TECHNICAL PAPER 33

Kwamarimba Forest Reserve

A biodiversity Survey

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

East Usambara Catchment Forest Project

Technical Paper 33

Kwamarimba Forest Reserve

A biodiversity survey

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Society for Environmental Exploration

Tanga 1996

Cover painting: Jaffary Aussi (1995)

ISSN 1236-620X
ISBN 952-446-013-0

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
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ACKNOWLEDGEMENTS

This report is the culmination of the advice, co-operation, hard work and expertise of many people.

Acknowledgements are due to the East Usambara Catchment Forest Project who commissioned the survey, notably Mr. Katigula (Project Manager), and Dr. S. Johansson (Chief Technical Adviser). All personal communications cited in this report were provided by the taxonomic experts listed in Appendix 2. Many thanks are due to their invaluable work identifying the specimens that the FT FRP collects each expedition survey. Thanks are also due to the Research Assistants without whom this project would not be possible:

Julia Lloyd	Anna Lavender
Cameron Jinks	Frixos Michael
Richard Harrison	Kristin Olsen
Simon Claydon	Sarah Phillips
Guy Banim	Robert Power
Jonathan Wibberley	Cassandra Robinson
Marc-Lucien Weyermann	Simon Whitehead
Jussi-Pekka Rasinmaki	Imogen Wright
Katie Parsons	Daniela Pezzato
Annuka Vahasarja	

We also thank the staff from the University of Dar es Salaam for their expertise:

Leonard Mwasumbi	Curator of the Herbarium, Botany Department
Bernard Mponda	Technician, Botany Department
Frank Mbago	Botanist
Ms.Tuyu	Socio-economist
Mike Fundi	Socio-economist

From FAO, Ronald Botterweg for map production (Department of Zoology and Marine Biology, UDSM).
From TAFORI, Ahmud Mndolwa, botanist.
From Mlingano Agricultural Research Institute, J.M. Shaka and A. Msangi, for the soil analysis.

We would also like to thank the field staff of the East Usambara Catchment Forest Project: Raymond R. Kilenga, Edgar Msikari, Frank Jonas and George Siafu.

And thanks are extended to the Frontier-Tanzania Project staff:

Julian Bayliss	Project co-ordinator
Pamela Cunneyworth	Zoologist
Diana Percy	Botanist
Ben Hayes	Camp co-ordinator

Many thanks also to those who provided comments on the first draft of this report: Dr. S. Johansson, Chief Technical Adviser for the East Usambara Catchment Forest Project; Dr. K. Howell from the University of Dar es Salaam; Ms. L. Stubblefield, Director of Research and Development for the Society for Environmental Exploration, Dr. Neil Burgess of the University of Copenhagen and Mr. M. S. Dilger and Ms. N. Doggart of Frontier-Tanzania.

Abstract

Kwamarimba 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 rich floral and faunal diversity and high levels of species endemism (Hamilton, 1989). To investigate further this biodiversity, a biological survey of Kwamarimba forest reserve was conducted with a socio-economic component between October and December 1995 for a total of 51 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 so as to highlight the importance of Kwamarimba 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 identified 165 species of tree and shrub, 16 species of mammal, 11 species of bird, 17 species of reptile and 11 species of amphibian.

Flora

Four tree species are endemic to the Usambara mountains and 39 which have restricted ranges limited to the Eastern Arc and/or East African lowland forests. Thirty-seven species are dependent on primary forest, and of these species, 14 were also endemic or near endemic to the Usambara mountains. Twenty non-forest tree and shrub species are established within the reserve boundaries.

Species of particular interest encountered during this survey included:

- *Cola usambarensis, Cynometra brachyrrhachis,* and *Cynometra longipedicellata* are wet evergreen forest trees, endemic to the East Usambara mountains recorded in the reserve. The first two were recorded twice and the latter 15 times;

- *Rinorea angustifolia,* a wet evergreen forest tree, endemic to the East and the West Usambara mountains was recorded once in the reserve;

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).

- *Sapium armatum*, a small dry forest tree, previously recorded as a coastal endemic, is a new record for the region (FTEA);

- *Nesogordonia holtzii* is considered a coastal endemic tree. The occurrence of this species in the Usambaras may represent a range extension however the full description of this species has yet to be published.

Fauna

Three faunal species were recorded which are endemic to the Usambara mountains and fourteen species were recorded as near-endemics, having restricted ranges limited to the Eastern Arc and/or East African lowland forests. Twenty species are dependent on primary forest, and of these species, 15 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:

- *Typhlops pallidus*, the pallid blind snake, known from Sudan, Kenya and Zanzibar. This is the first record from the Tanzanian mainland;

- The Usambara eagle owl, *Bubo vosseleri*, and the Southern hyliota, *Hyliota australis* spp. *usambarae*, were recorded in the reserve. Both are endemic to the Usambara mountains. The former, is a CITES II species, also considered 'Vulnerable' by IUCN;

- *Mertensophryne micranotis* is listed as 'Endangered' by IUCN;

- *Sheppardia gunningi, Bubo vosseleri, Philothamnus macrops, Elapsoidea nigra, Rhampholeon brevicaudatus, Bufo brauni, Leptopelis barbouri*, and *Scolecomorphus vittatus* are listed as 'Vulnerable' by IUCN;

- *Chamaeleo melleri, Swynnertonia swynnertoni* and *Rhynchocyon cirnei* spp. *petersi* are listed as 'Near-threatened' by IUCN.

Soils

The soils of Kwamarimba are typical of other soils studied in the East Usambaras. Human disturbance was found to be a major contributing factor to the differences in soil type. These differences are mainly in respect to nutrient status. Due to the tight nutrient cycle of the forests, this likely affects the vegetation the soil is able to sustain.

Disturbance

The highest level of pole and timber extraction recorded in the reserve was located on the transect which runs near to the central area of the reserve. This transect is characterised as mature mixed forest away from the reserve boundaries with areas of grassland and open/disturbed forest toward the boundaries. Trapping was not conducted on this transect therefore it is not possible to determine the extent the disturbance has on presence or absence of zoological species.

Socio-economics

The people living in the area of Kwamarimba forest reserve do not appear to understand the advantages of the forest reserves. They are given little information and education about the reserves and are thus unlikely to change their attitudes and consequently behaviour which have a direct impact on the forest, its' quality and long-term sustainability.

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. The dry seasons are from June to August and January to March. Precipitation, however, 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[3]: (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). The East Usambara Biodiversity Surveys provide further information on new species and species' range extensions. A new species of snake, *Prosymna semifasciata*, was recently found in Kwamgumi 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

[3]
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

Kwamarimba forest reserve (also known as Marimba) is located in the East Usambara Mountains, Tanzania at the grid reference 38°45'E 5°02'S. Administratively, Kwamarimba falls under the Muheza district.

Kwamarimba forest reserve is situated in the Sigi valley in the central area of the East Usambaras (Figure 1). The latest survey of the area was carried out by Hyytiäinen (1995), and updated by Johansson & Sandy (1996). The results for Kwamarimba forest reserve are summarised in Table 1 below. The majority of Kwamarimba forest reserve can be classified as lowland forest and specifically lowland evergreen forest. Kwamarimba is one of two forested areas in the East Usambaras remaining with this vegetation type (Iversen, 1991a).

The altitudinal zonation ranges from 95 m at the Sigi river to 445 m. The ridge runs south-west to north-east, with one peak in the south-west quadrant of the reserve and the other in the north-east quadrant. The Sigi river denotes the western border of the reserve (Figure 2). Longuza forest reserve lies on the opposite side of the Sigi river.

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

Kwamarimba Forest Reserve	**Area (ha)**	**Percent (%)**
Dense lowland forest	763.0	86.0
Poorly stocked lowland forest	124.4	14.0
Total for the reserve:	**887.4**	**100.0**

3.1.1 History and Status

Kwamarimba was one of six forest reserves initially gazetted by the German administration in 1913. At this time the reserve consisted of 802 ha. Regazetted in 1934 and 1951, its area was extended to its current size of 887.4 ha (Johansson & Sandy, 1996).

Table 2. Status of Kwamarimba forest reserve.

Name	**Status**	**Current Size (ha)**	**Gazettement date**	**Maps**
Kwamarimba	Forest Reserve	887.4	German 1913, 1934, 1954	JB. 189, 1287

No Figure / Map Currently Available in Digital Format

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

Figure 2. Topographical map.

4.0 SOILS

By Leigh Stubblefield

4.1 Introduction

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

4.2 Methods

The FT FRP constructed a total of 52 vegetation analysis plots in a grid system, each measuring 450 m x 450 m. Soil samples were taken from the south-west corner of each of these vegetation plots from altitudes ranging between 95 m and 445 m. 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 tree species density and tree species dominance.

A total of 52 soil-auger hole observations were established 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. Soil colour was described using the 'Munsell notation'. 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

Altitudinal variation was limited to lowland sites. The topography was undulating and slope gradients were between 5-50%, with upper slopes ranging from 30-35%; mid-slopes ranging from 25-30%; and lower slopes having an average gradient of 25%. In general, there appeared to be no significant relationship between soil type and catenary position. Soils on steeper slopes were very prone to severe erosion if vegetation cover was removed.

The soils of Kwamarimba ranged from very shallow (<20 cm) to very deep (>120 cm), but were predominantly deep to very deep (80-120+ cm), and all were well drained. These deep soils indicated heavy weathering as they showed very little horizon differentiation. As would be expected, the deeper soils were largely found on mid- to lower slopes. The shallow soils were generally correlated with catenary position and found on ridge tops and upper slopes.

Rock outcrops, including quartzite, were located on ridge tops and in areas that bordered drainage lines, particularly adjacent to the Sigi river. Soil texture was usually clay, though sandy clay loams grading to clays down the profile were dominant in areas that bordered drainage lines. Soils were dark reddish brown becoming dark red or red with depth. Interestingly, the soils sampled in plots-bordering the Sigi river, though subject to periodic flooding (NSS, 1996), showed no

signs of gleying. This suggests that despite seasonal inundation, waterlogging does not occur.

Soil reaction, measured by pH, was variable ranging from very strongly acid (4.5-5.0) to neutral (6.6-7.3). The dominant soil reaction in the topsoil was slightly acid (6.1-6.5) decreasing to medium acid (5.6-6.0) in subsoils. The soils were non-saline. Organic carbon and total nitrogen were found to decrease, moving down the soil profile. Levels of organic carbon were variable ranging from very high to high (>3.5-2.5%) in topsoils and decreasing to low levels (0.6-1.25%) in subsoils. Levels of total nitrogen were found to be predominantly, medium (0.2-0.5%) decreasing to low (0.1-0.2%). The carbon to nitrogen ratio indicates that the organic matter was of a sufficient quality to enable net mineralisation. Levels of available phosphorus were found to be low (<7 mg/kg) in all soils sampled.

The cation exchange capacity (CEC) indicates the ability of a soil to retain and supply nutrients for plant uptake. In general the CEC of the soils sampled was found to be medium, though for 18% of samples CEC was low. These were generally soils under poorly stocked forest or open woodland, typically areas of higher human disturbance. This indicates the negative impact of human disturbance on soil nutrient status. In the majority of soils (77%) the level of exchangeable calcium was found to be very high or high. Levels of exchangeable magnesium ranged from high to medium in topsoils and subsoils respectively. Levels of exchangeable potassium were found to range between medium and low. The level of exchangeable bases decreased markedly with increasing soil depth.

4.4 Discussion

The majority of the sample plots support dense, mature and mixed lowland forest. The western boundary of the reserve is marked by the Sigi river, and two smaller watercourses pass through the central plots. In these plots the vegetation is dominated by typical riparian elements. The eastern boundary of the reserve is bordered by agricultural land. The plots along these boundaries are characterised by woodland or wooded grassland with some forest remnants and bamboo. The soils sampled in the plots bordering the eastern boundary differ from soils in the rest of the reserve in that they are shallow to moderately deep, and mildly alkaline to neutral in terms of soil reaction. However, in terms of soil colour, texture, organic matter content, CEC and the level of exchangeable bases these eastern boundary soils are similar to other soils sampled in Kwamarimba.

The soils sampled from the plots in Longuza forest reserve were largely similar to the soils studied in other East Usambara forests, such as Magoroto, Mlungui, Bamba Ridge (Cunneyworth and Stubblefield, 1996a,b,c). They were deep, well drained, acidic, red clays which can be classified as Ferralsols (FAO, 1988). These soil properties are characteristic of sedentary soils developed *in situ* over weathered granitoid gneiss (Holmes, 1995), the underlying parent material of Kwamarimba. The soil reaction is acidic due to the high quartz content of the gneiss.

The soil surface horizons were generally clay in texture. The soils bordering drainage lines were generally clay loams which also graded to clays in the subsoil. These coarser surface elements may be the result of sedimentary deposits from the water

courses which run through the reserve. Similarly rock outcrops, including quartzite, were common near these drainage lines and their erosion may also contribute to the sand and silt particles which influence soil texture in these areas.

The soils sampled were reddish brown becoming more red down the profile. This is typical of tropical forest soils, particularly the Rhodic Ferralsols, which are sedentary soils subject to heavy weathering. The soils are typically red due to high levels of aluminium and iron sesquioxides since other more soluble bases are washed down the profile (Holmes, 1995), and the inorganic fraction is consequently low in available nutrients.

Soils were darker in colour in the surface horizon due to the natural incorporation of surface organic matter. This incorporated organic matter is important in maintaining both the soil structure and nutrient levels, since the Ferralsols have an inherently low nutrient status due to heavy leaching. For the East Usambaras, the nutrient holding capacity of these soils is directly associated with organic matter content (Milne, 1937; Hamilton, 1989). This explains why the level of exchangeable bases decreased markedly on moving down the soil profile.

As can be seen from the results of the soil sampling, the organic matter quality of the soils sampled was good. However, Hamilton (1989) states that this apparently high soil fertility is misleading since it is sustained by a very fragile cycling of nutrients between soils and vegetation. Any disruption to this cycle, therefore, will result in the rapid loss of nutrients and lead to soil impoverishment. The soils of Kwamarimba generally support dense lowland forest which has experienced minimal levels of human disturbance. However, on steeper slopes accelerated soil erosion was observed.

It appears that soil type is not as important an influence on floristic composition as the proximity to a permanent water course and to human disturbance. In general, dense riparian forest was found bordering the rivers and streams in the reserve. In other areas, the vegetation comprised both moist and dry lowland forest elements, though moist forest elements were more abundant. Disturbance has been most significant around the eastern boundary largely in the form of agricultural encroachment. The vegetation in this area is largely woodland and wooded grassland, with a few remnant forest patches. This is most likely as a result of past bushfires which were used to clear the land for agriculture and unfortunately spread into the reserve. Thus, any change in land use, particularly relating to the level of vegetation cover appears likely to influence the soil properties, particularly nutrient status, and this should be considered when monitoring Kwamarimba forest reserve.

5.0 BOTANY

5.1 Introduction

An integrated survey of the major vegetation types within the forest reserve was undertaken. These were assessed in terms of extent, distribution and species composition to determine the botanical diversity of the reserve. Simple, quantitative and repeatable methods were employed and the standardised results are comparable with other forest surveys undertaken during the survey series. Human disturbance and involvement within the forest was also studied.

5.2 Methods

The forest block is divided into grid squares which are measured and marked in the field. All methods are based on these transects. 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; (2) disturbance transects.

5.2.1.1 Quantitative vegetation analysis

A standardised method of vegetation plot sampling was used, based on a 450 m grid system constructed throughout the forest on transect 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 UDSM provided the field identification of plant species.

5.2.1.2 Disturbance transects

Disturbance transects provide an estimate of pole cutting and logging in a forest block. The disturbance transects were based on the 450 m x 450 m grid squares constructed for the vegetation plot analysis. Each transect running north-south was sampled from boundary to boundary. Every self-standing tree and sapling (i.e. not lianas or creepers) above 1 cm 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 and then subdivided to those less than 10 cm dbh or 10 cm dbh and larger. These divisions represent differences in usage extraction. The smaller are considered poles and the larger are considered timber. The percentages of each category were then calculated to estimate their relative abundance.

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.

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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 schweinfurthii	f		W
Lannea welwitschii	F	L	W
Sorindeia madagascariensis	f	S & L	N
Annonaceae			
Annona senegalensis	f		W
Lettowianthus stellatus[1]	f	S & L	N
Mkilua fragrans	F	S	N
Monodora minor[1]	O	L	N
Sphaerocoryne gracilis	f		N
Uvariodendron kirkii	f	L	N
Uvariodendron sp.	?		?
Uvariodendron sp.	?		?
Uvariodendron sp.	?		?
Xylopia parviflora	f	L	W
Apocynaceae			
Holarrhena pubescens	O	L	W
Araliaceae			
Cussonia zimmermannii	f	L	N
Bignoniaceae			
Fernandoa magnifica	f	L	N
Kigelia africana	f	L	W
Markhamia lutea	f	L & S	W
Markhamia obtusifolia	O		W
Stereospermum kunthianum	f		W
Bombacaceae			
Bombax rhodognaphalon	f		N
Boraginaceae			
Ehretia amoena	O	L	W
Burseraceae			
Commiphora eminii spp. *zimmermannii*	f	L	N
Celastraceae			
Maytenus acuminata	F	S	W
Maytenus undata	f	S	W
Platypterocarpus tanganyikensis	?		?
Combretaceae			
Combretum illairii	f	L	N
Combretum schumannii	f	L	N
Pteleopsis myrtifolia	f	L	W
Terminalia sambesiaca	f	L	W

Table 3 *(cont.)*

Species	Ecological type	Habitat[2]	Endemic status
Compositae			
Brachylaena huillensis	O	L	W
Dichapetalaceae			
Dichapetalum stuhlmannii[1]	f		W
Dracaenaceae			
Dracaena steudneri	f	S (forest gaps)	W
Dracaena usambarensis	f		W
Ebenaceae			
Diospyros abyssinica	f	S	W
Diospyros kabuyeana	f	S	N
Diospyros mespiliformis	f	L	W
Diospyros natalensis	f	L	W
Diospyros squarrosa[1]	?	L	W
Diospyros usambarensis	O		N
Diospyros sp.	?		?
Euclea sp.	?		?
Euclea sp.	?		?
Euphorbiaceae			
Bridelia cathartica	f		W
Bridelia micrantha	f	L & S	W
Drypetes gerrardii	F	S	W
Drypetes usambarica	f	S	N
Euphorbia candelabrum	O		W
Margaritaria discoidea	f		W
Mildbraedia carpinifolia	f	L	N
Mildbraedia fallax[1]	f		W
Ricinodendron heudelotii	f	L	W
Sapium armatum[1]	f		N
Sapium ellipticum	f	L & S	W
Suregada zanzibarense	f	L	W
Flacourtiaceae			
Flacourtia indica	f		W
Homalium abdessammadii[1]	F		W
Rawsonia lucida	F	S	W
Guttiferae			
Garcinia buchananii[1]	f	S	W
Vismia orientalis	f		N
Hernandiaceae			
Gyrocarpus americanus	f	L	W
Lecythidaceae			
Barringtonia racemosa	f	L	W
Leguminosae subfamily:			
Caesalpiniaceae			
Afzelia quanzensis	f	L	W
Cynometra brachyrrhachis	F	L & S common in both	E (EU)
Cynometra engleri	F	L	N
Cynometra fischeri[1]	f		W
Cynometra longipedicellata	F	L & S common in both	E (EU)
Cynometra webberi	f	L	N
Cynometra sp.	?		?
Dialium holtzii	f	L	N

Table 3 *(cont.)*

Species	**Ecological type**	**Habitat**[2]	**Endemic status**
Isoberlinia scheffleri	F	S & L	N
Julbernardia magnistipulata	f	L	N
Scorodophloeus fischeri	f	L	N
Zenkerella egregia	f	S	N
Leguminosae subfamily: Mimosaceae			
Acacia robusta	f	L	W
Acacia senegalensis[1]	O		W
Acacia sp.	?		?
Acacia sp.	?		?
Albizia glaberrima	f	L	W
Albizia gummifera	f	S & L	W
Albizia versicolor	O		W
Albizia zimmermannii	f		W
Newtonia paucijuga	F	L	N
Leguminosae subfamily: Papilionaceae			
Angylocalyx braunii	F	L	N
Craibia brevicaudata	f		N
Dalbergia boehmii	f	L	W
Erythrina sp.	?		?
Lonchocarpus bussei	O		W
Millettia usambarensis	O	L	N
Myroxylon holtzii[1]	?		?
Pterocarpus mildbraedii	F	L	N
Pterocarpus tinctorius	F	S & L	W
Pterocarpus sp.	?		?
Schefflerodendron usambarense	F	S	W
Loganiaceae			
Strychnos usambarensis	f	L	W
Meliaceae			
Trichilia emetica	f	L	W
Moraceae			
Antiaris toxicaria	f	L & S	W
Dorstenia kameruniana	f	L	W
Ficus exasperata	f	L & S	W
Ficus scassellatii	f	S	W
Ficus sycomorus[1]	f	L	W
Ficus vallis-choudae	f	L	W
Milicia excelsa	f	L & S	W
Morus mesozygia	F	L	W
Streblus usambarensis	F	L	W
Trilepisium madagascariensis	f	L & S	W
Ochnaceae			
Brackenridgea bussei[1]	?		?
Brackenridgea zanguebarica	F		W
Ochna mossambicensis	f		?
Palmae			
Elaies guineensis	F	L & S	W
Pandanaceae			
Pandanus rabaiensis	O		N
Pandanus stuhlmannii	O		W
Rhamnaceae			
Ziziphus mucronata	O	L	W

Table 3 *(cont.)*

Species	**Ecological type**	**Habitat**[2]	**Endemic status**
Rubiaceae			
Cremaspora triflora	f	S	N
Leptactina platyphylla	f	S	W
Pyrostria bibracteata	O		W
Rothmannia manganjae	F	L & S	W
Rytigynia bugoyensis	O		W
Rytigynia flavida	F		W
Sericanthe odoratissima	F		N
Tarenna graveolens	O		W
Tarenna nigrescens[1]	f	L	W
Tarenna pavettoides	F		W
Tricalysia pallens	f		W
Tricalysia sp.	?		?
Vangueria infausta	f		W
Rutaceae			
Teclea nobilis	f		W
Teclea simplicifolia	f	S	W
Zanthoxylum usambarense	F	S	W
Sapindaceae			
Allophylus calophyllus[1]	?		?
Blighia unijugata	F	L & S	W
Chytranthus obliquinervis	f	L (forest gaps)	N
Lecaniodiscus fraxinifolius	F	L	W
Zanha golungensis	F	L & S	W
Sapotaceae			
Bequaertiodendron natalense	f	L & S	W
Chrysophyllum gorungosanum	F	S	W
Chrysophyllum sp.	?		?
Chrysophyllum sp.	?		?
Manilkara obovata	f	S	W
Manilkara sansibarensis[1]	f	L	W
Manilkara sulcata	f	L	W
Mimusops sp.	?		?
Pachystela msolo	F	L & S	W
Vincentella passargei	f	L	W
Simaroubaceae			
Harrisonia abyssinica	f		W
Sterculiaceae			
Cola discoglypremnophylla[1]	?		?
Cola greenwayi	F		N
Cola microcarpa	F	S	N
Cola usambarensis	F	S	E (EU)
Dombeya shupangae	O		N
Nesogordonia holtzii[1]	?		N
Sterculia appendiculata	f	L	W
Tiliaceae			
Grewia bicolor	O		W
Grewia goetzeana	f	L	W
Grewia microcarpa	f		W
Ulmaceae			
Celtis africana	F	L	W
Celtis gomphophylla	F	L	W
Celtis mildbraedii	F	L & S	W

Table 3 *(cont.)*

Species	**Ecological type**	**Habitat[2]**	**Endemic status**
Celtis wightii	f	S	W
Umbelliferae			
Steganotaenia araliacea	O	L & S	W
Verbenaceae			
Vitex amaniensis	f	S & L	N
Violaceae			
Rinorea angustifolia	F		E (EU & WU)
Rinorea ferruginea	F	S	W
Rinorea usambarensis[1]	?		?
Rinorea sp.	?		?

[1] Species which do not appear in Iversen (1991b). 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, 1991b)
- 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: Species occurring at altitudes of <850 m;
- S - Submontane: Species 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, 1991b):
- 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 lowland forests;
- W - Widespread distribution.

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

Species accumulation rates:

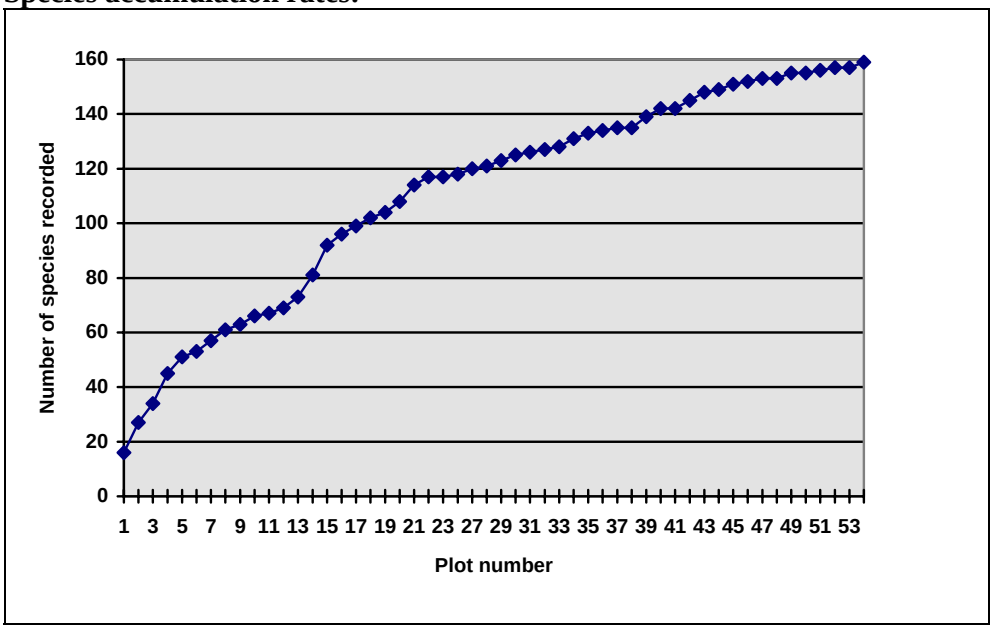

Figure 4. Species accumulation rates of recorded species by vegetation plot.

Table 4 summarises information for species which were recorded in Kwamarimba outside the range described by Ruffo *et al.* (1989).

Table 4. Trees found outside their previously recorded range in the East Usambara mountains.

Species	**Location as previously recorded**[1]
Garcinia buchananii	southern part of main range
Cussonia zimmermannii	Mhinduro and Mtai
Diospyros natalensis	Mhinduro and Mtai
Diospyros abyssinica	restricted to the southern end of the East Usambara range
Cola microcarpa	Mtai forest reserve
Vincentella passargei	Mtai forest reserve

[1] Information is based on Ruffo *et al.* (1989).

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

Table 5. Summary of ecological type for tree and shrub species (based on Table 3).

Ecological type	Number of species	% of total number of species
(F) Forest dependent species	37	22.4
(f) Non-forest dependent Species	84	50.9
(O) Non-forest species	20	12.1
Unknown	24	14.6
Total:	**165**	**100.0**

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

Table 6. Summary of habitat for tree and shrub species (based on Table 3).

Habitat	Number of species	% of total number of species
(L) Lowland Species	71	71.0
(S) Submontane Species	29	29.0
Total:	**100**	**100.0**

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 number of species
(E) Endemic	4 (3-EU & 1 EU & WU)*	2.4
(N) Near Endemic	39	23.6
(W) Widespread	99	60.0
Unknown	23	13.9
Total:	**165**	**99.9**

* EU - East Usambara mountains
WU - West Usambara mountains

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

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

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

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

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Figure 9. Distribution of submontane tree and shrub individuals.

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Figure 10. Distribution of submontane tree and shrub species.

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Figure 11. Distribution of endemic tree and shrub individuals.

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Figure 12. Distribution of endemic tree and shrub species.

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

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

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Figure 15. Vegetation of Kwamarimba forest reserve.

5.3.2 Disturbance transects

Four disturbance transects were recorded for pole and timber extraction during the survey. The results of the disturbance transects are summarised in Table 8 for poles and Table 9 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. 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
2	2640	431	138	**5.2**	293	**11.1**
4	3580	496	246	**6.9**	250	**7.0**
6	3250	424	115	**3.5**	309	**9.5**
8	2820	627	139	**4.9**	488	**17.3**

* 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.

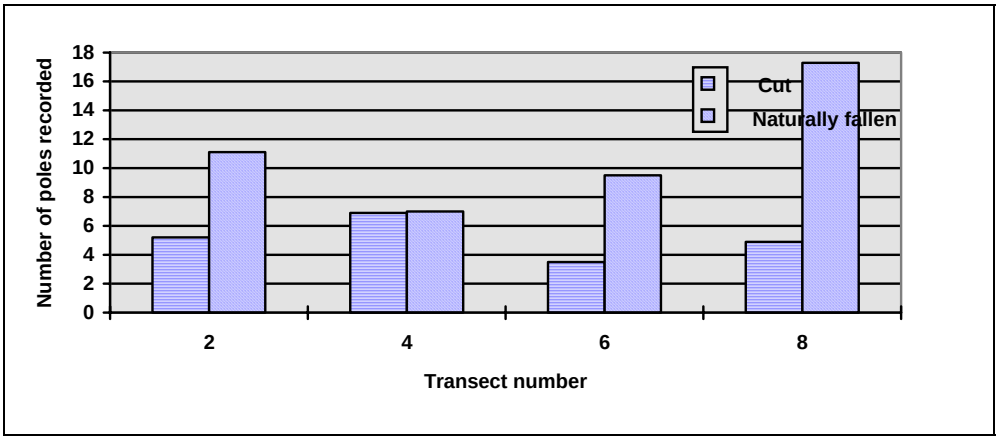

Figure 16. Cut and naturally fallen poles recorded per 100 metres by transect.

Table 9. 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
2	2640	103	12	**0.5**	91	**3.5**
4	3580	178	37	**1.0**	141	**3.9**
6	3250	275	14	**0.4**	261	**8.0**
8	2820	205	18	**0.6**	187	**6.6**

* 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.

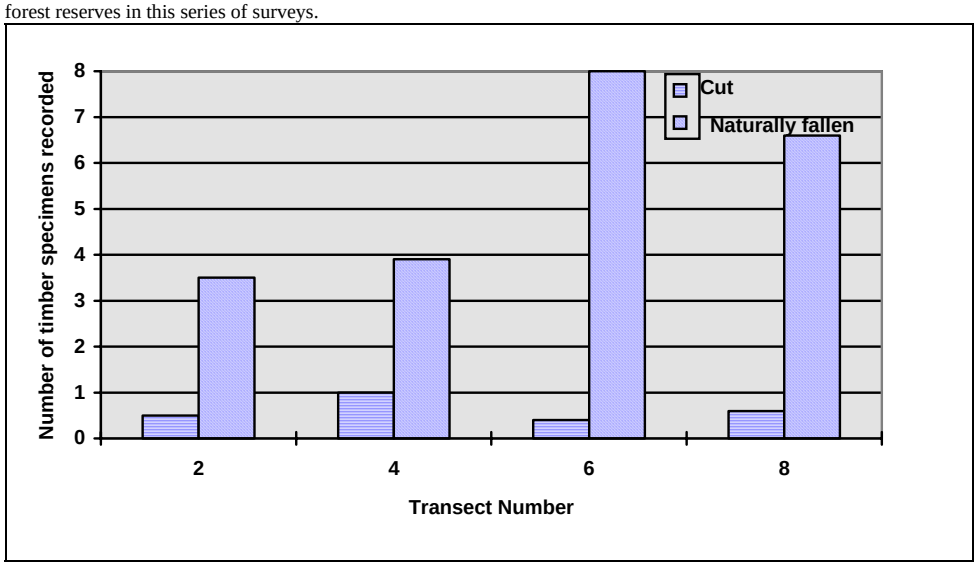

Figure 17. Cut and naturally fallen timber recorded per 100 metres by transect.

Table 10. Other human disturbance recorded in the forest on an *ad lib.* basis other than pole and timber cutting.

Transect number	Disturbance
1	none recorded
2	none recorded
3	fire (plot 5); Traps (Plot 12); pitsaw (plot 37); pitsaw (plot 44);
4	pitsaw (plot 13 & 40)
5	pitsaw (plot 45 & 50)
6	pitsaw (plot 51)
7	none recorded
8	pitsaw; trap; fire (plot 23)

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

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

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

No Figure / Map Currently Available in Digital Format

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

5.4 Summary

Kwamarimba forest reserve covers an area of 887.4 ha with altitudes ranging from 95 to 445 m and is one of two remaining forests with substantial lowland evergreen forest type (Iversen, 1991a). 2,229 trees and shrubs were surveyed, representing 165 species from 38 families.

Of the 52 plots systematically surveyed, 36 (69.2%) of the plots analysed were recorded as mature mixed forest, 13 (25.0%) as previously disturbed, colonising forest or poorly mixed forest, and 1 (1.9%) as open woodland and 2 (3.9%) as grassland.

Species Accumulation Rates

The species accumulation rate appears to be slowing in the latter plots but has not yet begun to plateau, indicating that the list of vascular plants of the size 10 cm dbh and larger is incomplete.

Ecological Type

Forest dependent species defined as limited to primary forest only were recorded 311 times. This represents 14.0% of all specimens recorded. Forest dependent individuals are distributed throughout the reserve however half of the plots without forest dependent species are located on the eastern forest boundary. The most common forest dependent tree is *Lecaniodiscus fraxinifolius*. Twelve of the forest dependent species are also endemic or near-endemic to the Usambaras.

Twenty non-forest species were recorded in 63.5% of the plots (33 plots). *Dombeya shupangae* is the most common non-forest species.

Habitat

Of the tree species surveyed with known altitude characteristics, 71% were considered to be typical of lowland forest and 29% are considered typical of submontane forest. Submontane species occur throughout the reserve in 65.4% of the plots surveyed in the lowland forest. This data serves to further clarify the ecological requirements and niches of these submontane species. The most common submontane species is *Celtis wightii*, a wet evergreen and riverine forest tree.

Endemic Status

Of the plant species recorded, 99 (60.0%) have widespread distributions. Near-endemics contribute 39 species (23.6%) from 16 families to the floristic composition of the reserve. These near-endemics are found throughout the reserve with at least one individual occurring in every plot surveyed and account for 643 of the surveyed specimens or 28.8% of all recorded trees and shrubs in the reserve. Of the 52 plots surveyed, 22 (42.3%) were found to have greater than 10 near-endemics. The most common near-endemics in the reserve are *Scorodophloeus fischeri* and *Julbernardia magnistipulata*. Of these 39 near-endemic species, ten species are also considered to be forest dependent. Five near-endemics are non-forest species *Dombeya shupangae*,

Diospyros usambarensis; Millettia usambarensis; Monodora minor and *Pandanus rabaiensis.*

Four of the species surveyed are endemic to the Usambaras. These are: *Cola usambarensis*, *Cynometra brachyrrhachis* and *C. longipedicellata* found only in the East Usambaras and *Rinorea angustifolia* found in the East and West Usambaras. *Cola usambarensis* is a submontane species, the *Cynometra* species are common in both lowland and submontane forest and *Rinorea angustifolia* is a lowland species. All four species are considered to be forest dependent species, restricted to wet evergreen forest (Iversen, 1991b).

Range Extensions

The record of *Sapium armatum* in Kwamarimba forest reserve represents a range extension (Flora of Tropical East Africa, FTEA). It previously was considered as a coastal endemic (Hawthorne, 1993).

Nesogordonia holtzii is a coastal endemic (Hawthorne, 1993). This species may also represent a range extension however the FTEA has not yet been published for this family.

Disturbance

Disturbance by pole and timber extraction was recorded at lower rates than naturally fallen trees. Other disturbances, such as fire, traps and cultivation were observed on about half the transects in the reserve. Pitsaws were recorded on five of the eight vegetation transects. For the reserve as a whole, cut poles were found at rates between 3.5 and 6.9 per 100 m. Cut timber occurred at the rate of 0.4 to 1.0 per 100 m.

The highest concentration of pole and timber disturbance occurred on transect 4. This transect runs north-south and is located toward the center of the reserve as opposed to the near the forest boundary. However, due to the limitations of the methods, which gives one numerical value for the entire transect, it is not known if the disturbance is heavier nearer the forest boundary, which is likely if considering pole extraction, or toward the central area of the reserve, where good quality timber probably remains.

6.0 ZOOLOGY

6.1 Introduction

The faunal biodiversity of Kwamarimba forest reserve was investigated using standard, repeatable, survey methods. Studies on small mammals, birds, bats, reptiles, amphibians and various invertebrate groups were carried out. 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 Figure 22.

6.2.1 Mammals

Four different methods are used to sample the mammal community within Kwamarimba 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 approximately 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. Kim Howell or by Dr. Dieter Kock (see Appendix 2).

6.2.1.2 Bucket pitfall trapping

The bucket pitfall traps consist of five 20 litre plastic buckets sunk flush to ground level in a linear transect. These were positioned approximate 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, are 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 Dr. Dieter Kock or Dr. William 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 Dr. Dieter 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 Birds

The aim of this study was to provide information concerning the presence of endemic and near-endemic birds of the reserve. However, as an experienced ornithologist was not present during the survey period, the results of an avifaunal survey conducted by the Cambridge-Tanzania Rainforest Project (1994), are presented here.

6.2.3 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. Kim Howell or Prof. Don Broadley (see Appendix 2).

6.2.4 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 are often beyond capture with the bucket pitfalls. After rain, typical amphibian habitats were targeted for sampling. Unless otherwise indicated, taxonomic identifications were made by Prof. Kim Howell or by Prof. John Poynton (see Appendix 2).

6.2.5 Invertebrates

Two methods were employed to sample the invertebrate community within the study site: (1) invertebrate pitfall trapping; (2) malaise trapping.

6.2.5.1 Invertebrate pitfall trapping

This method was used to sample the invertebrate ground (forest floor) dwelling community. Four 1.5 litre pots were sunk flush with the level of the ground. Plastic sheeting was erected between the pots using wood stakes to keep the plastic sheeting perpendicular to the ground surface. A lip of plastic sheeting was kept on the ground on to which soil and leaf litter was placed. The pots were placed in a star arrangement with one central pot and the other three positioned so that the plastic sheeting was at an angle of 120^{o} from the next line of plastic sheeting. Each length of plastic sheeting was 2.5 m. Approximately 1/4 litre of 10% formalin is put in each pot. A few drops of washing-up liquid was added to reduce surface water tension. The trap was then left for 5 days before collection. Specimens were identified and

sorted to order level in the field. These specimens were sent for curation at the Zoological Museum, University of Copenhagen. Specific groups will then be sent on to individual taxonomists.

6.2.5.2 Malaise trapping

This method was used to sample the flying invertebrate community. Sites for trap placement were selected at natural flyways, such as wet or dry watercourses and paths. The malaise trap was raised into the tree canopy thereby sampling the flying invertebrate forest community. Approximately 1/4 litre of 10% formalin was used in the collecting pot of the trap. The trap was then left for approximately 10 days before collection. Specimens were identified and sorted to order level in the field. These specimens were sent for curation at the Zoological Museum, University of Copenhagen. Specific groups will then be sent on to individual taxonomists.

6.3 Trapping sites and sampling intensity

Ten trapping sites were conducted in various habitats. Table 11 describes the sites and Tables 12 and 13 summarise the sampling intensity for each site and for each trapping method.

Table 11. Summary descriptions of trapping sites.

Plot number	Vegetation type	Altitude (m)	Topography	Slope (degrees)
1	mature mixed lowland forest	95	gentle lower slope	7
2	mature mixed lowland forest	150	gentle lower slope	10
4	mature mixed lowland forest	175	steep upper slope	20
5	colonising lowland forest	300	ridge top	30
6	mature mixed lowland forest	325	steep upper slope	30
10	colonising lowland forest	350	ridge top	30
16	mature mixed lowland forest	125	gentle lower slope	25
55	mature mixed lowland forest	150	gentle mid-slope	7
56	bushland/thicket	300	ridge top	0
57	mature mixed lowland forest	95	island in Sigi River	3

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

Trapping method	Plot 1	Plot 2	Plot 4	Plot 5	Plot 6	Plot 10	Plot 16	Plot 55	Plot 56	Plot 57
small snap traps	0	350	0	400	250	0	0	0	0	0
large snap traps	0	0	0	0	345	0	0	750	445	0
live traps	80	0	0	0	0	0	0	0	0	0
bucket pitfall*	90	0	70	0	0	75	0	0	0	110
invertebrate pitfall**	15	0	16	0	0	16	16	0	16	0
malaise trap	6	0	0	0	0	0	0	0	0	0

*each bucket represents one trap night
** each trap array of 4 pots is one trap night

Table 13. Summary of bat-netting sites.

Site description	Sampling intensity (hours)	Altitude	Topography
Over Sigi River	37.5	95	bottom of hill (riverine)
Outside reserve; on path; forest edge	1.5	135	plateau
plot 4	24	350	ridge top
Outside reserve; rocky outcrop; forest edge	12	100	bottom of hill

No Figure / Map Currently Available in Digital Format

Figure 22. Location of trapping sites.

6.4 Results

6.4.1 Mammals (non-bat)

A total of 22 specimens were retained for taxonomic purposes. The following have been identified so far. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (UDSM, 1997) and Kingdon (1989).

Table 14. Summary of mammals.

Species	Ecological type	Endemic status	IUCN status	Capture location by plot and number collected			
				1	**5**	**55**	**Total**
Cricetidae							
Beamys hindei	f	N	DD	4		1	**5**
Muridae							
Rattus rattus	O	W			1	3	**4**

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 East African lowland forests;
- W - Widespread distribution.

IUCN status:

- DD - Data deficient

A total of nine species from three 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 15. Summary of mammal observations.

Species	Certainty	Ecological type	Endemic status	IUCN status	Observation location
Cercopithecidae					
Colobus angolensis	definite	F	W		plot10,13,15, 17,18,19,20,3 5,36,48
Cercopithecus mitis	definite	f	W		plot 2,10,14, 16, 19,35,45
Cercopithecus aethiops	definite	f	W		OR
Papio cynocephalus	definite	f	W		plot 2,3,32
Sciuridae					
Xerus rutilus	possible	f	W		plot 1
Heliosciurus rufobrachium	possible	f	W		plot 4
Macroscelididae					
Petrodromus tetradactylus	definite	f	W		plot 2
Rhynchocyon cirnei spp. *petersi*	definite	F	N	NT	?

KEY TO ABBREVIATIONS FOR TABLE 15 (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 East African lowland forests;
- W - Widespread distribution.

IUCN status:
- 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 further information before being considered on the reserve's species list.
Possible: Species identification is may not be accurate.

6.4.2 Bats

A total of eight individuals were retained for taxonomic purposes in 9960 net hours (hours x length of net in metres). Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (UDSM, 1997) and Kingdon (1989).

Table 16. Summary of bats.

Species	Ecological type	Endemic status	IUCN status	Capture location
MEGACHIROPTERA				
Pteropodidae				
Lissonycteris angolensis	f	W		over Sigi River
MICROCHIROPTERA				
Nycteridae				
Nycteris macrotis	F	W		OR* (over path)
Rhinolophidae				
Rhinolophus deckenii	f	W	LC	?
Rhinolophus eloquens	?	?		over Sigi River
Vespertilionidae				
Myotis bocagei	f	W		over Sigi River
Nycticeius (Scotoecus) hirundo	f	W		over Sigi River
Pipistrellus nanus	f	W		over Sigi River

KEY TO ABBREVIATIONS FOR TABLE 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 East African lowland forests;
- W - Widespread distribution.

IUCN status:
- LC - Least concern

OR - Refers to observations outside but in proximity to the reserve to be considered associated to it.
? - No data available

No Figure / Map Currently Available in Digital Format

Figure 23. Distribution of forest dependent mammal species.

No Figure / Map Currently Available in Digital Format

Figure 24. Distribution of near-endemic mammal species.

6.4.3 Birds

There was not an ornithologist present for the survey, however, as birds are a valuable indicator of habitat quality and biodiversity, we include here a summary of important or interesting birds recorded in Kwamarimba forest reserve during the Cambridge-Tanzania Rainforest Project (1994). These specimens represent eleven species from nine families. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (UDSM, 1997) and Zimmerman *et al.* (1996).

Table 17. Summary of birds.

Species	Common name	Ecological type	Endemic status	IUCN status
Accipitridae				
Circaetus fasciolatus	Southern banded snake eagle	F	N	
Columbidae				
Columba delgorguei	Bronze-naped pigeon	F	W	
Strigidae				
Bubo vosseleri	Usambara eagle owl	F	E	V (CITES II)
Picidae				
Campethera mombassica/abingoni	Mombasa/Golden-tailed woodpecker	f	W	
Turdidae				
Sheppardia gunningi	East coast akalat	F	N	V
Swynnertonia swynnertoni	Swynnerton's forest robin	F	N	NT
Sylviidae				
Hyliota australis usambarae	Southern hyliota	F	E	
Muscicapidae				
Trochocercus albonotatus	White-tailed crested flycatcher	F	W	
Nectariniidae				
Anthreptes neglectus	Uluguru violet-backed sunbird	F	N	
Anthreptes reichenowi	Plain-backed sunbird	F	N	
Estrildidae				
Spermophaga ruficapilla	Red-headed bluebill	F	W	

KEY TO ABBREVIATIONS FOR TABLE 17 (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 East African lowland forests;
- W - Widespread distribution.

IUCN status:
- V - Vulnerable
- NT - Near-threatened

OR: Refers to observations outside but in proximity to the reserve to be considered associated to it.
? No data available

The ranges for the endemics and near-endemics are presented below.

Table 18. Ranges for endemic and near-endemic bird species recorded (Zimmerman *et al.*1996).

Species	**Range**
Endemics	
Bubo vosseleri	East Usambaras; West Usambaras
Hyliota australis usambarae	East Usambaras; West Usambaras
Near-endemics	**Range**
Anthreptes neglectus	Usambaras; Ngurus; Ulugurus; forests of Tana river and Taita hills, Kenya,
Anthreptes reichenowi	Usambaras; coastal forests of Tanzania and Kenya
Circaetus fasciolatus	Usambaras; coastal forests of Tanzania and Kenya
Sheppardia gunningi	Usambaras; coastal forests of Tanzania and Kenya

6.4.4 Reptiles

A total of 23 individuals were retained for taxonomic purposes. These specimens represent 14 species from eight families. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (1997), Broadley & Howell (unpubl.), Howell (1993), and Branch (1994).

Table 19. Summary of reptiles.

Species	**Ecological type**	**Endemic status**	**IUCN status**	**Capture location by plot and number collected**									
				1	**2**	**3**	**7**	**10**	**16**	**57**	**OR**	**UK**	**Total**
Typhlopidae													
Typhlops pallidus	?	N									1		**1**
Leptotyphlopidae													
Leptotyphlops scutifrons spp. *merkeri*	f	N	LC			1							**1**
Colubridae													
Lamprophis fuliginosus	f	W									4		**4**
Philothamnus punctatus	f	W		1									**1**
Philothamnus hoplogaster	f	W										1	**1**
Philothamnus macrops	F	N	V								1		**1**
Thelotornis capensis spp. *mossambicanus*	f	W										1	**1**
Elapidae													
Elapsoidea nigra	F	N	V							1			**1**
Lacertidae													
Cordylus t. tropidosternum	f	W							1				**1**
Agamidae													
Agama mossambica	f	W									2		**2**
Chamaeleonidae													
Rhampholeon brevicaudatus	F	N	V		1		2						**3**
Rhampholeon sp.	?	?		1									**1**
Gekkonidae													
Hemidactylus platycephalus	f	W			1								**1**
Hemidactylus mabouia	f	W					1	3					**4**

A total of three reptile species from two families were observed but not retained for taxonomic purposes.

Table 20. Summary of reptile observations.

Species	Certainty	Ecological type	Endemic status	IUCN status	Observation location
Viperidae					
Bitis gabonica	probable	F	W		plot 55
Chamaeleonidae					
Chamaeleo dilepis	probable	f	W		brought in by locals
Chamaeleo melleri	definite	f	W	NT (CITES II)	brought in by locals

KEY TO ABBREVIATIONS FOR TABLE 19 & 20 (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 East African lowland forests;
- W - Widespread distribution.

IUCN status:
- V - Vulnerable
- NT - Near-threatened
- LC - Least concern

OR - Refers to observations outside but in proximity to the reserve to be considered associated to it.
UK - Unknown capture location
? - 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 further information before being considered on the reserve's species list.

Table 21. Ranges for near-endemic reptile species recorded (Howell, 1993).

Near-endemic Species	Range
Typhlops (Rhinotyphlops) pallidus	East Usambaras; Zanzibar; Pemba
Leptotyphlops scutifrons merkeri	Usambaras; ???
Philothamnus macrops	Usambaras; Coastal forest
Elapsoidea nigra	East Usambaras; West Usambaras; Ulugurus
Rhampholeon brevicaudatus	East Usambaras; Ulugurus; Uzungwas; Coastal forest

No Figure / Map Currently Available in Digital Format

Figure 25. Distribution of forest dependent reptile species.

No Figure / Map Currently Available in Digital Format

Figure 26. Distribution of near-endemic reptile species.

6.4.5 Amphibians

A total of 29 individuals were retained for taxonomic purposes. These specimens represent eleven species from six families. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (UDSM, 1997), Poynton & Broadley (1991).

Table 22. Summary of amphibians.

Species	Ecological type	Endemic status	IUCN status	Capture location by plot and number collected								
				1	**5**	**7**	**10**	**55**	**56**	**57**	**OR**	**Total**
Bufonidae												
Bufo brauni	F	N	V							1		**1**
Bufo gutteralis	f	W						1				**1**
Bufo maculatus	f	W								1		**1**
Mertensophryne micranotis	F	N	E			1	1					**2**
Ranidae												
Hemisus sp.	?	?		2						1		**3**
Phrynobatrachus acridoides	f	W								1		**1**
Arthroleptidae												
Arthroleptis stenodactylus	f	W		5	1					8		**14**
Arthroleptis xenodactyloides	f	W							1			**1**
Rhacophoridae												
Chiromantis xerampelina	f	W									3	**3**
Hyperoliidae												
Leptopelis barbouri	F	N	V								1	**1**
Scolecomorphidae												
Scolecomorphus vittatus	F	N	V							1		**1**

KEY TO ABBREVIATIONS FOR TABLE 22 (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 East African lowland forests;
- W - Widespread distribution.

IUCN status:

- E - Endangered
- V - Vulnerable

OR - Outside reserve

? - No data available

Table 23. Ranges for near-endemic amphibian species recorded (Howell, 1993).

Species	Range
Bufo brauni	East Usambaras; West Usambaras; Ulugurus; Uzungwas;
Leptopelis barbouri	East Usambaras; Uzungwas
Mertensophryne micranotis	East Usambaras; Ulugurus; Coastal forest
Scolecomorphus vittatus	East Usambaras; West Usambaras; Ulugurus; N. Pare Mts.

No Figure / Map Currently Available in Digital Format

Figure 27. Distribution of forest dependent amphibian species.

No Figure / Map Currently Available in Digital Format

Figure 28. Distribution of near-endemic amphibian species.

6.4.6 Invertebrates

6.4.6.1 Invertebrate pitfall trapping.

Preliminary identifications to order level are provided in Table 24.

Table 24. Summary of ground-dwelling invertebrates.

Order	Common name	Plot 1	Plot 4	Plot 10	Plot 16	Plot 56
Araneae	spiders	74	51	10	115	193
Acari	mites	1	0	0	0	1
Amblypygi	Amblipygid	1	7	0	4	0
Blatteria	cockroaches	6	0	16	24	41
Chilopoda	centipedes	1	2	0	0	0
Coleoptera	beetles	134	55	21	102	169
Collembola	springtails	1	165	102	75	910
Dermaptera	earwigs	2	0	1	1	3
Diplopoda	millipedes	7	17	5	10	3
Diptera	flies	5	61	1	0	10
Heteroptera	true bugs	5	0	0	19	3
Homoptera	true bugs	0	0	0	0	3
Hymenoptera	bees, wasps, ants etc.	65	31	20	645	651
Isopoda	termites	1	0	1	80	12
Isoptera	wood lice	0	0	0	0	2
Mantodea	mantids	2	1	1	1	1
Opiliones	harvestmen	3	2	0	0	0
Orthoptera	crickets & grasshoppers	43	35	16	53	85
Psocoptera	booklice & barklice	0	0	0	0	3
Scorpiones	scorpions	0	3	0	0	0
Thysanoptera *	bristletails	8 million	4 million	1 million	5	2 million

*estimates

6.4.6.2 Malaise trapping

Preliminary identifications to order level are provided in Table 25.

Table 25. Summary of malaise captured invertebrates.

Order	Common name	Plot 1
Aranea	spiders	4
Coeleoptera	beetles	3
Dermaptera	earwigs	1
Diptera	flies	171
Heteroptera	true bugs	5
Homoptera	true bugs	9
Hymenoptera	bees, wasps, ants etc.	15
Neuroptera	mantispids	5
Orthoptera	crickets & grasshoppers	1
Plecoptera	stoneflies	3
Psocoptera	booklice & barklice	1

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:

Too few species have been identified to date to discuss mammalian species richness and diversity in the reserve however it appears that the near-endemic *Beamys hindei* is common at least near to the Sigi river. The invasive species, *Rattus rattus*, is also common in the woodland and grassland areas sampled.

Reptiles:

The most common reptile species are *Lamprophis fuliginosus, Rhampholeon brevicaudatus* and *Hemidactylus mabouia*. *R. brevicaudatus* is a near-endemic forest dependent species whereas the others are found widespread and are forest non-dependent. The former was caught four times and the latter two species, three.

Amphibians:

The most common amphibian is the widespread forest non-dependent frog, *Arthroleptis stenodactylus,* caught 14 times in three localities This species is also noted as the most common species in the coastal forest reserves (Howell, unpubl.). *Chiromantis xerampelina* and *Hemisus* sp. both caught three times may be locally common.

Endemics and near-endemics:

Of the 18 faunal endemics and near-endemics of the Usambaras recorded, three appear to be locally common as they were recorded at least three times during the survey: *Beamys hindei, Colobus angolensis* and *Rhampholeon brevicaudatus.*

Forest dependent species:

Of the 20 forest dependent species, one appears to be locally common: *Rhampholeon brevicaudatus.*

High risk species:

Assuming that the number captured reflects relative population size, the locally uncommon forest dependent, near-endemic and endemic species may well be of high conservation concern due to their low population density. These are represented by fewer than three records during the survey: *Philothamnus macrops; Elapsoidea nigra; Mertensophryne micranotis* and *Leptopelis barbouri.*

Table 26. Summary of faunal families and species (identified to date).

Taxon	Number of families	Number of species
mammals	10	18
bird	9	11
reptiles	9	17
amphibians	6	11

Table 27. Summary of capture locations of faunal species by plot number.

Taxon	1	2	3	4	5	7	10	16	55	56	57	Over Sigi river	Out-side reserve	Unknown capture location
mammal*	2	1	0	1	1	0	0	0	2	0	0	5	1	2
reptile	0	2	1	0	0	2	1	1	1	0	1	0	4	4
amphibian	2	0	0	0	1	1	1	0	1	1	6	0	2	0

*primates excluded due to their large ranges.

Ecological type

Of the forest dependent species, two are mammals, ten are birds, four are reptiles and four are amphibians. One invasive species was recorded, this is *Rattus rattus.* The species was recorded in plot 55, a plot 450 m from the Sigi river, in a grassland area.

Table 28. Summary of ecological type of faunal species.

Ecological type	No. of species	% of total species recorded
(F) Forest dependent	21	38.9
(f) Forest dwelling but not forest dependent	29	53.7
(O) Non-forest species	1	1.8
Unknown	3	5.6
Total:	**54**	**100.0**

Endemic Status

The one species and one subspecies that are endemic to the Usambara mountains are: *Bubo vosseleri* and *Hyliota australis* spp. *usambarae*. Both species were recorded previously by another survey.

Table 29. Summary of endemic status of faunal species.

Endemic status	No. of species	% of total species recorded
(E) Endemic to the Usambara Mountains	2	3.7
(N) Near-Endemic: ranges in restricted locations	16	29.6
(W) Widespread	34	63.0
Unknown	2	3.7
Total:	**54**	**100.0**

Range Extensions

Typhlops pallidus, the pallid blind snake, previously known from Sudan, Kenya and Zanzibar is a first record from the Tanzanian mainland (Broadley & Broadley, 1996).

IUCN Status (National Biodiversity Database, 1997)

Mertensophryne micranotis is listed as 'Endangered'.

Sheppardia gunningi, Bubo vosseleri, Philothamnus macrops, Elapsoidea nigra, Rhampholeon brevicaudatus, Bufo brauni, Leptopelis barbouri, and *Scolecomorphus vittatus* are listed as 'Vulnerable'.

Chamaeleo melleri, Swynnertonia swynnertoni and *Rhynchocyon cirnei* spp. *petersi* are listed as 'Near-threatened'.

No Figure / Map Currently Available in Digital Format

Figure 29. Areas of highest disturbance in relation to the distribution of animal species that are both forest dependent and near-endemic.

7.0 SOCIO-ECONOMICS

By M. Fundi

7.1 Introduction

The major threats to the lowland forests, both inside and outside gazetted reserves, are the expansion of agricultural cultivation, uncontrolled collection of fuel wood and building poles and illegal pitsawing.

7.2 Methods

Over a period of ten days forty-four interviews were conducted on a broad cross-section of local people. These interviews varied in format from informal group discussions to the more directed one to one interviews. The aim was to gather information on the nature and extent of local forest use and its likely future course.

7.3 Results

7.3.1 The people and the place

(1) Kiwanda: The working population of Kiwanda was 725 at the time of the 1988 census, however it is now estimated at 3000. The average number of children of interviewees was four. Though the Wasambaa is the dominant and indigenous tribe, other tribes such as Wamakonde, Webena Wapare, Wahehe, Wadigo, Wazigua, Wabondei and others are also present. The sub-villages of Kiwanda are Kiwanda Mission, Kiwanda Enyeji, Misajini, Mngeza A and Mngeza B, Kwevumo, Kwemananasi and Mangubu.

(2) Kweboha: Kweboha is administered as a subvillage of Kambai, its population is estimated at 630. The average number of children of interviewees was five. This subvillage lies on a former Sisal Estate, now belonging to Muheza District Development Corporation (SHUWIMU). The mixture of tribes is much more obvious in Kweboha where Kiswahili tends to be the main language of communication between neighbours rather than Kisambaa, though each family speaks its mother tongue in the home.

(3) Kwatango: Kwatango is the oldest of the 3 villages having as many as five generations of history. The 1988 census recorded the working population as 655 and it is now estimated to be approximately 1000. Research was concentrated in Tamota, a subvillage with an estimated population of 284. Land in Kwatango has been inherited rather than purchased therefore few immigrants have the opportunity to farm the surrounding land. Kwatango consists of Tamota, Mkoroshini, Gombero, Mlembule and Vumba subvillages. Kwamarimba forest reserve is approximately one hours walk.

7.3.2 Economic activities

The local population is, for the most part are engaged in subsistence farming. The main crops are maize and cassava. Most farmers practice inter-cropping and shifting cultivation. About a quarter of the total plot is left fallow and is rotated every two to

three years. The nearest transport to Muheza (market) is Bombani, which is 18 km from Kiwanda or about three hours walking distance.

Secondary incomes include fish selling, kiosk operation, hotel and tea houses, sale of palm oil and boha (fermented sugarcane juice), and mat and basket making.

In Kweboha many who are now primarily involved in agriculture were originally employed on Sisal Estates. In both Kweboha and Kiwanda, several interviewees mentioned pitsawing as an income source.

7.3.3 Village land tenure

Land is acquired either by inheritance, or by sale or donation by village authority. In the case of inheritance, land is passed down through the male line. A woman will be allocated some land from her father or brother, however if she marries and moves away from the village, her land reverts back to the family. If she marries within the village, she can still farm the land with her husband. A man who marries into the village has no claim on his wife's land and would have to buy or be given another piece that he can call his own. A married woman automatically shares her husband's land until he dies or they divorce. As a result, most couples interviewed owned at least two farms between them.

7.3.4 Use of and dependence on the forest

7.3.4.1 Hunting

Interviewees were unwilling to discuss hunting at length. Some admitted to hunting cane rats with dogs and traps and were aware of people hunting monkeys for food, although none admitted personal involvement in this. During the expedition however, boys were seen carrying a black and white colobus monkey that had been shot in the near-by Longuza forest reserve.

When questioned on measures taken to reduce crop disturbances by forest animals such as monkeys and wild pigs, none of the interviewees said that pests were scared off farms. When they were seen though and that at particular times of the year, farmers would sleep on their land in order to deter the animals.

7.3.4.2 Medicinal plants

The area is served by modern medicine through a government dispensary at Kiwanda Mission and at Tamota (Kwatango). The Kiwanda dispensary receives supplies once a month but these are insufficient and some medicines last less than three to four days. The situation is similar at Tamota which treats around 500 patients per month. The lack of conventional medicine contributes to the dependence upon forest products for herbal remedies. The doctor in Tamota neither encourages or discourages traditional remedies and reports a high local use with patients generally turning to a local herbalist first and then coming to him if this fails. Some of the medicinal products are available only within the forest reserves, and one interviewee commented, that supply is not a problem, indicating that they are being removed.

7.3.4.3 Farm forestry and tree planting

The perception of the future availability of such resources varies widely. Not surprisingly, those who believed there would be a building pole and fuelwood shortage within 5 to 10 years, were the most likely to have planted trees on their farms. Otherwise, people only leave standing trees whilst clearing their land to retain shade or because the effort required to remove them would be too great.

Apart from some innovators, such as former pitsawers, there are more organised attempts to establish village nurseries, specifically the Kambai Forest Conservation Project, operating in Kambai and Kweboha. The Kweboha Women's Group began one year ago, planting vegetables, but is now involved in the planting of teak seedlings. It is hoped that in the future money can be raised to help pay school fees from the sale of timber, but the primary aim is to provide fuelwood and building poles. None of the interviewees had planted teak on their farm land more than three years ago, and therefore, as yet, there had been no dividends. In general, those involved seem unsure of the likely returns, and it is too early to assess the likely outcome of such efforts.

7.3.5 Peoples attitudes to conservation

There often appeared to be an automatic and unconsidered response to questions on the benefits and disadvantages of living near a forest reserve. This response was that the forest "brings rain and a good climate" (a phrase we heard repeatedly and predictably). This resulted in contradictory statements when interviewees expressed frustration at bans on fuelwood and building pole collection in the forest reserves and complained of protection for pests such as monkeys, yet did not explicitly identify the advantages and disadvantages of living next to a reserve.

For many people, when forest reserves are declared or gazetted, it is viewed that the government is taking the villagers land and depriving them of future resources. No-one saw the forest reserves as a policy designed to conserve forest products. Thus there was the attitude, "where will the children stay if the government takes their land?" One interviewee had the impression that the reserves were being saved for use as future farmland.

A lot of people complained that they did not know much about the aims of a reserve and that they had not been consulted during the demarcation process. They would have like to be more informed and given more education on other alternatives to forest products. One interviewee argued that a prohibition on entry to the reserve was un-enforceable when certain resources are only available in the reserve. On the other hand, many felt that declaring reserves was the only way to provide incentives for village nurseries.

7.3.6 Eco-tourism potential

The impact on the local community as a result of the presence of the survey's camp in Kiwanda has mainly been on the financial side. The women employed to fetch water and wash the laundry are not the only ones benefiting. The local kiosks have sold more cigarettes, sodas and matches than ever before, as have the farmers who brought their bananas, spinach, pineapples, papaya, carrots, and eggs. When asked for their

opinion of the camp's presence, the reply was a positive one and they were most pleased by the fact that they could sell their products and increase the family income.

The economic impact through the presence of tourists in Kiwanda, Kweboha and Kwatanga would probably mean that the surplus crops would have a market. If not directly bought by the tourists' camps, the increased communication line between the market centres, Muheza and Tanga, would ensure sales of any surplus. A few people could be employed as staff in tourist camps, while local guides with a good knowledge of the paths and plants could prove useful. Unfortunately most of them do not speak English and do not have the skills required to serve a tourist camp (e.g. waiters, cooks). Tour operators may decide to employ English speaking and perhaps better skilled staff from elsewhere, and employ the locals as casual labourers or non-permanent staff.

In response to a tourist trade, better roads and infrastructure would be set up. This likely would lead to more intensive farming for increased revenue as surplus could reach markets. Fallow land would become rare, and farms would likely be extended, thus putting further pressure on the forest. More efficient farming techniques would have to be introduced to minimise soil erosion and pressure on the forest reserve.

7.4 Discussion

The local population draws on the forest reserves for a variety of products. In the case of medicinal plants, the scale of use does not pose a significant threat to the survival of the reserves. However, because forested land is cleared for agricultural use in direct relation to the size of population, the future is of concern. The interviewees on the whole reported good soil fertility and an abundance of land resulting in a surplus food production. It was stated that if a road were to be established creating market access, this would lead to increased prosperity. Currently, much land is left fallow allowing crop rotation however, if the crops were marketable, all available land may well be cultivated with little or no fallow land. In addition, pitsawing appears to still be an integral part of the culture and economic reliance on this activity persists. Hunting does exist but the extent of this activity was not ascertained due to the unwillingness of participants to co-operate in this discussion. Firewood collection and pole extraction is also of concern. There has been a limited amount of tree planting in the villages however it is too soon to assess the success of these projects.

In general, the pressure on the forest is high yet there appears to be little change in activities which will slow or reverse the present course of damage to the reserve.

8.0 CONCLUSIONS

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.

Kwamarimba forest, gazetted as a forest reserve in 1913, covers an area of 887.4 ha in the central area of the East Usambara range. With altitudes between 95 m and 445 m, it consists of approximately 69.2% mature forest, 25.0% previously disturbed, colonising or poorly stocked forest, and 5.8% woodland and grassland.

Disturbance

The highest level of pole and timber extraction recorded in the reserve was located on the transect running parallel, approximately 450 m, to the Sigi river. This area is characterised as mature mixed forest with levels of near-endemics occurring higher here than on the transects recorded in the reserve. Near-endemics and forest-dependent species of mammal, reptile and amphibian were recorded along this transect.

Species Richness

The forest reserve was found to contain a minimum of 165 species of trees and shrubs; 16 mammal, 11 bird, 17 reptile and 11 species of amphibian.

Flora

Four tree species were recorded which are endemic to the Usambara mountains and 39 have restricted ranges limited to the Eastern Arc and/or East African lowland forests. Thirty-seven species are dependent only on primary forest, and of these species, 14 are also endemic or near endemic to the Usambara mountains. Twenty non-forest tree and shrub species are established within the reserve boundaries.

Fauna

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

Table 30. 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	165	22.4	20	4	39	**14**
mammals	16	18.8	1	0	2	**2**
birds*	11	90.9	0	2	5	**7**
reptiles	17	23.5	0	0	5	**3**
amphibians	11	36.4	0	0	4	**4**
Total	**220**	**--**	**21**	**6**	**55**	**30**

* This does not represent an inventory. This information is limited to the important species discussed.

Conservation

The East Usambara mountains is important due to its floral and faunal diversity; and to its 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 values of the forests has caused and still cause a conflict of interest between the villagers and the authorities. The remaining forests of the East Usambara mountains are only small refuges of what was present just one hundred years ago due to human exploitation (Hamilton, 1989). The area continues to be vulnerable as the local populations increase and correspondingly, an increase in the need for new agricultural land will occur.

Yet, Kwamarimba forest still contains a good floral and faunal biodiversity. Changes in the structure of the forest as a result of human disturbance have occurred adjacent to the forest boundaries. In these areas, many non-forest tree and shrub species are colonising and in some places have become dominant. If there is no change in activity which will slow or reverse the present course of damage to the reserve, the area under high levels of exploitation will widen. This will occur as the availability of fuelwood, timber and poles decreases. The likelihood of changes in attitude and behaviour of the local people is low without information, education and access to alternatives to forest resources.

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Appendix 1:

General Plot Information

Plot Number	Topography	Altitude (metres)	Slope (degrees)	Vegetation Condition	Canopy Height (metres)
1	GL	95	5	M	20-30
2	GL	150	5	M	20-30
3	M	170	20	M	20-30
4	M	175	15	M	20-30
5	RT	300	30	P	10-20
6	SU	325	30	M	20-30
7	M	200	25	M	>30
8	M	250	20	M	20-30
9	GL	120	10	M	10-20
10	RT	350	30	EC	20-30
11	SU	220	40	M	20-30
12	SL	185	35	M	20-30
13	FV	200	5	G	few trees
14	M	210	15	P	20-30
15	SL	200	45	M	>30
16	GL	125	25	M	20-30
17	FV	155	10	EC	<10
18	GL	185	10	M	20-30
19	M	215	45	M	20-30
20	FV	160	5	M	20-30
21	SL	170	20	EC	10-20
22	SU	445	25	M	20-30
23	M	230	15	EC	10-20
24	M	220	30	EC	10-20
25	Skipped number				
26	Skipped number				
27	M	210	25	M	>30
28	GL	155	5	M	20-30
29	GL	150	5	G	10-20
30	M	195	10	M	>30
31	GL	300	20	M	>30
32	GL	160	5	P	10-20
33	M	170	15	W	<10
34	GL	180	20	M	>30
35	GL	165	5	M	10-20
36	FV	160	5	M	20-30
37	GL	205	5	M	10-20
38	GL	210	10	P	10-20
39	GL	230	20	M	>30
40	GL	215	20	M	>30
41	GL	210	5	EC	20-30
42	GL	140	15	EC	10-20
43	M	185	10	M	20-30
44	SL	150	25	M	>30
45	GL	170	5	M	20-30
46	M	225	30	M	20-30
47	M	250	25	M	10-20

Plot Number	Topography	Altitude (metres)	Slope (degrees)	Vegetation Condition	Canopy Height (metres)
48	GL	150	15	P	10-20
49	GL	160	20	M	>30
50	SL	200	25	M	10-20
51	GL	150	20	M	20-30
52	SU	260	30	EC	10-20
53	SU	245	35	M	20-30
54	GL	190	25	M	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
F - mature mixed forest	

Appendix 2:

Taxonomic Verification

BOTANY

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ZOOLOGY - INVERTEBRATES

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All other invertebrates:

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(ISSN 1236-620X)

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Suggested citation: Cunneyworth, P. 1996. Kwamarimba Forest Reserve: A biodiversity survey. East Usambara Catchment Forest Project Technical Paper No. 33. - Forestry and Beekeeping Division & Finnish Forest and Park Service & Society for Environmental Exploration, Dar es Salaam, Vantaa & London.