CHAPTER 3

METHODS

Introduction

Ecological studies of entire ecosystems often have a descriptive nature due to the difficulties of setting up true experimental controls within these complex and multivariate biological systems (Siebert 2001). The first step is usually to search for patterns in community structure and composition. Community ecology is therefore the search for simple ways to describe complex systems.

Conducting science at the community level is difficult due to the enormous size and complexity of the databases compiled. The analytical techniques used are determined by the objectives and scale of the study, and the results are influenced by the variables sampled and the manner in which they were sampled (Jongman *et al.* 1995). The inherent subjectivity associated with gathering descriptive field data contributes to this complexity of ecosystem and community ecology (Begon *et al.* 1996).

The need to develop procedures for describing and comparing communities has dominated the development of community ecology (Begon *et al.* 1996). Quantitative approaches or numerical techniques have been used extensively in plant community ecology (Kent & Coker 1995). Schamineé & Stortelder (1996) emphasized the importance of standardized sampling and data analysis for comparative reasons. According to Werger (1974), the following are important requirements to be fulfilled by any ecological classification method concerning total floristic composition:

1. The method should be scientifically sound.
2. It should fulfil the necessity of classification at an appropriate level or scale.
3. It should be efficient and versatile amongst comparable approaches.

For these reasons, it was decided to use the Braun-Blanquet method (Braun-Blanquet 1932; Werger 1973; Mueller-Dombois & Ellenberg 1974; Whittaker 1978) in order to classify the vegetation of the SC and BNR. The Braun-Blanquet method has been applied successfully by numerous vegetation scientists (Van Der Meulen 1979; Bredenkamp 1987; Brown *et al.* 1996; Witkowski & O'Connor 1996; Siebert *et al.*

2003a). The work presented in this thesis is essentially a scientific description and ecological interpretation of the complex vegetation patterns and its primary environmental drivers of the Soutpansberg Conservancy and the Blouberg Nature Reserve. Emphasis is placed on the deductive use of phytosociology as a tool for ecological application.

Vegetation reflects the complex interaction between the abiotic and biotic environmental drivers of ecosystems. The heterogeneity of ecosystem processes is therefore often expressed by variation in vegetation patterns. In order to understand and manage the processes of southern Africa's rich and diverse ecosystems, it is important to describe and interpret vegetation patterns in an ecologically sensible manner. Plant communities derived from vegetation classification, are often considered to represent the basic ecological units useful for management purposes. These plant communities therefore provide the basic building blocks for the development and implementation of management units and systems. There is a growing interest in applying phytosociological knowledge in nature conservation and natural resource management (Schamineé & Stortelder 1996; Reyers 2003).

Analytical phase

The analytical phases of the vegetation study of the BNR and SC were conducted over the growing seasons of 1988–1989 and 2001–2002 respectively. The field data from the BNR were gathered by H.L. Klopper, while the field data from the SC were collected by T.H.C. Mostert.

The vegetation of the study area was stratified into homogeneous physiographic–physiognomic units, using arial photographs (scale 1: 50 000), as well as maps on the topography, geology, soils and Land Types of the study area. A total of 466 sample plots were placed within each of these stratified units in such a way that habitat was as uniform as possible within each vegetation stand. Homogeneity is difficult to test statistically. It was, therefore, assessed visually and care was taken not to place plots in ecotonal zones. A minimum of 4 plots were place partially random within the subjectively stratified homogeneous vegetation units of the study area. The total number of plots for the study area depended on scale, available time and available resources at the disposal of the fieldworkers.

The sample plot size was set at 400 m^2 in accordance with vegetation studies elsewhere in the semi-arid environments of southern Africa (Siebert 2001). This relatively large plot size was chosen due to the scale of the survey and the heterogeneity of the Soutpansberg Centre of Endemism (Van Wyk & Smith 2001). The cover-abundance for every species present in a sample plot was assessed according to the Braun-Blanquet cover-abundance scale (Werger 1974, Mueller-Dombois & Ellenberg 1974):

- r Very rare and with a negligible cover (usually a single individual)
- \+ Present but not abundant, with a small cover value (<1% of the quadrat).
- 1 Numerous but covering less than 1% of the quadrat, or not so abundant but covering 1–5% of the quadrat.
- 2a Covering between 5–12% of the quadrat, independent of abundance
- 2b Covering between 13–25% of the quadrat, independent of abundance
- 3 Covering 25–50% of the quadrat area, independent of abundance
- 4 Covering 50–75% of the quadrat area, independent of abundance
- 5 Covering 75–100 % of the quadrat area, independent of abundance

The vegetation structure at each plot was described according to the structural classification system of Edwards (1983). All relevés are stored in the TURBOVEG database (Hennekens 1996a) and managed by the Department of Botany, University of Pretoria. The taxon names of identified species conform to those of Germishuizen & Meyer (2003). Environmental data include soil type, aspect, slope, surface rock cover and disturbance to the soil and vegetation.

Synthetic phase

The data set of 466 relevés, containing 846 infra specific taxa, was entered into a vegetation database created in TURBOVEG (Hennekens & Schamineé 2001). The unpublished phytosociological data, gathered by H.L. Klopper in 1988 from the Blouberg Nature Reserve, were included as representation of some of the variation in the Blouberg vegetation. Data collected by Geldenhuys & Murray (1993) were included as representative for the forests of the Hanglip State Forest.

A first approximation of the main communities was arrived by applying the Two Way INdicator SPecies ANalysis (TWINSPAN) classification algorithm (Hill 1979a) to the floristic data. TWINSPAN is a divisive, hierarchical classification technique that detects overall patterns of differences in biological data. Although the reliability of the TWINSPAN approach has been questioned under certain conditions (Van Groenewoud 1992; Van Der Maarel 1996), it was chosen for its proven combination of effectiveness, robustness, relative objectivity, speed and availability (Gauch & Whittaker 1981; Myklestad & Birks 1993). Due to the relative manageable size of the dataset, no subjective stratification of the data was performed before the numerical classification was done, as is suggested for large datasets (Van Der Maarel *et al.* 1987; Bredenkamp & Bezuidenhout 1995).

A synoptic table was constructed to represent the major groups defined by the TWINSPAN classification (Table 1). Refinement of the synoptic table was done with the Braun-Blanquet procedures according to the steps proposed by Behr & Bredenkamp (1988). These procedures have been used successfully in a number southern African vegetation studies (e.g. Bredenkamp *et al.* 1989; Fuls *et al.* 1993; Siebert *et al.* 2003a; Van Staden & Bredenkamp 2006). The synoptic table contains species in each of the identified Major Vegetation Types on constancy values of 20% ordinal scale (I–V). Only species with a minimum constancy value of 20% (II), in any of the given Major Vegetation Types, were included in the table. All the excluded taxa will be included into tables of subsequent papers that will focus on the composition of individual Major Vegetation Types.

This result was then used to subdivide the data into eight phytosociological tables, each representing on of the Major Vegetation Types of the study area. Each of these was again subjected to TWINSPAN. The resultant classification was further refined by using Braun-Blanquet procedures in the MEGATAB computer programme (Hennekens 1996b; Hennekens & Schaminée 2001). The groups obtained from this data set were subsequently described and classified the various chapters of this thesis. Although all the relevés collected from the SC and BNR were used for classification purposes, only selected relevés were presented in instances where the large size of classification tables became cumbersome.

The ordination algorithm DEtrended CORrespondence ANAlysis (DECORANA)(Hill 1979b) was applied using the computer software package PC-ORD (McCune & Mefford 1999), to determine gradients in vegetation and the relationship between these plant communities and the physical environment. Results are depicted on various scatter diagrams. These ordinations are presented for the Major Vegetation Types, as well as for the plant communities of each of the Major Vegetation Types.

The plant communities were named binomially according to the code of phytosociological nomenclature (Barkman *et al.* 1986). Due to the high turnover of species in the field-layer in these event-driven ecosystems, it was decided to deviate from the traditional rules and customs of community-name giving. Instead of rigidly assigning the first name to the most prominent diagnostic species (Werger 1974), the longevity and persistence of the species within the community was taken into consideration. Preference was given to persistent woody species, with the aim of assigning a name to a community with predictive value even in times of drought. Where applicable, informal alternative plant community names were added, coupled with descriptive physiognomic and environmental postfixes.

The decision was made to focus on the association level for the formal syntaxonomic classification and description of plant communities, based on the groupings and clusters derived from the TWINSPAN classification and the DECORANA ordination. The reason for avoiding the higher levels of the syntaxonomic hierarchy revolves around the incompleteness of the available data set with regard to the Soutpansberg–Blouberg Mountain Range and the surrounding region. Formal classification and identification of syntaxonomic units higher than the association, e.g. alliances, orders and classes, can only be defined and described accurately when using datasets representing most of the variation at the association level, within a naturally defined vegetation unit at regional scale, such as a biome. Classification of unrepresentative and incomplete datasets may lead to oversimplified images of regional vegetation. The classification of biomes and regional vegetation types into formal alliances, orders and classes, using spatially patchy vegetation data, which contains high-level detail on local scale, but which lack representation at a regional scale, may lead to the miss-allocation of hierarchical status and to the duplication of syntaxa (Van Der Meulen 1979). Hierarchical classification is undeniably bound to scale.

Available sources of literature concerning vegetation studies containing plant communities floristically similar to the plant communities described from the study area were used for phytosociological and ecological comparison. These include vegetation studies from:

- Southern African Mopaneveld (Du Plessis 2001; Siebert *et al.* 2003c)
- Sekhukhuneland (Siebert 2001; Siebert *et al.* 2003a, b)
- Lowveld (Van Der Schijff 1957; Bredenkamp 1982, 1986, 1987; Bredenkamp & Theron 1991; Van Rooyen 1978; Coetzee 1983; Gertenbach 1983, 1987; Acocks 1953; Bredenkamp & Theron 1991; Bredenkamp & Deutschlander 1994)
- Northern and Central Bushveld (Louw 1970; Coetzee *et al.* 1976; Scholes 1978; Van Der Meulen 1979; Westfall 1981; Westfall *et al.* 1985; Van Den Berg 1993; Brown *et al.* 1995; Van Rooyen & Bredenkamp 1996a, b, c; Breebaart & Deutchlander 1997; Winterbach 1998; Winterbach *et al.* 2000; Brown 1997; Götze 2002; Smit 2000; Henning 2002; Van Staden 2002; Van Staden & Bredenkamp 2005, 2006)
- Grassland Biome (White 1978b; Bredenkamp 1975; Bredenkamp & Theron 1980; Behr & Bredenkamp 1988; Bredenkamp *et al.* 1989; Bredenkamp & Van Rooyen 1996b; Acocks 1953; Du Preez & Bredenkamp 1991; Fuls *et al* 1993; Burgoyne 1995; Granger & Bredenkamp 1996; Bredenkamp *et al.* 1996)
- Forest Biome (Fanshawe 1969; Moll 1972, 1976; Geldenhuys 1987; Cawe 1990; Geldenhuys & Murray 1993; Louw *et al.* 1994; Lubke *et al.* 1988; Du Preez *et al.* 1991; Lubke & McKenzie 1996; MacDevette 1993; Midgley *et al.* 1995; Shackleton *et al.* 1999; Geldenhuys & Venter 2002; Von Maltitz *et al.* 2003; Van Staden & Bredenkamp 2006)
- Escarpment (Deall *et al.* 1989; Matthews 1991; Matthews *et al.* 1991, 1992a, b, 1993, 1994)
- Southern African wetlands (Le Roux *et al.* 1988; Smuts 1992; Marneweck *et al.* 2001; Venter 2003; Grundling & Grobler 2005)

- Others (Acocks 1953; White 1978a; White 1983; Rutherford & Westfall 1994)

Mapping

Mapping of heterogeneous vegetation in mountainous terrain is extremely challenging and the practical outcome or product is very much scale bound (Raal & Burns 1996; Kovar 2000; Cingolania *et al.* 2004). Due to the scale at which sampling was done and the topographic complexity of the study area, it was decided to restrict mapping resolution to the Major Vegetation Types identified. The smaller patches and finer mosaic patterns formed by Major Vegetation Types along the areas of more extreme morphological complexity was not mapped.

Limitations on fieldwork and data analysis

Due to the destruction caused by the floods of 2000, the Sand River Gorge lost all of its riverine forests and thickets. These vegetation types could therefore not be sampled at the time of data gathering in the summer of 2002–2003.

Some discrepancies between the data of the SC and the BNR required the classification and ordination results to be interpreted with some subjectivity. The homogeneous nature of the BNR vegetation dataset may indicate that some plots were placed incorrectly within heterogeneous transitional vegetation, resulting in mixed relevés.

Data collection of similar plant communities during different growing seasons, especially within the event-driven semi-arid and arid ecosystems of southern Africa, often lead to their separation during classification. These separations are mainly due to changes in the floristic composition of the dynamic herbaceous layer. However, the herbaceous component of event-driven plant communities is regarded as the more variable component of vegetation and is given less priority during the interpretation of results.

Phenological changes over the time of data collection influenced the perceived species abundance and cover, consequently affecting the data of the relevés (Fischer 2000).

The artificial boundaries of the study area place some restrictions on the vegetation data with regard to its representativeness of the regional vegetation. In turn, this had an influence on the hierarchical level of syntaxonomic vegetation classification that could be conducted with confidence.