for deeper clayey soil (Gertenbach 1987).

The *Acacia nigrescens - Colophospermum mopane* major plant community is related to the Acacio nigrescentis – Grewion bicoloris alliance (Coetzee 1983) and the *Cenchrus ciliaris* alliance described by Gertenbach (1987).

a)

b)

Figure 21 The *Acacia nigrescens - Colophospermum mopane* major plant community, the well-known shrubmopaneveld (a) of the South African Lowveld. *Sclerocarya birrea* often occurs in stunted individuals in this major plant community (b).

Four communities, four subcommunities and two variants were identified within the *Acacia nigrescens* – *Colophospermum mopane* major community of the *Cissus cornifolia* – *Colophospermum mopane* Lowveld Mopaneveld:

1. The *Themeda triandra* – *Acacia nigrescens* community

1.1 The *Setaria incrassata* – *Combretum imberbe* subcommunity

   a) The *Combretum collinum* variant

   b) The *Combretum imberbe* variant

1.2 The *Digitaria eriantha* – *Acacia nigrescens* subcommunity

   a) The *Colophospermum mopane* variant

   b) The *Acacia nigrescens* variant

2. The *Commiphora glandulosa* – *Enneapogon cenchroides* community

2.1 The *Indigofera bainesii* – *Aristida congesta* subcommunity

2.2. The *Phyllanthus parvulus* – *Combretum apiculatum* subcommunity

3. The *Euclea divinorum* –*Panicum maximum* community

4. The *Combretum mossambicense* – *Colophospermum mopane* community

Table 8 has relevance to the species groups refered to in the discussion of these communities, unless stated different.

1. The *Themeda triandra* – *Acacia nigrescens* community

The *Themeda triandra* - *Acacia nigrescens* community occurs along extensive stretches of shrubmopaneveld from the southern distribution of *Colophospermum mopane* in the Kruger National Park (Gertenbach 1987), through the shrubmopaneveld of the central district (north of the Olifants River to the Shingwedzi River) and adjacent Nature Reserves (Purchase 1997), up to the shrubmopaneveld in the northern Kruger National Park (Van Rooyen 1978). The mean annual rainfall for this community varies between 450 mm and 500 mm.

This community is restricted to bottomland clayey soil derived mainly from basic igneous gabbro or basalt. In this slightly undulating landscape to flat terrain, the igneous rocks weather to a dark-coloured, vertic clay. Intrusions of dolerite and other metamorphic rocks that also produce heavy clays are common within the *Themeda triandra – Acacia nigrescens* community.

In the study of Gertenbach (1978) on the gabbro complex in the Kruger National Park, a shrubmopane plant community was recognised as the *Themeda triandra - Colophospermum mopane* shrubveld. Although the *Themeda triandra – Acacia nigrescens* is to a great extent related to the *Themeda triandra – Colophospermum mopane* shrubveld (Gertenbach 1978) in terms of dominant species, these two communities differ in parent geological material as the *Themeda triandra – Acacia nigrescens* community is not restricted to gabbro, but is also present on heavy clay derived from igneous basalt and other geological intrusions. Gertenbach (1983) divided the shrubmopaneveld on basalt into three variations of which the *Themeda triandra – Acacia nigrescens* community is thought to comprise two of these variants: the *Themeda triandra* variation and the *Setaria woodii* (=*Setaria incrassata*) variation.

Diagnostic species for this community are listed in species group A, Table 8. Conspicuous woody species for the *Themeda triandra – Acacia nigrescens* community include *Combretum apiculatum* (species group P), *Colophospermum mopane*, *Acacia nigrescens*, *Dichrostachys cinerea*, *Combretum imberbe* and *Dalbergia melanoxylon* (species group S). Prominent forb species include *Chamaecrista mimosoides* (species group A) while *Cissus cornifolia* (species group P) is dominant in this community. Grass species generally dominate the vegetation layer and include species such as *Themeda triandra*, *Eragrostis superba*, *Heteropogon contortus* (species group A), *Cenchrus ciliaris* (species group B), *Bothriochloa radicans* (species group F), *Panicum coloratum* (species group J), *Digitaria eriantha*, *Aristida congesta*, *Bothriochloa insculpta*, *Schmidtia pappophoroides* (species group P) and *Urochloa mosambicensis* (species group S).

The *Themeda triandra – Acacia nigrescens* community is subdivided into two subcommunities and four variants.

1.2 The *Setaria incrassata – Combretum imberbe* subcommunity

This open shrubsavanna is confined to melanic clays with structured calcareous clayey subsoil, typical of the Bonheim soil series (Fraser *et al.* 1987), which are derived from basic rocks from the Karoo Sequence as well as dolerite and diabase, which form isolated intrusions in this shrubmopaneveld. Multi-stemmed *Colophospermum mopane* shrubs with an average height of 1 – 2 m is a diagnostic feature for this plant community (Figure 2c). Bredenkamp and Deutschländer (1994) identified the *Themedo triandrae – Setarietum incrassatae* as an association confined to the gabbro dyke dissecting the Manyeleti Game Reserve adjacent to the Kruger National Park. Being the dominant grass species of this association, *Setaria incrassata* (species group B) occurs even so dominant in the *Setaria incrassata – Combretum imberbe* subcommunity, although occurring on heavy clays derived from, not only gabbro, but also from other basic rocks. This subcommunity is strongly related to the *Setaria woodii* variant of the *Colophospermum mopane* shrubveld on basalt (Gertenbach 1983).

Diagnostic species for this community are listed in species group B, Table 8 of which *Setaria incrassata* is the diagnostic, as well as the dominant grass species. The *Setaria incrassata – Combretum imberbe* subcommunity is particularly well presented by different grass species of which *Themeda triandra* (species group A), *Panicum coloratum* (species group J), *Bothriochloa insculpta* (species group P), *Urochloa mosambicensis* (species group S) are dominant and *Heteropogon contortus* (species group A) and *Cenchrus ciliaris* (species group B) prominent. *Ozoroa engleri* (species group B), *Combretum apiculatum* (species group P), *Colophospermum mopane*, *Acacia nigrescens*, *Dichrostachys cinerea*, *Combretum imberbe* and *Dalbergia melanoxylon* (species group S) are among the plant species dominating the woody layer.

a) The *Combretum collinum* variant

The vegetation data of Gertenbach (1976; 1983) and Van Rooyen (1978) contributed to the identification of the *Combretum collinum* variant. This variant basically encompasses the *Pterocarpus rotundifolius/Combretum collinum* woodland (landscape no. 33) described by Gertenbach (1983). This variant is restricted to intrusions of dolerite and diabase, andesite and tuff of the Waterberg System and schist and banded ironstone, amphibolite and undifferentiated metamorphic formations of the Swaziland System, forming islands in the Mopaneveld (Gertenbach 1983).

Deep, well-drained, dark reddish brown clay (35–55 %) is derived from the geological parent material. The terrain is usually flat to undulating.

Species group C (Table 8) is diagnostic for this community. *Combretum collinum* and *Pterocarpus rotundifolius* (species group C) are confined to this variant in their distribution within the *Acacia nigrescens – Colophospermum mopane* major plant community and also dominate the woody layer. According to Gertenbach (1983), dense stands of *Pterocarpus rotundifolius* are associated with higher clay content. A local character species for the *Combretum collinum* variant include *Acacia gerrardii*, a woody species often differentiating plant communities on mesic clay (Coetzee 1983; Gertenbach 1987). Species dominating the herbaceous layer include grasses such as *Setaria incrassata* (species group B), *Urochloa brachyura* (species group C), *Themeda triandra* (species group A) and *Urochloa mosambicensis* (species group S) and forbs such as *Oxalis semiloba* (species group C).

b) The *Combretum imberbe* variant

The *Combretum imberbe* variant is also identified according to the vegetation data of Gertenbach (1976; 1983) and Van Rooyen (1978). This variant relates the *Themeda triandra* variation of the *Colophospermum mopane* shrubveld on basalt (landscape no. 12, Gertenbach 1983) and the *Colophospermum mopane - Themeda triandra* shrubsavanna (Van Rooyen 1978).

This open shrubmopaneveld is differentiated by the absence of species group C, Table 8 and is confined to flat mid-slopes and convex uplands on basaltic terrain of heavy, clayey soil. Soil series dominating the landscape are the Bonheim and Milkwood, both dark-coloured, often calcareous melanic clay (Fraser *et al.* 1987).

The *Combretum imberbe* variant is characterised by a grassy, open shrubveld with *Colophospermum mopane* and *Combretum imberbe* (species group S) dominating the woody layer, often as small trees. Dominant grass species include *Themeda triandra* (species group A), *Setaria incrassata* (species group B) and *Panicum coloratum* (species group J). Forb species are not highly frequent.

1.2. The *Digitaria eriantha - Acacia nigrescens* subcommunity

Vegetation data of Gertenbach (1976; 1983) and Purchase (1997) contributed to the identification of this subcommunity. The *Digitaria eriantha - Acacia nigrescens* subcommunity is included in the Gabbro complex (Gertenbach 1987), which also include the *Themeda triandra - Colophospermum mopane* shrubveld (Gertenbach 1978). The *Digitaria eriantha - Acacia nigrescens* subcommunity is however not completely restricted to heavy clays derived from gabbro.

The *Digitaria eriantha - Acacia nigrescens* subcommunity is also associated with heavy clay, although shallower than the *Setaria incrassata – Combretum imberbe* subcommunity. Geological parent material varies from igneous gabbro and basalt to footslopes of granite and rhiolite. Structurally this subcommunity is a dense, sometimes impenetrable mopane shrubland.

Species group D, Table 8 represents the diagnostic species for the *Digitaria eriantha – Acacia nigrescens* subcommunity. *Colophospermum mopane*-dominated shrubland and *Acacia nigrescens*-dominated shrubland alternate in this subcommunity with the latter occupying the heavier clay. *Combretum apiculatum* (species group P) and *Dichrostachys cinerea* (species group S) occur in this community, but of low significance. *Eragrostis rigidior* and *Pogonarthria squarrosa* (species group E) are prominent, whereas *Themeda triandra* (species group A), *Panicum coloratum* (species group J), *Urochloa mosambicensis* (species group S) and *Heteropogon contortus* are the dominant grass species. Forbs of conspicuous value include *Tephrosia polystachya* (species group L) and *Cissus cornifolia* (species group P).

a) The *Colophospermum mopane* variant

The *Colophospermum mopane* variant represents the *Colophospermum mopane*-dominated variant of the *Digitaria eriantha* - *Acacia nigrescens* subcommunity. This variant occupies slightly sloped, clayey terrain, although the percentage clay is lower than the soils of the *Acacia nigrescens* variant (the second variant for this subcommunity) and the *Setaria incrassata* - *Combretum imberbe* subcommunity.

Mid- to footslopes on granite, midslopes and plains on gabbro and footslopes on basalt and rhiolite underly the *Colophospermum mopane* variant.

Diagnostic species for this subcommunity are listed in species group E. Common woody species include *Commiphora africana* (species group I), *Combretum apiculatum* (species group P), *Colophospermum mopane* and *Dichrostachys cinerea* (species group S). High abundance values of *C. mopane* (species group S) express the difference between the *C. mopane* variant and the *Acacia nigrescens* variant on the more heavy clayey soils. Important forb species are *Tephrosia polystachya* (species group L), *Rhynchosia totta* (species group M) and *Cissus cornifolia* (species group P). *Pogonarthria squarrosa* (species group E), *Panicum coloratum* (species group J), *Aristida congesta*, *Digitaria eriantha* (species group P) and *Urochloa mosambicensis* (species group S) are amongst the dominant grass species of this variant.

b) The *Acacia nigrescens* variant

Vegetation data of Gertenbach (1976) and Purchase (1997) contributed to the identification of this variant. The *Acacia nigrescens* variant is restricted to dark-coloured, deep, vertic clayey soil derived from igneous basalt and gabbro. It is to some extent related to the *Bothriochloa radicans* variant within the *Colophospermum mopane* communities on basalt (Gertenbach 1983). The *Acacia nigrescens* variant of this community comprises the *Acacia nigrescens* variant within the *Themeda triandra* - *Colophospermum mopane* shrubveld (Gertenbach 1978). It is noteworthy that *C. mopane* (species group S) and *Combretum apiculatum* (species group P) are not commonly present in this subcommunity. Instead, *Acacia* *nigrescens* shrubs dominate the woody component, a significant feature of gabbroic landscapes. The landscape is in general flat to concave.

Diagnostic species for the *Acacia nigrescens* variant are listed in species group F, Table 8. Grass species, such as *Themeda triandra* (species group A) and *Digitaria eriantha* (species group P) and shrubby trees of *Acacia nigrescens* (species group S) are the major contributors to the vegetation cover in the *Acacia nigrescens* variant. Other dominant species include *Sclerocarya birrea* (species group F) and *Grewia bicolor* (species group S) in the woody layer and *Bothriochloa radicans* (species group F) *Panicum maximum* and *Urochloa mosambicensis* (species group S) in the grass layer. The *Acacia nigrescens* variant contains several forb species of significant value, such as *Heliotropium steudneri* (species group J) and *Tephrosia polystachya* (species group L).

2. The *Commiphora glandulosa – Enneapogon cenchroides* community

Vegetation data from the studies of Gertenbach (1983; 1987) and Van Rooyen (1978) are included in this community.

The *Commiphora glandulosa - Enneapogon cenchroides* community is restricted to slightly undulating to flat terrain where the weathering of basalt, andesite and shale produces fine-textured sand-clay-loam, sand-clay and clayey soil (Van Rooyen 1978; Gertenbach 1987). On the mid- and footslopes, the A-horizon is thin and overlays a thick layer of lime concretions (Gertenbach 1983). According to Gertenbach (1980), this community receives 450–500 mm rainfall annually.

Species group G, Table 8 represents diagnostic species for the *Commiphora glandulosa - Enneapogon cenchroides* community, of which *Terminalia prunioides* and *Commiphora glandulosa* (species group G) are prominent woody species for this community. Another conspicuous woody species is the shrub *Grewia bicolor* (species group S). *Seddera capensis* (species group G) is a prominent forb in this community. Dominant species include woodies such as *Colophospermum mopane* (species group S) and grasses such as *Aristida congesta*, *Digitaria eriantha* (species group P), *Panicum maximum* and *Enneapogon cenchroides* (species group S).

Two subcommunities within the *Commiphora glandulosa - Enneapogon cenchroides* community were identified:

2.1 The *Indigofera bainesii - Aristida congesta* subcommunity

Vegetation data of Gertenbach (1976 & 1987) contributed to the identification of this subcommunity, which is restricted to the undulating landscapes originated from basalt. Occurring on the mid- to footslopes, this subcommunity is characterised by a moderate to dense bush savanna on shallow clayey soil. Diagnostic species for this subcommunity are represented in species group H, Table 8. Although representing a subcommunity of the *Commiphora glandulosa - Enneapogon cenchroides* community, it is strongly related to the *Themeda triandra – Acacia nigrescens* community on melanic clay (species groups I & J). The tree *Commiphora glandulosa* (species group G) is dominant in the woody layer together with *Colophospermum mopane*, *Grewia bicolor* and to a lesser extent *Acacia nigrescens* (species group S). Forbs such as *Seddera capensis* (species group G), *Heliotropium steudneri* (species group J), *Tephrosia polystachya* (species group L), *Rhynchosia totta* (species group M) and *Hibiscus micranthus* (species group P) dominate the herbaceous layer together with grasses including *Aristida congesta*, *Schmidtia pappophoroides* (species group P) and *Enneapogon cenchroides* (species group R).

2.2. The *Phyllanthus parvulus - Combretum apiculatum* subcommunity

Vegetation data of Van Rooyen (1978) contributed to the identification of this subcommunity. The *Phyllanthus parvulus - Combretum apiculatum* subcommunity is confined to treeveld on deep, moderately alcalic clay derived from basalt, andesite and shale. It is well presented by the *Colophospermum mopane – Commiphora glandulosa – Seddera capensis* and the *C. mopane – Euclea divinorum – Enteropogon macrostachys* communities of the Punda Milia – Pafuri – Wambiya district in the northern Kruger National Park (Van Rooyen 1978). The landscape varies from flat terrain to steep slopes (Van Rooyen 1978). Although the soil contains high percentages clay, the texture is fine-grained revealing non-vertic clays.

Species group K, Table 8 represents the diagnostic species for the *Phyllanthus parvulus - Combretum apiculatum* subcommunity. *Combretum apiculatum* (species group P), *Colophospermum mopane* and *Grewia bicolor* (species group S) dominate the woody component whilst *Aristida congesta, Digitaria eriantha* (species group P), *Enneapogon cenchroides* (species group R) and *Panicum maximum* (species group S) dominate the grass layer. Forbs that are significantly present include *Phyllanthus parvulus*, *Neuracanthus africanus* (species group K) and *Hibiscus micranthus* (species group P).

3. The *Euclea divinorum – Panicum maximum* community

Vegetation data of Gertenbach (1976) and Van Rooyen (1978) contributed to the identification of this community, which represent *Colophospermum mopane* vegetation on dark-coloured, fine to medium textured loamy sand to clayey, alcalic soil (Van Rooyen 1978). These soils are derived mainly from different geological substrates such as shale, andesite, rhiolite, granite and basalt.

The *Euclea divinorum - Panicum maximum* community is usually found on plains as well as on gentle slopes. This dense shrub- to treeveld is recognizable from the almost sole dominance of *Colophospermum mopane* trees and *Euclea divinorum* high shrubs (species group N) and is therefore related to the Mopaneveld on shale (*Euclea divinorum – Colophospermum mopane* major plant community). The annual rainfall for this community varies between 500 mm and 550 mm (Gertenbach 1980).

Diagnostic species for the *Euclea divinorum - Panicum maximum* community are listed in species group N, Table 8. *Euclea divinorum* is the local character species whereas *Colophospermum mopane* (species group S) dominates the woody layer. Dominant in the grass layer are *Aristida congesta*, *Digitaria eriantha* (species group P), *Enneapogon cenchroides* (species group R) and *Panicum maximum* (species group S).

4. The *Combretum mossambicense – Colophospermum mopane* community

Vegetation data of Gertenbach (1976) and Purchase (1997) contributed to the identification of this community. The *Combretum mossambicense – Colophospermum mopane* community is commonly found on alluvial floodplains or bottomlands in the basaltic landscapes where it represents a high treeveld. Percentage clay in the soil varies between 15 and 55. Due to the extensive alluvial plains in the distribution of the Lowveld Mopaneveld, the annual rainfall of this community varies significantly. Species group Q, Table 8 represents the diagnostic species for this community of which many species are annuals. *Colophospermum mopane* is well presented in this community (species group S), whereas other woody species occurring in lesser dominance include *Maytenus senegalensis*, *Grewia flavescens* (species group Q), *Combretum mossambicense* (species group R), *Combretum imberbe* and *Lonchocarpus capassa* (species group S). Annual forbs such as *Achyranthes aspera*, *Sida cordifolia* (species group Q) and *Pupalia lappacea* (species group R) dominate the herbaceous layer indicating the disturbance typically associated with alluvial plains along drainage lines. The only common grass species in this community is *Panicum maximum* (species group S).

Table 6 Synoptic presentation of the four vegetation units in the Lowveld Mopaneveld

Vegetation type	1	2	3	4
Number of relevés	**145**	**425**	**383**	**158**
Species Group A				
Terminalia sericea	65	3	14	.
Combretum zeyheri	28	1	8	3
Agathisanthemum bojeri	25	5	9	1
Trichoneura grandigluma	31	2	8	2
Perotis patens	39	1	13	0.6
Hibiscus engleri	14	3	3	1
Mundulea sericea	25	5	5	3
Brachiaria nigropedata	41	9	6	0.6
Hermannia glanduligera	17	4	2	4
Combretum collinum	18	7	3	1
Monsonia angustifolia	10	3	10	6
Monechma debile	10	6	6	2
Pteleopsis myrtifolia	11	.	.	.
Guibourtia conjugata	10	.	.	.
Pseudolachnostylis maprouneifolia	15	0.9	.	.
Brachiaria serrata	10	1	4	1
Aristida mollissima	32	0.9	3	0.6
Strychnos madagascariensis	40	4	8	.
Boscia albitrunca	16	5	4	0.6
Hemizygia bracteosa	16	0.7	8	.
Tephrosia longipes	20	1	2	1
Aristida meridionalis	17	0.5	3	.
Fimbristylis complanatus	25	3	5	1
Zornia species	15	0.5	2	.
Xenostegia tridentata subsp. *angustifolia*	41	2	6	.
Species Group B				
Cenchrus ciliaris	0.7	26	7	4
Rhynchosia minima	0.7	11	3	6
Sorghum versicolor	.	12	0.8	0.6
Setaria incrassata	.	18	0.8	4
Neorautanenia amboensis	.	15	.	.
Urochloa brachyura	2	11	0.5	.
Neuracanthus africanus	1	11	0.8	6
Fingerhuthia africana	.	19	9	8
Species Group C				
Vigna unguiculata	52	15	8	2
Vernonia fastigiata	37	21	10	9
Indigofera heterotricha	11	12	2	3
Species Group D				
Grewia monticola	7	9	18	8
Ximenia americana	5	5	13	4
Sporobolus fimbriatus	2	8	12	8
Sporobolus panicoides	0.7	0.2	12	0.6
Sida chrysantha	.	0.5	14	7
Leucas neuflizeana	.	.	27	5
Vernonia poskeana	0.7	1	14	4
Monsonia burkeana	1	1	11	5
Sansevieria hyacinthoides	0.7	2	12	10
Enneapogon scoparius	2	5	25	9

Vegetation type	1	2	3	4
Number of relevés	145	425	383	158
Heliotropium strigosum	7	4	17	6
Kyllinga alba	10	4	19	4
Aristida scabrivalvis	.	0.2	28	5
Tricliceras laceratum	0.7	.	13	0.6
Aristida stipitata subsp. *graciliflora*	0.7	.	18	.
Seddera suffruticosa	.	0.5	13	4
Commiphora pyracanthoides	0.7	.	18	2
Grewia subspathulata	.	0.5	28	3
Limeum viscosum	4	0.2	18	5
Crabbea velutina	7	5	38	3
Rhinacanthus xerophilus	1	2	15	9
Chascanum hederaceum	2	0.9	11	3
Sesamum alatum	5	0.2	16	7
Commiphora mollis	8	4	23	1
Coccinia rehmannii	.	2	17	8
Aptosimum lineare	7	4	42	6
Species Group E				
Kohautia virgata	35	13	21	8
Clerodendrum ternatum	37	33	43	7
Ozoroa engleri	24	13	13	0.6
Combretum mossambicensis	15	13	17	6
Lonchocarpus capassa	19	22	16	9
Species Group F				
Peltophorum africanum	15	6	21	5
Ceratotheca triloba	11	5	45	6
Hibiscus sidiformis	10	9	22	8
Ipomoea magnusiana	39	5	25	3
Crotalaria schinzii	17	.	14	3
Chamaesyce neopolycnemoides	24	6	30	4
Polygala sphenoptera	19	6	21	8
Ornithogalum seineri	15	4	17	4
Chamaecrista absus	50	6	22	4
Andropogon gayanus	37	10	15	0.6
Indigofera filipes	15	0.9	24	2
Crotalaria virgulata	14	9	14	4
Bulbostylis hispidula	12	0.5	18	8
Cassia abbreviata	11	5	12	4
Xerophyta retinervis	12	0.7	13	.
Species Group G				
Acacia gerrardii	0.7	8	8	22
Urochloa panicoides	.	.	5	20
Ocimum americanum	3	3	8	25
Geigeria ornativa	.	0.7	5	17
Amaranthus thunbergii	.	1	7	12
Ipomoea coptica	4	1	6	18
Bolusanthus speciosus	0.7	4	8	18
Sida rhombifolia	.	4	3	20
Orthosiphon suffrutescens	5	6	9	17
Trianthema salsoloides	.	0.2	2	17
Hypertelis salsoloides	.	0.2	3	12
Dactyloctenium geminatum	.	.	0.8	11
Achyropsis leptostachys	1	0.2	0.3	17

Vegetation type	1	2	3	4
Number of relevés	145	425	383	158
Cyathula lanceolata	.	0.9	2	13
Zanthoxylum humile	.	0.9	1	10
Sporobolus ioclados	1	0.9	0.3	10
Dactyloctenium aegyptium	3	2	5	24
Abutilon guineense	3	5	2	18
Chloris roxburghiana	.	4	1	12
Species Group H				
Dicoma tomentosa	8	7	59	15
Eragrostis lehmanniana	0.7	1	11	10
Chloris virgata	3	5	12	49
Acalypha indica	9	9	52	16
Asparagus setaceus	7	9	47	27
Talinum caffrum	8	6	29	25
Oropetium capense	6	5	26	14
Indigofera rhytidocarpa	10	9	36	21
Boerhavia diffusa	.	5	12	13
Hermbstaedtia odorata	6	5	23	23
Cucumis africanus	8	7	19	22
Indigofera lupatana	7	5	10	15
Phyllanthus incurvus	.	0.7	14	11
Melhania prostrata	1	0.2	30	14
Endostemon tereticaulis	1	0.5	49	15
Phyllanthus asperulatus	.	0.7	28	11
Aristida adscensionis	1	5	65	29
Gisekia africana	3	0.9	17	13
Tribulus terrestris	0.7	2	13	17
Sporobolus nitens	.	3	12	54
Portulaca kermesina	.	0.2	25	29
Abutilon austro-africana	0.7	6	30	70
Justicia anagalloides	1	2	12	13
Chlorophytum galpinii	2	2	14	12
Ehretia amoena	1	4	15	15
Commelina erecta	8	3	17	15
Pupalia lappacea	4	6	25	36
Justicia flava	0.7	5	12	38
Melhania rehmannii	1	7	22	10
Corbichonia decumbens	.	8	19	15
Solanum coccineum	0.7	3	18	25
Achyranthes aspera	0.7	4	13	11
Hibiscus pusillus	2	8	12	17
Grewia flavescens	3	3	29	16
Grewia villosa	.	2	25	10
Brachiaria deflexa	0.7	4	46	17
Grewia hexamita	4	2	20	11
Species Group I				
Pavonia burchellii	3	11	30	30
Blepharis integrifolia	8	10	21	37
Maytenus heterophylla	9	14	24	22
Acacia tortilis	2	10	10	23
Sida dregei	9	12	17	23
Brachiaria xantholeuca	5	13	17	11
Ormocarpum trichocarpum	6	11	21	32

Vegetation type	1	2	3	4
Number of relevés	**145**	**425**	**383**	**158**
Maerua parvifolia	8	20	44	36
Euclea divinorum	7	15	20	55
Combretum hereroense	9	25	25	35
Seddera capensis	4	31	25	42
Themeda triandra	1	45	14	41
Bothriochloa insculpta	3	37	10	10
Terminalia prunioides	0.7	13	35	11
Tragus berteronianus	8	13	82	71
Bothriochloa radicans	0.7	12	32	37
Commiphora glandulosa	5	13	7	10
Combretum imberbe	4	27	9	13
Ehretia rigida	6	18	4	17
Panicum coloratum	5	29	9	26
Species Group J				
Waltheria indica	43	6	63	25
Melhania didyma	11	5	20	16
Mariscus rehmannianus	11	6	24	31
Indigofera bainesii	20	9	23	14
Tricholaena monachne	55	9	47	12
Leucas glabrata	30	7	36	26
Crotalaria sphaerocarpa	23	5	13	13
Limeum fenestratum	17	2	29	11
Cyperus rupestris	15	4	34	15
Kyphocarpa angustifolia	39	8	81	70
Species Group K				
Panicum maximum	81	68	87	87
Aristida congesta	71	73	86	80
Digitaria eriantha	94	74	61	52
Colophospermum mopane	48	83	42	30
Combretum apiculatum	87	50	86	13
Grewia bicolor	35	43	86	70
Enneapogon cenchroides	28	44	72	44
Cissus cornifolia	65	45	78	17
Sclerocarya birrea	41	26	51	12
Melinis repens	46	15	48	4
Dichrostachys cinerea	52	48	64	40
Urochloa mosambicensis	25	52	65	83
Pogonarthria squarrosa	78	19	52	12
Ziziphus mucronata	12	12	20	18
Lannea schweinfurthii	33	19	31	10
Acacia nigrescens	10	53	61	49
Cymbopogon plurinodis	10	23	27	22
Hermannia boraginiflora	16	10	59	13
Eragrostis superba	11	44	20	34
Dalbergia melanoxylon	41	34	24	22
Schmidtia pappophoroides	63	55	69	35
Albizia harveyi	25	22	26	35
Phyllanthus pentandrus	12	11	13	25
Heteropogon contortus	37	54	27	20
Commiphora africana	21	25	38	18
Ipomoea crassipes	21	17	15	20
Phyllanthus species	21	19	19	22

Vegetation type	1	2	3	4
Number of relevés	145	425	383	158
Chamaecrista mimosoides	27	21	25	15
Rhynchosia totta	36	36	42	18
Tragia dioica	11	17	20	30
Ipomoea obscura var. *obscura*	10	19	16	22
Lantana rugosa	12	18	31	35
Solanum panduriforme	17	29	35	55
Hibiscus micranthus	35	37	86	55
Flueggea virosa	12	22	29	23
Heliotropium steudneri	10	25	56	38
Tephrosia polystachya	57	37	83	53
Acacia exuvialis	11	23	43	30
Corchorus asplenifolius	24	25	67	39
Eragrostis rigidior	38	27	63	33
Indigofera vicioides	23	22	39	16
Phyllanthus maderaspatensis	15	23	27	16
Commelina benghalensis	17	15	48	39
Ruellia patula	10	14	46	52
Evolvulus alsinoides	37	11	74	49
Melhania forbesii	18	15	60	42
Commelina africana	28	10	36	20

Table 7 Phytosociological table of the *Terminalia sericea - Colophospermum mopane* major plant community

Relevé numbers (Turboveg database)	18	33	94	134	163	198	200	48	78	81	145	155	174	182	184	204	213	214	226	285	298	306	344	363	384	398	426	486	364	584	325	399	424	459	477	489	513	678	728	621	664	686	694	700	715	724	750	631	641	647	723	746	747	659	674	719	722	763	665	667	669	671
Community number	1																																							2																						
	1.1																	1.2																						2.1														2.2								
Species Group A																																																														
Clerodendrum ternatum	a	a	+	a	1	a	a	.	.	1	+	.	1	.	.	.	1	.	.	+	.	+	+	.	.	+	+	.	.	.	+	.	.	+	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Heteropogon contortus	.	+	.	.	1	.	.	.	+	+	1	.	+	1	.	+	+	+	+	+	.	+	+	+	.	.	1	+	1	+	.	.	.	.	a	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Kohautia virgata	.	+	1	.	.	.	.	.	+	.	1	+	.	1	1	.	1	+	+	1	+	+	.	.	1	.	.	1	.	.	.	.	.	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
Eragrostis rigidior	.	1	.	.	+	.	.	1	a	1	.	.	a	1	.	.	+	1	.	.	+	+	.	.	+	+	+	+	.	.	1	1	.	+	+	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Commelina benghalensis	1	+	.	1	.	+	+	+	.	+	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Indigofera bainesii	.	.	a	+	a	.	.	+	.	+	.	.	.	a	.	1	+	1	+	.	+	+	+	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chamaesyce neopolycnemoides	.	.	+	.	.	.	.	+	+	.	.	.	.	+	.	.	.	.	.	.	.	.	+	+	.	+	.	.	+	.	+	+	.	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Urochloa mosambicensis	.	.	.	.	+	+	.	+	+	+	.	.	1	+	+	+	+	+	.	.	.	+	.	.	.	.	.	.	.	a	.	.	.	+	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Albizia harveyi	1	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	1	.	.	.	+	+	.	+	.	.	1	+	.	.	.	+	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ruellia patula	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Commiphora africana	+	.	.	.	+	.	.	.	.	.	.	.	.	.	+	+	.	+	.	.	.	.	+	.	+	+	.	.	.	.	.	1	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ipomoea crassipes	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	+	+	.	+	.	.	.	.	.	.	+	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Phyllanthus species	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	+	.	+	.	.	+	+	+	+	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Limeum fenestratum	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	+	.	+	.	+	1	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Mariscus rehmannianus	+	.	+	+	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Heliotropium steudneri	1	.	+	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Blepharis integrifolia	.	.	.	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Combretum hereroense	.	.	.	1	.	.	a	.	.	.	.	.	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Oxygonum alatum	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species Group B																																																														
Indigofera filipes	.	1	a	.	.	.	.	+	1	1	.	+	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sida dregei	.	.	+	.	+	.	.	+	.	+	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Maytenus heterophylla	.	.	.	.	+	.	.	.	.	.	.	.	+	.	1	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acacia burkei	.	.	.	.	.	1	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Thunbergia dregeana	.	.	.	.	+	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chascanum hederaceum	.	+	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Limeum viscosum	.	1	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species Group C																																																														
Talinum caffrum	+	+	+	+	.	+	r	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Limeum sulcatum	.	.	1	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.

Relevé numbers (Turboveg database)	18	33	94	134	163	198	200	48	78	81	145	155	174	182	184	204	213	214	226	285	298	306	344	363	384	398	426	486	364	584	325	399	424	459	477	489	513	678	728	621	664	686	694	700	715	724	750	631	641	647	723	746	747	659	674	719	722	763	665	667	669	671
Community number	1																																							2																					
	1.1																	1.2																						2.1														2.2								
Merremia kentrocaulos	.	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sporobolus africanus	.	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pterodiscus aurantiacus	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Phyllanthus pentandrus	.	.	.	.	.	.	.	+	+	+	.	.	+	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
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Helichrysum candolleanum	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Orthosiphon suffrutescens	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Urochloa brachyura	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cucumis hirsutus	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Justicia anagalloides	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chascanum adenostachyum	.	.	.	.	.	.	.	.	.	.	.	.	a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Ozoroa engleri	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	+	.	+	.	.	+	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Phyllanthus maderaspatensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	+	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Indigofera vicioides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	1	+	.	.	.	+	1	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
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Crotalaria schinzii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	+	1	.	.	+	+	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Indigofera heterotricha	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	1	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Jatropha zeyheri	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aristida meridionalis	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	a	.	.	.	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hemizygia bracteosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	a	a	.	.	.	.	a	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
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Hemizygia elliottii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Trichoneura grandiglumа	.	.	+	.	.	.	.	+	+	+	1	+	+	.	+	+	+	+	+	+	1	+	+	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ornithogalum seineri	+	+	.	+	.	+	.	.	+	.	+	.	+	.	+	+	+	+	+	+	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Polygala sphenoptera	.	.	+	.	.	.	.	.	+	+	.	.	.	.	.	.	+	.	+	.	+	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Brachiaria serrata	+	1	+	+	.	.	.	a	.	.	1	.	.	.	.	+	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acacia exuvialis	.	.	.	.	.	+	.	.	+	a	.	.	.	+	+	+	.	.	.	.	.	.	+	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ipomoea obscura v. obscura	r	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Stylosanthes fruticosa	.	.	.	+	.	.	.	.	.	+	+	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Melhania didyma	.	.	.	r	.	.	.	+	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.

Relevé numbers (Turboveg database)	18	33	94	134	163	198	200	48	78	81	145	155	174	182	184	204	213	214	226	285	298	306	344	363	384	398	426	486	364	584	325	399	424	459	477	489	513	678	728	621	664	686	694	700	715	724	750	631	641	647	723	746	747	659	674	719	722	763	665	667	669	671
Community number	1																																							2																					
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Species Group H																																																													
Litogyne gariepina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	a	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ocimum americanum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Euclea divinorum	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	+	+	.	.	+	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bothriochloa insculpta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	a	b	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rhigozum zambesiacum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Kyllinga alba	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tricliceras glandulifera	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Hermannia boraginiflora	.	.	.	.	.	.	.	+	.	.	.	.	1	.	+	+	+	+	.	.	.	.	.	.	+	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Tragia dioica	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	+	.	.	.	+	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eragrostis superba	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cyperus rupestris	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	+	+	.	.	.	.	.	.	+	.	.	+	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Xerophyta retinervis	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Ceratotheca triloba	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Pseudolachnostylis maprouneifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	r	.	.	1	.	r	r	.	1	.	.	.	1	r	r	r	r
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Pteleopsis myrtifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	r	.	.	.	.	.	.	.	.	.	.	.	.	1	r	.	r	r
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Spermacoce senensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	+	.	.	+	1	.	+	.	.	.
Tephrosia elongata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	a	+	+	+	.
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Hibiscus engleri	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	+	.	.	+	.	+	.	+	+	.	.	.	+	.	.	.
Species Group K																																																													
Combretum collinum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	r	r	+	r	.	r	.	r	.	+	.	r	.	.	.	.	.	.	.	.	.	.	r
Hermannia glanduligera	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	.	.	.	.	+	+	+	+	+	.	+	+	+	.	.	.	.	1	.	.	.	.
Spirostachys africana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	r	.	.	.	r	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.
Strychnos decussata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	r	r	.	.	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Catunaregam spinosa	a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	r	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.
Monechma debile	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Species Group L																																																													
Eragrostis pallens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	3	1	1	3	b	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Indigofera inhambanens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tarenna zygoon	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Relevé numbers (Turboveg database)	18	33	94	134	163	198	200	48	78	81	145	155	174	182	184	204	213	214	226	285	298	306	344	363	384	398	426	486	364	584	325	399	424	459	477	489	513	678	728	621	664	686	694	700	715	724	750	631	641	647	723	746	747	659	674	719	722	763	665	667	669	671
Community number	1																																							2																						
	1.1																	1.2																						2.1														2.2								
Chamaesyce tettensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Vangueria infausta	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	r	r	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Polygala wilmsii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	1	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
Vitex ferruginea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	r	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
Xeroderris stuhlmannii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Turraea obtusifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hugonia orientalis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species Group M																																																														
Cassia abbreviata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	r	1	.	.	+	.	.	.	.	.	.	.	.	r	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hibiscus sidiformis	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Grewia monticola	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species Group N																																																														
Sclerocarya birrea	.	.	r	.	.	.	.	+	1	.	.	.	.	.	.	.	1	+	+	+	+	+	r	r	.	.	+	+	1	+	.	+	.	.	+	+	1	.	.	r	.	.	.	r	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aristida mollissima	r	.	.	.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	.	+	+	+	+	1	+	.	.	+	+	.	+	.	.	.	.	.	.	.	.	.	+	.	.	.	b	.	b	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lannea schweinfurthii	.	.	+	r	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	+	+	.	+	1	.	+	+	.	+	.	+	+	.	.	.	.	.	.	.	r	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species Group O																																																														
Cissus cornifolia	.	1	1	1	+	.	1	.	+	1	+	+	1	+	1	1	+	.	+	+	+	1	1	.	+	+	1	+	+	1	+	+	+	+	+	+	+	+	+	.	r	.	r	r	.	r	.	.	+	.	.	.	.	.	.	.	.	.	r	.	.	.
Chamaecrista mimosoides	.	+	.	+	+	+	1	+	+	+	.	.	.	+	.	.	+	.	.	.	.	+	.	.	.	+	+	+	.	+	.	.	+	+	.	.	+	.	+	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Crotalaria virgulata	.	.	+	.	.	.	+	+	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species Group P																																																														
Hymenocardia ulmoides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	.	r	r	1	.	.	+	.	.	.	.	.	r
Manilkara mochisia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	.	.	.	b	.	.	.	.	.	.	.	.	.
Commelina erecta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	+	+	.	.	.	.	.	.	.	.	.
Pupalia lappacea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	+	.	.	+	.	.	.	.	.	.	.	.	.
Rhoicissus revoilii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.
Leonotis nepetifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	1	.	.	.	.	.	.	.	.	.
Species Group Q																																																														
Dalbergia melanoxylon	.	.	.	.	.	.	.	+	+	.	+	1	+	1	.	.	+	.	.	.	.	+	.	.	.	.	+	.	1	+	.	.	+	+	.	+	.	.	.	r	r	.	.	r	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Ziziphus mucronata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.
Lantana rugosa	.	.	.	.	.	.	.	.	.	1	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
Acacia nigrescens	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	1	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Lonchocarpus capassa	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	+	.	+	.	.	.	.	+	.	.	r	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Acalypha indica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.
Indigofera rhytidocarpa	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
Species Group R																																																														
Schmidtia pappophoroides	.	+	.	a	a	.	b	1	1	+	+	.	+	+	.	+	b	.	+	+	.	+	b	+	1	+	a	.	a	.	.	.	.	.	1	+	.	+	.	.	3	.	+	1	.	b	1	.	+	+	3	.	.	.	.	.	.	.	.	.	.	.
Perotis patens	+	1	1	1	.	.	.	+	+	+	1	1	+	.	1	.	a	.	1	+	1	+	.	.	1	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	1	.	3	.	.	.	1	1	+	.	.	.	.	.	.	.	.	.
Terminalia sericea	1	.	b	b	a	a	.	+	1	1	b	a	.	.	a	.	1	.	+	b	b	a	a	.	b	a	.	a	.	.	.	.	1	+	.	.	+	.	.	r	r	+	r	r	.	r	r	.	.	.	.	r	b	.	.	.	.	.	.	.	.	r

Relevé numbers	1 1 1 2	1 1 1 1 1 2 2	2 2 2 2 3 3 3 3 3 4 4 3	5 3 3 4 4 4 4 5 6 7	6 6 6 6 7 7 7 7	6 6 6 7 7 7	6 6 7 7 7	6 6 6 6
(Turboveg database)	1 3 9 3 6 9 0	4 7 8 4 5 7 8 8 0 1	1 2 8 9 0 4 6 8 9 2 8 6	8 2 9 2 5 7 8 1 7 2	2 6 8 9 0 1 2 5	3 4 4 2 4 4	5 7 1 2 6	6 6 6 7
	8 3 4 4 3 8 0	8 8 1 5 5 4 2 4 4 3	4 6 5 8 6 4 3 4 8 6 6 4	4 5 9 4 9 7 9 3 8 8	1 4 6 4 0 5 4 0	1 1 7 3 6 7	9 4 9 2 3	5 7 9 1
			1			2		
Community number		1.1		1.2		2.1		2.2
Crotalaria sphaerocarpa	. . + . + . .	. . . . . . + . . .	. . . .	. + . . + . . . + +	. . . . . . + .	. . + . . .	. . . . .	. . . .
Corchorus asplenifolius	. + ...	+	+ + ... + + . .	. . . . . + . + . .	+ + ...	. . . . . .	. . . . .	. . . .
Flueggea virosa	. . . + . . .	+	. . . . + . . . +	. . + ...	. . . .	. 1	. . . . .	. . . .
Maerua parvifolia	. . . . + . .	+ . . . . + .	. . . . . . + . + . . .	. . . .	. . . .	. + ...	. . . . .	. . . .
Species Group S								
Diplorhynchus condylocarpon	. . . .	. . . .	. . . .	. . . .	. . . . . r . .	. . . r . .	. 1 + . a	r r r r
Blepharis maderaspatensis	. . . .	. . . .	. . . .	. . . .	. . . .	. . . . . .	. + + + +	. . + .
Bulbostylis hispidula	+ + + ...	. . . .	. . . .	. . . .	+	. . . . . .	+ + . . .	+ + + +
Rhynchosia venulosa	. . . .	. . . .	. . . .	. . . .	. . . .	. . . . . .	+	. . + +
Species Group T								
Artabotrys brachypetalus	. . . .	. . . .	. . . .	. . . .	. . . . r	. . . . . .	1 . . + .	r . . .
Phyllanthus reticulatus	. . . .	. . . .	. . . .	. . . .	. . . .	. . . . . .	+ . + + .	. . . .
Afzelia quanzensis	. . . .	. . . .	. . . .	. . . .	. . . .	1	+ + + . .	. . . .
Commiphora glandulosa	. . . .	. . . .	. . . .	. + ...	. . . .	. . 1 . . .	+ . + + .	. . . .
Pellaea calomelanos	. . . .	. . . .	. . . .	. . . .	. . . .	. . . . . .	. . + . +	. . . .
Kirkia acuminata	. . . .	. . . .	. . . .	. . . .	. . . .	+ 1	+ + . 1 1	. . . .
Species Group U								
Hippocratea crenata	. . . .	. . . .	. . . .	. . . .	. . . . . . r r	. . . . . .	. + . . .	. . . .
Corchorus kirkii	. . . .	. . . .	. . . .	. . . .	. . + + . . . 1	. . . . . .	. + . . +	. . . .
Rhynchosia resinosa	. . . .	. . . .	. . . .	. . . .	. . . + . . . +	. . . . . .	. . + 1 .	. . . .
Boscia albitrunca	. . . .	. . . .	. . . . . . + ... +	. . . . 1 .	r . . . r r r .	. . . . . .	+ . + . .	. . . .
Species Group V								
Colophospermum mopane	. . . .	3 . . . . . b . a .	+ + + . 1 . 1 + + 1 + r	1 a b b a a b a a 1	. . . .	. . . . . .	1	. . . .
Melinis repens	. . . .	. . . . . + + + + +	1 . + . + + + . + + . +	. + . . + . + a . .	. . . .	+	1 . + + .	. . . .
Enneapogon cenchroides	. . . .	. . + ... + +	+ . . . . + + . + + . +	. + ... 1 .	. . . . + . . .	+	a . . + .	. . . .
Combretum mossambicens	. . . .	. . . . + +	. . . . + . . +	. . + ... + .	. . . . . . r .	. . . . . .	. . . + .	. . . .
Species Group W								
Aristida congesta	+ m 1 + . + +	a a a m + b + + a +	1 + + + + + 1 . + 1 + +	. + . 1 + + 1 a + +	3 . . b 1 . . .	. . . . . .	1 + + + .	. . . .
Tephrosia polystachya	. . . + 1 + b	1 . + 1 . + + . . .	1 . . . . + + + + + . .	+ 1 1 + . 1 + + + +	. + + + + . . .	. . . . . .	+ + . . .	. . . .
Chamaecrista absus	+ + + . + . .	. a . . . . + + . .	. + + + 1 1 . 1 + + . +	+ + + . 1 + . + + .	+ . . . . + + +	+	. . . + .	. . . .
Grewia bicolor	. . . . . . b	. . . .	+ . . + . + . . + + . +	+ . + ... + 1	. r . r . . r .	. . . . . .	. . . + +	. . . .
Zornia species	. . + ...	1 . . + ...	. . . . + . . 1	. + . + ...	. . . . . + . +	. . . . . .	+ + + . .	. . . .
Solanum panduriforme	. . . + . + .	. + . . . + . . + .	. . . . . + ...	. . + ... + 1	. . . .	. + . . . +	. . . 1 .	. . . .
Tragus berteronianus	. . . . . + .	. . + ...	. . . .	. . . .	. . . .	. . . . . .	+	. . . .
Indigofera lupatana	. . . + . 1 .	+ . . + . + + . + .	. . . .	. . . .	. . . .	+	. . . . a	. . . .
Commiphora mollis	. . . . . + .	. . . . + .	. . . .	+ . . . . . . + . .	. . . .	. . . . . .	. + . + .	. . . .

Relevé numbers	1 1 1 2	1 1 1 1 1 2 2	2 2 2 2 3 3 3 3 3 4 4 3	5 3 3 4 4 4 4 5 6 7	6 6 6 6 7 7 7 7	6 6 6 7 7 7	6 6 7 7 7	6 6 6 6
(Turboveg database)	1 3 9 3 6 9 0	4 7 8 4 5 7 8 8 0 1	1 2 8 9 0 4 6 8 9 2 8 6	8 2 9 2 5 7 8 1 7 2	2 6 8 9 0 1 2 5	3 4 4 2 4 4	5 7 1 2 6	6 6 6 7
	8 3 4 4 3 8 0	8 8 1 5 5 4 2 4 4 3	4 6 5 8 6 4 3 4 8 6 6 4	4 5 9 4 9 7 9 3 8 8	1 4 6 4 0 5 4 0	1 1 7 3 6 7	9 4 9 2 3	5 7 9 1
	1				2			
Community number	1.1		1.2		2.1		2.2	
Species Group X								
Diheteropogon amplectens	. . . .	. . . . . + ...	. . . .	. . . .	. . . .	. . . . . .	. . . . .	. 1 . .
Buchnera longespicata	. . . .	. . . .	. . . .	. . . .	. . . .	. . . . . .	. . . . .	. + . .
Tylosema fassoglense	. . . .	. . . .	. . . .	. . . .	. . . .	. . . . . .	. . . . .	. . + .
Corchorus junodii	. . . .	. . . .	. . . .	. . . .	. . . .	. . . . . .	. . . . .	. . + .
Heteropyxis natalensis	. . . .	. . . .	. . . .	. . . .	. . . .	. . . . . .	. . . . .	. . + .
Ectadiopsis oblongifolia	. . . .	. . . .	. . . .	. . . .	. . . .	. . . . . .	. . . . .	. . + .
Parinari curatellifolia	. . . .	. . . .	. . . .	. . . .	. . . .	. . . . . .	. . . . .	. . . +
Zornia linearis	. . . .	. . . .	. . . .	. . . .	. . . .	. . . . . .	. . . . .	. . . +
Decorsea schlechteri	. . . .	. . . .	. . . .	. . . .	. . . .	. . . . . .	. . . . .	. . . +
Species Group Y								
Cheilanthes viridis	. . . .	. . . .	. . . .	. . . .	. . . .	. + + . . .	. . + + +	+ . + +
Triumfetta pentandra	. . . .	. . . .	. . . .	. . . .	. . . .	. . . . + .	. . + . .	+ . . .
Holarrhena pubescens	. . . .	. . . .	. . . .	. . . .	. r	. . . + r 1	. . . . .	r r . r
Bauhinia galpinii	. . . .	. . . .	. . . .	. . . .	. r	. . . + . .	. . . . .	r . r r
Monodora junodii	. . . .	. . . .	. . . .	. . . .	. . . .	. + . r r 1	. . . . .	r . . .
Maytenus mossambicensis	. . . .	. . . .	. . . .	. . . .	. . . .	. . + r . .	. . . . .	. . r .
Hexalobus monopetalus	. . . .	. . . .	. . . .	. . . . 1 . .	. . . .	. 1 . r r 1	+ . . + .	r . . r
Species Group Z								
Digitaria eriantha	a b b b a b b	a a a 1 . 1 b . a b	a b a b b b . a b a a b	4 + . a a b b a 3 3	b 5 b 3 5 3 4 1	3 b a 4 4 b	+ a b . b	3 1 + 5
Panicum maximum	1 a a + a 1 b	1 1 b a 3 1 + b 1 +	+ + . . . + + + + + + +	+ + . 1 1 + + . 3 b	1 + 4 1 1 b 1 3	+ b 3 1 3 4	. . 1 3 .	. 1 1 .
Combretum apiculatum	a a b . a 1 +	b b 3 a 1 b + a a b	3 a b a b b b b b b a b	3 a 1 a b b 1 a a b	r r r r r r . .	. 1 b . . .	+ b 3 a 3	. . . r
Pogonarthria squarrosa	1 1 1 + + b a	+ + 1 a 1 1 1 a 1 1	1 1 1 b a 1 a a 1 . 1 +	. 1 1 + . + a 1 + .	+ . . 1 . . . b	. + . 1 1 1	1 1 . . a	b + . 1
Hibiscus micranthus	+ . + + + + +	+ . . . . . . + + .	+ . . + + ... + . +	. . . . + +	. . + ...	+ + + . . .	. . . + .	+ . . .
Vigna unguiculata	+ . . 1 1 + 1	+ . . 1 . . . . . +	. . + + + + . + ...	+ . + . + + + . + .	+ + + + + . . +	+ + + + + .	. . . . .	+ + . .
Leucas glabrata	+ . + . + + +	+ + . + ... +	. . . . . + ... +	. + . . 1	+ . . . . + . .	. . + . . .	. . . . .	+ . . .
Dichrostachys cinerea	1 . + a . 1 1	. . . + . + . 1 1 +	+ + + + + + + . + + + +	. + ... + + +	. r r . . . . r	. . 1 . . +	. . . . .	. . r .
Evolvulus alsinoides	. + . + . . +	. + + + + . + + . .	. . . . + . .	. + . . + . + . . +	. + + ...	. . . . . .	+ + . + .	+ . . .
Commelina africana	. + . 1 + . +	+ . . + . + + . . +	. . . . . + ... +	. . . . . + + . . .	. . . r r . . .	. + ...	. . . . .	. . . +
Xenostegia tridentata s. angustifolia	. . . + . 1 +	. . . . + + . + . +	. + + 1 1 + . + . + + .	+ . + ...	. . . + . + + +	. . . . . +	. . . . .	+ + . +
Rhynchosia totta	. . + . . + .	+ + + + + + . + + +	+ . . . . 1 + . + + . .	. . . . . + + + . +	. . + ...	. . + + . .	. . + . +	. . + .
Peltophorum africanum	. . . . + . .	. . . .	. . + . . 1 . . . + . .	. . . .	. . . .	. + . r . .	. . . . .	+ . r .
Combretum zeyheri	. 3	. b a b b . . a . .	. . . . 1 .	a	r r . . . . . r	. 1 1 r . .	. + a . .	. r r r
Waltheria indica	. . + ...	+ + . . . 1 + + . +	. . + + + 1 . + . . + .	. 1 + ... 1 . +	. . . . +	+ . + + . .	1 + + + 1	+ . . +
Agathisanthemum bojeri	. . + ...	+ + . + + + + + + +	. . + ... + . . 1 .	. . . .	. . + ... +	. . . + . .	. . . . +	. . + .
Kyphocarpa angustifolia	. . 1	. + + . + + + + + +	+ . . + + + . + . . . +	. . . + + . . + + .	. . + + ...	. . + . . .	+ + + + +	+ . . .
Tricholaena monachne	. . + ...	. . + + + + + + + +	+ + + + . + . 1 1 a + .	. + 1 . . + + . 1 .	. . + + 1 . . +	. . . . . .	. . . 1 .	+ . . +
Tephrosia longipes	. . + ...	. . . 1 . . . + . +	. + 1 + . + + . . . + .	. . . . + . .	. . . . . + . .	. . + . . .	+ + . . .	. . . +

Relevé numbers	1 1 1 2	1 1 1 1 1 2 2	2 2 2 2 3 3 3 3 3 4 4 3	5 3 3 4 4 4 4 5 6 7	6 6 6 6 7 7 7 7	6 6 6 7 7 7	6 6 7 7 7	6 6 6 6
(Turboveg database)	1 3 9 3 6 9 0	4 7 8 4 5 7 8 8 0 1	1 2 8 9 0 4 6 8 9 2 8 6	8 2 9 2 5 7 8 1 7 2	2 6 8 9 0 1 2 5	3 4 4 2 4 4	5 7 1 2 6	6 6 6 7
	8 3 4 4 3 8 0	8 8 1 5 5 4 2 4 4 3	4 6 5 8 6 4 3 4 8 6 6 4	4 5 9 4 9 7 9 3 8 8	1 4 6 4 0 5 4 0	1 1 7 3 6 7	9 4 9 2 3	5 7 9 1
Community number	1				2			
	1.1		1.2		2.1		2.2	
Andropogon gayanus	. . 1	+ . . . . 1 +	1 + + + + . a . 1 1 . +	. . . . + + 1 . . .	. . . .	. . 1 . 1 b	. . a . .	b 4 4 4
Melhania forbesii	. . . .	+ . . . . + . + + .	. . . .	. + ... + +	. . + . + . . .	+ . 1 . . .	. . . 1 .	. . + .
Strychnos madagascariensis	. . . .	+ 1 a 1 1	. . . . + a . . 1 . . .	. . . . + . . + . .	. . . . r r r .	+ + . r r .	. . + 1 1	. . + .
Ipomoea magnusiana	. . . . +	+ . . . . +	+ . . 1 . + + + 1 . . .	. + . . + + ...	+ . . . . + + .	. . . . + +	. . . . .	. + . .
Brachiaria nigropedata	. . . .	. + ...	. . a . . + + a . . a +	. + . + a + + + . 1	. + 1 + . . . 1	. . . . . .	. a . . a	+ . . b
Vernonia fastigiata	. . . .	. . a . 1 . + + . .	. + . . + . 1 + . . + .	. . . . 1 + + + + .	. . . . . + . .	. . . + . +	. + + 1 1	+ + . +
Mundulea sericea	. . . .	. . . .	. . + + + . 1 . . . 1 +	. . . . + ...	. . . .	. 1 1 . . .	. 1 . . .	. . r .
Tricliceras schinzii	. . . .	. . . + ...	. . . . + + . . + . . .	. . . .	. . . .	. . . . . .	. . . + +	. . + .
Crabbea velutina	. . . .	. . . .	+ . . . . + . . .	. . . .	. . . + ...	+	. . . + .	. . + +
Tricalysia junodii	. . . .	. . . .	. . . .	. + ... + . .	. . . .	. . + . . .	. + . . +	r . . .
Asparagus setaceus	. . . .	. . . .	. . . .	. . . . + +	. . . .	. + + . . .	. . . . .	. . . +

Table 8 Phytosociological table of the *Acacia nigrescens* - *Colophospermum mopane* major plant community

Relevé numbers (Turboveg database)								
			1	1		1	1	1 2 2 1
	4 5 5 5 5 5 5 6	4 4 4 4 5 7 4 4	2 2 2 4 5 5 5	1 1 1 1 3	1 2 2 2 3 3 5	5 6 6 6 7 6 7 6	3 4 5 6 6 7 6 6	6 0 0 4 4 5 4 9
	8 2 3 7 7 7 9 7	4 4 6 9 8 6 0 4	3 4 8 7 0 1 7 4	1 1 6 3 3 7 9 2	9 9 1 6 7 3 8 1	9 1 1 3 3 2 0 4	3 3 7 0 7 0 5 3	3 1 1 0 0 4 8 3
	0 3 5 2 5 7 1 2	6 7 5 7 3 9 3 3	9 0 0 0 9 2 4 5	2 4 5 7 8 0 5 3	3 0 5 3 2 2 3 4	6 2 3 8 2 2 6 4	7 3 9 1 6 2 0 4	1 2 5 5 8 9 2 8
Community number	**1**				**2**		**3**	**4**
	1.1		**1.2**		**2.1**	**2.2**		
Species Group A								
Themeda triandra	1 3 a a . . b +	3 3 1 . 4 b r .	1 1 . + + . + .	1 3 + 1 b b b +	1	. . . .	. . . . . + . a	. . . .
Eragrostis superba	. + . . . + + .	. + . + + + . 1	. + . + . . 1 .	+ 1 + . + + + +	. . . . . + . .	. . . + ...	. + ...	. . . .
Chamaecrista mimosoides	. + + . . + + .	. + ...	. . . + + . . .	+ . . + + + + +	. . . .	. . . .	. . . . . . + .	. . . .
Heteropogon contortus	+ 1 . 1 . + 1 .	+ . . a + . . +	1 + . + . + + +	. . + . + + . 1	1 1 + . . . + .	+ + ...	. . . .	. . + ...
Albizia harveyi	+ . . + + . + .	+ . . . + . . .	. . + + . . r .	. 1 + . + . . .	+	. . . .	. . . .	. . . .
Ormocarpum trichocarpum	. . . . . . + 1	. + . . + . + .	. . + . + . . .	. . . . . 1 + +	. . . .	. . . .	. . . .	. . . . + . . .
Cymbopogon plurinodis	b + . + + + . .	. . . .	. . . . . 1 . +	. 1 1 . + 1 . +	. . . .	. . . .	. . . .	. . . .
Species Group B								
Setaria incrassata	. 1 + b 5 3 b 5	a . 3 . + b . +	. . + . . . + .	. . . .	. . . . a	. . . .	. . . .	. . . . 1 . . .
Ozoroa engleri	+ 1 . + . . + .	+ . . . + . . .	. . . + . + . .	. . . .	. . . .	. . . .	. . . .	. . . .
Jatropha zeyheri	+	. . + + . . . +	. . . .	. . . . r	. . . .	. . . .	+	+ . . . .
Cenchrus ciliaris	. + + . . + . .	1 + . a 1 . + .	. . . .	1	. + + ...	. . . + ...	+	. 1 . + + . . .
Species Group C								
Combretum collinum	b a a b a a b +	. . . .	. . . . . + . .	. . . .	. . . .	. . . .	. . + ...	. . . .
Neorautanenia amboensis	+ + + + + + + .	+ + ...	. . . + ...	. . . .	. . . .	. . . + ...	. . + ...	. . . .
Pterocarpus rotundifolius	1 + a + b a 1 .	. . . . . + . .	. . . .	. . . .	. . . .	. . . .	. . + ...	. . . .
Urochloa brachyura	+ . 1 1 + a . .	. . . .	. . . . . 1 . .	. . . . + . . .	. . . .	. . . .	. . . .	. + + ...
Oxalis semiloba	. + + + . + + .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .
Acacia gerrardii	. . . . + . + a	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .
Cassia abbreviata	+ . . + . . + .	. . . .	. . . . . + . .	+	. . . . . + . .	. . . . +	. . + ...	. . . .
Brachiaria nigropedata	+ . . . . . + .	. . . .	. . . .	. . . .	. . . .	. . . 1	. . . . . . + .	. . . .
Aspilia mossambicensis	. + . + . + . .	. . . .	. . . . . + . .	. . . .	. . . .	. + + ...	. . . .	+ . . . .
Crabbea velutina	. . . + . . + .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .
Ximenia caffra	. . . + + . . .	. . . .	. . . . . + . .	. . . .	. . . .	. . . .	. . . .	. . . .
Senna petersiana	. . . . . . + 1	. . . . . + . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .
Species Group D								
Lantana rugosa	. . . + . + . .	. . . .	. + . . . + . .	+ . . + . + . r	+ . . . . + . .	. . . .	. . . .	. . . .
Lannea schweinfurthii	. . . + + . . .	. . . .	. . . + + . + .	. + 1 . . r . .	. . . .	. . . . . . + .	. . + ...	. . . .

Relevé numbers			. . . . . . 1 .	 1		 1	 1	1 2 2 . . . 1 .
(Turboveg database)	4 5 5 5 5 5 5 6	4 4 4 4 5 7 4 4	2 2 . 2 4 5 5 5	. . . 1 1 1 1 3	1 . 2 2 2 3 3 5	5 6 6 6 7 6 7 6	3 4 5 6 6 7 6 6	6 0 0 4 4 5 4 9
	8 2 3 7 7 7 9 7	4 4 6 9 8 6 0 4	3 4 8 7 0 1 7 4	1 1 6 3 3 7 9 2	9 9 1 6 7 3 8 1	9 1 1 3 3 2 0 4	3 3 7 0 7 0 5 3	3 1 1 0 0 4 8 3
	0 3 5 2 5 7 1 2	6 7 5 7 3 9 3 3	9 0 0 0 9 2 4 5	2 4 5 7 8 0 5 3	3 0 5 3 2 2 3 4	6 2 3 8 2 2 6 4	7 3 9 1 6 2 0 4	1 2 5 5 8 9 2 8
Community number	1				2		3	4
	1.1		1.2		2.1	2.2		
Species Group E								
Eragrostis rigidior	. . + ...	. 1	+ . 1 . 1 + 1 .	 1	. . . .	. . . .	. + ... +	. . . .
Pogonarthria squarrosa	. . . .	. . . .	. . 1 + + + . .	. . . . + . . .	. . . .	. . . . . . + .	. . . .	. . . .
Aristida adscensionis	. . . .	. . . .	. . + . . . + .	. . + ...	. . . .	. . . .	. . . . +	. . + ...
Sida dregei	. . . .	. . . .	+ . . + . + . .	. + ...	. + ...	. . . . +	. + ...	. . . .
Blepharis integrifolia	. . . . . + . .	. . . .	. + . . + . r .	. + ...	. . . .	. . . .	. . . .	. . . .
Commelina africana	. . . .	. . . .	+ + ...	. . . .	. . . .	. . . .	. . . .	. . . .
Melhania didyma	. . . .	. . . .	. + ... +	. . . .	. . . .	. . . .	. . . .	. . . .
Chamaecrista absus	. . . .	. . . .	. . . . + + . .	. . . . +	. . . .	. . . .	. . . .	. . . .
Abutilon austro-africanum	. . . .	. . . .	+ . + ...	. + ...	. . . .	. . . .	. . . .	. . . .
Species Group F								
Bothriochloa radicans	. . . .	. . . .	b a . . . . 1 .	a . 1 3 a . 1 4	. 1 b	. . . .	. . . .	. . . .
Sclerocarya birrea	+ . . . . r . .	. . . . r . . .	. . . . . r . .	4 + . + + + . r	r r . . . + . .	. . . . + . . +	. . . .	. . . .
Ipomoea crassipes	. . . + ...	. . . . . + . .	. . . .	+ . + + . + . .	. . . .	. . . .	. . . .	. . . .
Ehretia amoena	. . . .	. . . .	. . . .	+ . . + . . . r	1	. . . .	. . . .	. . . .
Polygala sphenoptera	. . . .	. . . .	. . . .	. . . + . . + .	. . . . + . . .	. . . .	. . . .	. . . .
Eragrostis ciliaris	. . . .	. + ...	. . . .	+ . . + ...	. + ...	. . . .	. . . .	. . . .
Cyperus obtusiflorus	. . . .	. . . .	. . . .	+ . . . + . . .	. + ...	. . . .	. . . .	. . . .
Merremia palmata	. . . .	. . . .	. . . .	+ . . . . 1 . .	. . . .	. . . .	. . . .	. . . .
Hibiscus pusillus	. . . . . + . .	. . . .	. . . .	. . + ... +	. . . .	. . . .	. . . .	. . . .
Species Group G								
Commiphora glandulosa	. . . .	. . . .	+	. . . .	+ + + 1 . + 1 +	1 . + 1 + . . .	. . . 1	+ . . . .
Seddera capensis	. . . .	. + ... +	. + . + . . r 1	. . . .	+ + + + + + + +	. + . + + + . .	. . . + . + . .	. . . .
Terminalia prunioides	. . . .	. . . .	. . . .	. . + ...	1 . 1 . . a . +	. . . . 1 a . +	. . . . . 1 . .	. . . .
Species Group H								
Indigofera bainesii	. + ...	. . . .	. . . .	. . . .	1 a + ... +	. . . .	. . . .	. . . .
Orthosiphon suffrutescens	+	. . . .	. . . .	. . . .	+ . + . . 1 . .	+	. + ...	. . . .
Sericorema remotiflora	. . . . . . + .	. + ...	. . . .	. . . . . . + .	. . 1 . + . . +	. . . .	. . . .	. . . .
Merremia kentrocaulos	. . . .	. . . .	. . . .	. . . .	. . + . . + . .	. . . .	. . . .	. . . .
Ipomoea magnusiana	. . . .	. . . .	. . . .	. . . .	+ . + ...	. . . .	. . . .	. . . . . . + .
Species Group I								
Commiphora africana	. . . .	. . . . +	+ + . + + + . .	. . + . . . 1 .	+ . + . . + + .	. . . .	. . . .	. . . .
Tragia dioica	. . . .	. . . .	. . + . . + . .	. 1 + . . + . .	+ . . a . . . +	. . . .	. . + ...	. . . . . . + .

Relevé numbers (Turboveg database)								
			1	1		1	1	1 2 2 1
	4 5 5 5 5 5 5 6	4 4 4 4 5 7 4 4	2 2 2 4 5 5 5	1 1 1 1 3	1 2 2 2 3 3 5	5 6 6 6 7 6 7 6	3 4 5 6 6 7 6 6	6 0 0 4 4 5 4 9
	8 2 3 7 7 7 9 7	4 4 6 9 8 6 0 4	3 4 8 7 0 1 7 4	1 1 6 3 3 7 9 2	9 9 1 6 7 3 8 1	9 1 1 3 3 2 0 4	3 3 7 0 7 0 5 3	3 1 1 0 0 4 8 3
	0 3 5 2 5 7 1 2	6 7 5 7 3 9 3 3	9 0 0 0 9 2 4 5	2 4 5 7 8 0 5 3	3 0 5 3 2 2 3 4	6 2 3 8 2 2 6 4	7 3 9 1 6 2 0 4	1 2 5 5 8 9 2 8
Community number	1				2		3	4
	1.1		1.2		2.1	2.2		
Melhania rehmannii	. . . .	. . . .	+ . . . . . + +	. . . .	. . + + . + . .	. . . . . + . .	. . . .	. . . .
Kohautia virgata	. . . . + . . .	. . . .	. . + ... +	. 1	. + ...	. . . .	. . . .	. . . .
Acacia exuvialis	. . . .	. . . .	+ + . . + . + .	+ . . . . 1 . r	. . . 1 + . + 1	. . . .	. + ...	. . . .
Chamaesyce neopolycnemoides	. . . .	. . . .	+	. . + + ...	. + ...	. . . .	. . . .	. . . .
Phyllanthus species	. . . .	. . . . +	. . + ... +	+ + + ...	. . . + + + . .	. . . .	. . . .	+ . . . .
Pavonia burchellii	. . . .	. . . . +	+	+ . + ... +	1 . + ... +	. . . .	. . . .	. . . .
Cucumis africanus	. . . .	. . . . +	. . + ...	. . + ...	. + ...	. . . .	+	. . . + ...
Brachiaria xantholeuca	. . . .	. . . . . . + .	. . . + ...	+ + + ...	. . . + a . . .	. . . .	+	. . . .
Species Group J								
Panicum coloratum	. 1 1 . . . + .	+ . . 1 a . b .	a 1 . + . . b .	+ . . . . 1 . r	1 . b a	. . . .	. . . .	. . . . +
Ipomoea obscura v. obscura	. . . + + + + .	+ . . . + . . .	. . . + . + . .	. . + . + + . .	. . . . + . . .	. . . .	. . + ...	. . . .
Heliotropium steudneri	. . . .	. + + + ...	. . . .	a a + a . + + +	+ . + 1 1 . + +	. . . .	. . . .	. . . .
Rhynchosia minima	1 . . 1	. . . + 1 . . .	. . . .	. . . . 1 . . .	. . + ... +	. . . .	. . . .	. . . .
Clerodendrum ternatum	. . . .	. 1 . + . . + +	. + . . + + + +	+ 1 . . . + . .	. a . 1 + + + .	. . . .	. . . .	. + ...
Hybanthus enneaspermus	. . . .	. . + . . . + +	. . . . +	. . . . . . r .	. . . + + + . .	. . . .	. . . .	. . . .
Indigofera schimperi	. . . .	. . . + . . . +	. . . .	. . . .	. . . . 1 . 1 .	. . . .	1	. . . .
Species Group K								
Phyllanthus parvulus	. . . .	. . . . . + . .	. . . .	. . . .	. . . .	+ + + . 1 . + .	. . . .	. . . .
Chamaesyce tettensis	. . . .	. . . .	. . . .	. . . .	. . . .	. + + + . + + .	. . . .	. . . .
Neuracanthus africanus	. . . .	. . . + . + . .	. . . .	. . . .	. . + . + . . .	+ + . + + + + .	+	. . . .
Monechma debile	. . . .	. . . .	. . . . . + . +	. . . .	. + ...	. + + . + . + .	. . . + ...	. . . .
Becium obovatum	. . . .	. . . .	. . . .	. . . .	. . . .	. + . . + . . .	. . . . + . . .	. . . .
Commiphora mollis	. . . .	. . . .	. . . .	. . . .	. . . . . + . .	. + . . + . . .	. . . .	. . . . a
Acalypha indica	. . . .	. . . .	. . . . +	. . . .	. . . .	. . + . . + + .	+	. . . . . . + .
Kirkia acuminata	. . . .	. . . .	. . . .	. . . .	. . . .	+ + ...	. . . .	. . . .
Hermbstaedtia odorata	. . . .	. . . .	. . . .	. + ...	. . . .	. . + . . . + .	. . . .	. . . .
Dalechampia galpinii	. . . .	. . . .	. . . . + . . .	. . . .	. . . .	+ . . . + . . .	. . . .	. . . .
Aptosimum lineare	. . . .	. . . .	. . . . +	. . . .	. . . .	. . + + ...	. . . .	. . . .
Indigofera heterotricha	. . . .	. . . + . . + .	. . . .	. . . .	. . . . . . + .	+ . + . . + . .	. . . .	. . . .
Evolvulus alsinoides	. . . .	. . . .	. . . .	. . . + . + . .	+	+ + + . + . . .	. . . .	. . . .
Sorghum versicolor	. . . .	. . . . . . + +	. . . .	. . . .	. . . . +	+ + . . + . . .	. . . .	. . . .

Relevé numbers (Turboveg database)								
			1	1		1	1	1 2 2 1
	4 5 5 5 5 5 5 6	4 4 4 4 5 7 4 4	2 2 2 4 5 5 5	1 1 1 1 3	1 2 2 2 3 3 5	5 6 6 6 7 6 7 6	3 4 5 6 6 7 6 6	6 0 0 4 4 5 4 9
	8 2 3 7 7 7 9 7	4 4 6 9 8 6 0 4	3 4 8 7 0 1 7 4	1 1 6 3 3 7 9 2	9 9 1 6 7 3 8 1	9 1 1 3 3 2 0 4	3 3 7 0 7 0 5 3	3 1 1 0 0 4 8 3
	0 3 5 2 5 7 1 2	6 7 5 7 3 9 3 3	9 0 0 0 9 2 4 5	2 4 5 7 8 0 5 3	3 0 5 3 2 2 3 4	6 2 3 8 2 2 6 4	7 3 9 1 6 2 0 4	1 2 5 5 8 9 2 8
Community number	1				2		3	4
	1.1		1.2		2.1	2.2		
Species Group L								
Tephrosia polystachya	. . . .	. . . . +	+ + . a + . + 1	. + 1 + + 1 . +	+ + . + + + . +	+ . . . + . + .	. . . .	. . . .
Fingerhuthia africana	. . . .	. . . .	. + ... 1	. . + ...	. + . . + + + .	+ . . + ...	. . . .	. . . .
Corbichonia decumbens	. . . .	. . . .	. . . . . . r .	+ . 1	. . . + ...	. . + . + . . .	. . . .	. . . .
Species Group M								
Phyllanthus maderaspatensis	. . . + . . + .	. . + . . + . .	. . . .	. . . . +	. . . + + . . .	. . . + ...	. . . .	. . . .
Corchorus asplenifolius	. . . + + . + .	. . + ...	+	+ . . . . . + +	. + . + + . . .	. . . . + . . .	. . . .	. . . .
Hermannia glanduligera	. . . + . . . +	. . . .	. . . .	. . . .	. . . .	. . + . + . . .	. . . .	. . . .
Rhynchosia totta	. . . . +	+ . + 1 . . + .	. + . + . + + .	. + ...	+ + + . + + + .	. . + + ...	. . . .	. . . .
Species Group N								
Euclea divinorum	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. 1 + . b . a .	. . . .
Chloris roxburghiana	. . . .	. . . .	1	. . . . r	. . . .	. . . .	. 1 + . . . 1 .	. . . .
Ruellia patula	. . . .	. . . .	. + ...	. . . .	. . . .	. . . .	+ + + ...	. . . .
Asparagus plumosus	. . . .	. . . .	. . . + ...	. . . .	. . . .	. . . .	+ . + ...	. . . .
Zanthoxylum capense	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . 1 . + . .	. . . .
Species Group O								
Abutilon fruticosum	. . . .	. . . .	. . . .	. . . .	. . . .	. . + . 1 + . .	. . . + + . . .	. . . .
Sporobolus fimbriatus	. . . .	. . . .	. . . . + . . .	. . . .	. . . .	. . . + ...	. . . . + 1 . .	. . . .
Elytraria acaulis	. . . .	. . . .	. . . .	. . . .	. . . .	+ . . . . + . .	. . . + . . + .	. . . .
Megalochlamys revoluta	. . . .	. . . .	. . . .	. . . .	. . . .	+ . . . . + . .	. . . + ...	. . . .
Enteropogon macrostachys	. . . .	. . . .	. . . .	. . . .	. . . .	. . . . . + . .	. . . . 1 . + .	. . . .
Ximenia americana	. . . .	. . . .	. . . .	. . . .	. . . .	. . . . . + . .	. . . . + 1 . .	. . . .
Leucas glabrata	. . . .	. . . .	. . + ...	. . . .	. + ...	. . + . + . . .	. . . . + + . .	. . . .
Barleria lancifolia	. . . .	. . . .	. . . .	. . . .	. . . . . + . .	. + . . + . . .	. . . . . + + .	. . . .
Species Group P								
Aristida congesta	+ 1 + . . + + .	. + . . + . 1 +	+ a 1 + 1 . + .	+ + b + + + . +	+ a 1 1 + 1 + a	a a 4 + a . a +	+ 1 . + a 3 . .	. . . . . + . .
Digitaria eriantha	a . b . . . . +	. 1 . . + . a a	+ a b b 1 b + a	a a b b a 1 1 a	a a . 1 a a . .	a a 1 1 . . 3 .	. + b + a a . .	. . . . r
Hibiscus micranthus	. . . .	. . . .	+ . . . + + + .	. . . + . . . +	+ + + 1 + + . +	+ + + + 1 + + .	. . + + + + . .	. . . .
Bothriochloa insculpta	1 1 . . . + . 1	. . . a . + b b	. . . a a + . .	. . . .	. . . b a 1 3 .	. . + . a 1 . .	. b 1 . . . . +	. . . .
Combretum apiculatum	+ . r 1 + 1 + .	. . . + . . . b	. + . a . 1 . .	. a . . . . . +	. . . + . + . +	3 b b 1 b . a +	. . a	. . . .
Schmidtia pappophoroides	. + ...	. + . b . 1 + 1	+ . . + + . 1 .	. + 1 . + + . 1	b a . a a + 1 1	. . . 1 . + + .	. . . + . 1 . .	. . . . + . . .
Cissus cornifolia	+ . . + ...	. . . + . . . +	+ . . 1 1 1 + +	. 1 1 . . + . .	. . . + . + . .	+ . . + . . . +	. . + ... +	. . . .
Vernonia fastigiata	. . + ...	. . + . . 1 . +	+ + + . . + . .	1 1 + ...	. . . . + . . +	. . + + ...	. . . . + . . .	. . . .

Relevé numbers			. . . . . . 1 .	 1		 1	 1	1 2 2 . . . 1 .
(Turboveg database)	4 5 5 5 5 5 5 6	4 4 4 4 5 7 4 4	2 2 2 4 5 5 5	1 1 1 1 3	1 2 2 2 3 3 5	5 6 6 6 7 6 7 6	3 4 5 6 6 7 6 6	6 0 0 4 4 5 4 9
	8 2 3 7 7 7 9 7	4 4 6 9 8 6 0 4	3 4 8 7 0 1 7 4	1 1 6 3 3 7 9 2	9 9 1 6 7 3 8 1	9 1 1 3 3 2 0 4	3 3 7 0 7 0 5 3	3 1 1 0 0 4 8 3
	0 3 5 2 5 7 1 2	6 7 5 7 3 9 3 3	9 0 0 0 9 2 4 5	2 4 5 7 8 0 5 3	3 0 5 3 2 2 3 4	6 2 3 8 2 2 6 4	7 3 9 1 6 2 0 4	1 2 5 5 8 9 2 8
Community number	1				2		3	4
	1.1		1.2		2.1	2.2		
Melhania forbesii	. . . . . + . .	. . . .	. . . .	. . . . +	. . . . +	. . . .	. . + + ...	. . . .
Indigofera vicioides	. + . + + + + +	. . . . a	. . . . . . + +	. . . .	. . . + . 1 . .	. + + + ...	. . + . + . . .	. . . .
Maerua parvifolia	. . . .	. . . .	. + . . + . . .	. . . .	. . + ...	. . . . . + . .	. + + 1 . + . .	. . . .
Crotalaria virgulata	. . . .	. . . . . . + .	. . . + ...	. . . + + . . .	. . . .	. . . .	. . . . + + . .	. . . .
Tragus berteronianus	. . . .	. . . .	. . . + + . . .	+ + ... 1	. + ...	. . . .	+ . . . + . . .	. . . .
Phyllanthus pentandrus	. . . .	. . . .	. + + ...	+ + ... + .	. + ...	+ . . . + + + .	. . . . . + . .	. . . .
Indigofera rhytidocarpa	. . + ...	. . . .	. . . . . + . +	. . + . + . . r	. . . + ...	. . + . + + . .	. . . . . . + .	. . . .
Asparagus setaceus	. . . .	. . . .	. . . .	. . + ... r	. + ...	. . . . + . . .	. . . + + . . .	. . . .
Species Group Q								
Achyranthes aspera	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. + + 1 . . + .
Sida cordifolia	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. + ... 1 +
Tragus koelerioides	. . . .	. . . .	. . . .	. . . .	. . . .	. . . . +	. . . . +	+ 1 . . . . . .
Chloris virgata	. . . .	. . . .	. . + ...	. . . .	. . . .	. . . .	. . . .	. 1 . + ...
Maytenus senegalensis	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . + . . 1 .
Hibiscus engleri	. . . .	. . . .	. . . .	. . . .	. . . .	. . . . . + . .	. . . . . + . .	. + + ...
Grewia flavescens	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . + . . . 1 .
Abutilon guineense	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	+	. . . + . + . .
Species Group R								
Enneapogon cenchroides	. . + ...	. . . . . . + +	. 1 . . . . . +	r . + . . . + .	+ a 1 1 a + + .	. a + b 1 1 1 .	+ . + 1 + 3 . +	b . + . + . . a
Pupalia lappacea	. . . .	. . . .	. . . .	. . . .	. . . . + . . .	. + . . 1 + . .	. . . + + + . .	. . + + . + + .
Kyphocarpa angustifolia	. . . .	. . . .	. + + ...	. . + ...	. . . . . + . .	. . + . + . . .	. . + . . . + .	. + ...
Combretum mossambicense	. . . .	. . . .	. . . .	. . . .	. . . . +	. . . .	. . + + . + . .	. . . + + 1 1 +
Calostephane divaricata	. . . .	. . . .	. . . .	. . . .	. + . . 1 + . .	. . . .	. . . .	. r + . + . . .
Acacia tortilis	. . . .	. . . .	. . . .	. . . .	. . . . + . + .	. . . .	. . . . 1 . . .	. . . . . 1 . .
Species Group S								
Colophospermum mopane	1 + . 1 . + + .	. 3 a 3 b 1 3 b	b 3 4 b 3 3 4 b	. . b . . . . a	. 3 . 4 3 3 b 3	a 1 a b b a a a	4 4 b 3 b b 3 4	1 a a 1 + a . +
Panicum maximum	. . + . . + . .	+ . . . . 1 a +	+ + + . . . a .	a b 1 1 1 + b 1	1 a 1 + . a . 1	. 1 + a 1 . a .	+ + b . b . 3 1	. 1 + 3 1 b 5 .
Acacia nigrescens	+ + . + 1 + + +	. . + . . 1 . +	r . . 1 . + . +	a 1 3 1 + a b r	a b a . . + . 1	. . . . . 1 + .	. . . a . + . .	. . + . + . r .
Urochloa mosambicensis	a b b + . a . .	. + . . + . + +	1 . . . a a 3 .	+ + a + a + . .	. + + + 1 1 . a	. . . .	a . 1 . . . . +	+ . . a 3 b . .
Dichrostachys cinerea	+ + . . a . + 1	1 + . + . 1 + +	. + . + + + . 1	1 1 + ... r	a . + + + . + .	. + . + ...	. + + ...	. . . + + + r .
Combretum imberbe	+ + . + . + . +	a 1 . 1 + 1 r +	. . . .	. . . + r . . .	. + ... +	+	. . . .	. . . 1 + 1 1 .
Combretum hereroense	. 1 + + . + . .	. . . + ...	. . . . +	. + . . 1 . . .	. . . .	. . . .	. . + . + . . +	. . . . . . 3 .
Tephrosia multijuga	. . . .	+ . 1 + . . 1 .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . . a . . b

Relevé numbers																							1									1																1								1	1	2	2				1	
(Turboveg database)	4	5	5	5	5	5	5	6	4	4	4	4	5	7	4	4	2	2		2	4	5	5	5				1	1	1	1	3	1		2	2	2	3	3	5	5	6	6	6	7	6	7	6	3	4	5	6	6	7	6	6	6	0	0	4	4	5	4	9
	8	2	3	7	7	7	9	7	4	4	6	9	8	6	0	4	3	4	8	7	0	1	7	4	1	1	6	3	3	7	9	2	9	9	1	6	7	3	8	1	9	1	1	3	3	2	0	4	3	3	7	0	7	0	5	3	3	1	1	0	0	4	8	3
	0	3	5	2	5	7	1	2	6	7	5	7	3	9	3	3	9	0	0	0	9	2	4	5	2	4	5	7	8	0	5	3	3	0	5	3	2	2	3	4	6	2	3	8	2	2	6	4	7	3	9	1	6	2	0	4	1	2	5	5	8	9	2	8
Community number	1																																2																3								4							
	1.1																1.2																2.1								2.2																							
Grewia bicolor	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	1	.	.	.	.	+	+	+	.	.	a	+	.	+	+	r	1	.	1	.	+	+	1	+	.	a	+	1	1	a	1	1	.	+	+	+	.	1	.	.	.	.	.	.	.	.	1	r
Solanum panduriforme	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	+	+	+	1	.	.	+	.	.	.	.	+	.	.	.	.	.	.	+	+	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	+	.	.	.
Flueggea virosa	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	1	.	.	.	.	.	.	r	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	1	.	.	.	.	.	.	.	+	+	.	r	.
Grewia monticola	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	r
Dalbergia melanoxylon	.	.	.	+	.	+	+	.	+	+	+	.	1	1	.	.	.	+	.	.	.	.	.	1	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	1	1	.	.	+	.	.	+	.	+	.	.	.	.	+	.	.	.
Maytenus heterophylla	.	.	+	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.
Lonchocarpus capassa	.	.	+	.	.	.	.	.	+	+	.	.	+	a	.	1	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	b	+	+	+	.
Commelina benghalensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	+	.	+	.	.	.	+	.	+	.	.	+	+	.	.	.	.	.	.	.	.	.	+	.	a	.	+	.	+	.	.	.	.	.	.	.	.	.	+	.
Ehretia rigida	.	.	.	.	.	.	.	.	+	.	1	.	.	.	.	.	.	.	.	.	+	.	.	1	.	.	.	.	.	.	+	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	+	+	.	.	.

CHAPTER 7

RESULTS

SPECULATIONS ON THE DYNAMICS OF THE MOPANEVELD

This chapter represents a discussion on the particularly interesting results regarding vegetation dynamics, which arouse from the synthesis. These results stimulated interest on the role phytosociological data could play in explaining vegetation dynamics within the Mopaneveld. Since speculations on Mopaneveld dynamics do not fulfil one of the major objectives of the study, no in-depth dynamics study was undertaken, although such a future long-term study is urged.

The structure and outlay of this chapter is slightly different since sufficient background information needs to be included for best expression of the findings. The outlay includes a general study background, methodology, results, discussion and conclusions as to follow the common outlay of a scientific paper for the purpose of possible publication.

7.1 Introduction

African ecosystems have been studied with the assumption that they are potentially stable (equilibrial) systems which become destabilised by human disturbances, such as sustained heavy stocking and grazing, or clearing for agricultural purposes (Chesson & Case 1986; DeAngelis & Waterhouse 1987; Dodd 1994; Ellis & Swift 1988; Sprugel 1991; Laycock 1991; Westoby *et al.* 1989; Rothauge 2000). Stability of equilibrial ecosystems implicates that historical effects, chance factors, and occasional environmental perturbations play a small role. In natural systems, however, the environment is continually changing and species in many communities do not appear to have the attributes for stable equilibria. (Chesson & Case 1986; Sprugel 1991). Stability in ecosystems also involves the orderly and directional process of succession where one association or community of plant species replaces another (Stoddart *et al.* 1975; Milton *et al.* 1994). This implies that, after disturbance, the original climax state will be reached through a predictable sequence of intermediate vegetation stages (Figure 22a). The idea of an area maintained in a dynamic equilibrium by a balance between disturbance and recovery is attractive, because it provides some sense of stability even in the presence of constant change (Sprugel 1991). This view of African savannas has been reviewed (DeAngelis & Waterhouse 1987; Ellis & Swift 1988; Westoby *et al.* 1989; Friedel, 1991; Laycock 1991; Sprugel 1991; Palmer & Van Staden 1992; Behnke & Scoons 1993; Dodd 1994; Milton *et al.* 1994; Illius & O'Connor 1999; Rothauge 2000) and resulted in dynamic, rather than purely static models to explain vegetation change over time. This new tendency retains the idea of species composition change after severe disturbance, but questions the classic process of recovery.

The southern African Mopaneveld prevails under semi-arid conditions, making this extensive vegetation type susceptible to dynamic shifts in plant species composition due to the unpredictability of rainfall in most of its distribution range. This study therefore aims to present possible explanation on the vegetation dynamics of the southern African Mopaneveld according to results obtained during a phytosociological synthesis of the Mopaneveld.

7.2 The study

The Mopaneveld is one of the most distinctive vegetation types in the savanna biome, however, until recently, little was known about its ecology. In southern Africa *Colophospermum mopane* vegetation types cover approximately 555 000 km^2 (Mapaure 1994). In recent history an increase in *Colophospermum mopane* trees and shrub density and a decrease of herbaceous plants are perceived (Smit 1994). Economical implications of such a shift in the vegetation composition emphasised the need to understand the dynamics of Mopaneveld vegetation. Population dynamics of *Colophospermum mopane* have been studied exclusively (Thompson 1960; Scholes 1990; O'Connor 1992; Smit 1994; Smit & Rethman 1998b), but little attention is given to the dynamics of associated herbaceous species.

A phytosociological synthesis on Mopaneveld vegetation in southern Africa is being conducted at the University of Pretoria. Although the synthesis did not aim to give explanations on the dynamics of the Mopaneveld, multivariate analysis revealed useful information on the temporal shifts in plant species composition.

7.3 Methods

Phytosociological data on Mopaneveld vegetation, consisting of 2 298 relevés and 1 465 species selected from vegetation studies undertaken in South Africa, Zimbabwe and Namibia, were incorporated into a TURBOVEG (Hennekens 1996a) database. The first approximation of a vegetation classification, based on the total floristic data set was obtained by the application of Two-Way Indicator Species Analysis (TWINSPAN) (Hill 1979) at a single division level on default cutlevels. This first step of classification procedure separated azonal and intrazonal vegetation from the zonal Mopaneveld data set. This single division classification was repeated until a cluster of purely zonal vegetation resulted. Relevés from azonal and intrazonal types were excluded and stored in a separate database for future analysis. A total of 2 246 relevés representing zonal Mopaneveld were used for further vegetation analysis. A single division application of TWINSPAN to the zonal vegetation was expected to express two major units within the Mopaneveld, maybe indicating the co-existence of two different major higher syntaxa (subclasses or orders) within the Mopaneveld class. The results of this first step in the classification procedures are presented in a synoptic two-way table to facilitate exploration (Table 9). Species of less than 10% presence in both synrelevés were excluded in refinement procedures to produce a clear explanation of species composition.

7.4 Results

Contrary to the expectation, TWINSPAN results did not distinctly separate two different major vegetation units within the Mopaneveld. A vegetation unit representing *Combretum apiculatum* dominance was expected to be separated from *Colophospermum mopane* dominated vegetation. Although *Combretum apiculatum* is more frequently found in cluster 1 (species group A, Table 9), *Colophospermum mopane* (speices group C), occurs in equal percentages in clusters 1 and 2.

The second possible interpretation of the TWINSPAN division is that of a geographical separation between the Western Mopaneveld (Namibian Mopaneveld) and the Eastern Mopaneveld. Parallel to this division is the moisture difference between the more mesic Eastern Mopaneveld, largely represented by species group A, Table 9 and the arid Western Mopaneveld, largely represented by species group B. Although the above interpretation could be related to the location of the majority of sample plots, several sample plots however, did not correspond to this interpretation. These plots were classified into the semi-arid to arid cluster 2, rather than to the cluster representing mesic Mopaneveld (cluster 1), where they indeed belong to. Investigations into the species composition differences between the two clusters revealed that this separation was caused by differences in the herbaceous vegetation, especially in the grass species, rather than in the woody species (Table 9). Table 10 represents a summary on the arrangement of annual grass species and climax grass species along the two major clusters. The definition of annual and climax grass species conform to that of Van Oudtshoorn (1999).

Table 9 Synoptic presentation of the major division of the data set

Cluster number	1	2
Number of relevés	1895	379
Species Group A		
Combretum apiculatum	61	18
Digitaria eriantha	47	2
Acacia nigrescens	37	1
Urochloa mosambicensis	47	0.5
Tragus berteronianus	47	19
Abutilon austro-africanum	15	0.3
Achyranthes aspera	11	6
Aristida congesta s. barbicollis	35	0.8
Blepharis integrifolia	10	0.5
Bothriochloa radicans	16	5
Chloris virgata	10	9
Commelina benghalensis	22	0.3
Euclea divinorum	15	3
Indigofera rhytidocarpa	12	.
Ipomoea crassipes	10	.
Lantana rugosa	14	1
Oropetium capense	13	5
Panicum maximum	60	5
Panicum coloratum	13	6
Pupalia lappacea	12	4
Seddera capensis	21	0.5
Solanum panduriforme	21	4
Sporobolus nitens	10	.
Tragia dioica	12	.
Phyllanthus species	16	0.3
Acacia tortilis	12	6
Albizia harveyi	18	.
Chamaecrista mimosoides	14	.
Commelina africana	15	3
Cymbopogon plurinodis	15	0.3
Eragrostis superba	21	2
Evolvulus alsinoides	31	8
Hermbstaedtia odorata	10	4
Ipomoea obscura	11	5
Lannea schweinfurthii	20	0.8
Ormocarpum trichocarpum	11	.
Pavonia burchellii	14	4
Ruellia patula	18	.
Sclerocarya birrea	29	3
Themeda triandra	17	.
Vernonia fastigiata	10	.
Cissus cornifolia	39	.
Hibiscus micranthus	40	6
Maerua parvifolia	24	0.3
Mariscus rehmannianus	12	.

Cluster number	1	2
Number of relevés	1895	379
Talinum caffrum	10	0.8
Cyperus rupestris	11	.
Flueggea virosa	15	4
Heliotropium steudneri	24	0.5
Kyllinga alba	10	2
Kyphocarpa angustifolia	39	5
Leucas glabrata	17	.
Asparagus setaceus	15	0.3
Dalbergia melanoxylon	20	.
Lonchocarpus capassa	16	0.8
Tephrosia polystachya	35	0.3
Ziziphus mucronata	13	5
Dicoma tomentosa	24	6
Gisekia africana	11	7
Acacia exuvialis	18	.
Aptosimum lineare	17	8
Clerodendrum ternatum	20	6
Combretum imberbe	14	7
Corchorus asplenifolius	25	0.8
Heteropogon contortus	24	9
Rhynchosia totta	23	5
Tricholaena monachne	19	2
Eragrostis rigidior	30	0.8
Pogonarthria squarrosa	25	2
Acalypha indica	15	1
Limeum fenestratum	18	1
Combretum hereroense	18	5
Kohautia virgata	11	.
Grewia monticola	15	0.8
Bulbostylis hispidula	13	5
Chamaecrista absus	13	1
Melhania rehmannii	13	6
Maytenus heterophylla	11	0.3
Ceratotheca triloba	12	0.3
Waltheria indica	21	0.8
Melhania forbesii	21	2
Aristida congesta s. congesta	24	3
Enneapogon scoparius	12	7
Ipomoea magnusiana	14	0.5
Combretum mossambicense	11	3
Hermannia boraginiflor	21	0.3
Commiphora mollis	18	2
Sesamum alatum	11	.
Bothriochloa insculpta	12	.
Indigofera vicioides	16	.
Phyllanthus maderaspatensis	16	5
Brachiaria deflexa	30	4
Aristida congesta	17	7

Cluster number	1	2
Number of relevés	1895	379
Endostemon tereticauli	11	.
Species Group B		
Boscia albitrunca	9	29
Aristida meridionalis	3	12
Monechma divaricatum	2	21
Acacia nilotica	3	14
Chascanum pinnatifidum	0.7	10
Stipagrostis uniplumis	7	43
Otoptera burchellii	0.3	18
Commiphora pyracanthoides	5	20
Croton gratissimus	0.9	21
Asparagus species	1	17
Boscia foetida	0.6	12
Geigeria ornativa	3	12
Terminalia sericea	9	13
Urochloa brachyura	3	13
Tribulus terrestris	10	12
Grewia flava	7	17
Eragrostis trichophora	8	28
Hermannia modesta	1	10
Eragrostis nindensis	0.3	17
Catophractes alexandri	0.1	22
Grewia retinervis	.	14
Acacia mellifera	.	11
Acacia erioloba	0.1	10
Rhigozum brevispinosum	0.1	19
Heliotropium ovalifolium	0.3	10
Enneapogon desvauxii	.	16
Eragrostis echinochloidea	0.1	14
Leucosphaera bainesii	.	24
Anthephora schinzii	0.1	16
Acacia reficiens	.	17
Acacia fleckii	.	11
Anthephora pubescens	.	22
Helinus integrifolius	.	11
Montinia caryophyllaceae	.	14
Schmidtia kalihariensis	.	16
Pechuel-Loeschea leubnitziae	.	11
Pogonarthria fleckii	.	15
Species Group C		
Colophospermum mopane	59	59
Melinis repens	27	29
Grewia flavescens	14	11
Terminalia prunioides	22	36
Schmidtia pappophoroides	40	23
Enneapogon cenchroides	50	46
Dichrostachys cinerea	48	36
Grewia bicolor	52	31

Cluster number	1	2
Number of relevés	1895	379
Commiphora africana	18	10
Aristida adscensionis	27	38
Eragrostis lehmanniana	12	24
Cenchrus ciliaris	11	22

Table 10 Arrangement of diagnostic annual grass species and climax grass species between the two major clusters within Mopaneveld

	Cluster 1	Cluster 2
Total number of diagnostic grass species	19	11
Total number of annual grass species	4	5
Percentage annual grass species	21 %	45 %
Total number of climax grass species	6	2
Percentage climax grass species	31 %	18 %

From the above it is evident that, despite indications of a geographical or moisture induced division in the data set, the major groups (Cluster 1 and Cluster 2) were separated according to the frequency of climax, perennial grass species and the pioneer, annual grass species.

Although the discussion will mainly follow the results obtained from the single division in TWINSPAN, the identification of major vegetation types according to the application of TWINSPAN on default levels of division (6) strongly supported speculations on the dynamics of Mopaneveld vegetation. The *Enneapogon scoparius* – *Colophospermum mopane* major vegetation type is regarded as a transition community between the semi-arid to arid Western Mopaneveld and the more mesic conditions of the South African Lowveld Mopaneveld and the Save River Valley Mopaneveld (Chapter 5). The transition character of the *Enneapogon scoparius* – *Colophospermum mopane* major vegetation type can be supported by its location on the scatter diagram representing major vegetation types along a gradient of decreasing moisture (Figure 19, Chapter 5).

7.5 Discussion

This section focuses on answers related to the following key questions:

1. Considering the Mopaneveld as semi-arid, could non-equilibrial models for vegetation change testify these results?

2. Can phytosociological studies predict aspects of vegetation dynamics?
3. Does the woody component in a system necessarily follow the same model for dynamics as the herbaceous layer?

1. Non-equilibrial models to testify the results

Prior to the discussion of the applicability of non-equilibrial models to Mopaneveld, a few important notes are listed below.

- For the purpose of this discussion, **non-equilibrium / disequilibrium** refers to any situation where species composition and densities do not remain constant over time at each spatial location.
- Most parts of the Mopaneveld can be considered semi-arid since annual rainfall usually ranges below 500 mm. Although some areas in Mopaneveld (e.g. Zambia) receive well over 500 mm rainfall annually, it is still regarded semi-arid since soil moisture availability is limited due to high rainfall intensity (Chapter 3).
- With reference to the synthesis of the Mopaneveld, sample plots that did not correspond to speculations of a geographical separation by TWINSPAN, will be referred to as *odd relevés*. These relevés are all situated in cluster 2 of Table 9.
- These *odd relevés* are mixed in locality. Personal communication with the authors of these relevés revealed that vegetation surveying was undertaken under extreme drought conditions.

Literature review

Plant succession can be defined as the orderly and directional process whereby one plant community replaces another (Stoddart *et al.* 1975). The classical equilibrial theory (Clements 1916) assumes that a single, persistent and characteristic plant community, the climax, would dominate a particular site (Behnke & Scoones 1993; Milton *et al.* 1994). Furthermore the theory is based on predictable, unidirectional, community-orientated vegetation change after a disturbance to eventually reach the climax state again (Westoby *et al.* 1989; Milton *et al.* 1994; Cook 1996; Rothauge 2000) (Figure 22a).

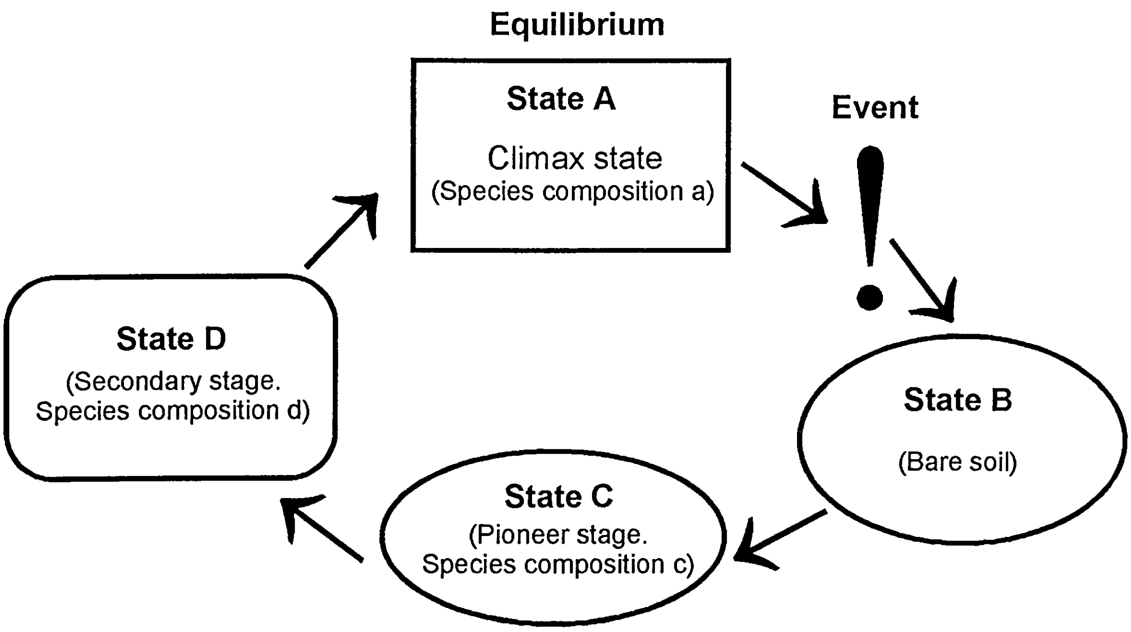
In semi-arid areas of unpredictable and erratic rainfall patterns or often sustained drought conditions, abiotic, rather than biotic events tend to drive system dynamics (O'Connor 1985;

Ellis & Swift 1988; Milton *et al.* 1994; Illius & O'Connor 1999). These stochastic events, usually being associated with soil moisture availability, determine vegetation composition of especially the herbaceous component (O'Connor 1985; Mentis *et al.* 1989; Skarpe 1992; Milton *et al.* 1994). Fluctuations in the herbaceous species composition as a response to episodic events are not consistent with simple successional pathways (Mentis *et al.* 1989; Behnke & Scoones 1993; O'Connor 1999). In the interest of range scientists, it is important to note vegetation change of, especially the herbaceous component. The study of plant species composition as a result of stochastic events evoked interest in the dynamics of semi-arid savanna systems.

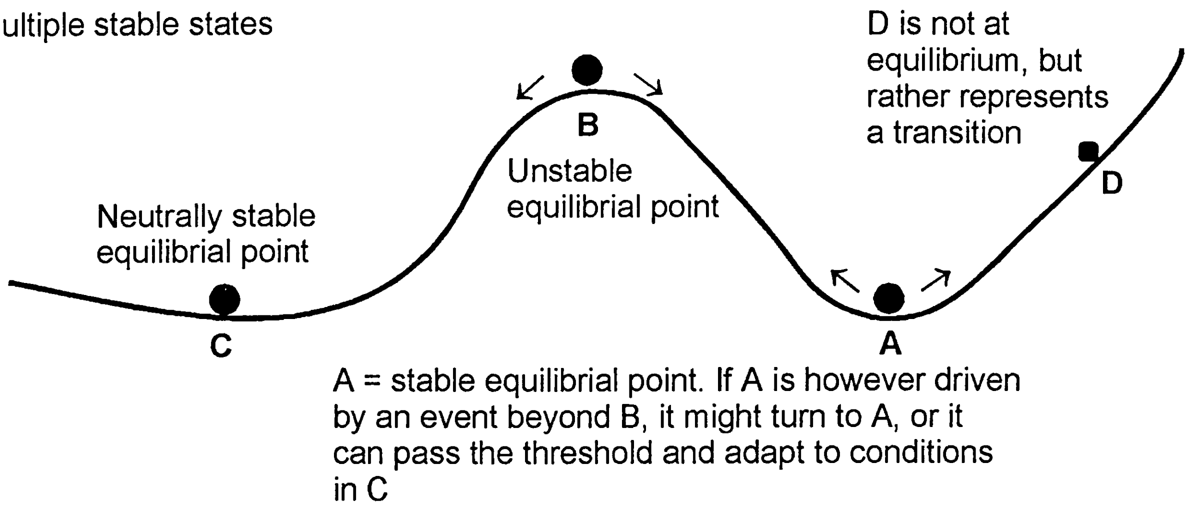
One of the first attempts to explain vegetation change in a model, was the range and succession model which was purely based on principles adapted from Clementsian concepts of plant ecology (Rothauge 2000). The equilibrial theory of Clements (1916) was thought to give a clear explanation of vegetation change until recently. From several studies where the spatio-temporal variation in the herbaceous plant species composition was studied, it became clear that Clementsian concepts of single equilibrium communities and deterministic succession pathways are no longer as dominant in ecology as when it was applied in range management (DeAngelis & Waterhouse 1987; Skarpe 1992; Rothauge 2000). Emphasis moved to ecological theories based on alternative stable states, discontinuous and irreversible transitions, non-equilibrial communities and stochastic events in succession (Westoby *et al.* 1989; Skarpe 1992; Milton *et al.* 1994) (Figure 22b & 22c).

A few non-equilibrial models for vegetaton change were selected to discuss their possible applicability to the situation in the Mopaneveld.

a) Species composition strive towards the climax state over a predictable, unidirectional process of vegetation change following an event



b) Multiple stable states



c) State-and-transition model

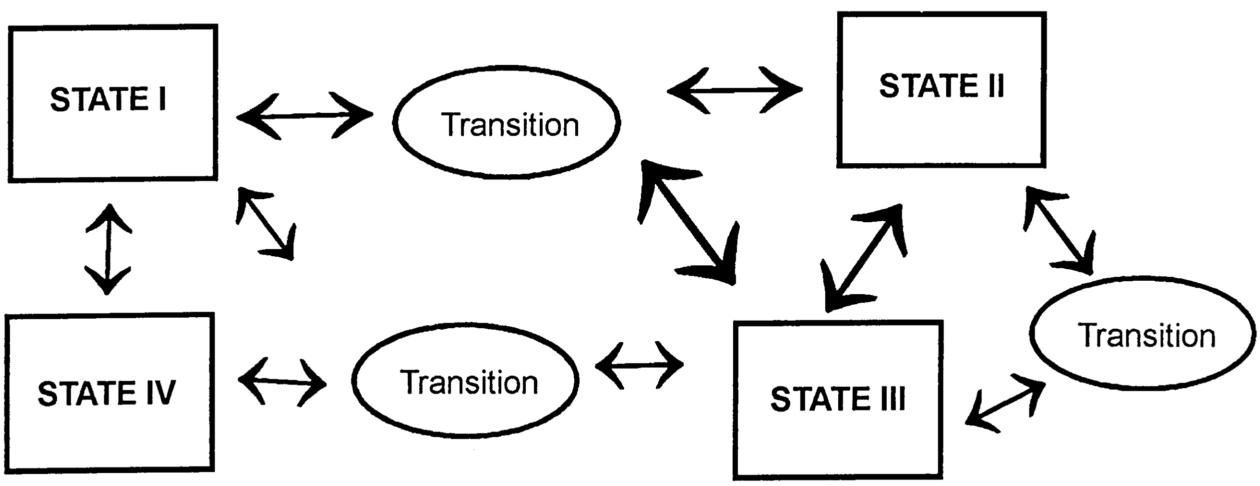


Figure 22 Simplified illustrations for theories of vegetation change: a) Clementsian equilibrial model b) Types of equilibrial points c) Example of dynamic shifts in a state-and-transition model.

Walker *et al.* (1986) suggested that moisture-limited rangelands need to be viewed as event-driven systems and that the management of such systems should be event-orientated. This non-equilibrial approach suggests different states in vegetation composition as a result of different events.

Westoby *et al.* (1989) proposed the state-and-transition model where relatively stable composition of species represent "states" (Figure 22c & Figure 23). This proposed model states that plant communities can exist in several discrete states and can change from one state to the next by means of a transition that was caused by an event. Transitions often require a combination of climatic circumstances and management actions, e.g. grazing or drought, to bring them about. According to Westoby *et al.* (1989) the state-and-transition model is adapted to be applicable to systems driven by catastrophic events, especially in semi-arid rangelands.

Ellis and Swift (1988) define a non-equilibrial but persistent model for arid lands. It is similar to the state-and-transition model of Westoby *et al.* (1989) in that it assumes non-equilibrial community dynamics in arid lands. They added, however, that non-equilibrial systems are usually not responsive to grazing pressure, but instead, almost completely regulated by abiotic controls.

In addition to the state-and-transition model of Westoby *et al.* (1989) and the non-equilibrial viewpoint of Ellis and Swift (1988), concepts on thresholds in vegetation dynamics have been examined both by Friedel (1991) and Laycock (1991). According to Friedel (1991) a threshold can be defined as the boundary between two states and this boundary is not naturally reversible on a practical time scale (Figure 22b). Laycock (1991) stipulated the importance of identifying thresholds and to understand the factors which can force a "stable" community across a threshold into a transitional phase moving towards another "stable state".

These examples are only but a few models for vegetation dynamics in which non-equilibrial systems have relevance. The models are applicable in especially the range science, since biotic events (e.g. grazing) as well as abiotic events (e.g. rainfall, fire etc.) have relevance on vegetation change in especially the herbaceous layer, which consequently influence livestock productivity.

Applicability to results obtained from the Mopaneveld synthesis

The diversity in believes around system dynamics in semi-arid and arid rangelands raises difficulties in drawing a parallel to results obtained from the synthesis of the Mopaneveld. From the literature study it is however clear that non-equilibrial, rather than equilibrial views have relevance in Mopaneveld system dynamics.

Simply by observing Mopaneveld vegetation, it is clear that the herbaceous component varies in composition and density literally from year to year (personal observation in the northern Kruger National Park). It is speculated that the herbaceous vegetation, totally independent of the woody vegetation, is mainly driven by annual rainfall events. If the system is exposed to extremely dry conditions and enhanced by grazing pressure, perennial, palatable grass species are likely to disappear and, following a rainfall event, the species composition might not be in accordance with the composition prior to drought conditions. These observations support non-equilibrial views on Mopaneveld ecosystem dynamics.

O'Connor (1999) appointed scientific value to the above speculations by a long-term study, which was undertaken to depict vegetation change after sustained drought conditions North of the Soutpansberg in South Africa. This study has relevant reference to the synthesis of the Mopaneveld since a large number of the *odd relevés*, which stimulated an investigation on the dynamics of the Mopaneveld, were surveyed North of the Soutpansberg. According to O'Connor (1999) perennial grasses such as *Digitaria eriantha*, *Heteropogon contortus* and *Panicum maximum* consistently showed a tendency to disappear during years of drought and to reappear during wet years.

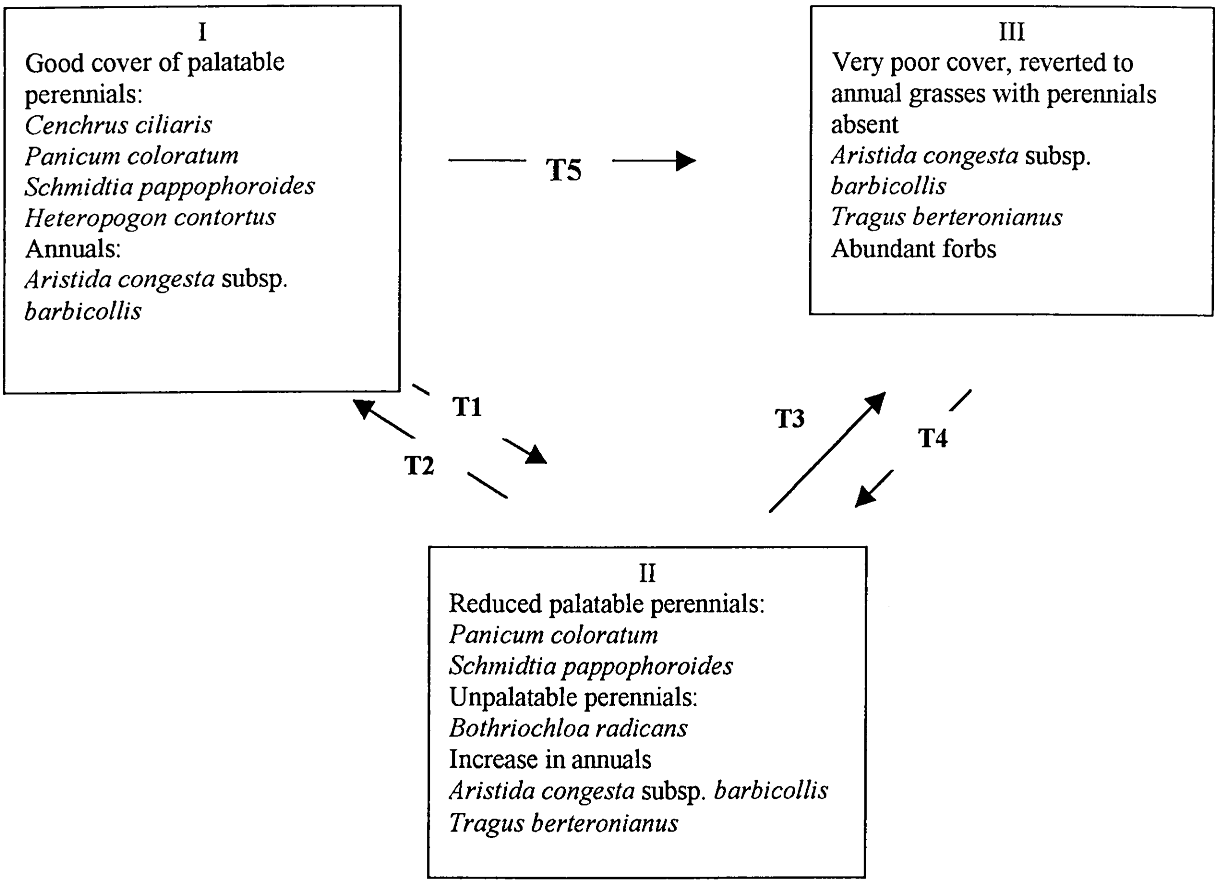
The results of the single division in the synthesis of the Mopaneveld accord with that of O'Connor (1999) in the following ways:

- The palatable, perennial species (listed by O'Connor (1999)) which are likely to disappear after a sustained drought, are mostly confined to species group A, Table 9 (cluster 1, i.e. Eastern Mopaneveld) and almost absent in species group B. These species probably disappeared in the *odd relevés* as a result of the drought which were experienced during sampling time.

- In comparison with the findings of O'Connor (1999), species which were relatively stable over the prolonged drought conditions, such as *Stipagrostis uniplumis*, are grouped to species group B, Table 9 (i.e. cluster 2, Western Mopaneveld).
- *Schmidtia pappophoroides* exibited a weaker tendency to decline (O'Connor 1999), which accord with its position in Table 9 (species group C).

Considering the low frequencies of perennial grass species and higher frequencies of species such as *Stipagrostis uniplumis* in these *odd relevés*, the polythetic divisive character of TWINSPAN (Hill 1979b) therefore easily explains the grouping of the *odd relevés* to cluster 2 rather than to cluster 1. From the results it can therefore be depicted that Mopaneveld vegetation, in particular grass species, change in composition as a result of drought conditions. The change is usually from a state where perennial grass species prevail, to a suggested transition state where species of sub-climax status (as for the eastern savannas of southern Africa) dominate. In comparison with the study of O'Connor (1999), it seems therefore that the state-and-transition model for vegetation change has relevance to the dynamics of the Mopaneveld.

A second case study of significant reference to the speculations based upon the synthesis, is the study of Oelofse *et al.* 2000. They examined the co-occurrence of a number of events (drought, fire and herbivory) and management actions (provision of water) in the Kruger National Park, South Africa. The survival and regeneration of the grass layer was monitored following the severe drought of 1992. Results showed that perennials were replaced by annual grasses and forbs. Perennials did not recover, despite an increase in rainfall after the drought. This shift was caused by the co-occurrence of several events (waterpoints, fire and drought) (Oelofse *et al.* 2000). A preliminary state-and-transition model (Figure 23) was developed in order to explore the herbaceous dynamics of shrubmopaneveld and to highlight management implications. From this model it is clear that Mopaneveld dynamics can be explained by non-equilibrium models for vegetation change. Similar results were obtained from the phytosociological synthesis of the Mopaneveld, which involves high versus low frequencies of perennial grasses.



Catalogue of Transitions

Transition 1: Heavy grazing by zebra or defoliation by frequent fire, combined with year-round supply of artificial waterpoints, reduces palatable perennial grasses.

Transition 2: Reduce fire frequency and reduction of artificial waterpoints (total closure if preceded by State III) reduces grazing pressure by zebra, thus increasing palatable grasses and perennials.

Transition 3: Drought plus availability of artificial waterpoints, promotes continued heavy grazing by zebra during periods of low rainfall, reducing palatable perennials.

Transition 4: Total removal of artificial waterpoints, thus reducing zebra densities. Time and above average rainfall increase perennial grasses.

Transition 5: Severe drought followed by fire and heavy grazing by zebra eliminates perennial grasses and results in a poor cover of pioneer species and forbs.

Figure 23 State-and-transition model for the herbaceous layer of shrubmopaneveld on basalt (adapted from Oelofse *et al.* 2000).

Figure 24 represents a simplified illustration of the speculated dynamics of Mopaneveld vegetation with special reference to semi-arid areas North of the Soutpansberg in South Africa, where a significant number of the *odd relevés* are situated. Although it is argued that clear-cut equilibrium points, such as those pictured in Figure 22b do not exist in ecological systems, they are convenient fictions that can serve as departure points for a more accurate characterization of natural systems (DeAngelis & Waterhouse 1987). Keeping this in mind, speculations of vegetation dynamics based upon TWINSPAN results are explained following the simplified illustration of vegetation change (Figure 24).

X represents the plant communities (probably the *Enneapogon scoparius - Colophospermum mopane* major vegetation type (Chapter 5)) representative of the *odd relevés* with species composition x_1 prior to sustained drought conditions, and x_2 the species composition of X after the sustained drought. Y represents the plant communities of the Western Mopaneveld to which X has affinity, (results obtained from TWINSPAN). y_1 represents the "stable state" species composition of Y. Following the drought event, x_1 changes from a significant cover of perennial, palatable grass sward to x_2, in which annual or sub-climax grass species such as *Stipagrostis uniplumis* dominate. In arid regions, such as the Western Mopaneveld, *S. uniplumis* is often regarded a climax species rather than a sub-climax species. Although conditions in the Eastern Mopaneveld were altered due to sustained drought, the species composition correspond to stable state conditions in the Western Mopaneveld, expressing its affinity in the TWINSPAN results. This state in the Eastern Mopaneveld is however regarded as a transitional state, although the same species composition in the Western Mopaneveld represents a stable state, rather than a transitional state. The threshold for vegetation change is speculated to have been exceeded (Figure 24b, position A) as a result of the sustained drought (O'Connor 1999), promoting a shift in plant species composition to x_2, which also represent y_1 (Figure 24b).

Du Plessis *et al.* (1998) also addressed the controversy regarding climax species and appointing increaser status to some grass species. Vegetation change along a degradation gradient in the western region of Etosha National Park, Namibia revealed that grass species such as *Anthephora schinzii*, which is categorised subjectively as an Increase 2b, does not always act as a pioneer species. Du Plessis *et al.* (1998) stated that, if a species such as *A. schinzii* is abundant in a soil type with a very low ecological potential, it behaves as a climax species. Under more favorable conditions, other species become more abundant. It is therefore evident that species composition in plant communities of areas exposed to low ecological potential (especially exposure to dry conditions) resembles species composition of highly degraded systems in areas where ecological potential is usually moderate to high (such as the Eastern Mopaneveld).

Climate, soil moisture availability and vegetation dynamics

The availability of moisture for plant growth is determined by total rainfall levels and distribution, soil physical properties (particularly infiltration rates) and topography (Behnke & Scoons 1993). Nutrient availability, as influenced by parent geology as well as by nutrient transport from weathering and water movement, in combinations with soil moisture availability, is proposed to create major vegetation types (Behnke & Scoons 1998). Vegetation change is therefore imperceptible of climate variability, especially variability in rainfall events. The unpredictability and variability of rainfall events in semi-arid areas inevitably supports non-predictable response to rainfall events. Annual rainfall is however not directly proportional to vegetation change since soil moisture and soil nutrients availability has a more pronounce influence on plant species composition (Behnke & Scoons 1993). Plant communities within significant annual rainfall measures often do not reflect high moisture availability. Species composition in such areas often reflects conditions of low ecological potential. Igneous basic rocks, such as gabbro and basalt, produces heavy, clayey soils with low infiltration rates. Soil moisture retention in combination with low infiltration produces conditions of low soil moisture availability for plant growth, although clayey soils are often associated with high levels of nutrients. A significant part of Mopaneveld vegetation occurs on these substrates, especially in the Eastern Mopaneveld (e.g. shrubmopaneveld of the Kruger National Park). Vegetation composition shifts towards affinity to arid environments (in terms of annual rainfall) could therefore be predicted after sustained drought conditions.

Another controversial concept of vegetation shifts, involves areas of significantly high annual rainfall measures (e.g. 1 000 mm per annum) which present plant species composition in accordance with semi-arid areas (e.g. maximum 500 mm rainfall per annum). Although 1 000mm rainfall is measured in some parts of Zambian Mopaneveld (Chapter 3), species composition do not reflect mesic conditions. Taking into account that the majority of precipitation falls during two months of the wet season (Figure 10), high run-off rates prevent soil moisture accumulation. These severe rainfall events are usually followed by eight months of hot, dry conditions (Figure 10). The herbaceous species composition therefore does not necessarily represent stable conditions as being expected in mesic environments. The herbaceous sward of the Mopaneveld in this type seems to be driven by alternating rainfall and drought events.

It is therefore evident that rainfall variability should not be excluded from vegetation dynamic models in the Mopaneveld of southern Africa.

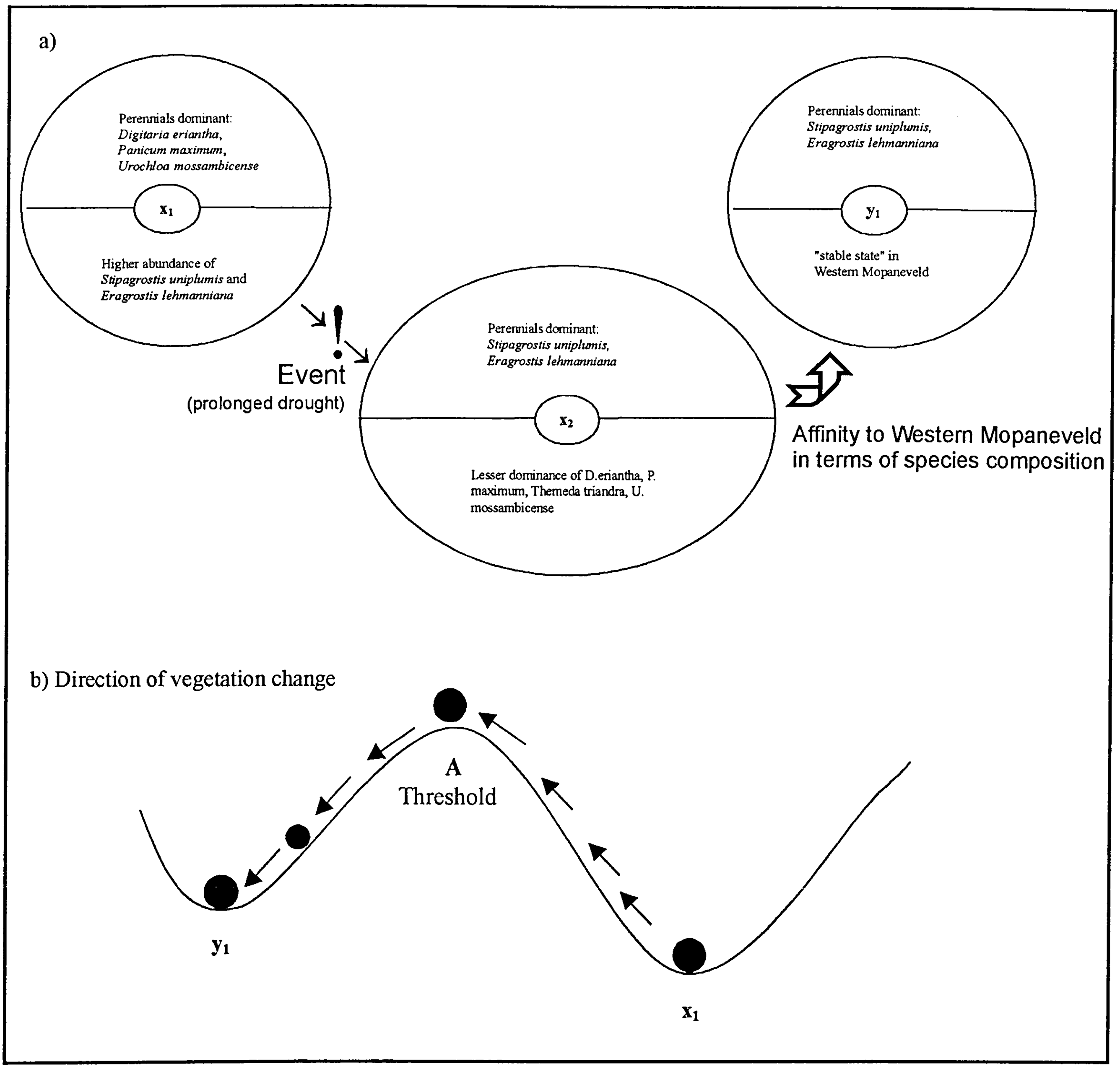


Figure 24 Simplified illustration to explain affinities of the *odd relevés* to the Western Mopaneveld.

2. Can phytosociological studies predict aspects of vegetation dynamics?

The major objectives of phytosociological studies will never be to study vegetation dynamics. Phytosociological results of a study such as the entire Mopaneveld were expected to be more exact than it was due to its distribution over environmental extremes, especially rainfall extremes. The strange results evoked deeper examination into the state of the data, which contributed to the results. Most phytosociological studies are undertaken on a much more local scale, preventing disorganisation of the classification output.

From the synthesis of the Mopaneveld it is evident that aspects on vegetation dynamics can be speculated upon. Long-term vegetation surveying is however inevitable for a clear explanation of the dynamics of an ecosystem. Phytosociological sytheses can only lighten speculations on vegetation dynamics. It will not replace studies on vegetation dynamics.

This study is however not the first to use the tools of phytosociology to predict vegetation change. Palmer & Van Staden (1992) also used the concept of floristic relevés to compare the state of vegetation with previous records.

2. Does the woody component in a system necessarily follow the same model for dynamics as the herbaceous layer?

The discussion on the dynamics of the woody component in relation to the herbaceous component in the Mopaneveld is based purely on speculations.

Savanna ecosystems show co-dominance of trees and grasses, but the mechanisms involved in their co-existence remain unresolved (Knoop & Walker 1985; Jeltsch *et al.* 1996; Jeltsch *et al.* 1998). It is inevitably true that woody species have a pronounce influence on herbaceous vegetation (Knoop 1985; Smit 1994; Smit & Swart 1994; Jeltsch *et al.* 1996; Jeltsch *et al.* 1998; Smit & Rethman 1998b), but do they necessarily follow the same dynamic pathway towards the same stable state?

Competition

The dominant woody species in Mopaneveld, namely *Colophospermum mopane*, exerts a pronounce influence on the growth of grasses through competition for soil moisture (Smit 1994). Drought invariably results in a decline in the abundance of perennial grasses in Mopaneveld (Donaldson *et al.* (1984) in O'Connor (1999)), as a result of competition with woody species (Knoop & Walker 1985). Considering grasses as the superior competitors for water in the topsoil and woody plants being it for the subsoil, it can be expected that drought conditions would have a more pronounce effect on the herbaceous layer than on the woody layer (Knoop & Walker 1985; Skarpe 1992).

Considering density-dependent and density independent competition in a typical semi-arid savanna system: when moisture is limited for a small period, there will still be sufficient moisture available to compete for in the sub-soil. Competition in the woody layer will therefore be density dependent, almost through any state of vegetation change. Under the exact same environmental conditions (limited moisture), the herbaceous component of the Mopaneveld system is speculated to be density-independent since moisture in the topsoil is limited to such an extent that, regardless the density of the herbaceous layer, individuals will die off as a result of limited soil moisture. It is rather abiotic events that control the co-existence of herbaceous species in semi-arid systems such as the Mopaneveld. Density dependent competition can however prevail under conditions of high soil moisture availability in a transition state (high percentage cover as a result of a rainfall event after a prolonged drought event).

It is therefore presumed that woody species in the Mopaneveld prevail under density dependent competition under dry conditions whereas herbaceous species rapidly emerge after a rainfall event, compete for the top-soil moisture under density dependent conditions, but after prolonged drought conditions, density independent mortality crashes the temporal stable state.

Trees and the herbaceous layer: parallel or non-parallel dynamic shifts?

O'Connor (1999) depicted changes, not only in the herbaceous vegetation, but also in the woody vegetation after a sustained drought in the semi-arid Mopaneveld. Almost complete mortality was observed for some trees and shrubs after the sustained drought conditions. Although *Colophospermum mopane* was also negatively influenced by the drought, it showed a greater tolerance to these dry conditions. Complete mortality or substantial topkill of several shrub species had occurred owing to the drought (O'Connor 1999). From these results it is apparent that the woody layer experienced a shift in species composition. *C. mopane* would probably fill the open spaces created by the dieback of other woody species. The succession pathway of the woody component is however speculated to be slower than for the herbaceous layer. Due to its rapid response to rainfall events, the herbaceous layer would alternate between different stable states or transition states, whereas the response of the woody component to an event is not as rapid, nor will the outcome of the event be evident over a short period.

The above speculations propose that in semi-arid savannas, the herbaceous vegetation and the woody vegetation are neither consistent in competition nor in dynamics. Competition in the woody layer, especially when dominated by *Colophospermum mopane*, seems to be density dependent. Suggesting non-equilibrial models to explain vegetation change in the herbaceous component of the Mopaneveld, abiotic events tend to drive system dynamics to rapidly changing species composition, which does not tend to regain the initial species composition. The same woody species composition over a given time can therefore comprise several states of the herbaceous component as a consequence of response to several events.

Since these speculations are purely philosophical thoughts, it is suggested that a clear view on these dynamic aspects of the Mopaneveld need to receive attention in the nearby future.

7.6 Conclusions

The study of Mopaneveld vegetation beyond the superior plant community evoked special interest in the dynamics of the vegetation of the Mopaneveld. The idea of Mopaneveld being a non-equilibrial system which follows stochastic events, were produced totally independent from results obtained from long-term dynamics studies (e.g. O'Connor 1999; Oelofse *et al.* 2000). The question evolved whether the observations in ecosystem dynamics could be explained simply by looking at vegetation composition. Comparison with long-term studies on Mopaneveld vegetation dynamics revealed significant support on speculations based upon a phytosociological synthesis. A great deal of derivations on vegetation dynamics can therefore be made from phytosociological data, but more comprehensive long-term studies are needed to support speculations. Phytosociological studies could not replace vegetation dynamic monitoring. They can however depict temporal species composition change after historical data to motivate further investigation.

Plant communities are not static representations of species composition. They are constantly adjusting to new conditions, but never completes the adjustments before conditions change again. Equilibrium concepts are highly scale-dependent. On a sufficiently small scale, in space or in time, all ecosystems are unstable and transient. Small scale – short-term disequilibrium may promote large scale – long term dynamic equilibrium persistence. The present community therefore cannot be clearly explained simply by studying it today!

CHAPTER 8

DISCUSSION

8.1 Introduction

This study adopted a broad approach in Vegetation Science. The viability of a proposed method to treat large vegetation data sets was tested upon the Mopaneveld vegetation in southern Africa. During the progress of the study, general limitations in the methodology and within vegetation science in southern Africa were identified. This discussion will therefore be of value to any scientist who attempts to treat large vegetation data sets, or to undertake a vegetation study in a relatively unexplored area such as the Mopaneveld in southern Africa.

Apart from the identification and discussion of limitations and general constraints, valuable ideas were born from the synthesis of the southern African Mopaneveld. These ideas are captured in the discussion of the results and are certainly of value to future research projects, not only in the vegetation science, but also in ecosystem dynamics.

Hence, this chapter comprises a discussion not only on the results of this study, but also on observations made during all different processes of the study.

8.2 Methodology

8.2.1 Introduction

It is important to note that this study was the first attempt to propose a method for the synthesis of a large data set of which all data were not fixed in syntaxa yet. The method was tested upon the Mopaneveld of southern Africa. Many limitations, already during the preparation of data for analysis, were identified. These limitations are discussed and possible alternatives in the methodology are stipulated.

8.2.2 Vegetation data surveying and capturing

The basic fundamentals of a sound phytosociological synthesis are adequate, comprehensive, comparable, uniform vegetation data. The very first step of this study was therefore to collect and collate vegetation data sets, which possibly could contribute to the synthesis of Mopaneveld vegetation in southern Africa. The criteria being used for data selection (Chapter 4) comprised minimum parameters for vegetation sampling for the purpose of vegetation classification, therefore stipulating basic needs for the identification of plant communities. Considering the wide distribution of Mopaneveld in southern Africa and the immense area of land occupied by this extensive vegetation type, it was unsatisfactory how little adequate vegetation data were available for a comprehensive phytosociological synthesis over the entire area. Du Plessis (2000) identified limitations in adequate vegetation data in the savannas of southern Africa (with special reference to the Mopaneveld) as a result of insufficient information being recorded during field surveys. The implementation of common standards for vegetation sampling in southern Africa was proposed in order to create a sound vegetation database for future reference.

Time restriction is a common constraint in any scientific study. The selection and capturing procedure was set to be finished before the end of 1998 for satisfactory progress in the study and to limit the project size. It was however hard to accumulate all existing vegetation data and relevant information within the time frame since data had to be collected from several different African countries. Constraints and delays in many attempts to capture vegetation data also caused difficulties in keeping within the time appointed for the pre-analysis phase of the study.

As a consequence of limited adequate vegetation data in the study area, every single data set that could contribute to the classification was considered for capturing. Many of the vegetation data sets which conformed to the requirements, were however only accessible in published format. Data of such studies had to be captured from the published Braun-Blanquet tables. Although the software package TURBOVEG (Hennekens 1996a) includes a valuable option to capture data directly from phytosociological tables, it remains a time-consuming process with a probability of parallax mistakes, especially when the phytosociological table was not subdivided into its larger vegetation units. After data capturing, the data had to be correlated with the hard copy. Data capturing from published tables eludes floristic detail because species that were downweighted during refinement are usually not printed for publication purposes or for submission to a dissertation, thesis or report. This floristic detail is however of lower significance for the phytosociological study although this floristic information might have been of great value in attempted future floristic studies. Furthermore, it may include data on the distribution of rare and endangered species.

Some data sets were accessible in CEP-format (e.g. the species names are summarised in 4-3 codes ACAC KAR for *Acacia karroo*). The corresponding species name had to be selected for the code, creating possible "misplacement" of species. Species had to be verified according to all the plant species listed by the author, which is a time-consuming process.

Data captured from the original field sheets were fairly compatible, except that a few species were not identified at the time of vegetation surveying. Those species had to be searched for in the published tables.

Many of the selected data sets comprised historical data (i.e. vegetation information being captured more than twenty years ago). These historical data sets were however of valuable contributions to the study. Due to the dynamic character of vegetation, one is not always comfortable in analysing historical data for present-day use. It is however evident that the complete picture remains stable to some extent.

Many vegetation studies conducted in southern African savannas include only species of the woody component for vegetation classification, which consequently limited the number of sound, total floristic vegetation data sets to be considered for the synthesis. In certain target areas for vegetation surveying, the only studies of contribution are those on which classification is based on satellite images. Since only the woody component could be stratified on the image, classification was based upon the woody component. Although these studies did not necessarily need to contain herbaceous surveying to conform to the objectives of the study, it would have been extremely valuable if all vegetation layers were included for classification. The description of these woody communities is of value, but a deductive method should be applied to the data to get significant results. An attempt was however made to relate communities, which were identified according to the classification of the woody component (referred to as woody communities), to the communities which were identified according to all vegetation layers. This attempt was paused due to time limitation and also due to uncertainties on the subjective method.

One of the limitations in capturing vegetation data was the general lack of available habitat data. The option in TURBOVEG to import habitat data in a database would have been of great contribution if habitat data were captured in electronic format by the author. Habitat information, if sufficient, therefore had to be summarised according to the descriptions of communities in the published format or in unpublished theses, dissertations and reports. This procedure was also time-consuming although of utmost importance for clear explanation of results.

Unpublished data lack substantial reference, which in turn constitute difficulties in terms of entering species names and habitat information. Published data should have been a prerequisite (an additional criterion for data selection), but being left with an unsatisfactory number of phytosociological data sets, unpublished data sets could not be ignored.

The above list of limitations regarding vegetation data in southern Africa is of significant motivation for the area to be targeted for future vegetation research. The southern African savannas, in particular the southern African Mopaneveld needs to be assessed in terms of vegetation classification.

8.2.3 The proposed method to classify large data sets

Unlike other attempts to treat large vegetation data sets, the pre-selected vegetation data were used in its raw form for phytosociological analysis.

The two-step method of Van der Maarel *et al.* (1987) and the prolonged three-step method of Bredenkamp and Bezuidenhout (1995) could not be applied to the data set due to insufficient information on the data itself. A new method for treating large vegetation data sets in the savannas of southern Africa was therefore proposed. The method followed basic procedures in the phytosociology, but still remained an immense task due to the extensive dimensions within the data set.

The proposed method failed in several ways for being the finest approach in which large data sets can be classified. However, the method was tested on a large vegetation data set and results were sufficient. New computer tools have evolved in the meanwhile, e.g. JUICE (Tichý 2001), which also address and evade common problems in treating large vegetation data sets.

8.2.3.1 Notes on the limitations of the methodology

Strict criteria for data selection were initially thought to be appointed because unfaithful, unpublished data usually evoke uncertainties in the applicability of a method. For the purpose of this study, it would have been impossible to follow strict criteria since the study area was almost unexplored in terms of vegetation data sampling.

During the analysis of a large vegetation data set, information that seems to be of low significance in the holistic view of a system is usually being ignored while its contribution to vegetation knowledge of that system should not be denied. In a study area such as the southern African Mopaneveld where only a limited area has been sampled, omitting relevé data might result in the ignorance of samples probably representing an undersampled community. It is therefore suggested that the Mopaneveld is a too diverse and a too unexplored study area to omit relevé data from classification. Still it was thought necessary to exclude those relevés from the data for the sake of handling the large data set.

A synoptic table was constructed to facilitate refinement procedures (Step 8). The refined synoptic table was used to identify major vegetation units within the Mopaneveld. The synoptic table was however refined according to frequency values and not according to general abundance of plant species. After examining the DECORANA scatter diagram (Figure 19) it was however evident that, despite the identification of major units within Mopaneveld from frequency values, it could be supported by the distribution of types along environmental gradients.

The synoptic table containing 29 clusters and 1 465 species was reduced to 10 clusters and 329 species (Step 11) for easier reference to species composition within the identified major vegetation units of the southern African Mopaneveld. This step in the methodology seems to be subjective. A synthesis is however a subjective study since it is needed to philosophise on all information based upon objective classification results. No matter which method is used in a phytosociological synthesis, the outcome of the analysis does not present all facets of the input. It is therefore needed to summarise the outcome of a synthesis in such a way that it is representative of the input of information by several authors.

8.2.4 Concluding remarks on the methodology

- Time was a common constraint in the study due to the data collection attempts over a large study area and due to attempt to make all adequate data electronically accessible for analysis.
- The proposed method is complex, but at least stipulates many general limitations for future attempts in treating a large vegetation data set based on raw data material.
- Although at times subjective, the methodology is based upon information accumulated from objective classification results.

8.3 Can the dynamics of Mopaneveld vegetation be explained by non-equilibrial models?

In Chapter 7, a detailed discussion on the dynamics of the Mopaneveld is presented. This discussion basically concludes what is discussed in Chapter 7.

The attempt to separate azonal and intrazonal vegetation from the complete data set by applying TWINSPAN on a single division level resulted in speculations on the dynamics of Mopaneveld vegetation. After relevés representing azonal and intrazonal vegetation were removed from the data set, the single division revealed two major groups within zonal Mopaneveld. After clear examination of the results, it was evident that the separation was induced by frequency values of perennial climax grass species rather than being a geographically separation between arid Western Mopaneveld and semi-arid to moist Eastern Mopaneveld, or any other possible major Mopaneveld types.

In the Mopaneveld, and of course other semi-arid savannas as well, temporal **and** spatial shifts in dynamics have relevance. Temporal change in vegetation is obvious in any ecosystem (i.e. change in plant species composition over time although the outcome of species composition is not clear in non-equilibrial systems). Vegetation change can also be presented on a spatial scale.

The Mopaneveld of southern Africa is geographically widespread and certain plant communities within this extensive vegetation type are thought to be too isolated to be related to each other. The opposite is proved during the attempt to identify the vegetation types and major plant communities within Mopaneveld. The distribution of the *Enneapogon scoparius – Colophospermum mopane* vegetation type could not be related to a specific locality. Relevés from Namibian Mopaneveld as well as from the Eastern Mopaneveld represent the vegetation type. After investigating plant species composition and relevant habitat information for each relevé present in the vegetation type, it became evident that the relevés from the Eastern Mopaneveld were surveyed under extreme drought conditions. The drought event altered the herbaceous species composition to such an extent that it relates to species composition of arid Namibian Mopaneveld. The two ecosystems represent different states in vegetation change, with the relevés from the Eastern Mopaneveld representing a transition state after the drought event whereas relevés from Namibian Mopaneveld represent a climax (stable) state. These results indicate spatial shifts in vegetation composition and emphasises the need for holistic approaches in Vegetation Science.

Non-equilibrial (disequilibrium) models to explain vegetation dynamics were thought to be applicable to the dynamics of the Mopaneveld. Abiotic influences, especially rainfall events drive vegetation change of especially the herbaceous component. The woody component is more resistant to the stochastic rainfall events and therefore is suggested to follow a different dynamic pattern of vegetation change. Examples of vegetation dynamics studies following sustained drought conditions in the Mopaneveld, revealed that palatable, perennial grass species die back, while species such as *Stipagrostis uniplumis*, being a climax species in the arid regions, but a sub-climax in the eastern savannas, survive these extreme conditions. From this example it became evident that after an event, such as sustained drought, the herbaceous species composition change in such a way that it correspond to the species composition from a different ecosystem. Keeping in mind the polythetic divisive character of TWINSPAN, this species relation with other ecosystems supported the grouping of relevés which, according to locality should have been separated. It is therefore clear that some data from which results were obtained represent transition states of vegetation change. The state-and-transition model (Westoby *et al.* 1989) is thought to describe vegetation dynamics in Mopaneveld best.

Non-equilibrial models however cannot explain all systems within Mopaneveld. If a transect is considered through southern African savannas, from the desert in the West, to the East Coast it is speculated that a gradient of vegetation dynamics follow the transect line, with event-driven systems representing the western savannas, and stable state dynamics representing the eastern savannas. Considering the location of Mopaneveld along this transect it is furthermore suggested that, not only stochastic events drive system dynamics to non-equilibrial explanations for vegetation change, nor do stable states explain vegetation dynamics of the Mopaneveld. The Mopaneveld itself can be explained as a transition between non-equilibrial models and stable state models to explain vegetation change!

8.4 Synthesis of the southern African Mopaneveld

8.4.1 Evaluation of the study

Cole (1986) defined a satisfactory classification of savannas by giving three basic guidelines, which include the following:

1) it should accommodate vegetation types for which the term savanna is used
2) it should comprise different levels of ecological detail
3) it should be able to be presented on different mapping scales

The value of this synthesis was determined according to the above criteria. The following were concluded:

- Despite the limitations within the data and within the method, sufficient results were obtained from the attempt to conform to the guidelines for a savanna vegetation classification given by Cole (1986). Vegetation types within the southern African Mopaneveld could be derived from classification results (criterium 1).
- Unexpected results however evoked uncertainty, but could be explained sufficiently. It was of valuable experience that unexpected results could stimulate further research focus in the study area, e.g. the dynamics of the Mopaneveld. The study therefore comprised not only a presentation of results, but an explanation and understanding the system, hence comprising different levels of ecological detail (criterium 2).

- Although no attempt has been made during this synthesis to present the communities on different mapping scales (criterium 3), it would be possible to do so.

8.4.2 Small-scale versus large-scale vegetation studies

Vegetation classification according to the Zurich-Montpellier School is a relatively new concept in southern Africa. Since the introduction of the Braun-Blanquet (BB) approach to South Africa by Werger in 1972, the use of this method for phytosociological research was proven successful in several attempts to describe vegetation (e.g. Van der Meulen 1979; Van Rooyen *et al.* 1981a; Van Rooyen *et al.* 1981b; Van Rooyen *et al.* 1981c; Westfall *et al.* 1985; Bredenkamp & Theron 1990; Bredenkamp & Theron 1991; Bredenkamp *et al.* 1993; Coetzee 1983; Nel *et al.* 1993; Schmidt *et al.* 1993; Bredenkamp & Deutschländer 1994; Bredenkamp & Deutschländer 1995; Brown *et al.* 1995a; Brown *et al.* 1995b; Brown *et al.* 1996; Dekker & Van Rooyen 1995; Bezuidenhout 1996; Visser *et al.*). The application of the BB-method to vegetation classification is however limited in other African countries, which consequently limits the possibility to completely understand ecosystem functioning in southern Africa on a scale larger than the association. The need and the essential value of small-scale studies in southern Africa are not being denied, although it is suggested that vegetation scientists should attempt to assess vegetation on a scale larger than the association. This study therefore aimed to highlight the need for adequate vegetation studies in southern Africa in order to investigate vegetation on a broader scale.

Why the need for vegetation studies on a regional scale?

The whole of a system is worth more than the sum of its parts. Fragments of data cannot be analysed separately to produce a holistic view of a subject. The information captured within the data can however be analysed and interpreted, and even if analysis can be described as subjectivity of method, the holistic picture is likely to appear. The sum of all vegetation classifications within the Mopaneveld (if ever the complete area had been classified) would not represent the holistic picture of the vegetation within the Mopaneveld. It surely would represent only fractions of the truth! Local-scale studies do not attempt to understand the position of a particular plant community in time and space. Plant communities identified and defined from a local-scale study may "disappear" when data from a larger area are classified, while other communities, not previously recognised, become apparent. This is due to the lack of knowledge species composition and variability over its entire distribution range. This became apparent in this study, where relevés classified in a single community in previous studies are now allocated to different communities. This is exactly why earlier phytosociologists, e.g. Werger (1974) warned against compiling a formal syntaxonomy too early, before adequate data over larger areas were available.

Key questions:

- What about ecotone plant communities? In local-scale studies ecotone vegetation is being ignored already during stratification. Isn't it time that ecotone vegetation types deserve unique management status?
- Do we understand ecosystem dynamics if we only study vegetation as it is today? Phytosociological studies never need to explain ecosystem dynamics. Phytosociological synthesis on a regional scale however can depict vegetation changes if the data comprise amongst others, historical information. It is important to note that the classification and hence the description of plant communities should not regard the plant communities as being static. Plant communities are indeed dynamic entities, but the overall composition tends to be relatively stable.
- Vegetation mapping often depends on clarity on treating extensive vegetation information. Major mapping projects in southern Africa are however based on extrapolation of localised knowledge rather than classifying and synthesising extensive raw data material. Wouldn't borders in mapping units be clearer if units were identified by analysis rather than by extrapolation? Considering the vast number of relevés a mapping project is encountered with, no current numerical analysis can treat so many samples in an area of such high species diversity, e.g. South Africa.

Nature can produce complex structures even in simple situations, and can obey simple laws even in complex situations (Goldenfeld & Kadanoff 1999). From the above it becomes evident that we are living in a chaotic world. How can we understand complex systems if studies focus on the situation on a local-scale as it prevails today?

8.4.3 Discussion on Mopaneveld vegetation

One of the primary objectives of the study was to define all major vegetation types within Mopaneveld, southern Africa. Limitations in adequate Braun–Blanquet vegetation data in the African countries engendered a less detailed definition of Mopaneveld vegetation types. Major types along a climatic gradient from the eastern, semi-moist Zimbabwean Mopaneveld to the arid western Namibian Mopaneveld however, could easily be identified from the pre-selected data.

Despite the extensive distribution of the Mopaneveld along environmental extremes and their geographical discontinuity, the vegetation types are to some extent related to each other (Table 5). The relation between the first four vegetation types and the relation between vegetation types 6 and 7 can primarily be ascribed to similar geological parent material they occur on, and secondary to soil moisture availability (Madams 1990). Vegetation types 1, 2, 3 & 4 represent the Eastern Mopaneveld of less arid conditions in comparison to the semi-arid to arid Western Mopaneveld (vegetation types 6 & 7).

The *Digitaria milanjiana – Colophospermum mopane* vegetation type representing the southeastern part of Zimbabwean Mopaneveld is a distinct vegetation unit, although the Zimbabwean Mopaneveld is far more extensive than is presented in this study. Comprehensive vegetation studies in Zimbabwean Mopaneveld need to be included for a more detailed picture of the entire southern African Mopaneveld.

The *Croton megalobotrys – Colophospermum mopane* vegetation type is associated with large rivers of the Eastern Mopaneveld, showing no relation to the Western Mopaneveld. No adequate data of the vegetation along large rivers in the Western Mopaneveld were available at time of data acquisition. The Mopaneveld along large rivers in Namibia is restricted to the upper clayey soils where the rivers are deeply incised. Shallow rivers tend to dry out seasonally, which consequently gives *C. mopane* the ability to inhabit these dry, sandy washes. In the Cuvelai Delta, northern Namibia, isolated patches of Mopaneveld are often associated with upland islands within the broad sandy, calcareous shores. Although adequate vegetation data from the Cuvelai Delta contributed to the identification of vegetation types in the Western Mopaneveld, TWINSPAN did not separate those relevés as being representative of riverbank Mopaneveld. It is however envisaged that local-scale studies on the northern Namibian Mopaneveld will separate the discontinuous Mopaneveld patches within the Cuvelai Delta.

High frequency values of *C. mopane* in the *Croton megalobotrys – Colophospermum mopane* vegetation type were first thought to be controversial since *C. mopane* is known as a terrestrial species occupying dry soils. This vegetation type rather seems to represent an ecotone between upland Mopaneveld on clayey alluvium and deep alluvium adjacent to the watercourse.

The *Cissus cornifolia – Colophospermum mopane* vegetation type is more diverse in terms of plant communities than is presented in the results. Therefore, a separate analysis of this vegetation type was undertaken. A detailed discussion on the results appears in Chapter 6. Representing the Mopaneveld of the South African Lowveld, this vegetation type hosts at least four different major plant communities on different geological substrates. The general ecology of Mopaneveld vegetation (variation in plant communities on different geology, physiognomical variation and vegetation dynamics) can be well observed in the Kruger National Park, South Africa. The first identified vegetation type, the *Terminalia sericea – Colophospermum mopane* major plant community already evoked curiosity on the Lowveld Mopaneveld due to its sandy component – an unusual association with *Colophospermum mopane*. A detailed discussion on the *Terminalia sericea – Colophospermum mopane* major plant community as well as an explanation of its ecology is given in Chapter 6. Born from the synthesis of the South African Lowveld Mopaneveld it is suggested that ecotone plant communities such as the *Terminalia sericea - Colophospermum mopane* major plant community should be studied in more detail in future vegetation studies. Other plant communities where *Colophospermum mopane* occurs in lesser dominance with plant species adapted to deep sandy soils, include amongst others the *Combretum* woodland thicket on colluvium and sandstone in Zimbabwe (Timberlake *et al.* 1993) and the *Terminalia sericea* deciduous tree savanna on medium and low altitude (Wild & Barbosa 1967). In Botswana many *Colophospermum mopane* communities occur on aeolian Kalahari sand. The soil profile to which these communities are confined consists of a considerably shallow, but sandy A-horizon and a clayey B-horizon. It is thus speculated that where the basalt opens, aeolian sand filled up the soil profile, resulting in a patch of deep sand which species such as *Terminalia sericea*, *Lonchocarpus nelsii*, *Baphia massaiensis* etc. inhabits.

The *Ptycholobium contortum* – *Colophospermum mopane* vegetation type, which represents the Mopaneveld north of the Soutpansberg in South Africa is related to the *Cissus cornifolia* – *Colophospermum mopane* vegetation type of the South African Lowveld Mopaneveld. This vegetation type also represents the most arid conditions of Mopaneveld in South Africa, explaining its strong relation to the Western Mopaneveld. Despite strong relations with other vegetation types, this type hosts a more diverse floristic composition, especially in the woody component. A detailed local-scale study on the vegetation and flora of the area north of the Soutpansberg is envisaged to emphasise its conservation value.

The *Enneapogon scoparius* – *Colophospermum mopane* vegetation type represents seral communities within the Mopaneveld. No specific location could be determined for this vegetation type. After a literature study on the vegetation dynamics of semi-arid savannas, it is suggested that this vegetation type represents transitions between stable states in the dynamics of the Mopaneveld. These transitions are temporal shifts in vegetation composition following an event. The event by which vegetation change was driven, is probably sustained drought conditions in the separate relevés representing this vegetation type. The identification of a seral vegetation type provides substantial motivation for vegetation dynamics studies in the southern African Mopaneveld. Being a seral vegetation unit, it may be questioned whether the *Enneapogon scoparius* – *Colophospermum mopane* carry sufficient value to be treated as a vegetation type on its own. On a scale as large as the southern African Mopaneveld, it certainly would be valued as a vegetation type since it is likely to occur over any time period, although it might not always follow the same spatial variation.

The Western Mopaneveld is represented by the *Boscia foetida* – *Colophospermum mopane* vegetation type and the *Bauhinia petersiana* – *Colophospermum mopane* vegetation type. The former is generally associated with shallow gravel or calcrete tolerating harsh environmental conditions, whereas the latter is commonly found on aeolian Kalahari sand. These two vegetation types are strongly associated with each other despite their difference in habitat preferences. Their relation could possibly be ascribed to similar climate conditions which is in general low rainfall or low soil moisture availability. Other than the *Asparagus nelsii* – *Colophospermum mopane* major plant community (6.2), the *Lonchocarpus nelsii* – *Colophospermum mopane* major plant community (7.1) shows affinity to the Eastern

Mopaneveld and to the *Boscia foetida* – *Colophospermum mopane* vegetation type. The environmental conditions of the *Asparagus nelsii* – *Colophospermum mopane* major plant community are different from any other vegetation type or major plant community. Although it represents the moister north-eastern Namibian Mopaneveld, moisture conditions are still low and erratic, which probably relate it to the *Lonchocarpus nelsii* – *Colophospermum mopane* major plant community. The combination of deep, sandy soils and limited moisture conditions on which the *Asparagus nelsii* – *Colophospermum mopane* major plant communty occurs, prevent this community from being highly related to the Eastern Mopaneveld. Although moisture limitations are much more significant in the *Lonchocarpus nelsii* – *Colophospermum mopane* major plant community than in the Eastern Mopaneveld, similarities in soil conditions might relate these communities to each other.

8.4.4 The South African Lowveld Mopaneveld

The synthesis of the South African Lowveld Mopaneveld (SALM) also follows a holistic approach. The vegetation data from the SALM (e.g. Gertenbach 1976; Van Rooyen 1978; Gertenbach 1987; Purchase 1997; Swart 1998) that contributed to the identification of the *Cissus cornifolia* - *Colophospermum mopane* were stored in a separate working directory in MEGATAB as a raw data matrix. The identification of major plant communities by the application of TWINSPAN came therefore independently from the results of the separate studies. It was expected that the synthesis of the raw data would confirm the existence of all plant communities which were previously described. Many of these plant communities could be identified from the synthesis, although the relevé composition within these plant communities often differed! Many relevés were not located within the same community as for the local-scale study. Extra plant communities were also identified by this procedure. These extra plant communities probably represent ecotonal plant communities or small, mosaic plant communities which were probably too small to be recognised as a separated vegetation unit during the local-scale studies.

This "misplacement" of relevés by TWINSPAN emphasises the need for a holistic approach in vegetation classification. The vegetation of the South African Lowveld Mopaneveld therefore does not represent the sum of all the plant communities that have been described earlier.

8.4.5 The need for floristic studies of the southern African Mopaneveld

The Mopaneveld is floristically far more extensive than presented in Table 5. Vegetation types represent broader units which usually represent variation in environmental conditions. Variation in environmental conditions constitutes different habitats occupying different plant communities of lower rank. Certain species are confined only to these plant communities (habitats), though will not have any influence on a synoptic table, as these communities are all consolidated into the single synrelevé. Such species of limited distribution often have very low frequency values and may not be included in the synoptic table. The vegetation types may therefore be floristically and environmentally much more diverse than indicated in the table and descriptions. A floristic analysis of the southern African Mopaneveld therefore needs attention in the nearby future.

Some key questions (and possible answers) on the floristics of the Mopaneveld evolved with the synthesis of the southern African Mopaneveld:

- What is the plant species diversity of the southern African Mopaneveld? Because *C. mopane* often totally dominates the woody layer and the herbaceous layer being sparse most of the year, the general feeling is that the diversity within this extensive vegetation type is low. Considering its distribution over an expanded area underlain by the different geological parent material, isn't its flora being eluded by Botanists?
- Is *Colophospermum mopane* the only woody savanna species that can tolerate such extreme environmental conditions? *Terminalia prunioides* is the only other woody species that occurs frequently in the Eastern Mopaneveld in mesic conditions and in the Western Mopaneveld often being recorded with *Welwitschia mirabilis*! *T. prunioides* can therefore probably withstand the same environmental conditions as *C. mopane*, although *C. mopane* probably will out-compete *T. prunioides* under stress conditions.
- Considering *C. mopane* and the miombo species *Julbernardia* and *Brachystegia*: are their some relation to their gregarious character and the family they belong to (Caesalpiniaceae)?

- What is the floristic relation between the *Terminalia sericea – Colophospermum mopane* major plant community in the South African Lowveld to the sand forests of northern Kwa-Zulu Natal? And what are their floristic relation to the Miombo in the adjacent north-eastern African countries?
- Which plant species are endemic to the Mopaneveld of southern Africa?
- Which plant species share endemicity with the above-mentioned sand forests?

It is envisaged that a detailed floristic analysis of the southern African Mopaneveld will provide answers to the above key questions.

8.5 Future research

Phytosociology is one of the major keys for understanding ecological processes. It is however not clear yet whether phytosociology is simply an independent collection of vegetation data to understand ecological systems on a local scale. From the synthesis of the southern African Mopaneveld the value of sound, adequate local-scale phytosociological studies were appreciated. These local-scale studies provide basic vegetation knowledge although the sum of various local-scale phytosociological studies will not provide in the understanding of the ecosystem as a whole. It is therefore suggested that local-scale phytosociological studies should be undertaken in all areas of Mopaneveld that are unexplored in terms of sound vegetation surveys. It is envisaged that such studies will contribute to a second, complete attempt to synthesise the vegetation of the southern African Mopaneveld. Furthermore it is of utmost importance that standards of vegetation surveying are set for future vegetation studies. Vegetation is a complex phenomenon that needs to be studied, not only to conform to the objectives of a specific study, but for future reference and use. It is therefore suggested that basic, minimum parameters for vegetation sampling should be identified for public domain. These minimum parameters should include detailed physical environmental information.

The southern African Mopaneveld is ecologically far more extensive than could be explored in this study. A detailed study on the physical environment of the southern African Mopaneveld was not included due to the enormous dimensions of the study. A proper study on the physical environment and possible relations between the physical environment and the vegetation is therefore suggested.

The dynamics of southern African savannas are currently under examination. Vegetation dynamics of the Mopaneveld in particular needs to be assessed in nearby future.

One of the most apparent shortages in a clear synthesis of the southern African Mopaneveld is the limitations in adequate vegetation data. Several vegetation data sets however could be of significant contribution to the knowledge of Mopaneveld vegetation, although these data sets usually include only information on the woody component. A deductive approach to incorporate this information in a database that could possibly be linked to the Mopaneveld database is suggested.

Research concerning specific and infraspecific diversity in the Mopaneveld is necessary to determine conservation priorities within this extensive vegetation type. The Convention on Biological Diversity states in its preamble that the contracting parties should recognise the dependence of local communities on biological resources (Geneva Executive Centre 1994). For future research to be holistic, the people inhabiting the southern African Mopaneveld and especially their traditional dependence on the vegetation of the region, should be taken into consideration. The recognition of the human component is relevant to the conservation and sustainable use of biodiversity (Siebert 1998).

To summarise suggested future research on Mopaneveld: studies should attempt to:

- fill all gaps in local-scale phytosociological research in southern African Mopaneveld;
- identify and set basic, minimum parameters for vegetation sampling in southern African savannas;
- examine the Sandveld areas of the South African Lowveld for representing a separate vegetation class;
- correlate the physical environment (specifically the geology and climate) of the southern African Mopaneveld to the distribution of vegetation types on a detailed scale;
- understand the vegetation dynamics of the Mopaneveld;

- correlate existing vegetation information which is based on the woody component with results obtained from the synthesis of the southern African Mopaneveld, and
- assess the specific and infraspecific plant diversity of the southern African Mopaneveld in order to prepare strong conservation priorities for the study area.

CONCLUSIONS

The aims for this study were successfully achieved:

a) The gregarious character of *Colophospermum mopane* gives the impression of a relatively homogeneous area. Representing the strong climatic, edaphic and topographic heterogeneity within the Mopaneveld, seven vegetation types and six major plant communities were derived by phytosociological criteria. The following is a list of all plant communities at various hierarchical levels in the Mopaneveld of South Africa, southeastern Zimbabwe and Namibia:

- *Digitaria milanjiana – Colophospermum mopane* vegetation type
  - *Justicia flava – Colophospermum mopane* major plant community
  - *Setaria sphacelata – Colophospermum mopane* major plant community
- *Croton megalobotrys – Colophospermum mopane* vegetation type
- *Cissus cornifolia – Colophospermum mopane* vegetation type
- *Ptycholobium contortum – Colophospermum mopane* vegetation type
- *Enneapogon scoparius – Colophospermum mopane* vegetation type
- *Boscia foetida – Colophospermum mopane* vegetation type
  - *Eragrostis viscosa – Colophospermum mopane* major plant community
  - *Leucosphaera bainesii – Colophospermum mopane* major plant community
- *Bauhinia petersiana – Colophospermum mopane* vegetation type
  - *Lonchocarous nelsii – Colophospermum mopane* major plant community
  - *Asparagus nelsii – Colophospermum mopane* major plant community

b) Despite limitations in adequate vegetation data from the study area, these major vegetation units represent Mopaneveld vegetation along environmental gradients, which is apparent in the ordination results.

c) None of the previous methods to treat large vegetation data sets could be applied for the purpose of a synthesis of Mopaneveld vegetation, since many data sets were not fixed into associations yet. A new method to treat large vegetation data sets was therefore proposed. This method attempts to classify a large vegetation data set according to its basic component, the vegetation relevé. The data are therefore classified by using raw data material. Although not the ultimate approach in meta-analysis, the method was successfully applied to the data set. Results of this synthesis adequately revealed the identification of the above vegetation types and major plant communities within the Mopaneveld.

d) A separate synthesis was conducted on the South African Lowveld Mopaneveld, which was identified as the *Cissus cornifolia – Colophospermum mopane* vegetation type. Four distinct major plant communities were identified from TWINSPAN classification:

- *Terminalia sericea – Colophospermum mopane* major plant community
- *Acacia nigrescens – Colophospermum mopane* major plant community
- *Euclea divinorum – Colophospermum mopane* major plant community
- *Combretum apiculatum – Colophospermum mopane* major plant community

These syntaxa are related to the most dominant geological substrates of the South African Lowveld Mopaneveld, namely sandstone, gabbro, basalt, Ecca-shale, granite and gneiss.

Only the *Terminalia sericea – Colophospermum mopane* and the *Acacia nigrescens – Colophospermum mopane* major plant communities are described in this synthesis.

e) Furthermore, this study also provided a better understanding of the ecological processes within the Mopaneveld. From the first results obtained from the synthesis, it became evident that non-equilibrial models for vegetation change is most likely to describe the vegetation dynamics of the Mopaneveld. Further dynamic studies are however suggested for clarity on the speculations.

f) Literature studies on the Mopaneveld vegetation in southern Africa, along with classification results, contributed to the knowledge of this extensive vegetation type.

The hypotheses of this study were met by holistic views in the approach of the study. The knowledge gained from this study will contribute to a better understanding of the ecology of the Mopaneveld.

SUMMARY

A phytosociological synthesis of Mopaneveld

by

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Supervisor: Prof. Dr. G.J. Bredenkamp

Submitted in partial fulfilment of the requirements for the degree

MAGISTER SCIENTIA (Botany)

One of the most critical shortcomings with regard to vegetation utilisation and conservation in southern Africa, is the lack of in-depth knowledge of the ecology of the various vegetation types. Mopaneveld is one of the largest savannas of Africa. However, knowledge of this extensive vegetation type is still limited to local-scale studies within the different *Colophospermum mopane*-hosting countries. The major aim of this study was to analyse existing phytosociological data from Mopaneveld over its entire distribution range. This holistic view of Mopaneveld vegetation contributes to the better understanding of large-scale vegetation continua, which contains identifiable plant communities along environmental gradients. Furthermore, provides a better understanding of ecological processes within this vegetation type, which occupies vast areas over a considerable variation in environmental parameters.

Compatible vegetation data were collected and captured in a TURBOVEG database. Known methods to analyse large vegetation data sets were considered. These methods could however not be applied successfully to the synthesis of the Mopaneveld because all suitable data were not processed to describe plant communities yet. A new method to treat large vegetation data sets was proposed. This method is based on the synthesis of raw data material by means of basic phytosociological principles. The complete data set was analysed by TWINSPAN procedures in MEGATAB. Results are presented in synoptic tables. Although the synoptic presentation limits the number of relevés, the number of species remains high. A reduced synoptic table was constructed to accommodate the need for a clear presentation of results in a reduced format. The

method was critically evaluated after which was concluded that the method is only a step in the direction of new methodology in meta-analysis.

A literature review on *Colophospermum mopane* was prepared in order to provide sufficient information on this plant species, which dominates the woody strata of the Mopaneveld through most of its distribution range. Lists of known described plant communities and vegetation types within the Mopaneveld are provided in two appendices. Mopaneveld occurs in eight African countries, which include Angola, Namibia, Botswana, Zambia, Zimbabwe, Malawi, Mozambique and South Africa. A summary on the Mopaneveld in these hosting countries is provided to contribute to the knowledge of Mopaneveld vegetation of its total distribution range.

TWINSPAN classification and subsequent refinement by procedures of the new approach, resulted in the identification of seven vegetation types and six major plant communities in the Mopaneveld of South Africa, Zimbabwe and Namibia. Due to special interest in the Mopaneveld of the South African Lowveld, a synthesis of this vegetation type was prepared separately. Four major plant communities were identified from this procedure of which two are described in this dissertation.

This synthesis revealed interesting notes on the dynamics of Mopaneveld vegetation. Results from the synthesis provided information on the probability that the Mopaneveld is an event-driven system and its dynamics can be explained by non-equilibrial models of vegetation change.

OPSOMMING

'n Fitososiologiese sintese van Mopaneveld

deur

Frances du Plessis

Studieleier: Prof. Dr. G.J. Bredenkamp

Voorgelê ter gedeeltelike vervulling van die vereistes vir die graad

MAGISTER SCIENTIA (Plantkunde)

Een van die grootste tekortkominge in bewaring en grondgebruik in suidelike Afrika is die gebrek aan in-diepte kennis van die ekologie van verskillende plantegroeitipes. Mopaneveld is een van die grootste savannas in Afrika. Kennis van hierdie uitgestrekte plantegroeitipe is nietemin beperk tot plaaslike studies binne die verskillende lande waarin *Colophospermum mopane* voorkom. Die primêre doel van hierdie studie was om bestaande fitososiologiese data van Mopaneveld oor die totale verspreiding daarvan te analiseer. Hierdie holistiese benadering van Mopaneveld plantegroei dra by tot 'n beter oorsig van grootskaalse plantegroeikontinua wat identifiseerbare plantgemeenskappe bevat langs omgewingsgradiënte. Verder voorsien hierdie studie ook in 'n beter oorsig van ekologiese prosesse binne die Mopaneveld, wat 'n groot area beset oor 'n merkwaardige variasie in omgewingsparameters.

Bruikbare plantegroeidata was versamel en in 'n TURBOVEG databasis gestoor. Bekende metodes was oorweeg vir die analise van die groot datastel. Hierdie metodes kon egter nie suksesvol toegepas word in die sintese van die Mopaneveld nie aangesien nie alle data geprosesseer en die plantgemeenskappe daarvan opgeskryf is nie. 'n Nuwe metode oor die hantering van 'n groot datastel is daarom voorgestel. Die metode is gebaseer op die sintese van roudatamateriaal volgens basiese fitososiologiese beginsels. Die totale datastel was geanaliseer in MEGATAB deur die gebruik van TWINSPAN prosedures. Resultate word voorgestel in sinoptiese tabelle. Die sinoptiese voorstellings beperk die aantal relevés, nietemin bly die aantal spesies hoog. A verkorte sinoptiese tabel is daarom saamgestel sodat resultate duidelik

voorgestel kan word. Die metode was krities ondersoek waarna beslis is dat die voorgestelde metodiek slegs beskou kan word as die eerste stap in die rigting van nuwe metodiek in meta-analise.

'n Literatuuroorsig van *Colophospermum mopane* is voorberei vir die weergee van nuttige inligting oor die spesie wat die houtagtige komponent van Mopaneveld domineer. Lyste van plantgemeenskappe en plantegroeitipes binne Mopaneveld wat reeds beskryf is, is voorsien. Mopaneveld kom voor in agt Afrika-lande, wat Angola, Namibië, Botswana, Zambië, Zimbabwe, Malawi, Mosambiek en Suid-Afrika insluit. 'n Opsomming oor die Mopaneveld van hierdie lande is gegee ter gedeeltelike bydrae tot kennis oor Mopaneveld plantegroei, oor die totale verspreidingsgebied.

TWINSPAN klassifikasie en die verfyning daarvan op grond van die nuwe metode, het gelei tot die identifisering van sewe plantgroeitipes en ses hoofplantgemeenskappe in die Mopaneveld van Suid-Afrika, Zimbabwe en Namibië. 'n Afsonderlike sintese van die Suid-Afrikaanse Laeveld Mopaneveld was voorberei. Vier hoof plantgemeenskappe was identifiseer waarvan twee beskryf is in hierdie verhandeling.

Hierdie sintese het verder interessante opmerkings oor die plantegroeidinamika van Mopaneveld opgelewer. Resultate van die sintese het bygedra tot die versterking van spekulasies dat die Mopaneveld gedryf word deur gebeurtenisse. Die dinamika kan met ander woorde voorgestel word deur nie-ekwilibrium modelle vir plantegroeiverandering.

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APPENDICES

APPENDIX 1

PLANT COMMUNITIES WITHIN SOUTHERN AFRICAN MOPANEVELD

This list is the first attempt to list all described plant communities within the southern African Mopaneveld. It should however be noted that the list is not completely fixed yet and should be regarded as a preliminary list. Only terrestrial communities are included.

South Africa

The Mopaneveld of South Africa is, when compared to other countries, relatively well sampled and described. It is however easier to get access to studies in South Africa where the study is centered from. Therefore the possible existence of more vegetation studies in Mopaneveld other than South Africa is not denied.

Study area: Southern Mopaneveld in the Kruger National Park, South Africa
Author: W.P.D. Gertenbach
Year of study: 1987
Study type: D.Sc. thesis, Botany Department, University of Pretoria
Reference No publications
Communities:

1 *Euclea divinorum* alliance

1.1 *Euclea divinorum – Acacia welwitschii* association

1.1.1 *Acacia welwitschii – Senecio longiflorus* moderate tree savanna

1.1.2 *Acacia welwitschii – Urochloa mosambicensis* moderate tree savanna

1.2 *Euclea divinorum – Albizia harveyi* association

1.2.1 *Albizia harveyi – Pappea capensis* open shrub savanna

1.2.2 *Albizia harveyi – Colophospermum mopane* dense tree savanna

a) *Combretum hereroense* variant

b) *Acacia tortilis* variant

2 *Cenchrus ciliaris* alliance

2.1 *Cenchrus ciliaris – Colophospermum mopane* association

2.1.1 *Colophospermum mopane – Neuracanthus africanus* moderate shrubsavanna

2.1.2 *Colophospermum mopane – Combretum apiculatum* dense bush savanna

2.2 *Cenchrus ciliaris – Acacia nigrescens* association

2.2.1 *Acacia nigrescens – Combretum apiculatum* moderate bush savanna

a) *Cerathotheca triloba* variant

b) *Terminalia prunioides* variant

2.2.2 *Acacia nigrescens – Acacia tortilis* open shrub savanna

2.2.3 *Acacia nigrescens – Sclerocarya birrea* moderate tree savanna

3 *Combretum apiculatum* alliance

3.1 *Combretum apiculatum – Colophospermum mopane* association

3.1.1 *Colophospermum mopane – Pogonarthria squarrosa* dense bush savanna

3.1.2 *Colophospermum mopane – Tricholaena monachne* moderate tree savanna

3.1.3 *Colophospermum mopane – Acacia gerrardii* dense bush savanna

3.1.4 *Colophospermum mopane – Terminalia prunioides* moderate tree savanna

3.2 *Combretum apiculatum – Terminalia sericea* association

3.2.1 *Terminalia sericea – Combretum zeyheri* dense bush savanna

a) *Strychnos madagascariensis* variant

b) *Sclerocarya birrea* variant

3.2.2 *Terminalia sericea – Eragrostis gummiflua* moderate tree savanna

3.2.3 *Terminalia sericea – Brachiaria nigropedata* moderate tree savanna

3.3 *Combretum apiculatum – Acacia nigrescens* association

3.3.1 *Acacia nigrescens – Commiphora mollis* dense tree savanna

3.3.2 *Acacia nigrescens – Grewia bicolor* moderate bush savanna

3.3.3 *Acacia nigrescens – Themeda triandra* moderate tree savanna

4 Gabbro complex

4.1 *Acacia nigrescens – Chloris virgata* open shrub savanna

a) *Sporobolus nitens* variant

b) *Schmidtia pappophoroides* variant

4.2 *Acacia nigrescens – Colophospermum mopane* dense shrub savanna

a) *Sclerocarya birrea* variant

b) *Acacia nigrescens* variant

4.3 *Acacia nigrescens – Sclerocarya birrea* moderate tree savanna

a) *Acacia tortilis* variant

b) *Heteropogon contortus* variant

c) *Bothriochloa radicans* variant

5 River- and creek vegetation

6 Vegetation of rocky outcrops

7 Vegetation of floodplains

Study area: Punda Milia-Pafuri-Wambiya, Kruger National Park, South Africa

Author: N. van Rooyen

Year of study: 1978

Study type: M.Sc. dissertation, Botany Department, University of Pretoria

Reference
1. *Journal of South African Botany* (1981) 47(2): 213–246
2. *Journal of South African Botany* (1981) 47(3): 405–449
3. *Journal of South African Botany* (1981) 47(4): 585–626

Communities

Higrophilous communities (publication 1)

1 *Lonchocarpus capassa – Panicum meyerianum* tree savanna

1.1 *Acacia borleae – Ischaemum afrum* shrub thicket

1.2 *Combretum imberbe – Fuirena pubescens* open tree savanna

1.3 *Acacia albida – Ficus sycomorus* riverine forest

1.4 *Acacia xanthophloea – Panicum meyerianum* open tree savanna

2 Pan communities

Sandveld communities (publication 2)

1 *Terminalia sericea – Pteleopsis myrtifolia* tree savanna

1.1 *Burkea africana – Pseudolachnostylis maprouneifolia* tree savanna

1.2 *Baphia massaiensis – Guibourtia conjugata* thicket

1.3 *Xeroderris stuhlmannii – Combretum apiculatum* tree savanna

1.4 *Terminalia sericea – Pogonarthria squarrosa* tree savanna

2 *Croton gratissimus – Phyllanthus reticulatus* tree savanna

2.1 *Kirkia acuminata – Afzelia quanzensis – Combretum apiculatum* tree savanna

2.2 *Androstachys johnsonii – Croton pseudopulchellus* dry forest

3 Rocky Outcrop community

4 Diabase community

Colophospermum mopane communities (publication 3)

1 *Colophospermum mopane - Euclea divinorum* tree savanna

1.1 *Colophospermum mopane – Acacia tortilis – Urochloa mosambicensis* tree savanna

1.2 *Colophospermum mopane – Euclea divinorum – Enteropogon macrostachyus* tall tree savanna

1.3 *Colophospermum mopane – Commiphora glandulosa – Seddera capensis* open tree savanna

2 *Colophospermum mopane – Dalbergia melanoxylon – Heteropogon contortus* shrub savanna

2.1 *Colophospermum mopane – Enneapogon scoparius* shrub savanna

2.2 *Colophospermum mopane – Themeda triandra* shrub savanna

3 *Colophospermum mopane – Combretum apiculatum – Digitaria eriantha* open tree savanna

Study area: Kruger National Park, South Africa

Author: W.P.D. Gertenbach

Year of study: 1983

Study type: Research project

Reference *Koedoe* 26: 9–121

Special note: The communities listed below are landscapes of the Kruger National Park, rather than plant communities. Although a landscape comprises several plant communities, they are listed below for possible future reference. All landscapes in which *Colophospermum mopane* occurs are listed below.

Communities:

1 *Combretum* spp. / *Colophospermum mopane* woodland of the Timbavati area (landscape no. 6)

2 Olifants River rugged veld (landscape no. 7)

3 Phalaborwa sandveld (landscape no. 8)

4 *Colophospermum mopane* savanna on basic soils (landscape no. 9)

5 Letaba River rugged veld (landscape no. 10)

6 Tsende sandveld (landscape no. 11)

7 *Colophospermum mopane / Acacia nigrescens* savanna (landscape no. 12)

8 *Colophospermum mopane* forest (landscape no. 15)

9 Thornveld on gabbro (landscape no. 19)

10 *Combretum* spp. / *Colophospermum mopane* rugged veld (landscape no. 22)

11 *Colophospermum mopane* shrubveld on basalt (landscape no. 23)

12 *Colophospermum mopane* shrubveld on gabbro (landscape no 24)

13 *Adansonia digitata / Colophospermum mopane* rugged veld (landscape no. 25)

14 *Colophospermum mopane* shrubveld on calcrete (landscape no. 26)

15 Mixed *Combretum* spp. / *Colophospermum mopane* woodland (landscape no. 27)

16 Limpopo / Levubu floodplains (landscape no. 28)

17 *Pterocarpus rotundifolius / Combretum collinum* woodland (landscape no. 33)

18 Punda Maria sandveld on Waterberg Sandtone (landscape no. 34)

19 *Salvadora angustifolia* floodplains (landscape no. 35)

Study area: Letaba Ranch, Northern Province, South Africa

Author: H.B. Swart

Year of study: 1995

Study type: M.Sc. dissertation, Centre for Wildlife Management, University of Pretoria

Reference No publications

Communities

1 *Colophospermum mopane – Combretum apiculatum* dense bush savanna

1.1 *Dalbergia melanoxylon – Eragrostis curvula* sub-community

1.1.1 *Aristida bipartita – Fingerhuthia africana* variant

1.1.2 *Grewia flavescens – Grewia monticola* variant

1.1.3 *Albizia harveyi – Maerua parvifolia* variant

1.1.4 *Ximenia americana – Cyperus rupestris* variant

1.1.5 *Lannea schweinfurthii – Dicoma tomentosa* variant

1.2 *Microchloa caffra – Kyphocarpa angustifolia* sub-community

2 *Panicum maximum – Dactyloctenium giganteum* river thicket

2.1 *Croton megalobotrys – Nuxia oppositifolia* sub-community

2.2 *Acacia tortilis – Eragrostis lehmanniana* sub-community

3 *Eragrostis rigidior – Tricholaena monachne* open grassland

Study area: Foskor mine, Northern Province, South Africa

Author: N.G. Beck

Year of study: 1998

Study type: B.Sc.(Hons.) dissertation, Centre for Wildlife Management, University of Pretoria

Reference No publications

Communities

Rhoda

1. *Colophospermum mopane – Combretum apiculatum* low closed woodland community

1.1 *Colophospermum mopane – Eragrostis rigidior* low open woodland sub-community

1.2 *Colophospermum mopane – Burkea africana* high closed woodland sub-community

2 *Grewia bicolor – Colophospermum mopane* tall closed shrubland community

3 *Croton megalobotrys – Cassia abbreviata* short closed woodland community

Shiela/Loole

1 *Combretum apiculatum – Barleria pretoriensis* tall closed shrubland community

2 *Colophospermum mopane – Combretum apiculatum* low closed woodland community

2.1 *Colophospermum mopane – Cleome angustifolia* low open woodland sub-community

2.2 *Colophospermum mopane – Boscia albitrunca* low closed woodland sub-community

2.3 *Colophospermum mopane Euclea divinorum* tall open shrublandsub-community

3 *Croton megalobotrys – Lonchocarpus capassa* tall closed woodlandcommunity

Cleveland

1 *Croton megalobotrys – Lonchocarpus capassa* short closed woodland community

2 *Combretum hereroense – Themeda triandra* high open shrubland community

3 *Colophospermum mopane – Sansevieria hyacinthoides* low closed woodland community

4 *Combretum apiculatum – Grewia monticola* tall closed shrubland community

Study area: Pylkop Nature Reserve, Northern Province, South Africa

Authors: G. Parker & L. Kelly

Year of study: 1996

Study type: B.Sc.(Hons.) dissertation, Centre for Wildlife Management, University of Pretoria

Reference No publications

Communities

1 *Croton gratissimus – Euphorbia cooperi* open rocky hill

2 *Terminalia sericea – Digitaria eriantha* short closed woodland

2.1 *Terminalia sericea – Elephantorrhiza elephantina* short closed woodland

2.2 *Terminalia sericea – Balanites maughamii* short closed woodland

2.3 *Terminalia sericea – Sclerocarya birrea* short closed woodland

2.4 *Digitaria eriantha – Colophospermum mopane* short closed woodland

3 *Thesium utile – Dichrostchys cinerea* low closed woodland

4 *Colophospermum mopane – Combretum apiculatum* low closed woodland

4.1 *Colophospermum mopane – Aristida congesta* low closed woodland

4.2 *Colophospermum mopane – Dicoma anomala* low closed woodland

4.3 *Colophospermum mopane – Terminalia prunioides* low closed woodland

5 *Albizia brevifolia – Combretum apiculatum* short closed woodland

6 *Enneapogon scoparius – Enneapogon cenchroides* low closed woodland

7 *Brachiaria eruciformis – Acacia mellifera* low closed woodland

Study area: Messina Experimental Farm, Northern Province, South Africa

Author: B. Dekker

Year of study: 1996

Study type: M.Sc. dissertation, Centre for Wildlife Management, University of Pretoria

Reference *South African Journal of Botany* (1995) 61(3): 158–167

Communities

1 *Hyphaene coriacea – Eragrostis rotifer* short sparse woodland

2 *Monechma divaricatum – Colophospermum mopane* low forest

3 *Commiphora pyracanthoides – Aristida congesta* low open woodland

4 *Mariscus rehmannianus – Colophospermum mopane* low closed woodland

5 *Kirkia acuminata – Enneapogon cenchroides* short closed woodland

6 *Blepharis diversispina – Combretum apiculatum* low closed woodland

6.1 *Tinnea rhodesiana* variant

6.2 *Abutilon austro-africanum* variant

7 *Tricholaena monachne – Commiphora tenuipetiolata* low thicket

8 *Ficus tettensis – Aristida meridionalis* tall closed woodland

Study area: Honnet Nature Reserve, Tshipise, Northern Province, South Africa

Author: N. Visser

Year of study: 1995

Study type: B.Sc.(Hons) dissertation, Centre for Wildlife Management, University of Pretoria

Reference *Koedoe* (1996) 39(1): 25-42

Communities

1 *Sclerocarya birrea – Panicum coloratum* high closed woodland

2 *Colophospermum mopane – Terminalia prunioides* high open woodland

2.1 *Colophospermum mopane – Canthium gilfillanii* high open woodland

2.2 *Colophospermum mopane – Grewia villosa* low closed woodland

3 *Sesamothamnus lugardii – Catophractes alexandri* low open woodland

4 *Boscia foetida – Canthium gilfillanii* low sparse shrubland

5 *Acacia nilotica – Terminalia prunioides* low open woodland

6 *Acacia senegal – Ehretia amoena* low open woodland

7 *Commiphora glandulosa – Gardenia resinifolia* low closed woodland

8 *Grewia hexamita – Melinis repens* low open woodland

8.1 *Grewia hexamita – Commelina africana* low open woodland

8.2 *Grewia hexamita – Croton gratissimus* low open woodland

9 *Commiphora mollis – Digitaria eriantha* low open woodland

10 *Acacia tortilis – Indigofera melanadenia* low open woodland

11 *Heliotropium ciliatum – Tribulus terrestris* open forbland

12 *Acacia borleae – Cyathula lanceolata* low closed woodland

Study area: Mopaneveld north of the Soutpansberg, Northern Province, South Africa

Author: A.J. Louw

Year of study: 1970

Study type: D.Sc. thesis, Department of Forage Science, University of Pretoria

Reference No publications

Special note: A non-quantitative study contributed to the identification of the communities listed below. Only the woody component were considered.

Communities

1 *Colophospermum – Combretum – Commiphora* community

2 *Colophospermum – Boscia rehmanniana* community

3 *Colophospermum – Commiphora – Terminalia prunioides* community

4 *Commiphora – Terminalia – Colophospermum* community

5 *Acacia – Salvadora – Boscia rehmanniana* community

6 *Colophospermum – Grewia flava – Terminalia sericea* community

7 *Commiphora – Terminalia prunioides* community

8 Semi-hygrophilous community along rivers and streams

9 Communities at the foot hills of granitic boulders and in ravines

Study area: Timbavati Private Nature Reserve

Author: R.N. Porter

Year of study: 1970

Study type: Research report

Reference No publications

Special note: A non-quantitative study contributed to the identification of the communities listed below. Physionomy was used to classify communities

Communities

1 *Combretum apiculatum / Sclerocarya caffra / Acacia nigrescens* savanna woodland

2 *Combretum zeyheri / Pterocarpus angolensis / Terminalia sericea* savanna woodland

3 *Acacia nigrescens* open woodland

4 *Colophospermum mopane* savanna woodland

5 Riparian forest and hydrophylous communities

6 Ecotonal vegetation types

6.1 *Combretum zeyheri / Combretum apiculatum / Sclerocarya caffra / Acacia nigrescens* savanna woodland

6.2 *Acacia nigrescens / Combretum zeyheri / Colophospermum mopane* savanna woodland

6.3 *Colophospermum mopane / Sclerocarya caffra / Combretum apiculatum* savanna woodland

7 Termitarial plant associations

8 *Themeda triandra* grassland

Botswana

Vegetation classification studies in Botswana are very scarce. Records of vegetation classification are mainly found in vegetation maps (Appendix 2). The study of Bonyongo (1999) includes vegetation classification, but only of the seasonal floodplains in the Okavango Delta, Botswana. Biggs (1979) studied the ecology of Chief's Island in the Okavango Delta. Only a very small percentage of Mopaneveld vegetation is covered by drylands in the Okavango delta. Communities are listed below.

Study area:	Chief's Island, Okavango Delta, Botswana
Author:	R.C. Biggs
Year of study:	1979
Study type:	M.Sc. dissertation, Wildlife Management, University of Pretoria
Reference	No publications known of
Special note:	Only a small patch of Mopaneveld covers the study area. Only marginal and dryland vegetation types also listed

Communities

MARGINAL VEGETATION TYPES

1 *Acacia nigrescens – Croton megalobotrys* woodland and savanna woodland

2 *Hyphaene ventricosa – Croton megalobotrys* palm woodland and palm savanna woodland

3 *Combretum imberbe – Croton megalobotrys* woodland and savanna woodland

DRYLAND VEGETATION TYPES

1 *Acacia tortilis* savanna woodland

2 *Acacia erioloba* woodland and savanna woodland

3 *Terminalia sericea – Combretum collinum* savanna woodland and scrub

4 *Colophospermum mopane* woodland and pyrophytic scrub savanna

5 *Grewia* spp. – *Croton megalobotrys* scrub savanna

Zimbabwe

Vegetation classification in Zimbabwe is more developed than in other countries hosting Mopaneveld. The studies are however mostly vegetation descriptions based on the woody species. These studies were not included for a phytosociological synthesis since they do not follow the criteria stated in Chapter 4. Communities described during these studies are however listed below.

Study area:	Hwange National Park, Zimbabwe
Author:	C.M.L. Rogers
Year of study:	1993
Study type:	A report prepared for the Department of National Parks and Wild Life Management, Zimbabwe
Reference	Published report
Special note:	Identification of plant communities (listed below) is based only on the woody component. Braun-Blanquet procedures were followed.

Communities

NON-KALAHARI SAND VEGETATION TYPES

Woodland thicket types on Lower to Upper Karoo sediments

1 *Combretum – Boscia angustifolia* open scrub and thicket on Lower Karoo sandstone

2 *Colophospermum mopane – Acacia woodland* adjacent to riverine vegetation

3 *Colophospermum mopane – Commiphora marlothii* mixed woodland on scree slopes

Mixed bushland, thicket and woodland on Basement Complex formations

4 Castle kopje mixed woodland and thicket

5 *Colophospermum mopane – Julbernardia – Combretum* wooded bushland

6 *Combretum – Baphia* thicket

Colophospermum mopane woodland and thicket on granitic gneiss and Madumabisa mudstones

7 *Colophospermum mopane – Combretum* woodland on Basement complex

8 *Colophospermum mopane – Terminalia pruniodes* woodland on Madumabisa mudstones

9 *Colophospermum mopane – Combretum elaeagnoides* thicket on Basement complex

***Colophospermum mopane* – *Combretum imberbe* woodland to bushed grassland in seasonally inundated areas**

10 Riverine vegetation with *Diospyros mespiliformis* and *Combretum mossambicense*

11 *Colophospermum mopane – Acacia – Combretum* grassland to woodland in seasonally inundated areas

***Colophospermum mopane* bushed grassland to woodland on the watershed, on Basalt and Karoo formations**

12 *Colophospermum mopane – Combretum hereroense* bushed grassland to bushland on the watershed

13 *Colophospermum mopane – Combretum bushland* on basalt

14 *Colophospermum mopane* bushland on basalt

15 *Colophospermum mopane – Vepris zambesiaca* woodland on Madumabisa mudstones

16 *Colophospermum mopane – Acacia – Grewia bicolor* stunted woodland in the Dzivanini area

KALAHARI SAND VEGETATION TYPES

***Combretum imberbe* bushed grassland of periodically waterlogged soils**

17 *Colophospermum mopane* woodland – *Combretum* bushed grassland mosaic on ecotone Kalahari sands

18 *Acacia – Boscia albitrunca – Colophospermum mopane* bushed grassland in interdune troughs

19 *Combretum hereroense – Hyphaene* bushed grassland on calcrete

***Acacia* – *Baikiaea* bushland and woodland on Kalahari sands**

20 *Acacia – Mundulea sericea* bushland

21 *Terminalia sericea – Lonchocarpus nelsii* bushland

22 *Colophospermum mopane – Combretum apiculatum* bushland

23 *Baikea – Combretum* woodland thicket on fossil sand dune crests

***Terminalia* – *Combretum* bushland**

24 *Terminalia sericea – Acacia erioloba* bushland

25 *Terminalia sericea – Baikiaea plurijuga* bushland

***Baikiaea plurijuga* woodland and bushland on deep Kalahari sands**

26 *Burkea africana – Pterocarpus angolensis* bushland and woodland

27 *Baikiaea plurijuga – Guibourtia coleosperma* woodland

28 *Baikiaea plurijuga – Croton gratissimus* woodland

Ecotone <u>Baikiaea plurijuga</u> woodland and thicket on red Kalahari sands

29 Ecotone *Baikiaea plurijuga – Commihora mossambicensis* woodland and thicket

<u>Burkea africana</u> bushland surrounding calcrete areas

30 *Burkea africana – Terminalia brachystemma* bushland

Study area:	Upper Save catchment, Zimbabwe
Author:	B.M. Campbell & R.F. du Toit
Year of study:	1994
Study type:	Research project
Reference	*Kirkia* (1994) 15(1): 10–32
Special note:	Identification of plant communities (listed below) is based only on the woody component. Braun-Blanquet procedures were followed.

Communities

1 *Brachystegia glaucescens* community

2 *Kirkia acuminata* community

3 *Combretum apiculatum – Acacia nigrescens* community

4 *Colophospermum mopane* community

5 *Julbernardia globiflora* community

5.1 *Terminalia stenostachya – Commiphora mollis* sub-community

5.2 *Brachystegia boehmii* sub-community

5.3 *Julbernardia globiflora* sub-community

6 Riverine community

7 *Acacia nilotica – Combretum adenogonium*

7.1 *Bridelia cathartica* sub-community

7.2 *Acacia nilotica* sub-community

8 *Terminalia sericea – Dalbergiella nyasae* community

9 *Bauhinia thonningii – Sclerocarya birrea* community

Study area: Nyahungwe area on the Lundi River, Gonarezhou National Park, Zimbabwe

Author: T.G. O'Connor & B.M. Campbell

Year of study: 1986

Study type: Research project

Reference *S. Afr. J. Bot.* (1986) 52(2): 117–123

Special note: Identification of plant communities (listed below) is based only on the woody component.

Communities

1 Mixed shrub woodland

2 *Colophospermum mopane* and mixed shrub woodland

3 *Colophospermum mopane* – *Markhamia acuminata* woodland

4 *Colophospermum mopane* – *Spirostachys africana* woodland

5 *Colophospermum mopane* woodland

6 Open riverine woodland

7 *Guibourtia conjugata* woodland

8 Riverine woodland

9 Riverine shrub woodland

10 Dune grassland

Study area: Communal lands – North and West Zimbabwe

Author: J.R. Timberlake, N. Nobanda & I. Mapaure

Year of study: 1993

Study type: Research project

Reference *Kirkia* (1993) 14(2): 171–270

Special note: Identification of plant communities (listed below) is based only on the woody component. Braun-Blanquet procedures were followed.

Communities

RIPARIAN FORESTS AND ALLUVIAL WOODLANDS

1 Dense woodland on alluvium/colluvium

2 Mixed riparian woodland

3 *Faidherbia* riparian woodland

4 *Syzygium* riverine woodland

DRY FORESTS AND THICKETS

1 *Terminalia brachystemma* bushed woodland

2 *Xylia* dry forest

3 *Combretum* woodland thicket on colluvium & sandstone

4 *Guibourtia conjugata* wooded thicket

5 *Baikiaea* woodland thicket on Kalahari sand

6 *Baikiaea* woodland on Kalahari sand

7 *Baikiaea – Acacia* bushed woodland on Kalahari dunes

MIOMBO WOODLAND

1 *Brachystegia spiciformis – Baikiaea* woodland on Kalahari sand

2 *Brachystegia spiciformis – B. boehmii* woodland on sand

3 *Brachystegia boehmii – Julbernardia – Pterocarpus angolensis* open woodland on sandstone plateaux

4 *Brachystegia boehmii – Julbernardia* woodland on shallow soils

5 *Brachystegia – Julbernardia* woodland on granite

6 *Brachystegia glaucescens* woodland on hills

7 *Brachystegia allenii* woodland

8 Mixed woodland on Zambezi escarpment

MIOMBO-MOPANE WOODLANDS

1 *Brachystegia boehmii – Colophospermum* woodland catena

2 *Julbernardia Colophospermum* woodland catena

3 *Combretum – Colophospermum* open woodland mosaic

4 *Colophospermum – Diospyros kirkii* open woodland on shallow soils

5 *Colophospermum – Brachystegia allenii* woodland mosaic

MOPANE WOODLANDS

1 *Colophospermum* woodland on skeletal soils

2 *Colophospermum – Terminalia stuhlmannii* woodland

3 *Colophospermum* woodland (single dominance)

COMBRETACEAE OPEN WOODLANDS

1 *Combretum collinum* open woodland on sand

2 Mixed dry woodland mosaic on granite

ACACIA OPEN WOODLANDS

1 *Acacia* open woodland on goldbelt soils

GRASSLANDS

1 *Parinari* wooded grassland

2 *Cynodon – Eragrostis* grassland on sand

3 *Cynodon – Sporobolus* grassland in granite vleis

4 *Panicum repens* lakeshore grassland

5 *Andropogon* grassland on serpentine

6 Grassland on basalt soils

7 *Setaria* grassland on clay

Study area: Eastern Mid-Zambezi Valley, Zimbabwe

Author: J.R. Timberlake & I. Mapaure

Year of study: 1992

Study type: Research project

Reference *Transactions of the Zimbabwe Scientific Association* (1992) 66: 1–14

Special note: Identification of plant communities (listed below) is based only on the woody component. Braun-Blanquet procedures were followed.

Communities

1 *Xylia torreana* dry forest and thicket

2 Dense woodland to woodland thicket on old alluvium

3 *Terminalia brachystemma* bushed woodland

4 Woodland or bushland fallows on alluvium/colluvium

5 Alluvial floodplains and riverine woodland

6 Mopane woodland on deeper soils

7 Mopane – *Terminalia stuhlmannii* woodland

8 Mopane – *Combretum apiculatum* woodland on shallow soils

9 Mopane – *Combretum apiculatum* – Julbernardia woodland

10 *Brachystegia allenii* – mopane woodland on colluvium

11 Escarpment woodlands

12 *Brachystegia allenii* – *B. boehmii* woodland on gneiss

Study area: Sango Ranch, Save Vallye, Zimbabwe

Author: C.J. Hin

Year of study: 1999

Study type: M.Sc. dissertation (completed 2000)

Reference No publications

Communities

1 *Acacia tortilis* subsp. *heteracantha – Urochloa mosambicensis* closed woodland

1.1 *Tephrosia purpurea* subsp. *leptostachya – Urochloa mosambicensis* short closed woodland

1.2 *Dichrostachys cinerea* subsp. *africana – Urochloa mosambicensis* short closed woodland

1.3 *Capparis tomentosa – Urochloa mosambicensis* tall closed woodland

1.4 *Sporobolus nitens – Urochloa mosambicensis* short closed woodland

2 *Colophospermum mopane – Brachiaria deflexa* short thicket // short closed woodland

2.1 *Commiphora edulis – Colophospermum mopane* short thicket

2.2 *Indigofera praticola – Colophospermum mopane* short closed woodland

2.3 *Thilachium africanum – Colophospermum mopane* short thicket

2.4 *Ruellia patula – Colophospermum mopane* tall closed woodland

3 *Combretum apiculatum* subsp. *apiculatum – Colophospermum mopane* short closed woodland

4 *Combretum apiculatum* subsp. *apiculatum – Digitaria milanjiana* tall closed woodland

4.1 *Dalbergia melanoxylon – Combretum apiculatum* subsp. *apiculatum* short closed woodland

4.2 *Commiphora africana – Digitaria milanjiana* tall closed woodland

4.3 *Kirkia acuminata – Panicum maximum* tall closed woodland

5 *Millettia usumarensis* subsp. *australis – Brachiaria deflexa* short koppie thicket

6 *Acacia tortilis* subsp. *heteracantha – Panicum maximum* tall closed woodland

7 *Dalbergia arbutifolia – Diospyros mespiliformes* high riverine forest

7.1 *Strychnos potatorum – Panicum maximum* high closed woodland // short thicket

7.2 *Albizia glaberrima* var. *glabrescens – Panicum maximum* high forest

7.3 *Faidherbia albida – Eriochloa meyeriana* tall closed woodland sub-community

8 *Phragmites mauritianus* tall closed reedbeds

9 *Echinochloa colona – Cyperus digitatus* subsp. *auricomus* tall open wetland

9.1 *Paspalidium obtusifolium – Echinochloa colona* tall closed woodland

9.2 *Acacia xanthophloea – Echinochloa colona* tall closed woodland

Zambia

Little vegetation classification studies exist in the Zambian Mopaneveld. The existence of vegetation classification studies are however not denied, but if they were undertaken, they are not easy accessible. Fanshawe (1969) however gave a description of the vegetation of Zambia. It is published in the Forest Research Bulletin (No. 7) in 1969. *Colophospermum mopane* dominates the woodland vegetation type in Zambia. The description of the types are however to broad to include for the purpose of this study.

Malawi

Malawi contains only a small percentage of Mopaneveld vegetation types. Some of these Mopaneveld vegetation types are covered in vegetation classification attempts.

Study area:	Liwonde National Park, Malawi
Author:	C.O. Dudley
Year of study:	1994
Study type:	The flora of Liwonde National Park
Reference	In: Seyani, J.H. & A.C. Chikuni (eds). Proceedings of the XIIIth plenary meeting of Aetfat, Malawi. Zomba, Malawi. Pp 1485–1509

Communities

MOPANE WOODLAND COMPLEX

Mopane woodland

Open mopane woodland

Mopane clump savanna

Mopane woodland/thickets

MIXED WOODLANDS

TALL GRASS TREE SAVANNA

RIVERINE SEMI-DECIDUOUS FOREST/THICKET

DROUGHT DECIDUOUS FOREST/THICKET

Mozambique

No vegetation classification study could be found in the Mopaneveld of Mozambique, emphasizing the need for detail vegetation classification for this area. The existence of vegetation studies are however not denied.

Angola

Angola hosts the highest cover of Mopaneveld vegetation. Due to political unstability in the country, vegetation classification studies are limited. Vegetation classification for a vegetation map contributed to vegetation knowledge in Angola. These types are listed under Appendix 2.

Namibia

The vegetation of Namibian Mopaneveld is well sampled in relation to other countries hosting this extensive veld type. Many of the vegetation studies were prepared for agricultural purposes and were compiled in reports rather than publications. They however contribute to the vegetation knowledge of Namibian Mopaneveld and are listed below.

Study area:	Kaokoland, Northern Damaraland, Owambo, Etosha and north-western South West
Author:	R.I. de S. Correia
Year of study:	1976
Study type:	Unpublished report
Reference	No publication
Special note:	Seventeen main vegetation types are identified and described by the author. Unknown method of classification. All 17 are listed below.

Communities

KALAHARI TYPE VEGETATION

1 Tree/shrub savanna of *Terminalia sericea* and *Acacia giraffae*

2 Tree/shrub savanna of *Baikaea plurijuga*

3 *Baikaea plurijuga / Colophospermum mopane* savanna

4 *Colophospermum mopane* and other tree species except for *Baikaea plurijuga*

5 Mosaic of:

5.1 *Terminalia sericea* savanna on yellow Kalahari sands

5.2 *Colophospermum / Cathophractes / Terminalia* prunioides / *Combretum apiculatum / Combretum imberbe* shrub savanna on greyish psammitic soils

5.3 Patches of *Sesamothamnus guerichii* on calcareous soil

6 *Colophospermum / Combretum / Terminalia sericea* savanna in the "oshanas" of Owambo

7 *Colophospermum mopane / Combretum mechowianum* savanna with pans and vleis

TRANSITIONAL TYPES

8 Dwarf savanna on sheet calcrete

9 Mosaic of:

9.1 Tree *Colophospermum / Spirostachys* savanna

9.2 Grassveld

9.3 Shrubveld

9.4 Dwarf savanna on rocky mountains

10 *Colophospermum mopane / Terminalia prunioides / Acacia* spp. savanna with *Terminalia sericea*, *Lonchocarpus nelsii*, *Combretum apiculatum*, *Combretum imberbe* and *Kirkia acuminata*

11 *Acacia giraffae* savanna

NAMIB AND PRE-NAMIB TYPES

12 *Colophospermum mopane / Terminalia prunioides* savanna

13 Sub-desert steppe to very dry dwarf savanna of *Colophospermum mopane* and *Terminalia prunioides*

14 Escarpment area with rocky hills, surrounding flats. The rocky hills supporting a dwarf shrubby desertic steppe and the flats are covered by grasses

15 Desert grassveld alternating with hills and gravelled flats of dwarf desertic steppe

16 Desert dwarf steppe on gravelled flat or undulated surfaces

17 Sandy dunes

Study area: Etosha National Park, Namibia

Author: E. Joubert

Year of study: 1971

Study type: Research project

Reference *Madoqua* 1(4): 5–32

Special note: A more detailed Braun-Blanquet vegetation classification (Le Roux 1980) followed this classification by Joubert.

Communities 1 Tree savanna on sand

1.1 *Colophospermum mopane* tree savanna on granitic sand

2 Tree and shrub savanna on Kalahari-like sand, granitic sand and alkaline soils

2.1 *Colophospermum mopane* – *Acacia reficiens* – *Terminalia prunioides* association

2.2 *Colophospermum mopane* – *Terminalia prunioides* – *Combretum apiculatum* association

2.3 *Combretum apiculatum* – *Colophospermum mopane* association

3 Shrub savanna on calcrete rubble and alkaline soils

3.1 *Colophospermum mopane* – *Catophractes alexandri* shrub savanna

3.2 *Catophractes alexandri* – *Acacia nebrownii* association

3.3 *Sesamothamnus guerichii* association

4 Valley community on alluvial soils

5 *Commiphora* – *Sterculia* association on rocky outcrops

Study area: Etosha National Park, Namibia

Author: C.J.G. Le Roux

Year of study: 1980

Study type: D.Sc. thesis, Department of Plant Production, University of Pretoria

Reference *S. Afr. J. Bot.* 54(1): 1–10

Special note: Le Roux did not name the communities according to plant species names. It is rather a list of mapping units. Detail on the vegetation of these communities (mapping units?) can be seen in the publication.

Communities

TALL GRASSVELD COMMUNITIES

1 Sweet grassveld on lime

2 Adoniveld

3 Okondeka duneveld

4 Poacher's peninsula

5 Ekuma grasslands

6 Omuramba onaiso

7 Karstveld turf pans

KARST BUSHVELD AND FOREST

8 Mopane treeveld

9 *Colophospermum mopane / Combretum apiculatum / Terminalia prunioides* bushveld

10 Dungaries vegetation mapping unit

11 Marble hillocks

12 Thai-Tkab woodlands

13 Marula associations

14 *Terminalia prunioides / Spirostachys africana* forest

15 Dolomite inselbergs

SANDVELD AREAS

16 Sandy shrub Mopaneveld

17 Paradys vegetation mapping unit

18 Sandy *Terminalia / Acacia* shrubveld

19 Southeastern sandy bushveld

20 Northeastern sandveld

SHRUB MOPANE ON LOAMY SOILS

21 Nineteenth latitude shrub Mopaneveld

22 Narawandu shrub Mopaneveld

23 Ekuma woodlands

24 Shrub mopane on Estcourt form soils

KAOKOLAND

25 *Acacia reficiens / Colophospermum mopane / Terminalia prunioides* thorn scrub

26 *Colophospermum mopane / Combretum apiculatum / Sesamothamnus guerichii* bushveld

27 Otjovasandu hilly mopane savanna

28 Kaross granitic Mopaneveld

29 Kowares sandy mopane shrubveld

30 Renostervlei mopane / *Combretum hereroense / Sesamothamnus guerichii* shrubveld

BOTTOMLANDS

31 Saline and/or depressed areas

Study area: Northern Regions, Namibia

Author: C. Hines & A. Burke

Year of study: 1997

Study type: Report for the Ministry of Agriculture, Water and Rural Development, Republic of Namibia

Reference No publications

Special note: Classification of the vegetation of the northern regions is based on vegetation maps. Communities, as been reassessed, are listed below

Communities

VEGETATION UNITS OF THE KABBE AREA

1 Associations on Kalahari sands and reworked fluvial deposits

1.1 *Combretum – Terminalia – Burkea* tall closed woodland

1.2 *Colophospermum mopane* tall closed woodland

1.3 *Terminalia sericea – Eragrostis pallens* short open/closed woodland

1.4 Ephemeral pan short closed grasslands

2 Associations of the Kalahari-Floodplain transition

2.1 *Acacia nigrescens – Lonchocarpus capassa* high closed woodland

2.2 *Combretum imberbe – Terminalia sericea* tall open woodland

3 Associations of the floodplain areas

3.1 Perennial swamps

3.2 *Paspalum scrobiculatum* short closed grasslands

3.3 *Cynodon dactylon* short closed grasslands

3.4 *Vertiveria nigritana – Cymbopogon* sp. tall closed grasslands

3.5 *Diospyros mespiliformis – Piliostigma thonningii* high closed woodlands

VEGETATION UNITS OF THE OKATJALI – EKUMA AREA

1 *Hyphaene ventricosa – Sclerocarya birrea* high open/sparse woodland

2 *Sporobolus – Brachiaria – Eragrostis* tall closed grasslands

3 *Odyssea* – *Schmidtia* short closed grasslands

4 Pan margin sedge and grasslands

Study area: Kaokoland, North-West Namibia

Author: T. Becker & N. Jürgens

Year of study: 2000

Study type: Research project

Reference *Phytocoenologia* 30(3–4): 543–565

Special note: Communities described in this study are identified along three transects of climate gradients.

Communities

NORTHERN TRANSECT (Opuwo – Etanga – Skeleton Coast Park)

I Ephemeral grassland and *Colophospermum mopane* savanna

1 *Stipagrostis uniplumis* grassland

2 *Commiphora wildtii* – *Stipagrostis hirtigluma* grassland

3 *Stipagrostis hirtigluma* – *Calicorema capitata* grassland

4 *Colophospermum mopane* – *Enneapogon desvauxii* savanna

5 *Colophospermum mopane* – *Tribulus zeyheri* savanna

6 *Colophospermum mopane* – *Stipagrostis hirtigluma* – *Stipagrostis uniplumis* savanna

7 *Colophospermum mopane* – *Stipagrostis uniplumis* savanna

II *Colophospermum mopane* – *Terminalia prunioides* savanna

8 *Colophospermum mopane* – *Terminalia prunioides* – *Curroria decidua* savanna

9 *Colophospermum mopane* – *Terminalia prunioides* – *Stipagrostis hirtigluma* savanna

10 *Colophospermum mopane* – *Terminalia prunioides* savanna

11 *Colophospermum mopane* – *Terminalia prunioides* – *Stipagrostis uniplumis* savanna

IIa *Colophospermum mopane* – *Terminalia prunioides* – *Combretum apiculatum* savanna

12 *Colophospermum mopane* – *Terminalia prunioides* – *Combretum apiculatum* savanna

13 *Colophospermum mopane* – *Terminalia prunioides* – *Combretum apiculatum* – *Tribulus zeyheri* savanna

14 *Colophospermum mopane* – *Terminalia prunioides* – *Combretum apiculatum* – *Geigeria acaulis* savanna

15 *Colophospermum mopane* – *Terminalia prunioides* – *Combretum apiculatum* – *Barleria*

senensis – Indigofera sp. savanna

16 *Colophospermum mopane – Terminalia prunioides – Combretum apiculatum – Euphorbia damarana* savanna

MIDDLE TRANSECT (Opuwo – Orupembe – Skeleton Coast Park)

I Ephemeral grassland

1 *Calicorema capitata – Euphorbia damarana* grassland

2 *Zygophyllum stapfii – Stipagrostis namaquensis* grassland

3 *Stipagostis hirtigluma* grassland

4 *Phaeoptilum spinosum – Curroria decidua* grassland

II *Colophospermum mopane – Terminalia prunioides* savanna

IIa Species poor *Colophospermum mopane – Terminalia prunioides* savanna

5 *Colophospermum mopane – Terminalia prunioides* savanna

6 *Colophospermum mopane – Terminalia prunioides – Stipagrostis hirtigluma* savanna

7 *Colophospermum mopane – Terminalia prunioides – Amphiasma merenskianum – Heliotropium hereroense* savanna

IIb Species rich *Colophospermum mopane – Terminalia prunioides*

8 *Colophospermum mopane – Terminalia prunioides – Ceraria longipedunculata – Hermannia gariepina* savanna

9 *Colophospermum mopane – Terminalia prunioides – Grewia flavescens – Ximenia americana* savanna

10 *Colophospermum mopane – Terminalia prunioides – Fingerhuthia africana* savanna

11 *Colophospermum mopane – Terminalia prunioides – Lindernia clavata* savanna

12 *Colophospermum mopane – Terminalia prunioides – Commiphora anacardifolia* savanna

13 *Colophospermum mopane – Terminalia prunioides – Dicoma tomentosa – Stipagrostis uniplumis* savanna

14 *Colophospermum mopane – Terminalia prunioides – Acacia* spp. savanna

15 *Colophospermum mopane – Terminalia prunioides – Catophractes alexandri* savanna

16 *Colophospermum mopane – Terminalia prunioides – Catophractes alexandri – Petalidium rossmannianum* savanna

III *Colophospermum mopane – Terminalia prunioides – Combretum apiculatum* savanna

17 *Colophsopermum mopane – Terminalia prunioides – Combretum apiculatum* savanna

SOUTHERN TRANSECT (Warmquelle – Puros – Skeleton Coast Park)

I Ephemeral grassland and *Colophospermum mopane* savanna

1 *Stipagrostis uniplumis – Cleome foliosa – Gisekia africana* grassland

2 *Stipagrostis hirtigluma* grassland

3 *Stipagrostis uniplumis – Calicorema capitata* grassland

4 *Colophospermum mopane – Stipagrostis uniplumis* savanna

5 *Colophospermum mopane* savanna

6 *Colophospermum mopane – Salvadora persica – Stipagrostis hirtigluma* savanna

II *Acacia* spp. savanna

7 *Acacia erioloba – Salvadora persica* savanna

8 *Acacia tortilis – Zygophyllum simplex* savanna

III *Commiphora* spp. savanna

9 *Commiphora wildii – Monechma genistifolia* savanna

10 *Commiphora oblanceolata – Euphorbia damarana* savanna

11 *Commiphora virgata* savanna

IV *Colophospermum mopane – Terminalia prunioides* savanna

12 *Colophospermum mopane – Terminalia prunioides – Catophractes alexandri* savanna

APPENDIX 2

VEGETATION TYPES (MAPPING UNITS) IN THE SOUTHERN AFRICAN MOPANEVELD

South Africa

Vegetation map / description of types:	Veld Types of South Africa
Scale:	1: 7 000 000
Author:	J.P.H. Acocks
Reference:	*Memoirs of the Botanical Survey of South Africa* 28 (1953)
Vegetation types:	***III TROPICAL BUSH AND SAVANNA TYPES***
	Mopani Veld (Veld Type no. 15)

Vegetation map / description of types:	Vegetation map of South Africa, Lesotho and Swaziland
Scale:	1: 2 000 000
Author:	A.B. Low & A.G. Rebelo
Reference:	A companion to the vegetation map of South Africa, Lesotho and Swaziland (1998). Department of Environmental Affairs and Tourism Pretoria
Vegetation types:	***SAVANNA BIOME***
	Mopane Shrubveld (Vegetation Type no. 9)
	Mopane Bushveld (Vegetation Type 10)

Botswana

Vegetation map / description of types:	Vegetation of the Chobe River in Northeast Botswana (1975)
Scale:	No vegetation map, only descriptions on vegetation
Author:	C.D. Simpson
Reference:	*Kirkia* 10: 185–227
Vegetation types:	*Colophospermum* tree / bush savanna

Vegetation map / description of types:	Vegetation map of South East Botswana (1980)
Scale:	1: 500 000
Author:	J. Timberlake
Reference:	Unpublished Report
Vegetation types:	***SANDVELD (TREE AND SHRUB SAVANNAS ON SAND)***
	Mopane shrub savanna on sand (type A4)
	HARDVELD (WOODLAND AND TREE SAVANNA ON NON-SANDY SOILS)
	Mopane woodland (type B2)
	WOODLAND ON HILLS AND ROCKY OUTCROPS
	Acacia nigrescens hill woodland (type C2)

Vegetation map / description of types:	Vegetation map of Botswana (1971)
Author:	P.R. Weare & A. Yalala
Reference:	*Botswana Notes and Records* 3: 131–147
Vegetation types:	***TREE SAVANNA***
	1 Tree and bush savanna with mopane (type 2c)
	2 North-western tree savanna (type 2d)
	3 Mopane bushveld (type 2j)
	4 Mixed mopane bushveld (type 2k)
	(i) Mopane closed tree savanna
	(ii) Mopane mixed tree savanna
	(iii) Mopane low tree savanna
	(iv) Mopane thicket woodland
	5 Mopane open tree savanna (type 2l)
	6 Mixed mopane tree and bush savanna (type 2m)
	7 Ngamiland tree savanna (type 2o)
	CLOSE TREE SAVANNA ON ROCKY HILLS
	Croton/Combretum association (type 3a)
	RIPARIAN FOREST
	Okavango fringe forest (type 8a)

Vegetation map / description of types: Vegetation map of the Flora Zambesiaca area (1967)

Scale: 1: 2 500 000

Author: H. Wild & L.A.G Barbosa

Reference: *Flora Zambesiaca* supplement. Harare, Zimbabwe

Vegetation types:

WOODLAND AND SAVANNA WOODLAND

Dry early deciduous savanna woodland (low-land): *Colophospermum* (type 35)

TREE SAVANNA

1 Deciduous dry tree savanna (in Kalahari sand): *Baikiaea* – *Colophospermum* – *Burkea* – *Dialium* (type 38)

2 Dry deciduous tree savanna: *Colophospermum mopane* (type 50)

SHRUB SAVANNA

1 Dry early deciduous shrub savanna: *Colophospermum mopane* – *Enneapogon* – *Aristida* (type 61)

Zimbabwe

Vegetation map / description of types: Vegetation types of Southern Rhodesia

Scale: No vegetation map, only description

Author: A.S. Boughey

Reference: *Proc. Trans. of Rhodesia Scientific Assoc*. 49: 54–98

Vegetation types: [Zone E – (b)] The *Colophospermum mopane* catena type

Vegetation map / description of types: Vegetation types of the Chewore – Angwa – Kanyemba area of the Zambezi Valley, Zimbabwe (1993)

Scale: 1: 100 000

Author: R. Du Toit

Reference: *Kirkia* 14(1): 61–77

Vegetation types:

RIVERINE VEGETATION

Vegetation in areas of diffuse drainage (type 1.3)

DRY DECIDUOUS FOREST AND WOODLAND WITH UNDERSTOREY

1 *Kirkia – Colophospermum* ridge vegetation (type 2.2)

2 *Combretum – Strychnos* woodland (type 2.3)

MOPANE COMMUNITIES

1 Extensive mopane communities (type 3.1)

2 Mopane communities on intercalated mudrock (type 3.2)

3 Mixed mopane woodland (type 3.3)

MIOMBO COMMUNITIES

1 Well-developed miombo woodland (type 4.1)

2 *Julbernardia – Colophospermum* woodland (type 4.2)

3 Miombo on intercalated sandstone (type 4.3)

4 Miombo on large sandstone hills (type 4.4)

5 Small tree savanna woodland (type 4.6)

TERMINALIA COMMUNITIES

1 *Terminalia* mosaic (type 5.1)

2 Open *Terminalia – Combretum – Colophospermum* community

Vegetation map / description of types: Vegetation of Southern Gokwe District, Rhodesia (1968)

Scale: 1: 250 000

Author: J.A.K. Farrell

Reference: *Kirkia* 6(2): 249–257

Vegetation types:

1 *Brachystegia boehmii – Julbernardia globiflora* vegetation type (type 3)

2 *Colophospermum mopane* vegetation type (type 4)

3 *Combretum apiculatum* vegetation type (type 6)

4 *Terminalia randii* vegetation type (type 11)

Vegetation map / description of types: Vegetation of Southern the lower Sabi-Lundi Basin, Rhodesia (1968)

Scale: 1: 250 000

Author: J.A.K. Farrell

Reference: *Kirkia* 6(2): 223–248

Vegetation types:

1 *Kirkia acuminata* and *Commiphora mollis* vegetation type (type 5)
2 *Colophospermum mopane* vegetation type (type 6)
3 *Combretum apiculatum* vegetation type (type 8)
4 *Spirostachys africana* vegetation type (type 15)
5 *Acacia nigrescens* vegetation type (type 16)

Vegetation map / description of types: Vegetation types of the Zambezi Valley, Rhodesia, between the Kariba and Mpata gorges (1975)

Scale: No vegetation map, only description of types

Author: P.R. Guy

Reference: *Kirkia* 10: 543–557

Vegetation types:

1 *Colophospermum mopane* woodland (type 1)
2 Mixed species woodland (type 4)
3 *Acacia* woodland savanna (type 9)
4 *Colophospermum mopane* – *Acacia* woodland-savanna (type 10)
5 *Colophospermum mopane* tree savanna (type 11)
6 *Colophospermum mopane* tree bush savanna (type 12)
7 *Combretum* – *Terminalia* – *Colophospermum mopane* bush savanna (type 14)
8 *Colophospermum mopane* scrub savanna (type 16)

Vegetation map / description of types: Vegetation map of the federation of Rhodesia and Nyasaland (1961)

Author: J.M. Rattray & H. Wild

Reference: *Kirkia* 2: 94–104

Vegetation types:

Woodlands

1 *Colophospermum mopane* woodland (type 16)

SAVANNA

1 *Burkea africana – Dialium engleranum – Baikiaea – Colophospermum* savanna (type 22)

2 *Colophospermum mopane* savanna (type 26)

Vegetation map / description of types: Vegetation types of southern Rhodesia (1962)

Scale: No vegetation map, only descriptions on vegetation types

Author: J.M. Rattray

Reference: *Kirkia* 2: 68–93

Vegetation types: ***WOODLANDS***

1 *Julbernardia globiflora* types (type 2c)

2 *Colophospermum mopane* types (type 2h)

SAVANNAS

1 Woodland savannas

2 Tree savannas

2.1 *Terminalia sericea* types (type 3Bb)

2.2 *Acacia* spp. types - on deep sandy soils derived from sandstones of the Permian system in the Sabi Valley (type 3Bd6)

2.3 *Colophospermum mopane* types (type 3Be)

1. *Colophospermum* alone - *Eragrostis* (Kalahari, Permian)
2. *Colophospermum* - *Brachystegia boehmii* - *Aristida* (Kalahari)
3. *Colophospermum* - *Acacia* - *Combretum* - *Cenchrus* (Basalt)
4. *Colophospermum* - *Commiphora* - *Adansonia* - *Aristida* (annual) (several soil types)

3 Tree/bush savannas

3.1 *Acacia* types (type 3Ca)

3.2 *Terminalia sericea* type (type 3Cb)

3.3 *Combretum* spp. types (type 3Cc)

3.4 *Colophospermum mopane* types (type 3Cd)

1. *Colophospermum* - *Pterocarpus* - *Aristida* (Kalahari sand)
2. *Colophospermum* - *Grewia* - *Sclerocarya* - *Kirkia* - *Eragrostis* (granite, paragneiss)

3. *Colophospermum - Grewia - Acacia - Combretum - Cenchrus* (Basalt)
4. *Colophospermum - Grewia - Commiphora - Aristida* (annual) (several soil types)
5. *Colophospermum - Grewia - Eragrostis*

4 Scrub savannas

4.1 *Colophospermum types* (type 3Gc)

(1) that occurring on deep cracking heavy clays on basalts and Madumabisa shales

(2) that occurring on shallow stony basalt soils

(3) that on low-lying drainage areas subject to severe frosts

(4) that which has developed as a result of coppicing

BUSHLANDS OR THICKETS

1 Other secondary thickets (type 4g)

Vegetation map / description of types: Vegetation of the communal lands - North and West Zimbabwe (1993)

Scale: 1: 500 000

Author: J.R. Timberlake, N. Nobanda & I. Mapaure

Reference: *Kirkia* 14 (2): 171–270

Vegetation types: ***RIPARIAN FORESTS AND ALLUVIAL WOODLANDS***

1 Dense woodland to woodland and thicket on alluvium / colluvium (type B1)

1.1 Subtype A: well developed closed woddland to woodland thicket on heavier textured soils

2 Mixed riparian woodland (type B2)

2.1 Subtype A: closed to open woodland characterized by trees

2.2 Subtype B: woodland to open woodland

DRY FORESTS AND THICKETS

1 *Terminalia brachystemma* bushed woodland (type C1)

2 *Combretum* woodland thicket on colluvium and sandstone (type C3)

2.1 Subtype A: well developed woodland thicket

2.2 SubtypeB: heterogeneous vegetation subtype ranging from woodland thicket to woodland

2.3 Subtype C: woodland thicket characterized by a usually well developed shrub layer

3 *Baikiaea* woodland on Kalahari sands (type C6)

3.1 Subtype B: open woodland

4 *Baikiaea - Acacia* bushed woodland on sand dunes (type C7)

4.1 Subtype B: wooded grassland to shrubland

MIOMBO WOODLANDS

1 *Brachystegia spiciformis - B. boehmii* woodland on sand (type D2)

Subtype A: *Brachystegia spiciformis* woodland (*Colophospermum mopane* only on termitaria)

1.2 Subtype B: *Brachystegia boehmii* woodland (*Colophospermum mopane* only on termitaria)

2 *Brachystegia boehmii - Julbernardia - Pterocarpus angolensis* open woodland on sandtone plateaux (type D3)

2.1 Subtype A: open woodland (*Colophospermum mopane* only on termitaria)

3 *Brachystegia boehmii - Julbernardia* woodland on shallow soils (type D4)

3.1 Subtype B: woodland, mostly rather open (*Colophospermum mopane* only on termitaria)

3.2 Subtype F: low woodland, mostly rather open (*Colophospermum mopane* only on termitaria)

4 *Brachystegia glaucescens* woodland on hills (typeD6)

4.1 Subtype A: woodland to open woodland

MIOMBO - MOPANE WOODLANDS

1 *Brachystegia boehmii - Colophospermum* woodland catena (type E1)

1.1 Subtype A: woodland to open woodland

1.2 Subtype B: woodland of alternating dominance by *Brachystegia boehmii*, *Julbernardia globiflora*, *Colophospermum mopane* and *Kirkia acuminata*

1.3 Subtype C: clumped woodland to woodland thicket on termitaria or rocky outcrops surrounded by more open woodland

2 *Julbernardia - Colophospermum* woodland catena (type E2)

2.1 Subtype A: mosaic of open woodland, woodland to bushed woodland - alternating dominance of *Julbernardia globiflora*, *Pteleopsis anisoptera* and *Colophospermum mopane*

2.2 Subtype B: woodland to open woodland

2.3 Subtype C: well developed woodland

3 *Combretum - Colophospermum* open woodland mosaic (type E3)

4 *Colophospermum - Diospyros kirkii* open woodland on shallow soils (type E4)

4.1 Subtype A: open woodland, verging on wooded grassland on the shallowest soils

4.2 Subtype B: open woodland to wooded grassland characterized by small trees

5 *Colophospermum - Brachystegia allenii* woodland mosaic (E5)

MOPANE WOODLANDS

1 *Colophospermum* woodland on skeletal soils (type F1)

1.1 Subtype A: open woodland with alternating dominance of *Colophsopermum mopane* and *Kirkia acuminata* with *Acacia nigrescens*

1.2 Subtype B: mosaic of open woodland

2 *Colophospermum - Terminalia stuhlmannii* woodland (type F2)

3 *Colophospermum* woodland (single dominance)

3.1 Subtype A: uniform woodland characterized by single-species dominance of *Colophospermum mopane*

3.2 Subtype B: woodland with low abundances of other woody species

3.3 Subtype C: open woodland

3.4 Subtype D: single-species dominance woodland with a lower canopy

COMBRETACEAE OPEN WOODLANDS

1 *Combretum collinum* low open woodland on sand (type G1)

2 Mixed dry woodland mosaic on granite (type G2)

ACACIA OPEN WOODLANDS

1 Acacia open woodland on Goldbelt soils (type H1)

1.1 Subtype A: open woodland

1.2 Subtype B: open woodland to woodland

Vegetation map / description of types: Vegetation in the Eastern Mid-Zambezi Valley, Zimbabwe

Scale: 1: 500 000

Author: J. Timberlake & I. Mapaure

Reference: *Transactions of the Zimbabwe Scientific Association* 66: 1–14

Vegetation types:

1 Dense woodland to woodland thicket on old alluvium (type 2)

2 *Terminalia brachystemma* bushed woodland (type 3)

3 Woodland or bushland fallows on alluvium / colluvium (type 4)

4 Mopane woodland on deeper soils (type 6)

5 Mopane - Terminalia stuhlmannii woodland (type 7)

6 Mopane - *Combretum apiculatum* woodland on shallow soils

7 Mopane - *Combretum apiculatum - Julbernardia* woodland (type 9)

8 *Brachystegia allenii* - mopane woodland on colluvium (type 10)

Vegetation map / description of types: Vegetation map of the Flora Zambesiaca area (1967)

Scale: 1: 2 500 000

Author: H. Wild & L.A.G Barbosa

Reference: *Flora Zambesiaca* supplement. Harare, Zimbabwe

Vegetation types:

WOODLAND AND SAVANNA WOODLAND

Dry early deciduous savanna woodland (low-land): *Colophospermum* (type 35)

TREE SAVANNA

1 Deciduous dry tree savanna (in Kalahari sand): *Baikiaea – Colophospermum – Burkea – Dialium* (type 38)

2 Dry deciduous tree savanna: *Colophospermum mopane* (type 50)

SHRUB SAVANNA

Dry early deciduous shrub savanna: *Colophospermum mopane – Enneapogon – Aristida* (type 61)

Zambia

Vegetation map / description of types: Vegetation of Zambia (1969)

Author: Fanshawe, D.B.

Reference: Forest Research Bulletin 7: 1–67

Vegetation types:

OPEN FOREST WITH GRASS

Mopane Woodland (type IIA3)

TERMITARIA

Mopane termitaria

Vegetation map / description of types: Vegetation map of the Flora Zambesiaca area (1967)

Scale: 1: 2 500 000

Author: H. Wild & L.A.G Barbosa

Reference: *Flora Zambesiaca* supplement. Harare, Zimbabwe

Vegetation types:

WOODLAND AND SAVANNA WOODLAND

Dry early deciduous savanna woodland (low-land): *Colophospermum* (type 35)

TREE SAVANNA

1 Deciduous dry tree savanna (in Kalahari sand): *Baikiaea – Colophospermum – Burkea – Dialium* (type 38)

2 Dry deciduous tree savanna: *Colophospermum mopane* (type 50)

Malawi

Vegetation map / description of types: Vegetation map of the Flora Zambesiaca area (1967)

Scale: 1: 2 500 000

Author: H. Wild & L.A.G Barbosa

Reference: *Flora Zambesiaca* supplement. Harare, Zimbabwe

Vegetation types: *WOODLAND AND SAVANNA WOODLAND*

Dry early deciduous savanna woodland (low-land): *Colophospermum* (type 35)

TREE SAVANNA

Dry deciduous tree savanna: *Colophospermum mopane* (type 50)

Mozambique

Vegetation map / description of types: Vegetation map of the Flora Zambesiaca area (1967)

Scale: 1: 2 500 000

Author: H. Wild & L.A.G Barbosa

Reference: *Flora Zambesiaca* supplement. Harare, Zimbabwe

Vegetation types: *WOODLAND AND SAVANNA WOODLAND*

Dry early deciduous savanna woodland (low-land): *Colophospermum* (type 35)

TREE SAVANNA

Dry deciduous tree savanna: *Colophospermum mopane* (type 50)

SHRUB SAVANNA

Dry early deciduous shrub savanna: *Colophospermum mopane – Enneapogon – Aristida* (type 61)

Angola

Vegetation map / description of types: Carta fitogeográfica de Angola

Author: L.A.G. Barbosa

Reference: Carta fitogeográfica de Angola. Luanda, Angola. Instituto de Investigaçâo Científica de Angola (1970)

Vegetation types:

Mapping unit	Vegetation type
20	Dry deciduous woodland and mosaic of savanna and shrubland
21	Dry valley woodland and riverine vegetation
27	Sublittoral shrubland

Vegetation map / description of types: Generalized vegetation map of Angola (after Barbosa 1970)

Scale: 1: 8 000 000

Author: Unknown

Vegetation types:

Mapping unit	Vegetation type
18WS	Mosaic of: (1) xeric (deciduous) woodland (2) xeric savannas
19S	Imperfectly drained *Colophospermum* shrubland on cracking clays
20WS	Mosaic of: (1) low growing woodlands (2)tall grass savannas
25SG	Mosaic of: (1) xerophytic shrublands (2) annual grasslands (3)dwarf shrubland

Namibia

Vegetation map / description of types: Vegetation map of Namibia (1998)

Scale: 1: 5 000 000

Author: W. Giess

Reference: *Dinteria* 4: 1–112

Vegetation types: *SAVANNA*

1 Mopane savanna (type 5)

2 Riverine woodland (not a mapping unit)

APPENDIX 3

LIST OF PLANT SPECIES / INFRASPECIFIC TAXA

Abrus laevigatus E.Mey.
Abutilon angulatum (Guill. & Perr.) Mast.
Abutilon austro-africanum Hochr.
Abutilon englerianum Ulbr.
Abutilon fruticosum Guill. & Perr.
Abutilon grandiflorum G.Don
Abutilon guineense (K.Schum.) Baker f. & Exell
Abutilon hirtum (Lam.) Sweet
Abutilon pycnodon Hochr.
Abutilon ramosum (Cav.) Guill. & Perr.
Abutilon species
Acacia arenaria Schinz
Acacia ataxacantha DC.
Acacia borleae Burtt Davy
Acacia burkei Benth.
Acacia caffra (Thunb.) Willd.
Acacia erioloba E.Mey.
Acacia erubescens Welw. ex Oliv.
Acacia exuvialis I.Verd.
Acacia fleckii Schinz
Acacia gerrardii Benth.
Acacia grandicornuta Gerstner
Acacia hebeclada DC.
Acacia hebeclada DC. ssp. *chobiensis* (O.B.Mill.) A.Schreib.
Acacia hebeclada DC. ssp. *hebeclada*
Acacia hebeclada DC. ssp. *tristis* A.Schreib.
Acacia karroo Hayne
Acacia kirkii Oliv.
Acacia luederitzii Engl.
Acacia mellifera (Vahl) Benth.
Acacia mellifera (Vahl) Benth. ssp. detinens (Burch.) Brenan
Acacia mellifera (Vahl) Benth. ssp. *mellifera*
Acacia montis-usti Merxm. & A.Schreib.
Acacia nebrownii Burtt Davy
Acacia nigrescens Oliv.
Acacia nilotica (L.) Willd. ex Del.
Acacia permixta Burtt Davy
Acacia reficiens Wawra
Acacia robusta Burch.
Acacia schweinfurthii Brenan & Exell
Acacia senegal (L.) Willd.
Acacia senegal (L.) Willd. var. leiorhachis Brenan
Acacia senegal (L.) Willd. var. rostrata Brenan
Acacia species
Acacia tortilis (Forssk.) Hayne
Acacia welwitschii Oliv. ssp. delagoensis (Harms) J.H.Ross & Brenan
Acacia xanthophloea Benth.
Acalypha fruticosa Forssk.
Acalypha glabrata Thunb.
Acalypha indica L.
Acalypha segetalis Müll.Arg.
Acalypha species
Acalypha villicaulis Hochst. ex A.Rich.
Acanthosicyos naudinianus (Sond.) C.Jeffrey
Acanthospermum hispidum DC.
Achyranthes aspera L.
Achyropsis leptostachya (E.Mey. ex Meisn.) Baker & C.B.Clarke
Acrachne racemosa (Roem. & Schult.) Ohwi
Acrotome hispida Benth.
Acrotome inflata Benth.
Actiniopteris radiata (J.Konig ex Sw.) Link
Adansonia digitata L.
Adenia digitata (Harv.) Engl.
Adenium boehmianum Schinz
Adenium multiflorum Klotzsch
Adenolobus garipensis (E.Mey.) Torre & Hillc.
Aerva leucura Moq.
Afzelia quanzensis Welw.
Agathisanthemum bojeri Klotzsch
Ageratum conyzoides L.
Aizoanthemum dinteri (Schinz) Friedrich
Aizoon giessii Friedrich
Aizoon glinoides L.f.
Aizoon species
Aizoon virgatum Welw. ex Oliv.
Albizia anthelmintica (A.Rich.) Brongn.
Albizia brevifolia Schinz
Albizia forbesii Benth.
Albizia harveyi E.Fourn.
Albizia petersiana (Bolle) Oliv.
Albizia species
Albizia tanganyicensis Bak. f.
Albizia versicolor Welw. ex Oliv.
Albuca angolensis Welw.
Albuca melleri Baker
Albuca setosa Jacq.
Alchornea laxiflora (Benth.) Pax & K.Hoffm.
Alectra orobanchoides Benth.

Alectra species
Aloe chabaudii Schonl.
Aloe excelsa A.Berger
Aloe littoralis Baker
Aloe species
Aloe x esculenta L.C.Leach
Alternanthera pungens Humb.
Alysicarpus vaginalis (L.) DC.
Amaranthus dinteri Schinz
Amaranthus praetermissus Brenan
Amaranthus schinzianus Thell.
Amaranthus species
Amaranthus thunbergii Moq.
Ammannia senegalensis Lam. ex Poir.
Ammocharis coranica (Ker Gawl.) Herb.
Ammocharis species
Amphiasma benguellense (Hiern) Bremek.
Andropogon chinensis (Nees) Merr.
Andropogon gayanus Kunth
Androstachys johnsonii Prain
Aneilema hockii De Wild.
Anisotes rogersii S.Moore
Anthephora pubescens Nees
Anthephora ramosa Gooss.
Anthephora schinzii Hack.
Anticharis inflata Marloth & Engl.
Anticharis linearis (Benth.) Hochst. ex Asch.
Aptosimum angustifolium E.Weber & Schinz
Aptosimum decumbens Schinz
Aptosimum glandulosum E.Weber & Schinz
Aptosimum lineare Marloth & Engl.
Aptosimum lugardiae (N.E.Br.) E.Phillips
Aptosimum species
Argemone mexicana L.
Argyrolobium stipulaceum Eckl. & Zeyh.
Aridaria species
Aristida adscensionis L.
Aristida bipartita (Nees) Trin. & Rupr.
Aristida canescens Henr.
Aristida congesta Roem. & Schult.
Aristida congesta Roem. & Schult. ssp. *barbicollis* (Trin. & Rupr.) De Winter
Aristida congesta Roem. & Schult. ssp. *congesta*
Aristida effusa Henrard
Aristida hordeacea Kunth
Aristida junciformis Trin. & Rupr.
Aristida meridionalis Henrard
Aristida mollissima Pilg.
Aristida rhiniochloa Hochst.
Aristida scabrivalvis Hack.
Aristida species
Aristida stipitata Hack.
Aristida stipitata Hack. ssp. *graciliflora* (Pilg.) Melderis
Aristida stipitata Hack. ssp. *stipitata*
Aristida stipoides Lam.
Artabotrys brachypetalus Benth.
Ascolepis species
Asparagus africanus Lam.
Asparagus buchananii Baker
Asparagus burchellii Baker
Asparagus crassicladus Jessop
Asparagus denudatus (Kunth) Baker
Asparagus exuvialis Burch. fo. ecklonii (Baker) Fellingham & N.L.Mey.
Asparagus falcatus L.
Asparagus macowanii Baker
Asparagus minutiflorus (Kunth) Baker
Asparagus natalensis (Baker) J.P.Lebrun & Stork
Asparagus nelsii Schinz
Asparagus pearsonii Kies
Asparagus plumosus Baker
Asparagus setaceus (Kunth) Jessop
Asparagus species
Asparagus spinescens Steud. ex Roem. & Schult.
Asparagus suaveolens Burch.
Aspilia mossambicensis (Oliv.) Wild
Asystasia gangetica (L.) T.
Asystasia subbiflora C.B.Clarke
Atriplex lindleyi Moq.
Azima tetracantha Lam.
Baikiaea plurijuga Harms
Baissea wulfhorstii Schinz
Balanites maughamii Sprague
Balanites pedicellaris Mildbr. & Schltr.
Balanites welwitschii (Tiegh.) Exell & Mendonca
Baphia massaiensis Taub.
Barleria affinis C.B.Clarke
Barleria crossandriformis C.B.Clarke
Barleria elegans S.Moore ex C.B.Clarke
Barleria galpinii C.B.Clarke
Barleria holubii C.B.Clarke
Barleria kaloxytona Lindau
Barleria lanceolata (Schinz) Oberm.
Barleria lancifolia T.Anderson
Barleria lugardii C.B.Clarke
Barleria mackenii Hook.f.
Barleria merxmuelleri P.G.Mey.
Barleria oxyphylla Lindau

Barleria prionitis L.
Barleria rogersii S.Moore
Barleria saxatilis Oberm.
Barleria senensis Klotzsch
Barleria species
Barleria transvaalensis Oberm.
Basananthe pedata (Baker f.) W.J.de Wilde
Bauhinia galpinii N.E.Br.
Bauhinia petersiana Bolle
Becium filamentosum (Forssk.) Chiov.
Becium obovatum (E. Mey. ex Benth.)
Becium species
Berchemia discolor (Klotzsch) Hemsl.
Berchemia zeyheri (Sond.) Grubov
Bergia salaria Bremek.
Bidens biternata (Lour.) Merr. & Sherff
Bidens pilosa L.
Bidens species
Blainvillea gayana Cass.
Blepharis diversispina (Nees) C.B.Clarke
Blepharis gerlindae P.G.Mey.
Blepharis innocua C.B. Cl.
Blepharis integrifolia (L. f.) E. Mey. ex Schinz
Blepharis leendertziae Oberm.
Blepharis maderaspatensis (L.) Heyne ex Roth
Blepharis obmitrata C.B.Clarke
Blepharis species
Blepharis subvolubilis C.B. Cl.
Boerhavia coccinea Mill.
Boerhavia diffusa L.
Boerhavia species
Bolusanthus speciosus (Bolus) Harms
Bonamia schizantha (Hallier f.) A.Meeuse
Boophane disticha (L.f.) Herb.
Boscia albitrunca (Burch.)
Boscia foetida Schinz
Boscia foetida Schinz ssp. foetida
Boscia matabelensis Pestal.
Boscia microphylla Oliv.
Boscia mossambicensis Klotzsch
Boscia salicifolia Oliv.
Boscia tomentosa Toelken
Bothriochloa insculpta (A.Rich.) A.Camus
Bothriochloa radicans (Lehm.) A.Camus
Bothriochloa species
Brachiaria brizantha (A.Rich.) Stapf
Brachiaria deflexa (Schumach.)
C.E.Hubb. ex Robyns
Brachiaria eruciformis (Sm.) Griseb.
Brachiaria humidicola (Rendle) Schweick.
Brachiaria malacodes (Mez & K.Schum.) Scholz
Brachiaria marlothii (Hack.) Stent
Brachiaria nigropedata (Ficalho & Hiern) Stapf
Brachiaria schoenfelderi C.E.Hubb. & Schweick.
Brachiaria serrata (Thunb.) Stapf
Brachiaria species
Brachiaria xantholeuca (Schinz) Stapf
Brachylaena huillensis O.Hoffm.
Breonadia salicina (Vahl) Hepper & J.R.I.Wood
Bridelia cathartica Bertol.f.
Bridelia micrantha (Hochst.) Baill.
Bridelia mollis Hutch.
*Brunsvigia s*pecies
Buchnera glabrata Benth.
Buchnera longespicata Schinz
Bulbostylis contexta (Nees) M.Bodard
Bulbostylis hispidula (Vahl) R.W.Haines
Bulbostylis species
Burkea africana Hook.
Cadaba aphylla (Thunb.) Wild
Cadaba schroeppelii Suess.
Caesalpinia rubra (Engl.) Brenan
Calostephane divaricata Benth.
Camptorrhiza strumosa (Baker) Oberm.
Canthium glaucum (Klotzsch) Kuntze
Canthium setiflorum Hiern
Capparis tomentosa Lam.
Cardamine africana L.
Cardiospermum corindum L.
Cardiospermum halicacabum L.
Carissa bispinosa (L.) Desf. ex Brenan
Carissa tetramera (Sacleux) Stapf
Cassia abbreviata Oliv.
Cassine aethiopica Thunb.
Cassine eucleiformis (Eckl. & Zeyh.) Kuntze
Cassine transvaalensis (Burtt Davy) Codd
Catophractes alexandri D.Don
Catunaregam spinosa (Thunb.)
Celosia trigyna L.
Cenchrus ciliaris L.
Centropodia glauca (Nees) Cope
Cephalocroton mollis Klotzsch
Ceraria longipedunculata Merxm. & Podlech
Ceratotheca species
Ceratotheca triloba (Bernh.) Hook.f.
Cereus peruvianus (L.) Mill.
Chaetacanthus costatus Nees
Chamaecrista absus (L.) Irwin & Barneby
Chamaecrista biensis (Steyaert) Lock
Chamaecrista comosa E. Mey.
Chamaecrista mimosoides (L.) Greene
Chamaesyce glanduligera (Pax) Koutnik

Chamaesyce inaequilatera (Sond.) Sojak
Chamaesyce neopolycnemoides (Pax & K.Hoffm.) Koutnik
Chamaesyce prostrata (Aiton) Small
Chamaesyce tettensis (Klotzsch) Koutnik
Chascanum adenostachyum (Schauer) Moldenke
Chascanum hederaceum (Sond.)
Chascanum pinnatifidum (L.f.)
Cheilanthes dinteri Brause
Cheilanthes involuta (Swartz) Schelpe & N.C. Anthony
Cheilanthes viridis (Forssk.) Swartz
Chenopodium album L.
Chloris gayana Kunth
Chloris mossambicensis K.Schum.
Chloris roxburghiana Schult.
Chloris species
Chloris virgata Sw.
Chlorophytum galpinii Oberm.
Cirsium vulgare (Savi) Ten.
Cissampelos mucronata A.Rich.
Cissus cornifolia (Baker) Planch.
Cissus nymphaeifolia (Welw. ex Baker) Planch.
Cissus quadrangularis L.
Cissus rotundifolia (Forssk.) Vahl
Cissus species
Citrullus lanatus (Thunb.) Matsum. & Nakai
Cleistanthus schlechteri (Pax) Hutch.
Clematis brachiata Thunb.
Cleome angustifolia (Forssk.)
Cleome gynandra L.
Cleome hirta (Klotzsch) Oliv.
Cleome maculata (Sond.) Szyszyl.
Cleome monophylla L.
Cleome oxyphylla Burch.
Cleome rubella Burch.
Cleome species
Clerodendrum dekindtii Guerke
Clerodendrum glabrum E. Mey.
Clerodendrum species
Clerodendrum ternatum Schinz
Clerodendrum uncinatum Schinz
Clitoria ternatea L.
Coccinia adoensis (A.Rich.) Cogn.
Coccinia rehmannii Cogn.
Coccinia sessilifolia (Sond.) Cogn.
Cocculus hirsutus (L.) Diels
Coddia rudis (E.Mey. ex Harv.) Verdc.
Coelachyrum yemenicum (Schweinf.) S.M.Phillips
Colophospermum mopane (J.Kirk ex Benth.) J.Kirk ex J.Léonard
Combea mollusca (Ach.) Nyl.
Combea species
Combretum albopunctatum Suess.
Combretum apiculatum Sond.
Combretum celastroides Welw. ex Laws.
Combretum collinum Welw. ex Laws.
Combretum engleri Schinz
Combretum erythrophyllum (Burch.) Sond.
Combretum hereroense Schinz
Combretum imberbe Wawra
Combretum microphyllum Klotzsch
Combretum molle R.Br. ex G.Don
Combretum mossambicense (Klotzsch) Engl.
Combretum nelsonii Dummer
Combretum padoides Engl. & Diels
Combretum psidioides Welw.
Combretum species
Combretum wattii Exell
Combretum zeyheri Sond.
Commelina africana L.
Commelina benghalensis L.
Commelina diffusa Burm. f.
Commelina erecta L.
Commelina forskaolii Vahl
Commelina livingstonii C.B.Clarke
Commelina species
Commelina subulata Roth
Commicarpus africanus (Lour.) Dandy
Commicarpus fallacissimus (Heimerl) Heimerl ex Oberm.
Commiphora africana (A.Rich.) Engl.
Commiphora anacardiifolia Dinter & Engl.
Commiphora angolensis Engl.
Commiphora crenato-serrata Engl.
Commiphora edulis (Klotzsch) Engl.
Commiphora giessii J.J.A.van der Walt
Commiphora glandulosa Schinz
Commiphora glaucescens Engl.
Commiphora gracilifrondosa Dinter ex J.J.A.van der Walt
Commiphora marlothii Engl.
Commiphora merkeri Engl.
Commiphora mollis (Oliv.) Engl.
Commiphora mossambicensis (Oliv.) Engl.
Commiphora multijuga (Hiern) K.Schum.
Commiphora pyracanthoides Engl.
Commiphora schimperi (O.Berg) Engl.
Commiphora species
Commiphora tenuipetiolata Engl.
Commiphora virgata Engl.
Conostomium zoutpansbergense (Bremek.)

Convolvulus ocellatus Hook. f.
Conyza attenuata DC.
Corallocarpus bainesii (Hook.f.) A.Meeuse
Corallocarpus triangularis Cogn.
Corbichonia decumbens (Forssk.) Exell
Corchorus asplenifolius Burch.
Corchorus confusus Wild
Corchorus junodii (Schinz) N.E.Br.
Corchorus kirkii N.E.Br.
Corchorus longipedunculatus Mast.
Corchorus tridens L.
Corchorus trilocularis L.
Cordia caffra Sond.
Cordia grandicalyx Oberm.
Cordia monoica Roxb.
Cordia sinensis Lam.
Cotyledon barbeyi Schweinf. ex Baker
Crabbea hirsuta Harv.
Crabbea velutina S.Moore
Crinum buphanoides Welw. ex Baker
Crinum delagoense I.Verd.
Crinum macowanii Baker
Crinum species
Crossandra mucronata Lindau
Crossopteryx febrifuga (Afzel. ex G.Don) Benth.
Crotalaria argyraea Welw. ex Baker
Crotalaria barnabassii Dinter ex Baker f.
Crotalaria damarensis Engl.
Crotalaria distans Benth.
Crotalaria laburnifolia L.
Crotalaria meyeriana Steud.
Crotalaria monteiroi Taub. ex Bak. f.
Crotalaria pallida Ait.
Crotalaria pisicarpa Welw. ex Baker
Crotalaria platysepala Harv.
Crotalaria podocarpa DC.
Crotalaria schinzii Baker f.
Crotalaria spartioides DC.
Crotalaria species
Crotalaria sphaerocarpa Perr. ex DC.
Crotalaria teixeirae Torre
Crotalaria virgulata Klotzsch
Croton gratissimus Burch.
Croton megalobotrys Müll.Arg.
Croton menyhartii Pax
Croton pseudopulchellus Pax
Croton species
Cryptolepis oblongifolia (Meisn.) Schltr.
Ctenolepis cerasiformis (Stocks) Hook.f.
Cucumella species
Cucumis africanus L.f.
Bremek.
Cucumis anguria L.
Cucumis hirsutus Sond.
Cucumis metuliferus Naudin
Cucumis species
Cucumis zeyheri Sond.
Cullen obtusifolia (DC.) C.H.Stirt.
Curroria decidua Planch. ex Hook.f. & Benth.
Cussonia zuluensis Strey
Cyathula lanceolata Schinz
Cyathula uncinulata (Schrad.) Schinz
Cycnium adonense E. Mey. ex Benth.
Cymbopogon excavatus (Hochst.) Stapf ex Burtt Davy
Cymbopogon plurinodis (Stapf) Stapf ex Burtt Davy
Cymbopogon validus (Stapf) Stapf ex Burtt Davy
Cynodon dactylon (L.) Pers.
Cynodon species
Cyperus amabilis Vahl
Cyperus esculentus
Cyperus fenzelianus Steud.
Cyperus fulgens C.B. Cl.
Cyperus margaritaceus Vahl
Cyperus marginatus Thunb.
Cyperus obtusiflorus Vahl
Cyperus procerus Rottb.
Cyperus rupestris Kunth
Cyperus schinzii Boeck.
Cyperus sexangularis Nees
Cyperus species
Cyphia angustifolia Eckl. & Zeyh.
Cyphostemma cirrhosum (Thunb.) Descoings ex Wild & Drum.
Cyphostemma currorii (Hook.f.) Desc.
Cyphostemma hereroense (Schinz) Desc. ex Wild & R.B.Drumm.
Cyphostemma puberulum (C.A.Sm.) Wild & R.B.Drumm.
Cyphostemma schlechteri (Gilg & M.Brandt) Desc. ex Wild & R.B.Drumm.
Cyphostemma species
Cyphostemma subciliatum (Baker) Desc. ex Wild & R.B.Drumm.
Dactyloctenium aegyptium (L.) Willd.
Dactyloctenium australe Steud.
Dactyloctenium geminatum Hack.
Dactyloctenium giganteum Fisher & Schweick.
Dalbergia melanoxylon Guill. & Perr.
Dalbergia nitidula Baker
Dalechampia galpinii Pax

Danthoniopsis dinteri (Pilg.) C.E.Hubb.
Datura ferox L.
Decorsea schlechteri (Harms) Verdc.
Desmodium velutinum (Willd.) DC.
Dialium engleranum Henriq.
Dicerocaryum eriocarpum (Decne.) Abels
Dichanthium annulatum (Forssk.)
Dichapetalum cymosum (Hook.) Engl.
Dichrostachys cinerea (L.) Wight & Arn.
Dicoma anomala Sond.
Dicoma galpinii Wilson
Dicoma schinzii O.Hoffm.
Dicoma species
Dicoma tomentosa Cass.
Digitaria argyrograpta (Nees) Stapf
Digitaria diagonalis (Nees) Stapf
Digitaria eriantha Steud.
Digitaria milanjiana (Rendle) Stapf
Digitaria seriata Stapf
Digitaria species
Digitaria velutina (Forssk.) P.Beauv.
Diheteropogon amplectens (Nees) Clayton
Dinebra retroflexa (Vahl) Panz.
Dioscorea cotinifolia Kunth
Diospyros chamaethamnus Mildbr.
Diospyros lycioides Desf.
Diospyros mespiliformis Hochst. ex A.DC.
Dipcadi glaucum (Ker Gawl.) Baker
Dipcadi gracillimum Baker
Dipcadi species
Diplachne fusca (L.) P.Beauv. ex Roem. & Schult.
Diplachne species
Diplorhynchus condylocarpon (Müll.Arg.) Pichon
Dolichos falciformis E.Mey.
Dolichos trilobus L.
Dombeya cymosa Harv.
Dombeya kirkii Mast.
Dombeya rotundifolia (Hochst.) Planch
Dovyalis caffra (Hook.f. & Harv.) Hook.f.
Dracaena aletriformis (Haw.) Bos
Dracaena mannii Baker
Dregea macrantha Klotzsch
Drosera acaulis L.f.
Drypetes gerrardii Hutch.
Duosperma crenatum (Lindau) P.G.Mey.
Dyschoriste rogersii S.Moore
Ecbolium glabratum Vollesen
Echinochloa colona (L.) Link
Echinochloa crus-galli (L.) P.Beauv.
Echinochloa pyramidalis (Lam.) Hitchc. & Chase
Ehretia amoena Klotzsch
Ehretia rigida (Thunb.) Druce
Ekebergia capensis Sparrm.
Elephantorrhiza burkei Benth.
Elephantorrhiza elephantina (Burch.) Skeels
Elephantorrhiza species
Elephantorrhiza suffruticosa Schinz
Eleusine coracana (L.) Gaertn.
Elytraria acaulis (L.f.) Lindau
Elytrophorus globularis Hack.
Emilia ambifaria (S.Moore) C.Jeffrey
Emilia transvaalensis (Bolus) C.Jeffrey
Endostemon obtusifolius (E.Mey. ex Benth.) N.E.Br.
Endostemon tenuiflorus (Benth.) M.Ashby
Endostemon tereticaulis (Poir.) M.Ashby
Enicostema hyssopifolium (Willd.) I.Verd.
Enicostema species
Enneapogon cenchroides (Roem. & Schult.) C.E.Hubb.
Enneapogon desvauxii P.Beauv.
Enneapogon scoparius Stapf
Enneapogon species
Entandrophragma caudatum (Sprague) Sprague
Enteropogon macrostachyus (A.Rich.) Benth.
Enteropogon monostachyus (Vahl) K. Schum.
Eragrostis annulata Rendle ex Scott-Elliot
Eragrostis aspera (Jacq.) Nees
Eragrostis biflora Hack. ex Schinz
Eragrostis capensis (Thunb.) Trin.
Eragrostis chloromelas Steud.
Eragrostis cilianensis (All.) F.T.Hubb.
Eragrostis ciliaris (L.) R.Br.
Eragrostis curvula (Schrad.) Nees
Eragrostis cylindriflora Hochst.
Eragrostis dinteri Stapf
Eragrostis echinochloidea Stapf
Eragrostis glandulosipedata De Winter
Eragrostis gummiflua Nees
Eragrostis heteromera Stapf
Eragrostis inamoena K.Schum.
Eragrostis lappula Nees
Eragrostis lehmanniana Nees
Eragrostis micrantha Hack.
Eragrostis nindensis Ficalho & Hiern
Eragrostis pallens Hack.
Eragrostis pilgeriana Dinter ex Pilg.
Eragrostis porosa Nees
Eragrostis racemosa (Thunb.) Steud.
Eragrostis rigidior Pilg.
Eragrostis rotifer Rendle
Eragrostis sabinae Launert

Eragrostis species
Eragrostis stapfii De Winter
Eragrostis superba Peyr.
Eragrostis trichophora Coss. & Durieu
Eragrostis viscosa (Retz.) Trin.
Eriocephalus pubescens DC.
Eriocephalus species
Eriochloa meyeriana (Nees) Pilg.
Eriospermum bakerianum Schinz
Eriospermum rautanenii Schinz
Erlangea misera (Oliv. & Hiern) S.Moore
Erucastrum arabicum Fisch. & C.A.Mey.
Erythrina latissima E.Mey.
Erythrina lysistemon Hutch.
Erythrina species
*Euclea crispa (*Thunb.) Guerke
Euclea divinorum Hiern
Euclea natalensis A. DC.
Euclea pseudebenus E.Mey. ex A.DC.
Euclea schimperi (A. DC.) Dandy
Euclea species
Euclea undulata Thunb.
Euphorbia confinalis R.A. Dyer
Euphorbia cooperi N.E. Br. ex Berger
Euphorbia crotonoides Boiss.
Euphorbia cyathophora Murray
Euphorbia gueinzii Boiss.
Euphorbia guerichiana Pax
Euphorbia ingens E.Mey. ex Boiss.
Euphorbia monteiroi Hook. f.
Euphorbia quadrata Nel
Euphorbia schinzii Pax
Euphorbia tirucalli L.
Euphorbia venenata Marloth
Euphorbia virosa Willd.
Eustachys paspaloides (Vahl) Lanza & Mattei
Evolvulus alsinoides (L.) L.
Faidherbia albida (Delile) A.Chev.
Felicia alba Grau
Felicia anthemidodes (Hiern) Mendonca
Felicia bechuanica Mattf.
Felicia clavipilosa Grau
Felicia minima (Hutch.) Grau
Felicia mossamedensis (Hiern) Mendonca
Ferraria glutinosa (Baker) Rendle
Ficus abutilifolia (Miq.) Miq.
Ficus capreifolia Delile
Ficus cordata Thunb.
Ficus glumosa (Miq.) Delile
Ficus lutea Vahl
Ficus stuhlmannii Warb.
Ficus sycomorus L.
Ficus tettensis Hutch.
Fimbristylis complanata (Retz.) Link
Fimbristylis species
Fingerhuthia africana Lehm.
Flacourtia indica (Burm.f.) Merr.
Flaveria bidentis (L.) Kuntze
Flueggea virosa (Roxb. Ex Willd.) Pax & K. Hoffm.
Fockea angustifolia K.Schum.
Fockea species
Forsskaolea viridis Ehrenb. ex Webb
Fuirena pachyrrhiza Ridley
Fuirena pubescens (Poir.) Kunth
Garcinia livingstonei T.Anderson
Gardenia resiniflua Hiern
Gardenia species
Gardenia volkensii K.Schum.
Gardenia volkensii K.Schum. ssp. spatulifolia (Stapf & Hutch.) Verdc.
Geigeria acaulis (Sch.Bip.) Benth. & Hook.f. ex Oliv. & Hiern
Geigeria burkei Harv.
Geigeria odontoptera O.Hoffm.
Geigeria ornativa O.Hoffm.
Geigeria schinzii O. Hoffm.
Gisekia africana (Lour.) Kuntze
Gisekia pharnacioides L.
Gisekia species
Glinus lotoides L.
Gloriosa superba L.
Gnidia rubescens B.Peterson
Gnidia sericea L.
Gnidia sericocephala (Meisn.) Gilg ex Engl.
Gomphocarpus fruticosus (L.) Aiton f.
Gomphocarpus tomentosus Burch.
Gomphrena celosioides Mart.
Gossypium anomalum
Gossypium herbaceum Wawra ex Wawra & Peyr.
Gossypium triphyllum (Harv.) Hochr.
Grewia avellana Hiern
Grewia bicolor Juss.
Grewia caffra Meisn.
Grewia falcistipula K.Schum.
Grewia flava DC.
Grewia flavescens Juss.
Grewia hexamita Burret
Grewia inaequilatera Garcke
Grewia microthyrsa K.Schum. ex Burret
Grewia monticola Sond.
Grewia occidentalis L.
Grewia pachycalyx K.Schum.

Grewia retinervis Burret
Grewia species
Grewia subspathulata N.E.Br.
Grewia tenax (Forssk.) Fiori
Grewia villosa Willd.
Guibourtia coleosperma (Benth.) J.Léonard
Guibourtia conjugata (Bolle) J.Léonard
Gymnema sylvestre (Retz.) Schult.
Haemanthus species
Harpagophytum procumbens (Burch.) DC. ex Meissn. F. sublobatum Engl.
Harpagophytum zeyheri
Heinsia crinita
Helichrysum album N.E.Br.
Helichrysum candolleanum H.Buek
Helichrysum herbaceum (Andrews) Sweet
Helichrysum herniarioides DC.
Helichrysum lineare DC.
Helichrysum miconiifolium DC.
Helichrysum species
Helichrysum tomentosulum (Klatt) Merxm.
Helinus integrifolius (Lam.) Kuntze
Helinus spartioides (Engl.) Schinz ex Engl.
Heliotropium ciliatum Kaplan
Heliotropium giessii Friedr.-Holzh.
Heliotropium indicum L.
Heliotropium lineare (A.DC.) Guerke
Heliotropium ovalifolium Forssk.
Heliotropium species
Heliotropium steudneri Vatke
Heliotropium strigosum Willd.
Heliotropium zeylanicum (Burm.f.) Lam.
Hemizygia bracteosa (Benth.) Briq.
Hemizygia elliottii (Baker) M.Ashby
Hemizygia petrensis (Hiern) M.Ashby
Hemizygia species
Hermannia boraginiflora Hook.
Hermannia eenii Baker f.
Hermannia glanduligera K.Schum.
Hermannia glandulosissima Engl.
Hermannia modesta (Ehrenb.) Mast.
Hermannia quartiniana A. Rich.
Hermannia rigida Harv.
Hermannia species
Hermannia tomentosa (Turcz.) Schinz ex Engl.
Hermbstaedtia glauca (J.C.Wendl.) Rchb. ex Steud.
Hermbstaedtia linearis Schinz
Hermbstaedtia odorata (Burch.) T. Cooke
Hermbstaedtia species
Heteromorpha arborescens (Thunb.) Cham. & Schltdl.
Heteropogon contortus (L.) Roem. & Schult.
Heteropogon melanocarpus (Elliott) Benth.
Heteropyxis natalensis Harv.
Hexalobus monopetalus (A. Rich.) Engl. & Diels
Hibiscus allenii Sprague & Hutch.
Hibiscus caesius Garcke
Hibiscus calyphyllus Cav.
Hibiscus cannabinus L.
Hibiscus elliottiae Harv.
Hibiscus engleri K.Schum.
Hibiscus micranthus L.f.
Hibiscus nigricaulis Baker f.
Hibiscus palmatus Forssk.
Hibiscus pedunculatus L.f.
Hibiscus platycalyx Mast.
Hibiscus praeteritus R.A.Dyer
Hibiscus pusillus Thunb.
Hibiscus sidiformis Baill.
Hibiscus species
Hibiscus subreniformis Burtt Davy
Hibiscus trionum L.
Hibiscus upingtoniae Guerke
Hibiscus vitifolius L.
Hiernia angolensis S.Moore
Hippocratea crenata (Klotzsch) K.Schum. & Loes.
Hippocratea longipetiolata Oliv.
Hirpicium bechuanense (S.Moore) Roessler
Hirpicium gazanioides (Harv.) Roessler
Hirpicium gorterioides (Oliv. & Hiern) Rössl.
Holarrhena pubescens (Buch.-Ham.) Wall.
Holubia saccata Oliv.
Huernia hystrix (Hook. f.) N.E. Br.
Huernia kirkii N.E.Br.
Huernia species
Hugonia orientalis Engl.
Hybanthus enneaspermus (L.) F.Muell.
Hygrophila auriculata (Schumach.) Heine
Hymenocardia ulmoides Oliv.
Hyparrhenia anamesa Clayton
Hyparrhenia hirta (L.) Stapf
Hyparrhenia rufa (Nees) Stapf
Hyparrhenia species
Hyparrhenia tamba (Steud.) Stapf
Hyparrhenia variabilis Stapf
Hyperacanthus amoenus (Sims) Bridson
Hypertelis salsoloides (Burch.) Adamson
Hyperthelia dissoluta (Nees ex Steud.) Clayton
Hyphaene coriacea Gaertn.
Hyphaene petersiana Klotzsch
Hypoestes forskaolii (Vahl) R.Br.

Hypoxis hemerocallidea Fisch. & C.A.Mey.
Indigastrum costatum
Indigastrum fastigiatum (E.Mey.) Schrire
Indigastrum parviflorum
Indigofera adenocarpa E.Mey.
Indigofera arrecta Hochst. ex A.Rich.
Indigofera astragalina DC.
Indigofera auricoma E.Mey.
Indigofera bainesii Baker
Indigofera charlieriana Schinz
Indigofera colutea (Burm.f.) Merr.
Indigofera comosa N.E.Br.
Indigofera daleoides Benth. ex Harv.
Indigofera enormis N.E.Br.
Indigofera filipes Benth. ex Harv.
Indigofera flavicans Baker
Indigofera frutescens L.f.
Indigofera galpinii N.E.Br.
Indigofera heterotricha DC.
Indigofera holubii N.E.Br.
Indigofera ingrata N.E.Br.
Indigofera inhambanensis Klotzsch
Indigofera lupatana Baker f.
Indigofera lydenburgensis N.E.Br.
Indigofera melanadenia Benth. ex Harv.
Indigofera nebrowniana J.B.Gillett
Indigofera rautanenii Baker f.
Indigofera rhytidocarpa Benth. ex Harv.
Indigofera schimperi Jaub. & Spach
Indigofera species
Indigofera suffruticosa Mill.
Indigofera swaziensis (H. Bol.)
Indigofera teixeirae Torre
Indigofera trigonelloides Jaub. & Spach
Indigofera tristis E.Mey.
Indigofera tristoides N.E.Br.
Indigofera trita L. f.
Indigofera vicioides Jaub. & Spach
Ipomoea adenioides Schinz
Ipomoea arachnosperma Welw.
Ipomoea bolusiana Schinz
Ipomoea cairica (L.) Sweet
Ipomoea chloroneura Hallier f.
Ipomoea coptica (L.) Roth ex Roem. & Schult
Ipomoea coscinosperma Hochst. ex Choisy
Ipomoea crassipes Hook.
Ipomoea eriocarpa R.Br.
Ipomoea hochstetteri House
Ipomoea magnusiana Schinz
Ipomoea obscura (L.) Ker-Gawl.
Ipomoea papilio Hallier f.
Ipomoea pes-tigridis L.
Ipomoea sinensis (Desr.) Choisy
Ipomoea species
Ipomoea transvaalensis A.Meeuse
Ipomoea tuberculata Ker Gawl.
Ipomoea verbascoidea Choisy
Ischaemum afrum (J.F.Gmel.) Dandy
Ischaemum fasciculatum Brongn.
Jacquemontia tamnifolia (L.) Griseb.
Jamesbrittenia micrantha (Klotzsch) Hilliard
Jamesbrittenia montana (Diels) Hilliard
Jasminum fluminense Vell.
Jasminum stenolobum Rolfe
Jatropha schlechteri Pax
Jatropha species
Jatropha spicata Pax
Jatropha variifolia Pax
Jatropha zeyheri Sond.
Justicia anagalloides (Nees) T.Anderson
Justicia betonica L.
Justicia exigua S.Moore
Justicia flava (Vahl) Vahl
Justicia matammensis (Schweinf.) Oliv.
Justicia odora (Forssk.) Vahl
Justicia petiolaris (Nees) T. Anders.
Justicia platysepala (S.Moore) P.G.Mey.
Justicia protracta (Nees) T. Anders.
Justicia species
Kalanchoe brachyloba Welw. ex Britten
Kalanchoe lanceolata (Forssk.) Pers.
Kalanchoe paniculata Harv.
Kalanchoe rotundifolia (Haw.) Haw.
Kalanchoe species
Kedrostis capensis (Sond.) A.Meeuse
Kedrostis foetidissima (Jacq.) Cogn.
Kigelia africana (Lam.) Benth.
Kirkia acuminata Oliv.
Kirkia wilmsii Engl.
Kleinia longiflora DC.
Kohautia amatymbica Eckl. & Zeyh.
Kohautia amboensis (Schinz) Bremek.
Kohautia azurea (Dinter & K.Krause) Bremek.
Kohautia caespitosa Schnizl.
Kohautia cicendioides (K.Schum.) Bremek.
Kohautia cynanchica DC.
Kohautia ramosissima Bremek.
Kohautia species
Kohautia virgata (Willd.) Bremek.
Kyllinga alba Nees
Kyphocarpa angustifolia (Moq.) Lopr.
Lagenaria species

Laggera decurrens (Vahl) Hepper & J.R.I.Wood
Lagynias dryadum (S.Moore) Robyns
Landolphia kirkii Dyer
Lannea discolor (Sond.) Engl.
Lannea schweinfurthii (Engl.) Engl.
Lantana angolensis Moldenke
Lantana camara L.
Lantana dinteri Moldenke
Lantana rugosa Thunb.
Lantana species
Lapeirousia sandersonii Baker
Launaea intybacea (Jacq.) P.Beauv.
Ledebouria species
Lemna aequinoctialis Welw.
Leonotis nepetifolia (L.) R.Br.
Leonotis ocymifolia (Burm. f.) Iwarsson
Leonotis species
Lepidagathis scabra C.B.Clarke
Leptactina delagoensis K. Schum.
Leptocarydion vulpiastrum (De Not.) Stapf
Leptochloa uniflora A.Rich.
Lessertia benguellensis Baker f.
Leucas glabrata (Vahl) Sm.
Leucas martinicensis (Jacq.) R.Br.
Leucas neuflizeana Courbon
Leucas pechuelii (Kuntze) G□rke
Leucas sexdentata Skan
Leucosphaera bainesii (Hook.f.) Gilg
Limeum aethiopicum Burm.
Limeum argute-carinatum Wawra & Peyr.
Limeum dinteri G.Schellenb.
Limeum fenestratum (Fenzl) Hiemerl
Limeum myosotis H. Walter
Limeum species
Limeum sulcatum (Klotzsch)
Limeum viscosum (Gay)
Lindneria clavata (Mast.) Speta
Lippia javanica (Burm.f.) Spreng.
Litanthus pusillus Harv.
Litogyne gariepina (DC.) Anderb.
Lonchocarpus capassa Rolfe
Lonchocarpus nelsii (Schinz) Heering & Grimme
Lophiocarpus polystachyus Turcz.
Lophiocarpus tenuissimus Hook.f.
Lotononis brachyantha Harms
Lotononis pulchella (E.Mey.) B.-E.van Wyk
Lotononis pulchra Dummer
Lotononis rabenaviana Dinter & Harms
Lotononis solitudinis Dummer
Lotononis species
Lotononis stipulosa Baker f.
Ludwigia octovalvis (Jacq.) Raven
Ludwigia stolonifera (Guill. & Perr.) P.H.Raven
Lycium bosciifolium Schinz
Lycium oxycarpum Dunal
Lycium species
Maclura africana (Bureau) Corner
Macrotyloma axillare (E. Mey.)
Macrotyloma maranguense (Taub.) Verdc.
Maerua angolensis DC.
Maerua cafra (DC.) Pax
Maerua edulis (Gilg & Gilg-Ben.) DeWolf
Maerua juncea Pax
Maerua parvifolia Pax
Maerua schinzii Pax
Maerua species
Manilkara mochisia (Baker) Dubard
Margaritaria discoidea (Baill.) Webster
Mariscus aristatus (Rottb.) Cherm
Mariscus congestus (Vahl) C.B.Clarke
Mariscus macer Kunth
Mariscus rehmannianus C.B.Clarke
Mariscus species
Markhamia zanzibarica (Bojer ex DC.) K.Schum.
Maytenus heterophylla (Eckl. & Zeyh.) N.Robson
Maytenus mossambicensis (Klotzsch) Blakelock
Maytenus procumbens (L.f.) Loes.
Maytenus senegalensis (Lam.) Exell
Maytenus species
Maytenus tenuispina (Sond.) Marais
Megalochlamys kenyensis Vollesen
Megalochlamys marlothii (Engl.) Lindau
Megalochlamys revoluta (Lindau) Vollesen
Melanthera triternata (Klatt) Wild
Melhania acuminata Mast.
Melhania burchellii DC.
Melhania damarana Harv.
Melhania didyma Eckl. & Zeyh.
Melhania forbesii Planch. ex Mast.
Melhania prostrata DC.
Melhania rehmannii Szyszyl.
Melhania species
Melia species
Melinis longiseta (A. Rich.) Zizka
Melinis nerviglumis (Franch.) Zizka
Melinis repens (Willd.) Zizka
Melinis species
Melolobium glanduliferum Dummer
Merremia kentrocaulos (C.B.Clarke) Rendle
Merremia palmata Hallier f.
Merremia pinnata (Hochst. ex Choisy) Hallier f.
Merremia tridentata (L.) Hallier f.

Microchloa caffra Nees
Microchloa kunthii Desv.
Millettia grandis (E.Mey.) Skeels
Millettia sutherlandii Harv.
Mollugo cerviana (L.) Ser. ex DC.
Mollugo nudicaulis Lam.
Momordica balsamina L.
Momordica boivinii Baill.
Momordica cardiospermoides Klotzsch
Momordica species
Monadenia bracteata (Sw.) T.Durand & Schinz
Monechma cleomoides (S.Moore) C.B.Clarke
Monechma debile (Forssk.) Nees
Monechma divaricatum (Nees) C.B.Clarke
Monechma genistifolium (Engl.) C.B. Cl.
Monechma species
Monechma tonsum P.G.Mey.
Monelytrum luederitzianum Hack.
Monodora junodii Engl. & Diels
Monsonia angustifolia E.Mey. ex A.Rich.
Monsonia burkeana Planch. ex Harv.
Monsonia glauca R.Knuth
Monsonia senegalensis Guill. & Perr.
Monsonia species
Montinia caryophyllacea Thunb.
Moringa ovalifolia Dinter & A.Berger
Mucuna coriacea Bak.
Mundulea sericea (Willd.) A.Chev.
Myrothamnus flabellifolius Welw.
Nelsia quadrangula (Engl.) Schinz
Neorautanenia amboensis Schinz
Neorautanenia species
Nesaea schinzii Koehne
Neuracanthus africanus S.Moore
Neuradopsis austro-africana (Schinz) Bremek. & Oberm.
Nicolasia costata (Klatt) Thell.
Nicolasia stenoptera (O. Hoffm.) Merxm.
Nidorella resedifolia DC.
Nolletia rarifolia (Turcz.) Steetz
Nuxia oppositifolia (Hochst.) Benth.
Nymphaea nouchali Burm. f.
Nymphaea species
Ochna arborea Burch. ex DC
Ochna inermis (Forssk.) Schweinf.
Ochna natalitia (Meisn.) Walp.
Ochna pretoriensis E.Phillips
Ochna pulchra Hook.
Ocimum americanum L.
Ocimum gratissimum L.
Ocimum species
Odyssea paucinervis (Nees) Stapf
Olax dissitiflora Oliv.
Olea capensis L.
Ophioglossum polyphyllum A.Braun
Ophioglossum species
Opilia campestris Engl.
Opuntia ficus-indica (L.) Mill.
Opuntia stricta Haw.
Ormocarpum trichocarpum (Taub.) Engl.
Ornithogalum seineri (Engl. & K.Krause) Oberm.
Ornithoglossum calcicola K.Krause & Dinter
Oropetium capense Stapf
Orthosiphon labiatus N.E.Br.
Orthosiphon suffrutescens (Thonn.) J.K.Morton
Otoptera burchellii DC.
Oxalis latifolia Humb.
Oxalis semiloba Sond.
Oxalis species
Oxygonum alatum Burch.
Oxygonum dregeanum Meisn.
Oxygonum sinuatum (Hochst. & Steud. ex Meisn.) Dammer
Oxygonum species
Ozoroa engleri R.& A.Fern.
Ozoroa insignis Del.
Ozoroa paniculosa (Sond.) R. & A. Fernandes
Ozoroa schinzii (Engl.) R.& A.Fern.
Pachypodium lealii Welw.
Panicum coloratum L.
Panicum deustum Thunb.
Panicum dregeanum Nees
Panicum heterostachyum Hack.
Panicum lanipes Mez
Panicum maximum Jacq.
Panicum natalense Hochst.
Panicum novemnerve Stapf
Panicum schinzii Hack.
Panicum species
Panicum stapfianum Fourc.
Pappea capensis Eckl. & Zeyh.
Parinari curatellifolia Planch. ex Benth.
Paspalum dilatatum Poir.
Paspalum distichum L.
Pavetta catophylla K.Schum.
Pavetta gardeniifolia A. Rich
Pavetta schumanniana F.Hoffm. ex K.Schum.
Pavetta zeyheri Sond.
Pavonia burchellii (DC.) R.A.Dyer
Pavonia columella Cav.
Pavonia leptocalyx (Sond.) Ulbr.
Pavonia species

Pechuel-Loeschea leubnitziae (Kuntze) O.Hoffm.
Pegolettia senegalensis Cass.
Pelargonium englerianum R.Knuth
Peliostomum leucorrhizum E.Mey. ex Benth.
Pellaea calomelanos (Swartz) Link
Peltophorum africanum Sond.
Pennisetum foermerianum Leeke
Pentarrhinum insipidum E.Mey.
Pergularia daemia (Forssk.) Chiov.
Peristrophe bicalyculata (Retz.) Nees
Peristrophe cernua Nees
Perotis patens Gand.
Petalidium bracteatum Oberm.
Petalidium coccineum S.Moore
Petalidium engleranum (Schinz) C.B.Clarke
Petalidium luteo-album A.Meeuse
Petalidium ohopohense P.G.Mey.
Petalidium rautanenii Schinz
Petalidium setosum C.B.Clarke ex Schinz
Petalidium species
Petalidium variabile (Engl.) C.B. Cl.
Pharnaceum elongatum (DC.) Adamson
Phoenix reclinata Jacq.
Phragmites australis (Cav.) Steud.
Phragmites mauritianus Kunth
Phragmites species
Phylica retorta Pillans
Phyllanthus asperulatus Hutch.
Phyllanthus burchellii Müll.Arg.
Phyllanthus dinteri Pax
Phyllanthus incurvus Thunb.
Phyllanthus maderaspatensis L.
Phyllanthus nummulariifolius Poir.
Phyllanthus parvulus Sond.
Phyllanthus pentandrus Schumach. & Thonn.
Phyllanthus reticulatus Poir.
Phyllanthus species
Phymaspermum pinnatifidum (Oliv.) Kallersjo
Piliostigma thonningii (Schumach.) Milne-Redh.
Plectranthus hereroensis Engl.
Plectranthus neochilus Schltr.
Plectranthus species
Plectranthus tetensis (Baker) Agnew
Plectranthus tetragonus Guerke
Plectroniella armata (K.Schum.) Robyns
Plumbago zeylanica L.
Pogonarthria fleckii (Hack.) Hack.
Pogonarthria species
Pogonarthria squarrosa (Roem. & Schult.) Pilg.
Pollichia campestris Aiton
Polygala erioptera DC.
Polygala hottentotta C.Presl
Polygala pallida E.Mey.
Polygala producta N.E.Br.
Polygala schinziana Chodat
Polygala species
Polygala sphenoptera Fresen.
Polygala wilmsii Chodat
Polygonum aviculare L.
Portulaca collina Dinter
Portulaca hereroensis Schinz
Portulaca kermesina N.E.Br.
Portulaca oleracea L.
Portulaca quadrifida L.
Portulaca species
Portulacaria afra Jacq.
Priva africana Moldenke
Pseudolachnostylis maprouneifolia Pax
Pseudosalacia species
Psydrax livida (Hiern) Bridson
Ptaeroxylon obliquum (Thunb.) Radlk.
Pteleopsis myrtifolia (M.A.Lawson) Engl. & Diels
Pterocarpus angolensis DC.
Pterocarpus lucens Guill. & Perr. ssp. antunesii (Taub.) Rojo
Pterocarpus rotundifolius (Sond.) Druce
Pterococcus africanus (Sond.) Pax & K.Hoffm.
Pterodiscus aurantiacus Welw.
Pterodiscus luridus Hook.f.
Ptycholobium biflorum (E. Mey.)
Ptycholobium contortum (N.E.Br.) Brummitt
Ptycholobium plicatum (Oliv.) Harms
Pupalia lappacea (L.) A. Juss.
Pycreus pelophilus (Ridl.) C.B.Clarke
Pyrostria hystrix (Bremek.) Bridson
Raphionacme elata N.E.Br.
Raphionacme lanceolata Schinz
Raphionacme procumbens Schltr.
Raphionacme species
Requienia pseudosphaerosperma (Schinz) Brummitt
Requienia species
Requienia sphaerosperma DC.
Rhigozum brevispinosum Kuntze
Rhigozum obovatum Burch.
Rhigozum species
Rhigozum virgatum Merxm. & A.Schreib.
Rhigozum zambesiacum Baker
Rhinacanthus xerophilus A.Meeuse
Rhoicissus digitata (L.f.) Gilg & M.Brandt
Rhoicissus revoilii Planch.
Rhoicissus tridentata (L.f.) Wild & Drum.

Rhus dentata Thunb.
Rhus gueinzii Sond.
Rhus leptodictya Diels
Rhus marlothii Engl.
Rhus pentheri Zahlbr.
Rhus pyroides Burch.
Rhus species
Rhus tenuinervis Engl.
Rhynchosia angulosa Schinz
Rhynchosia caribaea (Jacq.) DC.
Rhynchosia densiflora (Roth) DC.
Rhynchosia longiflora Schinz
Rhynchosia minima (L.) DC.
Rhynchosia resinosa (A.Rich.) Baker
Rhynchosia species
Rhynchosia sublobata (Schumach.) Meikle
Rhynchosia totta (Thunb.) DC.
Rhynchosia venulosa (Hiern) K.Schum.
Rhynchospora candida (Nees) Boeck.
Rogeria adenophylla J.Gay ex Delile
Rothia hirsuta (Guill. & Perr.) Baker
Rottboellia cochinchinensis (Lour.) Clayton
Ruellia cordata Thunb.
Ruellia malacophylla C.B.Clarke
Ruellia patula Jacq.
Ruelliopsis setosa (Nees) C.B.Clarke
Salacia luebbertii Loes.
Salix babylonica L.
Salsola aphylla L.f.
Salsola rabieana I.Verd.
Salsola sericata Botsch.
Salsola tuberculata (Moq.) Fenzl
Salvadora australis Schweick.
Salvadora persica L.
Sansevieria aethiopica Thunb.
Sansevieria hyacinthoides (L.) Druce
Sansevieria pearsonii N.E.Br.
Sarcostemma viminale (L.) R.Br.
Schinziophyton rautanenii (Schinz) Radcl.-Sm.
Schizachyrium exile (Hochst.) Pilg.
Schizachyrium jeffreysii (Hack.) Stapf
Schizobasis intricata (Baker) Baker
Schkuhria pinnata (Lam.) Cabrera
Schmidtia kalihariensis Stent
Schmidtia pappophoroides Steud.
Schoenoplectus muricinux (C.B.Clarke) J.Raynal
Schotia brachypetala Sond.
Schotia capitata Bolle
Schrebera alata (Hochst.) Welw.
Scilla nervosa (Burch.) Jessop
Scilla species
Scirpoides dioecus (Kunth) Browning
Sclerocarya birrea (A. Rich.) Hochst.
Sebaea grandis (E.Mey.) Steud.
Seddera capensis (E.Mey. ex Choisy) Hallier f.
Seddera species
Seddera suffruticosa (Schinz) Hallier f.
Selaginella dregei (C.Presl) Hieron.
Senecio harveianus MacOwan
Senecio inaequidens DC.
Senecio sociorum Bolus
Senecio species
Senecio speciosus Willd.
Senna italica Mill.
Senna occidentalis (L.) Link
Senna petersiana (Bolle) Lock
Sericanthe andongensis (Hiern) Robbrecht
Sericorema remotiflora (Hook.f.) Lopr.
Sericorema sericea (Schinz) Lopr.
Serruria stellata Rourke
Sesamothamnus guerichii (Engl.) E.A.Bruce
Sesamothamnus lugardii N.E.Br. ex Stapf
Sesamum alatum Thonn.
Sesamum species
Sesamum triphyllum Welw. ex Aschers
Sesbania bispinosa (Jacq.) W. f. Wight
Sesbania sesban (L.) Merr.
Setaria incrassata (Hochst.) Hack.
Setaria sagittifolia (A.Rich.) Walp.
Setaria species
Setaria sphacelata (Schumach.) Moss
Setaria ustilata de Wit
Setaria verticillata (L.) P.Beauv.
Sida alba L.
Sida chrysantha Ulbr.
Sida cordifolia L.
Sida dregei Burtt Davy
Sida ovata Forssk.
Sida rhombifolia L.
Sida species
Solanecio species
Solanum anguivi Lam.
Solanum burchellii Dunal
Solanum catombelense Peyr.
Solanum coccineum Jacq.
Solanum delagoense Dunal
Solanum incanum L.
Solanum kwebense N.E.Br.
Solanum multiglandulosum Bitter
Solanum nodiflorum Jacq.
Solanum panduriforme E.Mey.
Solanum species

Solanum tomentosum L.
Sonchus oleraceus L.
Sorghum bicolor (L.) Moench
Sorghum versicolor Andersson
Spermacoce senensis (Klotzsch) Hiern
Sphaeranthus incisus Robyns
Sphaeranthus peduncularis DC.
Sphedamnocarpus pruriens (Juss.) Szyszyl.
Spirostachys africana Sond.
Sporobolus acinifolius Stapf
Sporobolus africanus (Poir.) Robyns & Tournay
Sporobolus consimilis Fresen.
Sporobolus festivus A.Rich.
Sporobolus fimbriatus (Trin.) Nees
Sporobolus ioclados (Trin.) Nees
Sporobolus nitens Stent
Sporobolus panicoides A.Rich.
Sporobolus pectinatus Hack.
Sporobolus pyramidalis P.Beauv.
Sporobolus salsus Mez
Sporobolus species
Sporobolus spicatus (Vahl) Kunth
Sporobolus stapfianus Gand.
Stachys hyssopoides Burch. ex Benth.
Stadmannia oppositifolia (Lam.) Poir.
Stapelia gigantea N.E.Br.
Steganotaenia araliacea Hochst.
Sterculia africana (Lour.) Fiori
Sterculia rogersii N.E.Br.
Stigmatorhynchus hereroensis Schltr.
Stipagrostis hirtigluma (Trin. & Rupr.) De Winter
Stipagrostis hirtigluma (Trin. & Rupr.) De Winter ssp. *hirtigluma*
Stipagrostis hirtigluma (Trin. & Rupr.) De Winter ssp. *patula* (Hack.) De Winter
Stipagrostis hirtigluma (Trin. & Rupr.) De Winter ssp. *pearsonii* (Henrard) De Winter
Stipagrostis hochstetteriana (Beck ex Hack.) De Winter
Stipagrostis uniplumis (Licht.) De Winter
Stipagrostis uniplumis (Licht.) De Winter var. uniplumis
Stomatostemma monteiroae (Oliv.) N.E.Br.
Streptopetalum serratum Hochst.
Striga asiatica (L.) Kuntze
Striga bilabiata (Thunb.) Kuntze
Striga forbesii Benth.
Striga gesnerioides (Willd.) Vatke ex Engl.
Strychnos cocculoides Baker
Strychnos decussata (Pappe) Gilg
Strychnos madagascariensis Poir.
Strychnos potatorum L.f.
Strychnos pungens Soler.
Strychnos spinosa Lam.
Stylochiton natalensis Schott
Stylosanthes fruticosa (Retz.) Alston
Suaeda articulata Aellen
Syzygium cordatum Hochst.
Tabernaemontana elegans Stapf
Tagetes minuta L.
Talinum arnotii Hook.f.
Talinum caffrum (Thunb.) Eckl. & Zeyh.
Talinum portulacifolium (Forssk.) Asch. ex Schweinf.
Talinum species
Tapinanthus oleifolius (J.C.Wendl.) Danser
Tarchonanthus camphoratus L.
Tarenna species
Tarenna zygoon Bridson
Tavaresia barklyi (Dyer) N.E.Br.
Teclea pilosa (Engl.) I.Verd.
Tephrosia burchellii Burtt Davy
Tephrosia dregeana E.Mey.
Tephrosia elongata E. Mey.
Tephrosia longipes Meisn.
Tephrosia lupinifolia DC.
Tephrosia multijuga R.G.N.Young
Tephrosia pietersii H.M.L.Forbes
Tephrosia polystachya E. Mey.
Tephrosia purpurea (L.) Pers.
Tephrosia reptans Bak.
Tephrosia rhodesica Bak. f.
Tephrosia semiglabra Sond.
Tephrosia species
Tephrosia uniflora Pers.
Tephrosia villosa (L.) Pers.
Terminalia phanerophlebia Engl. & Diels
Terminalia prunioides M.A.Lawson
Terminalia sericea Burch. ex DC.
Tetradenia riparia (Hochst.) Codd
Tetragonia species
Tetrapogon tenellus (Roxb.) Chiov.
Thamnosma africana Engl.
Themeda triandra Forssk.
Thesium gypsophiloides A.W.Hill
Thesium lineatum L.f.
Thesium resedoides A.W.Hill
Thesium utile A.W.Hill
Thilachium africanum Lour.
Thunbergia atriplicifolia E.Mey. ex Nees
Thunbergia dregeana Nees
Thunbergia neglecta Sond.

Tinnea rhodesiana S.Moore
Tinospora fragosa (I.Verd.) I.Verd. & Troupin
Trachyandra species
Trachypogon spicatus (L.f.) Kuntze
Tragia dioica Sond.
Tragia glabrata (Müll. Arg.) Pax & K. Hoffm.
Tragia incisifolia Prain
Tragia okanyua Pax
Tragia rupestris Sond.
Tragia species
Tragus berteronianus Schult.
Tragus koelerioides Asch.
Tragus racemosus (L.) All.
Trema species
Trianthema salsoloides Fenzl ex Oliv.
Trianthema species
Trianthema triquetra Rottler ex Willd.
Triaspis hypericoides (DC.) Burch.
Tribulus species
Tribulus terrestris L.
Tribulus zeyheri Sond.
Tricalysia junodii (Schinz) Brenan
Tricalysia species
Trichilia emetica Vahl
Tricholaena monachne (Trin.) Stapf & C.E.Hubb.
Trichoneura grandiglumis (Nees) Ekman
Tricliceras glanduliferum (Klotzsch) R.Fern.
Tricliceras laceratum (Oberm.) Oberm.
Tricliceras longipedunculatum (Mast.) R. Fernandes
Tricliceras schinzii (Urb.) R. Fernandes
Tripogon minimus (A.Rich.) Steud.
Triraphis purpurea Hack.
Triraphis ramosissima Hack.
Triraphis schinzii Hack.
Tritonia nelsonii Baker
Triumfetta pentandra A.Rich.
Triumfetta rhomboidea Jacq.
Trochomeria macrocarpa (Sond.) Hook. f.
Turraea nilotica Kotschy & Peyr.
Turraea obtusifolia Hochst.
Tylosema esculentum (Burch.) A.Schreib.
Tylosema fassoglense (Schweinf.) Torre & Hillc.
Urginea epigea R.A.Dyer
Urginea sanguinea Schinz
Urginea species
Urochloa brachyura (Hack.) Stapf
Urochloa mosambicensis (Hack.) Dandy
Urochloa oligotricha (Fig. & De Not.) Henrard
Urochloa panicoides P.Beauv.
Urochloa species
Urospermum picroides (L.) Scop. ex F.W.Schmidt
Uvaria caffra E.Mey. ex Sond.
Vahlia capensis (L. f.) Thunb.
Vangueria infausta
Vepris carringtoniana Mendonca
Verbena bonariensis L.
Vernonia cinerascens Sch.Bip.
Vernonia cinerea (L.) Less.
Vernonia colorata (Willd.) Drake
Vernonia fastigiata Oliv. & Hiern
Vernonia natalensis Sch.Bip. ex Walp.
Vernonia oligocephala (DC.) Sch.Bip. ex Walp.
Vernonia poskeana Vatke & Hildebr.
Vernonia schlechteri O.Hoffm.
Vernonia species
Vernonia steetziana Oliv. & Hiern
Veronica persica Poir.
Vigna frutescens A. Rich.
Vigna oblongifolia A. Rich.
Vigna species
Vigna unguiculata (L.) Walp.
Vitellariopsis dispar (N.E.Br.) Aubrev.
Vitex ferruginea
Vitex species
Waltheria indica L.
Welwitschia mirabilis Hook.f.
Welwitschia species
Willkommia annua Hack.
Willkommia sarmentosa Hack.
Wissadula rostrata (Schumach.) Hook.f.
Xanthium strumarium L.
Xanthocercis zambesiaca (Baker) Dumaz-le-Grand
Xeroderris stuhlmannii (Taub.) Mendonca & E.C.Sousa
Xerophyta equisetoides Bak.
Xerophyta humilis (Baker) T.Durand & Schinz
Xerophyta retinervis Baker
Xerophyta species
Xerophyta squarrosa Baker
Ximenia americana L.
Ximenia caffra Sond.
Xylia torreana Brenan
Zanthoxylum capense (Thunb.) Harv.
Zanthoxylum humile (E.A.Bruce) P.G.Waterman
Ziziphus mucronata Willd.
Zornia glochidiata DC.
Zornia linearis E.Mey.
Zornia species