TECHNICAL PAPER 31

Bamba Ridge Forest Reserve

A biodiversity survey

Frontier-Tanzania
University of Dar es Salaam
Society for Environmental Exploration

East Usambara Catchment Forest Project

Technical Paper 31

Bamba Ridge Forest Reserve

A biodiversity survey

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East Usambara Catchment Forest Project (EUCFP)
The East Usambara rain forests are one of the most valuable conservation areas in Africa. Several plant and animals 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 Catchment Forest Project aims at establishing the Amani Nature Reserve; protecting water sources; establishing and protecting forest reserves; sustaining villager's benefits from the forest; and rehabilitating the Amani Botanical Garden. The project 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 Finnish Forest and Park Service. 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 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 Catchment Forest Project (EUCFP). This survey of selected forests collects baseline biodiversity data and assists the EUCFP in the management of the East Usambara forests.

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FOREWORD

The East Usambara forests in north-eastern Tanzania are part of the Eastern Arc mountains. More than one hundred years of biological interest and research has shown that these forests have a unique diversity of flora and fauna, and an exceptionally high degree of endemism. They are globally listed as one of the biodiversity hotspots and centres of plant diversity, and recognized as among the most valuable conservation areas in Africa. Since 1990, the East Usambara Catchment Forest Project (EUCFP) has worked in the East Usambaras 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 implementation support from the Finnish Forest and Park Service (FPS).

Although a considerable amount of biological information exists from the East Usambaras much of this is restricted to the Amani area and systematic surveys are few. In order to get more comprehensive information on the forests biodiversity surveys were initiated and contracted by EUCFP in July 1995. The surveys are conducted by Frontier Tanzania, a joint venture between the University of Dar es Salaam and the Society for Environmental Exploration, together with EUCFP. 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, as well as training forestry staff in the use of biological inventory techniques. They will also help setting of priorities in the conservation of this valuable area.

The surveys have been carried out over ten-week field phases. The programme involves short-term expatriate volunteer research assistants, permanent EUCFP, Frontier, University of Dar es Salaam, and Tanzania Forestry Research Institute staff, 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 Usambaras. EUCFP has also commisioned the development of a biodiversity database, a work which also contributed the maps to these reports. All data collected during the surveys will be entered in this database, which is linked to the national biodiversity database and will become operational in 1997.

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 a better management and conservation of the East Usambaras so that the beauty of the area will continue to amaze coming generations and that the light in the tunnel will become the bright future.

M.I.L. Katigula
Project Manager

Stig Johansson
Chief Technical Adviser

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Abstract

Bamba Ridge forest reserve is situated in the East Usambara mountains in north-east Tanzania. The East Usambaras form part of the mountain chain called the Eastern Arc which ranges from southern Kenya to southern Tanzania. These mountains are known for their high levels of species endemism and rich floral and faunal diversity (Hamilton, 1989). To investigate further this biodiversity, a biological survey of Bamba Ridge forest reserve was conducted with a socio-economic component between July and September 1995 for a total of 50 research-days.

This report summarises the findings of the survey in terms of floral and faunal inventories. Notes on ecological requirements and degree of endemism for each species is presented to provide an indication of the number of (a) forest dependent species as opposed to forest non-dependent and non-forest species; (b) threatened and rare species (based on IUCN 1994 criteria[1]) and (c) endemics and near-endemics[2] to the Usambara mountains. These are presented to highlight the importance of Bamba Ridge forest reserve in a national and international context. These three categories are then combined to assess which species are considered at high risk of becoming locally extinct if the forest continues to be further degraded and fragmented.

The survey of Bamba Ridge identified 167 species of tree and shrub, 28 species of mammal, 26 species of reptile and 23 species of amphibian.

Flora

One tree species was recorded which is endemic to the Usambara mountains and 39 which have restricted ranges limited to the Eastern Arc and/or East African lowland forests. Forty-five species are dependent on primary forest, and of these species, 18 are also endemic or near endemic to the Usambara mountains. Twenty-five non-forest tree and shrub species are established within the reserve boundaries.

Species of particular interest encountered during this survey include:

- *Cola usambarensis*, a submontane, wet evergreen forest tree, endemic to the East Usambaras was recorded in 7 plots;
-
- The record of *Cola discoglypremnophylla* in Bamba Ridge forest reserve represents a range extension. It is considered to be a rare species limited to five locales in southern Tanzania and Mozambique.

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1 All IUCN notes are based on IUCN 1994 criteria for species as compiled by the National Biodiversity Database in the Department of Zoology and Marine Biology, UDSM, Dar es Salaam. Definitions are as follows:

Endangered - a species facing a very high risk of extinction in the wild in the near future.

Vulnerable - a species facing a high risk of extinction in the wild in the medium-term future.

Near threatened - species which are close to qualifying for the status 'Vulnerable.'

2 Endemic - Species occurring only in the Usambara mountains
Near-endemic - Species with limited ranges in the Eastern Arc mountains and/or the East African lowlands between Somalia and Mozambique (Iversen, 1991b).

Fauna

Three faunal species were recorded which are endemic to the Usambara mountains and 19 species were recorded as near-endemics, having restricted ranges limited to the Eastern Arc and/or East African lowland forests. Twenty-six species are dependent on primary forest, and of these species, 20 are also endemic or near endemic to the Usambara mountains. One non-forest species is established in the reserve.

Species of particular interest encountered during this survey include:

- The bat, *Miniopterus m. minor* is a first record for the East Usambara mountains;
- A new species of *Rhampholeon* was collected, a genus of forest chameleon;
- *Hoplophryne rogersi*, a ground frog, was collected during the survey. This represents a range extension. This species is an Usambara endemic;
- *Boulengerula boulengeri*, a caecilian, endemic to the East and West Usambaras, was recorded once during the survey;
- *Nectophrynoides tornieri* is listed as a CITES Appendix I species;
- *Bradypodion tenue Chamaeleo melleri* and *Varanus niloticus* are listed as CITES Appendix II reptile species;
- *Rhampholeon temporalis* and *Mertensophryne micranotis* are listed as 'Endangered' by IUCN;
- Of the mammals, *Rhynchocyon petersi* is considered 'Near-threatened' and *Myonycteris relicta* is considered 'Vulnerable' by IUCN;
- The reptiles, *Aparallactus werneri; Philothamnus macrops; Crotaphopeltis tornieri; Leptosiaphos kilimensis; Agama montana; Bradypodion tenue; Rhampholeon brevicaudatus; Scolecomorphus vittatus* are considered 'Vulnerable' by IUCN;
- *Boulengerula boulengeri; Callulina kreffti; Hoplophryne rogersi; Leptopelis parkeri; Leptopelis barbouri; Leptopelis uluguruensis;* and *Nectophrynoides tornieri* are listed as 'Vulnerable' by IUCN;
- *Miniopterus m. minor* and *Galago zanzibaricus* are listed as 'near-threatened' by IUCN.

Soils

The soils of Bamba Ridge are predominantly acidic, reddish-brown clays typical of soils developed in the Tropics over gneiss. The forest soils contain high levels of

organic matter, a product of the reserve's abundant vegetation. This high level of organic matter means that the soils are reasonably fertile. The impact of disturbance on the reserve's soils is variable with some disturbed plots having a considerably lower organic matter content than in undisturbed plots.

Disturbance

Of the five areas assessed for levels of human disturbance, three are considered under threat. These areas are in the vicinity of Muhinduro Ndogo and Lukindo plateau.

Socio-economics

The people that live in the vicinity of Bamba Ridge forest reserve are subsistence farmers. Land still retains much fertility and fertilisers are not used. The main problem is access to water. In many villages, wells dry up often for up to six months per year. The high amount of time which it then takes to collect water has made it difficult for people to complete work necessary to meet other needs. The conflict thus arises between the apparent wealth of the forest and the marginal lifestyle of the people. Their use and dependence on the forest includes hunting, timber extraction, pole cutting, the collection of herbal medicines and firewood and growing cardamom. These all put pressure on the forest albeit in different degrees.

1.0 INTRODUCTION: EAST USAMBARA AND FOREST DIVERSITY

The East Usambara mountains are situated in north-east Tanzania, close (40 km) to the coastal town of Tanga between $4^{O}48'$-$5^{O}13'$S and $38^{O}32'$-$38^{O}48'$E. These mountains form part of a chain known as the Eastern Arc which 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 uprise (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. Conversely, the dry seasons are from June to August and January to March. Precipitation occurs in all months. Rainfall is greatest at higher altitudes and in the south-east of the mountains, increasing from 1,200 mm annually in the foothills to over 2,200 mm at the higher altitudes. Because of the topographical and climatic interactions, the western slopes are drier compared to the eastern slopes. Due to their age, isolation and their function as condensers of the moisture from the Indian Ocean, they support ancient and unique forests, rich in endemic species (Hamilton, 1989).

Research in the East Usambara mountains began in the late 1890's with substantial botanical collections being undertaken. Later, in 1928, surveys were undertaken on amphibians and by the 1930's detailed ornithological work had begun. Biological research in the mountains has steadily increased over the years since. More recently, work in the area has also included an attempt to understand the drainage and catchment value of the mountain's forests (Bruen, 1989; Litterick, 1989).

The East Usambara forests have been likened to the African equivalent of the Galapagos Islands in terms of their endemism and biodiversity (Rogers & Homewood, 1982; Howell, 1989). They are considered to be one of the most important forest blocks in Africa, if not the most important (Tye, 1994). Currently, around 2,800 taxa of plants have been recorded of which it is suggested that over one quarter are endemic or near-endemic (Iversen, 1991). Many are threatened (Rodgers, 1996).

In addition to the biodiversity value is the drainage and catchment value of the East Usambara forests. The forests play an important role in maintaining the hydrological cycle which feeds the Sigi river. The Sigi 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 more irregular run off and in a deterioration in water quality due to siltation.

The latest survey of the area, conducted by Johansson & Sandy (1996) shows that approximately 45,137 ha of the East Usambaras 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 850 m.

Hyytiäinen (1995) classifies these two forest types into three categories[1]: (1) dense forest; (2) poorly stocked forest; and (3) cultivated forest, according to the density of the forest and the degree of human involvement. In the East Usambaras, submontane forest occupies 12,916.6 ha (30.7%), lowland forest occupies 29,497.4 ha (62.9%), and forest plantations occupy 2,723.6 ha (6.5%). 21,900 ha are presently gazetted forest reserves. The remainder, 35,909 ha (43%) of the East Usambaras is classified as agricultural land; woodland; grassland; ponds; rivers; barren land; and settlements (Johansson & Sandy, 1996).

The mammals of the East Usambaras show limited endemism (Collar & Stuart, 1987). However, there are several species of special interest. These include: the restricted Black and Rufous Elephant Shrew, *Rhynchocyon petersi*, which is common in the Usambaras (Collar & Stuart, 1987) yet listed as globally 'Endangered' by IUCN due to a decline in habitat extent and quality; Abbott's Duiker, *Cephalophus spadix*, listed as 'Vulnerable'(Groombridge, 1993); and the Lesser Pouched Rat, *Beamys hindei* about which insufficient information is available to determine its status (IUCN 1996).

There are at least 24 species of reptiles and amphibians endemic to the East Usambaras (Rodgers & Homewood, 1982). This series of surveys provide further information on new species and species' range extensions. A new species of snake, *Prosymna semifasciata,* was recently found in Kwamgumi forest reserve (Broadley, 1995), and a range extension for the endemic frog, *Hoplophryne rogersi*, was recorded at Bamba Ridge forest reserve (Cunneyworth & Stubblefield, 1996b).

The forest avifauna of the East Usambaras is remarkable in its diversity with 110 species, the highest recorded in this part of Africa (Stuart, 1989). Six species occurring in the lowland forests are considered threatened with 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* (Collar *et al.*, 1994).

The East Usambaras are essentially forest 'islands' (Lovett, 1989). There has been natural forest in the area for thousands, if not millions, of years. These forests have been under continuous exploitative human pressure for at least 2,000 years (Schmidt, 1989). Until recently, especially in the past 50 years, (Kikula, 1989), this pressure has been 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 (Collar & Stuart, 1987). The Usambaras harbour many species which have been geographically separated from their closest relatives for long periods. They

[1]
1. Dense forest: uneven-aged, more or less disturbed natural forest which has a species composition characteristic to the original forest type & has an unbroken crown cover.
2. Poorly stocked forest: a variety of primary or secondary forests which are poorly stocked because of various natural or man-made reasons. They are forests with low density, fairly open crown cover, modest volume and dominant height less than in dense forests belonging to the same forest type.
3. Cultivation under forest: encroached areas which still have at least moderate forest cover.

After Hyytiainen (1995)

also serve as a refuge for formerly widespread flora and fauna that have become extinct over much of their former area (Iversen, 1991). The conservation and preservation of this unique area of biodiversity should be given high priority.

2.0 AIMS OF THE SURVEY

The specific aims of the survey as outlined in the Terms of Reference between Frontier Tanzania Forest Research Programme and the East Usambara Catchment Forest Project are:

- to conduct biological baseline surveys in selected gazetted forests and in forests which are proposed for gazettement;
- 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 develop a system for monitoring aspects of forest biodiversity, both on a general as well as a forest-specific level.

Furthermore, the aims of the survey methods applied are:

- to sample the vegetation and tree species composition of six forests of the East Usambaras using systematic sampling techniques along systematically located vegetation transects, which sample approximately 0.5% in 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 standard and repeatable methods to record biodiversity values of the forest in terms of small mammal species, reptiles, amphibians, and invertebrate species;
- to collect opportunistic data on all other groups of vertebrate and invertebrates. Species lists resulting from this will be compared against standard appraisals of species rarity and other values in order to assess the overall biodiversity values of each forest.
- to undertake a socio-economic appraisal of the impact of resource-use activities by human communities in the vicinity of each forest and produce a brief assessment of how these activities affect the integrity of the forests.

Consequently, this survey will provide standardised and repeatable methods to assess the biodiversity values of the forests to enable their importance to be determined and permit biodiversity value to be monitored through time.

3.0 DESCRIPTION OF THE FOREST

3.1 General description

Bamba Ridge forest reserve is located in the East Usambara mountains, Tanzania at the grid reference 38°47'E 4°58'S. Administratively, Bamba Ridge falls under the Muheza district.

Bamba Ridge forest reserve is situated on the eastern side of the main East Usambara range (Figure 1). This reserve forms part of a forest continuum with the adjoining Segoma and Kwamgumi reserves. Segoma and Kwamgumi are contiguous with the north-west border of Bamba Ridge reserve. The cumulative reserve area is 3,750 ha.

The altitudinal range of the reserve is from 150 m to 1,033 m, thus two major types of forest exist: lowland and submontane (Hamilton, 1989). Muhinduro peak is the fifth highest peak in the East Usambara mountains at an altitude of 1,033 m. It is located on the west side of Bamba Ridge.

The most recent survey of the area, was carried out by Hyytiäinen (1995), and updated by Johansson & Sandy (1996). The results are summarised in Table 1 below and indicate that the majority of Bamba Ridge forest reserve can be classified as 'dense lowland forest', forest that is more or less similar to the original forest species composition with an unbroken crown cover. Lowland forest has been classified as occurring up to 850 m (Hamilton, 1989).

Table 1. Land use distribution (Johansson & Sandy, 1996).

Forest Class	Area (ha)	Percent (%)
Dense sub-montane forest	36.9	3.3
Dense lowland forest	878.3	77.6
Poorly stocked lowland forest	79.5	7.0
Peasant cultivation	36.0	3.2
Barren land	100.8	8.9
Total for the reserve	**1,131.5**	**100.0**

3.1.1 History and Status

Bamba Ridge forest was gazetted as a forest reserve in 1958. The forest of Bamba Ridge and the forest of Mlungui Hill, approximately one km to the east, were contiguous up until the 1960's. Large areas of natural forest were cleared up to the present day boundaries when the sisal estates were established. The estates brought an influx of people from outside the area who were employed as labourers. This influx resulted in increased pressure on the forest. With the present collapse in the sisal industry and the attendant high rate of unemployment, pressure on the forest is now at its most intense.

Table 2. Status of Bamba Ridge forest reserve.

Name	Status	Size (ha)	Gazettement Notice and Date
Bamba Ridge	Forest Reserve	1,109	GN 409 22/8/1958

Figure 1. The location of Bamba Ridge forest reserve in relation to other East Usambara forests.

Figure 2. Topographical map.

4.0 SOILS

4.1 Introduction

The National Soil Service (NSS) carried out a soil survey of Bamba Ridge forest reserve. The objectives of the study were to assess the nature and distribution of soil types (Shaka and Msangi, 1996).

4.2 Methods

This section details the study approach used by NSS. All available sources of data were studied before commencing field work, including topographical and geological maps. The FT FRP constructed a total of 33 vegetation analysis plots in a grid system, each measuring 450 m x 450 m, within Bamba Ridge forest reserve. Soil samples were taken from the south-west corner of each of these vegetation plots. The floristic composition of a 50 m x 20 m sub-plot, also located in the south-west corner of the larger vegetation plot, was analysed in terms of species density and species dominance.

A total of 33 soil-auger hole observations were made to a depth of 150 cm where possible. Data was recorded on the soil cores extracted by the auger according to FAO (1977) guidelines for describing soil profiles. Furthermore, soil colour was described using the Munsell notation (Munsell colour charts Inc., 1973). Soil samples were taken from both the surface horizon, at a depth between 0-25 cm, and from the sub-soil, at a depth between 25-50 cm. These samples were analysed at the NSS Central Laboratory to determine the following properties: soil texture; pH; total nitrogen; organic carbon; available phosphorus; cation exchange capacity; and exchangeable calcium, potassium, magnesium and sodium.

4.3 Results

The soils in the study area varied from shallow to very deep, dominantly well drained, sandy-clays and clays. However, localised sandy-loams and loams which were dark reddish-brown to dark brown were also recorded. In some of the plots, rock outcrops were observed, though the soil exhibited no surface stoniness. The slope gradients for those plots surveyed ranged from 3 to 30%.

Chemical analysis of the soil samples revealed that the soils were very strongly acid or strongly acid to neutral (5-6.9 pH), with pH levels increasing in acidity moving down the profile. Data on electrical conductivity indicates that soils were non-saline. Organic carbon and total nitrogen are variable in the study area. In some of the samples the level of organic carbon and total nitrogen varies from medium to high or very high (C: 0.1-4.8% N: 0.03-0.45%). The organic carbon and total nitrogen content of the soil decreased with soil depth. This data indicates that the amount of organic matter within the soils sampled was high or even very high, especially in the topsoil, and the organic matter was of a good quality as shown by the carbon/nitrogen ratio which ranged between 8. and 15.

Available phosphorus in all plots was low (0.80-6.8 mg/kg) while exchangeable bases varied from medium to high. The low levels of recorded phosphorus was probably due to the influence of the parent material, dominantly gneiss, which is inherently low in phosphorus. The ability of the soil to retain and supply nutrients for plant uptake was found to be variable between plots. It varied from medium levels in the topsoil (1.03- 6.8 mg/kg) to low levels in the subsoil (0.8-3.9 mg/kg). The cation exchange capacity was found to decrease with soil depth (topsoil: 12.0-24.3 Cmolc/kg; subsoil: 5.2-15.7 Cmolc/kg). The level of exchangeable calcium was found to be high to very high in all samples (topsoil: 6.0-18.0 Cmolc/kg; subsoil: 2.1-10.1 Cmolc/kg). It appeared, therefore, that the parent material was rich in calcium though low in phosphorus.

4.4 Discussion

The results of the soil analysis for Bamba Ridge forest reserve were typical of other East Usambara forests surveyed by the FT FRP (i.e. Cunneyworth & Stubblefield, 1996a,b). The underlying parent rock, dominantly gneiss, appeared to be the primary influence on soil characteristics, namely colour, texture and pH. The acidic, reddish-brown clays are typical of soils developed on weathered material that is still in contact with the parent rock gneiss (Holmes, 1995). The pH analysis reflects the influence of parent material as subsoils generally had a lower pH than surface horizons where the incorporation of organic matter reduced soil acidity. However, the influence of climate was also observed. The predominant reddish-brown clays are, in part, a product of the tropical climate. The soils are subjected to heavy weathering from high rainfall and temperatures consequently more soluble salts are washed down the soil profile leaving aluminium and iron sesquioxides (FAO, 1988; Bunnett, 1989).

These characteristic red clay soils are usually of low nutrient status (Holmes, 1995). However, in Bamba Ridge forest reserve, the soil analysis indicates that the fertility level was high. This was due to the high organic matter content of these soils. Holmes (1995) states that organic matter (humic) layers in the tropics are best developed under forest vegetation. Organic matter is an important soil component, maintaining both soil structure and nutrient levels. Furthermore, the high organic matter supports an abundant soil fauna which convert soil humus into nutrients available for uptake by the vegetation (Holmes, 1995).

The high levels of organic matter recorded from the Bamba Ridge forest reserve soil samples are a product of the abundant vegetation. Disturbance to the forest cover is likely to reduce the level of soil humus and, consequently, the soil nutrient status. Soil samples taken from plots which had been disturbed showed variable levels of soil organic matter, some with considerably lower levels than plots that remained undisturbed.

5.0 BOTANY

5.1 Introduction

A survey of the major vegetation types within the forest reserve was undertaken to quantify the extent and distribution of forest types and their species composition. 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 studied. Data collected by this survey will be entered onto the EUCFP data base in Tanga.

5.2 Methods

The forest block is divided into grid squares which are measured and marked in the field. The methods used during this survey are detailed in the FT FRP methodologies report (SEE, 1996). A brief description is presented below. The location of vegetation plots and disturbance transects are illustrated in Figure 3.

5.2.1 Forest structure

Two methods were used to analyse forest structure: (1) quantitative vegetation analysis and (2) disturbance transects.

5.2.1.1 Quantitative vegetation analysis

A 450 m grid system was constructed throughout the forest on transect lines using boundary tape to mark the lines. A sample plot size of 50 m x 20 m was sampled in each grid square, giving an approximate sampling intensity of 0.5%. Within the sample plot, every tree with a dbh (diameter at breast height) of 10 cm and over was recorded, tagged and identified. Botanists from the Tanzanian Forestry Research Institute (TAFORI) and from the University of Dar es Salaam (UDSM) provided the field identification of plant species.

5.2.1.2 Disturbance transects

Disturbance transects provide a statistical estimate of pole cutting and logging in a forest block. Each transect consisted of three parallel sub-transects, 250 m long and at least 30 m apart, within a recognised forest type. Every self-standing tree and sapling (i.e. not lianas or creepers) above 1cm dbh was measured within an area 2.5 m either side of each transect line. Each plant was recorded under one of two categories: 'cut' or 'naturally fallen'.

Due to limitations of this method, one number representing the average cut and naturally fallen poles and timber per 100 m is given for the entire transect. The data are unable to be broken down into more meaningful units.

Figure 3. Location of vegetation plots and disturbance transects.

5.3 Results

5.3.1 Quantitative vegetation analysis

Table 3 presents a checklist of the tree and shrub species recorded in the 20 m x 50 m vegetation plots. Species are described, where adequate information exists, in terms of their ecological type, their habitat and their endemic status.

Table 3. Checklist of trees and shrubs.

Species	Ecological type	Habitat[2]	Endemic status
Anacardiaceae			
Lannea welwitschii	F	L	N
Lannea schweinfurthii stuhlmannii	f		W
Mangifera indica	O		W
Sorindeia madagascariensis	f		W
Annonaceae			
Annona senegalensis	f		W
Enantia kummeriae	F		N
Lettowianthus stellatus	f	L & S	N
Uvariodendron sp.	?		?
Xylopia parviflora	f	L	W
Monodora sp.	?		?
Apocynaceae			
Funtumia africana	F	L & S	W
Rauvolfia mombasiana	f		N
Tabernaemontana holstii[1]	?		?
Tabernaemontana pachysiphon	F	S	W
Tabernaemontana ventricosa	F	L	W
Voacanga thouarsii	O		W
Araliaceae			
Cussonia zimmermannii	f	L (forest gaps)	N
Bignoniaceae			
Fernandoa magnifica	f	L	W
Markhamia lutea	f	L & S (forest gaps)	W
Markhamia obtusifolia	O		W
Stereospermum kunthianum	f		W
Bombacaceae			
Bombax rhodognaphalon	f	L	N
Boraginaceae			
Cordia africana	f	L (forest gaps)	W
Burseraceae			
Commiphora eminii ssp. *zimmermannii*	f	L	W
Caricaceae			
Cylicomorpha parviflora	f	S & L (forest gaps)	N
Celastraceae			
Maytenus acuminata	F	S	W
Combretaceae			
Combretum schumannii	f	L	W
Combretum molle	O		W
Pteleopsis myritifolia	f		W
Terminalia sambesiaca	f	L	N

Table 3 *cont.*

Species	**Ecological type**	**Habitat**[2]	**Endemic status**
Compositae			
Vernonia colorata	O		W
Dracaenaceae			
Dracaena steudneri	f	S (forest gaps)	W
Ebenaceae			
Diospyros abyssinica	f	S	W
Diospyros kabuyeana	f		N
Diospyros mespiliformis	f	L	W
Diospyros natalensis	f	L	W
Diospyros squarrosa[1]	?	L	W
Diospyros sp.	?		?
Euphorbiaceae			
Alchornea hirtella	f	S (forest gaps)	W
Antidesma membranaceum	f	L	W
Bridelia micrantha	f	L & S	W
Bridelia cathartica melanthesoides	f		W
Croton sylivaticus	f	L	W
Drypetes gerrardii	F	S	W
Drypetes natalensis	f	L	W
Drypetes usambarica	f	S	N
Drypetes sp.	?		?
Euphorbia candelabrum	O		W
Margaritaria discoidea	f		W
Mildbraedia fallax[1]	f		W
Macaranga capensis	F		W
Manihot glaziovii[1]	O (cultivated)		W
Ricinodendron heudelotii	f	L	N
Sapium ellipticum	f	L & S	W
Guttiferae			
Allanblackia stuhlmannii	F	S	N
Garcinia volkensii	F	S	W
Symphonia globulifera	f	S	W
Hernandiaceae			
Gyrocarpus americanus	f	L	W
Lecythidaceae			
Barringtonia racemosa	f	L	W
Leguminosae subfamily: Caesalpiniaceae			
Brachystegia microphylla[1]	?		?
Cynometra webberi	f		N
Dialium holtzii	f	L	N
Erythrophleum suaveolens	F		W
Isoberlinia scheffleri	F	S & L	N
Julbernardia magnistipulata	f	L	N
Scorodophloeus fischeri	f	L	N
Senna singueana	O		W
Senna spectabilis[1]	?		?
Leguminosae subfamily: Mimosaceae			
Acacia senegalensis[1]	O		W
Albizia adianthifolia	f		W
Albizia glaberrima	f	L	W
Albizia gummifera	f	L	W
Albizia zimmermannii	f	L	W
Albizia schimperana amaniensis	F		N

Table 3 *cont.*

Species	Ecological type	Habitat[2]	Endemic status
Albizia sp.	?		?
Newtonia paucijuga	F	L	N
Parkia filicoidea	F	L & S	W
Leguminosae subfamily: Papilionaceae			
Angylocalyx braunii	F	L	N
Craibia brevicaudata	f	L	N
Craibia sp.	?		?
Erythrina abyssinica	O		W
Lonchocarpus bussei	O		W
Millettia oblata	F		N
Millettia stuhlmannii[1]	O		W
Millettia usaramensis	O		W
Millettia usaramemnophylla[1]	?		?
Pterocarpus tinctorius	F	S & L	W
Xeroderris stuhlmannii	O		W
Loganianceae			
Strychnos innocua[1]	?		?
Meliaceae			
Entandrophragma excelsum	F	S	W
Trichilia emetica	f		W
Moraceae			
Antiaris toxicaria	f	L & S	W
Artocarpus heterophyllus	O		W
Dorstenia kameruniana	f	L	W
Ficus exasperata	f	L & S	W
Ficus persicifolia[1]	?		?
Ficus scassellattii	f	S	W
Ficus usambarensis	f		N
Ficus vallis-choudae	f	L	W
Ficus sp.	?		?
Mesogyne insignis	F	S	N
Milicia excelsa	f	L & S	W
Morus mesozygia	F	L	W
Myrianthus holstii[1]	?	S	W
Trilepisium madagascariensis	f		W
Myrtaceae			
Psidium guajava	O		W
Syzygium sp.	?		?
Olacaceae			
Strombosia scheffleri	F	S	W
Ximenia americana[1]	O		W
Palmae			
Cocus nucifera[1]	O		W
Pandanaceae			
Pandanus stuhlmannii	f		W
Rhamnaceae			
Ziziphus mucronata	O	L	W
Rubiaceae			
Cremaspora triflora	f		W
Morinda asteroscepa	f	S (forest gaps)	N
Oxyanthus speciosus	F	S (forest gaps)	W
Oxyanthus sp.	?		?
Porterandia penduliflora[1]	?		N

Table 3 *cont.*

Species	**Ecological type**	**Habitat**[2]	**Endemic status**
Rothmannia manganjae	F	L & S	W
Rytigynia flavida	F		W
Sericanthe odoratissima	F		N
Tarenna nigresens[1]	f	L	W
Tricalysia pallens	f		W
Rutaceae			
Fagaropsis angolensis	f		W
Teclea amaniensis	f		N
Teclea simplicifolia	f	S	W
Teclea trichocarpa	f		W
Zanthoxylum usambarensis	F	S	W
Sapindaceae			
Afrosersalisia cerasifera	f	S	W
Allophylus callophyllus[1]	?		?
Allophylus melliodorus	f		N
Blighia unijugata	F	L & S	W
Deinbollia borbonica	O		W
Lecaniodiscus fraxinifolius	F	L	W
Zanha golungensis	F	L & S	W
Sapotaceae			
Bequaertiodendron natalense	f	L & S	W
Malacantha alnifolia	f	L & S	W
Manilkara densiflora[1]	?		?
Manilkara sansibarensis[1]	f		W
Manilkara sulcata	f	L	W
Manilkara sp.	?		?
Mimusops sp.	?		?
Pachystela msolo	F	L & S	W
Vincentella passargei	f	L	W
Simaroubaceae			
Quassia undulata[1]	F		N
Sterculiaceae			
Cola discoglypremnophylla[1]	F		N
Cola greenwayi	F		N
Cola microcarpa	F		N
Cola scheffleri	F	L	N
Cola usambarensis	F	S	E (EU)
Dombeya shupangae	O		N
Leptonychia usambarensis	F	L & S	N
Nesogordonia sp.	?		?
Sterculia africana	O		W
Sterculia appendiculata	F	L	W
Tiliaceae			
Grewia bicolor	O		W
Grewia goetzeana	f	L	N
Grewia microcarpa	f		W
Ulmaceae			
Celtis africana	F	L	W
Celtis gomphophylla	F	L	W
Celtis mildbraedii	F	L & S	W
Celtis wightii	f	S	W
Celtis zenkeri	F	L & S	W

Table 3 (*cont.*)

Species	Ecological type	Habitat[2]	Endemic status
Trema orientalis	f	L & S (forest gaps)	W
Umbelliferae			
Steganotaenia araliacea	O	L & S	W
Verbenaceae			
Premna chrysoclada	O	L	N
Vitex keniensis	F		W
Violaceae			
Rinorea ferruginea	F		N

[1] Species which do not appear in Iversen (1991). Summary information is based on Ruffo *et al*. (1989), Lovett (1993) or the *Flora of Tropical East Africa*.
[2] Information is based on Ruffo *et al*. (1989).

KEY TO ABBREVIATIONS FOR TABLE 3

Ecological type:(based on Iversen, 1991)
- F - Forest dependent species: This is defined as primary forest only. It does not include forest edge or secondary forest;
- f - Forest dwelling but not forest dependent: Species occurring in primary forest as defined above as well as other vegetation types. Thus these are not forest-dependent species; and
- O - Non-forest species: These are species that do not occur in primary or secondary forest or forest edge.

Habitat: (based on Hamilton, 1989)
- L - Lowland: Occurring at altitudes of <850 m;
- S - Submontane: Occurring at altitudes of >850 m.

In the case where species occur in both lowland and submontane habitats, the most common habitat will be listed first and only this habitat will be counted in the summary statistics. If a species is common in forest gaps, rather than in the forest proper, this will also be noted.

Endemic status: (based on Iversen, 1991)
- E - Endemic: Occurring only in the Usambara mountains;
- N - Near endemic: Species with limited ranges in the Eastern Arc mountains and/or the East African lowlands between Somalia and Mozambique.
- W - Widespread distribution.

EU - Range limited to the East Usambaras ; WU - Range limited to the West Usambaras
? Insufficient data

Species accumulation rates:

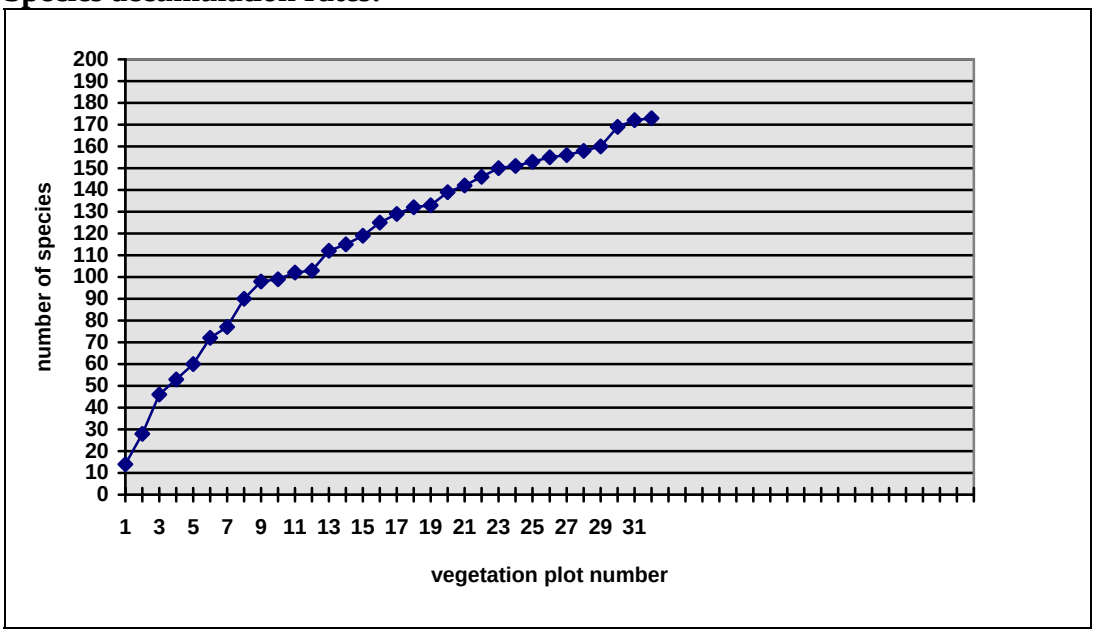

Figure 4. Species accumulation rates of trees and shrubs (10 cm dbh and larger) by vegetation plot.

Ecological type (refer to Figures 5,6,7,8)**:**

Table 4. Summary of ecological type for tree and shrub species (based on Table 3).

Ecological type	Number of species	% of total species
(F) Forest Dependent Species	45	26.9
(f) Forest Non- Dependent Species	74	44.3
(O) Non-Forest Species	25	15.0
Unknown	23	13.8
Total:	**167**	**100.0**

Habitat (refer to Figures 9 and 10)**:**

Table 5. Summary of the habitat for tree and shrub species (based on Table 3).

Habitat	Number of species	% of total species
(L) Lowland Forest Species	62	71.3
(S) Submontane Forest Species	25	28.7
Total:	**87**	**100.0**

Table 6. Submontane species occurring in lowland areas and the altitudes where they were recorded.

Species	Altitude (meters)
Dracaena steudneri	300, 450, 600
Alchornea hirtella	300
Celtis wightii	300, 340, 350, 360, 500
Cola usambarensis	300, 305, 350, 440, 500, 630
Afrosersalisia cerasifera	700
Teclea simplicifolia	480
Zanthoxylum usambarensis	350, 600
Oxyanthus speciosus	450, 600, 700
Strombosia scheffleri	700
Morinda asteroscepa	340,500
Symphonia globulifera	700
Garcinia volkensii	300
Allanblackia stuhlmannii	700
Drypetes gerrardii	340, 630
Drypetes usambarica	290, 340, 360, 450, 560
Tabernaemontana pachysiphon	250, 640, 700
Myrianthus holstii	640
Mesogyne insignis	700
Ficus scassellattii	450, 480
Diospyros abyssinica	305, 340, 360, 500

Endemic status (refer to Figures 11,12,13,14)**:**

Table 7. Summary of endemic status for tree and shrub species (based on Table 3).

Endemic status	Number of species	% of total species
(E) Endemic	1 (EU)	0.6
(N) Near Endemic	39	23.3
(W) Widespread	107	64.1
Unknown	20	12.0
Total:	**167**	**100.0**

* EU - endemic to the East Usambaras

Figure 5. Distribution of forest dependent tree and shrub individuals.

Figure 6. Distribution of forest dependent tree and shrub species.

Figure 7. Distribution of non-forest tree and shrub individuals.

Figure 8. Distribution of non-forest tree and shrub species.

Figure 9. Distribution of submontane tree and shrub individuals.

Figure 10. Distribution of submontane tree and shrub species.

Figure 11 Distribution of endemic tree and shrub individuals.

Figure 12. Distribution of endemic tree and shrub species.

Figure 13. Distribution of near-endemic tree and shrub individuals.

Figure 14. Distribution of near-endemic tree and shrub species.

Figure 15. Vegetation of Bamba Ridge forest reserve.

5.3.2 Disturbance transects

Five disturbance transects were recorded for pole and timber extraction during the survey. The disturbance transects are described in Table 8 and the results summarised in Table 9 for poles and Table 10 for timber. The terms pole and timber are used in this section only as this method examines the forest in terms of its extractive value. Poles are defined as <10 cm dbh and timber as >= 10 cm dbh.

Table 8. Summary description of disturbance transects.

Transect number	Plot number	Topography	Altitude	Vegetation type
1	35	ridge top	870	mature forest
2	10	upper slope	600	open forest
3	17	mid-slope	700	mature forest
4	32	mid-slope	630	mature forest
5	4	upper slope	530	mature forest

Table 9. Disturbance transect results for pole counts*.

Transect number	Length of transect (m)	Total poles sampled	Cut poles	Average per 100 metres	Naturally fallen poles	Average per 100 metres
1	750	51	33	**0.9**	18	**4.8**
2	750	102	56	**14.9**	46	**12.2**
3	750	111	66	**17.6**	45	**12.0**
4	750	96	21	**5.6**	75	**20.0**
5	750	291	217	**57.9**	74	**20.0**

* Due to differences in methods, the results under 'Average per 100 metres' are doubled to allow direct comparisons with other forest reserves in this series of surveys.

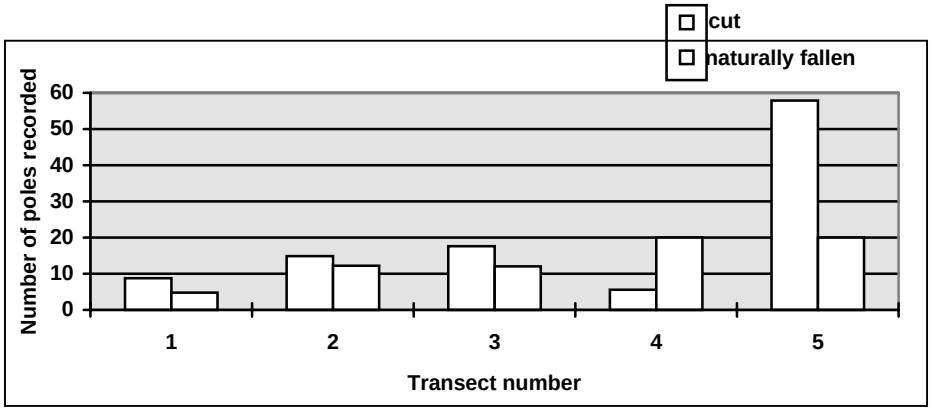

Figure 16. Cut and naturally fallen poles recorded per 100 metres by transect.

Table 10. Disturbance transect results for timber counts.*

Transect number	Length of transect (m)	Total timber sampled	Cut timber	Average per 100 metres	Naturally fallen timber	Average per 100 metres
1	750	20	3	**0.8**	17	**4.5**
2	750	27	15	**4.0**	12	**3.2**
3	750	27	15	**4.0**	12	**3.2**
4	750	14	1	**0.3**	13	**3.5**
5	750	24	12	**3.2**	12	**3.2**

* Due to differences in methods, the results under 'Average per 100 metres' are doubled to allow direct comparisons with other forest reserves in this survey.

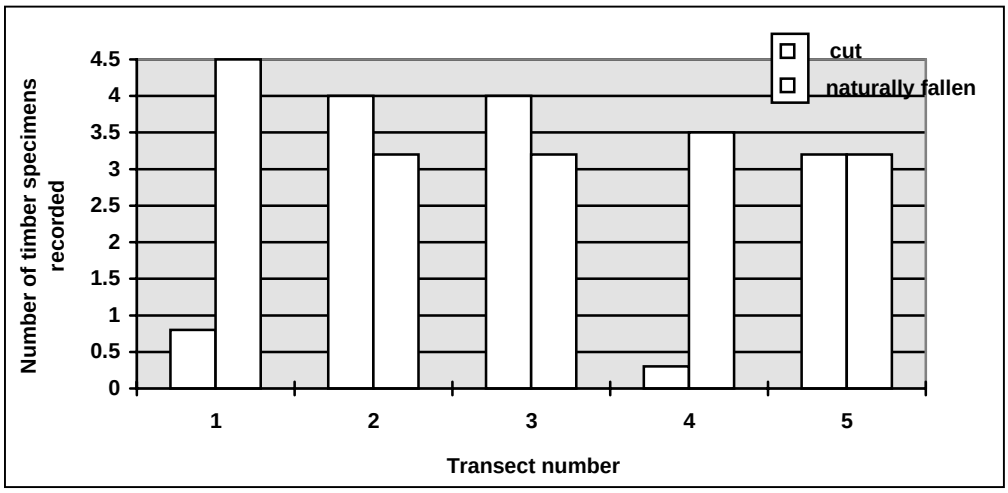

Figure 17. Cut and naturally fallen timber recorded per 100 metres by transect.

Figure 18. Areas of highest distribution in relation to the distribution of tree and shrub individuals that are both forest dependent and endemic.

Figure 19. Areas of highest distribution in relation to the distribution of tree and shrub species that are both forest dependent and endemic.

Figure 20. Areas of highest distribution in relation to the distribution of tree and shrub individuals that are both forest dependent and near-endemic.

Figure 21. Distribution of disturbance in relation to the distribution of tree and shrub species that are both forest dependent and near-endemic.

5.4 Summary

Bamba ridge forest reserve covers an area of 1,131.5 ha with altitudes ranging from 150 to 1,033 m. 1,294 trees and shrubs were surveyed, representing 167 species from 38 families.

Based on the 32 plots systematically surveyed, 17 (53.1%) were recorded as mature mixed forest, 13 (40.6%) as open forest or poorly stocked forest and 2 (6.3%) as woodland or grassland. These figures may underestimate the percent of mature mixed forest as sample plots were concentrated near the eastern reserve border where disturbance is likely to be higher from neighbouring settlements.

Species Accumulation Rates

The species accumulation rate does not appear to be approaching a plateau indicating that the sampling of the trees and shrubs is far from complete.

Ecological Type

Forest dependent species are defined as being limited to primary evergreen forest only. Individuals from this category were recorded 366 times. This represents 28.3% of all specimens recorded. Forest dependent individuals are distributed throughout the reserve and in general increase in frequency away from the eastern forest boundary. The most common forest dependent tree is *Lecaniodiscus fraxinifolius*. Eighteen of the forest dependent species are also endemic or near-endemic to the Usambaras.

Twenty-five non-forest species were recorded in 81.3% of the plots (26 plots). *Pandanus stuhlmannii* is the most common non-forest species. It is limited to rocky outcrops (Iversen, 1991).

Habitat

Submontane species are found throughout the reserve occurring in 93.8% of the plots (30 plots) surveyed. Many of these are found in the lowland areas often well below 850 m, the altitude defining submontane. The most common submontane forest species is *Markhamia lutea,* common in forest gaps (Ruffo *et al.,* 1989). The second most common species is the endemic, *Cola usambarensis.*

Endemic Status

Of the species recorded, 107 (64.1%) have widespread distributions. Near-endemics contribute 39 species (23.4%) from 20 families to the floristic composition of the reserve. These near-endemics are found throughout the reserve occurring in every plot surveyed except two and account for 365 of the surveyed specimens or 28.2% of all recorded trees and shrubs in the reserve. Of the 32 plots surveyed, 14 (43.8%) have >10 near-endemics. The most common near-endemic in the reserve is *Scorodophloeus fischeri.*

Only one of the species surveyed is endemic to the Usambaras. This is *Cola usambarensis,* found only in the East Usambaras. This species is considered to be

submontane, typical of wet evergreen forests (Iversen, 1991). It is represented by 27 individuals from seven plots.

Range Extensions

The record of *Cola discoglypremnophylla* in Bamba Ridge forest reserve represents a range extension. It is considered to be a rare species limited to about five locales in southern Tanzania and Mozambique (Flora of Tropical East Africa, FTEA).

Disturbance

In the areas assessed, the rate of pole cutting was between 0.9 and 57.9 stems per 100 m and for timber cutting, the rate was between 0.3 to 4.0 stems per 100 m.

Three of the five areas assessed are considered to be under threat due to the high rate of pole and timber extraction. These are:

(1) In the southern end of the reserve, near a ridge top on Lukindo plateau, at an altitude of approximately 400 m. This area is characterised as mature mixed forest. This area has high numbers of forest dependent trees and it is one of six plots where no non-forest trees or shrubs were recorded.

(2) On the ridge top of Muhinduro Ndogo at an altitude of 750 m. This area has high numbers of forest dependent trees and shrubs from six species and three non-forest species. This area is characterised as mature mixed forest.

(3) On the upper slopes of Muhinduro Ndogo at an altitude of 600 m. This area has four forest dependent species and two non-forest species. This is area is characterised as open forest/previously disturbed.

6.0 ZOOLOGY

6.1 Introduction

The faunal biodiversity of Bamba Ridge forest reserve was investigated using standard, repeatable, survey methods. Studies on small mammals, bats, reptiles, and amphibians were carried out. In line with the specific aims of the survey, an inventory of all fauna encountered was compiled. This data was analysed to assess the biodiversity value of the area.

6.2 Methods

All methods used during the expedition survey are outlined in detail in the FT FRP methodologies report (SEE, 1996). A brief description is presented below. The location of trap sites are presented in Figure22.

6.2.1 Mammals

Four different methods were used to sample the mammal community within Bamba Ridge forest reserve: (1) snap trap lines, (2) bucket pitfalls, (3) bat netting and (4) opportunistic observations.

6.2.1.1 Snap-trap lines

In order to sample the community of rodents, small and large break-back traps (snap-traps) were used. Typically the traps were set out in transect lines of 50, with traps positioned at least 2 m apart. However, this was not always possible due to the nature of the habitat. The traps were set each evening and checked early the following morning. A bait of fried coconut and peanut butter was used. Previous forest surveys indicate that this bait is very successful in terms of catch numbers and species diversity (Stanley, *pers. comm.*). Each mammal caught was weighed and measured. Trapping and biometric data was recorded on standardised data sheets. Unless otherwise indicated, specimens were identified by Prof. K. Howell or by Dr. D. Kock (see Appendix 2).

6.2.1.2 Bucket pitfall trapping

The bucket pitfall traps consisted of five 20 litre plastic buckets sunk flush to ground level in a linear transect. These were positioned approximately 2.5 m apart. A continuous piece of plastic sheeting ran perpendicular to the ground across the centre of each bucket forming a “runner”. A lip of plastic sheeting, a drift fence, was kept on the ground on to which soil and leaf litter was placed. An animal was, therefore, channelled along the plastic to one of the buckets. The bucket pitfalls, acting as live traps, were designed for sampling a community of shrews within the forest. Each mammal captured was weighed and measured. Trapping and biometric information was recorded on standardised data sheets. Unless otherwise indicated, taxonomic identification was made by Prof. K. Howell, Dr. D. Kock or Dr. W. Stanley (see Appendix 2).

6.2.1.3 Bat netting

Bat mist netting was used to collect and study a representative sample of the forest bat community, and also provide data on species' ranges. Mist nets were placed near potential roosts sites and across obvious flight "corridors", such as paths and rivers. Nets were set up at dusk, observed continuously throughout the night and closed shortly before dawn. Each bat caught was weighed and measured at the netting site. Trapping and biometric information was recorded on standardised data sheets. Unless otherwise indicated, taxonomic identification was made by Prof. K. Howell or Dr. D. Kock (see Appendix 2).

6.2.1.4 Mammal observations

Other vertebrate species were recorded on an opportunistic basis throughout the survey.

6.2.2 Reptiles

The aim of this study was to collect and identify a representative sample of the forest reptile community. The community of ground-dwelling reptiles was sampled using the bucket pitfall method (see 6.2.1.2 above). Opportunistic captures were also conducted by hand, and a snake stick where necessary. Unless otherwise indicated, taxonomic identifications were made by Prof. K. Howell or Prof. D. Broadley (see Appendix 2).

6.2.3 Amphibians

The aim of this study was to collect and identify a representative sample of the forest amphibian community. The community of ground-dwelling amphibians was sampled using the bucket pitfall method (see 6.2.1.2 above). Opportunistic captures were also conducted, especially in reference to tree frog collections since they were beyond capture with the bucket pitfalls. After rain, typical amphibian habitats were targeted for sampling. Unless otherwise indicated, taxonomic identifications were made by Prof. K. Howell or by Prof. J. Poynton (see Appendix 2).

6.3 Trapping sites and sampling intensity

Trapping was conducted in various habitats throughout the reserve. Table 11 describes the sites and Table 12 summarises the sampling intensity for each site and for each trapping method.

Table 11. Summary description of trapping sites.

Site number	Vegetation type	Altitude (m)	Topography	Slope (degrees)
plot 8	open forest/grassland	470	mid-slope	28
plot 10	cycad forest	600	mid-slope	27
plot 12	forest edge	260	gentle lower slope	12
plot 31	dense forest: no signs of harvesting	780	ridge top	10
plot 33	open forest: no signs of harvesting	640	gentle upper slope	25
plot 34	previously cultivated	200	valley	10
?	riverine lowland forest	?	?	?
OR	forest edge/previously disturbed	260	gentle lower slope	10

Table 12. Sampling intensity by trap night (number of traps x number of nights).

Trapping method	Plot 8	Plot 10	Plot 12	Plot 31	Plot 33	Plot 34	Riverine *	Outside reserve/ clearing
snaps traps	240	0	0	128	240	224	696	0
bucket pitfall**	35	0	0	25	15	50	0	0
bat netting***	0	1	7	1	0	2	0	1

* Plot number unknown.
** Each bucket of a line represents one trap night.
*** Length of net unknown.

Figure 22. Location of trapping sites.

6.4 Results

6.4.1 Mammals

6.4.1.1 Mammals (non-bats)

Seven specimens were retained for taxonomic purposes. They represent at least two species from two families. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (UDSM, 1997) and Kingdon (1989).

Table 13. Summary of mammals (non-bats).

Species	Ecological type	Endemic status	IUCN status	Capture location by plot & number collected				
				8	**31**	**33**	**R***	**Total**
Cricetidae								
Beamys hindei	f	N	DD	1	1		1	**3**
Soricidae								
Crocidura sp.	?	?		1		3		**4**

KEY TO ABBREVIATIONS FOR TABLE 13 (Definitions based on those described in the botanical section of this report).

Ecological type:
- F - Forest dependent species: This is defined as primary forest only. It does not include forest edge or secondary forest;
- f - Forest dwelling but not forest dependent: Species occurring in primary forest as defined above as well as other vegetation types. Thus these are not forest-dependent species; and
- O - Non-forest species: These are species that do not occur in primary or secondary forest or forest edge.

Endemic status:
- E - Endemic: Occurring only in the Usambara mountains;
- N - Near endemic: Species with limited ranges usually only including coastal forest and/or the Eastern Arc mountains;
- W - Widespread distribution.

IUCN status:
- DD - Data deficient

* R: riverine, plot unknown

6.4.1.2 Opportunistic Observations

A total of ten species from six families were observed but not retained for taxonomic purposes. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (UDSM, 1997) and Kingdon (1989).

Table 14. Summary of mammal observations.

Species	Certainty	Ecological type	Endemic status	IUCN status	Observation location by locale
Galagonidae					
Galago zanzibaricus	definite	f	W	NT	lowland forest
Cercopithecidae					
Cercopithecus mitis	definite	f	W		Plot 34; lowland forest
Cercopithecus aethiops	definite	f	W		cultivated area
Colobus angolensis	definite	F	W		forest edge; Plot 31
Herpestidae					
Atilax sp.	probable	?	?		forest edge
Rodentia					
Heliosciurus rufobrachium	possible	F	W		lowland forest edge
Paraxerus palliatus	possible	f	W		lowland secondary forest
Suidae					
Potamochoerus porcus	definite	f	W		droppings seen location ?
Macroscelididae					
Petrodromus tetradactylus	definite	f	W		lowland forest
Rhynchocyon petersi	definite	F	N	NT	lowland forest

KEY TO ABBREVIATIONS FOR TABLE 14 (Definitions based on those described in the botanical section of this report).

Ecological type:
- F - Forest dependent species: This is defined as primary forest only. It does not include forest edge or secondary forest;
- f - Forest dwelling but not forest dependent: Species occurring in primary forest as defined above as well as other vegetation types. Thus these are not forest-dependent species; and
- O - Non-forest species: These are species that do not occur in primary or secondary forest or forest edge.

Endemic status:
- E - Endemic: Occurring only in the Usambara mountains;
- N - Near endemic: Species with limited ranges usually only including coastal forest and/or the Eastern Arc mountains;
- W - Widespread distribution.

IUCN status:
- E - Endangered
- NT - Near-threatened

OR - Refers to observations outside but in proximity to the reserve to be considered associated to it.
? - No data available
Certainty: Indicates the probability of the correctness of the identity of the species observed;
Definite: Can be regarded as occurring in the reserve.
Probable: Identification is likely but requires confirmation before placing on the reserve's species list.

Figure 23. Distribution of forest dependent mammal species.

Figure 24. Distribution of near-endemic mammal species.

6.4.1.3 Bats

A total of 18 specimens were retained for taxonomic purposes. These represent 14 species from five families. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (UDSM, 1997); Howell (1993) and Kingdon (1989).

Table 15. Summary of bats.

Species	**Ecological type**	**Endemic status**	**IUCN status**	**Capture location by plot and number captured**							
				10	**12 FE**	**12 RF**	**12 CR**	**34**	**31 RT**	**OR L**	**Total**
Rhinolophidae											
Rhinolophus landeri	f	W				1					**1**
Rhinolophus deckenii	f	W			1	1					**2**
Rhinolophus hildebrandti	f	W								2	**2**
Nycteridae											
Nycteris thebaica	f	W		1							**1**
Hipposideridae											
Hipposideros ruber	f	W						1			**1**
Hipposideros caffer	f	W					1				**1**
Triaenops persicus afer	f	W			1						**1**
Vespertilionidae											
Pipistrellus nanus	f	W			1						**1**
Pipistrellus sp.	?	?			1						**1**
Miniopterus m. minor	f	W	NT		1						**1**
Kerivoula argentata	f	W						1			**1**
Pteropodidae											
Rousettus aegyptiacus spp. *leachii*	f	W						1			**1**
Myonycteris relicta	F	N	V		1				1		**2**
Epomophurus wahlbergi	F	W							2		**2**

Table 16. Summary of bat observations.

Species	**Ecological type**	**Endemic status**	**Observation location by plot and number observed**							
			10	**12 FE**	**12 RF**	**34**	**31 RT**	**OR**	**UK**	**Total**
Rhinolophidae										
Rhinolophus fumigatus	O	W		3	50					**53**
Pteropodidae										
Epomophurus wahlbergi	F	W	2	1		1	7	2		**13**
Lissonycteris angolensis	f	W							12	**12**

KEY TO ABBREVIATIONS FOR TABLE 15 & 16 (Definitions based on those described in the botanical section of this report).

Ecological type:

- F - Forest dependent species: This is defined as primary forest only. It does not include forest edge or secondary forest;
- f - Forest dwelling but not forest dependent: Species occurring in primary forest as defined above as well as other vegetation types. Thus these are not forest-dependent species; and
- O - Non-forest species: These are species that do not occur in primary or secondary forest or forest edge.

Endemic status:

- E - Endemic: Occurring only in the Usambara mountains;
- N - Near endemic: Species with limited ranges usually only including coastal forest and/or the Eastern Arc mountains;
- W - Widespread distribution.

IUCN status:

- V - Vulnerable
- NT - Near-threatened

Capture locale codes:

RT - ridge top
FE - forest edge
RF - rock face in forest
CR - cave roost in forest
L - brought in by local people; unknown capture location
UK - unknown capture location

Table 17. Ranges for near-endemic mammal recorded (National Biodiversity Database, UDSM, 1997).

Near-endemic species	**Range**
Rhynchocyon petersi	NE and E Tanzania; Zanzibar; Mafia; SE Kenya
Beamys hindei	Usambara Mts.; coastal forest; SE Kenya
Myonycteris relicta	Usambara; Nguru; coastal forests; Shimba Hills, Kenya

6.4.2 Reptiles

A total of 33 specimens were retained for taxonomic purposes. These represent 25 species from nine families. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (UDSM, 1997); Broadley and Howell (unpubl.); Howell (1993); and Branch (1994).

Table 18. Summary of reptiles.

Species	Ecological type	Endemic status	IUCN status	Capture location & number collected				
				F	C	FT	UK	Total
Colubridae								
Lamprophis fuliginosus	f	W		1	2			**3**
Aparallactus werneri	F	N	V	1				**1**
Aparallactus guentheri	F	W					1	**1**
Philothamnus macrops	F	N	V			1		**1**
Philothamnus punctatus	f	W			1			**1**
Philothamnus hoplogaster	f	W					1	**1**
Thelotornis capensis spp. *mossambicana*	f	W			1			**1**
Crotaphopeltis tornieri	F	N	V	1				**1**
Elapidae								
Dendroaspis angusticeps	f	W		1				**1**
Viperidae								
Bitis arietans arietans	f	W			1			**1**
Cordylidae								
Cordylus t. tropidosternum	f	W		1		1		**2**
Gerrhosaurus flavigularis	f	W			2			**2**
Lacertidae								
Holaspis guentheri laevis	F	W		1				**1**
Scincidae								
Leptosiaphos kilimensis	F	N	V	1				**1**
Mabuya m. maculilabris	f	W		1				**1**
Agamidae								
Agama montana	F	N	V	2			1	**3**
Chamaeleonidae								
Bradypodion tenue	F	N	V (CITES II)			1		**1**
Chamaeleo dilepis	f	W					1	**1**
Chamaeleo melleri	f	W	LC (CITES II)	1				**1**
Rhampholeon brevicaudatus	F	N	V	1	1			**2**
Rhampholeon temporalis	F	N	E	1				**1**
Rhampholeon sp. nov.	F?	E		2				**2**
Rhampholeon kerstenii kerstenii	F	N	LC		1			**1**
Gekkonidea								
Hemidactylus mabouia	f	W			1			**1**
Hemidactylus sp.	?	?		1				**1**

* Plot numbers not available for most species.

Table 19. Summary of reptile observations.

Species	Certainty	Ecological type	Endemic status	Capture location by plot number
Varanidae				
Varanus niloticus	definite	f	W (CITES II)	34

KEY TO ABBREVIATIONS FOR TABLE 18 & 19 (Definitions based on those described in the botanical section of this report).

Ecological type:
- F - Forest dependent species: This is defined as primary forest only. It does not include forest edge or secondary forest;
- f - Forest dwelling but not forest dependent: Species occurring in primary forest as defined above as well as other vegetation types. Thus these are not forest-dependent species; and
- O - Non-forest species: These are species that do not occur in primary or secondary forest or forest edge.

Endemic status:
- E - Endemic: Occurring only in the Usambara mountains;
- N - Near endemic: Species with limited ranges usually only including coastal forest and/or the Eastern Arc mountains;
- W - Widespread distribution.

IUCN status:
- E - Endangered
- NT - Near-threatened
- LC - Least concern

Capture locale codes:
- FT - forest ridge top
- F - forest
- C - cultivation outside reserve
- UK - unknown capture location

? - Insufficient data

Certainty: Indicates the probability of the correctness of the identity of the species observed;
Definite: Can be regarded as occurring in the reserve.
Probable: Identification is likely but requires further information before being considered on the reserve's species list.

Table 20. Ranges for endemic and near-endemic reptile recorded (Howell, 1993).

Endemic species	Range
Rhampholeon sp. nov.	Bamba Ridge forest reserve
Near-endemic species	**Range**
Crotaphopeltis tornieri	East and West Usambara; Uluguru; Uzungwa; Ukinga; Rungwe; Misuku Mts., Malawi
Aparallactus werneri	East Usambara; West Usambara; Uluguru; Coastal forest
Philothamnus macrops	East Usambara; Zanzibar; Rondo Plateau
Leptosiaphos kilimensis	Kenya; Northern Tanzania (Montane forest)
Agama montana	East Usambara; West Usambara; Uluguru; Nguru
Bradypodion tenue	East Usambara; West Usambara; Shimba Hills, Kenya
Rhampholeon kerstenii kerstenii	Arabuko-Sokoke forest, Kenya; Gendagenda forest reserve, Tanzania
Rhampholeon brevicaudatus	East Usambara; Uluguru; Uzungwa; Coastal forest
Rhampholeon temporalis	East Usambara; West Usambara; Shimba Hills, Kenya

6.4.3 Amphibians

A total of 42 specimens were retained for taxonomic purposes. These represent 23 species from ten families. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (UDSM 1997); Howell (1993); Poynton and Broadley (1991); and Poynton (unpubl.).

Table 21. Summary of amphibians.

Species	Ecological type	Endemic status	IUCN status	Capture location by plot and number collected*						
				G	**FE**	**F**	**OF**	**OR**	**UK**	**Total**
Arthroleptidae										
Arthroleptis stenodactylus	f	W				2				**2**
Arthroleptis xenodactyloides	f	W				3			1	**4**
Bufonidae										
Bufo gutturalis	f	W						1		**1**
Mertensophryne micranotis	F	N	E			1				**1**
Nectophrynoides tornieri	F	N	V (CITES I)		1	5			1	**7**
Hemisidae										
Hemisus gutteralis	f	W								**1**
Hyperoliidae										
Leptopelis barbouri	F	N	V						1	**1**
Leptopelis flavomaculatus	F	W				1	1			**2**
Leptopelis uluguruensis	F	N	V			3				**3**
Leptopelis parkeri	F	N	V							**1**
Leptopelis sp.	?	?				2				**2**
Microhylidae										
Hoplophryne rogersi	F	E	V			1				**1**
Callulina kreffti	F	N	V			5				**5**
Breviceps mossambicus	f	W		1						**1**
Parhoplophryne sp.	?	?				1				**1**
Ranidae										
Phrynobatrachus acridoides	f	W						1		**1**
Rana angolensis	f	W								**1**
Ptychadena oxyrhynchus	f	W						2		**2**
Ptychadena anchietae	f	W						1		**1**
Rhacophoridae										
Chiromantis xerampelina	f	W						1		**1**
Pipidae										
Xenopus muelleri	f	W								**1**
Caeciliidae										
Boulengerula boulengeri	F	E	V				1			**1**
Scolecomorphidae										
Scolecomorphus vittatus	F	N	V							**2**

* Plot numbers not available for most species

KEY TO ABBREVIATIONS FOR TABLE 21 (Definitions based on those described in the botanical section of this report).

Ecological type:

- F - Forest dependent species: This is defined as primary forest only. It does not include forest edge or secondary forest;
- f - Forest dwelling but not forest dependent: Species occurring in primary forest as defined above as well as other vegetation types. Thus these are not forest-dependent species; and
- O - Non-forest species: These are species that do not occur in primary or secondary forest or forest edge.

Endemic status:

- E - Endemic: Occurring only in the Usambara mountains;
- N - Near endemic: Species with limited ranges usually only including coastal forest and/or the Eastern Arc mountains;
- W - Widespread distribution.

IUCN status:

- V - Vulnerable
- E - Endangered

Capture locale codes:

G - grassland
FE - forest edge
F - forest
OF - open forest
OR - outside reserve
UK - unknown capture location

Table 22. Ranges for endemic and near-endemic amphibian species recorded (Howell 1993).

Endemic Species	**Range**
Hoplophryne rogersi	East Usambara; West Usambara
Boulengerula boulengeri	East Usambara; West Usambara
Near-endemic Species	**Range**
Nectophrynoides tornieri	East Usambara; West Usambara; Uluguru; Uzungwa
Mertensophryne micranotis	East Usambara; Coastal forest
Leptopelis barbouri	East Usambara; Uzungwa
Leptopelis uluguruensis	East Usambara; West Usambara; Uluguru; Uzungwa
Leptopelis parkeri	East Usambara; West Usambara; Ulugurus
Callulina kreffti	East Usambara; West Usambara; Nguru; Uluguru; Uzungwa; Taita Hills, Kenya
Scolecomorphus vittatus	East Usambara; West Usambara; Uluguru; N. Pare

6.5 Summary

Species Richness

In this section, species which have been captured or observed three or more times during the survey are considered locally common. Although unproven this figure is based on extensive sampling of populations in the region and seems a reasonable basis for assessing abundance.

Mammals:

Beamys and *Crocidura* were the only two genus trapped. Low capture rates are likely to be due to low rainfall during the trapping nights. The most common bat was *Epomophorus wahlbergi*.

Reptiles:

The two most common reptile species were *Lamprophis fuliginosus* and *Agama montana*. The former is a widespread forest non-dependent snake and the latter is a forest dependent, near-endemic agama. Each was recorded three times indicating that they are abundant species.

Amphibians:

For tree frogs, the most commonly caught species was *Leptopelis uluguruensis*. Other amphibians that appear to be locally common are *Callulina kreffti, Nectophrynoides tornieri* and *Arthroleptis xenodactyloides*. The former two are forest dependent, near-endemics and the latter is a widespread forest non-dependent species.

Endemics and near-endemics:

Of the 22 faunal endemics and near-endemics of the Usambaras recorded, five appear to be locally common as they were recorded at least three times during the survey. These are: *Beamys hindei; Callulina kreffti, Leptopelis uluguruensis; Nectophrynoides tornieri* and *Agama montana.*

Forest dependent species:

Of the 27 forest dependent species, five appear to be locally common these are: *Epomophorus wahlbergi; Callulina kreffti; Leptopelis uluguruensis; Nectophrynoides tornieri* and *Agama montana.*

High risk species:

Assuming that the number captured reflects relative population size, those species that are locally uncommon, forest dependent and either near-endemic or endemic species are considered to be at high risk. These species are: *Rhynchocyon petersi; Myonycteris relicta; Crotaphopeltis tornieri; Aparallactus werneri*; *Philothamnus macrops; Leptosiaphos kilimensis; Bradypodion tenue; Rhampholeon brevicaudatus; R. k. kerstenii; R. temporalis; R.*. sp. nov*; Prosymna semifasciata; Mertensophryne micranotis; Leptopelis barbouri; L. parkeri; Hoplophryne rogersi; Boulengerula boulengeri* and *Scolecomorphus vittatus.*

Table 23. Summary of faunal families and species (identified to date).

Taxon	Number of families	Number of species
mammals	13	28
reptiles	10	26
amphibians	10	23

Table 24. Summary of capture locations of faunal species.

Taxon	Forest	Forest edge	Open forest	grass land	farm land	unknown	Lukinao Dam
mammals *	7	2	5	11	2	3	5
reptiles	17	0	0	0	8	4	4
amphibians	15	1	3	1	5	3	0

* primates excluded due to their large ranges.

Ecological type

Of the forest dependent species, five are mammals, 12 are reptiles and ten are amphibians. One invasive species was recorded, this is *Rhinolophus fumigatus,* a widespread bat typical of open country habitats (Kingdon, 1989). This species was found on the forest edge.

Table 25. Summary of ecological type of faunal species.

Ecological type	No. of species	% of total species recorded
(F) Forest dependent	27	35.1
(f) Forest dwelling but not forest dependent	43	55.8
(O) Non-forest species	1	1.3
Unknown	6	7.8
Total	**77**	**100.0**

Endemic Status

The three species that are endemic to the Usambara mountains are: *Rhampholeon* sp. nov.; *Hoplophryne rogersi*, *Boulengerula boulengeri. Rhampholeon* sp. nov. and *Hoplophryne rogersi* were recorded in mature mixed forest whereas *Boulengerula boulengeri* was found in open forest.

Table 26. Summary of endemic status of faunal species.

Endemic status	No. of species	% of total species recorded
(E) Endemic to the Usambara Mountains	3	3.9
(N) Near-Endemic: ranges in restricted locations	19	24.7
(W) Widespread	49	63.6
Unknown	6	7.8
Total	**77**	**100.0**

Range Extensions

Mammals:
The bat, *Miniopterus minor minor*, is a first record for Tanzania (Kock, *pers. comm.*). This specimen was captured on the forest edge.

Reptiles:
A new species of Leaf Chamaeleon, *Rhampholeon* sp. nov. was recorded in mature forest.

Amphibians:
The East Usambara endemic ground frog, *Hoplophryne rogersi*, was collected in an *Achatina* sp. shell at an altitude of 750 m. Previously known only from the Amani area and Magoroto forest.

CITES

Nectophrynoides tornieri is listed as a CITES Appendix I species.

The Nile monitor lizard, *Varanus niloticus*, as are all Varanidae, is a CITES Appendix II species. These reptiles have encountered high hunting pressure for their meat and skin and are now protected (Branch, 1994).

IUCN Status (National Biodiversity Database, 1997)

Rhynchocyon petersi, Rhampholeon temporalis and *Mertensophryne micranotis* are listed as 'Endangered'.

Myonycteris relicta; Aparallactus werneri; Philothamnus macrops; Crotaphopeltis tornieri; Leptosiaphos kilimensis; Agama montana; Bradypodion tenue; Rhampholeon brevicaudatus; Scolecomorphus vittatus; Boulengerula boulengeri; Callulina kreffti; Hoplophryne rogersi; Leptopelis parkeri; Leptopelis barbouri; Leptopelis uluguruensis; and *Nectophrynoides tornieri* are listed as 'Vulnerable'.

Miniopterus m. minor and *Galago zanzibaricus* are listed as 'Near-threatened'.

Figure 25. Areas of highest disturbance in relation to the distribution of species that are both forest dependent and near-endemic. (Note: this map only includes species with known capture locations which therefore is limited only to mammals).

7.0 SOCIO-ECONOMICS

By M. Fundi

7.1 Introduction

The following socio-economic survey conducted in August 1995 comprises of data collected in the Maramba District, covering the ward of Muhinduro. This ward is made up of seven villages: Muhinduro; Churwa; Matemboni; Kuzekibango; Bosha-Kwamtili; Bamba-Mavangero; and Segoma. Sub-localities included in the interviews were: Jambe; Turiani; and the village of Kichangani adjoining Bamba Sisal Estate.

7.2 Methods

A total of forty-eight semi-structured interviews were conducted in the Muhinduro and Bamba-Mavangero area between June and September 1995. A range of methods were combined to triangulate data rapidly including Rapid Rural Appraisal, household interviews and ethnography, whereby a researcher participated in typical daily tasks (WRI, 1990).

7.3 Results

7.3.1 Population and surrounding land use

The majority of people interviewed were members of the Wasambaa tribe although others including Wabondei, Wakonde, Wabena, Wadigo, Wamuha, Wachagga, Wazigua, and some Indian people were also interviewed. It appears that these people mix socially with no apparent friction and inter-marriage between tribes is now common practice. The majority of families in the main district have origins within this area, although a small percentage have settled from areas including Kenya, Mozambique, and Zambia. Christianity is the predominant religious denomination, though approximately 10% are Muslim.

The majority of local people are subsistence farmers, with some cash-crop production for sale in Tanga. The average land holding per family is 0.5-4 ha including fallow land. The approximate ratio between cash crops and subsistence is 1:3. A few families hold plots of 4-20 ha (including fallow) and in these cases, cash crops account for more than 50% of productive output. Most individuals with more than 0.5 ha of land carry out crop rotation, mainly inter-cropping. Land was either purchased or inherited in a ratio of approximately 1:1. The majority of farmers have no problem with soil fertility and therefore have no need for artificial fertilisers. Virtually all farmers leave land fallow for a period if soil fertility wanes. Generally, farming techniques were passed down from generation to generation.

7.3.2 Economic activities and development

The main source of household income is cash crop sales, consisting of a variety of beans, nuts, fruit and vegetables. These crops are sold mostly in Tanga, collected from the villages by truck. Money earned is used to purchase cooking fat, kerosene, salt, sugar, and medicines, and to pay for school fees.

Each village and sub-locality visited had one tea shop, with two in Bamba main village. Jambe, Mavangero, and Kichangani had one shop each for limited domestic supplies. Muhinduro had two small general retail shops, a tailor, two local bars, a bike repair shop, a small motor vehicle repair business, and a maize mill for the surrounding villages. Bamba has three small retail shops, one local bar, a tailor, a fish and vegetable store, and a bike repair shop. There are no butchers available in any village. There are no outlets for farming tools and agrochemicals. Many people expressed a need for herbicides and insecticides to combat crop damage. The Bamba Sisal Estate provides casual work to the surrounding villages, namely Kichangani, Bamba and Muhinduro. It is mainly men who find extra employment in this way.

The area is served by two primary schools, at Muhinduro and Bamba. The nearest secondary school is at Maramba. Primary registration is between 40-60% of school-age children, however, attendance is between 40-60% of those registered. The main explanation of low registration levels was shortage of money: annual fees and compulsory uniforms cost 4,100 tsh per child. The main reason for low attendance was the preference of leisure to education by the children. In addition, the children have complained about poor quality English instruction and the frequent absence of teachers. The school authorities claim to be flexible about fees according to the ability of parents to pay. Both schools had little equipment: desks and chairs were in short supply and in Bamba only one-third have seating, the rest have to use the floor. In Muhinduro there were only two classrooms, and the majority of students were taught outdoors under a tree. These reasons may well exacerbate low attendance rates. It has been some time since any children from this area graduated to secondary education.

Development is greatly restricted by poor transport infrastructure. In particular, the road from Muhinduro to Segoma is very bad, with the few vehicles that use it often getting stuck.

Electricity is available in the main villages of Muhinduro and Bamba, but is almost exclusively for the use of businesses. The general population express a desire for electricity but the present cost is beyond their reach therefore they continue to rely on candles and kerosene lamps for lighting, and firewood for fuel.

7.3.3 Forest and land tenure

A high percentage of the farmers in the area own farm land, acquiring it either through inheritance or purchase. Use of the forest has been limited since the area was gazetted in 1958.

Residents of Bamba-Mavangero claim to retrieve firewood and building poles from allotted areas within the forests, with permission from the Catchment Forest office, either once or twice a week depending on requirement. It is likely that people enter the forest for firewood without permission if the supply around their farm land runs short. In Muhinduro and Jambe, residents insist that their farm land supplies enough firewood and they do not need to enter the forests. In Kichangani, residents were allowed to collect firewood and building poles freely from the nearby sisal estate.

Many use branches from coconut trees to supplement fuel supply. There is little or no use of charcoal in this area.

A surprisingly large number of people admitted to hunting in the forest, using traps and guns, for wild pigs, *Potamochoerus porcus*, blue monkeys, *Cercopithecus mitis*, and duiker, Cephalophinae. Some claim to domesticate guinea fowl from the forest. One individual in Bamba confirmed that hunting of Colobus monkeys, *Colobus angolensis*, also occurs. In Jambe and Kichangani it was mentioned that impala, *Aepyceros melampus*, are hunted when they wander into the area during the rainy seasons. A high proportion of interviewees however claimed only to trap or shoot on their farm land to protect crops.

No large mammals, such as elephant or lion have been seen in recent times. The general opinion is that the establishment of Bamba Sisal Estate in 1952, and the relocation of people from rural to villages through a villagisation policy, caused a reduction in animal populations through hunting and forced dispersal.

All interviewees referred to water shortages as their primary concern. Each village has three or four shallow wells which often run dry for up to six months a year during the dry seasons. When this happens, people walk between 1 - 2.5 hours for water and spend a majority of the day waiting for access to the water pump. Muhinduro is partially serviced by the Kwasenkondo River which, for the majority of those who use it, was the most reliable water source. Residents of Kichangani are sometimes able to get water from the nearby sisal estate.

7.3.4 Use of and dependence on the forest

Local herbal remedies for stomach complaints, malaria and a variety of other diseases are commonly used. Interviewees stated that all herbal medicines were obtained from their farm land, and not from the forests. From the information retrieved, it is unknown what future pressure will be on the forest in terms of herbal medicine procurement.

The majority of houses are made from mud pressed into wooden frames although there is a move toward sun dried mud bricks. Species cultivated on their farm land for use as building poles include: *Markhamia hildebrandtii*, *Millettia dura* and *Lecaniodiscus fraxinifolius*.

Forest timber trees include: *Casuarina* sp. and *Bombax rhodognaphalon*. Despite insistence to the contrary, and the obvious fear of Catchment Forest staff, evidence of pitsawing throughout the forest indicates that a number of people continue to enter the forests to acquire timber illegally.

In Muhinduro and Jambe residents insist that their farm land supplies enough firewood that they do not need to enter the forests. In Kichangani, residents are allowed to collect firewood as well as poles for building from the nearby sisal estate free of charge. Many people throughout the area use branches from coconut trees to supplement their fuel supply needs. Dependence on the forest for fuelwood appears to be limited. Future consumption may be of concern though as population increases.

Dependence on the forest also includes access to wild meat. As mentioned earlier, numerous people admitted to hunting in the forest for wild pigs, blue monkeys, black and white colobus and duiker.

7.3.5 Peoples attitudes to conservation

Although virtually all interviewees complained about restrictions imposed on forest use, they also expressed appreciation of the reasons behind the gazettement mentioning the connection between the re-growth of the gazetted areas and the increase in rainfall, which they acknowledge as beneficial to their crops. One man likened the forest reserve regulations to the instruction of a father to his son. Wildlife conservation was viewed with mixed feeling with many people expressing pleasure that their children had the opportunity to grow up surrounded by wildlife, but equally as many expressed a desire for extermination of all animals that damaged their crops.

7.3.6 Development

The aim of the eco-tourism evaluation was to determine the extent of the present facilities available to tourists, and identify the outstanding requirements. Furthermore, using the biological data, it is possible to outline the potential impacts which eco-tourism development may have on this forest reserve.

There are no facilities available for tourists within or adjacent to Bamba Ridge forest reserve. However, the surrounding sisal estates contain many unused buildings which, with minimum renovation, would be adequate for accommodation. Electricity is already supplied to the estate and to the occupied buildings. Running water is supplied to a few buildings, and furniture could be found on the estate or made locally. Currently no tourists visit the forest, except for the occasional biologist.

The ecotourism potential of Bamba Ridge forest reserve is twofold. Firstly, it contains some impressive forest and sites of particular biological interest, which may attract those interested in the natural history of the area. Secondly, the forest offers spectacular views and scenic walks which would be of interest to those of a less scientific background who want to visit an attractive forest site. It was also noted that the villagers interviewed responded positively towards the idea of eco-tourism. However, the slopes within the forest are very steep in places which has implications for trail creation.

7.4 Discussion

People living around Bamba Ridge forest reserve are subsistence farmers, with some cash-crop production. In the past small-scale agriculture occurred at the expense of the forest. The economic level of the area is low and almost all income is spent meeting daily requirements. Since gazettment of the forest conflict between the people and the conservation of the forest has ensued.

Access to water was the main concern of the communities around Bamba Ridge forest reserve. Village water wells regularly dry up for as much as six months of the year, water must then be obtained from sources up to 2 hours walk away. Supplies of firewood and poles for building are also limited. Many people collect wood from allotted areas with Catchment Forest permits. Collecting the basic items of fuel and

water occupies a substantial amount of people's time and energy. The conflict thus arises between the apparent wealth of the forest and the marginal lifestyle of the people. The forest is viewed as fertile land for agriculture; feral animals are perceived as pests because of crop raiding; hunting occurs regularly regardless of the laws, cardamom is still grown at the forest edge; and procurement of timber and poles continues far into the forest once again, against management policy.

People have an understanding of the catchment function of the forests and they appear to be aware of the management policies of forest reserves as they were reluctant to state how they used the forests. Their traditional dependence on the forest has been made illegal and many of the cultural traditions associated with forest use are declining among the younger generation.

Farm land is still relatively fertile and artificial fertilisers are not needed. Farming practises are passed down through generations. Formal education is limited. Farmers do not have the resources, either financially or through education, for increased food production which otherwise would result in an increased standard of living.

8.0 CONCLUSION

This report presents the raw data of the survey with preliminary descriptions in terms of ecological type and endemic status. These two factors provide an indication of three main 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.

Bamba Ridge forest, gazetted as a forest reserve in 1958, covers an area of 1,131.5 ha on the eastern side of the main East Usambara range. With altitudes between 150 m and 1,034 m, it consists of approximately 53.1% mature forest, 40.6% open forest or poorly stocked forest and 6.3% woodland or grassland.

Disturbance

Three areas assessed for disturbance are considered to be under threat due to their high rate of pole and timber extraction. These are in the southern end of the reserve near Lukino plateau and in the vicinity of Muhinduro Ndogo.

Species Richness

The forest reserve was found to contain a minimum of 167 species of trees and shrubs; 28 mammal, 26 reptile and 23 species of amphibian.

Flora

One tree species was recorded which is endemic to the Usambara mountains and 39 have restricted ranges limited to the Eastern Arc and/or East African lowland forests. Forty-five species are dependent only on primary forest, and of these species, 18 are also endemic or near endemic to the Usambara mountains. Twenty-five non-forest tree and shrub species are established within the reserve boundaries.

Fauna

Three faunal species were recorded which are endemic to the Usambara mountains and nineteen species were recorded as near-endemics, having restricted ranges limited to the Eastern Arc and/or East African lowland forests. Twenty-six species are dependent only on primary forest, and of these species, 22 are also endemic or near endemic to the Usambara mountains. One non-forest species is established in the reserve.

Table 27. Summary of biodiversity of taxa surveyed.

Taxon:	Total no. of species	% forest dependent	No. of non-forest species	No. of endemics	No. of near-endemics	No. of forest dependent endemics and near-endemics
trees and shrubs	167	27.0	25	1	39	**18**
mammals	18	27.8	1	0	3	**2**
reptiles	26	46.2	0	1	9	**9**
amphibians	23	43.5	0	2	7	**9**
Total	**234**	**--**	**26**	**4**	**59**	**38**

Conservation

The East Usambara mountains are important due to their floral and faunal diversity, their high levels of species endemism and their water catchment value. The forests are also an important source of fuelwood, poles, timber, food and medicinal plants for the local people. Differences in the perceived value of the forests have caused and still cause a conflict of interest between the villagers and the Catchment authorities. The remaining forests of the East Usambara mountains are now only small refuges of what was present just one hundred years ago (Hamilton, 1989). The area continues to be vulnerable because of growing pressure for agricultural land associated with a growing population.

As has been documented many times before, forests are fragile ecosystems sensitive to overexploitation. Forest soils are highly susceptible to soil erosion and loss of fertility once the land has been cleared. Due to the tight nutrient cycling in the forest, once the land has been cleared the soil quickly loses fertility (Hamilton, 1989). Similarly, soil erosion increases dramatically with the removal of the canopy cover, causing increased siltation of the rivers and a corresponding decline in water quality. Damage to the catchment capacity of the East Usambaras is of particular concern given that they supply water to communities along the Sigi river as well as to the coastal town of Tanga.

Bamba Ridge forms part of a large forest continuum with Kwamgumi and Segoma forest reserves. For this reason, the zoological and botanical species of Bamba Ridge forest reserve can likely endure some amount of forest degradation before its effects on the overall sustainability of species occurs.

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Appendix 1:

General Plot Information

Plot Number	Topography	Altitude (metres)	Slope (degrees)	Vegetation Condition	Canopy Height (metres)
1	MS	350	?	M	?
2	MS	350	24	P	?
3	GL	340	15	M	20-30
4	G	400	6	M	20-30
5	Missed plot				
6	SL	300	36	M	>40
7	SU	450	35	M	10-20
8	MS	470	28	P/G	20-30
9	SU	480	42	M	20-30
10	MS	600	27	P	10-20
11	GL	290	20	M	10-20
12	GL	260	12	G	<10
13	MS	360	18	M	20-30
14	MS	425	28	P	20-30
15	GL	305	21	M	20-30
16	MS	340	27	M	>30
17	SU	720	?	M	20-30
18	SU	560	40	M	>30
19	GL	290	10	M	>30
20	MS	440	16	P	20-30
21	G	460	21	M	20-30
22	GL	300	19	P	20-30
23	MS	500	22	P	>30
24	GL	400	25	P	10-20
25	GL	300	16	C	10-20
26	MS	300	27	M	10-20
27	SU	250	26	M	20-30
28	MS	450	30	P	10-20
29	MS	460	26	P	10-20
30	MS	360	26	P	20-30
31	SU	700	24	M	>30
32	MS	630	32	M	20-30
33	GL	640	25	P	20-30

KEY TO ABBREVIATIONS

Topography	Vegetation Condition
GL - gentle lower slope	M - mature mixed forest/more or less natural forest
SL - steep lower slope	P - disturbed primary forest or secondary forest
M - mid-slope	G - grassland
GU - gentle upper slope	B - bushland and/or thicket
SU - steep upper slope	W - woodland
FV - flat valley floor	FC - forest edge/colonising
RT - ridge top	EC - former encroachment/colonising
G - gully	

Appendix 2:

Taxonomic Verification

BOTANY

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Ahmed Mdolwa	TAFORI	Lushoto, Tanzania

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Prof. J. Poynton	British Natural History Museum	Cromwell Road, South Kensington, London, UK.

Reptiles:

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All other invertebrates:

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Muhinduro Peak

Muhinduro Ndogo

Lukindo Plateau