VEGETATION SURVEY OF MOUNT GORONGOSA

Tom Müller, Anthony Mapaura, Bart Wursten,
Christopher Chapano, Petra Ballings & Robin Wild

2008 (published 2012)

Occasional Publications in Biodiversity No. 23

VEGETATION SURVEY OF MOUNT GORONGOSA

Tom Müller, Anthony Mapaura, Bart Wursten, Christopher Chapano, Petra Ballings & Robin Wild

2008

(published 2012)

Occasional Publications in Biodiversity No. 23

Biodiversity Foundation for Africa
P.O. Box FM730, Famona, Bulawayo, Zimbabwe

SUMMARY

Mount Gorongosa is a large inselberg almost 700 sq. km in extent in central Mozambique. With a vertical relief of between 900 and 1400 m above the surrounding plain, the highest point is at 1863 m. The mountain consists of a Lower Zone (mainly below 1100 m altitude) containing settlements and over which the natural vegetation cover has been strongly modified by people, and an Upper Zone in which much of the natural vegetation is still well preserved. Both zones are very important to the hydrology of surrounding areas.

Immediately adjacent to the mountain lies Gorongosa National Park, one of Mozambique's main conservation areas. A key issue in recent years has been whether and how to incorporate the upper parts of Mount Gorongosa above 700 m altitude into the existing National Park, which is primarily lowland. [These areas were eventually incorporated into the National Park in 2010.]

In recent years the unique biodiversity and scenic beauty of Mount Gorongosa have come under severe threat from the destruction of natural vegetation. This is particularly acute as regards moist evergreen forest, the loss of which has accelerated to alarming proportions. To assess the conservation value of the flora and to assist with the management of this additional conservation area, in 2007 the Carr Foundation (now the Gorongosa Restoration Project) requested Tom Müller of the Biodiversity Foundation for Africa (BFA), a regional NGO, to carry out a vegetation survey of the mountain above 700 m altitude.

During the field work, 127 sites were recorded using a phytosociological approach, 111 in the Upper Zone and 16 in the Lower Zone. Ten main vegetation types were recognized in the Upper Zone, of which Moist Evergreen Forest, Montane and Sub-montane Grassland and Wooded Grassland covered the greatest area. Moist Evergreen Forest was subdivided into three sub-types based on altitude and species dominance. These are described in detail in terms of both structure and species composition.

A total of 605 vascular plant species were recorded, including 104 species of ferns and fern allies, a total that is expected to increase considerably when additional recording is done in other seasons. Species richness and endemism were below that found on some similar mountains across southern Africa.

The main conservation conclusions confirm the importance of extending protected area status over the entire mountain above 700 m altitude, which should be managed as a

Biodiversity Reserve. Management should consist primarily of the protection of vegetation. However, ecotourism and gathering of medicinal plants on a sustainable base could be permitted.

In the settled Lower Zone, environmental stability needs to be achieved through management. Based on a comprehensive land use plan, systems have to be introduced aimed at settlement, farming and resource utilization that are sustainable and which require low energy inputs.

Twenty-one recommendations are given. The most important and urgent one is to prevent people from cutting timber and forest clearance. The other important recommendation concerns the boundary area between the Upper and Lower Zone – where the boundary follows the lower margin of moist forest, the degraded and often frayed forest edge should be rendered into a clearly defined boundary line by planting a belt of native pioneer forest species. Where the boundary follows the lower margin of woodland or goes through grassland, a belt of agroforestry should be established in order to prevent fires from spreading between zones.

PREFACE

This study was requested in 2007 by the Carr Foundation, now known as the Gorongosa Restoration Project, which was funding the rehabilitation of the Gorongosa National Park in central Mozambique in conjunction with the Mozambique Government's National Parks authority. That request resulted in a proposal being developed by the Biodiversity Foundation for Africa, which was then implemented by the authors of this report.

The Mt Gorongosa massif itself lay outside the National Park at that time, but it was increasingly being recognised that its inclusion was essential if the drier lowlands comprising Gorongosa National Park with its herds of plains wildlife was to be conserved succesfully. The rivers and lakes in the National Park are all fed by rainfall coming from forests and grasslands on the mountain. There was increasing encroachment up the lower and mid slopes from subsistence agriculture and settlement, while in the past there had also been livestock grazing at mid-altitudes. The purpose of this study was not only to describe and map the vegetation across the mountain, but also to indicate what the conservation priorities and options might be, and provide recommendations as to future action.

Since the study took place – in April to June 2007 – significant changes have occurred. The whole of Mt Gorongosa above the 700 m contour has now (22 July 2010, published in decree 78/2010 on 31 December 2010) been incorporated into the Gorongosa National Park. However, the situation with illegal settlement appears to have become much worse with between 9,000 and 14,000 people living or with machambas (small agricultural plots) on the mountain (F. Steinbruch, pers. comm.). The upland forests are being increasingly cleared and fragmented. Active initiatives for boundary tree planting are underway under the Gorongosa Restoration Project, but the situation now appears worse than it was in 2007.

This report was written in 2008 and reflects the situation and findings at that time. It was reformatted, edited and produced as a BFA Publication in February 2012.

LIST OF CONTENTS

1. INTRODUCTION

Mount Gorongosa is a large inselberg, almost 700 sq. km in extent, located in Sofala Province in central Mozambique. Some 80 km from the Indian Ocean, it lies just west of the famous Gorongosa National Park which is situated in an extension of the East African Rift valley. The highest point on the Gorongosa massif is Mt Gogogo at 1863 m above sea level, and the massif has a vertical relief of between 900 and 1400 m above the surrounding pediments and plains.

The mountain consists of a Lower Zone (mainly below 1100 m altitude) containing settlements and over which the natural vegetation cover has been strongly modified by people, and an Upper Zone in which much of the natural vegetation is still well preserved. Both are very important to the hydrology of the surrounding areas and to the continued stability of water catchments.

Surprisingly, there have been few studies on the botany or vegetation of Mount Gorongosa, despite it being so close to the main National Park in the country. Two papers were identified that are relevant to this study:

a) **Framework of the Gorongosa Ecosystem** (Tinley 1977) covering the entire ecosystem from Mount Gorongosa to the coast. This a large and comprehensive DSc thesis includes species lists of the woody vegetation of Mount Gorongosa, but apart from this does not refer much to the mountain. However, Tinley collected numerous plant specimens on the mountain, duplicates of which are housed in the National Herbarium of Zimbabwe (SRGH) and proved most useful when identifying the plant specimens.

b) **Carta de Vegetação da Serra Gorongosa** (Macedo 1970b) and **Serra da Gorongosa: necessidade e bases da sue protecção** (Macedo 1970a) give a general account of the vegetation of Mount Gorongosa and proved most useful for gaining an initial overview, but contained insufficient detail to help significantly with the present survey.

Adjacent to Mount Gorongosa is Gorongosa National Park, one of Mozambique's premier protected areas, managed by the National Directorate of Conservation Areas (DNAC) of the Ministry of Tourism with generous long-term assistance from the Carr Foundation (now called the Gorongosa Restoration Project). The whole area was the site of much military activity during the civil war that ended in 1992, and the National Park is now being rehabilitated and opened up for tourism.

The mountain is of great importance to the continued ecological functioning of the lowland parts of the National Park as it provides much of the water flow to its rivers, lakes and wetlands, and also provides a great range of habitats otherwise not found in the main Park. The wetlands in particular are some of the park's most scenic focal points. Until recently Mount Gorongosa lay outside the National Park and the question of whether and how to include it was a major conservation

management concern. Areas above 700 m altitude were eventually incorporated into the National Park in July 2010, three years after this survey took place.

During this debate, the state of the mountain's catchment area was looked at and extensive recent destruction of forest was observed. This was monitored retrospectively using satellite imagery. Results showed that the slow removal of trees up the mountain slopes, which commenced long ago, had accelerated exponentially since 2000, and by 2007 has reached alarming proportions. In particular there were severe losses of moist evergreen forest. It was realized that the protection of the remaining natural vegetation was of utmost importance, not only for the protection of the catchments but also to safeguard the unique biodiversity and scenic beauty of the mountain itself.

In order to better understand the conservation importance of vegetation on the mountain and make recommendations as to how it could be managed, in 2007 the Carr Foundationt requested the Biodiversity Foundation for Africa (BFA), a regional NGO, to carry out a vegetation survey of the mountain above 700 m altitude.

There were six objectives for the survey:

- To carry out a vegetation survey of Mount Gorongosa above the 700 m contour line in order to classify it into types and to produce a vegetation map showing their distribution;
- To provide descriptions of the vegetation types indicating vegetation structure and characteristics, the major and associated species, and plant species of conservation interest and concern;
- To provide ecological notes regarding important features and determining factors and to compile a species list recorded in the study area;
- To make suggestions on the reintroduction of native species;
- To make suggestions regarding a land use plan for the degraded lower slopes, rendering them more stable, introduce sustainable agriculture where appropriate, and also take the natural biodiversity into account;
- To provide in-service training for a Mozambican botanist.

This report outlines and describes the main vegetation types, lists the plant species found, and provides recommendations on how to manage both lower and upper parts. Unfortunately, the vegetation map was never produced owing to difficulties with the satellite imagery and changes in personnel.

2. THE STUDY SITE

Mount Gorongosa is located in Gorongosa District of Sofala Province in central Mozambique, about 20 km NNE of Gorongosa town and approximately 80 km from the Indian Ocean. It falls mostly between longitudes 33°50' and 33°13' East and latitudes 18°13' and 18°42' South.

The study site is that portion of the mountain lying above the 700 m contour line and is approximately 350 km^2 in extent, whereas the entire mountain covers an area of almost 700 km^2. The area as seen on Google Earth is shown in figure 1.

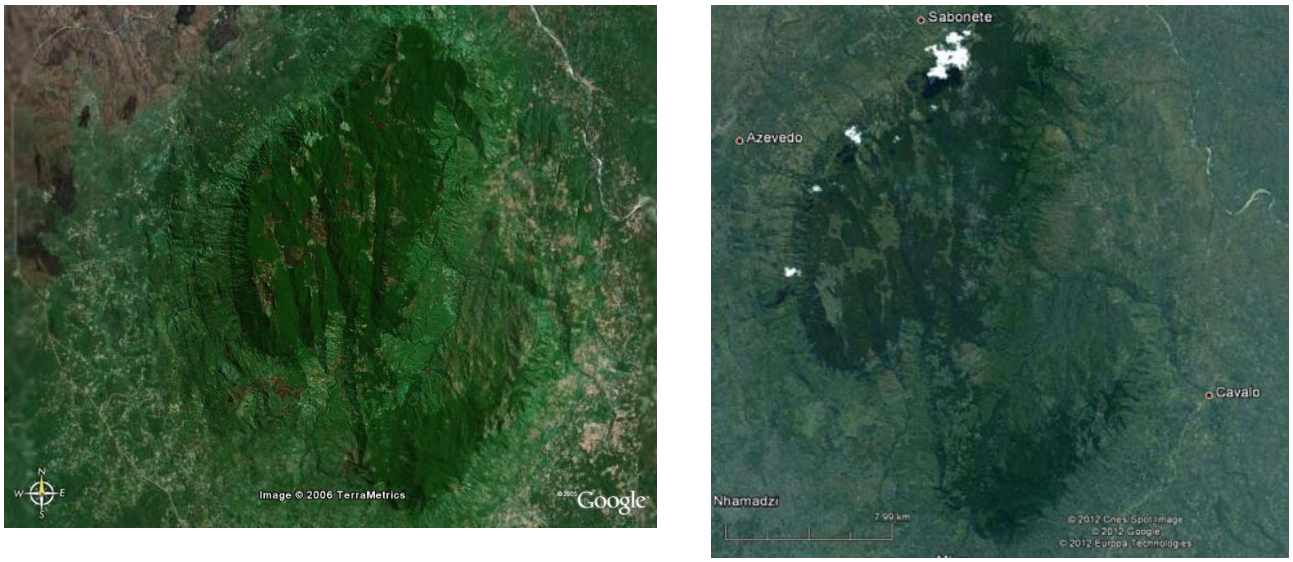

Fig.1. Google Earth images of Mt Gorongosa area – 2003? (left) and Sept 2006 (right), showing recent deforestation.

2.1 The Physical Environment

Mount Gorongosa is more a gigantic inselberg or massif rather than an individual mountain. It rises out of the Mozambique plain from an altitude of 350–450 m above sea level to over 1850 m, with a vertical relief of between 900 and 1400 m. There are three main peaks, one toward the north, one in the south and one in the southwest, of which Monte Gogogo in the southwest, rising to an altitude of 1863 m, is the highest. The massif's outline is very roughly circular with a diameter of about 28 km.

The geology consists mostly of granites of Late Jurassic age with a ring structure of gabbro on the western and southern slopes. The geomorphology of the gabbros is undulating with gentle slopes up to 15º. Granites, on the other hand, form steeper slopes up to 30º and more interspersed with cliffs, and generally occurs as bare rock is exposed over large areas. Soils are sandy (granite-derived) or sandy to loamy-clay (gabbro-derived) and generally skeletal, but can be deeper on flatter ground.

The main massif has a large inner portion, sometimes referred to as the plateau, which contains three valleys. Its topography is rugged and steeply undulating in many areas, with scattered knolls and rocky outcrops. The massif's general topography is tilted from the west and north towards the southwest, with all the flatter high ground in the west. The Monte Nhassacassa section consists of a broad and undulating ridge which rises gradually towards Monte Nhassacassa, a prominent peak at the southern end of the Gorongosa Range.

There are three main streams draining the mountain, the Nhandare, Muera and Vunduzi. All have their origins at 1400–1700 m close to each other in the northwestern part of the mountain. The valleys of the inner section and the streams of the southern and some western slopes drain into the Nhandare river that flows south through the Vunduzi into the Pungwe, forming the southern boundary of the National Park. Only the Vunduzi connects directly with the Urema floodplains of Gorongosa National Park and plays an important role in the recharging of the floodplain aquifers, feeding Lake Urema during the dry season. The Muera flows into the Nhandugue River, the largest and most important for the annual inundations of the Urema floodplain.

The rainfall distribution is governed by moist air coming from the Indian Ocean and orographic rainfall moving from East to West across the mountain.

2.2 Settlements and Shifting Agriculture

On the lower slopes of the mountain below the 700 m contour settlements have probably existed since the early parts of the last century or even longer, and most of the original woodland and forest was removed long ago (figure 2).

Fig.2. Recent clearing in montane forest (photo: Jeff Barbee).

On the lower slopes of the study site, between the 700 m contour and the zone of natural vegetation, practically all the original timber has been cleared, but most of the clearing has probably occurred since 1950. However, as mentioned earlier, this clearing has accelerated in recent years (see figure 1). Settlements have increased in number on Mount Gorongosa over the last few decades, first lower down and more recently higher up.

A recent development that commenced a few years ago and which is still taking place, is the clearing of sizeable plots several hectares in extent for growing potatoes as a cash crop, and sometimes marijuana. This is taking place within the zone of natural vegetation inside the moist evergreen forest up to an altitude of about 1500 m higher. Goats are also being kept on the grasslands. There has also been a steep increase in the incidence of fire.

3. SURVEY METHODS

An initial understanding of the vegetation patterns was gained by visually studying the RGB false colour composite of the Landsat TM scenes and also by looking at some unsupervised classifications of the same images. This was done in conjunction with a helicopter flight over the entire study site during which several stops were made for ground checking. From this initial exercise the main vegetation types were recognized and an appreciation gained of their spatial arrangement.

It became immediately obvious that the whole mountain falls within two main categories of vegetation cover:

1. A lower zone in which the natural vegetation has been greatly altered by human activities and from which much of the original timber (woodland and forest cover) has been removed,
2. An upper zone in which much of the natural vegetation is still well preserved [although this is now changing].

On a map of the study site the areas covered by each zone are roughly equal. However, looking at the actual land occupied by each the upper zone, because of the extremely dissected nature of its topography, is considerably larger.

The limited time available for the study required some priority-setting of survey activity. Considering the objectives, it was obvious that the main focus had to be on the natural vegetation of the upper zone, and that much less attention could be given to the strongly altered vegetation of the lower zone.

Availability of a helicopter during the latter stages of the field work greatly facilitated sampling, and allowed access to some sites which otherwise could not have been reached in the time available for the study.

3.1 Location of Sampling Points

Sampling was initially planned by using the relevant Landsat scenes as well as panchromatic aerial photographs. Both were stratified into what appeared on them as homogenous units, which were assumed to represent vegetation types. The stratification served as the initial framework for sampling. Following stratification, provisional sampling areas were located on the air photos. These are shown on the map in figure 3. A major consideration when locating sampling sites was to ensure reasonable sample coverage, a good geographical spread and a range of topographical positions.

Fig.4. Survey team deciding where to begin.

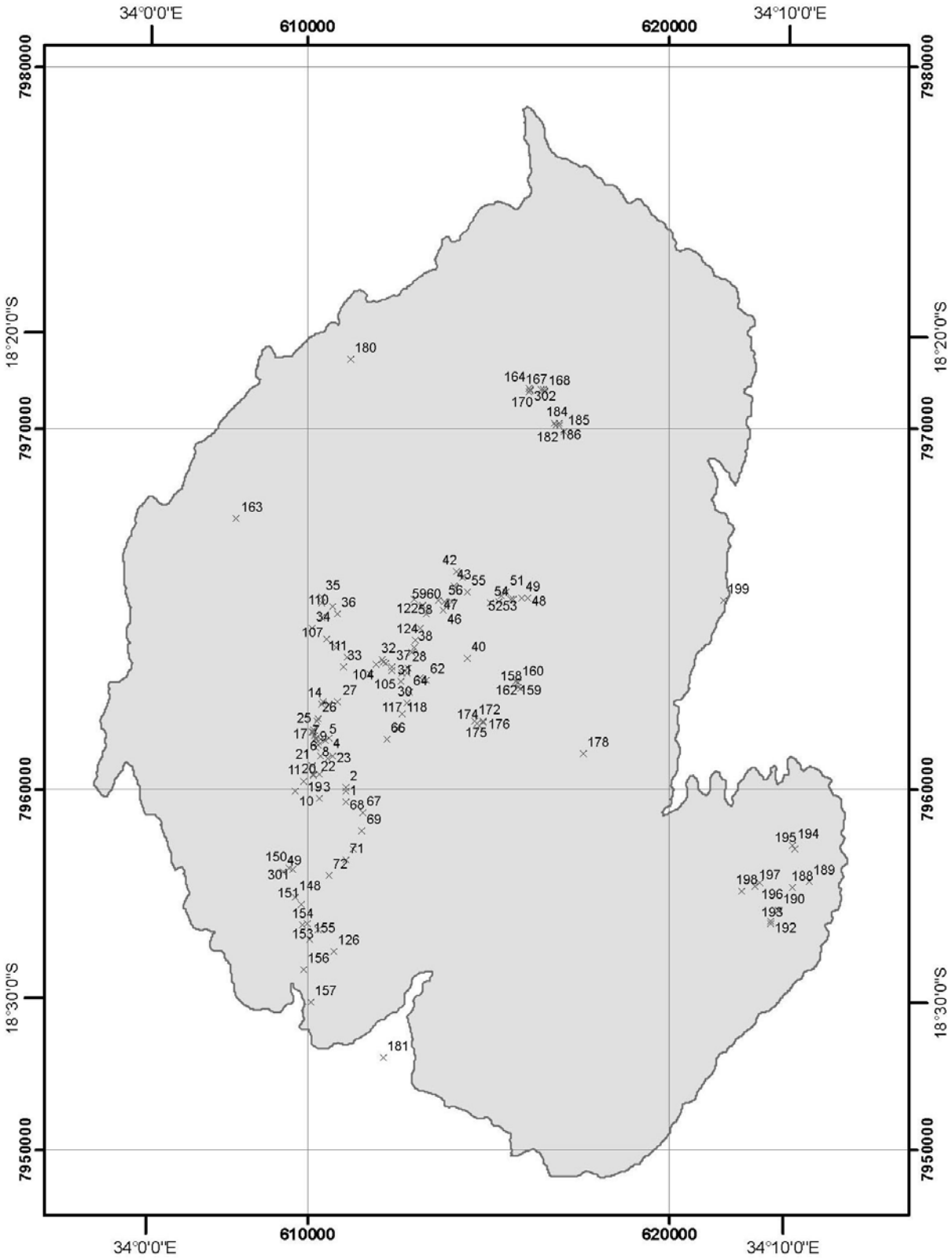

Fig. 3. Location of vegetation sampling points, Mt Gorongosa 2007.

The actual sampling points were subjectively located during transects across the predetermined sampling areas (figure 4). Great care was taken, that the sample represented a significant vegetation type and that it did not fall within an environmental boundary area. When sampling in the upper zone, due to the scarcity of footpaths and the often rugged terrain, access to sampling sites could be difficult and at times the sampling strategy was influenced by access problems.

The access routes to the various sample sites were used as transects on which the general composition of the vegetation was continuously examined so as to verify the information gained during sampling, and also to build up an understanding of the vegetation patterns and their relationship to the environment.

Moist Evergreen Rainforest was a widespread vegetation type in the natural upper zone, occurring at altitudes from approximately 1000 to 1800 metres. It is well known that species composition in moist forest changes with altitude. However, different forest types normally cannot be determined on satellite or air photos. Forests were therefore investigated more or less randomly at various altitudes in different parts of the massif. A special investigation was made along what is probably the longest forest catena found on the mountain – the main group of peaks on the southern slopes. Sampling took place from the top downwards and from the bottom upwards. Whenever a significant change in species composition was observed sampling of a new site was initiated.

3.2 Data Recording

Vegetation sampling was essentially plotless, but generally covered 1 to 2 ha in forest or woodland and approximately 0.25 to 0.5 ha in grassland. A starting point was selected for each sampling plot. The investigation moved onwards from this point, covering all the ground and traversing an approximately circular area from the central point. A list of all species that could be identified was compiled, and the area of investigation was expanded until no new species were appearing. For each species, the cover abundance was visually assessed using a modified Braun-Blanquet scale (Table 1).

In moist forest, woody species were recorded within each of the five strata recognized in closed-canopy forest. In woodland or wooded grassland, woody species were recorded in three height classes: less than 0.5 m (mostly regenerating), 0.5–3 m (shrubs and young trees), and trees and large shrubs more than 3 m high. Care was taken to ensure that while sampling the investigation did not stray across the boundaries of a different vegetation unit.

Table 1. Modified Braun-Blanquet scale.

Species frequency & estimated area cover	**Braun-Blanquet symbol**
Few, with small cover	+
Numerous but less than 5% cover, or scattered with up to 5% cover	1
Any number with 5–25% cover	2
Any number with 25–50% cover	3
Any number with 50–75% cover	4
Any number with more than 75% cover	5

Three botanists (Tom Müller, Christopher Chapano, Anthony Mapaura) participated in fieldwork for the entire duration (31 days), while one Mozambican botanist from the Eduardo Mondlane University (Alice Massingue) participated for 16 days during the first period. Fieldwork took place from the 16 April–4 May and from 13–24 June 2007. Most fieldwork was carried out on foot from base camps; altogether seven base camps were used. The time spent walking to the site was considerable. During the second period of field work a helicopter was available on 6 days.

Altogether 127 sites were recorded, 111 in the natural Upper Zone and 16 in the Lower Zone. In the upper zone, 48 were in moist forest, 31 in grassland, 23 in wooded grassland, 8 in microphyllous (ericoid) scrub and 1 in miombo (*Brachystegia*) woodland. In the Lower Zone 3 of the recording sites were in riparian forest and the remainder in woodland remnants and grassland.

To gain an understanding of the distribution of the dominant grassland types, and also to assist with the mapping of grasslands, frequent recordings of the dominant and indicator species, together with GPS readings, were made at various points along the access treks (mini-samples).

Stands investigated during the first period of fieldwork were used as ground control points. The spectral signatures of pixels at these points on the satellite image were extrapolated over the entire study site, which helped in planning fieldwork during the second period.

3.4 Data Analysis

The species-based classification of vegetation types was derived subjectively during field work and subsequently from the field sheets. As only a few main vegetation types were involved a computer-aided analysis was deemed unnecessary.

The proposed vegetation map has not yet been made as the satellite imagery available was not adequate to clearly separate the vegetation types recognised on the ground, and owing to changes in Gorongosa Restoration Project personnel and responsibilities.

A checklist of all 501 flowering plant species and gymnosperms recorded showing their growth form and the main vegetation type in which they occur is given in Appendix 1. Species identifioed only to genus were included in this total if that genus was not already recorded in the list. Nomenclature follows Mapaura & Timberlake (2004) and that in current use at the National Herbarium, Harare (SRGH). The plant lists recorded at each site are available from the senior author and lodged at the National Herbarium in Harare and at Gorongosa National Park HQ. A separate checklist of 104 Pteridophytes recorded from across Mount Gorongosa at various times is given as Appendix 2.

4. EVALUATION AND DESCRIPTION OF VEGETATION

4.1 General Considerations

Mount Gorongosa falls within the pan-tropical belt of summer seasonal rainfall which has a pronounced dry season of 6 to 8 months. Floristically, most of the surrounding country belongs to the Zambesian Regional Centre of Endemism (White 1988) consisting of vegetation adapted to withstand prolonged periods without moisture. However, because of the mountain's height, its upper parts, especially the ocean-facing slopes, receive sufficient orographic rain and mist during the winter months to allow for the existence of a much less xeromorphic vegetation over many parts of the mountain than is found in other parts of Mozambique.

Fig. 5. The near-endemic plant *Jamesbrittenia carvalhoi* in montane grassland.

A further cause of vegetation variation are the differing temperature regimes that prevail at different altitudes. In addition, the relief of a mountain as well as the often abrupt changes in soil depth can cause sharp differences in available moisture over a very short distance. In turn this causes sharp environmental boundaries and as a consequence one finds the juxtaposition of quite different vegetation types in many areas. Soil moisture conditions and altitude (temperature) are assumed to be the main environmental factors that determine vegetation types and their boundaries.

Much of the inner portion of the main massif, the upper parts of the Monte Nhassacassa section, the upper portions of the plain-facing slopes and, to a lesser extent, the upper slopes of the Vanduzi Valley are covered with moist evergreen forest. As one moves down the slopes, out of the mist belt towards areas of lower and less frequent rainfall, the areas covered by moist forest become increasingly relief-related and therefore more fragmented. This pattern would have been more obvious before the extensive clearing of woodland and forest that has taken place on the lower slopes over a long period. It is assumed that before this clearing practically all parts of the slopes that were too dry for the development of moist forest, were covered with woodland, mostly

Miombo (*Brachystegia*) woodland. By 2007 extensive areas of the original woodland were extremely rare and generally were only found in widely scattered small remnants.

4.2 Vegetation of Natural Upper Zone

Apart from moist evergreen forest, which has still remained on the outer slopes, the major areas of floristic interest are the inner portion of the main massif and the upper parts of the Monte Nhassacassa section where the vegetation, over most parts, is still in its natural state. Here, in areas which are either too dry (rocky slopes) or too wet (seasonally waterlogged) to maintain moist forest, other vegetation types occur. These are mainly dominated by grasses and sedges or microphyllous scrub. Moist evergreen forest has sharp and clearly-defined boundaries, whereas the other vegetation types sometimes grade into each other.

The following ten main vegetation types are recognized:

1. Moist Evergreen Forest
2. Montane Grassland
3. Sub-montane Grassland
4. Wetland
5. Wooded Grassland
6. Ericoid Scrub
7. *Erica hexandra – Rhytidosperma macowanii* Open Scrub
8. *Widdringtonia nodiflora* Forest
9. *Brachystegia tamarindoides* Woodland
10. *Brachystegia spiciformis* Woodland

4.3 Moist Evergreen Forest

Viewed along a moisture gradient, the moist evergreen forests of southern Africa represent the dry end of tropical rainforest development. They have much lower species richness than the forests of the equatorial belt and their constituent plants show a relatively high degree of xeromorphic adaptation. Physionomically and structurally however, they resemble tropical rainforest. Some of the trees are briefly deciduous, but the forest is generally evergreen.

Approximately 80 km^2 of the natural upper zone is covered by moist evergreen forest. Altitude is the principal factor correlated with species composition. In accordance with the forest classification used for Zimbabwe by Müller (1999), three forest types are recognized. They are:

1. *Syzygium guineense* subsp. *afromontanum* montane forest (above 1600 m)
2. Mixed sub-montane forest (1300 to 1600 m)
3. Medium-altitude forest (900 to 1300 m).

Fig. 6. High-altitude forest dominated by *Trichocladus ellipticus*.

These altitudinal limits are approximate and vary considerably with aspect and relief. Superimposed on these three fairly distinct altitudinal vegetation belts, there is an incipient and continuous change in species composition along the slope with many species having their own specific altitudinal zone and others occurring from top to bottom, but sometimes more commonly at a certain level.

On the outer mountain slopes, moist evergreen forest has been continuously removed for many decades, mainly from the bottom upwards. In 1970 the main cutting-line on the southern slopes was observed to be between 900 and 1000 m (personal observation). By 2007 it was in the vicinity and above the 1100 m contour in the south and south-east, but much higher on the northern slopes.

Since the different forest types cannot be distinguished on air photos or satellite imagery, estimates of the areas covered by the three types are difficult to make.

Montane forest only occurs on the uppermost slopes towards the main peaks and in some isolated patches on high ground in the central area. It is estimated that it consists of up to 15% of the total forested area.

Most of the forest that still occurs on the outer mountain slopes, and most of what covers the valleys and hills in the central area of the massif, is Mixed sub-montane forest. Approximately 85% of the forest on the mountains can be assigned to this type.

Medium-altitude forest occurs mainly in a few irregular narrow belts above 1100 m on the southern, southeastern and eastern slopes, and also in some isolated patches (remnants) down to 900 m on the southeastern-most slopes. It is estimated that Medium altitude forest covers less than 5% of the total forest area, all of it under severe threat. Cutting of timber was observed in several localities during fieldwork in June 2007.

4.3.1 *Syzygium guineense* subsp. *afromontanum* Montane Forest

All forest above an altitude of 1600 m belongs to this type. Often the dominant canopy tree species is *Syzygium guineense* subsp. *afromontanum*, with *Aphloia theiformis*, *Macaranga mellifera*, *Maesa*

lanceolata, *Olea capensis* subsp. *macrocarpa*, *Podocarpus latifolius*, *Rapanea melanophloeos* being important and sometimes dominant components and *Chionanthus foveolatus* subsp. *major*, *Cryptocarya liebertiana*, *Curtisia dentata*, *Ilex mitis*, *Pittosporum viridiflorum*, *Schefflera umbellifera*, *Trichocladus ellipticus* (figure 6) and *Widdringtonia nodiflora* typically present. Past disturbance is indicated by the dominance of *Macaranga mellifera*.

The often merging and poorly developed sub-canopy and sapling layer mainly consists of young specimens of the canopy tree species. *Tabernaemontana stapfiana* and *Xymalos monospora* are characteristic sub-canopy species, and *Canthium oligocarpum* subsp. *captum*, *Cassinopsis tinifolia*, *Dovyalis lucida* and *Oxyanthus speciosus* are prominent in the sapling layer.

Common species in the well-developed shrub layer are *Acanthopale pubescens*, *Carissa bispinosa* subsp. *zambesiensis*, *Erythrococca polyandra*, *Gymnosporia mossambicensis*, *Maytenus acuminata*, *Pavetta comostyla*, *Peddiea africana*, *Psychotria zombamontana* and *Pauridiantha symplocoides*.

Fig. 7. *Dietes iridioides* on the forest floor.

The most conspicuous lianas are *Cephalanthus natalensis*, *Keetia gueinzii*, *Secamone alpini*, *Schefflera goetzenii* and *Urera hypselodendron*.

Ground cover is generally sparse and patchy. Common herbs are *Cryptostephanus vansonii*, *Dietes iridioides* (figure 7), *Impatiens cecilli* and *Plectranthus swynnertonii*. Occasional grass species are *Coelachne africana*, *Festuca africana* and *Isachne mauritiana*.

4.3.2 Mixed Sub-montane Forest

This forest type is essentially a mixture of species from montane forest above and the medium altitude forest below. In its upper parts, montane species are more prominent, while lower down species from below are more common. Its altitudinal range is between 1300 and 1600 m.

The most typical and often dominant canopy species is *Craibia brevicaudata*. Other important, sometimes dominant, components of the canopy are *Cassipourea malosana*, *Chrysophyllum gorungosanum*, *Macaranga mellifera* (a sign of past disturbance when dominant), *Olea capensis* subsp. *macrocarpa*, *Podocarpus latifolius*, *Strombosia scheffleri* (normally below 1450 m) and *Syzygium guineense* subsp. *afromontanum*. Less frequent but typically large trees are *Albizia gummifera*, *Croton sylvaticus*, *Cryptocarya liebertiana*, *Diospyros abyssinica*, *Ekebergia capensis*, *Ficus chirindensis*, *Ficus craterostoma*, *Ficus scassellatii*, *Margaritaria discoidea* var. *nitida*, *Nuxia congesta* and *Pterocelastrus echinatus*. *Ocotea kenyensis* is a rarely encountered large canopy species. The most common large sub-canopy species is *Tabernaemontana stapfiana* with the generally smaller *Ochna arborea* also common. Other typical members of the sub-canopy and sapling layer are *Canthium oligocarpum* subsp. *captum*, *Chionanthus flaveolata* subsp. *major*, *Cola greenwayi*, *Drypetes gerrardii*, *Englerophytum magalismontanum*, *Erythroxylum emarginatum* and *Garcinia kingaensis* (especially on steep slopes), *Heinsenia dievilleoides*, *Ochna holstii*, *Oxyanthus speciosus*, *Rawsonia lucida*, *Rothmannia urciliformis*, *Vangueria esculenta*, *Vepris bachmannii* and *Xymalos monospora*.

Fig.8. *Acanthopale pubescens* in the forest understorey.

The shrub layer is normally distinct and well-developed. Shrubs common in montane forest such as *Carissa bispinosa* subsp. *zambesiensis*, *Erythrococca polyandra*, *Gymnosporia mossambicensis*, *Pavetta comostyla*, *Peddiea africana* and (especially) *Psychotria zombomontana* and *Pauridiantha symplocoides*, are still frequently encountered. Additional typical and sometimes common shrubs are *Achyrospermum carvalhi*, *Coffea ligustroides*, *Diospyros ferrea* (normally a small tree but here only recorded in the shrub layer), *Justicia betonica*, *Lasianthus kilimanscharicus*, *Mostuea brunonis*, *Piper capense* and *Rytigynia macrura*. *Dracaena fragrans* is increasingly common from 1450 m downwards. The soft-branched Acanthaceae, *Acanthopale pubescens* (figure 8), *Brachystephanus africanus* and, to a lesser extent, *Isoglossa mossambicensis* can be locally very common, often forming extensive dense patches.

Keetia gueinzii, *Schefflera goetzenii* and *Urera hypselodendron* are the most frequent lianas, while *Hippocretea africana* var. *richardiana*, *Jasminum abyssinicum*, *Landolphia buchananii*, *Secamone alpini* and *Tiliacora funifera* are occasionally recorded climbing plants.

Typical herbaceous species in the rather patchy and sparse ground cover are *Dietes iridioides* (figure 7), *Impatiens cecillii*, *Plectranthus swynnertonii* and *Thunbergia petersiana*. *Calanthe sylvatica*, an attractive purple-pink orchid, was common in some places. The most frequently seen grass species were *Coelachne africana*, *Isachne mauritiana* and *Poecilostachys oplismenoides*.

4.3.3 Medium-altitude Forest

This forest type is found at altitudes between 900 and 1300 m and is characterized by the presence of *Newtonia buchananii* (figure 9), often dominant at lower altitudes but always an important component. Other typical canopy species are *Albiza gummifera*, *Chrysophyllum gorungosanum*, *Craibia brevicaudata*, *Croton sylvaticus*, *Diospyros abyssinica*, *Drypetes gerrardii*, *Ekebergia capensis*, *Ficus chirindensis*, *Ficus craterostoma*, *Ficus scassellatii*, *Margaritaria discoidea* var. *nidida*, *Strombosia scheffleri* and *Trichilia dregeana*. *Ocotea kenyensis* was again recorded as a rare species and *Khaya anthotheca* was noted in one locality below 1000 m. *Albizia gummifera*, *Anthocleista grandiflora*, *Macaranga mellifera*, *Polyscias fulva*, *Rauvolfia caffra* and *Sapium elliplicum* are characteristic species of disturbed sites.

Common species in the sub-canopy and sapling layer are *Aidia micrantha*, *Cola greenwayi*, *Heinsenia diervilleoides*, *Garcinia kingaensis* (mainly on steep slopes), *Ochna arborea*, *Oxyanthus speciosus*, *Rawsonia lucida*, *Rothmannia urcilliformis*, *Strychnos usambarensis*, *Vangueria esculenta* and *Vepris bachmannii*.

In the well-defined shrub layer *Dracaena fragrans* is very common in the upper parts, where it often covers extensive areas. Characteristic shrubs not found higher up are *Allophyllus chaunostachys*, *Argomuellera macrophylla*, *Clerodendrum cephalanthum* subsp. *swynnertonii*, *Clerodendrum pleiosciadium*, *Cremaspora triflora*, *Dracaena mannii* (also in the sapling layer), *Mellera lobulata*, *Psychotria capensis* subsp. *capensis*, *Rinorea ferruginea*, *Rutidea orientalis*, *Rytigynia uhligii*, *Tarenna pavettioides* (also in the sapling layer) and *Tricalysia pallens*. Shrubs also found higher up but still prominent are *Achyrospermum carvalhii*, *Carissa bispinosa* subsp. *zambesiensis*, *Coffea ligustroides*, *Diospyros ferrea*, *Justicia betonica*, *Mostuea brunonis*, *Peddiea africana*, *Psychotria zombamontana* and *Rytigynia macrura*.

Fig.9. Giant trees of *Newtonia buchananii* in medium-altitude forest.

There are many species of lianas, the most common being *Acacia pentagona*, *Agelaea pentagyna*, *Combretum paniculatum*, *Embelia schimperi*, *Gouania longispicata*, *Hippocratea africana* var. *richardiana*, *Landolphia buchananii*, *Landolphia kirkii*, *Oncinotis tenuiloba*, *Strychnos lucens* and *Tiliacora funifera*.

Ground cover is often dense, with the sub-shrub *Pseuderanthemum subviscosum* and the 2 m tall *Aframomum angustifolium* very common. Seedlings of the common lianas, especially *Agelaea pentagyna*, contribute substantially to the lower strata. Common grass species are *Isachne mauritiana*, *Leptaspis cochleata*, *Oplismenus compositus*, *Oplismenus hirtellus*, *Poecilostachys oplismenioides* and *Setaria megaphylla*.

4.3.4 State of Moist Evergreen Forests

Mature, undisturbed moist evergreen forest can be recognized by its age structure and its stratification. It has an age structure in which all age classes are represented, and all of them have their characteristic distribution patterns which vary for different species. Mature trees occur in more or less set numbers per unit area. Stratification of the woody vegetation is normally distinct, consisting of three layers at higher altitudes (canopy, sapling layer and shrub layer) and four layers lower down (with the addition of a sub-canopy statum).

In most of the 48 forest stands investigated, there was rarely a continuous canopy, and stratification of the middle layers was normally poor. Forest patches showing a mature age structure were rarely observed and normally occurred only over relatively small areas.

The best-preserved forest seen was in Stand 36 in a remote area of the middle section of the main massif. It consisted of Mixed Sub-montane forest with a canopy height of 45 m. During the survey

period, clearing of several hectares of forest took place in the inner section of this fairly extensive forest. Reasonably well preserved Sub-montane forest occurred in the vicinity of stands 35a and 177, and good Montane forest was observed in stand 165. Well preserved Medium-altitude forest was only seen covering relatively small areas.

In general, canopy height of the forest was 15 to 20 m in the uppermost areas, gradually increasing downwards to over 50 m in Medium-altitude forest.

The most species-rich part of the forest is Medium-altitude forest between 900 and 1100 m (its lower portion). Tree clearing at this altitude was observed during fieldwork in April and June 2007, on the southern and eastern slopes of the main massif, and the southeastern slopes of Monte Nandondo on the Monte Nhassacassa section.

The scarcity of undisturbed mature forest leads to the assumption that prehistoric shifting agriculture could have taken place in the forests of Mount Gorongosa. This would have caused unnaturally large openings, making the forest more prone to damage by storm and possibly fire. For a forest to reach maturity from ground level could take several hundred years.

4.3.5 Forest Edge Vegetation

Along the forest margins there was almost everywhere a distinct belt of forest edge vegetation which had a different species composition to that found inside the forest, with only a few species occurring on the margin and inside. Most of the edge species are shrubs, and the tree species among them normally have a shrubby habit (figure 10). Species composition of the forest margin changes little with altitude and a generally similar species composition is found from 1300 to 1800 m. Typical forest edge species include *Aphloia theiformis*, *Buddleja salviifolia*, *Cassinopsis ilicifolia*, *Cassinopsis tinifolia*, *Cliffortia serpyllifolia*, *Clutia swynnertonii*, *Crotalaria capensis*, *Cussonia spicata*, *Erica hexandra*, *Halleria lucida*, *Heteromorpha arborescens* var. *abyssinica*, *Hypericum revolutum*, *Macaranga mellifera*, *Maesa lanceolata*, *Morella pilulifera*, *Myrsine africana*, *Pavonia columella*, *Polygala gazensis*, *Polygala virgata*, *Protea caffra* subsp. *gazensis*, *Rapanea melanophloeos*, *Rhus chirindensis*, *Rhus tumulicola*, *Rubus apetalus*, *Schefflera umbellifera*, *Smilax anceps*, *Sparrmannia ricinocarpa*, *Tephrosia aequilata* subsp. *mlanjeana* and *Widdringtonia nodiflora*. Prominent herbaceous species are *Helichrysum nudiflora*, the often over 1m tall *Impatiens psychadelphoides*, the fern *Pteridium aquilinum* and the tussock grass *Merxmuellera macowanii*.

Fig.10. *Aloe arborescens* at the forest edge.

Fig.11. Montane grassland below Nhandowe Peak with *Helichrysum* species, small shrubs of *Kotschya thymodora* and the tree fern *Cyathea dregei* in the seepage of a small stream.

4.4 Montane Grassland

Montane grassland occurs only on the highest parts of the mountain up on the main massif at altitudes from 1700 to 1820 m, often on flattish or gently sloping ground but sometimes on steeper slopes of up to 30º (figure 11). The bulk of the sward is made up of two fine-leaved species of Cyperaceae referred to in this study as "blue sedge" and "green sedge". No flowering material was found during April and June and these two important species could not be identified. Often the most common grass species is *Festuca abyssinica*, while other typical grasses include *Eragrostis volkensii*, *Eulalia villosa*, *Panicum ecklonii* and *Setaria sphacelata*. Less frequent grass species are *Andropogon schirensis*, *Digitaria maitlandii*, *Ischaemum fasciculatum* and *Trichopteryx dregeana*. *Loudetia simplex* is mainly present in patches with rock outcrops. Herbs make up an important portion of the ground cover and the most common species are *Helichrysum buchananii*, *Helichrysum nitens* and *Vernonia natalensis*. Other common herbs are *Eriosema psoraleoidies*, *Haumaniastrum venosum*, *Indigofera hedyantha*, *Kotschya thymodora*, *Lotus wildii*, *Rhynchosia clivorum* and *Sopubia mannii*. Other herbaceous species typically present are *Alepidea swynnertonii*, *Aloe rhodesiaca*, *Gladiolus crassifolius* (figure 12), *Kniphofia linearifolia*, *Knowltonia transvaalensis*, *Sabaea leiostyla* and *Jamesbrittenia carvalhoi* (figure 5). The fern, *Pteridium aquilinum* occurred over much of the grassland, never very common, but always present.

4.5 Sub-montane Grassland

Sub-montane grassland occurs from 1300 to 1700 m over extensive areas on the more gentle hills and valleys in the central portion of the main massif, and also on some of the higher ground of the Monte Nhassacassa section (figure 13). Its species composition is generally similar to that of Montane grassland the main differences being that *Loudetia simplex* is the most common and often dominant grass species, *Monocymbium ceresiiformis* is an important associate and *Hyparrhenia*

newtonii typically occurs. “Green sedge” and “blue sedge” are always present but not as prominent as higher up. The grass *Eragrostis acraea* forms large patches in some areas but was absent in others. Apart from this, the grass and herbaceous species are similar to those occurring higher up.

Fig.12. An unusual variety of *Gladiolus crassifolius* in montane grassland.

Fig.13. Submontane grassland in the upper Nhandare valley, with the spectacular *Kniphofia splendida* in flower.

4.6 Wetland

Wetlands are areas with higher soil moisture content than the surrounding land and occurs at the lower end of grassland slopes, along drainage lines and in the vicinity of stream valleys. They normally cover small areas of 1 to 5 ha and occur occasionally throughout the study site at altitudes from 1300 to 1720 m. Species distribution within the wetlands is often clumped and patchy, and in some places different vegetation sub-units can be discerned. The species composition is generally similar throughout the altitudinal range, except for one Cyperaceae (“brown sedge”) that was only

recorded above 1680 m, where it was dominant and gave the wetlands a brownish appearance. No fertile material could be found and identification was impossible.

The bulk of plant mass in wetlands normally comprises Cyperaceae (sedges), but unfortunately a number of them could not be identified. *Costularia natalensis* is an often prominent and sometimes dominant sedge, *Xyris gerrardii* is typically present but of little bulk, and the "blue sedge" and "green sedge" are generally important components. Common grass species include *Eragrostis volkensii*, *Eulalia villosa* and *Setaria sphacelata*, while *Eragrostis* was occasionally present in patches. Herbs are present but rarely conspicuous. Typical herbaceous species are *Eriosema psoraleoides*, *Gerbera ambigua*, *Haumaniastrum venosum*, *Helichrysum odoratissimum*, *Kniphofia linearifolia* and *Kniphofia splendida* (figure 13), *Sebaea leiostyla* and *Schistostephium artemisiifolium*. The fern *Pteridium aquilinum* is often present and sometimes quite common.

4.7 Wooded Grassland on Rock

Wooded grassland occurs on knolls and kopjes but also on broad mountain slopes with outcropping rock. Normally woody species are clumped or irregularly scattered and their number increases with an increase of outcropping rock. Where there is little rock there are widely scattered *Protea caffra* subsp. *gazensis* and a few *Morella pilulifera* and *Strelitzia caudata* (figure 15). With more rock the species composition increases to a complex assemblage.

Generally present are the same species that are typical of forest margins. The most typical and common tree species are *Cussonia spicata*, *Erica hexandra* (often a shrub), *Morella pilulifera*, *Strelitzia caudata* and *Widdringtonia nodiflora*. Trees normally found in moist forest but commonly occurring as stunted specimens on rocky slopes include *Aphloia theiformis*, *Ilex mitis*, *Curtisia dentata*, *Apodytes dimidiata*, *Macaranga mellifera*, *Maesa lanceolata* and *Schefflera umbellifera*. The most common and typical shrub species are *Aeschynomene nodulosa* var. *glabrescens*, *Aloe arborescens* (figure 10), *Buddleja salviifolia*, *Clutia swynnertonii*, *Cliffortia serpyllifolia*, *Halleria lucida*, *Heteromorpha arborescens* var. *abyssinica*, *Myrsine africana*, *Protea caffra* subsp. *gazensis*, *Rhus chirindensis*, *Rhus tumulicola*, *Rubus apetalus*, *Tephrosia aequilata* subsp. *mlanjeana*, *Tetradenia riparia* and *Vangueria apiculata*. Characteristic smaller plants include *Aloe rhodesiaca*, *Berkheya zeyheri*, *Diplolophium buchananii*, *Kotschya thymodora*, *Plectranthus chimanimanensis* and *Thesium nigricans*. *Loudetia simplex* is generally the most common grass, but higher up (above 1650 m) *Festuca abyssinica* and *Merxmuellera macowanii* can be very common, while below 1700 m *Eragrostis acraea* occurs locally in large patches. A striking and very

Fig.14. Clumps of the sedge *Coleochloa setifera* survive on bare rock surfaces, where they are often bizarrely sculpted by fire and weather conditions.

common feature on bare rock is the tussock sedge, *Coleochloa setifera* (figure 14), which occurs in rock cracks. Besides the occasional specimen of *Crassula nodulosa* var. *nodulosa* and *Crassula swazienis* var. *swaziensis* it is the only plant that can survive in this habitat.

4.8 Ericoid Scrub

Ericoid scrub occurs on similar rocky slopes as the wooded grassland described above, and contains almost the same species assemblage. However, the vegetation is almost impenetrably dense and dominated by *Erica hexandra*, with *Widdringtonia nodiflora* also common. From a vantage point it can be seen that Ericoid scrub sometimes merges into almost pure stands of *Widdringtonia* forest. The extent of Ericoid scrub is difficult to estimate, but it seems fairly common on some of the valley slopes in the central parts of the massif.

In areas where the slope flattens, the scrub is often less dense and *Erica hexandra* less dominant. Here *Aeschynomene nodulosa* var. *glabescens* or *Anthospermum ammannioides* are common or dominant and *Morella pilulifera*, *Rhus tumulicola*, *Stoebe vulgaris*, *Tephrosia aequilata* subsp. *mlanjeana* and *Tetradenia riparia* are prominent shrubby species; the fern *Pteridium aquilinum* is typically present (stands 175 and 186). Similar associations are observed in the flatter portion of slopes covered with wooded grassland.

Fig.15. Flora on exposed rock often includes similar components as ericoid scrub, such as *Erica hexandra*, *Aeschynomene nodulosa* and the banana-like *Strelitzia caudata*.

4.9 *Erica hexandra – Merxmuellera macowanii* Open Scrub

This is a seldom-observed association occurring on slopes close to moist forest. There is an open shrub layer consisting of *Erica hexandra* and *Cliffortia serpyllifolia*, interspersed with *Morella pilulifera*. In between the tussock grasses *Merxmuellera macowanii* and the tussock sedge

Costularia natalensis are common and *Setaria sphacelata* frequent. Typical herbaceous species include *Eriosema psoraleoides*, *Kniphofia linearifolia* and *Nidorella auriculata*. A similar association was observed immediately to the north of forest stand 35a. However, here the vegetation mainly consists of *Merxmuellera macowanii* interspersed with the fern *Pteridium aquilinum*.

4.10 *Widdringtonia* Forest

Widdringtonia forest occurs in narrow belts within Ericoid scrub or wooded grassland. Only a few hectares is thought to exist on the mountain. The canopy is made up of *Widdringtonia nodiflora* only, while sometimes *Erica hexandra* is frequently associated. The sub-canopy and sapling layer consists of moist forest species such as *Aphloia theiformis*, *Garcinia kingaensis*, *Macaranga mellifera*, *Olea capensis*, *Podocarpus latifolius*, *Rapanea melanophloeos*, *Schefflera umbellifera* and *Xymalos monospora*. The lower part of the forest is very open. Typical species in the widely scattered shrub layer are *Cassinopsis tinifolia*, *Cliffortia serpyllifolia*, *Clutia swynnertonii*, *Morella pilulifera, Psychotria zombamontana*, *Rubus apetalus* var. *apetalus*, *Rhus tumulicola* var. *tumulicola* and *Smilax anceps*. In the sparse ground cover *Pteridium aquilinum* is prominent. The forest consists of fairly young even-aged trees, suggesting that it occasionally burns down.

4.11 *Brachystegia tamarindoides* Woodland

Brachystegia tamarindoides woodland was only observed on the north-western slopes of the Monte Nhassacassa section, where it covers around 25 ha in a more-or-less continuous stand. The canopy is made up almost entirely of *Brachystegia tamarindoides* subsp. *microphylla* (previously known as *B. glaucescens*). Other typical tree species, all of them smaller, are *Albizia adianthifolia*, *Albizia versicolor*, *Anthocleista grandiflora*, *Bridelia micrantha*, *Burkea africana*, *Dalbergia nitidula*, *Englerophytum magalismontanum*, *Entada abyssinica*, *Erythrophleum suaveolens*, *Harungana madagascariensis*, *Morella pilulifera*, *Parinari curatellifolia*, *Pericopsis angolensis*, *Pterocarpus angolensis*, *Securidaca longipedunculata* and *Syzygium cordatum*.

Typical shrub species are *Aeschynomene nodulosa* var. *glabrescens*, *Erythroxylum emarginatum*, *Psorospermum febrifugum*, *Rhus chirindensis*, *Smilax anceps*, *Tarenna pavettoides*, *Tephrosia aequilata* subsp. *mlanjeana*, *Tricalysia pallens*, *Vangueria apiculata* and *Vangueria infausta*.

Loudetia simplex and *Melinis nerviglumis* are the most common grass species and *Afromomum angustifolium*, normally found in moist forest, is occasionally seen in the ground cover. Trees are covered with epiphytes, mainly orchids and ferns and the conspicuous lichen *Usnea*.

The canopy is almost continuous in many places with a cover of 80 to 90% and many mature trees up to 25 m in height. Generally the woodland is reasonably well-preserved. However, there are obvious signs indicating that tree cutting has recently taken place.

An interesting record was the very rare *Asplenium holstii* (figure 16). It has a simple frond and strongly resembles the cultivated birds nest fern (*Asplenium nidus*) from Australasia.

4.12 *Brachystegia spiciformis* Woodland

This was only seen through binoculars, on the upper western slopes. There was no time available to investigate it.

Fig.16. One of a number of new records for Mt Gorongosa was the rare fern *Asplenium holstii*.

4.13 Vegetation and Fire

It is assumed that the natural limits of moist forest are generally determined by soil moisture and fire has little influence on the boundaries. This is borne out by the fact that when comparing the present boundaries with the ones shown on air photos taken 37 years ago, no significant change in the outline of the forests can be observed.

However, considering the strong fires that regularly take place in the open areas of the mountain, we must assume that the vegetation patterns and successional development of all plant communities occurring between grassland and moist forest are greatly influenced by fire. There might, over large areas, be a natural progression from wooded grassland towards Ericoid scrub and further towards *Widdringtonia nodiflora* forest, which is regularly set back again by fire. In some areas the fire regime might be such that the final stages are never reached. These successional processes are also affected by soil moisture conditions, which are very variable in mountainous terrain; fire superimposed on areas with variable soil moisture conditions will increase vegetation heterogeneity. Generally in high rainfall areas of seasonal rainfall where strong fires prevail, such as on Mount Gorongosa, plant communities with woody components are much more in a state of flux than they would be with less or no fire.

4.14 Vegetation of the Modified Lower Zone

This zone is artificial but constitutes a useful unit for the purpose of this study. It has been created by the removal of most of the woodland and moist forest, which, at one time, must have covered almost all of the lower slopes of the mountain. It extends from the boundary (the 700 m contour) up to the edge of the zone of well-preserved natural vegetation, and makes up more than half of the study site (approximately 200 sq. km). Its upper boundary is ill-defined and jagged and varies in altitude between approximately 1000 and 1200 m. Over large areas the natural vegetation has been obliterated to make space for agricultural land and villages.

Much of the area where there was previously miombo woodland is still covered with the original grassland species, although most probably strongly modified by the different fire regime. In some

areas the grassland contains small remnants of the original trees and regenerating woody vegetation (mostly small). If not converted to agricultural land the areas previously covered with moist forest are covered with secondary grassland, often containing scattered young trees of forest edge and forest pioneering species – an assemblage which is typical of degraded high rainfall situations. Very occasionally there are remnants of degraded moist forest.

4.14.1 Vegetation on the Western Slopes (stands 163 to 180)

The western slopes are rain-shadow country and most of them were once covered with miombo woodland, with moist forest found only higher up in concave areas and along drainage lines.

The slopes are essentially occupied by field, fallow land and grassland which in some areas contains widely scattered woodland trees and isolated pockets of woodland remnants (figure 17). Very few narrow ribbons of moist forest were observed in the uppermost sections.

Fig.17. The north-western slopes of the mountain are in the rain shadow. They are less densely settled due to lack of suitable agricultural land, so some remnants of the former woodlands are left.

Typical tree species recorded were *Acacia karroo*, *Brachystegia boehmii*, *Combretum zeyheri*, *Cussonia arborea*, *Diplorhynchus condylocarpon*, *Dombeya rotundifolia*, *Erythrina abyssinica*, *Faurea saligna*, *Pericopsis angolensis*, *Pterocarpus rotundifolia*, *Securidaca longipedunculata* and *Strychnos spinosa*. Characteristic shrubs were *Annona senegalensis*, *Diospyros lycioides*, *Senna petersiana* and *Vangueria infausta*. All species are typical components of miombo woodland, while *Acacia karroo* is the most important woodland pioneer species on the lower parts of the mountain. The most common grass species were *Cymbopogon caesius*, *Hyparrhenia cymbaria*, *Hyparrhenia filipendula*, *Hyparrhenia newtonii*, *Hyparrhenia rufa*, *Melinus repens* and *Themeda triandra*.

4.14.2 Vegetation on the Southern Slopes (stands 148 to 156)
Where there are no fields and fallow lands there is grassland, often containing regenerating woody species (figure 18). Much of the grassland appears to be secondary, covering areas from where moist forest had been cleared. However, in many areas it is not obvious whether it was moist forest or woodland that was removed; more fieldwork is needed to establish the actual pattern. Typical tree species recorded were *Acacia karroo*, *Albizia adianthifolia*, *Bridelia micrantha*, *Cussonia spicata*, *Dalbergia boehmii*, *Dalbergia nitidula*, *Erythrina lysistemon*, *Ficus sur*, *Harungana madagascariensis*, *Heteropyxis natalensis*, *Parinari curatellifolia*, *Pericopsis angolensis*, *Pteroocarpus rotundifolius*, *Syzygium cordatum* and *Trema orientalis*. Often these trees occur as low suckers below 3 m in height, but sometimes as about 5 m tall, widely scattered small trees. They rarely form patches of secondary woodland with a canopy up to 10 m high.

Typical shrub species are *Aeschynomene nodulosa* var. *glabrescens*, *Annona senegalensis*, *Dombeya burgessiae*, *Heteromorpha arborescens* var. *abyssinica*, *Polygala gazensis*, *Protea caffra* subsp. *gazensis*, *Psorospermum febrifugum*, *Rhus chirindensis*, *Smilax anceps*, *Tephrosia aequilata* subsp. *mlanjeana*, *Tephrosia vogellii*, *Vangueria infausta* and *Vangueria apiculata*.

Fig.18. Large areas of miombo woodland were cleared from the southwestern slopes many years ago to create grazing for cattle. Due to regular fires, these areas have now become well-established grasslands with only scattered pockets of the original woodland or forest in more sheltered places.

The common grass species are *Cymbopogon caesius*, *Hyparrhenia cymbaria* (often dominant), *Hyparrhenia filipendula*, *Hyparrhenia rufa*, *Loudetia simplex* (sometimes dominant, sometimes absent), *Melinis nerviglumis*, *Melinis repens*, *Panicum maximum* and *Paspalum scrobiculatum*. The fern species *Pteridium aquilinum* is often present and the forest herb *Aframomum angustifolium* was noted frequently.

Tree species recorded along streams were *Anthocleista grandiflora*, *Apodytes dimidiata*, *Breonadia salicina*, *Catha edulis*, *Cussonia spicata*, *Ficus sur*, *Filicium decipiens*, *Khaya anthotheca*, *Macaranga mellifera*, *Maesa lanceolata*, *Mimusops zeyheri*, *Newtonia buchananii*, *Sapium ellipticum* and *Syzygium cordatum*.

4.14.3 Vegetation on the Eastern Slopes (stand 199)

Only one investigation was carried out on the eastern slopes, close to the 700 m contour where remnants of the original woodland were looked at. The tree species recorded were *Acacia sieberiana*, *Albizia adianthifolia*, *Albizia versicolor*, *Bridelia micrantha*, *Combretum psidioides* subsp. *psidioides*, *Cussonia arborea*, *Dalbergia boehmii*, *Markhamia obtusifolia*, *Millettia stuhlmannii*, *Pericopsis angolensis*, *Philenoptera violacea*, *Pterocarpus angolensis*, *Strychnos spinosa*, *Terminalia sericea* and *Vitex payos*. This species assemblage might be typical of the lower slope, but not of the eastern slope as a whole.

Typical shrub species were *Annona senegalensis*, *Antidesma venosum*, *Psorospermum febrifugum*, *Senna petersiana*, *Smilax anceps*, *Tephrosia vogelli* and *Vangueria infausta*. *Hyparrhenia cymbaria* and *Panicum maximum* are the dominant grasses.

4.14.4 Vegetation on slopes of Nhassacassa section

Only one area was looked at, located on the north-northwest facing slopes above the Vanduzi River.

The slopes in this area are covered with extensive grasslands containing a variety of regenerating woody species, most of them young and below 3 m in height. Typical regenerating tree species are *Albizia adianthifolia*, *Bridelia micrantha*, *Burkea africana*, *Cussonia spicata*, *Dalbergia boehmii*, *Dalbergia nitidula*, *Ficus sur*, *Harungana madagascariensis*, *Morella pilulifera*, *Heteropyxis natalensis*, *Pericopsis angolensis* and *Syzygium cordatum*. Characteristic shrubs are *Aeschynomene nodulosa* var. *glabrescens* (widespread), *Annona senegalensis*, *Hymenocardia acida*, *Mussaenda arcuata*, *Psorospermum febrifugum*, *Rubus apetalus*, *Smilax anceps*, *Tetradenia riparia* and *Tephrosia aequilata* subsp. *mlanjeana* (common).

The most common grass species are *Hyparrhenia filipendula*, *Loudetia simplex*, *Melinus minutiflora*, *Melinus nerviglumis* and *Paspalum scorbiculatum*. The fern *Pteridium aquilinum* is common and typical of this grassland type.

5. CONCLUSIONS

5.1 General Considerations

The vegetation of the study site falls into two distinct zones:

1. A Lower Zone which contains settlements and from which almost all of the forest and woodland has been removed. This zone is similar in physiognomy to the area between the 700 m contour and the base of the mountain, except that there are fewer settlements and shifting agriculture is less intense. Apart from the riparian vegetation of the watercourses, the zone contains little that is of special conservation interest.

2. An Upper Zone in which much of the original natural vegetation is still well preserved and which is considered important for nature conservation. The boundary between the two zones is ill-defined in many parts and often jagged and frayed, lying mainly between the 1100 and 1200 m contour lines, but sometimes higher.

5.2 Stability of the Environment

Vegetation condition in the Lower Zone looks generally stable despite the removal of timber, mainly because of the scarcity of livestock. The prevailing shifting agriculture is posing a potential threat to the stability of the mountain slopes.

The physical environment of the Upper Zone is in a stable condition. However, the clearing of land within moist forest constitutes an enormous threat to its biodiversity. If the number of goats on the mountain is allowed to increase, they too will have an adverse effect on biodiversity and the stability of the slopes. [but see Preface]

A separate study undertaken by Franziska Steinbruch of the Gorongosa Restoration Project using satellite imagery produced a map showing the loss of forest cover between 1972 and 2008 above the 700 m contour line. This is shown in figure 19.

5.3 Endangered Species and Endemism

To analyse reliably the long list of recorded species with regards to endemism and conservation status would take more time than was available for this study, and would also involve assistance from taxonomic specialists in specific plant families. However, it is assumed that a moderate number of rare and endangered species have been recorded and that endemics occur (e.g. *Streptocarpus brachynema*, figure 20), but the number is lower than was generally anticipated. As the survey was carried out during two relatively short periods in April and June, and covered only a fraction of the entire area, it can not be regarded as comprehensive, especially as a sizeable proportion of the rare and/or endemic species are likely to belong to groups that have a relatively short period of their life-cycle above ground (bulbous plants and orchids). In addition, herbaceous species and small shrubs are likely to be overlooked when not in flower or fruit. Therefore, unless the montane and sub-montane grasslands and wetlands – the most likely habitats for unusual plants – are scrutinized at various times of the year, especially between October and March, one cannot make reliable statements about the number of rare and endemic plants.

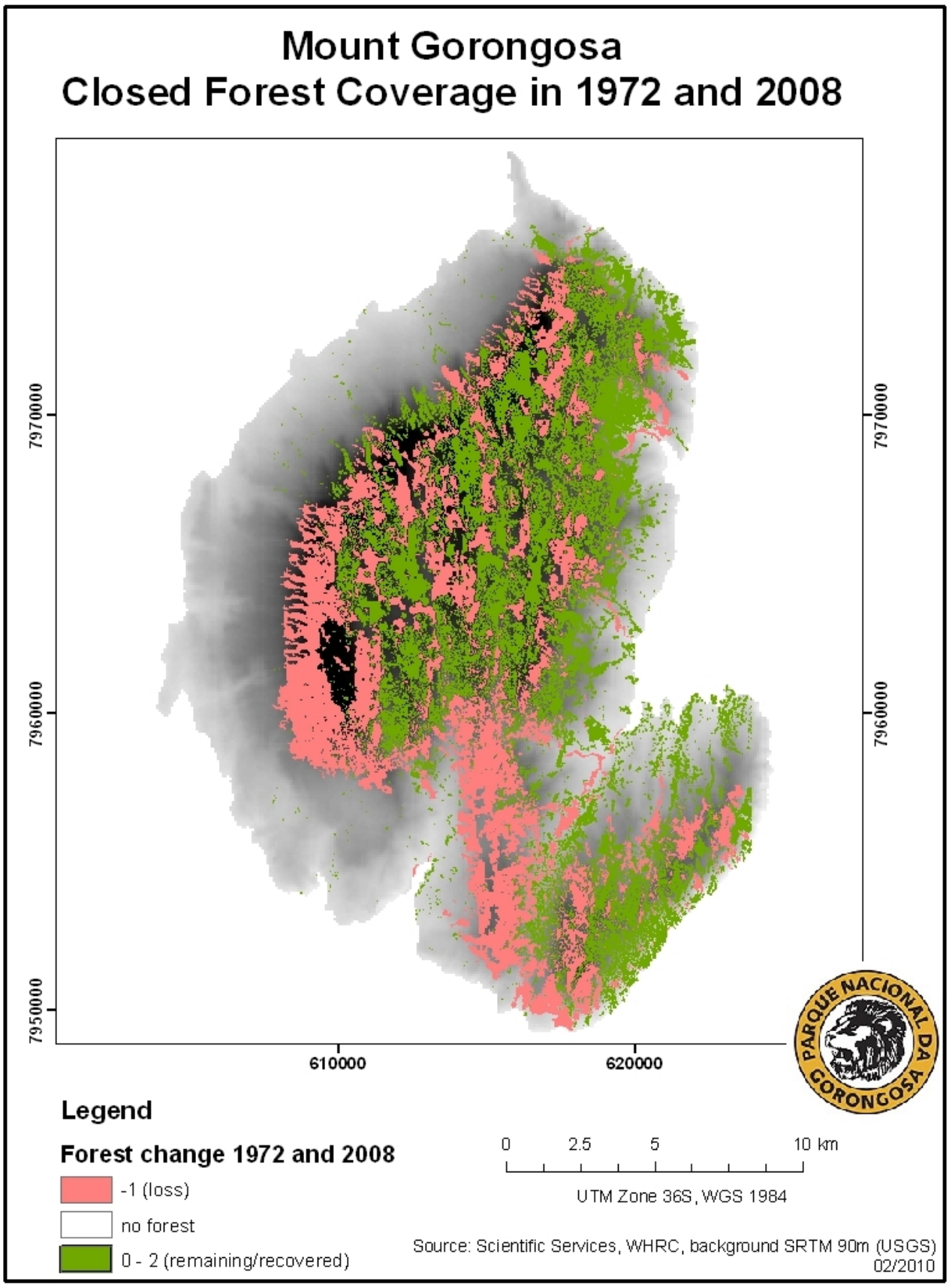

Fig.19. Forest loss 1972-2008 from Mt Gorongosa above the 700 m contour.

Fig. 20. *Streptocarpus brachynema*, a true endemic only found in the montane forests of Mt Gorongosa.

Fig.21 & 22. *Polystachya subumbellata* and *Cynorkis anisoloba*; two new records for Mt Gorongosa.

Several species thought to be endemic to the Eastern Highlands of Zimbabwe were recorded also on Mount Gorongosa. Two species of Orchidaceae in particular, *Polystachya subumbellata* (figure 21) and *Cynorkis anisoloba* (figure 22), may actually have their largest populations on the mountain.

Many species were recorded for Mount Gorongosa for the first time, while others were new records for Mozambique as a whole. Pteridophyta (ferns and fern-allies) in particular, appear to be rich in species diversity, with many species recorded for the mountain for the first time (see Appendix 2 for a provisional list).

5.4 Conservation of Moist Evergreen Forest

Very little mature, near-pristine moist evergreen forest was observed. Nevertheless, most of the stands are in an advanced state of succession and could be regarded as well-developed forest. All types of moist forest are of limited distribution in southern Africa and are particularly rare in Mozambique. They are therefore considered an important conservation priority.

5.5 Conservation of Vegetation in the Upper Zone

Vegetation of most of the Upper Zone consists of an interesting variety of Afromontane vegetation types, quite different from other vegetation in Mozambique, although species richness and endemism is probably less than on similar mountains in southern Africa. However, its flora is still of sufficient interest to make it an important conservation priority. There are other equally important considerations as follows:

- Afromontane vegetation types are of limited distribution and are extremely rare in Mozambique.
- For many species, Mount Gorongosa is the only locality where they occur in Mozambique. It also supports many species which are generally rare while some are endemic to the mountain.

- The inherent qualities of Mount Gorongosa's vegetation, its pristine nature, its uniqueness and its juxtaposition of many of the ecosystems.
- The vegetation is well preserved over much of the upper parts.
- The vegetation is an important component of an extremely beautiful landscape, with great potential for ecotourism.
- The vegetation protects an important water catchment area.

5.6 Management

Initially, concern about environmental stability focussed attention on Mount Gorongosa. The mountain's obvious potential for nature conservation makes its inclusion into Gorongosa National Park imperative. [This has now been achieved.] As an integral part of the National Park, it should be easier to achieve the environmental stability sought, both for the wildlife area of Gorongosa National Park and the surrounding area.

5.6.1 Management of the Upper Zone

In the Upper Zone (the main water catchment area), the only management required is protection of the vegetation. If vegetation cover is maintained, stability is maintained. Conservation here should consist of the appropriate intervention to achieve environmental stability.

Protection of vegetation essentially entails three management operations:

1. Prevent all cutting of timber
2. Prevent the occurrence of fires caused by people
3. Prevent excessive grazing by livestock.

If it is not possible to succeed in these operations, the proposed project of creating a National Park and Biodiversity Reserve in the upper zone of Mount Gorongosa will fail.

Fires caused by lightening strikes have always occurred on the mountain, and such fires comprise an integral part of its ecology, However, natural fires occur at irregular intervals and consequently are of variable intensity. Annual burning, as practiced at present, is adversely affecting biodiversity and is changing natural vegetation patterns. In a large conservation area such as Mount Gorongosa, it is important that natural fire patterns are allowed to re-establish themselves.

The only human activities that can be reconciled with the type of biodiversity or nature reserve envisaged on Mount Gorongosa is a benign form of ecotourism and sustainable small-scale gathering of medicinal plants. Both activities have to be monitored to ensure their sustainability. For instance, footpaths on sloping terrain are likely to develop into erosion channels, and measures have to be taken to prevent this. Likewise, excessive harvesting of medicinal plants such as bark can kill trees (figures 17 & 18).

5.6.2 Management of the Lower Zone

In the Lower Zone the situation is entirely different. Stability (and some conservation) has to be achieved by environmental management. The Lower Zone is an area where people live and practice shifting agriculture. Current practices often lead to degradation of the environment, but modified practices can lead to environmental stability.

This offers a unique opportunity for National Park managers and the Gorongosa Restoration Project to attempt something that has probably never been achieved over an area as large as the Lower

Zone. With the right intentions and resources it is possible to introduce systems of settlement, farming and resource utilization that are sustainable and which require low energy input. Possible crops are vegetables, including potatoes, tea, coffee and various sub-tropical fruits, under irrigation where appropriate.

There are also ample opportunities for agroforestry with agroforestry zones strategically placed, for example in areas prone to erosion or as fire guards to protect the Upper Zone from fire in areas where fires are likely to spread. In order to maintain as much of the natural biodiversity of the Lower Zone as possible, agricultural areas should be interspersed with a planned pattern of areas with natural vegetation, consisting of original woodland and forest remnants and small carefully selected areas of natural secondary vegetation.

Fig.17 & 18. An important threat to miombo woodland is construction of beehives from tree bark.

6. RECOMMENDATIONS

The following recommendations are made to the managers of the National Park :

1. It is of the utmost importance to the biodiversity of Mozambique and to the stability of water catchment areas that all of the upper portion of Mt Gorongosa still covered with the original vegetation is maintained as a Nature Reserve. This generally includes land above 1100 to 1200 m, but also some lower areas.
2. Immediate measures must be put in place to prevent the cutting of forest trees and forest clearance. This is most urgent and must be vigorously pursued and supported with as many resources as possible. The most vulnerable forests are the lowermost ones on the southern and eastern slopes of the main mountain and on the eastern slopes of the Mt Nhassacassa section, but also the most remote forests in the inner areas of the main massif.
3. Immediate measures must be put in place to prevent people from burning the grasslands of the natural Upper Zone and to prevent fires from spreading from the Lower to the Upper Zone.
4. Immediate measures must be put in place to prevent grazing by livestock in the Upper Zone.
5. All recently cleared openings within moist forests should be allowed to regenerate naturally.
6. In recognition of community needs, sustainable small-scale gathering of medicinal plants should be permitted, even in the Nature Reserve of the Upper Zone.
7. It is recognised that Mt Gorongosa has exceptional potential for ecotourism, and that ecotourism activities are strongly supported as long as they are carried out sustainably.
8. The impact of ecotourism and gathering of medicinal plants must be monitored in order to ensure that both activities are carried out sustainably.
9. As the vegetation map was ot completed, an opportunity should be provided as soon as possible to complete this work in collaboration with the Gorongosa Restoration Project scientists responsible.
10. All existing stands of original woodland and forests in the Lower Zone should be protected, even remnants. A few good stands of secondary woodland should also be protected, as both original and secondary woodland are important for biodiversity and the hydrology of the mountain.
11. All riparian vegetation along watercourses down to the base of the mountain and beyond should be protected. Where these have been destroyed they should be replanted. All woody species that naturally occur along watercourses are suitable for planting and practically all of them are easy to grow.
12. An erosion survey be carried out to determine the extent and location of erosion. Where eroded slopes occur, stands of *Acacia karroo* should be planted. This species occurs naturally on the lower slopes of the mountain and can easily be grown from seed. It produces a commercially valuable gum.
13. The proposal that the boundary of the National Park should extend to Mt Gorongosa and coincide with the 700 m contour is strongly endorsed. It is assumed that it would be difficult to resettle the people who inhabit areas between 700 and 1100 m, but the environmental impacts of people living within a National Park can be better monitored.
14. The understanding that cooperation of the local population is essential for conserving biodiversity is strongly supported. Such cooperation must be secured by giving local people alternatives that compensate them for what they lose.

15. The preparation of a comprehensive land use plan for the Lower Zone is strongly recommended. The plan should be based on a survey that aims at: (i) defining homogenous environmental units (a soil survey with inputs from a vegetation survey); (ii) identifying the socio-political and socio-economic status and concerns; (iii) fostering and securing adequate public awareness and participation. Such a plan should make provision for modified systems of land use and settlement, for sustainable agriculture and agroforestry, and take the maintenance of natural biodiversity into account wherever possible.
16. The number of cattle allowed in the Lower Zone should be strictly controlled. Too many cattle cause horrendous erosion on mountain slopes.
17. The land use plan and suggested developments for the Lower Zone should be extended down to the base of the mountain. It would be disastrous to have a stable upper mountain and an unstable base.
18. In other parts of southern Africa, moist evergreen forests below 700 m (lowland forest) are of particular botanical interest. Most of such forests that are assumed to have existed on Mt Gorongosa has probably been destroyed. Even rudiments of them may have recovery potential. If elements are found to exist, strong efforts should be made to protect them.
19. The botany and ecology of *Brachystegia spiciformis* woodland on the western slopes of Mt Gorongosa should be investigated.
20. Additional vegetation survey work should be carried out in the Lower Zones (so far only 16 sites have been investigated) so that the natural biodiversity can be incorporated into the proposed land use plan.
21. A particular recommendation, which can commence immediately, is made for the boundary between the Upper Zone, the Lower Zone and the base of the mountain. This is for the planting of a belt of native forest pioneer species along the lower edge of moist evergreen forest (effectively the boundary between the Upper and Lower Zones and also the new proposed boundary of the National Park). Clearing of forest has moved upwards on the mountain and has created a most irregular jagged and frayed forest edge; the planting of tens of thousands of trees will be needed to give a clear margin to the forest. Once the pioneer trees have grown up, the natural succession of forest development will follow. A clearly-defined lower forest margin will mark the lower edge of the conservation area in a conspicuous way. In the longer-term, as modified land uses commence, a band of agroforestry can be established along and immediately below this forest margin.

The recommendations above refer in turn to the Upper Zone, the Lower Zone and the base of the mountain. A particular recommendation above is made for planting the boundary between the Upper and Lower Zones, which can commence immediately. Suitable pioneer species for planting are:

Albizia adianthifolia
Albizia gummifera
Anthocleista grandiflora
Cordia africana
Croton sylvaticus
Ficus sur
Harungana madagascariensis
Macaranga mellifera
Polyscias fulva
Sapium ellipticum
Trema orientalis

What is visualized from all these recommendations is a mountain with a Nature Reserve in its upper part and a well-planned and sustainable managed agricultural zone below. The agriculture zone would be interspersed with strategically placed areas of agroforestry and with patches of indigenous vegetation still in existence.

The involvement of the Carr Foundation/Gorongosa Restoration Project in the conservation of Mount Gorongosa has rekindled the concept of "Mountain to Mangrove" first outlined by Ken Tinley (1977), a research scientist based in Gorongosa National Park during the 1970s. This concept visualised a wildlife corridor and conservation area extending from Mount Gorongosa through Gorongosa National Park over the Cheringoma Plateau to the Zambezi Delta. The area would include the four hunting concessions (Coutadas 10, 11, 12 and 14) which, together with the Marromeu Reserve, are known as the Marromeu Complex and make up a continuous wildlife area almost 10,000 sq. km in extent. Historically the Marromeu Complex is known to have supported a wide diversity and enormous populations of wildlife species. These were hugely reduced through illegal commercial meat hunting activities at the end of the civil war, but appear to have made a slow recovery over the last 10 to 14 years. The area also contained unique flora, including moist evergreen and dry forests and the portion of the delta floodplain not destroyed by commercial agriculture. However, the forests have since been drastically reduced, mainly by logging and shifting agriculture, and are now extremely threatened. The "Mountain to Mangrove" concept would have created a totally unique conservation area, equal to the best in Africa. In a reduced form it may still be possible to connect Gorongosa National Park with the coast and create a biodiversity conservation area of truly global significance, but only if immediate action is taken.

7. ACKNOWLEDGEMENTS

The senior author wishes to thank Anthony Mapaura and Christopher Chapano from the National Herbarium in Harare and Alice Massingue from the Universidade Eduardo Mondlane herbarium in Maputo for enthusiastic and efficient assistance with the arduous fieldwork; Bart Wursten and Petra Ballings for managing logistics in the field; and Franziska Steinbruch of the Scientific Services of Gorongosa National Park for digital processing and mapping. Anthony Mapaura and Bart Wursten helped with specimen identification and in the preparation of the original report. Petra Ballings did all pteridophyte identifications and compiled Appendix 2. All photos used were taken by Bart Wursten, unless otherwise indicated. Robin Wild is thanked for overall project management and help with the initial report, along with Julian Spurway. Jonathan Timberlake later converted the original report and edited it into a BFA Publication.

The Gorongosa Restoration Project/Carr Foundation in Mozambique, in particular Franziska Steinbruch and Richard Beilfuss, are thanked for giving us the possibility of carrying out the survey and for organisational support.

8. REFERENCES

Burrows, J.E. (1990). *Southern African Ferns and Fern Allies*. Frandsen Publishers, Sandton.

Schelpe, E.A.C.L.E. (1970). Pteridophyta. In: Flora Zambesiaca (editors A.W. Exell & E. Launert). Crown Agents, London.

Macedo, J. de Aguiar (1970a). Serra da Gorongosa. Necessidade e bases da sua protecção. Comunicação No.44. Instituto de Investigação Agronómica de Moçambique, Lourenço Marques. 92 pp.

Macedo, J. de Aguiar (1970b). Carta de Vegetação do Serra da Gorongosa. Comunicação No.50. Instituto de Investigação Agronómica de Moçambique, Lourenço Marques. 75 pp.

Mapaura, A. & Timberlake, J. (2004). A checklist of Zimbabwean vascular plants. Southern African Botanical Diversity Network Report No.33. Sabonet, Pretoria & Harare. 149 pp.

Müller, T. (199). The distribution, classification and conservation of rainforests in Zimbabwe. In: Timberlake, J.R. & Kativu, S. (eds.), *African Plants: Biodiversity, Taxonomy and Uses*, pp. 221–235. Royal Botanic Gardens, Kew.

Roux, J.P. (2001). Conspectus of Southern African Pteridophyta. Southern African Botanical Diversity Network Report No.13. Sabonet, Pretoria. 223 pp.

Tinley, K.L. (1977). Framework of Gorongosa Ecosystem. Unpublished DSc thesis, University of Pretoria. Pretoria, South Africa. 194 pp.

White, F. (1983). *The Vegetation of Africa*. A descriptive memoir to accompany the Unesco/ AETFAT/UNSO vegetation map of Africa. Natural Resources Research 20. UNESCO, Paris.

Appendix 1: List of flowering plant species recorded from above 700 m in the Mt Gorongosa study site, arranged alphabetically by family.

Nomenclature follows Mapaura & Timberlake (2004) updated from recent parts of Flora Zambesiaca, or that currently used at the National Herbarium, Harare, Zimbabwe.

Growth form: C = Climbing plant, twiner, liane; H = herb S = Shrub T = Tree **DICOTYLEDONS**	Growth Form	Forest	Grassland/ Woodland	Wetland	Ericoid scrub	Old field
ACANTHACEAE						
Acanthopale pubescens *(Lindau) C.B.Clarke*	H	X				
Brachystephanus africanus *S.Moore*	C	X				
Brillantaisia subulugurica *Burkhill*	S	X				
Dicliptera sp.	H	X				
Hypoestes aristata *(Vahl) Roem.& Schult.*	H		X			
Isoglossa mossambicensis *(Vahl) Roem.& Schult.*	S	X				
Justicia betonica *L.*	H	X				
Mellera lobulata *S.Moore*	H	X				
Mimulopsis solmsii *Schweinf.*	H	X				
Pseuderanthemum subviscosum *(C.B.Clarke) Stapf*	S	X				
Thunbergia natalensis *Hook.*	H	X				
Thunbergia petersiana *Lindau*	H	X				
AMARANTHACEAE						
Achyranthes aspera *L.*	H	X				
Celosia trigyna *L.*	H					X
ANACARDIACEAE						
Ozoroa insignis *Delile* subsp. reticulata *(Baker f.) J.B.Gillett*	T		X			
Rhus chirindensis *Baker f.*	ST	X	X			
Rhus tumulicola *S.Moore* var. tumulicola	S	X	X		X	
ANNONACEAE						
Annona senegalensis *Pers.*	T	X	X			
Xylopia sp.	T	X				
APIACEAE						
Alepidea peduncularis *A.Rich.*	H	X	X	X		
Diplolophium buchananii *(Oliv.) C.Norman* subsp. swynnertonii *(Baker f.) Cannon*	H	X	X			
Heteromorpha arborescens *(Thunb.) Cham.& Schltdl.* var. abyssinica *(A.Rich.) H.Wolff*	ST	X	X	X		
Heteromorpha arborescens *(Thunb.) Cham.& Schltdl.* var. arborescens	ST		X			
Peucedanum linderi *C.Norman*	H	X	X	X		
Peucedanum nyassicum *H.Wolff*	H		X	X		
Pimpinella stadensis *(Eckl.& Zeyh.) D.Dietr.*	H		X			
Steganotaenia araliacea *Hochst.*	ST		X			
APOCYNACEAE						
Alafia orientalis *De Wild.*	C	X				
Carissa bispinosa *(L.) Brenan* subsp. zambesiensis *Kupicha*	S	X				
Diplorhynchus condylocarpon *(Müll.Arg.) Pichon*	T		X			
Landolphia buchananii *(Hallier f.) Stapf*	C	X	X			
Oncinotis tenuiloba *Stapf*	C	X				
Rauvolfia caffra *Sond.*	T	X				
Secamone alpini *Schult.*	C	X	X			
Tabernaemontana stapfiana *Britten*	T	X				

Growth form: C = Climbing plant, twiner, liane; H = herb S = Shrub T = Tree	Growth Form	Forest	Grassland/ Woodland	Wetland	Ericoid scrub	Old field
Tabernaemontana ventricosa *A.DC.*	T	X				
Tylophora sp.	C	X				
Voacanga africana *Stapf*	T		X			
AQUIFOLIACEAE						
Ilex mitis *(L.) Radlk.*	T	X	X			
ARALIACEAE						
Cussonia arborea *A.Rich.*	T		X			
Cussonia spicata *Thunb.*	T	X	X			
Polyscias fulva *(Hiern) Harms*	T	X				
Schefflera goetzenii *Harms*	C	X				
Schefflera umbellifera *(Sond.) Baill.*	T	X	X	X		
ASTERACEAE						
Ageratum conyzoides *L.*	H		X			
Aspilia mossambicensis *(Oliv.) Wild*	H		X			
Aspilia pluriseta *Schweinf.*	H		X			
Berkheya setifera *DC.*	H	X	X	X		
Berkheya sp.	H			X		
Berkheya zeyheri *(Sond.& Harv.) Oliv.& Hiern* subsp. zeyheri	H		X			
Bidens pilosa *L.*	H					X
Bothriocline inyangana *N.E.Br.*	H	X	X			
Brachylaena discolor *DC.* var. rotundata *(S.Moore) Beentje*	ST	X	X			
Cineraria sp.	H		X			
Crassocephalum montuosum *(S.Moore) Milne-Redh.*	H		X			
Gerbera ambigua *(Cass.) Sch.Bip.*	H		X	X		
Haplocarpha nervosa *(Thunb.) P.Beauv.*	H		X			
Helichrysum adenocarpum *DC.* subsp. adenocarpum	H		X	X		
Helichrysum buchananii *Engl.*	H		X	X		
Helichrysum cephaloideum *DC.*	H		X			
Helichrysum forskahlii *(J.F.Gmel.) Hilliard & B.L.Burtt* var. forskahlii	H	X				
Helichrysum lepidissimum *S.Moore*	H		X			
Helichrysum nitens *Oliv.& Hiern*	H		X	X		
Helichrysum nudifolium *(L.) Less.*	H	X	X			
Helichrysum odoratissimum *(L.) Sweet*	H		X	X	X	
Helichrysum setosum *Harv.*	H		X	X		
Helichrysum splendidum *(Thunb.) Less.*	H			X		
Inula glomerata *Oliv.& Hiern*	H		X			
Mikania carteri *Baker*	C	X	X			
Nidorella auriculata *DC.*	H		X	X	X	
Nidorella undulata *(Thunb.) Harv.*	H		X			
Schistostephium artemisiifolium *Baker*	H		X	X		
Senecio auriculatissimus *Britten*	H	X	X	X		
Senecio latifolius *DC.*	H		X			
Senecio lydenburgensis *Hutch.& Burtt Davy*	H	X	X			
Senecio sp.	H		X			
Senecio sp. cf. auriculatissimus *Britten*	H		X			
Senecio tamoides *DC.*	C	X				
Solanecio mannii *(Hook.f.) C.Jeffrey*	H	X	X			
Stoebe vulgaris *Levyns*	S		X			
Tagetes minuta *L.*	H					X
Vernonia holstii *O.Hoffm.*	H		X			

Growth form: C = Climbing plant, twiner, liane; H = herb S = Shrub T = Tree	Growth Form	Forest	Grassland/ Woodland	Wetland	Ericoid scrub	Old field
Vernonia karaguensis *Oliv.& Hiern*	H		X	X		
Vernonia myriantha *Hook.f.*	H	X	X			
Vernonia natalensis *Walp.*	H		X	X		
Vernonia pteropoda *Oliv.& Hiern*	H	X				
Vernonia thomsoniana *Oliv.*	H		X			
Vernonia wollastonii *S.Moore*	H	X			X	
BALSAMINACEAE						
Impatiens cecilii *N.E.Br.*	H	X				
Impatiens psychadelphoides *Launert*	H	X	X			
Impatiens sp.	H	X	X			
Impatiens sylvicola *Burtt Davy & Greenway*	H	X				
BEGONIACEAE						
Begonia sonderiana *Irmsch.*	H	X				
BIGNONIACEAE						
Markhamia obtusifolia *(Baker) Sprague*	T	X	X			
CACTACEAE						
Rhipsalis baccifera *(J.Mill.) Stearn*	H	X	X			
CAPPARACEAE						
Ritchiea albersii *Gilg*	T	X				
CELASTRACEAE						
Catha edulis *(Vahl) Endl.*	T	X	X			
Gymnosporia bachmannii *Loes.*	ST	X				
Gymnosporia mossambicensis *(Klotzsch) Loes.*	S	X				
Gymnosporia senegalensis *(Lam.) Loes.*	ST	X				
Hippocratea africana *(Willd.) Loes.* var. richardiana *(A.St.-Hil.) N.Robson*	C	X				
Hippocratea pallens *Oliv.*	C	X				
Maytenus acuminata *(L.f.) Loes.*	ST	X				
Pterocelastrus echinatus *N.E.Br.*	T	X				
CHRYSOBALANACEAE						
Parinari curatellifolia *Benth.*	T	X	X	X		
CLUSIACEAE						
Garcinia kingaensis *Engl.*	T	X				
Harungana madagascariensis *Poir.*	T	X	X			
Hypericum revolutum *Vahl*	S	X	X		X	
Psorospermum febrifugum *Spach*	ST	X	X			
COMBRETACEAE						
Combretum gueinzii *Sond.*	C	X				
Combretum molle *G.Don*	T		X			
Combretum paniculatum *Vent.*	T	X				
Combretum psidioides *Welw.* subsp. psidioides	T		X			
Combretum zeyheri *Sond.*	T		X			
Terminalia sericea *DC.*	T		X			
Terminalia trichopoda *Diels*	T		X			
CONNARACEAE						
Agelaea pentagyna *(Lam.) Baill.*	C	X				
Rourea orientalis *Baill.*	ST	X				
CONVOLVULACEAE						
Ipomoea coptica *(L.) Roem.& Schult.*	C		X			
CORNACEAE						
Curtisia dentata (Burm.f.) C.A.Sm.	T	X	X			

Growth form: C = Climbing plant, twiner, liane; H = herb S = Shrub T = Tree	Growth Form	Forest	Grassland/ Woodland	Wetland	Ericoid scrub	Old field
CRASSULACEAE						
Crassula alsinoides *(Hook.f.) Engl.*	H		X			
Crassula sp.	H		X			
CUCURBITACEAE						
Coccinia barteri *(Hook.f.) Keay*	H	X	X			
Peponium chirindense *(Baker f.) Cogn.*	H	X				
Peponium sp.	H	X				
Zehneria minutiflora *(Cogn.) C.Jeffrey*	C		X			
Zehneria scabra *(L.f.) Sond.* subsp. scabra	C	X				
DIPSACACEAE						
Scabiosa columbaria *L.*	H		X	X		
EBENACEAE						
Diospyros abyssinica *(Hiern) F.White*	T	X				
Diospyros ferrea *(Willd.) Bakh.*	T	X				
Diospyros lycioides *Desf.*	T		X			
Diospyros whyteana *F.White*	T	X				
Euclea natalensis *A.DC.*	H		X			
ERICACEAE						
Erica hexandra *(S.Moore) E.G.H.Oliv.*	S	X	X		X	
ERYTHROXYLACEAE						
Erythroxylum emarginatum *Thonn.*	T	X	X			
ESCALLONIACEAE						
Choristylis rhamnoides *Harv.*	ST	X	X		X	
EUPHORBIACEAE						
Alchornea hirtella *Benth.*	ST	X				
Alchornea laxiflora *(Benth.) Pax & K.Hoffm.*	ST	X				
Antidesma venosum *Tul.*	ST		X			
Argomuellera macrophylla *Pax*	ST	X				
Bridelia micrantha *(Hochst.) Baill.*	T	X	X			
Clutia swynnertonii *S.Moore*	S	X	X			
Croton sylvaticus *C.Krauss*	T	X				
Drypetes gerrardii *Hutch.*	T	X				
Erythrococca polyandra *(Pax & K.Hoffm.) Prain*	T		X			
Euphorbia sp.	H	X				
Hymenocardia acida *Tul.*	ST		X			
Macaranga capensis *(Baill.) Sim*	T	X				
Macaranga mellifera *Prain*	T	X	X		X	
Margaritaria discoidea *(Baill.) G.L.Webster* subsp. nitida *(Pax) Radcl.-Sm.*	T	X				
Phyllanthus beillei Hutch.	S	X	X			
Phyllanthus delagoensis *Hutch.*	H		X			
Phyllanthus sp.	H		X			
Sapium ellipticum *(C.Krauss) Pax*	T	X				
Tragia brevipes *Pax*	C	X				
FLACOURTIACEAE						
Aphloia theiformis *(Vahl) Benn.*	T	X	X		X	
Casearia battiscombei *R.E.Fr.*	T	X				
Dovyalis lucida *Sim*	T	X	X			
Kiggelaria africana *L.*	T		X			
Rawsonia lucida *Harv.& Sond.*	T	X				
Trimeria grandifolia *(Hochst.) Warb.* subsp. grandifolia	T	X				

Growth form: C = Climbing plant, twiner, liane; H = herb S = Shrub T = Tree	Growth Form	Forest	Grassland/ Woodland	Wetland	Ericoid scrub	Old field
GENTIANACEAE						
Sebaea leiostyla *Gilg*	H		X	X		
GERANIACEAE						
Geranium incanum *Burm.f.*	H	X	X	X	X	
Geranium nyassense *R.Knuth*	H		X	X		
GESNERIACEAE						
Streptocarpus brachynema *Hilliard & B.L.Burtt*	H	X				
HAMAMELIDACEAE						
Trichocladus ellipticus *Eckl.& Zeyh.* subsp. malosanus *(Baker) Verdc.*	T	X				
HETEROPYXIDACEAE						
Heteropyxis natalensis *Harv.*	T	X	X			
ICACINACEAE						
Apodytes dimidiata *Arn.*	T	X	X			
Cassinopsis ilicifolia *(Hocsht.) Kuntze*	CS	X				
Cassinopsis tinifolia *Harv.*	T	X	X			
Rhaphiostylis beninensis *(Planch.) Benth.*	C	X				
LAMIACEAE						
Achyrospermum carvalhi *Gürke*	H	X				
Aeollanthus buchnerianus *Briq.*	H	X				
Clerodendrum capitatum *(Willd.) Schumach.& Thonn.*	S		X			
Clerodendrum cephalanthum *Oliv.* subsp. swynnertonii *(S.Moore) Verdc.*	C	X				
Clerodendrum silvanum *Henriq.* var. silvanum	S	X				
Haumaniastrum dissitifolium *(Baker) A.J.Paton*	H		X			
Haumaniastrum venosum *(Baker) Agnew*	H	X	X	X		
Hemizygia sp.	H		X			
Hoslundia opposita *Vahl*	H		X			
Leonotis ocymifolia *(Burm.f.) Iwarsson* var. raineriana *(Vis) Iwarsson*	S	X	X			
Leucas milanjiana *Gürke*	H		X			
Plectranthus chimanimanensis *S.Moore*	H		X			
Plectranthus hadiensis *(Forssk.) Spreng.*	H		X			
Plectranthus sp.	H	X	X			
Plectranthus swynnertonii *S.Moore*	H	X				
Pycnostachys urticifolia *Hook.*	S	X	X			
Tetradenia riparia *(Hochst.) Codd*	S	X	X		X	
Vitex doniana *Sweet*	T	X	X			
Vitex payos *(Lour.) Merr.*	T		X			
LAURACEAE						
Cryptocarya liebertiana *Engl.*	T	X				
Ocotea kenyensis *(Chiov.) Robyns & R.Wilczek*	T	X				
LEGUMINOSAE: CAESALPINIOIDEAE						
Brachystegia boehmii *Taub.*						
Brachystegia tamarindoides *Benth.* subsp. microphylla *(Harms) Chikuni*						
Burkea africana *Hook.*						
Erythrophleum suaveolens *(Guill.& Perr.) Brenan*						
Senna petersiana *(Bolle) Lock*						
LEGUMINOSAE: MIMOSOIDEAE						
Acacia karroo *Hayne*	T		X			
Acacia pentagona *(Schumach.) Hook.f.*	C	X				
Acacia sieberiana *DC.*	T		X			
Albizia adianthifolia *(Schumach.) W.Wight*	T	X	X			

Growth form: C = Climbing plant, twiner, liane; H = herb S = Shrub T = Tree	Growth Form	Forest	Grassland/ Woodland	Wetland	Ericoid scrub	Old field
Albizia gummifera *(J.F.Gmel.) C.A.Sm.*	T					
Albizia versicolor *Oliv.*	T		X			
Dichrostachys cinerea *(L.) Wight & Arn.*	S		X			
Entada abyssinica *A.Rich.*	T		X			
Newtonia buchananii *(Baker) G.C.C.Gilbert & Boutique*	T	X				
LEGUMINOSAE: PAPILIONOIDEAE						
Aeschynomene nodulosa *(Baker) Baker f.* var. glabrescens *J.B.Gillett*	S		X		X	
Canavalia africana *Dunn*	C		X			
Craibia brevicaudata *(Vatke) Dunn* subsp. baptistarum *(Büttner) J.B.Gillett*	T	X				
Crotalaria capensis *Jacq.*	S	X				
Crotalaria chirindae *Baker f.*	S					X
Crotalaria gazensis *Baker f.* subsp. gazensis	S		X			
Crotalaria lanceolata *E.Mey.* subsp. lanceolata	S	X				
Crotalaria natalitia *Meisn.* var. natalitia	S	X				
Dalbergia boehmii *Taub.*	S	X	X			
Dalbergia fischeri *Taub.*	S	X	X			
Dalbergia nitidula *Baker*	T	X	X			
Desmodium repandum *(Vahl) DC.*	S	X				
Desmodium setigerum *(E.Mey.) Harv.*	S		X	X		
Dolichos kilimandscharicus *Taub.* subsp. kilimandscharicus	H		X			
Dumasia villosa *DC.*	C	X	X	X		
Eriosema affine *De Wild.*	S		X			
Eriosema nutans *Schinz*	S	X				
Eriosema psoraleoides *(Lam.) G.Don*	S	X	X	X	X	
Erythrina abyssinica *DC.*	T		X			
Erythrina lysistemon *Hutch.*	T		X			
Flemingia grahamiana *Wight & Arn.*	S		X			
Indigofera arrecta *A.Rich.*	S		X	X		
Indigofera atriceps *Hook.f.* subsp. atriceps	S		X			
Indigofera cecilii *N.E.Br.*	S		X	X		
Indigofera hedyantha *Eckl.& Zeyh.*	S		X	X		
Indigofera lyallii *Baker* subsp. lyallii	S		X		X	
Indigofera setiflora *Baker*	S	X				
Indigofera sp.	S		X			
Kotschya scaberrima *(Taub.) Wild*	S		X			
Kotschya thymodora *(Baker f.) Wild* subsp. thymodora	S		X			
Lotus wildii *J.B.Gillett*	H	X	X	X		
Macrotyloma axillare *(E.Mey.) Verdc.* var. macranthum *(Brenan) Verdc.*	C		X			
Millettia stuhlmannii *Taub.*	T		X			
Mucuna coriacea *Baker* subsp. irritans *(Burtt Davy) Verdc.*	C		X			
Pericopsis angolensis *(Baker) Meeuwen*	T		X			
Philenoptera violacea *(Klotze) Schrire*	T		X			
Psophocarpus lancifolius *Harms*	C		X	X		
Pterocarpus angolensis *DC.*	T		X			
Pterocarpus rotundifolius *(Sond.) Druce*	T	X	X			
Rhynchosia clivorum *S.Moore* var. pycnantha *(Harms) Verdc.*	S		X			
Rhynchosia monophylla *Schlter.*	C		X			
Sesbania macrantha *E.Phillips & Hutch.* var. levis *J.B.Gillett*	S	X				
Sesbania sesban *(L.) Merr.*	S	X	X			
Tephrosia aequilata *Baker* subsp. australis *Brummitt*	H		X			

Growth form: C = Climbing plant, twiner, liane; H = herb S = Shrub T = Tree	Growth Form	Forest	Grassland/ Woodland	Wetland	Ericoid scrub	Old field
Tephrosia aequilata *Baker* subsp. mlanjeana *Brummitt*	H	X	X	X	X	X
Tephrosia festina *Brummitt*	H		X			
Tephrosia montana *Brummitt*	H	X				
Tephrosia sp.	H	X			X	
Tephrosia vogelii *Hook.f.*	H		X			
Vigna gazensis *Baker f.*	C	X	X		X	X
Vigna unguiculata *(L.) Walp.*	C		X	X		
LOBELIACEAE						
Lobelia goetzei *Diels*	H	X		X		
LOGANIACEAE						
Anthocleista grandiflora *Gilg*	T	X	X			
Buddleja salviifolia *(L.) Lam.*	S	X	X	X	X	
Mostuea brunonis *Didr.* var. brunonis	S	X				
Nuxia congesta *Fresen.*	T	X				
Nuxia floribunda *Benth.*	T	X	X		X	
Nuxia oppositifolia *(Hochst.) Benth.*	ST	X				
Nuxia sp.	S	X				
Strychnos angolensis *Gilg*	C	X				
Strychnos lucens *Baker*	C	X	X			
Strychnos spinosa *Lam.*	T		X			
Strychnos usambarensis *Gilg*	T	X				
MALVACEAE						
Pavonia columella *Cav.*	H	X				
MELASTOMATACEAE						
Antherotoma senegambiensis *(Guill.& Perr.) Jacq.-Fél.*	HS		X			
Dissotis canescens *(Graham) Hook.f.*	S		X	X		
Dissotis princeps *(Kunth) Triana*	S	X				
MELIACEAE						
Ekebergia capensis *Sparrm.*	T	X				
Khaya anthotheca *(Welw.) C.DC.*	T	X				
Trichilia dregeana *Sond.*	T	X				
MELIANTHACEAE						
Bersama abyssinica *Fresen.*	T	X				
MENISPERMACEAE						
Tiliacora funifera *(Miers) Troupin*	C	X				
MONIMIACEAE						
Xymalos monospora *(Harv.) Baill.*	T	X				
MORACEAE						
Ficus chirindensis *C.C.Berg*	T	X				
Ficus craterostoma *Mildbr.& Burret*	T	X				
Ficus lutea *Vahl*	T	X				
Ficus rokko *Warb.& Schweinf.*	T	X				
Ficus scassellatii *Pamp.*	T	X				
Ficus sp.	T	X				
Ficus sur *Forssk.*	T	X	X			
Trilepisium madagascariense *DC.*	T	X				
MYRICACEAE						
Morella microbracteata *(Weim.) Verdc.& Polhill*	ST		X			
Morella pilulifera *(Rendle) Killick*	ST	X	X		X	

Growth form: C = Climbing plant, twiner, liane; H = herb S = Shrub T = Tree	Growth Form	Forest	Grassland/ Woodland	Wetland	Ericoid scrub	Old field
MYRSINACEAE						
Embelia schimperi *Vatke*	C	X	X			
Maesa lanceolata *Forssk.*	T	X	X			
Myrsine africana *L.*	S	X	X		X	
Rapanea melanophloeos *(L.) Mez*	T	X	X			
MYRTACEAE						
Eugenia natalitia *Sond.*	S	X				
Eugenia sp.	S	X				
Psidium guajava *L.*	T	X				
Syzygium cordatum *C.Krauss*	T	X	X			
Syzygium guineense *(Willd.) DC.* subsp. afromontanum *F.White*	T	X				
OCHNACEAE						
Ochna arborea *DC.*	T	X				
Ochna holstii *Engl.*	T	X				
OLACACEAE						
Strombosia scheffleri *Engl.*	T	X				
OLEACEAE						
Chionanthus foveolatus *(E.Mey.) Stearn* subsp. major *(I.Verd.) Stearn*	T	X				
Jasminum abyssinicum *DC.*	C	X				
Olea capensis *L.* subsp. macrocarpa *(C.H.Wright) I.Verd.*	T	X				
Schrebera alata *(Hochst.) Welw.*	T	X				
PASSIFLORACEAE						
Adenia gummifera *(Harv.) Harms*	C	X				
Basananthe triloba *(Bolus) W.J.de Wilde*	H	X				
PEDALIACEAE						
Holubia saccata *Oliv.*	H		X			
PIPERACEAE						
Peperomia rotundifolia *(L.) Kunth*	H	X				
Peperomia tetraphylla *(G.Forst.) Hook.& Arn.*	H	X	X			
Piper capense *L.f.*	H	X				
PITTOSPORACEAE						
Pittosporum viridiflorum *Sims*	T	X				
POLYGALACEAE						
Polygala gazensis *Baker f.*	S	X	X		X	
Polygala virgata *Thunb.*	S	X	X			
Securidaca longepedunculata *Fresen.*	T		X			
PROTEACEAE						
Faurea saligna *Harv.*	T		X			
Faurea rochetiana *(A.Rich.) Pic.Serm.*	T	X				
Protea caffra *Meisn.* subsp. gazensis *(Beard) Chisumpa & Brummitt*	T	X				
RANUNCULACEAE						
Knowltonia transvaalensis *Szyszyl.* var. transvaalensis	H		X	X		
Thalictrum rhynchocarpum *Quart.-Dill.& A.Rich.*	H	X				
RHAMNACEAE						
Gouania longispicata *Engl.*	C	X				
Rhamnus prinoides *L'Hér.*	S	X	X			
RHIZOPHORACEAE						
Cassipourea gummiflua *Tul.*	T	X				
Cassipourea malosana *(Baker) Alston*	T	X				

Growth form: C = Climbing plant, twiner, liane; H = herb S = Shrub T = Tree	Growth Form	Forest	Grassland/ Woodland	Wetland	Ericoid scrub	Old field
ROSACEAE						
Cliffortia linearifolia *Eckl.& Zeyh.*	S	X	X	X	X	
Cliffortia serpyllifolia *Cham.& Schltdl.*	S		X			
Leucosidea sericea *Eckl.& Zeyh.*	S	X				
Rubus apetalus *Poir.* var. apetalus	C	X	X			
RUBIACEAE						
Aidia micrantha *(K.Schum.) F.White*	T	X				
Anthospermum ammannioides *S.Moore*	S	X	X	X		
Breonadia salicina *(Vahl) Hepper & J.L.I.Wood*	T	X				
Canthium oligocarpum *Hiern* subsp. captum *(Bullock) Bridson*	T	X				
Cephalanthus natalensis *Oliv.*	S	X				
Coffea ligustroides *S.Moore*	S	X				
Coffea racemosa *Lour.*	S	X				
Cremaspora triflora *(Thonn.) K.Schum.*	S	X				
Heinsenia diervilleoides *K.Schum.* subsp. diervilleoides	T	X				
Heinsia crinita *(Afzel.) G.Taylor* subsp. parviflora *(K.Schum.& K.Krause) Verdc.*	T	X				
Keetia gueinzii *(Sond.) Bridson*	ST	X	X			
Keetia venosa *(Oliv.) Bridson*	CH	X	X			
Lasianthus kilimandscharicus *K.Schum.* subsp. kilimandscharicus	S	X				
Mussaenda arcuata *Poir.*	T	X	X			
Oxyanthus speciosus *DC.* subsp. stenocarpus *(K.Schum.) Bridson*	T	X				
Oxyanthus goetzei *S.Moore* subsp. goetzei	T	X				
Pauridiantha symplocoides *(S.Moore) Bremek.*	S	X				
Pavetta comostyla *S.Moore*	S	X				
Pentas purpurea *Oliv.*	H		X	X		
Psychotria capensis *(Eckl.) Vatke*	ST	X				
Psychotria zombamontana *(Kuntze) E.M.A.Petit*	ST	X				
Rothmannia fischeri *(K.Schum.) Bullock*	T	X				
Rothmannia urcelliformis *(Hiern) Robyns*	T	X				
Rutidea orientalis *Bridson*	C	X				
Rytigynia macrura *Verdc.*	S	X				
Rytigynia uhligii *(K.Schum.& K.Krause) Verdc.*	S	X				
Tarenna pavettoides *(Harv.) Sim*	T	X	X			
Tricalysia coriacea *(Benth.) Hiern* subsp. angustifolia *(J.G.García) Robbr.*	S	X				
Tricalysia delagoensis *Schinz*	ST	X				
Tricalysia pallens *Hiern*	T	X	X			
Tricalysia sonderiana *Hiern*	S	X				
Vangueria apiculata *K.Schum.*	T	X	X			
Vangueria esculenta *S.Moore*	T	X				
Vangueria infausta *Burch.*	T	X	X			
RUTACEAE						
Clausena anisata *(Willd.) Benth.*	T	X				
Toddalia asiatica *(L.) Lam.*	C	X				
Vepris bachmannii *(Engl.) W.Mziray*	T	X				
SANTALACEAE						
Osyridicarpos schimperianus *(A.Rich.) A.DC.*	C	X				
Thesium nigricans *Rendle*	H	X	X	X		
SAPINDACEAE						
Allophylus chaunostachys *Gilg*	ST	X				

Growth form: C = Climbing plant, twiner, liane; H = herb S = Shrub T = Tree	Growth Form	Forest	Grassland/ Woodland	Wetland	Ericoid scrub	Old field
Filicium decipiens *(Wight & Arn.) Thwaites*	T	X				
Pappea capensis *Eckl.& Zeyh.*	T	X				
SAPOTACEAE						
Chrysophyllum gorungosanum *Engl.*	T	X				
Englerophytum magalismontanum *(Sond.) T.D.Penn.*	T	X	X			
Mimusops zeyheri *Sond.*	T	X				
SCROPHULARIACEAE						
Halleria elliptica *L.*	S	X				
Halleria lucida *L.*	T	X	X			
Sopubia mannii *Skan*	H		X			
Jamesbrittenia carvalhoi *(Engl.) Hilliard*	H		X			
SIMAROUBACEAE						
Harrisonia abyssinica *Oliv.*	ST		X			
SOLANACEAE						
Solanum anguivi *Lam.*	S	X				
Solanum terminale *Forssk.* subsp. sanaganum *(Bitter) Heine*	C	X				
STERCULIACEAE						
Cola greenwayi *Brenan*	T	X				
Dombeya burgessiae *Harv.*	T		X			
Dombeya rotundifolia *(Hochst.) Planch.*	T		X			
THYMELAEACEAE						
Peddiea africana *Harv.*	T	X				
TILIACEAE						
Sparrmannia africana *L.f.*	H	X				
Sparrmannia ricinocarpa *(Eckl.& Zeyh.) Kuntze*	H	X				
ULMACEAE						
Celtis africana *Burm.f.*	T	X				
Trema orientalis *(L.) Blume*	T	X	X		X	
URTICACEAE						
Laportea peduncularis *(Wedd.) Chew* subsp. peduncularis	H	X				
Procris crenata *C.B.Rob.*	H	X				
Urera hypselodendron *(A.Rich.) Wedd.*	C	X				
Urera sp.	C	X				
Urera trinervis *(Hochst.) Friis & Immelman*	C	X				
VERBENACEAE						
Lantana camara *L.*	S		X			
Lantana moldenkei *R.Fern.*	H	X				
Lippia javanica *(Burm.f.) Spreng.*	S	X	X			
VITACEAE						
Cissus petiolata *Hook.f.*	C	X				
Cissus rotundifolia *(Forssk.) Vahl*	C	X				
Cissus sp.	C	X				
Cyphostemma sp.	C		X			
Rhoicissus rhomboidea *(Harv.) Planch.*	C	X	X			
Rhoicissus tomentosa *(Lam.) Wild & R.B.Drumm.*	C	X				
Rhoicissus tridentata *(L.f) Wild & R.B.Drumm.*	C	X				
VIOLACEAE						
Rinorea ferruginea *Engl.*	S	X				

Growth form: C = Climbing plant, twiner, liane; H = herb S = Shrub T = Tree	Growth Form	Forest	Grassland/ Woodland	Wetland	Ericoid scrub	Old field
MONOCOTYLEDONS						
ALOACEAE						
Aloe arborescens *Mill.*	H	X	X			
Aloe rhodesiana *Rendle*	H		X			
Aloe swynnertonii *Rendle*	H	X	X			
AMARYLLIDACEAE						
Cryptostephanus vansonii *I.Verd.*	H	X				
ANTHERICACEAE						
Chlorophytum sp.	H	X				
ARACEAE						
Culcasia falcifolia *Engl.*	C	X				
Zamioculcas zamiifolia *(Lodd.) Engl.*	H	X				
ASPARAGACEAE						
Asparagus africanus *Lam.*	H		X			
Asparagus asparagoides *(L.) Wight*	C	X	X			
Asparagus falcatus *L.*	C	X				
Asparagus laricinus *Burch.*	C	X				
Asparagus plumosus *Baker*	C	X	X			
Asparagus setaceus *(Kunth) Jessop*	H	X				
Asparagus sp.	C	X				
Asparagus virgatus *Baker*	S		X			
ASPHODELACEAE						
Kniphofia linearifolia *Baker*	H	X	X	X	X	
Kniphofia splendida *E.A.Bruce*	H		X			
BEHNIACEAE						
Behnia reticulata *(Thunb.) Didr.*	C	X				
COMMELINACEAE						
Aneilema aequinoctiale *(P.Beauv.) Loudon*	H	X				
Aneilema hockii *De Wild.*	H	X				
Commelina africana *L.*	H	X	X	X		
Cyanotis foecunda *Hassk.*	H		X			
CYPERACEAE						
Bulbostylis atrosanguinea *(Boeck.) C.B.Clarke*	H	X				
Carex spicato-paniculata *C.B.Clarke*	H	X				
Coleochloa setifera *(Ridl.) Gilly*	H	X	X			
Costularia natalensis *C.B.Clarke*	H		X	X		
Cyperaceae (blue sedge)	H		X	X		
Cyperaceae (brown sedge)	H			X		
Cyperaceae (green sedge)	H		X	X		
Cyperus holostigma *Schweinf.*	H		X			
Cyperus sp.	H	X				
Fimbristylis sp.	H	X				
Scleria achtenii *De Wild.*	H	X	X	X		
Scleria bulbifera *A.Rich.*	H		X			
DIOSCOREACEAE						
Dioscorea dumetorum *(Kunth) Pax*	C	X	X			
Dioscorea quartiniana *A.Rich.* var. quartiniana	C	X	X			
DRACAENACEAE						
Dracaena fragrans *(L.) Ker-Gawl*	S	X				

Growth form: C = Climbing plant, twiner, liane; H = herb S = Shrub T = Tree	Growth Form	Forest	Grassland/ Woodland	Wetland	Ericoid scrub	Old field
Dracaena mannii *Baker*	S	X	X			
ERIOCAULACEAE						
Eriocaulon sonderianum *Körn*	H		X			
HYACINTHACEAE						
Drimia elata *Willd.*	H		X			
Ledebouria cooperi *(Hook.f.) Jessop*	H		X			
HYPOXIDACEAE						
Hypoxis villosa *L.f.*	H		X			
IRIDACEAE						
Crocosmia aurea *(Hook.) Planch.*	H	X				
Dietes iridioides *(L.) Klatt*	H	X				
Gladiolus crassifolius *Baker*	H		X	X		
ORCHIDACEAE						
Bulbophyllum josephi *(Hook.) Planch.*	H	X	X			
Bulbophyllum maximum *(Lindl.) Rchb.f.*	H	X				
Calanthe sylvatica *(Thouars) Lindl.*	H	X				
Liparis bowkeri *Harv.*	H	X				
Microcoelia stolzii *(Schltr.) Summerh.*	H	X				
Mystacidium tanganyikense *Summerh.*	H	X				
Oberonia disticha *(Lam.) Schltr.*	H	X				
Polystachya adansoniae *Rchb.f.*	H	X	X			
Polystachya cultriformis *(Thouars) Spreng*	H	X				
Polystachya subumbellata *P.J.Cribb & Podzorski*	H	X				
Polystachya transvaalensis *Schltr.*	H	X				
Rangaeris muscicola *(Rchb.f.) Summerh.*	H	X	X			
Satyrium neglectum *Schltr.*	H	X	X			
Solenangis conica *(Schltr.) L.Jonss.*	H	X				
Tridactyle anthomaniaca *(Rchb.f.) Summerh.*	H	X				
Tridactyle bicaudata *(Lindl.) Schltr.*	H	X	X			
Tridactyle latifolia *Summerh.*	H	X				
Tridactyle tridactylites *(Rolfe) Schltr.*	H	X				
POACEAE						
Andropogon schirensis *A.Rich.*	H		X			
Brachiaria brizantha *(A.Rich.) Stapf*	H		X			
Poecilostachya oplismenoides *(Hack.) Clayton*	H	X				
Cymbopogon caesius *(Hook.& Arn.) Stapf*	H		X			
Digitaria maitlandii *Stapf & C.E.Hubb.*	H	X	X	X		
Eragrostis acraea *De Winter*	H		X	X		
Eragrostis volkensii *Pilg.*	H		X	X		
Eulalia sp.	H			X		
Eulalia villosa (Thunb.) Nees	H	X	X	X		
Festuca abyssinica *A.Rich.*	H	X	X			
Festuca africana *(Hack.) Clayton*	H	X	X			
Festuca altissima *All.*	H	X				
Hyparrhenia cymbaria *(L.) Stapf*	H	X	X			X
Hyparrhenia filipendula *(Hochst.) Stapf*	H	X	X			
Hyparrhenia newtonii *(Hack.) Stapf* var. newtonii	H		X	X		
Hyparrhenia rufa *(Nees) Stapf*	H		X			
Imperata cylindrica *(L.) Raeusch.*	H			X		

Growth form: C = Climbing plant, twiner, liane; H = herb S = Shrub T = Tree	Growth Form	Forest	Grassland/ Woodland	Wetland	Ericoid scrub	Old field
Isachne mauritiana *Kunth*	H	X				
Ischaemum fasciculatum *Brogn.*	H	X	X			
Leptaspis cochleata *Thwaites*	H	X				
Loudetia simplex *(Nees) C.E.Hubb.*	H		X	X		
Melinis minutiflora *P.Beauv.*	H	X	X			
Melinis nerviglumis *(Franch.) Zizka*	H	X	X			
Melinis repens *(Willd.) Zizka*	H		X			X
Merxmuellera macowanii *(Stapf) Conert*	H		X			
Monocymbium ceresiiforme *(Nees) Stapf*	H		X	X		
Oplismenus compositus *(L.) P.Beauv.*	H	X				
Oplismenus hirtellus *(L.) P.Beauv.*	H	X				
Oxytenanthera abyssinica *(A.Rich.) Munro*	H	X				
Panicum ecklonii *Nees*	H	X	X	X		
Panicum maximum *Jacq.*	H	X	X			X
Panicum monticola *Hook.f.*	H	X				
Paspalum scrobiculatum *L.*	H	X				
Pennisetum purpureum *Schumach.*	H	X				
Poecilostachys oplismenoides *(Hack.) Clayton*	H	X				
Setaria megaphylla *(Steud.) T.Durand & Schinz*	H	X				
Setaria sphacelata *(Schumach.) M.B.Moss*	H	X	X	X	X	
Sporobolus centrifugus *(Trin.) Nees*	H	X				
Sporobolus panicoides *A.Rich.*	H		X			
Sporobolus pyramidalis *P.Beauv.*	H		X			
Themeda triandra *Forssk.*	H		X			
Trachypogon spicatus *(L.f.) Kuntze*	H	X				
Trichopteryx dregeana *Nees*	H		X			
SMILACACEAE						
Smilax anceps *Willd.*	C	X	X			
STRELITZIACEAE						
Strelitzia caudata *R.A.Dyer*	T		X		X	
XYRIDACEAE						
Xyris gerrardii *N.E.Br.*	H		X	X		
ZINGIBERACEAE						
Aframomum albiflorum *Lock*	H	X	X			
Aframomum angustifolium *(Sonn.) K.Schum.*	H	X	X			
GYMNOSPERMAE						
CUPRESSACEAE						
Widdringtonia nodiflora *(L.) Powrie*	T	X	X			
PODOCARPACEAE						
Podocarpus latifolius *(Thunb.) Mirb.*	T	X				

Appendix 2: Preliminary list of Pteridophytes

This preliminary list containing 104 taxa has been compiled by Petra Ballings and Bart Wursten. It is based on personal findings, records from *Southern African Ferns & Fern Allies* (Burrows 1990) and *Flora Zambesiaca part Pteridophyta* (FZ 1970). The latest nomenclature changes in *Conspectus of Southern African Pteridophyta* (Roux, Sabonet Report No.13, 2001) have been used where applicable. Where specimens were collected collection numbers are given. Species are listed alphabetically by family and genus.

Record references: BU=J.E.Burrows, BW=Bart Wursten, FZ=Flora Zambesiaca, PB=Petra Ballings, SRGH=National Herbarium, Harare.

Belvisia spicata, a rare fern found in *Brachystegia tamarindoides* woodland

FAMILY/ GENUS/SPECIES	**Coll.no**.	**records**
Family Anemiaceae [Schizaceae]		
Mohria lepigera *(Baker) Baker*		FZ, SRGH
Mohria nudiuscula *J.P.Roux*		SRGH
Mohria vestita *Baker*	Ballings 435	PB, BU
Family Aspleniaceae		
Asplenium aethiopicum *(Burm.f.) Bech.*	Ballings 443	PB,BU
Asplenium anisophyllum *Kunze*	Ballings 422	PB,BU, SRGH
Asplenium blastophorum *Hieron*	Ballings 460	PB, BU
Asplenium christii *Hieron*	Ballings 498	PB, BU
Asplenium dregeanum *Kunze* subsp. dregeanum	Ballings 452	PB, BU, FZ
Asplenium erectum *Willd.*	Ballings 434	PB, BU, SRGH
Asplenium flexuosum *Schrad.*	Ballings 454	PB, BU
Asplenium formosum *Willd.*	Ballings 358	PB
Asplenium friesiorium *C.Chr.*	Ballings 419	PB, BU, FZ,
Asplenium gemmiferum *Schrad.*	Ballings 418	PB, BU, SRGH
Asplenium holstii *Hieron*	Ballings 737	PB
Asplenium inaequilaterale *Willd.*	Ballings 456	PB, BU
Asplenium lobatum *Pappe & Raws.*	Ballings 450	PB, BU, SRGH
Asplenium mannii *Hook.*	Ballings 417	PB, BU
Asplenium mossambicense *Schelpe*	Ballings 430	PB, BU, FZ
Asplenium normale *D.Don*	Ballings 431	PB, BU
Asplenium preussii *Brause*	Ballings 453	PB, BU, FZ
Asplenium protensum *Schrad.*	Ballings 416	PB, BU, FZ
Asplenium rutifolium *(P.J.Bergius) Kunze*	Ballings 357	PB, BU, SRGH
Asplenium sandersonii *Hook.*	Ballings 423	PB, BU, SRGH
Asplenium theciferum *(Kunth) Mett.*		
var. concinnum *(Schrad.) Schelpe*	Ballings 516	PB, BU, FZ
Asplenium torrei *Schelpe*	Ballings 499	PB, BU, FZ,
Family Blechnaceae		
Blechnum attenuatum *(Sw.) Mett*	Ballings 415	PB, BU
Blechnum capense *Burm.f.*	Ballings 579	PB, BU, FZ
Blechnum tabulare *(Thunb.) Kuhn*	Ballings 466	PB, BU, FZ
Family Cyatheaceae		
Cyathea dregei *Kunze*	Ballings 465	PB, BU, FZ
Family Dennstaedtiaceae		
Blotiella glabra *(Bory) R.M.Tryon*	Ballings 414	PB, BU, FZ

Blotiella natalensis *(Hook.) R.M.Tryon*	Ballings 565	PB, BU
Hypolepis sparsisora *(Schrad.) Kuhn*	Ballings 484	PB, BU, SRGH
Pteridium aquilinum *(L.) Kuhn* subsp. aquilinum	Ballings 501	PB, BU, FZ
Family Dryopteridaceae [Aspidiaceae]		
Didymochlaena truncatula *(Sw.) J.Sm.*	Ballings 445	PB, BU
Dryopteris inaequalis *(Schltr.) Kuntze*	Ballings 532	PB
Dryopteris kilemensis *(Kuhn) Kuntze*		BU, FZ
Dryopteris manniana *(Hook.) C.Chr.*	Ballings 441	PB, BU
Polystichum zambesiacum *Schelpe*	Ballings 403	PB, BU, SRGH
Family Gleicheniaceae		
Gleichenia umbraculifera *(Kunze) T.Moore*	Ballings 574	PB
Family Grammitidaceae		
Grammitis nanodes *(Peter) Ching*	Ballings 529	PB, BU, FZ
Grammitis oosora *(Baker) J.E.Burrows*	Ballings 581	PB
Family Hymenophyllaceae		
Cephalomanes rigidum *(Sw.) K.Iwats*	Ballings 580	PB
Crepidomanes borbonicum *(Bosch) J.P.Roux*	Ballings 426	PB, BU, FZ
Crepidomanes melanotrichum *(Schltdl.) J.P.Roux*		BU
Hymenophyllum capense *Schrad.*	Ballings 424	PB, BU, FZ
Hymenophyllum kuhnii *C.Chr.*	Ballings 407	PB, BU, FZ
Hymenophyllum tunbridgense *(L.) Sm.*	Ballings 526	PB, BU, FZ
Sphaerocionium capillare *(Desv.) Copel*	Ballings 558	PB
Sphaerocionium splendidum *(Bosch) Copel*	Ballings 425	PB, BU
Trichomanes erosum *Willd.* var. aerugineum	Ballings 427	PB, BU
Trichomanes erosum *Willd.* var. erosum	Ballings 429	PB, BU
Family Lomariopsidaceae		
Elaphoglossum acrostichoides *(Hook.& Grev.) Schelpe*	Ballings 464	PB, BU, FZ
Elaphoglossum aubertii *(Desv.) T.Moore*	Ballings 412	PB, BU, FZ
Elaphoglossum chevalieri *Christ*		BU, FZ
Elaphoglossum hybridum *(Bory) Brack.*	Ballings 411	PB, BU, FZ
Elaphoglossum lastii *(Baker) C.Chr.*	Ballings 517	PB, BU, FZ
Elaphoglossum macropodium *(Fée) T.Moore*	Ballings 413	PB, BU
Elaphoglossum spathulatum *(Bory) T.Moore*	Ballings 402	PB, BU, FZ
Lomariopsis warneckei *(Hieron.) Alston*	Ballings 444	PB, BU
Family Lycopodiaceae		
Huperzia dacrydioides *(Baker) Pic.Serm.*	Ballings 459	PB, FZ
Huperzia gnidioides *(L.f.) Trevis.*	Ballings 437	PB, BU, FZ
Huperzia ophioglossoides *(Lam.) Rothm.*	Ballings 588	PB, BU, FZ
Huperzia phlegmaria *(L.) Rothm.*	Ballings 582	PB
Huperzia verticillata *(L.f.) Trevis.*	Ballings 410	PB, BU, FZ
Lycopodiella sarcocaulon *(Kuhn) Pic.Serm.*	Ballings 513	PB, FZ
Lycopodium clavatum *L.*	Ballings 530	PB
Family Lygodiaceae [Schizaceae]		
Lygodium kerstenii *Kuhn*		PB
Family Marattiaceae		
Marattia fraxinea *Sm.*	Ballings 448	PB, BU
Family Oleandraceae [Davalliaceae]		
Arthropteris monocarpa (*Cordem) C.Chr.*	Ballings 347	PB, BU, FZ,
Arthropteris orientalis (*J.F.Gmel.) Posth.* var. orientalis	Ballings 731	PB, BU, FZ
Oleandra distenta *Kunze*	Ballings 438	PB, BU, FZ
Family Osmundaceae		
Osmunda regalis *L.*	Ballings 355	PB, BU, FZ,

Family Polypodiaceae		
Belvisia spicata *(L.f.) Mirb.*	Ballings 739	PB, BU, FZ
Lepisorus excavatus *(Willd.) Ching*	Ballings 489	PB, BU, FZ
Lepisorus schraderi *(Mett.) Ching*	Ballings 523	PB, BU, FZ
Loxogramma abyssinica *(Baker) M.G. Price*	Ballings 409	PB, BU, FZ
Pleopeltis macrocarpa *(Willd.) Kaulf.* var. macrocarpa	Ballings 406	PB, BU, FZ
Pleopodium simianum *Schelpe & N.C.Anthony*		BW
Microsorum punctatum *(L.) Copel*	Ballings 354	PB
Microsorum scolopendria *(Burm. f.) Copel*	Ballings 735	PB, SRGH
Polypodium polypodioides *(L.) Watt*		
subsp. ecklonii *(Kunze) Schelpe*	Ballings 732	PB, BU, FZ,
Pyrrosia rhodesiana *(C.Chr.) Schelpe*	Ballings 405	PB, BU, SRGH
Pyrrosia schimperiana *(Kuhn) Alston* var. schimperiana		BU
Family Pteridaceae [Adiantaceae]		
Actiniopteris dimorpha *Pic.Serm.*	Ballings 687	PB
Cheilanthes inaequalis *(Kunze) Mett.*		
var. buchananii *(Baker) Schelpe*		BU, FZ
Cheilanthes multifida *(Sw.) Sw.*	Ballings 500	PB
Cheilanthes quadripinnata *(Forssk.) Kuhn*	Ballings 752	PB, BU, FZ
Cheilanthes viridis *(Forssk.) Sw.*		
var. glauca *(Sim) Schelpe & N.C.Anthony*	Ballings 688	PB
Cheilanthes viridis *(Forssk.) Sw.* var. viridis		PB
Pellaea doniana *Hook.*	Ballings 746	PB
Pteris catoptera *Kunze* var. catoptera	Ballings 447	PB, BU, SRGH
Pteris muricella *Fée*	Ballings 449	PB, BU
Family Selaginellaceae		
Selaginella kraussiana *(Kunze) A.Br.*	Ballings 401	PB, BU
Selaginella mittenii *Baker*	Ballings 408	PB
Selaginella tenerrima *Kuhn*		FZ
Family Tectariaceae [Aspidiaceae]		
Tectaria gemmifera (*Fée) Alston*	Ballings 451	PB, BU
Family Thelypteridaceae		
Thelypteris gueinziana *(Mett.) Schelpe*		FZ, SRGH
Thelypteris madagascariensis *(Fée) Schelpe*	Ballings 586	PB
Thelypteris sp. (fronds tufted)	Ballings 351	PB
Thelypteris sp. (creeping rhizome)	Ballings 710	PB
Vittariaceae		
Vittaria guineensis *Desv.* var. orientalis *Hieron.*	Ballings 455	PB, BU, FZ
Vittaria isoetifolia *Bory*	Ballings 400	PB, BU, FZ
Vittaria volkensii *Hieron* var. volkensii	Ballings 436	PB, BU, FZ
Woodsiaceae		
Diplazium nemorale *(Baker) Schelpe*	Ballings 446	PB, BU