TECHNICAL PAPER 59

# Mgambo Forest Reserve

## A biodiversity survey

**Frontier Tanzania**
**2002**

# East Usambara Conservation Area Management Programme

## Technical Paper 59

# Mgambo Forest Reserve

## A biodiversity survey

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**Tanzania**
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**East Usambara Conservation Area Management Programme (EUCAMP)**
The East Usambara rain forests are one of the most valuable conservation areas in Africa. Several plant and animal species are found only in the East Usambara mountains. The rain forests secure the water supply of 200,000 people and the local people in the mountains depend on these forests. The East Usambara Conservation Area Management Programme has established the Amani Nature Reserve and aims; at protecting water sources; establishing and protecting forest reserves; sustaining villager's benefits from the forest. The programme is implemented by the Forestry and Beekeeping Division of the Ministry of Natural Resources and Tourism with financial support from the Government of Finland, and implementation support from the Indufor / Metsähallitus Group. To monitor the impact of the project, both baseline biodiversity assessments and development of a monitoring system are needed. The present activity is aimed at establishing baseline information on biological diversity in selected East Usambara forests.

**The University of Dar es Salaam (UDSM)**
The University of Dar es Salaam was established in July 1970 as a centre for learning and research in the arts and the physical, natural, earth, marine, medical and human sciences. The University is surveying and mapping the flora and fauna of Tanzania and is conducting research into the maintenance and improvement of the environment and the sustainable exploitation of Tanzania's natural resources.

**The Society for Environmental Exploration (SEE)**
The Society is a non-profit making company limited by guarantee and was formed in 1989. The Society's objectives are to advance field research into environmental issues and implement practical projects contributing to the conservation of natural resources. Projects organised by The Society are joint initiatives developed in collaboration with national research agencies in co-operating countries.

**Frontier Tanzania Forest Research Programme (FT FRP)**
The Society for Environmental Exploration and the University of Dar es Salaam have been conducting collaborative research into environmental issues since July 1989 under the title of Frontier Tanzania, of which one component is the Frontier Tanzania Forest Research Programme (FT FRP). Since July 1994, the FT FRP has been working in the forests of the East Usambara mountains in collaboration with the East Usambara Conservation Area Management Programme (EUCAMP). This survey of selected forests collects baseline biodiversity data and assists the EUCAMP in the management of the East Usambara forests.

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# EXECUTIVE SUMMARY

Mgambo Forest Reserve (FR) is located in the north-east of the main East Usambara Mountain range, adjacent to the savanna plateau that reaches into Kenya. Mgambo FR covers an area of 13.46 $km^2$ (1346 ha). It lies in the district of Muheza, Maramba Division, Tanga Region and covers land approximately 10 km north from Maramba town, located on latitude $4^o$46'00" and longitude $38^o$45'15". Mgambo FR was gazetted in July 1998, as delineated and described on the Forest and Beekeeping Division map number. Jb. 2291. It was gazetted primarily to protect the catchment areas supplying Bwiti, Mavovo, Mgambo and Daluni villages. The region has an average annual rainfall of between 1000 and 1500mm per year, falling principally from March to June although, in recent years, rain has been unpredictable and low. Vegetation cover within Mgambo Forest Reserve has previously been recorded as containing 1,295 ha of poorly stocked lowland forest and 51 ha of cultivation under lowland forest (Johansson, 1996). The biodiversity survey within Mgambo FR shows that this has now changed.

As part of the East Usambara Conservation Area Management Programme, (EUCAMP), (formerly the East Usambara Catchment Forest Project), Frontier-Tanzania conducted a biological survey of Mgambo FR between April and June 2002 for a total of 10 research weeks. The systematic vegetation survey covered all parts of the reserve with a sampling intensity of 0.25%, the zoological survey was focussed on 4 ten night trapping sites and 2 two night sites. This report provides an inventory of the trees, shrubs, herbs, mammals, reptiles, amphibians, birds and butterflies recorded during the survey. The report also describes patterns of human disturbance within the reserve. The species richness, endemism and ecological affinities of the taxa recorded are summarised in Table 1.

**Table 1** Summary of biodiversity of taxa surveyed

| Taxon | Total no. of species | % forest dependent | No. of non-forest species | No. of endemic species | No. of near-endemic species | No. of forest dependent endemics and near-endemics |
|---|---|---|---|---|---|---|
| Trees and shrubs | 128 | 5.0 | 29 | 1 | 12 | 2 |
| Mammals | 45 | 9.5 | 12 | 0 | 3 | 1 |
| Birds | 52 | 6.0 | 31 | 0 | 2 | 0 |
| Reptiles | 20 | 10.0 | 18 | 0 | 2 | 0 |
| Amphibians | 14 | 36.0 | 3 | 0 | 5 | 5 |
| Butterflies | 138 | 17.0 | 44 | 0 | 11 | 7 |
| **Total** | **397** | **n/a** | **137** | **1** | **35** | **15** |

Relative to other reserves surveyed by Frontier-Tanzania, Mgambo FR has a low floral diversity and low to average faunal diversity.

In terms of flora, Mgambo FR is made up of patches of several different vegetation types including dry lowland forest, riverine lowland forest, scrub forest, open woodland and miombo woodland (*Brachystegia* sp.*)*. A large proportion of species recorded within Mgambo FR were categorised as non-forest dwelling (Table 1). Lowland riverine forest and some of the lowland scrubby habitats were the most important habitats for endemic and near endemic species, althouth the majority of the reserve suffers substantially from fire and overgrazing disturbances. Only one plant species was identified as endemic to the Usambaras, this was *Cassia abbreviata*.

Despite its small size, Mgambo Forest Reserve supports a high diversity of butterfly species and several near endemic amphibian species. The reserve is home to 3 endangered and 5 vulnerable species according to the National Biodiversity Database (UDSM, 1997) and IUCN categories.

To this day, Mgambo FR has spiritual value to local Washambaa communities and serves as a source of medicinal plants and non-timber forest products. A number of ritual areas were observed during the course of the study. These sites were often located in the better forest areas such as the riverine forest areas and site locations included bases of trees and caves.

The greatest threat to Mgambo FR is fire disturbance, to provide fresh grass for illegal livestock grazing in the forest. Pole and timber cutting and animal hunting continue illegally on a small scale within the reserve, generally close to inhabitation.

The information collected by this survey will be used for management planning by the EUCAMP. The survey results are also available as a baseline for monitoring. The data are stored on a Microsoft Access (version Windows 97) database in the EUCAMP library in Tanga, and parts of it are available on the Internet at the following address: www.usambara.com

Animal specimens have been deposited at: the Department of Zoology and Marine Biology, University of Dar es Salaam; Natural History Museum, London; Zoological Museum of Copenhagen, Denmark; Frankfurt Zoological Museum, Germany; The Natural History Museum of Zimbabwe, Bulawayo and the African Butterfly Research Institute, Nairobi. Contact names and addresses are listed in Appendix 2.

Botanical specimens are held at the National Herbarium of Tanzania (NHT) in Arusha, Missouri Botanical Gardens, USA and Kew Royal Botanical Gardens, UK.

# FOREWORD

The East Usambara forests in northeastern Tanzania are part of the Eastern Arc mountains. More than one hundred years of biological interest and research have shown that these forests have a unique diversity of flora and fauna, and an exceptionally high degree of endemism. They have gained global recognition as being part of a Biodiversity Hotspot (Conservation International), an Endemic Bird Area (BirdLife), a Centre of Plant Diversity (WWF and IUCN) and a Globally Important Ecoregion (WWF). Since 1990, the East Usambara Conservation Area Management Programme (EUCAMP) (formerly known as the East Usambara Catchment Forest Project (EUCFP)) has worked in the East Usambara Mountains with the mission to protect these natural forests. The project is implemented by the Forestry and Beekeeping Division (FBD) of the Ministry of Natural Resources and Tourism (MNRT) with financial support from the Government of Finland, and technical support from Metsähallitus Consulting.

Although a considerable amount of biological information exists from the East Usambara Mountains, systematic surveys were previously largely restricted to the Amani area. In order to aquire more comprehensive information on the forests, biodiversity surveys were initiated and contracted in July 1995 to Frontier Tanzania, a joint venture between the University of Dar es Salaam and the Society for Environmental Exploration, together with EUCAMP. The aim of the surveys is to provide systematic baseline information on the biological values of different forests as a basis for management planning and long-term monitoring. They will help to set priorities in the conservation of this valuable area. In addition, the surveys provide training for forestry staff in the use of biological inventory techniques.

The programme involves locally employed field assistants, permanent staff from EUCAMP, Frontier-Tanzania, University of Dar es Salaam, and Tanzania Forestry Research Institute, as well as an international network of taxonomists and other experts. The surveys have become progressively more systematic and quantitative, and have already resulted in the discovery of several previously unknown taxa. This will further raise awareness of the unique conservation values of the East Usambara Mountains. EUCAMP has also commissioned the development of a biodiversity database. All data collected during the surveys is entered into this database, which is linked to the Tanzanian national biodiversity database held at the Department of Zoology and Marine Biology, University of Dar es Salaam.

The reports are the result of the work of many people – too many to be listed here. We would like to thank all of them for their invaluable effort. We hope that the surveys will make yet another contribution to the long historic chain of efforts to study and understand these unique forests. Perhaps even more than that we hope that this information will contribute to better management and conservation of the East Usambara Mountains so that the beauty of the area will remain for future generations to know and enjoy.

| | |
|---|---|
| Mr. Mathias Lema | Dr Veli Pohjonen |
| Project Manager | Chief Technical Adviser |

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| Biodiversity Co-ordinator and Botanical collector | Mr. Albert Ntemi Sallu |
| Foresters: | Mr. Johari Mtango, Mr. Francis Tunguli and Mr. Josephat Maingu. |

**SOCIETY FOR ENVIRONMENTAL EXPLORATION**

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# 1.0 INTRODUCTION

## 1.1 The East Usambara Mountains and forest diversity

The East Usambara Mountains are situated in northeastern Tanzania within 40 km of the coastal town of Tanga between 4°48'-5°13'S and 38°32'-38°48'E. These mountains form part of a chain known as the Eastern Arc that stretches down the coast of East Africa from southern Kenya to southern Tanzania. This is a chain of isolated mountains composed of Precambrian rock exposed by block faulting and slow uprising (Griffiths, 1993). Being adjacent to the Indian Ocean, considerable orographic rainfall occurs in this area. The rainfall distribution is bi-modal, peaking between March and May and between September and December. The dry seasons are from June to August and January to March. However precipitation occurs in all months. Rainfall is greatest at higher altitudes and in the southeast of the mountains, increasing from 1,200 mm annually in the foothills to over 2,200 mm at higher altitudes. Due to topographic and climatic interactions, the west-facing slopes of the mountains are drier compared to the east-facing slopes. Due to their age, isolation and their role as condensers of the moisture from the Indian Ocean, the East Usambara Mountains support ancient and unique forests, rich in endemic species (Hamilton, 1989).

Research in the East Usambara Mountains began in the late 1890s with substantial botanical collections being undertaken. Later, in 1928, surveys were undertaken on amphibians and, by the 1930s, detailed ornithological work had begun. Since these early studies biological research in the mountains has steadily increased .

The East Usambara forests have been likened to the African equivalent of the Galapagos Islands in terms of their endemism and biodiversity (Rodgers and Homewood, 1982; Howell, 1989). They are considered to be one of the most important forest blocks in Africa (Tye, 1994). Currently, at least 3450 species of vascular plants have been recorded in the Usambara Mountains of which it is suggested that over one quarter are endemic or near-endemic (Iversen, 1991a) and many species are threatened (Rodgers, 1996).

The forests of the East Usambara Mountains are not only important for their biodiversity, they also play an important role in maintaining the hydrological cycle that feeds the Sigi River. This river is a vital water source for the local communities as well as supplying water for the large coastal town of Tanga. Deforestation in the area will lead to increased soil erosion, particularly from the steeper slopes. Soil erosion is liable to result in a more irregular run off and deterioration in water quality due to siltation.

The latest survey of the East Usambara Mountains, conducted by Johansson and Sandy (1996) shows that approximately 45,137 ha of the East Usambara Mountains remain as natural forest. This can be divided into two types: submontane rain forest and lowland forest. Altitude is the factor differentiating these two forest types (Hamilton, 1989), with submontane forest generally occurring above 850m. The area recorded as forest in the East Usambara Mountains according to these categories is described in Table 2.

**Table 2** Forest area in the East Usambara Mountains (based on Johansson and Sandy, 1996).

| Forest type | Area | % of area |
|---|---|---|
| Lowland forest | 29497.4 | 62.9 |
| Submontane forest | 12916.6 | 30.6 |
| Forest plantation | 2723.6 | 6.5 |
| **TOTAL** | **45137.6** | |

The mammals of the East Usambara Mountains show limited endemism (Kingdon and Howell 1993). However, there are several species of special interest. These include: the restricted Zanj elephant shrew, *Rhynchocyon petersi*, which is common in the Usambara Mountains (Collar and Stuart, 1987) yet listed as globally 'Endangered' by IUCN due to a decline in habitat extent and quality; Eastern tree hyrax, *Dendrohyrax validus*, listed as 'Vulnerable' by IUCN (Hilton-Taylor, 2000), and the Lesser pouched rat, *Beamys hindei* which is also considered 'Vulnerable' by IUCN (Hilton-Taylor, 2000).

There are at least 11 species of reptiles and amphibians endemic to the East and West Usambara Mountains (Howell, 1993). The East Usambara Biodiversity Surveys provide further information on new species and species' range extensions. A new species of snake, *Prosymna semifasciata*, was recently found in Kwamgumi and Segoma Forest Reserves (Broadley, 1995) and a recently described amphibian species; *Stephopaedes usambarae* (Poynton and Clarke, 1999) has been recorded by the surveys in Mtai and Kwamgumi Forest Reserves.

The forest avifauna of the East Usambara Mountains has a high diversity with at least 110 species (Stuart, 1989). Six species occurring in the lowland forests are considered 'Vulnerable' to global extinction: Sokoke scops owl, *Otus ireneae*; the endemic Usambara eagle owl, *Bubo vosseleri*; Swynnerton's robin, *Swynnertonia swynnertoni*; East coast akalat, *Sheppardia gunningi*; Amani sunbird, *Anthreptes pallidigaster* and the Banded green sunbird, *Anthreptes rubritorques* (IUCN, 1996).

The East Usambara Mountains are essentially forest 'islands' (Lovett, 1989). There has been natural forest in the area for several million years. The Usambara Mountains harbour many species that have been geographically separated from their closest relatives for long periods. They also serve as a refuge for formerly widespread flora and fauna that have become extinct over much of their former area (Iversen, 1991a).

These forests have been under continuous exploitative human pressure for at least 2,000 years (Schmidt, 1989). Until recently, especially before the past 50 years, (Kikula, 1989), this pressure was sustainable. However, the growing human population in the area is leading to increased pressure on the remaining natural forest, and represents the main threat to their survival.

## 1.2 Report structure

This report provides a floral and faunal inventory of Mgambo Forest Reserve (Mgambo FR). Each species is described in terms of its ecological requirements and its endemic status.

Ecological requirements are defined as:

- **Forest dependent species (F)**: Species dependent on primary forest only. This category does not include forest edge or secondary forest species;
- **Forest non-dependent species (f)**: Forest dwelling but not dependent on primary forest: species occurring in primary forest as defined above as well as other vegetation types. It should be emphasised that many of these species are still dependent on a forest habitat albeit forest edge or disturbed forest. Most species in this category will still be adversely affected by forest destruction.
- **Non-forest species (O)**: These are species that do not normally occur in primary or secondary forest or forest edge.

Levels of endemism are defined as:

- **Endemic (E):** Occurring only in the Usambara Mountains;
- **Near-endemic (N):** Species with ranges restricted to the Eastern Arc Mountains and / or the East African lowland forests;
- **Widespread (W):** Species with ranges extending beyond the Eastern Arc and East African lowland forests.

The typical habitat association of plant species is categorised as either:

- **Lowland (L):** Species occurring at altitudes of <850m.
- **Submontane (S):** Species occurring at altitudes of >850m.
- **Montane (M):** Species occurring at altitudes of >1250m.

This refers to the habitat(s) in which they are typically found in East Africa, rather than to where they have been recorded in the reserve.

These three criteria are used to analyse the uniqueness of the biodiversity of the reserve and its vulnerability to disturbance. The categories are based on information from various sources.

### 1.2.1 Flora

Floral nomeclature generally follows the following databases located on the internet:
www.mobot.org (TROPICOS database in University of Missouri, Botanical Garden)
www.ipni.org (International Plant Names Index)
Family organisation follows Iversen (1991b).

For plants the ecological type and endemic status are primarily based on Iversen (1991b). Forest dependent species refers to those species listed as being exclusively associated with Iversen's categories 1a (wet evergreen forest), 1b (dry evergreen forest) and/or 1c (riverine forest). Species defined as forest dwelling also occur in other habitats.

Definitions of habitat type are based on Hamilton (1989). For those species not listed by Iversen (1991b) or Hamilton (1989), the information is taken from the Flora of Tropical East Africa and from the List of East African Plants (LEAP), Knox (2000).

Endemic and near-endemic status for plants was taken from Iversen (1991b) and FTEA categories Tanzania T3, T6, T8 and Kenya K7.

### 1.2.2 Fauna

For fauna, the following references were used:

| | |
|---|---|
| Mammals: | Kingdon (1997), Kingdon (1989), Kingdon (1974), Walker (1996). |
| Birds: | Zimmerman *et al*. (1996), Stattersfield *et al* (1998), Mlingwa *et al.* (2000), Stuart (1989). |
| Reptiles: | Spawls *et al.* (2002). |
| Amphibians: | Passmore and Carruthers (1995). |
| Butterflies: | Kielland (1990) and Larsen (1996). |

For animals, the endemic and near-endemic status was gleaned from the Tanzanian National Biodiversity Database (NBD) (UDSM, 1997).

#### *1.2.2.1 Birds*

Ecological type of bird species recorded were based on, Mlingwa *et al*. (2000) which is turn is based on Bennum *et al*. (in press). Those species not included in the above were categorised by Zimmerman *et al.* (1996) and Stuart (1989).

Forest dependence Mlingwa *et al.* (2000):

- **Forest specialist (FF):** Species that are typical of forest interior and likely to disappear when the forest is modified to any extent.
- **Forest generalist (F):** Species that can occur in undisturbed forest but which are able to exist (and may even be numerous) at the forest edge or in modified and fragmented forests. However, these generalists continue to depend upon forests for some of their resources, such as nesting sites.
- **Forest visitors (f):** Species that occur outside forest areas but which might visit forest.

Stuart (1989) categorises species by adaptability:

1. those which live in forest but are not dependent upon it for their survival
2. those which live in forest and 'overspill' into adjacent habitats, but are dependent upon forest for their continued survival
3. those that can only survive in forest and hardly 'overspill' into adjacent habitats.

The NBD (UDSM, 1997) and IUCN 2000 were used to categorise threat status of the animals listed. The NBD lists were compiled with regard to status and threat within Tanzania and East Africa. The status of most species are undergoing national and international evaluation. IUCN, categorises species in terms of global threat and produces Red data books, available from 1996 and earlier. However, a new IUCN 2000 CD-Rom has been released. Many Tanzanian species are not included in the 2000 IUCN Red data CD-Rom. IUCN 2000 status is given, where available, in addition to NBD for all taxa groups and is the main source of threat status for bird species.

## 1.3 Maps

The distribution of plant species within the reserve is presented as a series of maps. These are thematic maps where the size of each spot is directly proportional to the value that they represent. In the plots where no spot is shown, the relevant taxa were either not found or not surveyed. Only one map summarises animal data. Not enough capture data was available to produce useful thematic maps for each animal taxa.

## 1.4 Data and monitoring

Data are stored in a Microsoft Access (version Windows 97) database currently stored at the East Usambara Conservation Area Management Programme and Frontier-Tanzania. Parts of it are now available on the Internet. Zoological data are also stored on the National Biodiversity Database at the Department of Zoology and Marine Biology, University of Dar es Salaam. This is also a Microsoft Access database. The data are geographically referenced and so can be used as a baseline for biodiversity monitoring.

## 1.5 Survey period and personnel

The survey of Mgambo FR was conducted between 9th April and 17th June 2002 for a total of 10 research weeks. Frontier-Tanzania staff, Catchment Forest Officers, and locally employed field assistants from Maramba, Tanga, Amani and Bwiti conducted the survey.

# 2.0 AIMS OF THE SURVEY

The specific aims of the biodiversity survey as outlined in the Terms of Reference between the Frontier Tanzania Forest Research Programme and the East Usambara Conservation Area Management Programme (EUCAMP) are:

- to conduct biological baseline surveys in selected forests as a baseline against which to monitor future changes in biodiversity status;
- to provide information on the biological value and importance of these forests in order to assist in the development of management plans and practices for these forests;
- to provide information on human disturbance and levels of resource use in different areas of the forest;
- to develop specific, quantitative methods of monitoring key biodiveristy indicators, and assist in establishing long term monitoring procedures to address specific aspects of the forest ecology and management such as regeneration and hunting;
- to train Tanzanian personnel from EUCAMP, UDSM, the TAFORI and the Forestry and Bee Keeping Division in forest survey work;
- to contribute to global biodiversity assessment and conservation efforts through collaboration with specialists elsewhere, and the sharing of information, data and material collected during surveys.

Furthermore, the aims of the survey methods applied are:

- to sample the vegetation and tree species composition of selected forests of the East Usambara Mountains using systematic sampling techniques along systematically located vegetation transects, which sample 0.25% of the area of each forest reserve;
- to assess levels of disturbance by systematically sampling the incidence of tree cutting, animal trapping and other illegal activities along the vegetation transects;
- to use standardised and repeatable methods to record biodiversity values of the forest in terms of small mammal, reptile, amphibian, and invertebrate species;
- to collect opportunistic data on all other groups of vertebrate and invertebrates. Species lists resulting from this will be compared against IUCN categories of threat and other conservation criteria in order to assess the overall biodiversity values of each forest.

By using standardised and repeatable methods these surveys provide an assessment of the biodiversity value of the forests, enabling their importance to be determined and their biodiversity value to be monitored in future.

An additional aim of the project that is covered in a separate report includes:

- to provide small scale feedback with regard to the survey findings through environmental education activities within school and village committee networks, in co-operation with the EUCAMP Village Forestry Programme.

# 3.0 DESCRIPTION OF THE FOREST

## 3.1 General description

### 3.1.1 Description

Name: Mgambo Forest Reserve
Muheza District, Tanga Region, Tanzania.

Area: 1346 ha

Status: Catchment Forest Reserve
Gazetted July 1998 as delineated and described on Forest and Bee Keeping Division Map No. Jb. 2291 Gazettement notice GN 99 (1931; (1995).
Central Authority Status

Maps: Ordnance Survey topographic maps 1: 50 000 Series Y742 (D.O.S. 422) Sheet 110/4 'Gombero' of 1989 and Sheet 110/2 'Mwakijembe' of 1989
Forest and Bee Keeping Division maps:
Jb 2291 1996 'Mgambo Forest Reserve' 1:10,000

### 3.1.2 Location

Lat/Long: S 04°44'53" - S 04°47'50", E 38°47'18" - 38°49'11" E

UTM/UPS: 94 75228 - 94 69784 S, 04 76554 - 04 80020 E

Elevation: 320m – 820m above sea level

Mgambo Forest Reserve (FR) is located in the north-east of the main East Usambara Mountain range with Mpanga and Mtai forest reserves to the south. Mgambo FR lies adjacent to the savanna plateau that reaches into Kenya (Figure 2). Mgambo FR covers an area of 13.46 $km^2$ (1346 ha). It lies in the district of Muheza, Maramba Division, Tanga Region and covers land approximately 10 km north from Maramba town, located on latitude $4^o$46'00" and longitude $38^o$45'15". Mgambo FR was gazetted in July 1998, as delineated and described on the Forest and Beekeeping Division map number. Jb. 2291. It was gazetted primarily to protect the catchment areas supplying Bwiti, Mavovo, Mgambo and Daluni villages. The region has an average annual rainfall of the area is between 1000 and 1500 mm per year falling principally from March to June although, in recent years, rain has been unpredictable and low. Vegetation cover within Mgambo Forest Reserve has previously been recorded as containing 1,295 ha of poorly stocked lowland forest and 51 ha of cultivation under lowland forest (Johansson, 1996).

### 3.1.3 Topography

Mgambo FR consists of two ridges running north to south in the western and eastern halves of the reserve (Figure 3). A photograph of the view from a northerly point along the eastern ridge top can be found in Figure 1. The ridge top reaches an altitude of 800m above sea level. All but one or two rocky cliff areas is accessible by foot. There is a water source feeding Bwiti village and subvillages and another that is used by Mgambo village.

### 3.1.4 Land use

The latest survey of the area was carried out by Hyytiäinen (1995), and updated by Johansson and Sandy (1996). The most common habitat found within Mgambo FR from this survey was recorded as poorly stocked lowland forest (Table 3).

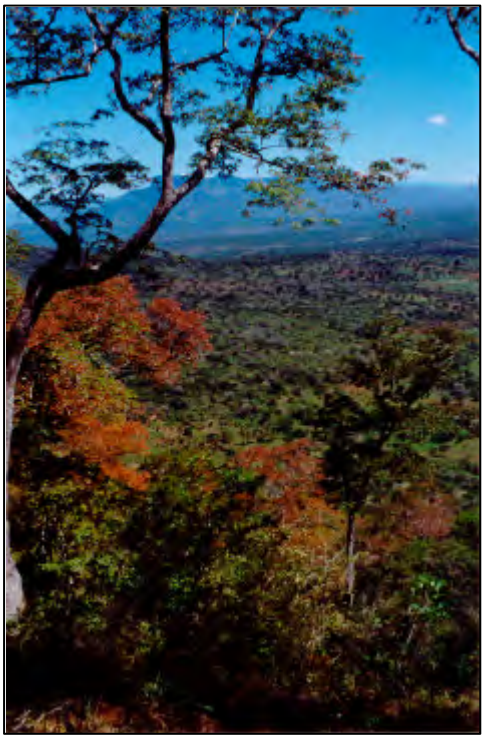

**Figure 1** View from Mgambo FR ridgetop looking westwards to the West Usambaras.

**Table 3** Land use distribution (Johansson and Sandy, 1996).

| **Mgambo PFR** ('proposed' FR at time of consideration) | **Area (hectares)** | **% of area** |
|---|---|---|
| **Lowland forest:** | | |
| Poorly Stocked forest | 1295.0 | 96.2 |
| Cultivation under forest | 51.0 | 3.8 |
| **Total** | **1346.0** | **100%** |

### 3.1.5 History and Status

There has been human pressure in the East Usambara Mountains for at least 2000 years. In the 19th Century it appears populations were markedly lower in the East Usambara Mountains relative to the West Usambara Mountains with much of the area remaining forested.

Since gazettment, the Mgambo FR has continued to be used for the collection of cultural resources and worshipping. Regular and extensive fires and grazing practices in recent years have occurred within the Forest Reserve and have significantly reduced the quality and expanse of closed forest habitat.

In comparison with other Forest Reserves in the East Usambara Mountains, little research has been conducted within Mgambo FR. This survey is the first comprehensive, systematic and comparable survey of all accessible parts of the forest reserve.

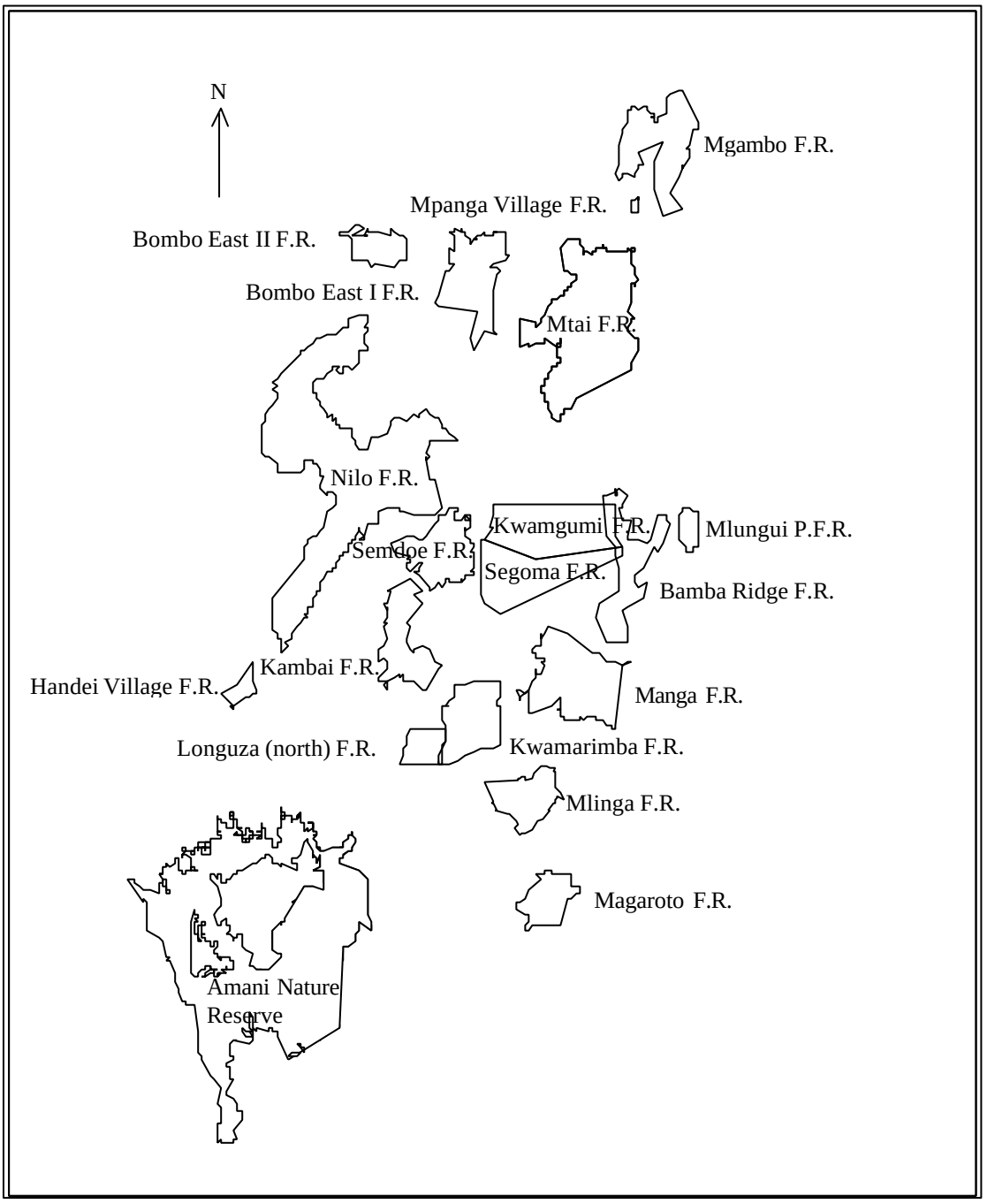


**Figure 2** The location of Mgambo FR in relation to other East Usambara forests

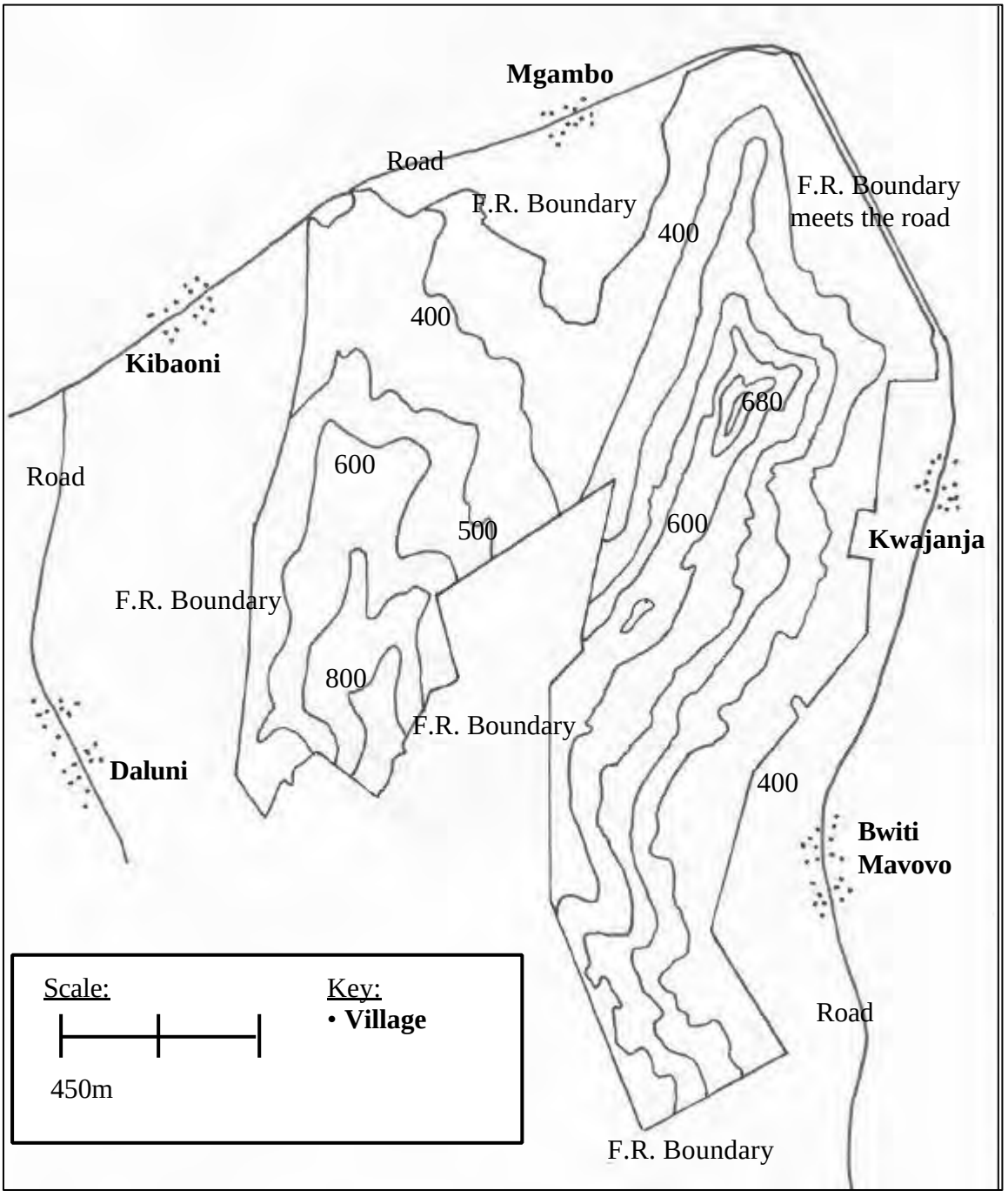


**Figure 3** Topographical map of Mgambo FR.

# 4.0 VEGETATION

**Authors: Oliver, S.A., Ntemi, A.S., Bracebridge, C.E. pp. 11-42**

## 4.1 Introduction

A species inventory was compiled of the trees and shrubs found within the Mgambo Forest Reserve (FR). Simple, quantitative and repeatable methods were employed and the results are comparable with other forest surveys undertaken by FT FRP. Human disturbance within the forest was also documented. Botanical and disturbance data collected by this survey have been entered onto the EUCAMP database.

**Figure 4** Typical Miombo woodland (*Brachystegia* sp.) in Mgambo FR

## 4.2 Methods

The forest reserve was divided into a grid of numbered squares marked in the field by tagged transect lines. All methods are based on this grid system and are detailed in the FT FRP methodologies report (SEE, 1998). A brief description is presented below. The location of vegetation plots and disturbance transects were recorded using Global Positioning System (GPS) (see Appendix 2) and their locations on the Mgambo FR outline are illustrated in Figure 5.

### 4.2.1 Forest composition

Three methods were used to analyse forest composition: (1) quantitative vegetation analysis; (2) opportunistic observations and (3) disturbance transects.

#### *4.2.1.1 Quantitative vegetation analysis*

The botanical survey was based on a 900m x 450m grid marked in the field using tagged transect lines. One plot 50m x 20m was sampled in each grid square, giving an approximate sampling intensity of 0.25%. The 50m x 20m vegetation plots were located in the southeast corner of each of the 900m x 450m grid rectangles. Within each sample (vegetation) plot, every tree with a diameter at breast height (dbh) of 10cm and over was recorded, marked with red paint, and identified. An EUCAMP botanist provided the field identification of plant species. Specimen collection was made of fertile individuals, and difficult to identify species.

The regeneration layer was sampled within 3m x 3m nested subplots at the centre of each vegetation plot. All trees and shrubs with a dbh below 10cm were counted and identified within these plots. The ground cover (of herbaceous vegetation, bare soil, leaf litter and rocks), and the dominance of other vegetation (such as grasses, forbs, mosses, lichens and ferns) were documented as percentages. Systematically sampled vegetation data is presented in the form of checklists and analytical calculations summarised in tables, graphs and maps.

#### *4.2.1.2 Opportunistic collection and observation*

Opportunistic collections and observations of ground, shrub and tree floras were made throughout the survey. Fertile individuals were collected as specimens and dried in the field using a kerosene stove. Detailed field notes were made of each specimen and are stored with the specimens. All botanical specimens are held at the National Herbarium, Arusha and Missouri Botanical Gardens, USA. Some specimens are also kept at Kew National Herbarium, UK. Opportunistic data is presented as a checklist, with location information for specimens that were collected.

#### *4.2.1.3 Disturbance transects*

Disturbance transects were used to record the intensity of pole and timber cutting and incidence of other disturbance types in the forest reserve. The disturbance transects were based on the 900m x 450m grid prepared for the vegetation plots (Figure 3). Each transect running east-west was sampled from border to border where accessible. Disturbance was recorded per 50m section along each transect.

Every self-standing tree and sapling (not lianas or creepers) 5cm or above dbh was measured within 5m either side of each transect line. Each plant was recorded under one of four categories: live, old cut, new cut or naturally dead. Within these categories a distinction was made between poles and timbers. Poles were classified as having a dbh (diameter at breast height) between 5 and 15cm and a minimum of 2m relatively straight trunk. Timbers were classified as having a dbh of 15cm or above with a minimum 3m relatively straight trunk. These divisions are based on differences in use. New cut stems were determined by cream coloured slash and classified as freshly cut within recent months (approximately within the past 3 months). Old cut stems were determined by black coloured slash and classified as old cut (approximately more than 3 months old). Timber and pole cutting data are presented as an average per hectare and summarised in graphs and maps.

The incidence of other signs of disturbance (such as fire, cultivation, grazing, animal trapping and pitsawing) were documented every 50m section and summarised in a table and maps. The most disturbed plots were calculated using pole and timber cutting counts and incidence figures for 'other signs of disturbance'. Pole and timber cutting counts were combined, summed and then ranked, with the most disturbed plot ranked first. Incidence of fire and grazing disturbance was also summed and ranked, with the most disturbed plot ranked first. The combined top nine plots were used within Figures 19 and 24.

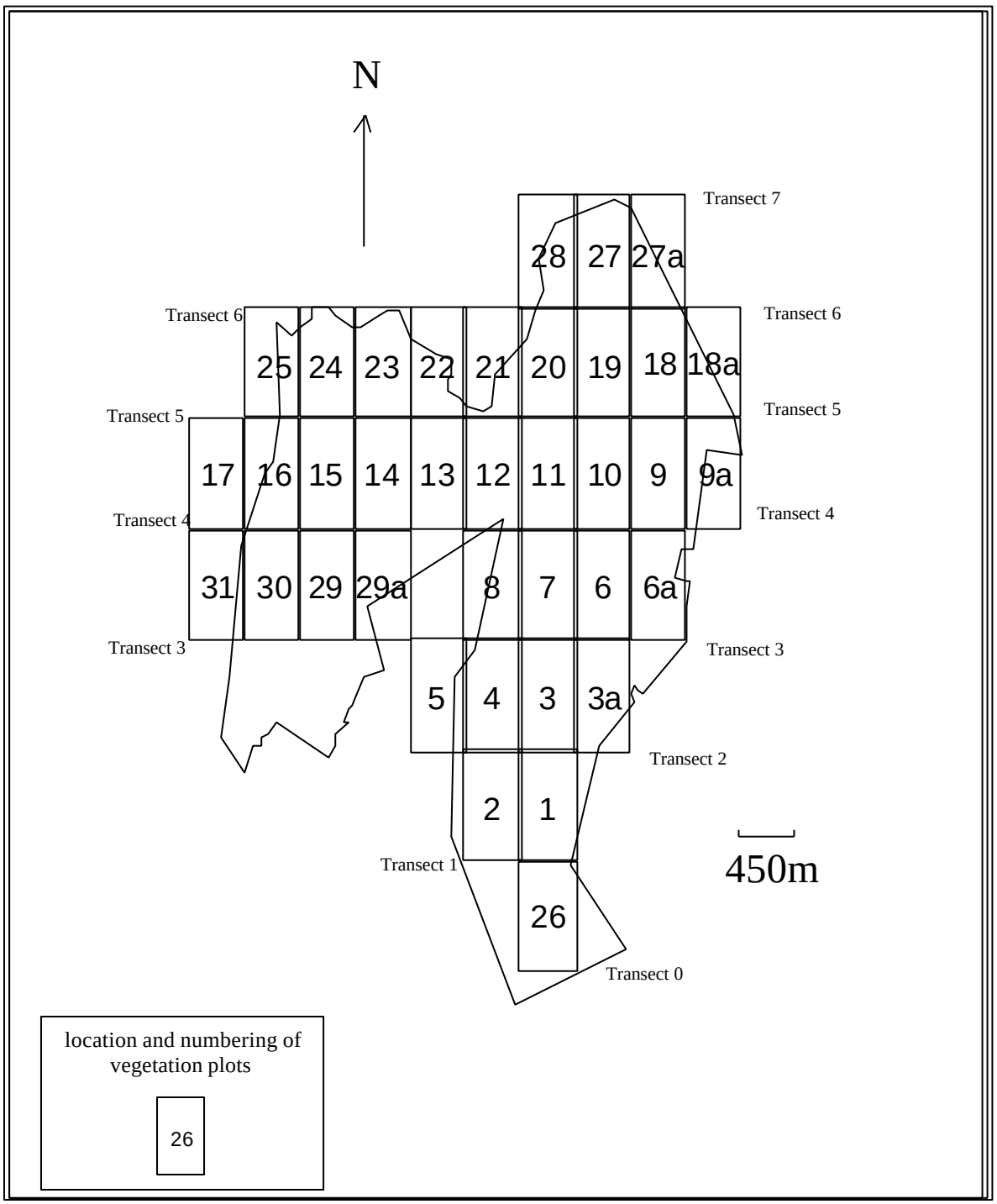


**Figure 5** Location of vegetation plots and disturbance transects in Mgambo FR.
(GPS co-ordinates of vegetation plots are summarised in Appendix 2).

## 4.3 Results

### 4.3.1 Quantitative vegetation analysis

#### *4.3.1.1 Vegetation Plots*

A total of 31 50 x 20m vegetation plots were established. By far the most dominant vegetation type within vegetation plots was found to be open woodland (65% of plots), with lowland forest found in just 16% of plots. There was none submontane forest vegetation plots. Almost 65% of all vegetation plots had an average canopy height of less than 10m, and there were no vegetation plots recorded with canopy heights greater than 20m. A total of 68% of vegetation plots had been affected by fire. The average slope for all accessible vegetation plots was moderately steep at 20.5 degrees. Vegetation plot descriptions are summarised in Appendix 3 and a vegetation map shown in Figure 6.

A total of 858 individuals, representing 31 families and 101 species were recorded in thirty-one 20m x 50m vegetation plots at 0.25% sampling intensity. Species are described, where adequate information exists, in terms of their ecological type, their habitat and their endemic status. Nomenclature follows Iversen (1991b), the Flora of Tropical East Africa (Polhill, 1988) and the LEAP database (Knox, 2000). Table 4 presents a checklist of these tree and shrub species.

**Table 4** Checklist of trees and shrubs recorded within the vegetation plots.

| | Ecol. Type | Habitat | End. Status | Total no. of individuals | Present in n plots | Local name |
|---|---|---|---|---|---|---|
| **Angiospermae – Dicotyledonae** | | | | | | |
| ANACARDIACEAE | | | | | | |
| *Lannea schweinfurthii (* Engl.) Engl. 1897 | f | L&S | W | 19 | 9 | Mumbu |
| *Lannea schweinfurthii* var. *stuhlmannii* (Engl.) J.D. Kokwaro 1980 | f | L&S&M[1] | W | 12 | 9 | Mumbu |
| *Ozoroa insignis* Delile | f | L | W | 2 | 1 | |
| *Sclerocarya birrea* (A. Rich) Hochst | O[1] | L&S&M[1] | W[1] | 4 | 2 | Mng'ongo |
| *Sorindeia madagascariensis* Thouars ex DC. 1825 | f | L&S | W | 6 | 1 | Mkwingwira |
| ANNONACEAE | | | | | | |
| *Asteranthe asterias* (S. Moore) Engl. & Diels Verde | f | L | N | 3 | 1 | |
| *Annona senegalensis* Pers. 1806 | f | L&S | W | 7 | 5 | Mtonkwe |
| *Monodora grandidieri* Baill. 1867 | O | L | N | 3 | 1 | |
| ARALIACEAE | | | | | | |
| *Cussonia arborea* Hochst. ex A. Rich. 1847 | f | L&S&M | W | 2 | 2 | Mtindii |
| BALANITACEAE | | | | | | |
| *Balanites aegyptica* Wall | O | S&M[2] | W[2] | 9 | 4 | |
| BIGNONIACEAE | | | | | | |
| *Markhamia lutea* (Benth.) K. Schum. 1895 | f | L&S | W | 18 | 3 | Mtalawanda |
| *Stereospermum kunthianum* Cham. 1832 | f | L&S | W | 27 | 9 | Mkande |
| BOMBACEAE | | | | | | |
| *Rhodognaphalon schumannianum* A.Robyns 1963 (basionym *Bombax rhodognaphalon* K.Schum.ex Engl. 1895) | f | L[2] | W[2] | 2 | 2 | Msufimwitu |
| BORAGINACEAE | | | | | | |
| *Cordia ovalis* R.Br. ex. DC. 1845 | f[1] | L&S&M[1] | W[1] | 22 | 9 | Mzei |
| *Ehretia amoena* Klotzsch | O | L[1] | W | 11 | 8 | |
| BURSERACEAE | | | | | | |
| *Commiphora africana* (A. Rich) Engl. | O | L&S | W | 3 | 3 | Mbambaa |
| *Commiphora eminii* Engl. ssp. *zimmermannii* (Engl.) J. B. Gillet 1991 (basionym. *C. Zimmermannii* Engl.) | F | L&S | W | 3 | 2 | |
| CAPPARACEAE | | | | | | |
| *Maerua kirkii* (Oliv.) F.White 1958 | f | L&S[1] | W[1] | 1 | 1 | |

**Table 4** continued

| | Ecol. Type | Habitat | End. Status | Total no. of individuals | Present in n plots | Local name |
|---|---|---|---|---|---|---|
| CELASTRACEAE | | | | | | |
| *Maytenus sp.* | ? | ? | ? | 3 | 1 | |
| *Maytenus undata* (Thunb.) Blakelock 1956 | f | L&S&M[2] | W | 14 | 5 | |
| *Mystroxylon aethiopicum* Loes. | f | L | W | 4 | 1 | |
| COMBRETACEAE | | | | | | |
| *Combretum exalatum* (Engl.) 1895 | f | L | N | 1 | 1 | |
| *Combretum molle* R. Br. ex G. Don 1827 | O | L | W | 15 | 10 | Mnama |
| *Combretum schumannii* Engl. 1895 | f | L&S[2] | W | 6 | 2 | Mperamwitu |
| *Combretum zeyheri* Sond. 1950 | O | L | W | 77 | 16 | Mgodogodo |
| *Pteleopsis myrtifolia* (Laws) Engl. & Diels | f | L | W | 15 | 8 | Myovu |
| *Terminalia prunioides* M. Laws | f | L | W | 1 | 1 | |
| *Terminalia sambesiaca* Engl. & Diels 1900 | f | L | W | 3 | 2 | Mkenge |
| COMPOSITAE | | | | | | |
| *Brachylaena huillensis* O. Hoffm. 1902 | f | L&S | W | 11 | 3 | |
| EBENACEAE | | | | | | |
| *Diospyros squarrosa* Klotzsch. | f | L | W | 4 | 3 | |
| *Euclea natalensis* A. DC | f | L&S | W | 7 | 5 | Mdaa |
| EUPHORBIACEAE | | | | | | |
| *Bridelia cathartica* Bertol.f. 1854 | O | L | W | 3 | 2 | |
| *Bridelia micrantha* (Hochst.) Baill 1862 | f | L&S&M | W | 1 | 1 | Mwiza |
| *Euphorbia candelabrum* Tremaut ex. Klotshy 1857 | O | L | W | 2 | 2 | Kibaranga |
| *Magaritaria discoides* (Baill.) Webster 1967 | O | L&S | W | 4 | 4 | |
| *Phyllanthus* sp. | ? | ? | ? | 2 | 1 | |
| *Ricinodendron heudelotii* (Baill.) Pierre ex Pax 1911 | f | L&S | W[1] | 1 | 1 | |
| *Spirostachys africana* Sond. 1850 | O | L | W | 5 | 1 | Mshaaka |
| *Suregada zanzibarensis* (Baill.) Mill 1861 | f | L | W | 3 | 3 | |
| FLACOURTIACEAE | | | | | | |
| *Caloncoba welwitschii* (Olive.) Gilg 1908 (basionym *Oncoba welwitschii* Oliv. 1868) | f[1] | S&M[2] | W[2] | 1 | 1 | |
| *Dovyalis hispidula* Wild | f | L | W | 9 | 2 | |
| LEGUMINOSAE subfamily: CAESALPINIDAE | | | | | | |
| *Afzelia quanzensis* Welw. 1858 | f | L | W | 1 | 1 | Mbambakofi |
| *Brachystegia spiciformis* Benth 1866 | f | L | W | 33 | 3 | Miombo |
| *Cassia abbreviata* Oliver | O[1] | L[1] | E[1] | 4 | 3 | |
| *Piliostigma thonningii* (Schumach.) Milne-Redh. | f | L&S&M | W | 2 | 2 | Kigona mbogo |
| *Scorodophloeus fischeri* (Taub.) J. Leonard 1951 (basionym. *Theodora fischeri* Taub. 1895) | O | L&S | N | 15 | 3 | Mhande |
| LEGUMINOSAE subfamily: MIMOSOIDAE | | | | | | |
| *Acacia hockii* De Wild. 1913 | O | L | W | 19 | 5 | |
| *Acacia mellifera* Benth[1] 1842 | O | S | W | 6 | 3 | Kikwata |
| *Acacia nilotica* Delile | f | S[1] | W | 17 | 2 | Mgunga |
| *Acacia polyacantha* Willd. | f | L&S | W | 15 | 5 | Mgunga |
| *Acacia* sp. (*new)* | ? | ? | ? | 4 | 1 | Mgunga |
| *Albizia anthelmintica* Brongn 1860 | O | L&S | W | 31 | 14 | Mfueta |
| *Inga glaberrima* (Schumach. & Thonn.) Roberty 1954 (basionym *Albizia glaberrima* (Schumach. & Thonn.) Benth. 1844) | f | L&S | W | 1 | 1 | Mshai |

**Table 4** continued

| | Ecol. Type | Habitat | End. Status | Total no. of individuals | Present in n plots | Local name |
|---|---|---|---|---|---|---|
| LEGUMINOSAE subfamily: MIMOSOIDAE cont. | | | | | | |
| *Albizia gummifera* (J.F. Gmel.) C.A. Sm. 1930* | f | L&S&M | W | 24 | 9 | Mshai |
| *Feuillea versicolor* (Welw. ex Oliv.) Kuntze 1891*Albizia versicolor* (Welw.ex) Oliv. 1871 | O | L&S&M | W | 6 | 2 | Mshai |
| *Dichrostachys cinerea* (L.) Wight & Arn. 1834 | f | L&S&M[2] | W | 12 | 3 | Kikulagembe |
| *Julbernadia globiflora* (no author) | f | L&S | W | 1 | 1 | |
| *Tamarindus indica (*L.) | f | L | W | 2 | 2 | Mkwaju |
| LEGUMINOSAE subfamily: PAPILIONIDAE | | | | | | |
| *Dalbergia melanoxylon* Guill & Perr | f[1] | L&S&M[1] | | 8 | 5 | Mpingo |
| *Erythrina abyssinica* D.C. | f | L&S&M[1] | W | 2 | 2 | |
| *Lonchocarpus bussei* Harms 1902 | O | L&S&M | W | 22 | 8 | Mfumbii |
| *Milletia dura* Dunn | f | S&M | W | 3 | 2 | Mhata |
| *Xeroderris stuhlmannii* (Taub.) Mendonça & E.P Sousa | f | L&S&M[1] | W | 4 | 2 | |
| LABIATAE | | | | | | |
| *Unknown* species | ? | ? | ? | 2 | 1 | Msoo |
| LOGANIACEAE | | | | | | |
| *Strychnos henningsii* Gilg. | f | L | W | 1 | 1 | |
| *Strychnos innocua* Delile 1826 | O[1] | M[2] | W[2] | 2 | 2 | Mkwakwa |
| *Strychnos spinosa* Lam (syn. *Strychnos madagascariensis* Poir) | f | L[1] | W | 1 | 1 | Mkwakwa |
| MELIACEAE | | | | | | |
| *Trichilia emetica* Vahl | f | L&S | W | 2 | 1 | Mgoimazi |
| *Turraea holstii* Guerke 1894 | F | L&S&M | W | 22 | 7 | Mduayu |
| MORACEAE | | | | | | |
| *Artocarpus heterophyllus* Lam. 1789 (exotic) | O | other | W | 1 | 1 | Mfenesi |
| *Ficus ottoniifolia* (S. Miq.) | f | L | N | 3 | 1 | Mkuyu |
| *Ficus* sp. (*new)* | ? | ? | ? | 1 | 1 | Mkuyu |
| *Milicia excelsa* (Welw.) C.C. Berg 1982 | f | L&S | W | 1 | 1 | Mvule |
| MYRSINACEAE | | | | | | |
| *Baeobotrys lanceolata* (Forssk. Vahl 1790 (basionym *Maesas lanceolata* Forssk 1775) | f | L&S&M | W | 1 | 1 | |
| OLACACEAE | | | | | | |
| *Ximenia americana* Linn. | O | L&S | W | 1 | 1 | |
| RHAMNACEAE | | | | | | |
| *Ziziphus mucronata* Willd. 1809 | f | L&S&M[2] | W | 1 | 1 | |
| RUBIACEAE | | | | | | |
| *Canthium mombazense* Baill. | f | L&S | N | 10 | 5 | |
| *Rothmannia manganjae* (Hiern) Garcia 1958* | F | L&S&M | W | 1 | 1 | |
| *Rutidea fuscenscens* Hiern. | f | L | W | 1 | 1 | Mshembeshembe |
| *Rytigynia* sp. | ? | ? | ? | 2 | 1 | |
| *Vangueria tomentosa* Hochst. 1842 | f | L | W | 5 | 3 | Mviu |
| RUTACEAE | | | | | | |
| *Vepris amaniensis* (Engl.) Mziray 1992 | f | L | W | 1 | 1 | |
| *Vepris trichocarpa* (Engl.) Mziray 1992 (basionym *Toddalia trichocarpa* Engl.) | f | L | W | 10 | 5 | Kidimu |
| *Zanthoxylum deremense* (Engl.*)* Kokwaro | F | L&S | N | 2 | 2 | Muungu |
| *Zanthoxylum* sp. | ? | ? | ? | 1 | 1 | Mhombo |

**Table 4** continued

| | Ecol. Type | Habitat | End. Status | Total no. of individuals | Present in n plots | Local name |
|---|---|---|---|---|---|---|
| SAPINDACEAE | | | | | | |
| *Allophylus calophyllus* Gilg. | f | L | W | 4 | 3 | |
| *Allophylus ferrugineus* Taub. | f | L | W | 1 | 1 | |
| *Allophylus melliodorus* Gilg ex Radlk. 1909 | f | S&M | N | 1 | 1 | |
| *Deinbollia kilimandscharica* Taub. 1895 | F | S&M | N | 1 | 1 | |
| *Haplocoelum inopleum* Radlk. 1878 | f[1] | L[1] | N[1] | 2 | 2 | Kigogodeka |
| *Haplocoelum foliolosum* (Hiern) Bullock 1931 | O | L | W | 1 | 1 | |
| *Lecaniodiscus fraxinifolius* Baker* | f | L&S&M | W | 27 | 9 | Mbwewe |
| SAPOTACEAE | | | | | | |
| *Manilkara sulcata* (Engl.) Dubard 1915 | f | L[2] | W | 28 | 6 | Mgambo |
| SIMAROBACEAE | | | | | | |
| *Harrisonia abyssinica* Oliver | f | L | W | 1 | 1 | |
| STERCULIACEAE | | | | | | |
| *Dombeya kirkii* Mast. | O | L | W | 6 | 1 | Kwengaa |
| *Dombeya shupangae* K. Schum. 1900 | O | L[2] | N | 55 | 12 | Mkiika |
| *Sterculia africana* (Lour.) Fiori 1911 | O | S | W | 7 | 3 | Mosa |
| TILIACEAE | | | | | | |
| *Grewia bicolor* Juss. 1804 | O | S | W | 41 | 13 | Mkole |
| *Grewia goetzeana* K. Schum | f | L&S[1] | N | 4 | 2 | Mkole-ngombe |
| *Grewia holstii* Burrett 1910 | f | L&S[1] | W | 5 | 3 | Mkole |
| *Grewia microcarpa* K. Schum. | O | L | W | 21 | 9 | Mkole-mbuzi |
| VERBENACEAE | | | | | | |
| *Clerodendrum* sp. | ? | ? | ? | 3 | 2 | |

[1] Information is based on FTEA

[2] Information is based on LEAP (Knox, 2000)

**KEY TO ABBREVIATIONS FOR TABLE 4**

Ecological type: (based on Iversen, 1991b)

- F - Forest dependent species: Species previously recorded as restricted to primary or closed canopy forest only, e.g. wet evergreen forest, dry evergreen forest and/or riverine forest;
- f - Forest dwelling but not forest dependent: Species previously recorded in primary or closed canopy forest as defined above and/or in forest edge, clearings, secondary forest, deciduous forest and woodland, and
- O - Non-forest species: These are species that do not occur in primary or secondary forest or forest edge (e.g. species that have been recorded in bushland, heathland, thicket, secondary scrub, grassland, rocky outcrops, swamps, wastelands and cultivation.

Habitat: (where possible based on Hamilton, 1989)

- L - Lowland: Species occurring at altitudes less than 850m above sea level;
- S - Submontane: Species occurring at altitudes greater than 850m above sea level.
- M – Montane Species occurring at altitudes greater than 1,250m above sea level.

If species occur in more than one habitat range, this has been recorded (e.g. L&S – this species has been recorded at altitudess between 0 and 850m above sea level).

Endemic status: (based on Iversen, 1991b):

- E - Endemic: Occurring only in the Usambara mountains, EU - Range limited to the East Usambara Mountains, WU - Range limited to the West Usambara Mountains;
- N - Near endemic: Species with limited ranges in the Eastern Arc mountains and/or the East African lowland forests;
- W - Widespread distribution.

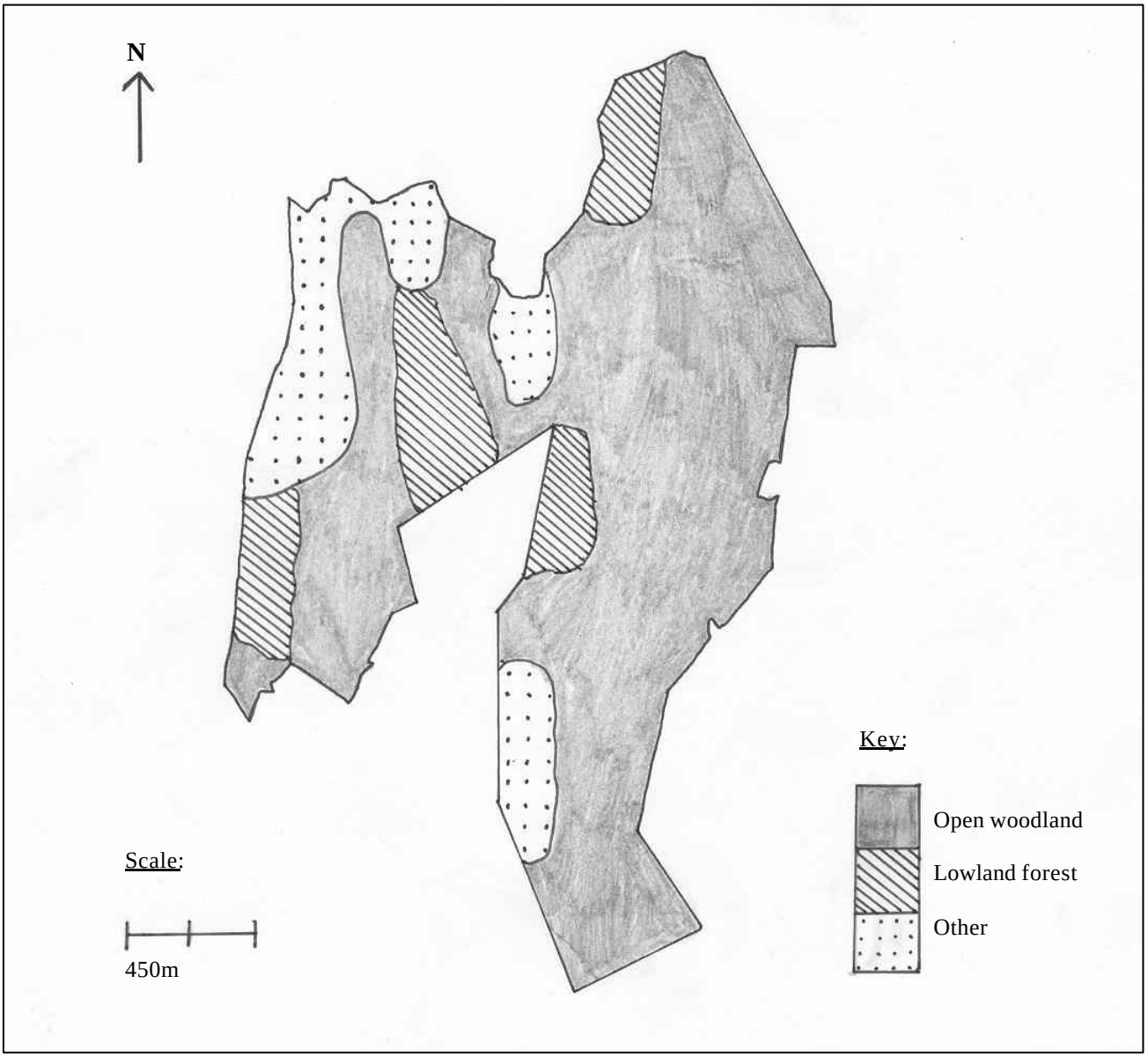


**Figure 6** Sketch map of vegetation types in Mgambo FR (based on vegetation plots).

#### *4.3.1.2 Species Abundance*

The most abundant species within vegetation plots was *Combretum zeyheri* representing 9.0% of all individuals sampled. This species was present within 16 vegetation plots and was the most dominant species in 5 vegetation plots (Table 5). *Combretum zeyheri* was common at low altitudes in open woodland and lowland forest margins. *Dombeya shupangae* was ranked as the second most abundant species within vegetation plots representing 6.4% of all individuals sampled. This woodland species was found in 12 vegetation plots. All of the most abundant species are widespread in their distribution and common in woodland and lowland forest.

**Table 5** Ranked abundance of tree and shrub individuals within vegetation plots.

| Family | Species | Rank | Number of Individuals | % of total no. individuals | In x plots (n=31) | % of total no. plots |
|---|---|---|---|---|---|---|
| COMBRETACEAE | *Combretum zeyheri* | 1 | 77 | 9.0 | 16 | 51.6 |
| STERCULIACEAE | *Dombeya shupangae* | 2 | 55 | 6.4 | 12 | 38.7 |
| TILIACEAE | *Grewia bicolor* | 3 | 41 | 4.8 | 13 | 41.9 |
| LEGUMINOSAE | *Brachystegia spiciformis* | 4 | 33 | 3.8 | 3 | 9.7 |
| LEGUMINOSAE | *Albizia anthelmintica* | 5 | 31 | 3.6 | 14 | 45.2 |
| SAPOTACEAE | *Manilkara sulcata* | 6 | 28 | 3.3 | 6 | 19.4 |
| SAPINDACEAE | *Lecaniodiscus fraxinifolius* | 7 | 27 | 3.1 | 9 | 29.0 |
| BIGNONIACEAE | *Stereospermum kunthianum* | 7 | 27 | 3.1 | 9 | 29.0 |
| LEGUMINOSAE | *Albizia gummifera* | 9 | 24 | 2.8 | 9 | 29.0 |
| BORAGINACEAE | *Cordia ovalis* | 10 | 22 | 2.6 | 9 | 29.0 |
| LEGUMINOSAE | *Lonchocarpus bussei* | 10 | 22 | 2.6 | 8 | 25.8 |
| MELIACEAE | *Turraea holstii* | 10 | 22 | 2.6 | 7 | 22.6 |
| TILIACEAE | *Grewia microcarpa* | 13 | 21 | 2.4 | 9 | 29.0 |

*Combretum zeyheri* and *Dombeya shupangae* were present in the greatest numbers of plots (9.0% and 6.4% of total individuals respectively) (Table 5). Both of these are woodland species that are fire tolerant.

*Combretum zeyheri* was also found in the most number of vegetation plots (51.6% of all plots). *Albizia anthelmintica*, *Grewia bicolor* and *Dombeya shupangae* were also found in a large proportion of the vegetation plots (45.2%, 41.6% and 38.7% respectively). These are also all woodland species.

#### *4.3.1.4 Endemic Status*

Only 4 individual specimens from 1 species recorded in vegetation plots was endemic to the Usambara Mountains, this species was *Cassia abbreviata*. There were 12 species (11.8% of total) and 97 individuals recorded as near endemic. The majority of species recorded were therefore widespread in their distribution (Table 4). Endemic and near endemic species were found in greater numbers on the western side of the reserve (Figures 7 and 8).

**Table 6** Summary of endemism for tree and shrub species recorded in the 50m x 20m vegetation plots (based on Table 4).

| | Number of species | % of species | Number of individuals | % of individuals |
|---|---|---|---|---|
| Endemic to the Usambara Mountains (E) | 1 | 1.0 | 4 | 0.5 |
| Near endemic (N) | 12 | 11.8 | 97 | 11.3 |
| Widespread (W) | 81 | 80.2 | 741 | 86.4 |
| Unknown (?) | 7 | 7.0 | 16 | 1.8 |
| **Total** | **101** | **100** | **858** | **100** |

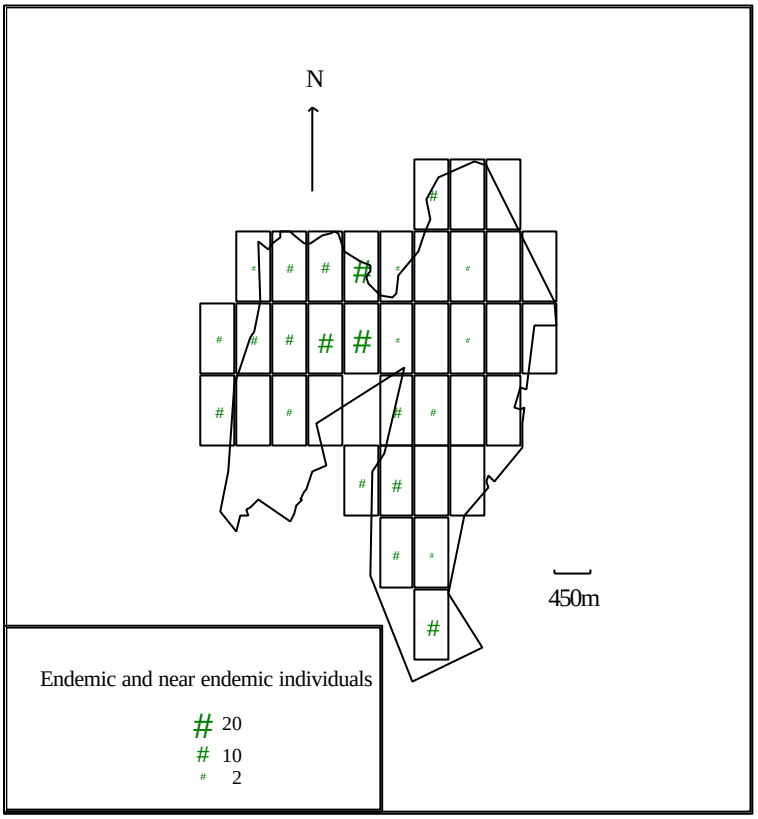


**Figure 7** Distribution of endemic and near endemic tree and shrub individuals in Mgambo FR.

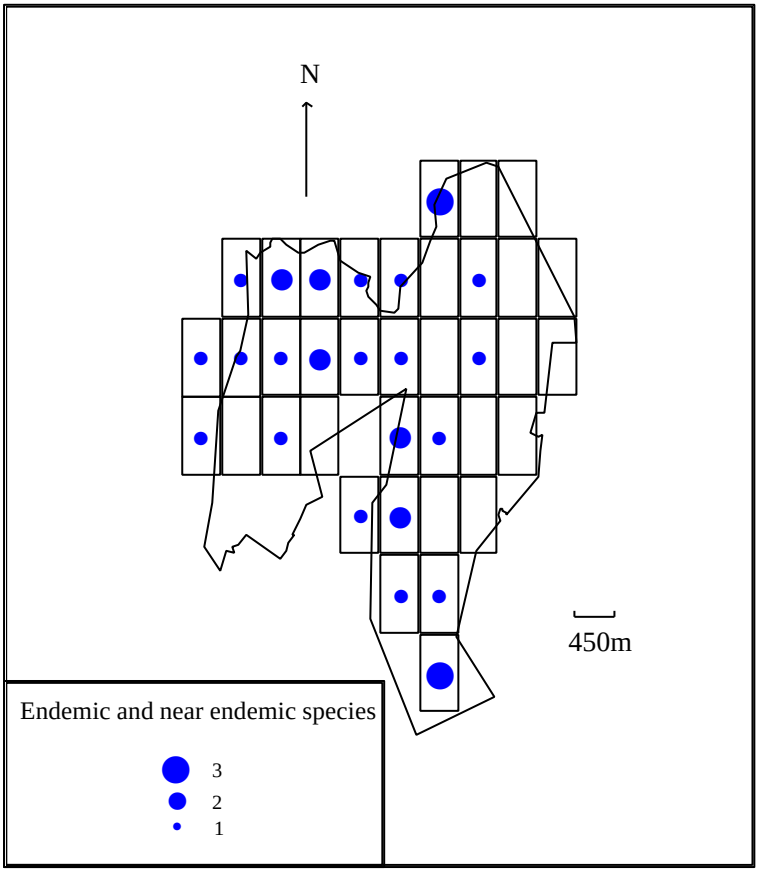


**Figure 8** Distribution of endemic and near endemic tree and shrub species in Mgambo FR.

### *4.3.1.5 Ecological type*

Just 29 individuals representing 5 species (5% of total) recorded within vegetation plots were forest dependent (Table 7). However, the majority individuals recorded were from species that were forest dwelling (Table 7). Figures 9 and 10 shows the distribution of forest dependent individuals and species. The south-western section of the reserve contained the most forest dependent species.

Non-forest individuals and species were found widely distributed throughout the forest reserve (Figures 11 and 12). This widespread distribution resulted in the majority of the forest reserve being woodland and grassland habitat and this reflects the significant disturbance pressure the the forest reserve is under.

**Table 7** Summary of ecological type of tree and shrub species recorded in the 50m x 20m vegetation plots (based on Table 4).

| Ecological Type | Number of species | % of total species | Number of individuals | % of total individuals |
|---|---|---|---|---|
| Forest dependent (F) | 5 | 5.0 | 29 | 3.4 |
| Forest dwelling (f) | 62 | 61.4 | 437 | 50.9 |
| Other (O) | 27 | 26.7 | 374 | 43.6 |
| Unknown (?) | 7 | 6.9 | 18 | 2.1 |
| **Total** | **101** | **100** | **858** | **100** |

### *4.3.1.6 Habitat*

Flora recorded from the vegetation plots of Mgambo FR was most commonly categorised within the lowland forest habitat type. A total of 39 (38.6%) species and 363 (42.3%) individuals were categorised as lowland forest species. There were only 4 species, *Acacia mellifera, Acacia nilotica, Grewia bicolor* and *Sterculia africana,* that were categorised as sub-montane species and 1 species, *Strychnos innocua,* categorised as a montane species (Figure 13 and 14). Despite the habitat categories of these species, they were all found in woodland lowland areas. Many other species (48 in total) were categorised as combinations of lowland with submontane and/or without montane forest habitats.

**Table 8** Summary of habitat type for tree and shrub species recorded in the 50m x 20m vegetation plots (based on Table 4).

| Habitat | No. of species | % of total species | No. of individuals | % of total individuals |
|---|---|---|---|---|
| Montane (M) | 1 | 1.0 | 2 | 0.2 |
| Submontane & montane (S&M) | 5 | 5.0 | 15 | 1.7 |
| Submontane (S) | 4 | 4.0 | 71 | 8.3 |
| Lowland, submontane & montane (L&S&M) | 18 | 17.8 | 185 | 21.7 |
| Lowland & submontane (L&S) | 25 | 24.8 | 201 | 23.4 |
| Lowland (L) | 39 | 38.6 | 365 | 42.5 |
| Unknown (?) | 7 | 6.9 | 19 | 2.2 |
| **Total** | **101** | **100** | **858** | **100** |

**Table 9** Submontane and/or montane species and the altitudinal ranges at which they were recorded in Mgambo FR.

| Family | Species | Altitudinal range (masl) |
|---|---|---|
| BALANITACEAE | *Balanites aegyptica* | 420-505 |
| FLACOURIACEAE | *Caloncoba welwitschii* | 505 |
| LEGUMINOSAE | *Acacia mellifera* | 400 |
| LEGUMINOSAE | *Acacia nilotica* | 510 |
| LEGUMINOSAE | *Milletia dura* | 540-570 |
| LOGANIACEAE | *Strychnos innocua* | 360-430 |
| SAPINDACEAE | *Allophylus melliodorus* | 480 |

| | | |
|---|---|---|
| SAPINDACEAE | *Deinbollia kilimandscharica* | 530 |
| STERCULIACEAE | *Sterculia africana* | 505-520 |
| TILIACEAE | *Grewia bicolor* | 400-800 |

Altitude (masl): metres above sea level
**Bold Type:** Montane Forest species

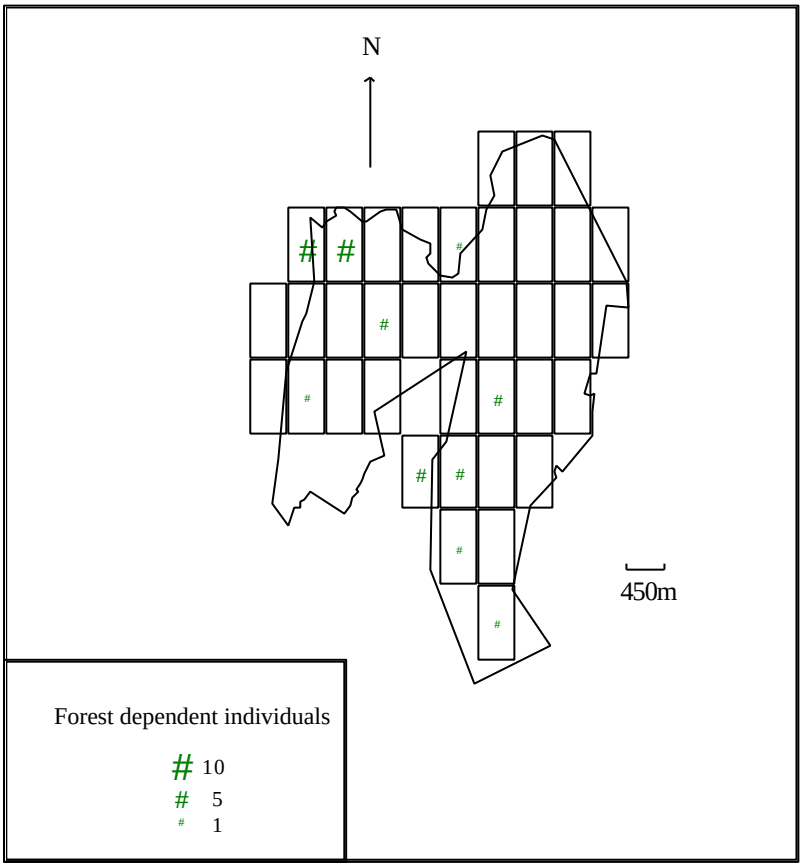


**Figure 9** Distribution of forest dependent tree and shrub individuals in Mgambo FR.

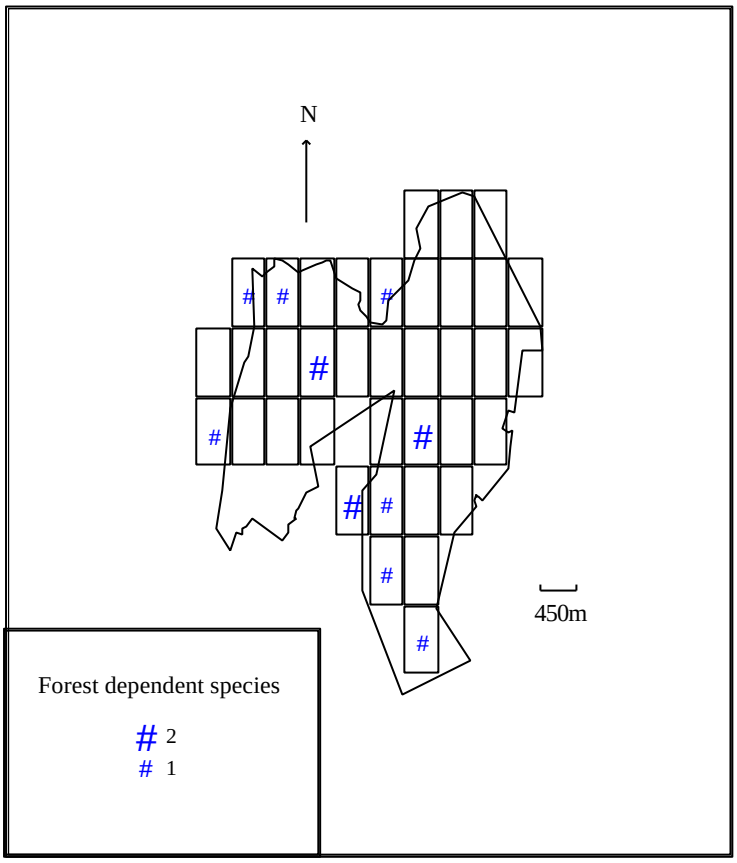


**Figure 10** Distribution of forest dependent tree and shrub species in Mgambo FR.

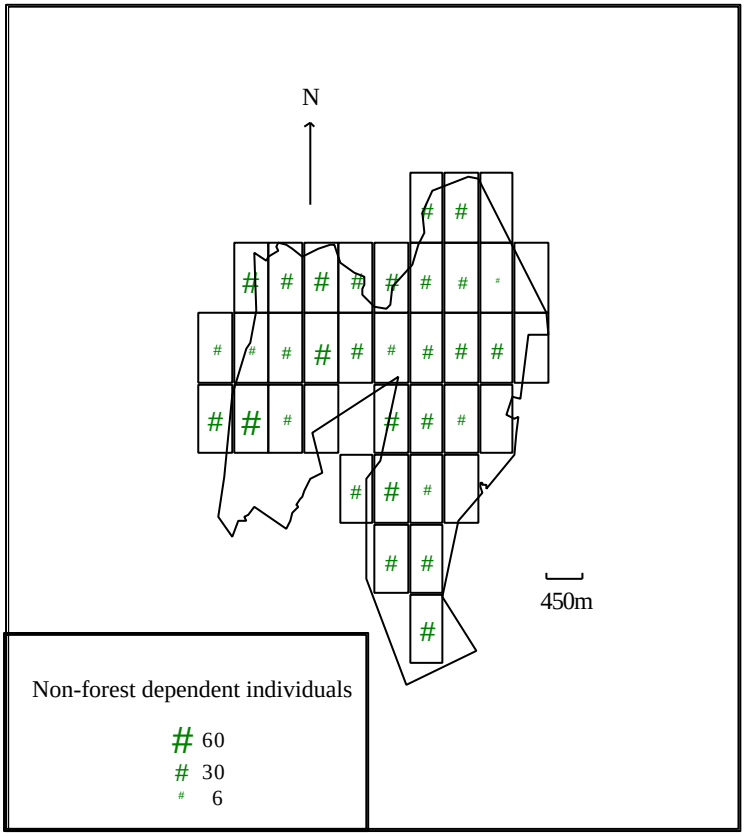


**Figure 11** Distribution of non-forest dependent tree and shrub individuals in Mgambo FR.

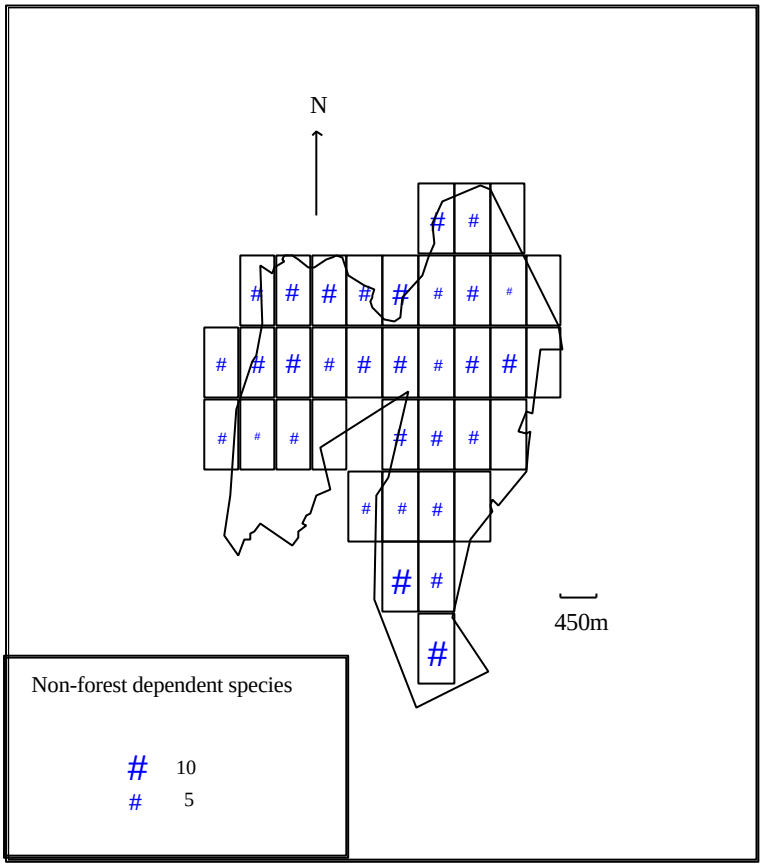


**Figure 12** Distribution of non-forest tree and shrub species in Mgambo FR.

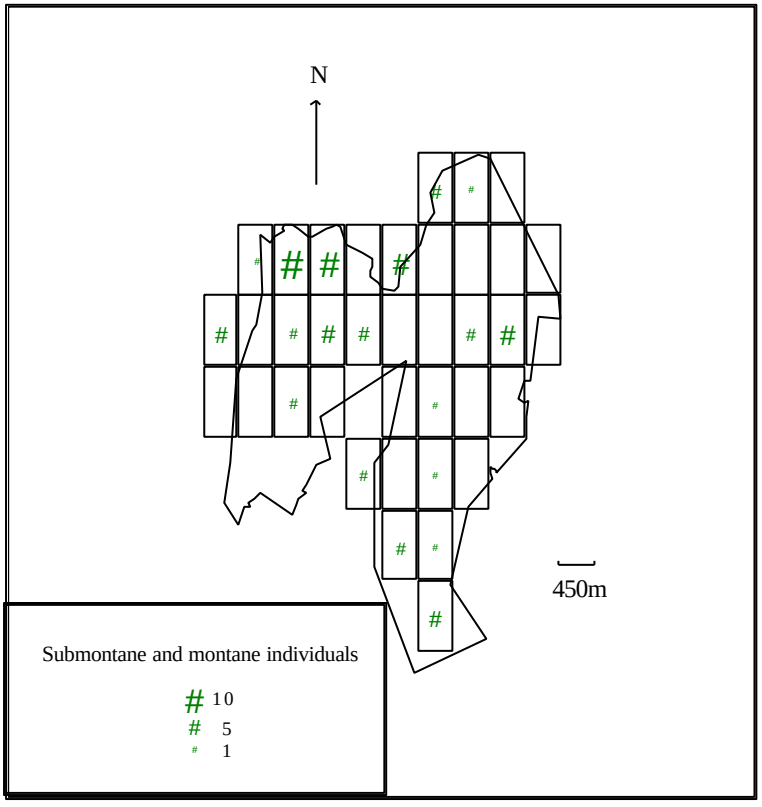


**Figure 13** Distribution of submontane and montane tree and shrub individuals in Mgambo FR.

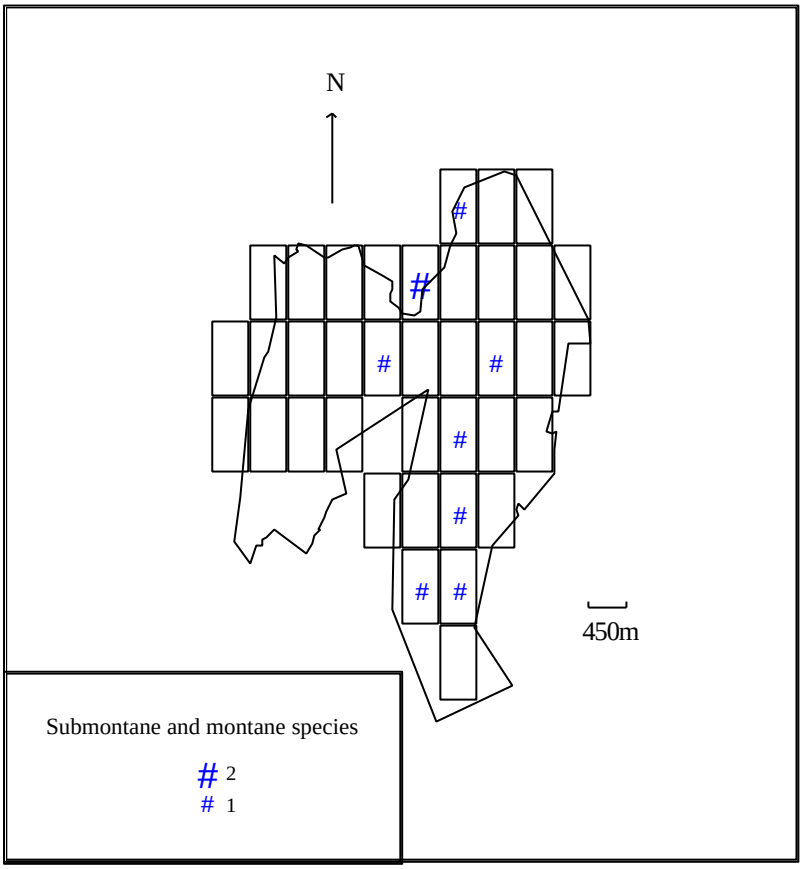


**Figure 14** Distribution of submontane and montane tree and shrub species in Mgambo FR.

### *4.3.1.7 Range extensions*

In 1986 and 1987, botanical surveys was conducted in a number of reserves in the East Usambara Mountains (Ruffo et al. 1989). 33 species recorded in vegetation plots in Mgambo FR were also recorded by Ruffo et al. (1989) within these surveys. The remaining 71 species were not recorded at all by Ruffo et al. (1989). Table 10 lists those species not previously recorded by Ruffo et al (1989).

Despite more than seven years systematic and opportunistic vegetation survey work by the EUBS team throughout the majority of the East Usambara Forest Reserves, 8 new species were found in the vegetation plots in Mgambo FR that were new to the East Usambara Biodiversity Database. These species are listed in Table 11 and Appendix 4.

**Table 10** Tree and shrub species found within Mgambo FR not listed by Ruffo *et al*., 1989.

| Species | Species |
|---|---|
| ANACARDIACEAE | LEGUMINOSAE subfamily: MIMOSOIDEAE cont. |
| *Lannea schweinfurthii*. | *Acacia nilotica* |
| *Lannea schweinfurthii* var. *stuhlmannii* | *Acacia polyacantha* |
| *Ozoroa insignis* | *Albizia anthelmintica* |
| *Sclerocarya birrea* | *Albizia versicolor* |
| ANNONACEAE | *Dichrostachys cinerea* |
| *Asteranthe asterias* | *Julbernadia globiflora* |
| *Annona senegalensis* | *Tamarindus indica* |
| ARALIACEAE | LEGUMINOSAE subfamily: PAPILIONOIDEAE |
| *Cussonia arborea* | *Dalbergia melanoxylon* |
| BALANITACEAE | *Erythrina abycaffra* |
| *Balanites aegyptica* | *Xeroderris stuhlmannii* |
| BIGNONIACEAE | LOGANIACEAE |
| *Stereospermum kunthianum* | *Strychnos innocua* |
| BORAGINACEAE | *Strychnos spinosa* |
| *Cordia ovalis* | MELIACEAE |
| *Ehretia amoena* | *Trichilia emetica* |
| BURSERACEAE | MORACEAE |
| *Commiphora africana* | *Artocarpus heterophyllus* |
| *Maerua kirkii* | *Ficus ottoniifolia* |
| CELASTRACEAE | OLACACEAE |
| *Mystroxylon aethiopicum* | *Ximemia americana* |
| COMBRETACEAE | RUBIACEAE |
| *Combretum exalatum* | *Canthium mombazense* |
| *Combretum molle* | *Rutidea fuscenscens* |
| *Combretum zeyheri* | *Vangueria tomentosa* |
| *Pteleopsis myrtifolia* | RUTACEAE |
| *Terminalia prunioides* | *Vepris amaniensis* |
| COMPOSITAE | *Vepris trichocarpa* |
| *Brachylaena huillensis* | SAPINDACEAE |
| EBENACEAE | *Allophylus calophyllus* |
| *Euclea natalensis* | *Allophylus ferrugineus* |
| EUPHORBIACEAE | *Deinbollia kilimandscharica* |
| *Bridelia cathartica* | *Haplocoelum inopleum* |
| *Euphorbia candelabrum* | *Haplocoelum foliolosum* |
| *Spirostachys africana* | SAPOTACEAE |
| FLACOURTIACEAE | *Manilkara sulcata* |
| *Dovyalis hispidula* | STERCULIACEAE |
| LEGUMINOSAE subfamily: CAESALPINOIDEAE | *Dombeya kirkii* |
| *Brachystegia spiciformis* | *Sterculia africana* |
| *Cassia abbreviata* | TILIACEAE |
| *Piliostigma thonningii* | *Grewia bicolor* |
| LEGUMINOSAE subfamily: MIMOSOIDEAE | *Grewia goetzeana* |
| *Acacia hockii* | *Grewia microcarpa* |
| *Acacia mellifera* | |

**Table 11** Tree and shrub species found in Mgambo FR but new to the East Usambara Plant Biodiversity Database (Pohjonen, 2001).

| **Species** | |
|---|---|
| ANACARDIACEAE | FLACOURTIACEAE |
| *Lannea schweinfurthii var. stuhlmannii* | *Dovyalis hispidula* |
| *Ozoroa insignis* | LEGUMINOSAE |
| *Sclerocarya birrea* | *Cassia abbreviata* |
| COMBRETACEAE | *Erythrina abyssinica* |
| *Combretum exelatum* | |
| EUPHORBIACEAE | |
| *Spirostachys africana* | |

#### *4.3.1.8 Timber species*

Small scale extraction of timber for local and commercial use over the years within most East Usambara forest reserves is suspected to have been significant. The most commonly extracted trees within Tanzania (Ruffo, 1989) are listed in Table 12 to present an indication of the remaining populations of these species within Mgambo FR.

A total of five tree species recorded within the vegetation plots were listed by Ruffo (1989) as useful for timber or plywood use. Four of these species (34 individuals) were recorded as 'timber only' (species that are regarded by the Forestry Division as timber trees, although may not necessarily have been used in the East Usambaras) and one species (2 individuals) were listed as 'plywood only' (information based on Sikh Saw Mills (T) Ltd of Tanga).

**Table 12** The abundance of selected timber and plywood species.

| **Family** | **Species** | **Ruffo, (1989) category** | **No. of Individuals** | **Present in n plots** |
|---|---|---|---|---|
| COMBRETACEAE | *Combretum schumannii*. | Timber only | 6 | 2 |
| COMBRETACEAE | *Terminalia sambesiaca* | Timber only | 3 | 2 |
| LEGUMINOSAE | *Albizia gummifera* | Timber only | 24 | 9 |
| MORACEAE | *Milicia excelsa* | Timber only | 1 | 1 |
| BOMBACEAE | *Rhodognaphalon schumannianum* | Plywood only | 2 | 2 |
| | | **Total** | **36** | **16** |

**Bold Type** – species that are listed by Ruffo (1989) as one of four prefered species utilised by pitsawyers.
Timber only – regarded as timber trees by the Forestry Division but have not necessarily been used in the East Usambaras.
Plywood only and Plywood & Timber – lists of species provided by Sikh Saw Mills (T) Ltd of Tanga.

Appendices 5 and 6 provide further lists of useful plant species found within Mgambo FR (including fuelwood, building poles and medicinal plants).

#### *4.3.1.10 Regeneration*

An additional five species were recorded solely in the regeneration layer within the 3 x 3m sample plots. None of these species was classified as forest dependent, although most were forest dwelling (Table 13).

Only two species, *Cola clavata* and *Ochna* sp. were previously recorded in the survey by Ruffo *et al*. (1989). All of the species are present in the East Usambara Plant Biodiversity Database (Pohjonen, 2001). *Cola clavata* is also listed as a useful species for providing building poles (Ruffo, 1989).

Herbaceous vegetation dominated the ground layer in plots, with grasses predominant. Soils were a mixture of loamy clay, sandy clay, sandy loam. Regeneration, in general was poor with an

average of 2.1 species regenerating within each 3 x 3m plot. A more detailed summary of regeneration plot information is shown in Appendix 7.

**Table 13** Species recorded exclusively in the regeneration layer.

| | Ecol. Type | Habitat | Endemic Status |
|---|---|---|---|
| APOCYNACEAE | | | |
| *Carissa tetramera* | f | ? | W |
| CAPPARIDACEAE | | | |
| *Boscia salicifolia* | O | ? | W |
| CELASTRACEAE | | | |
| *Maytenus hetelophylla*. | f | ? | W |
| OCHNACEAE | | | |
| *Ochna sp.* | ? | ? | ? |
| STERCULIACEAE | | | |
| *Cola clavata* | ? | ? | ? |

**KEY TO ABBREVIATIONS FOR TABLE 13**

Ecological type: (based on Iversen, 1991b)

- F - Forest dependent species: Species previously recorded as restricted to primary or closed canopy forest only, e.g. wet evergreen forest, dry evergreen forest and/or riverine forest;
- f - Forest dwelling but not forest dependent: Species previously recorded in primary or closed canopy forest as defined above and/or in forest edge, clearings, secondary forest, deciduous forest and woodland, and
- O - Non-forest species: These are species that do not occur in primary or secondary forest or forest edge (e.g. species that have been recorded in bushland, heathland, thicket, secondary scrub, grassland, rocky outcrops, swamps, wastelands and cultivation.

Habitat: (based on Hamilton, 1989)

- L - Lowland: Species occurring at altitudes less than 850m above sea level;
- S - Submontane: Species occurring at altitudes greater than 850m above sea level.
- M – Montane Species occurring at altitudes greater than 1,250m above sea level.

If species occur in more than one habitat range, this has been recorded (e.g. L&S – this species has been recorded at altitudess between 0 and 850m above sea level).

Endemic status: (based on Iversen, 1991b):

- E - Endemic: Occurring only in the Usambara mountains, EU - Range limited to the East Usambara Mountains, WU - Range limited to the West Usambara Mountains;
- N - Near endemic: Species with limited ranges in the Eastern Arc mountains and/or the East African lowland forests;
- W - Widespread distribution.

#### *4.3.1.12 Opportunistic plant collection and observation*

A total of 34 species of dicotyledons were opportunistically recorded within Mgambo FR. These represented 22 families. An additional one near endemic and one forest dependent species were recorded during opportunistic collection.

Eight species from the opportunistic checklist (Table 14) are new species records for the East Usambara Biodiveristy Database. These species are summarised in Appendix 4.

**Table 14** Checklist of opportunistic plant collection and observation

| Species | Lifeform | Ecol. Type | Habitat | Endemic Status |
|---|---|---|---|---|
| **Angiospermae – Dicotyledonae** | | | | |
| ACANTHACEAE | | | | |
| *Acanthaspermum hispidum* DC | Herb | ? | ? | ? |
| ASCELEPIDACEAE | | | | |
| *Secamore* sp. | Climber | ? | ? | ? |
| BORAGINACEAE | | | | |
| *Cordia goetzei* Guerke (basionym *Gerascanthus goetzei* (Guerke) A. Borhidi) | Shrub | f | L&S&M[1] | W[1] |
| CAPPARIDACEAE | | | | |
| *Maerua triphylla* A. Rich | Shrub | f | L&S | W |
| CELASTRACEAE | | | | |
| *Mystroxylon aethiopicum* (Thunb.) Loes | Shrub | f | L&S&M[1] | W[1] |
| COMBRETACEAE | | | | |
| *Combretum zeyheri* Sond | Tree | O | L&S&M[1] | W[1] |
| EBENACEAE | | | | |
| *Diospyros squarrosa* Klotzsch | Shrub | f | L&S&M | W |
| EUPHORBIACEAE | | | | |
| *Acalypha psilostachya* Hochst | Herb | ? | S&M[1] | W[1] |
| *Bridelia cathartica* Bertol. f 1854 | Shrub | O | L&S&M[1] | W |
| FLACOURTIACEAE | | | | |
| *Dovyalis hispidula* Wild. | Shrub | f | L | W |
| ICACINACEAE | | | | |
| *Pyranacantha* sp. | Climber | ? | ? | ? |
| LABIATAE | | | | |
| *Becium kirkii* Bak | Shrub | ? | ? | ? |
| *Orthosiphon rubicondus* (D.Don) Benth | Herb | ? | M[1] | W[1] |
| *Tinnea aethiopica* Kotschy ex. Hook.f. | Shrub | ? | ? | ? |
| LEGUMINOSAE: MIMOSACEAE | | | | |
| *Acacia polyacantha* Willd. | Tree | f | L&S | W |
| LOGANIACEAE | | | | |
| *Strychnos henningsii* Gilg | Tree | f | L&S&M[1] | W[1] |
| MELIACEAE | | | | |
| *Turraea holstii* Guerke 1894 | Tree | F | S&M[1] | W |
| MORACEAE | | | | |
| *Dorstenia tayloriana* Rendle 1915 | Herb | ? | L[1] | W[1] |
| *Ficus cyathistipula* Warb | Tree | | L&S&M[1] | W[1] |
| *Ficus ottoniifolia* (Mildbr. & Burret) C.C.Berg | Tree | f | L | N |
| OLACACEAE | | | | |
| *Ximenia caffra* Sond. | Tree | f | L&S&M | W |
| RHAMNACEAE | | | | |
| *Ziziphus mucronata* Willd. 1809 | Shrub | f | L&S&M[2] | W |
| ROSACEAE | | | | |
| *Abrus schimperi* Bak | Climber | ? | ? | ? |
| RUBIACEAE | | | | |
| *Canthium mombazense* Baill 1878 | Shrub | f | L&S | W |
| *Heinsia crinita* (Afzel) G. Taylor 1944 | Shrub | | L | W |
| *Pavetta crebrifolia* Hiern | Shrub | | L&S&M[1] | W[1] |
| *Polysphaeria lanceolata* Hiern | Shrub | | L&S[1] | W |
| *Psychotria ambonia* K. Schum 1894 | Shrub | ? | ? | ? |
| *Psychotria lauracea* (K. Schum) E. Petit 1964 | Shrub | | L | ? |
| *Rutidea fuscenscens* Hiern | Shrub | f | L | W |
| TILIACEAE | | | | |
| *Triumfetta rhomboidea* Jacq. | Shrub | f | L&S&M[1] | W |
| VERBENACEAE | | | | |
| *Lantana trifolia* L. | Shrub | f[1] | L&S&M[1] | W[1] |
| VITACEAE | | | | |
| *Cissus quadrangularis* L. | Climber | f | L&S | W |
| *Rhoicissus revoilii* Planch 1887 | Climber | O | L&S&M[1] | W[1] |

[1] Information is based on FTEA
[2] Information is based on LEAP (Knox, 2000)

**KEY TO ABBREVIATIONS FOR TABLE 14**

Ecological type: (based on Iversen, 1991b)

- F - Forest dependent species: Species previously recorded as restricted to primary or closed canopy forest only, e.g. wet evergreen forest, dry evergreen forest and/or riverine forest;
- f - Forest dwelling but not forest dependent: Species previously recorded in primary or closed canopy forest as defined above and/or in forest edge, clearings, secondary forest, deciduous forest and woodland, and
- O - Non-forest species: These are species that do not occur in primary or secondary forest or forest edge (e.g. species that have been recorded in bushland, heathland, thicket, secondary scrub, grassland, rocky outcrops, swamps, wastelands and cultivation.

Habitat: (based on Hamilton, 1989)

- L - Lowland: Species occurring at altitudes less than 850m above sea level;
- S - Submontane: Species occurring at altitudes greater than 850m above sea level.
- M – Montane Species occurring at altitudes greater than 1,250m above sea level.

If species occur in more than one habitat range, this has been recorded (e.g. L&S – this species has been recorded at altitudess between 0 and 850m above sea level).

Endemic status: (based on Iversen, 1991b):

- E - Endemic: Occurring only in the Usambara mountains, EU - Range limited to the East Usambara Mountains, WU - Range limited to the West Usambara Mountains;
- N - Near endemic: Species with limited ranges in the Eastern Arc mountains and/or the East African lowland forests;
- W - Widespread distribution.

### 4.3.2 Disturbance transects

A total area of 13.635 ha was assessed for signs of disturbance. Disturbance categories were recorded for all 50m sections along each transect line. Every self standing tree (not creepers or lianas) above 5cm diameter at breast height (dbh) was measured within a distance of 5m either side of each transect line. Each plant was recorded under one of four categories: live, old cut, new cut or naturally fallen. Old cut was identified by darkening and rotting of a cut stump, and was assumed to have been cut more than 6 months prior to sampling. New cut was identified by fresh cream or green cut stumps and assumed to have been cut less than six months prior to sampling. Within these categories a distinction was made between poles and timbers. Poles were classified as having a dbh between 5 and 15cm and a minimum 3m relatively straight trunk. Timber was classified as having a dbh greater than 15cm with a minimum of 3m relatively straight trunk. These divisions are based on differences in use. Timber and pole cutting data are presented as an average per hectare.

All other forms of anthropogenic disturbance within a distance of 5m either side of each transect were also recorded for every 50m section.
Other forms of disturbance were defined as follows:
**Fire damage** - an area affected by fire, evidence included burnt trees and ground vegetation.
**Pitsaw site** - an area cleared for pitsaw activities, with pitsaw platform, or remains of such.
**Timber/planks/poles** - cut wood on ground abandonned or ready for transportation.
**Trapping** - animal traps of all varieties whether set or sprung or unused.
**Cultivation** - evidence of crop cultivation (past or present).
**Grazing** - direct evidence or remains of cattle grazing.
**Roads/tracks** - including all human used footpaths.
**Old Settlement** - well-established clearings as a consequence of past human settlement.

The topography of Mgambo FR was generally not difficult and, consequently, only one 50m section was found to be inaccessible. A total of 10949 live stems were sampled throughout the reserve, giving a mean total of 613.7 poles per hectare and 189.3 timbers per hectare, 76% and 24% respectively.

#### *4.3.2.1 Pole and Timber extraction*

Pole and timber extraction was found along all seven transects, however, new extraction was only observed at a low intensity within the reserve.

Rates of pole extraction are summarised in Table 15 and Figures 11 and 13. An average total of 3359 poles per hectare were alive, 695 dead and 198 cut, representing 79%, 17% and 4% of all poles sampled respectively (Table 15). None of the transects had a significantly higher rate of extraction than the others. (Figure 11). A significant proportion of the poles sampled were dead, particularly along transects 0 and 1 (Figure 13). Live poles were least abundant along transect 6 with 291 poles per hectare compared with all of the other transects with figures over 450 poles per hectare. (Table 15 and Figure 11).

Pole cutting was most intensive along reserve border areas (Figure 15). A high level of extraction was observed within proximity to Daluni and Bwiti villages to the south of both halves of the reserve (see Figure 3 for positioning of villages).

**Table 15** Disturbance transect results showing total pole counts and average pole counts per hectare.

| Transect number | Transect length (m) | Total no. poles sampled | Live Poles | Average Live Poles/ha | Dead Poles | Average Dead Poles/ha | Old Cut Poles | Old Cut Poles /ha | New Cut Poles | New Cut Poles /ha |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 450 | 267 | 228 | 507 | 27 | 60 | 11 | 24 | 1 | 2 |
| 1 | 850 | 596 | 467 | 549 | 80 | 94 | 40 | 47 | 9 | 11 |
| 2 | 1200 | 807 | 656 | 547 | 120 | 100 | 26 | 22 | 5 | 4 |
| 3 | 2535 | 1639 | 1146 | 452 | 402 | 159 | 90 | 36 | 1 | 0 |
| 4 | 3550 | 1987 | 1655 | 466 | 265 | 75 | 63 | 18 | 4 | 1 |
| 5 | 3800 | 2572 | 2077 | 547 | 428 | 113 | 63 | 17 | 4 | 1 |
| 6 | 1250 | 500 | 364 | 291 | 117 | 94 | 19 | 15 | 0 | 0 |
| **Total** | **13635** | **8368** | **6593** | **3359** | **1439** | **695** | **312** | **179** | **24** | **19** |

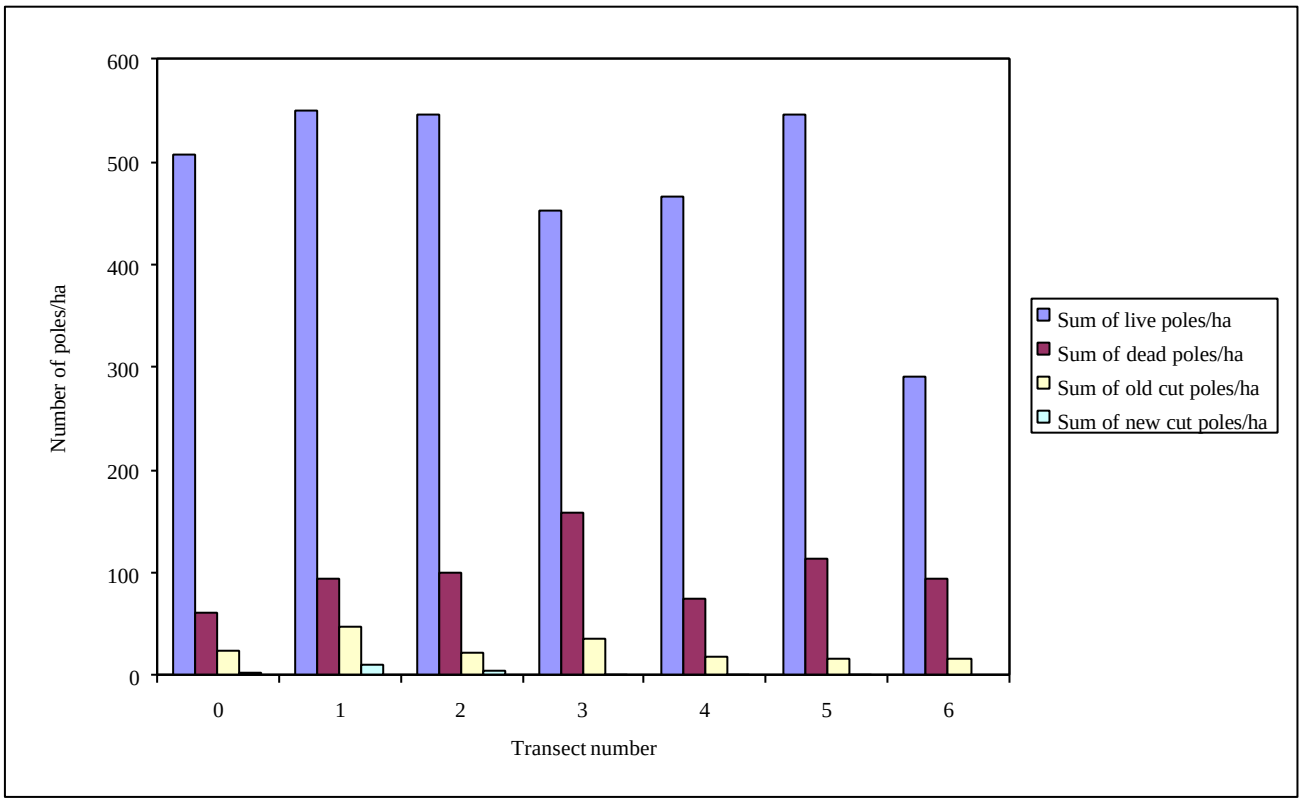


**Figure 11** The relative abundance of live, dead and cut poles in Mgambo FR.

Rates of timber extraction are summarised in Table 16 and Figures 12 and 14. A total of 1011 timbers per hectare were alive, 229 dead and 21 cut, representing 80%, 18% and 2% of all timbers sampled respectively (Table 16). Transect 3 showed greatest evidence of timber cutting with 9 cut timbers per hectare representing 5% of all timber sampled along this transect line. (Table 16 and Figure 12). The incidence of live and dead timbers was fairly evenly distributed through the reserve with no particular transects showing significantly higher concentrations of timbers than others. (Table 16 and Figure 14). As with pole-extraction, the highest levels of timber extraction was found to be within proximity of Daluni and Bwiti villages (see Figure 16, and refer to Figure 3 for positioning of villages).

**Table 16** Disturbance transect results showing total timber counts and average timber counts per hectare.

| Transect number | Transect length (m) | Total no. timber sampled | Live Timbers | Live Timbers/ ha | Dead Timbers | Dead Timbers/ ha | Old Cut Timbers | Old Cut Timbers /ha | New Cut Timbers | New Cut Poles /ha |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 450 | 89 | 69 | 153 | 20 | 44 | 0 | 0 | 0 | 0 |
| 1 | 850 | 143 | 117 | 138 | 22 | 26 | 3 | 4 | 1 | 1 |
| 2 | 1200 | 165 | 137 | 114 | 27 | 23 | 1 | 1 | 0 | 0 |
| 3 | 2535 | 527 | 419 | 165 | 84 | 33 | 24 | 9 | 0 | 0 |
| 4 | 3550 | 571 | 480 | 135 | 85 | 24 | 5 | 1 | 1 | 0 |
| 5 | 3800 | 894 | 692 | 182 | 194 | 51 | 8 | 2 | 0 | 0 |
| 6 | 1250 | 192 | 154 | 123 | 35 | 28 | 3 | 2 | 0 | 0 |
| **Total** | **136350** | **2581** | **2068** | **1011** | **467** | **229** | **44** | **20** | **2** | **1** |

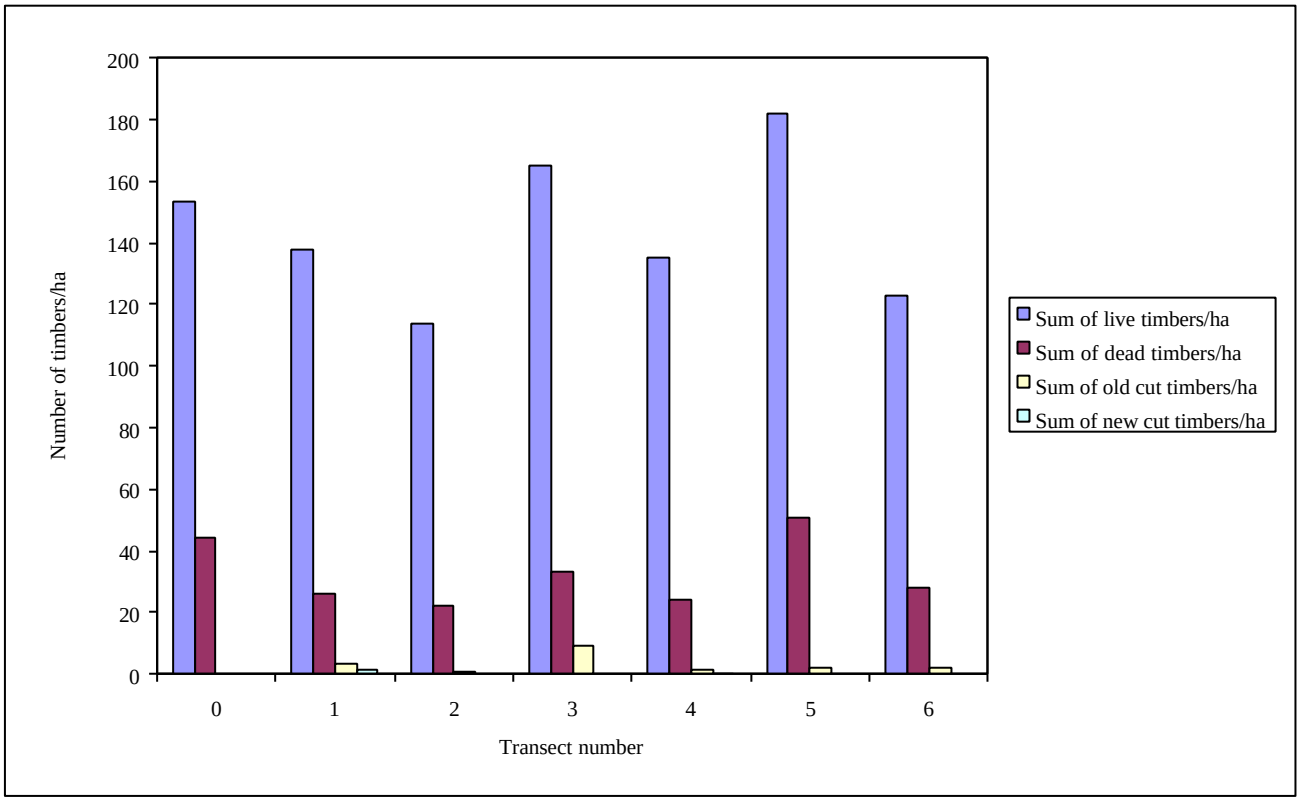


**Figure 12** The relative abundance of live, dead and cut timbers in Mgambo FR.

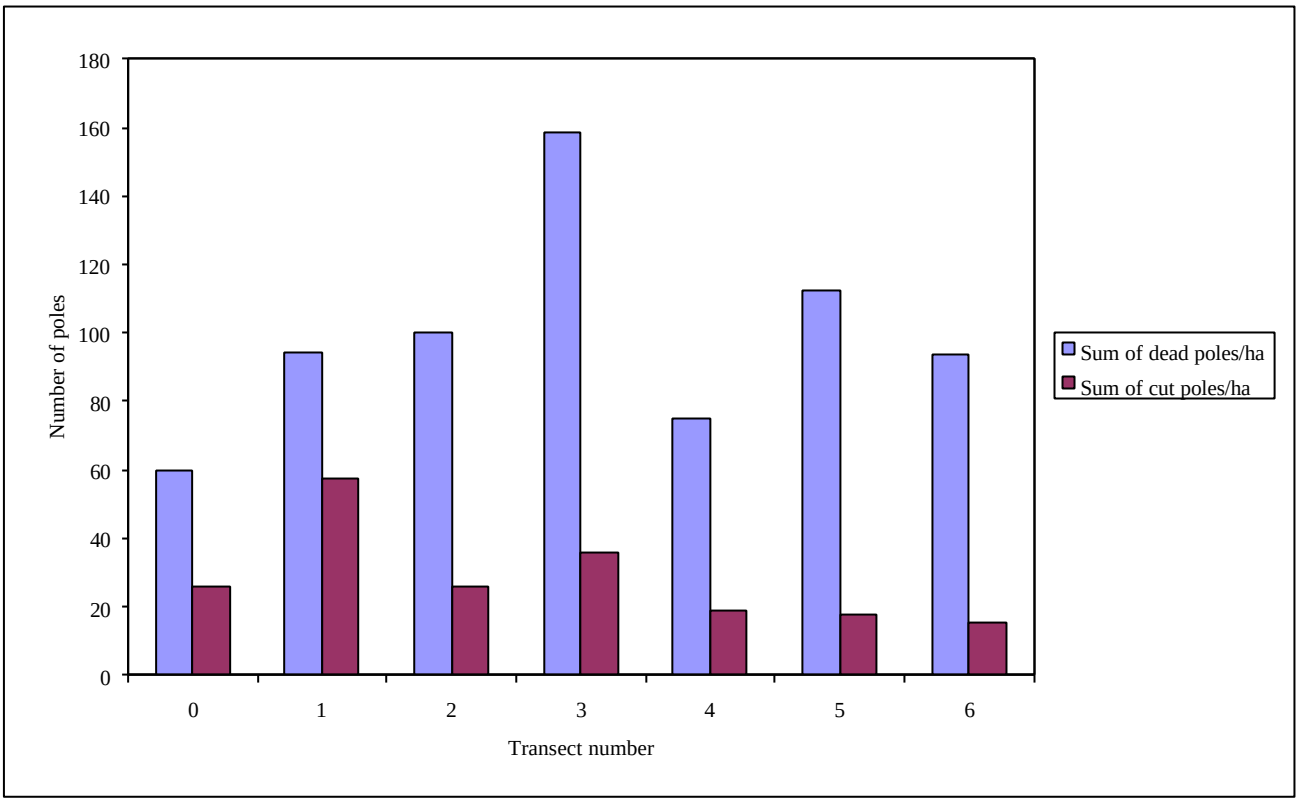


**Figure 13** Comparison of cut poles to dead poles per hectare in Mgambo FR.

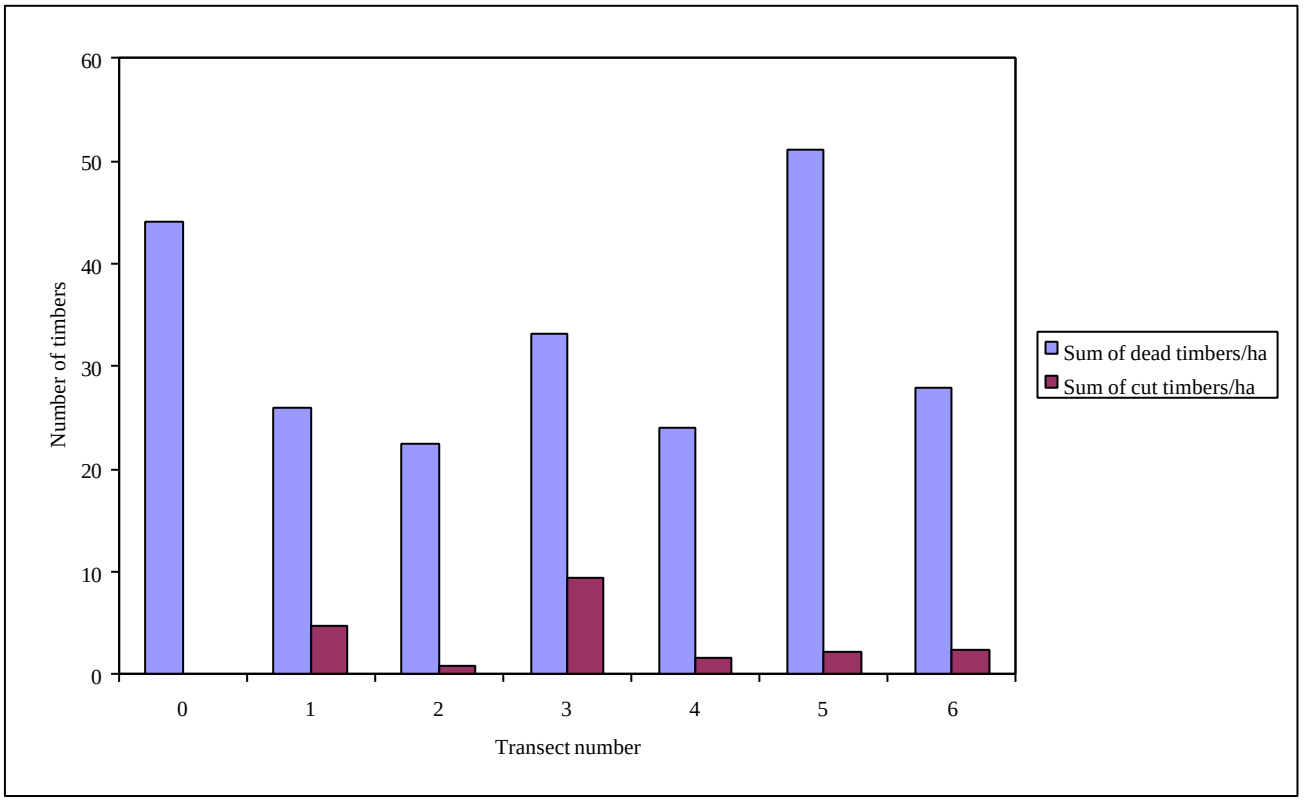


**Figure 14** Comparison of cut timbers to dead timbers per hectare in Mgambo FR.

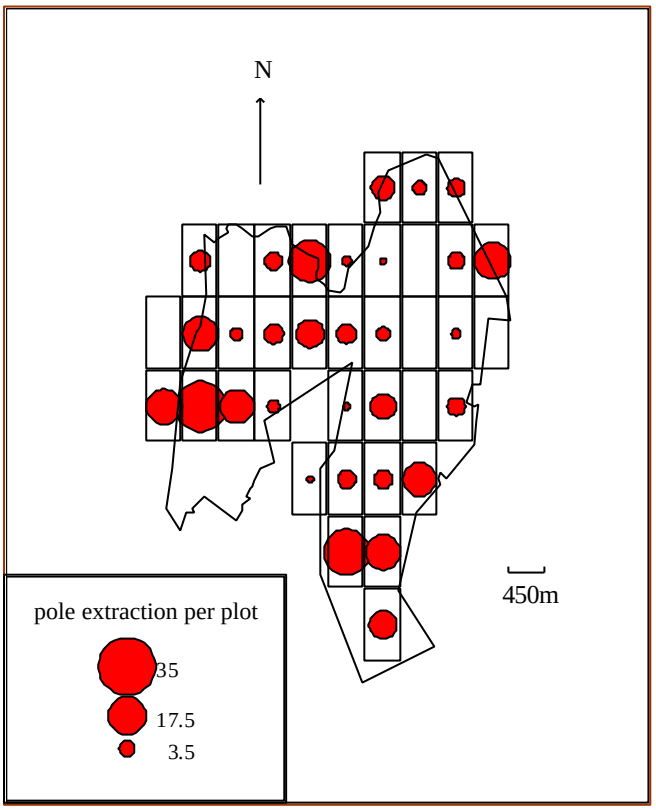


**Figure 15** Actual pole extraction values per transect length along plot in Mgambo FR.

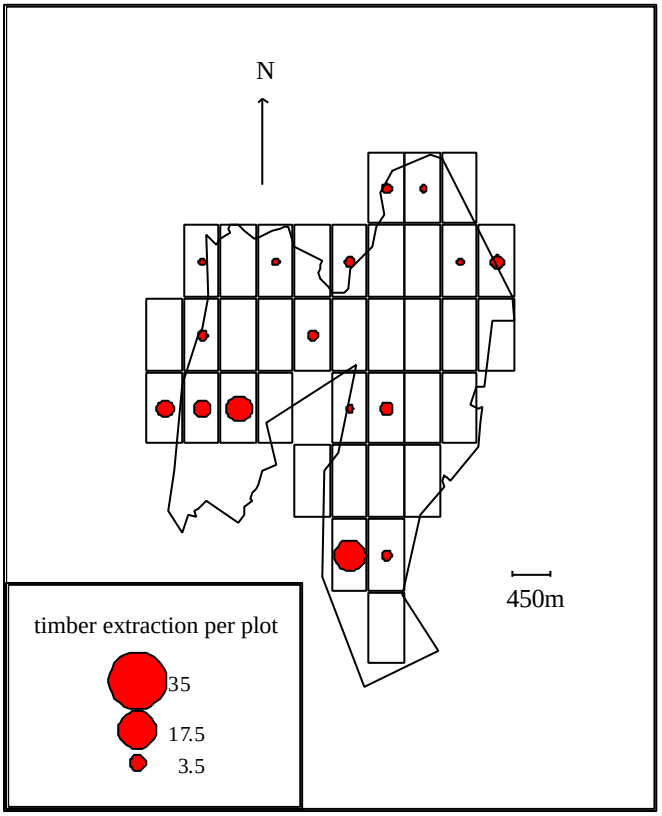


**Figure 16** Actual timber extraction values per transect length along plot in Mgambo FR.

#### *4.3.2.2 Other signs of disturbance*

**Fire**

The most common form of disturbance was fire disturbance, present within 62% of all 50 metre sections sampled (Table 17). Deliberate fires, started to create grazing land, represent the most significant threat to Mgambo FR. Fire incidence was most intense in the eastern side of the reserve, although was common throughout (Figure 17). A large burnt area was in grid sections 6, 10 and 11, which had been burnt around October 2001.

**Grazing**

Grazing pressure on Mgambo FR was very evident throughout the survey period. A total of 23% of all 50 metre sections sampled contained signs of grazing, and animals and herdsmen were sighted on a number of occasions. (Figure 18).

**Footpaths**

There were some well-used livestock and human paths within the reserve, and so this form of disturbance ranked third within Mgambo FR.

**Pitsawing**

There was evidence of three fairly recent pitsawing sites and one old site. Two of the recent sites were close together near to the western border of transect 3, not far from Daluni village. The other recent site was at the zoological trapsite 3, close to the path heading north towards Mgambo village. Two piles of old cut poles were seen along transect 5 and one pile along transect 4 close to human paths. (Table 17)

**Trapping**

Only two animal traps were seen (Table 17). These were set up with a brush-fence corridor probably to catch small duiker. One trap was sprung and contained a live Banded Mongoose (*Mungos mungo*) which was later released. Both traps were found close to Mgambo village along transect 6.

**Table 17** The incidence of various types of disturbance shown as percentage and rank (calculated as presence (1) or absence (0) every 50m transect section)

| | **Fire** | **Grazing** | **Paths** | **Pitsawing** | **Trapping** | **Planks/Poles** |
|---|---|---|---|---|---|---|
| Incidence Tally | 170 | 64 | 17 | 2 | 2 | 2 |
| Percentage (%) | 62 | 23 | 6 | <0.1 | <0.1 | <0.1 |
| **Rank** | **1** | **2** | **3** | **4** | **4** | **4** |

**DEFINITIONS FOR TABLE 17**
Fire refers to an area affected by fire, evidence including burnt trees and ground flora.
Grazing refers to cattle or goat grazing.
Paths refer to all human used footpaths.
Pitsaw refers to any site with the remains of pitsaw activity past or present.
Trapping refers to any form of animal trapping.
Planks/Poles refers to cut timber and poles laying on the ground ready for transportation.

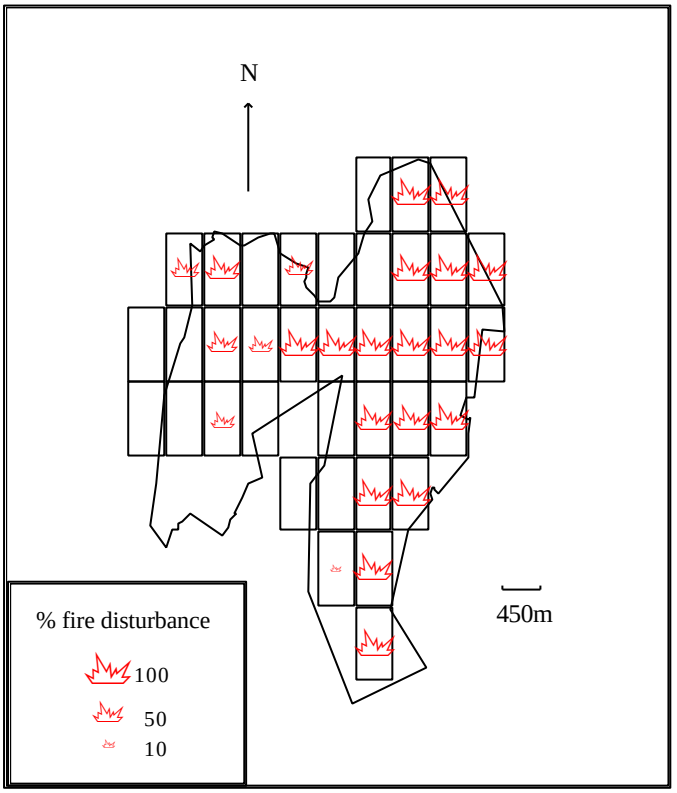


**Figure 17** Incidence of fire as percentage of sections evidence was found in, for Mgambo FR.

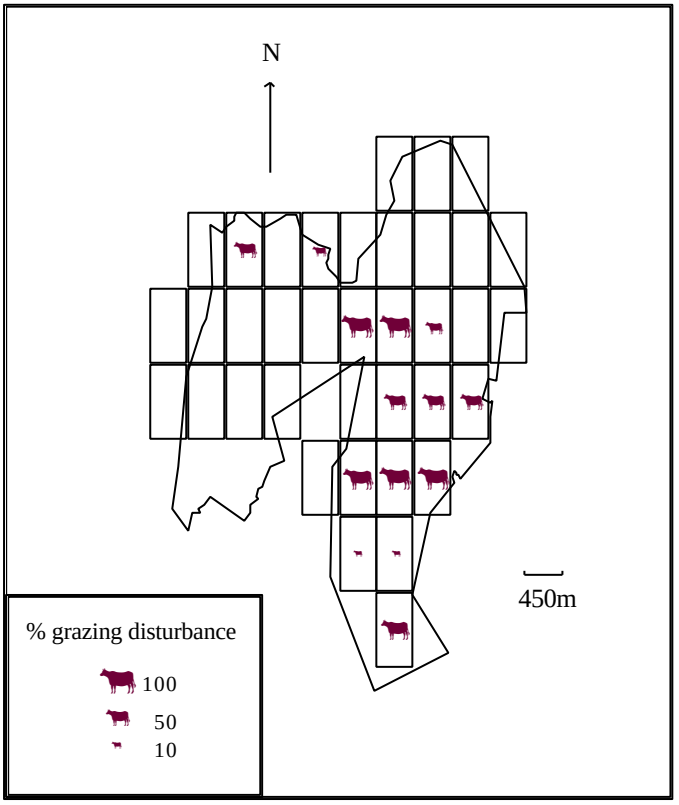


**Figure 18** Incidence of grazing as percentage of sections evidence was found in, for Mgambo FR.

#### *4.3.2.3 Areas of greatest disturbance*

The most disturbed areas within Mgambo were located on the eastern half of the reserve. These areas were grids that contained evidence of fire and grazing within each 50m transect section. Some endemic, near endemic and forest dependent vegetation was in these most disturbed grid areas; most notably, grid 26 to the far south of the reserve where *Cassia abbreviata* (endemic), *Dombeya shupangae* (near endemic) and *zanthoxylum deremense* (near endemic and forest dependant). (Figures 19 and 20).

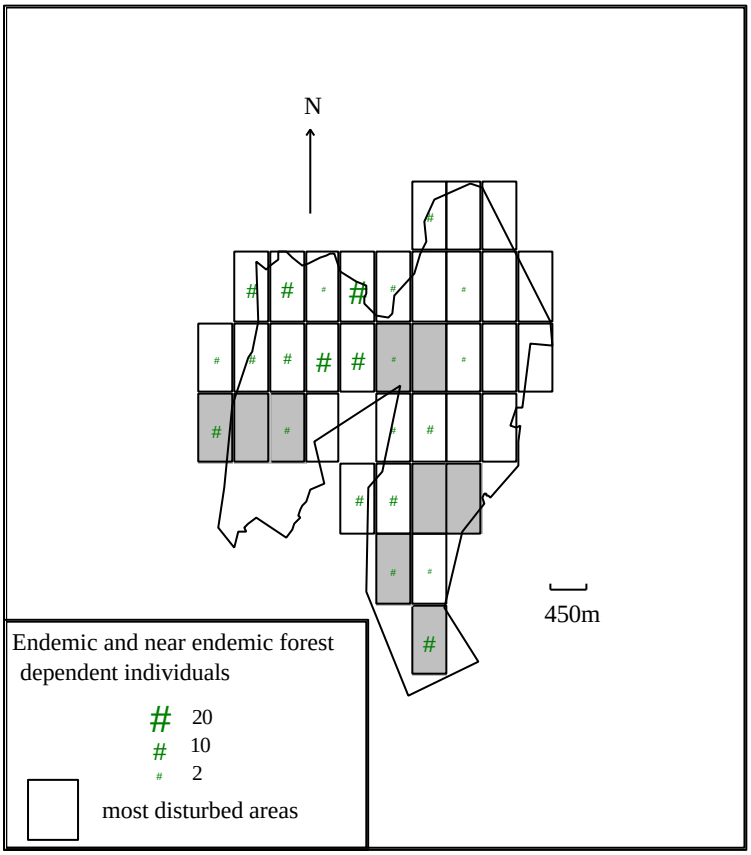


**Figure 19** Distribution of forest dependent, endemic and near endemic tree and shrub individuals in relation to areas of highest disturbance in Mgambo FR.

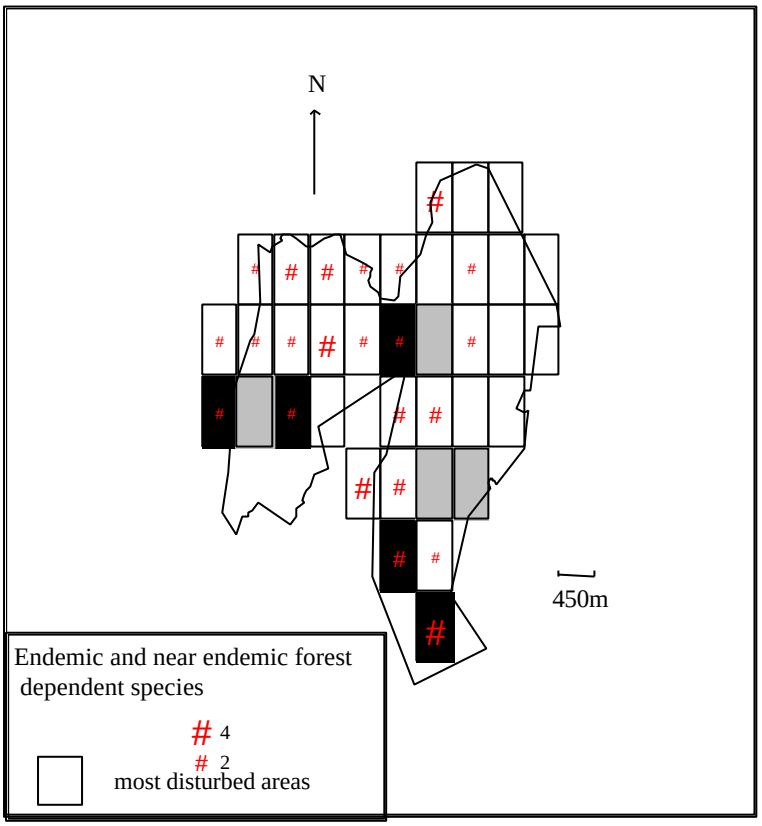


**Figure 20** Distribution of forest dependent, endemic and near endemic plant species in relation to areas of highest disturbance in Mgambo FR.

## 4.4 Discussion

Mgambo FR covers an area of 13.46 $km^2$ (1346 ha) with an altitude range of 300m to 800m above sea level. Topography is, at times, fairly steep but not extreme and the landscape generally a mix of open woodland, scrub and grassland. Mgambo FR only containted small patches of lowland forest and riverine forest habitat.

Habitat

Of the 31 vegetation plots surveyed systematically, 20 were open woodland (65% of plots), 5 were lowland forest (16% of plots) and 6 were scrub/grassland/previously disturbed (19% of plots). Mgambo FR had previously been recorded as 96% poorly stocked lowland forest by Johannson and Sandy (1996). The large proportion of open woodland actually recorded suggests increased disturbance in recent years. None of the vegetation plots was recorded with an average canopy height of over 20m. Approximately two-thirds of vegetation plots had been affected by fire.

**Species richness**

In the systematic vegetation plots 858 trees and shrubs were surveyed, representing 101 species from 31 families. An additional five species were recorded in the regeneration plots. Opportunistic observations and collections recorded an additional 22 plant species from 14 families. In total 128 plant species from 39 families were recorded.

Relative to other forest reserves surveyed in the East Usambara Mountains the botanical diversity of Mgambo FR was low, largely as a result of the high level of fire and grazing disturbance.

The most abundant species in vegetation plots, representing 9.0% of individuals was the woodland species *Combretum zeyheri*. Other commonly encountered species in vegetation plots were *Dombeya shupangae*, *Brachystegia spiciformis*, *Acacia nilotica*, *Grewia bicolor*, *Cordia ovalis* and *Maytenus undata*. All of these species were seen to be resilient to disturbance and at competetive advantage in disturbed areas.

**Endemic Status**

The majority of species recorded in vegetation plots (87%) had widespread distributions. Only the species *Cassia abbreviata* was recorded as endemic to the Usambara Mountains and 12 species were recorded as near endemic. The most commonly recorded near-endemic tree species in the reserve was *Dombeya shupangae* (55 individuals), then was *Scorodophloeus fischeri* (15 individuals) and *Canthium mombazense* (10 individuals). Endemic and near endemic species were fairly evenly distributed in the reserve, but tended to be more frequently found in the western half of the reserve.

Only two near endemic species recorded in vegetation plots were forest dependent, namely *Deinbollia kilimandscharica* and *Zanthoxylum deremense*. Three near endemic species, *Dombeya shupangae*, *Scorodophloeus ficheri* and *Monodora grandidieri* are non-forest species.

**Ecological Type**

Only five species (5.0%) recorded in vegetation plots were classified as forest dependent defined as 'limited to primary or closed canopy forest only'. These species were *Deinbollia kilimandscharica, Commiphora eminii, Zanthoxylum deremense, Turraea holstii* and *Rothmannia manganjae*. The most commonly recorded forest dependent tree species was *Turraea holstii* represented by 22 individuals in 7 plots in a selection of scrub, woodland and lowland forest habitats.

Sixty two species (61.4%) were recorded in vegetation plots as forest dwelling and 27 species (26.7%) non-forest dwelling. *Brachystegia spiciformis* was the most abundant forest dwelling species represented by 77 individuals in just 3 open woodland plots. *Combretum zeyheri*, represented by 33 individuals in 3 plots, was the most abundant non-forest species present in disturbed open woodland habitats.

**Habitat**

Flora recorded from the vegetation plots of Mgambo FR was most commonly categorised within the lowland forest habitat type. A total of 39 (38.6%) species and 363 (42.3%) individuals were categorised as lowland forest species. There were only 4 species, *Acacia mellifera, Acacia nilotica, Grewia bicolor* and *Sterculia africana*, that were categorised as sub-montane species and 1 species, *Strychnos innocua*, categorised as a montane species (although it was found in woodland in lowland areas). Many other species (48 in total) were categorised as combinations of lowland with submontane and/or without montane forest habitats.

Of the tree species surveyed with known altitudinal preferences, 38.6% were considered to be solely typical of lowland forest, 4.0% of submontane forest and 1.0% of montane forest. The remainder (47.5%) were considered to be typical of a combination of habitats.

**Range Extensions**

The vegetation plot data generated a total of 71 new species records for Mgambo FR, when compared to the study by Ruffo *et al.* (1989). Eight of these species were also new to the East Usambara Plant Biodiversity Database, Pohjonen (2001).

**Regeneration**

An additional 5 species were also recorded from the regeneration plots. Three of these species were not present in the study by Ruffo *et al* (1989). None of these species were endemic, near endemic or forest dependent.

**Disturbance**

Evidence of disturbance was found throughout Mgambo FR, notably around the forest areas close to Bwiti and Daluni villages.

The most significant disturbance category recorded in Mgambo FR was fire disturbance. Evidence of fire was noted in 62% of all disturbance transect sections and 21 vegetation plots (68% of the total). Fire disturbance was particularly intense in eastern areas although was fairly common throughout the forest reserve. Most of the reserve had poor canopy cover (with no canopy recorded over 20m) and fire disturbed areas were generally open wooded grassland habitats. Very few forest dependent, or endemic species were recorded in Mgambo, and it is likely that fire has played a significant role in the impoverishment of Mgambo's forest habitats and has resulted in limited regeneration prospects.

A second major disturbance category affecting Mgambo FR is grazing pressure. This was noted in 23% of all disturbance transect sections and 6 vegetation plots (19.4% of the total). It is likely that

these two disturbances are linked as herdsmen light fires to obtain new grasses for their animals to graze on. During the course of the survey, stock, and evidence of stock, was frequently observed in the reserve. This high level of disturbance must result in substantial detrimental effects on floral diversity.

Pole cutting was more concentrated around forest borders with an average of cut poles at 4% of the total per hectare. Timber extraction was fairly low and also tended to occur near forest borders around Daluni and Bwiti villages. The intensity of pole and timber extraction was, along all transects, much less than the number of dead poles and timber.

A total of 17% of poles and 18% of all timber sampled were dead. This was a high figure, compared with other East Usambara forest reserves and is likely to be directly influenced by the high levels of fire disturbance in the reserve.

There was virtually no signs of old cultivation except for one old shamba area which had only recently been designated as inside the reserve.

There was some recent and some old pitsawing evidence. As pitsawing is largely confined to the riverine and lowland forest habitats where the few larger trees remain, this may be of some concern to Mgambo's small relatively undisturbed areas.

Only one area in Mgambo FR was seen to have animal traps, this was a disturbed scrub habitat close to Mgambo village. The traps were likely set to target duiker species. The lack of large mammal sightings and signs, and local knowledge suggests that hunting activity was substantial in recent times.

# 5.0 FAUNA

**Authors: Bracebridge, C.E., Oliver, S.A. and Hall, S. pp. 43-72**

## 5.1 Introduction

The fauna of Mgambo Forest Reserve (FR) was studied to assess diversity within specific taxonomic groups. Inventories were compiled of mammal, reptile, amphibian, butterfly, mollusc and millipede species. Practicalities of capture methods, identification techniques and potential information that could be extracted from the data, influenced the taxonomic groups chosen for the study. The results of the inventories were analysed to assess the relative biodiversity value of the reserve's fauna.

## 5.2 Methods

Within Mgambo FR, target groups of fauna were surveyed using a combination of standardised, repeatable methods at 'zoological trapsites'. Transect surveys of dung and other animal signs, and the opportunistic collection and observation of all animals were also implemented. Brief descriptions of the methods employed and trapsite locations follow. A more detailed methodology of survey techniques can be found in the FT FRP *Methodology Report* (SEE, 1998).

### 5.2.1 Bucket pitfall traps

Small mammals, amphibians and reptiles were sampled using bucket pitfall traps. Three 50m linear transects were created at a zoological trapsite location whereby eleven 10 litre plastic buckets were sunk into the ground with their rims flush to ground level. Buckets contained small holes to allow rainwater to drain from them and each bucket was positioned 5m apart. A sheet of vertical plastic (approximately 0.5m high, and no less than 0.2m) was run along the bucket line crossing the centre of each bucket to form a 'drift fence'. A 10-15cm lip of plastic sheeting was left flat on the ground onto which soil and leaf litter was placed to prevent any gap in the drift fence at ground level. Animals moving into the area from either side would be channelled along the plastic towards the bucket traps.

Each line was placed no more than 50m apart, but was located to encompass a range of micro-habitats. Brief habitat notes were taken for each bucket position. Traps were checked early each morning for the duration of the trapsite period and data recorded on standardised data sheets regarding the identification of each animal captured.

### 5.2.2 Sherman traps

Small rodents and insectivores were sampled using 100 Sherman traps (standard size) baited with toasted coconut and peanut butter. Traps were placed at least 2m apart, forming a wide loop around the bucket pitfall trap lines; 33 around two of the lines and 34 around the third. Traps were baited each evening (16.00hr or later) for the duration of the trapsite and checked early the following morning (08.00hr or earlier). Traps were closed during each day of the trapsite.

Data were recorded on standardised sheets regarding the identification, sex, breeding status and biometrics of each animal captured, as well as habitat notes. Specimens were retained when species level could not be ascertained and in cases where sexed specimens were required; these specimens were subsequently sent to international taxonomic experts (refer to Appendix 1).

In the case of small rodents, individuals to be released were each given a distinct mark-code made by trimming small patches of fur in a given pattern. 'Recaptured' individuals were then able to be identified.

### 5.2.3 Bat mist-netting

Bats were sampled using varying combinations and configurations of mist-nets within 4 trapping sites. Up to four mist-nets of varying sizes (3m x 3.5m, 6m x 3.5m, 9m x 3.5m) were utilised at any one time. Nets were placed across assumed 'flight corridors' such as rivers and paths. Nets were opened at dusk (approximately 18.30hr) and checked every 10 to 15 minutes for the duration of the netting session.

Data were recorded on standardised data sheets regarding the identification, sex, breeding status, weight and biometrics of each bat captured. Detailed habitat notes were taken for each mist-netting location and the number of net-metre hours calculated for each session.

### 5.2.4 Butterfly sweep-netting

Low-flying butterflies were sampled using hand-held sweep-nets. Two man-hours were spent netting along the bucket pitfall lines each day for the duration of the trapsite.

### 5.2.5 Butterfly canopy traps

Five Blendon-style canopy traps were set up at the trapsites, one trap close to one bucket pitfall line, and two traps on each of the remaining two lines. Traps were baited with fermented banana in the mornings (usually around 08.00hr). Traps were checked morning and late afternoon. One individual of each species captured was taken; any 'repeat species' butterflies were identified, recorded and released.

### 5.2.6 Mollusc plots

Molluscs were sampled in three 1m x 1m quadrats per trapsite; whereby quadrats were established close to each of the bucket pitfall trap lines and located in order to encompass a range of microhabitats. Two man-hours were spent searching the leaf litter, to a depth of 5cm within each quadrat. All molluscs encountered were collected and preserved.

### 5.2.7 Millipede plots

Millipedes were sampled in three 3m x 3m quadrats per trapsite; again, one established close to each of the bucket pitfall trap lines and located in order to encompass a range of microhabitats. Four man-hours were spent searching the leaf litter, to a depth of 5cm within each quadrat. All millipedes encountered were collected and preserved.

### 5.2.8 Dung and sign surveys

Spoor and other signs of animal presence were assessed along every established transect line through the Forest Reserve (Figure 5). A 2m strip either side of each transect line was assessed for animal dung, tracks and paths, as well as other signs such as burrows, diggings, feathers etc. All animal signs were recorded along with brief geographical and habitat details. To determine identification of indirect evidences, the knowledge of experienced field assistants was utilised, in conjunction with a Reference Dung Collection and Walker (1996).

### 5.2.9 Opportunistic collection and observations

All taxa were also collected and observed on a casual basis throughout the survey period. Opportunistic collections of amphibians, reptiles, molluscs and millipedes were taken and direct and indirect observations of birds and larger mammals were recorded to determine the presence of species otherwise omitted in the standardised techniques.

## 5.3 Trapping sites and sampling intensity

Zoological trapsites were established at four different locations in Mgambo FR. Non-systematic trapping also occurred in 2 additional areas for two nights each. Trapsites were strategically positioned to incorporate a range of habitats reflective of the reserve. The location of trapsites within Mgambo FR are shown in Figure 21.

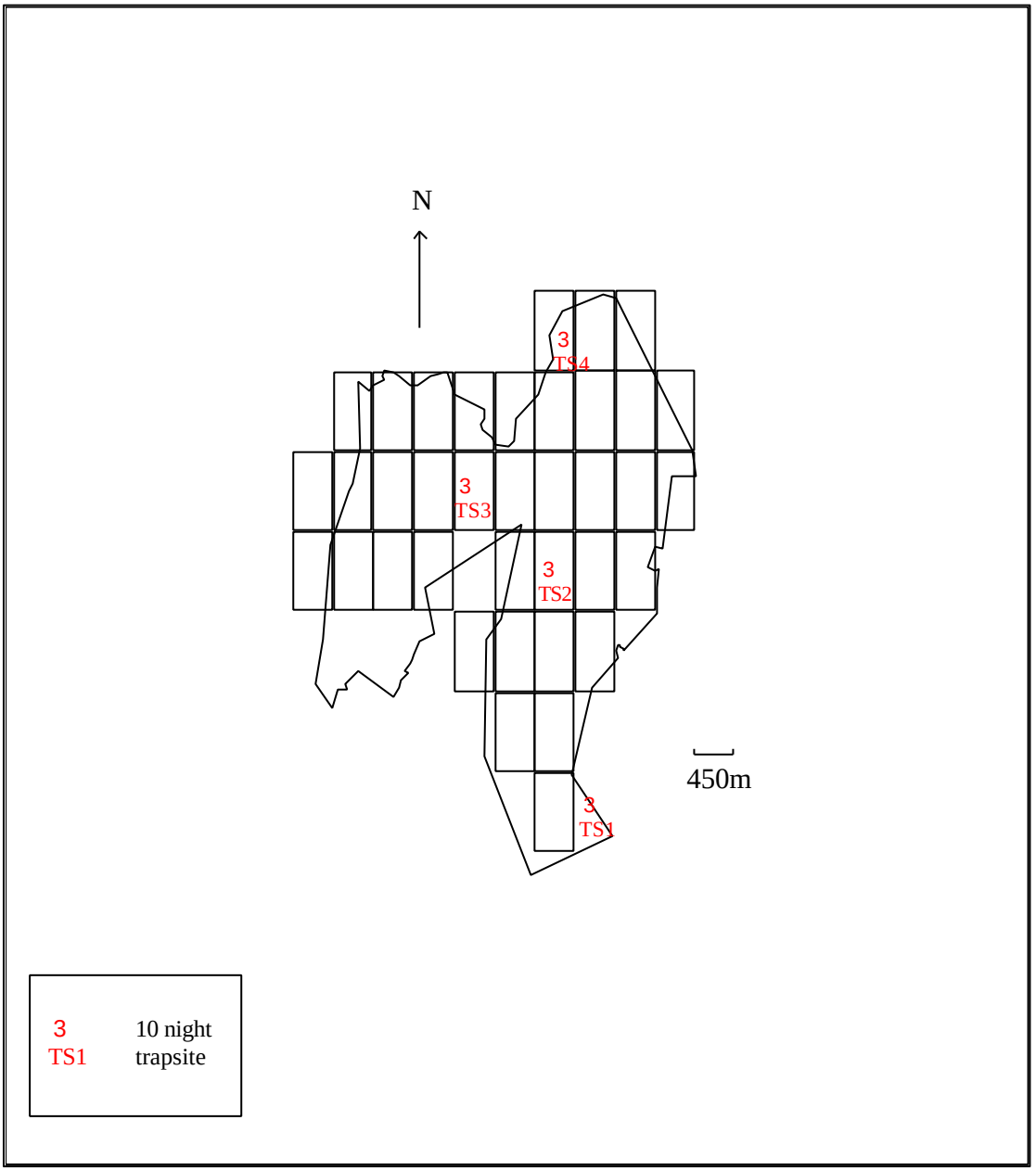


**Figure 21** Location of zoological trapsites in Mgambo FR.

Table 18 provides brief descriptions of the trapping sites. Table 19 summarises the sampling intensity for each site and each trapping method. Table 20 briefly describes bat mist-netting sites.

**Table 18** Descriptions and locations of zoological trapsites in Mgambo FR.

| Trapsite Number | Duration (nights) | Vegetation type | Altitude (masl) | Topography | Co-ordinates |
|---|---|---|---|---|---|
| 1 | 10 | Lowland Riverine Forest and Lowland Forest | 300-320 | Gentle Lower to Upper Slope | S 04° 47' 31.2" E 038° 48' 46.7" |
| 2 | 10 | Grazed Miombo Woodland | 560 | Gentle Upper Slope to Hill Top | S 04° 46' 03.5" E 038° 48' 39.5" |
| 3 | 10 | Dry Lowland Forest / Lowland Riverine Forest | 470 | Gentle Lower Slope | S 04° 45' 40.5" E 038° 47' 58.6" |
| 4 | 10 | Lowland Scrub / Disturbed Scrubby Woodland | 410 | Gentle Mid Slope | S 04° 44' 52.7" E 038° 48' 34.3" |
| **Casual Site** | | | | | |
| 5 | 2 | Lowland Forest / Disturbed Scrubby Woodland | 320 | Lowland Plain | S 04° 47' 08.1" E 038° 48' 40.1" |
| 6 | 2 | Lowland Forest | 380 | Gentle Lower Slope | S 04° 47' 11.8" E 038° 48' 33.5" |

**Table 19** Zoological sampling intensities in Mgambo FR.

| Trapsite Number | Trapsite Duration (dates) | Sherman traps x trap nights | Bucket traps x trap nights | Butterfly traps x trap days | Butterfly sweepnetting hours | Mollusc plots per trapsite | Millipede plots per trapsite |
|---|---|---|---|---|---|---|---|
| 1 | 17/04/02-27/04/02 | 998 | 330 | 50 | 20 | 3 | 3 |
| 2 | 30/04/02–10/05/02 | 989 | 330 | 50 | 20 | 3 | 3 |
| 3 | 13/05/02-23/05/02 | 997 | 330 | 50 | 20 | 3 | 3 |
| 4 | 26/05/02-05/06/02 | 997 | 330 | 50 | 20 | 3 | 3 |
| **Casual Site** | | | | | | | |
| 5 | 04/06/02-05/06/02 | 29 | 0 | 0 | 0 | 0 | 0 |
| 6 | 10/06/02-11/06/02 | 100 | 0 | 0 | 0 | 0 | 0 |
| | **TOTAL** | **4110** | **1320** | **200** | **80** | **12** | **12** |

**Table 20** Bat mist-netting sites and sampling intensities in Mgambo FR.

| Net site number | Site location | Site description | Co-ordinates | Altitude (m) | Sampling intensity (square metres of net x no. of hours) |
|---|---|---|---|---|---|
| 1 | Zoological Trapsite 1 | Stream in Riverine Forest. Gentle lower slope. 10-20m canopy height. | S 04° 47' 31.2" E 038° 48' 46.7" | 300 | 57.2 |
| 2 | Near Basecamp | Stream in Riverine Forest, 250m upstream from basecamp. Gully. 10-20m canopy height. | S 04° 47' 34.5" E 038° 48' 39.4" | 240 | 416 |
| 3 | Zoological Trapsite 3 Near (Vegetation Plot 13) | Dry stream in Riverine Forest and Dry Lowland Forest. Gentle lower slope. 10-20m canopy height. | S 04° 45' 40.5" E 038° 47' 58.6" | 380 | 684.8 |
| 4 | East border of forest reserve / shamba (Near to Transect line 1). | Lowland forest and scrub forest just inside the reserve border and on the border line of Cassia trees. Cultivated land up to border. | S 04° 47' 09.2" E 038° 48' 42.2" | 240 | 390 |
| | | | | **TOTAL** | **1548** |

## 5.4 Results

### 5.4.1 Mammals

#### *5.4.1.1 Small mammals (not including bats)*

A total of 39 small mammals were captured during 4110 sherman trapping nights and 1320 bucket-pitfall nights in Mgambo FR and, of these, 18 specimens were retained for taxonomic purposes. Identifications in this report remain tentative while awaiting taxonomic verifications from Frankfurt Zoological Museum (refer to Appendix 1). The specimens collected represent at least 9 species from 3 families. A summary of trapping data is shown in Appendix 8 and, species list of captured small mammals with their corresponding ecological, endemic and threat status is presented in Table 21.

Ecological type, endemic status and threat status for the mammal tables 21, 22, 23 and 24 were compiled using the National Biodiversity Database (UDSM, 1997), IUCN (Hilton-Taylor, 2000), Kingdon (1974 and 1997) and CITES listings (2001). Nomenclature follows Kingdon (1997).

**Table 21** Summary of captured small mammals from Mgambo FR.

| Species | | Ecol. type | End. status | Threat status | | | Total nos. captured | No. of specimens taken |
|---|---|---|---|---|---|---|---|---|
| | | | | IUCN 2000 | UDSM 1997 | CITES 2001 | | |
| SORICIDAE | | | | | | | | |
| *Crocidura* cf. *bicolor* | **White-toothed Shrew** | f | W | | | | 1 | 1 |
| *Crocidura* cf. *elongius* | **White-toothed Shrew** | f | N | VU | | | 6 | 5 |
| *Crocidura* cf. *hirta/xantippe* | **White-toothed Shrew** | f | W | | | | 2 | 2 |
| *Crocidura* cf. *hildegardeae* | **White-toothed Shrew** | f | W | | | | 1 | 1 |
| *Crocidura* sp. | **White-toothed Shrew** | ? | ? | | | | 3 | 3 |
| MURIDAE | | | | | | | | |
| *Acomys spinosissimus* | **Spiny Mouse** | f | W | | | | 23 | 3 |
| *Grammomys* sp. | **Narrow–footed Woodland Mouse** | O | W | | | | 1 | 1 |
| *Mastomys natalensis* | **Multimammate rat** | O | W | | | | 1 | 1 |
| MYOXIDAE | | | | | | | | |
| *Graphiurus* sp. | **Dormouse** | f | W | | | | 1 | 1 |
| **TOTAL** | | | | | | | **39** | **18** |

**KEY TO ABBREVIATIONS FOR TABLES 21 and 22**

Ecological (Ecol.) type:
F – Forest dependent species: Species confined to primary forest only; not including forest edge or secondary forest.
f – Forest dwelling but not forest dependent species: Species occurring in primary forest, forest edge or secondary forest.
O – Non-forest species: Species that do not occur in primary or secondary forest or forest edge.

Endemic (End.) status:
E – Endemic: Species only found in the Usambara Mountains.
N – Near endemic: Species with limited ranges usually only including coastal forest and/or East African lowland forests.
W – Widely distributed species.

IUCN status:
EN – Endangered
VU – Vulnerable
LR/NT – Lower Risk/Near Threatened
DD – Data Deficient

CITES listings:
I – Appendix One listed species
II – Appendix Two listed species
(Appendix Three species not included in Table)

Of most interest was the *Graphiurus* sp. (Dormouse) captured in dry lowland forest, one of the few patches of undisturbed forest within the reserve. It is a species that has been captured in small numbers in Amani Nature Reserve and Nilo Forest Reserve in previous surveys (2 individuals within each reserve within a time frame of one year and six months respectively). *Graphiurus* prefers dense woodland / forest habitats. (Table 21).

### *5.4.1.2 Dung survey*

Dung from 9 mammal species was recorded, 2 of which were domesticated goats and cows commonly found illegally grazing throughout the reserve. Apart from livestock, evidence of baboons were most commonly collected along the transect lines. The most interesting species was that of the Giant elephant shrew, most likely to be the *Rhynchocyon petersi* (Zanj elephant shrew), which is considered forest-dependent, near endemic and endangered (IUCN 2000). (Table 22).

**Table 22** Summary of dung survey in Mgambo FR.

| Species | Ecol. type | End. status | Threat Status | | | No. of occurrences | Altitude of dung findings |
|---|---|---|---|---|---|---|---|
| | | | IUCN 2000 | UDSM 1997 | CITES 2001 | | |
| CERCOPITHECIDAE | | | | | | | |
| *Papio cynocephalus* **Yellow Baboon** | f | W | | | II | 11 | 420-670 |
| HERPESTIDAE | | ? | | | | | |
| Unknown sp. **Mongoose** | ? | | | | | 1 | 550 |
| THRYONOMYIDAE | | | | | | | |
| *Thryonomys* sp. **Cane-Rat** | ? | ? | | | | 10 | 350-685 |
| VIVERRIDAE | | | | | | | |
| *Civettictis civetta* **African Civet** | O | W | | | | 1 | 360 |
| *Genetta genetta*. **Common Genet** | O | W | | | | 3 | 410-520 |
| ANTILOPINAE | | | | | | | |
| *Cephalophus* sp. **Duiker sp.** | f | W | | | | 1 | 680 |
| *Madoqua sp*. **Dik Dik** | ? | ? | | | | 3 | 450-500 |
| *Capra hircus* **Domestic Goat sp.** | O | W | | | | 3 | 450-620 |
| RHYNCHOCYONINAE | | | | | | | |
| *Rhynchocyon* sp. **Giant Elephant Shrew sp.** | ? | ? | | | | 1 | 620 |
| BOVIDAE | | | | | | | |
| **Domestic cow sp** | O | W | | | | 9 | 370-720 |

For key to abbreviations, see Table 21.

#### *5.4.1.3 Mammal observations*

A total of 22 species from 14 families were observed directly and indirectly but not retained for taxonomic purposes. This included species detected from the presence of tracks, paths, diggings and feeding sites, but not those detected through the dung survey. All mammal observations are summarised in Table 23. As many observations were made by indirect means, positive identification was not always possible to a species level. An 'identification confidence' column clarifies the reliability of each sighting. Identification is ranked as follows: Certain, Near Certain, Probable, Possible.

Of particular interest was the sighting of the *Rhynchocyon petersi* (Zanj elephant shrew) which is forest-dependent, near endemic and endangered (IUCN 2000). (Table 23). Observations were made of up to six different groups of forest dependent *Colobus angolensis palliatus* (Black and white colobus monkey) in patches of lowland and riverine forest throughout the reserve. These primates, although considered widespread, seem to be limited to rapidly decreasing areas of lowland forest and must be at risk from local extinction due to limitations to disperse and interbreed. Also of interest was the sighting of the vulnerable (IUCN 2000) *Paraxerus palliatus* (Red bellied coastal squirrel).

Five nocturnal species were seen and/or heard at trapsite 3, an area of good lowland and riverine forest. These were the *Dendrohyrax validus* (Eastern tree hyrax), which is near endemic and vulnerable (IUCN 2000); *Galagoides zanzibaricus* (Zanzibar galago), a forest-dependent species;

*Otolemur garnetti* (Small eared galago), which was also seen and heard frequently around basecamp in an area of riverine forest on the reserve border; *Otolemur crassicaudatus* (Greater galago), a species typically known to inhabit open Miombo-type woodland, indicating it's presence on the Miombo ridge tops of Mgambo FR and, lastly, *Petrodromus tetradactylus* (Four-toed elephant shrew). All of the nocturnal species identifications were verified by Andy Perkins, a visiting *Galago* expert, with an extensive knowledge on other nocturnal species.

There was also much evidence of grazing by domestic livestock, goats and cattle. This is a problem within the reserve.

**Table 23** Summary of mammal observations in Mgambo FR.

| Species | Common Name | Ecol. type | End. status | Threat Status | | | Identification confidence | Evidence |
|---|---|---|---|---|---|---|---|---|
| | | | | IUCN 2000 | UDSM 1997 | CITES 2001 | | |
| COLOBIDAE | | | | | | | | |
| *Colobus angolensis palliatus* | **Angola Pied Colobus** | F | W | DD | | II | Certain | obs, voc |
| CERCOPITHECIDAE | | | | | | | | |
| *Papio anubis* | **Olive Baboon** | O | W | | | II | Possible | obs |
| *Papio cynocephalus* | **Yellow Baboon** | f | W | | | II | Certain | obs,voc,pa, sp,sk, tr, fed |
| *Cercopithecus (n.) mitis* | **Gentle Monkey** | f | W | | | II | Certain | obs, voc, fed |
| GALAGONIDAE | | | | | | | | |
| *Otolemur crassicaudatus* | **Greater Galago** | f | W | | | II | Certain | obs, voc |
| *Otolemur garnettii* | **Small-eared Galago** | f | W | | | II | Certain | voc |
| *Galagoides zanzibaricus* | **Zanzibar Galago** | F | W | LR/NT | | II | Certain | obs, voc |
| MACROSCELIDIdAE | | | | | | | | |
| *Pterodromus tetradactylus* | **Four-toed Elephant Shrew** | f | W | | | | Certain | obs,voc |
| *Rhynchocyon petersi* | **Zanj Elephant Shrew** | F | N | EN | NT | | Certain | obs, voc, pa, dig |
| ANTILOPINAE | | | | | | | | |
| *Cephalophus* sp. | **Duiker sp.** | f | W | | | | Probable | tr, sk, pa |
| *Capra hircus* | **Domestic Goat** | O | W | | | | Certain | obs, tr, pa |
| SCIURIDAE | | | | | | | | |
| *Heliosciurus undulatus* | **Zanj Sun Squirrel** | f | W | | LR/NT | | Certain | obs |
| *Paraxerus palliatus* | **Red-Bellied Coastal Squirrel** | F | W | VU | | | Near Certain | obs |
| CRICETOMYINAE | | | | | | | | |
| *Cricetomys* sp. | **Giant Pouched Rat** | O | W | | | | Possible | obs |
| MURIDAE | | | | | | | | |
| *Praomys* sp. | **Soft Furred Rat** | f | W | | | | Possible | obs |
| HYSTRICIDAE | | | | | | | | |
| *Hystrix* sp. | **Porcupine sp.** | O | W | | | | Certain | hair |
| THRYONOMYIDAE | | | | | | | | |
| *Thryonomys* sp. | **Cane Rat** | - | - | | | | Near Certain | fed |
| PROCAVIDAE | | | | | | | | |
| *Dendrohyrax validus* | **Eastern Tree Hyrax** | f | N | VU | EN | | Certain | voc |

**Table 23** continued Summary of mammal observations in Mgambo FR.

| Species | Common Name | Ecol. type | End. status | Threat Status | | | Identification confidence | Evidence |
|---|---|---|---|---|---|---|---|---|
| | | | | IUCN 2000 | UDSM 1997 | CITES 2001 | | |
| SUIDAE<br>*Potamochoerus larvatus* | **Bush Pig** | f | W | | | | Certain | tr, dig, pa |
| BOVIDAE<br>Unknown sp. . | **Domestic Cow** | O | W | | | | Certain | obs, tr, pa, fed |

**KEY TO ABBREVIATIONS FOR TABLE 23**

Ecological (Ecol.) type:
F – Forest dependent species: Species confined to primary forest only; not including forest edge or secondary forest.
f – Forest dwelling but not forest dependent species: Species occurring in primary forest, forest edge or secondary forest .
O – Non-forest species: Species that do not occur in primary or secondary forest or forest edge.

Endemic (End.) status:
E – Endemic: Species only found in the Usambara Mountains.
N – Near endemic: Species with limited ranges usually only including coastal forest and/or East African lowland forests.
W – Widely distributed species.

IUCN status:
EN – Endangered
VU – Vulnerable
LR/NT – Lower Risk/Near Threatened
DD – Data Deficient

CITES listings:
I – Appendix One listed species
II – Appendix Two listed species
(Appendix Three species not included in Table)

Evidence:
voc - vocalisations heard; tr - track; fed - remains of feedings; sk - skull found; sp -spoor
obs - observed; dig - diggings; hair - fur/hair found; bns - bones found; pa - path

#### *5.4.1.4 Bats*

A total of 45 individuals were caught during 1548 net-metre-hours of trapping in Mgambo FR. These individuals represented potentially 10 species from 4 families. Seventeen individuals were retained for taxonomic purposes. A summary of trapping data is shown in Appendix 8 and a species list presented in Table 24. Identifications remain tentative while awaiting taxonomic verification from Frankfurt Zoological Museum (refer to Appendix 1).

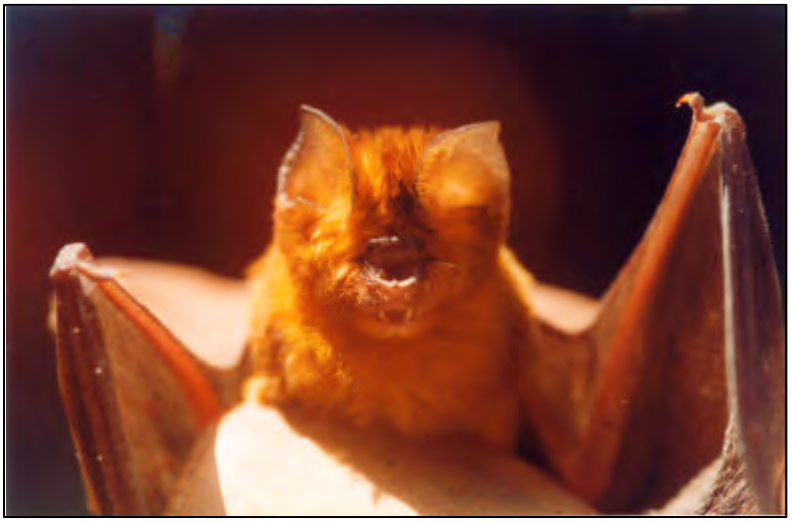

**Figure 20** Leaf-nosed bat (*Hipposideros* sp.)

It is interesting to note that most of the bat species caught were those that live in a mosaic of habitats, including open woodland and are non-forest dependent. This probably reflects the level of disturbance throughout the reserve and loss of pristine forest habitat. Those species that live in forest or on forest edges (ecological type = f) were caught in areas of either dry lowland forest and/or riverine forest. At trapsite 1, a large number of bats were caught, suggesting a roost close to the positioning of the mist nets. These were situated in riverine forest on the edge of the reserve border, close to shambas. Most bats were *Rhinolophus* species and it is possible that they flew out of the forest into drier open areas to feed.

**Table 24** Summary of bat records in Mgambo FR

| **Species** | **Common name** | **Ecol. type** | **End. status** | **Threat Status** | | | **Total nos. captured** | **No. of specimens taken** |
|---|---|---|---|---|---|---|---|---|
| | | | | **IUCN 2000** | **UDSM 1997** | **CITES 2001** | | |
| NYCTERIDAE | | | | | | | | |
| *Nycteris* sp. | **Slit-faced Bat** | ? | ? | | | | 1 | 1 |
| *Nycteris grandis* | **Large Slit-faced Bat** | f | W | | | | 1 | 1 |
| PTEROPODIDAE | | | | | | | | |
| *Epomorphus wahlbergi* | **Epauletted Fruit Bat** | f | W | | | | 3 | 1 |
| RHINOLOPHIDAE | | | | | | | | |
| *Hipposideros caffer / ruber* | **Leaf-nosed Bat** | ? | W | | | | 2 | 1 |
| *Rhinolophus clivosus* | **Horseshoe Bat** | O | W | | | | 18 | 5 |
| *Rhinolophus hildebrandti* | **Horseshoe Bat** | O | W | | | | 5 | 2 |
| *Rhinolophus landeri* | **Horseshoe Bat** | O | W | | | | 1 | 1 |
| VESPERTILIONIDAE | | | | | | | | |
| *Glauconycteris argentata / variegata* | **Butterfly Bat** | f | W | | | | 7 | 2 |
| *Nyctecius shlieffeni* | **Twilight Bat** | O | W | | | | 1 | 1 |
| *Scotoecus* sp. | **Evening Bat** | O | W | | | | 6 | 2 |
| **TOTAL** | | | | | | | **45** | **17** |

**KEY TO ABBREVIATIONS FOR TABLE 24**

Ecological (Ecol.) type:
F – Forest dependent species: Species confined to primary forest only; not including forest edge or secondary forest.
f – Forest dwelling but not forest dependent species: Species occurring in primary forest, forest edge or secondary forest.
O – Non-forest species: Species that do not occur in primary or secondary forest or forest edge.

Endemic (End.) status:
E – Endemic: Species only found in the Usambara Mountains.
N – Near endemic: Species with limited ranges usually only including coastal forest and/or East African lowland forests.
W – Widely distributed species.

IUCN status:
EN – Endangered
VU – Vulnerable
LR/NT – Lower Risk/Near Threatened
DD – Data Deficient

CITES listings:
I – Appendix One listed species
II – Appendix Two listed species
(Appendix Three species not included in Table)

### 5.4.2 Birds

A total of 52 species from 30 families were recorded. As no systematic survey of bird fauna was undertaken, the findings do not represent a complete inventory (Table 25). An 'identification confidence' column is presented in Table 25 to clarify the reliability of each sighting. Identification is ranked as follows: Certain, Near Certain, Probable and Possible.

Where possible Mlingwa *et al*. (2000) and Stuart (1989) was used to determine ecological type and Stattersfield *et al*. (1998) used to define endemic status. When this was not possible, ecological type, endemic status and threat status were compiled using the National Biodiversity Database (UDSM, 1997), IUCN (Hamilton, 2000), CITES (2001) and Zimmerman *et al*. (1996).

**Table 25** Summary of birds observed opportunistically in Mgambo FR.

| Species | Common name | Ecol. type | End. status | Threat Status | | | Identification confidence |
|---|---|---|---|---|---|---|---|
| | | | | IUCN 2000 | UDSM 1997 | CITES 2001 | |
| ACCIPITRIDAE | | | | | | | |
| *Aquila rapax* | **Tawny Eagle** | f | W | | LR | II | Probable |
| *Buteo augur* | **Augur Buzzard** | f | W | | LR | II | Certain |
| *Buteo buteo vulpinus* | **Common Buzzard** | f | W | | LR | II | Certain |
| *Gypohierax angolensis* | **Palm-nut Vulture** | f | W | | LR | II | Certain |
| *Polyboroides typus* | **African Harrier Hawk** | f | W | | | II | Certain |
| *Stephanoaetus coronatus* | **African Crowned Eagle** | **FF**2 | W | | NT | II | Certain |
| *Terathopius ecaudatus* | **Bateleur** | f | W | | LR | II | Certain |
| ALCEDINIDAE | | | | | | | |
| *Ispinina picta natalensis* | **African Pygmy Kingfisher** | **f**1 | W | | | | Certain |
| *Halcyon senegalensis* | **Woodland Kingfisher** | f | W | | | | Certain |
| APODIDAE | | | | | | | |
| *Apus affinis* | **Little Swift** | f | W | | | | Possible |
| BUCEROTIDAE | | | | | | | |
| *Bycanistes brevis* | **Silvery Cheeked Hornbill** | **F**2 | W | | | | Probable |
| *Bycanistes bucinator* | **Trumpeter Hornbill** | **F**2 | W | | | | Certain |
| *Tokus alboterminatus* | **Crowned Hornbill** | **f**1 | W | | | | Certain |
| CAMPEPHAGIDAE | | | | | | | |
| *Campephaga flava* | **Black Cuckoo Shrike** | f1 | W | | | | Certain |
| CAPITONIDAE | | | | | | | |
| *Pogoniulus bilineatus* | **Yellow Rumped Tinker Bird** | f | W | | | | Certain |
| COLIIDAE | | | | | | | |
| *Urocolius macrourus* | **Blue-Naped Mousebird** | f | W | | | | Probable |
| COLUMBIDAE | | | | | | | |
| *Treron calva* | **African Green Pigeon** | F | W | | | | Certain |
| *Streptopelia capicola* | **Ring-necked Dove** | f | W | | | | Certain |
| *Streptopelia semitorquata* | **Red-eyed Dove** | f | W | | | | Certain |
| *Streptopelia senegalensis* | **Laughing Dove** | f | W | | | | Certain |
| CORACIIDAE | | | | | | | |
| *Eurystomus glaucurus* | **Broad-billed Roller** | **f** | W | | | | Certain |
| CUCULIDAE | | | | | | | |
| *Centropus superciliosus* | **White-browed Coucal** | f | W | | | | Certain |

**Table 25** continued Summary of birds observed opportunistically in Mgambo FR.

| Species | Common name | Ecol. type | End. status | Threat Status | | | Identification confidence |
|---|---|---|---|---|---|---|---|
| | | | | IUCN 2000 | UDSM 1997 | CITES 2001 | |
| CAPITONIDAE | | | | | | | |
| *Stactolaema leucotis kilimensis* | **White-eared Barbet** | **F**1 | W | | | | Certain |
| DICRURIDAE | | | | | | | |
| *Dicrurus adsimilis* | **Common Drongo** | f | W | | | | Certain |
| *Dicrurus ludwigii* | **Square-tailed Drongo** | **F**3 | W | | | | Certain |
| ESTRILDIDAE | | | | | | | |
| *Hypargos niveoguttatus* | **Peter's Twinspot** | **F**1 | W | | | | Near Certain |
| *Lonchura fringilloides* | **Magpie Mannikin** | f | W | | | | Possible |
| MALACONOTIDAE | | | | | | | |
| *Laniarius aethiopicus* | **Tropical Boubou** | f | W | | | | Certain |
| MEROPIDAE | | | | | | | |
| *Merops n. nubicus* | **Northern Carmine Bee-eater** | f | W | | | | Near Certain |
| *Merops pusillus* | **Little Bee-eater** | | W | | | | Certain |
| MONARCHIDAE | | | | | | | |
| *Terpsiphone viridis* | **African Paradise Fly-catcher** | f1 | W | | | | Certain |
| MUSOPHAGIDAE | | | | | | | |
| *Tauraco fischeri* | **Fisher's Turaco** | **F**2 | N | | | II | Certain |
| *Tauraco porphyreolophus chlorochlamys* | **Purple Crested Turaco** | F | W | | LR/NT | II | Possible |
| NECTARINIIDAE | | | | | | | |
| *Anthreptes* sp. | **Sunbird** | ? | ? | | | | Possible |
| *Cyanomitra olivacea* | **Olive Sunbird** | **FF**1 | W | | | | Certain |
| *Hedydipna collaris* | **Collared Sunbird** | **F**1 | W | | | | Certain |
| NUMIDIDAE | | | | | | | |
| *Numida meleagris* | **Helmeted Guineafowl** | f | W | | | | Certain |
| ORIOLIDAE | | | | | | | |
| *Oriolus* sp. | **Oriole** | ? | ? | | | | Certain |
| *Oriolus chlorocephalus* | **Green Headed Oriole** | **F**2 | W | | | | Certain |
| PICIDAE | | | | | | | |
| *Campethera mombassica* | **Mombasa Woodpecker** | F | N* | | LR | | Probable |
| PLATYSTEIRIDAE | | | | | | | |
| *Platysteira p. peltata* | **Black-Throated Wattle-eye** | F | W | | | | Certain |
| PRIONOPIDAE | | | | | | | |
| *Prionops retzii* | **Retz's Helmet Shrike** | f1 | W | | | | Certain |
| PYCNONOTIDAE | | | | | | | |
| *Andropadus milanjensis* | **Stripe-Cheeked Greenbul** | **FF**2 | W | | | | Certain |
| *Andropadus virens* | **Little Greenbul** | **F**2 | W | | | | Certain |
| *Pycnonotus barbatus* | **Common Bulbul** | **f** | W | | | | Certain |
| STRIGIDAE | | | | | | | |
| *Strix woodfardii nigricantoir* | **African Wood Owl** | **F**2 | W | | LR | II | Certain |
| STURNIDAE | | | | | | | |
| *Onychognathus morio* | **Red-winged Starling** | f | W | | | | Near Certain |

**Table 25** continued Summary of birds observed opportunistically in Mgambo FR.

| Species | Common name | Ecol. type | End. status | Threat Status | | | Identification confidence |
|---|---|---|---|---|---|---|---|
| | | | | IUCN 2000 | UDSM 1997 | CITES 2001 | |
| TROGONIDAE | | | | | | | |
| *Apaloderma narina* | **Narina's Trogon** | f3 | W | | | | Certain |
| TURDIDAE | | | | | | | |
| *Cossypha natalensis* | **Red-capped Robin-chat** | **F**1 | W | | | | Certain |
| *Pogonocichla stellata* | **White-starred Robin** | F2 | W | | | | Certain |
| TYTONIDAE | | | | | | | |
| *Tyto alba affinis* | **Barn Owl** | f | W | | LR | II | Certain |
| UPUPIDAE | | | | | | | |
| *Phoeniculus purpureus* | **Green Wood-hoopoe** | F1 | W | | | | Certain |
| *Rhinopomastus cyanomelas* | **Common Scimitarbill** | f | W | | | | Certain |

*****Endemic status determined using Stattersfield *et al* (1998)
**Bold text** Ecological type determined using Mlingwa *et al.* (2000)

**KEY TO ABBREVIATIONS FOR TABLE 25**

Forest dependence Mlingwa *et al.* (2000):
**Forest specialist (FF):** Species that are typical of forest interior and likely to disappear when the forest is modified to any extent.
**Forest generalist (F):** Species that can occur in undisturbed forest but which are able to exist (and may even be numerous) at the forest edge or in modified/ fragmented forests. However, these generalists continue to depend upon forests for some of their resources, such as nesting sites.
**Non-forest birds (f)**: Forest visitors

Forest dependence Stuart (1989) categories:
1. those which live in forest but are not dependent upon it for their survival
2. those which live in forest and 'overspill' into adjacent habitats, but are dependent upon forest for their survival
3. those that can only survive in forest and hardly 'overspill' into adjacent habitats.

Endemic (End.) status:
E – Endemic: Species only found in the Usambara Mountains.
N – Near endemic: Species with lim ited ranges usually only including coastal forest and/or E. African lowland forests.
W - Widely distributed species

IUCN status:
EN - Endangered
VU - Vulnerable
LR/NT - Low Risk/Near Threatened
DD - Data Deficient

CITES listings:
I – Appendix One listed species
II – Appendix Two listed species
(Appendix Three not included in Table)

A total of 60% of bird species (31 species) recorded in Mgambo FR were non-forest species (Mlingwa *et al*, 2000), with 6% (3 species) forest specialists and 31% (16 species) forest generalists. Forest specialists are summarised in Table 26.

**Table 26** Summary of forest dependant birds with corresponding threat status categories.

| Species name | Common name | Ecol. type | End. status | Threat status | | |
|---|---|---|---|---|---|---|
| | | | | IUCN 2000 | UDSM 1997 | CITES 2001 |
| *Andropadus milanjensis* | **Stripe-cheeked Greenbul** | **FF** | W | | | |
| *Cyanomitra olivacea* | **Olive Sunbird** | **FF** | W | | | |
| *Stephanoaetus cornatus* | **African Crowned Eagle** | **FF**2 | W | | NT | II |

*****Endemic status determined using Stattersfield *et al* (1998)

Two bird species observed in Mgambo FR were of restricted range and are summarised in Table 27.

**Table 27** Restricted ranges of near endemic birds
(1º source: Statterfield *et al* (1998), 2º Mlingwa *et al.* 2000), 3º: source: UDSM (1997).)

| Species name | Common name | Range |
|---|---|---|
| *Campethera mombassica* | **Mombasa Woodpecker** | East Usambara Mountains and Coastal forests north of Tanga from Shimba NP to Boni Forest. |
| *Tauraco fischeri* | **Fischer's Tauraco** | Endemic to Tanzania, Kenya, Coastal forest endemic. |

Apart from those birds that are of obvious importance in terms of threat status and retricted range, such as *Tauraco fischeri* (Fischer's tauraco) which has been used to define one of the Birdlife International Endemic Bird Areas, there were a number of birds that were interesting because they are locally common and have a restricted and patchy distribution in East Africa. These include: *Lonchura fringilloides* (Magpie mannikin), commonly known from Amani; *Tauraco porphyreolophus chlorochlamys* (Purple-crested turaco), with no recent records in north Tanzania (Zimmerman *et al* 1996); and *Onychognathus morio* (Red-winged starling), known to be rare in the Usambara foothills.

*Bycanistes brevis* (Silvery cheeked hornbill), *Bycanistes bucinator* (Trumpeter hornbill) and *Stactolamema leucotis kilimensis* (White-eared barbet) are common but fairly restricted to North Eastern Tanzania and Southern Kenya.

Also of interest was *Ispinina picta natalensis* (African pygmy kingfisher), a non-breeding migrant species from South Africa, present in Coastal forests from April to September, and *Cossypha natalensis* (Red-capped Robin-chat), an Afrotropical migrant.

It is also important to consider the birds species that have not been found in Mgambo forest reserve, such as the lowland species: Sokoke scops owl, *Otus ireneae*; the endemic Usambara eagle owl, *Bubo vosseleri*; Swynnerton's robin, *Swynnertonia swynnertoni*; East coast akalat, *Sheppardia gunningi*; Amani sunbird, *Anthreptes pallidigaster* the Banded green sunbird, *Anthreptes rubritorques* and the near-threatened Southern banded snake eagle (*Circaetus fasciolatus*). Forest dependent species, such as Burr-spotted fluff tail (*Sarothrura elegans*), Barred long-tailed cuckoo (*Cercococcyx montanus*) and the Forest batis (*Batis mixta*), are known from wetter and more intact lowland forest areas of the East Usambaras. Therefore, this preliminary bird species list may suggest that Mgambo is too dry and fragmented for many typical lowland coastal forest species.

### 5.4.3 Reptiles

A total of 45 reptile individuals representing 20 species and 9 families were captured in Mgambo FR during 1320 pitfall trapping nights and opportunistic collection. These species are summarised in Table 28. At least one individual representing each species were taken as specimens for taxonomic purposes and await formal identification. Nomenclature follows Spawls *et al* (2002).

**Table 28** Summary of reptile pitfall and opportunistic captures in Mgambo FR.

| Family | Ecol. type | End. status | Threat Status | | | No. of individuals captured | | |
|---|---|---|---|---|---|---|---|---|
| | | | IUCN 2000 | UDSM 1997 | CITES 2001 | Trap sites | Additional Locations | Total |
| CHAMAELEONIDAE | | | | | | | | |
| *Rhamploleon k. kerstenii* **Kenyan Pygmy Chameleon** | O | N | | LR/NT | | - | 1 | **1** |
| COLUBRIDAE | | | | | | | | |
| *Natriciteres olivacea* **Olive Marsh Snake** | O | W | | | | - | 2 | **2** |
| *Philothamnus* sp. **Green Snake** | ? | ? | | | | - | 1 | **1** |
| *Psammophis sudanensis* **Northen Stripe-bellied Sand Snake** | O | W | | | | - | 2 | **2** |
| *Scaphiophus albopunctatus* **Hook-nosed Snake** | O | W | | | | 5 | - | **5** |
| **Unknown *genus*** | ? | ? | | | | 1 | - | **1** |
| ELAPIDAE | | | | | | | | |
| *Dendroaspis angusticeps* **Eastern Green Mamba** | f | W | | | | - | 1 | **1** |
| *Naja* sp. **Cobra sp.** | ? | W | | | | 1 | - | **1** |
| GEKKONIDAE | | | | | | | | |
| *Cnemaspis africana* **Usambara Forest Gecko** | F | W | | NT | | 2 | - | **2** |
| *Hemidactylus* sp. **Tropical Gecko** | ? | ? | | | | - | 1 | **1** |
| *Hemidactylus platycephalus* **Tree Gecko** | O | W | | | | 2 | - | **2** |
| *Pachydactylus* sp. **Thick-toed Gecko** | O | W | | | | - | 1 | **1** |
| GERRHOSAURIDAE | | | | | | | | |
| *Gerrhosaurus flavigularis* **Yellow-throated Plated Lizard** | O | W | | | | 11 | - | **11** |
| *Gerrhosaurus* sp. **Plated Lizard** | O | W | | | | - | 1 | **1** |
| LACERTIDAE | | | | | | | | |
| *Heliobolus speckii speckii* **Speke's Sand Lizard** | O | W | | LR/NT | | 2 | 1 | **3** |
| *Holaspis guentheri laevis* **Blue-tailed Gliding Lizard** | F | W | | LR/NT | | - | 1 | **1** |
| *Latastia longicaudata* **Southern Long-tailed Lizard** | O | W | | | | 2 | - | **2** |
| LEPTOTYPHLOPIDAE | | | | | | | | |
| *Leptotyphlops* sp. **Worm Snake** | ? | ? | | | | 1 | 1 | **2** |
| SCINCIDAE | | | | | | | | |
| *Mabuya maculilabris* **Speckle-lipped Skink** | O | W | | | | 1 | 1 | **2** |
| *Lygosoma* sp. **Writhing Skink** | O | ? | | | | - | 1 | **1** |
| VIPERIDAE | | | | | | | | |
| *Bitis arientans* **Puff Adder** | O | W | | | | 1 | 1 | **2** |
| **TOTAL** | | | | | | 29 | 16 | **45** |

**KEY TO ABBREVIATIONS FOR TABLE 28**

Ecological (Ecol.) type:
F – Forest dependent species: Species confined to primary forest only; not including forest edge or secondary forest.
f – Forest dwelling but not forest dependent species: Species occurring in primary forest, forest edge or secondary forest.
O – Non-forest species: Species that do not occur in primary or secondary forest or forest edge.

Endemic (End.) status:
E – Endemic: Species only found in the Usambara Mountains.
N – Near endemic: Species with limited ranges usually only including coastal forest and/or East African lowland forests.
W – Widely distributed species.

IUCN status:
EN – Endangered
VU – Vulnerable
LR/NT – Lower Risk/Near Threatened
DD – Data Deficient

CITES listings:
I – Appendix One listed species
II – Appendix Two listed species
(Appendix Three species not included in Table)

Appendix 9 summarises reptile trapping data, 35% of individuals were captured opportunistically. Ecological type, endemic status and threat status were compiled from the National Biodiversity Database (UDSM, 1997), IUCN (Hilton-Taylor, 2000) and Spawls *et al* (2002).

Two species captured were categorised as forest dependent, *Holaspis guentheri laevis* (Speke's Sand Lizard) and *Cnemaspis africana* (Usambara forest gecko) with one near endemic, *Rhamploleon k. kerstenii* (Kenyan pygymy chameleon). None were listed as vulnerable or endangered (IUCN 2000).

Five additional species were recorded in Mgambo FR as observations. These are listed in Table 29. An 'identification confidence' column has been presented to clarify the reliability of each sighting. Identification is ranked as follows: Certain, Near Certain, Probable, Possible.

**Table 29** Summary of reptile observations in Mgambo FR.

| Species | Common Name | Ecol. type | End. status | Threat Status | | | Identification confidence |
|---|---|---|---|---|---|---|---|
| | | | | IUCN 2000 | UDSM 1997 | CITES 2001 | |
| COLUBRIDAE | | | | | | | |
| *Philothamnus battersbyi* | **Battersby Green Snake** | O | W | | | | Probable |
| *Thelotornis capensis* | **Vine Snake** | O | W | | | | Certain |
| GEKKONIDAE | | | | | | | |
| *Lygodactylus lutecpicturatus* | **Yellow-headed Dwarf Gecko** | O | N | | LR | | Certain |
| TESTUDINIDAE | | | | | | | |
| *Kinixys belliana* | **Bell's Hinged Tortoise** | O | W | | | II | Certain |
| VARANIDAE | | | | | | | |
| *Varanus niloticus* | **Nile Monitor Lizard** | O | W | | | II | Certain |

**KEY TO ABBREVIATIONS FOR TABLE 29**

Ecological (Ecol.) type:
F – Forest dependent species: Species confined to primary forest only; not including forest edge or secondary forest.
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O – Non-forest species: Species that do not occur in primary or secondary forest or forest edge.

Endemic (End.) status:
E – Endemic: Species only found in the Usambara Mountains.
N – Near endemic: Species with limited ranges usually only including coastal forest and/or East African lowland forests.
W – Widely distributed species.

IUCN status:
EN – Endangered
VU – Vulnerable
LR/NT – Lower Risk/Near Threatened
DD – Data Deficient

CITES listings:
I – Appendix One listed species
II – Appendix Two listed species
(Appendix Three species not included in Table)

An additional one near endemic reptile species was recorded through observation, *Lygodactylus lutecpicturatus* (Yellow-headed dwarf gecko).

Additionally, two species of Chameleon were observed just outside of the forest reserve, *Chameleo dilepsis* (Flap-necked chameleon), a widespread forest dwelling species, and *Chameleo melleri* (Giant one-horned chameleon), mostly distributed along the coast in well-wooded savannah and woodland.

Many of the species found in Mgambo predominantly range in the Eastern coastal forests with some patchy distribution in other more central parts of east and central Africa. Therefore, although they cannot be categorised as 'near endemic' based on the definition given in this report, they are of limited distribution. For example, *Dendroaspis angusticeps* (Green mamba, see Figure 22), *Heliobolus spekii spekii* (Speke's sand lizard), *Holaspis guentheri laevis* (Blue-tailed lizard) and *Cnemaspis africana* (Usambara forest gecko).

Both the forest dependent reptiles were captured in good quality patchily distributed riverine forest. The presence or absence of *Holaspis guentheri laevis* may be a good future indicator of the levels of deforestation to the remaining areas of lowland forest.

Of interest was the capture of 5 junevile *Scaphiophus albopunctatus* (Hook-nosed snake) at trapsite 4, an area of scrub forest. This species is not currently on the East Usambara database (available from EUCAMP). The East African population of this genus seems to be isolated (Spawls *et al* 2002). Also interesting was the sighting of an adult *Varanus niloticus* (Nile monitor lizard).

Most of the reptiles species captured and observed seemed to be indicative of the disturbance seen throughout the reserve, reflecting a tendency for dry habitat, open woodland / savannah species to dominate, such as *Latastia longicaudata* (Southern long-tailed lizard), *Pachydactylus* sp. (Thick-toed gecko) and *Natriciteres olivecea* (Olive marsh snake). Even the near endemic *Rhampholeon k. kerstenii* (Kenyan pygmy chameloen) prefers a dry habitat.

**Figure 22** Green mamba (*Dendroaspis angusticeps)*, found in riverine forest.
This individual was approximately 2m in length.

### 5.4.4 Amphibians

A total of 184 amphibians were captured during 1320 pitfall trapping nights. An additional 18 individuals were captured opportunistically. These individuals represented 14 species and 7 families. Twenty-four individuals were retained for taxonomic purposes. A summary of trapping data is presented in Appendix 10. A species list is shown in Table 30. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (UDSM, 1997), IUCN (Hilton-Taylor, 2000) and Poynton & Broadley (1991). Identifications remain tentative while awaiting taxonomic verifications from the University of Dar es Salaam and the British Natural History Museum (refer to Appendix 1). Common names are from Passmore and Carruthers (1995).

**Table 30** Summary of pitfall and opportunistic amphibian captures in Mgambo FR.

| **Species** | **Common name** | **Ecol. type** | **End. status** | **Threat status** | | | **No. of individuals captured** |
|---|---|---|---|---|---|---|---|
| | | | | **IUCN 2000** | **UDSM 1997** | **CITES 2001** | |
| ARTHROLEPTIDAE | | | | | | | |
| *Arthroleptis stenodactylus* | **Shovel footed Squeaker** | f | W | | | | 78 |
| *Arthroleptis xenodactyloides* | **Shovel nosed Squeaker** | f | W | | | | 71 |
| BUFONIDAE | | | | | | | |
| *Bufo brauni* | **Dead leaf Toad** | F | N | | VU | | 7 |
| *Bufo gutturalis* | **Square-marked Toad** | O | W | | | | 1 |
| *Bufo maculatus* | **Flat Backed Toad** | O | W | | | | 10 |
| *Bufo* sp. | | ? | ? | | | | 1 |
| *Mertensophryne micranotis* | **Dwarf Toad** | F | N | | EN | | 1 |
| HEMISOTIDAE | | | | | | | |
| *Hemisus marmoratus* | **Mottled Shovel Nosed Frog** | O | W | | | | 16 |
| HYPEROLIIDAE | | | | | | | |
| *Leptopelis barbouri* | **Tree Frog** | F | N | | VU | | 5 |
| PIPIDAE | | | | | | | |
| *Xenopus muelleri* | **Tropical Platanna** | O | W | | | | 1 |
| RHACOPHORIDAE | | | | | | | |
| *Chiromantis xerampelina* | **Foam Nest Frog** | O | W | | | | 1 |
| RANIDAE | | | | | | | |
| *Arthroleptides martiensseni* | **Usambara Montane Torrent Frog** | F | N | | VU | | 1 |
| *Phrynobatrachus* sp. | **Puddle Frog** | ? | ? | | | | 1 |
| *Rana angolensis* | **Common River Frog** | O | W | | | | 7 |
| **GYMNOPHONIA** | | | | | | | |
| SCOLECOMORPHIDAE | | | | | | | |
| *Scolecomorphus vittatus* | **Caecilian** | F | N | | VU | | 1 |
| **TOTAL** | | | | | | | **201** |

**KEY TO ABBREVIATIONS FOR TABLE 30**

Ecological (Ecol.) type:

F – Forest dependent species: Species confined to primary forest only; not including forest edge or secondary forest.
f – Forest dwelling but not forest dependent species: Species occurring in primary forest, forest edge or secondary forest.
O – Non-forest species: Species that do not occur in primary or secondary forest or forest edge.

Endemic (End.) status:

E – Endemic: Species only found in the Usambara Mountains.
N – Near endemic: Species with limited ranges usually only including coastal forest and/or East African lowland forests.
W – Widely distributed species.

IUCN status:

EN – Endangered
VU – Vulnerable
LR/NT – Lower Risk/Near Threatened
DD – Data Deficient

CITES listings:

I – Appendix One listed species
II – Appendix Two listed species
(Appendix Three species not included in Table)

By far the most commonly captured genus in pitfalls was *Arthroleptis*, or Squeakers, which dwell in leaf litter (Table 30). Interestingly, their life history involves direct development of frogs in the leaf litter without a freeswimming stage. This makes at least a partially covered wooded area to create leaf litter an essential habitat requirement. Individuals in this genera are particularly difficult to identify to species level and, particular care must be taken with this group to treat identifications as tentative until taxonomic confirmation is obtained.

An interesting capture was that of *Mertensophryne micranotis* (Dwarf toad), as it is most commonly known to be an Eastern Arc and coastal endemic.

In addition to these captures, one further species was observed casually but not retained (Table 31).

**Table 31** Amphibians observed casually in Mgambo FR.

| Species | Common name | Ecol. type | End. status | Threat Status | | | Certainty of identification |
|---|---|---|---|---|---|---|---|
| | | | | IUCN 2000 | UDSM 1997 | CITES 2001 | |
| RANIDAE | | | | | | | |
| *Ptychadena anchietae* | **Plain Grass Frog** | f | W | | | | Certain |

**Figure 23** Plain grass frog (*Ptychadena anchietae*).

Five forest dependent amphibian species were captured and observed in Mgambo FR, all of which were also categorised as near endemic (UDSM 1997). Four are classified as Vulnerable and one species Endangered (*Mertensophryne micranotis)* (UDSM 1997) (Table 30). Five amphibian species have restricted ranges (UDSM, 1997), these are summarised in Table 32.

**Table 32** Restricted ranges for near-endemic amphibians (UDSM, 1997).

| Species | Common name | Range |
|---|---|---|
| *Bufo brauni* | **Dead leaf Toad** | Usambara; Uluguru and Udzungwa Mountains. |
| *Mertensophryne micranotis* | **Dwarf Toad** | Coastal forests and East Usambaras (Kilulu Hill), and Sokoke, Kenya. |
| *Leptopelis barbouri* | **Tree Frog** | Usambara and Udzungwa Mountains |
| *Scolecomorphus vittatus* | **Caecilian** | Usambara, Uluguru, North Pare Mountains, Magrotto and lowlands near Usambaras. |
| *Arthroleptides martiensseni* | **Usambara Montane Torrent Frog** | Usambara, Magarotto, Uluguru, Nguru and Udzungwa Mountains. |

Of particular interest was the capture of the caecilian *Scolecomorphus vittatus,* a leg-less worm-like amphibian of the order Gymnophoinia, in lowland forest at trapsite 1. Although locally common, they are not commonly captured, especially in the smaller forest reserves. They are sometimes known as 'Queen of the Ants' because they can be observed at the front of a trail of ants. They are thought to feed on earth worms and other invertebrates – little else is known of their ecology.

### 5.4.5 Invertebrates

#### *5.4.5.1 Butterflies*

A total of 138 species of butterfly were captured in Mgambo FR, using sweepnets and canopy traps. These species represented 5 families (taxonomic classicification is taken from Larsen (1996), where Nymphalidae is one large family incorporating genera, such as *Acraea, Bicyclus, Charaxes, Danaus, Hypolimnas, Salamis,* etc. This is in contrast to Kielland (1990), where there are 5 families under the superfamily of Nymphaloidea, thereby splitting the above genera into different families). One hundred and ninety one specimens were retained for taxonomic purposes. Official taxonomic identifications have yet to be obtained. Ecological type and endemic status were compiled using Kielland (1990) and Larsen (1996).

The butterfly species list for Mgambo FR is presented to subspecies level in Table 33. This table also indicates whether butterflies have previously been recorded in the East Usambara Mountains, using an East Usambara butterfly species list up to April 2000 and specimens collected by EUBS and listed in reports from 2000 onwards. Capture data for trapsites is summarised in Appendix 11.

Eighty percent of all butterfly species captured in Mgambo FR were widespread in distribution with eleven species of near endemic status. Seventeen percent of butterfly species were forest dependent, 39% forest dwelling, 8% non-forest species, and 12% unknown. If identifications are accurate (to be confirmed) at least five species records represent range extensions and ten represent those of uncommon, localised or rare species.

A large number of butterfly species were caught, possibly because Mgambo FR has a variety of different habitats, reflecting changes through overgrazing and fire disturbance. The majority of the butterfly species were non-forest species, possibly indicating the predominance of open habitat types, such as open and Miombo woodland.

**Table 33** Summary of butterflies captured in Mgambo FR.

| Species | Ecol. type | End. status | Other information | Existing EU Record (Y / N) |
|---|---|---|---|---|
| HESPERIIDAE | | | | |
| *Coeliades anchises anchises* | O | W | | N |
| LYCAENIDAE | | | | |
| *Aslauga purpurascens* | f | W | | N |
| *Axiocerses amanga* | O | W | | N |
| *Axiocerses harpax* | O | W | | Y |
| *Axiocerses punicea* | f | W | Not common in Usambaras | N |
| *Axiocerses tjoane* | O | W | | Y |
| *Baliochila hildegarda* | f | W | | Y |
| *Baliochila* sp. | ? | ? | | ? |
| *Leptotes adamsoni* | f | N | | N |
| *Ornipholodotos peucetia peucetia* | F | W | Expect 800-1200m | Y |
| *Pentila tropicalis* | f | W | | Y |
| *Spindasis mozambica* | f | W | | N |
| *Teriominia subpunctata* | F | N | Coastal lowland forest | Y |
| *Zizeeria knysna* | O | W | | N |
| NYMPHALIDAE | | | | |
| Unknown sp. | ? | ? | | ? |
| *Acraea* sp.[1] | ? | ? | | ? |
| *Acraea* sp.[2] | ? | ? | | ? |
| *Acraea acrita* | O | W | | N |
| *Acraea anemosa* | f | W | | Y |
| *Acraea eponina eponina* | f | W | | Y |
| *Acraea cf. macarista* | ? | ? | | N |
| *Acraea cf. matuapa* | F | N | Not common in East Usambaras | N |
| *Acraea natalica natalica* | O | W | | Y |
| *Acraea rabbaiae mombasae* | f | W | Not common in Usambaras | N |
| *Amauris niavius niavius* | F | W | | Y |
| *Amauris ochlea ochlea* | f | W | | Y |
| *Apaturopsis cleochares schulzei* | f | W | Very local and uncommon | Y |
| *Bicyclus campinus ocelligerus* | F | W | | Y |
| *Bicyclus ena* | O | W | | Y |
| *Bicyclus safitza safitza* | O | W | | Y |
| *Byblia anvatara acheloia* | O | W | | Y |
| *Byblia ilithyia* | O | W | | Y |
| *Charaxes* sp. [1] | ? | ? | | ? |
| *Charaxes* sp. [2] | ? | ? | | ? |
| *Charaxes* sp. [3] | ? | ? | | ? |
| *Charaxes* sp. [4] | ? | ? | | ? |
| *Charaxes achaemenes achaemenes* | O | W | | Y |
| *Charaxes aubyni ecketti* | f | W | | Y |
| *Charaxes bohemani* | O | W | | Y |
| *Charaxes brutus* | f | W | | Y |
| *Charaxes candiope candiope* | f | W | | Y |
| *Charaxes castor castor* | f | W | | Y |
| *Charaxes cithaeron nairobicus* | F | W | | Y |

**Table 33** continued Summary of butterflies captured in Mgambo FR.

| Species | Ecol. type | End. status | Other information | Existing EU Record (Y / N) |
|---|---|---|---|---|
| NYMPHALIDAE continued | | | | |
| *Charaxes contrarius* | f | N | Coastal forests | Y |
| *Charaxes etesipe gordani* | f | W | | Y |
| *Charaxes ethalion kikuyensis* | f | W | | Y |
| *Charaxes* cf. *etheocles evansi* | f | W | | Y |
| *Charaxes fionae* | O | W | | Y |
| *Charaxes fulvescens* | f | W | Ususally found in West Tanzania | N |
| *Charaxes guderiana rabaiensis* | f | W | | N |
| *Charaxes* cf. *hansali baringana* | O | W | | Y |
| *Charaxes* cf. *howarthi* | O | W | Usually found in West Tanzania | |
| *Charaxes jahlusa kenyensis* | f | W | Uncommon, local race | Y |
| *Charaxes kirki kirki* | O | W | Locally common | Y |
| *Charaxes lasti kimbozae* | F | W | Not common to East Usambaras | Y |
| *Charaxes lasti lasti* | f | N | | Y |
| *Charaxes pleione oriens* | f | W | | Y |
| *Charaxes protoclea azota* | f | W | | Y |
| *Charaxes pythodoris nesaea* | F | N | Uncommon, very local | N |
| *Charaxes saturnus* | O | W | | N |
| *Charaxes varanes vologese* | O | W | | Y |
| *Charaxes violetta maritimus* | f | W | | Y |
| *Charaxes zoolina zoolina* | f | W | | Y |
| *Danaus* sp. | ? | ? | | |
| *Euphaedra neophron littoralis* | F | N | Usambaras, South Pare Mts | Y |
| *Euptera kinugnana* | F | W | | Y |
| *Euryphura achlys* | F | W | | Y |
| *Eurytela dryope angulata* | f | W | | Y |
| *Euxanthe tiberius* | F | N | Coastal forest | Y |
| *Euxanthe wakefieldi* | F | W | Lowland forest | Y |
| *Hamanumida daedalus* | O | W | | Y |
| *Henotesia perspicua* | O | W | | Y |
| *Henotesia* sp. | ? | ? | | ? |
| *Hypolimnas anthedon* | F | W | | Y |
| *Hypolimnas deceptor deceptor* | f | W | | Y |
| *Hypolimnas* cf. *deceptor* | f | W | | Y |
| *Hypolimnas misippus* | O | W | | Y |
| *Hypolimnas usambara* | F | N | Rare, coastal primary forest | Y |
| *Junonia* cf. *hierta* | O | W | | Y |
| *Junonia natalica natalica* | f | W | | Y |
| *Junonia oenone oenone* | O | W | | Y |
| *Libythea labdaca laius* | f | W | | Y |
| *Melantis leda* | O | W | | Y |
| *Neptidopsis fulgurata platyptera* | f | W | | Y |
| *Neptis carcassoni* | F | W | Lowland forest | Y |
| *Neptis goochi* | F | W | | Y |
| *Neptis saclava marpessa* | f | W | | Y |
| *Phalanta phalantha aethipicus* | O | W | | Y |
| *Physcaeneura leda* | O | N | Coastal N.E. Tanzania and Kenya | Y |
| *Pseudacraea eurytus condrati* | F | W | | Y |
| *Pseudacraea lucretia expansa* | f | W | | Y |
| *Pseudacraea lucretia protracta* | f | W | | Y |

**Table 33** continued Summary of butterflies captured in Mgambo FR.

| Species | Ecol. type | End. status | Other information | Existing EU Record (Y / N) |
|---|---|---|---|---|
| NYMPHALIDAE continued | | | | |
| *Salamis* cf. *anacardii* | f | W | | Y |
| *Salamis cacta* | F | W | | Y |
| *Sallya garega garega* | f | W | West Tanzania | N |
| *Sallya natalensis* | f | W | | Y |
| *Sallya* sp. | ? | ? | | ? |
| *Tirumala petiverana* | f | W | | N |
| PAPILIONIDAE | | | | |
| *Graphium* sp. | ? | ? | | ? |
| *Graphium angolanus angolanus* | O | W | | N |
| *Graphium antheus* | f | W | | Y |
| *Graphium colonna* | f | W | | Y |
| *Graphium leonides leonides* | O | W | More common in West Tanzania | Y |
| *Graphium policenes* | F | W | | Y |
| *Graphium porthaon mackie* | f | W | | Y |
| *Papilio bromius* | F | W | West Tanzania | Y |
| *Papilio constantinus* | f | W | | Y |
| *Papilio dardanus polytrophus* | f | W | | Y |
| *Papilio demodacus demodacus* | O | W | | Y |
| *Papilio hornimani* | F | N | E & W Usambaras, S. Pare Mts | Y |
| *Papilio nireus lyaeus* | f | W | | Y |
| *Papilio ophidicephalus ophidicephalus* | f | W | | Y |
| PIERIDAE | | | | |
| *Unknown sp.* | ? | ? | | ? |
| *Appias epaphia orbona* | f | W | | N |
| *Appias lasti lasti* | f | W | Coastal and Masagati | Y |
| *Appias sabina phoebe* | f | W | | Y |
| *Belenois creona severina* | O | W | | Y |
| *Belenois thysa thysa* | f | W | | Y |
| *Belenois subeida* | O | W | | Y |
| *Colotis* sp.[1] | ? | ? | | ? |
| *Colotis sp.*[2] | ? | ? | | ? |
| *Colotis aurigineus* | f | W | | Y |
| *Colotis auxo incretus* | O | W | | Y |
| *Colotis danae* | O | W | | Y |
| *Colotis* cf. *daira jacksoni* | O | W | Comparatively rare in Tanzania | Y |
| *Colotis euippe omphale* | f | W | | Y |
| *Colotis evagore antigone* | O | W | | Y |
| *Colotis ione* | O | W | | Y |
| *Colotis regina* | O | W | | Y |
| *Colotis vesta* | O | W | | N |
| *Dixeia doxo* | O | W | | N |
| *Eronia leda* | O | W | | Y |
| *Eurema brigatta brigatta* | O | W | | Y |
| *Eurema floricola* | F | W | Confined to lowland forest | Y |
| *Eurema regularis* | O | W | | Y |
| *Mylothris agathina* | O | W | | N |
| *Mylothris similis* | F | W | | N |
| *Nepheronia argia argia* | f | W | | Y |

Existing EU record: Yes (Y) or No (N). This column only considers specimens to species level.

**KEY TO ABBREVIATIONS FOR TABLE 33**

Ecological (Ecol.) type:

F – Forest dependent species: Species confined to primary forest only; not including forest edge or secondary forest.
f – Forest dwelling but not forest dependent species: Species occurring in primary forest, forest edge or secondary forest.
O – Non-forest species: Species that do not occur in primary or secondary forest or forest edge.

Endemic (End.) status:

E – Endemic: Species only found in the Usambara Mountains.
N – Near endemic: Species with limited ranges usually only including coastal forest and/or East African lowland forests.
W – Widely distributed species.

Other Information obtained from:

Larsen (1996); Kielland (1990)

### *5.4.5.2 Molluscs*

A total of 153 molluscs were collected in zoological trapsites and opportunistically. Taxonomic determinations were not available at the time of publication. Specimens were deposited at the Zoological Museum of Copenhagen (refer to Appendix 1).

### *5.4.5.3 Millipedes*

A total of 392 millipedes were collected in zoological trapsites and opportunistically. Taxonomic determinations were not available at the time of publication. Specimens were deposited at the Zoological Museum of Copenhagen (refer to Appendix 1).

### 5.4.6 Distribution of endemic and forest dependent species

Almost all near endemic and forest dependent fauna were captured or observed outside the 9 most disturbed areas (Figure 24). Fire and grazing were the two most significant forms of disturbance in Mgambo FR (refer to Figures 17 and 18 and disturbance discussion, page 36 of report) and it is likely that illegal grazing poses the greatest threat to endemic and forest dependant fauna within the reserve as the forest patches are further encroached.

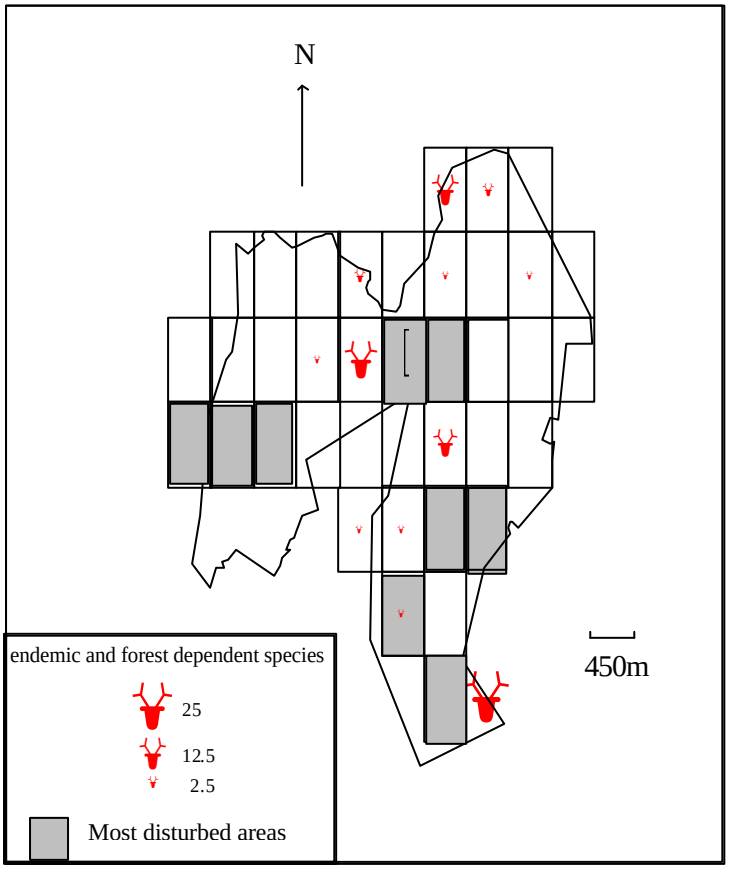


**Figure 24** Distribution of forest dependent and near endemic fauna in comparison with the most disturbed areas in Mgambo FR

## 5.4 Discussion

### 5.5.1 Introduction

Mgambo FR is 1,346ha and despite its relatively small size, the number of animal species recorded was comparable to those found in nearby forest reserves, such as Bombo East I and II and Mtai FRs (refer to Frontier Tanzania, 1999, Frontier Tanzania 2002c and Frontier Tanzania 2002d) (although the number of mammal species captured was lower than expected). Amani Nature Reserve, for comparison, is almost 6 times the area but, when surveyed, was found to contain approximately 25% more species (refer to Frontier Tanzania, 2001).

**Table 34** Summary of faunal families and species (identified to date) and inclusive of casual observations, dung surveys etc.

| Taxon | Number of families | Number of species |
|---|---|---|
| Mammals (not including bats) | 18 | 35 |
| Bats | 4 | 10 |
| Birds | 30 | 52 |
| Reptiles | 9 | 20 |
| Amphibians | 7 | 14 |
| Butterflies | 5 | 138 |

### 5.5.2 Species Abundance and Importance

To provide a concept of species abundance, the frequency of species-capture was investigated. This makes the assumption that the frequency with which an animal is recorded reflects its general abundance and it must be highlighted that abundance of highly cryptic species may not be reflected accurately. Also, it does not give a good measure of species distribution within the reserve.

#### *5.5.2.1 Mammals*

The most commonly captured mammal species was *Acomys spinosissimus* (Spiny mouse, 23 individuals captured, 10 of which were recaptures). Most of these captures were from trapsite 2, an area of Miombo woodland. The other species frequently recorded were those of the genus *Crocidura* (White-toothed shrew, 13 individuals captured). All of the identifications to species level are tentative, but of those, *Crocidura* cf. *elongius* was the most frequently captured, mostly in trapsite 2.

Other species recorded in low abundance, at a frequency of one individual per species, were *Grammomys* sp. (Narrow-footed woodland mouse), *Mastomys* sp. (Multi-mammate rat) and *Graphiurus* sp. (Dormouse)

Of the larger mammals, there were at least 7 separate sightings of *Cercopithecus (n.) mitis* (Gentle/blue monkey) in the forested areas (not including basecamp, where one group was seen almost daily) and *Papio cynocephalus* (Yellow baboon) was seen on a number of occasions in and near the forest borders. *Colobus angolensis palliatus* (Angola pied colobus) was observed on over eleven different occasions and heard a number of times, although these may represent approximately six different groups in patchily distributed lowland forest.

Frequent aural records of *Dendrohryax validus* (Eastern tree hyrax), *Otolemur garnetti* (Small-eared galago) *Otolemur crassicaudatus* (Greater galago) and *Galagoides zanzibaricus* (Zanziibar galago) were heard nightly at trapsite 3, an area of lowland and riverine forest.

Species recorded indirectly through spoor on many occasions were *Thryonomys gregorianus* (Cane rat), *Papio cynocephalus* (Yellow baboon) and *Cephalophus* sp. (Duiker sp.). Unfortunately, the frequency of domestic cattle and goat spoor was also very high within the reserve, particularly in open woodland areas.

The most commonly caught bat species was *Rhinolophus clivosus* (Horseshoe bat, 18 individuals captured), most of which were from trapsite 1, where there was thought to be a roost, possibly a cave, nearby. Also frequently captured were *Glauconycteris argentata/variegata* (Butterfly bat, 7 individuals captured) and *Scotoecus* sp. (Evening bat, 6 individuals captured), mainly from trapsite 3.

#### *5.5.2.2 Birds*

Bird species frequently observed in the reserve in a number of locations are as follows, *Tokus alboterminatus* (Crowned hornbill), *Bycanistes bucinator* (Trumpeter hornbill) and *Buteo augur* (Augur buzzard), although the latter may have been the same pair on several of those occasions. The 2 owl species *Strix woodfardii nigricantoir* (African wood owl) and *Tyto alba affinis* (Barn owl) were frequently heard at trapsite 3 and in riverine forest near to base camp.

The bird list for Mgambo has not been compared with an East Usambara species list in the same way as for other taxa. However, if the *Tauraco porphyreolophus chlorochlamysi* (Purple-crested turaco) sightings were correct, this is currently a species with no recent records in north Tanzania (Zimmerman *et al*, 1996). Similarly, *Onychognathus morio* (Red-winged starling) is known to be rare in the Usambara foothills and *Lonchura fringilloides* (Magpie mannikin), is commonly known from Amani, (Zimmerman *et al* 1996).

#### *5.5.2.3 Reptiles*

Two species caught relatively frequently were: *Gerrhosaurus flavigularis* (Yellow-throated lizard, 11 individuals captured), mostly at trapsite 2, and *Scaphiophus albopunctatus* (Hook-nosed snake, 5 individuals captured). The latter were juveniles caught at trapsite 4, an area of scrub forest. This species is not currently on the East Usambara database (available from EUCAMP website) and the East African population of this genus seems to be isolated (Spawls *et al* 2002).

Other species not commonly recorded, if at all, in the EUBS database (from EUCAMP website), but captured in small numbers in Mgambo were: *Pachydactylus* sp. (Thick-toed gecko, one individual captured), *Latastia longicaudata* (Southern long-tailed lizard, two individuals captured) and *Heliobolus speckii speckii* (Speke's sand lizard, three individuals captured). These are important findings in that these species prefer drier habitats. This may be indicative of the increasing levels of disturbance within the forest reserve and a change of species type, abundance and distribution.

*Mabuya maculilabris* (Speckle-lipped skink) was frequently seen throughout the reserve, although it was not often captured.

#### *5.5.2.4 Amphibians*

By far the most abundant amphibian genus was *Arthroleptis* (Squeakers). Captures of *Arthroleptis stenodactylus* (78 individuals) and *Arthroleptis xenodactyloides* (71 individuals), were recorded from trapsites 1 and 3, although field identification of these species may not be very accurate. Also caught with relative abundance were *Hemisus marmoratus* (Mottled shovel-nosed frog, 16 individuals captured) and *Bufo maculatus* (Flat backed toad, 10 individuals captured). Again these were from trapsites 1 and 3, areas of riverine and lowland forest.

### *5.5.2.5 Invertebrates*

Relative abundance for molluscs and millipedes was not determined.

Butterflies caught 10 or more times are listed in descending order, with the numbers caught in brackets, as follows:
*Charaxes brutus* (78), *Charaxes candiope candiope* (77), *Belenois creona severina* (53), *Melanitis leda* (49), *Charaxes violetta maritimus* (43), *Charaxes zoolina zoolina* (42), *Charaxes cithaeron nairobicus* (36), *Bicyclus safitza safitza* (34), *Charaxes contrarius* (33), *Charaxes jahlusa kenyensis* (30), *Byblia anvatara acheloia* (26), *Eurytela dryope angulata* (21), *Byblia ilithyia* (20), *Acraea rabbaiae mombasae* (18), *Charaxes castor castor* (18), *Papilio dardanus polytrphus* (17), *Charaxes varanes vologeses* (15), *Euphaedra neophron littoralis* (14) *Euptera kinugnana* (14), *Charaxes ethalion kikuyensis* (11).

With provisional identifications, 23 (17%) of Mgambo's butterfly species caught have not previously been recorded on the East Usambara Mountains biodiversity database (Pohjonen, 2001).

### *5.5.2.6 Endemics and near-endemics*

Most of the near endemic species found during the four 10 day trapsites were at trapsite 1, in riverine forest, and trapsite 3, lowland forest (Figure 25). Of those species found at trapsite 2 (Miombo woodland) and trapsite 4 (scrub forest), most were butterfly species. Casual findings outside of the trapsites were predominantly found in riverine forest.

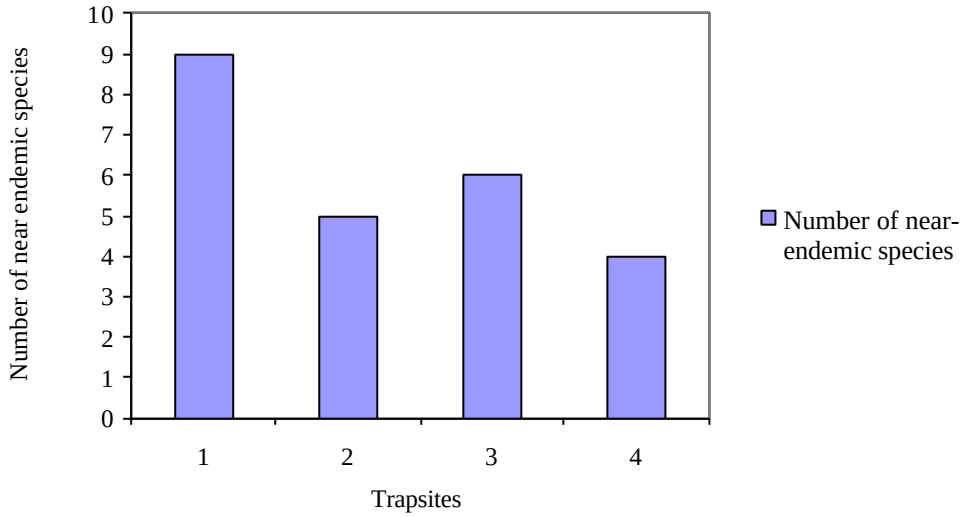


**Figure 25** Distribution of near endemic species found at trapsites 1-4

Of the 12 mammal, bird, reptile and amphibian species, which are near-endemic to the Usambara Mountains and were recorded during this survey, only the following were recorded frequently, *Bufo brauni* (Deal leaf toad) and *Lygodactylus lutecpicturatus* (Yellow-headed dwarf gecko).

### *5.5.2.7 Forest dependent species*

The concentration of forest dependant species was highest for trapsite 1 (Figure 26), which was a riverine forest habitat. Most of the forest dependant species found there were butterflies and amphibians. Of approximately equal concentration were forest dependent species found at trapsites 3 and 4, lowland forest and scrub forest respectively. Most species at trapsite 3 were mammals and birds.

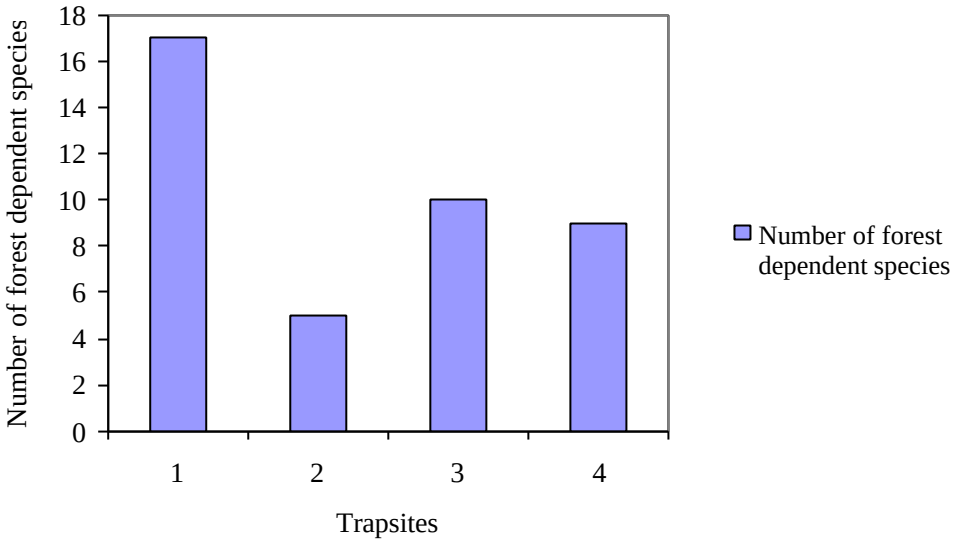


**Figure 26** Distribution of forest dependent species found at trapsites 1-4

Of the 14 mammal, bird, reptile and amphibian species which are dependant on primary forest, only the following were recorded frequently during this survey, *Colobus angolensis palliatus* (Angola Pied Colobus), *Galagoides zanzibaricus* (Zanzibar galago) and *Bufo brauni* (Dead leaf toad).

Of the 24 (17%) forest dependant butterfly species, only three species were caught frequently during the survey. These were *Charaxes cithaeron nairobicus, Euphaedra neophron littoralis* and *Euptera kinugnana.*

#### *5.5.2.8* ***High risk species***

With the assumption that species observed rarely may have a low abundance, species of conservation concern in Mgambo can be determined. Cryptic species, such as chameleons have not been included in the following list. The species that were observed infrequently and are both forest dependent and near-endemic are as follows, *Rhynchocyon* petersi (Zanj elephant shrew), *Mertensophryne micranotis* (Dwarf toad), *Leptopelis barbouri* (Tree frog), *Athroleptides martiensseni* (Usambara montane torrent frog), *Scolecomorphus vittatus* (Caecilian). Butterfly species include: *Teriominia subpunctata*, *Acraea* cf. *matuapa, Charaxes pythodoris nesaea, Euxanthe tiberius, Hypolimnas usambara* and *Papilio hornimani.*

Specific research would be essential before any further comments were to be made on the conservation status of specific taxa.

### 5.5.3 Ecological Type

Of all the faunal species found, 38 are forest dependant species; 4 of these are mammals, 3 are birds, 2 are reptiles, 5 are amphibians and 24 are butterflies.

**Table 35** Summary of ecological type of mammal, bird, reptile, amphibian and butterfly species.

| Ecological type | No. of species | % of total species recorded |
|---|---|---|
| Forest dependent | 38 | 14 |
| Forest dwelling but not forest dependent | 96 | 35 |
| Non-forest species | 111 | 40 |
| Unknown | 31 | 11 |
| **TOTAL:** | **276** | **100** |

### 5.5.4 Endemic Status

A total of 23 faunal species recorded are near-endemics; of these 3 are mammals, 2 are birds, 2 are reptiles, 5 are amphibians and 11 are butterflies.

**Table 36** Summary of endemic status of mammal, bird, reptile, amphibian and butterfly species.

| Endemic status | No. of species | % of total species recorded |
|---|---|---|
| Endemic to the Usambara Mountains | 0 | 0 |
| Near-Endemic: ranges in restricted locations | 23 | 8 |
| Widespread | 223 | 81 |
| Unknown | 30 | 11 |
| **Total:** | **276** | **100** |

### 5.5.5 IUCN Status

Only one species are listed as endangered (IUCN, 2000). This are *Rhynchocyon petersi* (Zanj elephant shrew).

Species listed as vulnerable (IUCN, 2000) are *Crocidura* cf. *elongius* (White-toothed shrew), *Dendrohyrax validus* (Eastern tree hyrax), *Paraxerus palliatus* (Red-bellied coastal squirrel).

For the purpose of this study, the National Biodiversity Database has also been taken into consideration to establish threat status (UDSM, 1997). This is because certain Tanzanian species, in particular reptile and amphibian species, have been omitted from the IUCN 2000, listings despite their situation not having improved since the previous IUCN listings in 1994. The National Biodiversity Database, therefore, currently utilises the 1994 IUCN list to reflect current situations more closely. Species recorded as endangered under this classification are, *Dendrohyrax validus* (Eastern tree hyrax) and *Mertensophryne micranotis* (Dwarf toad).

Those present on the UDSM, 1997 list as vulnerable are, *Crocidura* cf. *elongius* (White-toothed shrew), *Bufo brauni* (Dead leaf toad), *Leptopelis barbouri* (Tree frog), *Arthroleptides martiensseni* (Usambara montane torrent frog) and *Scolecomorphus vittatus* (Caecilian).

# 6.0 CONCLUSIONS

## Authors: Bracebridge, C.E. and Oliver, S.A. pp. 73-74

This report presents the data collected during the baseline biodiversity survey of Mgambo Forest Reserve. The report presents preliminary checklists of flora and fauna groups and categorises the ecological type and endemic status of species. These two factors provide an indication of three aspects of biodiversity and conservation:

1. the relationship between forest dependency and endemism;
2. the extent to which non-forest species are established in the reserve; and
3. the relationship between disturbance and areas of biological value.

Mgambo Forest Reserve was gazetted in July 1998. The gazetted reserve covers an area of 1,346ha, with an altitudinal range of 320m - 820m. The forest reserve has altered significantly in recent years as a consequence of intensive overgrazing and fire damage. It is presently made up of a mixture of riverine forest, lowland forest, scrub forest, *Miombo* woodland and open woodland, all subject to a variety of different levels of disturbance.

### 6.1 Disturbance

Fire was the most significant threat to both flora and fauna in Mgambo FR, and was recorded in just over two thirds of all vegetation plots sampled. There were no vegetation plots surveyed with canopy heights greater than 20m. Open grass/bushland and woodland habitats were dominant in burnt areas, increasing the susceptibility of the reserve to future fire disturbance.

One of the causes of deliberate fire was to provide fresh grazing for livestock, and, indeed, another major disturbance category for Mgambo was grazing. This was also predominantly found on the eastern side of the reserve. Other forms of disturbance, such as pole and timber extraction, trapping, cultivation and pitsawing, were relatively low in Mgambo FR.

### 6.2 Species Richness

Mgambo FR was found to contain a minimum of 101 species of plant, 34 mammal, 10 bat, 52 bird, 25 reptile, 14 amphibian and 138 butterfly species (figures for molluscs and millipedes have yet to be determined). The number of faunal species found in Mgambo FR was fewer than the number found within nearby forest reserves, (refer to Frontier Tanzania, 2002c and 2002d, and Frontier Tanzania, 1999). Relative to the other thirteen forest reserves surveyed by Frontier-Tanzania Mgambo FR had a below average species richness for plants, and a below average species richness of mammals, an average species richness for reptiles and amphibians and a high species richness for butterflies. Species richness was likely to be associated with forest reserve size and the degree of patchiness and/or isolation of forested areas. Mgambo FR is relavtively small in size with patchy distribution of forest habitats that are isolated as a consequence of grazing and fire disturbance.

### 6.3 Flora

Only one tree species recorded in the vegetation plots was endemic to the Usambara Mountains. Twelve species were found to have ranges restricted to the Eastern Arc and/or East African lowland forests. Five species were dependent on primary forest and 62 were forest dwelling.

Twenty-seven non-forest tree and shrub species were established within the reserve boundaries.

## 6.4 Fauna

Twenty three species were listed as near endemic to the Usambara Mountains. Thirty eight fauna species were forest dependant, many of which were butterflies.

Three species recorded in Mgambo FR have endangered status (either listed by IUCN, 2000 or UDSM, 1997) - one mammal, one reptile and one amphibian species.

## 6.5 Conservation

The forests of the East Usambara Mountains are recognised as being part of a Biodiversity Hotspot (Mittermeier, 1999), an Endemic Bird Area (ICBP, 1992), a Centre of Plant Diversity (WWF and IUCN) and a Globally Important Ecoregion (WWF). They are a conservation priority due to their floral and faunal diversity and to the high number of endemic species. The forests also have a direct value to surrounding communities as a principle water catchment area and as a source of fuel-wood and medicinal plants.

The forests of the East Usambara Mountains have been reduced to fragments within a matrix of agricultural land. Little forest remains outside of the gazetted forest reserves. For those species that are forest dependent, the forest reserves now provide almost the only available habitat.

There are differences in the perceived value of the forests between the villagers and the Forest and Beekeeping Division. Alternative sources of building material and fuel are required in order to meet the needs of surrounding villages while ensuring the protection of the forests.

The impact of illegal fire damage and overgrazing is of serious concern throughout Mgambo Forest Reserve and increased protection is required to prevent future disturbance destroying the patches of forest that remain. Further degradation of forest habitats in Mgambo FR will lead to local population extinctions, particularly of those species identified as being at high risk. The loss of forested areas in Mgambo will also reduce the reliability of the water supply to neighbouring communities.

It is likely that past hunting has seriously depleted large mammal populations. Present data supports this. Little can presently be done to reverse this problem unless the need for forest meat disappears.

Mgambo FR, as one of the smaller forest blocks in the East Usambara Mountains, has a particularly high risk of flora and faunal population extinctions compared to larger forest reserves. There is a need for older generations and forestry managers, jointly, to reinstil a sense of responsibility amongst younger and less knowledgeable generations, to insure the importance of the remaining forest is known. This will go some way towards helping the sustainable management of their forest reserve. Small scale environmental education activities during the present survey went some way to promote such an idea (refer to Frontier Tanznia, 2002a and Frontier, 2002b), but much work remains. Mgambo FR is thought to be a very suitable location for the implementation of Joint Forest Management activities. Surrounding communities have well organised and active village and environmental committees.

# 7.0 REFERENCES

Broadley, D.G. 1995. A new species of *Prosymna* Gray (Serpentes: COLUBRIDAE) from coastal forest in northeastern Tanzania. *Arnoldia Zimbabwe* 10 (4): 29 - 32.

CITES listings 2001. Copied from TRAFFIC office, Dar-es-Salaam, Tanzania, March 2001.

Collar, N.J. & Stuart, S.N. 1987. Priorities for conservation action. *ICBP Monograph* No. 3. 1988. Cambridge.

EUBS 2000. East Usambara biodiversity survey database. From *East Usambara Conservation Area Management Programme* website.

Frontier Tanzania, 1999. Mtai Forest Reserve: A biodiversity survey. *East Usambara Conservation Area Management Programme Technical Paper No. 39.* Forestry and Beekeeping Division, Metsähallitus Consulting & Society for Environmental Exploration, Dar es Salaam, Vantaa & London.

Frontier Tanzania, 2001. Amani Nature Reserve: A biodiversity survey. *East Usambara Conservation Area Management Programme, Technical Paper 52.* Forestry and Beekeeping Division & Metsähallitus Consulting & Society for Environmental Exploration, Dar es Salaam, Vantaa & London.

Frontier Tanzania, 2002a Oliver,S.A., Bracebridge, C., Fanning, E. & Muruke, M (eds.).*Environmental Education Programme, Environmental Activities within Local Communities.East Usambara Mountains.* East Usambara Conservation Area Management Programm, Working Paper No. 47. Society for Environmental Exploration, UK; University of Dar es Salaam and Forestry and Beekeeping Division, Tanzania.

Frontier Tanzania 2002b. Oliver, S.A., E. Fanning, Hall, S., & Muruke, M., (eds.). *Resource Pack for Environmental Educators – Activities to Encourage Environmental Awareness for Forest Reserves.* . East Usambara Conservation Area Management Programme Working Paper No. 48. Society for Environmental Exploration, UK; University of Dar es Salaam and Forestry and Beekeeping Division, Tanzania.

Frontier Tanzania, 2002c Bombo East I Forest Reserve. A biodiversity survey. *East Usambara Conservation Area Management Programme Technical Paper No. 57.* Frontier Tanzania and Forestry and Beekeeping Division, Dar es Salaam, Tanzania; and Indufor / Metsähallitus Group, Vantaa, Finland.

Frontier Tanzania, 2002d Bombo East II Forest Reserve. A biodiversity survey. *East Usambara Conservation Area Management Programme Technical Paper No. 58.* Frontier Tanzania and Forestry and Beekeeping Division, Dar es Salaam, Tanzania; and Indufor / Metsähallitus Group, Vantaa, Finland.

Griffiths, C.J. 1993. The geological evolution of East Africa. In J.C. Lovett, & S.K. Wasser (eds.). *Biogeography and ecology of the rain forests of eastern Africa.* Cambridge University Press, Cambridge. 9-22 pp.

Hamilton, A.C. 1989. The place and the problem. A survey of forest types on the East Usambara Mountains using the variable-area tree plot method. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania.* IUCN, Gland. pp 213-226.

Hilton-Taylor, C. (compiler) 2000. *2000 IUCN Red List of Threatened Species.* IUCN, Gland, Switzerland and Cambridge, UK. xviii+61 pp.

Howell, K.M. 1989. The East Usambara Fauna. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania.* IUCN, Gland. pp 315-355.

Howell, K.M. 1993. Herpetofauna of the eastern African forests. In J.C. Lovett, & S.K. Wasser (eds.). *Biogeography and ecology of the rain forests of eastern Africa.* Cambridge University Press, Cambridge. pp 173-201.

Hyytiäinen, K. 1995. Land use classification and mapping for the East Usambara mountains. *East Usambara Conservation Area Management Programme.*

ICBP. 1992. *Putting Biodiversity on the Map: Priority areas for conservation*. Cambridge, UK. International Council for Bird Preservation.

IUCN 1996. *IUCN Red list of threatened animals*. IUCN, Gland, Switzerland.

Iversen, S.T. 1991a. *The Usambara mountains, NE Tanzania: History, Vegetation and conservation*. Uppsala University, Uppsala.

Iversen, S.T. 1991b. *The Usambara mountains, NE Tanzania: Phytogeography of the vascular plant flora*. Uppsala University, Uppsala.

Johansson, S. 1996. Facts and figures on the East Usambaras – a source for conservators. *East Usambara Conservation Area Management Programme, Working Paper No. 23*. Forestry and Beekeeping Division, Metsähallitus Consulting & Society for Environmental Exploration, Dar es Salaam, Vantaa & London.

Johansson S. & Sandy R. 1996. Updated Forest area information in the Usambara mountains. *East Usambara Conservation Area Management Programm, Working Paper No. 19.* Forestry and Beekeeping Division, Metsähallitus Consulting & Society for Environmental Exploration, Dar es Salaam, Vantaa & London.

Kielland, J. 1990. *Butterflies of Tanzania.* Hill House Publishers (Melbourne & London).

Kikula, I.S. 1989. Spatial changes in forest cover on the East Usambara mountains. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania.* IUCN, Gland. Pp 79 - 86.

Kingdon, J. 1974. *East African Mammals. An atlas of evolution in Africa. Vol. 2B: Hares and rodents.* University Chicago Press, Chicago.

Kingdon, J. 1989. *East African mammals. An atlas of evolution in Africa. Vol. 2A: Insectivores and bats.* University of Chicago Press, Chicago.

Kingdon, J. 1997. *The Kingdon field guide to African Mammals*. Academic Press, London. 464 pages.

Kingdon, J & Howell, K. M. 1993. Mammals in the forests of Eastern Africa. In J.C. Lovett, & S.K. Wasser (eds.). *Biogeography and ecology of the rain forests of eastern Africa.* Cambridge University Press, Cambridge. Pp 229-241.

Knox, E.B. 2000. List of East African Plants (LEAP). *Database compiled largely from the Flora of Tropical East Africa (Rotterdam: Balkema) and Beentje (1994)*.

Larsen, T. B. 1996. *The butterflies of Kenya and their natural history*. Oxford University Press, Oxford.

Lovett, J.C. 1989. The botanical importance of the East Usambara forests in relation to other forests in Tanzania. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania.* IUCN, Gland. Pp 207-212.

Mittermeier, R. A., Myers, N., Gil, P. R., and Mittermeier, C. G., 1999. *Hotspots: Earth's Biologically Richest and Most Endangered Terrestrial Ecoregions.* CEMEX and Conservation International. Washington DC, USA.

Mlingwa, C.O.F., Waiyaki, E.M., Bennun, L.A. and Burgess, N.D. 2000. Birds. In: Burgess, N.D. and Clarke, G.P. *Coastal Forests of Eastern Africa* xiii +443pp. IUCN, Gland, Switzerland and Cambridge, UK.

Passmore, N. I. And V. C. Carruthers. 1995. *South African frogs: a complete guide*. Southern book publishers.

Pohjonen, V.M. 2001. *East Usambara Biodiversity Database*, EUCAMP, unpublished. 28/10/2001.

Polhill, D. 1988. *Flora of Tropical East Africa. Index of collecting localities*. Royal Botanical Gardens, Kew.

Poynton J.C. & Clarke, B.T. 1999. Two species of *Staphopaedes* (Anura: Bufonidae) from Tanzania, with review of the genus. *African Journal of Herpetology. 48(1&2): 1-14.*

Poynton J.C. & Broadley, D.G. 1991. Amphibia zambesiaca 5. Zoogeography. *Ann. Natal Mus.* Vol 32:221-277.

Rodgers, W.A. 1996. *Biodiversity values of Tanzanian forests: A training and awareness manual for forest managers and conservationists*. FAO, Dar es Salaam.

Rodgers, W.A. & Homewood, K.M. 1982. The conservation of the East Usambara Mountains, Tanzania: a review of biological values and land use pressures. *Biol. J. Linn. Soc.* 24: 285-304.

Ruffo. K. 1989. Some useful plants of the East Usambara Mountains. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania.* IUCN, Gland. pp 185-194.

Ruffo. K.; Mmari, C.; Kibuwa, S.P.; Lovett, J.; Iversen, S. & Hamilton, A.C. 1989. A preliminary list of the plant species recorded from the East Usambara forests. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania.* IUCN, Gland. pp 157-179.

Sallu A.N, (2002) *The Reliance of Local Communities on Protected Forest for Traditional Uses and Their Role in Forest Conservation*, BTEC project, unpublished report.

Schmidt, P. 1989. Early exploitation and settlement in the Usambara mountains. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania.* IUCN, Gland. pp 357-361.

SEE, 1998. Methodology report (SEE, 1996. Frontier Tanzania Forest Research Programme: Methodology report 'Old and New'. L. Stubblefield & P. Cunneyworth eds. *Technical paper of the Society for Environmental Exploration*, London).

Spawls, S., Howell, K., Drewes, R. and Ashe, J. 2002. *A Field Guide to the Reptiles of East Africa.* Academic Press, London, UK.

Stattersfield, A.J., Crosby, M.J., Long, A.J. and Wege, D.C. 1998. *Endemic Bird Areas of the World. Priorities for Biodiversity Conservation.*BirdLife Conservation Series No. 7, BirdLife International

Stuart, S.N. 1989. The avifauna of the East Usambara mountains. Chapter 35 - Forest conservation in the East Usambara mountains Tanzania. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania*. IUCN, Gland. pp 357-361.

Tye, A. 1994. Magarotto rainforest conservation - Proposal for establishment of a new reserve. *EUCDP, IUCN, Amani, Tanzania (unpublished.).*

UDSM. 1997. *National Biodiversity Database 1997.* Unpublished. Department of Zoology and Marine Biology, University of Dar es Salaam, Dar es Salaam.

Walker, C. 1996. *Signs of the Wild*. Struik. 215 pages.

Zimmerman, D.A., Turner, D.A. & Pearson, D.J. 1996. *Birds of Kenya and Northern Tanzania*. Russel Friedman Books, South Africa.

# 8.0 APPENDICES

## Appendix 1: Taxonomic Verification

**BOTANY**

| | | |
|---|---|---|
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**ZOOLOGY**

**Mammals:**

| | | |
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| | | |
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**Reptiles:**

| | | |
|---|---|---|
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**Molluscs:**

| | | |
|---|---|---|
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**Millipedes:**

| | | |
|---|---|---|
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**Butterflies**

| | | |
|---|---|---|
| C/O Dr N. Scharff | Zoological Museum | University of Copenhagen,<br>Universitetsparken 15, DK-2100,<br>Copenhagen, Denmark |

# Appendix 2: GPS Co-ordinates of vegetation plots

Summary of GPS Coordinates of vegetation plots in Mgambo FR.

| Vegetation Plot | Longitude | Latitude | Grid Ref. 37M | Grid Ref. UTM |
|---|---|---|---|---|
| 1 | E 038°48'39.9" | S 04°47'21.0" | 0479052 | 9470687 |
| 2 | E 038°48'25.2" | S 04°47'23.0" | 0478598 | 9470626 |
| 3 | E 038°48'40.0" | S 04°46'52.0" | 0479052 | 9471578 |
| 4 | E 038°48'25.5" | S 04°46'52.8" | 0478607 | 9471554 |
| 5 | E 038°48'10.0" | S 04°46'52.4" | 0478130 | 9471563 |
| 6 | E 038°48'54.6" | S 04°46'23.1" | 0479503 | 9472465 |
| 7 | E 038°48'40.6" | S 04°46'22.6" | 0479072 | 9472479 |
| 8 | E 038°48'26.1" | S 04°46'24.0" | 0478624 | 9472437 |
| 9 | E 038°49'09.3" | S 04°45'51.7" | 0479956 | 9473429 |
| 10 | E 038°48'55.2" | S 04°45'52.5" | 0479523 | 973405 |
| 11 | E 038°48'40.9" | S 04°45'52.7" | 0479080 | 9473397 |
| 12 | E 038°48'27.3" | S 04°45'54.7" | 0478662 | 9473336 |
| 13 | E 038°48'12.3" | S 04°45'55.0" | 0478199 | 9473328 |
| 14 | E 038°47'58.0" | S 04°45'55.4" | 0477760 | 9473317 |
| 15 | E 038°47'43.6" | S 04°45'56.3" | 0477315 | 9473287 |
| 16 | E 038°47'29.4" | S 04°45'57.3" | 0476878 | 9473254 |
| 17 | E 038°47'15.2" | S 04°45'58.2" | 0476440 | 9473228 |
| 18 | E 038°49'09.3" | S 04°45'22.3" | 0479956 | 9474330 |
| 19 | E 038°48'54.6" | S 04°45'23.2" | 0479501 | 9474304 |
| 20 | E 038°48'39.7" | S 04°45'24.3" | 0479045 | 9474271 |
| 21 | E 038°48'26.2" | S 04°45'25.0" | 0478629 | 9474249 |
| 22 | E 038°48'26.3" | S 04°45'24.5" | 0477765 | 9474208 |
| 23 | E 038°47'58.0" | S 04°45'28.5" | 0477757 | 9474200 |
| 24 | E 038°47'58.0" | S 04°45'26.5" | 0477330 | 9474166 |
| 25 | E 038°47'29.5" | S 04°45'29.4" | 0476882 | 9474113 |
| 26 | E 038°48'42.4" | S 04°47'50.4" | 0479127 | 9469784 |
| 27 | E 038°48'54.7" | S 04°44'53.1" | 0479505 | 9475228 |
| 28 | E 038°48'40.1" | S 04°44'53.9" | 0479055 | 9475202 |
| 29 | E 038°47'43.8" | S 04°46'25.8" | 0477322 | 9472382 |
| 30 | E 038°47'28.9" | S 04°46'26.9" | 0476863 | 9472347 |
| 31 | E 038°47'16.2" | S 04°46'26.3" | 0476473 | 9472365 |

# Appendix 3: General vegetation plot descriptions

Summary of vegetation plot descriptions in Mgambo FR.

| Plot No. | Topo-graphy | Altitude (masl) | Slope (degrees) | Vegetation Condition | Canopy Height (m) | Disturbance Category | Features of Interest | No. species | No. indivs | Dominant sp. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | GLS | 360 | 6 | Open woodland | <10 | Fire | Roads/Tracks | 10 | 27 | *Combretum zeyheri* |
| 2 | GMS | 510 | 6 | Scrub/Thicket/Bush | <10 | Cutting/Fire | Clearings | 14 | 32 | |
| 3 | SLS | 430 | 24 | Open woodland | <10 | Cutting/Fire | None | 8 | 15 | |
| 4 | SLS | 460 | 27 | Open woodland | 10-20 | Fire | Rock outcrops | 16 | 37 | |
| 5 | SUS | 570 | 32 | Lowland Forest | 10-20 | Fire | None | 15 | 27 | |
| 6 | GMS | 420 | 5 | Open woodland | <10 | Cutting/Fire | None | 4 | 13 | *Combretum zeyheri* |
| 7 | SLS | 530 | 35 | Open woodland | <10 | Fire | None | 18 | 30 | |
| 8 | SLS | 340 | 30 | Lowland Forest | 10-20 | Cutting/Fire/Grazing | None | 18 | 42 | *Maytenus undata* |
| 9 | GMS | 400 | 7 | Open woodland | <10 | Fire | None | 9 | 28 | *Combretum zeyheri* |
| 10 | GMS | 480 | 22 | Open woodland | <10 | Fire | Rock outcrops | 9 | 26 | *Acacia hockii* |
| 11 | GMS | 600 | 34 | Open woodland | 10-20 | Fire/Grazing | Footpaths | 7 | 22 | *Brachystegia spiciformis* |
| 12 | SLS | 640 | 30 | Open woodland | 10-20 | Cutting/Fire/Grazing | Rock outcrops | 7 | 23 | *Stereospermum kunthianum* |
| 13 | GLS | 420 | 15 | Open woodland | <10 | Cutting | Roads/Paths | 8 | 30 | *Dombeya shupangae* |
| 14 | GMS | 960 | 29 | Lowland Forest | 10-20 | Fire | Path/Rock outcrops | 16 | 46 | |
| 15 | SMS | 635 | 36 | Open woodland | <10 | Fire | None | 9 | 18 | |
| 16 | GUS | 600 | 20 | Scrub/Thicket/Bush | <10 | Fire | None | 7 | 12 | |
| 17 | GLS | 510 | 8 | Scrub/Thicket/Bush | 10-20 | Fire | Roads/Tracks | 5 | 12 | *Acacia nilotica* |
| 18 | GLS | 440 | 6 | Open woodland | <10 | Cutting/Fire | None | 3 | 3 | |
| 19 | GMS | 500 | 13 | Open woodland | <10 | Cutting/Fire | None | 6 | 16 | *Combretum zeyheri* |
| 20 | GUS | 610 | 30 | Open woodland | 10-20 | Fire | None | 4 | 24 | *Brachystegia spiciformis* |
| 21 | GMS | 505 | 21 | Scrub/Thicket/Bush | <10 | None | None | 13 | 32 | |
| 22 | GLS | 440 | 7 | Open woodland | <10 | None | None | 10 | 28 | *Dombeya shupangae* |
| 23 | GMS | 440 | 26 | Scrub/Thicket/Bush | <10 | None | None | 16 | 38 | *Grewia bicolor* |
| 24 | GUS | 520 | 30 | Open woodland | <10 | None | None | 15 | 35 | *Grewia bicolor/Cordia ovalis* |
| 25 | GMS | 560 | 5 | Scrub/Thicket/Bush | <10 | Cutting | None | 17 | 58 | |
| 26 | GMS | 450 | 16 | Open woodland | <10 | Cutting/Fire | Roads/Tracks | 17 | 42 | |
| 27 | GLS | 400 | 11 | Open woodland | <10 | Fire | None | 5 | 30 | *Combretumzehyri* |
| 28 | GUS | 470 | 25 | Lowland Forest | <10 | Cutting | None | 22 | 33 | . |
| 29 | SUS | 800 | 35 | Open woodland | 10-20 | Cutting/Grazing | None | 7 | 13 | |
| 30 | SUS | 780 | 30 | Open woodland | 10-20 | Fire | None | 5 | 12 | |
| 31 | GMS | 560 | 17 | Lowland Forest | 10-20 | Cutting | Rock outcrops | 13 | 41 | |

**KEY** Topography:GLS – Gentle lower slope, GMS – Gentle mid-slope, GUS – Gentle upper slope, SLS – Steep lower slope, SMS – Steep mid slope

# Appendix 4: New flora for the East Usambara plant biodiversity database

Summary of new flora records for the East Usambara Plant Biodiversity Database (Pohjonen, 2001) from vegetation plots and opportunistic collection, Mgambo FR.

**VEGETATION PLOT TREES AND SHRUBS**

| | |
|---|---|
| ANACARDIACEAE | *Ozoroa insignis* |
| ANACARDIACEAE | *Sclerocarya birrea* |
| COMBRETACEAE | *Combretum exalatum* |
| EUPHORBIACEAE | *Spirostachys africana* |
| FLACOURTIACEAE | *Dovyalis hispidula* |
| LEGUMINOSAE | *Cassia abbreviata* |
| LEGUMINOSAE | *Erythrina abyssinica* |

**OPPORTUNISTIC COLLECTION AND OBSERVATION (MLINGA)**

| **Angiospermae – Dichotyledonae** | |
|---|---|
| ACANTHACEAE | *Acanthaspermum hispidum* |
| BORAGINACEAE | *Cordia goetzei* |
| FLACOURTIACEAE | *Dovyalis hispidula* |
| LABIATAE | *Orthosiphon rubicondus* |
| RUBIACEAE | *Polysphaeria lanceolata* |
| RUBIACEAE | *Psychotria ambonian* |
| ICACINACEAE | *Pyranacantha* sp. |
| ASCELPIDACEAE | *Secamone* sp. |
| OLACACEAE | *Ximenia caffra* |

* Species recorded in regeneration layer as well as vegetation plots

# Appendix 5: Useful plants

A summary of useful plants sampled systematically in vegetation plots in Mgambo FR (based on Ruffo, 1989)

| | Building Poles | Fuelwood | Tool handles | Pestles | Mortars | Ornamental | Dyes | Honey | Edible fruits | Other |
|---|---|---|---|---|---|---|---|---|---|---|
| ANACARDIACEAE | | | | | | | | | | |
| *Sorindeia madagascariensis* . | | + | + | | + | | | | + | Wooden spoons |
| BOMBACEAE | | | | | | | | | | |
| *Rhodognaphalon schumannianum* | + | | | | | | | | | |
| BURSERACEAE | | | | | | | | | | |
| *Commiphora eminii* ssp. *zimmermannii* | | | | | | | | | | Cups |
| COMBRETACEAE | | | | | | | | | | |
| *Combretum schumannii* | + | + | | + | | | | + | | |
| *Terminalia sambesiaca* | | | | + | | | | + | | |
| EUPHORBIACEAE | | | | | | | | | | |
| *Bridelia micrantha* | + | + | + | + | | | + | + | | |
| LEGUMINOSAE subfamily: MIMOSOIDEAE | | | | | | | | | | |
| *Albizia gummifera* | | + | | | + | | | + | | |
| LEGUMINOSAE subfamily: PAPILIONIDAE | | | | | | | | | | |
| *Milletia dura* | + | | | | | | | | | |
| MELIACEAE | | | | | | | | | | |
| *Turraea holstii* | | | | | | | | | | Wooden spoons |
| MORACEAE | | | | | | | | | | |
| *Milicia excelsa* | | | | | + | | + | | | |
| MYRSINACEAE | | | | | | | | | | |
| *Baeobotrys lanceolata* | | | | | | | | + | | |
| RUBIACEAE | | | | | | | | | | |
| *Vangueria tomentosa* | | | | | | | | | + | |
| RUTACEAE | | | | | | | | | | |
| *Zanthoxylum* sp. | | | | | | | | + | | |
| STERCULIACEAE | | | | | | | | | | |
| *Cola clavata* | + | | + | | | | | | | Wooden spoons |
| TILIACEAE | | | | | | | | + | | |
| *Grewia* sp. | | | | | | | | | | |

# Appendix 6: Medicinal plants

Summary of Medicinal Plants recorded in Mgambo FR (Sallu A.N, (2002).

| Family | Genus | species | Local name |
|---|---|---|---|
| Agavaceae | *Dracaena* | *steudneri* | Papata |
| Amaranthaceae | *Pupalia* | *atropurpurea* | Mamata |
| Ampelaceae | *Ampeloccissus* | *grantii* | Tongotongo |
| Anacardiaceae | *Rhus* | *natalensis* | Mhunguu |
| Anacardiaceae | *Lannea* | *schweinfurthii* | Mumbu |
| Anacardiaceae | *Mangifera* | *indica* | Mwembe dodo |
| Annonaceae | *Uvaria* | *acuminata* | Mshofu |
| Aracaceae | *Culcasia* | *scandens* | Kiandama |
| Aracaceae | *Gonatopus* | *boivinii* | Mshunghuu |
| Asclepidaceae | *Kanahia* | *laniflora* | Keema nkuuka |
| Asteraceae | *Crassocephalum* | *bojeri* | Eza |
| Asteraceae | *Blepharispermum* | *zanguebaricum* | Mlenga |
| Asteraceae | *Vernaonia* | *iodocalyx* | Mshasha |
| Asteraceae | *Microglossa* | *oblongifolia* | Mshashu |
| Asteraceae | *Sonchus* | *exauricalatus* | Mshunga |
| Asteraceae | *Sonchus* | *oleraceus* | Mshunga purapura |
| Asteraceae | *Aspilia* | *mossambicensis* | Nyangaanyangaa |
| Asteraceae | *Loggera* | *pterodonta* | Tulishi |
| Astersceae | *Bidens* | *pilosa* | Khamachuma |
| Balanitaceae | *Balanites* | *aegyptica* | Mkonga |
| Bignoniaceae | *Stereospermum* | *kunthianum* | Mkoma |
| Bignoniaceae | *Markhamia* | *lutea* | Mtalawanda |
| Bombacaceae | *Adansonia* | *digitata* | Mbuyu |
| Bombacaceae | *Bombax* | *rhodognaphalon* | Msufi mwitu |
| Caesalpinaceae | *Julbernardia* | *globiflora* | Mhangala |
| Caesalpinaceae | *Cassia* | *sengueana* | Mhumba |
| Caesalpinaceae | *Afzelia* | *quanzensis* | Mkomba |
| Caesalpinaceae | *Isoberlinia* | *scheffleri* | Msuke |
| Capparaceae | *Boscia* | *salicifolia* | Mguluka |

**Medicinal Plants Table continued**

| Family | Genus | species | Local name |
|---|---|---|---|
| Capparaceae | *Maerua* | *grantii* | Mtunda |
| Chaillentaceae | *Tapura* | *fischeri* | Msonogoi |
| Combretaceae | *Combretum* | *schummanii* | Mkongolo |
| Combretaceae | *Combretum* | *molle* | Mnama |
| Combretaceae | *Combretum* | *exalatum* | Mwekei |
| Commelinaceae | *Commelina* | *africana* | Nkongo |
| Cucurbitaceae | *Melothria* | *microsperma* | Fuiza |
| Cucurbitaceae | *Zehneria* | *scabra* | Fuiza |
| Cyperaceae | *Cyperus* | *alternifolia* | Zira |
| Ebenaceae | *Euclea* | *fructuosa* | Mdaa |
| Ebenaceae | *Diospyros* | *natalensis* | Mtambakuzimu |
| Euphorbiaceae | *Drypetes* | *usambarica* | Kihambie |
| Euphorbiaceae | *Jatrohpa* | *curcas* | Mbono |
| Euphorbiaceae | *Phyllanthus* | *innflatus* | Mkeche |
| Euphorbiaceae | *Phyllanthus* | *inflatus* | Mkeche |
| Euphorbiaceae | *Sapium* | *ellipticum* | Mkongoo |
| Euphorbiaceae | *Macaranga* | *capensis* | Mkumba |
| Euphorbiaceae | *Phyllanthus* | *guincensis* | Mkwamba |
| Euphorbiaceae | *Spirostachys* | *africana* | Msharaka |
| Euphorbiaceae | *Acalypha* | *paniculata* | Mzindu |
| Euphorbiaceae | *Ricinus* | *communis* | Mzono |
| Euphorbiaceae | *Ricinodendron* | *heudelotii* | Toudoo |
| Flacourtiaceae | *Dasylepis* | *leptophylla* | Kigwande |
| Graminae | *Eleusine* | *indica* | Kikuse |
| Graminae | *Pennisetum* | *purpureu* | Ngugu |
| Graminae | *Olyra* | *latifolia* | Ufiha |
| Graminae | *Oplismenus* | *hirlellus* | Ukoka |
| Graminae | *Rotteboellia* | *axaltata* | Ushuki |
| Hamamelidaceae | *Trichocladus* | *allipticus* | Mkombechi |
| Icacinaceae | *Leptaulis* | *holstii* | Mkungu |
| Labiatae | *Hyptis* | *pectinata* | Hozandogoi |

**Medicinal Plants Table continued**

| Family | Genus | species | Local name |
|---|---|---|---|
| Labiatae | *Lipia* | *asperifolia* | Mzugwa |
| Labiatae | *Ocimum* | sp. | Vumba manga |
| Labitae | *Plectranthus* | *amaniensis* | Hozandogoi |
| Labitae | *Ocimum* | *suave* | Kivumbasi |
| Labitae | *Hoslundia* | *oposita* | Mshwee |
| Labitae | *Plectranthus* | *barbatus* | Mzugwa |
| Loganiaceae | *Strychnos* | *innocua* | Mtonga |
| Menispemaceae | *Stephania* | *abyssinica* | Usisi mdodo |
| Mimosaceae | *Acacia* | *mellifera* | Kikwata |
| Mimosaceae | *Acacia* | sp | Mgungamwita |
| Mimosaceae | *Acacia* | *clavigera* | Mkame |
| Mimosaceae | *Albizia* | *harveyi* | Msisimizi |
| Monimiaceae | *Xymaros* | *monospora* | Kidimudimu |
| Moraceae | *Ficus* | *kirkii* | Kinyandege |
| Moraceae | *Ficus* | *sur* | Mkuyu |
| Moraceae | *Ficus* | *valis choudae* | Mkuyu maji |
| Moraceae | *Ficus* | *exasperata* | Msasa |
| Moraceae | *Ficus* | *holstii* | Msoso |
| Moraceae | *Ficus* | *natalensis* | Mvumo |
| Moraceae | *Milicia* | *excelsa* | Mzutwe |
| Musaceae | *Musa* | sp | Tindi |
| Myrtaceae | *Psdium* | *guajava* | Mpea |
| Myrtaceae | *Myrica* | *salicifolia* | Mshegheshe |
| Olacaceae | *Ximenia* | *americana* | Mtundwi |
| Onaginaceae | *Jussiaea* | sp | Kisagata |
| Palmae | *Cocos* | *nucifera* | Mnazi |
| Palmae | *Borassus* | *aethiopum* | Mvuma |
| Papilionaceae | *Cajanus* | *cajan* | Mbaazi |
| Papilionaceae | *Lonchocarpus* | *bussei* | Mfumbii |
| Papilionaceae | *Entada* | *abyssinica* | Mgodogodo |
| Papilionaceae | *Dalbergia* | *melanoxylon* | Mpingo |

**Medicinal Plants Table continued**

| Family | Genus | species | Local name |
|---|---|---|---|
| Papilionaceae | *Dalbergia* | *elata* | Msangazi |
| Papilionaceae | *Abrus* | *precatorius* | Ufyambo |
| Passifloraceae | *Adenia* | *cissampeloides* | Ghoe |
| Piperaceae | *Piper* | *capnesis* | Ngoko |
| Polygonaceae | *oxygonumatriplici* | *folium* | Mbigili |
| Rubiacea | *Canthium* | sp | Mlawa |
| Rubiacea | *Rytigynia* | *amaniensis* | Msonganya |
| Rubiaceae | *Vangueria* | *infausta* | Mvui |
| Rutaceae | *Citrus* | *aurantifolia* | Mdimu |
| Rutaceae | *Toddalia* | *asiatica* | Mdongonyezi |
| Rutaceae | *Zanthoxylum* | *eickii* | Mhombo |
| Rutaceae | *Citrus* | *aurantium* | Mshusa |
| Sapindaceae | *Alluphyllus* | *abyssinica* | Mbangwe |
| Sapindaceae | *Allophylus* | *calophyllus* | Mbangwe |
| Sapindaceae | *Deinbollia* | *borbonica* | Mbwakabwaka |
| Sapindaceae | *Lecaniodiscus* | *fraxinifolia* | Mbwewe |
| Sapindaceae | *Blighia* | *unijugata* | Mzinda nguuwe |
| sapotaceae | *Afrosersalsia* | *cerasifora* | Mohoyo |
| Solanaceae | *Solanum* | *incanum* | Mtua |
| Solanaceae | *Nicotiana* | *tabacum* | Tumbaku |
| Sterculiaceae | *Sterculia* | *appendiculata* | Mfune |
| Sterculiaceae | *Dombeya* | *shupangae* | Mkiika |
| Sterculiaceae | *Dombeya* | *rotundifolia* | Mkilika |
| Sterculiaceae | *Dombeya* | *guinguieseta* | Mlwati |
| Tiliaceae | *Grewia* | *forbesii* | Mkongodeka |
| Ulmaceae | *Trema* | *orientalis* | Mshinga |
| Umbeliferea | *Steganotaenia* | *araliacea* | Mnyongampembe |
| Verbenaceae | *Lantana* | *camara* | Mvuti |
| Zingiberaceae | *Aframomum* | *angustifolium* | Samaka |

# Appendix 7: Regeneration plot descriptions

Summary of rgenereration plot descriptions in Mgambo FR.

| Regen. Plot | Habitat | Ground cover (%) | | | | Dominance (%) | | | Soil Texture | Soil Colour | No. of inds. | No. of species |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Herbs | Bare soil | Litter | Rocks | Grasses | Forbs | Sages | | | | |
| 1 | Open Woodland | 60 | 20 | 10 | 10 | 55 | 10 | 0 | sandy-loam | dark brown | 9 | 3 |
| 2 | Scrub/Thicket/Bush | 50 | 30 | 20 | 0 | 40 | 60 | 0 | sandy-loam | dark brown | 5 | 2 |
| 3 | Open Woodland | 50 | 30 | 5 | 15 | 80 | 20 | 0 | sandy-loam | dark brown | 14 | 2 |
| 4 | Open Woodland | 10 | 20 | 30 | 40 | 10 | 90 | 0 | loam | dark brown | 1 | 1 |
| 5 | Lowland Forest | 45 | 40 | 10 | 5 | 80 | 20 | 0 | loamy-clay | brown | 3 | 2 |
| 6 | Open Woodland | 40 | 40 | 0 | 20 | 55 | 45 | 0 | sandy-loam | dark brown | 29 | 6 |
| 7 | Open Woodland | 10 | 30 | 60 | 0 | 10 | 90 | 0 | loam | brown | 5 | 3 |
| 8 | Lowland Forest | 5 | 15 | 80 | 0 | 2 | 98 | 0 | loam | dark grey | 9 | 5 |
| 9 | Open Woodland | 50 | 30 | 20 | 0 | 60 | 40 | 0 | clay | brown | 8 | 2 |
| 10 | Open Woodland | 70 | 30 | 0 | 20 | 90 | 10 | 0 | sandy-loam | dark grey | 3 | 1 |
| 11 | Open Woodland | 45 | 20 | 30 | 15 | 60 | 40 | 0 | sandy-loam | brown | 2 | 1 |
| 12 | Open Woodland | 50 | 20 | 30 | 0 | 80 | 20 | 0 | loamy-clay | dark brown | 2 | 1 |
| 13 | Open Woodland | 50 | 40 | 10 | 0 | 80 | 20 | 0 | sandy-clay | dark brown | 3 | 2 |
| 14 | Lowland Forest | 10 | 10 | 80 | 0 | 0 | 100 | 0 | loamy-clay | dark brown | 1 | 1 |
| 15 | Open Woodland | 70 | 10 | 20 | 0 | 95 | 5 | 0 | loam | black | 1 | 1 |
| 16 | Scrub/Thicket/Bush | 60 | 30 | 10 | 0 | 90 | 10 | 0 | sandy-loam | brown | 8 | 5 |
| 17 | Scrub/Thicket/Bush | 50 | 40 | 10 | 0 | 80 | 20 | 0 | sandy-loam | brown | 9 | 2 |
| 18 | Open Woodland | 80 | 20 | 0 | 0 | 80 | 20 | 0 | loamy-clay | brown | 3 | 2 |
| 19 | Open Woodland | 45 | 40 | 15 | 0 | 80 | 20 | 0 | loamy-clay | dark brown | 5 | 2 |
| 20 | Open Woodland | 25 | 0 | 70 | 5 | 50 | 40 | 10 | sandy-loam | red brown | 1 | 1 |
| 21 | Scrub/Thicket/Bush | 10 | 5 | 85 | 0 | 0 | 100 | 0 | loam | brown | 1 | 1 |
| 22 | Open Woodland | 60 | 0 | 40 | 0 | 60 | 40 | 0 | loam | dark brown | 0 | 0 |
| 23 | Scrub/Thicket/Bush | 5 | 20 | 75 | 0 | 0 | 100 | 0 | sandy-loam | light grey | 0 | 0 |
| 24 | Open Woodland | 40 | 40 | 20 | 0 | 10 | 90 | 0 | loamy-clay | brown | 4 | 3 |
| 25 | Scrub/Thicket/Bush | 10 | 0 | 90 | 0 | 0 | 100 | 0 | loamy-clay | brown | 28 | 2 |
| 26 | Open Woodland | 20 | 30 | 50 | 0 | 70 | 30 | 0 | sandy-clay | dark brown | 4 | 3 |
| 27 | Open Woodland | 60 | 30 | 10 | 0 | 95 | 5 | 0 | loamy-clay | red brown | 3 | 3 |
| 28 | Lowland Forest | 15 | 50 | 35 | 0 | 10 | 80 | 0 | sandy-clay | brown | 17 | 5 |
| 29 | Open Woodland | 85 | 0 | 15 | 0 | 90 | 10 | 0 | loam | dark brown | 1 | 1 |
| 30 | Open Woodland | 100 | 0 | 0 | 0 | 100 | 0 | 0 | loamy-clay | dark brown | 0 | 0 |
| 31 | Lowland Forest | 20 | 0 | 50 | 30 | 0 | 100 | 0 | loamy-clay | dark brown | 1 | 1 |
| | **MEAN** | **41.94** | **22.26** | **31.61** | **5.16** | **52.00** | **46.23** | **0.32** | | | **5.81** | **2.06** |
| | **Standard Deviation** | **25.26** | **14.80** | **28.10** | **9.96** | **35.73** | **36.03** | **1.77** | | | **7.19** | **1.50** |

# Appendix 8: Mammal capture data

**8a** Summary of small mammal capture at zoological trapsites in Mgambo FR (refer to Tables 18 and 19 for trapsite locations, descriptions and sampling intensity).

| Species | Number of individuals caught in trapsites 1-6 (sampling intensity in Sherman trap nights) | | | | | | No. of individuals captured | No. of recaptures | Total specimens taken |
|---|---|---|---|---|---|---|---|---|---|
| | 1 (998) | 2 (989) | 3 (997) | 4 (997) | 5 (29) | 6 (100) | (4110) | | |
| SORICIDAE | | | | | | | | | |
| *Crocidura bicolor* | - | 1 | - | - | - | | **1** | **-** | **1** |
| *Crocidura elongius* | - | 5 | - | 1 | - | - | **6** | **-** | **5** |
| *Crocidura hirta/xantippe* | - | 2 | - | - | - | - | **2** | **-** | **2** |
| *Crocidura hildegardeae* | 1 | - | - | - | - | - | **1** | **-** | **1** |
| *Crocidura* sp. | 2 | - | 1 | - | - | - | **3** | **-** | **3** |
| MURIDAE | | | | | | | | | |
| *Acomys spinosissimus* | 1 | 21 | - | - | 1 | - | **23** | **10** | **3** |
| *Grammomys* sp. | - | - | 1 | - | - | - | **1** | **-** | **1** |
| *Mastomys natalensis* | - | 1 | - | - | - | - | **1** | **-** | **1** |
| MYOXIDAE | | | | | | | | | |
| *Graphiurus* sp. | - | - | 1 | - | - | - | **1** | **-** | **1** |
| **TOTAL** | 4 | 30 | 3 | 1 | 1 | 0 | **39** | **10** | **18** |

**8b** Summary of bat capture at bat-netting sites in Mgambo FR (refer to Table 20).

| Species | Number of individuals caught in bat net sites 1-3 (sampling intensity in net square meter hours) | | | | Total no. individuals captured | Total specimen taken |
|---|---|---|---|---|---|---|
| | 1 (52.7) | 2 (416) | 3 (684.8) | 4 (390) | (1548) | |
| NYCTERIDAE | | | | | | |
| *Nycteris* sp. | - | - | 1 | - | **1** | **1** |
| *Nycteris grandis* | - | - | 1 | - | **1** | **1** |
| PTEROPODIDAE | | | | | | |
| *Epomorphus wahlbergi* | - | - | 1 | 2 | **3** | **1** |
| RHINOLOPHIDAE | | | | | | |
| *Hipposideros caffer / ruber* | 2 | - | - | - | **2** | **1** |
| *Rhinolophus clivosus* | 14 | 1 | - | 3 | **18** | **5** |
| *Rhinolophus hildebrandti* | 1 | 4 | - | - | **5** | **2** |
| *Rhinolophus landeri* | - | - | 1 | - | **1** | **1** |
| VESPERTILIONIDAE | | | | | | |
| *Glauconycteris argentata / variegata* | - | 1 | 6 | - | **7** | **2** |
| *Nyctecius shlieffeni* | 1 | - | - | - | **1** | **1** |
| *Scotoecus* sp. | - | - | 6 | - | **6** | **2** |
| **TOTAL** | 18 | 6 | 16 | 5 | **45** | **17** |

# Appendix 9: Reptile capture data

Summary of reptile capture at zoological trapsites and during opportunistic collection in Mgambo FR (refer to Tables 18 and 19 for trapsite locations, descriptions and sampling intensity).

| **Species** | **Number of individuals caught in traps at trapsites 1-4 (sampling intensity in trap nights)** | | | | **Casual collections** | **Total no. individuals captured** | **Total specimens taken** |
|---|---|---|---|---|---|---|---|
| | **1 (330)** | **2 (330)** | **3 (330)** | **4 (330)** | | | |
| CHAMAELEONIDAE | | | | | | | |
| *Rhampholeon k. kerstenii* | - | 1 | - | - | - | 1 | 1 |
| COLUBRIDAE | | | | | | | |
| *Natriciteres olivacea* | - | - | - | - | 2 | **2** | **2** |
| *Philothamnus* sp. | - | - | - | - | 1 | **1** | **1** |
| *Psammophis sudanensis* | - | - | - | - | 2 | **2** | **2** |
| *Scaphiophus albopunctatus* | - | - | - | 5 | - | **5** | **1** |
| Unknown genus | - | - | 1 | - | 1 | **1** | **1** |
| ELAPIDAE | | | | | | | |
| *Dendroaspis angusticeps* | - | - | - | - | 1 | **1** | **1** |
| *Naja* sp. | 1 | - | - | - | - | **1** | **1** |
| GEKKONIDAE | | | | | | | |
| *Cnemaspis africana* | 1 | - | 1 | - | - | **2** | **2** |
| *Hemidactylus* sp. | - | - | - | - | 1 | **1** | **1** |
| *Hemidactylus platycephalus* | - | - | 2 | - | - | **2** | **1** |
| *Pachydactylus* sp. | - | - | - | - | 1 | **1** | **1** |
| GERRHOSAURIDAE | | | | | | | |
| *Gerrhosaurus flavigularis* | 1 | 10 | - | - | - | 11 | 2 |
| *Gerrhosaurus sp.* | - | - | - | - | - | **1** | **1** |
| LACERTIDAE | | | | | | | |
| *Heliobolus speckii speckii* | - | 2 | - | - | 1 | 3 | 1 |
| *Holaspis guentheri laevis* | - | - | - | - | 1 | **1** | **1** |
| *Latastia longicaudata* | - | 1 | - | 1 | - | **2** | **2** |
| LEPTOTYPHLOPIDAE | | | | | | | |
| *Leptotyphlops* sp. | - | - | - | - | 2 | **2** | **2** |
| SCINCIDAE | | | | | | | |
| *Mabuya maculilabris* | 1 | - | 1 | - | - | **2** | **2** |
| *Lygosoma* sp. | - | - | - | - | 1 | **1** | **1** |
| VIPERIDAE | | | | | | | |
| *Bitis arientans* | 1 | - | - | - | 1 | **2** | **2** |
| **TOTAL** | 5 | 14 | 5 | 6 | 15 | **45** | **29** |

# Appendix 10 : Amphibian capture data

Summary of amphibian capture at zoological trapsites and during opportunistic collection in Mgambo FR (refer to Tables 18 and 19 for trapsite locations, descriptions and sampling intensity).

| **Species** | **Number of individuals caught in traps Trapsites 1-4 (sampling intensity in bucket pitfall nights)** | | | | **Casual collections** | **Total no. indivuals captured*** | **Total specimens taken** |
|---|---|---|---|---|---|---|---|
| | **1 (330)** | **2 (330)** | **3 (330)** | **4 (330)** | | | |
| ARTHROLEPTIDAE | | | | | | | |
| *Arthroleptis stenodactylus** | 53 | - | 25 | - | - | **78** | **3** |
| *Arthroleptis xenodactyloides** | 39 | - | 32 | - | - | **71** | **7** |
| BUFONIDAE | | | | | | | |
| *Bufo brauni* | 7 | - | - | - | - | **7** | **2** |
| *Bufo gutturalis* | - | - | - | - | 1 | **1** | - |
| *Bufo maculatus* | - | - | 10 | - | - | **10** | **1** |
| *Bufo* sp. | - | - | - | - | 1 | **1** | **1** |
| *Mertensophryne micranotis* | - | - | - | - | 1 | **1** | **1** |
| HEMISOTIDAE | | | | | | | |
| *Hemisus marmoratus* | 6 | - | 10 | - | - | **16** | **2** |
| HYPEROLIIDAE | | | | | | | |
| *Leptopelis barbouri* | 1 | - | - | - | 4 | **5** | **1** |
| PIPIDAE | | | | | | | |
| *Xenopus muelleri* | - | - | - | - | 1 | **1** | **1** |
| RHACOPHORIDAE | | | | | | | |
| *Chiromantis xerampelina* | - | - | - | - | 1 | **1** | **1** |
| RANIDAE | | | | | | | |
| *Arthroleptides martiensseni* | - | - | - | - | 1 | **1** | **1** |
| *Phrynobatrachus* sp. | - | - | - | - | 1 | **1** | **1** |
| *Rana angolensis* | 2 | - | 1 | - | 4 | **7** | **2** |
| SCOLECOMORPHIDAE | | | | | | | |
| *Scolecomorphus vittatus* | 1 | - | - | - | - | **1** | **1** |
| **TOTAL** | 109 | 0 | 78 | 0 | 15 | **202** | **25** |

*May include recaptures

# Appendix 11: Butterfly capture data

**11a** Summary of butterfly capture in canopy traps at zoological trapsites 1 to 4 in Mgambo FR (refer to Tables 18 and 19 for trapsite locations, descriptions and sampling intensity).

| **Species** | **Number of individuals caught in canopy traps Trapsites 1-4 (sampling intensity in butterfly trap days)** | | | | **Total no. individuals captured** | **No. of specimens taken** |
|---|---|---|---|---|---|---|
| | **1 (50)** | **2 (50)** | **3 (50)** | **4 (50)** | | |
| LYCAENIDAE | | | | | | |
| *Baliochila hildegarda* | - | 1 | - | - | **1** | **1** |
| NYMPHALIDAE | | | | | | |
| *Apaturopsis cleochares schulzei* | 1 | - | - | - | **1** | **1** |
| *Bicyclus campinus ocelligerus* | - | - | 2 | - | **2** | **0** |
| *Bicyclus safitza safitza* | 1 | 1 | 13 | | **15** | **0** |
| *Byblia ilithyia* | - | 11 | 4 | | **15** | **0** |
| *Byblia anvatara acheloia* | - | 16 | 2 | - | **18** | **2** |
| *Charaxes* sp[1]. | - | 1 | - | - | **1** | **1** |
| *Charaxes* sp[2]. | - | - | - | 1 | **1** | **1** |
| *Charaxes* sp3. | - | - | - | 1 | **1** | **1** |
| *Charaxes achaemenes achaemenes* | - | 2 | | - | **2** | **1** |
| *Charaxes aubyni ecketti* | - | - | - | 2 | **2** | **2** |
| *Charaxes bohemani* | - | 2 | - | - | **2** | **2** |
| *Charaxes brutus* | 1 | 15 | 45 | 17 | **78** | **3** |
| *Charaxes candiope candiope* | 1 | 10 | 35 | 31 | **77** | **2** |
| *Charaxes castor castor* | 2 | 3 | 2 | 11 | **18** | **2** |
| *Charaxes cithaeron nairobicus* | 2 | 1 | 29 | 4 | **36** | **3** |
| *Charaxes contrarius* | - | 1 | 14 | 18 | **33** | **2** |
| *Charaxes* cf. *etheocles evansi* | - | - | 3 | - | **3** | **1** |
| *Charaxes etesipe gordoni* | 1 | 1 | - | 1 | **3** | **1** |
| *Charaxes ethalion kikuyensis* | - | 2 | 6 | 3 | **11** | **3** |
| *Charaxes fionae* | - | 1 | - | - | **1** | **1** |
| *Charaxes fulvescens* | 1 | - | - | - | **1** | **1** |
| *Charaxes guderiana rabaiensis* | - | 2 | - | - | **2** | **2** |
| *Charaxes* cf. *howarthi* | - | 2 | 3 | - | **5** | **2** |
| *Charaxes* cf. *hansali baringana* | - | 1 | 1 | 1 | **3** | **1** |
| *Charaxes jahlusa kenyensis* | - | 1 | 9 | 19 | **29** | **1** |
| *Charaxes kirki kirki* | - | 2 | 3 | 1 | **6** | **1** |
| *Charaxes lasti kimbozae* | - | - | 4 | - | **4** | **1** |
| *Charaxes lasti lasti* | 1 | - | 7 | - | **8** | **1** |
| *Charaxes protoclea azota* | - | - | 4 | 5 | **9** | **0** |
| *Charaxes pythodoris nesaea* | 1 | - | - | - | **1** | **1** |
| *Charaxes saturnus* | - | 1 | 1 | 1 | **3** | **1** |
| *Charaxes varanes vologeses* | - | - | 8 | 6 | **14** | **0** |
| *Charaxes violetta maritimus* | 9 | - | 29 | 5 | **43** | **1** |
| *Charaxes zoolina zoolina* | - | 6 | 15 | 19 | **40** | **5** |
| *Danaus* sp. | - | 1 | - | - | **1** | **1** |

**11a** continued

| Species | Number of individuals caught in canopy traps Trapsites 1-4 (sampling intensity in butterfly trap days) | | | | Total no. individuals captured | No. of specimens taken |
|---|---|---|---|---|---|---|
| | **1 (50)** | **2 (50)** | **3 (50)** | **4 (50)** | | |
| NYMPHALIDAE continued. | | | | | | |
| *Euptera kinugnana* | 11 | - | - | - | **11** | **6** |
| *Euryphura achlys* | - | - | 1 | 1 | **2** | **1** |
| *Eurytela dryope angulata* | 1 | 2 | 10 | 5 | **18** | **2** |
| *Euxanthe wakefieldi* | - | - | - | 1 | **1** | **1** |
| *Hamanumida daedalus* | 2 | - | 1 | - | **3** | **1** |
| *Henotesia* sp. | - | 1 | - | - | **1** | **1** |
| *Henotesia perspicua* | - | 2 | - | - | **2** | **2** |
| *Hypolimnas anthedon* | 3 | - | - | 3 | **6** | **1** |
| *Hypolimnas deceptor deceptor* | 1 | - | - | - | **1** | **1** |
| *Hypolimnas usambara* | 1 | - | - | - | **1** | **1** |
| *Libythea labdaca laius* | 1 | - | 2 | 4 | **7** | **1** |
| *Melantis leda* | 2 | 5 | 25 | 12 | **44** | **2** |
| *Pseudacraea lucretia expansa* | 1 | - | - | 3 | **4** | **2** |
| *Pseudacraea lucetia protracta* | 2 | - | - | 6 | **8** | **2** |
| *Sallya garega garega* | - | 1 | - | 3 | **4** | **3** |
| *Sallya natalensis* | - | 2 | 1 | 1 | **4** | **2** |
| PIERIDAE | | | | | | |
| *Belenois creona severina* | - | - | - | 3 | **3** | **0** |
| **TOTAL** | 46 | 97 | 279 | 188 | **610** | **78** |

**11b** Summary of butterflies caught sweepnetting at zoological trapsites and casually in Mgambo FR (refer to Tables 18 and 19 for trapsite locations, descriptions and sampling intensity).

| **Species** | **Number of individuals caught in systematic sweepnetting Trapsites 1-4 (sampling intensity in sweepnet hours)** | | | | **Casual sweepnet captures** | **Total no. individuals captured** | **No. of specimens taken** |
|---|---|---|---|---|---|---|---|
| | **1 (20)** | **2 (20)** | **3 (20)** | **4 (20)** | | | |
| HESPERIIDAE | | | | | | | |
| *Coeliades anchises anchises* | - | - | - | - | 1 | **1** | **1** |
| LYCAENIDAE | | | | | | | |
| *Aslauga purpurascens* | - | 1 | - | - | - | **1** | **1** |
| *Axiocerses amanga* | - | 1 | - | - | - | **1** | **1** |
| *Axiocerses harpax* | - | - | - | - | 2 | **2** | **1** |
| *Axiocerses punicea* | - | 1 | - | - | - | **1** | **1** |
| *Axiocerses tjoane* | - | 1 | - | - | 1 | **2** | **1** |
| *Baliochila* cf. *hildegarda* | - | 2 | - | - | - | **2** | **2** |
| *Baliochila* sp. | - | 1 | - | - | - | **1** | **1** |
| *Ornipholidotos peucetia peucetia* | 1 | - | - | - | - | **1** | **1** |
| *Pentila tropicalis* | - | 1 | - | - | - | **1** | **1** |
| *Spindasis mozambica* | - | 4 | - | - | 1 | **5** | **3** |
| *Teriominia subpunctata* | - | - | 1 | - | - | **1** | **1** |
| *Zizeeria knysna* | - | 1 | - | - | - | **1** | **1** |
| NYMPHALIDAE | | | | | | | |
| Unknown sp. | - | - | - | - | 1 | **1** | **1** |
| *Acraea* sp.[1] | - | - | - | 1 | - | **1** | **1** |
| *Acraea* sp.[2] | - | - | - | - | 1 | **1** | **1** |
| *Acraea acrita* | - | 1 | - | - | - | **1** | **1** |
| *Acraea anemosa* | - | 5 | - | - | 2 | **7** | **2** |
| *Acraea eponina eponina* | 1 | - | - | - | 1 | **2** | **1** |
| *Acraea* cf. *macarista* | 1 | - | - | - | - | **1** | **1** |
| *Acraea* cf. *matuapa* | - | 1 | - | - | - | **1** | **1** |
| *Acraea natalica natalica* | - | 1 | - | - | - | **1** | **1** |
| *Acraea rabbaiae mombasae* | 6 | 8 | - | 4 | - | **18** | **1** |
| *Amauris ochlea ochlea* | - | - | - | - | 1 | **1** | **1** |
| *Bicyclus ena* | - | 2 | - | - | - | **2** | **2** |
| *Bicyclus safitza safitza* | - | 4 | 11 | - | 2 | **17** | **1** |
| *Byblia anvatara acheloia* | - | 7 | 1 | - | - | **8** | **1** |
| *Byblia ilithyia* | | 5 | - | - | - | **5** | **0** |
| *Charaxes* sp.[4] | - | - | - | - | 1 | **1** | **0** |
| *Charaxes* cf. *howarthi* | - | - | 1 | - | - | **1** | **0** |
| *Charaxes juhlasa kenyensis* | - | 1 | - | - | - | **1** | **1** |
| *Charaxes pleione oriens* | 1 | - | - | - | - | **1** | **0** |
| *Charaxes protoclea azota* | - | - | - | - | 1 | **1** | **1** |
| *Charaxes zoolina zoolina* | 1 | - | - | 1 | - | **2** | **1** |
| *Charaxes varanes vologeses* | - | 1 | - | - | - | **1** | **0** |
| *Danaus* sp. | - | 2 | - | - | - | **2** | **1** |

**11b** continued

| Species | Number of individuals caught in systematic sweepnetting Trapsites 1-4 (sampling intensity in sweepnet hours) | | | | Casual sweepnet captures | Total no. individuals captured | No. of specimens taken |
|---|---|---|---|---|---|---|---|
| | 1 (20) | 2 (20) | 3 (20) | 4 (20) | | | |
| NYMPHALIDAE continued. | | | | | | | |
| *Euphaedra neophron littoralis* | 8 | - | 4 | 1 | 1 | **14** | **2** |
| *Euptera kinugnana* | 3 | - | - | - | - | **3** | **1** |
| *Eurytela dryope angulata* | - | 2 | - | - | 1 | **3** | **1** |
| *Euxanthe tiberius* | 1 | - | - | - | - | **1** | **1** |
| *Hamanumida daedalus* | - | 1 | - | - | 1 | **2** | **1** |
| *Henotesia perspicua* | - | 1 | - | - | - | **1** | **1** |
| *Hypolimnas misippus* | - | - | - | - | 1 | **1** | **1** |
| *Hypolimnas* cf. *deceptor* | - | - | - | - | 1 | **1** | **1** |
| *Junonia oenone oenone* | - | - | - | - | 1 | **1** | **0** |
| *Junonia natalica natalica* | - | 1 | - | - | 1 | **2** | **1** |
| *Libythea labdaca laius* | - | - | 1 | 1 | - | **2** | **1** |
| *Melanitis leda* | - | 1 | 4 | - | - | **5** | **0** |
| *Neptis carcassoni* | - | - | - | 1 | - | **1** | **1** |
| *Neptis goochi* | - | - | - | - | 1 | **1** | **1** |
| *Neptis saclava marpessa* | 1 | - | - | - | - | **1** | **1** |
| *Phalanta phalantha aethiopicus* | - | 1 | - | - | - | **1** | **1** |
| *Physcaeneura leda* | 1 | 1 | - | - | - | **2** | **1** |
| *Pseudacraea eurytus condrati* | 1 | - | - | - | - | **1** | **1** |
| *Pseudacraea lucretia expansa* | 1 | - | - | - | - | **1** | **0** |
| *Salamis* cf. *anacardii*. | - | - | - | - | 1 | **1** | **1** |
| *Salamis cacta* | - | - | - | - | 1 | **1** | **1** |
| PAPILIONIDAE | | | | | | | |
| *Graphium angolanus angolanus* | - | - | - | - | 2 | **2** | **1** |
| *Graphium antheus* | 1 | 1 | - | 1 | - | **3** | **2** |
| *Graphium colonna* | - | - | - | - | 1 | **1** | **0** |
| *Graphium policenes* | 1 | - | - | - | - | **1** | **0** |
| *Graphium porthaon mackie* | - | - | - | 1 | - | **1** | **1** |
| *Papilio bromius* | 4 | - | - | - | - | **4** | **1** |
| *Papilio constantinus* | - | 2 | - | - | 1 | **3** | **1** |
| *Papilio dardanus polytrophus* | 1 | - | 1 | 14 | - | **16** | **1** |
| *Papilio demodocus demodocus* | - | 8 | - | - | 1 | **9** | **1** |
| *Papilio hornimani* | - | - | - | 1 | - | **1** | **1** |
| *Papilio nireus lyaeus* | - | - | - | 1 | - | **1** | **1** |
| *Papilio ophidicephalus ophidicephalus* | - | - | - | 1 | 1 | **2** | **1** |
| PIERIDAE | | | | | | | |
| Unknown sp | - | - | - | - | 1 | **1** | **1** |
| *Appias epaphia orbona* | - | - | - | 2 | 1 | **3** | **2** |
| *Appias lasti lasti* | 1 | - | - | - | - | **1** | **1** |
| *Appias sabina phoebe* | 1 | - | - | - | - | **1** | **1** |
| *Belenois creona severina* | - | 22 | - | 27 | 1 | **50** | **4** |

**11b** continued.

| **Species** | **Number of individuals caught in systematic sweepnetting Trapsites 1-4 (sampling intensity in sweepnet hours)** | | | | **Casual sweepnet captures** | **Total no. individuals captured** | **No. of specimens taken** |
|---|---|---|---|---|---|---|---|
| | **1 (20)** | **2 (20)** | **3 (20)** | **4 (20)** | | | |
| PIERIDAE continued | | | | | | | |
| *Belenois thysa thysa* | 2 | 3 | - | 1 | 1 | **7** | **1** |
| *Belenois subeida* | - | 1 | - | - | - | **1** | **1** |
| *Colotis aurigineus* | - | 1 | - | - | - | **1** | **1** |
| *Colotis auxo incretus* | - | 4 | - | 1 | - | **5** | **4** |
| *Colotis danae* | - | - | - | - | 1 | **1** | **1** |
| *Colotis* cf. *diara jacksoni* | - | 1 | - | - | - | **1** | **1** |
| *Colotis euippe omphale* | 1 | 4 | - | - | 1 | **6** | **1** |
| *Colotis evagore antigone* | - | 1 | - | - | - | **1** | **1** |
| *Colotis ione* | - | - | - | - | 2 | **2** | **1** |
| *Colotis regina* | - | 7 | - | 1 | - | **8** | **1** |
| *Colotis* sp.[1] | - | 1 | - | - | - | **1** | **1** |
| Colotis *sp.*[2] | - | - | - | 1 | - | **1** | **1** |
| *Colotis vesta* | - | 1 | - | - | 1 | **2** | **1** |
| *Dixeia doxo* | - | 1 | - | - | - | **1** | **1** |
| *Eronia leda* | - | - | - | - | 1 | **1** | **0** |
| *Eurema brigatta brigatta* | - | 1 | - | - | - | **1** | **1** |
| *Eurema floricola* | 6 | 1 | - | - | 1 | **8** | **2** |
| *Eurema regularis* | - | 5 | - | - | 1 | **6** | **3** |
| *Mylothris agathina* | - | - | - | 1 | - | **1** | **1** |
| *Mylothris similis* | - | 1 | - | - | - | **1** | **1** |
| *Nepheronia argia argia* | 2 | - | - | - | 2 | **4** | **1** |
| **TOTAL** | 47 | 125 | 24 | 62 | 45 | **303** | **101** |

**11c.** Summary of butterflies caught casually within Mgambo Forest reserve (excluding the zoological trapsites).

| **Species** | **Number. of individuals caught in casual sweepnet captures** | **Total no. of individuals captured** | **No. of spciemens taken** |
|---|---|---|---|
| LYCAENIDAE | | | |
| *Leptotes adamsoni* | 1 | **1** | **1** |
| NYMPHALIDAE | | | |
| *Acraea eponina eponina* | 1 | **1** | **0** |
| *Amauris niavius naivius* | 1 | **1** | **1** |
| *Bicyclus safitza safitza* | 2 | **2** | **0** |
| *Charaxes cithaeron* | 1 | **1** | **1** |
| *Junonia cf. hierta* | 1 | **1** | **1** |
| *Junonia oenone oenone* | 1 | **1** | **1** |
| *Neptidopsis fulgurata platyptera* | 1 | **1** | **1** |
| *Physcaeneura leda* | 1 | **1** | **1** |
| *Sallya* sp.. | 1 | **1** | **1** |
| *Tirumala petiverana* | 1 | **1** | **1** |
| PAPILIONIDAE | | | |
| *Graphium leonidas leonidas* | 1 | **1** | **1** |
| *Graphium* sp**.** | 1 | **1** | **0** |
| *Papilio dardanus polytrophhus* | 1 | **1** | **1** |
| *Papilio cf. hornimani* | 2 | **2** | **0** |
| PIERIDAE | | | |
| *Eurema floricola* | 1 | **1** | **1** |
| **TOTAL** | 18 | **18** | **12** |

# Appendix 12: East Usambara Conservation Area Management Programme Technical Paper Series

(ISSN 1236-620X)

The East Usambara Conservation Area Management Programme Technical Papers Series consists of reports on forestry issues in the East Usambara Mountains. This series started in 1991. These reports aim to make information more widely available to staff members of the East Usambara Conservation Area Management Programme, to the Forestry and Beekeeping Division, and to other institutions and individuals concerned and interested in the conservation of the East Usambara forests.

The reports are prepared by staff members of the East Usambara Conservation Area Management Programme or by other researchers, consultants and interested individuals. The views expressed in the reports are those of the author(s).

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