THE CONTRIBUTION OF RIPARIAN VEGETATION TO THE SPECIES COMPOSITION OF THE JONKERSHOEK VALLEY IN STELLENBOSCH, SOUTH AFRICA

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Thesis submitted in partial fulfillment of the requirements for the degree of

MASTER SCIENTIAE

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December 2003

DECLARATION

I, the undersigned, hereby declare that the work contained in this thesis is my own original work and has not previously, in its entirety or in part, been submitted to any university for a degree

ABSTRACT

Many authors express the value of riparian vegetation in terms of the function and number of species per unit area. Although riparian vegetation is confined to narrow bands of plants along watercourses, kloofs and gullies, it is a specialised habitat for many species.

To determine the contribution of riparian vegetation to the species richness of the Jonkershoek Valley, Western Cape Province, South Africa, a checklist was compiled, by referring to past research and to the PRECIS national database for the South African flora for a list of species recorded from the area. A total of 1 743 taxa and 108 families were included in this list for the Valley.

Specific characteristics were attributed to each of the 1 743 species on the basis of characters determined from the literature. Analysis of these data indicates that woody perennial shrubs with sclerophyll leaves are the representative plant type for the study area as a whole. The specialist structural description of a riparian species in the Jonkershoek Valley is: an unbranched woody perennial phanerophyte of a height between 2.0-8.0 m with microphyllous sclerophyll leaves. This group contributes 63% towards the riparian flora.

Riparian habitats occupy only 2.5% of the total study area but contribute 26% of the vascular plants. The riparian communities of the Santa Monica Mountains (USA) cover 0.7% of that mountain study area and provide a habitat for 20.5% of the total vascular plants of the area. Both areas, therefore, show a similar level of diversity. This remarkable species richness of riparian zones is consistent with that found in other riparian communities i.e. Sweden and France.

The study area was sampled by means of relevés arranged along 53 transects through the main stem and it's tributaries. A total number of 139 relevés were recorded which were used to identify, characterise and describe the riparian communities. Eight vegetation units, consisting of two groups, three communities, two subcommunities and one form, were described. The one group described the riparian communities while the other described a seepage community. The bigger groups exhibit environmental properties over a broader spectrum, while smaller groups exhibit characteristic environmental properties.

The vegetation is found to represent a continuum rather than discreet entities. Many indicator species are encountered in the communities. Because of the characteristic canopy-understorey physiognomy of riparian vegetation, many communities are interspersed, making it difficult to delineate discreet community boundaries.

The vegetation of the riparian zone of the Eerste River in the Jonkershoek Valley, is relatively pristine. Thirty-six species not native to the Valley were included in the checklist of which only four were recorded during the phytosociological study.

UITTREKSEL

Verskeie skrywers beklemtoon die kosbaarheid van rivieroewerplantegroei in terme van hul funksie en aantal spesies per oppervlakeenheid. Alhoewel rivieroewerplantegroei beperk is tot 'n noue band van plante langs waterweë, klowe en skeure, is dit 'n gespesialiseerde habitat vir baie spesies.

Om die bydrae wat rivieroewerplantegroei tot die spesie-rykheid van die Jonkershoekvallei, Wes-Kaapprovinsie, Suid-Afrika te bereken, is 'n spesieslys saamgestel uit vorige studies en 'n PRECIS nasionale databasis vir die Suid-Afrikaanse flora waaruit 'n lys saamgestel is van spesies wat aangeteken is vir die area. 'n Totaal van 1 746 taxa uit 108 families is ingesluit in die plantelys.

Vir elk van die 1 743 spesies, is spesifieke karakters uit die literatuur bepaal. 'n Analise hiervan dui aan dat die verteenwoordigende plant van die Jonkershoekvallei as gehele studie area 'n houtagtige, meerjarige struik met sklerofil blare is. Die spesialis strukturele beskrywing van 'n plant vir die Jonkershoekvallei is as volg: 'n onvertakte houtagtige meerjarige fanerofiet met 'n hoogte van 2.0-8.0 m met mikrofilliese sklerofil blare. Hierdie groep dra tot 63% by tot hierdie flora.

Rivieroewer habitatte beslaan slegs 2.5% van die totale studie area, maar het tot 26% tot die vaatplante bygedra. Die Santa Monica Berge (VSA) se rivieroewerplantegroei bedek 0.7% van die bergagtige studie area en voorsien 'n habitat vir 20.5% van die vaatpplante. Beide gebiede toon dieselfde mate van diversiteit. Hierdie uitstaande spesiesrykheid is in lyn met wat gevind is in ander rivieroewergemeenskappe bv. in Swede en Frankryk.

Die studie area is gemonster deur relevés wat uitgemerk is langs 53 transekte deur die hoofstroom en die sytakke. 'n Totaal van 139 releves is gemonster wat gebruik is om die gemeenskappe te identifiseer, karaktifiseer, en te beskryf. Agt plantegroei-eenhede, bestaande uit twee groepe, drie gemeenskappe, twee subgemeenskappe en een vorm, is beskryf. Die een groep beskryf rivieroewergemeenskappe terwyl die ander groep 'n gemeenskap in die syfersone beskryf. Die groter groepe het wyer omgewingseienskappe getoon, terwyl die kleiner groepe spesifieke eienskappe toon.

Dit is vasgestel dat die plantegroei eerder 'n kontinuum voorstel as diskrete eenhede. Dit het tot gevolg dat dit moeilik is om die grense van gemeenskappe uit te wys. Vele indikatorspesies is aangetref.

Die plantegroei van die rivieroewer van die Eersterivier in die Jonkershoeksvallei, kan beskryf word as relatief onversteurd. Ses-en-dertig spesies wat nie eie aan die Vallei is nie, is ingesluit in die spesieslys waarvan vier tydens die fito-sosiologiese studie aangeteken is.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

GENERAL INFORMATION

1.1 INTRODUCTION

1.1.1 Rationale

Riparian zones are fundamental to wetland ecosystem dynamics. Situated at the interface between terrestrial and aquatic ecosystems, riparian communities buffer hydrological erosion, control and regulate biogeochemical cycles of nitrogen and other nutrients, limit fire movement and create unique microclimates for animal and plant species (Gregory *et al.* 1991). This ecosystem is a centre of high biodiversity (Nilsson *et al.* 1989, Gregory *et al.* 1991, Aguiar *et al.* 2000). Ecosystems are dynamic and will change over time, and riparian systems are probably more dynamic than the associated uplands. The dynamic nature of riparian zones represents a major challenge to land managers, who must make decisions about a system that is constantly changing. Changes in upland vegetation occur either through conversion to agriculture and fire suppression, or the introduction of invader plant species can have an impact on water and sediment movement to riparian species (Svejcar 1997).

The ecological deterioration of the riparian zones along the Eerste (or First) River in the Western Cape Province, South Africa is accentuated by the presence of industrial and farming activities along the greater length of the river. These activities utilise the water resources, thus creating a limiting factor for plant growth. Furthermore, human activities and the periodic occurrence of veld fires have a negative effect on the river ecology, with catastrophic results (Salie 1995). The riparian zones have been subjected to many threats in the past. One of these threats was presented by South African timber growers, who wanted to annex the riparian zone (20 m strips on either side of the river) for commercial afforestation. They claimed that these under-utilised zones have an excellent timber-growing potential (Bosch *et al.* 1994). Riparian zones, with their very promising productivity potential, are therefore highly attractive to forest managers. Careful consideration has to be exercised when deciding on the utilisation of natural vegetation areas for commercial afforestation. Logging debris tends to accumulate at the bottom of slopes and thereby bury headwater streams that lack riparian buffers (Jackson *et al.* 2001). From 1945 to 1984, fynbos vegetation afforested with *Pinus radiata* showed a reduction of 58% in the total number of species (Richardson & Van Wilgen 1986). Fortunately, South African law has addressed the issue and there has been a change in afforestation in the Jonkershoek Valley, through which the Eerste River flows, in that no further plantations are to be planted. Although the Jonkershoek Valley catchment is protected by law for now, the situation might change over time as more pressure is placed on the country's natural resources by development.

Despite the importance of the riparian zones, few studies have been carried out on the plant diversity within river ecosystems in the Western Cape Province, South Africa. A qualitative and quantitative evaluation of the distribution and performance of plants along the Eerste River is very necessary. The upper reaches of the catchment could serve as a perfect study area because, according to Salie (1995), this zone is the least disturbed and the closest to the pristine state in the whole catchment area. With more than 80% of the total catchment of the Eerste River already encroached by alien invasive species (Salie 1995), the need to investigate the importance of riparian zones within the fynbos vegetation mosaic takes priority. All species characteristic of a wetland type or associated with water such as riparian zones, flood plains and seepage zones, would have to be included to cover the wetland habitat as thoroughly as possible.

This thesis focuses on compiling a vegetation checklist for the Jonkershoek Valley and a phytosociological study of the riparian vegetation of the upper reaches of the Eerste River.

1.2 STUDY AREA

1.2.1 General description

The Eerste River is a relatively small river in the south-western Cape Province. It has its source in the Dwarsberg Mountains, 1 320 m above sea level, 60 km east of Cape Town and its catchment comprises about 400 km^2 (King 1982). The highest point in the catchment area is Sneeukop, 1 700 m above sea level. The river flows in a north-westerly direction through Stellenbosch, and then southwards to a small estuary opening into False Bay near Macassar. The general geographical location of the Eerste River and its main tributaries is illustrated in Fig. 1.

1.2.2 Definition of boundaries for study area and riparian zone

For the purpose of this study, the riparian zone needs to be defined for delimitation purposes. According to Jackson (1928), riparian vegetation is defined as the plants frequenting the riverbanks or growing by rivers or streams. Jaeger (1947) classifies the riparian zone as the bank of the stream; frequenting or belonging to a stream bank. These are both subjective ways of defining the riparian zone, but they do provide a theoretical definition to use by which the riparian zone can be differentiated from the rest of the catchment. Jaeger's (1947) definition is a more practical way of defining the riparian zone than the timber growers' definition (Bosch *et al.* 1994), according to which the riparian zone is simply defined in terms of distance: 20 m strips on either side of the river. Rivers are not linear structures, but form complex systems of gradually coalescing channels of various sizes (Nilsson *et al.* 1994). During field excursions, the practicality of Jaeger's (1947) and Jackson's (1928) definitions of the riparian zone became apparent, because the area where the riparian zone flowed into the adjacent fynbos vegetation could easily be observed. Nilsson *et al.* (1994) define the width of the riverbank as the distance between the spring (winter in the south-western Cape) high-water level and the summer low-water level. In most cases, the debris deposited on the riverbank during floods forms a very conspicuous boundary. It is visible over most of the upper reaches, except for sections of the river that have very steep sides or where floods or human activities have removed the debris line. For the purpose of this study, the riparian vegetation refers to that vegetation which is controlled by riverine processes, particularly riverine sediments, and in part by moisture conditions.

The lower boundary of the study area is defined by the Langrivier tributary and the upper boundary by the western summit of the Dwarsberg (Fig. 2). This stretch of the river was selected because it is just above the Kleinplaas Dam, which is one of the major influences on the ecological function of the river. The upper reaches of the Eerste River are relatively undisturbed by human impacts and the vegetation along the steep river course consists mostly of indigenous fynbos (Tharme 1997).

1.2.3 Geology

Much of the catchment area consists of undulating hills with fertile soils overlying Cape Granite, Malmesbury Group shales and Table Mountain Group sandstones (Heydorn & Grindley 1982a). The Eerste River is a mountain stream, with the bed covered with gravel and boulders and with an initial steep slope from the source; its bed grows finer towards the mouth and eventually gives way to a silty deposit (Seddon 1967). This evaluation is supported by Lategan (1978), who remarked that the alluvium deposits along the Eerste River bed change markedly in their physical characteristics between the origin and the mouth of the river.

Geological formations

Malmesbury Group shales

The Malmesbury Group was deposited as shales, greywacke and siltstone in a geosyncline basin over the largest part of the Eerste River drainage basin. This is very characteristic of river valleys, where this sediment is exposed to deep erosion to form thick clay masses (Wessels & Greeff 1980).

Cape Granites (earlier Younger Cape Granites)

After intrusion of the Cape Granites and during the renewal tectonism in the south-western Cape, major faulting occurred in both the Malmesbury Group and in the Cape Granites. The Jonkershoek Valley is carved along two such milonitised fault-zones by the Eerste River (Wessels & Greeff 1980).

The Cape Supergroup

In the catchment under discussion, only the bottom two units of the Table Mountain Group are present, namely the Graafwater Formation (thin siltstone and shale at the base) and the Peninsula Formation (hard, massive, layered fine quartzitic sandstone which is often cross-bedded). The overlying formations were removed by later erosion processes, but the resistant Peninsula Sandstone built the prominent mountains on the east side of the catchment area (Wessels & Greeff 1980).

The geology of the Eerste River catchment area is illustrated in Fig. 3.

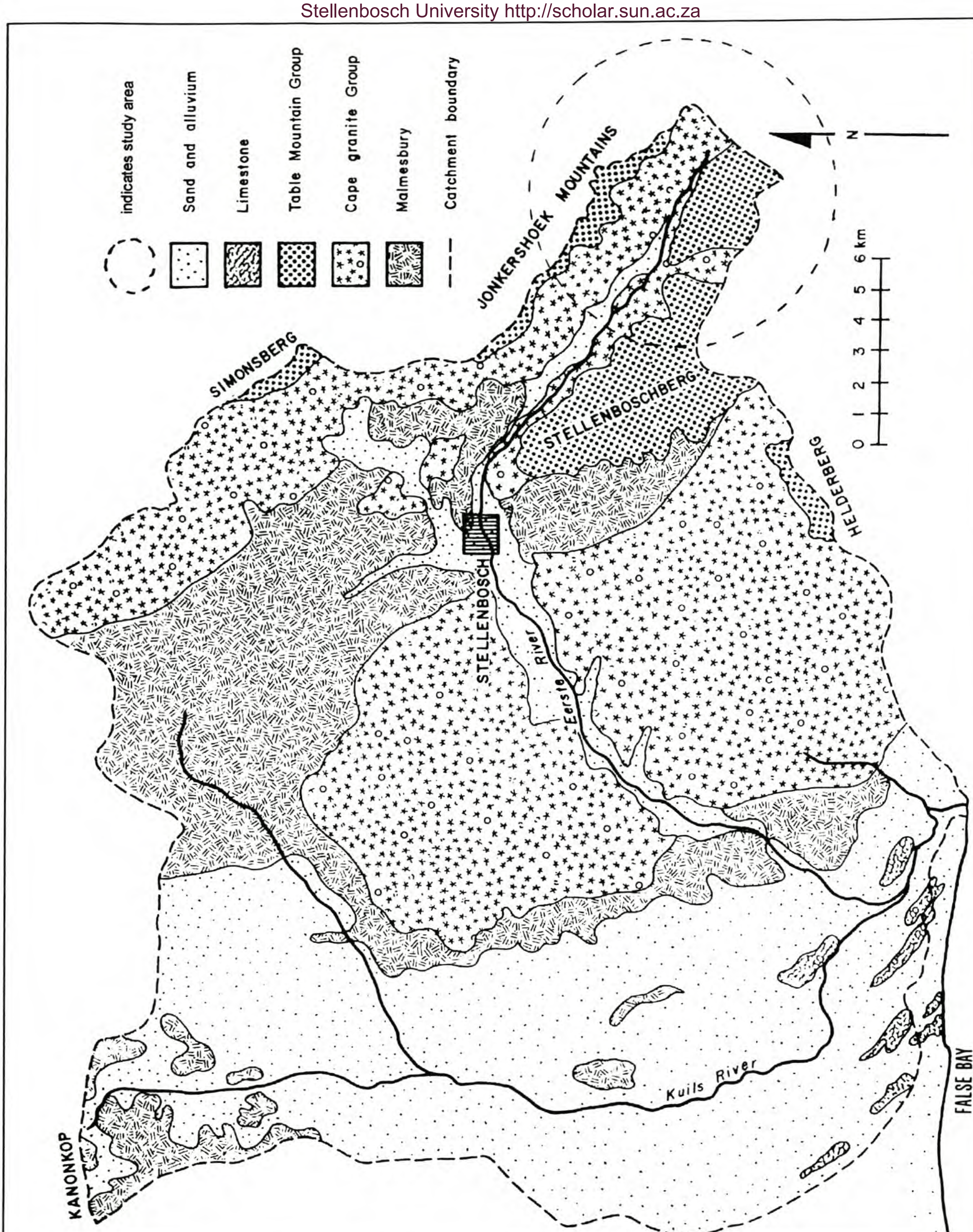


Figure 3. Geology of the Eerste River Catchment area (Wessels & Greeff 1980).

Sand and alluvium

During the Quaternary period, sediments, including sand, silt, clay and mud, accumulated in the river basin. Plant material collected in the marshes and led to the development of peat layers between sand layers. The geology is characterised by considerable depths of tertiary and recent deposits of loose sand, underlain by scattered clay lenses. Deposits of gravel, sandstone and conglomerates, together with the irregular development of silicrete, occur throughout the area (Wessels & Greeff 1980).

1.2.4 Alluvial history of the Eerste River

The gravel deposits in the Eerste River valley comprise an older sequence of remnants on the slopes above the valley floor and a younger group forming the wide terraces of the Stellenbosch Flats. The younger gravels accumulated on a mature valley floor largely stripped of dated palaeosol profiles prior to human occupation in the Middle Pleistocene. Stone Age artefacts were subsequently incorporated in exposed alluviums that were continually being reworked (Söhnge 1991).

The Eerste River was one of several short consequent streams beginning on the coastal plain in the Late Cretaceous after the Atlantic Ocean had opened up. In the Palaeogene, it captured a postulated proto-Jonkershoek River flowing north-northwest and proceeded to carve out the Stellenbosch Basin, while widening the Jonkershoek Valley. The Neogene Eerste River probably swung west-southwest in the vicinity of the present Krom River, depositing an arc of Pliocene gravels along this older course. During the early Pleistocene, the main channel shifted southward, leaving a local gravel terrace in the central area, while spreading out the bedded alluvial fan further to the south and west (Söhnge 1991).

1.2.5 Climate

Pressure cells

The Eerste River catchment is located within the Mediterranean climate zone of South Africa. The current climatic conditions can be ascribed to the annual change in position and intensity of three high pressure cells, the South Atlantic Anti-cyclone, the South Indian Ocean high pressure and the anti-cyclone, which is located over the interior of South Africa. The above three cells cause cold fronts which are usually associated with rainy conditions and gale force north-westerly winds (Fuggle 1981). These cold fronts cause the notorious winter storms, accompanied by rain (June - September), which are characteristic of the south-western Cape.

Temperature

The average daily maximum temperature is 28°C in midsummer and 17°C in midwinter. The average daily minimum is 15°C in January and 6°C in July, while minima of 4°C and -5°C in January and July respectively can occur at higher altitudes (Weather Bureau 1984). The monthly average maximum and minimum temperature readings for Swartboskloof are shown in Fig. 6 (Anonymous 2000). The 1999 and 2000 data sets were compared to the 10-year average (1991 - 2000) for Swartboskloof. These data sets were selected because most of the fieldwork was done during this period. An increase was found in both the maximum temperatures and minimum temperatures for 1999 and 2000. The increase in maximum temperatures could possibly be a reason for the higher evaporation rate and lower rainfall readings in 2000. Although the figures show an increase, they indicate the same trends as the 10-year averages for Swartboskloof. Although climate change scenarios of increased temperatures have been predicted, which may cause the extinction of plant species, the rate and number of extinctions are likely to depend strongly on the different environmental tolerances of the specific biotic components (Rutherford *et al.* 1999).

Wind

South-easterly winds blow during the summer months (December - March), with the "Black Southeaster" often reaching gale force strength, generating the characteristic mountain cloud which brings rain to the mountainous regions of Stellenbosch. Winter winds are north-westerly and do not occur regularly (Fig. 4). The gale force nature of winter winds is responsible for uprooting many riverine trees (Weather Bureau 1960).

Rainfall

The rainfall is usually cyclonic and orographic, but thunderstorms can occur (Weather Bureau 1960). The Jonkershoek Mountains (Fig. 2), which provide the major influxes of water into the Eerste River, have an average annual rainfall of 1 096 mm (Fig. 5). The Jonkershoek Mountains are compared to two other weather stations in the Stellenbosch region, namely Welgevallen and Glen Arum. These stations have an average annual rainfall of 797 and 1 039 mm respectively. Walter and Leith's (1967) klimadiagrams for the three weather stations are illustrated in Fig. 5 (Weather Bureau 1984). The average monthly rainfall and evaporation for the Swartboskloof catchment are illustrated in Fig. 7 (Anonymous 2000). The rainfall for 1999 and 2000 was compared to the 10-year average (1991 - 2000) for Swartboskloof. The rainfall for 1999 was higher than the rainfall for 2000. Contrary to the rainfall readings, the evaporation was higher in 2000 than in 1999. Both factors show similar trends to the 10-year average for Swartboskloof. The upper reaches of catchments are known to have higher rainfall than the lower areas, thus they are more prone to flooding and spate flows. Although prone to flooding, these plant communities have remarkable resilience and, as they are adapted to withstand these periodic high flow events, they can return to their previous state within one or two years after the flood (Sera & Cudlin 2001).

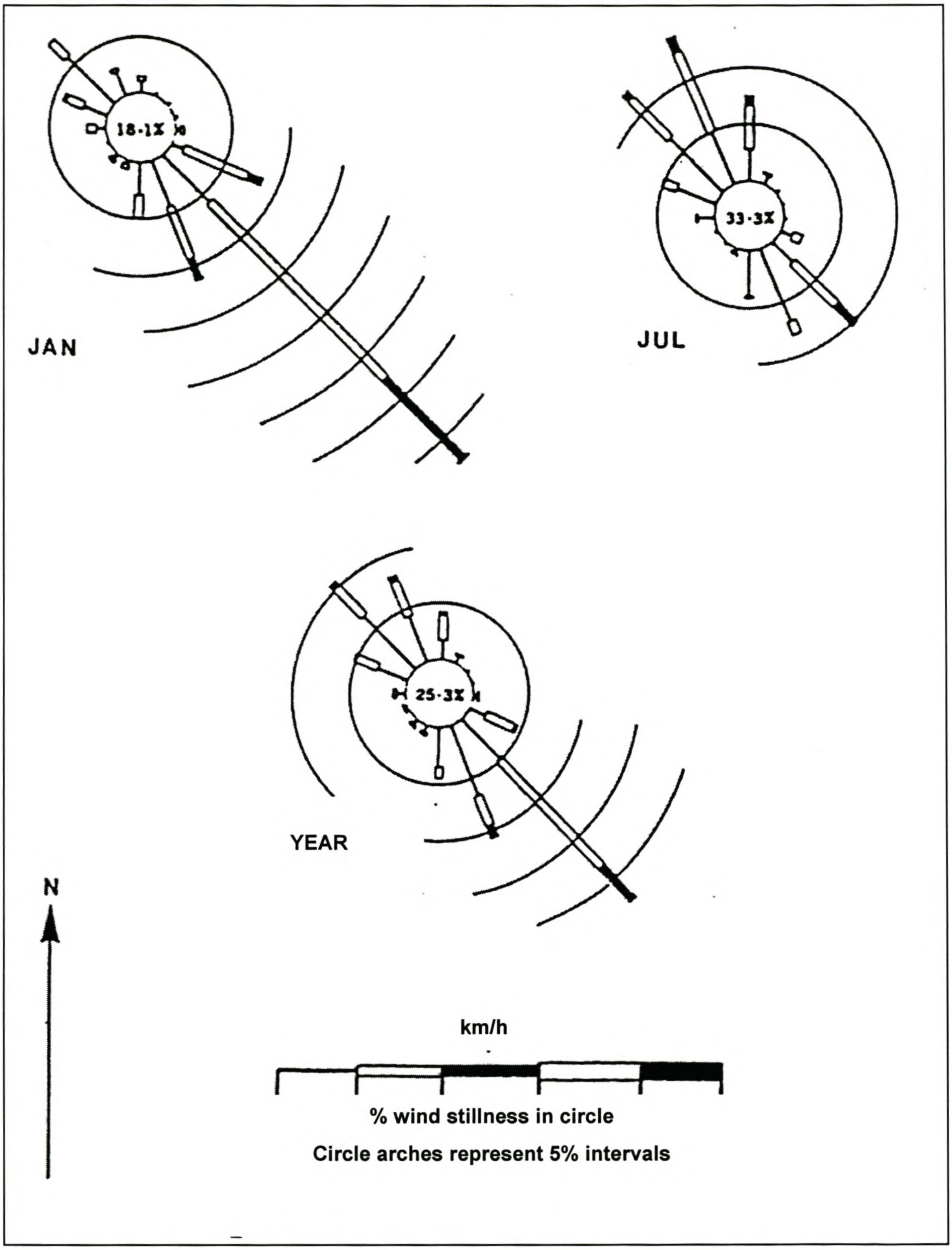


Figure 4. Summer (Jan), winter (Jul) and yearly (Year) windroses for Stellenbosch (Weather Bureau 1960).

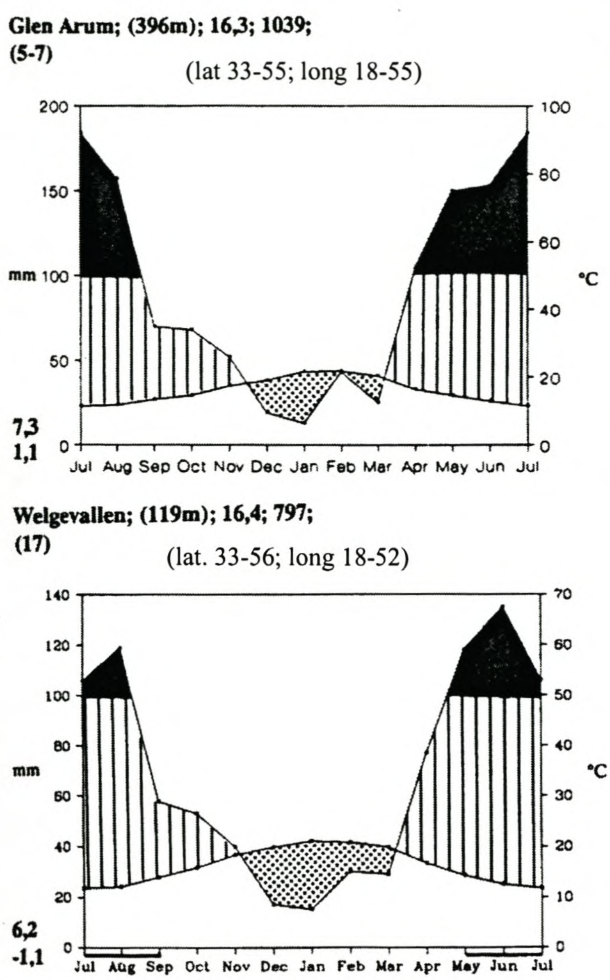


Figure 5. Walter and Leith Klimadiagrams for three weather stations in the Stellenbosch area (Weather Bureau 1960).

It is predicted that many of the biomes of South Africa are under threat from climatic changes. It is forecast that, by 2050, the country is likely to be warmer and drier, with temperature increases of as much as 3°C. Although the Fynbos Biome is expected to lose a large number of species under these conditions, much of the fynbos may remain fairly constant, mainly because it grows in mountainous areas, which provide many niches where plants can survive (Midgley *et al*. 2002).

1.2.6 History and archaeology

Riparian areas were used by the indigenous people as sources of water, pelts, fish and other raw materials, and may have served as camping grounds for migrating tribes (Deacon 1992). Many watercourses in the Western Cape were altered by colonial settlement for extensive irrigation and floodplains that were developed for agriculture. The removal of vegetation causes erosion, flooding and sediment deposition (Svejcar 1997).

Pre-European man

The oldest sets of artefacts found in the Fynbos landscape are those of the Early Stone Age and are associated with the Acheulian culture. These artefacts were studied in detail at the turn of the 19th century in Stellenbosch. It appears that, at least from the beginning of the Late Pleistocene (125 000 years ago), fire was being used as a tool to farm the fynbos for grazing animals. The Khoi had large herds of sheep and cattle and they migrated past Stellenbosch annually on their way to the Berg River. There are abundant hearths in human occupation sites of this time showing the ability to make fire at will (Deacon 1992).

Colonial settlement

The Eerste River was the first river (hence its name) that the early settlers came upon after leaving the settlement at the foot of Table Mountain and travelling across the inhospitable and sandy wastes of the Cape Flats (King 1982). In November 1679, the governor of the Cape, Simon van der Stel, gave the name Stellenbosch to the small island in the Eerste River on which he had camped and after which the settlement was later named. Land was allocated along the river to the farming community. The placement, quantity and quality of these allocations had social implications. According to Raper (in Vos 1993), those issued with land closest to the island of Stellenbosch and lower along the Eerste River's fertile flood plain were afforded the highest status.

The river followed a braided course, forming numerous little islands and, in its erratic flow along old and new channels, either churned up the gravel and sands or gashed deep potholes. When heavy rains fell, torrential waters swept over the shallow riverbanks into the town, the cornfields and the wine lands. The watercourse of the Eerste River was eventually changed so that excess water would bypass immediately south of the government buildings situated near the town of Stellenbosch. The arrival of the European settlers heralded the final, massive onslaught on the indigenous vegetation of the region (Boucher 1980).

Arrival of Shaykh Yusuf

Shaykh Yusuf was an aristocrat of the Makasar (or Macassar) Kingdom in the South Celebes. He was the chief figure in the resistance against the Dutch claims for authority over their territories. The Dutch East India Company succeeded in acquiring the monopoly of trade in the South Celebes islands and Shaykh Yusuf was captured and exiled to the Cape in 1693. He and his party established themselves on the farm Zandvliet at the mouth of the Eerste River on 14 June 1694. Since many of Shaykh Yusuf's followers hailed from Makasar, the district around Zandvliet is still known as Macassar (Dangor 1982).

There was a consistent demand for larger building timber in the Cape, where up to a third of the early colonial population was housed (Deacon 1992). The colonists used riparian species such as the assegai tree (*Curtisia dentata*) for spokes, yellowwood (*Podocarpus elongatus*) and red beech *(Rapanea melanophloeos*) for furniture, and ladle wood (*Cassine schinoides*) and other Afromontane forest species for kitchen utensils. All of these species are important riparian zone species in this region, although they are, in general, Afromontane Forest species. The broad bands of indigenous riparian forest that flourished along the Eerste River and in the mountain ravines 300 years ago have largely been eradicated by fires, human intervention and intrusion by exotics, such as pines, oaks, poplars, acacias and willows (Smuts 1979). The Afromontane forest patches were especially heavily exploited in the 17th century. The disturbance of the indigenous ecosystems was all the greater because the preferred species of plants were not dominant (Deacon 1992).

Recent causes of degradation of the Eerste River system

The river flow in the Eerste River system has been altered in two different ways, namely by over-abstraction and over-regulation (Wiseman & Simpson 1989). Owners of riparian property abstract water along most of the length of the river. The main impact on the flow of the Eerste River itself has been found to be as a result of the Kleinplaas Dam (Wiseman & Simpson 1989). This “balancing and diversion structure”, which is not primarily intended for water storage, has reduced the river flow by some 2,4 million m^3 per annum, mostly in the drier summer months. The regulatory administrative framework shows that each local authority takes planning decisions that are judged to be in their best interest. They are not obliged to consider the combined effects of their decisions on downstream areas and the provisions for the consideration of flood lines are ignored. This can lead to problems with flooding, followed by canalisation to protect life and property (Wiseman & Simpson 1989).

1.3 BOTANICAL BACKGROUND

The first detailed study of the Stellenbosch flora and vegetation was done by Duthie (1929). She included a classification of the life forms of riparian species, such *as Olinia ventosa, Ilex mitis, Olea europaea* and *Podocarpus latifolius*. She stated that the natural forest on the river banks had shrunken because riparian trees were felled by settlers for timber and fuel and also as a result of competition with introduced tree species such *as Quercus* spp., *Pinus* spp., *Populus* spp. and *Salix* spp. She described the trees and shrubs of the fringing forest on the Eerste River's banks and included species such as *Brachylaena neriifolia, Cliffortia cuneata, Freylinia lanceolata, Erica caffra, Kiggelaria africana* and *Podalyria calyptrata*. A dense, heath-like thicket composed of *Halleria elliptica, Metalasia muricata, Thesium strictum* and species of *Anthospermum, Aspalathus, Bobartia* and *Cliffortia* was found outside the forest fringe. She also described species of seasonal swamps along the river and included *Psoralea pinnata* as the most conspicuous feature of this vegetation.

The work of Acocks (1953) is a standard guide for most vegetation studies in South Africa. He produced a vegetation map which is of great value to both academic and applied ecologists. Acock's (1975, 1988) description of the veld type Fynbos (69) states that, in the wetter and warmer parts of the fynbos, the succession leads on, via tall *Leucadendron, Protea, Virgilia* and others, to *Podocarpus* and *Widdringtonia* forest.

Van der Merwe (1962, 1966) described riparian communities in Swartboskloof as narrow margins along the stream. Characteristic species in these communities are *Brachylaena neriifolia, Brabejum stellatifolium* and *Cunonia capensis*. He also described marsh communities in which *Osmitopsis asteriscoides, Psoralea aphylla, Utricularia capensis* and *Cliffortia graminea* occur. Van der Merwe (1966) compiled one of the first species lists for Swarboskloof. The list includes 448 species of flowering plants.

Werger *et al.* (1972) described the riverine scrub and forest in Jonkershoek as woody vegetation fringing stream channels. Based on floristic composition, one riverine scrub and two forest communities were distinguished. *Ischyrolepis subverticillata* is considered to be a common species in these woody communities. The riverine community was the *Brabejum stellatifolium* community. It included characteristic species such as *B. stellatifolium, Blechnum capense, Halleria elliptica, Pentameris thuarii* and *Podalyria calyptrata*. The two forest communities were the *Rapanea melanophloeos* community and the *Heeria argentea* community. These two communities had the following species in common: *Cassine schinoides, Maytenus acuminata, Olea europaea, Olinia ventosa* and *Podocarpus elongatus*.

McDonald (1988) divided the vegetation of Swartboskloof into Mesic Mountain Fynbos and Riparian and Forest Communities. One group of Riparian and one group of Forest Communities were distinguished. Under his *Cassine schinoides – Diospyros glabra* Riparian and Forest Communities he described the *Halleria elliptica – Brabejum stellatifolium* Short Forest and the *Halleria elliptica – Cliffortia cuneata* High Closed Shrubland. Under his *Diospyros glabra – Rapanea melanophloeos* Tall Forest Communities he described the *Rapanea melanophloeos – Cunonia capensis* High Forest and the *Rapanea melanophloeos – Heeria argentea* Short Forest. McDonald and Morley (1988) compiled the latest checklist for Swartboskloof and included 651 vascular plant species.

Other studies include that of King (1982), Wahl (1986), Duvenhage (1993), Low (1994) and Salie (1995), who surveyed the vegetation along the Eerste River in the Stellenbosch area. Kerfoot (1968) compiled one of the first floristic lists for the Jonkershoek Valley. Buys *et al.* (1991) also compiled a provisional analysis of the flora of Stellenbosch. Campbell (1986b) and Nel (1995) have described the riparian vegetation of local catchments in the study area.

A vegetation survey of the Eerste River was also done by McDowell (1996) for the Stellenbosch Municipality. Sieben (2002) did an in-depth Ph.D. study of the riparian vegetation of the Hottentots Holland Mountains, but this study has not yet been completed.

1.4 OBJECTIVES

The objectives of this study were:

- to compile a vegetation checklist for the Jonkershoek Valley
- to complete a phytosociological study of the upper reaches of the Eerste River

1.4.1 Key questions

The objectives of the study are addressed in the following key questions:

1. How many and which species occur in the riparian habitats?
2. How many species are common to the riparian zone and to adjacent Mesic Mountain Fynbos in the study area?
3. What is the total area, in square meters, covered by the riparian zone compared to the adjacent Mountain Fynbos, calculated using a Geographic Information System (GIS)?
4. What are the main characteristics of the riparian and the adjacent Fynbos species and are there any significant floristic or structural differences between them?
5. How does the riparian zone in the Jonkershoek Valley compare to other riparian zones in similar environments?
6. Which plant communities occur in the riparian zone of the Eerste River in Jonkershoek?
7. How does the distribution of these plant communities correlate with a variation in environmental parameters?
8. Are the plant communities discrete entities or does the vegetation represent a continuum?
9. Can indicator species be used to indicate riparian plant communities?

10. Which exotic/alien encroacher species occur in the riparian zone along the Eerste River in Jonkershoek?

1.4.2 Thesis structure

The thesis is presented with the aim of publishing two papers based on Chapter 2 and Chapter 3. Each chapter is divided into the following sections: abstract, introduction, research methodology, results and discussion and general discussion. Chapter 4 concludes the study by integrating the two chapters and proposing management guidelines.

CHAPTER 2

FLORISTIC EVALUATION OF THE UPPER CATCHMENT, JONKERSHOEK VALLEY

ABSTRACT

A checklist is presented of the plants of the Jonkershoek Valley, south-western Cape, South Africa. The study area covered the drier Mesic Mountain Fynbos (MMF) as well as the riparian vegetation. The flora comprises 108 families, of which Penaeaceae and Stilbaceae are endemic. The checklist includes 1 743 flowering plants and ferns, of which 36 are not native to the Cape Flora Region. The species richness of the riparian zone is compared to the MMF in terms of number of taxa per unit area covered. Riparian vegetation has an average of 11 species per hectare, while the MMF has 1,1 species per hectare. Although the riparian zone covers only 2,5% of the Jonkershoek Valley, it contributes 25% to the total species of the area. It is not surprising that such a small area can support a habitat for so many different species, as both the determining factors, productivity and disturbance, are present along the rivers in the Jonkershoek Valley. The plant characteristics of the riparian vegetation are shown to be quite similar to that of the MMF, except for the life form distribution – the MMF favours hemicryptophytes and the riparian vegetation favours phanerophytes. The plant structure is significantly different. In the MMF, dwarf shrubs and perennial herbs are more important, whereas trees and shrubs are important in the riparian vegetation. Comparisons are made to similar riparian studies in other Mediterranean regions as well as in South Africa.

2.1 INTRODUCTION

The mountain stream zone in the Jonkershoek Valley is relatively undisturbed by human impact and the vegetation along the roughly six metre wide, steep river course comprises mostly indigenous fynbos (Tharme 1997). This section of the Eerste River catchment provides an ideal study area for research on the vegetation (Heydorn & Grindley 1982a).

The Mountain Fynbos areas are important for water catchment, and are managed mainly for water yield and for nature conservation (Higgins *et al.* 1987). However, many concerns have been expressed about the current and future fate of riverine ecosystems, especially of the riparian vegetation and the threat of invasive alien species such as *Quercus robur*, *Populus canescens* and *Acacia mearnsii* (Duvenhage 1993). Other threats in Jonkershoek are indiscriminate abstraction of water by adjacent commercial farmers, polluted effluent discharges and the construction of river-altering obstacles in the main stream. The need for data about species composition and species specific characteristics has become more evident with the global trend of attaching economic value to catchment areas (King 1982). This shift in perception provides a channel through which strategic management can be applied to the conservation of our catchments.

The theory of convergence predicts that, given similar selected regimes, both present and past, unrelated ecological communities will show similar attributes (Ojeda *et al.* 2001). The five Mediterranean climate regions of the world (California, Chile, Mediterranean Basin, South Africa and Western Australia) occupy less than 5% of the Earth's surface, yet harbour about 48 250 known vascular plant species, almost 20% of the world total (Cowling *et al.* 1996). Rundel and Sturmer (1998) found that, although species of associated wetland habitats of the Santa Monica Mountains in Southern California make up less than 1% of the land area, they are a primary habitat for 20% of the vascular plant flora. The region they studied is climatically similar to the Western Cape Province. The ecological significance of the riparian zone is therefore accentuated in the semi-arid Mediterranean Region of Southern California.

The tributaries of the main river channel are just as important to investigate as the main channel, because there are fundamental differences in habitat that can contribute to the comparative differences in species richness between the two stream types. Nilsson *et al.* (1994) investigated the differences in species richness and frequencies between vascular plants found in a main channel and those of seven of its tributaries. They found that species richness per site was higher in the main channel than in the tributaries. This type of information is much needed for any ecological management of an area, which should be based on sound scientific data about the natural resources present in that area.

The floristic evaluation follows the methods used by Rundel and Sturmer (1998) in their study of vascular plant diversity in the riparian communities of the Santa Monica Mountains, California. They hypothesised that although riparian communities occupy only a small area, they serve as a habitat for a large number of species, thus contributing significantly towards the species number of an area. The Jonkershoek Valley study will compare the species richness of the riparian zone to that found in the study by Rundel and Sturmer (1998), as well as to other similar studies encountered in the literature.

The Jonkershoek Valley study is likely to not differ much from California, because both study areas show similar geographical and climatic characteristics. One of the more important products of this study will be the compilation of a checklist for the area, which will serve as a follow-up to the list compiled for Swartboskloof by McDonald and Morley (1998).

2.2 RESEARCH METHODOLOGY

Published floristic studies by Van der Merwe (1966), Kerfoot (1968), Werger *et al.* (1972), Kruger (1974), McDonald and Morley (1988), Duvenhage (1993), Salie (1995) and McDowell

(1996) were examined. Floristic data were also obtained from the National Botanical Institute in Pretoria, which provided a PRECIS list for the grids covered by the study area (3318DD 25 Die Pieke, 3319CC 21 Banghoek-piek, 3418BB 5 and 3419AA 1 Dwarsberg). All the taxa included under the Jonkershoek Valley were selected. These data references were used to compile a comprehensive checklist for the Valley and included species from a wide range of habitats, including riparian communities. These data were augmented with data collected during the present study. The taxonomy of all the taxa follows that of Goldblatt and Manning (2000). The checklist is presented in Appendix 1.

Species were ordered by families and a list of characteristics was compiled for each species using the following fields: leaf type, leaf size, leaf nature, plant height, life form, stem type, stem architecture, leaf architecture, approximate longevity and occurrence. Phenology was omitted due to insufficient information in the literature.

Field observations and the following references were used to obtain information to complete the various fields: Harvey and Sonder (1894a, b & c), Thiselton-Dyer (1896, 1904a & b, 1906, 1909, 1912, 1913, 1925), Hill (1933), Adamson and Salter (1950), Van der Merwe (1966), Kerfoot (1968), Burman and Bean (1985), Leistner *et al.* (1986), Linder and Ellis (1990), Schumann *et al.* (1992), Arnold and De Wet (1993), Schelpe (1996), Goldblatt and Manning (2000) and Leistner (2001).

The numerical values in the data collection form were used to record the characteristic descriptions of the plant features as one digit entries in order to simplify statistical analyses (Rundel & Sturmer 1998). The data collection form, with definitions taken from Raunkiaer (1934), Jackson (1928) and Blackmore and Tootill (1984), is shown in Appendix 2.

The Eerste River catchment was digitised from a 1:50 000 map of Stellenbosch and the Jonkershoek Valley supplied by the Maptography Offices in Cape Town. The valley edge was demarcated following the watershed of the Eerste River as defined from the 1:50 000 maps (Fig. 2.). By using Langrivier, one of the eastern tributaries of the Eerste River, as a reference point for where the tributary joins the main stream, the total length of all the streams above the reference point were calculated in kilometres using Arcview GIS (1998) program. For the purpose of this study, all the streams were taken as being perennial to allow easier calculation of the area covered by the streams (Arcview 1998). The width of the streams was calculated as an average of 10 mm on the 1:10 000 orthophoto maps, i.e. 1 mm represents a 10 m width. The average width was calculated using the main stream and the four major tributaries on both the eastern (Langrivier and Jakkalsvlei River) and western aspects (First and Second Waterfalls), as well as field measurements (Fig. 2). There is no specific stream width to capture riparian vegetation, but most riparian species are found within the geolittoral and epilittoral zones, and the zone between the stream edge and a few metres above the high water mark is adequate to capture these species (Spackman & Hughes 1995). The total area covered by the study area was calculated in hectares using the Arcview (1998) program.

Species were recorded as being riparian specialists, riparian generalists and wetland specialists (seepage, marshes and moist areas). All were taken as representative of the associated riparian vegetation and were counted and noted from the checklist (Appendix 1). The final estimate was calculated as a percentage from the total number of taxa on the checklist.

A list of riparian species was compiled during the sampling of transects along the Eerste River (Appendix 3). This list was expressed as a percentage of the taxa listed for the catchment as a whole and compared to the information obtained from the literature.

For the purpose of this study, the dominance of a particular characteristic is determined by the highest count of individuals for each category.

2.3 RESULTS AND DISCUSSION

A comprehensive checklist was compiled for the Jonkershoek Valley and is presented in Appendix 1. The list is classified according to divisions of the plant kingdom, namely pteridophytes (fern and fern-allies), gymnosperms (cone-bearing plants) and angiosperms (flowering plants). The angiosperms are further categorised into the Palaeodicotyledons, Monocotyledons and Eudicotyledons. A total of 1 743 taxa was recorded, 1 271 taxa from past studies and 406 from the PRECIS national data bank. Many of the taxa in the PRECIS are varieties and subspecies of species previously recorded in Jonkershoek. The total number of flowering and non-flowering taxa include 108 families and 441 genera. The pteridophytes are represented by eighteen families, with Pteridaceae being the largest with four genera and nine species. The gymnosperms have three families in the area, with Podocarpaceae being the largest with two genera and two species. Of the angiosperms, the Palaeodicotyledons have only one family, Lauraceae, with three genera and four species. The Monocotyledons include 22 families, with Iridaceae being the largest with 20 genera and 153 species. There are 65 families of Eudicotyledons, with Asteraceae being the largest. It has 62 genera and 213 species. A summary of the vascular plant flora is shown in Table 1. Another region of South Africa where Asteraceae is also the dominant family is the Mahwaqa Mountains in Kwazulu Natal (Meter *et al*. 2002). The flora of the southern Cape forests comprises 470 species, which belong to 280 genera and 106 families (Geldenhuys 1993). Boucher and Stindt (1992) found the largest dicotyledonous family to be the Asteraceae, with 30 genera and 57 species in the vegetation of the Haasvlakte. The montane flora of the southern Langeberge is rich, with 1 228 species found in 105 families and 361 genera (McDonald 1999). The Jonkershoek Valley is even richer in species composition compared to the Langeberge. Two families have endemic species of the flora of the Jonkershoek Valley. The one is Penaeaceae, which has two genera and two species, and the other is Stilbaceae, which has only one species. The ranking of the ten largest families in the Jonkershoek Valley flora is summarised in Table 2.

Table 1. Summary of the vascular plant flora of the Jonkershoek Valley.

Group	Families	Genera	% of total	Taxa	% of total
Non-flowering Plants					
Pteridophytes (ferns and fern-allies)	18	26	0,06	46	0,03
Gymnosperms (cone-bearing plants)	3	3	0,01	4	0,002
Flowering Plants					
Palaeodicotyledons	1	3	0,01	4	0,002
Monocotyledons	22	135	31,0	608	35,0
Eudicotyledons	64	274	62,0	1081	62,0
Total	**108**	**441**		**1 743**	

The largest genus by far in the Jonkershoek Valley flora is *Erica* (Ericaceae), with 95 taxa. *Erica* contributes 5,4% to the total number of taxa. It is also the largest genus in the Cape flora, contributing more than 7% to the species number (Goldblatt & Manning 2000). The second largest genus is *Aspalathus* (Fabaceae), with 48 taxa, followed by *Cliffortia* (Rosaceae), with 40 taxa. The fourth largest is *Disa* (Iridaceae), with 36 taxa. Each of these four genera has 30 taxa and more and contribute 13% to the total number of taxa. The ranking of the 10 largest genera in the Jonkershoek Valley flora is presented in Table 3.

Table 2. Ranking of the ten largest families of the Jonkershoek Valley flora.

Families	Taxa	Genera	Taxa : Genera
Asteraceae	213	62	3,4
Iridaceae	153	20	7,7
Fabaceae	146	25	5,8
Poaceae	128	39	3,3
Restionaceae	96	14	6,9
Ericaceae	96	2	48
Orchidaceae	74	12	6,2
Cyperaceae	64	14	4,6
Campanulaceae	51	14	3,6
Proteaceae	46	9	5,1
Totals	**1067**	**211**	**5.1**

Table 3. Ranking of the 10 largest genera in the Jonkershoek Valley flora

Genera	Taxa	% of Total	Cumulative %
Erica	95	5,4	5.4
Aspalathus	48	2,8	8.2
Cliffortia	40	2,3	10.5
Disa	36	2,1	12.6
Pentaschistis	28	1,6	14.2
Restio	28	1,6	15.8
Oxalis	27	1,5	17.3
Pelargonium	25	1,4	18.7
Moraeae	24	1,4	20.1
Helichrysum	23	1,3	21.4

From the checklist, 435 species out of a total of 1 743 were recorded in the riparian zone, including the categories riparian specialists, riparian generalists and wetland specialists (seepage zones, marshes, moist areas, wetlands). The distribution and number of taxa across the three habitats are: riparian specialists (114), riparian generalists (90) and wetland specialists (231). The number of taxa that are exclusively associated with Mesic Mountain Fynbos total 1 308.

The dominant characteristics of the riparian zone species are shown in Table 4. An analysis of the dominant characteristics of non-riparian species is summarised in Table 5.

According to the data analysis, a typical riparian species of the Jonkershoek Valley is an unbranched, woody perennial phanerophyte with a height of between 0,5 and 1 m and microphyllous, evergreen sclerophyllous leaves. This result is based on individual counts. It does not reflect the structural characteristics of the riparian vegetation and therefore the specialist description for a riparian species in this study is an unbranched, woody perennial phanerophyte with a height of between 2,0 and 8,0 m and microphyllous, evergreen sclerophyll leaves. Most of the riparian species would be found in seepage zones or moist places and not necessarily in close proximity to a perennial stream. The specialist description for a non-riparian species (adjacent fynbos surrounding) is a branched, woody perennial hemicryptophyte with a height of between 1,0 and 2,0 m and evergreen microphyllous leaves. Forest and thickets in mountain fynbos are characterised by a high cover of large shrubs or trees with leaves other than leptophylls (Lechmere-Oertel & Cowling 2000). Many fynbos species have sturdy, fire-resistant rootstocks which provide insulating mechanisms that enable them to survive fire and produce a sprouting strategy afterwards. Many of the Proteaceae, Restionaceae and Cyperaceae, as well as a host of other families, show this survival strategy (Mustart 2000) and this was also found to be the case in the Jonkershoek

Valley vegetation.

The life form classes of all the riparian species recorded here are shown in Fig. 8. The dominant life form is phanerophytes, i.e. trees or shrubs. The next two dominant life forms are the hemicryptophytes and the cryptophytes (geophytes). These species life forms, such as the hemicryptophyte *Ischyrolepis subverticillata* and the geophyte *Gladiolus carneus*, are usually the first plants to appear after an area has been burnt. The therophytes are the fifth largest group. These plants are also called "summer plants" for summer is considered to be the favourable season. These plants complete their entire life cycle from seed to seed during the favourable season. Many genera of Asteraceae are included under the therophytes with the *Corymbium* genus being prominent. The sixth group of life forms is the epiphytes, followed by the parasites. Only a few epiphytes and parasites have been recorded in the study area.

The leaf type classes of the riparian species are presented in Fig. 9. The most abundant leaf type category is the sclerophyll, although the riparian specialist species recorded in the phytosociological study have predominantly orthophyllous leaves. Evergreen sclerophylly is a prominent feature of leaves in fynbos vegetation. This is an adaptation in Cape plants to enable them to survive the dry, hot summers. The fact that sclerophyllous leaves contribute to limiting water loss is only one of a suite of hypotheses for this dominant feature in fynbos vegetation. Most of the plants recorded as riparian and adjacent fynbos species have sclerophyll leaves. The same was found in the Chaparral vegetation of California, where broad-leaved sclerophylls become important as conditions become more mesic (Keeley & Keeley 1988). The second most common leaf type is the orthophyll leaf. This leaf type was recorded in 278 (30%) riparian taxa. Eighteen taxa that were succulent in both leaves and stem were recorded in areas of disturbance along the river. These plants are regarded as opportunists and are not typical of riparian habitats.

The plant height classes of riparian species are illustrated in Fig. 10. The dominant class is 0,51 - 1,0 m. Nearly the same number of individuals are shown for the 0,26 – 0,50 m class. Although the dominant plant height class is between 0,51 and 1,0 m, riparian vegetation is structurally characterised by riparian trees and shrubs of 2 - 8 m, for example *Brachylaena neriifolia, Brabejum stellatifolium, Ilex mitis* and *Metrosideros angustifolia*. According to Duthie (1929), very few of the riparian phanerophytes (trees and shrubs) grow to a height of nine meters. This physiognomy represents most of the sedges and shrubs. These are not only dominant for the riparian vegetation, but for fynbos vegetation as a whole. The few trees recorded are mostly in the 1 - 2 m class, with a few reaching more than 2 m.

All the riparian species were divided into longevity classes, which are shown in Fig. 11. The perennials (woody and herbaceous), of which 410 were recorded, are dominant. Only one biennial was recorded in the riparian habitat, namely *Hypochoeris radicata*. Twenty-four were recorded as annuals. Most of the annuals occur outside the perimeter of the riparian zone. The perennials have a long-term survival regime and are characteristic of fynbos. This is also the case in the Strait of Gibraltar region in the western Mediterranean (Ojeda *et al*. 2001). The long-term survival regime results in the permanent evergreen appearance of the vegetation. The longevity forms of the riparian species are compared to the longevity forms of the Cape flora (Goldblatt & Manning 2000) and to those of California and Chile (Arroyo *et al*. 1994). Goldblatt & Manning (2000) further divides the Cape flora into perennials, shrubs, trees and annuals. The shrubs and trees make up 53.3% and 2,5% respectively. The data for perennials and annuals are presented in Table 6.

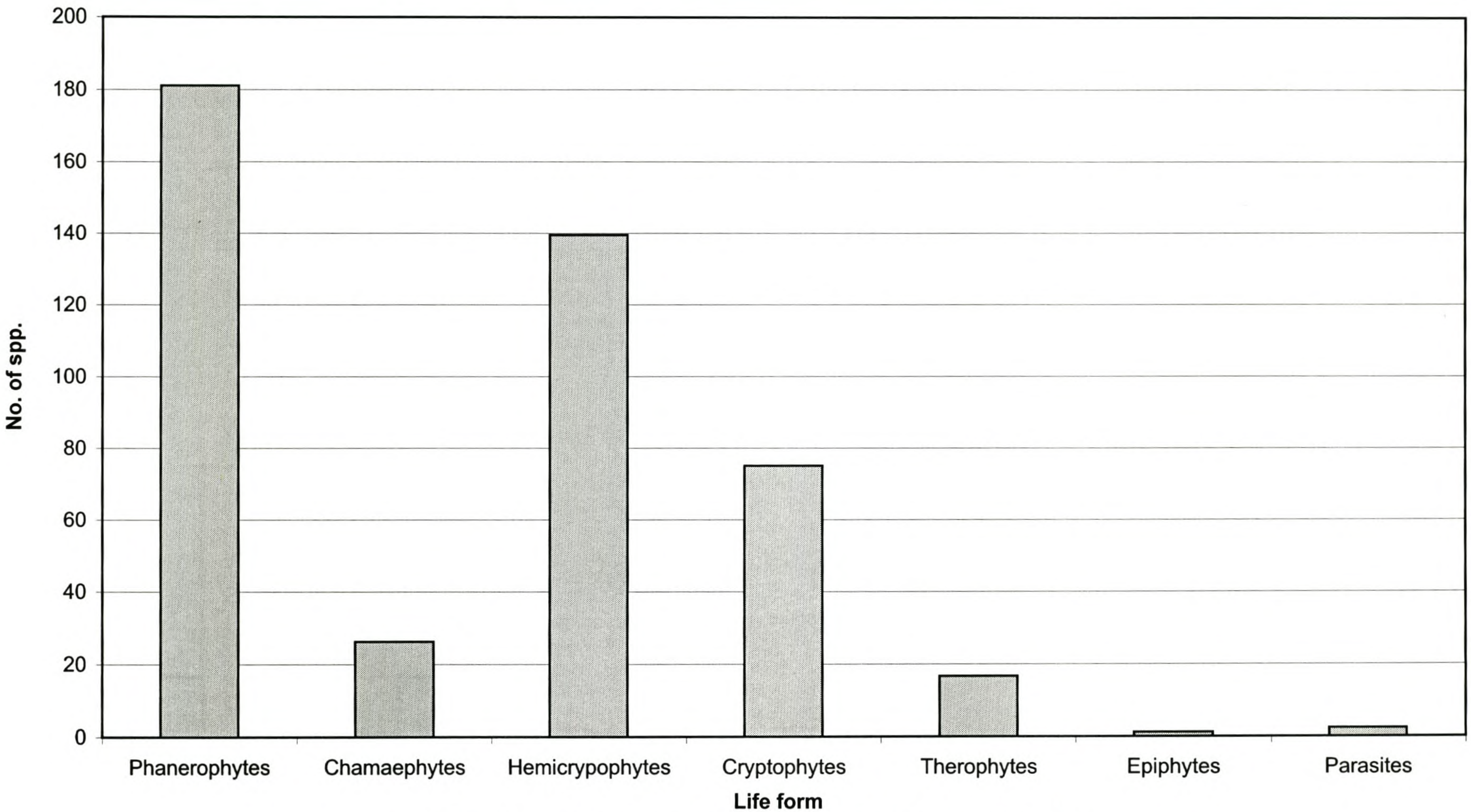


Figure 8. Life form classes of all riparian species (n = 435).

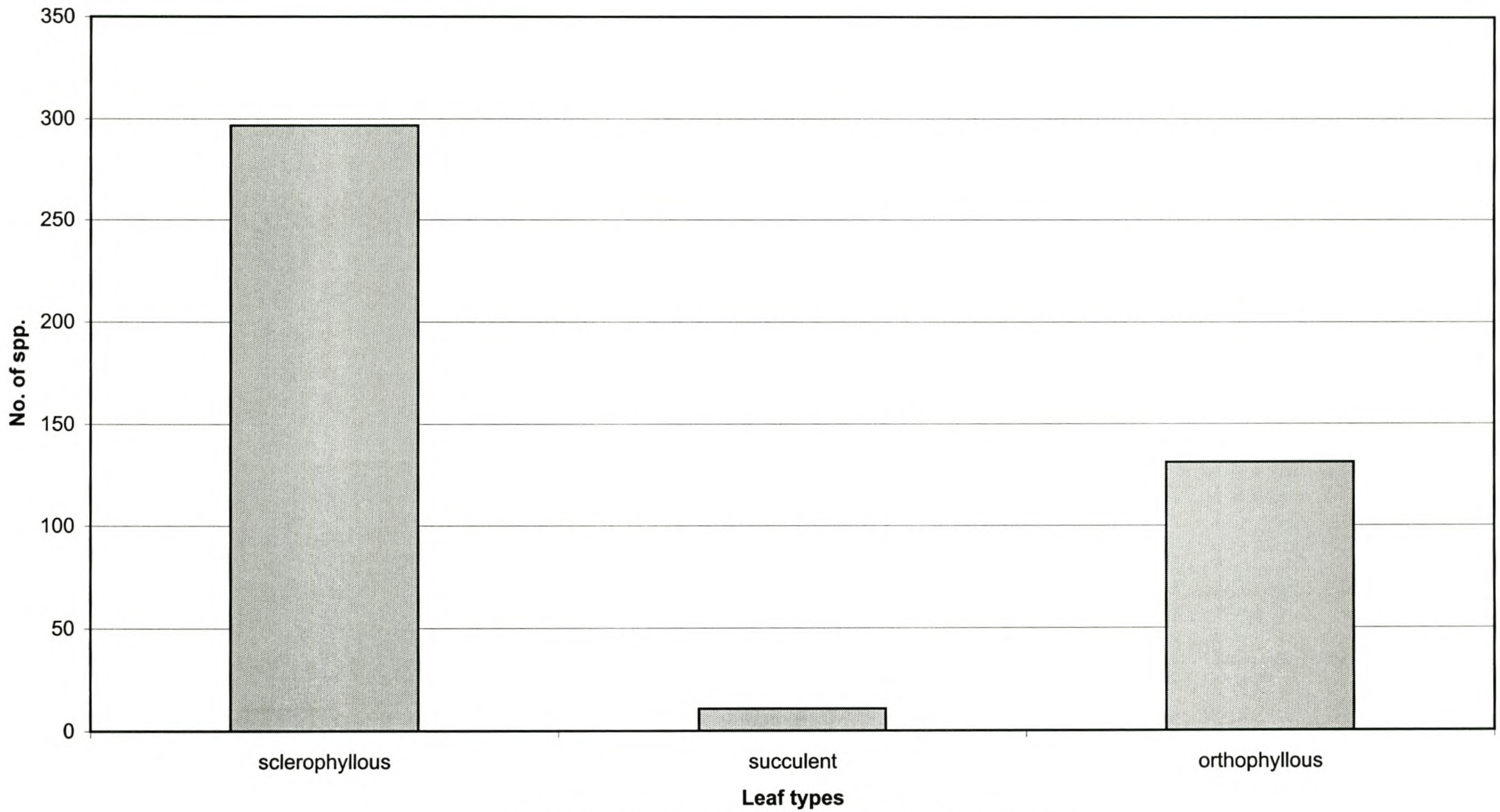


Figure 9. Leaf type classes of all riparian species.

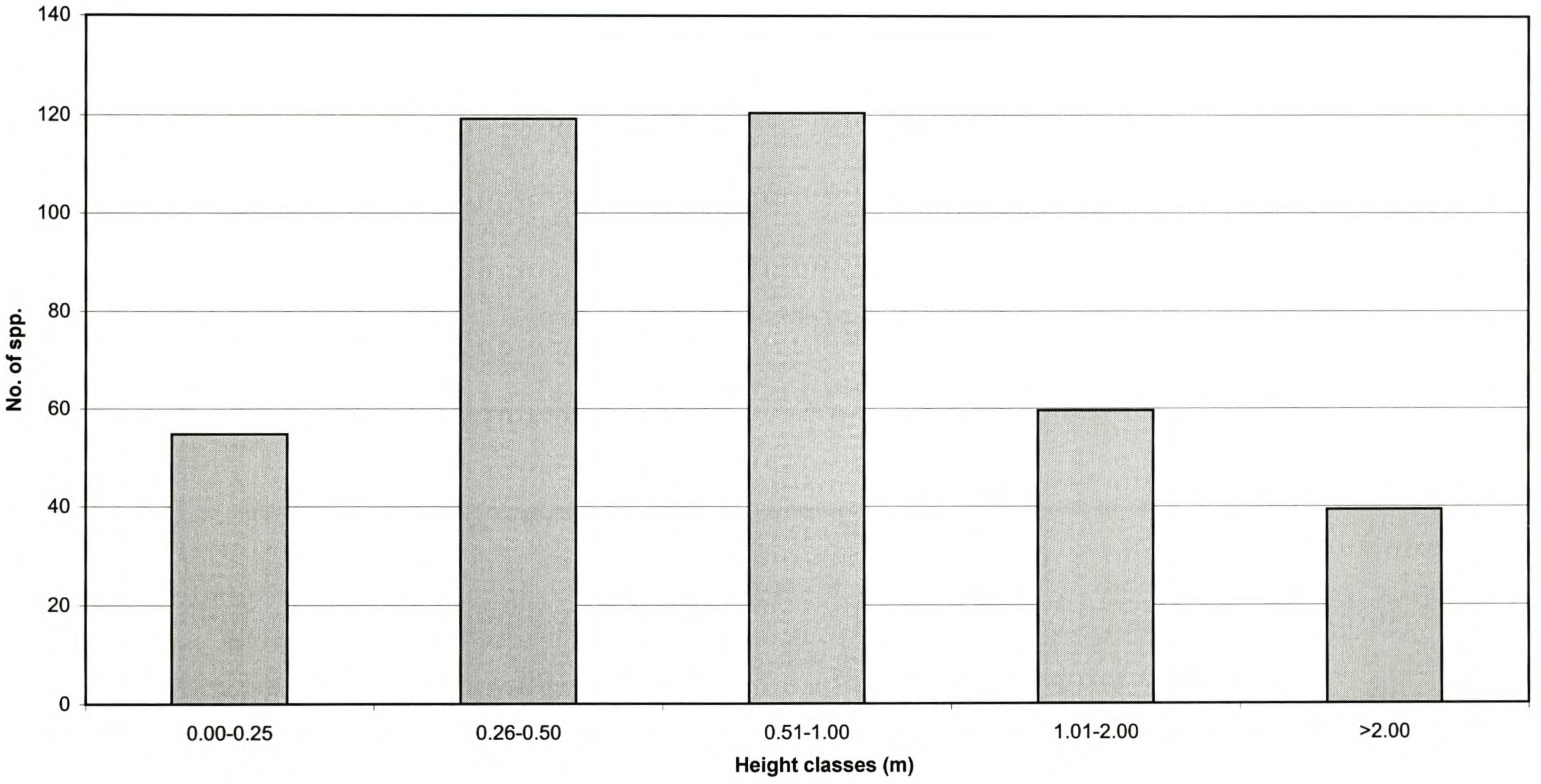


Figure 10. Height classes of all riparian species.

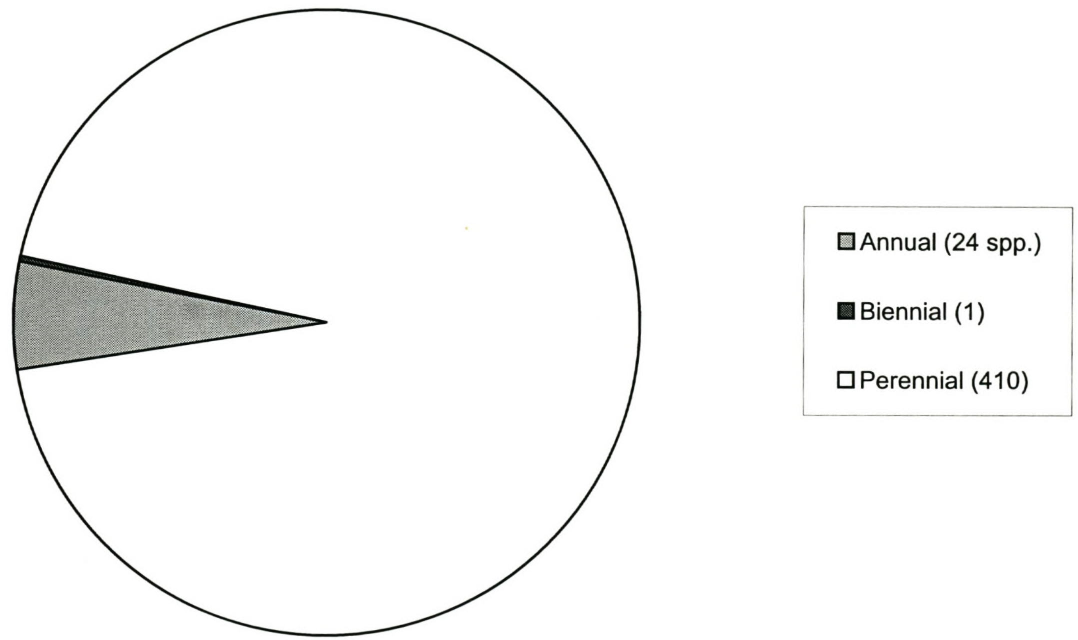


Figure 11. Longevity classes of all riparian species.

Thirty-six plants that are not native to the Jonkershoek Valley were recorded in the checklist and included species such as *Briza maxima, Conyza canadensis, Hypochoeris radicata* and *Solanum mauritianum*. This figure represents 2% of the total. These species have been described in areas of disturbance. The genus *Solanum* and the three other species have been included in the study of alien flora of the Cape of Good Hope Nature Reserve (McDonald *et al*. 1987). Van Wyk *et al.* (1988b) recorded 5,6% of the total of 1 100 species in the Zuurberg National Park as naturalised exotic species. The Jonkershoek Valley percentage is much lower.

Table 6. Comparison of longevity forms of all the riparian species of Jonkershoek Valley to the flora of California, central Chile and the Cape.

Region	Perennials (%)	Annuals (%)
Jonkershoek	94,2	5,1
Cape Flora	37,4	6,8
California	56,2	30,2
Central Chile	63,4	15,8

The lengths of the tributaries were recorded from a 1:10 000 orthophoto map and are presented in Table 7.

Table 7. Lengths of selected sections of the Eerste River

Section	Length (km)
Langrivier to Witbrug	0,89
Witbrug to area of seepage summit	3,66
Total length of main stream	4,60
Total for all the streams	41,73

Table 4. An analysis of the dominant characteristics of riparian species.

Characteristic	LF	LS	LST	PH (m)	LFO	ST	SA	LA	L	O
Class or type	sclerophyll	microphyll	evergreen	0,51-1,0	phanerophyte	woody	unbranched	simple	perennial	moist areas
No. of taxa	296	139	435	122	183	274	235	318	418	231
Percentage	68	32	100	28	42	63	54	73	96	53

LF = leaf type, LS = leaf size, LST = leaf structure, PH = plant height, LFO = life form, ST = stem type, SA = stem architecture, LA = leaf architecture, L = longevity, O = occurrence

Table 5. An analysis of the dominant characteristics of non-riparian species.

Characteristic	LF	LS	LST	PH (m)	LFO	ST	SA	LA	L	O
Class or type	sclerophyll	mesophyll	evergreen	1.10 - 2.0	hemicryptophyte	woody	branched	simple	perennial	MMF
No. of taxa	1036	564	1308	498	446	813	944	878	1141	1308
Percentage	79	43	100	38	34	62	72	67	87	100

LF = leaf type, LS = leaf size, LST = leaf structure, PH = plant height, LFO = life form, ST = stem type, SA = stem architecture, LA = leaf architecture, L = longevity, O = occurrence

The study area is calculated as 1 652 hectares. The average width of all the streams, calculated from the orthophoto map, was 10 m. This gives a surface area of 41 hectares. The surface covered by the streams in the Jonkershoek Valley comprises 2,5% of the total. The number of taxa calculated per hectare for the riparian zone is 11 taxa per hectare. The adjacent Mesic Mountain Fynbos in the study area has 1,1 taxa per hectare (11 taxa per 1 km^2), as calculated from the data. The fynbos diversity of the study area compares well with other Mediterranean-type ecosystems, such as the chaparral of California, where there are 6,4 species per 1 km^2 (Mooney & Parsons 1974). Marchant (1973) reported 22 species per 1 km^2 in Western Australia. Calculations of species per hectare can prove to be useful as long as the scale of areas considered are not very different. A comparison of species richness in the Jonkershoek Valley to the floras of the six phytogeographical centres of the Cape flora (Goldblatt & Manning 2000) is in presented in Table 8.

Table 8. Comparison of species richness in the Jonkershoek Valley to the floras of the six phytogeographical centres of the Cape flora (Goldblatt & Manning 2000).

Region	**Area 10^3 (km^2)**	**Taxa**
Jonkershoek Valley	0,02	1 743
North-western Centre	22	4 062
South-western Centre	23	4 654
Karoo Mountain Centre	3	1 374
Langeberg Centre	7	2 365
South-eastern Centre	18	2 832
Cape Peninsula	4,7	2 250

The south-western zone of the Cape has the highest diversity of flora (Cowling *et al.* 1996). Jonkershoek has a high species diversity compared to the smaller regions of

Central Chile and south-western Australia. The comparison of Jonkershoek to the Mediterranean-climate regions (Cowling *et al*. 1996) is shown in Table 9.

The total number of taxa recorded in the Jonkershoek Valley catchment is 1 743. The number of taxa recorded in the riparian habitats is 435. The percentage contribution of riparian taxa to the study area is therefore 25%. The riparian areas cover only 2,5% of the total study area, but contribute 25% to the total number of taxa. Limin *et al.* (2002) found that species richness of riparian communities was higher than that of non-riparian communities in the Changbai Mountains, China.

Table 9. Plant species diversity in Jonkershoek compared to the Mediterranean climate regions (Cowling *et al*. 1996).

Region	**Area 10^3(km^2)**	**Taxa**
Jonkershoek	0,02	1 743
Cape	90	9 000
California	320	4 300
Central Chile	140	2 400
Mediterranean Basin	2 300	25 000
South-western Australia	310	1 451

One hundred and forty-four species were recorded from the field recordings done by means of transect studies. The number of riparian taxa on the checklist is 435. This is 33% of the number of taxa in the area as a whole recorded in field studies. Paine and Ribic (2002) recorded 104 species in 38 850 km^2 in their riparian plant community study in south-western Wisconsin, while Decocq (2002) recorded 177 vascular plant species in 315 km^2 in the upper Oise Valley (Belgium and France). The floristic composition of the upper Paraguay River basin includes 637 species (Schessl 1999). Generally, the riparian vegetation in the upper reaches of the Jonkershoek Valley is richer in species composition in comparison to other riparian areas.

The wetland area calculated for the Santa Monica Mountains is 1 066 ha, compared to the 1 652 ha of Jonkershoek. The riparian areas contribute 0,7% of the area of the Santa Monica Mountains, compared to 2,5% of the Jonkershoek Valley catchment. Of the total native vascular plant flora of 644 species in the Santa Monica Mountains, 132 are characteristically riparian wetland species. This amounts to 20,5% of the flora. The total number of taxa for Jonkershoek is 1 743. The riparian contribution is 435. This amounts to 25% of the taxa in the catchment.

There are 10 riparian specialist trees in the flora of the Santa Monica Mountains. Fourteen indigenous riparian specialist trees were recorded in the Jonkershoek study area. This includes the following species: *Brabejum stellatifolium, Brachylaena neriifolia, Cassine schinoides, Cunonia capensis, Erica caffra, Freylinia lanceolata, Ilex mitis, Kiggelaria africana, Maytenus acuminata, Maytenus oleoides, Metrosideros angustifolia, Morella serrata, Olea europaea, Olinia ventosa, Platylophus trifoliatus, Podalyria calyptrata, Podocarpus elongatus, Pterocelastrus rostratus* and *Rapanea melanophloeos*. Some of the riparian trees listed above do occur in patches of Afromontane Forests far from the riparian zones. This underlines similarity in habitat conditions associated with distribution of these species.

The largest proportion of riparian specialists in the Santa Monica Mountains were herbaceous perennials (hemicryptopytes), which amounted to 58% of the riparian species. Jonkershoek riparian specialists are woody perennials (phanerophytes), which form 63% of the total riparian taxa.

2.4 GENERAL DISCUSSION

Compiling a floristic checklist for an area presents unique challenges associated with the revision of past vegetation studies (Medina-Abreo & Castillo-Campos 1995). The last checklist for plants recorded in a part of the Jonkershoek Valley was published by McDonald and Morley (1988), who described the vegetation of Swartboskloof. Swartboskloof covers 373 ha (23%) of the study area. They express similar views and state that a checklist should not be seen as an exhaustive list. With the dynamic nature of the fynbos vegetation, the number of species in some areas within a community, defined as species richness (Barbour *et al.* 1987), will never be the same over a period of time. The species composition of a community is also extremely important, because communities are partly defined on a floristic basis.

The floristic checklist consists of 1 743 taxa and 108 families. A comparison of the flora of the study area with that south of George in the Eastern Cape Province shows that the number of taxa and genera in the present study is comparatively high in relation to its size. The checklist for the area south of George included 271 taxa over 190 hectares (Victor *et al.* 2000). A checklist can serve as a basis for future studies and needs to be augmented by follow-up research on the vegetation in the study area. Most of the ground cover vegetation in the upper reaches of the Eerste River was extensively burned by a fire in April 1999. This area needs to be re-surveyed to record other species, such as geophytes that were stimulated by the fire. Regeneration after the first 12 months post-fire is illustrated in Fig. 15 in Chapter Four.

Asteraceae, with 62 genera and 213 species, is the largest family in the Jonkershoek Valley. The largest genus in Jonkershoek is *Erica*, which contributes 5,4% to the total species number. Both of these findings are synonymous for the Cape flora (Goldblatt &

Manning 2000). The checklist includes 36 taxa not native to the Jonkershoek Valley. This amounts to 2% of the total and is relatively low compared to other fynbos areas, such as the Cape of Good Hope Reserve, which has up to 30% non-native species.

For each of the 1 743 taxa, specific characteristics were noted from the literature. The most important characteristics of both riparian and non-riparian specialists were determined by the largest number of counts for each specific characteristic. A woody perennial shrub with sclerophyll leaves is the most representative plant type in the study area, which is predominantly fynbos vegetation. This provides evidence for the contribution of fynbos species to the flora. The same characteristics were recorded for the representative riparian species, except that the architecture of riparian species was predominantly unbranched in comparison to the branched nature of the majority of fynbos species. The above findings indicate that the physiognomy of both riparian and adjacent fynbos vegetation is very similar. The exception is the riparian tree specialists, which are unique in the riparian habitat. There is a definite correlation between the moisture regime of riparian habitats and the occurrence of trees (Salie 1995). The vegetation survey for the study, which is discussed in Chapter Three, describes the distribution of species in the riparian zone in more detail.

Rich assemblages of plant species occur along river margins (Svejcar 1997) and this is certainly the case for the upper reaches of the Eerste River. One explanation for the richness of riparian zones is that the places where these assemblages develop are among the most dynamic portions of the landscape (De Camps *et al.* 1994). Riparian zones are frequently disturbed by floods, which contribute to the heterogeneity of the landscape. Another major characteristic of riparian areas is their high productivity. They can produce considerable amounts of litter in diverse climatic zones. These two factors, productivity and disturbance, are among the important aspects that interact to control patterns of species richness (Solbrig 1992). Riparian habitats occupy only 2,5% of the total study area but contain 25% of the vascular plants. It is not surprising that such a small area can support a habitat for so many different species, as both the determining factors, productivity and disturbance, are present along the rivers in the Jonkershoek Valley. The Santa Monica Mountain riparian communities cover 0,7% of the relevant mountain area and provide a habitat to 20,5% of the total vascular plants of the area (Rundel & Sturmer 1998). Riparian habitats have approximately 11 species per hectare, compared to the 1,1 species per hectare for non-riparian communities. The species richness per unit area for riparian communities is nearly twice that of non-riparian communities.

This remarkable species richness in the riparian zones in Jonkershoek Valley is different from that found in other riparian communities. According to Nilsson *et al.* (1989, 1991), more than 100 species of vascular plants can be found along a 200 m stretch of a Swedish riverbank, including the area between the summer low water and the spring high water level, with a record number of 131 species per 200 m. In similar situations along the Adour River in France, 169 - 665 (mean 314) species are found per 500 m stretches of riparian corridor (Tabacchi 1995). In one of the sites studied along the Adour, more than 90% of the species in the surrounding hills were found in the riparian zone (Tabacchi 1995). De Camps *et al.* (1994) concluded that species richness is low to moderate in the mountains of the Adour River mainly because of the narrow valley and severe climatic conditions. Species richness is high in the piedmont zone, where there is a sharp fall in stream gradient, and very high in the middle course of the river, where substrate heterogeneity is maximal and disturbance intermediate in frequency and duration. According to Boutin *et al.* (2002), the number of plant species naturally found in pristine wetland areas in southern Quebec, Canada is expected to be small but significant compared to the adjacent farmed area. The Jonkershoek Valley is more species rich than other Mediterranean regions in the world.

According to the data analysis, a typical riparian species of the Jonkershoek Valley is an unbranched woody perennial phanerophyte with a height of between 0,5 and 1 m and microphyllous, evergreen sclerophyllous leaves. This does not reflect the structural characteristics of the riparian vegetation. Riparian zones are identified by tree strata. Twenty-five percent of the riparian species are taller than one metre, with 10 percent reaching heights of two metres and more. Thus, a riparian specialist would be an unbranched woody perennial phanerophyte with a height of between 2 and 8 m and microphyllous, evergreen sclerophyllous leaves. It is interesting to note how this differs from the floodplain vegetation of Botswana, which falls in a summer rainfall area. Here the dominant growth form is herbaceous perennials (Bonyongo *et al*. 2000). The riparian specialists of the Jonkershoek Valley make up 26% of the flora of the riparian zone. Most of the riparian species are wetland specialists and would be found in seepage zones or moist places and are not necessarily obligates to the riparian zone of a perennial stream (Goldblatt & Manning 2000). The wetland specialists contribute 53% to the riparian vegetation. Annuals make up 5% of the recorded riparian species. The largest single group of riparian specialists in the Santa Monica Mountains is herbaceous perennials (hemicryptophytes), which form 58% of the flora. In contrast to the Jonkershoek Valley, these riparian specialists have a higher relative frequency of herbaceous perennials and a lower relative frequency of woody shrubs and trees, geophytes and annuals. A winter deciduous phenology characterises nearly 80% of the woody riparian species in the Santa Monica Mountains study. This is in direct contrast with the Jonkershoek Valley riparian species, of which all the perennial species are evergreen. The Santa Monica Mountains are drier and lower than Jonkeershoek, with a range of mean annual rainfall from about

300-650 mm and a maximum elevation under 1 000 m. Summers are extremely dry. This means that many smaller streams in the Santa Monica Mountains cease flow in the summer and early autumn (Rundel & Sturmer 1998). This suggests that selective regimes for riparian species may be very different. The specialist description for a non-riparian species (adjacent fynbos surrounding) is a branched woody perennial hemicryptophyte with a height above 1,0 m and evergreen microphyllous leaves.

The riparian species recorded along the transects make up 33% of the total number of riparian species in the checklist. This is a relatively low percentage. Two reasons are given for this:

1. Only the riparian zones, with the outer boundary defined by the winter-flow debris line, were sampled by the transects. No plots extended into the seepage zones, such as marshes, and other moist areas associated with the riparian/wetland habitat. Information on the distribution of riparian species in these habitat types were obtained from the literature.
2. The stages of development in the fire cycle were not examined.

The analysis of the flora of the Jonkershoek Valley underpins the importance of the contribution of niche communities, such as those found in riparian zones, to the species richness of an area. Plant diversity in fynbos is partly a consequence of the peculiar geography of the zone, and partly of palaeo-climate change, which favour geographic speciation (Kruger & Taylor 1979). It is always emphasised how much diversity is found in non-riparian fynbos, although non-fynbos communities actually contribute quite significantly to diversity.

Given the scope of this study, the checklist was not evaluated for rare or endangered species. Nilsson *et al*. (1988) found that species richness was higher on sites with rare species than on sites without rare species. Future analyses of the flora of the Jonkershoek Valley could include rare or endangered species and the extent of invasion of plants not native to the study area, especially in the riparian zone.

CHAPTER 3

CLASSIFICATION OF THE VEGETATION ALONG THE UPPER REACHES OF THE EERSTE RIVER, JONKERSHOEK VALLEY

ABSTRACT

The Jonkershoek Valley forms part of the upper reaches of the greater Eerste River catchment in the south-western Cape, South Africa. The community structure and composition of the riparian communities were studied. Vegetation was analysed using the standard sampling procedures of the floristic-sociological approach of Braun-Blanquet (1932). Data were collected at 139 relevés along the main stream, as well as along the tributaries of the Eerste River. The relevé data were subject to TWINSPAN-based divisive classification and ordinated by Canonical Correlation Analysis with the aim to identify the vegetation coenocline, which was subsequently interpreted in terms of the underlying environmental gradients. Eight vegetation units were described. These included two groups, three communities, two subcommunities and one form. Only one vegetation unit was found to be strongly correlated to edaphic factors. The *Erica hispidula* Shrubland Form of the *Erica caffra – Ischyrolepis gaudichaudiana* Thicket Community was found to be located on sand over shale. The rest of the riparian communities are related more to moisture gradients then to soil properties. The *Pentameris thuarii – Cullumia setosa* Short Closed Shrubland is characterised by seepage and the *Erica caffra – Anthochortus crinalis* Subcommmunity of the *Erica caffra – Prionium serratum* Shrubland Community is characterised by marshes. Three alien species were found. One of them, *Conyza canadensis*, forms large stands.

3.1 INTRODUCTION

The Jonkershoek Valley Catchment is situated in the Jonkershoek Forest Reserve, about 15 km from Stellenbosch in the Western Cape Province, South Africa. It covers approximately 1 652 hectares and forms the upper catchment area of the greater Eerste River Catchment. The Eerste River flows in a north-westerly direction from its source in the Dwarsberg Mountain, and then southwards to a small estuary opening into False Bay near Macassar (Fig. 1).

The upper reaches of the Eerste River contain relatively pristine indigenous riparian vegetation (Salie 1995). Areas above Witbrug (Fig. 2) contain close to 100% indigenous plant species (Salie 1995). Vegetation habitats are exposed to various natural factors that determine the species composition of plant communities (Kopecky *et al.* 1995). Riparian areas are very dynamic and change continuously as a result of seasonal flooding and the fluctuation of water levels and flow regimes. Long periods of decreased water flow may cause irreversible changes from dense riverine vegetation to open riparian scrub or bush, or general degradation of the natural dense riparian forest (Bredenkamp 1982). River systems and the associated riparian vegetation are ecologically extremely sensitive (Anonymous 1990). Both spatially and temporally, this vegetation forms part of a dynamic ecotone, in which there are major physical and biological interrelationships. Riparian vegetation and forest patches are the only types of large-scale tree communities in the semi-arid Mediterranean climate and contribute distinctive landscape characteristics (Salinas *et al.* 2000). The Mesic Mountain Fynbos consists of small-scale shrub communities.

Vegetation science, like any science, uses classification to organise knowledge (Klinka *et* *al.* 1996). The classification of vegetation is helpful to develop a better understanding of how different plant communities relate to one another and their environment, and to facilitate further systematic and coordinated studies of vegetation. It has become necessary for resource management to compile phytosociological data pertaining to riparian plant communities in the Fynbos Biome in order to maintain and update the database for vegetation studies in this specialised habitat, such as the "Inventory of sources pertaining to the Fynbos Biome (Boucher *et al.* 1996). This database will prove to be crucial for future research projects. The classification of ecosystem attributes is an important step in establishing means to extrapolate knowledge of specific sites to larger managerial units (Davis 1988). Although plant communities are dynamic entities undergoing continuous changes in response to climate, land use patterns and intrinsic dynamics within the community, basic inventories provide a baseline against which these changes can be determined. Understanding vegetation-environmental correlations at a point in time may help to predict possible shifts attributable to climate and land use changes (Burke 2001).

Moisture and the substrate are believed to be the overriding factors determining vegetation patterns in the Swartboskloof communities (McDonald 1988). The variation in vegetation distribution and composition is best explained by a complex temperature/moisture – substrate gradient in riparian communities (Zimmerman *et al.* 1999). Hancock *et al.* (1996) emphasised that more attention should be paid to documenting the range of riparian plant communities and to assessing the health of the vegetation that are present in this area.

The primary aim of this study is to present a classification of the riparian vegetation of the upper catchment of the Eerste River and to provide an ecological interpretation of the communities that are present.

3.2 RESEARCH METHODOLOGY

Riparian vegetation is very dynamic in nature and a suitable classification approach is needed to collect data to identify and describe plant communities. The classification has to be based on the approach that component plant species are the most important determining feature of a plant community (Van Rooyen 1978, Bredenkamp 1982, Bredenkamp & Van Rooyen 1996). Knowledge of the distribution of riparian communities is invaluable for conservation and management purposes (Bredenkamp & Van Rooyen 1996).

The Jonkershoek Valley study area was viewed using aerial photographs and 1:10 000 othophoto maps in order to identify broad-scale physiographic-physiognomic communities. Braun-Blanquet (1932) techniques were used, following the methodology described by Werger (1974). The Zurich-Montpellier, or Braun-Blanquet, approach has been widely used to survey and classify vegetation (Werger 1974). Of the many vegetation classifications that have been used, only the Braun-Blanquet approach has the potential for creating a framework based on strong similarities of vegetation occurring in similar habitats, yet also recognising important floristic variation within these units (Walker *et al.* 1994). Relevés were used to sample the riparian vegetation of the Eerste River. These were placed in relation to the changes in vegetation structure on the riverbank. According to Mustart *et al.* (1993) and Campbell (1986a), plant relationships with the environment and with other plants will be related to both the scale of environmental variation and to plant size. Relevés therefore have to be placed in relation to changes in vegetation structure. Guo and Rundel (1997) suggested using multiple species variables, notably density, cover, biomass and energy utilisation, to identify the similarities and differences among ecological communities, but concluded that this approach is time consuming and has not yet found application among researchers.

Large plots, possibly covering heterogenous habitats and hence reflecting transitional communities, are time consuming for data collection (Mustart *et al.* 1993). It was impractical to use large plots in this study, as the riparian vegetation is confined to a narrow band along each watercourse. Limin *et al.* (2002) found that the minimum sampling area for riparian plant communities is smaller than that for non-riparian communities. According to Sayagues-Laso *et al.* (2000), human effort is important in sampling design, more so due to the nature of riparian zones.

Transects with a width of 10 m were used for this study, as this is the minimum width to view vegetation structure (Boucher 1987). Transects were demarcated on both the eastern and western side of the river. The upper border of each transect was determined by the debris line on the banks, which indicate the winter flood levels. The lower border was the water level of the river during sampling. For the practical purposes of sampling the study area, the border of the riparian zone was taken at the level of the winter flood level (Salie 1995). The location of transects was decided using a combination of vegetation structure and accessibility. In total, 53 transects were placed in the study area and relevés were placed in the transects according to strata.

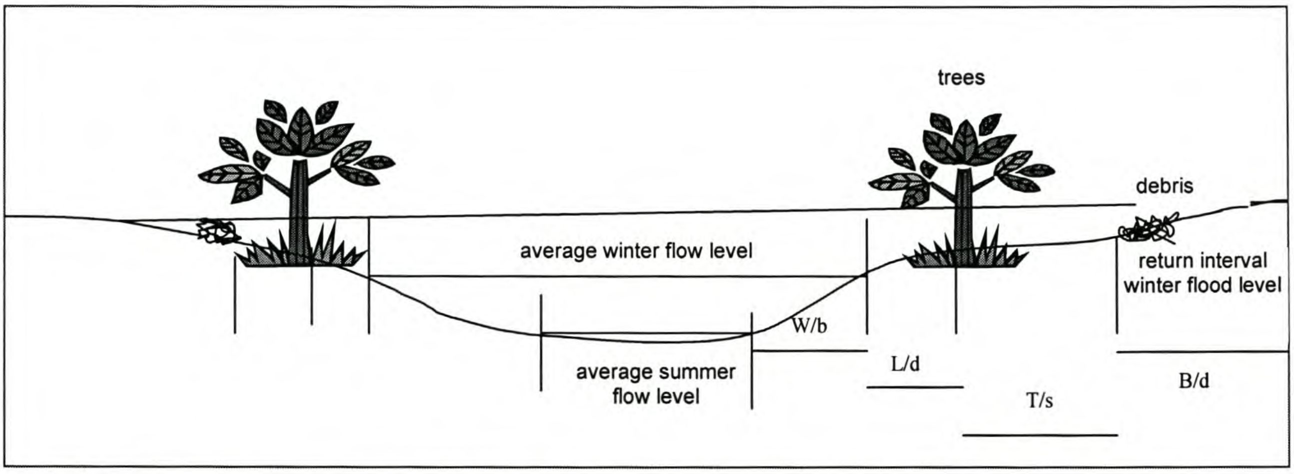
The strata were grouped into the following zones following McDonald (1988):

- Dwarf/Low shrub zone (0 – 0,5 m);
- Mid-high shrubs and sedge zone (0,5 - 2 m);
- Tall shrubs and tree zone (>2m);
- Area behind trees to the debris line (mixture of structural heights, sprawling of 0,10 to >2 m).

Taking the vegetation structure in consideration, relevés were placed in zones. The demarcation of zones according to water levels is described by Boucher and Tlale (1999):

- From the summer water level to the average winter flow level – Wetbank Zone;
- From the average winter flow level to trees – Lower Dynamic Zone;
- From the trees to the return interval winter flood level – Tree/Shrub Zone;
- Area behind the return interval winter flood level – Back Dynamic Zone.

A generalised cross-section of the river with the location of the different riparian zones is illustrated in Fig. 12.



W/b = Wetbank Zone; L/d = Lower Dynamic Zone; T/s = Tree/Shrub Zone; B/d = Back Dynamic Zone

Figure 12. Generalised cross-section of the river indicating riparian zones

Riparian vegetation forms a continuum along the watercourse and therefore the width of each transect at the line of the inclusive plot remains standard at 10 m. The widths of the plots were taken as a function of the border of the structural units. Although care was taken to sample relatively homogenous vegetation units, overlapping between units is possible and results in mixed samples. Transitional communities are more or less a "sink" for those relevés that cannot be unequivocally placed in "pure" communities (McDonald 1988). Peinado *et al.* (1994) refer to transitional zones as zono-ecotones, which are equivalent to Boucher and Tlale's (1999) Dynamic Zones.

The history and background of the study area is important when describing the vegetation. Information on past studies in Jonkershoek was obtained from:

- the Western Cape Nature Conservation Board, Jonkershoek;
- the South African Forestry Company Limited (SAFCOL) and the Council for Scientific and Industrial Research (Forestek), which were previously based at Jonkershoek;
- the examination of maps indicating locality, climate, geology and topography;
- the study of relevant published and unpublished literature and research project reports; and
- an inventory of recorded plant communities and sources of data pertaining to the Fynbos Biome (Boucher & McDonald 1982, Boucher *et al.* 1996).

Field surveys were carried out from 1997 to 2002. One hundred and thirty-nine relevés were sampled in 54 transects. The transects were located at regular intervals of 100 to 150 m along the main stream of the Eerste River. Intervals of 20 to 50 m were used along four tributaries on both sides of the main stream. The location of transects and samples is shown in Fig. 2. Tributaries were included in the study as they are known to show high levels of biodiversity. According to Johnson (2002), tributaries will show high levels of biodiversity as long as the tributary continues to contribute high flow variability and sediment to the main stream. This method of sampling was used to cover the largest possible variation in habitat and geological substrate. The different geological substrates were taken from the geology map (Fig. 4.). Species occupying instream habitats, such as bedrocks, rock pools and boulders, were noted and were included in the analysis. In each relevé, structural data were collected and the projected total canopy cover (%) was recorded. The dominant species were also identified for each stratum. Species occurrences were recorded, together with their percentage cover. Unidentified plant species were collected for later identification at the Stellenbosch Herbarium, Department of Botany, University of Stellenbosch. Voucher specimens were lodged with the National Botanical Institute at Kirstenbosch. The naming of plant taxa followed Goldblatt and Manning (2000). The species list of the phytosociological study is presented in Appendix 2. Almost the entire study area was destroyed by a major fire in April 1999 (Fig. 13 a, b & c). This made it difficult to revisit sampled plots to record additional information. On the follow-up visits, the study area was covered with juvenile growth of pioneering species, as well as geophytes and plants which sprouted from protected underground rhizomes. Problems of this nature will need to be handled carefully in the future classification of riparian vegetation.

Within each plot, the cover of a plant species was estimated using the Braun-Blanquet cover-abundance scale (Mueller-Dombois & Ellenberg 1974). In addition to vegetation cover, altitude, aspect, slope, latitude and longitude were recorded for each relevé as prescribed by Boucher (1987). Annuals and geophytes were also recorded if they were encountered in the plots. As their occurrence may have been strongly influenced by the season, the data are incomplete in this regard.

Nomenclature stability is urgently required to avoid further confusion and to allow easy and correct usage of syntaxonomic names by applied vegetation ecologists. Such stability can only be achieved by the uniform application of generally accepted nomenclatural rules (Weber *et al.* 2000). The description of communities applies a species binomial system, using two differential species in the syntaxon name. The first species used in the naming is the dominant one in the community, identifying the group as a whole. Informal categories of group, community, subcommunity and forms are used to indicate the hierarchical relationship between the different floristic vegetation units identified in this study. No suffixes are used as an indication of syntaxonomic hierarchical ranking because the sampling and study area were not located/spread over the entire range of the communities so that meaningful syntaxonomic nomenclature could not be applied (Whittaker 1962, Weber *et al.* 2000). A habitat indication, as well as a structural name, as described by Edwards (1983), is used in conjunction with the binomial naming system. The structural equivalent (Campbell *et al.* 1981) is also indicated.

3.3 SOIL SAMPLING AND ANALYSIS

Soil profile data were not recorded because of the rocky soils, which in most cases precluded the use of augers. Soil samples of approximately 500 g (two cupped-hands full of soil) were taken from the top 10 cm layer in each relevé for laboratory analyses. A standard method was used for measuring the pH in a saline water (KCl) paste (The Non-Affiliated Soil Analysis Work Committee 1990). A soil-water-paste medium is prepared to measure soil resistance using a Konduktometer. The soil samples were also analysed for organic carbon using the Walkley-Black Method (Walkley 1935).

The sand content was measured by sieving. The sieves used for particle size were: Coarse fraction (2 mm and >), Coarse sand (2 – 0,5 mm), Medium sand (0,5 – 0,25 mm), Fine sand (0,25 – 0,05) and Coarse silt (0,05 – 0,02). The soil analyses are summarised in Table 12. Soil depth was determined in each sample plot by hammering a metal stake into the ground until bedrock was struck. Although soil depths were recorded, they were left out of the analysis because they were used to determine the correlation between substrate depth and plant structure for the riparian zones. Soils in the montane plant environments in the Fynbos Biome are usually considered to be extremely shallow, on average less than 0,50 m (Campbell 1983).

3.4 DATA PROCESSING

The European Vegetation Survey Project is currently in the stage of gathering computerised information. There is an urgent need for the development and unification of survey methods, including numerical analysis of large data sets (Bruelheide & Milan 2000). This data set (139 relevés) is considered to be relatively small according to the European Vegetation Survey Project. Westfall *et al.* (1997) describe the sorting process of relevés as being subjective and propose a computerised approach, hence reducing decision making in the classification process. The relevé data were captured into the database TurboWin1.98 (Hennekens 1998). The data were then exported in CEP format from Turbowin into Megatab 2.0 (Hennekens 1996). Megatab was used to classify the relevés using the program TWINSPAN (Two-way Species Indicator Analysis) (Hill 1979). TWINSPAN is imbedded within Megatab. TWINSPAN classifies sampled plots on the basis of total floristic data. It produces a tabular matrix approximating possible Braun-Blanquet plant communities. For the purpose of this study, the phytosociological table was further refined by hand. Single occurrences of species were excluded from the analysis, but were listed at the bottom of the phytosociological table.

An ordination was performed to analyse environmental gradients across the landscape, as well as linkages between the distribution of relevés and environmental variables. Ordination was done with Canonical Correlation Analysis (CCA; Ter Braak 1986, 1987), using the default options of the CANOCO 4 program package (Ter Braak & Smilauer 1998). Physical soil properties included in the analyses of environmental variables are pH, resistance, organic carbon and particle size. Sample biplots were constructed using the 139 relevés. The relevés were arranged along CCA-axes according to a combination of soil variables (Fig. 14). Table 10 is a summary of the exact field location of the transects. The end of the transect closest to the river was used to record GPS locations.

Table 10. Summary of the exact field location of the transects.

Transect	Field location	Latitude	Longitude
Main Stem			
1	Eerste River, 350 m downstream from Witbrug	33^0-59'-30"	18^0-58'-24"
2	Eerste River, 250 m downstream from Witbrug	33-59-33	18-58-26
3	Eerste River, 50 m downstream from Witbrug	33-59-36	18-58-27
4	Eerste River, 100 m above Witbrug	33-59-37	18-58-36
5	Eerste River, 300 m above Witbrug	33-59-38	18-58-38
6	convergence First Waterfall (FW) with Eerste River (ER)	33-59-40	18-58-41
7	100 m upstream from confluence of FW with ER	33-59-43	18-58-49
8	200m upstream from confluence of FW with ER	33-59-46	18-58-51
9	320 m upstream from confluence of FW with ER	33-59-51	18-58-52
10	450 m upstream from confluence of FW with ER	33-59-55	18-58-52
11	confluence of Second Waterfall (SW) with ER	34-00-00	18-58-53
12	50m upstream in ER from confluence of SW with ER	34-00-01	18-59-55
13	150m upstream in ER from confluence of SW with ER	34-00-02	18-59-63
14	250m upstream in ER from confluence of SW with ER	34-00-04	18-59-75
15	400m upstream in ER from confluence of SW with ER	34-00-06	18-59-81
First Waterfall Tributary			
1	50 m upstream from confluence of FW with ER	34-00-13	18-59-39
2	100 m upstream from confluence of FW with ER	34-00-15	18-59-40
3	130 m upstream from confluence of FW with ER	34-00-16	18-59-44
4	150 m upstream from confluence of FW with ER	34-00-18	18-59-45
5	200 m upstream from confluence of FW with ER	34-00-21	18-59-47
Second Waterfall Tributary			
1	50 m upstream from confluence of SW with ER	34-00-22	18-59-50
2	80 m upstream from confluence of SW with ER	34-00-23	18-59-54
3	110m upstream from confluence of SW with ER	34-00-25	18-59-57
4	150 m upstream from confluence of SW with	34-00-27	18-59-58
5	170 m upstream from confluence of SW with ER	34-00-28	18-59-60
Langrivier Tributary			
1	150 m upstream in tributary	33-59-24	18-58-22
2	120 m upstream in tributary	33-59-26	18-58-23
3	90 m upstream in tributary	33-59-27	18-58-25
4	50 m upstream in tributary	33-59-30	18-58-28
5	20 m upstream in tributary	33-59-32	18-58-30

Table 10 continued…			
Jakkalsvlei River Tributary			
1	200 m upstream in tributary	33-59-48	18-58-42
2	150 m upstream in tributary	33-59-49	18-58-46
3	100 m upstream in tributary	33-59-50	18-58-47
4	50 m upstream in tributary	33-59-52	18-58-52
5	20 m upstream in tributary	33-59-54	18-58-54
Tributary 1of ER			
1	80 m upstream in tributary	34-00-04	18-59-80
2	60 m upstream in tributary	34-00-04	18-59-80
3	40 m upstream in tributary	34-00-04	18-59-80
4	20 m upstream in tributary	34-00-04	18-59-80
Tributary 2 of ER			
1	80 m upstream in tributary	34-00-08	18-59-76
2	60 m upstream in tributary	34-00-08	18-59-77
3	40 m upstream in tributary	34-00-09	18-59-78
4	20 m upstream in tributary	34-00-09	18-59-78
Tributary 3 of ER			
1	20 m upstream in tributary	34-00-05	18-59-74
2	50 m upstream in tributary	34-00-06	18-59-76
3	70 m upstream in tributary	34-00-07	18-59-77
4	90 m upstream in tributary	34-00-07	18-59-78
Tributary 4 of ER			
1	20 m upstream in tributary	34-00-10	18-59-78
2	40 m upstream in tributary	34-00-11	18-59-78
3	60 m upstream in tributary	34-00-11	18-59-78
4	80 m upstream in tributary	34-00-12	18-59-78
Seepage at source of ER on Dwarsberg			
1	seepages, summit	34-00-29	19-01-03
2	seepages, summit	34-00-29	19-01-03
3	seepages, summit	34-00-29	19-01-03

3.5 RESULTS AND DISCUSSION

Vegetation classification

The communities that make up the riparian vegetation are associated with moist conditions, often with perennial running water in watercourses, seasonally wet conditions in kloofs and gullies and other moist situations in marshes and seepages (McDonald 1988). Environmental gradients in riparian zones are complex and there is a clear lack of coupling between the tree, shrub and herb layers, which indicates a differential response to the underlying influence of environmental controls (Decocq 2002). The same situation was found in the study area, where structural overlapping made it difficult to determine the influence of environmental parameters on vegetation distribution. The riparian zone of the Eerste River can be subdivided into the two main components, namely marshland and riverbank. The riverbank is subdivided into the wet bank and dry bank according to Boucher and Tlale (1999). There are also areas of seepage in the riparian zone.

Eight vegetation units were identified in the TWINSPAN classification. These vegetation units are presented in Table 11. The results of the environmental analysis for each vegetation unit and relevé are presented in Table 12. Two community groups occur in the *Erica caffra – Elegia capensis* Riparian Group of Communities and one in the *Pentameris thuarii – Cullumia setosa* Seepage Community.

A. Riparian Zone Communities

1. *Erica caffra – Elegia capensis* Riparian Group of Communities

E. caffra is used to link riparian communities. It is found in all the riparian communities along the Eerste River in the upper reaches of the study area. Three major riparian communities occur in the Jonkershoek Valley: *Erica caffra – Prionium serratum* Shrubland; *Erica caffra – Elegia persistens* Shrubland and *Erica caffra – Ischyrolepis* *gaudichaudiana* Thicket. These communities are mainly associated with perennial running water in the main stem and tributaries of the Eerste River. They are closely associated with McDonald's (1988) *Cassine schinoides – Diospyros glabra* Riparian and Forest Communities.

Two wetbank communities, *Erica caffra – Prionium serratum* Shrubland and *Erica caffra – Elegia persistens* Shrubland, were identified. *Erica caffra – Anthochortus crinalis* forms a Marshland Subcommunity of the *Erica caffra – Prionium serratum* Shrubland. One community was identified on the drybank of the riparian zone, namely the *Erica caffra – Ischyrolepis gaudichaudiana* Thicket Community. This community is subdivided into the *Erica caffra – Juncus lomatophyllus* Sedgeland Subcommunity and the *Erica hispidula* Shrubland Form. These vegetation units form a fringing shrubland to the Eerste River between the water and the adjacent Mesic Mountain Fynbos.

Floristically, the vegetation units share many species, but they differ in habitat. They occur on alluvial and colluvial sandy deposits with different degrees of organic content. The sandy soils are shallow and well-drained and the *Erica caffra – Juncus lomatophyllus* Sedgeland Subcommunity is the only vegetation unit with shale present in the soil. Many of the species in these vegetation units have established themselves on soil and debris accumulation as a result of physical stream obstructions, such as boulders or branches. The ground layer of these vegetation units is partially exposed to sunlight where the overhanging riparian trees form a canopy.

The *Erica caffra – Elegia Ischyrolepis gaudichaudiana* Thicket Community can be regarded as the transition between the riparian zone and the Mesic Mountain Fynbos.

Species such as *Protea nitida*, *Cyclopia maculata* and *Pelargonium cucullatum* are present in both vegetation types.

1.1 Erica caffra - Prionium serratum Short Closed Shrubland Community

Campbell *et al.* (1981) structural category: Low Closed Shrubland.

The differential species are: *P. serratum* and *E. caffra*.

Dominant species: *P. serratum, E. caffra* and *Metrosideros angustifolia*.

This community is located on the wetbank of the Eerste River and occurs in relevés 1, 3, 6, 9, 13, 16, 19, 22, 27,32, 34 and 43. It occurs at altitudes between 360 - 400 m. This community is at the lower end of the study area, where there is relatively little steepness and the river levels out. The riparian strip is noticeably wider and this can be ascribed to greater lateral flooding through lower water velocities.

The estimated total cover is 65%. Two strata are distinguished: a low herb stratum with *P. serratum* as the dominant herb (< 1,00 m), and an overhanging stratum (2 - 5 m) in which riparian trees, such as *Brachylaena neriifolia, E. caffra, M. angustifolia* and *Morella serrata* are the dominant species. Other trees, such as *Brabejum stellatifolium, Cunonia capensis* and *Ilex mitis*, are also present. There are single occurrences of *Cymbopogon marginatus, Elegia capensis, Isolepis digitata, Merxmuellera cincta* and *Olinia ventosa.* Grasses such as *C. marginatus* and *M. cincta* are generally found on sandy soil with boulders and gravel. *Isolepis digitata* is a species which usually occurs on rock substrates in the water. It was sampled in relevé 43. This relevé was sampled during the summer months at a period when the water level was at its lowest. This species was recorded on the riverbank at the summer water level, which would be under water during winter. It has adopted a strategy of regenerating both in water and out of the water. When covered by water, it regenerates vegetatively and, when not covered by water, it regenerates through seed production. The community has a typical *P. serratum* cover. It can be up to 100% in some places, creating an impenetrable layer. Under these conditions, no other species are present in the community. Another characteristic feature of this community is the absence of ferns, especially *Pteridium aquilinum*. This feature accentuates that *P. aquilinum* does not prefer areas with free water, a phenomenon that is shared with the *Anthochortus crinalis - Prionium serratum* Riparian Marshland and *Prionium serratum – Freylinia lanceolata* Tall Closed Shrubland communities.

Van der Merwe (1962) refers to this community as "oewergemeenskappe of galleria wat langs die waterstrome voorkom" (riverbank communities or galleria that occur along streams).

1.1.1 *Erica caffra - Anthochortus crinalis* Riparian Marshland Subcommunity

Campbell *et al.* (1981) structural equivalent: Low Closed Restioid Shrubland.

The dominant species are: *Anthochortus crinalis*, *Ehrharta setacea* and *Cliffortia tricuspidata*.

This vegetation unit is a marshland sampled in relevés 86, 87 and 88. It is a subcommunity of the *Erica caffra - Prionium serratum* Short Closed Shrubland. Boucher (1978) describes marshes as areas of "soft wet land, commonly covered wholly or partially with water". Locally, marshes are called "vleis" because they have permanent or temporary standing water. All the species present in this subcommunity are definitive species and include *A. crinalis, A. graminifolius, E. setacea, Elegia grandis, Epischoenus* *quadrangularis, Erica calycina, Restio filiformis, R. corneolus* and *Senecio crispus.* The species that are shared with other communities are *P. serratum*, *C. mucronatum*, *Gladiolus carneus*, *Stoebe plumosa*, *Restio purpurascens*, *C. tricuspidata* and *Restio echinatus. Anthochortus graminifolius* is a single occurrence.

This subcommunity is highly specialised, consists mainly of restioids and is confined to the upper reaches of the Eerste River, at altitudes higher than 1 200 meters. Only two of the species, *P. serratum* and *C. mucronatum*, have been found to be present at lower altitudes in other parts of the study area. In this subcommunity, *P. serratum* has a very conspicuous dwarf structure of not more than 0,30 m in height compared to the individuals occurring at lower altitudes in the study area, where it can reach heights of more than one metre. It can be considered as an ecological variation of the species (Barbour *et al.* 1987) and care must be taken not to confuse it with *Juncus lomatophyllus*, which is similar in structure. The widespread and generally high cover of Restionaceae substantiate the hypothesis that these shallow-rooted species are adapted to survive in areas exposed to dry summer periods and fluctuating moisture regimes (Van der Heyden & Lewis 1990).

The sandy soils have a coarse fraction, with more than 60% of the particles in the range between 3 mm to 8 mm, and all being bigger than 2 mm. The soils have a high organic content of 6 - 15% (Table 12). A similar subcommunity was described as the *Restio-Hypolaena* Subcommunity by Laidler *et al.* (1978) in a phytosociological study of Table Mountain. This subcommunity occurs on steeper, relatively flat sites with deeper soils.

The projected total canopy cover of this subcommunity is 90%. Three strata can be distinguished. The tallest stratum consists of restios, >1,00 m, has a patchy presence in the community, and has an average projected canopy cover of 10%. *Chondropetalum* *mucronatum* is the dominant restio in this stratum and is present in this subcommunity as a few emergent individuals. It contributes less than 5% towards the total cover of this subcommunity. *Anthothortus crinalis, A. graminifolius, E. grandis, E. quadrangularis, R. corneolus* and *R. filiformis* dominate the second stratum, which is 0,51 – 1,00 m high and has an average projected canopy cover of 75%. The lowest stratum (< 0,50 m tall) consists of herbaceous species and dwarf shrubs and is dominated by *E. calycina* and *P. serratum*. *Senecio crispus* is present only as a few plants in the low stratum. The projected canopy cover of the bottom stratum is estimated at 5% on average. The bottom stratum is usually poorly developed where light penetration is limited, which prevents potential species from becoming established (Baker & Van Lear 1998).

This subcommunity is found on the Table Mountain Group geological formation. All the important upper reaches of the Eerste River originate in the higher parts of the mountains, which contain quartzic sandstone of the Table Mountain Group (Lategan 1978). The subcommunity differs from other riparian communities through the total absence of trees. McDonald (1993a) describe a *Restio inconspicuous – Anthochortus crinalis* Closed Graminoid Shrubland Community as being structurally the same. Both are dominated by restios without trees and shrubs and occur at elevations above 1 000 m and on southwest-facing slopes. The locations where these communities are found are characterised by a high annual rainfall of 1 000 - 1 200 mm.

1.2 *Erica caffra – Elegia persistens* Low Closed Shrubland Community

Campbell *et al.* (1981) structural category: Mid-dense Restioland.

The differential species are: *Elegia persistens, Ischyrolepis triflora* and *Pentaschistis pallida*.

The dominant species are: *D. glabra, E. persistens, F. lanceolata, I. triflora, P. pallida, Pteridium aquilinum* and *Metrosideros angustifolia*.

This community is distributed along the Eerste River at altitudes ranging from 365 - 370 m. The *Erica caffra – Elegia persistens* Low Closed Shrubland occurs in relevés 10,11,12, 17, 18, 21, 26, 31 at altitudes that vary from 360-368 m above sea-level. It was sampled in an area with high erosion. The erosion was caused by a veld fire that had destroyed much of the riparian vegetation that anchors the soil. The only species that survived were mature riparian trees and species that are well-protected against fire, such as *Protea nitida.* The relatively low percentage coverage by the riparian trees indicates that the trees are young and had regenerated after the fire. Much of the adjacent fynbos soil was washed down with the first winter rains. Sandstone is the dominant parent material on which this community is found. The eroded area created a disturbed habitat, which is ideal for pioneer fynbos species such as *Centella montana* and *Oxalis versicolor.* No exotic species were recorded in this disturbed area.

The community is characterised by a total dominance of restioids and graminoids. Three strata are distinguished, with the tall stratum being dominated by *E. caffra*. The height of the stratum is between 2 - 4 m, with a projected canopy cover of 62%. Although *Erica caffra* is only present in relevé 10, it contributes 38% to the total vegetation cover in the top stratum. The branches of two other trees in this stratum, *F. lanceolata* and *M. angustifolia,* form an overhanging canopy, which creates semi-shaded conditions. Approximately 38% of the substratum is exposed and not covered by the tree canopy.

The second stratum has a height of 1 - 2 m. It forms a projected canopy cover of 20%. It is dominated by *D. glabra* and *Cliffortia ruscifolia*, with other species, such as *Elegia capensis* and *Thesium strictum*, contributing to the stratum.

The lower stratum (0,1 - 1 m tall) is dominated by the restios *E. persistens* and *I. triflora* and the grass *P. pallida.* The dwarf restio, *I. triflora*, and the short grass, *P. pallida*, are both less than 0,5 m tall and form small tussocks in the community. The high species richness of this community is very noticeable and is possibly a result of the disturbed habitat. The dominance of *Elegia persistens* has been described in Mesic Ericaceous Fynbos communities that are confined to steep south-facing slopes (Cowling *et al*. 1988). Other species in this stratum are *Asparagus capensis, A. lignosus, Muraltia heisteria, Ruschia pulchella* and *Restio ejuncidus.* The presence of *P. aquilinum*, which occurs in exposed, moist places in the community, is an indication of a moisture gradient.

1.3 ***Erica caffra - Ischyrolepis gaudichaudiana* Low Thicket Community**

Campbell *et al.* (1981) structural category: Low Forest.

The differential species are *Aristea major* and *I. gaudichaudiana*.

The dominant species are *A. major, Brachylaena neriifolia, E. caffra, I. gaudichaudiana, I. subverticillata, Maytenus oleoides, Podalyria calyptrata* and *P. aquilinum*.

The *Erica caffra - Ischyrolepis gaudichaudiana* Low Thicket community is found in relevés 2, 8, 29, 33, 36, 38, 40, 46, 49, 50, 51, 52, 55, 56, 61, 63, 65, 67, 68, 69, 79 and 84. This community is found in a large part of the lower to mid-central zone of the study area at altitudes from 377 - 900 m. The *Erica caffra - Ischyrolepis gaudichaudiana* Low Thicket community is characterised by a total dominance of riparian trees. Almost all the riparian trees recorded in the study were present in this community, except for *F. lanceolata, Kiggelaria africana, Olea europeae, Olinia ventosa and Pterocelastrus rostratus*. Riparian trees favour humus-rich, sandstone-derived soils. The high organic content is a result of leaf shedding and the accumulation of washed-up tree and plant material. Trees are natural buffers when rivers are in flood, causing accumulation of debris. Open soil areas for plant settlement are limited by high water levels throughout the year and a thick cover of plant debris. Dense tree cover uses most of the available areas for settlement and contributes to heavy leaf litter. Litter accumulation has no significant effect on relative changes in riparian plant biomass and can act as a physical barrier by directly preventing plant establishment (Xiong *et al.* 2001a, Xiong *et al*. 2001b). Fry (1987) described forest communities on quartzite boulder scree slopes associated with gullies and steamlines and further noted that the Short Forest community occurs on loose, unstable boulder screes. There is little soil development, but leaf litter accumulates under the forest vegetation.

The *Erica caffra - Ischyrolepis gaudichaudiana* Low Thicket community forms distinct patches along the rivers, where it is interspersed between other communities, and creates overhanging canopies. The physiognomy of this community is characterised by the canopy trees with subcanopy growth and attains the stature of a short forest. Although *Maytenus oleoides* has a high presence in this community, as well as in other Mesic Mountain Fynbos regions, it is considered a "true" riparian tree, as it regularly occurs in riparian forests. *Viscum rontundifolim*, which is a parasite, is usually associated with *M. oleoides*

Humus-rich soils occur on the banks of some riverine areas, but in most cases soil development is minimal and the material is a mixture of sand and humus that has accumulated on the banks of the stream. This results in the formation of uniform-sized, sandy soils of quartzitic origin. They have a high coarse fraction content and little horizon development (Fry 1987).

The *Erica caffra - Ischyrolepis gaudichaudiana* Low Thicket is characterised by a top stratum (2 - 8 m tall) with an average projected canopy cover of 75%. The crowns of individual plants interlock and form a microhabitat for understorey growth. This vegetation type is dominated by *B. stellatifolium, B. neriifolia, E. caffra, Ilex mitis, P. calyptrata, M. oleoides* and *M. angustifolia.* The second stratum has a height of 1 - 2 m. It forms a projected canopy cover of 6% and is dominated by *Diospyros glabra* and *Elegia capensis*, with other species, such as *Psoralea pinnata*, contributing to the stratum. The understorey or third stratum (0,5 - 1 m tall) is dominated by *Aristea major*, *I. gaudichaudiana*, *I. subverticillata, P. aquilinum, Stoebe cinerea* and *Todea barbara.* Restionaceae has a high presence in the community and an average projected canopy cover of 38%. *Ischyrolepis subverticillata* is prominent in these communities, which are found in the dynamic zone of the river. The woody communities have a few faithful species in common (e.g. *Ischyrolepis subverticillata*) and there is usually an overlap in species between the different riverine scrub and forest communities (Werger *et al.* 1972). The presence of *Asparagus scandens*, which is common in forest undergrowth, indicates a similarity to low forest (Mustart *et al.* 1993). There are single occurrences of *Agathosma crenulata, Cliffortia polygonifolia, Elegia intermedia, Erica hirta, Leucadendron salicifolium, Merxmuellera cincta, Metalasia cephalotes, Morella integra, Pelargonium cucullatum, R. echinatus* and *R. purpurascens.* They contribute less than 5% to the cover. The presence of *Fontinalis squamosa* and *P. aquilinum* is an indication of a moisture gradient, with *Pteridium aquilinum* occurring in moist places that are not shaded by the trees and *Fontinalis squamosa* occurring in moist, shaded areas under trees. *F. squamosa* usually forms green mats under trees. Under moist conditions, *P. aquilinum* completely dominates the community and forms extensive beds of dense vegetation. This species is typical of a habitat on the riparian forest line (Goldblatt & Manning 2000). It prefers less shady areas and is only found as single individuals under the tree canopy and not as a fern mat, which is characteristic of the forest border. It therefore prefers moisture rather than cool, shady areas, unlike most of the other ferns. Boucher and Stindt (1992) described a closely related *Pteridium aquilinum – Berzelia lanuginosa* Community with the same dominance by *P. aquilinium*, but without the same species composition. This community shows similarity with Wahl's (1986) description of the *Brabejum-Pteridium* Community, which is characterised by the presence of *Blechnum capense, D. glabra, M. angustifolia, Myrsine africana* and *P. aquilinum.* All of these species are present in the *Metrosideros angustifolia – Freylinia lanceolata* community, except for *Myrsine africana*, which was not recorded in the study area. Wahl (1986) described this community as prominent in the upper catchment of the Eerste River. Mustart *et al.* (1993) described the *Erica caffra – Ischyrolepis gaudichaudiana* community under their *Olea europaea – Maytenus oleoides* community and McDonald (1988) described it under the *Rapanea melanophloeos – Cunonia capensis* High Forest. The riparian trees described by McDonald (1988) were taller (2 - 25 m) in comparison to the trees encountered along the Eerste River (2 - 10 m). This could be an indication that the riparian vegetation in Swartboskloof has encountered less disturbance from frequent fires than is in the case in the Eerste River catchment.

There are many species in the *Erica caffra - Ischyrolepis gaudichaudiana* Low Thicket community and they occur in a wide spectrum of environmental conditions. The dominant presence of *I. gaudichaudiana* is an indication that this community has a strong affinity to heavier soils of granite or mixed derivations (McDonald 1988). Van Wilgen and Kruger

(1985) described a similar community under their *Restio gaudichaudianus* - *Metrosideros angustifolia* Closed Woodland Community.

1.3.1 *Erica caffra – Juncus lomatophyllus* Sedgeland Subcommunity

Campbell *et al.* (1981) structural category: Low Forest.

Ficinia distans and *Juncus lomatophyllus* are the differential species.

The dominant species are: *B. capense, B. neriifolia, B. stellatifolium, Cunonia capensis, E. caffra*, *I. subverticillata, J. lomatophyllus, M. angustifolia* and *Todea barbara*

The *Erica caffra – Juncus lomatophyllus* Sedgeland is a subcommunity of the *Erica caffra - Ischyrolepis gaudichaudiana* Low Thicket and is spread over relevés 35, 37, 39, 41, 42, 66, 70, 72, 78, 82 and 83. This subcommunity occurs at altitudes ranging from 377 - 620 m along a dynamic section of the river. The habitat is characterised by temporary or recently deposited shallow sandy soils. In periods of winter seasonal flooding of the river, alluvial deposits form sandy plains along the river. The parent material of these soils is sandstone.

This subcommunity forms a small group and its distribution is limited by underlying environmental properties. It is found along the tributary leading from the First Waterfall to the main stream of the Eerste River (Fig. 3). This tributary flows in a westerly direction with a gentle slope of four degrees. The tributary is characterised by large boulders and areas covered with bedrock that are either in or adjacent to the watercourse. Both the bedrock and the logjams play a significant role in increasing patch hierarchy and the availability of microsites for the germination and establishment of seedlings (Van Coller *et* *al.* 2000). Hydrological additions of fine alluvial sediments during flooding represent enrichment of the sites by both water and nutrients (Klinka *et al*. 1996). This serves as an area for the regeneration of riparian species and also for the establishment of typical fynbos elements. Much of the juvenile growth is destroyed during the subsequent winter storm conditions. Many of these species can survive these conditions if they are sheltered or protected by obstructions on the riverbank such as mature riparian trees, vegetation debris or large boulders. The other condition under which juvenile plants become established is a long interval between flood events. The soils have a low organic content as a result of heavy alluvial movement. *Ficinia distans* and *Juncus lomatophyllus* are two distinctive species in this type of habitat.

The vegetation has a projected canopy cover of 90% and is very dense, creating shady conditions for the understorey. The dominant stratum of the *Erica caffra – Juncus lomatophyllus* Sedgeland subcommunity is a tall layer (<2 m tall) with an average projected canopy cover of 75%. This stratum is dominated by *B. stellatifolium, B. neriifolia, C. capensis, E. caffra, I. mitis* and *M. angustifolia*. Trees that grow next to the watercourse, such as *E. caffra* and *I. mitis*, create a natural buffer for the accumulation of alluvial deposits. This area is well known for the establishment of fynbos and riparian species and these two riparian trees occupy a very specific habitat, in that they are only found very close to the water's edge. The other trees that show a similar distribution are *B. stellatifolium, B. neriifolia* and *M. angustifolia. Brabejum stellatifolium* is the only one of the riparian trees mentioned that can occur further up on the riverbank, as well as in other moist areas. Werger *et al.* (1972), who discussed this community under the *Brabejum stellatifolium* Community, said it was difficult to subdivide these communities on the basis of the absence or presence of character species. A similar community was described by Campbell & Moll (1977) under the *Cunonia capensis – Ilex mitis* sub-association, and also by Glyphis *et al*. (1978) in their *Ilex-Blechnum* Forest Community. These two are confined to the wet kloofs and streams of Table Mountain.

Below the top stratum is a shrub substratum (0,5 - 1m tall) with a projected cover of 1 - 25% (an average of 5%). It is dominated by the restios *I. gaudichaudiana* and *I. subverticillata* and the ferns *B. capense, B. punctulatum* and *T. barbara*. This habitat has a high moisture content due to shade and water run-off, in combination with slope-related drainage patterns. This has allowed the development of a closed woodland of trees and shrubs (Mustart *et al.* 1993). The presence of the ferns is an indication of perennial moist and shady conditions (McDonald 1993c). It is typical of a forest situation, in which mature trees form a microhabitat for the proliferation of ferns.

The ground layer (0,1 – 0,5 m) is poorly developed and consists of sparsely occurring *A. major, F. distans, J. lomatophyllus*, *M. cincta, O. versicolor* and *Schoenoxiphium lanceum. I. digitata* usually occurs on rocky substrates in the water. It was sampled in relevés 66, 72, 82 and 83. These relevés were sampled during the summer months in a period when the water level was at its lowest. *I. digitata* was also recorded on the riverbank, which was under water during winter. Taller shrubs and restios, such as *Podalyria calyptrata* and *Elegia capensis*, emerge as single individuals in the substratum. This subcommunity shows similarity with *the Halleria elliptica – Brabejum stellatifolium* Short Forest community described by McDonald (1988). Van der Merwe (1966) included the description of this community under the broad concept of 'Oewergemeenskappe" (river bank communities).

1.3.2 *Erica hispidula* Shrubland Form

Campbell *et al.* (1981) structural category: Mid-high Closed Shrubland.

The differential species of the *Erica hispidula* Form are *Erica hispidula* and *Tetraria bromoides*.

The dominant species are: *E. rehmannii, E. hispidula, C. cuneata, I. gaudichaudiana, I. subverticillata* and *S. cinerea.*

The *Erica hispidula* Form is transitional between the Wetbank and Drybank communities. It is a form of the *Erica caffra – Ischyrolepis gaudichaudiana* Low Thicket and occurs in relevés 71, 74, 77, 81 and 85 at the interphase between sandy alluvial deposits and on a mixture of granite and shale of the drybank and adjacent fynbos. According to the soil analyses, this form has a high organic carbon content with a relatively low soil resistance. The high organic content is a direct result of the accumulation of organic material and its decomposition in moist conditions. Kruger (1974) labelled these communities as phreatic communities, which occur along streams and drainage lines and on seepage steps. It occurs in transitions on soils that are moist or wet and very humic. *Ischyrolepis gaudichaudiana* is a shallow-rooted resprouter and can established easily on these types of soils (Smith & Richardson 1990). The presence of *Tetraria bromoides* and *Protea neriifolia* is an indication that part of this community is found on soils derived from shale (McDonald 1993c). *Tetraria bromoides* points to soils with a higher fertility, i.e. soils with a high clay content (Boucher 1978, Boucher & Stindt 1992, McDonald 1993b). Boucher (1982) stated that shale bands support vegetation which is rich in grass-like sedges, such as *T. bromoides*. It is restricted to the mid-section of the study area. It is evident in areas along the river where the riverbank flattens and is marked by the absence of steep cliffs and huge boulders. The community occurs at altitudes ranging from 500-580 m. This vegetation unit belongs to a group that includes Boucher's (1978) Kogelberg *Protea-Tetraria* Dry Short Fynbos, Kruger's (1974) Jakkalsrivier *Tetraria bromoides – Erica* *plukeneti* Communities and Boucher and Stindt's (1992) Haasvlakte *Brunia laevis* – *Tetraria bromoides* Community.

Structurally, this form can be divided into three strata. The tall shrub stratum (1 - 2 m tall) is dominated by *Cannomois virgata, C. schinoides, C. cuneata, E. hispidula, P. calyptrata* and *T. bromoides*. It has an estimated canopy cover of 30%. *Cassine schinoides* (previously *Hartogiella schinoides*) has been described as a dominant understorey species in Afromantane Forest Communities (Cowling 1984). The ground layer (0,1 - 1 m tall) is a sprawling tangled mass of graminoids and small shrubs and herbs. Species that are dominant are *A. major, E. rehmannii, I. gaudichaudiana, I. subverticillata* and *S. cinerea.* This stratum has a cover of 37%. Scattered trees form the top emergent stratum (>2 m tall). The trees present in this stratum are *B. neriifolia, C. schinoides, E. caffra,* and *I. mitis.* Juvenile trees of *C. capensis, M. oleoides* and *Rapanea* melanophloeos were recorded in this community. The constant presence of *I. gaudichaudiana* is a strong indication that these communities have an affinity with heavier soils of granite or mixed derivation (McDonald 1988).

The alien species, *Hypochoeris radicata* (Duvenhage 1993), has been recorded in this community. It also occurs in the *Erica caffra – Juncus lomatophyllus* Sedgeland community.

2. Riparian Zone Seepage

This community is associated with seepage areas in the riparian zone. Only one community was identified in this area, namely the *Pentameris thuarii – Cullumia setosa* Short Closed Shrubland. The community is uniform in structure and can be compared to fynbos seepage. Boucher (1978) described fynbos seepage communities as giving a rather drab and uniform impression during most of the year. The presence of *Psoralea aphylla* is an indication of similarities between fynbos and riparian seepages. This community is found along the tributaries at different altitudes on slopes of different aspects.

2.1 *Pentameris thuarii – Cullumia setosa* Short Closed Shrubland Community

Campbell *et al.* (1981) structural equivalent: Low Closed Shrubland.

The differential species are: *Centella* sp., *Conyza canadensis, C. setosa* and *P. thuarii.*

The dominant species are: *C. setosa, P. thuarii* and *P. calyptrata*.

This community is found in relevés 89 to 139 (excluding relevé 136) at altitudes ranging from 300 - 800 m. It occurs along the tributaries of the Eerste River on both the west- and east-facing slopes. These areas are characterised by steep gradients and are difficult to access, especially during the rainy season. Van Coller *et al.* (2000) found that the main gradient in the vegetation composition was largely a result of the steep-sided macro-channel banks that created a strong gradient in elevation above the channel, and a change in substratum type from fluvially-generated substrata along a macro-channel floor to terrestrial soil along the macro-channel bank. Ridges and riparian valleys can be viewed as end members of a soil sequence that is geomorphologically related to the transport of water, soil and nutrients from upper to lower landscape positions (Scatena & Lugo 1995).

This shrubland community fringes the wetbank and forms distinct units along the river. The differential species of *Centella* sp., *C. canadensis, C. setosa* and *P. thuarii* are not shared with any other community described in the study. Soil development is weak and the soil is a mixture of colluvial and alluvial material from granite and sandstone origin. The soils are well drained and could be described as seepages in the riparian zones. Tributaries arising from the Jonkershoek and Stellenbosch Mountains have the presence of mainly quarzitic Table Mountain Group (Heydorn & Grindley 1982a). The sandstone gravel forms a thin line along the watercourse and is an indication of fast flowing streams. These soils generally have a higher nutrient content than leached sandstone soils due to the colluvial mixing of soils derived from sandstone and granite parent materials (McDonald 1993b). These soils are further enriched through mixing with organic material derived from leaf litter and other plant debris.

Structurally, the *Pentameris thuarii – Cullumia setosa* Short Closed Shrubland community can be divided into two strata. The tree stratum (2 - 10 m tall) has an average of 40 - 60% canopy cover. This layer is dominated by *B. neriifolia, C. capensis, I. mitis, M. acuminata* and *P. calyptrata.* Although *Kiggelaria africana* was only recorded once and indicates that it is not important in the upper reaches, it is mentioned because it was the only riparian tree to be recorded from the upper reaches to the estuary (Salie 1995). This is an indication of its wide tolerance of changing habitat along the course of the Eerste River.

The substratum (0,1 – 1,5 m tall) is well-defined, with a projected canopy cover of 90%. It is dominated by *C. setosa* and *P. thuarii. Pentameris thuarii* covers up to 70% of this stratum. *Pentameris thuarii* is a robust, branched perennial with culms growing up to 1,5 m. It forms large tussocks along the stream. Another species of importance in this stratum is *Conyza canadensis*. *C. canadensis* is considered to be a naturalised exotic (Anonymous 2002a). It has been described as a pioneer species that has settled along the Lourens River in areas of gravel deposits (Heydorn & Grindley 1982b). It is a herbaceous perennial from the Asteraceae and has small, light seeds that are dispersed by wind. The fact that it was recorded many times along watercourses indicates that it has the potential to be invasive. Van Wilgen *et al.* (2000) describe another species of Asteraceae, *Chromolaena odorata*, which shows similar characteristics. Its wind-dispersed seeds have already established themselves along forest margins, watercourses, road verges and plantations.

The vegetation of the study area was burnt by the April 1999 fire and many areas were left open with no vegetation cover. The burning of vegetation in other Mediterranean basins can result in a 20 - 30% increase in stream flow (Lavabre *et al*. 1993, Loaiciga *et al*. 2001). The annual total stream flow increase after fire is about 16% in South African mountain catchments (Scott 1993). Habitat modification through erosion and the availability of open spaces caused by the opening of the canopy by fire are two possible reasons for the prolific increase in settlement of *C. canadensis*. *Cullumia setosa* also shows a high cover of up to 40% and occurs as a sprawling shrub among stands of *P. thuarii* grass. *Centella* sp. also have a relatively high presence (15 - 20 %). This latter genus has a wide geographical occurrence in marshy and damp places in Southern Africa (Goldblatt & Manning 2000). The genus is currently under review (Anonymous 2002a). The literature indicates that it might be *Centella asiatica* (Goldblatt & Manning 2000).

The substratum has a high presence of ferns such as *B. punctulatum* and *T. barbara*. *Diospyros whyteana* was recorded once in relevé 114. It is of phytogeographical importance in that it is considered to be a typical Afromontane species (Van Wyk *et al*. 1988a). Werger (1974) described the *Brabejum stellatifolium* Community with similar characteristics and species composition, with *P. thuarii* having the same dominance in the understorey.

Table 12. Phytosociological Table (Part 2. Environment)

Vegetation unit 1.1

Relevé	1	3	6	9	13	16	19	22	27	32	34	43
date	28.4.97	28.4.97	17.5.97	17.5.97	31.5.97	31.5.97	7.6.97	7.6.97	14.6.97	15.6.97	17.6.97	17.2.99
gps (latitude)	33.59.30	33.59.30	33.59.32	33.59.32	33.59.34	33.59.34	33.59.34	33.59.34	33.59.36	33.59.36	33.59.37	33.59.46
gps (longitude)	18.58.24	18.58.24	18.58.25	18.58.25	18.58.26	18.58.26	18.58.26	18.58.26	18.58.26	18.58.27	18.58.36	18.58.49
riparian zone	w/b	w/b	w/b	w/b	w/b	w/b	w/b	w/b	w/b	w/b	w/b	w/b
location	main	main	main	main	main	main	main	main	main	main	main	main
% organic carbon	0.60	1.14	0.07	0.23	0.80	0.37	0.87	2.04	2.21	2.81	0.84	0.60
pH	5.37	5.27	5.59	5.45	6.14	6.37	5.92	5.61	5.46	4.90	6.46	5.63
resistance (ohm)	3.41	5.84	8.48	7.29	4.03	6.58	9.84	3.63	1.89	1.23	5.30	13.83
coarse fraction (2mm) %	26.93	45.65	56.86	42.16	0.13	9.76	32.48	6.00	19.40	26.25	1.37	36.09
coarse sand (2-0.5) %	10.58	16.67	12.92	11.81	2.19	2.63	8.54	2.79	5.11	7.55	0.94	7.90
medium sand (0.5-0.25) %	3.77	3.98	6.29	3.22	4.36	4.50	2.57	4.82	4.86	8.79	4.92	3.27
fine sand (0.25-0.05) %	1.19	0.69	1.95	0.67	1.68	1.55	0.47	2.38	1.40	7.87	3.83	0.59
coarse silt (0.05-0.02) %	0.07	0.04	0.03	0.02	0.02	0.02	0.02	0.10	0.08	0.04	0.11	0.02
sum of percentages	42.54	67.03	78.05	57.87	8.38	18.45	44.09	16.08	30.86	50.50	11.17	47.87
particles bigger than 2mm - %	57.46	32.97	21.95	42.13	91.62	81.55	55.91	83.92	69.14	49.50	88.83	52.13
relevé area m^2	26	26.2	27	12	8	7.1	13	17	12.5	15	16	8
altitude (m)	360	360	365	365	368	368	368	368	369	370	377	400
aspect (degrees)	4	4	4	4	4	4	4	4	4	4	4	14
slope (degrees)	1	1	1	1	1	1	1	1	1	1	1	1
relevé width (m)	2.6	2.6	2.7	1.2	0.8	0.7	1.3	1.7	1.3	1.5	1.6	0.8
no of species	23	7	1	6	5	9	10	9	12	1	1	5

Vegetation unit 1.1.1

Relevé	86	87	88
date	7.3.99	7.3.99	7.3.99
gps (latitude)	34.00.29	34.00.29	34.00.29
gps (longitude)	19.01.03	19.01.03	19.01.03
riparian zone	marsh	marsh	marsh
location	summit	summit	summit
% organic carbon	13.18	27.02	11.17
pH	4.76	4.72	4.74
resistance (ohm)	1.49	1.59	1.57
coarse fraction (2mm) %	6.56	4.20	16.98
coarse sand (2-0.5) %	6.69	6.51	9.64
medium sand (0.5-0.25) %	12.69	10.48	15.03
fine sand (0.25-0.05) %	11.24	6.52	9.16
coarse silt (0.05-0.02) %	0.78	0.61	0.22
sum of percentages	37.96	28.32	51.03
particles bigger than 2mm - %	62.04	71.68	48.97
relevé area m^2	100	100	100
altitude (m)	1280	1270	1265
aspect (degrees)	180	180	220
slope (degrees)	7	7	7
relevé width (m)	10	10	10
no of species	23	13	10

Vegetation unit 1.2

Relevé	10	11	12	17	18	21	26	31
date	17.5.97	17.5.97	17.5.97	31.5.97	31.5.97	7.6.97	14.6.97	15.6.97
gps (latitude)	33.59.32	33.59.32	33.59.32	33.59.34	33.59.34	33.59.34	33.59.36	33.59.36
gps (longitude)	18.58.25	18.58.25	18.58.25	18.58.26	18.58.26	18.58.26	18.58.26	18.58.27
riparian zone	l/d	t/s	b/d	l/d	b/d	b/d	l/d	b/d
location	main	main	main	main	main	main	main	main
% organic carbon	2.98	0.13	0.44	0.64	2.88	0.74	0.50	6.25
pH	4.97	5.74	5.70	5.25	5.70	5.67	5.37	5.25
resistance (ohm)	3.38	8.65	7.10	4.69	5.86	2.74	2.25	0.72
coarse fraction (2mm) %	13.59	33.17	56.47	13.54	6.36	7.41	5.58	4.88
coarse sand (2-0.5) %	5.96	12.50	27.49	5.09	2.54	4.26	9.16	5.82
medium sand (0.5-0.25) %	6.86	1.62	8.07	3.79	4.71	7.10	3.88	7.49
fine sand (0.25-0.05) %	2.94	0.12	5.39	1.43	2.69	2.89	0.32	3.31
coarse silt (0.05-0.02) %	0.10	0.01	0.56	0.09	0.20	0.16	0.01	0.30
sum of percentages	29.45	47.43	97.98	23.94	16.52	21.83	18.94	21.81
particles bigger than 2mm - %	70.55	52.57	2.02	76.06	83.48	78.17	81.06	78.19
relevé area m^2	13	19	22	18	18	53	44	15
altitude (m)	365	365	365	368	368	368	369	370
aspect (degrees)	4	4	4	4	4	4	4	4
slope (degrees)	1	1	1	1	1	1	1	1
relevé width (m)	1.3	1.9	2.2	1.8	1.8	5.3	4.4	1.5
no of species	19	14	11	9	12	11	25	15

Vegetation unit 1.3

Relevé	2	8	29	33	36	38	40	46	49	50	51	52	55	56	61	63	65	67	68	69	79	84
date	2.8.97	17.5.97	14.6.97	15.6.97	17.6.98	17.6.98	18.6.98	17.2.99	17.2.99	20.2.99	20.2.99	20.2.99	20.2.99	20.2.99	20.2.99	21.2.99	21.2.99	21.2.99	21.2.99	21.2.99	20.3.99	11.4.99
gps (latitude)	33.59.30	33.59.32	33.59.36	33.59.36	33.59.37	33.59.37	33.59.36	33.59.46	33.59.46	34.00.06	34.00.06	34.00.06	34.00.06	33.59.43	33.59.43	34.00.16	34.00.16	34.00.13	34.00.13	34.00.13	34.00.05	34.00.08
gps (longitude)	18.58.24	18.58.25	18.58.26	18.58.27	18.58.36	18.58.36	18.58.38	18.58.49	18.58.49	18.59.41	18.59.41	18.59.41	18.59.41	18.58.58	18.58.58	18.59.39	18.59.39	18.59.40	18.59.40	18.59.40	18.59.51	18.59.43
riparian zone	l/d	t/s	t/s	t/s	t/s	b/d	b/d	b/d	b/d	l/d	t/s	b/d	b/d	l/d	b/d	l/d	t/s	b/d	l/d	b/d	t/s	t/s
location	main	main	main	main	main	main	main	main	main	main	main	main	main	main	main	main	main	trib.	trib.	trib.	trib.	trib.
% organic carbon	2.14	0.13	1.81	2.71	2.61	7.57	3.89	5.63	3.48	0.50	0.84	5.03	8.93	0.34	4.29	3.75	6.70	1.47	0.60	4.22	8.26	1.91
pH	5.81	5.67	5.08	5.51	5.42	4.75	4.53	5.30	5.43	5.48	5.32	5.15	5.12	5.32	5.48	4.64	5.00	5.50	5.60	5.51	6.39	5.48
resistance (ohm)	2.68	12.70	1.34	2.94	3.67	2.39	2.96	4.81	3.92	7.39	3.11	0.96	3.15	9.07	3.99	1.87	2.08	3.91	15.47	3.69	2.49	2.67
coarse fraction (2mm) %	34.36	35.44	2.04	21.59	13.91	11.65	13.60	13.12	13.48	42.15	10.00	8.03	11.33	37.62	13.85	14.00	27.44	4.93	37.45	2.82	23.69	5.58
coarse sand (2-0.5) %	6.80	14.10	0.48	15.63	2.85	2.72	2.33	4.12	3.11	16.86	5.66	6.96	5.13	8.10	4.31	10.50	13.88	3.13	8.56	2.57	6.31	10.10
medium sand (0.5-0.25) %	2.35	1.73	3.84	10.84	4.88	4.56	3.81	4.23	3.26	4.42	4.72	13.23	3.43	2.69	2.50	16.22	18.60	6.21	3.77	5.58	3.20	7.92
fine sand (0.25-0.05) %	0.69	0.15	7.56	6.67	4.19	4.73	2.30	3.56	1.47	0.55	0.42	5.89	3.04	1.21	2.86	6.47	12.74	3.73	0.71	4.12	3.79	3.13
coarse silt (0.05-0.02) %	0.03	0.00	0.13	0.30	0.72	0.83	0.24	0.51	0.28	0.00	0.01	0.20	0.33	0.21	0.43	0.11	0.66	0.16	0.02	0.24	0.28	0.35
sum of percentages	44.24	51.42	14.06	55.03	26.55	24.49	22.28	25.54	21.60	63.97	20.81	34.32	23.26	49.83	23.95	47.30	73.33	18.17	50.51	15.34	37.27	27.08
particles bigger than 2mm - %	55.76	48.58	85.94	44.97	73.45	75.51	77.72	74.46	78.40	36.03	79.19	65.68	76.74	50.17	76.05	52.70	26.67	81.83	49.49	84.66	62.73	72.92
relevé area m^2	26.1	16	17	27	31	14	21	17	12	60	80	14	80	65	90	31	16.5	30	50	90	15	18
altitude (m)	360	365	369	370	377	377	378	400	400	480	480	480	480	415	415	600	600	600	600	600	580	500
aspect (degrees)	4	4	4	4	4	4	4	14	14	320	320	320	320	345	345	267	267	264	264	264	278	200
slope (degrees)	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	5	5	4	4	4	5	8
relevé width (m)	2.6	1.6	1.7	2.7	3.1	1.4	2.1	1.7	1.2	6	8	1.4	8	6.5	9	3.1	1.7	3	5	9	1.5	1.8
no of species	14	10	17	24	15	11	12	7	7	12	16	10	8	5	12	13	23	16	5	11	8	16

Vegetation unit 1.3.1

Relevé	35	37	39	41	42	66	70	72	78	82	83
date	17.6.98	17.6.98	18.6.98	18.6.98	18.6.98	21.2.99	21.2.99	20.3.99	20.3.99	20.3.99	11.4.99
gps (latitude)	33.59.37	33.59.37	33.59.36	33.59.36	33.59.36	34.00.13	34.00.08	34.00.06	34.00.05	34.00.04	34.00.08
gps (longitude)	18.58.36	18.58.36	18.58.38	18.58.38	18.58.38	18.59.40	18.59.51	18.59.52	18.59.51	18.59.52	18.59.43
riparian zone	l/d	t/s	t/s	w/b	l/d	l/d	w/b	l/d	l/d	t/s	l/d
location	main	main	main	main	main	main	main	trib.	trib	trib.	trib.
% organic carbon	1.27	1.41	2.48	4.36	8.51	0.50	0.70	0.34	2.24	6.25	0.44
pH	5.64	5.83	5.24	5.52	4.88	5.53	6.12	5.69	6.22	6.46	6.63
resistance (ohm)	8.03	10.18	7.21	3.53	2.68	9.97	6.11	9.00	6.41	2.00	4.87
coarse fraction (2mm) %	28.77	19.59	12.40	4.53	18.11	43.56	13.47	38.18	17.63	25.22	56.44
coarse sand (2-0.5) %	11.06	3.89	1.89	2.89	4.17	12.70	9.14	9.58	5.59	6.03	28.21
medium sand (0.5-0.25) %	4.05	3.17	2.59	4.19	4.32	4.07	4.47	1.38	4.32	3.65	4.96
fine sand (0.25-0.05) %	1.00	0.59	1.51	3.91	2.65	0.61	0.25	0.10	2.34	3.28	1.10
coarse silt (0.05-0.02) %	0.06	0.02	0.14	0.33	0.26	0.02	0.02	0.00	0.17	0.79	0.07
sum of percentages	44.94	27.26	18.53	15.86	29.51	60.96	27.36	49.24	30.05	38.97	90.80
particles bigger than 2mm - %	55.06	72.74	81.47	84.14	70.49	39.04	72.64	50.76	69.95	61.03	9.20
relevé area m^2	30	53	18	13	19	46	100	25	26	22	13
altitude (m)	377	377	378	378	378	600	620	560	580	520	500
aspect (degrees)	4	4	4	4	4	264	280	292	278	28	200
slope (degrees)	1	1	1	1	1	4	68	5	5	4	8
relevé width (m)	3	5.3	1.8	1.3	1.9	4.6	10	2.5	2.6	2.2	1.3
no of species	8	16	14	14	16	13	15	8	15	21	12

Vegetation unit 1.3.2

Relevé	71	74	77	81	85
date	20.3.99	20.3.99	20.3.99	20.3.99	11.4.99
gps (latitude)	34.00.06	34.00.06	34.00.05	34.00.04	34.00.08
gps (longitude)	18.59.52	18.59.52	18.59.51	18.59.52	18.59.43
riparian zone	b/d	b/d	b/d	b/d	b/d
location	trib.	trib	trib	trib	trib
% organic carbon	20.77	12.95	16.97	12.40	3.82
pH	4.57	6.29	5.61	5.79	4.87
resistance (ohm)	1.78	2.57	2.76	4.37	1.52
coarse fraction (2mm) %	11.97	24.07	9.99	15.13	25.63
coarse sand (2-0.5) %	28.26	5.55	5.35	5.10	16.06
medium sand (0.5-0.25) %	18.58	2.42	4.38	4.08	8.23
fine sand (0.25-0.05) %	29.44	2.48	4.40	6.16	10.10
coarse silt (0.05-0.02) %	7.31	0.70	0.44	1.24	2.43
sum of percentages	95.57	35.22	24.57	31.70	62.44
particles bigger than 2mm - %	4.43	64.78	75.43	68.30	37.56
relevé area m^2	10	9.2	34	28	16
altitude (m)	560	560	580	520	500
aspect (degrees)	292	292	278	28	200
slope (degrees)	5	5	5	4	8
relevé width (m)	1	0.9	3.4	2.8	1.6
no of species	21	15	16	28	24

Vegetation unit					2.1												
Relevé	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**100**	**101**	**102**	**103**	**104**	**105**
date	9.2.02	9.2.02	9.2.02	9.2.02	9.2.02	9.2.02	10.2.02	10.2.02	10.2.02	10.2.02	10.2.02	10.2.02	16.2.02	16.2.02	16.2.02	16.2.02	16.2.02
gps (latitude)	34.00.06	34.00.06	34.00.06	34.00.04	34.00.04	34.00.04	34.00.10	34.00.10	34.00.10	34.00.04	34.00.04	34.00.04	34.00.07	34.00.07	34.00.07	34.00.01	34.00.01
gps (longitude)	19.00.00	19.00.00	19.00.00	18.59.87	18.59.87	18.59.87	18.59.78	18.59.78	18.59.78	18.59.74	18.59.74	18.59.74	18.59.75	18.59.75	18.59.75	18.59.76	18.59.76
riparian zone	w/b	w/b	t/s	l/d	t/s	l/d	w/b	t/s	t/s	w/b	t/s	t/s	w/b	t/s	t/s	w/b	t/s
location	trib.	trib.	trib.	trib.	trib.	trib.	trib.	trib.	trib.	trib.	trib.	trib.	trib.	trib.	trib.	trib.	trib.
% organic carbon	5.56	5.97	6.29	5.92	5.58	5.69	5.61	5.89	6.15	6.22	6.03	5.67	5.81	5.86	5.48	5.59	5.84
pH	5.92	5.76	6.17	5.91	5.89	5.02	5.85	6.1	6.74	5.4	5.76	5.77	6.32	6.27	6.41	5.48	6.98
resistance (ohm)	3.69	1.91	1.44	2.41	3.72	2.10	4.44	2.12	1.53	2.96	1.91	8.26	1.10	3.60	9.25	2.45	5.43
coarse fraction (2mm) %	58.9	42	13.5	20.2	13.8	41.2	52.4	30.83	5.8	38.9	14.8	13	32.9	21.9	15.8	43.9	19
coarse sand (2-0.5) %	9.3	14.8	25.3	35.1	12.2	15.8	13.8	10.8	8.4	11.9	11.8	14.9	16	11.2	16.9	37.2	10.9
medium sand (0.5-0.25) %	2.37	4.44	8	12	2.94	5.23	9.4	19	12	2.28	3.3	5.57	11.2	4.9	5.28	4.32	4.5
fine sand (0.25-0.05) %	1.36	2.95	11	3.92	4.86	2.5	3.48	20.2	17.7	0.86	3.99	9.38	5.08	10.2	7.52	0.85	9.89
coarse silt (0.05-0.02) %	0.13	0.57	1.31	0.25	3.17	0.32	0.33	2.4	2.33	0.12	1.19	1.9	0.34	0.67	2.1	0.15	0.88
sum of percentages	72.06	64.76	59.11	71.47	36.97	65.05	79.41	83.23	46.23	54.06	35.08	44.75	65.52	48.87	47.6	86.42	45.17
particles bigger than 2mm - %	27.94	35.24	40.89	28.53	63.03	34.95	20.59	16.77	53.77	45.94	64.92	55.25	34.48	51.13	52.4	13.58	54.83
relevé area m2	12	14	24	10	25	8	14	26	28	12	25	26	10	27	24	14	28
altitude (m)	680	680	680	680	660	650	640	640	660	620	580	580	560	560	550	550	550
aspect (degrees)	260	260	260	200	200	200	200	200	200	200	180	180	180	180	45	45	48
slope (degrees)	47	47	47	47	49	49	49	49	48	48	48	48	48	40	40	40	40
relevé width (m)	1.2	1.4	2.4	1	2.5	0.4	1.4	2.6	2.8	1.2	2.5	2.6	1	2.7	2.4	1.4	2.8
no of species	6	6	7	10	10	9	7	11	17	6	12	15	7	18	8	6	14

Vegetation unit																
Relevé	**106**	**107**	**108**	**109**	**110**	**111**	**112**	**113**	**114**	**115**	**116**	**117**	**118**	**119**	**120**	**121**
date	16.2.02	16.2.02	16.2.02	16.2.02	16.2.02	16.2.02	16.2.02	16.3.02	16.3.02	16.3.02	16.3.02	16.3.02	16.3.02	16.3.02	16.3.02	16.3.02
gps (latitude)	34.00.01	34.00.10	34.00.10	34.00.10	34.00.06	34.00.06	34.00.06	34.00.10	34.00.10	34.00.10	34.00.10	34.00.07	34.00.07	34.00.07	34.00.08	34.00.08
gps (longitude)	18.59.76	18.59.76	18.59.76	18.59.76	18.59.87	18.59.87	18.59.87	18.59.72	18.59.72	18.59.72	18.59.72	18.59.82	18.59.82	18.59.82	18.59.83	18.59.83
riparian zone	t/s	w/b	t/s	t/s	l/d	t/s	w/b	w/b	t/s	w/b	t/s	w/b	t/s	t/s	w/b	t/s
location	trib.	trib.	trib.	trib.	main	main	main	main	main	main	main	main	main	main	main	main
% organic carbon	5.86	5.96	6.16	5. 73	5.66	5.83	6.25	5.81	5.83	5.62	5.68	5.60	5.62	5.79	5.81	5.61
pH	6.23	5.2	5.6	6.1	4.87	6.7	4.9	6.74	6.87	6.12	5.99	5.99	6.23	6.34	6.35	6.24
resistance (ohm)	3.67	1.87	4.30	6.78	4.70	2.89	2.87	5.98	5.12	7.89	7.89	5.12	7.75	5.67	5.89	7.99
coarse fraction (2mm) %	20.4	14.4	33.4	12.3	45.7	3.9	36.8	45.8	4.9	51.3	6.58	48.7	6.6	5.8	5.2	6.6
coarse sand (2-0.5) %	11	11.1	8.8	13.5	12.4	12.2	12.4	39.9	13.5	10.9	15.7	17.9	17.6	14.6	39.9	19.6
medium sand (0.5-0.25) %	6.7	2.45	2.01	6.58	10.2	17.7	3.5	18.7	12.5	1.83	24.4	3.32	23.1	12.9	13.5	23.4
fine sand (0.25-0.05) %	9.88	4.37	1.25	6.75	4.57	20.7	0.99	5.9	16.8	1.25	12.3	1.08	13.4	16.7	7.68	12.4
coarse silt (0.05-0.02) %	0.57	1.27	0.32	2.34	0.35	3.19	0.14	0.32	2.57	0.12	0.75	0.12	0.72	2.57	0.23	0.73
sum of percentages	48.55	33.59	45.78	41.47	73.22	57.69	53.83	11.1	50.27	65.4	59.73	71.12	61.42	52.57	66.51	62.73
particles bigger than 2mm - %	51.45	66.41	54.22	58.53	26.78	42.31	46.17	88.9	49.73	34.6	40.27	28.88	38.58	47.43	33.49	37.27
relevé area m2	32	26	11	32	10	24	12	18	32	16	36	14	40	46	16	54
altitude (m)	540	540	540	540	525	525	528	528	528	528	528	531	531	531	534	534
aspect (degrees)	48	50	50	50	280	280	280	280	285	285	285	285	288	288	288	290
slope (degrees)	35	35	35	35	28	28	28	28	28	30	30	30	30	30	32	32
relevé width (m)	3.2	2.6	1.1	3.2	1	2.4	1.2	1.8	3.2	1.6	3.6	1.4	4	4.6	1.6	5.4
no of species	8	17	7	20	8	10	6	6	18	7	8	7	9	16	9	10

Vegetation unit					2.1	continued...											
Relevé	**122**	**123**	**124**	**125**	**126**	**127**	**128**	**129**	**130**	**131**	**132**	**133**	**134**	**135**	**137**	**138**	**139**
date	**13.4.02**	**13.4.02**	**13.4.02**	**13.4.02**	**13.4.02**	**13.4.02**	**13.4.02**	**13.4.02**	**13.4.02**	**20.4.02**	**20.4.02**	**20.4.02**	**20.4.02**	**20.4.02**	**20.4.02**	**20.4.02**	**20.4.02**
gps (latitude)	**34.00.08**	**34.00.08**	**34.00.08**	**34.00.08**	**34.00.08**	**34.00.08**	**33.59.52**	**33.59.52**	**33.59.52**	**33.59.48**	**33.59.48**	**33.59.48**	**33.59.48**	**33.59.48**	**33.59.24**	**33.59.24**	**33.59.24**
gps (longitude)	**18.59.78**	**18.59.78**	**18.59.77**	**18.59.77**	**18.59.77**	**18.59.77**	**18.58.42**	**18.58.42**	**18.58.42**	**18.58.54**	**18.58.54**	**18.58.54**	**18.58.54**	**18.58.54**	**18.58.22**	**18.58.22**	**18.58.22**
riparian zone	**w/b**	**t/s**	**w/b**	**t/s**	**w/b**	**t/s**	**t/s**	**w/b**	**t/s**	**w/b**	**t/s**	**t/s**	**t/s**	**t/s**	**t/s**	**w/b**	**t/s**
location	main	main	main	main	main	main	trib.	trib.	trib.	trib.	trib.	trib.	trib.	trib.	trib.	trib.	trib.
% organic carbon	5.56	5.62	5.78	5.66	5.66	5.62	5.86	5.60	5.73	6.04	5.61	5.98	5.67	5.53	5.55	5.78	5.55
pH	6.12	6.13	6.45	5.99	5.67	6.56	6.37	6.03	6.33	5.88	6.36	6.11	5.94	6.03	6.62	6.36	6.19
resistance (ohm)	6.99	3.45	5.67	4.23	4.67	2.98	5.84	6.88	5.51	3.32	3.42	3.37	4.82	6.78	6.89	5.22	3.84
coarse fraction (2mm) %	51.2	13.5	51.6	14.4	52.4	14.5	44.34	68.5	69.3	61.3	13.9	19.3	55.3	55.6	66.3	35.2	25.3
coarse sand (2-0.5) %	13.4	21.6	40.5	18.1	19.8	16.6	14.3	17	23.7	21.5	20	18.7	20.7	11	22.7	33.5	32.5
medium sand (0.5-0.25) %	1.53	18.7	2.1	18.7	2.21	18.7	13.4	5	4.47	8.75	19.6	12.5	2.7	1.6	6.1	19.5	6.98
fine sand (0.25-0.05) %	0.71	16.5	5.43	16.5	0.57	16.5	19.3	2.02	2.13	4.72	15.6	6.27	0.66	0.53	2.26	6.98	2.62
coarse silt (0.05-0.02) %	0.41	0.57	0.12	0.63	0.04	0.65	2.1	0.15	0.04	0.56	0.76	0.18	0.09	0.05	0.36	0.02	0.01
sum of percentages	67.25	70.87	99.75	68.33	75.02	66.95	93.44	92.67	99.64	96.83	69.86	56.95	79.45	68.78	97.72	95.2	67.41
particles bigger than 2mm - %	32.75	29.13	0.25	31.67	24.98	33.05	6.56	7.33	0.36	3.17	30.14	43.05	20.55	31.22	2.28	4.8	32.59
relevé area m2	20	48	16	58	18	46	36	18	46	12	35	33	36	38	48	18	52
altitude (m)	534	534	535	535	535	535	440	440	460	460	460	480	480	500	400	400	420
aspect (degrees)	290	290	290	290	300	220	75	75	75	75	80	80	85	85	85	88	88
slope (degrees)	34	34	34	35	35	35	8	8	8	8	8	8	8	10	10	10	10
relevé width (m)	2	4.8	1.6	5.8	1.8	4.6	3.6	1.8	4.6	1.2	3.5	3.3	3.6	3.8	4.8	1.8	5.2
no of species	13	20	6	16	9	13	10	6	17	6	12	9	13	11	19	3	20

Vegetation units in floristic phytosociological table

1	Erica caffra - Elegia capensis Riparian Group of Communities
1.1	*Erica caffra - Prionium serratum* Wetbank Fringing Shrubland Community
1.1.1	*Erica caffra - Anthochortus crinalis* Riparian Marshland Subcommunity
1.2	*Erica caffra - Elegia persistens* Drybank Fringing Shrubland Community
1.3	*Erica caffra - Ischyrolepis gaudichaudiana* Riparian Thicket Community
1.3.1	*Erica caffra - Juncus lomatophyllus* Riparian Sedgeland Subcommunity
1.3.2	*Erica hispidula* Riparian Shrubland Form
2	Seepage Communities
2.1	*Pentameris thuarii - Cullumia setosa* Seepage Short Closed Shrubland

Abbreviations

w/b	Wetbank Zone
l/d	Lower Dynamic Zone
b/d	Back Dynamic Zone
t/s	Tree/Shrub Zone
main	Main stream
trib.	Tributary

Ordination

The arrangement of 139 samples in CCA-ordination in correlation with the physical characters is illustrated in Figure 13. The following soil parameters were superimposed on a scatter plot representing the ordination of the augmented data set: pH, resistance, percentage organic carbon, particles bigger than 2 mm, coarse fraction (2 mm), coarse (2 – 0,5 mm), medium sand (0,5 – 0,25 mm), fine sand (0,25 – 0,05 mm), coarse silt (0,05 – 0,02 mm) and fine silt and clay.

Whilst the clusters produced by the classification are not clear on the ordination scatter, the physiognomic differences in the plots are much clearer. Organic carbon is an indication of a moisture gradient. The moisture gradient increases from left to right. There are two vegetation units that show affinity to high organic carbon in the soil. The first is the *Erica caffra – Anthochortus crinalis* Riparian Marshland Subcommunity, which is confined to the seepage zones at the source of the Eerste River on the Dwarsberg Mountain. The other vegetation unit is the *Erica hispidula* form of the *Erica caffra - Ischyrolepis gaudichaudiana* Community. This form occurs at the interface of the wetbank and the drybank habitat of the riparian vegetation. This habitat is characterised by the accumulation of organic material originating from leaf litter and other plant debris. The soil in the *Erica caffra – Anthochortus crinalis* Subcommunity is also characterised by a high presence of fine sand. Fine materials accumulate where water velocities are low.

The *Erica hispidula* form is also characterised by the present of coarse silt and fine sand. This form is situated on soils with sand deposited on shale. It is one of the few vegetation units where the soil shows clear horizontal layer stratification.

The soil of the *Erica caffra – Anthochortus crinalis* Subcommunity has a high soil resistance and a coarse sand fraction compared to a low organic carbon value. It shows a negative correlation in that higher organic carbon soils have a lower soil resistance and a coarse fraction. This subcommunity is also characterised by the presence of fine sand and shows a negative correlation in that fine sand soils have a lower soil resistance and coarse fraction.

The rest of the vegetation units (1, 1.1, 1.2, 1.3, 1.3.1 and 2.1) are all concentrated in the top left and bottom left of the diagram and are grouped around the centre. These vegetation units show a high level of floristic overlapping. The soils have a relatively low pH, but a high percentage of soil particles larger than 2 mm. These vegetation units have a high coarse fraction and soil resistance. Along the axis, the pH values of these vegetation units are negatively correlated with medium sand. Geologically, this implies that these soils are derived from sandstone parent material that has accumulated along watercourses with high velocity.

Generally, the results of the ordination indicate that, although most of the vegetation units are related floristically, there are smaller discreet units which occur along specific environmental gradients. There are many indications that the distribution of species is not always closely linked with the environment alone (Spribille *et al.* 2001). In a study of the riparian vegetation of the Sabie River, Van Coller *et al.* (2000) found that dominant environmental gradients provide a poor explanation for variation in vegetation patterns. Xiong *et al.* (2001) found that the responses of riparian vegetation to both litter and silt accumulation were negatively correlated to litter mass and silt depth, and positively related to plant traits such as seed mass, seed persistence and lateral spread.

Species composition can best be explained by mean annual rainfall. Substrate chemistry and the type of deposited material explain little of the floristic variation (Rüdiger *et al.* 2001). This indicates that sites with different environmental features can have closely similar floristic composition. On a broader scale, the gradient analysis shows that the vegetation responds to a set of environmental gradients in a complex manner that could not be predicted by single gradients. It would be advisable to include more environmental parameters in an indirect classification. A direct classification of samples constrained by the two most important explanatory variables, soil pH and moisture, resulting in the four combination of acidic/basic vs. moist/dry, poorly reproduce the classification. It will also sacrifice the floristic homogeneity of clusters. An indirect approach to classification is the best way to simultaneously optimise the precision of the vegetation description and the ecological validity (Bruun & Erjrnes 2000). The percentage of bedrock and the formation of large alluvial bars, such as islands, relate strongly to vegetation patterns (Van Coller *et al.* 2000). These two parameters could be included in sampling plots for future research.

3.6 GENERAL DISCUSSION

The classification of the riparian vegetation of the Eerste River has not been easy. The distribution of plant communities along the river in the upper reaches of the catchment is determined by the combined influence of different moisture regimes and edaphic factors, and not by any single factor. This pattern is observed in many catchments (Werger *et al.* 1972, Kruger 1974, Wahl 1986, McDonald 1988, Bredenkamp & Van Rooyen 1996, Sieben 2002). Many research studies have been conducted in the Jonkershoek Valley catchment during the past decade. The first concern about a need for an overall management strategy was spelled out by Heydorn and Grindley (1982a).

Two habitat types are distinguished on the basis of the degree of wetness, namely Riparian and Seepage. Eight vegetation units are identified and grouped into these two habitat types. The sampling of the riparian vegetation was concentrated into the riparian zone defined by Salie (1995). Riparian communities occur as long narrow strips of vegetation along watercourses and seepage lines. Riparian communities are largely characterised by a high ratio of margin to surface area, or a large "edge effect". Because of this large "edge effect", intruding species from the adjacent Mesic Mountain Fynbos are more likely to be found throughout such long narrow communities than in communities with other shapes (Werger *et al*. 1972). The intrusion of species that have a wider distribution through the rest of the fynbos is relatively common in the following communities: *Erica caffra – Elegia persistens* Wetbank Fringing Shrubland Community, *Erica hispidula* Riparian Shrubland Form and *Erica caffra – Juncus lomatophyllus* Riparian Sedgeland Subcommunity. Examples of widespread fynbos species intruding into the riparian zone are: *Asparagus capensis, Agathosma crenulata, C. montana, D. glabra, Ehrharta rehmannii, Erica hispidula, Otholobium obliquum, P. neriifolia, P. nitida, Rhus angustifolia, Struthiola myrsinites* and *Thesium strictum.* Although *D. glabra, Ehrharta rehmannii* and *Rhus angustifolia* are fynbos species, they are considered to be normal riparian associates. Species such as *Berzelia lanuginosa, Cliffortia cuneata* and *Psoralea aphylla* are seepage or marsh species. Species that are likely to intrude are those with wide ecological tolerances that usually settle or established themselves on alluvial deposits and areas of disturbance, such as erosional zones and secondary drainage channels. Two of the above-named species, *P. neriifolia* (Kruger 1974) and *O. obliquum* (Boucher 1978) are specific in habitat and are found on heavier, clay-rich soils such as weathered granites and shales. The occurrence of these species is an indication of sandy and granite soils on shale bands.

Protea nitida, which occurs on sandstone slopes (Goldblatt & Manning 2000), has also successfully intruded into the riparian vegetation. The occurrence of *P. nitida* can be ascribed to the dominance of sandstone as parent material in the colluvial riparian soils. *Pteridium aquilinum* is described by Kruger (1974) as a species occurring in ecotones of a shrubby nature. Van Leeuwen (1966) called it a species of the "lime convergents", i.e. species living under unstable conditions, usually as large numbers of individuals. *Pteridium aquilinum* occurs in all the communities, except in the *Erica caffra – Anthochortus crinalis* Riparian Marshland Subcommunity and the *Erica caffra – Prionium serratum* Wetbank Fringing Shrubland Community. *Erica caffra – Anthochortus crinalis* Riparian Marshland is a marshland subcommunity and the *Erica caffra – Prionium serratum* Wetbank Fringing Shrubland is a river-fringing community. McDonald (1988) associated *P. aquilinum* with the Magwa and Nomanci Forms, which are characterised by the presence of granite in the soil. In the study area, *Pteridium aquilinum* was recorded on the riparian forest fringe, in areas with little canopy cover and less shade. It forms large homogenous stands in this location

Communities that are widespread represent environmental conditions that are fairly broad, thus forming a common habitat. Rosales *et al*. (2001) state that hydro-ecological processes (e.g. hydraulic disturbances driven by velocity and sediment deposition gradient and hydraulic backwater causing in-flood depths and duration that drive biogeochemical gradients within the riparian soils) are important in causing variability in species composition, structure and diversity in riparian vegetation.

The riparian vegetation of the upper reaches of the Eerste River is poorer in species than the riparian vegetation of the Sabie River in the Kruger National Park (Bredenkamp & Van Rooyen 1996). The difference is probably phytogeographical or due to the substrate and general climate. It differs phytogoegraphically because forests (which include riparian forests) are generally more species depauperate in the west of South Africa than in the east. The geology of the Sabie River shows greater heterogeneity than the geology of the Eerste River catchment. The soils of the Eerste River riparian vegetation are mainly sandstone derived or a mixture of sandstone, granite and shales. The parent material of the soils is the Malmesbury Group (shales), Cape Granite (granite) and Table Mountain Group (sandstones and shales). Alluvium and colluvium, dating from Tertiary to Recent, are also present. Fynbos soils derived from sandstone are often shallow, stony and rocky (Higgins *et al.* 1987). The occurrence of shale is very limited in the study area. The shale-derived soils are much more finely textured (Campbell 1983) than the sandy, rocky scree substrates and are richer in nutrients, thus providing greater diversification. Although the Sabie River receives a lower average annual rainfall, it fluctuates more from location to location, thus creating a wide range of ecological conditions.

Floristic data about the Eerste River riparian vegetation in the literature is negligible, which makes it difficult to link communities described in this study with other riparian communities along the river as a whole. The few other studies done on the riparian vegetation of the Eerste River are those by Wahl 1986, Duvenhage 1993, Salie 1995 and McDowell 1996. The most recent one is by Sieben (2002), but his results were not yet available at the time of finishing this study. Other authors (e.g. Van der Merwe 1962, Werger *et al.* 1972, McDonald 1988 and Nel 1995) have described the riparian vegetation of local parts of the catchment. These studies provided valuable information for the classification of the vegetation in the study area.

The study area is still in a relatively pristine condition, with few exotic species present. The area above Witbrug has a 100% presence of indigenous riparian tree species (Salie

1995). No exotic trees were recorded in the phytosociological study of the riparian vegetation. The only three alien species encountered in the present vegetation analysis are *C. canadensis*, *H. radicata* and *S. mauritianum*. *Solanum mauritianum* has also been recorded in the *Typha capensis – Solanum mauritianum* Disturbed Pan Subcommunity in the wetland vegetation of southern KwaZulu Natal (Perkins *et al*. 2000), where it was described as one of the most disturbed communities in the study area. Duvenhage (1993) expressed the view that the riverbank vegetation in the upper reaches of the Eerste River is fairly undisturbed, although under threat from the expansion of agricultural activities. Alien species, such as *Briza maxima, C. candensis* and *Pennisetum clandestinum*, were encountered along the hiking trail leading to the First Waterfall. Riparian vegetation is naturally protected against mountain fires by the presence of large boulders in the riparian strip. Indiscriminate expansion of pine plantations and other agricultural activities can provide the stimulus for alien species to invade the riparian vegetation by creating disturbed areas in the riparian zone.

The physiognomic units are demarcated in areas with a narrow band (2 - 4 m) of vegetation. Smaller plots were used, as recommended by Mustart *et al.* (1993), because they can limit the possibility of sampling transitions. As a result of the physiognomic structural overlaps in riparian zones, transitions can be easily sampled (Van Wilgen & Kruger 1985). Van Wilgen and Kruger (1985) encountered transitions in their study of the vegetation communities in the Zachariashoek catchment. In areas where the riverbank was wider, the area was characterised by disturbance, resulting in many fynbos species intruding into the riparian vegetation. No transitions were sampled in the Jonkershoek Valley.

A representative phytosociological table of the vegetation was produced from the analysis of the 139 samples examined in this study. The classification of the vegetation units indicates that the structure and dynamics of the vegetation is not exclusively a result of habitat conditions. Although habitat does play a major structuring role, processes such as site history (including floristic-genetic processes and disturbance), interactions within the community, or chance can overrule the structure generated by the habitat (Ladislav 1997). It would be advisable to include more relevés in future research, thus producing a phytosociological table containing greater detail. Particular care should be taken in the placement of plots to limit the possibility of sampling transitions. Further research could focus on a more comprehensive summary of all the riparian zones of the Fynbos Biome Mountain areas.

CHAPTER 4

CONCLUSIONS

4.1 GENERAL

The Eerste River catchment is very important in terms of the interaction between land-use and catchment resources, as it is a life source for agriculture in the Stellenbosch region and in the greater catchment area. The Eerste River has its origin in the Dwarsberg Mountain in the Jonkershoek Valley and the vegetation includes relatively pristine riparian and Mesic Mountain Fynbos. Riparian zones are known to be areas with diverse habitats that support a number of species. It is therefore important to firstly describe the vegetation of the surrounding Mesic Mountain Fynbos and, secondly, to describe the riparian vegetation and to determine the value of each in relation to the other. By qualifying the value of riparian zones, strategic management for the conservation of this ecosystem can be facilitated. This type of research can provide data that can be extrapolated to similar situations in other catchments. The study represents the first step in defining the importance of riparian zones in relation to surrounding non-riparian vegetation.

The soils of the Eerste River in the Jonkershoek Valley consists mainly of the Table Mountain Group (sandstone and shales), the Cape Granites (granites) and the Malmesbury Group (shales). Much of the upper catchment area consists of undulating hills with fertile soils overlying Cape Granites Malmesbury Group shales (Heydorn & Grindley 1982a). The soils originate mainly from sandstone parent materials, as well as from a mixture of granites and shales. The nature of the geology of the upper reaches is such that run-off is relatively high. The soils are characterised by loose sand, covered by a thin layer of loam. Alluvial soils result from materials formed by fluvial and colluvial processes. Ridges and riparian valleys can be viewed as end-members of a soil sequence that is physically and genetically related to the transport of water, soil and nutrients from upper to lower landscape positions (Scatena & Lugo 1995).

The correlation between the distribution of the plant communities and the occurrence of soil forms is not very clear. Swartboskloof showed the same scenario where the correlation of soils with the vegetation was the result of the broad relationship between the groups of communities and the soil geology, rather than specific soil forms or series (McDonald 1988). No specific single environmental factor can be isolated to describe community distribution. The primary gradient for predicting community distribution is complex and does not simply follow a geographical trend from north to south (McDonald *et al.* 1996). It was difficult to determine whether communities are localised and reflect specific edaphic conditions. Many of the communities reflect environmental conditions that are fairly broad. Understorey diversity was generally related to changes in slope and sand/gravel substrate. The same has been found in riparian systems in north-central Arizona (Zimmerman *et al.* 1999). Hancock *et al.* (1996) ascribed the distribution of riparian plant communities on either side of a stream in Western Australia to the gradient of environmental factors perpendicular to the stream line, with the predominant factor being water availability.

Eight vegetation units were described in the study. The vegetation units were described under the *Erica caffra – Elegia capensis* Riparian Group of Communities and the *Pentameris thuarii – Cullumia setosa* Seepage Community. Riparian plant community composition is influenced by moisture, erosion, original native plant communities, and current and past land use (Richards *et al.* 1995, Van Wyk *et al.* 2000, Paine & Ribic 2002, Siebert *et al.* 2002). It was evident that one large, well-defined community, *Pentameris thuarii – Cullumia setosa* Short Closed Shrubland, which was found on the eastern slope (west-facing) of the Jonkershoek Valley, appears to be directly related to edaphic factors. This community was found to be related to seepages in the riparian zone. The eastern slope is steeper than the western slope and this could explain the richer, mixed soils. The *Erica hispidula* Shrubland Form of the *Erica caffra – Ischyrolepis gaudichaudiana* Community is a small vegetation unit found on soils with sand on shale. The *Erica caffra – Anthochortus crinalis* Riparian Marshland Subcommunity of the *Erica caffra – Prionium serratum* Wetbank Fringing Shrubland Community occurs on steep, flat slopes with soils with a high organic content. This subcommunity was found on the Dwarsberg Mountain at the source of the Eerste River. For the rest of the communities, the distribution indicates a combination of environmental conditions, with water availability and soil mixture playing an important role.

The role of fire is an important contributing factor to species distribution in fynbos. Riparian areas are protected from fires mainly through the condition that heat rises and riparian zones are low lying. Additionally, the humid microclimate and generally high foliage moisture content also disfavours fires in riparian zones (Rundel & Sturmer 1998). On average, fynbos areas burn at intervals of about 12 to 15 years (Mustart 2000). This interval is long enough for most species to reach reproductive maturity in order to establish adequate seed stores before the next fire (Mustart 2000). The fire in the Jonkershoek Valley in April 1999 occurred eight years after the previous devastating fire in the valley. If fires are too frequent, occurring at shorter intervals than above, plants may not accumulate enough seeds between fires. The period between the two fires was not long enough and could affect the future regeneration of plants. The regeneration of the vegetation after the April 1999 fire is shown in Fig. 15 a & b. Fire also causes lower-order tributary upgrading, while the highest order channel degrades and previously stored alluvium is transported from the basin. In the longer term, the tributaries degrade and the main channel upgrades due to alluvial transport (Laird & Harvey 1986).

In Mesic Mountain Fynbos, it appears that habitat types are often characterised by functionally and structurally similar plant communities, even though their floristic composition may differ owing to local factors (McDonald 1988). One such example in the study area is the comparison between the *Berzelia lanuginosa – Merxmuellera cincta* Tall Closed Shrubland Community described by McDonald (1988), the *Berzelia lanuginosa – Leucadendron salicifolium* Community described by Kruger (1974), and the *Pentameris thuarii – Cullumia setosa* Short Closed Shrubland described in this study. Future research could be directed to detail the effect of edaphic factors on community composition and distribution through the catchment as a whole.

The vegetation along the riparian zone of the Eerste River confirms the zones recognised by Boucher & Tlale (1999), namely 1. Wetbank Zone, 2. Lower Dynamic Zone, 3. Tree/shrub Zone and 4. Back Dynamic Zone. The Back Dynamic Zone is a floristically complex zone that is difficult to classify due to the mixing of Mesic Mountain Fynbos with riparian elements. The different zones have specific indicator species that could be used to determine zonation patterns. For example, *P. serratum* is characteristic of the wetbank, while *I. gaudichaudiana* and *I. subverticillata* are two species confined to the Lower Dynamic Zone. The Lower Dynamic Zone is characterised by an unstable habitat of temporary alluvial deposits and lateral channelling. The Tree/Shrub Zone contains riparian trees, with *Brachylaena neriifolia* and *Erica caffra* being prominent. Although riparian trees are considered to be localised, this localisation in other areas may be on hillsides and forest margin e.g. for species such as *Olinia ventosa, Olea europaea* and *Pterocelastrus rostratus*. The Back Dynamic Zone is characterised by the dominance of *Pteridium* *aquilinum* and the presence of Mesic Mountain Fynbos elements, such as *Asparagus capensis, Agathosma crenulata, C. montana, Erica hispidula, Otholobium obliquum, P. neriifolia, P. nitida, Struthiola myrsinites* and *Thesium strictum.* The riparian zone plant communities form a continuum, and not discrete entities, in the vegetation. The continuum in riparian physiognomy could be regarded as one reason for the resilience of riparian zones against habitat modifying devastation through phenomena such as fires, torrential flooding and exotic species encroachment. So far, only three exotic species were recorded in the vegetation classification. They were *Conyza canadensis*, *Hypochoeris radicata* and *Solanum mauritianum.*

The primary aim of the floristic part of this study was to compile a checklist for the Jonkershoek Valley. The previous checklist for the area was McDonald's (1988) checklist of the flowering plants and ferns of Swartboskloof. Although a checklist is a huge task to undertake, most researchers find it invaluable in vegetation studies. The checklist covers an area of 1 652 ha and includes 1 743 taxa, including all the vegetation types in the area. Great care was taken to ensure that the taxa included in the statistical analysis, all occur within the boundaries of the Jonkershoek Valley. The compilation of the checklist was mostly based on reviewing past studies. There is a minor possibility that a few of the taxa included in the checklist, do not occur within these boundaries. Plant species which occur on the fringes of the Valley or in adjacent areas, could have been mistakenly included as occurrences in the Jonkershoek Valley.

Thirty-six taxa were not native to the Cape Flora. The total number of taxa in Jonkershoek include 108 families with 441 genera. Asteraceae is the largest family, with 62 genera and 213 species. The largest genus in the study area is *Erica*, with 95 species. It contributes 5,4% to the total species number. All the species lists from past studies in the area have been updated as far as possible following Goldblatt and Manning (2000).

The riparian zone was subdivided according to habitat occurrence and included species that were riparian specialists (riparian only, 114 species), riparian generalists (riparian and other habits, 90 species) and wetland specialists (wetlands, marshes, seepages and moist areas, 231 species). A total of 435 riparian zone taxa were recorded in the checklist for Jonkershoek. The second aspect was to attach a value to riparian zones, based on the species contribution to an area. It was found that riparian zones in the Jonkershoek Valley cover 41 ha (2,5%) of the total study area (1 652 ha) and yet contribute 26% to the species count. The riparian zones have an average of 11 species per hectare compared to the 1,1 species per hectare for the Mesic Mountain Fynbos. A similar study done in the Chaparral of the Santa Monica Mountains (Rundel & Sturmer 1998) found that riparian zones cover 0,7% of the area and contribute 20,5% to the species count. The convergence of many aspects of Fynbos and Chaparral supports the hypothesis that similar climates select for similar plant structures and functions (Keeley 1992). Both studies show the importance of riparian corridors as habitats for species diversity. Similar results were published by Nilsson *et al.* (1989, 1991), Tabacchi (1995) and Boutin *et al.* (2002).

The final aspect dealt with in this chapter includes the plant characteristics of both Mesic Mountain Fynbos and riparian zone vegetation. A typical riparian species specialist in the Jonkershoek Valley is an unbranched woody perennial phanerophyte with a height of between 2 and 8 m and microphyllous, evergreen sclerophyllous leaves. Although the average height of 0,5 - 1 m was measured for most of the riparian species, it is structurally evident that riparian vegetation is characterised by trees and shrubs taller than one metre. The specialist description for a non-riparian species (adjacent fynbos surrounding) is a branched, woody perennial hemicryptophyte with a height above 1,0 m and evergreen microphyllous leaves. The only difference in character is the life form, which is a phanerophyte for riparian and a hemicryptophyte for non-riparian species. A reason for this is that non-riparian vegetation is more prone to be destroyed by fire than riparian vegetation. Riparian zones are buffered from mountain fires by large boulders lining the watercourses. The hemicryptophyte life form ensures regeneration after above-ground growth has been destroyed (Higgins *et al*. 1987). It has to be kept in mind that the intensity and frequency of fire regimes determine the survival of species. Van der Merwe (1966) reported that only 33% of the species at Swartboskloof in the Jonkershoek Mountain catchment regenerated from seed after a fire.

Both vegetation types have predominantly sclerophyllous leaves. Stock *et al.* (1992) give three reasons for this. Firstly, the suitability as an adaptation to drought; secondly, it is an adaptation improving nutrient use efficiency in a low nutrient environment; and thirdly, the leaf modification is a highly successful means of reducing herbivory.

Another aspect is the relatively low presence of trees in the Mesic Mountain Fynbos. The flora is dominated by shrubs and perennial herbs. This is largely explained by the nutrient-poor soils which favour a shrubby vegetation structure (Goldblatt & Manning 2000). The Mediterranean floras in Chile and California have a higher percentage of annuals (Arroyo *et al.* 1994). Trees occur more frequently in riparian zones, which indicates that these soils are nutrient rich. Riparian habitats with trees support less encroachment by weeds (Boutin *et al.* 2002). Trees also play an important role in the stabilisation of riverbanks (Abernethy & Rutherfurd 2000). Only about 30% of riparian tree regeneration is adequate to sustain the riparian forests (Hibbs & Alison 2001).

This study has made a contribution to future vegetation studies in the Jonkershoek Valley by compiling a floristic checklist for the area. A checklist is generally the first point of departure for many research studies. An attempt was also made to describe the plant communities along the upper reaches of the Eerste River. Although many studies have been conducted in the Jonkershoek Valley, none has previously concentrated exclusively on describing riparian vegetation. The riparian vegetation was always described as part of a bigger area, such as Jakkalsvlei (Kruger 1974) and Swartboskloof (McDonald 1988). The vegetation classification could be the basis to improve the methodology of and approach to future studies on riparian vegetation.

The limitations to the study were the following:

- Inaccessible areas – many of the areas are microhabitats and the likelihood of finding additional species and plant communities is high.
- Insufficient correlation of edaphic factors to plant distribution – a range of environmental parameters needs to be devised to investigate the correlation between plant distribution and environmental gradients.

Future studies could focus on:

- A comparison of the vegetation of tributaries with the vegetation of the main stream of the Eerste River.
- Succession after fire along streams.
- A comparison of the riparian zones of Fynbos Biome Catchments.

South Africa's Cape Floristic Region is a global priority for conservation action (Cowling & Heijnis 2001). The Jonkershoek Valley forms an important part of the Cape Floristic Region and, given its relatively pristine state of vegetation, the catchment is a valuable natural resource.

4.2 MANAGEMENT OVERVIEW

A secondary objective of this study was to focus on the management and conservation of riparian communities. The biodiversity of the world's Mediterranean regions is under severe and rapidly escalating threats (Cowling *et al*. 1996). The difficulties associated with conservation in the Fynbos Biome were spelt out nearly 25 years ago in the Fynbos Biome Project (Kruger 1978). There are great economic incentives to replace degraded fynbos areas with agriculture and housing developments. A lot of pressure has already been applied on Renosterveld plant communities to be replaced by more productive agricultural crops (Cowling 1994). Mountain catchment areas in the Western Cape Province are critically important for maintaining the scarce water resources of the region. The higher run-off from mountainous areas compared to the rest of the region is due to the higher rainfall in the mountains as well as the low water use of the natural cover of fynbos vegetation (Burgers *et al.* 1995).

Decisions on riparian management need to start with an understanding of the goals of stream health and water quality and of the fact that riparian zones are linked longitudinally and must be managed holistically (Naiman *et al.* 2000, Quinn *et al.* 2001). Management strategies should be based on natural patterns of diversity and on the ecological processes that influence these patterns, and classification schemes should therefore include understorey as well as overstorey components (Sagers & Lyon 1997).

Riparian zones are easier to manage in the upper reaches than lower down, where anthropogenic influences are more profound. Human activities, especially agricultural practices, flood control programmes and waterway commerce, have greatly modified existing riparian wetlands, largely through direct alteration of stream channels (Mensing *et al.* 1998). The pollution of rivers is usually associated with land use, such as household and industrial effluent and indiscriminate riparian agriculture (Heydorn & Grindley 1982b). Constructed wetlands have proved to be highly efficient in reducing pollution levels along the Lourens River in the Western Cape (Schulz & Peall 2001).

Farmers make up the biggest percentage of land users along rivers. They should be the first people to be consulted to formulate management strategies. Tucker and Napier (2002) concluded that conservationists should include a wide range of information channels in their outreach effort, including interpersonal methods, traditional mass media and emerging online technologies. Clustering of impacts into finite areas could be considered a positive management strategy (Stein & Ambrose 2001). The continuity and integrity of riparian zones needs to be conserve. Increasing or maintaining landscape connectivity can reduce species extinction and prevent the inbreeding depression of species in isolated fragments (De Lima & Gascon 1999).

Riparian zones are particularly prone to exotic plant species invasion (Humphries 1994, Planty-Tabacchi *et al*. 2001). This is mainly explained by the disturbance regime gradient, by geomorphological attributes, by human influences and by climatic influences (Planty-Tabacchi *et al*. 2001). Three exotic plants were recorded during the phytosociological study, namely *Conyza canadensis, Hypochoeris radicata* and *Solanum mauritianum*. None of them is considered to be invasive, as they generally perform as herbaceous weeds, but the fact that they have established themselves in the riparian zone indicates that the potential exists for exotic plants of the invasive type to settle here as well. Any form of disturbance could create a habitat for exotic plants (Privett *et al*. 2001). Seed size appears to be an important factor affecting establishment levels in the post-fire environment and the probability of successful germination increases with seed size. Smoke from fynbos fires is responsible for breaking seed dormancy and stimulating seed germination in many species (Brown & Botha 2002). Alien plants such as *Acacia* spp. generally have larger seeds (Musil & de Witt 1990). Hoare *et al.* (2000) found a high degree of invasion by *Acacia cyclops* (present in 78% of relevés) in their description of the *Relhania calycina – Phylica confusa* Fynbos Community and expressed the potential of these alien species to cause irreversible changes in species composition and vegetation structure. *Acacia cyclops* has eliminated virtually all the vegetation in one of the research sites in the Cape of Good Hope Nature Reserve within 30 years (Taylor & McDonald 1985, Privett *et al.* 2001). The situation in this reserve has deteriorated from 1976 to 1980, with two indigenous species now absent and 13 alien woody species encroaching the previously pristine indigenous vegetation (Taylor *et al.* 1985). Many alien plants are planted as ornamental trees and later make their way into the fynbos (Richardson 1999). Fortunately, many biological control agents have been found for the Australian acacias (Hoffman 2001). Revegetation of fynbos has also been successful, for it allows natural communities to extend their boundaries, thus limiting invasion by alien plants (Romoff 1986).

Conservation officers have to limit unnatural riparian habitat destruction, as well as proactively manage natural habitat modification. This will protect species richness in riparian zones, which reduces invasibility by exotic plants in the absence of frequent disturbance (Hood & Naiman 2000). The riparian zone in Jonkershoek Valley is fortunate in having few exotic and naturalised plants. Nearly 20% of the riparian zone in Chuncheon, Korea contains naturalised plants (Park *et al.* 2001). The riparian areas in the chaparral in Central Coastal California contains 15% introduced species (Knops *et al.* 1995).

It is necessary to develop special techniques and an information base specifically for collating the features and environmental requirements of riparian plant species before effective rehabilitation and management can be implemented confidently (Hancock *et al.* 1996). Fleming *et al.* (2001) developed a 10-step method to evaluate riparian health. These steps include streambank geology and embeddedness, width/depth ratio, bank stability, pool/riffle ratio, buffer width, vegetation characteristics and canopy shading. This could easily be applied to riparian ecosystems. Remote sensing of the regeneration of vegetation after fire is another tool for conservation. Riano *et al.* (2002) have developed remote sensing programmes to assess the regeneration of vegetation after fire in the Mediterranean region of the Santa Monica Mountains. Remote sensing and GIS can also be used successfully to delineate and analyse riparian buffer zones (Narumalani *et al.* 1997).

The vegetation component of the managed riparian landscape has changed in particular as a result of a decrease in stream dynamics, the replacement of natural forests by planted ones and the invasion of natural communities by introduced woody species (Tabacchi & Planty-tabacchi 2003). The South African Government has set a strategic goal according to which, by the year 2020, institutions and communities will be working together to ensure that appropriate catchment management is in place to protect both water sources and biodiversity (Anonymous 2000). The first step in this direction has been achieved by the Working for Water Programme, which involves communities to improve the ecological integrity of natural systems by removing alien vegetation from catchments (Anonymous 2001). The removal of alien invasive vegetation from key source catchments could delay the future requirement for costly dams (Gillham *et al.* 2001).

4.3 PROPOSED MANAGEMENT GUIDELINES

This study has proved the importance of the upper reaches of the Eerste River catchment in relation to the Mesic Mountain Fynbos through:

a.) the high number of species per unit area (species richness) in the riparian vegetation in comparison to the adjacent Mesic Mountain Fynbos, and

ii.) the vegetation units present along the river determined by environmental cues.

Many of the riparian species are very specific in their occurrence along the watercourse, e.g. *Prionium serratum* and *Freylinia lanceolata* are water-fringing plants, *Tetraria bromoides* is indicative of shale bands and *Pteridium aquilinum* has a preference for disturbed, moist areas on the riparian forest fringe (Goldblatt & Manning 2000) and in the Back Dynamic Zone (Boucher & Tlale 1999). The mature riparian plants have established themselves on screes and among boulders, which are partly protected from fires and moist conditions through run-off from the boulders. These plant species function as a unit, creating a continuum of vegetation in which the species are interdependent on each other, for example where a riparian tree creates a microhabitat for ferns and mosses by providing shady conditions.

The Cape Floristic Region (the world's smallest floral kingdom) has a high concentration of rare plant taxa whose survival is threatened mainly by clearing for agriculture and urbanisation, but also by alien plants and pathogens (Cowling *et al*. 1996). Riparian vegetation is under threat as a result of drying due to global warming and from intruding alien vegetation (Cowling *et al*. 1996). Although this study recorded only three alien species, many were noticed along hiking trails and in other areas of disturbance. The middle and lower reaches of the Eerste River have been described by many authors as being invaded by alien vegetation.

Proposed management guidelines could be as follows:

- the mapping and monitoring of indicator species as the response of individual plants to environmental changes compared to the response of vegetation units;
- further investigation into the modelling of sequences or zonation along the river;
- control of stream flow dynamics through litigation of water impoundments and extraction;
- integration of littoral fauna and zooplankton in future ecological research;
- investigation of the potential of re-introducing riparian vegetation in areas of high disturbance; and
- quantification of the economical importance of riparian zones in order to create awareness.

These few guidelines are based on the findings of this study and it is suggested that future government research protocols need to be revised. Further investigation is required into the financial and technical feasibility of proposing a management plan for catchments. The challenge is directed towards South African ecologists to prioritise areas for future research.

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude and appreciation to the following:

- Drs C. Boucher (study leader) and K.J. Esler (co-study leader) - Their guidance and extreme patience have been a motivating factor.

- Prof L. Mucina and Dr J. King - Both have contributed to the design of my research protocol.

- Students and technical staff of the Department of Botany - Their assistance with computer programmes and fieldwork material is greatly appreciated.

- The National Research Foundation - They provided me with a bursary afforded to undertake this study.

- Mazda Wildlife Fund - Provided a 4X4 vehicle, which I used in my study.

- My wife Aisha and the rest of my family - Their support and encouragement have been reassuring.

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Appendix 1: Checklist with classification system as used by the Angiosperm Phylogeny Group (Goldblatt & Manning 2000). Taxa are arranged alphabetically. Species not native to Cape Flora Region are marked with an asterisk*.

PTERIDOPHYTES (Ferns and Fern-allies)
ANEMIACEAE
Anemia simii Tardieu
Mohria caffrorum (L.) Desv.

ASPLENIACEAE
Asplenium aethiopicum (Burm.f.) Bech.
Asplenium lunulatum Sw.
Ceterach cordatum (Thunb.) Desv.

BLECHNACEAE
Blechnum attenuatum (Sw.) Mett.
Blechnum attenuatum (Sw.) Mett. var. giganteum (Kaulf.) Bonap.
Blechnum australe L.
Blechnum capense Burm.f.
Blechnum punctulatum Sw.
Blechnum sylvaticum L.

CYATHACEAE
Cyathea capensis (L.f.) Sm.

DENNSTAEDTIACEAE
Histiopteris incisa (Thunb.) J.Sm.
Pteridium aquilinum (L.) Kuhn

DRYOPTERIDACEAE
Dryopteris callolepis C.Chr.
Dryopteris inaequalis (Schltdl.) Kuntze
Polystichum pungens (Kaulf.) C.Presl
Rumohra adiantiformis (G.Forst.) Ching

GLEICHENIACEAE
Gleichenia polypodioides (L.) Sm.

GRAMMITIDACEAE
Grammitis poeppigiana (Mett.) Pic.Serm.

HYMENOPHYLLACEAE
Hymenophyllum capense Schrad.
Hymenophyllum marlothii Brause
Hymenophyllum peltatum (Poir.) Desv.
Hymenophyllum tunbrigense (L.) Sm.

LOMARIOPSIDACEAE
Elaphoglossum acrostichoides (Hook. & Grev.) Schelpe
Elaphoglossum angustatum (Schrad.) Hieron.
Elaphoglossum conforme (Sw.) Schott ex J.Sm.

LYCOPODIACEAE
Lycopodiella caroliniana L.
Lycopodium clavatum L.

OSMUNDACEAE
Todea barbara (L.) T.Moore

POLYPODIACEAE
Polypodium vulgare L.

PTERIDACEAE
Adiantum aethiopicum L.
Adiantum poiretii Wikstr.
Cheilanthes contracta (Kunze) Mett. ex Kuhn
Cheilanthes hastata (L.f.) Kunze
Cheilanthes multifida (Sw.) Sw.
Pellaea calomelanos (Sw.) Link
Pellaea pteroides (L.) Prantl
Pteris dentata Forssk.

SALVINIACEAE
Salvinia molesta D.S.Mitch.

SCHIZAEACEAE
Schizaea pectinata (L.) Sw.
Schizaea tenella Kaulf.

SPHAGNACEAE
Sphagnum capense Hornsch.
Sphagnum truncatum Hornsch.

THELYPTERIDACEAE
Thelypteris confluens (Thunb.) C.V.Morton
Thelypteris gueinziana (Mett.) Schelpe

GYMNOSPERMS (Cone-bearing plants)
CUPRESSACEAE
Widdringtonia nodiflora (L.) Powrie

PINACEAE
Pinus pinaster Aiton*

PODOCARPACEAE
Podocarpus elongatus (Aiton) L'Her. ex Pers.
Podocarpus falcatus (Thunb.) R.Br. ex Mirb.

ANGIOSPERMS (Flowering plants)
PALAEODICOTYLEDONS
LAURACEAE
Cassytha ciliolata Nees
Cassytha filiformis L.
Cryptocarya angustifolia E.Mey. ex Meisn.
Ocotea bullata (Burch.) Baill.

MONOCOTYLEDONS
AGAPANTHACEAE
Agapanthus africanus (L.) Hoffmanns.

ALLIACEAE
Tulbaghia alliacea L.f.

AMARYLLIDACEAE
Amaryllis belladonna L.
Boophone guttata (L.) Herb.
Crinum variabile (Jacq.) Herb.
Crossyne guttata (L.) D.Müll.-Doblies & U.Müll.-Doblies
Cyrtanthus ventricosus (Jacq.) Willd.
Gethyllis afra L.
Haemanthus coccineus L.
Haemanthus sanguineus Jacq.
Nerine sarniensis (L.) Herb.
Zephyranthes candida Herb.

ANTHERICACEAE
Chlorophytum rigidum Kunth

ARACEAE
Zantedeschia aethiopica (L.) Spreng.
Wolffia arrhiza (L.) Horkel ex Wimm.

ASPARAGACEAE
Asparagus africanus Lam.
Asparagus asparagoides (L.) W.Wight
Asparagus capensis L.
Asparagus declinatus L.
Asparagus kraussianus (Kunth) J.F.Macbr.
Asparagus lignosus Burm.f.
Asparagus retrofractus L.
Asparagus rigidus Jessop
Asparagus rubicundus P.J.Bergius
Asparagus scandens Thunb.

ASPHODELACEAE
Aloe haemanthifolia A.Berger & Marloth
Aloe mitriformis Mill.
Aloe perfoliata L.
Bulbine alooides (L.) Willd.
Bulbine cepacea (Burm.f.) Wijnands
Bulbine favosa (Thunb.) Roem. & Schult.

Bulbine sp.
Bulbinella trinervis (Baker) P.L.Perry
Bulbinella floribunda (Aiton) T.Durand & Schinz
Bulbinella triquetra (L.f.) Kunth
Kniphofia tabularis Marloth
Kniphofia uvaria (L.) Oken
Trachyandra esterhuysenae Oberm.
Trachyandra hirsuta (Thunb.) Kunth
Trachyandra muricata (L.f.) Kunth
Trachyandra tabularis (Baker) Oberm.

COLCHICACEAE
Baeometra uniflora (Jacq.) G.J.Lewis
Onixotis punctata (L.) Mabberley
Wurmbea monopetala (L.f.) B.Nord.
Wurmbea recurva B.Nord.
Wurmbea spicata (Burm.f.) T.Durand & Schinz

COMMELINACEAE
Commelina diffusa Burm.f. subsp. diffusa

CONVALLARIACEAE
Eriospermum bakerianum Schinz subsp. bakerianum
Eriospermum cordiforme T.M.Salter
Eriospermum lanceifolium Jacq.

CYPERACEAE
Capeobolus brevicaulis (C.B.Clarke) J.Browning
Carpha capitellata (Nees) Boeck.
Carpha glomerata (Thunb.) Nees
Chrysitrix capensis L. var. capensis
Chrysitrix junciformis Nees
Cyathocoma hexandra (Nees) J.Browning
Cyperus denudatus L.f. var denudatus
Cyperus thunbergii Vahl
Epischoenus adnatus Levyns
Epischoenus complanatus Levyns
Epischoenus gracilis Levyns
Epischoenus quadrangularis (Boeck.) C.B. Clarke
Epischoenus sp.
Epischoenus villosus Levyns
Ficinia acuminata (Nees) Nees
Ficinia bergiana Kunth
Ficinia brevifolia Nees ex Kunth
Ficinia bulbosa (L.) Nees
Ficinia capitella (Thunb.) Nees
Ficinia compasbergensis Drège
Ficinia deusta (P.J.Bergius) Levyns
Ficinia distans C.B.Clarke
Ficinia ecklonea (Steud.) Nees
Ficinia fascicularis Nees
Ficinia grandiflora T.H.Arnold & Gordon-Gray
Ficinia indica (Lam.) Pfeiff. var. indica
Ficinia ixioides Nees
Ficinia monticola Kunth
Ficinia nigrescens (Schrad.) J.Raynal
Ficinia oligantha (Steud.) J.Raynal
Ficinia polystachya Levyns
Ficinia ramosissima Kunth
Ficinia sp.
Ficinia trichodes (Schrad.) Benth. & Hook.f.
Ficinia zeyheri Boeck.
Fuirena hirsuta (P.J.Bergius) P.L.Forbes
Isolepis digitata Schrad.
Isolepis marginata (Thunb.) A.Dietr.
Isolepis prolifer R.Br.
Isolepis venustula Kunth
Mariscus congestus (Vahl) C.B.Clarke
Mariscus thunbergii (Vahl) Schrad.
Neesenbeckia punctoria (Vahl) Levyns
Pycreus nitidus (Lam.) J.Raynal
Schoenoxiphium lanceum (Thunb.) Kuk
Tetraria brevicaulis C.B.Clarke
Tetraria bromoides (Lam.) Pfeiffer
Tetraria burmannii (Schrad.) C.B.Clarke
Tetraria capillacea (Thunb.) C.B.Clarke
Tetraria compar (L.) T.Lestib.
Tetraria crassa Levyns
Tetraria cuspidata (Rottb.) C.B.Clarke
Tetraria exilis Levyns
Tetraria fasciata (Rottb.) C.B.Clarke
Tetraria fimbriolata (Nees) C.B.Clarke
Tetraria flexuosa (Thunb.) C.B.Clarke
Tetraria involucrata (Rottb.) C.B.Clarke
Tetraria nigrovaginata (Nees) C.B.Clarke
Tetraria picta (Boeck.) C.B.Clarke
Tetraria pillansii Levyns
Tetraria sp.
Tetraria sylvatica (Nees) C.B.Clarke
Tetraria triangularis (Boeck.) C.B.Clarke
Tetraria ustulata (L.) C.B.Clarke

HAEMODORACEAE
Dilatris corymbosa P.J.Bergius
Dilatris pillansii W.F.Barker
Dilatris viscosa L.f.
Wachendorfia brachyandra W.F.Barker
Wachendorfia paniculata Burm.
Wachendorfia thyrsiflora Burm.

HEMEROCALLIDACEAE
Caesia contorta (L.f.) T.Durand & Schinz

HYACINTHACEAE
Albuca echinosperma U.Müll.-Doblies
Albuca maxima Burm.f.
Albuca sp.
Drimia convallarioides (L.f.) J.C.Manning & Goldblatt
Drimia dregei (Baker) J.C.Manning & Goldblatt
Drimia exuviata (Jacq.) Jessop
Drimia filifolia (Jacq.) J.C.Manning & Goldblatt
Drimia fragrans (Jacq.) J.C.Manning & Goldblatt
Drimia minor (A.V.Duthie) Jessop
Drimia sp.
Lachenalia aloides (L.f.) Engl.
Lachenalia orchioides (L.) Aiton
Lachenalia orchioides (L.) Aiton var. glaucina (Jacq.) W.F.Barker
Lachenalia orchioides (L.) Aiton var. orchioides
Lachenalia unifolia Jacq.
Lachenalia unifolia Jacq. var unifolia
Ornithogalum dregeanum Kunth
Ornithogalum esterhuyseniae Oberm.
Ornithogalum graminifolium Thunb.
Ornithogalum graminifolium Thunb.
Ornithogalum hispidum Hornem. subsp. bergii (Schltdl.) Oberm.
Ornithogalum schlechterianum Schinz.
Ornithogalum suaveolens Jacq.
Ornithogalum thyrsoides Jacq.

HYPOXIDACEAE
Empodium plicatum (Thunb.) Garside
Spiloxene capensis (L.) Garside
Spiloxene curculigoides (Bolus) Garside
Spiloxene flaccida (Nel) Garside
Spiloxene schlechteri (Bolus) Garside
Spiloxene serrata (Thunb.) Garside

IRIDACEAE
Aristea africana (L.) Hoffmanns.
Aristea bakeri Klatt
Aristea confusa Goldblatt
Aristea cuspidata Schinz
Aristea dichotoma (Thunb.) Ker Gawl.
Aristea glauca Klatt
Aristea juncifolia Baker
Aristea latifolia G.J.Lewis
Aristea lugens (L.f.) Steud.
Aristea major Andrews
Aristea racemosa Baker
Aristea sp.
Aristea spiralis (L.f.) Ker Gawl.
Babiana ambigua (Roem. & Schult.) G.J.Lewis
Babiana angustifolia Sweet
Babiana disticha Ker Gawl.

Babiana sp.
Babiana stricta (Aiton) Ker Gawl.
Babiana stricta (Aiton) Ker Gawl. var. stricta
Babiana villosa (Aiton) Ker Gawl.
Babiana villosula (J.F.Gmel.) Ker Gawl. ex Steud.
Bobartia filiformis (L.f.) Ker Gawl.
Bobartia gladiata (L.f.) Ker Gawl.
Bobartia gladiata (L.f.) Ker Gawl. subsp. gladiata
Bobartia gladiata (L.f.) Ker Gawl. subsp. teres Strid
Bobartia indica L.
Chasmanthe aethiopica (L.) N.E.Br.
Chasmanthe floribunda (Salisb.) N.E.Br. var. floribunda
Ferraria crispa Burm. subsp. crispa
Galaxia galaxia (L.f.) Goldblatt
Geissorhiza aspera Goldblatt
Geissorhiza bolusii Baker
Geissorhiza burchellii R.C.Foster
Geissorhiza confusa Goldblatt
Geissorhiza grandiflora Goldblatt
Geissorhiza hesperanthoides Schltr.
Geissorhiza inaequalis L.Bolus
Geissorhiza inflexa (D.Delaroche) Ker Gawl.
Geissorhiza juncea (Link) A.Dietr.
Geissorhiza nubigena Goldblatt
Geissorhiza ovalifolia R.C.Foster
Geissorhiza ovata (Burm.f.) Aschers. & Graebn.
Geissorhiza ramosa Ker Gawl. ex Klatt
Geissorhiza sp.
Geissorhiza umbrosa G.J.Lewis
Gladiolus alatus L.
Gladiolus alatus L. var. alatus
Gladiolus blommesteinii L.Bolus
Gladiolus brevifolius Jacq.
Gladiolus brevifolius Jacq. var. minor G.J.Lewis
Gladiolus brevitubus G.J.Lewis
Gladiolus carneus D.Delaroche
Gladiolus debilis Ker Gawl.
Gladiolus debilis Ker Gawl. var. cochleatus (Sweet) G.J.Lewis
Gladiolus debilis Ker Gawl. var. debilis
Gladiolus gracilis Jacq.
Gladiolus hirsutus Jacq.
Gladiolus hyalinus Jacq.
Gladiolus inflatus Thunb.
Gladiolus inflatus Thunb. subsp. Inflatus var. inflatus
Gladiolus liliaceus Houtt.
Gladiolus maculatus Sweet
Gladiolus martleyi L.Bolus
Gladiolus nerineoides G.J.Lewis
Gladiolus teretifolius Goldblatt & M.P.de Vos
Gladiolus tristis L. var. aestivalis (Ingram) G.J.Lewis
Gladiolus undulatus L.
Hesperantha falcata (L.f.) Ker Gawl.
Hesperantha radiata (Jacq.) Ker Gawl.
Hexaglottis longifolia (Jacq.) Salisb.
Hexaglottis virgata Jacq.
Homeria collina (Thunb.)
Homeria miniata Andr.
Homeria ochroleuca Salisb.
Ixia cochlearis G.J.Lewis
Ixia dubia Vent.
Ixia esterhuyseniae M.P.de Vos
Ixia flexuosa L.
Ixia maculata L.
Ixia polystachya L. var. lutea (Ker Gawl.) G.J.Lewis
Ixia polystachya L. var. polystachya
Ixia sp.
Lapeirousia anceps (L.f.) Ker Gawl.
Lapeirousia corymbosa (L.) Ker Gawl.
Lapeirousia neglecta Goldblatt & J.C.Manning
Micranthus alopecuroides (L.) Rothm.
Micranthus junceus (Baker) N.E.Br.
Micranthus tubulosus (Burm.) N.E.Br.
Moraea angusta (Thunb.) Ker Gawl.
Moraea anomala G.J.Lewis
Moraea bellendenii (Sweet) N.E.Br.
Moraea bituminosa (L.f.) Ker Gawl.
Moraea collina Thunb.
Moraea cooperi Baker
Moraea fugax (D.Delaroche) Jacq. subsp. fugax
Moraea gawleri Spreng.
Moraea inconspicua Goldblatt
Moraea lewisiae (Goldblatt) Goldblatt
Moraea longifolia (Jacq.) Pers.
Moraea lugubris (Salisb.) Goldblatt
Moraea miniata Andr.
Moraea neglecta G.J.Lewis
Moraea neopavonia R.C.Foster
Moraea ochroleuca (Salisb.) Drapiez
Moraea papilionacea (L.f.) Ker Gawl.
Moraea pyrophila Goldblatt
Moraea ramosissima (L.f.) Druce
Moraea tricuspidata (L.f.) G.J.Lewis
Moraea tripetala (L.f.) Ker Gawl.
Moraea unguiculata Ker Gawl.
Moraea versicolor (Salisb. ex Klatt) Goldblatt
Moraea viscaria (L.f.) Ker Gawl.
Romulea flava (Lam.) M.P.deVos
Romulea flava (Lam.) M.P.deVos var. flava
Romulea flava (Lam.) M.P.de Vos var. minor (Bég.) M.P.de Vos
Romulea gracillima Baker
Romulea hirsuta (Steud. ex Klatt) Baker
Romulea hirsuta (Eckl. ex Klatt) Baker var. cuprea (Bég.) M.P.de Vos
Romulea hirsuta (Eckl. ex Klatt) Baker var. hirsuta
Romulea rosea (L.) Eckl.
Romulea rosea (L.) Eckl. var. australis (Ewart) M.P.de Vos
Romulea rosea (L.) Eckl. var. communis M.P.de Vos
Romulea rosea (L.) Eckl. var. reflexa (Eckl.) Bég.
Romulea rosea (L.) Eckl. var. rosea
Romulea triflora (Burm.f.) N.E.Br.
Thereianthus bracteolatus (Lam.) G.J.Lewis
Thereianthus ixioides G.J.Lewis
Thereianthus longicollis (Schltr.) G.J.Lewis
Thereianthus minutus (Klatt) G.J.Lewis
Thereianthus spicatus (L.) G.J.Lewis
Thereianthus spicatus (L.) G.J.Lewis var. linearifolius G.J.Lewis
Thereianthus spicatus (L.) G.J.Lewis var. spicatus
Tritonia crispa (L.f.) Ker Gawl.
Tritoniopsis antholyza (Poir.) Goldblatt
Tritoniopsis burchellii (N.E.Br.) Goldblatt
Tritoniopsis dodii (G.J.Lewis) G.J.Lewis
Tritoniopsis lata (L.Bolus) G.J.Lewis
Tritoniopsis lata (L.Bolus) G.J.Lewis var. lata
Tritoniopsis parviflora (Jacq.) G.J.Lewis
Tritoniopsis parviflora (Jacq.) G.J.Lewis var. parviflora
Tritoniopsis pulchella G.J.Lewis
Tritoniopsis pulchella G.J.Lewis var. pulchella
Tritoniopsis ramosa (Eckl. ex Klatt) G.J.Lewis
Tritoniopsis ramosa (Eckl. ex Klatt) G.J.Lewis var. ramosa
Tritoniopsis ramosa (Eckl. ex Klatt) G.J.Lewis var. robusta G.J.Lewis
Tritoniopsis sp.
Tritoniopsis triticea (Burm.f.) Goldblatt
Watsonia angusta Ker Gawl.
Watsonia borbonica (Pourr.) Goldblatt subsp. borbonica
Watsonia marginata (L.f.) Ker Gawl.
Watsonia meriana (L.) Mill.
Watsonia schlechteri L.Bolus
Watsonia sp.

JUNCACEAE
Juncus capensis Thunb.
Juncus cephalotes Thunb.
Juncus effusus L.
Juncus lomatophyllus Spreng.

ORCHIDACEAE
Acrolophia lamellata (Lindl.) Schltr. & Bolus
Bartholina etheliae Bolus
Ceratandra atrata (L.) T.Durand & Schinz
Ceratandra bicolor Sond. ex Bolus
Ceratandra globosa Lindl.
Ceratandra harveyana Lindl.
Corycium carnosum (Lindl.) Rolfe
Corycium orobanchoides (L.f.) Sw.
Disa atricapilla (Harv. ex Lindl.) Bolus

Disa atrorubens Schltr.
Disa begleyi L.Bolus
Disa bivalvata (L.f.) T.Durand & Schinz
Disa bolusiana Schltr.
Disa bracteata Sw.
Disa caulescens Lindl.
Disa comosa (Rchb.f.) Schltr.
Disa cornuta (L.) Sw.
Disa cylindrica (Thunb.) Sw.
Disa draconis (L.f.) Sw.
Disa ferruginea (Thunb.) Sw.
Disa filicornis (L.f.) Thunb.
Disa glandulosa Burch. ex Lindl.
Disa graminifolia Ker Gawl. ex Spreng.
Disa harveiana Lindl. subsp. harveiana
Disa longicornu L.f.
Disa maculata L.f.
Disa micropetala Schltr.
Disa multifida Lindl.
Disa neglecta Sond.
Disa obtusa Lindl.
Disa obtusa Lindl. subsp. hottentotica H.P.Linder
Disa obtusa Lindl. subsp. obtusa
Disa obtusa Lindl. subsp. picta (Sond.) H.P.Linder
Disa oligantha Rchb.f.
Disa racemosa L.f.
Disa rufescens (Thunb.) Sw.
Disa sp.
Disa tenella (L.f.) Sw. subsp. tenella
Disa tenuifolia Sw.
Disa tenuis Lindl.
Disa tripetaloides (L.f.) N.E.Br.
Disa uncinata Bolus
Disa uniflora Bergius
Disa vaginata Harv. ex Lindl.
Disperis capensis (L.f.) Sw.
Disperis circumflexa (L.) T.Durand & Schinz.
Disperis circumflexa (L.) T.Durand & Schinz. subsp. circumflexa
Disperis paludosa Harv. ex Lindl.
Disperis villosa (L.f.) Sw.
Eulophia litoralis Schltr.
Holothrix cernua (Burm.f.) Schelpe
Holothrix villosa Lindl.
Holothrix villosa Lindl. var villosa
Monadenia bolusiana Schltr.
Monadenia bracteata Sw.
Pterygodium acutifolium Lindl.
Pterygodium alatum (Thunb.) Sw.
Pterygodium catholicum (L.) Sw.
Pterygodium platypetalum Lindl.
Satyrium bicallosum Thunb.
Satyrium bicorne (L.) Thunb.
Satyrium bracteatum (L.f.) Thunb.
Satyrium coriifolium Sw.
Satyrium humile Lindl.
Satyrium retusum Lindl.
Satyrium sp.
Satyrium stenopetalum Lindl. subsp. brevicalcaratum (Bolus) A.V.Hall
Satyrium striatum Thunb.
Schizodium bifidum (Thunb.) Rchb.f.
Schizodium cornutum (L.) Schltr.
Schizodium inflexum Lindl.
Schizodium obliquum Lindl.
Schizodium obliquum Lindl. subsp. clavigerum (Lindl.) H.P.Linder
Schizodium obliquum Lindl. subsp. obliquum

POACEAE
Agrostis bergiana Trin.
Aira cupaniana Guss.*
Andropogon appendiculatus Nees
Anthoxanthum dregeanum (Nees) Stapf
Anthoxanthum odoratum L.
Anthoxanthum tongo (Trin.) Stapf
Aristida canescens Henrard subsp. canescens
Aristida junciformis Trin. & Rupr.
Aristida junciformis Trin. & Rupr. subsp. junciformis
Avena barbata Brot.*
Avena sativa L.*
Brachypodium flexum Nees
Briza maxima L.*
Briza minor L.*
Bromus catharticus Vahl*
Bromus diandrus Roth*
Bromus hordeaceus L. subsp. ferronii (Mabille) P.M.Sm.*
Bromus hordeaceus L. subsp. molliformis (J.Lloyd) Maire & Weiller*
Cymbopogon marginatus (Steud.) Stapf ex Burtt Davy
Cynodon dactylon (L.) Pers.
Digitaria sanguinalis (L.) Scop.*
Ehrharta bulbosa J.E.Sm.
Ehrharta calycina J.E.Sm.
Ehrharta calycina Sm. var. calycina
Ehrharta capensis Thunb.
Ehrharta dura Nees ex Trin.
Ehrharta erecta Lam.
Ehrharta erecta Lam. var natalensis Stapf
Ehrharta erecta Lam. var. erecta
Ehrharta longiflora J.E.Sm.
Ehrharta longifolia Schrad.
Ehrharta ottonis Kunth ex Nees
Ehrharta ramosa (Thunb.) Thunb. subsp. aphylla (Schrad.) Gibbs-Russ
Ehrharta ramosa (Thunb.) Thunb. subsp. ramosa
Ehrharta ramosa (Thunb.) Thunb. var. aphylla (Schrad.) Gluckman
Ehrharta rehmannii Stapf
Ehrharta rehmannii Stapf subsp. filiformis (Stapf) Gibbs-Russ.
Ehrharta rehmannii Stapf subsp. rehmannii
Ehrharta rupestris Nees ex Trin. subsp. dodii (Stapf) Gibbs-Russ.
Ehrharta rupestris Nees ex Trin. subsp. tricostata (Stapf) Gibbs-Russ.
Ehrharta setacea Nees
Ehrharta setacea Nees subsp. setacea
Ehrharta sp.
Ehrharta villosa Schult.f.
Eleusine coracana (L.) Gaertn.*
Eragrostis capensis (Thunb.) Trin.
Eragrostis curvula (Schrad.) Nees
Eragrostis sarmentosa (Thunb.) Trin.
Eragrostis sp.
Festuca scabra Vahl
Gastridium phleoides (Nees & Meyen) C.E.Hubb.*
Helictotrichon capense Schweick.
Helictotrichon dodii (Stapf) Schweick.
Helictotrichon hirtulum (Steud.) Schweick.
Helictotrichon leoninum (Steud.) Schweick.
Helictotrichon longum (Stapf) Schweick.
Hemarthria altissima (Poir.) Stapf & C.E.Hubb.
Heteropogon contortus (L.) P.Beauv. ex Roem. & Schult.
Holcus setiger Nees
Hordeum murinum L. subsp. leporinum (Link) Arcang.*
Hyparrhenia anamesa Clayton*
Hyparrhenia hirta (L.) Stapf
Imperata cylindrica (L.) Raeuschel*
Imperata sp.
Koeleria capensis (Steud.) Nees
Melinis repens (Willd.) Zizka subsp. repens*
Merxmuellera cincta (Nees) Conert
Merxmuellera drakensbergensis (Schweick.) Conert
Merxmuellera lupulina (Thunb.) Conert
Merxmuellera rufa (Nees) Conert
Merxmuellera stricta (Schrader)Conert
Paspalum dilatatum Poir.*
Paspalum urvillei Steud.*
Pennisetum clandestinum Chiov.*
Pennisetum macrourum Trin.
Pennisetum thunbergii Kunth
Pentameris distichophylla (Lehm.) Nees
Pentameris hirtiglumis N.P.Barker
Pentameris macrocalycina (Steud.) Schweick.
Pentameris oreophila N.P.Barker
Pentameris sp.
Pentameris thuarii P.Beauv.
Pentaschistis airoides (Nees) Stapf subsp. airoides
Pentaschistis ampla (Nees) McClean
Pentaschistis argentea Stapf
Pentaschistis aristidoides (Thunb.) Stapf
Pentaschistis aspera (Thunb.) Stapf

Pentaschistis aurea (Steud.) McClean
Pentaschistis aurea (Steud.) McClean subsp. aurea
Pentaschistis barbata (Nees) H.P.Linder subsp. barbata
Pentaschistis capensis (Nees) Stapf
Pentaschistis colorata (Steud.) Stapf
Pentaschistis curvifolia (Schrad.) Stapf
Pentaschistis densifolia (Nees) Stapf
Pentaschistis eriostoma () Stapf
Pentaschistis holciformis (Nees) H.P.Linder
Pentaschistis involuta (Steud.) Adamson
Pentaschistis malouinensis (Steud.) Clayton
Pentaschistis pallescens (Schrad.) Stapf
Pentaschistis pallida (Thunb.) H.P.Linder
Pentaschistis patula (Nees) Stapf
Pentaschistis pusilla (Nees) H.P.Linder
Pentaschistis rigidissima Pilg. ex H.P.Linder
Pentaschistis rupestris (Nees) Stapf
Pentaschistis sp.
Pentaschistis tortuosa (Trin.)Stapf
Pentaschistis triseta (Thunb.) Stapf
Pentaschistis tysonii Stapf
Pentaschistis veneta H.P.Linder
Pentaschistis viscidula (Nees) Stapf
Phragmites australis (Cav.) Trin. ex Steud.
Pseudopentameris caespitosa N.P.Barker
Pseudopentameris macrantha (Schrad.) Conert
Sporobolus africanus (Poir.) Robyns & Tournay
Stipa dregeana Steud.
Stipa dregeana Steud. var elongata (Nees) Stapf
Stipagrostis zeyheri (Nees) De Winter
Stipagrostzeyheri (Nees) De Winter subsp. zeyheri
Themeda triandra Forssk.
Tribolium acutiflorum (Nees) Renvoize
Tribolium brachystachyum (Nees) Renvoize
Tribolium echinatum (Thunb.) Renvoize
Tribolium hispidum (Thunb.) Desv.
Tribolium obliterum (Hemsl.) Renvoize
Tribolium sp.
Tribolium uniolae (L.f.) Renvoize
Vulpia bromoides (L.) S.F.Gray
Vulpia myuros (L.) C.C.Gmel.*

PRIONIACEAE
Prionium serratum (L.f.) Drège ex E.Mey.

RESTIONACEAE
Anthochortus crinalis (Mast.) H.P.Linder
Anthochortus graminifolius (Kunth) H.P.Linder
Askidiosperma andreaeanum (Pillans) H.P.Linder
Askidiosperma chartaceum (Pillans) H.P.Linder
Askidiosperma chartaceum (Pillans) H.P.Linder subsp. chartaceum
Askidiosperma esterhuyseniae (Pillans) H.P.Linder
Askidiosperma paniculatum (Mast.) H.P.Linder
Calopsis esterhuyseniae (Pillans) H.P.Linder
Calopsis membranacea (Pillans) H.P.Linder
Calopsis nudiflora (Pillans) H.P.Linder
Calopsis paniculata (Rottb.) Desv.
Calopsis rigida (Mast.) H.P.Linder
Calopsis rigorata (Mast.) H.P.Linder
Calopsis viminea (Rottb.) H.P.Linder
Cannomois nitida (Mast.) Pillans
Cannomois scirpoides (Kunth) Mast.
Cannomois virgata (Rottb.) Steud.
Ceratocaryum argenteum Nees ex Kunth
Chondropetalum aggregatum (Mast.) Pillans
Chondropetalum deustum Rottb.
Chondropetalum ebracteatum (Kunth) Pillans
Chondropetalum hookerianum (Mast.) Pillans
Chondropetalum mucronatum (Nees) Pillans
Elegia asperiflora (Nees) Kunth
Elegia capensis (Burm.f.) Schelpe
Elegia fistulosa Kunth
Elegia grandis (Nees) Kunth
Elegia intermedia (Steud.) Pillans
Elegia juncea L.
Elegia neesii Mast.
Elegia persistens Pillans
Elegia racemosa (Poir.) Pers.
Elegia sp.
Elegia spathacea Mast.
Elegia stokoei Pillans
Elegia thyrsifera (Rottb.) Pers.
Elegia vaginulata Mast.
Hypodiscus albo-aristatus (Nees) Mast.
Hypodiscus aristatus (Thunb.) Mast.
Hypodiscus willdenowia (Nees) Mast.
Ischyrolepis capensis (L.) H.P.Linder
Ischyrolepis cincinnata (Mast.) H.P.Linder
Ischyrolepis curvibracteata Esterh.
Ischyrolepis curviramis (Kunth) H.P.Linder
Ischyrolepis fraterna (Kunth) H.P.Linder
Ischyrolepis gaudichaudiana (Kunth) H.P.Linder
Ischyrolepis ocreata (Kunth) H.P.Linder
Ischyrolepis paludosa (Pillans) H.P.Linder
Ischyrolepis saxatilis Esterh.
Ischyrolepis sieberi (Kunth) H.P.Linder
Ischyrolepis sp.
Ischyrolepis subverticillata Steud.
Ischyrolepis tenuissima (Kunth) H.P.Linder
Ischyrolepis triflora (Rottb.) H.P.Linder
Platycaulos depauperatus (Kunth) H.P.Linder
Restio bifarius Mast.
Restio bifidus Thunb.
Restio bolusii Pillans
Restio burchellii Pillans
Restio corneolus Esterh.
Restio debilis Nees
Restio degenerans Pillans
Restio dispar Mast.
Restio distans Pillans
Restio distichus Rottb.
Restio echinatus Kunth
Restio ejuncidus Mast
Restio filiformis Poir.
Restio leptostachyus Kunth
Restio multiflorus Spreng.
Restio pachystachyus Kunth
Restio perplexus Kunth
Restio pillansii H.P.Linder
Restio pulvinatus Esterh.
Restio purpurascens Nees ex Mast.
Restio quadratus Mast.
Restio sarocladus Mast.
Restio sejunctus Mast.
Restio sp.
Restio triticeus Rottb.
Restio tuberculatus Pillans
Restio versatilis H.P.Linder
Restio zwartbergensis Pillans
Staberoha cernua (L.f.) T.Durand & Schinz
Staberoha remota Pillans
Thamnochortus cinereus H.P.Linder
Thamnochortus erectus (Thunb.) Mast.
Thamnochortus fruticosus P.J.Bergius
Thamnochortus gracilis Mast.
Thamnochortus insignis Mast.
Thamnochortus lucens (Poir.) H.P.Linder
Thamnochortus pulcher Pillans
Thamnochortus sp.
Willdenowia glomerata (Thunb.) H.P.Linder
Willdenowia sp.
Willdenowia sulcata Mast.

TECOPHILAEACEAE
Cyanella hyacinthoides L.

EUDICOTYLEDONS
AIZOACEAE
Carpanthea pomeridiana (L.) N.E.Br.
Carpobrotus edulis (L.) L.Bolus
Dorotheanthus bellidiformis (Burm.f.) N.E.Br. subsp. bellidiformis
Erepsia anceps (Haw.) Schwantes
Erepsia aspera (Haw.) L.Bolus
Erepsia heteropetala (Haw.) Schwantes

Erepsia laxa L.Bolus
Erepsia pillansii (Kensit) Liede
Erepsia ramosa L.Bolus
Lampranthus acutifolius (L.Bolus) N.E.Br.
Lampranthus altistylus N.E.Br.
Lampranthus arbuthnotiae (L.Bolus) L.Bolus
Lampranthus emarginatus (L.) N.E.Br.
Lampranthus emarginatus (L.) N.E.Br. var. emarginatus
Lampranthus framesii (L.Bolus) N.E.Br.
Lampranthus scaber (L.) N.E.Br.
Lampranthus stenus (Haw.) N.E.Br.
Oscularia deltoides (L.) Schwantes
Ruschia pulchella (Haw.) Schwantes
Skiatophytum tripolium (L.) L.Bolus
Tetragonia nigrescens Eckl. & Zeyh.

ANACARDIACEAE
Heeria argentea (Thunb.) Meisn.
Rhus angustifolia L.
Rhus dissecta Thunb.
Rhus glauca Thunb.
Rhus laevigata L.
Rhus lucida L.
Rhus rosmarinifolia Vahl
Rhus tomentosa L.
Rhus undulata Jacq.

APIACEAE
Anginon sp.
Annesorhiza nuda (Aiton) B.L.Burtt
Arctopus echinatus L.
Chamarea capensis (Thunb.) Eckl. & Zeyh.
Chamarea sp.
Glia prolifera (Burm.f.) B.L.Burtt
Hermas capitata L.f.
Hermas ciliata L.f.
Hermas gigantea L.f.
Hermas pillansii C.Norman
Hermas quinquedentata L.f.
Itasina filifolia (Thunb.) Raf.
Lichtensteinia lacera Cham. & Schltdl.
Peucedanum galbaniopse H.Wolff
Peucedanum galbanum (L.) Drude
Peucedanum gummiferum (L.) Wijnands
Peucedanum polyactinum B.L.Burtt
Peucedanum sp.
Peucedanum strictum (Spreng.) B.L.Burtt
Peucedanum tenuifolium Thunb.
Sanicula elata Buch.-Ham. ex D.Don
Sonderina caruifolia (Sond.) H.Wolff
Sonderina sp.
Torilis arvensis (Huds.) Link

APOCYNACEAE
Aspidoglossum gracile (E.Mey.) Kupicha
Eustegia filiformis Schult.
Eustegia minuta Schult.
Gomphocarpus cancellatus (Burm.f.) Bruyns
Microloma tenuifolium (L.) K.Schum.
Oncinema lineare (L.f.) Bullock
Secamone alpini Schult.
Xysmalobium undulatum (L.) W.T.Aiton

AQUIFOLIACEAE
Ilex mitis (L.) Radlk.

ARALIACEAE
Centella caespitosa Adamson
Centella calliodus (Cham. & Schltdl.) Drude
Centella eriantha (A.Rich.) Drude
Centella flexuosa (Eckl. & Zeyh.) Drude
Centella glabrata L.
Centella macrocarpa (Rich.) Adamson var. macrocarpa
Centella macrodus (Spreng.) Burtt
Centella montana (Cham. & Schltdl.) Domin
Centella restioides Adamson
Centella villosa L.
Centella villosa L. var. latifolia (Eckl. & Zeyh.) Adamson

ASTERACEAE
Amphiglossa sp.
Anaxeton arborescens (L.) Less.
Anaxeton asperum (Thunb.) DC. subsp. asperum
Anaxeton asperum (Thunb.) DC. subsp. pauciflorum Lundgren
Arctotheca calendula (L.) Levyns
Arctotis angustifolia L.
Arctotis flaccida Jacq.
Artemisia afra Jacq. ex Willd.
Athanasia crithmifolia (L.) L.
Athanasia quinquedentata Thunb. subsp. quinquedentata
Athanasia trifurcata (L.) L.
Athrixia crinita (L.) Druce
Athrixia heterophylla (Thunb.) Less.
Athrixia heterophylla (Thunb.) Less. subsp. heterophylla
Athrixia heterophylla (Thunb.) Less. subsp. sessifolia (DC.) Kroner
Atrichantha gemmifera (Bolus) Hilliard & B.L.Burtt
Berkheya armata (Vahl) Druce
Berkheya herbacea (L.f.) Druce
Berkheya rigida (Thunb.) Adamson & T.M.Salter
Brachylaena neriifolia (L.) R.Br.
Bryomorphe lycopodioides (Sch.Bip.) Levyns
Chrysanthemoides monilifera (L.) Norl.
Chrysocoma ciliata L.
Chrysocoma coma-aurea L.
Cineraria erosa (Thunb.) Harv.
Cineraria mitellifolia L'Hér.
Cineraria tomentosa (DC.) Less.
Conyza bonariensis (L.) Cronquist
Conyza canadensis (L.) Cronquist*
Conyza scabrida DC.
Conyza ulmifolia (Burm.f.) Kuntze
Corymbium africanum L.
Corymbium africanum L. subsp. scabridum (P.J.Bergius) Weitz var. gramineum (Burm.f.) Weitz
Corymbium africanum L. subsp. scabridum (P.J.Bergius) Weitz var. scabridum
Corymbium congestum E.Mey. ex DC.
Corymbium cymosum E.Mey. ex DC.
Corymbium glabrum L.
Corymbium villosum L.f.
Cotula turbinata (L.) Pers.
Cullumia ciliaris (L.) R.Br.
Cullumia ciliaris (L.) R.Br. subsp. ciliaris
Cullumia setosa (L.) R.Br.
Dimorphotheca montanaNorl.
Dimorphotheca nudicaulis (L.) B.Nord.
Dimorphotheca nudicaulis (L.) DC. var. nudicaulis
Dimorphotheca pluvialis (L.) Moench
Disparago ericoides (P.J.Bergius) Gaertn.
Dolichothrix ericoides (Lam.) Hilliard & B.L.Burtt
Edmondia pinifolia (Lam.) Hilliard
Edmondia sesamoides (L.) Hilliard
Elytropappus glandulosus Less.
Elytropappus gnaphaloides (L.) Levyns
Elytropappus rhinocerotis (L.f.) Less.
Eriocephalus africanus L.
Eriocephalus sericeus Gaudich.
Euryops abrotanifolius (L.) DC.
Euryops lateriflorus (L.f.) DC.
Euryops rupestris Schltr. var. dasycarpus B.Nord.
Euryops rupestris Schltr. var. rupestris
Felicia bellidioides Schltr. subsp. bellidioides
Felicia bergerana (Spreng.) O.Hoffm.
Felicia cymbalariae (Aiton) Adamson & T.M.Salter
Felicia cymbalariae (Aiton) Bolus & Wolley-Dod ex Adamson & T.M.Sa subsp. cymbalariae
Felicia cymbalarioides (DC.) Grau
Felicia dubia Cass.
Felicia fruticosa (L.) G.Nichols.
Felicia tenella (L.) Nees
Gazania krebsiana Less. subsp. krebsiana
Gazania pectinata (Thunb.) Spreng.
Gazania serrata DC.
Gazania sp.

Gerbera crocea (L.) Kuntze
Gerbera linnaei Cass.
Gerbera piloselloides (L.) Cass.
Gerbera sp.
Gibbaria ilicifolia (L.) Norl.
Haplocarpha lanata (Thunb.) Less.
Helichrysum asperum (Thunb.) Hilliard & B.L. Burtt
Helichrysum capense Hilliard
Helichrysum crispum (L.) D.Don
Helichrysum cylindriflorum (L.) Hilliard & B.L.Burtt
Helichrysum cymosum (L.) D.Don
Helichrysum diffusum DC.
Helichrysum felinum Less.
Helichrysum foetidum (L.) Moench
Helichrysum helianthemifolium (L.) D.Don
Helichrysum indicum (L.) Grierson
Helichrysum litorale Bolus
Helichrysum marifolium DC.
Helichrysum nudifolium (L.) Less.
Helichrysum odoratissimum (L.) Sweet
Helichrysum panduratum O.Hoffm. var. panduratum
Helichrysum pandurifolium Schrank
Helichrysum patulum (L.) D.Don
Helichrysum rotundifolium (Thunb.) Less.
Helichrysum rutilans (L.) D.Don
Helichrysum teretifolium (L.) D.Don
Helichrysum tinctum (Thunb.) Hilliard & B.L.Burtt
Helichrysum vestitum (L.) Schrank
Helichrysum zeyheri Less.
Heterolepis aliena (L.f.) Druce
Hippia frutescens (L.) L.
Hippia pilosa (P.J.Bergius) Druce
Hypochaeris radicata L.*
Lachnospermum umbellatum (D.Don) Pillans
Lasiopogon brachypterus O.Hoffm. ex Zahlbr.
Lasiospermum bipinnatum (Thunb.) Druce
Leysera gnaphalodes (L.) L.
Mairia crenata (Thunb.) Nees
Mairia foliosa Harv.
Mairia hirsuta DC.
Mairia sp.
Metalasia cephalotes (Thunb.) Less.
Metalasia densa (Lam.) Karis
Metalasia divergens (Thunb.) D.Don subsp. divergens
Metalasia divergens (Thunb.) D.Don subsp. fusca P.O.Karis
Metalasia inversa Karis
Metalasia muricata (L.) D.Don
Metalasia sp.
Oedera capensis (L.) Druce
Oedera hirta Thunb.
Oedera imbricata Lam.
Oedera laevis DC.
Oldenburgia intermedia Bond
Oldenburgia paradoxa Less.
Oreoleysera montana (Bolus) Bremer
Osmitopsis afra (L.) Bremer
Osmitopsis asteriscoides (P.J.Bergius) Less.
Osmitopsis nana Schltr.
Osmitopsis pinnatifida (DC.) Bremer subsp. angustifolia (DC.) Bremer
Osteospermum ciliatum P.J.Bergius
Osteospermum clandestinum (Less.) Norl.
Osteospermum junceum P.J.Bergius
Osteospermum spinosum L.
Osteospermum spinosum L. var. runcinatum P.J.Bergius
Osteospermum tomentosum (L.f.) Norl.
Othonna bulbosa L.
Othonna hederifolia B.Nord.
Othonna heterophylla L.f.
Othonna multicaulis Harv.
Othonna perfoliata Jacq.
Othonna quinquedentata DC.
Othonna ramulosa DC.
Othonna sonchifolia DC.
Plecostachys polifolia (Thunb.) Hilliard & B.L.Burtt
Polyarrhena reflexa (L.) Cass. subsp. reflexa
Printzia aromatica (L.) Less.
Printzia pyrifolia Less.
Pseudognaphalium undulatum (L.) Hilliard & B.L.Burtt
Pteronia camphorata (L.) L.
Pteronia camphorata L. var. camphorata
Pteronia camphorata L. var. longifolia Harv.
Pulicaria scabra (Thunb.) Druce
Senecio bipinnatus (Thunb.) Less.
Senecio burchellii DC.
Senecio consanguineus DC.
Senecio cordifolius L.f.
Senecio crispus Thunb.
Senecio elegans L.
Senecio erosus L.f.
Senecio erubescens Aiton var. erubescens
Senecio hastatus L.
Senecio hastifolius (L.f.) Less.
Senecio lanifer Mart. ex C.Jeffrey
Senecio lineatus (L.f.) DC.
Senecio paniculatus P.J.Bergius
Senecio pinifolius (L.) Lam.
Senecio pinnulatus Thunb.
Senecio pterophorus DC.
Senecio pubigerus L.
Senecio purpureus L.
Senecio rigidus L.
Senecio sp.
Senecio speciosus Willd.
Senecio tuberosus (DC.) Harv.
Senecio umbellatus L.
Sonchus oleraceus L.
Stoebe aethiopica L.
Stoebe capitata P.J.Bergius
Stoebe cinerea (L.) Thunb.
Stoebe cyathuloides Schltr.
Stoebe fusca (L.) Thunb.
Stoebe incana Thunb.
Stoebe plumosa (L.) Thunb.
Stoebe prostrata L.
Stoebe sp.
Stoebe spiralis Less.
Syncarpha canescens (L.) B.Nord. subsp. canescens
Syncarpha gnaphaloides (L.) DC.
Syncarpha lepidopodium (Bolus) B.Nord.
Syncarpha speciosissima (L.) B.Nord. subsp. angustifolia (DC.) B.Norc
Syncarpha variegata (P.J.Bergius) B.Nord.
Tolpis capensis (L.) Sch.Bip.
Tripteris clandestina Less.
Tripteris tomentosa (L.f.) Less.
Troglophyton parvulum (Harv.) Hilliard & B.L.Burtt
Ursinia anthemoides (L.) Poir. subsp. anthemoides
Ursinia caledonica (E.Phillips) Prassler
Ursinia crithiufolia
Ursinia dentata (L.) Poir.
Ursinia nana DC.
Ursinia nudicaulis (Thunb.) N.E.Br.
Ursinia paleacea (L.) Moench
Ursinia pinnata (Thunb.) Prassler
Ursinia scariosa (Aiton) Poir. subsp. subhirsuta (DC.) Prassler
Ursinia sp.
Vellereophyton dealbatum (Thunb.) Hilliard & B.L.Burtt
Zyrphelis burchellii (DC.) Kuntze
Zyrphelis foliosa (Harv.) Kuntze
Zyrphelis lasiocarpa (DC.) Kuntze
Zyrphelis microcephala (Less.) DC.
Zyrphelis montana (Schltr.) Nesom
Zyrphelis taxifolia (L.) DC.

BALANOPHORACEAE
Mystropetalon thomii Harv.

BORAGINACEAE
Echium plantagineum L.*
Lobostemon pearsonii Levyns
Lobostemon regulareflorus (Ker Gawl.) M.H.Buys
Lobostemon sanguineus Schltr.
Myosotis arvensis (L.) Hill*

BRASSICACEAE

Cardamine africana L.
Heliophila callosa (L.f.) DC.
Heliophila concatenata Sond.
Heliophila cuneata Marais
Heliophila diffusa (Thunb.) DC. var. diffusa
Heliophila diffusa (Thunb.) DC. var. flacca (Sond.) Marais
Heliophila dregeana Sond.
Heliophila esterhuyseniae Marais
Heliophila linoides Schltr.
Heliophila nubigena Schltr.
Heliophila scoparia Burch. ex DC. var. scoparia
Heliophila tabularis Wolley-Dod.

BRUNIACEAE
Berzelia abrotanoides (L.) Brongn.
Berzelia intermedia (D.Dietr.) Schltdl.
Berzelia lanuginosa (L.) Brongn.
Berzelia squarrosa (Thunb.) Sond.
Brunia laevis Thunb.
Brunia noduliflora Goldblatt & J.C.Manning
Nebelia fragarioides (Willd.) Kuntze
Nebelia paleacea (P.J.Bergius) Sweet
Pseudobaeckea cordata (Burm.f.) Nied.
Thamnea massoniana Dummer
Tittmannia laxa (Thunb.) C.Presl var. laxa

CAMPANULACEAE
Cyphia bulbosa (L.) P.J.Bergius
Cyphia bulbosa (L.) P.J.Bergius var. bulbosa
Cyphia digitata (Thunb.) Willd.
Cyphia digitata (Thunb.) Willd. subsp. digitata
Cyphia phyteuma (L.) Willd.
Cyphia volubilis (Burm.f.) Willd.
Cyphia volubilis (Burm.f.) Willd. var volubilis
Cyphia volubilis (Burm.f.) Willd. var. latipetala (C.Presl) E.Wimm.
Grammatotheca bergiana (Cham.) C.Presl
Grammatotheca bergiana (Cham.) C.Presl var. bergiana
Laurentia pygmaea (Thunb.) Sond.
Lobelia comosa L.
Lobelia comosa L. var. comosa
Lobelia coronopifolia L.
Lobelia erinus L.
Lobelia humifusa (A.DC.) Phillipson ined.
Lobelia jasionoides (A.DC.) E.Wimm.
Lobelia jasionoides (A.DC.) E.Wimm. var. jasionoides
Lobelia pinifolia L.
Lobelia pinifolia L. var pinifolia
Lobelia stenosiphon (Adamson) E.Wimm.
Lobelia tomentosa L.f.
Monopsis lutea (L.) Urb.
Monopsis simplex (L.) E.Wimm.
Monopsis variifolia (Sims) Urb.
Nebelia fragarioides (Willd.) Kuntze
Nebelia paleacea (P.J.Bergius) Sweet
Nebelia sphaerocephala (Sond.) Kuntze
Prismatocarpus brevilobus A.DC.
Prismatocarpus diffusus (L.f.) A.DC.
Prismatocarpus fruticosus L'Hér.
Prismatocarpus nitidus L'Hér. var nitidus
Prismatocarpus tenerrimus H.Buek
Pseudobaeckea cordata (Burm.f.) Nied.
Raspalia microphylla (Thunb.) Brongn.
Raspalia virgata (Brongn.) Pillans
Roella ciliata L.
Roella muscosa L.f.
Thamnea massoniana Dummer
Tittmannia laevis Pillans
Wahlenbergia capensis (L.) A.DC.
Wahlenbergia capillaris (H.Buek) Lammers
Wahlenbergia ecklonii H.Buek
Wahlenbergia exilis A.DC.
Wahlenbergia obovata Brehmer
Wahlenbergia paniculata (Thunb.) A.DC.
Wahlenbergia parvifolia (P.J.Bergius) Lammers
Wahlenbergia procumbens (Thunb.) A.Dc.
Wahlenbergia subulata (L'Hér.) Lammers var. subulata
Wimmerella bifida (Thunb.) L.Serra, M.B.Crespo & Lammers
Wimmerella pygmaea (Thunb.) L.Serra, M.B.Crespo & Lammers

CARYOPHYLLACEAE
Cerastium capense Sond.
Silene bellidioides Sond.
Silene gallica L.*
Silene pilosellifolia Cham. & Schltdl.
Silene sp.
Silene undulata Aiton
Silene vulgaris (Moench) Garcke subsp. vulgaris*
Stellaria media (L.) Vill.*

CELASTRACEAE
Cassine peragua L.
Cassine schinoides (Spreng.) R.H.Archer
Gymnosporia laurina (Thunb.) Szyszyl.
Maurocenia frangula Mill.
Maytenus acuminata (L.f) Loes. var acuminata
Maytenus oleoides (Lam.) Loes.
Pterocelastrus rostratus (Thunb.) Walp
Pterocelastrus tricuspidatus (Lam.) Sond.

CONVOLVULACEAE
Cuscuta campestris Yunck.
Cuscuta nitida E.Mey. ex Choisy
Myosotis arvensis (L.) Hill

CORNACEAE
Curtisia dentata (Burm.f.) C.A.Sm.

CRASSULACEAE
Crassula capensis (L.) Baill
Crassula coccinea L.
Crassula dejecta Jacq.
Crassula dichotoma L.
Crassula fascicularis Lam.
Crassula flava L.
Crassula natans Thunb. var. minus (Eckl. & Zeyh.) G.D.Rowley
Crassula nudicaulis L.
Crassula nudicaulis L. var. nudicaulis
Crassula obtusa Haw.
Crassula pellucida L. subsp. pellucida
Crassula pruinosa L.
Crassula saxifraga Harv.
Crassula scabra L.
Crassula sp.
Crassula umbellata Thunb.

CUNONIACEAE
Cunonia capensis L.
Platylophus trifoliatus (Thunb.) D.Don

DIPSACEAE
Cephalaria rigida (L.) Roem. & Schult.
Scabiosa columbaria L.

DROSERACEAE
Drosera aliciae Raym.-Hamet
Drosera capensis L.
Drosera cistiflora L.
Drosera hilaris Cham. & Schltdl.
Drosera pauciflora Banks ex DC.
Drosera trinervia Spreng.

EBENACEAE
Diospyros glabra (L.) De Winter
Diospyros whyteana (Hiern) F.White

ERICACEAE
Erica abietina L. subsp. abietina
Erica abietina L. subsp. aurantiaca E.G.H.Oliv. & I.M.Oliv.
Erica argyrea Guthrie & Bolus
Erica armata Klotzsch ex Benth. var. breviaristata Bolus
Erica artemisioides (Klotzsch) E.G.H.Oliv.
Erica articularis L. var articularis
Erica autumnalis L.Bolus
Erica axillaris Thunb.

Erica bicolor Thunb.
Erica binaria E.G.H.Oliv.
Erica brevifolia Sol. ex Salisb.
Erica caffra L.
Erica calycina L.
Erica calycina L. var. calycina
Erica calycina L. var. fragrans (Andrews) Bolus
Erica calycina L. var. periplociflora (Salisb.) Bolus
Erica calycina L. var. viscidiflora (Esterh.) Dulfer
Erica canescens J.C.Wendl.
Erica carduifolia Salisb.
Erica cerinthoides L.
Erica coccinea L.
Erica coccinea L. var. coccinea
Erica corifolia L var. corifolia
Erica corifolia L.
Erica cristata Dulfer
Erica cristiflora Salisb.
Erica curviflora Salisb.
Erica curvifolia Salisb. var. curvifolia
Erica curvifolia Salisb. var. sulphurea (Andrews) Bolus
Erica curvirostris Salisb.
Erica curvirostris Salisb. var. curvirostris
Erica denticulata L.
Erica desmantha Benth.
Erica desmantha Benth. var. desmantha
Erica doliiformis Salisb.
Erica equisetifolia Salisb.
Erica fastigiata L.
Erica fastigiata L. var. fastigiata
Erica fausta Salisb.
Erica glutinosa P.J.Bergius
Erica glutinosa P.J.Bergius var. glutinosa
Erica gracilis J.C.Wendl.
Erica grandiflora L.f.
Erica grandiflora L.f. var. exsurgens (Andrews) E.G.H.Oliv.
Erica hirta Thunb.
Erica hirtiflora Curtis var. hirtiflora
Erica hispidula L.
Erica hispidula L. var. hispidula
Erica humifusa Salisb.
Erica imbricata L.
Erica intervallaris Salisb.
Erica intervallaris Salisb. var intervallaris
Erica labialis Salisb.
Erica lateralis Willd.
Erica longifolia Aiton
Erica lucida Salisb.
Erica lucida Salisb. var. lucida
Erica lutea P.J.Bergius
Erica muscosa (Aiton) E.G.H.Oliv.
Erica nudiflora L.
Erica obtusaKlotzsch ex Benth.
Erica odorata Andrews
Erica oreophila Guthrie & Bolus
Erica paniculata L.
Erica parviflora L.
Erica parviflora L. var. exigua (Salisb.) Bolus
Erica parviflora L. var. parviflora
Erica penicilliformis Salisb.
Erica petrophila L.Bolus
Erica plukenetii L.
Erica plukenetii L. var. plukenetii
Erica praecox Klotzsch
Erica quadrangularis Salisb.
Erica racemosa Thunb.
Erica racemosa Thunb. var. aristata L.Bolus
Erica racemosa Thunb. var. racemosa
Erica savilea Andews
Erica sessiliflora L.f.
Erica setacea Andrews
Erica sp.
Erica spumosa L.
Erica squarrosa Salisb.
Erica strigosa Sol.
Erica subdivaricata P.J.Bergius
Erica taxifolia Bauer
Erica tegulifolia Salisb.
Erica thimifolia J.C.Wendl.
Erica tottaThunb.
Erica transparens P.J.Bergius
Erica triflora L.
Erica triflora L. var triflora
Erica urceolata (Klotzsch) Benth.
Erica velitaris Salisb. var. velitaris
Erica ventricosa Thunb.
Erica ventricosa Thunb. var. ventricosa
Sympieza sp.

EUPHORBIACEAE
Chamaesyce prostrata (Aiton) Small
Clutia alaternoides L.
Clutia alaternoides L. var. alaternoides
Clutia alaternoides L. var. angustifolia E.Mey. ex Sond.
Clutia alaternoides L. var. brevifolia E.Mey. ex Sond.
Clutia polifolia Jacq.
Clutia polyadenia Pax
Clutia polygonoides L.
Euphorbia ernestii N.E.Br.
Euphorbia erythrina Link var. erythrina
Euphorbia erythrina Link var. meyeri N.E.Br.
Euphorbia erythrina Link.
Euphorbia genistoides P.J.Bergius
Euphorbia prostrata Aiton

FABACEAE
Acacia longifolia (Andrews) Willd. *
Acacia saligna (Labill.) H.L.Wendl. *
Amphithalea bowiei (Benth.) A.L.Schutte
Amphithalea cuneifolia Eckl. & Zeyh.
Amphithalea imbricata (L.) Druce
Amphithalea perplexa Eckl. & Zeyh.
Argyrolobium filiforme (Thunb.) Eckl. & Zeyh.
Argyrolobium lanceolatum Eckl. & Zeyh.
Argyrolobium rupestre (E.Mey.) Walp. subsp. rupestre
Argyrolobium tuberosum Eckl. & Zeyh.
Aspalathus acuminata Lam. subsp. acuminata
Aspalathus araneosa L.
Aspalathus astroites L.
Aspalathus biflora E.Mey. subsp. biflora
Aspalathus bracteata Thunb.
Aspalathus cephalotes Thunb. subsp. cephalotes
Aspalathus cephalotes Thunb. subsp. violaceae R.Dahlgren
Aspalathus ciliaris L.
Aspalathus commutata (Vogel) R.Dahlgren
Aspalathus cordata (L.) R.Dahlgren
Aspalathus costulata Benth.
Aspalathus crenata (L.) R.Dahlgren
Aspalathus cymbiformis DC.
Aspalathus divaricata Thunb. subsp. divaricata
Aspalathus divaricata Thunb. Subsp. gracilior R.Dahlgren
Aspalathus elliptica (E.Phillips) R.Dahlgren
Aspalathus ericifolia L. subsp. ericifolia
Aspalathus forbesii Harv.
Aspalathus globosa Andrews
Aspalathus hispida Thunb.
Aspalathus hispida Thunb. subsp. albiflora (Eckl. & Zeyh.) R.Dahlgren
Aspalathus hispida Thunb. subsp. hispida
Aspalathus humilis Bolus
Aspalathus juniperina Thunb.
Aspalathus juniperina Thunb. subsp. juniperina
Aspalathus laricifolia P.J.Bergius
Aspalathus laricifolia P.J.Bergius subsp. canescens (L.) R.Dahlgren
Aspalathus laricifolia P.J.Bergius subsp. laricifolia
Aspalathus macrantha Harv.
Aspalathus marginata Harv.
Aspalathus neglecta T.M.Salter
Aspalathus nigra L.
Aspalathus parviflora P.J.Bergius
Aspalathus perfoliata (Lam.) R.Dahlgren
Aspalathus perfoliata (Lam.) R.Dahlgren subsp. perfoliata
Aspalathus pinea Thunb. subsp. caudata R.Dahlgren
Aspalathus pinea Thunb. subsp. pinea
Aspalathus retroflexa L.

Aspalathus retroflexa L. subsp. retroflexa
Aspalathus rubiginosa R.Dahlgren
Aspalathus salicifolia R.Dahlgren
Aspalathus setacea Eckl. & Zeyh.
Aspalathus sp.
Aspalathus spicata Thunb.
Aspalathus spinosissima R.Dahlgren subsp. spinosissima
Aspalathus ulicina Eckl. & Zeyh. subsp. ulicina
Aspalathus uniflora L.
Aspalathus willdenowiana Benth.
Bolusafra bituminosa (L.) Kuntze
Crotalaria excisa (Thunb.) Baker f. subsp. excisa
Cyclopia buxifolia (Burm.f.) Kies
Cyclopia falcata (Harv.) Kies var. falcata
Cyclopia falcata (Harv.) Kies var. ovata Kies
Cyclopia galioides (P.J.Bergius) DC.
Cyclopia genistoides (L.) R.Br. var. genistoides
Cyclopia maculata (Andrews) Kies
Cyclopia meyeriana Walp.
Dipogon lignosus (L.) Verdc.
Indigofera alopecuroides (Burm.f.) DC. var. alopecuroides
Indigofera candolleana Meisn.
Indigofera capillaris Thunb.
Indigofera cytisoides (L.) L.
Indigofera digitata L.f.
Indigofera filicaulis Eckl. & Zeyh.
Indigofera gracilis Spreng.
Indigofera incana Thunb.
Indigofera mauritanica (L.) Thunb.
Indigofera ovata L.f.
Indigofera sarmentosa L.f.
Indigofera sp.
Lebeckia simsiana Eckl. & Zeyh.
Lessertia capensis (P.J.Bergius) Druce
Lessertia pappeana Harv.
Liparia capitata Thunb.
Liparia laevigata L.
Liparia myrtifolia Thunb.
Liparia sp.
Liparia tomentosa L.
Lotononis involucrata (P.J.Bergius) Benth.
Lotononis involucrata (P.J.Bergius) Benth. subsp. bracteata B.-E.van Wyk
Lotononis involucrata (P.J.Bergius) Benth. subsp. peduncularis (E.Mey.) B.-E.van Wyk
Lotononis varia (E.Mey.) Steud.
Lotus subbiflorus Lag. subsp. subbiflorus*
Otholobium bracteolatum (Eckl. & Zeyh.) C.H.Stirt.
Otholobium fruticans (L.) C.H.Stirt.
Otholobium hirtum (L.) C.H.Stirt.
Otholobium obliquum (E.Mey.) C.H.Stirt.
Otholobium parviflorum (E.Mey.) C.H.Stirt.
Otholobium polystictum (Benth. ex Harv.) C.H.Stirt.
Otholobium rotundifolium (L.f.) C.H.Stirt.
Otholobium sp.
Otholobium spicatum (L.) C.H.Stirt.
Otholobium virgatum (Burm.f.) C.H.Stirt.
Otholobium zeyheri (Harv.) C.H.Stirt.
Paraserianthes lophantha (Willd.) I.C.Nielsen subsp. lophantha*
Podalyria biflora (L.) Lam.
Podalyria calyptrata (Retz.) Willd.
Podalyria cuneifolia Vent.
Podalyria glauca DC.
Podalyria montana Hutch.
Podalyria myrtillifolia (Retz.) Willd.
Podalyria sericea (Andrews) R.Br.
Podalyria sp.
Psoralea aculeata L.
Psoralea affinis Eckl. & Zeyh.
Psoralea alata (Thunb.) T.M.Salter
Psoralea aphylla L.
Psoralea asarina (P.J.Bergius) Salter
Psoralea cordata Thunb.
Psoralea imbricata (L.) T.M.Salter
Psoralea monophylla (L.) C.H.Stirt.
Psoralea oligophylla Eckl. & Zeyh.
Psoralea pinnata L.
Psoralea sp.
Rafnia amplexicaulis (L.) Thunb.
Rafnia capensis (L.) Schinz
Rafnia crassifolia Harv.
Rafnia cuneifolia Thunb.
Rafnia meyeri Schinz
Rafnia ovata (P.J.Bergius) Schinz
Rafnia perfoliata (L.) Willd.
Rafnia sp.
Rafnia triflora (L.) Thunb.
Rhynchototta (Thunb.) DC.
Sesbania punicea (Cav.) Benth.*
Tephrosia capensis (Jacq.) Pers.
Tephrosia capensis (Jacq.) Pers. var. capensis
Trifolium angustifolium L. var. angustifolium
Trifolium arvense L. var. arvense
Trifolium campestre Schreb. var. campest
Virgilia oroboides (P.J.Bergius) T.M.Salter
Virgilia oroboides (P.J.Bergius) T.M.Salter subsp. oroboides
Xiphotheca elliptica (DC.) A.L.Schutte & B.-E.van Wyk
Xiphotheca guthriei (L.Bolus) A.L.Schutte & B.-E.van Wyk
Xiphotheca reflexa (Thunb.) A.L.Schutte & B.-E.van Wyk
Xiphotheca tecta (Thunb.) A.L.Schutte & B.-E.van Wyk

FUMARIACEAE
Cysticapnos cracca (Cham. & Schltdl.) Lidén
Discocapnos mundii Cham. & Schltdl.

GENTIANACEAE
Chironia baccifera L.
Chironia linoides L. subsp. linoides
Chironia linoides L. subsp. nana I.Verd.
Sebaea aurea (L.f.) Roem. & Schult.
Sebaea exacoides (L.) Schinz

GERANIACEAE
Geranium canescens L'Hèr.
Geranium incanum Burm.f.
Geranium incanum Burm.f. var. incanum
Geranium molle L.
Pelargonium alchemilloides (L.) L'Hèr.
Pelargonium auritum (L.) Willd. subsp. auritum
Pelargonium capitatum (L.) L'Hèr.
Pelargonium chamaedryfolium Jacq.
Pelargonium cucullatum (L.) L'Hèr.
Pelargonium cucullatum (L.) L'Hèr. subsp. cucullatum
Pelargonium cucullatum (L.) L'Hér. subsp. strigifolium Volschenk
Pelargonium cucullatum (L.) L'Hèr. subsp. tabulare Volschenk
Pelargonium elongatum (Cav.) Salisb.
Pelargonium gilgianum Schlt. ex R.Knuth
Pelargonium grandiflorum (Andrews) Willd.
Pelargonium grossularioides (L.) L'Hèr.
Pelargonium longicaule Jacq. var. longicaule
Pelargonium longifolium Jacq.
Pelargonium myrrhifolium (L.) L'Hèr. var. coriandrifolium (L.) Harv.
Pelargonium myrrhifolium (L.) L'Hér. var. myrrhifolium
Pelargonium papilionaceum (L.) L'Hèr.
Pelargonium patulum Jacq.
Pelargonium patulum Jacq. var patulum
Pelargonium pinnatum (L.) L'Hèr.
Pelargonium rapaceum (L.) L'Hér.
Pelargonium sidoides DC.
Pelargonium sp.
Pelargonium tabulare (Burm.f.) L'Hèr.
Pelargonium triste (L.) L'Hèr.
Pelargonium vitifolium (L.) L'Hèr.

GUNNERACEAE
Gunnera perpensa L.

HALORAGACEAE
Laurembergia repens P.J.Bergius
Laurembergia repens P.J.Bergius subsp. brachypoda (Hiern) Oberm.
Myriophyllum aquaticum (Vell.) Verdc.*
Myriophyllum spicatum L.

ICANCINACEAE
Apodytes dimidiata E.Mey. ex Arn.

Apodytes dimidiata E.Mey. ex Arn. subsp. dimidiata

KIGGELARIACEAE
Kiggelaria africana L.

LAMIACEAE
Leonotis leonurus (L.) R.Br.
Mentha longifolia (L.) Huds.
Mentha longifolia (L.) Huds. subsp. capensis (Thunb.) Briq.
Salvia africana-caerulea L.
Salvia chamelaeagnea P.J.Bergius
Salvia verbenaca L.
Stachys aethiopica L.
Stachys thunbergii Benth.

LENTIBULARIACEAE
Utricularia bisquamata Schrank

LINACEAE
Linum africanum L.
Linum quadrifolium L.
Linum thesioides Bartl.
Linum thunbergii Eckl. & Zeyh.

MALVACEAE
Anisodontea scabrosa (L.) D.M.Bates
Hermannia alnifolia L.
Hermannia grossularifolia L.
Hermannia hyssopifolia L.
Hermannia rudis N.E.Br.
Hermannia rugosa Adamson
Hermannia sp.
Hermannia ternifolia C.Presl ex Harv.
Hibiscus aethiopicus L.
Hibiscus trionum L.
Sida ovata Forssk.

MELIANTHACEAE
Melianthus major L.

MENISPERMACEAE
Cissampelos capensis L.f.

MENYANTHACEAE
Villarsia capensis (Houtt.) Merr.

MOLLUGINACEAE
Adenogramma glomerata (L.f.) Druce
Adenogramma sylvatica (Eckl. & Zeyh.) Fenzl
Limeum africanum L.
Limeum africanum L. subsp. africanum
Pharnaceum brevicaule (DC.) Bartl.
Pharnaceum dichotomum L.f.
Pharnaceum elongatum (DC.) Adamson
Pharnaceum incanum L.

MONTINIACEAE
Montinia caryophyllacea Thunb.

MYRICACEAE
Morella integra (A.Chev.) Killick
Morella kraussiana (Buchinger ex Meisn.) Killick
Morella serrata (Lam.) Killick

MYRSINACEAE
Myrsine africana L.
Rapanea melanophloeos (L.) Mez

MYRTACEAE
Leptospermum laevigatum (Gaertn.) F.Muell.*
Metrosideros angustifolia (L.) Sm.

OLEACEAE
Olea capensis L.
Olea europaea L.

OLINIACEAE
Olinia ventosa (L.) Cufod.

ONAGRACEAE
Epilobium capense Buch.-Ham. ex Hochst.
Epilobium hirsutum L.

OROBANCHACEAE
Buchnera glabrata Benth.
Harveya bolusii Kuntze
Harveya capensis Hook.
Harveya coccinea (Harv.) Schltr.
Harveya purpurea (L.f.) Harv.
Harveya tubulosa Harv. ex Hiern
Melasma scabrum P.J.Bergius

OXALIDACEAE
Oxalis bifida Thunb.
Oxalis commutata Sond.
Oxalis commutata Sond. var. commutata
Oxalis depressa Eckl. & Zeyh.
Oxalis eckloniana C.Presl var. sonderi Salter
Oxalis glabra Thunb.
Oxalis imbricata Eckl. & Zeyh.
Oxalis imbricata Eckl. & Zeyh. var. imbricata
Oxalis imbricata Eckl. & Zeyh. var. violacea R.Knuth
Oxalis incarnata L.
Oxalis lanata L.f. var. lanata
Oxalis lanata L.f. var. rosea Salter
Oxalis livida Jacq.
Oxalis livida Jacq. var. altior Salter
Oxalis luteola Jacq.
Oxalis melanosticta Sond. var. melanosticta
Oxalis nidulans Eckl. & Zeyh.
Oxalis nidulans Eckl. & Zeyh. var. denticulata (Wolley-Dod) Salter
Oxalis obtusa Jacq.
Oxalis pes-caprae L.
Oxalis pes-caprae L. var. pes-caprae
Oxalis pes-caprae L. var. sericea (L.f.) Salter
Oxalis purpurea L.
Oxalis strigosa T.M.Salter
Oxalis tenuifolia Jacq.
Oxalis truncatula Jacq.
Oxalis versicolor L.

PENAEACEAE
Glischrocolla formosa (Thunb.) R.Dahlgren
Penaea mucronata L.

PITTOSPORACEAE
Pittosporum undulatum Vent.*

POLYGALACEAE
Muraltia alba Levyns
Muraltia alopecuroides (L.) DC.
Muraltia asparagifolia Eckl. & Zeyh.
Muraltia decipiens Schltr.
Muraltia heisteria (L.) DC.
Muraltia longicuspis Turcz.
Muraltia macroceras DC.
Muraltia muraltioides (Eckl. & Zeyh.) Levyns
Muraltia oxysepala Schltr.
Muraltia pauciflora (Thunb.) DC.
Muraltia sp.
Muraltia stipulacea (Burm.f.) DC.
Muraltia thymifolia (Thunb.) DC.
Muraltia trinervia (L.f.) DC.
Muraltia vulpina Chodat
Polygala bracteolata L.
Polygala garcinii DC.
Polygala pappeana Eckl. & Zeyh.

POLYGONACEAE
Rumex acetosella L. subsp. angiocarpus (Murb.) Murb.*
Rumex cordatus Desf.
Rumex lativalvis Meisn.

PRIMULACEAE

Anagallis arvensis L.

PROTEACEAE
Aulax cancellata (L.) Druce
Aulax pallasia Stapf
Brabejum stellatifolium L.
Hakea acicularis R.Br. *
Leucadendron burchellii I.Williams
Leucadendron coniferum (L.) Meisn.
Leucadendron daphnoides (Thunb.) Meisn.
Leucadendron gandogeri Schinz ex Gand.
Leucadendron rubrum Burm.f.
Leucadendron salicifolium (Salisb.) I.Williams
Leucadendron salignum P.J.Bergius
Leucadendron sessile R.Br.
Leucadendron spissifolium (Salisb. ex Knight) I.Williams subsp. spissifolium
Leucadendron strobilinum (L.) Druce
Leucadendron xanthoconus (Kuntze) K.Schum.
Leucospermum conocarpodendron (L.) H.Buek
Leucospermum conocarpodendron (L.) H.Buek subsp. viridum Rourke
Leucospermum grandiflorum (Salisb.) R.Br.
Leucospermum gueinzii Meisn.
Leucospermum lineare R.Br.
Leucospermum mundii Meisn.
Leucospermum oleifolium (P.J.Bergius) R.Br.
Leucospermum sp.
Mimetes argenteus Salisb. ex Knight
Mimetes cucullatus (L.) R.Br.
Protea acaulos (L.) Reichard
Protea burchellii Stapf
Protea caespitosa Andrews
Protea coronata Lam.
Protea cynaroides (L.) L.
Protea grandiceps Tratt.
Protea lacticolor Salisb.
Protea nana (P.J.Bergius) Thunb.
Protea neriifolia R.Br.
Protea nitida Mill.
Protea repens (L.) L.
Protea rupicola Mund ex Meisn.
Protea scolopendriifolia (Salisb. ex Knight) Rourke
Protea sp.
Serruria fasciflora Salisb. ex Knight
Serruria florida (Thunb.) Salisb. ex Knight
Serruria kraussii Meisn.
Spatalla confusa (E.Phillips) Rourke
Spatalla propinqua R.Br.
Spatalla setacea (R.Br.) Rourke
Spatalla sp.

RANUNCULACEAE
Anemone tenuifolia (L.f.) DC.
Knowltonia anemonoides H.Rasm. subsp. anemonoides
Knowltonia capensis (L.) Huth
Knowltonia vesicatoria (L.f.) Sims subsp. grossa H.Rasm.
Knowltonia vesicatoria (L.f.) Sims subsp. vesicatoria
Ranunculus multifidus Forssk.

RHAMNACEAE
Phylica atrata Licht. ex Roem. & Schult.
Phylica callosa L.f.
Phylica constricta Pillans
Phylica constricta Pillans var. constricta
Phylica ericoides L. var. ericoides
Phylica gracilis (Eckl. & Zeyh.) D.Dietr.
Phylica imberbis P.J.Bergius
Phylica imberbis P.J.Bergius var. eriophoros (P.J.Bergius) Pillans
Phylica imberbis P.J.Bergius var. imberbis
Phylica minutiflora Schltr.
Phylica nodosa Pillans
Phylica plumosa L. var. plumosa
Phylica propinqua Sond.
Phylica pubescens Aiton var. angustifolia Sond.
Phylica sp.
Phylica spicata L.f.
Phylica spicata L.f. var. spicata
Trichocephalus stipularis (L.) Brongn.

ROSACEAE
Cliffortia aculeata Weim.
Cliffortia apiculata Weim.
Cliffortia atrata Weim.
Cliffortia burchellii Stapf
Cliffortia complanata E.Mey.
Cliffortia cuneata Aiton
Cliffortia dentata Willd.
Cliffortia dodecandra Weim.
Cliffortia dregeana C.Presl
Cliffortia erectisepala Weim.
Cliffortia eriocephalina Cham.
Cliffortia exilifolia Weim.
Cliffortia ferruginea L.f.
Cliffortia graminea L.f.
Cliffortia graminea L.f. var. graminea
Cliffortia grandifolia Eckl. & Zeyh.
Cliffortia grandifolia Eckl. & Zeyh. var. denticulata Weim.
Cliffortia grandifolia Eckl. & Zeyh. var. grandifolia
Cliffortia grandifolia Eckl. & Zeyh. var. recurvata Weim.
Cliffortia integerrima Weim.
Cliffortia intermedia Eckl. & Zeyh.
Cliffortia odorata L.f.
Cliffortia ovalis Weim.
Cliffortia pedunculata Schltr.
Cliffortia phillipsii Weim.
Cliffortia polygonifolia L.
Cliffortia polygonifolia L. var. membranifolia Weim.
Cliffortia polygonifolia L. var. pubescens Weim.
Cliffortia polygonifolia L. var. trifoliata (L.) Harv.
Cliffortia pterocarpa (Harv.) Weim.
Cliffortia ruscifolia L.
Cliffortia serpyllifolia Cham. & Schltdl.
Cliffortia stricta Weim.
Cliffortia strobilifera Murray
Cliffortia theodori-friesii Weim.
Cliffortia theodori-friesii Weim. var. theodori-friesii
Cliffortia tricuspidata Harv.
Cliffortia triloba Harv.
Cliffortia tuberculata (Harv.) Weim.
Cliffortia tuberculata (Harv.) Weim. var. tuberculata
Rubus fruticosus L.
Rubus rigidus Sm.

RUBIACEAE
Anthospermum aethiopicum L.
Anthospermum galioides Rchb.f. subsp. galioides
Anthospermum sp.
Anthospermum spathulatum Spreng. subsp. ecklonianum (Cruse) Puff
Carpacoce spermacocea (Rchb.f.) Sond. subsp. spermacocea
Carpacoce vaginellata T.M.Salter
Galium mucroniferum Sond.
Galium mucroniferum Sond. var. mucroniferum
Galium sp.
Galium subvillosum Sond. var. subglabrum Puff
Galium subvillosum Sond. var. subvillosum

RUTACEAE
Acmadenia sp.
Acmadenia teretifolia (Link) E.Phillips
Adenandra coriacea Licht. ex Roem. & Schult.
Adenandra marginata (L.f.) R. & Schult. subsp. mucronata Strid
Adenandra marginata (L.f.) R. & Schult. subsp. serpyllacea (Bartl.) Stri
Adenandra uniflora (L.) Willd.
Adenandra villosa (P.J.Bergius) Licht. ex Roem. & Schult. subsp. umb
(J.C.Wendl.) Strid
Adenandra villosa (P.J.Bergius) Licht. ex Roem. & Schult. subsp. villos
Agathosma abrupta Pillans
Agathosma anomala E.Mey. ex Sond.
Agathosma bifida (Jacq.) Bartl. & H.L.Wendl.
Agathosma capensis (L.) Dummer
Agathosma cerefolium (Vent.) Bartl. & H.L.Wendl.
Agathosma ciliata (L.) Link
Agathosma crenulata (L.) Pillans
Agathosma juniperifolia Bartl.
Agathosma microcalyx Dummer

Agathosma odoratissima (Montin) Pillans
Agathosma pulchella (L.) Link
Agathosma serpyllacea Licht. ex Roem. & Schult.
Coleonema juniperinum Sond.
Coleonema nubigenum Esterh.
Diosma acmaeophylla Eckl. & Zeyh.
Diosma hirsuta L.
Diosma oppositifolia L.
Diosma sp.
Empleurum unicapsulare (L.f.) Skeels
Euchaetis elsieae I.Williams
Euchaetis esterhuyseniae I.Williams
Euchaetis glabra I.Williams
Sheilanthera pubens I.Williams

SALICACEAE
Salix mucronata Thunb. subsp. capensis (Thunb.) Immelman

SANTALACEAE
Osyris compressa (P.J.Bergius) A.DC.
Thesium capitatum L.
Thesium capitellatum A.DC.
Thesium carinatum A.DC.
Thesium carinatum DC. var. carinatum
Thesium carinatum DC. var. pallidum A.W.Hill
Thesium densiflorum A.DC.
Thesium euphrasioides A.DC.
Thesium funale L.
Thesium nigromontanum Sond.
Thesium paniculatum L.
Thesium pinifolium A.DC.
Thesium pseudovirgatum Levyns
Thesium pycnanthum Schltr.
Thesium scabridulum A.W.Hill
Thesium scabrum L.
Thesium sp.
Thesium spicatum L.
Thesium spinulosum A.DC.
Thesium strictum P.J.Bergius
Thesium translucens A.W.Hill
Thesium virgatum Lam.

SAPINDACEAE
Dodonaea angustifolia L.f.

SCROPHULARIACEAE
Charadrophila capensis Marloth
Diascia capensis (L.) Britten
Diascia elongata Benth.
Dischisma ciliatum (P.J.Bergius) Choisy
Dischisma ciliatum (P.J.Bergius) Choisy subsp. ciliatum
Freylinia lanceolata (L.f.) G.Don
Freylinia undulata (L.f.) Benth.
Halleria elliptica Thunb.
Halleria lucida L.
Hebenstretia dentata L.
Hebenstretia paarlensis Roessler
Hemimeris racemosa (Houtt.) Merrill
Manulea cheiranthus (L.) L.
Manulea rubra (P.J.Bergius) L.f.
Microdon dubius (L.) Hilliard
Microdon polygaloides (L.) Druce
Nemesia acuminata Benth.
Nemesia barbata (Thunb.) Benth.
Nemesia diffusa Benth.
Nemesia lucida Benth.
Nemesia macrocarpa (Aiton) Druce
Oftia africana (L.) Bocq.
Phyllopodium heterophyllum (L.f.) Benth.
Polycarena sp.
Pseudoselago ascendens (E.Mey.) Hilliard
Pseudoselago gracilis Hilliard
Pseudoselago quadrangularis (Choisy) Hilliard
Pseudoselago serrata (P.J.Bergius) Hilliard
Pseudoselago sp.
Pseudoselago spuria (L.) Hilliard
Pseudoselago subglabra Hilliard
Pseudoselago verbenacea (L.f.) Hilliard
Selago corymbosa L.
Selago fruticosa L.
Sutera hispida (Thunb.) Druce
Sutera uncinata (Desr.) Hilliard
Teedia lucida (Aiton) Rudolphi
Zaluzianskya capensis (L.) Walp.
Zaluzianskya divaricata (Thunb.) Walp.

SOLANACEAE
Solanum africanum Mill
Solanum linnaeanum Hepper & E.Jaeger
Solanum mauritianum Scop.*
Solanum nigrum L.
Solanum retroflexum Dunal
Solanum tomentosum L.

STILBACEAE
Stilbe mucronata N.E.Br.

THYMELAEACEAE
Cryptadenia uniflora Meisn.
Gnidia anomala Meisn.
Gnidia decurrens Meisn.
Gnidia ericoides C.H.Wright
Gnidia harveyiana Meisn.
Gnidia inconspicua Meisn.
Gnidia juniperifolia Lam.
Gnidia linearifolia (Wikstr.) B.Peterson
Gnidia linoides Wikstr.
Gnidia nana (L.f.) Wikstr.
Gnidia oppositifolia L.
Gnidia penicillata Licht. ex Meisn.
Gnidia polycephala (C.A.Mey) Gilg
Gnidia tomentosa L.
Lachnaea buxifolia Lam.
Lachnaea macrantha Meisn.
Lachnaea nervosa (Thunb.) Meisn.
Lachnaea sp.
Passerina glomerata Thunb.
Passerina vulgaris Thoday
Struthiola ciliata (L.) Lam. subsp. angustifolia (Lam.) B.Peterson
Struthiola ciliata (L.) Lam. subsp. ciliata
Struthiola confusa C.H.Wright
Struthiola martiana Meisn.
Struthiola myrsinites Lam.
Struthiola tomentosa Andrews

VALERIANACEAE
Valeriana capensis Thunb. var. capensis

VIOLACEAE
Viola arvensis Murray
Viola decumbens L.f.
Viola decumbens L.f. var. decumbens
Viola decumbens L.f. var. scrotiformis (DC.) Jessop

VISCACEAE
Viscum pauciflorum L.f.
Viscum rotundifolium L.f.

ZYGOPHYLLACEAE
Zygophyllum album L. var. album
Zygophyllum fulvum L.

Appendix 2.

Data collection form with character fields used for describing species in the study area

Plant Feature	***Numerical Value***	***Character Description***
Leaf type	1	Orthophyll
	2	Succulent
	3	Sclerophyll
Leaf size	0	Not having
	1	Briophyll
	2	Picophyll
	3	Leptophyll
	4	Nanophyll
	5	Microphyll
	6	Mesophyll
	7	Macrophyll
	8	Megaphyll
Leaf nature	1	Evergreen
	2	Deciduous
Plant height (cm)	1	0 – 25
	2	26 – 50
	3	51 – 100
	4	101 – 200
	5	>200
Life form	1	Phanerophyte
	2	Chamaephyte
	3	Hemicryptophyte
	4	Cryptophyte
	5	Therophyte
	6	Epiphyte
	7	Parasite
Stem type	1	Woody perennial
	2	Herbaceous perennial
Stem architecture	1	Unbranched
	2	Branched
Leaf architecture	1	Simple
	2	Compound
Approximate longevity	1	Annual
	2	Biennial
	3	Perennial
Occurrence	1	Riparian specialists
	2	Riparian generalists
	3	Wetland specialists
	4	Mesic Mountain Fynbos

Definitions were taken from Raunkiaer (1934), Jackson (1971) and Blackmore & Tootill (1984). It serves as a field guide for Western Cape conditions.

LEAF TYPE

1. Orthophyllous – ordinary leaves, thin, soft and flexible when folded
2. Succulent – fleshy, sappy leaves; moisture flows when crushed
3. Sclerophyllous – leathery texture; hard, stiff and thick texture; usually evergreen and cracks when folded

LEAF SIZE

The classification of leaf size is based on the surface area of the leaf. In the case of compound leaves, the individual leaflet was measured for nature does not regard the whole compound leaf as a biological unit, but the individual leaflet of the compound leaf.

1. Briophyll = < 4 mm^2
2. Picophyll = 4 – 10 mm^2
3. Leptophyll = 10 – 25 mm^2
4. Nanophyll = 25 - 225 mm^2
5. Microphyll = 226 - 2 025 mm^2
6. Mesophyll = 2026 – 18 22518 225 mm^2
7. Macrophyll = 18 226 – 164 025 mm^2
8. Megaphyll – > 164 025 mm^2

LEAF NATURE

1. Evergreen

Plant is bearing green foliage all the year.

2. Deciduous

Plants with falling in season, as petals fall after flowering, or leaves in autumn

PLANT HEIGHT

The height was measured in meters from the ground level to the tip of the crown canopy.

1. 0 - 0.25 m
2. 0.26 – 0.50 m
3. 0.51 – 1.00 m
4. 1.01 – 2.00 m
5. > 2.00 m

LIFE FORMS

Raunkiaer (1934) gave a contribution on biological types and how they are adapted to survive unfavourable conditions. He characterised life forms by the amount and kind of protection afforded to the buds and shoot-apices.

1. Phanerophytes

The surviving buds or shoot-apices are borne on negatively geotrophic shoots which project into the air. The buds and apical shoots are destined to survive the unfavourable period of the year. The primary shoots, and often the also lateral shoots, are negatively geotrophic, so that the buds are bound to carry upwards.

2. Chamaephytes

The surviving buds or shoot-apices destined to survive the unfavourable season, are borne on shoots or portions of shoots which either lie on the surface of the earth or are situated very close to the ground.

3. Hemicryptophytes

The surviving buds or shoot-apices are situated in the soil-surface, so that only the lowest parts of the plant, protected by the soil and withered leaves, remain alive and bear buds destined in the next period of growth to form shoots bearing leaves and flowers.

4. Cryptophytes (Geophytes)

The surviving buds or shoot-apices are buried in the ground or at the bottom of water; the depth below the surface varies in the different species.

5. Therophytes

They are plants of the summer or of favourable season or "summer plants". These plants survive the unfavourable season in the form of seeds; but they complete their entire life cycle from seed to seed during the favourable season. Some of the annual plants which survive winter, and which germinate in the late summer or autumn, and pass the winter in the form of rosettes from which flowering shoots are produced during the next spring, are called biennials. The biennials are reckoned among the hemicryptophytes.

6. Epiphyte (Liane)

These plants grow on another plant, but gain no nourishment from the host, and only use the host as a physical place of anchorage.

7. Parasite

These plants grow on another plant, but gain nourishment from the host, and this interaction is to the disadvantage of the host.

STEM TYPE

1. Woody perennial

These are trees and shrubs whose aerial stems have woody tissues and persist above ground. They may be deciduous or evergreen.

2. Herbaceous perennial

They survive each winter as undergrowth storage or perennating organs such as bulbs, corms, rhizomes and stem and root tubers. The foliage leaves and flowers die back in winter.

STEM ARCHITECTURE

1. Unbranched

These are trees and shrubs whose aerial stems do not have branches at ground level from the main stem.

2. Branched

These are trees and shrubs whose aerial stems do have branches at ground level from the main stem.

LEAF ACHITECTURE

1. Simple

This refers to a leaf of one blade, with no incomplete segmentation.

2. Compound

The leaf is divided into separate blades (leaflets or pinnae).

APPROXIMATE LONGEVITY

1. Annual

Plant completes its life cycle within one year. The use of the plant perishes within that period.

2. Biennial

Plant which requires two years to complete its life cycle (growing one year, and flowering and fruiting the second).

3. Perennial

Plant which lasts several years, not perishing normally after once flowering and fruiting.

OCCURRENCE

1. Riparian specialist

Plants occurring exclusively on the riparian bank and not in the stream.

2. Riparian generalists

Plants occurring in Mesic Mountain Fynbos and on river banks.

3. Wetland specialist

Plants occurring in seepages, marshes and moist areas.

4. Mesic Mountain Fynbos

Species list of plants recorded in transect study

asterisk* = not native to Cape Flora Region, (-) = non flowering plants and (?) = information is lacking or doubtful

Species arranged alphabetically followed by author	Family	Flowering time	Life form	Height up to (m)	Common name
Adiantum aethiopicum L.	Pteridoceae	-	hemicryptophyte	0.4	
Agathosma crenulata (L.) Pillans	Rutaceae	June-Nov	phanerophyte	0.25	boegoe
Anthochortus crinalis (Mast) H.P.Linder	Restionaceae	May	hemicryptophyte	0.80	
Anthochortus graminifolius (Kunth) H.P.Linder	Restionaceae	?	hemicryptophyte	0.70	
Arctotheca calendula (L.) Levyns	Asteraceae	July-Nov	chamaephyte	0.30	cape weed
Aristea major Andrews	Iridaceae	Oct-Dec	cryptophyte	1.50	blouvuurpyl
Askidiosperma esterhuyseniae (Pillans) H.P.Linder	Restionaceae	May	hemicryptophyte	1.00	
Asparagus capensis L.	Asparagaceae	Apr-Aug	phanerophyte	1.00	katdoring
Asparagus lignosus Burm.f.	Asparagaceae	Oct-May	phanerophyte	0.80	wilde aspersie
Asparagus scandens Thunb.	Asparagaceae	Sep-Jan	phanerophyte	2.00	krulkransie
Berzelia lanuginosa (L.) Brongn.	Bruniaceae	Sept-Dec	phanerophyte	2.00	vleiknopbos
Blechnum capense Burm.f.	Blechnaceae	-	hemicryptophyte	0.60	cape deer fern
Blechnum punctulatum Sw.	Blechnaceae	-	hemicryptophyte	0.80	
Bobartia gladiata (L.f.) Ker Gawl.	Iridaceae	Sept-Dec	cryptophyte	0.80	
Brabejum stellatifolium L.	Proteaceae	Dec-Jan	phanerophyte	8.00	wild almond
Brachylaena neriifolia (L.) R.Br.	Asteraceae	Jan-Mar	phanerophyte	8.00	waterwitels
Cannomois virgata (Rottb.) Steud.	Restionaceae	?	hemicryptophyte	3.00	bergbamboes
Carpobrotus edulis (L.) L.Bolus	Aizoaceae	Aug-Oct	chamaephyte	2.00	suurvy
Cassine schinoides (Spreng.) R.H.Archer	Celastraceae	Oct-Dec	phanerophyte	6.00	cape saffron
Centella montana (Cham. & Schltdl.) Domin	Araliaceae	Aug-Jan	chamaephyte	0.10	perdekloutjie
Centella sp. (genus under review)	Araliaceae	Nov- Mar	chamaephyte	0.50	varkoortjie
Chondropetalum mucronatum (Nees) Pillans	Restionaceae	Oct-Nov	hemicryptophyte	2.00	bergriet
Chondropetalum deustum Rottb.	Restionaceae	?	hemicryptophyte	0.70	dekriet
Cliffortia cuneata Aiton	Rosaceae	Oct-Nov	phanerophyte	2.00	climbers friend
Cliffortia grandifolia (Eckl. & Zeyh.	Rosaceae	Dec-Jan	phanerophyte	5.00	grootblaarrysbos
Cliffortia polygonifolia L.	Rosaceae	Apr-Nov	phanerophyte	1.50	paddabos
Cliffortia ruscifolia L.	Rosaceae	Aug-Oct	phanerophyte	1.50	steekbos
Cliffortia tricuspidata Harv.	Rosaceae	Dec-Apr	phanerophyte	0.50	kammiebos
Conyza canadensis (L.) Cronquist *	Asteraceae	Jun-May	phanerophyte	1.00	bakbesembossie
Corymbium cymosum E.Mey. ex DC.	Asteraceae	Oct-Dec	phanerophyte	0.40	heuningbos
Cullumia setosa (L.) R.Br.	Asteraceae	Aug-Oct	chamaephyte	0.60	steekhaarbos
Cunonia capensis L.	Cunoniaceae	Mar-June	phanerophyte	30.00	butterspoon tree
Cyathea capensis (L.f.) Sm.	Cyatheaceae	-	hemicrypto/phanerophyte	4.50	cape fern tree
Cyclopia maculata (Andrew.) Kies	Fabaceae	Sept	phanerophyte	3.50	vleitee
Cymbopogon marginatus (Steud.) Stapf ex Burtt Davy	Poaceae	Oct-May	hemicryptophyte	0.80	motwortelterpentyngras
Diospyros glabra (L.) De Winter	Ebenaceae	Oct-Dec	phanerophyte	2.00	bloubessiebos
Diospyros whyteana (Hiern) F.White	Ebenaceae	Apr-Jun	phanerophyte	6.00	wild coffee
Disa uniflora P.J.Bergius	Orchidaceae	Jan-Mar	cryptophyte	0.60	red disa
Ehrharta rehmannii Stapf	Poaceae	Aug-Jan	phanerophyte	1.00	muggiesgras
Ehrharta setacea Nees	Poaceae	Sept-Jan	phanerophyte	0.60	olifantsgras
Ehrharta villosa Schult.f.	Poaceae	Sept-Mar	phanerophyte	1.50	pypgras
Elaphoglossum conforme (Sw.) Schott ex J.Sm.	Lomariopsidaceae	-	hemicryptophyte	0.40	tongue fern
Elegia capensis (Burm.f.) Schelpe	Restionaceae	?	hemicryptophyte	2.00	fonteinriet
Elegia grandis (Nees) Kunth	Restionaceae	May	hemicryptophyte	1.00	vlerkies
Elegia intermedia (Steud.) Pillans	Restionaceae	Dec	hemicryptophyte	1.00	besemriet
Elegia persistens Pillans	Restionaceae	?	hemicryptophyte	1.00	duineriet
Epischoenus complanatus Levyns	Cyperaceae	Dec-Mar	hemicryptophyte	0.65	

		Flowering time	Growth structure	(m)	Common name
Epischoenus quadrangularis (Boeck.) C.B.Clarke	Cyperaceae	Nov-May	hemicryptophyte	0.75	
Erica axillaris Thunb.	Ericaceae	May-Dec	phanerophyte	0.80	klokkiesheide
Erica caffra L.	Ericaceae	July-Dec	phanerophyte	4.00	water heath
Erica calycina L.	Ericaceae	Aug-Jan	phanerophyte	2.00	
Erica fastigiata L.	Ericaceae	July-Dec	phanerophyte	0.50	four sisters heath
Erica hispidula L.	Ericaceae	Jan-Dec	phanerophyte	1.80	taaiheide
Erica intervallaris Salisb.	Ericaceae	July-Jan	phanerophyte	0.60	
Erica longifolia Aiton	Ericaceae	Jan-Dec	phanerophyte	1.00	
Erica hirta Thunb.	Ericaceae	Feb-Aug	phanerophyte	0.80	
Erica totta Thunb.	Ericaceae	Sept-Dec	phanerophyte	0.30	
Euchaetis glabra I.Williams	Rutaceae	Mar-May	phanerophyte	0.50	
Ficinia distans C.B.Clarke	Cyperaceae	Dec-Apr	hemicryptophyte	0.60	
Fontinalis squamosa L. Hedw.*	Bryaceae	?	hemicryptophyte	0.10	carpet moss
Freylinia lanceolata (L.f.) G.Don	Scrophulariaceae	Feb-July	phanerophyte	6.00	heuningklokkiesbos
Gladiolus carneus D.Delaroche	Iridaceae	Oct-Nov	cryptophyte	0.60	bergpypie/painted lady
Halleria elliptica Thunb.	Scrophulariaceae	Sept-Apr	phanerophyte	1.20	umbinza
Halleria lucida L.	Scrophulariaceae	July-Feb	phanerophyte	12.00	tree fuchsia/notsung
Haplocarpha lanata (Thunb.) Less.	Asteraceae	Mar-June	phanerophyte	0.15	brandblom
Heeria argentea (Thunb.) Meisn.	Anacardiaceae	Jan-July	phanerophyte	5.00	kliphout
Helichrysum cymosum (L.) D.Don.	Asteraceae	Sept-Apr	phanerophyte	1.00	strooiblom
Helichrysum tinctum (Thunb.) Hilliard & B.L.Burtt	Asteraceae	Sept-Dec	chamaephyte	0.40	vaalteebossie
Hymenophyllum peltatum (Poir.) Desv.	Hymenophyllaceae	-	hemicryptophyte	0.18	filmy fern
Hypochaeris radicata L. *	Asteraceae	?	chamaephyte	0.30	
Ilex mitis (L.) Radlk.	Aquifoliaceae	Sept-Dec	phanerophyte	30.00	african holly/waterboom/umduma
Ischyrolepis gaudichaudiana (Kunth) H.P.Linder	Restionaceae	?	hemicryptophyte	1.00	
Ischyrolepis subverticillata Steud.	Restionaceae	Feb-June	hemicryptophyte	1.50	katstert
Ischyrolepis triflora (Rottb.) H.P.Linder	Restionaceae	?	hemicryptophyte	0.60	
Isolepis digitata Schrad.	Cyperaceae	Sept-Jan	chamaephyte	0.35	
Juncus lomatophyllus Spreng.	Juncacaea	Oct-Apr	cryptophyte	0.80	
Kiggelaria africana L.	Kiggelariaceae	Feb-Jun	phanerophyte	17.00	wild peach
Leucadendron salicifolium (Salisb.) I.Williams	Proteaceae	July-Sept	phanerophyte	2.00	tolbos
Maytenus acuminata (L.f.) Loes.	Celastraceae	May-Jan	phanerophyte	10.00	sybas/umnama
Maytenus oleoides (Lam.) Loes.	Celastraceae	Apr-Sept	phanerophyte	4.00	klipkershout
Merxmuellera cincta (Nees) Conert	Poaceae	Oct-Apr	hemicryptophyte	2.00	
Metalasia cephalotes (Thunb.) Less.	Asteraceae	Aug-Nov	phanerophyte	1.00	blombos
Metrosideros angustifolia (L.) Sm.	Myrtaceae	Dec-Feb	phanerophyte	7.00	smalblad
Montinia caryophyllacea Thunb.	Montiniaceae	May-Oct	phanerophyte	1.50	peperbos
Muraltia alopecuroides (L.) DC.	Polygalaceae	Oct-Dec	phanerophyte	1.00	skilpadbos
Muraltia heisteria (L.) DC.	Polygalaceae	Oct-Dec	phanerophyte	2.00	purple-gorse
Morella integra (A.Chev.) Killick	Myricaceae	Sept-Apr	phanerophyte	3.00	basterwaterolier
Morella serrata (Lam.) Killick	Myricaceae	Aug-Dec	phanerophyte	3.00	waterolier
Nebelia fragarioides (Willd.) Kuntze	Bruniaceae	Mar-Sept	phanerophyte	1.50	
Neesenbeckia punctoria (Vahl) Levyns	Cyperaceae	Mar-Apr	hemicryptophyte	2.00	
Olea europaea L.	Oleaceae	Oct-Mar	phanerophyte	14.00	wild olive
Olinia ventosa (L.) Cufod.	Oliniaceae	May-July	phanerophyte	15.00	hard pear
Oscularia deltoides (L.) Schwantes	Aizoaceae	Oct-Dec	phanerophyte	0.20	sandsteenvygie
Otholobium obliquum (E.Mey.) C.H.Stirt.	Fabaceae	June-Dec	phanerophyte	1.00	skaapbostee
Othonna quinquedentata DC.	Asteraceae	Oct-Mar	phanerophyte	1.00	geelbossie
Oxalis nidulans Eckl. & Zeyh.	Oxalidaceae	July-Aug	cryptophyte	0.25	waterklawer

Oxalis versicolor L.	Oxalidaceae	May-Nov	cryptophyte	0.20	candycane sorrel
Pelargonium alchemilloides (L.) L'Her.	Geraniaceae	Sept-Nov	phanerophyte	0.50	herba
Pelargonium cucullatum (L.) L'Her.	Geraniaceae	Sept-Feb	phanerophyte	2.00	wildemalva
Pellaea pteroides (L.) Prantl	Pteridaceae	-	hemicryptophyte	0.60	myrtle fern
Pentameris thuarii P.Beauv.	Poaceae	Sept-Dec	hemicryptophyte	1.70	
Pentaschistis malouinensis (Steud.) Clayton	Poaceae	Nov-Jan	hemicryptophyte	0.30	bokbaard
Pentaschistis pallida (Thunb.) H.P.Linder	Poaceae	Sept-Oct	hemicryptophyte	0.40	haasgras
Platylophus trifoliatus (Thunb.) D.Don.	Cunoniaceae	Dec-Feb	phanerophyte	30.00	witels
Plecostachys polifolia (Thunb.) Hillard & B.L.Burtt	Asteraceae	Sept-Dec	chamaephyte	1.00	vaaltee
Podalyria calyptrata (Retz.) Willd.	Fabaceae	Aug-Oct	phanerophyte	5.00	bush sweet pea
Podocarpus elongatus (Aiton) L'Her ex Pers.	Podocarpaceae	Oct	phanerophyte	6.00	Breëriviergeelhout
Pterocelastrus rostratus (Thunb.) Walp.	Celastraceae	Apr-June	phanerophyte	10.00	red cherrywood
Prionium serratum (L.f.) Drège ex E.Mey.	Prioniaceae	Sept-Feb	phanerophyte	2.00	palmiet
Protea neriifolia R.Br.	Proteaceae	Feb-Nov	phanerophyte	8.00	suikerbos
Protea nitida Mill.	Proteaceae	May-Aug	phanerophyte	10.00	waboom
Psoralea aphylla L.	Fabaceae	Sept-May	phanerophyte	4.00	fonteinbos
Psoralea pinnata L.	Fabaceae	Oct-Apr	phanerophyte	4.00	penwotel
Pteridium aquilinum (L.) Kuhn	Dennstaedtiaceae	-	hemicryptophyte	1.50	bracken fern
Rapanea melanophloeos (L.) Mez	Myrsinaceae	Oct-Dec	phanerophyte	20.00	cape beech
Restio corneolus Esterh.	Restionaceae	?	hemicryptophyte	0.90	
Restio echinatus Kunth	Restionaceae	?	hemicryptophyte	0.50	
Restio ejuncidus Mast.	Restionaceae	Apr	hemicryptophyte	0.50	
Restio filiformis Poir.	Restionaceae	Aug	hemicryptophyte	0.60	
Restio purpurascens Nees ex Mast.	Restionaceae	?	hemicryptophyte	1.00	
Rhus angustifolia L.	Anacardiaceae	Oct-Nov	phanerophyte	4.00	wilgerkorentebos
Ruschia pulchella (Haw.) Schwantes	Aizoaceae	July-Sept	chamaephyte	0.40	
Schizaea pectinata (L.) Sw.	Schizaeaceae	-	chamaephyte	0.20	curly grass fern
Schizaea tenella Kaulf.	Schizaeaceae	-	chamaephyte	0.25	toothbrush fern
Schoenoxiphium lanceum (Thunb.) Kuk	Cyperaceae	June-Nov	hemicryptophyte	0.60	
Senecio crispus Thunb.	Asteraceae	Dec-Mar	chamaephyte	0.40	hongerblom
Solanum mauritianum Scop. *	Solanaceae	?	phanerophyte	2.00	
Stoebe cinerea (L.) Thunb.	Asteraceae	Apr-may	phanerophyte	1.50	vaal hartebeeskaroo
Stoebe incana Thunb.	Asteraceae	Feb-May	phanerophyte	0.60	hartebeeskaroo
Stoebe plumosa (L.) Thunb.	Asteraceae	Apr-June	chamaephyte	1.00	slangbos
Struthiola myrsinites Lam.	Thymelaeaceae	Jan-Dec	phanerophyte	2.00	featherhead
Tetraria bromoides (Lam.) Pfeiffer	Cyperaceae	Oct-Feb	hemicryptophyte	1.50	bergpalmiet
Tetraria capillacea (Thunb.) C.B.Clarke	Cyperaceae	Oct-Nov	hemicryptophyte	0.80	biesiegras
Tetraria pillansii Levyns	Cyperaceae	Jan-Feb	hemicryptophyte	0.25	biesie
Thamnochortus fruticosus P.J.Bergius	Restionaceae	July-Nov	hemicryptophyte	0.60	besemriet
Thesium strictum P.J.Bergius	Santalaceae	Sept-feb	phanerophyte	2.00	teringbos
Todea barbara (L.) T.Moore	Osmundaceae	-	hemicryptophyte	1.00	
Trichocephalus stipularis (L.) Brongn.	Rhamnaceae	May-Sept	phanerophyte	0.90	dogface
Ursinia caledonica (E.Phillips) Prassler	Asteraceae	Feb-July	phanerophyte	1.20	bergmagriet
Ursinia paleacea (L.) Moench	Asteraceae	Aug-Dec	phanerophyte	0.90	geelmagriet
Viscum rotundifolium L.f.	Viscaceae	Feb-May	epiphytic parasite	0.75	mistletoe/voëlent
Wahlenbergia procumbens (Thunb.) A.DC.	Campanulaceae	Nov-Apr	chamaephyte	0.40	african blue-bell
Wimmerella bifida (Thunb.) L. Serra, M.B. Crespo & Lammers	Campanulaceae	Sept-Apr	phanerophyte	0.30	
Widdringtoni nodiflora (L.) Powrie	Cupressaceae	?	phanerophyte	10.00	mountain cypress