INTERNATIONAL COUNCIL FOR BIRD PRESERVATION

Study Report No. 53

A WILDLIFE SURVEY OF THE EAST USAMBARA AND UKAGURU MOUNTAINS, TANZANIA

The Birds, Amphibians, Reptiles, Butterflies, Fishes and Mammals recorded by The Cambridge Tanzania Rainforest Survey 1990

BY TOM EVANS, GUY ANDERSON, SCOTT AKKER, NORBERT CORDEIRO, ROSALIND HIGHSTEAD AND ANTHONY MOODY

EDITED BY T.D. EVANS AND G.Q.A. ANDERSON

A Wildlife Survey of the East Usambara and Ukaguru Mountains, Tanzania

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ABBREVIATIONS

AFIMP Amani Forest Inventory and Management Plan
BLOWS British Library of Wildlife Sounds
BMNH British Museum of Natural History (The Natural History Museum)
CITES Convention on International Trade in Endangered Species
EANHS East African Hatural History Society
EARS East African Ringing scheme
EC European Community
ICBP International Council for Bird Preservation
IUCN International Union for the Conservation of Nature and Natural Resources
RSPB Royal Society for the Protection of Birds
UDSM University of Dar-es-Salaam
WCST Wildlife Conservation Society of Tanzania
WWF World Wide Fund for Nature
mm milimetre(s)
cm centimetre(s)
m metre(s)
km kilometre(s)
ha hectare(s)
sq. km square kilometre(s)
sq. miles square miles
sp. species
spp. species (plural)
ssp. subspecies

CONVENTIONS

Threatened and near-threatened.
Categories indicating, respectively, high and moderate risk of extinction in the near future, as used in the Red Data Lists (e.g. Collar and Andrew 1987). The more detailed Red Data Books (e.g. Collar and Stuart 1985) include a further, less threatened category 'Candidate species', and subdivide the Threatened category into (in descending order of threat) Extinct, Endangered, Vulnerable, Rare, Indeterminate, Insufficiently Known, Out of Danger and Of Special Concern.

Eastern Arc
Biogeographical region consisting of lowland, transitional and submontane forests on mountains from north Tanzania to Malawi and Mozambique. It is here taken in its broadest sense, as defined by Map 1. The mountain ranges included are very similar to those of the Tanganyika-Nyasa Montane Forest Group of Moreau (1966).

CITES Appendix I and II
Species in which international trade is restricted by the CITES convention are listed on these Appendices. Appendix I covers those taxa so threatened that no trade in them is allowed, Appendix II those in which limited trade is allowed under a special licensing and quota system.

ABSTRACT

The chain of ancient crystalline mountain blocks running from Kenya, through Tanzania, to Malawi and Mozambique is known as the Eastern Arc. Limited areas of evergreen forest exist on these mountains and these support numerous rare and restricted-range species, with many known from just one or a few sites. Despite some existing protection, the habitats for these species are severely threatened by agricultural encroachment and unsustainable exploitation.

The members of the Cambridge Tanzania Rainforest Survey 1990 visited the Ukaguru and East Usambara Mountains. Both were known to be of high conservation value, and the survey results further support this. The forests deserve protection on social, economic and scientific grounds, which are explained.

There were seven team members on Mount Mtai (5°00'S, 38°30'E) in the East Usambaras (7th July-14th August) and four in the Ukagurus (7°00'S, 36°30'E) (24th August-14th September). Both areas are Forest Reserves under the jurisdiction of the Forestry Division. Two ornithologists concentrated on mist-netting in both forests. Two members studied reptiles and amphibians at both sites, with an emphasis on nocturnal searching and sound-recording. In Mtai the three additional workers carried out a butterfly survey and a study of fish ecology, the latter in streams outside, but flowing from, the forest. In all the studies, a high priority was placed on locating poorly known, threatened and localised species.

Results indicate that Mount Mtai in the East Usambaras has a rich forest fauna, containing at least three threatened species of bird and many restricted-range amphibians and butterflies. Of particular importance are a butterfly, *Celaenorrhinus* sp., previously unknown to science, a threatened bird, Swynnerton's Forest Robin *Swynnertonia swynnertoni*, previously unknown from the Usambaras despite a great deal of ornithological work there, and several forest butterflies and amphibians new to the Usambaras. Mount Mtai has at least a fifth of the remaining virgin forest in the East Usambaras. Forest is continuous from 300 m to 1100 m altitude, with a large area of low altitude forest, a poorly protected habitat in Tanzania. The conservation value of the Forest Reserve is unquestionably high.

The forest is being degraded by poorly regulated pit-saw logging. Proposals for its protection are made, the most urgent being the reduction or cessation of pit-sawing. Other proposals include posting additional Forest Officers, extending the Forest Reserve boundary to cover the whole forest and marking the boundary with a tree cordon. Continued support for the IUCN/EC-supported East Usambaras Conservation and Development Project is also urged. The fish fauna of the Msimbasi river is apparently influenced by the presence of Maramba village, but this is of low conservation significance.

In the Ukagurus four forest bird species new for the mountains were recorded and both previously known threatened birds were found in reasonable numbers. All herpetological records were new, and included many rare species. *Nectophrynoides minutus* and *Rhampholeon* near *platyceps*, both found quite commonly, were previously known from single localities elsewhere. Many species appear to be limited to the small area of forest persisting below 1650 m, which requires urgent protection. The forest is clearly valuable on biological grounds, in addition to its local environmental importance.

The forest is under heavy pressure of degradation as it is the sole source of firewood to around 10,000 local households. Modest funds are required by the Wildlife Conservation Society of Tanzania to support a local initiative to plant woodlots for the future, encourage soil conservation measures and complete demarcation of the gradually eroding Forest Reserve boundary. A nearby softwood plantation could perhaps supply firewood in the interim - it is suggested that this possibility should be investigated.

Section 1: BACKGROUND

1.1 INTRODUCTION

by T.D. Evans

The chain of ancient crystalline mountain blocks running from southern Kenya, through Tanzania, to Malawi and northern Mozambique is known as the Eastern Arc. Limited areas of evergreen forest exist on these scattered mountains and these show high levels of endemicity among all biological groups except mammals, which show moderate levels. Many species are known from just one or a few sites in the Arc (see e.g. Rodgers and Homewood 1982, Collar and Andrew 1988, Schioz 1981, Kielland 1990). The Eastern Arc forests are biologically distinct from the East African coastal forests (White 1983, Stuart 1983).

The majority of the Eastern Arc mountains and the most biologically important forests are in Tanzania, with others in Mozambique, Malawi and Kenya (see Map 1 which defines the Eastern Arc for the purposes of this report). Most of Tanzania's remaining forests are gazetted as Forest Reserves, set up to preserve their water catchment properties or extractive value. One of the largest and most species-rich sites, Mwanihana in the Uzungwas, is now a National Park. Nonetheless, clearance for agriculture and excessive harvesting of timber, poles and firewood are threatening to destroy many of the forests. Conservation of the remnants, backed up by improved knowledge of the species they contain, is thus increasingly urgent.

The Wildlife Conservation Society of Tanzania is spearheading efforts to catalogue and protect all Tanzania's forests, with substantial inputs from the IUCN, RSPB, ICBP, WWF and Frontier Tanzania. There is a great deal of scope for new fieldwork to contribute to these projects, and also a need for financial support from governments and non-governmental organisations abroad.

The International Council for Bird Preservation (ICBP) suggested in late 1989 that the members of the Cambridge Tanzania Rainforest Survey 1990 visit the Ukaguru and East Usambara mountains. The project was intended to provide new information on the distribution and ecology of various forest animals and also provide an up-to-date report on the conservation problems in those areas.

The East and West Usambaras are extremely species rich, with a high vegetational diversity and many plant and animal endemics (Rodgers and Homewood 1982). They were known to support seven bird species listed as threatened (by Collar and Andrew 1988) and were ranked as 4th of all the forests in continental Africa in their importance for bird conservation in a recent review (Collar and Stuart 1988). Only the areas around Amani, Mazumbai and Lushoto have been well studied, while the other forest blocks have been largely ignored. To date there has only been one effective conservation project in the Usambaras, the current Conservation and Development Project being implemented by the Ministry of Agriculture and Livestock Development, the Ministry of Tourism, Natural Resources and Environment, Tanga Region and IUCN. This is also confined to the Amani area but due to expand to the whole of the East Usambaras in late 1992. The East Usambaras Catchment Forest Project, under the jurisdiction of the Forest Division, has responsability for some of the forests in the region. Its primary concern is catchment protection but also aims to conserve biodiversity (Hamilton and Benstead-Smith 1989). The Mount Mtai block, our chosen study site in the East Usambaras, was biologically almost unknown, though it was included in the recent inventory of East Usambara forest resources made by AFIMP (1986) and Hamilton and Bensted-Smith (1989) present some botanical data.

The Ukaguru Mountains have been less well studied than the East Usambaras, and in particular no previous herpetofaunal records are known. Fewer scarce plants and birds

were known there, but the area still qualifed for the review by Collar and Stuart (1987). No conservation initiatives had occurred or were in prospect.

There were seven team members in the Usambaras (7th July-14th August) and four in the Ukagurus (24th August-14th September). The two ornithologists concentrated on mist-netting in both forests. Two members studied reptiles and amphibians at both sites, with an emphasis on nocturnal searching and sound recording. In Mtai the additional members were involved with a butterfly survey and a study of fish ecology, the latter in streams outside but flowing from the forest. In all studies, a high priority was placed on locating poorly known or threatened species and endemics.

This report expands on the preliminary report circulated in 1990 (Evans *et al.* 1990). The more important records are also being submitted as short papers to suitable journals.

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The numerous sponsors who made the project financially possible are listed in the next section. We are indebted to them all.

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The team members would like to thank the following for their generosity in supporting the expedition:

1.2.2.1 Flights

British Airways for our special treatment and discounted flights.

1.2.2.2 Money (c.t.=charitable trust)

Charles and Mavis Aitchison
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Whitley Animal Protection League
George Williamson and Co. Ltd
Wilson Smithett and Company
York University

1.2.2.3 In Kind

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Top-up Aquatics	Aquarium equipment
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Walker's Shortbread Ltd	Shortbread and Oatcakes
Water Research Centre	Loan of Electro-fishing Equipment
J.E. Wilson and Sons Ltd	Kendal Mint Cake
Woodside Laboratories	Shoo! Insect Repellents

1.3 ITINERARY

1.3.1 Dates of fieldwork

27 June	Arrive Dar-es-Salaam. Most of team stays ten days with Neil and Liz Baker.
27 June-6 July	TDE and NJC visit Moshi, Mweka, Lushoto and Amani looking unsuccessfully for student counterparts.
7 July	Team meets up in Tanga and drives to Maramba, near Mount Mtai Forest Reserve. Fieldwork begins.
9 August	Meeting between TDE and Mr. Hatibu Haji, Amani IUCN/EEC Project
13 August	Meeting between TDE and Mr Mlowe, Catchment Forest Project, Tanga. Fieldwork completed. Return to Dar-es-Salaam.
16/17 August	Weekend ringing session in Pugu Forest Reserve with the Bakers
21 August	Depart for the Ukagurus
23 August	Arrive Mamiwa-Kisara FR, Ukagurus, commence fieldwork
25 August	Meeting between SAA, GQAA and Mr Tangwa, Mandege Forest Station
14-18 Sept.	Fieldwork completed. Return to Dar-es-Salaam via Mikumi National Park
20 Sept.	Part of team visits Manyara National Park, Serengeti National Park and Ngorongoro Conservation Area
29 Sept.	Last team members fly back to Britain.

1.3.2 Timing of the Survey

Eastern Tanzania experiences two wet seasons, the long rains from March to May and the short rains from November to December (Brown and Britton 1980) although the mountains are usually wetter and their rain less seasonal due to orographic rainfall. However, only four days of rain were experienced in five weeks on Mount Mtai.

Most forest birds are thought to breed around the time of the long rains (Brown and Britton 1980), many at the beginning or end of the rains. Thus the survey fell in the post-breeding season for most species, leading us to expect low levels of song, high numbers of immature birds and a concentration of smaller birds in roving mixed flocks. This was the case, for example only a handful of species were noted singing.

It is likely that amphibians and butterflies would be considerably more numerous and active at a wetter time of year, with higher numbers of species and individuals being evident. See Sections 2.2 and 2.3.

1.4 GENERAL BACKGROUND

1.4.1 Conservation in Tanzania

Tanzania has protected over 25% of its area for conservation (IUCN 1987). Huge tracts of savanna are well protected and produce substantial revenue from tourism. However, the forest biome (originally less than 5% of the land surface) is underprotected. Although much of the remaining forest is in Forest Reserves these give only limited statutory protection, constrained in practice by a lack of resources. The Forest Reserves are the responsibility of the Department of Forestry and Beekeeping, with local and regional offices administering most sites. The recently declared Mwanihana National Park in the forested Uzungwas should ensure the long-term survival of at least one part of the Eastern Arc.

In the Usambaras as a whole there are around 20 Forest Reserves, some of them protecting plantations, totalling 16,500 ha. A large proportion of protected forest is in the West Usambaras There is also a 300 ha reserve in mid-altitude forest at Mazumbai, West Usambaras, guarded by the University of Dar-es-Salaam for research purposes.

The Ukagurus have two Forest Reserves but only Mamiwa Kisara still contains a sizeable area of forest - approximately 10,000 ha of natural forest and a comparable area of softwood plantations (Stuart and van der Willigen 1978).

1.4.2 Biogeographical Context

Though Eastern Arc forests (Map 1) have a lower species richness than those of West and Central Africa, they are of great biological interest. There is little overlap at the species level between Eastern Arc and West African forests (e.g. zero percent overlap between species of forest amphibian, Schioz 1981), so the conservation of Eastern and Western species require independent initiatives. These locally evolved species of the Eastern Arc are thought to derive from eastern 'refugia' where some forests persisted through recent Ice Age droughts. This is the common explanation for the variable species numbers in Eastern Arc forests, with very high richness indicating actual refuges (e.g. the Usambaras, the Ulugurus and the Uzungwas), whilst forests which disappeared during the driest periods and are being recolonised are less species rich (e.g. Ukagurus, Pare Mountains) (Stuart 1983, Diamond and Hamilton 1985). Such variation is probably exaggerated by uneven scientific effort - some forests, such as the Tanzanian Rubehos have yet to be visited by biologists, and other sites have been very poorly covered (N.E. Baker and N. Burgess, pers. comm.). Similar problems hamper

the understanding of biodiversity and species ranges in the biogeographically distinct coastal forests of East Africa.

The younger volcanic mountains of the Northern Highlands-Kilimanjaro region lack most of the characteristic Eastern Arc species and have few endemic species of their own (Stuart and Hutton 1978). The fragmented coastal forests have a number of species not shared with the Eastern Arc and may have had their own refugia (Stuart 1981, 1983), but the foothills of the Ulugurus and Usambaras and the coastal forests have many similarities, for example in their avifaunas.

The different forest types (see Vegetation below) support different animal and plant species - the coastal and foothill forests and the montane forests each have many species restricted to them. Forests at intermediate altitudes contain representatives from both, so here species richness is highest (Rodgers and Homewood 1982). Part of the East Usambaras forms a broad plateau at an altitude suitable for this transitional forest, one reason for their biological importance. They also have forest over a great altitudinal range. However, the division of the Usambaras into East and West by the Lwengera Valley has contributed little to their biological richness - most species and subspecies are found at suitable altitudes in both ranges (Moreau 1935, Kielland 1990).

1.4.3 Geography of Study Sites

The Eastern Arc forests stand on crystalline mountain blocks uplifted at least 25 million years ago. They form a North South belt, each block being highly folded and deeply dissected. The montane soils are generally lateritic, red and yellow, with some resistance to erosion, but they cannot withstand prolonged cropping without chemical fertilisers (Rodgers and Homewood 1982).

The Eastern Arc mountains have long proved attractive to subsistence farmers and more recently to tea farmers and to foresters, who felled the broadleaves and replanted with conifers in many places (Hamilton and Bensted-Smith 1989, Chapters 3-6). The soils of the foothills are fertile but the montane areas can only support a few special acidophilous crops such as tea and quinine in the long term. Forest clearance has not stopped despite recent poor economic conditions for plantation forestry and agriculture, the emphasis switching back to clearance for subsistance farming. For example 50% of the forest in the 196 sq. km around Amani was cleared from 1954-1976.

During the 1960s and 70s cardamom cultivation was popular in the East Usambaras. This destroyed the undergrowth of large areas without immediately affecting the forest canopy. however, deterioration or clearance often followed. Cardamom is currently not a popular crop here, being uneconomic, and was not observed on Mount Mtai. Future changes in the market could restore its popularity, however.

The East Usambaras rise to 1506 m, and cover around 1300 sq km, with broad, dissected plateaus around 800-1000 m. The West Usambaras rise to 2412 m with little forest occurring below 1200 m. The East Usambaras still have up to 22,000 ha (220 sq km) of forest (AFIMP 1986, which excludes "several thousand hectares" of lowland forest, Hamilton and Bensted-Smith 1989). The plateau was originally almost wholly forested. Only 1000-4000 ha (in addition to some proportion of the unsurveyed lowland forest, but erroneously including areas where cultivation occurs beneath a closed canopy) appeared unexploited on aerial photographs in 1986-87. The remaining blocks are highly fragmented (see Map 2). The surrounding dry bushlands are heavily burnt over in the dry season, so forest regeneration is not occurring outside the current forest boundary. Population density is high and rising, with easy access to many forest areas and a moderately good infrastructure.

Rainfall at Amani is typically 2000 mm per year with no month having less than 75 mm (Rodgers and Homewood 1982). Rainfall is lower and temperatures higher at lower altitudes, e.g. the lower margin of Mt Mtai (Moreau 1935).

The dramatic Ukaguru Mountains are higher (to 2264 m) and most of their forest has been cleared. Only Mamiwa Kisara Forest Reserve, c.10,000 ha (Stuart and van der Willigen 1978), running from 1500 m to 2264 m, has any significant forest left. The local infrastructure is poor, but the population is fairly high and rising.

Rainfall is 1200 mm (Collar and Stuart 1987) and the summer dry season cool - we experienced night-time temperatures down to 6°C at 1800 m.

1.4.4 Vegetation

Moreau (1935) discusses the vegetation types of the East Usambaras with respect to altitude and climate. The following description is based on his work. He recognises three chief types of evergreen closed forest, namely:

i) Lowland - up to approximately 2500 feet (c. 800 m)
ii) Intermediate - from 2500 feet to 4500 feet (800 m to 1500 m)
iii) Highland - from 4500 feet (1500 m) upwards.

These altitudes are only loosely predictive of animal or even plant communities on the ground - even though prime examples of a habitat in the middle of an altitudinal band will contain many of the 'typical' species, the zones of overlap between forest types are broad and each species seems to respond to altitude in an different way - many parts of the forest thus contain mixtures of species that typify Lowland, Intermediate or Highland zones but spread well outside them (Stuart 1983, Stuart *et al.* 1987).

The botanical resemblances between these three types are far more striking than their differences. All are essentially three-storied, with a unifom canopy around 100 feet (30-35 m) high, though sometimes higher in intermediate forest. Seasonality is not very marked, although the lowland forest has some deciduous species. Dominant plant species are hard to single out.

Nonetheless, differences are visible - the obvious features are given below:
Lowland The canopy is lighter and less even than in Intermediate forest. Lianas are numerous but there are few ferns, epiphytes, beard lichens (*Usnea longissima*) or mosses. Typical tree species are *Antiaris usambarensis*, *Ficus* spp. *Sterculia appendiculata*. *Trema guineenesis*, *Milicia excelsa* and *Albizzia* spp..
Intermediate The most luxuriant forest type in East Africa. There are large numbers of epiphytes, lianas, mosses, beard lichens and mistletoes (*Loranthus* and *Viscum*), as well as tree ferns *Cyathea usambarensis* and strangling figs. Typical tree species (though none is dominant) are *Macaranga usambarensis*, *Allanblackia stuhlmannii*, *Piptadenia buchananii*, *Myrianthus arboreus*, *Berlinia scheffleri* and *Parinari* spp.
Highland The physiognomy is similar to that of intermediate forest. Grasses are absent, whilst lianas and epiphytes are moderately abundant. Typical trees are *Podocarpus* sp., *Ocotea usambarensis*, *Allanblackia stuhlmannii*, *Pygeum africanum*, *Olea* sp., *Chrysophyllum* sp., *Ficus* spp., *Cassipourea eickii* and *Ficalhoa laurifolia*..

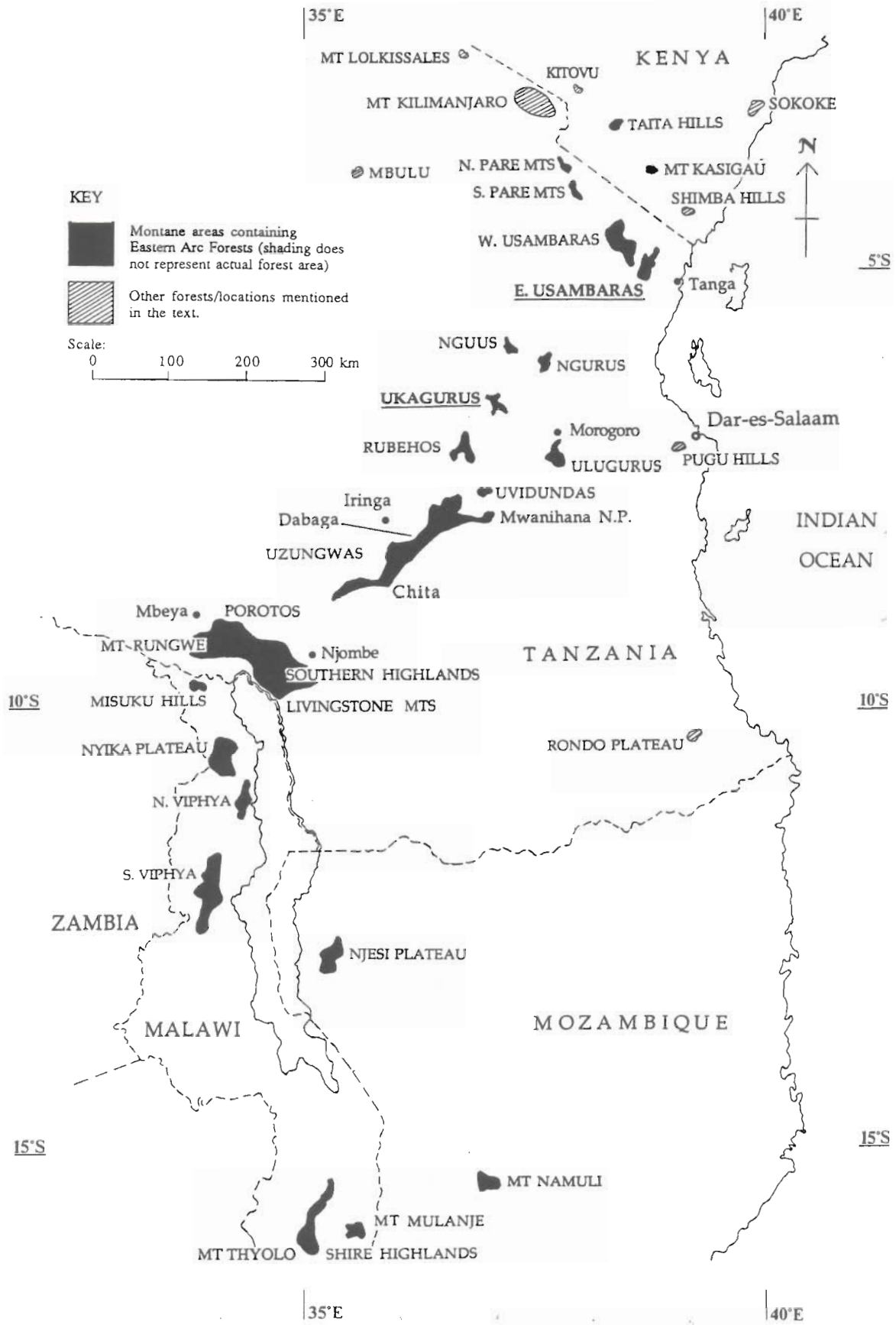
Many of the Lowland and Intermediate species mentioned have been recorded from Mount Mtai (AFIMP 1986).

Hamilton and Bensted-Smith (1989) report just Lowland and Submontane forest types in the East Usambaras, based on detailed botanical studies, and stress the differences between them, both in species composition and structure.

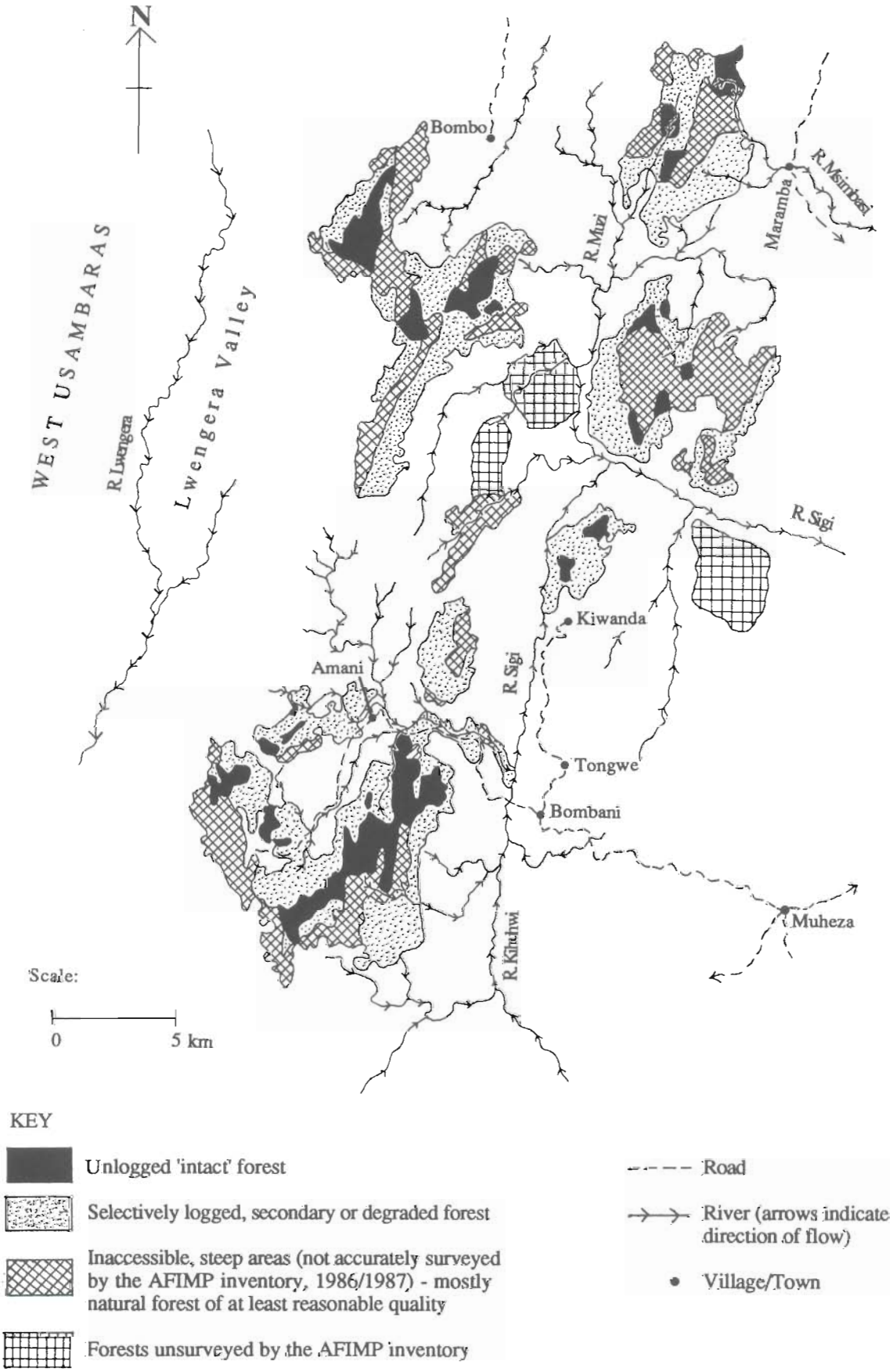
Only Lowland and Intermediate/Submontane types are represented on Mount Mtai (pers. obs., AFIMP 1986), with the transition being around 700-800 m. Altitudinal

belts come lower here than elsewhere in Tanzania as a result of the very steep altitude-temperature gradient, the influence of the Indian Ocean (25 miles to the East) and the steepness of the seaward-facing slopes. The summit ridge (800-1060 m) was cool and very wet during our visit, with frequent fogs due to low cloud - the high rainfall (80 in, 2000 mm at Amani) must be supplemented by considerable occult precipitation (dew formation), accentuating the contrast with the drier, hotter lowland forest.

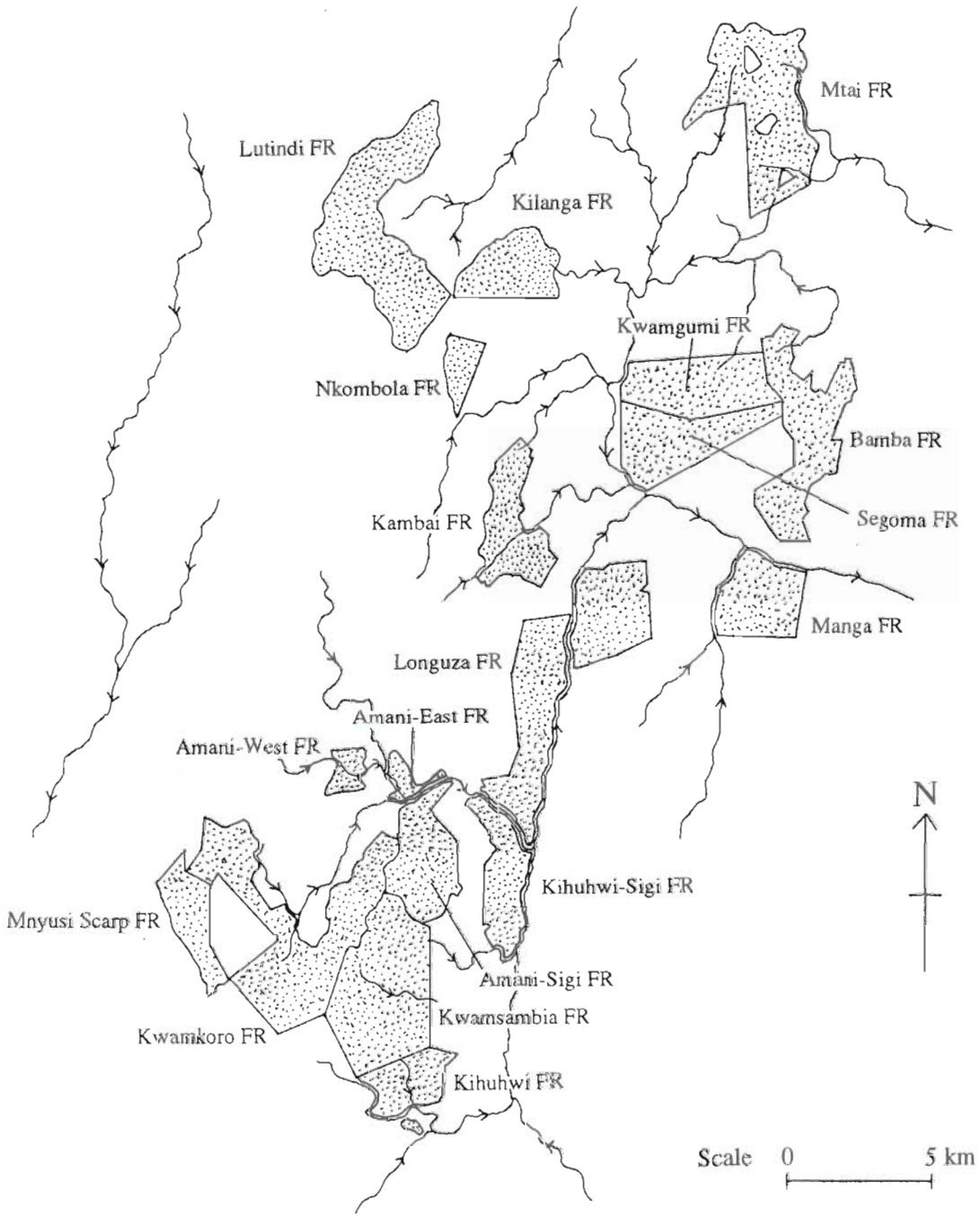
The Ukagurus support only montane forest. This differs from Usambara Highland forest, being drier with a rather broken canopy and dense understorey (Friedmann and Stager 1964, Collar and Andrew 1987). This structure has been attributed to logging in the past (Stuart 1983) but little evidence was presented to support the suggestion. We feel that the dryness of the area has been overstated. The ridge-top forest was often foggy, with water dripping from the leaves. The weather was frequently rainy during our fieldwork and the lower altitude forest was considerably more humid than that at 1700-1900 m. Streams are abundant.



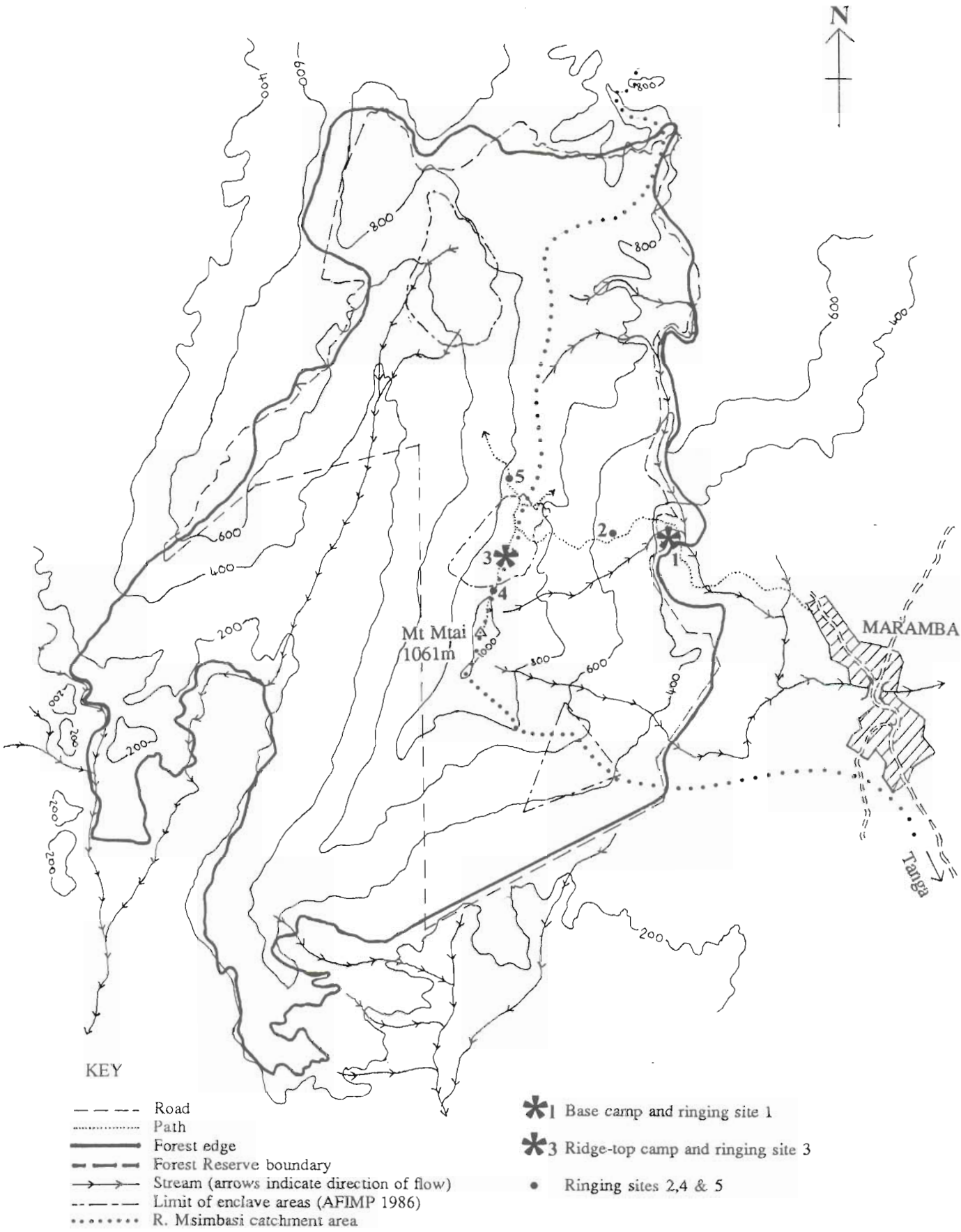
Map 1. The Eastern Arc Forests (As defined for the purposes of this report. The mountains in northern Mozambique and central and southern Malawi are not ususally referred to as part of the Eastern Arc.)



Map 2. Forests of the East Usambara Mountains (Based on maps in Hamilton and Bensted-Smith 1989) Forest reserve boundaries are not shown. Approx. 70-80% (by eye) of all remaining forest is within forest reserves.

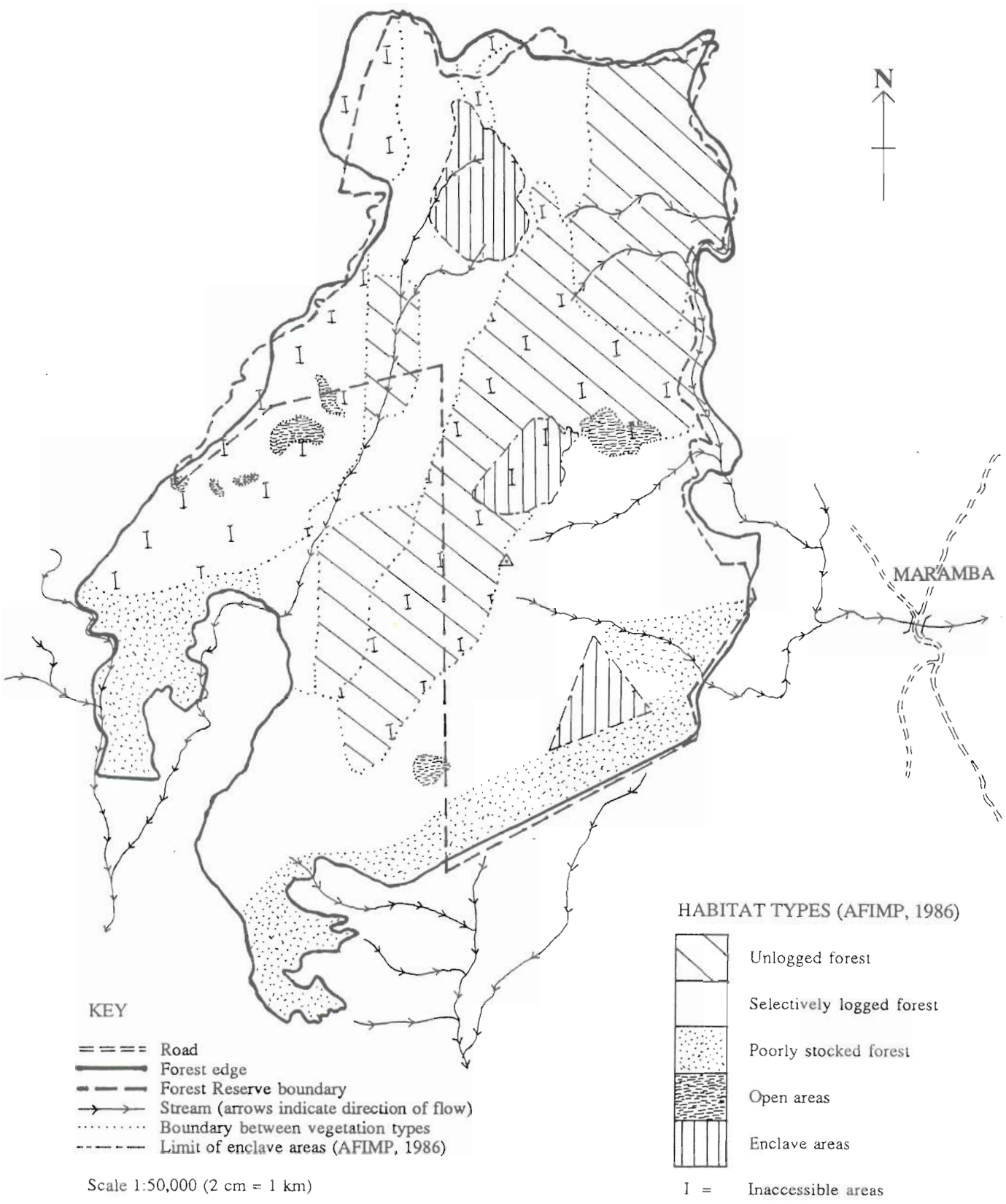


Map 2a. Forest Reserves in the East Usambaras (Based on maps in Hamilton and Bensted-Smith 1989) Compare with actual forest cover (Map 2)

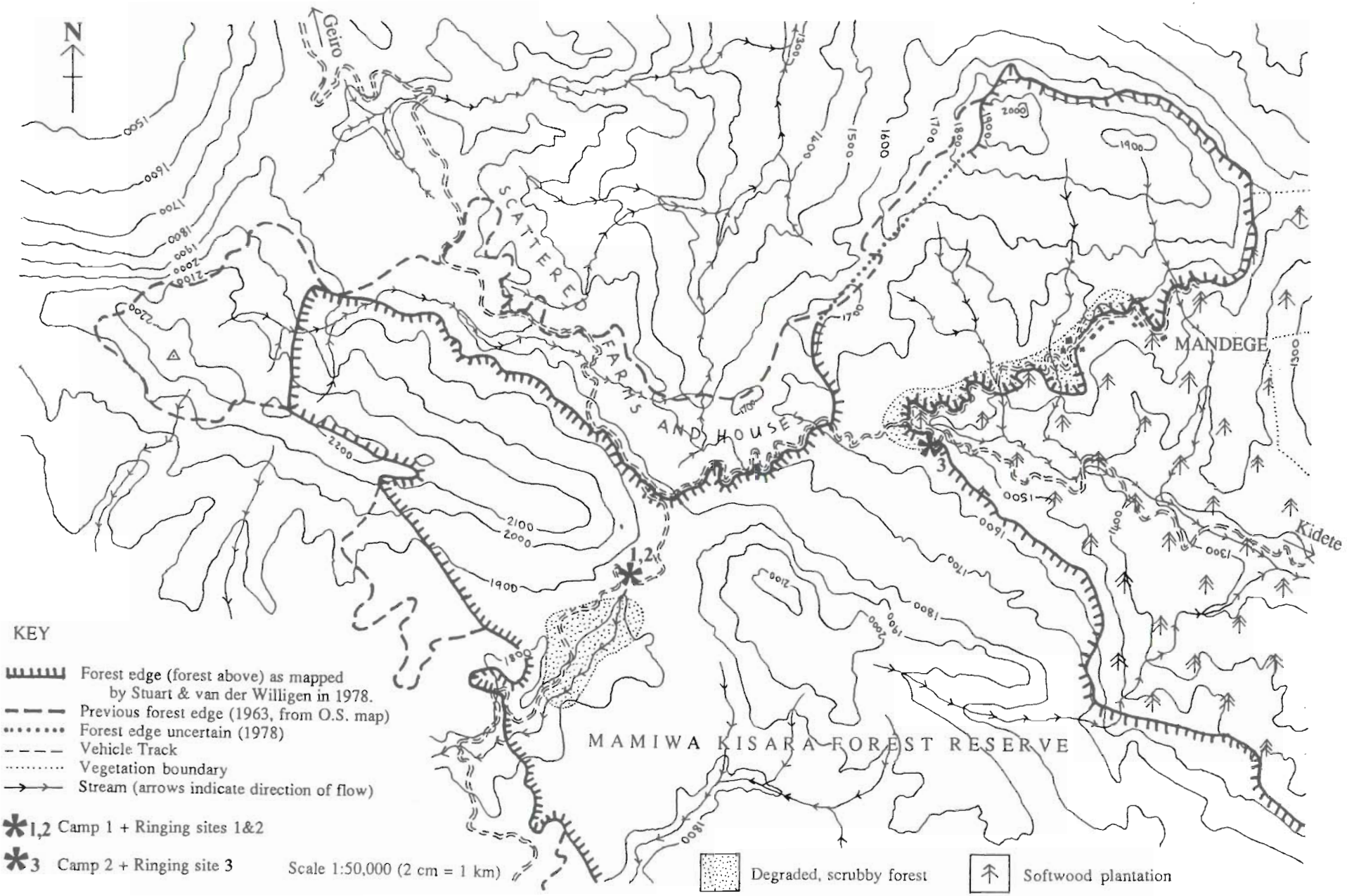


Scale 1:50,000 (2 cm = 1 km)

Map 3. Mt Mtai - Topography Contour interval 100m. Contours and streams are taken from 1:50,000 maps produced by the O.S. for the Govt of Tanzania (1988 and 1989).



Map 4. Mt Mtai - Habitat Types (from AFIMP 1989) Areas marked as enclaves in AFIMP (1986) contain a variety of habitats from natural forest to cultivated land. Location of streams is from 1:50,000 maps produced by the O.S. for the Govt of Tanzania (1988 and 1989). Note the large area of forest currently not within the Forest Reserve.



Map 5. Ukaguru Mountains - Topography and Habitat Types Contour interval 100m. Contours in metres calculated from O.S. map (ariel photographs 1963, publ. 1967) with contours in feet.

Section 2: METHODS AND RESULTS

2.1 BIRDS

by G.Q.A. Anderson

2.1.1 Summary

Sixty-eight forest species were recorded on Mount Mtai. These included three threatened species, Usambara Eagle Owl *Bubo vosseleri,* Banded Green Sunbird *Anthreptes rubritorques* and Swynnerton's Forest Robin *Swynnertonia swynnertoni*.. *S. swynnertoni* had not previously been recorded closer than the Uzungwa Mts, 400 km to the south. Two near-threatened species were observed. One to four additional threatened species may also have been overlooked, as the habitat appears suitable. 205 birds were mist-netted, ringed and measured.

Fifty-one forest species were reorded in the Ukagurus, including six new to the area. Two threatened species, Mrs Moreau's Warbler *Bathmocercus winifredae* and Iringa Ground Robin *Dryocichloides lowei* were recorded, the latter only above 1800 m, as well as one near-threatened species. 324 birds were mist-netted, ringed and measured.

2.1.2 Previous Research

2.1.2.1 East Usambaras

Parts of the East Usambara mountains, especially the plateau around Amani, have been well studied ornithologically, most notably by Sclater and Moreau (1932), Moreau (1935), Stuart and Hutton (1978), Stuart and van der Willigen (1979), Stuart (1983) and Newmark (1991). These studies have revealed a diverse avifauna, the richest of all the Eastern Arc forests (Rodgers and Homewood 1982), with at least 116 forest species recorded (this figure and the definition of a 'forest species' are taken from Stuart (1981), Stuart in Hamilton and Bensted-Smith (1989) and our study). Eight of these species are endemic to the Eastern Arc.

Coverage has been rather uneven - there are very few definite reports anywhere away from Amani, though many of Moreau's specimens simply say "East Usambara" and may be from other sites, including Mtai (N.E. Baker, pers. comm.). Otherwise, the forest on Mt Mtai had not been studied and its avifauna was completely unknown. Due to its low altitude and proximity to the coast, it was considered possible that the Mtai forest could hold some of the rare and threatened species otherwise restricted to coastal forests in Kenya and Tanzania (see Section 2.1.4.2)

2.1.2.2 Ukaguru Mountains

In contrast to the Usambaras, there had been little ornithological investigation in the Ukaguru Mountains. The only ornithological visits were by Fuggles-Couchman (1939), Friedmann and Stager (1964), Stuart and van der Willigen (1978) and a one-day visit by N.E. and E.M. Baker in 1989 (verbally). Considering the limited length and scope of these studies (none lasted more than 8 days and only the most recent two involved any mist-netting) we considered it probable that the forest species list of 45 (Stuart 1981) was incomplete and certainly in need of re-assessing twelve years after the last major study.

For a complete summary of the Tanzanian Eastern Arc avifaunas, as known up to 1978, see Stuart and van der Willigen (1979). Dowsett-Lemaire (1989) describes the avifauna of the Malawian mountain forests in detail.

2.1.3 Methods

The main aim of the birds project was to survey the two areas to obtain comprehensive species lists. These could then be used in assessing the biodiversity and conservation value of the two areas in comparison with other Eastern Arc forests. The survey methods used in both areas were field observation and mist-netting. Identification guides available to us in the field were Mackworth-Praed and Grant (1953, 1955), Britton (1980), Maclachlan and Liversidge (1976) and Williams and Arlott (1980). Although we spent significant lengths of time in each area (35 days at Mtai, 22 days in the Ukagurus), it is unlikely that we managed to record every species at either site. Nocturnal species or the less numerous canopy species (unlikely to be caught in mist-nets) are those most likely to be missed using our methods.

2.1.3.1 Field Observation

Birds were observed while walking through the forests, usually along existing tracks. All major sub-habitat types were covered over the whole altitude range at either site (forest interior, forest edge, ridgetop forest, enclaves within forest, streamside vegetation, etc) except for the stunted ridge-top forest (2000 m+) in the Ukagurus. It was also intended to record bird calls and use playback census methods, and although a limited number of bird calls were taped, playback was made impossible due to loss of equipment.

2.1.3.2 Mist-netting

Nets were set, successively at a range of altitudes in each forest and were moved every few days, to maximise catch rates. Up to six nets were used at Mtai, ten to twelve in the Ukagurus. One 10 m-long net was used in both areas, the rest being 12 m. Nets were opened at dawn, closed before dusk and occasionally closed during the middle of the day when bird activity was low. Nets were checked every hour and birds processed in camp or at a temporary ringing station. Descriptions of all netting sites, with the number of net-metre-hours operated at each, are given in Appendix 1.2. No systematic results were required from the ringing, the object being to locate as many species as possible. The secondary aim of the mist-netting was to provide data for the East African Ringing Scheme, therefore all birds caught were fitted with metal rings supplied by the EARS and measurements taken of wing, tarsus, tail and bill. Moult, brood-patch and fat scores were also taken. All our biometric data are now within the central database of the EARS.

2.1.4 Results

2.1.4.1 Completeness of Surveys

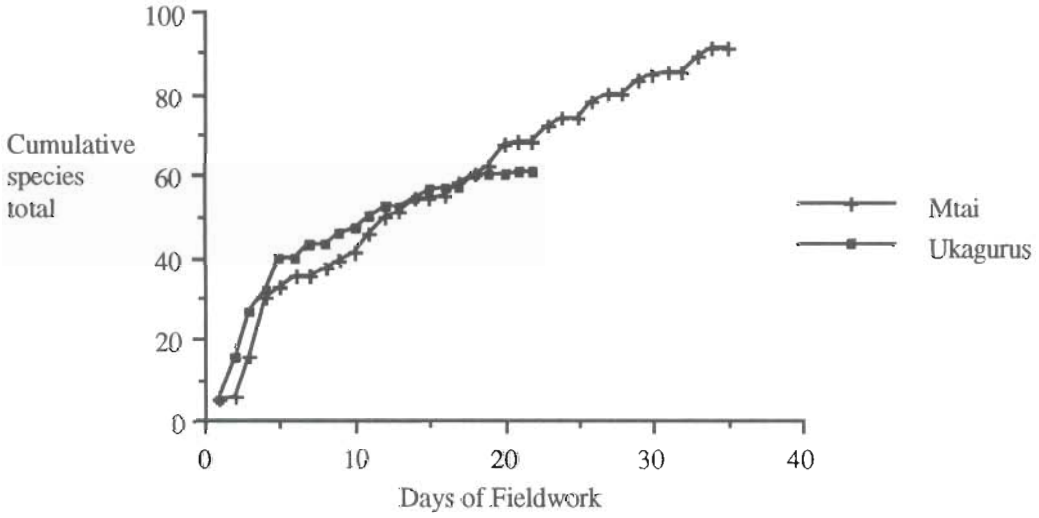
We recorded 91 species (including three 'possible's) in the forested areas of Mt Mtai (35 days fieldwork) and 62 species in the forests of the Ukagurus (22 days fieldwork). Species lists for each forest site are given in Appendix 1.5. Taxonomic order and nomenclature is based on Britton (1980) and the revision of non-passerines by Turner *et al* (1991). The status of the birds recorded is summarised in Table 2.1.1. 'Threatened', 'near-threatened' and 'candidate' are the categories used by Collar and Stuart (1985).

As a rough indication of the completeness of our survey, species-discovery curves for each site have been plotted (Fig. 2.1.1). The species included in Fig. 2.1.1 are all those listed in Appendix 1.5 and include those discovered by netting as well as observation in the field. In theory, as the curve approaches saturation, the survey can

Table 2.1.1 Summary of the status of birds recorded in both areas.

Status category	Mt Mtai		Ukaguru Mts	
	Currently known from the E. Usambaras	Recorded in our study at Mtai	Currently known from the Ukagurus	Recorded in our study
Threatened species	7	**3**	2	**2**
Near-threatened species	3	**2**	2	**1**
Other candidate species	14	**9 (10?)**	4	**4**
Species endemic to the Eastern Arc (see Map 1)	9	**4**	8	**8**
Forest species (defined by Stuart, in Hamilton and Bensted-Smith 1989)	110	**68**	51	**51**

Fig 1. Species discovery curves for the two study areas



be considered reasonably complete. The curve for the Ukagurus suggests that there were relatively species left to discover whereas we cannot say this with certainty for Mt Mtai, even after spending so much longer in this area. A high priority was given to the mist-netting in both areas, with the result that less time was available for field observation. This undoubtedly had significant effects on the shape of the curves in Fig 2.1.1, tending to reduce the rate at which new species were discovered.

Any conclusions on species abundance from a short-term study such as this must be treated with great caution as this can vary greatly from season to season and year to year in any one area. This was observed during expeditions to the Usambaras in consecutive years (Stuart and Hutton 1978 and Stuart and van der Willigen 1979), most noteably for two of the rarer species; Long-billed Apalis *Apalis moreaui* and Red-headed Bluebill *Spermophaga ruficapilla*. See also the note on Hornbills in the Ukagurus in the species list (Appendix 1.5)

Much of the information on species distributions in the following sections is from Britton (1980), Collar and Stuart (1985), Stuart and van der Willigen (1979) and Dowsett-Lemaire (1989). Most locations mentioned in the text are shown on Map 1.

2.1.4.2 Mount Mtai Forest Reserve

Overview

The large number of species recorded in this small area of forest suggests that Mtai shares the rich avifauna of the rest of the East Usambaras. Although just 54% of all known forest species in the East Usambaras were recorded, it is obvious from Fig 2.1.1 that our species list for Mtai is rather incomplete and many of the other forest species probably await discovery here. The species discovered are all known from other parts of the East Usambaras, with the exception of one, Swynnerton's Forest Robin *Swynnertonia swynnertoni* (see below).

Red Data Book species (Collar and Stuart 1985)

Collar and Stuart (1985) list six threatened and three near-threatened species for the East Usambaras. Of these, we recorded one (possibly two) of these threatened species and two near-threatened. We also recorded an additional threatened species, Swynnerton's Forest Robin *Swynnertonia swynnertoni*, not previously known from the Usambaras.

Usambara Eagle Owl *Bubo vosseleri (Rare)**
A tape recording of a distant nocturnal bird call was obtained in wet ridge-top forest at c.1000 m. In Britain, the call was compared with recordings of West African owls (Chappuis 1978) and found to be very similar to the resonant 'churring' of Verreaux's Eagle Owl *Bubo lacteus*. [Note: The species has been susequently heard and seen in lowland forest in the middle of the East Usambaras, in 1992 (Cambridge Tanzania Rainforest Survey 1992, in prep.) and the call recorded at Mtai confirmed as *B. vosseleri*.] The few records of this little-known and elusive species pre-1990 are from 900-1500 m in the Usambaras, mostly at Amani and Mazumbai (Collar and Stuart 1985). There is also one possible record of the species from the Nguru Mts (Moreau 1964). Two old males are still held at London Zoo, but no call could be elicited from them in response to the 1990 recording or those of *Bubo poensis* from Chappuis (1978). Neither has been heard to call for many years (P.J.S. Olney, *in litt.*).

Swynnerton's Forest Robin *Swynnertonia swynnertoni* (Rare)
This species was observed and trapped at 550 m in lowland-type forest with a dense understorey. Two birds were seen on 13 August 1990 and an adult male and adult female were netted together at the same site on 28 August 1990. These records are the first for the Usambaras and extend the known range of the species northwards by 400 km (Anderson et al., in prep.). The nearest populations are in the Uzungwa Mountains (Chita and Mwanihana forests), where the species was discovered in 1981 (Stuart and Jensen 1981). It is also known from Chirinda forest and the Vumba Highlands in Zimbabwe and Mt Gorongosa in Mozambique (Collar and Stuart 1985). The Mtai records represent a new population and a new sub-species (Anderson et al., in prep.). In the other parts of its range the species is thought to be highly sedentary and the Uzungwa, Zimbabwe and Mozambique populations represent three separate sub-species. Our records are at the lowest altitude ever recorded for the species, the previous known limits being 850-1750 m (Collar and Stuart 1985). [Note: The species has subsequently be found breeding in forest at 200-300 m in the middle of the East Usambaras (Cambridge Tanzania Rainforest Survey 1992, in prep.) and is apparently a lowland species in the East Usambaras.] If it does occur at montane altitudes in the Usambaras, it is remarkable that it has not been found by other ornithologists.

*Here we deviate from the taxonomy of Britton (1980) in considering this a separate species (after Collar and Stuart, 1985) rather than a sub-species of Fraser's Eagle Owl *B. poensis*.

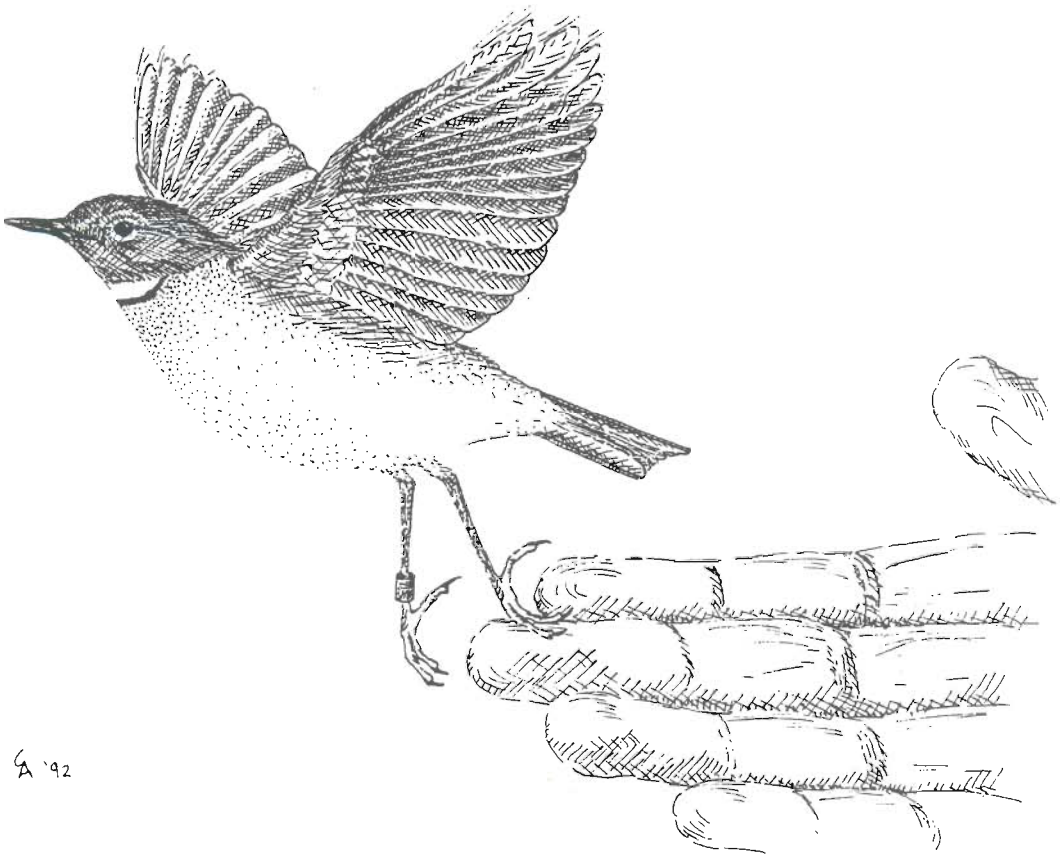


Plate 1. Adult male Swynnerton's Forest Robin being released after ringing.

Banded Green Sunbird *Anthreptes rubritorques* (Rare)
This species was observed at 1000 m and 1050 m in wet sub-montane ridge-top forest. Two small groups (5+ and 2+) were seen, the smaller within a mixed bird flock. The species is present elsewhere in the East Usambaras where it has been found to be fairly common (Moreau and Moreau 1937 and Stuart and Hutton 1978). It is also known from the West Usambaras, Ngurus, Ulugurus and, most recently, the Uzungwas (Stuart *et al.* 1987). Our records are the most northerly yet. Considering the species has only been found above 750 m elsewhere in the East Usambaras, the area in which it occurs on Mtai may be rather small.

Plain-backed Sunbird *Anthreptes reichenowi* (near-threatened)
Seen twice in mixed-species flocks at 350-400 m close to the forest edge. This is a lowland species found elsewhere in Kenyan and Tanzanian coastal forests and in southern Mozambique.

Uluguru Violet-backed Sunbird *Anthreptes neglectus* (near-threatened)
One individual was seen at 350 m in mixed species flocks close to the forest edge. It has been found up to 1200 m elsewhere in the East Usambaras and is also known from the Uluguru, Nguru and Uzungwa Mountains as well as coastal forest patches from southern Kenya to Mozambique.

Forest-dependent species with limited distribution

Species included here are based on the list given in Stuart and van der Willigen (1979). All the species listed below, except Green Barbet, Red-tailed Ant Thrush and Red-headed Bluebill are listed as 'candidate' species in Collar and Stuart (1985).

Green Ibis ***Bostrychia olivacea*** was seen (up to two birds on four days) in dense ridgetop forest at 1000 m, and possibly heard on 4 nights in July at 350 m, when a call fitting the description in Brown, Urban and Newman (1982) was heard from birds circling above the forest but none were seen. This is a West African lowland forest species with an isolated sub-species in a few Kenyan montane forests (Mt Kenya, the Aberdares and the Nyambenis), on Mt Kilimanjaro and in the East Usambaras.

Fischer's Turaco ***Tauraco fischeri*** was seen three times around 500-600 m. This species seemed much rarer at Mtai than in other areas of the East Usambaras, where it was said to be abundant in forest (Stuart and van der Willigen 1979). This is typically a coastal forest species, occurring from Somalia to Zanzibar, but also inland, to the the West Usambaras.

Green Barbet ***Stactolaema olivaceum*** was found to be common, especially around fruiting trees along the ridge-top. One was netted on the ridge-top. Elsewhere it is found in Kenyan coastal forests south from the Tana River, Eastern Arc forests from the Usambaras to Mt Thyolo (south Malawi) and north Natal coastal forests.

Green Tinkerbird ***Pogoniulus simplex*** was probably fairly common below c. 900 m. Calls of tinkerbirds were heard regularly and were presumably this species since its close relative, Moustached Green Tinkerbird *P. leucomystax*, only occurs above 900 m elsewhere in the East Usambaras. (We saw *P. leucomystax* twice at 900 m) *P. simplex* is a lowland forest species, occurring in Kenyan and Tanzanian coastal forests, the Selous game reserve, southern Malawi and southern Mozambique.

Green-headed Oriole ***Oriolus chlorocephalus*** was seen or heard daily up to c. 850 m and often seen in mixed bird flocks with African Golden Oriole *O. auratus*. *O. chlorocephalus* is found in the East Usambaras, Ngurus and Ulugurus, the Rondo plateau, Mt Thyolo (southern Malawi), Mt Gorongosa (Mozambique), Mt Lolkissale (northern Tanzania), and the Shimba Hills, Jadini and Sokoke forests in Kenya.

White-chested Alethe ***Alethe fuelleborni*** was netted (3 birds) at 550 m and 950 m. The species is apparently rarer on Mtai than elsewhere in the East Usambaras where it has been described as common (Stuart and van der Willigen 1979). Newmark (1991) netted 26 individuals in approx 60848 net-metre-hours in forest near Amani (4.3 birds per 10,000 nmh), compared with our total of 7019 nmh (2.8 birds per 10,000 nmh). It is virtually an Eastern Arc endemic, occurring from the Usambaras south through the Southern Highlands of Tanzania, to the South Viphya region of Malawi and also on Mt Gorongosa and in the (coastal) Dondo region of Mozambique.

Red-tailed Ant Thrush ***Neocossyphus rufus*** was observed once at 550 m. This is largely a West African lowland species with an isolated East African sub-species (actually the nominate race) occurring in the coastal forests of southern Kenya and Tanzania, on Zanzibar, the Rondo plateau (Bagger *et al.* 1990) and up to 900 m in the East Usambaras and Ulugurus.

Sharpe's Akalat ***Sheppardia sharpei*** was netted (two birds) at 950 m in dense ridge-top forest. This species is an Eastern Arc endemic, found from the Usambaras to the North Viphya region of Malawi. It has been suggested as a possible dominant competitor to Swynnerton's Forest Robin in the Uzungwa Mountains by Collar and Stuart (1985).

Little Yellow Flycatcher ***Erythrocercus holochlorus*** was common up to c.600 m and frequently found in mixed bird parties. Essentially a coastal forest species, it is found from Somalia to the Pugu Hills in Tanzania but also in the Shimba hills and the foothills of the East Usambaras, Ngurus and Ulugurus.

Chestnut-fronted Helmet Shrike ***Prionops scopifrons*** was seen on two dates at 400 m (probably the same group of 20+ within a mixed species flock). This is another lowland forest species, at its altitudinal limit here. It is found near the coast from the Tana River, Kenya to southern Mozambique and inland in central Kenya, the foothills of the East Usambaras and Ulugurus, and south-eastern Zimbabwe. One or two Green Wood Hoopoes *Phoeniculus purpureus* were seen associating with this flock. A similar association has been noted for *P. purpureus* and Retz's Helmet Shrike *Prionops retzii* (Williams and Arlott 1980).

Kenrick's Starling ***Poeoptera kenricki*** was common along the ridge-top (900-1100 m) where flocks of 20+ were regularly seen and one bird was netted. The species is known from Mt Kenya and the Nyambeni Mts, the mountains of northern Tanzania, the Usambaras, Ulugurus and the Njombe area in the Southern Highlands of Tanzania. According to Stuart, in Hamilton and Bensted-Smith (1989), these birds were at the extreme upper limit of their cold season (April-September) range.

Red-headed Bluebill ***Spermophaga ruficapilla*** was netted at 350 m, 550 m and 950 m (4 individuals). Like the Red-tailed Ant Thrush, this is chiefly a West African species, but with a very isolated and distinct East African sub-species *S. r. cana*, endemic to the East Usambaras. It is described as 'not common' here by Stuart and van der Willigen (1979). Newmark (1991) only caught 8 individuals in 60848 net-metre-hours near Amani (1.3 birds per 10,000 nmh compared to our figure of 5.7 birds per 10,000 nmh).

Rare and restricted species not recorded

i) Threatened Species

Collar and Stuart (1985) list four Threatened species for the East Usambaras that we did not record at Mtai. One of these, Dappled Mountain Robin *Modulatrix orostruthus,* has only been recorded elsewhere in the Usambaras at around 900 m and it is possible that there is not enough habitat at sufficient altitude for it to survive on Mt Mtai. However, van der Willigen and Lovett (1981) suggest it may occur down to 760 m in the Usambaras. Also, the species is known to be at very low density in the East Usambaras hence we may have overlooked it. Newmark (1991) only netted one individual in 60848 net-metre-hours near Amani, equivalent to 0.16 birds per 10,000 nmh.

Another threatened species, Tanzanian Mountain Weaver *Ploceus nicolli** , has not been seen in the East Usambaras since 1932 (Sclater and Moreau 1932) despite extensive searches (Stuart and Hutton 1978, and Stuart and van der Willigen 1979, Stuart 1983). It is distinctly possible that this species is extinct in the region, although it still occurs in the West Usambaras (and is also known from the Ulugurus and Uzungwas).

The absence of the other two threatened species, Amani Sunbird *Anthreptes pallidigaster* and Long-billed Apalis *Apalis moreaui*, is more difficult to explain. Amani Sunbird occurs up to 900 m elsewhere in the East Usambaras and also in the Sokoke forest on the coast of southern Kenya. It would be very surprising if it was not found at Mtai and we believe it may have been overlooked. Long-billed Apalis has been found around 900-1000 m at Amani and so, like Dappled Mountain Robin, there may be insufficient habitat at the required altitude for its existence on Mt Mtai. Alternatively, our nets may not have been placed in suitable habitat. This secretive species seems to inhabit dense undergrowth (Sclater and Moreau 1932) and vines, but not necessarily

* Treated as a sub-species of Olive-headed Golden Weaver P. ocularis by Britton (1980) but split by Stuart and van der Willigen (1978) and Collar and Stuart (1985)

within good-quality forest (Stuart and van der Willigen 1979). It is apparently a very difficult species to locate even when the call is known (Stuart and Hutton 1978).

ii) Near-threatened and Candidate Species

The near-threatened Southern Banded Snake Eagle *Circaetus fasciolatus* was not recorded although it is known from other parts or the East Usambaras. This species is sparsely scattered from Somalia to South Africa and is apparently nowhere common although found over a wide altitudinal range. Much of its distribution is based on single records. It is described as 'hard to locate and see' by Brown, Urban and Newman (1982) and may well have been overlooked on Mtai.

Kretschmer's Longbill *Macrosphenus kretschmeri* was described as common in the East Usambaras by Sclater and Moreau (1932) but three recent surveys all failed to locate it (Stuart and Hutton 1978, Stuart and van der Willigen 1979 and van der Willigen and Lovett 1981). They concluded that the species may have declined significantly in the area, however Newmark (1991) found the species in a forest fragment north-west of Amani and it is reported as not uncommon from 900-1000 m in the southern East Usambaras (A. Tye, in litt.). Its range extends from Mt Kilimanjaro and the Moshi area of northern Tanzania, to the Usambaras, the Kitovu forest of south-east Kenya, the Ngurus, Ulugurus, Pugu Hills, Uzungwas and northern Mozambique. It seems to be much more common in the West Usambaras (Turner 1978) and the Uzungwas (Stuart *et al.* 1987) than in the East Usambaras.

Two other noteworthy species, known from elsewhere in the East Usambaras, were not recorded at Mtai. Spot-throat *Modulatrix stictigula* is an Eastern Arc endemic which is only found above 900 m elsewhere in the range. White-starred Forest Robin *Pogonocichla stellata* has no such altitudinal limitation and considering it is found in almost all other forests in Eastern Tanzania it would be most peculiar if it were not present at Mtai. Both species were considered rare in the East Usambaras by Stuart and Hutton (1978), and Newmark (1991) netted only two *M. stictigula* and one *P. stellata* in 60848 net-metre-hours near Amani, so we may well have overlooked them.

iii) Other Lowland Forest Species

We were aware of the possibility of finding (at low altitude on Mt Mtai) some of the rare species otherwise known only from coastal forest patches in Kenya and Tanzania, e.g. Sokoke Pipit *Anthus sokokensis*, East Coast Akalat *Sheppardia gunningi sokoensis*, Clark's Weaver *Ploceus golandi* and Spotted Ground Thrush *Turdus fischeri fischeri* (N.E. and E.M. Baker, verbally) All eluded us, but since the latter two are known to be migratory to some extent, they may yet be found at Mtai or in the extensive unsurveyed lowland forests of the Usambaras. [Note: *S. gunningi* has been subsquently found, in 1992, breeding in lowland forest in the middle of the East Usambaras (Cambridge Tanzania Rainforest Survey 1992, in prep.).]

2.1.4.3 Ukaguru Mountains

Overview

The lower species total for this site and the relative completeness of our survey (as suggested by the species-discovery curves, Section 2.1.4.1) certainly suggest that the Ukaguru forests support a less diverse avifauna than the East Usambaras, Ulugurus or Uzungwas. They do, however, support more forest species than most of the Malawian mountain forests (Dowsett-Lemaire 1989) and so their avifauna can hardly be considered poor. The relative lack of species compared to neighbouring Tanzanian forests is partly the effect of higher altitude, but perhaps more important is the relatively low rainfall (1200 mm per annum, Stuart 1983), causing the forest to be scrubby with a

low, broken canopy and very few tall emergent trees. The lack of previous work in this area is emphasised by our total of 51 forest species, exceding that previously known (45, Stuart 1981), and including six new species. The most notable additions are three hornbill species (see Section 2.1.6), the others being Mountain Yellow Warbler *Chloropeta similis*, Redwing Starling *Onycognathus morio* and Slender-billed Chestnut-winged Starling *O. tenuirostris*.

Red Data Book Species

Iringa Ground Robin *Dryocichloides lowei* (Rare)
This species was observed and netted (6 birds) at 1850 m in late August. Birds were caught along the open road through the forest and observed feeding among herbs and low branches at the roadside. Relatively little is known about this species although it seems to tolerate some level of forest disturbance (van der Willigen and Lovett 1981). It was only known from the Southern Highlands of Tanzania (Njombe area and the Livingstone Mts) and the Uzungwas (Dabaga, Mufindi and Kigogo areas) until two birds were netted at 1800 m in the Ukagurus by N.E. and E.M. Baker in January, 1989, only a few hundred metres from our ringing sites 1 & 2. This species evidently prefers relatively dry montane forests and most records elsewhere are above 2000 m. None were caught or seen in the vicinity of our 1500 m ringing site. Stuart (1983) has suggested that competition may prevent the co-existence of this species and Sharpe's Akalat *Sheppardia sharpei*. We did not record *S. sharpei* in the Ukagurus.

Mrs. Moreau's Warbler *Bathmocercus winifredae* (Rare)
This species was netted at 1500 m (2 birds) and 1850 m (3 birds). It was also observed and heard in the field moderately frequently although we could not say that it was common here, as was the view of Stuart and van der Willigen (1979). The species was first discovered in the Ukagurus by Friedmann and Stager (1964) and is also known from the Ulugurus and, more recently, the Uzungwas (Stuart, Jensen and Brogger-Jensen 1987)

Moreau's Sunbird *Nectarinia moreaui* (near-threatened)
This was one of the commonest species we encountered around 1800 m and was also present at 1500 m. We netted 40 individuals and saw the species daily in the field, usually in the canopy or in bushes along the open road through the forest. *N. moreaui* is also known from the Ngurus, the Uvidundas and the eastern escarpment of the Uzungwas. The species is very closely related to Eastern Double Collared Sunbird *N. mediocris* (abundant in other high mountain forests of Tanzania) and Loveridge's Sunbird *N. loveridgei* (restricted to the Ulugurus, but common there), indeed Stuart and van der Willingen (1980) give much evidence to suggest it is a stable hybrid species between the other two. *N. moreaui* was originally described as a sub-species of *N. mediocris* and, indeed, it is due to be re-lumped in a current revision of the East African list (EANHS Ornithological Sub-committee, in prep, N.E. and E.M. Baker, verbally) and will hence lose its near-threatened status.

Forest-dependent species with limited distribution

All five species below are are listed as candidate species for Threatened or near-threatened status in Collar and Stuart (1985).

White-chested Alethe *Alethe fuelleborni* was fairly commonly netted (12 birds) from 1500-1850 m but very rarely seen, being such a secretive species. See Section 1.3 for notes on distribution.

Olive-flanked Ground Robin *Dryocichloides anomalus* was netted (2 birds) at 1800 m but was never seen in the field and was apparently rather rare at this site (as reported by Stuart and van der Willigen 1979). The species is found, usually above 1500 m, in the Eastern Arc forests from the Ukagurus south to Mulanje Mt, Malawi

and Namuli Mt, Mozambique, but there is also a very isolated population in Mbulu in northern Tanzania.

Spot-throat ***Modulatrix stictigula*** was netted at 1850 m (1 bird) and 1500 m (3 birds) but also never seen in the field. It certainly did not seem as common as suggested by Stuart and van der Willigen (1979). The species is an Eastern Arc Endemic, found from the Usambaras south to the Southern Highlands and Songea region of southern Tanzania and the Misuku Hills of Malawi.

Red-capped Forest Warbler ***Orthotomus metopias*** was recorded fairly frequently from 1500-1850 m. Several were seen, usually in dense undergrowth, and 8 birds were netted. This species is another almost completely endemic to the Eastern Arc. It is known from the Usambaras, Ngurus, Ukagurus, Ulugurus, Uzungwas, the Songea region of south-western Tanzania and the Unangu area of Mozambique, usually only above 900 m.

Fülleborn's Black Boubou ***Laniarius fuelleborni***, another Eastern Arc endemic, was found to be fairly common at our sites with 7 birds netted and several seen in the field from 1500-1850 m. Like Red-capped Forest Warbler, it is strictly a montane species, reaching its lowest altitude in the Ulugurus (900 m). Stuart and van der Willigen (1979) found it apparently capable of surviving in agricultural and secondary habitats as well as forest. Its range extends from the West Usambaras to the South Viphya Region of Malawi.

Rare and restricted species not recorded

Southern Banded Snake Eagle *Circaetus fasciolatus* (near-threatened) was the only rare or restricted forest species previously recorded from the Ukagurus (Stuart and van der Willigen 1979) that we did not locate. As mentioned in Section 2.1.4.2.3, the species is apparently sparsely scattered at low density and could easily have been missed.

We considered it possible that Dappled Mountain Robin *Modulatrix orostrothus* might occur in the Ukagurus as it is known from the Uzungwas to the south and the Usambaras to the north. We found no sign of this species, however its close relative, Spot-throat *M. stictigula*, was found. The possibility of competitive exclusion preventing co-existence of these two species was suggested by Stuart (1981b). However Stuart et al. (1987) found them to be sympatric over an altitudinal range of 300 m at Mwanihana in the Uzungwas. Moreover, Jensen found exactly the same situation at Chita, also in the Uzungwas, where the two species are both reasonably common (Collar and Stuart 1985).

2.1.4.4 Breeding records for the two sites

Our fieldwork was conducted late in the dry season, so few birds were expected to be breeding (Brown and Britton 1980). All records of display, nest-building or parental care of young birds are given below.

Crowned Eagle *Stephanoaetus coronatus*
One bird was observed displaying on three dates in July, at 1000 m on Mt Mtai however the species has been reported displaying year-round at Amani (A. Tye, in litt.)

Livingstone's Turaco *Tuaraco livingstonii*
A pair was observed in courtship-display at 1850 m in early September in the Ukagurus. The pair faced each other while standing on a horizontal branch, bowed to each other and appeared to exchange a food item (see Plate 2). Fry, Keith and Urban (1988) state that courtship feeding is by regurgitation, but it was not clear whether this was the case here.

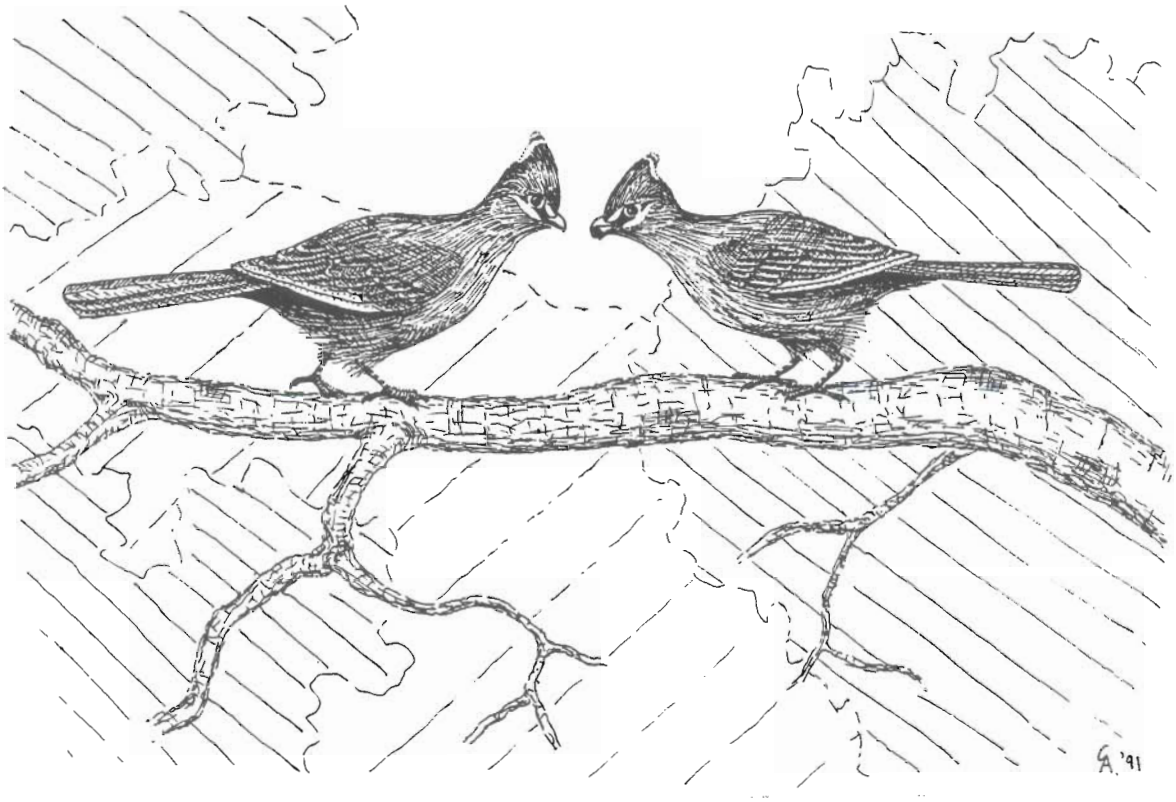


Plate 2. Livingstone's Turacos courtship feeding.

Black Rough-wing *Psalidoprocne pristoptera*
Many dependent juveniles were seen along the ridge-top (at 900-1000 m) at Mtai in late July and early August.

White-eyed Slaty Flycatcher *Melaenornis chocolatina.*
One pair observed nest-building in bushes by a road at 1800 m in the Ukagurus in late August.

Moreau's Sunbird *Nectarinia moreaui*
Several birds were seen nest-building from 1600-1800 m in the Ukagurus in late August and early September. One female was observed using the 'silk' from an ants' nest (a ball of woven and glued leaves suspended from a branch) for her own nest construction. Birds with large brood patches were caught at the same time (see below), as well as one recently fledged juvenile. (See Evans and Anderson, in prep.)

Peter's Twinspot *Hypargos niveoguttatus*
Three males were seen displaying to one female at 350 m on Mt Mtai on 22nd July. All the birds were on the ground, the males hopping around, fanning their wings and calling, reminiscent of the display of male House Sparrows *Passer domesticus.*

In addition to these sight records, birds in the hand were scored on a 0-5 scale for brood patch (0 = no brood patch, 5 = very extensive) as detailed in Baker (1989). An enlarged and vascularised brood patch (scoring 4 or 5) may indicate a bird has eggs in the nest and is incubating. Birds caught with this feature are listed in Appendix 1.1.

2.1.4.5 Ringing Report

Ringing sites and capture rates

Appendix 1.2 summarises the netting operation. Appendix 1.3 indicates the number of individuals of each species we ringed in each forest. Appendix 1.5 gives the capture rate of each species per 10,000 net-metre-hours allowing better comparison betwen the two study areas.

Retraps

None of the birds we ringed and recaught had moved to different sites, except between Ukaguru 1 and Ukaguru 2, which were only 100 m apart. Seven birds from 1 were subsequently caught at 2. These were :

Olive Mountain Greenbul - 2
White-chested Alethe - 1
Moreau's Sunbird - 2
Olive Sunbird - 1
Red-faced Crimson-wing - 1

Three individuals caught at Ukaguru 1 on 25th August had been ringed 18 months earlier in January 1989 by N.E. and E.M. Baker at a site c. 400 m away, at the same altitude in the same valley. These were Scaly-throated Honeyguide, Shelley's Greenbul and Olive Sunbird.

2.2 AMPHIBIANS AND REPTILES

by S.A. Akker and R.C. Highstead

2.2.1 Summary

At each site detailed observations of behaviour and habitat were made, along with numerous sound recordings. Both specimens and colour photographs were taken.

Fourteen forest amphibians were recorded on Mount Mtai, three of them new to the Usambaras. Nine of these are entirely endemic to the Eastern Arc. We also found 3 chamaeleon species and a number of other reptiles. The latter remain largely unidentified, but included one species definitely new to the Usambaras.

Nine forest amphibians were recorded in the Ukagurus, including one, *Nectophrynoides minutus*, previously known only from its type locality. Two chamaeleon species were found, of which *Rhampholoen* nr *platyceps* was also previously known from just one specimen. A few other reptiles were also identified. Many species were more common in, or wholly restricted to, the small area of forest below 1650 m, which is therefore of particular conservation importance.

It is noted that recent work in the Ukagurus and Ngurus is extending the known ranges of several species previously thought to be near-endemics to the Usambara, Uluguru or Uzungwa Mountains. The significance of this for conservation planning is discussed. An updated distribution table for the Eastern Arc frogs and toads is presented.

2.2.2 Previous Research

Collecting expeditions to the Usambaras have been made by Reichenow (1887) and Matschie (1892) and by Barbour and Loveridge (1928). The latter study resulted in species descriptions for all the species known at the time. In 1957, after further collecting, 'The Checklist of the Reptiles and Amphibians of East Africa' was produced by Loveridge and this gives the names and distributions and the discoverers of the species. In 1975 Schiotz published 'The Treefrogs of Eastern Africa' which contains colour photographs and descriptions for the seven Usambara species.

The herpetofauna of the Ukagurus had never been reported on (K.M.H. Howell and J. Fanshawe, pers. comm.).

A new key to the reptiles of Tanzania (Broadley and Howell 1991) was available to us in draft form during our fieldwork in the Ukagurus.

2.2.3 Methods

2.2.3.1 Searching Techniques

Methods consisted of daytime and nightime searching. Amphibians were searched for during the day under rocks and logs, particularly by streams. Many were found in protected, moist leaf axils. Banana plant and *Dracaena* axils were particularly productive search sites. Hollow bamboo stems were also searched. Reptiles were searched for in sunny spots around noon. Fast reptiles such as *Holaspis* and skinks were caught using a nylon noose at the end of a stick which could be placed over their heads fairly easily. Chamaeleons were found by chance, by locals or by careful searching of likely sites; for *Chamaeleo* species these were low-lying bushes and branches and for pigmy chamaeleons leaf litter and shrubs by streams. Chamaeleons were generally easier to find at night when their silhouettes could be seen on branches

over streams. Amphibians were also easy to find at night when calling males or noisy movements gave away their locations. Where possible the calls were recorded, as indicated below by the call description. Copies of the recordings can be found at the UDSM, the BMNH and the British Library of Wildlife Sounds.

Amphibians were collected in plastic bags, identified and photographed before release the next night. Reptiles were collected in cloth bags for identification. Many of the amphibian identifications would not have been possible without the time and expertise of Dr Barry Clarke at the BMNH for which we are very grateful.

2.2.3.2 Collection of specimens

For species of amphibians and reptiles which proved difficult to identify, a specimen was killed in a chloroform killing jar and preserved in formalin with field notes attached. Amphibian specimens can be found in the BMNH and reptile specimens were left at UDSM where they remain to be identified.

2.2.4 Results

2.2.4.1 Mount Mtai Forest Reserve

Overview

The forest had never been visited by herpetologists before. Work in other forests, notably at Amani, shows that the Usambara mountains are a major centre of endemism. There are no less than 22 species of forest amphibian (not including caecilians) listed for the Usambaras; the species richness is comparable to that of the important West and Central African forests which are far more extensive. Four of the twelve genera and all the species on published lists are endemic to the Eastern Arc Forests (Schiotz 1981). We encountered fourteen species in Mtai (including one caecilian), three of which are not listed for the Usambara forests and two of which remain to be identified.

We expected the herpetofaunal list for Mtai to closely resemble that of other East Usambara forests; for *Leptopelis* the apparent absence of two of the four Usambara species surprised us - we did not encounter *L. parkeri* or *L. vermiculatus* yet we did find *L. flavomaculatus*, not previously listed for the Usambaras. This species has a fairly large range in lowland Tanzania and it may be that its presence has affected that of other *Leptopelis* species (see Distribution section). Only two adult specimens each of *L. flavomaculatus* and *L. barbouri* were found and we could easily have missed other species present at similarly low densities. However, *L. ulugurensis* was common.

Nectophrynoides tornieri, a viviparous toad listed on CITES Appendix I was abundant at all altitudes in Mtai. *Callulina kreffti*, a microhylid species, was common only at higher altitudes (above 900 m).

We had hoped to encounter *Hyperolius spinigularis* and *Afrixalus ulugurensis* as both species seem to have distinct differences between different Eastern Arc populations and possibly represent more than one species (B. Clarke pers. comm.). Despite much searching of banana plants only two specimens of *A. ulugurensis* were found.

Although we found 14 species of amphibian at Mtai, a high total for a single site, it is likely that work at a different time of year would reveal more species, for example *L. parkeri* and *L. vermiculatus*.

Forest Amphibians

Leptopelis ulugurensis (Barbour and Loveridge 1928)
- The most common *Leptopelis* in Mtai and a species we expected to find.

Distribution: Rainforests of the Usambara, Uluguru and Uzungwa Mts.
Description: The usual colour of this treefrog was brown yet specimens showed a remarkable range of colours including lime green, mustard yellow and turquoise blue (see photo in Schiotz 1975). Only a very few specimens had the random white fungus-like markings described by Schiotz (1975).
New colour and pattern notes: Some pale brown specimens were distinctly marked with banding on the arms and legs and a backward-pointing triangle on the head between the eyes. Some juveniles were similar and also had bright lemon-yellow markings. One adult had distinct yellow areas below the tympanum and around the rim of the jaw and yellow flecks on the throat. Another undescribed but distinctive feature of this treefrog is the blue-green eyelids vermiculated with black spots. The iris is brown.
Altitudinal variation: The species inhabits all the surviving Mtai forest but it was more frequently found in the highest areas of forest. Males were only heard calling at 1000 m but this could have been due to the drier conditions at lower altitudes in August.
Habits: Specimens were found during the day in shaded areas on open leaves. None were found in enclosed sites such as leaf axils. They were, however, extremely well camouflaged, being flattened and moulded to the leaf with limbs tucked close in to the body, thus resembling an amorphous lump. Their colour also matched that of the leaf on which they were sitting. The height at which they were most commonly encountered was at about 1.5 m above the ground. This was true during the day while the animals were resting and also at night when they were active .
Call: The call is a single, brief, subdued croak with long intervals between croaks. The males call on open leaves about 1-1.5 m above the ground. One damp night many calling males congregated in one small area on the ridgetop (900m), each male having a distinct territory.
Breeding: The males were found calling a long distance from the nearest stream. A pair were found several hundred metres from the nearest stream heading downhill in the early morning. It may be that the frogs pair up some distance from water and then make their cumbersome way to the nearest stream. Whether this is normal behaviour or not is unknown.

Leptopelis barbouri (Ahl 1929)
- Only two adult specimens and two froglets were found, all next to a stream at 350 m.

Distribution: Rainforests of the Usambaras and at Dabaga in the Uzungwa Mts.
Description: This species is normally translucent green although the shade can vary. Random white fungus-like spots were present on all individuals. Similar markings were found on the leaves of the trees upon which they were resting. The throat was turquoise blue and the belly translucent blue.
New colour notes: All four specimens had distinctive eyes; the iris was white with fine black vermiculations with a blood red band around the outer edge. This band was much broader than in the Uzungwa specimen photographed in Schiotz (1975). At night the iris became entirely red. The eyelids had a yellowish upper part and a pale green lower part.
Altitudinal variation: Despite the greater number of treefrogs found at higher altitudes we only found *L. barbouri* at 350 m.
Habits: Like *L. ulugurensis* these frogs spend the day resting on open leaves and were even better camouflaged. Both adult specimens were found at a height of about 1.5 m . The species seemed more agile than *L. ulugurensis*.

Leptopelis flavomaculatus (Gunther 1864).
- A large *Leptopelis* species. Only two specimens were found, both at night.

Distribution: Forests of coastal Kenya to eastern Zimbabwe and Mozambique. The species does not, however, appear on any of the species lists for the Eastern Arc forests. This could be explained by the higher altitudes of the other well-studied forests. We only found it at 350 m.
Description: The smaller specimen was earthy brown with darker hourglass-shaped markings on the body and an backwards-pointing triangle between the eyes. A clear white band was present at the rear. The second specimen was much larger, had distinct white lines running around the jaw, down the side of the body, arms and legs. The dorsum was mostly earthy brown but with a greenish tympanum and an ill-defined green stripe above the white line along the side of the body. The iris was golden yellow with black vermiculations and a black rim.
Habits: Both specimens were found at night, one was on the ground, the other jumped into SA's hand!

Afrixalus ulugurensis (Barbour and Loveridge 1928)

Distribution: Rainforests of the Usambara, Uluguru and Uzungwa Mts. and we also found it in the Ukaguru Mts. The call for the Usambara and the Uzungwa populations is distinctly different (Schiotz 1975).
Description: A small, very agile treefrog with white back speckled with brown and a brown stripe along the side of the body. When caught, these frogs turned brown. This colour change was never observed in the Ukaguru specimens.
Altitudinal variation: Only two specimens were found at 1000 m.
Habits: The two specimens were found together in the same outer leaf axil of a banana plant. Despite searches of over a hundred more banana plants, we found no more. See Ukaguru species list.

Nectophrynoides tornieri (Roux 1906)
- A small viviparous toad, on CITES Appendix I, which is very agile and highly arboreal, easily mistaken for a *Hyperolius* in its habits. It was the most common amphibian at Mtai during August.

Distribution: Rainforests of the Usambara, Uluguru and Rungwe Mts.
New colour notes: Whilst some specimens were plain earthy brown, others had lighter, paired dorsal markings. Some specimens had white flecks on their bellies and the irises were either silver or gold. Two particularly interesting specimens were found in the same banana leaf axil; both were pregnant females and had bright yellow markings on their sides and bellies.
Altitudinal variation: Common throughout the remaining forest of Mt Mtai although the highest density was found at the higher, wetter, altitudes at night.
Habits: During the day most specimens were found in damp leaf axils, particularly in banana plants and *Dracaena*, both of which were common by streams and in the damper areas of the forest. At night the males were found calling on leaves up to 1 m off the ground. More were heard to call on damp nights but the species was not restricted to areas close to streams. The species was never found on the ground.
Call: The call is a rapid "pink-pink" with a metallic quality. The males called on open leaves standing in an extraordinary position, with forelimbs and hindlimbs fully outstretched so that the body was raised well off the leaf (resembling a person doing press-ups).
Reproduction: Mating couples were never encountered but one pregnant female was kept until she gave birth to 18 fully mature froglets.

Callulina kreffti (Nieden 1910)
- A micro-hylid frog which was very common at higher altitudes; hundreds were heard whenever it rained on the ridgetop.

Distribution: Rainforests of the Usambara, Uluguru, Uzungwa and Nguru Mts. We also found it in the Ukagurus.
Description: This species was usually dark brown but could become lighter, revealing mottled markings on the dorsum. The iris is golden yellow.
New colour notes: One specimen had distinct red patches on its cheeks and dorsum, another had a uniform rusty red dorsum.
Altitudinal variation: The species was much more common at the higher altitudes on Mtai where more specimens were found and a greater number were heard calling.
Habits: During the day most specimens were found in the depths of leaf axils, in pools of water and in rotting logs. At night specimens were found climbing on low branches. These frogs not agile and moved extremely slowly with deliberate clasping movements. Why they were climbing is unknown but males were found calling from branches. When disturbed or handled the frogs swelled up greatly and exuded a sticky secretion which picked up the surrounding leaf litter; this later dried out and became brittle.
Call: The call is a rapid series of chirps of constant pitch but decreasing in frequency. Each series lasts 2-3 seconds. This was a most elusive frog; it took many nights to track down the source of this very distinct call, even when hundreds were calling. Individuals called on damp nights and were found sitting on banana plants or small trees about 1-1.5 m off the ground. The throat sac expanded to an incredible size during calling and it was very hard to determine the direction from which the sound was coming. The abundance of the species was realised whenever it rained at around 1000 m. Many individuals called in the grass, although these were impossible to find. This gives some support to reports of terrestrial/burrowing habits, although all individuals observed at night and found by day were well off the ground.

Probreviceps macrodactylus macrodactylus (Nieden 1926)

Distribution of *P. macrodactylus*: Rainforests of the Usambara, Uluguru and Rungwe Mountains.
Description: A very unusual microhylid with a velvety mustard-yellow back and lemon-yellow eyes.
Altitude: Only one specimen was found at 1100 m.
Habits: The specimen was found under a large log on damp ground. It secreted a sticky fluid when handled.

Phrynobatrachus acridoides (Cope 1867)
- Found by streams up to about 700 m.

Distribution: East Africa to Natal but not previously known from the Eastern Arc.
Description: The dorsum is a dark sandy brown with lightly banded limbs. The iris is golden yellow.

Arthroleptis affinis (Ahl 1939)
- An agile little frog found by fast flowing streams and on the forest floor.

Ditsribution: The rainforests of the Usambara and Uzungwa Mts.
Description: A variable dorsal colour with a dark line running from the nostrils to the shoulder. The undersides of the thighs are orange.

Arthroleptis stenodactylus (Pfeffer 1893)
- Juveniles were very common by all the fast flowing streams.

Distribution: Southern and eastern Zaire, Kenya, and south to Zimbabwe and Mozambique, but not found on Eastern Arc lists.
Description: Typical dark brown hourglass patterning on a fawn background. The irises are dark golden yellow.
Habits: Found in the open or under rocks or wood near streams.

Arthroleptides martiensenni (Nieden 1910)
- A large stream frog found near streams at 350 m.

Distribution: Rocky *montane* streams of the Usambara, Uluguru, Uzungwa and Magrotto Mts.
Description: Juveniles were most commonly encountered; they often had infestations of an orange parasite on their undersides (see specimen in BMNH). Some specimens had orange markings on their dorsum and banding on their legs. The species also has very square tips to its well developed toes; adults were found clinging to vertical rock faces.
Froglets: Froglets of this species were found in the mud and on rocks beside streams at 350 m. They had very long tails and well developed back legs, yet absolutely no sign of forelimbs. They were more than capable of avoiding predators such as ourselves!
Habits: Juveniles were often found at night sitting on leaves of small plants beside streams, about 30 cm off the ground.

Arthroleptis/Schoutedenella sp.
- An unidentified stream frog found by a stream around 650 m.

Bufo brauni (Nieden 1910)
- A large toad encountered regularly at night in a fast flowing stream on the lower slopes of Mt Mtai.

Distribution: The rainforests of the Usambara and Uluguru Mts.
Description: A toad with dark velvety markings with yellow outlines on a light fawn-brown background. It had banded legs and the irises are golden.
Altitudinal variation: All specimens were found in a stream beside camp at 350 m.
Habits: Rarely encountered during the day when they obviously remain well hidden.
Call: A loud, harsh and protracted croak.
Reproduction: The most popular calling site was the deepest pool of the stream which was also our bath; at dusk we would be joined by several dozen *B. brauni* males which appeared and called in unison, competing with the crash of water.

Caecilian sp.
- An unidentified species: Two juvenile specimens were found under rotting wood at 350 m and 950 m. They were identical, being completely pink and closely resembling earthworms.

Forest Chamaeleons

Bradypodion tenue (Chamaeleo tenuis).
- The Single Soft-horned Chamaeleon. Only one specimen was found of this strange CITES II species.

Distribution: Virgin rainforests of the Usambara Mts.
Description: A species with a large, single, soft horn with enlarged scales. Our specimen had the following measurements: Horn 3.5 mm, Snout to Vent 35 mm, Tail 43 mm.
Habits: Our specimen was found 1.5 m up a mist net pole in fairly open forest at 950 m. It was apparently a fairly good climber.

Rhampholeon brevicaudatus
- The Bearded Pigmy Chamaeleon. The species was relatively common at all altitudes in Mtai and was frequently found in pairs.

Distribution: Coastal Tanzania.
Description: A typical stump-tailed pigmy chamaeleon with a short, squat body, distinguished by the small tuft of scales under the throat.

Habits: This species can hardly climb at all. One specimen actually clambered onto a rock, lost balance and fell off the other side. We did however find one specimen about 15 cm off the ground on a branch by a stream. The species was normally seen crossing paths or spotted, whilst we were sitting still, moving very slowly with a swaying motion. The species was normally encountered in pairs. One of the pair often had a distinct dorsal crest and was paler in colour with dark lateral stripes.
Defence: As well as relying on colour camouflage this species went one step further on several occasions: on our approach the chamaeleon would lie flat against the ground or a rock and shrivel up its whole body, giving it the appearance of a dried leaf.

Rhampholeon temporalis
- The Pitted Pigmy Chamaeleon. Only one specimen was found.

Distribution: Virgin rainforests of the Usambaras.
Description: A pigmy chamaeleon without a beard but with a small flexible rostral appendage on the snout and spines on the palms. There were small white spines on the legs and arms and a dark line running down its side which remained constant during colour changes.
Habits: The specimen was found mid-afternoon on the ground at 850 m.

Other forest reptiles

Holaspis guentheri laevis
- The only gliding Lacertid in the world!

Distribution: The type locality of this sub-species is in the Usambara Mts. Its range is given as Tanzania, Malawi and Mozambique although it is only found at a few sites within this range (Arnold 1989).
Description: An extraordinary lizard which is extremely well camouflaged when resting on tree trunks but, when in the hand, is found to have two turquoise blue stripes running down the back which meet at the base of the tail and continues for the length of the tail. The rest of the dorsum is black with two outer yellow stripes. The sides and underside are orange-tinted. The most striking feature of the species is its amazing dorso-ventral flatness.
Altitudinal variation: Found in all sunny spots from the base of Mt Mtai (c.300 m altitude) to about 700 m. Its apparent absence at higher altitudes could have been due to difficulty in observing due to fewer open sunny areas and denser foliage, or a genuine absence due to duller, wetter and cooler conditions.
Habits: Many hours were spent observing this amazing lizard; they could be caught easily with a noose when close to the ground. Most of our observation sites were in natural or man-made tree-fall sites and the lizards could be studied on fallen logs a few feet off the ground only a couple of feet from the observer. There were seven regularly visited sites with fallen trees but only three sites where they were observed on standing trees alone (one of these was on a coconut palm in Maramba village). Presumably *Holaspis* stays closer to the sunny canopy in standing trees. It was, however, observed on standing trees by streams where the sunlight reached the tree base. Our sightings suggest *Holaspis* is not only associated with standing trees (Arnold 1989) but we agree that it rarely comes to the ground; only on one occasion did a specimen momentarily descend to the ground.
Activity: An extremely agile and fast lizard which appears to glide over smooth trunks quite effortlessly. It is just as agile running up or down a vertical trunk or even on the underside of fallen trunks. It is only active in sunlight and is quick to hide in a crack in the bark when the sun is obscured by cloud. Once active it intersperses short periods of hunting, covering large areas of foraging ground, with periods of basking, when it flattens itself against the bark forming a circle with its body and often raising its feet off the trunk (if on a horizontal surface).
Feeding: *Holaspis* fed by two principal methods; during the speedy active foraging periods *Holaspis* would cover large areas and would use its nose to nudge aside pieces

of loose bark, but it would also jump up to catch small flies. If on a vertical trunk it would cling on with its back legs and rapidly lift its front half of body off the trunk. It caught the flies with a quick flick of its tongue. It always avoided ants.
Interactions with other members of the species: One interesting observation is that we never encountered single *Holaspis*. Once one was observed it would not be long before a second was spotted.
Interactions with possible predators: Upon approach of large predators, such as ourselves, the lizards would race up the nearest tree trunk. On one occasion a skink approached a *Holaspis* foraging on a fallen log. In this instance the *Holaspis* froze, flattening itself against the log and relying on its camouflage rather than its greater speed.
Gliding: Many of our observation sites were on fallen trunks and were thus too low for flight, but at one site 3-4 *Holaspis* used three standing trees and one fallen trunk as a hunting area. These individuals took to the air quite readily when the sun appeared and they began hunting. They showed a remarkable ability in judging the angle and length of flight (see also Schiotz and Volsoe 1959) as seen from the precise landing sites - on several occasions they glided at a very steep angle and landed only centimetres away from the tree base, although they were quite capable of flight at shallower angles. We made measurements of three flights: (1) a flight of 2.5 m at an angle of descent of 55°, (2) a flight of 7.2 m at an angle of descent of 38° (3) a flight of 4.4 m at an angle of descent of 60°. When gliding, *Holaspis* makes use of its extremely flat body. It holds its head and front half of its body at a virtual right angle to the tree trunk, flattens its body and leaps. When viewed from underneath, the underside resembles a parachute with the outer edges curled round. Presumably it is by changing this "curl" and the flatness of its body that Holaspis can vary its flight angle. *Holaspis* always takes off with the head pointing down the trunk and lands with the head facing upwards, ready for a rapid ascent.

Gerrhasaurus major major
- A very large lizard not previously recorded for the Usambaras.

Habits: Two specimens were encoutered regularly at the same sites, at 350 m and 450 m. One specimen lived by the forest edge near camp; it was caught using a noose and measured 46 cm in length, the tail measuring 27 cm. They were found basking in the sun on rocky outcrops and would disappear into crevices when approached.

Non-forest species

Afrixalus fornasinii (Bianconi 1849)

Distribution: From coastal Kenya through eastern Tanzania to coastal South Africa.
Description: Our specimen was of the striped variety described by Schiotz (1975).
Habits: One specimen was caught in reeds by a stream at the base of Mt Mtai, near Maramba village.

Xenopus muelleri (Peters 1844)

Distribution: Savanna from Upper Volta south along East African coastal belt to South Africa.
Description: A totally aquatic clawed toad.
Habits: A single specimen was caught in a stream at the base of Mt Mtai.

Chamaeleo dilepis dilepis
- The Common Flap-necked Chamaeleon listed on CITES I. The locals found many specimens in the cultivated areas around Mtai forest.

2.2.4.2 Ukaguru Mountains

Overview

Compared with the forest of Mt Mtai we found far fewer amphibians for a given amount of time in the field. This difference in population density is most probably attributable to the higher altitude and lower temperatures. However, a total of nine species of amphibian were found in the forest and we believe more species would probably be found if the forest were visited in the rainy season. With no previous work done, *Leptopelis vermiculatus* was an unexpected find as it has previously been recorded only in the distant Usambara and Rungwe Mountains. It is thus likely that it could be found in the Nguru, Uluguru and the Uzungwa forests also.

We found another example of a difference between separate Eastern Arc populations: *Callulina kreffti* looks identical to the Mtai specimens but the call was noticeably different (see call descriptions), suggesting a possible necessity for taxonomic splitting.

Nectophrynoides minutus was a very exciting find as it is a CITES I species which has only been found on one previous occasion at 2200 m on Mt Uluguru. This toad was common above 1800 m (many calling) but was never heard or found below 1750 m. Only males were found.

Both species of chamaeleon recorded were also unexpected finds: *Chamaeleo werneri* is the Uzungwa Three-horned Chamaeleon and is known from that forest and the Ulugurus. It is listed on CITES Appendix II. It was common in the forest and villages up to a height of about 1800 m.

The *Rhampholeon* (Pygmy Chamaeleon) species was also a very exciting find as it is only known in Tanzania from a single specimen found at Bandwa in the Uluguru Mountains. The similar species found on Mulanje Mountain, Malawi is named *R. platyceps*. Thus our first specimen was the second of the (as yet un-named) Tanzanian species ever found. It was relatively common at an altitude of about 1450-1500 m but was never found above this height.

The Effect of Altitude

The remaining forest of the Ukagurus lies mostly above 1800 m, where the night time temperature in September was about 7°C. The temperature difference has created a distinct altitudinal variation in species distribution with a greater species diversity found in the very lowest block of forest, c.1450-1550 m. Five out of the nine amphibian species and both the chamaeleon species found here were encountered rarely or not at all at higher altitudes. High altitude and the associated low temperatures may explain the lack of certain species which are present in neighbouring forests. For instance, *Leptopelis ulugurensis* is found in the Usambaras, Ulugurus and the Uzungwas and would thus be expected in the Ngurus and the Ukagurus. Thus the urgency of forest conservation in the Ukagurus is higher than it first appears, since the imminent destruction of the remaining patches below 1550 m will result in the local extinction of several species of extremely restricted range, no matter how much higher altitude forest remains. Further work needs to be carried out at different times of the year to ascertain whether seasonal temperature and humidity changes affect the local distribution of species.

Forest Amphibians

Leptopelis vermiculatus (Boulenger 1909)
- A large and striking *Leptopelis* which was an unexpected find, as its closest known locality is the Rungwe Mountains.

Distribution: Previously found only in the Usambara and Rungwe Mountains; our find in the Ukagurus would suggest the species may well be present in the intervening ranges (Nguru, Uluguru and Uzungwa).
Description: It follows a distinct set of colour and pattern changes as it matures. All juveniles and young adults are bright green with black vermiculations, older adults begin to turn brown and a dark 'V' appears on the back. The ventrum is a pale blue-white in juveniles but pure white in adults. The eyes are golden.
Altitudinal variation: Only found in the lowest parts of the forest (1450-1500 m).
Habits: Only three specimens were detected during the day and these were young frogs hiding in hollow bamboo stems which had a pool of water in the base. All other specimens were found calling in groups at night. The height at which the males called was very variable, between 0.5 m and about 5 m off the ground. Where the adults hid during the day remained a mystery to us - perhaps they are more arboreal than most *Leptopelis*.
Call: The call is a single, strangled croak which is also quite subdued. This was the best mode of detection. At one site there were more than fifty males in one small area of saplings, all with very distinct territories.
Reproduction: The males congregated in trees above still pools next to fast flowing streams. Virtually nothing is known about *Leptopelis* breeding habits, but Schiotz (1975) writes that one West African species lays eggs in muddy holes that they dig by still pools. This seems a likely method of egg laying for *Leptopelis vermiculatus* as the streams are very fast flowing and the males call beside pools, not the actual streams. The males are highly territorial, if a neighbouring male moves over a border, he is immediately challenged with a territorial call (sounding like a gurgled purr). If not deterred, he is physically attacked; first with boxing fists and if this doesn't work, the frog leaps round and kicks out into the challenger's face. The fights continue until the loser is kicked off the branch. Only one very large female was found at one of these supposed breeding sites.

Afrixalus ulugurensis (Barbour and Loveridge 1928)
- This species, also found in Mtai, was one of the most common frogs encountered at lower altitudes in the Ukagurus.

For description and distribution see Mtai list.
New colour notes: Many specimens had orange toes, foot pads and inner thighs. The underside of the throat was pale to bright orange and much of the belly was often bright orange.
Altitudinal variation: Like most of the Ukaguru species there was clear altitudinal variation; the species was very common in the lowest block of forest (1400-1550 m) and whilst some specimens were found at 1850 m they were relatively rare. This presumably reflects the marked temperature difference between these altitudes.
Habits: Most specimens were found during the day; the commonest hiding place was leaf axils of both wild and cultivated banana plants where they were often found by the dozen, together with *Hyperolius puncticulatus*. The very central axil and those immediately surrounding it were the most popular, presumably as they collect water most effectively. Specimens were also encountered in banana plants within the mature pine plantation.
Breeding: Two froglets were found in early September; their dorsum was brown above and translucent with brown specks below. The underside was translucent also but the hands and feet were yellow.

Hyperolius puncticulatus (Pfeffer 1892)
- A common, bright orange treefrog - the young show great variation in pattern and colour.

Distribution: A wide distribution from coastal Kenya to South Africa and in Schiotz (1975) it is listed for most of the Eastern Arc forests although it does not appear on other published species lists.
Description: Adults are usually bright orange with a yellow eye-stripe bordered with black (c.f. northern population at Amani, Schiotz 1975). Juveniles are normally more creamy in colour with brown stripes, or spots, or both, but this is very variable. The feet of juveniles are orange. The irises are cream coloured.
Altitudinal variation: As with *A. ulugurensis, H. puncticulatus* is found more commonly in the lower band of forest and only the occasional individual was found above 1550 m.
Habits: Like *A. ulugurensis* they were mainly found in the central leaf axils of banana plants where several individuals were often found at a time. The species was also found in banana plants in the pine plantation.
Call: The call is a series of metallic clicks closely resembling a hammer hitting a nail. Males were heard calling from the higher leaves of banana plants bordering streams.

Hyperolius sp.
- One juvenile *Hyperolius* was found which was clearly a different species to *H. puncticulatus,* but is still unidentified.

Description: The dorsum was pale lime green with a cream dorsolateral line from the snout over the upper eyelid to the rear. The feet were yellow and the iris was golden.

Nectophrynoides minutus (Perret 1972)
- A very small member of this CITES I-listed genus which was only known from its type locality in the Uluguru Mts. Apparently a strictly high altitude species in the Ukagurus.

Distribution: Previously known only from the type locality on Mt Uluguru at 2200 m.
Description: This toads were earthy brown with a translucent belly which normally has white spotting. Hourglass markings were sometimes visible on the dorsum - these were orange-brown as were the lighter areas sometimes present between the eyes. The irises were bronze.
Altitudinal variation: All specimens were located by call and a distinct divide was observed at about 1850 m below which none were heard. Calls were heard, night and day, up to 2200 m, the highest area of Ukaguru forest.
Habits: Unlike *N. tornieri, N. minutus* cannot climb and was always found well camouflaged in the leaf litter of the forest floor. The only way to find them was by cupping ones hands over the noise being produced. No females were found.
Call: A series of drawn out croaks with short intervals between croaks. The result was a sound like a coin running over a comb.

Callulina kreffti (Nieden 1910)

For distribution and description see Mtai list.
Altitudinal variation: Specimens were only caught at 1450 m in banana plants but calls were heard up to 2200 m.
Call: The call is markedly different from that of the species at Mtai. The call consists of an inhaling wheeze closely followed by a shorter croak; these may be in pairs or in a series.

Arthroleptis reichei (Nieden 1910)
- A very common frog at lower altitudes.

Distribution: Previously known from the forests of the Poroto, Rungwe, Uluguru and Uzungwa Mts of Tanzania through to Malawi.
Description: Often dark brown/black although some specimens were lighter and had typical hourglass patterns dorsally. The eye had a distinctive brown bar going horizontally through the centre.
Altitudinal variation: This species was only found below 1450 m.
Habits: Found at night by streams or calling on the forest floor during rain-storms and during the day underneath rocks and wood.
Call: The call is a series of paired high pitched chirps in rapid succession. When it rained the whole forest became alive with this sound.
Breeding: Males called on the forest floor within 100 m or so of a small stream.

***Arthroleptis/Schoutedenella* sp.**
- A very common frog found at lower altitudes, particularly in the pine plantations. The specimen remains to be identified.

***Strongylopus fasciata* (*fuellebourni*?) (*Rana fasciata*)**
- Only one juvenile specimen was found in forest at 1850 m in an empty plastic mug!

Distribution: From South Africa through the uplands to Tanzania.
Description: A striking frog, the dorsum is creamy fawn with orange and brown stripes.

Caecilian sp.
- Three adult specimens were found, one under a huge rock at 1850 m and two which were found by local people at about 1450 m.

Description: All three had a purplish black dorsum with a pink underside and white under the tail. Two small white feelers were present. No sticky substance was secreted on handling, but the specimens seem to fit the description of *Scolemorphus vittatus* (Barbour and Loveridge 1927).

Forest Chamaeleons

Chamaeleo werneri
- The Uzungwa Three-horned Chamaeleon; many specimens could be found upon careful searching.

Distribution: Previously known from the rainforests of the Uzungwa and Uluguru Mts.
Description: A large, impressive chamaeleon listed on CITES II. The male has three horns and the female one. Many specimens showed red occipital flaps, perhaps used as a warning signal to would-be predators or rivals.
Altitudinal variation: The species was common in and around the lower areas of forest. One juvenile male was found as high as 1850 m near a stream.
Habits: During the day specimens were found on small bushes and trees in the forest and in open clearings. Some specimens were found in the pine plantation.
Defence: The standard threatening behaviour of this species towards other chamaeleons and ourselves was to puff out the neck, raise the occipital flaps, open the mouth wide and give a loud hiss. This posture gives the animal a prehistoric look and is highly effective - the local people believe the breath can kill and have great respect for the chamaeleons.

***Rhampholeon sp.* (near *platyceps*)**
- The Flat-headed Pygmy Chamaeleon. A total of six specimens were found.

Distribution: Only one specimen, from Bandwa in the Uluguru Mts, has previously been found. The most similar species to have been named is *Rhampholeon platyceps* known from Mt Mulanje in Malawi. Broadley and Howell (1991) describe the single specimen as "near *platyceps*", probably representing a different, new species. We hope our specimens will allow furthur taxonomic clarification.
Description: The first specimen found was bright orange although others were varying shades of brown. Some specimens had distinct dorsal crests.
Altitudinal variation: All the specimens we found were below 1550 m.
Habits: All specimens were found within 10 m of a stream - the first specimen was found on a banana plant about 30 cm. off the ground in the early morning, another specimen was found on a branch over a stream at night. The other four specimens were all found during the day by careful searching of the relatively dense weeds by the side of a stream; these specimens were all on the ground. The species is a very poor climber.

Other Forest Reptiles

Typhlops schegelli mucrosa
- A single specimen of this blind snake was found at 1500 m.

Description: This snake has pink and black blotches.

2.2.5 Note on Eastern Arc Endemism

Many of the 22 Usambara species were initially thought to be endemic to the Usambaras alone, however most species have now been found in other forests which have been less well studied. Whilst there are often small taxonomic differences between populations of the same species in different forests, particularly noticeable in the call (for example: *Afrixalus ulugurensis* in the Usambaras and the Uzungwa Mts. and *Callulina kreffti* in Mtai and the Ukagurus), it would appear that the Usambara and Uluguru Mts have the highest known species diversity largely because they are the best known forests. Our work in the Ukagurus revealed two species previously only found once in the Ulugurus (*Nectophrynoides minutus* and *Rhampholeon sp* near *platyceps*) and several unexpected species which are not listed for neighbouring Eastern Arc forests but are found in forests further afield. For example, *Leptopelis vermiculatus* has previously been found in the Usambaras and in the Rungwe Mts: intervening areas of montane forest include the Ngurus, Ulugurus, Ukagurus and the Uzungwas. Our discovery of the species in the Ukagurus would suggest that it is probably present in the other forests also. The same holds true for the reptiles. Recent unpublished work in the Nguru Mts by Dietmar Emmrich (pers. comm.) appears to further bear out this conclusion. More thorough surveys are also likely to reduce the levels of single-site endemicity among other groups. This will have an important bearing on the selection of conservation priorities in the Eastern Arc.

See Appendix 2 for distribution and habitat tables for the Eastern Arc as a whole and the two sites visited.

2.3 BUTTERFLIES

by N.J. Cordiero

2.3.1 Summary

Two studies were conducted simultaneously on the butterflies of Mt Mtai:
(a) The compilation of a species checklist, with notes on status, habitat, behaviour and altitudinal range.
(b) A stratification study of fruit-feeding nymphalids (Nymphalidae) and satyrids (Satyridae) in the forest canopy and understorey. No quantitative results from this study can yet be presented.

No previous butterfly records have been located for Mt Mtai. A total of 206 species were recorded and are represented by the following families with total numbers of species in each family in brackets: Lycaenidae (38), Hesperiidae (25), Papilionidae (13), Nymphalidae (69), Satyridae (8), Libytheidae (1), Acraeidae (20), Danaidae (5) and Pieridae (27). Three known taxa, (*Papilio rex, Tuxentius stempfferi* and *Neptis carcassoni*), a new species of *Celaenorrhinus* and probably a new race of *Euthecta cooksoni*, none previously recorded from the Usambaras, are now known from Mtai.

Compared to five other Eastern Arc mountains, the Usambaras have the greatest endemism. Twenty three taxa are listed as Usambara endemics and 8 of these were located at Mtai. A further 19 species which are restricted to less than six localities in Africa were recorded from Mtai. Seven taxa which are distributed mainly in West and Central Africa were also recorded from Mtai. Behavioural and ecological notes for over 30 taxa are presented.

The butterflies of the Ukaguru Mountains were not studied.

2.3.2 Previous Research and Objectives

The East and West Usambaras have been well-studied with regard to butterflies (Kielland 1990). The richness of species unveiled by early scientific exploration encouraged great interest in these mountain ranges. Collectors and/or taxonomists like T.H.E. Jackson (*vide*. van Someren 1952), Dr. A.H.B. Rydon (pers. comm.), I. Bampton (*vide*. van Someren 1975), S.C. Collins (*in litt.*) and J. Kielland (*in litt.*) have explored various parts of the Usambaras. Their contributions to the knowledge of butterflies in these mountain ranges include several new species and subspecies. Many other amateur and professional lepidopterists have also visited the area.

Collecting in the West Usambaras has been mainly limited to Lushoto-Magamba/Shume Forest (1700-2100 m), Mazumbai (1500 m) and Ambangulu (1100 m), whereas in the East, Amani (1000-1300 m) has been the most-studied area. Kielland (undated) records as many as 303 species for the Usambaras (but this includes some which are not forest-dependent).

The study described here is important because it covered forest ranging from 300-1060 m, whereas most previous biological research has concentrated on areas above 900 m, in the Amani area. I have not come across information on the butterflies of Mtai, although it is possible that lepidopterists have visited the mountain.

Two studies were simultaneously conducted on the butterflies of Mt Mtai:

(a) A compilation of a species checklist with notes on status, habitat, behaviour, and altitudinal range.

(b) A stratification study of fruit-feeding nymphalids and satyrids in the forest understorey and canopy.

The latter study is briefly described in this report and will be dealt with in a future paper (Cordeiro in prep.). In this report I present a full list of species collected during the study period with notes on features of special interest. The annotated list follows the systematic arrangement and updated taxonomy in Kielland (1990).

Two additional tables are given: (i) a summary of the distribution of restricted range species to demonstrate the conservation importance of Mt Mtai and the Usambaras as a whole in the context of other Afrotropical forests (Appendix 3.4) and, (ii) a list of Usambara endemics, comparing the West and East Usambaras and the Usambaras as a whole with five other 'Eastern Arc' blocks (Appendix 3.3).

2.3.3 Methods

2.3.3.1 Annotated Checklist of Species

This study took place from the beginning of July to mid August, 1990. Butterflies were collected opportunistically (with a telescoping-handle net and baited *Charaxes* traps) across a large portion of the mountain and the full range of altitudes (ie. 300-1060 m). Forest butterflies were targetted although species occurring at (i) the forest edge bordering the cultivated areas above Maramba and (ii) the enclaves, are also taken into account. About three weeks were spent surveying the lower forest from 300-800 m and two weeks in the wetter forest from 800 m to the summit (1061 m).

The following data were obtained for each species based on where it was caught or observed: (i) habitat - cultivation, grassy area, lowland forest, submontane forest, riverine vegetation, and forest margin; (ii) apparent abundance of the form - either rare, uncommon, common or very common; (iii) altitude; (iv) behaviour, for certain species only; (v) sex and (vi) date.

2.3.3.2 Stratification study on fruit-feeding forest butterflies

This experiment was an adaptation of de Vries (1988), who found differences in species present and the biometrics and patterning of individual species between canopy and understorey in a Costa Rican rainforest. It used *Charaxes* traps baited with fermenting banana to sample butterfly populations at understorey and canopy levels in four light-gaps.

2.3.3.3 Identification sources

Most of the common butterflies were identified in the field, however, specimens of the more difficult species were collected. Many were later identified using D'Abrera (1980) and Kielland (1990). However, the expertise of Jan Kielland was essential in determining the majority of difficult groups like the Lycaenids and Hesperiids.

2.3.4 Results

2.3.4.1 Mtai Forest Reserve Checklist

Species numbers and status

Appendix 3.1 lists the species found at Mtai. 206 species representing the following families were recorded, with the number of species in each family placed in brackets: Lycaenidae (38), Hesperiidae (25), Papilionidae (13), Nymphalidae (69), Satyridae (8), Libytheidae (1), Acraeidae (20), Danaidae (5) and Pieridae (27). [NB: Both species of *Baliochila* and *Papilio echerioides/P. fülleborni* are counted as single species due to unconfirmed identification]. Forty-five taxa are listed as uncommon or rare at Mtai (Appendix 3.1). Very local or rare species recorded such as *Hypolimnas antevorta, H. usambara* and *Apaturopsis cleochares*, are likely to become locally extinct if the current rate of "selective logging" continues in the lower forest. These species were recorded in lower forests only (i.e. below 650 m) and may be vulnerable to forest destruction in a direct or indirect manner. That is, for example, if their foodplants are negatively affected by such disturbance, then they too would inevitably suffer. The same situation can depicted for the new hesperiid (see below).

New localities and taxa

Five species (*Neptis carcassoni, Tuxentius stempfferi, Papilio rex, Euthecta cooksoni* ssp.? and *Celaenorrhinus* sp.) are recorded from the Usambaras for the first time (Appendices 3.1 & 3.4). The latter two are probably new to science (J. Kielland *in litt.*).

Altitudinal ranges of special interest

Of the 206 species in this study, 17 had altitudinal ranges which differed from those recorded by Kielland (1990) (Appendix 3.1). These are as follows: *Papilio echerioides/P. fülleborni, P. hornimani, P. rex, Mylothris kilimensis, Acraea conradti, A. pharsalus, Amauris albimaculata, Hypolimnas antevorta, Bebearia chriemhilda, Charaxes acuminatus, Ch. dilutus, Ch. pollux, Ch. usambarae, Epamera nolaensis, Uranothauma falkensteini, Coeliades chalybe* and *Chondrolepis niveicornis*.

Plate 3. *Graphium leonidas* at the summit of Mt Mtai.

2.3.4.2 New localities and taxa

Despite the monumental work of Kielland (1990), many areas in Tanzania require further research. As such places continue to attract interest, further information on species distribution and new taxa will come to light. After only 5 weeks of research at Mtai, we already see some advances in this direction as evidenced by the six following species [Note: *Charaxes baumanni* is mentioned in this section only to draw attention to the question of its subspecific status].

Papilio rex. In Tanzania this taxon is restricted mainly to the Northern Highlands (Mounta Meru, Kilimanjaro, Kwaraha, Ngorongoro, Mbulu, etc.); two isolated populations occur on the Uluguru and Nguru Mts (Kielland 1990). It is surprising that there are no previous records from the Usambaras, especially given the favourable montane forest habitats above 1400 m in the West Usambaras and at Mt Hundu (East Usambaras). Its foodplant, *Teclea* sp. (Rutaceae) (Kielland 1990), occurs in both the East and West Usambaras.

***Charaxes baumanni* ssp.?** Kielland (1990), in a comment on the taxonomic status of the Usambara population of *baumanni*, indicates that there is a sufficient difference to warrant subspecific status.

Neptis carcassoni. This species is known from forests in Mozambique, Malawi, Zambia and Tanzania (Kielland 1990). In Tanzania it is sparsely distributed (Appendix 3.4) and the record for Mtai extends its continental range northwards.

Euthecta cooksoni. Several specimens of this insect were taken mainly from the mid-stratum of forest. The Mtai population not only extends its range northwards (it was previously known only from Mozambique and Rondo Plateau in Lindi region) but could also represent a new race. J. Kielland (*in litt.*) noticed a difference in the genitalia of the single male specimen when he compared it with one from Rondo. He states that though there is a slight difference, more material is needed for examination and comparison before a decision can be made on its taxonomic status.

Tuxentius stempfferi. The distribution of this insect is so far restricted to a few areas of Tanzania (Appendix 3.4). It was collected in a forest glade on the east side of the mountain: this is a new species record for the Usambaras.

***Celaenorrhinus* sp.** Two specimens of this skipper, obtained at 350 m along a forest stream, basked in the sun and maintained territories on shrubs. According to J. Kielland (*in litt.*) the Mtai population belongs to the *sanjeensis-kimboza* group. This new taxon plus its closely related species, *C. sanjeensis* and *C. kimboza*, are all restricted to low-lying forest (250-800 m) (Kielland 1990). J. Kielland (*in litt.*) found marked differences in the genitalia of the Mtai insect when compared to the other two taxa and believes that it is a new species.

2.3.4.3 Usambara endemics

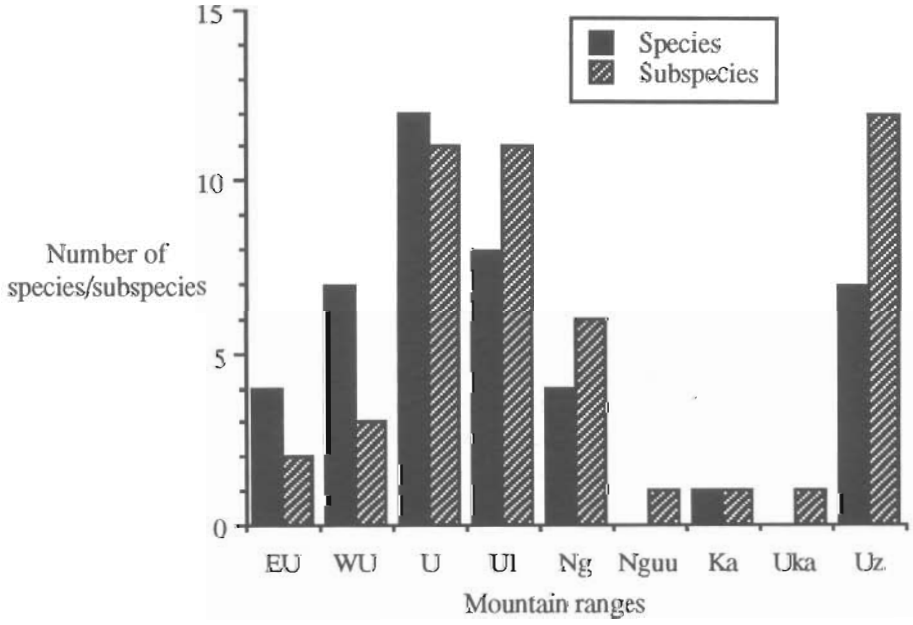
In this section, species are considered endemic if they are restricted to one locality only. The East and West Usambaras are often considered in their entirety as the Usambaras, thus Figure 2.3.1 summarizes this information. However, since these blocks contain separate butterfly faunas to some extent, endemism on both the East and West Usambaras has also been illustrated here.

In comparison to the six mountain ranges, the Usambaras have the highest number of endemic taxa, followed by the Ulugurus, Uzungwas, Ngurus, Kanga Mt, and the Nguu Mt and Ukagurus respectively (Fig. 2.3.1). This level of endemism is more remarkable when it is considered that some of these other ranges contain more species

in total than the Usambaras (Usambaras - 303, Ulugurus - 425, Uzungwas - 446, Kielland, undated). N.B. These figures include some non-forest species. Kielland (*in litt.*) postulates that five of the very rare Usambara endemics are likely to be in danger due to forest destruction (*Hypolimnas antevorta, Charaxes ansorgei rydoni, Acraea rohlfsi, Mimacraea gelinia* and *Spindasis collinsi*).

Although the Usambaras are important as a whole, when broken down into the East and West blocks, a different trend in the distribution of endemics is evident. The West Usambaras are richer in endemism (7 species, 3 subspecies) than the East Usambaras (4 species, 2 subspecies) (Appendix 3.3, Fig. 2.3.1) and the two ranges share 7 taxa (Appendix 3.3). Of the 7 Usambara endemics recorded at Mtai (Appendices 3.1 & 3.3) two are considered probable endemics as their subspecific status remains to be confirmed (see Section 2.3.4.2).

Figure 2.3.1 Comparison of endemic taxa on 7 mountain ranges, including the Usambaras.



Source: Kielland (1990) and this study.
Abreviations: EU = East Usambaras; WU = West Usambaras; U = Total Usambaras; Ul = Ulugurus; Ng = Ngurus; Nguu Mt; Ka = Kanga Mt, Uka = Ukagurus; Uz = Uzungwas.

2.3.4.4 Restricted range and predominantly West/Central African species

In this category, 23 species occurring in the Usambaras are listed (Appendix 3.4) on the basis of the following criteria: that they are found in less than six localities in Africa (eg. *Ceratrichia bonga*) or that they are predominantly West or Central African species with isolated populations in eastern Africa (eg. *Pseudacraea dolomena*). 19 species are restricted to six or less localites and 7 are predominantly West/Central African species.

Appendix 3.4 summarizes the East African taxa in this category, showing that 9 (39%) are recorded from the Mtai area. Of those not recorded at Mtai, 12 are considered likely to be present.

2.3.4.5 Altitudinal ranges of special interest

Every taxon discussed below differs in the altitudinal ranges from those in Kielland (1990). It is easier to document these differences than to identify the reasons why this might be so for each individual taxon. Butterflies are not influenced by altitude *per se*, rather, the effects of altitude on climate and vegetation are probably the determining factors.

The Massenerhebung effect, where vegetation zones are lower on smaller mountains or mountains close to the coast, may play an effective role in the altitudinal distribution of many of the species listed below. For example, the characteristic highland forest taxa like *Papilio rex, Charaxes usambarensis, Ch. dilutus, Ch. usambarensis* and *Chondrolepis niveicornis*, amongst others, were found considerably lower than recorded by Kielland (1990). Kielland's records refer to relatively larger mountains that are also further away from the coast than Mt Mtai. However, one cannot completely rule out inadequate coverage of much of Tanzania as a factor affecting the known altitude ranges of many of these butterfly species. For example, even though the East Usambaras has been well-surveyed biologically, most research has centred at Amani and, apparently less attention has been devoted to the East Usambara forests below 1000m.

Papilio echerioides/P. fülleborni. These species have been recorded from the Usambaras with altitudinal ranges of 1400-2200 m and 1000-2000 m respectively in Tanzania (Kielland 1990). At Mtai, specimens at, or above, 900 m were very rarely encountered flying along the forest floor. Overall appearance suggested that they represent one or both of the above species yet further investigation is needed to confirm which of the two (or both) occur at Mtai. However, the records at 900 m lower the known altitudinal limit for either taxon.

Papilio hornimani. A tailed black and blue swallowtail, observed from 350-1060m and relatively rare, is assumed to be of this species as no other butterfly of this description has been recorded in the Usambaras (D'Abrera 1980, Kielland 1990). This strong flier eluded the net on the few occasions that I encountered it. It mainly flew in the canopy and sometimes descended into clearings such as pit-saw sites.

Papilio rex. The low altitude of 900-1060 m is of interest as this species is usually restricted to elevations above 1400 m in Tanzania (Kielland 1990) (Appendix 3.1). I observed territorial males four times on the summit as they bouyantly circled canopy trees. A. Rydon (*in litt.*) observed similar behaviour on the crater rim of Lake Duluti, Arusha, where *P. rex* exploited the thermals.

Mylothris kilimensis. This slow-flying pierid occured above 850 m at the forest edge near the Handei enclave and in forest clearings along the ridge. Kielland (1990) records the altitudinal range as 900-2000 m, however the species has been recorded as low as 750 m in the Rau Forest, Moshi (*pers. obs.*).

Charaxes acuminatus usambarensis. Kielland (1990) records the Usambara race as occurring above 500 m: at Mtai it was fairly common from 300-500 m.

Charaxes dilutus amanica. I have observed this species in the Nguru Mts, only near streams or rivers and its flight and pale greenish-white colour make it unmistakeable in the field (in the absence of other pale green *Charaxes* of the same size). At Mtai, I only saw (what I assume to be) this species once as it patrolled a stream at 350 m. Kielland (1990) records its altitudinal range in Tanzania from 300-2100 m and also notes the male's characteristic river patrolling behaviour. Collins (1990), however, states that the East Usambara population is rare and has only been taken between 1000-1300 m at Amani. Hence this Mtai record lowers its altitudinal range considerably.

Ch. pollux mirabillis. Kielland (1990) records the altitudinal range of this nymphalid to be from 1200-2100m, wheareas at Mtai, it commonly ranged from 300-1060 m.

Charaxes usambarae. Only a single specimen was collected at 350 m, although it is recorded above 800 m (Kielland 1990). It was sucking moisture along a stream bed at about 0930 hrs. I saw another black male (with very long tails), maintaining a territory at the summit, which could possibly have been of the same species.

Antanartia dimorphica. Although abundant in most parts of its range, only a single specimen was taken at Mtai. Kielland (1990) records its Tanzanian altitudinal range as 1500-2700 m, although he has found it as low as 600 m on some mountains in the east of the country. The male was hill-topping at the summit (1060 m) and its rareness at Mtai might suggest its limitation to higher altitudes.

Hypolimnas antevorta. This Usambara endemic (D'Abrera 1980, Kielland 1990), is found at around 1000 m according to Kielland (1990), who also records it only from Amani area. This species was very abundant along a stream from 300-350 m, where it either rested in the shade of trees, sunned itself on large rocks or branches, or sucked at damp sand.

Amauris albimaculata hanningtoni. At Mtai, this taxon commonly flew from 450-1060 m (Appendix 3.1), 350 m below the limit given by Kielland (1990).

Acraea conradti. The nominate race of this forest *Acraea*, known from the Usambaras and Mt Meru, has an altitudinal range of 1000-1500 m (Kielland 1990). At Mtai *conradti* made its only appearance in a pit-saw clearing at 650 m that had been taken over by shrubs (*Vernonia* spp.) whose flowers it visited.

Acraea pharsalus pharsaloides. At Mtai, this species ranged from 300-1000 m, 300 m below that recorded by Kielland (1990) (Appendix 3.1).

Uranothauma falkensteini. Kielland (1990) records the Tanzanian altitudinal range of this species from 800-2200 m. A specimen collected at 350 m (Appendix 3.1) represents a considerable extension towards lower altitudes.

Coeliades chalybe, recorded from 300 m to the summit, differs from Kielland's (1990) lower limit of 700 m. This skipper flew in the early morning or evening hours and occasionally during cloudy periods.

Chondrolepis niveicornis. Kielland (1990) records the altitudinal range of this skipper as 800-2200 m, whereas at Mtai it ranged from 400-850 m. Individuals were often encountered in sun-lit spots where they maintained territories in the herbal layer. This taxon was especially abundant from 400-550 m.

2.3.4.6 Ecological and Behavioural Notes

Papilio pelodurus vesper. This large swallowtail was relatively common from 900-1060 m where it flew in the forest canopy. It was encountered hill-topping at the summit and sometimes three or four males would give chase around this peak. Such territorial behaviour was limited during cloudy conditions and at the sign of rain, when the butterflies would either rest in the canopy or find shelter in a small fern patch at the summit. On two occasions, a male *Pseudacraea boisduvali* joined in the territorial pursuit.

Dixeia spilleri. This conspicuous yellow pierid flew along stream beds (300-350 m) and visited flowers in glades (450 m). It was very abundant near streams, where it often settled on damp sand to suck moisture with other pierids and lycaenids.

Physcaeneura jacksoni. Above Maramba village this small white satyrid frequently occured in the cultivated grassy areas. It was also found within the Mtai Forest Reserve, inhabiting the grassy and cultivated zones of both the Handei and Mamba enclaves (c.800 m).

Euxanthe tiberius & E. wakefieldi. The former species was much less common than the latter at Mtai; only a single pair were collected at 350 m. *E. wakefieldi,* on the other hand, abundantly flew from 300-500 m in thick forest. It was also observed at 900 m where it maintained a territorial perch at the forest edge and was occasionally encountered flying over the summit.

Charaxes aubyni, Ch. baumanni, Ch. brutus, Ch. ethalion, Ch. pollux & Ch. protoclea. Males of all these species maintained territories at the summit, chasing each other around the trees when one intruded on another's territory.

Charaxes lasti & Ch. pleione. Both species were confined to the lower and drier forest from 300-450 m. The latter staked out territories on middle-storey trees, descending at mid-morning and midday hours to suck moisture along a stream bank.

Cymothoe amaniensis. This aggressive butterfly is highly territorial, occurring in the Usambaras from 900-1200 m (Kielland 1990). Males were observed at their summit territories, patrolling them constantly and pugnaciously pursuing intruding conspecifics. After removing a male, another moved in to take over the territory within a few minutes. At the perch, they rested with wings open during sunny conditions and closed them during cloudy periods. Minimum territorial activity was observed during cloudy conditions and when there was sunlight at least 4 males shared and patrolled an area of roughly 80 square metres. Rydon (*in litt.*) has observed similar behaviour in *C. teita, C. magambae* and *C. aurivillii.*

Euptera kinungnana. Like the above *Cymothoe*, this taxon is very territorial, staking out its territories in the mid-stratum and canopy. Both sexes sucked at moisture along a stream bed.

Bebearia orientis & B. chriemhilda. These related taxa were very common at Mtai, though due to their habitat differences were separated altitudinally. *B. orientis* inhabits the forest margins, cultivated areas and enclaves at Mtai, though it is commonest at 300 m and below where this habitat is extensive. At the Handei enclave (800 m) only a few specimens were seen. Fermenting jackfruit and sugarcane left by humans along the well-used path from the forest to Maramba village were well attended by *B. orientis*, often in the company of *Hamanumida daedalus, Euphaedra neophron* and *Bicyclus safitza.*

B. chriemhilda was present in the forest from 300-1060 m, being most abundant above 350 m where both species occurred in some numbers. This zone of overlap is probably suggestive that both species were at their marginal habitats. I often encountered males along the ridge as they sunned themselves, with their wings flat, in the herb layer.

Euphaedra neophron. This ground-dwelling nymphalid has a broad habitat range, from cultivation (with fruiting trees) to forest. The species was very abundant in the forest from 300-500 m and an increase in altitude steadily saw the numbers dropping. Although present near the summit (1000 m), it was rare there, compared to lower down, possibly being replaced by the abundant *B. chriemhilda.*

***Aterica galene* & *Catuna sikorana*.** These two ground-fliers were recorded from 300-1000 m and 300-900 m respectively (Appendix 3.1). The former was especially abundant from 300-550 m, where the latter was uncommon, and then almost replaced by the *Catuna* species from 550-750 m (where *A. galene* was uncommon). Above 750 m, both taxa were scarce, suggesting that they are probably confined to the lower, drier forests.

***Pseudacraea boisduvali*.** This species is a good mimic of large red *Acraea*. At Mtai, the presence of *A. egina* and *A. acara* which are similar in pattern, shape and size to *P. boisduvali* (especially *A. acara*) suggests that this mimic probably does attain protection from predators by its resemblance to these models. A single male possessed a territory at the summit at any given time, warding off intruders very aggressively. For more information, see notes on *Papilio pelodurus*.

***Pseudacraea dolomena*.** Males of this nymphalid are territorial, mainly selecting perches on middle story trees. This nymphalid flew in abundance from 300-400 m and less commonly up to 900 m, which was the highest elevation that it was observed, although Kielland (1990) records it up to 2000 m.

***Pseudacraea eurytus*.** Another mimic of the distasteful Acraeids, the distribution of this species coincided with that of its probable models *Bematistes adrasta, B. epaea* and *Acraea esebria*. It resembles the two *Bematistes* more than it does the *Acraea* in size, shape and pattern, but it probably obtains protective advantages from all three species.

Neptis aurivillii flew above 900 m in the wetter ridge-top forest. Males seemed to have a certain flight path that they used as they patrolled the ridge. One could often stand in the path and catch the specimen. To determine whether the path was the same for any one individual, I marked two specimens and released them. Two days later I twice caught a marked specimen along the same path where it was first caught. The other individual was not recaptured.

Hypolimnas usambara was seen once along a stream at 350 m. It basked in the sun, perching on shrubs, and when disturbed, it flew onto a tree trunk resting head-down. When further disturbed it flew away rapidly and erratically. Although Kielland (1990) states that this species is confined to primary forests, a single specimen from a garden at Nguvumali (outskirts of Tanga) in 1981 (pers. obs.) suggests that this species might also stray into lightly wooded areas. Its flight and pattern is similar to *H. dubius* (except for the red patch at the anal region of the hind wing) and not unlike their model *Amauris niavius* which they strongly resemble (except for the shape of their wings). At Nguvumali, both *Hypolimnas* species associated with a large number of their models and *A. ochlea* (Cordeiro 1988), suggesting that they were probably trying to obtain protection by confusing their predators in this vulnerable habitat.

***Bematistes epaea* & *B. quadricolor*.** Kielland (1990) places the Usambara population of *B. quadricolor* near ssp. *leptis*, and notes that it frequents summits where it defends its territories. About four males staked their territories on two trees (two per tree), all choosing different branches a few metres away from each other as favoured look-outs. When a male intruded into another's territory, both would begin chasing each other and in the chaos that ensued other territories that were trespassed on caused a foursome pursuit. All four would fly up vertically, 'tumbling' over each other until they finally chose to descend bouyantly to their perches. This species often fought with *B. epaea* which also maintained summit territories.

***Bicyclus campinus* & *B. dankelmanni*.** Both forest taxa occurred commonly at Mtai, the former from 300-1000 m and the latter 900-1060 m. It seemed that above 900 m, *B. campinus* became scarce and was apparently replaced by *B. dankelmani*.

Eurytela dryope and ***E. hiarbas*** were separated on an altitudinal basis, the former being very common below 900 m where *E. hiarbas* was scarce, and the latter dominating the wetter forest (above 850 m) where *E. dryope* was uncommon.

Alaena nyassa. A single specimen was taken at the forest edge in thick grass along a rocky outcrop.

Thermoniphas micylus & Oboronia bueronica. These taxa appeared to be separated on an altitudinal basis. *O. bueronica* was common from 300-650 m where *T. micylus* was less common, and the latter was very abundant from 600-850 m where the former was uncommon.

2.3.5 Discussion

2.3.5.1 The influence of season on species numbers and status

This study was mainly restricted to part of July and August, a relatively cold and dry season in the E. Usambaras (Moreau 1935, Hamilton and Benstead-Smith 1989). Thus, species numbers could possibly have been affected by this, since rainfall and temperature are factors that affect seasonality in butterflies (Owen & Chanter 1972, Owen 1977). Owen (1971) found that the populations of various butterfly families demonstrated seasonal fluctuations in Sierra Leone. He attributes this to the ecological requirements of any one group of species: e.g. abundance of larval foodplant, availability of food sources for adults. For example, he suggests that *Graphium policenes*, which breeds in the dry season, delays pupation until the end of the wet season, probably because of the lack of sufficient flowering plants for adults to feed on during the rainy season. Also, data on status speak only for the study period and thus might be biassed by the season. Since the data is based on the abundance of adult butterflies, species noted as rare or uncommon could possibly have been very common in the larval or pupal stage. It must be noted however, that species like *Charaxes dilutus amanica, Ch. usambarae, Apaturopsis cleochares, Hypolimnas usambara* and *Celaenorrhinus* sp., are relatively rare or uncommon throughout their range (Collins 1990, Kielland 1990, pers. obs.).

In Appendix 3.1, the numbers of Acraeidae, Hesperiidae and Lycaenidae represent a small proportion of the species-rich East Usambara fauna. For example, four common forest acraeids (*Bematistes aganice, Acraea petraea, A. sotikensis* and *A. zonata*) known from the Usambaras (Kielland 1990) were not recorded at Mtai despite the fact that their known altitudinal ranges coincided with those at Mtai (see Appendix 3.5). Kielland (1990) provides an explanation for the apparent absence of another *Acraea* known from the Usambaras; he notes that, in Tanzania, *A. pentapolis epidica* flies mainly from September-October and Febuary-March, that is, not during the Mtai study period. Further examples of common forest butterflies not recorded at Mtai are listed in Appendix 3.5.

If we assume that Owen's (1971) data from Sierra Leone can be applied to Mtai, as both sites are characterized by distinct wet and dry seasons, we can see that the low numbers of species in the Hesperiidae and Pieridae might be due to the season. Owen (1979) found that skippers, satyrids, acraeids and pierids were especially abundant in the wet season: skippers, acraeids and pierids might have been more abundant in the larval or pupal stage during the study period. Satyrids, on the other hand, although well-represented, would probably have flown in greater numbers during the wet season. Nymphalids and swallowtails were also well-collected groups, probably because of their conspicuousness, territorial behaviour, and habits of feeding near ground-level at damp mud, fermenting fruits and sap.

2.3.5.2 Endemism in the Usambaras

In comparison with the six other 'Eastern Arc' mountains in Tanzania, the Usambaras are highest in endemism and are closest to the Ulugurus in this respect (Fig. 2.3.1). The situation of the Uzungwas is interesting since three endemic species and one race are confined to the *Brachystegia* woodlands on the Madibira Hills. Thus, the Uzungwas endemics are fewer if only forest-dependent species were to be counted. The other four ranges are poor in endemic butterflies. [It is important to note, however, that the Ulugurus and Usambaras are two of the best-collected areas in Tanzania (Kielland 1990), and that more taxa probably await discovery on the other mountains]. Moreau (1952) demonstrates that the Usambara and Uluguru ranges are much older than the Nguru and Ukaguru Mts: may be one reason behind the high endemism. Stuart (1981) supports this theory with evidence provided from the avifauna. He shows that the Ulugurus and Usambaras not only share a majority of their fauna, but that they have a high species diversity and the highest number of endemics when compared to the the Nguru and Ukaguru Mts. The pattern of endemism shown in Figure 3.2.1 support this result.

With regard to the differences in endemism between the West and East Usambaras (Fig. 2.3.1, Appendix 3.3), it appears that altitude [i.e. 300-1300 m in the East (except Mt Hundu at 1500 m) and 1200-2200 m in the West (Stuart 1981)] may be a key factor. Most of the East Usambara endemics are found below 1000 m, in lowland and intermediate forest, and those of the West above 1700 m, in montane forest (except *Acraea rohlfsi*) (Appendix 3.3). The seven taxa shared by both blocks are found in the zone of altitudinal overlap (Appendix 3.3). This variation, dependent on forest type, may well reflect the distribution of suitable foodplants.

At Mtai, six Usambara endemics of an expected ten were recorded. [*Aphysoneura pigmentaria* was not expected as its distribution is restricted by its foodplant, montane bamboo (Kielland 1990), of which there is none at Mtai]. The remaining four (Appendix 3.3), *Parnara guttana*, *Baliochila pringley* , *Mimacrea gelinia* and *Charaxes ansorgei* may well be present. At least one new taxon has been added onto the list of Usambara endemics with two others yet to be determined (see Section 2.3.4.2). That this number of endemics occur on Mtai alone demonstrates the importance of this mountain in relation to the rest of East Usambaras.

2.3.5.3 Restricted range and predominantly West/Central African species

Alongside the high numbers of endemics found at Mtai, about 39% of the restricted range and predominantly West/Central African species known from East Africa inhabited the Mtai area. Should Mtai be revisited in the future, Appendix 3.4 indicates that 12 more species may be present, as Mtai has suitable habitats within the usual altitudinal range of these species. They may have been overlooked due to low densities or preference for a different time of year. Another four taxa are unlikely to occur in the East Usambaras as they seem to require montane forest conditions above 1700 m, which are only available in the West Usambaras (Appendix 3.4).

2.4 FISHES
by A.L. Moody

2.4.1 Summary

The head waters of the Msimbasi stream were surveyed close to the village of Maramba. A species list for the area was produced and human usage of the stream was examined. The interactions between the native and introduced species were examined in relation to man-made perturbations. Feeding and reproductive ecology were investigated in individual species. A trophic spectrum and simplified food web were constructed.

2.4.2 Objectives

One original aim was to produce a species list for the previously unsurveyed Msimbasi river and assess its ichthyological similarity to the adjacent Umba and Sigi rivers, for which species lists have been produced (Bernacsek 1980).

This study was to be secondary to a comparison of the fish faunas in the Mkulu tributary and the Msimbasi itself. These two streams originate in very different parts of the Mtai mountain block. The Msimbasi drains the southern slopes, near Mtai peak, which are covered largely in intact primary moist forest, whereas the Mkulu drains the more accessible north-east side which is scrubbier, secondary exploited forest. Unfortunately, as a result of the timing of the study, the numerous streams shown on maps around the Mkulu were either reduced to a trickle or entirely missing. Thus, a comparison with the Mkulu was unfeasible.

The aims were then changed to a limited study of the ecology of the fishes themselves by investigating feeding relationships and reproductive states of specimens captured. Variation in species composition at different sites was examined as the river flowed through the village of Maramba.

2.4.3 Methods

2.4.3.1 Techniques

Electrofishing is usually the most efficient and unbiassed way of catching fish in shallow streams (HMSO Books 1988) and was thus employed here, using equipment kindly loaned by the Water Research Council.

Details of electrofishing technique may be found elsewhere (HMSO Books 1988 and Hartley 1975) but a brief summary is given here:
A 12 V car battery is plugged into the electrofishing unit which transforms the input into a pulsed D.C. output of 300 V of controllable current. The cathode from the unit ends in a plate electrode which is placed upstream. A metal rimmed net, with an on/off switch allowing the operator to control the circuit, forms the anode. It is placed as far downstream of the plate electrode as the length of cable permits.

When current is allowed to flow between the two electrodes fish caught between the electrodes swim towards the net anode by the phenomenon of electrotaxis and are caught by the operator. The fish are slightly stunned by the electric field as they get closer to the net making them easier to catch. The entire run is fished by moving upstream, sweeping the net from side to side, towards the cathode. The whole procedure requires the assistance of several people to receive fish from the net, to transfer them to the holding vessel on the bank and ensure the cables do not snag on

vegetation. It is essential that the fishers be insulated from the water, and hence the wearing of waders is necessary to avoid electrocution.

Standard lengths of 50 m of stream were fished were sampled. At either end of the sampling length, block nets of 6 mm mesh were placed to prevent migration into and out of the sampling area. By placing block nets and analysing the numbers of fish caught in multisequential fishing runs of equal effort, quantitative sampling should have been possible enabling population estimates to be made. Difficulties with battery failure and placing of block nets prevented such study.

The fish caught were killed by immersion in a solution of lethally concentrated fish anaesthetic; benzocaine. Field preservation of the specimens was in approx. 8% formaldehyde. On return to the lab they were transferred to a 1% aqueous solution of propylene phenoxetol.

2.4.3.2 Assessing reproductive state

Gonad state was assessed using a scheme adapted from (Nikolsky 1963) in which:

I Immature, gonads very small; virgin fish not yet reproducing.
II Gonads small, eggs indistinguishable; maturing, virgin or resting spent fish.
III Gonads occupying about half of abdominal cavity, eggs visible to the naked eye; maturing fish.
IV Gonads at maximum size, more or less filling abdominal space; mature or ripe fish.
V Gametes extruded with slight pressure; spawning fish.

Groups IV and V were not separated due to difficulties involved in assessing preserved material.

2.4.3.3 Diet

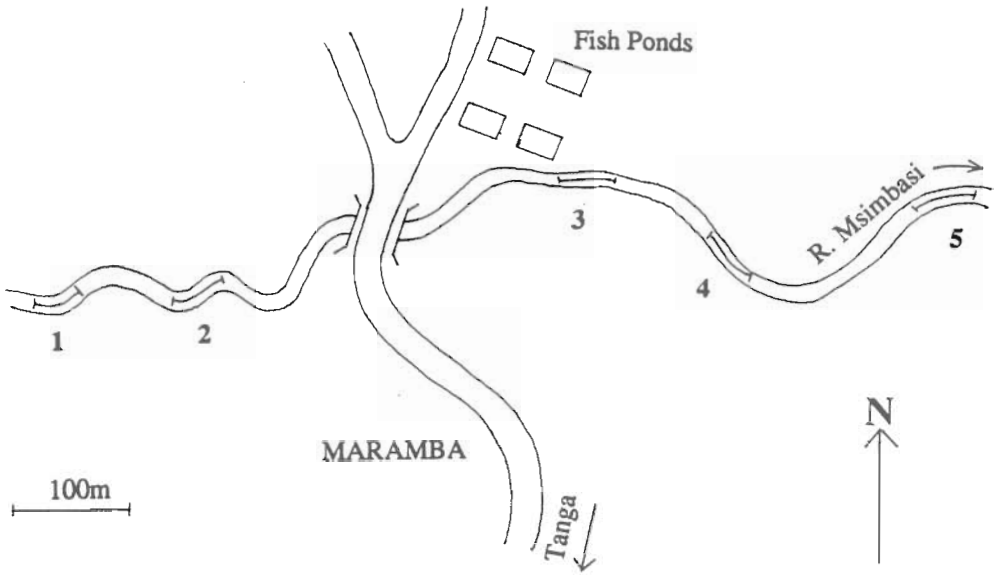
The diet of the fish was investigated by gut analysis. Contents of preserved specimens' guts were identified and then the number of guts in which each food item occurred was recorded and expressed as a percentage of the total number of guts containing food. An indication of the relative abundance of different foods in individual guts was obtained by visual estimation.

2.4.3.4 Study Sites

The Msimbasi river drains the eastern side of Mt Mtai. The river rises at the southern end of Mtai and is joined by its tributaries the Mkulu and Sega, which drain the northern part of the block, about four kilometres east of Maramba.

The Msimbasi flows for 25 km east, largely through savannah, before entering the sea at Mtubwani, 15 km north of Tanga, Tanzania's second largest city. By Tanzanian standards this water is very small: it is flanked by two larger rivers; the Sigi to the south and the Umba to the north.

The study area was centred on the village of Maramba. Five sample sites were chosen up to one km up or downstream of the main road through Maramba (see Map 6). It proved impossible to sample the river further away from the village than this due to the density of vegetation and weight of fishing equipment. As a result of this all the collecting sites experienced regular human activity to differing degrees prior to sampling.



Map 6. Electrofishing sites on the Msimbasi at Maramba.

The village of Maramba has a population of around 5000. This population is most densely concentrated close to the road slightly south of the Msimbasi, although people live up to 1 km from the road, to the limit of the sampling sites and over 1 km north of the river. Many villagers use the stream in the course of their everyday lives. Activities include the digging of sand from the stream bed, for use in house building, and irrigation of rice fields. Some villagers fish for the catfish, *Clarius mossambicus*, in the stream to supplement the tilapia farmed in ponds.

Drinking water is piped to the village via stand pipes from a stream high on Mtai mountain. Most washing (of people and clothes) is carried out in the Msimbasi itself. Such activity may affect the stream's ecology. The stream probably constitutes a health hazard to the villagers since it is said to harbour the bilharzia parasite and because human faeces were regularly seen in the water while fishing.

The stream at the sites of sampling rarely had any habitation within 50 m of it, due to the risk of flooding in the wet season. Instead this area was given over to small areas of plantation of banana, cocoa and coconut. The river banks were steep (about 1.3 m high) and heavily vegetated with grasses, ferns and pipers.

The actual stream itself has a very fine sandy/silt substrate. No macrophytes grow in the stream, but shelter is provided in it by rotting palm leaves and bankside roots. The turbidity of the water appeared to be low.

Stream Statistics

Width:	Mean 2.00 m
	Range 1.70-2.60 m

Depth (at deepest part of stream): 20-50 cm

Current Velocity: 0.3 m/s

Water temperature (at 1000 hours):	23.2-24.2°C
pH:	7.7
Nitrite:	0.05 mg/l
Nitrate:	<10 mg/l
Ammonia:	0.1-0.2 mg/l
Total hardness:	280 ppm 18 dH
Carbonate hardness:	260 ppm 17 dH

2.4.4 Results

2.4.4.1 Systematic List

The following nine species were encountered in the length of sampled river.

Family	Species
Cyprinidae	*Barbus lineomaculatus* (Boulenger) *Barbus amphigramma* (Boulenger) *Barbus paludinosus* (Peters) *Garra dembeensis* (Ruppell)
Amphiliidae	*Amphilius uranoscopus* (Boulenger)
Clariidae	*Clarius mossambicus* (Peters)
Cichlidae	*Oreochromis niloticus* (Linnaeus) *Oreochromis esculentus* (Graham)
Poeciliidae	*Poecilia reticulata* (Linnaeus)

Several species of freshwater crab, freshwater shrimp, dragonfly nymph and frog were also recorded and collected.

The list recorded is small for a tropical stream. The East African fish fauna (excluding the Rift Valley lakes) is very poor (Roberts 1975). The species list compiled is undoubtedly incomplete for the river as a whole with families such as Characidae, Bagridae and Mochokidae unrecorded at the sampling area but expected to be present where the river widens and slows in its lower reaches.

The *Oreochromis* and *Poecilia* species recorded in the list are not native species to the Msimbasi. *Oreochromis* was brought to the Maramba area from Mombassa by fish farmers. In the fish ponds close to the stream these tilapia are bred by the farmers and the juveniles then sold to local villagers for rearing in their own ponds for food. Periodically the stream and ponds flood resulting in the escape of the tilapia into the river. *Poecilia*, the guppy, is well known as an aquarium fish. How this species was introduced into the Msimbasi was impossible to ascertain, but in other areas they have been purposely added to waters to eat mosquito larvae in an attempt to prevent malaria. Careless disposal of infected aquarium guppies may account for its occurrence in some areas.

2.4.4.2 Species Distribution

The species distribution at each site is shown in Table 2.4.1. For location of site numbers, see Map 6.

On study of Figure 2.4.1 it is apparent that the proportion of the catch made up by *B. lineomaculatus* declines progressively the further downstream the river is sampled. This is rather unexpected since this species is considered to be a common species in large rivers and lakes as much as in small streams.

The percentage catch that *B. lineomaculatus* makes up can be directly correlated with relative abundance at that site. Such an assumption is valid for two reasons:
1. The nature of electrofishing is unselective towards any species

2. The landing net mesh size is small enough not to let small specimens escape, ensuring all fish that arrive at the net are caught.

Table 2.4.1 Table showing distribution of species at each of the sites sampled on the Msimbasi.

Species	Site				
	1	2	3	4	5
Barbus lineomaculatus	76	54	23	65	25
B. amphigramma	0	0	0	2	0
B. paludinosus	0	4	0	0	0
Garra dembeensis	1	0	0	0	1
Amphitus uranoscopus	1	3	5	1	3
Clarius mossambicus	2	5	2	4	0
Poecilia reticulata	11	11	4	11	12
Oreochromis spp.	0	3	1	9	5
Total number at each site	91	80	35	92	46

Note: Differences in totals at different sites are due to different in sampling effort, i.e. lengths of time of sampling.

Significant trends in the reduced relative abundance of *B. lineomaculatus* (χ^2= 13.77, 4d.f.; p<0.01) and a relative increase in the levels of the *Oreochromis* species, *O. niloticus* and *O. esculentus*, (χ^2= 12.57, 4d.f.; p<0.025) were observed over the course of the sampling area. Since no other species show such trends this observation may suggest competition between these species.

It is possible to speculate that the decline in *B. lineomaculatus* and the rise in levels of *Oreochromis* are linked. Experiments are needed to investigate this. Factors influencing this change may be strong since the results were obtained from only 1500 m of stream. Over this distance no other streams joined the main stream, and thus the dimensions of the stream remained largely the same, and no change in bankside vegetation was observed. Changes in water quality may be an influencing factor. The further downstream the water has passed through the village, the greater the level of human disturbance it experiences. This disturbance may have adverse effects on water quality by progressively increasing levels of pollutants, such as detergents, oil and nitrogenous compounds, and suspended matter. Apparatus necessary to detect such substances were not available to the expedition. Nitrogenous ion levels were found to be low and not increase significantly.

If human activity reduces water quality *Oreochromis* might intuitively be expected to fare better compared to *B. lineomaculatus* since its hardiness is a major factor in its choice as a species for fish farming.

2.4.4.3 Ecology of Individual Species

The diet and reproductive state of the individual species were examined by gut and gonadal analyses of preserved specimens.

Barbus lineomaculatus

Distribution: This was the commonest species found at all sites. Often seen swimming in open water with areas of bank side cover.

Size: Standard length=29.7-63.6 mm (n=236)
Mass=0.47-6.78 g (n=234)

Length and mass distributions were examined for each site. No significant differences were found between any two sites. The data were then pooled to produce the distributions shown in Figure 2.4.1 and Figure 2.4.2.

Fig. 2.4.1 Histogram of standard length for *Barbus lineomaculatus*. n=236

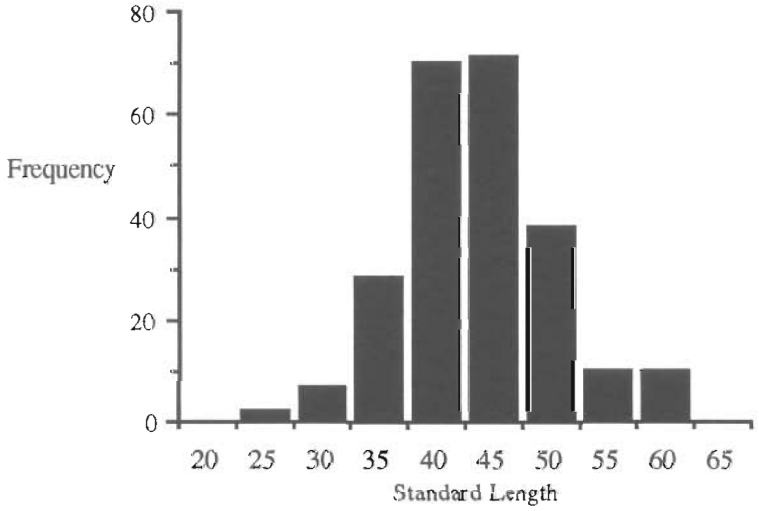
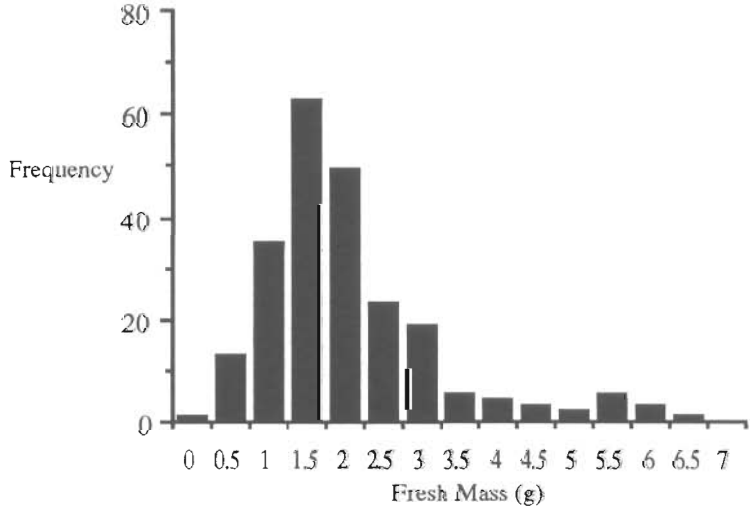


Fig. 2.4.2 Histogram of fresh mass for *Barbus lineomaculatus*. n=234



Reproduction: n=35 GS I=9, GS II=14, GS III=9, GS IV=5

Some correlation of gonad state with size was observed:

GS I	0-50 mm
GS II	38-53 mm
GS III	48-60 mm
GS IV	58+ mm

The heaviest classes of the mass histogram (Fig. 2.4.2) appeared to be exclusively large, ripe females GS IV. The occurrence of individuals in breeding condition in the dry season is contrary to that found in other studies (Bailey *et al.* 1978). Previously ripe females had been found from April through to June; during and after the the peak of the rains in April and May.

Food: This species was found to be largely insectivorous, feeding mainly on terrestrial insects, particularly ants, and aquatic insect larvae such as small mayfly nymphs. The diet described is similar to that described for this species in the Nyumba ya Munga reservoir (Bailey *et al* 1978) except for the predominance of terrestrial insects in the diet.

Barbus amphigramma

Only two specimens were caught (both at site 4).

Size: Standard length=32.3 & 38.3 mm
Mass=0.81 & 1.32 g

Barbus paludinosus

Four specimens were caught, all at site 2.

Size: Standard length=39.0-57.0 mm
Mass=1.16-4.48 g

Reproduction: n=4; GS I=2, GS II=2

Food: Ants, Ephemeroptera larvae and other aquatic insect larvae formed the bulk of the gut contents. Higher plant tissue was also found in the guts of the dissected fish.

Garra dembeensis

Distribution: This species was very common closer to the source of the stream, near camp (alt. 350 m a.s.l.). Often found in the fast-flowing stretches of stream between rocks. This minnow-like fish has a ventral suction disc on the chin used for attaching itself to the substrate. the two specimens caught were possibly at the limit of their range down the stream.

Size: Standard length=48.0 & 48.9 mm
Mass=2.25 & 2.48 g

Food: The two specimens were not dissected. It is reported this species feeds on algae rasped off rock surfaces and on small aquatic insects (Bernacsek 1980).

Amphilius uranoscopus

Distribution: This species was, like *Garra dembeensis*, common above the sampling area in a 'mountain stream' type habitat.

Size: Standard length=35.6-91.9 mm
Mass=0.75-14.21 g

Reproduction: In all individuals studied the gonads were small; n=5,
GS=1/2

Food: Terrestrial and aquatic insects made up almost all the gut contents in the limited numbers studied. Organic debris and sand grains were also found.

Clarius mossambicus

Distribution: Usually found among bank side roots or around drifts of vegetation (such as decaying coconut palm leaves).

Size: n=11 Standard length=42.3-272 mm
Mass=0.98-156 g

Reproduction: n=6; GS I=3, GS II=2, GS III=1

Only one specimen was recorded in GS III. This was the largest individual (S.L.=272 mm). All specimens caught were small compared to a maximum attainable size of over 1 m. The species is some times caught for food around Maramba, as in much of Africa.

Food: Aquatic insect larvae, ants and small guppies were the most important items in the diet. This is consistent with previous study (Bernacsek 1980 and Bailey 1978). Adult specimens are largely piscivorous.

Poecilia reticulata

Distribution: This introduced species was found in all waters connected to the stream, including the rice fields and smallest drainage channels.

Size:	Males; n=12	Standard length=11.0-18.7 mm Mass=0.09-0.20 g
	Females; n=37	Standard length=24.9-35.2 mm Mass=0.37-1.35 g

The gross imbalance in numbers of each sex caught is undoubtedly due to the fact that the mesh size of the net was too big to catch all the male guppies. Pregnant females with their swollen bellies were unable to swim through the mesh.

Reproduction: n=20; All the females studied were bearing young.

Food: Algae and organic debris were the commonest items found. Also recorded were small aquatic insect larvae, sand grains and silver foil.

Oreochromis spp

Distribution: Both *O. niloticus* and *O. esculentus* were predominantly found around bank side shelter.

Size: n=13 Standard length=57.5-136 mm
Mass=7.40-83.61 g

Reproduction: All specimens were immature. These species of *Oreochromis* do not reach maturity until 20+ cm long (Trewavas 1983). n=4; GS I=3, GS II=1.

Food: *O. niloticus* and *O. esculentus* are phytoplanktivorous species (Trewavas 1983). The main food item found in the guts examined was microscopic algae. Higher plant tissue, filamentous algae and aquatic insect larvae were also found.

2.4.4.4 Trophic Spectrum

The bar graphs (Figures 2.4.3 - 2.4.8) shown below display the trophic spectra of five of the species found. The shaded bars represent the percentage of specimens where that food type was the largest component of the gut contents. The solid black bars represent the percentage of guts containing that food type regardless of quantity.

Fig 2.4.3 Trophic spectrum of *Barbus lineomaculatus*.

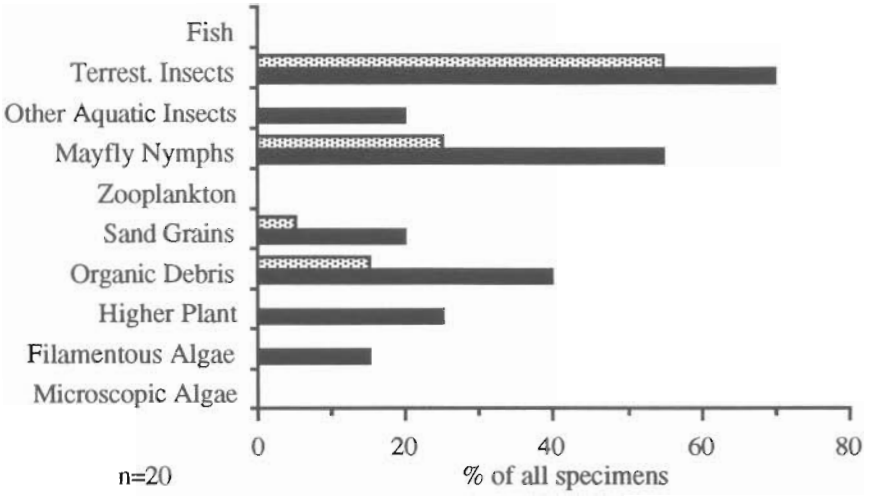


Figure 2.4.4 Trophic spectrum of *Barbus paludinosus*.

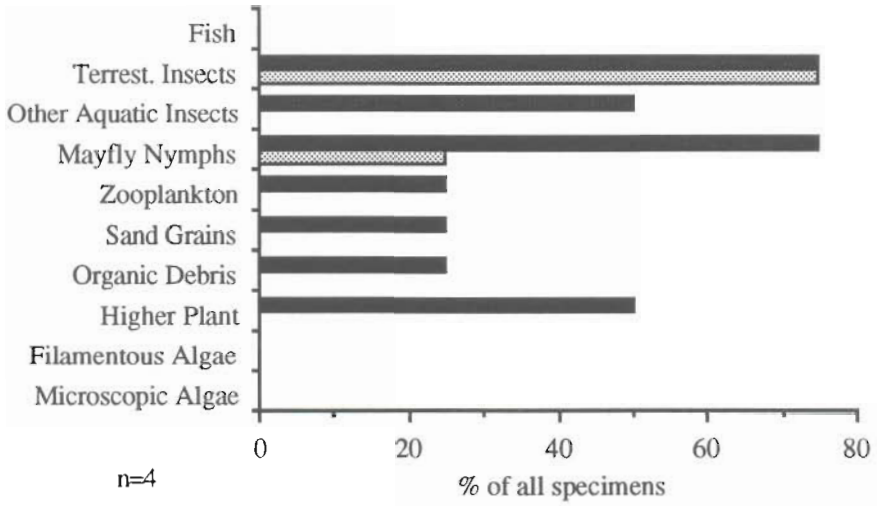


Figure 2.4.5 Trophic spectrum of *Clarius mossambicus*.

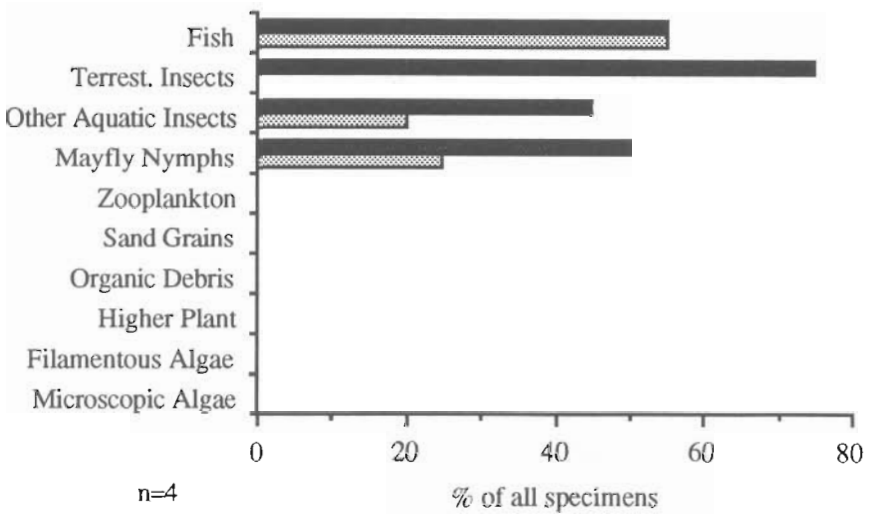


Figure 2.4.6 Trophic spectrum of *Poecilia reticulata*.

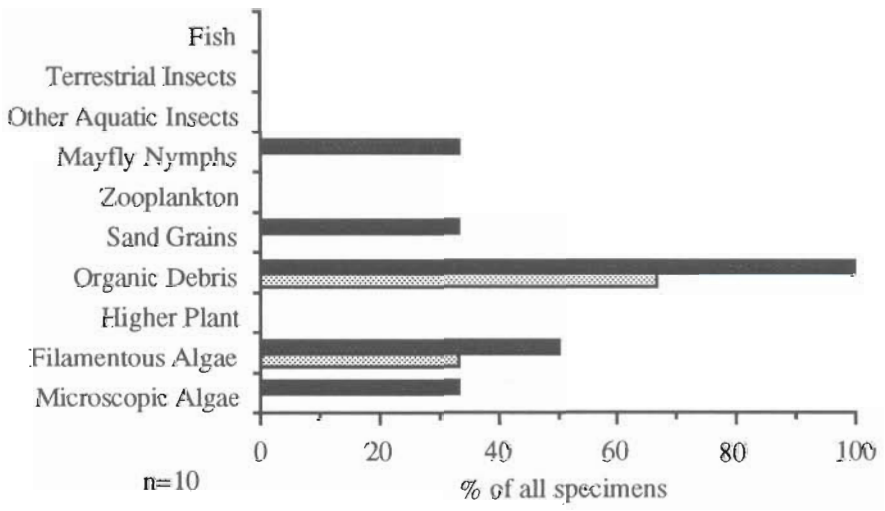
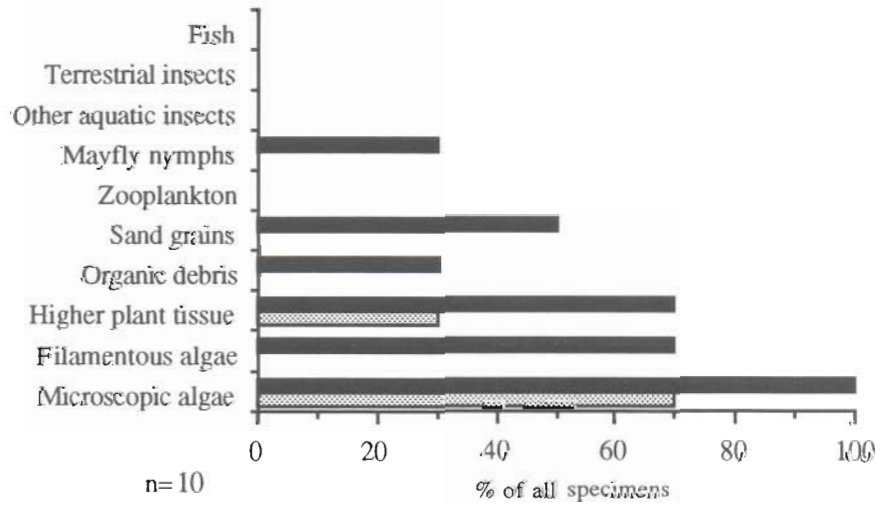


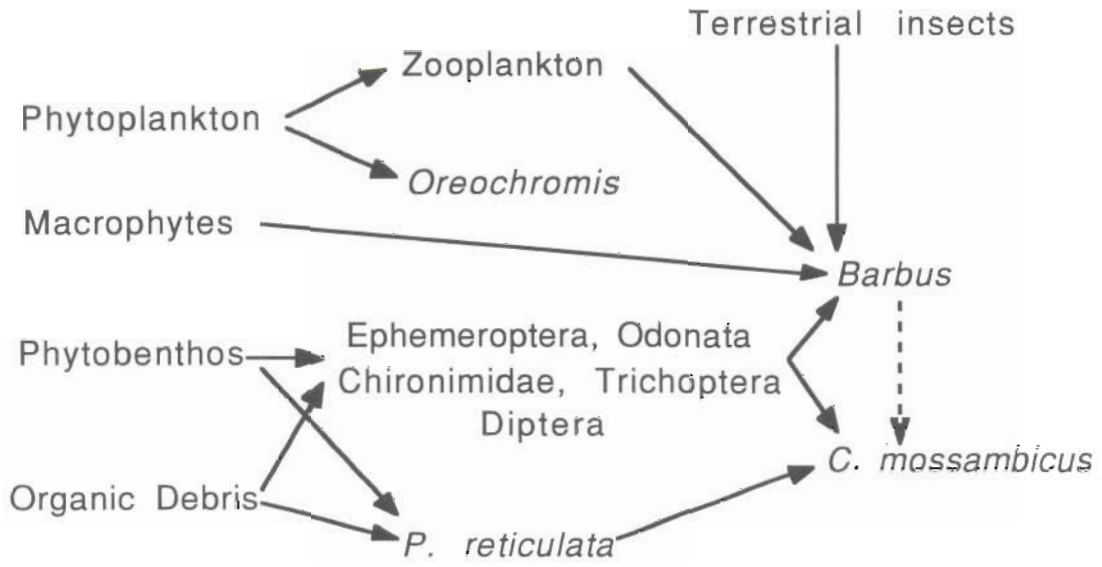
Figure 2.4.7 Trophic spectrum of *Oreochromis* spp.



2.4.4.5 Simplified Food Web

From the feeding ecology of the individual fish species a simplified food web can be constructed for the head waters of the Msimbasi stream.

Figure 2.4.8 Simplified food web for the head waters of the Msimbasi.



2.4.5 Conclusion

The fish community in the Msimbasi around Maramba has been shown to be a mixed one, in terms of native and introduced species. *Oreochromis* spp. and *Poecilia reticulata* are well established in the fish community. The effect the introduction of these species has had on the indigenous species is difficult to assess since the introduction was many years ago and any change caused is probably now well stabilised.
It is possible that some native species were displaced or have changed in population density as a result of the exotic species introduction. An indication of this might be the limited number of *Barbus* species encountered. Often in such small streams the diversity of these cyprinids is large, often with six or more species present. The densities of *B. paludinosus* and *B. amphigramma* are very low. These may be depressed by some sort of competition with the introduced species. The feeding ecologies of the existing native species found are very different from *Oreochromis* and *P. reticulata*. In the past these species, or now locally extinct native species, may have had diets which overlapped with the native species. Over the course of time competition would be likely to either wipe out the less competitive species or displace its realised niche. The trophic spectrum of *B. lineomaculatus* in the Msimbasi shows a greater intake of terrestrial insects in the diet than elsewhere (Bailey 1978).

Reinforcing the above speculation with facts is very difficult since such events occurred in the past, and extrapolating backwards from the present situation is difficult.

Similarly, extracting the effects the human population had on the interactions between the species at the time of introduction is difficult to assess. Present human impact is, however, easier to study. Human effects may have a hand in the changing abundances of *Oreochromis* and *B. lineomaculatus* as the stream passes through the village. Phosphate levels were not tested. The village may be a source of this and other

nutrients, resulting in increased levels of phytoplankton, on which the *Oreochromis* feeds, the further down the sampling area one goes. Detrimental effects caused by the village might be expected to be less damaging to the introduced *Oreochromis*, which is chosen as a food fish from among the tilapia partly as a result of its hardiness. Further study could test this speculation.

A better assessment of human impact would have been possible if the study area could have been extended beyond the the edges of the village, both up and downstream. This unfortunately proved impossible due to difficulties in access and surveying techniques, since electrofishing worked poorly in water over eighteen inches deep.

Most species of fish inspected were not in breeding condition. This was unsurprising since most East African species spawn seasonally in the wet season around April and May. The survey was conducted around July and early August and only large *B. lineomaculatus* specimens were found to still be in breeding condition. A follow up survey during the wet season would reveal more about the species breeding ecology. Such a study would, however, preclude the use of electrofishing apparatus as the stream is very much deeper then. Such a study would also permit monitoring of the various species abundances and shows whether the level of the introduced species have yet reached equilibrium.

2.5 MAMMALS

by T.D. Evans and N.J. Cordeiro

2.5.1 Summary

A few species of mammal were recorded incidentally during the fieldwork. None are of particular conservation significance, except for Leopard *Felis pardus*, though several other threatened species potentially occur at the study sites.

2.5.2 Methods

No systematic attempt was made to study mammals. All observations during the course of other fieldwork, diurnal and nocturnal, were recorded. A few bats were caught in mist-nets, some of which were taken as specimens. A handful of photographs and sound-recordings were also obtained. Descriptions taken in the field were compared with Haltenorth and Diller (1980) and Kingdon (1971, 1974, 1977, 1982, 1984) for identification.

2.5.3 Systematic List for Both Sites

Order and taxonomy follow Corbet and Hill (1983).
Abreviations: **M**= Recorded on Mount Mtai
U= Recorded in the Ukaguru
Some important species *not* recorded are also mentioned here.

CHIROPTERA:

Banana Bat *Pipistrellus nanus* **M**
One was found in a furled banana leaf at 900 m on Mount Mtai. Another was caught in a mist-net at 950 m.

Insectivorous Bat sp. **U**
One mist-netted at 1800 m. Photographs were taken, but it was not measured before release.

Fruit Bat sp. **U**
Four were caught in a mist-net at 1800 m. Three were taken as specimens, measured and deposited at UDSM.

PRIMATES:

Black and White Colobus *Colobus angolensis* Not recorded.
It seems remarkable that this species was not recorded - it is present throughout Tanzania, including the East Usambaras, in upland and lowland forests (Kingdon 1971). Hunting may have eliminated it from Mt Mtai. Local people there knew the species from adjacent mountains.

Vervet *Cercopithecus aethiops* **M**
Common in scrub and cultivation around the forest and in the enclaves.

Diademed (=Blue) Monkey *C. mitis* **M U**
Moderately common (recorded daily, frequently several troops in a day) at both sites.

Olive Baboon *Papio anubis* **M**
Footprints were found on a path at 450 m and local people knew the species well.
Greater Bushbaby *Otolemur crassicaudatus* **M**

Seen in farmland at 100 m by Maramba village, and both seen and heard frequently in forest around 300 m, but no higher. Regularly visited the camp to steal food by night.

Bushbaby sp. **U**
Bushbabies called briefly on a number of evenings around the 1500 m campsite. No recordings could be obtained, but the calls were different from any heard on Mount Mtai. The most likely species are *Otolemur crassicaudata* and *Galagoides demidoff orinus*. Kingdon (1971) splits the latter, calling the East African taxon *G. zanzibaricus*, the Zanzibar Galago.

HYRACOIDEA:

East Coast Tree Hyrax *Dendrohyrax validus* **M**
Common, heard calling nightly around our 300 m campsite and up to at least 500 m. There was a considerable colony in boulder-piles here.

ARTIODACTYLA:

Bushpig *Pomatochoerus porcus* **M? U?**
Reported as common in both forests by local residents. There were several pit-fall traps apparently intended mainly for this species at both sites.

Small Antelope Species
Four forest antelopes could occur at the study sites, including Abbott's Duiker *Cephalophus spadix*, a threatened species (Kingdon 1982). None were seen, though there were reports of duikers being hunted in the Ukaguru forests.

CARNIVORA:

African Palm Civet *Nandinia binotata* **M**
One was seen at 300 m one evening in the crown of a forest tree. It was scolded by two Greater Galagos *Galago crassicaudatus* for about 15 minutes.

Kenyan Bushy-tailed Mongoose *Bdeogale crassicaudata omnivora* Not Recorded
We had hoped to find this highly threatened subspecies, which is known only from the Kenyan coastal forests, with one old specimen from Mount Mtai. It should be sought by future fieldworkers.

Leopard *Felis pardus* **U**
Footprints of this species were found on a forest trail at c. 2000 m. The species is threatened IUCN (1990).

RODENTIA:

Tanganyika Mountain Squirrel *Funisciurus lucifer* **U**
One jumped into a mist net at 1500m allowing identification before freeing itself.

Red-legged Sun Squirrel *Helioscuirus rufobrachium* **M**
Seen fairly frequently in clearings below 600 m. One was observed taking termites from amongst debris in the forks of a *Newtonia* tree for 45 minutes.

Giant Pouched Rat *Cricetomys gambianus* **M**
One individual was a frequent nocturnal visitor to the camp at 300 m, visiting most often from 2 am-5 am. It was fairly confiding with observers.

MACROSCELIDA:

Chequered Elephant Shrew *Rhynchocyon cirnei* **M U**
Seen once at 1800m in the Ukagurus.
Several sight records on Mount Mtai, from 300 m to 1000 m. We did not record the recently split Black and Rufous Elephant Shrew *R. petersi* here, although several sightings of Elephant Shrews were too poor to allow certain identification. It is conceivable that *R. petersi* might occur at Mtai.

Section 3 - CONSERVATION - VALUES, PROBLEMS AND PROPOSALS

by T.D. Evans

3.1 SOCIO-ECONOMIC VALUES OF THE STUDY SITES

There are many arguments for protecting forests against clearance, all stressing the potential renewable benefits of a forest at the local, regional and international scales. The high global rate of deforestation will probably lead to mass extinctions, cultural and economic impoverishment and climatic change. This can best be combatted at a national level, with each country taking responsibility for its share of the world's forest resource and endeavouring to maintain it for present and future benefits.

In this section, five key reasons are presented for maintaining forest cover on Mt Mtai and the Ukaguru Mts.

3.1.1 Catchment Protection

Forested mountains form better catchments than denuded ones unless land-use after clearance is very strictly controlled (Bruijnzeel 1990). Tree cover prevents erosion on steep slopes more effectively than most other land uses. This slows the siltation of reservoirs (such as that on the Sigi River, supplying Tanga city), maintains the quality of river waters and prevents coastal coral reefs and fisheries being smothered with silt. These values are generally higher than that of the additional agricultural land made available. Newly cultivated land is subject to erosion and rapid leaching of nutrients, and yields from it decline rapidly after a few years.

The trees may also slow the movement of stormwater into the rivers, so reducing the risk of devastating flash floods and ensuring a supply of water through the dry season (Bruijnzeel 1990, Hamilton and Bensted-Smith 1989, Chapter 15), though certain altermative land-uses are as effective. Early in 1991, heavy rains on the largely deforested Mulanje Mountain in Malawi led to mudslides and flash floods which killed 500 people and left an estimated 50,000 homeless (The Times, March 23, 1991). This could happen again, perhaps in Tanzania, and the risk is increasing as forests continue to be cleared.

Both the study sites are important catchments. Mount Mtai supplies part of the water for Tanga township (100,000 people) via a major reservoir on the River Sigi and directly to several thousand local villagers via the Rivers Sigi and Msimbazi. Its steep slopes are protected from erosion by the remaining forest. Deforestation and degradation of existing forest threaten all these functions.

Rivers draining the Ukagurus supply water to a large area of plains, where summer droughts, due in part to failure of the rivers coming off the mountains, are an increasing problem for farmers (frequent comment by local residents, 1990). Further deforestation, combined with poor soil conservation measures, might worsen the problem (Bruijnzeel 1990, Hamilton and Bensted-Smith 1989, Chapter 15). Erosion and flooding could also worsen as forest cover is reduced here, jeopardising the livelihoods of many local farmers. Natural forest is generally better at protecting catchments than plantations and the preservation of the remaining forest must be the first priority. Catchments are particularly vulnerable in the period immediately after deforestation or harvesting of a plantation.

3.1.2 Climate

Trees help to maintain a moist local climate with frequent light rains by passing water vapour into the air during transpiration. Adverse climate changes and alterations in vegetation observed around Amani in the East Usambaras are probably due in part to drastic local deforestation (Hamilton and Bensted-Smith 1989, Chapters 6, 14, 27, 28), and the regional tendency for worsening droughts and rising temperatures has been blamed on degradation of the woods and forests across huge areas (Hamilton 1984). The problems may worsen as burning and clearance continue.

3.1.3. Forest Products

There are many products which could be sustainably cropped from natural forest - examples known to be important in East Africa include medicinal herbs, game, honey, pole timber and fruit, either for local consumption or for sale. Medicines from forest plants are important to local communities at both study sites (Hamilton and Bensted-Smith 1989, Chapter 20).

The accumulating annual financial benefit of such harvesting could easily exceed the value of one-off logging at a site, particularly from the point of view of local residents, who gain little from the logging in many cases. Increasing population pressure and lack of regulation are causing traditionally sustainable harvests to collapse in many forest areas, but the potential is still great. Clearly these benefits will be lost for the forseeable future if forest is degraded or cleared.

The extraction of timber by pit-sawing may ultimately be sustainable, but only if tightly regulated and corruption-free. This is not feasible at present (A. Tye, pers. comm.). Current practices are worryingly destructive and a detailed reassessment by the Department of Forestry may be called for. The destructive nature of mechanical logging makes its sustainability in such mountainous areas highly doubtful.

3.1.4 Tourism

Big game tourism in the savannas is a key source of foreign revenue in Tanzania. There is also potential for forest tourism, in view of the increasing awareness of rainforests' importance in Europe and North America. The scale may be smaller, but the revenue could still be substantial. Two initial possibilities are plant enthusuiasts coming to see the African violets *Saintpaulia* and various other favourites of cultivation in their natural state (Hamilton and Bensted-Smith 1989) and ornithologists visiting in search of the many rare birds of Eastern Arc and coastal forests. One tour company, Birdquest, will start such bird tours in Tanzania in 1992, and several other companies could follow suit.

3.1.5 Biodiversity

Forests act as refuges for large numbers of species which cannot survive elsewhere, and will thus be driven to extinction by forest clearance.

Forests are made up of inter-dependent communities of species, so the extinction of one species may have knock-on effects on others, which may in time drastically alter the nature of the forest. For example, the extinction of hornbills through hunting could prevent the regeneration of key forest trees which rely on these birds to spread their seeds. Such interactions are not well studied, and it is very difficult to predict whether or not any given species has a key role. All extinctions thus carry the risk of knock-on effects, and so should be avoided for this reason alone.

There are more immediate reasons for preserving all existing species, one of which is the potential economic value of their genes. Medicine and agriculture depend on genetic characteristics from wild gene pools to provide novel characteristics - e.g. disease resistance - as well as entire new species to exploit. Many internationally important species (e.g. cocoa, coffee, rice, bananas, chickens, pigs, rubber, *Cinchona* [the source of quinine] spices and peppers) initially came from tropical forests, and even more important ones may be waiting to be discovered. Tropical forests are the world's chief source of unexplored genetic diversity and should be valued for their future economic contribution to the countries which safeguard them.

The current wave of global extinction caused by wholesale deforestation will be irreversible. The preservation of the full diversity of species of life for future generations, as a scientific and economic resource, is a major goal of conservation. Our work, in the context of previous studies, indicates the great importance of the study sites for this purpose. The significance of the study sites is analysed in Section 3.2.

3.2 THE BIOLOGICAL SIGNIFICANCE OF THE STUDY SITES

3.2.1 Background

All species at a site contribute to its biodiversity. Typically sites important for one animal or plant group are equally important for most others (Diamond 1985). This allows certain easily studied groups to be used as indicators of the overall value of a site. Birds and large mammals are the most frequently used indicators. Our studies use birds, reptiles and amphibians at both sites, with additional data on butterflies from Mt Mtai. Sufficient data are available from all these groups to allow comparisons with other forests in the Eastern Arc and further afield. Our results can be considered representative of the sites' importance for most other invertebrate and plant taxa. Scarce species (especially those listed in IUCN 1990) are given special weight in assigning conservation priorities. Both study sites are considered of high conservation value, fully meriting the protective measures laid out in Section 3.4.

African forests can be classified biogeographically to form a hirearchy of regions, the most extensive being the whole Afrotropical forest region, intermediate classes including the Eastern Arc (at the same level as the Upper and Lower Guinea blocks etc.), and the smallest units being individual forest patches. Conservation priorities are only meaningful when comparing classes at the same level - thus Mtai can be compared only with other East Usambara forest blocks and the Ukagurus with other Eastern Arc mountain ranges.

3.2.2 The Importance of the Eastern Arc

Despite the low species richness in comparison to the far more extensive West African forests, the Eastern Arc is of comparable importance for conservation of biodiversity due to the high rate of endemism Many other forests in Tanzania are less important - e.g. Mount Kilimanjaro, Mount Mbulu and the Northern Highlands each support very few species of limited range.

This level of endemicity may stem from long-term ecological isolation from other regions of forest, combined with long-term persistence of forest cover, even during the driest glacial periods. This is discussed in detail by Stuart (1983) and Diamond and Hamilton (1980). The Eastern Arc has been compared to the Galapagos in its importance for the study of speciation and evolution.

Eighteen bird species are virtually limited to the Eastern Arc (see Appendix 1.6), with seven more found just there and in the East African coastal forests, which are under even greater threat of clearance. Twelve of these twenty-five are listed as threatened or near-threatened in Collar and Andrew (1988). The remainder of the c.150 forest birds have broader ranges, particularly in western East Africa, with some extending into West Africa. For comparison, twenty-two bird species are endemic or near-endemic to the Upper Guinea forest region (Allport 1991).

The forest amphibians are even more distinct - none of the 37 Eastern Arc Anuran species occur in West or Central Africa, and only 12 of these occur outside the Eastern Arc (e.g. in the East African coastal forests).

Reptiles show a similar pattern. Of the 38 lizard species occurring in the Eastern Arc, 22 are forest species and 14 of these are endemic. Thirty snake species occur in the Eastern Arc, and of the 13 forest species, 6 are endemic to the region, with 2 endemic to the East Usambaras alone. In contrast, Mt Kilimanjaro has only 2 forest snake species.

Among the forest butterflies, many are restricted almost entirely to the Eastern Arc, 43 being endemic to single mountain blocks within the region. Many others occur only in the Eastern Arc and the coastal belt of East Africa. At least eight Eastern Arc butterflies are globally threatened (IUCN 1990).

The fish and mammals are far less distinct, partly since fewer species are limited to forest. Two large mammal species and nine rodents and shrews are restricted to the Eastern Arc and coastal forests and all are listed as threatened in IUCN (1990). Very few fishes are endemic to the rivers draining eastern Kenya and Tanzania, and these are unlikley to be directly threatened by forest clearance.

The Eastern Arc has a very distinct flora - some 25-30% of the c.2000 species in the Tanzanian portion are wholly endemic (Hamilton and Bensted-Smith 1989, Chapter 21). These include many species of current commercial importance (e.g. timber trees such as *Cephakosphaera usambarensis* and *Isoberlinia scheffleri* , wild coffee *Coffea*, African violets *Saintpaulia*) and numerous others of local importance as medicines, construction materials, fruit sources etc. (Hamilton and Bensted-Smith 1989, Chapter 19), and it seems likely that others will prove important in the future, if scientists find them before they become extinct.

Overall, then, the Eastern Arc forests are clearly of very high importance for genetic conservation. Our results added six species (3 amphibians, 1 reptile, 2 butterflies) to published lists for the Eastern Arc, including one butterfly species new to science.

3.2.3 Current Forest cover in the Eastern Arc

Large protected areas of each habitat are important to maintain adequate populations of all the important species - large enough to avoid the chance extinctions to which small populations are vulnerable (see Newmark 1991). The lowest-density species of bird may only occur at 1-2 pairs per km^2 (e.g. Nduk Eagle Owl and Dappled Mountain Robin, Collar and Stuart 1985) - a viable population of perhaps 500 pairs (Frankel and Soule 1981) would thus require around 250-500 km^2 of suitable forest to be preserved. The remaining Eastern Arc forests are already perilously small if such species, and the other values of the forests are to be retained.

Montane forest is found throughout the Eastern Arc, though there are only about three square miles (c. 8 km^2) of it on the East Usambaras (all on Mount Nilo, Moreau 1935). It is generally the least threatened type since lower altitudes are cleared in preference. In the Ukagurus, however, all lower forest has already been cleared and the montane forest is under direct destructive pressure. Some Eastern Arc endemics depend on it (for example Iringa Ground Robin, the toad *Nectophrynoides minutus* and several important timber trees).

Lowland and intermediate types, which are richer biologically, are limited to foothills and low plateaux where there is sufficient rainfall at low altitudes for luxuriant and species-rich forest to develop.

Intermediate forest contains most of the endemic species of the Eastern Arc. It is best developed on the Amani plateau in the East Usambaras and the eastern rim of the West Usambaras and on some slopes of the Uzungwas, Ngurus and Ulugurus. It has retreated rapidly this century and has been the focus of recent conservation efforts, partly because of the high proportion of Eastern Arc endemics it supports (for example six of the eight threatened bird species known from the Usambaras up to 1990) Only that contained by the proposed Mwanihana National Park will have full statutory protection, though some montane forest is protected in Malawi (Dowsett-Lemaire 1989)

Lowland forest is found partly in the coastal belt, where it supports a different set of scarce species from the Eastern Arc (Stuart 1981, Stuart 1983, Burgess *et al.* in press). Otherwise it is limited to the eastern foothills of the Ulugurus, the Ngurus and the Uzungwas and to the seaward-facing escarpments of the East Usambaras. Here it supports some of the Eastern Arc endemic species, some typically coastal species, a few species of its own and a high proportion of the birds which move out of higher areas during the cold season (Stuart 1983, Stuart *et al.* 1987, Stuart and Jensen 1985).

The true extent of the foothills habitat is not clear (the lowlands of the Usambaras were not included in recent forest inventories) but it is small and declining (a few thousand hectares in the Usambaras (see Cambridge Tanzania Rainforest Survey 1992, in prep), a few hundred in the Ulugurus and unknown amounts elsewhere), as are the coastal forest patches, which total less than 400 sq km, split between up to 40 patches (Burgess *et al.* in press).

Two important factors in addition to total forest extent are fragmentation and habitat quality.

Fragmentation is a problem since forest birds are poor at dispersing across more open habitats. Smaller forest patches thus contain isolated populations of each species, which are prone to more frequent random extinctions. Recolonisation from neighbouring forest also occurs less often in isolated patches, so such areas come to support fewer species (a process known as 'faunal relaxation') and are of less value for conservation. This has recently been shown clearly for the East Usambaras by Newmark (1991).

Fragmentation also reduces the contact between different forest types (e.g. wet and dry, or warm and cool) which species (particularly birds and mammals) may need to move between at different times of their annual cycle. The preservation of areas where lowland and intermediate forest are still in contact (e.g. Mount Mtai) has been recognised as a high priority for the past 15 years (e.g. recommendations in Stuart and Hutton 1978, Stuart 1983 and Hamilton and Bensted-Smith 1989).

Forest quality can differ markedly depending on aspect, soil type and degree of disturbance. In particular logging alters the forest structure, reducing the number of big trees and the area of cool, humid, shaded understorey. This latter effect is probably important for understorey birds (e.g. Swynnerton's Forest Robin and Dappled Mountain Robin) and for amphibians, both of which require a moist, shady, invertebrate-rich leaf litter. Thus it is probably important to maintain large areas of virgin forest where such habitat features remain undisturbed.

Natural variation is also significant e.g. the most sheltered parts of the Ukaguru Mountain forests, though 'montane', clearly supported a richer fauna than higher areas. Some rare 'microhabitats', for example tree-fern thickets, support their own characteristic species. Care should be taken to protect enough of such subhabitats.

3.2.4 Priorities within the Eastern Arc

Certain Eastern Arc forests are more species-rich than others. The effect of uneven research effort has tended to exaggerate this situation. Recent research on the amphibians of the Ukagurus and Ngurus, for example, is reducing the number of species thought endemic to the Usambaras or Ulugurus (see Section 2.2). Nonetheless the pre-eminence of the Usambaras (East and West) and the Uzungwas is still clear, with the Ulugurus next and the other ranges (Nguru, Nguu, Ukaguru, Southern Highlands, Mount Mulanje, Mount Thyolo, Mount Namuli, etc.) clustered below these three. The less important ranges have a great combined importance, however, since they each support different rare species.

The three best areas (the Usambaras, Ulugurus and Uzungwas) each combine a wide altitudinal range and high rainfall. This is related to the likelihood that they were species-rich refuges during dry glacial periods, but must also explain why they retain a high faunal and floral diversity today by promoting a diversity of habitat types (Stuart 1983).

The importance of the East Usambaras was detailed by Rodgers and Homewood (1982). Biologically, they are among the very best forests in Africa. For example, they were ranked fourth on the continent in their importance for rare birds by Collar and Stewart (1987) and support the "highest avifauna diversity of all East African mountain and lowland forests" Stuart (1983). They have more forest amphibians than some forest countries (e.g. Ivory Coast, Rodgers and Homewood 1982). They support "one of the most diversified floras in the world and are probably unique in the number of phytogeographic elements they harbour". This includes 276 tree species over 10 m tall, compared with 50 on Kilimanjaro and only 180 in the whole of Malawi (Rodgers and Homewood 1982). They were listed as a key community globally for the preservation of rare invertebrates in IUCN (1983).

A very high proportion of the the species are listed in the Red Data books (see IUCN 1990) or the Appendices of CITES, a reflection of their very limited ranges. As indicated above, the number of species definitely endemic to the Usambaras is falling, but still includes two bird species, 15 amphibians and reptiles, one mammal (Swynnerton's Squirrel *Paraxerus vexillarius*), 12 forest butterflies and 11 forest trees (Hamilton and Bensted-Smith 1989, Chapter 1).

The Usambaras support a variety of economically important groups such as timber trees, Coffee and African Violets with numerous endemic species.

The high conservation value of the Usambaras is thus unarguable, and when the rate of degradation, fragmentation and clearance there is considered, the urgent need for action is clear.

The Uzungwa mountains are likely to be almost as important - they support similar numbers of rare bird species, including at least one wholly endemic species, and most other groups are similarly well represented. The Ulugurus appear to be somewhat less species-rich but nonetheless support, amongst others, two endemic birds, three endemic amphibians and eight endemic butterflies.

The Ukagurus are not so species-rich, only having montane forest and receiving rather limited rainfall (Stuart 1981). Nonetheless they support at least two globally threatened bird species, six amphibians and two reptiles endemic to the Eastern Arc. The Ukaguru forests are of lower priority than the Usambaras, and are probably comparable to the Ngurus or the Malawian mountains. It must, however, be stressed that they rank highly compared to most forests in Tanzania and Africa as a whole, and have a key environmental role to play in addition to their biological importance. Their conservation is fully justified.

3.2.5 Priorities within the East Usambaras

The Amani forests are clearly of great importance, but they only represent a fraction of the Usambaras, and a narrow part (albeit the richest) of the altitudinal range. Knowledge of the other forest blocks is scanty, though some of the montane Forest Reserves in the West Usambaras are moderately well known. It must be stressed that the remaining forest is so restricted that any further clearance or fragmentation will compromise the area's biological and environmental values.

Our brief survey has shown that the Mt Mtai forest supports important species known from elsewhere in the range as well several not previously known from the Usambaras. The former include Banded Green Sunbird, East Coast Tree Hyrax, Black-and-White Elephant Shrew, the amphibians *Nectophrynoides tornirei*, *Leptopelis ulugurensis* and *L. barbouri*, Bearded and Pitted Pigmy Chameleons *Rhampholeon brevicaudata* and *R. temporalis*, and the Red Data Book butterflies *Charaxes usambarae*, *Cymothoe amaniensis* and *Hypolimnas antevorta*. The latter include Swynnerton's Forest Robin, the amphibians *Leptopelis flavomaculatus*, *Arthroleptis stenodactylus* and *Phrynobatrachus acridoides* and the butterflies *Papilio rex*, *Neptis carcassoni*, *Euthecta cooksoni* and *Tuxentius stempferri*. The newly described *Celeanorrhinus* butterfly may depend wholly on Mtai for its survival. These records may be considered indicative of a wealth of rare plants and invertebrates on Mtai. The lower parts of the forest (below 600 m) support most of those species not known from Amani, since they represent lowland forest, a distinct habitat type. They are probably important to altitudinal migrants such as the smaller birds during the cold season (Stuart 1983). The forest on Mtai protects very steep slopes from erosion and includes a great proportion of the remaining virgin forest (Hamilton and Bensted-Smith 1989, Chapter 1), the most biologically valuable in the East Usambaras.

Any regional management programme must therefore make improved protection of Mt Mtai's forests a very high priority. However, irrevocable choices between forest blocks (e.g. allowing some to be replaced by plantations) cannot be made with any great confidence given the current state of knowledge. Though several authors have given lists of priorities, these are made on the assumption that all the forest should be safe-guarded if resources allow.

The ideal course course of action will be to protect all the remaining forest, small as it is, in the Usambaras from clearance and to protect considerable tracts from any exploitation at all. A higher priority should be given to incorporating the lowland forests into future management plans (see Cambridge Tanzania Rainforest Survey 1992, in prep.).

3.3 THE FORESTS TODAY - CONDITION AND THREATS

3.3.1 Methods

Pressures on the two study sites were assessed in two ways:

(i) General observations on human activities (tree felling, hunting etc.) in the course of other fieldwork
(ii) Detailed discussions with local people and forestry officials, in particular:

Mr Johannes Daffa, Forest Officer, Mtai Forest Reserve;
Mr Charles Mlowe, East Usambara Catchment Forest Project, Tanga;
(Addresses: both c/o Catchment Forest Project Office, P. O. Box 1449, Tanga)
Mr Hatibu Haji, IUCN Field Officer, Amani;
(Address: c/o EEC/IUCN East Usambaras Agricultural Development and Environmental Conservation Project, P. O. Box 1, Amani, Muheza)
Mr Tangwa, Softwood Plantation Officer, Mandege Forest Station;
Mr Sebastian Malisa, Tree Nursery Officer, Mandege Forest Station;
(Addresses: both c/o Ukaguru Forest Project, P. O. Box 2, Gairo, Dodoma, Morogoro)

No attempt was made to quantify these pressures, our primary objective being the biological surveys. The following discussion does however highlight important and in some cases urgent topics for detailed assessment. The conclusion at each site was that human pressures are high and likely to severely reduce the value of the forest (as discussed in Section 3.2). There is therefore a need for a re-evaluation of resource utilisation, followed by improved regulation and the development of alternative sources of income or resources.

3.3.2 Mount Mtai

3.3.2.1 Background

Hamilton and Bensted-Smith (1989) review the problems in the East Usambaras in detail and propose some solutions. These excellent proposals have been partly implemented over a limited part of the East Usambaras. However the proposed pristine nature reserve areas have yet to be established, and pit-saw lumbering is still not suitably regulated. The discussion below refers mainly to Mtai, and not to the other Forest Reserves of the East Usambaras, all of which have individual needs. It borrows freely from Hamilton and Bensted-Smith's work.

The IUCN, the EEC and the Tanzanian authorities have commenced a programme of integrated management around Amani, seeking to:
(i) regulate forest exploitation at a sustainable level;
(ii) improve use of existing farmland through education and direct support, and establish woodlots, thus reducing pressure on remaining forest.

The project has had some success, and is seeking funding to extend operations to Maramba Division, which includes Mt Mtai.

3.3.2.2 Current Status of Forest

Mount Mtai was included in the East Usambara forest inventory by AFIMP (1986). We observed few differences from that study (results illustrated on Map 4). In 1986

the forest block covered 2860 ha, of which 1645 ha were in a statutory Forest Reserve. There were 650 ha of 'intact', virgin forest in the reserve (930 ha including that on Public Lands) in 1986 but logging has occurred in some of the 'intact' areas since then (pers. obs.). The forest is still continuous from 300 m to 1100 m, mostly on steep slopes classified as 'inaccessible to mechanical logging' (AFIMP 1986).

Three legal cultivated enclaves exist, and are apparently expanding, illegally. The south-west part of the forest contains a number of small clearings, some of which were burnt during our visit. Much of the forest has a rather scrubby aspect, with a broken canopy, presumably as a result of logging and the steep gradients.

3.3.2.3 Current Pressures

1 Pit-sawing
This form of extraction, where trees are felled by chainsaw then cut into planks *in situ* by hand, is still permitted. There is a system of licensing and sub-licensing administered by the Catchment Forest Project Office in Tanga. The selection of individual trees is overseen by the local resident Forest Officer. The level of pit-sawing is very high in Mtai. We heard more than 15 large trees felled in 23 days (and more must have come down out of earshot), felling continues throughout the year and several small trees are felled near each large one to build the sawing platform, in addition to those damaged when the big tree falls. Most of the 20 recent pit-saw sites we saw were in the steep areas 'inaccessible to mechanical logging' which Hamilton and Bensted-Smith (1986) strongly recommend be left inviolate to protect the soil from erosion. Felling damages surrounding trees, selectively removes the large trees (which are now very scarce) and leaves large, heavily trampled clearings. The level of licensed cutting is reportedly sustainable (C. Mlowe. pers. comm.) but our view is that the forest risks severe degradation. This will result in the loss of the benefits and values listed in Section 3.2.

2 Lack of Statutory Protection
A large area of the forest (1200 ha) on the south west of the mountain is outside the Forest Reserve, and so lacks even limited protection.

3 Clearance for agriculture
This was not particularly apparent on Mtai, except for small cleared patches on the west slopes of the main valley. However, the Forest Reserve boundary is not marked and cultivation comes right to the forest edge, both around its borders and within it where three inhabited enclaves exist. Population pressures are increasing; the town of Maramba, 30 minutes walk from the forest, has 5000-10,000 inhabitants.

4 Logging
Renewed, selective logging of Mount Mtai was proposed in 1986 but since 1987 a moratorium has prevented the mechanical logging of any montane or lowland forest in the East Usambaras. 39% of Mt Mtai Forest Reserve, or c.650 ha, and 930 ha including that on Public Lands is 'intact' i.e. never mechanically logged, according to the 1986 survey by the IUCN (AFIMP 1986). Pit-sawing has occurred in much of this 'intact' forest, however (A. Tye, pers. comm.).

5 Invasive Species
Mtai is currently almost free of the invasive exotic tree *Maesopsis eminii* (AFIMP 1986) which is causing great problems in the forests around Amani. It forms monospecific stands in disturbed forest, reducing the biological, commercial and catchment value of the forest (Hamilton and Bensted-Smith 1989, Chapters 24, 27, 30-33). It seems to be dispersed by wandering frugivores, both birds and bats, which travel between forest blocks carrying the seeds. Careless exploitation of Mtai could easily allow *Maesopsis*

to gain a foothold, as it has elsewhere, after which eradication would be both difficult and costly.

6 Fire
Drier scrub adjoining the northern boundary of the Forest Reserve was heavily burnt during our visit. Damage to the forest would result if such fires were frequent or poorly controlled. The cause of the fires was not established, but they were reportedly set by local farmers to improve grazing or clear bush for cultivation .

7 Hunting
This did not seem to be a major threat to wildlife. We were not offered any animals for sale and no snares were found. Blue and vervet monkeys could be seen daily, but hunting of the latter, which occur outside the forest, and of bushpigs and duikers, was said to occur since they are pests of crops in the enclaves. Large mammal densities, as judged from dung and trail abundance, seemed low compared to the Ukagurus and to Kilimanjaro, where NJC has extensive experience.

3.3.3 Ukaguru Mountains

3.3.3.1 Background

Stuart and van der Willigen (1979) mapped the extent of the forest and suggested that there was little threat, in view of the low population pressure and committed staff of forest officers.

We found the local Forest Reserve staff helpful, well informed and moderately equipped. However, they have insufficient resources to assist the development of village woodlots and soil conservation measures.

3.3.3.2 Condition of Forest

There is very little vegetation outside Mamiwa Kisara Forest Reserve, most land being cultivated or rough grassland. Considerable soil erosion on the highly denuded hillsides is evident from viewpoints along the road into the mountains from Geiro.

Remaining forest is mostly above 1600 m, although in the valleys around Mandege it reaches down to 1500 m, with the softwood plantation stretching considerably lower. The forest descended to 4000 feet (1300 m) in 1964, with *Brachystegia* woodland at lower altitudes. At that time there were also reports of numerous big game - elephants, buffalo, lions etc. (Friedmann and Stager 1964). According to local people these are now long gone.

The remaining forest is montane in character, but lacks a closed canopy. Friedmann and Stager (1964) suggested this was due to the relatively low rainfall combined with a history of logging. Many recent clearings exist, due to felling of medium-sized trees (i.e. 5-15 m tall).

3.3.3.3 Current Pressures

1 Encroachment
We found the population pressure much higher than Stuart and van der Willigen (1978) thought. Clearance for farmland is not occurring along the north-eastern margin of the Forest Reserve, where the boundary is clearly marked by a road or cordon of *Eucalyptus*, but is reportedly quite serious on the poorly demarcated southern and north-western boundaries (S. Malisa, verbally).

The loss of most forest cover from the Ukagurus is viewed locally as a major cause of the worsening water supply problems being experienced by people in the foothills and surrounding plains.

2 Collection of firewood

The farmland around the forest is virtually treeless with nearly all available land under cultivation, including very steep slopes and stream banks. According to Mr. Malisa, all the thousands of households in the area cut firewood inside the Forest Reserve, the only remaining forest area, each typically taking several trees a year. The cutting is illegal but without a short-term alternative it continues. The high and uncontrolled harvesting rate, mainly of medium sized trees (5-15 m high) is causing gross damage to the forest.

A very large softwood plantation (mostly of *Pinus radiata* and planted in the early 1960s) borders the forest. It is overmature and was not thinned so the timber is poor and the remoteness makes large scale extraction uneconomical (Mr Tangwa, verbally). A few carefully controlled pit-sawyers operate in the plantation, but the difficulty of getting the timber to distant markets limits their activities as well (S. Malisa, Mr Tangwa, verbally). This would seem a potential source of firewood for local people but cutting of standing timber is not permitted (nor feasible for farmers, since the trees are huge) and only chippings and offcuts from pit saw sites may be taken. Even though the government levy on these chippings is waived, few people use them - the natural forest is far closer for most.

3 Improved Communications

The Forest Department is lobbying for a new road to the lowlands to enable exploitation of the plantation. If it is built then pit-sawing of natural forest, currently negligible, would escalate and strict control would be needed.

4 Hunting

Trapping of frugivorous birds seemed popular, mainly for food. Bushpig and small antelope species (presumably including the Red Data Book species, Abbott's Duiker, if present) are hunted. The abundance of pigeons and turacos suggested little impact on them. Signs of mammals were also frequent in comparison with Mount Mtai (see Section 2.5).

3.4 CONSERVATION PROPOSALS

These proposals address the threats outlined in Section 3.3. Action is required chiefly by the Department of Forestry at national and regional levels, by the Forest Officers at local level and by the IUCN and WCST. The many justifications for protection of these forests are detailed in Section 3.2.

3.4.1 Proposals for Mt Mtai Forest Reserve

Mtai may one of the very few places in the Usambaras where there is still a chance to maintain good quality forest in a continuous band from 300m to 1100m altitude - lowland and transitional forest types still in contact over a broad area. The 930 ha of intact forest represents about a fifth of all the virgin forest in the East Usambaras.

To safeguard this forest and its associated benefits we recommend:

1 Make the Forest Reserve staff more effective.
Without this first step, none of the other recommendations can be implemented. The existing forest officer could benefit from more overt support from the Regional Office, and from the police when dealing with illegal activities in the forest. It may be possible to improve the pay and mobility of the Forest Officer, which would allow the forest to be patrolled more efficiently.

An increase in the number of patrol guards to two or three in addition to the nurseryman would provide the manpower to plant a tree cordon, patrol the proposed extension to the Forest Reserve and improve pit-sawing practices.

Enhanced social status for the Forest Officers and more overt presence in the Reserve would have a useful educational effect, reminding local people of the true importance of managing the forest for the common good.

2 Incorporate the rest of the forest into the Forest Reserve as soon as possible.
The management and protection of the forest will be hindered if it is divided between Forest Reserve and Public Lands. There appeared to be no inhabitants of the unprotected forest, so its inclusion in the Reserve should not be difficult. This was recommended by Hamilton and Bensted-Smith (1989) as one of the priorities for action in the East Usambaras as a whole.

3 Reduce the level of pit-sawing and improve practices
Current pit-saw activity on Mt Mtai is apparently not sustainable, and needs urgent reconsideration. There is an apparently excessive level of felling, on slopes too steep to be logged, in one of the few blocks of virgin forest in the East Usambaras. We noted little effort to ensure that suitable regeneration occurs, though this aspect was not investigated thoroughly.

The moratorium on pit-sawing in the Amani District could be extended to Maramba District as well.

Mt Mtai has large areas which should not be logged at all:
i) the 1200ha of 'intact forest' which is now a very scarce resource in the East Usambaras
ii) the extensive forest on 'inaccessible slopes' i.e. too steep and thus highly vulnerable to erosion, threatening catchment properties and regeneration

Map (4) indicates the areas not excluded by these criteria. Improved standards of forestry are required if these can be sustainably logged. A code of practice exists, and should be adhered to. This will require an effective, suitably equipped and motivated forestry staff with external support when required. Suggestions to this end are given above (point 1 above). In addition the felling quota would need to be re-evaluated for the areas which are still open to logging, erring on the side of caution in ensuring that over-exploitation does not damage the forest. The theoretical basis for planning sustainable yields is not strong, and damage from over-harvesting may prove irreversible.

4 The Forest Reserve boundary should be marked with a tree cordon to prevent encroachment.
A nursery of seedlings intended for this task exists in Maramba, but the forest officers will need more materials if they are to complete the task for the entire forest.

5 Support the extension of the IUCN/EEC Integrated Land-Use project to Maramba District

6 Enable local people to profit from the Forest Reserve
The Reserve is currently seen as being protected at the expense of local people for the benefit of outsiders; most of the income from pit-sawing goes to the external contractors (Hamilton and Bensted-Smith 1989). The Tanzanian authorities, through the medium of the IUCN/EEC project, are best equipped to tackle this problem. Detailed planning of any other sustainable exploitation will be difficult given the small area available for buffer zones, etc.

7 Examine the future of the three inhabited enclaves
This is likely to be a sensitive issue, but if it is not addressed the enclaves will grow and conflict with conservation interests will increase.

The inhabitants of the enclaves could perhaps be moved out, resettled with adequate compensation and the enclaves returned to forest. The budget of the Finnida-financed Catchment Project provides for generous compensation of locals. It is probable that alternatives exist, and these should be explored to find an option which will prove acceptable to all users of the forest.

8 Enforce ban on mechanical logging.
This can be far more damaging than pit-sawing, and the existing moratorium should in be made permanent. The arguments are discussed in detail in Hamilton and Bensted-Smith (1989).

3.4.2 Proposals for the Ukaguru Mountains

The forest could be a hugely valuable local resource indefinitely, and an excellent reserve for threatened species. To achieve this goal it will be necessary to:

1 Prevent further agricultural encroachment
This will be aided by completing the boundary tree cordon, a large task in itself, and improving land-use efficiency around the forest. This may be a suitable site for an externally funded integrated land-use project.

2 Stop the cutting of natural forest for firewood by creating alternative sources.
The local nurseryman, Sebastian Malisa, has detailed plans to step up his operation specifically for these purposes and to provide trees for the Forest Reserve boundary. The Wildlife Conservation Society of Tanzania has agreed to fund the project initially.

He will need additional manpower and external funding if the potential of this scheme is to be fully exploited.

This could a very cost-effective project, producing accurately targetted measures with minimal bureaucracy. The WCST should continue to support it, receiving funds from international conservation bodies if possible, and offering its valuable store of expertise on the education side of the project.

3 Make better use of the softwood plantation.
The role of the plantation could be reconsidered and efforts made to meet local firewood needs by harvesting it. A directive from the Department of Forestry may be required to allow this. The difficulties of getting firewood from the plantation to the farms at an economic price are great. The donation of a truck and fuel by some conservation body to the Forest Office would enable distribution of the softwood over a wide area.

4 Keep pit-sawing at a low level.
The operators should be closely monitored.

5 Evaluate the impact of illegal hunting on mammals and birds.
It may be feasible to allow controlled hunting of the larger birds, pigs and antelope.

6 Protect the catchment exposed during felling of the softwoods.
Otherwise the catchment currently protected by these trees will be highly vulnerable to erosion and flooding. The choice of replacement species will be an economic one, but serious consideration should be given to native hardwoods for conservation and biodiversity reasons.

3.5 SUGGESTIONS FOR FUTURE WORK

Large parts of the East Usambaras are still in need of systematic study. Two obvious candidates are the highest and lowest extremes, namely the 1500m Mt Nilo/Hundu and the lowland forests of Marimba Forest Reserve and the central valley of the East Usambaras. This last area was not covered by the various forest inventories of the 1980's and is wholly unprotected (Hamilton and Bensted-Smith 1989). There is clearly scope for finding new threatened species for the East Usambaras, even after years of ornithological coverage (see Cambridge Tanzania Rainforest Survey 1992, in prep.).

Visits in the rainy season have been few and far between, both here and elsewhere in the Eastern Arc. This leaves our knowledge of many groups, particularly seasonally dormant ones like insects and amphibians, incomplete.

Individual species to be searched for must include the Usambara Eagle Owl, which is still shrouded in mystery, and the several threatened birds not known in the Usambaras away from Amani, e.g. Dappled Mountain Robin and Long-Billed Apalis. A return visit to Mt Mtai in the breeding season might give a clearer idea of the abundance of Swynnerton's Forest Robin there. Another visit concentrating on field observation rather than netting, would probably reveal 20-30 more forest species.

There has been little recent study of the mammals of either study site - it is likely that further species of small mammal and bat remain to be described.

For amphibians, Appendix 2.1 indicates a low species total for the Uzungwa mountains. The Uzungwas are likely to have a herpetofauna of equivalent richness to their excellent avifauna and so the area would appear to be a high priority for future herpetological work.

Section 4: APPENDICES

Appendix 1. Birds

Appendix 1.1 Birds netted with brood patch indicating breeding (scoring 4 or 5)

Species	Site	No. (& sex)	Altitude (m)	Date
Bar-tailed Trogon *Apaloderma vittatum*	Ukagurus	1 male	1500	early Sept.
Moustached Green Tinkerbird *Pogoniulus leucomystax*	Ukagurus	1	1800	late Aug.
Shelley's Greenbul *Andropadus masukuensis*	Mtai	3	850 & 950	early Aug.
Shelley's Greenbul *Andropadus masukuensis*	Ukagurus	1	1800	late Aug.
Little Greenbul *Andropadus virens*	Ukagurus	2	1850	late Aug.
Nicator *Nicator chloris*	Mtai	1	350m	late July
Yellow-streaked Greenbul *Pyllastrephus flavostriatus*	Mtai	1	850m	early Aug.
Fülleborn's Black Boubou *Laniarius fuelleborni*	Ukagurus	2	1800 & 1850	late Aug. & early Sept.
Moreau's Sunbird *Nectarinia moreaui*	Ukagurus	6 females*	1800 & 1850	late Aug. & early Sept.
Olive Sunbird *Nectarinia olivacea*	Mtai	1 female	850m	early Aug.
Red-faced Crimson-wing *Cryptospiza reichenovii*	Ukagurus	1 male	1800m	late Aug.

*Six out of seventeen fully-grown females. None of the twenty-four fully-grown males had brood patches.

Appendix 1.2 Description of mist-netting sites and totals caught.

Site*	Altitude (m)	Habitat	No. Net-metre-hrs	No. birds caught	No. species
Mtai 1	350	Lowland Forest Edge	1825	30	13
Mtai 2	550	Lowland Forest Interior	1575	15	6
Mtai 3	900	Submontane Forest Edge (ridge-top)	1970	39	16
Mtai 4	950	Submontane Forest Interior (ridge-top)	1360	99	14
Mtai 5	850	Submontane Forest Interior	289	22	7
Subtotals			**7019**	**205**	**33**
Ukaguru 1	1800	Montane Forest Interior (+open road)	5555	106	23
Ukaguru 2	1850	Montane Forest Interior (+open road)	3615	70	17
Ukaguru 3	1500	Montane Forest Interior	5340	148	24
Subtotals			**14510**	**324**	**33**
TOTALS			**21529**	**529**	**53**

* Ringing sites were mapped and given a unique reference number. See Map 3.

Appendix 1.3 Mist-netting totals and sites for each species

Species	Mtai		Ukagurus	
	Number	Site(s)	Number	Site(s)
African Goshawk *Accipiter tachiro*	-		1	3
Tambourine Dove *Turtur tympanistria*	1	4	1	3
White-browed Coucal *Centropus superciliosus*	1	3	-	
Bar-tailed Trogon *Apaloderma vittatum*	-		1	3
Pygmy Kingfisher *Ispidina picta*	1	1	-	
Green Barbet *Stactolaema olivaceum*	3	3	-	
Moustached Green Tinkerbird *Pogoniulus leucomystax*	-		1	1
African Hill Babbler *Alcippe abyssinica*	-		12	1,2,3
Shelley's Greenbul *Andropadus masukuensis*	52	1,4,5	28	1,2,3
Stripe-cheeked Greenbul *A. milanjensis*	3	2,4	6	3
Mountain Greenbul *A. tephrolaemus*	-		3	1,2
Little Greenbul *A. virens*	31	1-5	17	1,2,3
Nicator *Nicator chloris*	1	1	-	
Yellow-streaked Greenbul *Phyllastrephus flavostriatus*	3	4,5	-	
Olive Mountain Greenbul *P. placidus*	11	2,4,5	36	1,2,3
Common Bulbul *Pycnonotus barbatus*	4	3	-	
White-chested Alethe *Alethe fuelleborni*	2	2,4	12	1,2,3
Robin Chat *Cossypha caffra*	-		2	1
Red-capped Robin Chat *C. natalensis*	3	1,3	-	
Olive-flanked Robin Chat *Dryocichloides anomalus*	-		2	1
Iringa Ground Robin *D. lowei*	-		5	1,2
Spot-throat *Modulatrix stictigula*	-		4	2,3
White-starred Forest Robin *Pogonocichla stellata*	-		8	1,2,3
Sharpe's Akalat *Sheppardia sharpei*	2	4	-	
Swynnerton's Forest Robin *Swynnertonia swynnertoni*	2	2	-	
Orange Ground Thrush *Turdus gurneyi*	-		1	1
Bar-throated Apalis *Apalis thoracica*	-		6	1,2,3
Mrs Moreau's Warbler *Bathmocercus winifrediae*	-		5	1,3
Evergreen Forest Warbler *Bradypterus barratti*	-		5	1,3
Grey-backed Camaroptera *Camaroptera brachyura*	6	1,3	-	
Red-capped Forest Warbler *Orthotomus metopias*	-		8	2,3
Tawny-flanked Prinia *Prinia subflava*	1	3	-	
White-eyed Slaty Flycatcher *Melaenornis chocolatina*	-		1	1
Forest Batis *Batis mixta*	4	2,4,5	26	1,2,3
Chin-spot Batis *B. molitor*	1	3	-	
Paradise Flycatcher *Terpsiphone viridis*	2	1,2	1	3
White-tailed Crested Flycatcher *Trochocercus albonotatus*	1	3	13	1,2,3
Crested Flycatcher *T. cyanomelas*	2	1,2	-	
Black-backed Puffback Shrike *Dryoscopus cubla*	1	3	-	
Fülleborn's Black Boubou *Laniarius fuelleborni*	-		7	1,2,3
Kenrick's Starling *Poeoptera kenricki*	1	3	-	
Collared Sunbird *Anthreptes collaris*	2	3	-	
Moreau's Sunbird *Nectarinia moreaui*	-		40	1,2,3
Olive Sunbird *N. olivacea*	41	1-5	31	1,2,3
Yellow White-eye *Zosterops senegalensis*	-		2	2
Dark-backed Weaver *Ploceus bicolor*	2	2	-	
Red-faced Crimson-wing *Cryptospiza reichenovii*	8	3,4,5	31	1,2,3
Common Waxbill *Estrilda astrild*	1	3	-	
Peter's Twinspot *Hypargos niveoguttatus*	1	1	-	
Green-backed Twinspot *Mandingoa nitidula*	5	3,4	2	3
Red-headed Bluebill *Spermophaga ruficapilla*	4	1,2,4	-	
Rufous-backed Mannikin *Lonchura bicolor*	2	3	-	
Oriole Finch *Linurgus olivaceus*	-		2	1,3

Appendix 1.4 Mist-netting capture rates

Species	Capture rate (No. birds per 10,000 net-metre-hours)	
	Mtai	Ukagurus
African Goshawk *Accipiter tachiro*	-	0.7
Tambourine Dove *Turtur tympanistria*	1.4	0.7
White-browed Coucal *Centropus superciliosus*	1.4	-
Bar-tailed Trogon *Apaloderma vittatum*	-	0.7
Pygmy Kingfisher *Ispidina picta*	1.4	-
Green Barbet *Stactolaema olivaceum*	4.3	-
Moustached Green Tinkerbird *Pogoniulus leucomystax*	-	0.7
African Hill Babbler *Alcippe abyssinica*	-	8.3
Shelley's Greenbul *Andropadus masukuensis*	73.8	19.3
Stripe-cheeked Greenbul *A. milanjensis*	4.3	4.1
Mountain Greenbul *A. tephrolaemus*	-	2.1
Little Greenbul *A. virens*	44.0	11.7
Nicator *Nicator chloris*	1.4	-
Yellow-streaked Greenbul *Phyllastrephus flavostriatus*	4.3	-
Olive Mountain Greenbul *P. placidus*	15.6	24.8
Common Bulbul *Pycnonotus barbatus*	5.7	-
White-chested Alethe *Alethe fuelleborni*	2.8	8.3
Robin Chat *Cossypha caffra*	-	1.4
Red-capped Robin Chat *C. natalensis*	4.3	-
Olive-flanked Robin Chat *Dryocichloides anomalus*	-	1.4
Iringa Ground Robin *D. lowei*	-	3.4
Spot-throat *Modulatrix stictigula*	-	2.8
White-starred Forest Robin *Pogonocichla stellata*	-	5.5
Sharpe's Akalat *Sheppardia sharpei*	2.8	-
Swynnerton's Forest Robin *Swynnertonia swynnertoni*	2.8	-
Orange Ground Thrush *Turdus gurneyi*	-	0.7
Bar-throated Apalis *Apalis thoracica*	-	4.1
Mrs Moreau's Warbler *Bathmocercus winifrediae*	-	3.4
Evergreen Forest Warbler *Bradypterus barratti*	-	3.4
Grey-backed Camaroptera *Camaroptera brachyura*	8.5	-
Red-capped Forest Warbler *Orthotomus metopias*	-	5.5
Tawny-flanked Prinia *Prinia subflava*	1.4	-
White-eyed Slaty Flycatcher *Melaenornis chocolatina*	-	0.7
Forest Batis *Batis mixta*	5.7	17.9
East Coast Batis *B. soror*	1.4	-
Paradise Flycatcher *Terpsiphone viridis*	2.8	0.7
White-tailed Crested Flycatcher *Trochocercus albonotatus*	1.4	8.9
Crested Flycatcher *T. cyanomelas*	2.8	-
Black-backed Puffback Shrike *Dryoscopus cubla*	1.4	-
Fülleborn's Black Boubou *Laniarius fuelleborni*	-	4.8
Kenrick's Starling *Poeoptera kenricki*	1.4	-
Collared Sunbird *Anthreptes collaris*	2.8	-
Moreau's Sunbird *Nectarinia moreaui*	-	27.6
Olive Sunbird *N.olivacea*	58.2	23.4
Yellow White-eye *Zosterops senegalensis*	-	1.4
Dark-backed Weaver *Ploceus bicolor*	2.8	-
Red-faced Crimson-wing *Cryptospiza reichenovii*	11.4	21.3
Common Waxbill *Estrilda astrild*	1.4	-
Peter's Twinspot *Hypargos niveoguttatus*	1.4	-
Green-backed Twinspot *Mandingoa nitidula*	7.1	1.4
Red-headed Bluebill *Spermophaga ruficapilla*	5.7	-
Rufous-backed Mannikin *Lonchura bicolor*	2.8	-
Oriole Finch *Linurgus olivaceus*	-	1.4

Appendix 1.5 Systematic List

The species included here are those recorded in, or over, forest, or in farmland enclaves surrounded by forest. Forest species are marked '*'. (The term 'forest species' is used here to describe those species dependant on forest but also includes those which can survive in other habitats; the definition used by Stuart, in Hamilton and Bensted-Smith 1989.) A rough indication of the abundance of each species is given on a scale of 1-6 (1 = recorded only once, 2 = recorded rarely, 3 = recorded occasionally, 4 = recorded regularly, 5 = common, 6 = abundant). A question mark indicates the identification was not 100% certain.

Species	Mtai	Ukagurus
Green Ibis *Bostrychia olivacea**	2	-
Palm-nut Vulture *Gypohierax angolensis*	4	-
Harrier Hawk *Polyboroides typus**	3	4
African Goshawk *Accipiter tachiro**	3	3
(One seen attacking and killing a netted Shelley's Greenbul *Andropadus masukuensis*.)		
Augur Buzzard *Buteo augur*	3	3
Mountain Buzzard *B. oreophilus**	-	5
Ayres' Hawk Eagle *Hieraaetus ayresii**	3	-
Long-crested Eagle *Lophaetus occipitalis*	3	-
Gabar Goshawk *Micronisus gabar*	1	-
(One melanistic bird seen in forest)		
Crowned Eagle *Stephanoaetus coronatus**	4	-
Hobby sp. *Falco subbuteo/cuvieri*	-	1
Olive Pigeon *Columba arquatrix**	1?	2
Bronze-naped Pigeon *C. delegorguei**	-	2
(Many unidentified pigeons seen in flight in the Ukagurus were probably this or the previous species)		
Wood Dove sp. *Turtur chalcospilos/afer*	5	-
Tambourine Dove *T. tympanistria**	5	1
African Green Pigeon *Treron calva**	4	2
Fischer's Turaco *Tauraco fischeri**	3	-
Livingstone's Turaco *T. livingstonii**	-	5
Emerald Cuckoo *Chrysococcyx cupreus**	3	-
Red Chested Cuckoo *Cuculus solitarius**	1	-
White-browed Coucal *Centropus superciliosus*	5	-
(One young bird netted in ridge-top forest having killed an Olive Sunbird *Nectarinia olivacea* in the same net. Being caught did not deter the coucal from eating most of the sunbird!)		
African Wood Owl *Strix woodfordii**	4	4
Usambara Eagle Owl *Bubo vosseleri**	1	-
Palm Swift *Cypsiurus parvus*	3	-
Narina's Trogon *Apaloderma narina**	3	-
Bar-tailed Trogon *A. vittatum**	-	3
Brown-hooded Kingfisher *Halcyon albiventris*	1	-
Pygmy Kingfisher *Ispidina picta**	1	-
Green Wood Hoopoe *Phoeniculus purpureus**	4	-
Silvery-cheeked Hornbill *Bycanistes brevis**	3	2
Trumpeter Hornbill *B. bucinator**	5	4
Crowned Hornbill *Tockus alboterminatus**	5	5
(No hornbills had been previously recorded from the Ukagurus (Stuart and van der Willigen 1979). We find this remarkable considering how conspicuous the three species were during our visit.)		
White-eared Barbet *Stactolaema leucotis**	6	-
Green Barbet *S. olivaceum**	5	-

Species	Mtai	Ukagurus
Moustached Green Tinkerbird *Pogoniulus leucomystax**	2	4
Green Tinkerbird *P. simplex**	4?	-
Lesser Honeyguide *Indicator minor*	1	2
Scaly-throated Honeyguide *I. variegatus**	1	1
Golden-tailed Woodpecker *Campethera abingoni**	3	-
Little-spotted Woodpecker *C. cailliautii**	3	-
Olive Woodpecker *Dendropicos griseocephalus**	-	1
African Broadbill *Smithornis capensis**	1	-
African Rock Martin *Hirundo fuligula*	3	3
Eurasian Swallow *H. rustica*	-	1
Black Rough-wing Swallow *Psalidoprocne pristoptera*	5	3
Square-tailed Drongo *Dicrurus ludwigii**	6	-
African Golden Oriole *Oriolus auratus*	4	-
Green-headed Oriole *O. chlorocephalus**	5	-
White-necked Raven *Corvus albicollis*	4	5
(On several dates in the Ukagurus, large numbers (up to 85) were seen flying over forest in the late afternoon, apparently towards a roost site.)		
African Hill Babbler *Alcippe abyssinica**	-	5
Black Cuckoo Shrike *Campephaga flava**	-	2
Grey Cuckoo Shrike *Coracina caesia**	5	-
Shelley's Greenbul *Andropadus masukuensis**	6	5
Stripe-cheeked Greenbul *A. milanjensis**	2	3
Mountain Greenbul *A. tephrolaemus**	-	4
Little Greenbul *A. virens**	6	5
Nicator *Nicator chloris**	2	-
Yellow-streaked Greenbul *Phyllastrephus flavostriatus**	3	-
Olive Mountain Greenbul *P. placidus**	5	6
Common Bulbul *Pycnonotus barbatus*	5	6
White-chested Alethe *Alethe fuelleborni**	2	5
Robin Chat *Cossypha caffra*	-	4
Red-capped Robin Chat *C. natalensis**	3	-
Olive-flanked Ground Robin *Dryocichloides anomalus**	-	2
Iringa Ground Robin *D. lowei**	-	4
Spot-throat *Modulatrix stictigula**	-	2
Red-tailed Ant Thrush *Neocossyphus rufus**	1	-
White-starred Forest Robin *Pogonocichla stellata**	-	4
Sharpe's Akalat *Sheppardia sharpei**	2	-
Swynnerton's Forest Robin *Swynnertonia swynnertoni**	2	-
Orange Ground Thrush *Turdus gurneyi**	-	1
Black-headed Apalis *Apalis melanocephala**	4	-
Chestnut-throated Apalis *A. porphyrolaema**	-	4
Bar-throated Apalis *A. thoracica**	-	5
Mrs Moreau's Warbler *Bathmocercus winifredae**	-	4
Evergreen Forest Warbler *Bradypterus barratti**	-	4
Grey-backed Camaroptera *Camaroptera brachyura**	5	-
Mountain Yellow Warbler *Chloropeta similis**	-	1
Red-capped Forest Warbler *Orthotomus metopias**	-	4
Tawny-flanked Prinia *Prinia subflava*	1	-
White-eyed Slaty Flycatcher *Melaenornis chocolatina*	-	4
Dusky Flycatcher *Muscicapa adusta**	2	3
Forest Batis *Batis mixta**	3	6
East Coast Batis *B. (molitor) soror*	2	-
Black and White Flycatcher *Bias musicus**	2	-
Black-throated Wattle-eye *Platysteira peltata*	4?	1
Little Yellow Flycatcher *Erythrocercus holochlorus**	5	-
Paradise Flycatcher *Terpsiphone viridis**	3	2

Species	Mtai	Ukagurus
White-tailed Crested Flycatcher *Trochocercus albonotatus**	1	5
Crested Flycatcher *T. cyanomelas**	3	-
Mountain Wagtail *Motacilla clara*	3	-
Black-backed Puffback Shrike *Dryoscopus cubla**	2	3
Tropical Boubou *Laniarius ferrugineus*	3	-
Fülleborn's Black Boubou *L. fuelleborni**	-	4
Black-fronted Bush Shrike *Malaconotus multicolor**	3	4
(The yellow-breasted form was seen at Mtai. Both pink- and yellow-breasted forms were seen in the Ukagurus.)		
Chestnut-fronted Helmet Shrike *Prionops scopifrons**	3	-
Violet-backed Starling *Cinnyricinclus leucogaster**	3	-
Black-breasted Glossy Starling *Lamprotornis corruscus**	3	-
Red-winged Starling *Onychognathus morio**	4	2
Slender-billed Chestnut-winged Starling *O. tenuirostris**	-	3
Kenrick's Starling *Poeoptera kenricki**	5	-
Collared Sunbird *Anthreptes collaris**	5	-
Uluguru Violet-backed Sunbird *A. neglectus**	1	-
Plain-backed Sunbird *A. reichenowi**	1	-
Banded Green Sunbird *A. rubritorques**	3	-
Amethyst Sunbird *Nectarinia amethystina*	3	-
Moreau's Sunbird *N. moreaui**	-	6
Olive Sunbird *N. olivacea**	6	6
Variable Sunbird *N. venusta*	-	3
Yellow White-eye *Zosterops senegalensis**	3	6
Dark-backed Weaver *Ploceus bicolor**	6	-
Red-faced Crimson-wing *Cryptospiza reichenovii**	4	6
Waxbill *Estrilda astrild*	5	-
Peter's Twinspot *Hypargos niveoguttatus**	2	-
Green-backed Twinspot *Mandingoa nitidula**	3	2
Red-headed Bluebill *Spermophaga ruficapilla**	3	-
Rufous-backed Mannikin *Lonchura bicolor*	5	-
Oriole Finch *Linurgus olivaceus**	-	3
Yellow-fronted Canary *Serinus mozambicus*	3	-
Total species number	91	62
Number of forest species	68	51

Currently known forest avifaunas:
East Usambaras: 110 (Stuart, in Hamilton and Bensted-Smith 1989)
Ukagurus: 51 (this report)

Appendix 1.6 Bird species considered endemic to the Eastern Arc (The Eastern Arc as defined on Map 1):

Usambara Eagle Owl *Bubo vosseleri*
White-chested Alethe *Alethe fuelleborni*
Olive-flanked Ground Robin *Dryocichloides anomalus*
Iringa Ground Robin *Dryocichloides lowei*
Usambara Ground Robin *Dryocichloides montanus*
Dappled Mountain Robin *Modulatrix orostruthus*
Spot-throat *Modulatrix stictigula*
Sharpe's Akalat *Sheppardia sharpei*
Long-billed Apalis *Apalis moreaui*
Mrs Moreau's Warbler *Bathmocercus winifredae*
Red-capped Forest Warbler *Orthotomus metopias*
Fülleborn's Black Boubou *Laniarius fuelleborni*
Uluguru Bush Shrike *Malaconotus alius*
Banded Green Sunbird *Anthreptes rubritorques*
Loveridge's Sunbird *Nectarinia loveridgei*
Moreau's Sunbird *Nectarinia moreaui*
Rufous-winged Sunbird *Nectarinia rufipennis*
Tanzanian Mountain Weaver *Ploceus nicolli*

Appendix 2. Amphibians and Reptiles

Appendix 2.1 Eastern Arc amphibian species list (not including Caecilians).

Species	Mt	Us	Ng	Ul	Uk	Uz	Rg	Other
Total Species no. for each area:	12	22	1	17	7	14	8	-
Leptopelis ulugurensis	+	+	-	+	-	+	-	
L. vermiculatus	-	+	-	-	+	-	+	-
L. parkeri	-	+	-	+	-	-	-	-
L. barbouri	+	+	-	-	-	+	-	-
L. flavomaculatus	+	-	-	-	-	-	-	Coastal K.Zi.Moz.
Afrixalus ulugurensis	+	+	-	+	+	+	-	-
Hyperolius tanneri	-	W*	-	-	-	-	-	-
H. spinigularis	-	+	-	-	-	-	-	-
H. sp. nov.	-	+	-	-	-	-	-	-
H. puncticulatus	-	+	-	+	+	+	+	Coastal K. to Ma.
H. mitchelli	-	+	-	-	-	-	-	-
H. minutissimus	-	-	-	-	-	-	+	Southern Tz.
H. tornieri	-	-	-	*	-	-	-	-
Phlyctimantis keithae	-	-	-	-	-	*	-	-
Nectophrynoides tornieri	+	+	-	+	-	-	+	-
N. viviparus	-	-	-	+	-	+	+	-
N. minutus	-	-	-	*	+	-	-	-
N. cryptus	-	+	-	+	-	+	-	-
N. wendyae	-	-	-	-	-	*	-	-
Callulina kreffti	+	+	+	+	+	+	-	-
Probreviceps macrodactylus	+	+	-	+	-	-	+	-
P. ulugurensis	-	-	-	+	-	-	-	-
Hoplophryne rogersi	-	+	-	-	-	-	-	-
H. ulugurensis	-	-	-	+	-	-	-	-
Parhoplophryne usambarica	-	+	-	-	-	-	-	-
Arthroleptitides martiensenni	+	+	-	+	-	+	-	-
Phrynobatrachus kreffti	-	+	-	-	-	-	-	-
P. acridoides	+	-	-	-	-	-	-	E. Af. to Natal
P. ukingensis	-	-	-	-	-	-	+	Ukinga,Misuku
Phrynobatrachus uzungwensis	-	-	-	+	-	+	-	-
Arthroleptis affinis	+	+	-	-	-	+	-	-
A. reichei	-	-	-	+	+	+	+	Poroto & Mal.
A. tanneri	-	W	-	-	-	-	-	-
A. stenodactylus	+	-	-	-	-	-	-	Za. K. Zi. Moz.
Bufo uzungwensis	-	+	-	-	-	+	-	SW Tz. >1800 m
Bufo brauni	+	+	-	+	-	-	-	-
Strongylopus fasciata	-	-	-	-	+	-	-	Rep.S.Afr to N.Tz

Abbreviations used in table 1:

Eastern Arc Forests:	Mt.=Mtai, Us.=Usambaras (W=West Usambaras only), Ng.=Ngurus, Ulu.=Ulugurus, Uk.=Ukagurus, Uz.=Uzungwa, Ru.=Rungwe.
Other Forests:	Misuku forest is in Malawi, Poroto forest, Ukinga forest and the Magrotto Mts.are all in Tanzania.
Country abbreviations:	K.=Kenya, Ma.=Malawi, Moz=Mozambique, Rep.S.Afr.=Republic of South Africa, Tz=Tanzania, Za=Zaire, Zi=Zimbabwe.
Code:	'+' =present, '*' =only known from type locality, '-' =not listed for site.

Appendix 2.2 Mtai Amphibian species list.

Species	Alt. Range (m)	Abundance 350m	Abundance 1000m	Habits	Common mode of detection
Leptopelis ulugurensis	350-1100	R	C	A	Call/seen on open leaves
L. barbouri	350	R	-	A	Seen on open leaves
L. flavomaculatus	350	R	-	A	Found at night
Afrixalus ulugurensis	1000	-	R	A	Banana leaf axil
Nectophrynoides tornieri	350-1100	VC	VC	A	Call/*Dracaena* leaf axils
Callulina kreffti	350-1100	R	VC	G/A	Call/Climbing at night
Probreviceps macrodactylus	1100	-	R	G	Under log
Bufo brauni	350	C	-	G/S	Calling in pools
Arthroleptis affinis	600-1000	U	U	G/S	Streams/Forest floor
A. stenodactylus	300-650	VC	-	S	By streams
A./Schoutedenella sp.	650	-	-	S	Under rock by stream
Arthroleptides martiensenii	350-650	VC	-	S	By streams
Phrynobatrachus acridoides	300-650	U	U	S	Around streams
Caecilian sp.	350-1100	R	R	G/B	Under logs

Appendix 2.3 Mtai Forest Chamaeleon species list.

Species (Common Name)	Altitudinal Range (m)	Habits
Bradypodion tenue (Single Soft-horned)	950	A
Rhampholeon brevicaudata (Bearded Pygmy)	350-1100	G
R. temporalis (Pitted Pygmy)	850	G

Appendix 2.4 Ukaguru amphibian species list.

Species	Alt. Range (m)	Abundance 1450m	Abundance 1850m	Habits	Common mode of detection
Leptopelis vermiculatus	1400-1500	C	-	A	Call
Hyperolius puncticulatus	1400-1500	C	R	AP	Banana leaf axils
Afrixalus ulugurensis	1400-1850	C	R	AP	Banana leaf axils
Nectophrynoides minutus	1850-2200	-	C	G	Call
Callulina kreffti	1450-2200	C	R	G/A	Call/Banana leaf axils
Arthroleptis reichei	1450	VC	-	G/SP	Streams/Call
A. /Schoutedenella sp.	1400-1500	VC	-	GP	Search
Strongylopus fasciata	1850	-	R	G	Found at night
Caecilian sp.	1500-1850	R	R	G/B	Under rocks/After rain

Appendix 2.5 Ukaguru Forest Chamaeleon species list.

Species (Common Name)	Altitudinal Range (m)	Habits
Chamaeleo werneri (Uzungwa Three-horned)	1400-1850	A
Rhampholeon nr *platyceps* (Flat-headed Pygmy)	1450-1550	G

Abbreviations used in appendices 2.2-2.5:

Alt. Range: the altitudinal range within which we found the species.
Relative Abundance: VC=Very Common, C=Common, R=Rare, U=Abundance Uncertain, dash=Not Found. Relative abundances are given, in broad terms, for the best studied altitudes (i.e. the altitudes of our two campsites). To quantify these abundance labels to some degree; VC suggests one would be able to find a specimen after a few minutes searching, C suggests the species would be encountered on most days in the field and R suggests that no more than five specimens were found during our time in the forest.
Habits: A=Arboreal, G=Ground, S=Near Streams, B=Burrowing, P=Found also in pine plantation (Ukagurus only, where the plantation makes up a large proportion of the total forest cover).

Appendix 3. Butterflies

Appendix 3.1 Checklist of butterflies of Mtai Forest Reserve with data on status and habitat. A comparison with altitudes in Kielland (1990 and undated) is included.

Family, Genus & Species	Status	Habitat	Altitudinal Range (m)	
			Keilland	Mtai
PAPILIONIDAE				
Papilio Lin.				
P. dardanus tibullus K.	ox	lsf., fm	0-2100	300-1060
P. demodocus demodocus E.	xx	c, fm	0-2600	300-900
P. desmondi usambaraensis Ko.*	o	sf	300-2600	900-1060
P. echerioides Tri.?	o	sf	1400-2200	900-1060
P. fülleborni Kar.?	o	sf	1000-2200	900-1060
P. hornimani Di.	oo	lsf	400-2200	350-1060
P. nireus lyaeus D.	ox	c, fm	0-1500	300
P. ophidicephalus O.	ox	rv, lf	0-2000	300-450
P. pelodurus vesper Le C.	ox	sf	300-2000	850-1060
P. rex O.	o	sf	1400-2600	900-1060
Graphium Sco.				
G. angolanus angolanus Go.	ox	c	0-2200	300
G. leonidas leonidas F.	ox	lsf., c	0-2200	300-1060
G. philonoe philonoe W.	ox	fm	0-2140	300
G. policenes Cr.	ox	lsf	0-2000	300-1060
PIERIDAE				
Catopsilia H.				
C. florella F.	ox	c., fm	0-2500	300-850
Eurema H.				
E. brigitta Cr.	ox	c, g	0-2400	300-850
E. desjardinsi marshalli Bu.	xx	sf	400-2500	850-1000
E. floricola nr. *floricola* Bois.	xx	lsf	0-1200	300-(900)
E. hecabe solifera Bu.	xx	fm, lsf, c	0-2200	300-950
E. regularis Bu.	ox	c, fm	300-1800	300-850
Pinacopteryx Wall.				
P. eriphia melanarge Bu.	ox	c	500-2000	300
Nepheronia Bu.				
N. argia mhondana S.	ox	rv, lsf	75-2000	300-1060
N. thalassina Bois.	ox	rv, lsf	0-1700	300-1060
Eronia H.				
E. cleodora dilatata Bu.	ox	lsf	0-1200	300-1060
E. leda Bu.	ox	fm	75-2100	300
Colotis H.				
C. evagore antigone Bois.	ox	g, c	0-1800	300
C. evenina sipylus Sw.	ox	c	0-1950	300
C. evippe omphale God.	ox	g, c	0-1900	300
C. vesta catachrysops Bu.	ox	g, c	0-1500	300
Belenois H.				
B. aurota aurota Fa.	ox	c, g	0-2600	300
B. creona severina Stol.	ox	c, g	0-2600	300
B. gidica God.	xx	c, fm	0-2100	300-1060
B. thysa Ho.	xx	fm., c	0-2600	300-850
Dixeia T.				
D. spilleri Spil.	ox	rv, fm	0-1700	300-450
Appias H.				
A. epaphia contracta Bu.	ox	lf	0-2100	300
A. lasti Gr.	ox	lf., fm	0-870	300-850
A. sabina phoebe Bu.	ox	lsf	250-2200	300-1060
Mylothris H.				
M. agathina Cr.	ox	fm, c	0-2200	300-850

Appendix 3.1 continued

Family, Genus & Species	Status	Habitat	Altitudinal Range (m)	
			Keilland	Mtai
M. kilimensis Kie.	xx	fm, sf	900-2000	850-1060
M. sagala narcissus Bu.	oo	sf	900-2500	950-1060
Leptosia H.				
L. alcesta inalcesta Ber.	ox	rv, lf	0-1850	300-450
ACRAEIDAE				
Bematistes Hem.				
B. adrasta Wey.	ox	lsf	200-1250	400-1060
B. epaea epitellus Sta.	xx	lsf	0-1750	300-1060
B. quadricolor nr. *leptis* Jor.	oo	sf	1000-2150	1060
Acraea F.				
A. acara Hew.	ox	c	0-1800	850
A. cabira Ho.	ox	c, fm, sf	0-2100	750-900
A. caecilia pudora Aur.	ox	c, fm	0-1950	850
A. conradti conradti O.	o	lf	1000-1500	650
A. egina areca Ma.	ox	fm, c	0-1800	300-850
A. encedon Lin.	ox	c	0-2100	300
A. eponina Cr.	ox	c	0-1100	300
A. esebria Hew.	ox	rv, lf, fm	0-2000	300
A. igola Tri.	oo	(l)sf	0-1200	750-900
A. insignis Di.	xx	lsf	0-2300	300-1060
A. johnstoni johnstoni God.	xx	rv, lsf, c	0-2150	300-1000
A. natalica natalica Bois.	ox	c	0-2000	300
A. neobule D. &. Wes.	ox	c	0-2200	750
A. orestia sambar Sto.	o	lf	no record	300-1060
A. pharsalus pharsaloides Holl.	xx	rv, lsf	600-1500	300-1000
A. quirina rosa Elt.	ox	rv, lf	0-1800	350-850
A. servona orientis Aur.	oo	lsf	250-1700	300-1060
DANAIDAE				
Danaus Kl.				
D. chrysippus Lin.	ox	fm, c	0-2200	300-1060
D. petiverana D. & Hew.	ox	lf, c	400-1600	300-650
Amauris H.				
A. albimaculata hanningtoni Bu.	ox	lsf	800-1800	450-1060
A. niavius dominicanus Tri.	xx	rv, lf	0-2340	300-800
A. ochlea ochlea Bois.	xx	rv, lf	0-1000	300-650
SATYRIDAE				
Gnophodes Wes.				
G. betsimena diversa Bu.	ox	lsf	0-1600	300-1000
Melantis F.				
M. leda africana Fr.	xx	lsf	0-2000	300-1000
Bicyclus K.				
B. campinus ocelligerus Str.	xx	lsf	?-2000	300-1000
B. dankelmani Rog.	ox	sf	800-1800	900-1060
B. safitza Hew.	xx	fm, c	0-2200	300-850
Henotesia Bu.				
H. perspicua Tri.	xx	c, g	0-2150	300-850
Ypthima H.				
Y. granulosa Bu.	oo	c, g	0-2000	300
Physcaeneura Wall.				
P. jacksoni Car.	xx	g, c	0-1500	300-850
NYMPHALIDAE				
Lachnoptera D.				
L. iole ayresi Tri.	ox	lf, fm	0-2000	300-550

Appendix 3.1 continued

Family, Genus & Species	Status	Habitat	Altitudinal Range (m)	
			Keilland	Mtai
Phalantha Hor.				
P. eurytis D.	ox	lsf, fm, c	0-2100	300-1060
P. phalanta Dr.	ox	lf, fm, c	0-2600	300
Apaturopsis Aur.				
A. cleochares schultzei Schm.	o	lf	300-700	350
Hypolimnas H.				
H. antevorta Di.	ox	lf	1000	300-650
H. deceptor Tri.	xx	lf, fm	0-900	300-850
H. dubius wahlbergi Wall.	xx	lf, fm	0-1700	300-850
H. misippus Lin.	ox	fm, c	0-2300	300-900
H. usambara W.	o	rv	75-1000	350
Salamis Bois.				
S. anacardii Lin.	ox	fm, lsf, c	0-2200	300-1000
S. parhassus Dr.	ox	fm, lsf, c	0-2400	300-1000
Junonia H.				
J. hierta cebrene Tri.	ox	c, g	0-2300	300
J. natalica Fel.	ox	c, g	0-2200	300
J. oenone Lin.	ox	c, g	no rec.	300
J. terea elgiva Hew.	ox	c, g, fm	0-2200	800-900
Precis H.				
P. actia	ox	c, g	250-2000	300-850
P. octavia sesamus Tri.	ox	c, g	800-2600	850
P. sinuata	ox	(ls)f, fm, c	300-1500	850
P. tugela aurorina Bu.	oo	sf, fm	350-2500	850-1060
Vanessa F.				
V. cardui Lin.	ox	c, g	0-3000	300-850
Antanartia Ro. & Jor.				
A. dimorphica How.	o	sf	1500-2700	1060
Byblia H.				
B. anvatara acheloia Wall.	ox	c, g	0-?	300
B. ilithyia Dr.	ox	c, g	0-1800	300-850
Neptidopsis Aur.				
N. ophione velleda Ma.	xx	(l)sf, fm, c	0-2200	750-1060
Eurytela Bois.				
E. dryope angulata Aur.	xx	c, f	0-2200	300-1060
E. hiarbas lita Ro. & Jor.	xx	sf	800-2200	850-1060
Sallya Hem.				
S. moranti Tri. ssp.?	ox	lsf	0-1800	300-1000
S. natalensis Bois.	ox	lf	0-1600	350
Cyrestis Bois.				
C. camillus sublineata La.	oo	rv	0-1600	350
Neptis F.				
N. alta Ov.	ox	c	300-2000	300
N. aurivillii Sch.	ox	sf	800-2400	800-1060
N. carcassoni van S.	oo	lf	200-850	450
N. goochi Tri.	xx	lf	0-1500	300-750
N. laeta Ov.	ox	fm, c	0-2200	750-1000
N. nina Stau.	xx	sf	0-2140	850-1060
N. saclava marpesa Ho.	xx	lsf, fm	0-2200	300-1060
N. serena Ov.	xx	lf	0-2000	300-850
Cymothoe H.				
C. amaniensis Ry.	ox	sf	900-1200	950-1060
Euptera Stau.				
E. kinungnana Gr.	xx	lf	0-1000	300-750
Euryphura Stau.				
E. achlys Ho.	ox	lf, fm	0-1100	300

Appendix 3.1 continued

Family, Genus & Species	Status	Habitat	Altitudinal Range (m)	
			Keilland	Mtai
Bebearia Hem.				
B. chriemhilda Stau.	ox	lsf	0-1000	300-1060
B. orientis Kar.	ox	fm, c	0-1100	300(800)
Euphaedra H.				
E. neophron littoralis T.	xx	c, fm, lf	400-1600	300-1000
Hamanumida H.				
H. daedalus F.	ox	c	0-?	300
Aterica Bois.				
A. galene theophanes Ho.	xx	c, fm, lf	0-1800	300-1000
Catuna K.				
C. sikorana Rog.	ox	fm, lf	250-1200	300-900
Pseudacraea D.				
Ps. boisduvali trimeni Bu.	ox	sf, fm	0-2150	1060
Ps. dolomena usagara Stau.	ox	lsf, fm	300-2000	300-900
Ps. eurytus conradti O.	ox	lsf	0-1200	350-850
Ps. lucretia expansa Bu.	xx	lsf	0-2200	300-800
Charaxes Och.				
Ch. acuminatus usambarensis van So.	xx	lsf	500-1800	300-1060
Ch. aubyni aubyni van So. & Jac.	oo	sf	400-2400	1060
Ch. baumanni ssp.?	oo	sf	0-2000	1060
Ch. brutus alcyone Sto.	xx	lsf	0-2600	300-1060
Ch. candiope God.	xx	lf, fm, c	0-2600	0-900
Ch. cithaeron kennethi Pou.	xx	lf	0-800	0-1000
Ch. dilutus amanica Col.	o	rv	1000-1300	350
Ch. ethalion ssp.? *littoralis* van So.	oo	lf	0-2000	300-1060
Ch. lasti Gr.	ox	lf	0-900	300-450
Ch. pleione oriens Pl..	ox	lf	250-1600	300-450
Ch. pollux mirabilis Tu.	ox	lsf	1200-2100	300-1060
Ch. protoclea azota Hew.	oo	lsf	0-1700	300-1060
Ch. tavetensis Ro.	oo	lf, c	0-1500	300
Ch. usambarae van So. & Jac.	o	rv	800-?	350 (1060?)
Ch. varanes vologeses Ma.	oo	lf, c	0-2300	300-1000
Ch. violetta maritimus van So.	ox	lf	0-850	300-550
Ch. zoolina Wes.	oo	fm, c	0-2140	300
Euxanthe H.				
E. tiberius Gr.	o	lf	0-1350	350
E. wakefieldi W.	ox	fm, lsf	0-600	300-1060
LIBYTHEIDAE				
Libythea Lind.				
L. labdaca laius Tri.	oo	rv	0-2000	300
LYCAENIDAE				
Alaena Bois.				
A. nyassa major O.	o	g	300-1200	300
A. picata Sha.	oo	lf	300-1500	400
Pentila Wes.				
P. rogersi parapetreia Re.	ox	lf	0-900	350-900
P. tropicalis mombasae Gr. & K.	o	fm	0-900	300
Teriomima K.				
T. micra Gr.	oo	lf	no record	350-450
T. subpunctata K.	oo	lf	0-1200	500
Euthecta Ben.				
E. cooksoni Benn.	ox	lsf	(750-870)	300-1060
Baliochila Stem. & Ben.				
B. amanica Stem. & Ben.?	o	lf	0-1100	350
B. latimarginata Ha.?	o	lf	0-800	350

Appendix 3.1 continued

Family, Genus & Species	Status	Habitat	Altitudinal Range (m)	
			Keilland	Mtai
Spalgis Mo.				
S. lemolea Dr.	ox	c	0-1800	300
Lachnocnema Trì.				
L. bibulus Fa.	ox	c	0-2000	300
Myrina F.				
M. silenus ficedula Tri.	oo	fm	75-1600	300
Axiocerses H.				
A. styx Re.	o	lf	0-1300	400
Epamera Dr.				
E. nolaensis amanica Stem.	oo	sf	300-1000	1060
Hypolycaena Fel.				
H. buxtoni rogersi Bet.	ox	lf	0-1500	300-550
H. philippus F.	ox	c	0-2000	300
Anthene				
A. definita Bu.	ox	sf	0-2200	1000
A. indefinita Bet.	ox	lf	500-2400	450-850
A. kersteni Ger.	ox	fm, f, c	0-1800	600
A. larydas Cr.	xx	lf, fm, c	300-1700	300-650
A. lemnos loa Stran.	xx	l(s)f	0-1900	300-850
A. rubrimaculata Stran.	xx	lf	0-2100	300-650
Cupidopsis Kar.				
C. cissus God.	ox	c	0-2400	300
Petrelaea To.				
P. sichela Wall.	oo	lf	0-2000	650
Lampides H.				
L. boeticus Lin.	ox	c, g	0-2200	300-1060
Uranothauma Bu.				
U. falkensteini Dew.	o	rv	800-2200	320
Cacyreus Bu.				
C. lingeus Stol.	ox	fm, c	0-2300	300-1060
C. virilis Aur.	ox	fm, c	0-2200	850
Leptotes Scu.				
L. pirithous Lin.	ox	fm, c	0-2200	300-850
Tuxentius Lar.				
T. stempfferi Kie.	oo	lf	300-1900	650
Zizina Ch.				
Z. antanossa Ma.	xx	c, g	75-1700	300-850
Zizeeria Ch.				
Z. knysna Tri.	ox	c	0-2100	300
Zizula Ch.				
Z. hylax F.	ox	c, g	0-2600	300-850
Eicochrysops Bet.				
E. hippocrates F.	oo	fm	0-2500	1000
Euchrysops Bu.				
E. subpallida Bet.	ox	c, g	0-2000	300-850
Lepidochrysops Hed.				
L. peculiaris Rog.	oo	c, fm	0-300	300
Thermoniphas Ka.				
T. micylus colorata U.	xx	lsf, fm	0-1500	300-1060
Oboronia Ka.				
O. bueronica Ka.	xx	rv, lf	250-1100	300-850
HESPERIIDAE				
Coeliades H.				
C. chalybe Wes.	ox	lsf	700-1800	300-1000
C. forestan Cr.	ox	fm, c	0-2600	300-850
C. sejuncta Ma. & Vu.	ox	rv, fm, c	0-2100	850

Appendix 3.1 continued

Family, Genus & Species	Status	Habitat	Altitudinal Range (m)	
			Keilland	Mtai
Celaenorrhinus H.				
C. galenus F.	oo	lsf	300-2400	350-1000
Celaenorrhinus sp.	o	rv	—	350
Tagiades H.				
T. flesus F.	ox	lf	0-2200	300-800
Eagris Gue.				
E. sabadius astoria Hol.	ox	sf	800-2600	1000
Eretis Ma.				
E. melania Ma.	ox	fm, sf	360-2000	850
Sarangesa Mo.				
S. maculata Ma.	ox	lsf	0-1700	300-1000
Netrobalane Ma.				
N. canopus Tri.	oo	fm	0-1700	300
Spialia Sw.				
S. confusa obscura Hi.	ox	fm	0-500	300
Metisella Hem.				
M. orientalis Aur.	ox	fm, sf	800-2700	900-1000
Gorgyra Hol.				
G. subfacatus vosseleri Gru.	ox	sf	900-1200	1000
Ceratrichia Bu.				
C. bonga Ev.	ox	lf	1000	300-450
Pardaleodes Bu.				
P. incerta Sn.	ox	fm, (l)sf	0-2000	750-900
Acleros Ma.				
A. mackenii Tri.	ox	fm	0-2000	350
A. ploetzi Ma.	ox	fm	300-1600	350
Semalea Hol.				
S. pulvina Pl.	ox	sf	400-2000	1000
Andronymus Hol.				
A. caesar philander Hop.	ox	fm	0-1500	300
Chondrolepis Ma.				
C. niveicornis Pl.	ox	lf	800-2200	400-850
Monza Ev.				
M. punctata Aur.	ox	(l)sf	300-1700	750-1000
Platylesches Hol.				
P. picanini Hol.	o	rv	300-2000	350
Zenonia Ev.				
Z. zeno Tri.	ox	fm, c	400-2600	750-950
Borbo Ev.				
B. fatuellus Ho.	xx	lf	0-2100	300-650
B. lugens Hop.	ox	fm, lsf	0-2000	300-1000

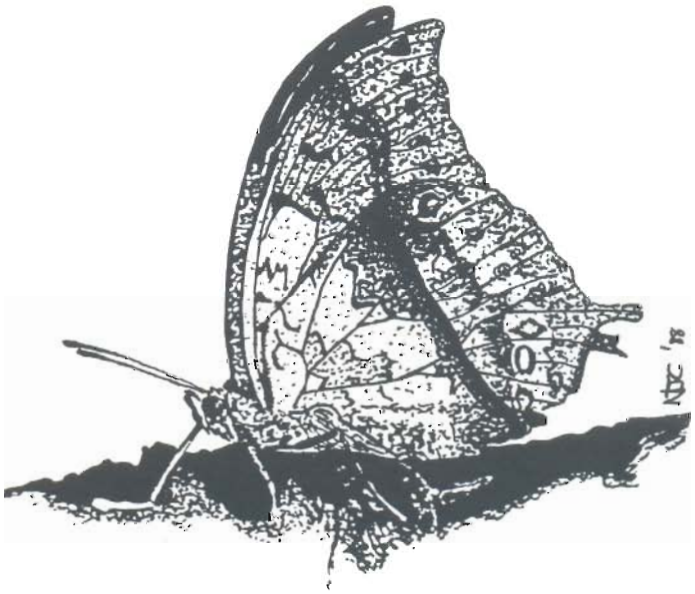
Abbreviations and notes:

(1) Species status at Mtai: o = rare, oo = uncommon, ox = common, xx = very common
(2) Habitat: lf = lowland forest, sf = submontane forest, lsf = lowland/submonatane forest, fm = forest margin, c = cultivation, rv = riverine vegetation, g = grassy area
(3) A "?" after a taxon implies that identification is uncertain.
(4) *Baliochila latimarginata* or *B. ansorgei*. A female specimen taken at 350m, in the mid-stratum of forest, could not be distinguished between the two *Baliochila* species by Kielland (*in litt.*).
* *Papilio desmondi usambaraensis*. Kielland (1990) records this species from the Usambaras where it is confined to montane forest and forest margins. Several observations of a tail-less swallowtail at the summit suggested that this species occurs at Mtai but due to its strong erratic flight and relative scarcity, no specimens were obtained for verification.
(5) Full names of authors, abreviated here are given in Appendix 3.2

Appendix 3.2 Abbreviations of authors' names used in Appendix 3.1.

Aur - Aurivillius
Benn - Bennett
Ber - Bernardi
Bet - Bethune-Baker
Bois - Boisduval
Bu - Butler
Car - Carcasson
Ch - Chapman
Col - Collins
Cr - Cramer
D - Doubleday
Dew - Dewitz
Di - Distant
Dr - Drury
E - Esper
Elt - Eltringham
Ev - Evans
F - Fabricius
Fel - Felder
Fr - Fruhstorfer
Ger - Gerstaecker
Go - Goeze
God - Godart
Gr - Grose-Smith
Gru - Grünberg
Gue - Guenee
H - Hübner
Hed - Hedicke
Hem - Hemming
Hew - Hewitson
Hi - Higgins
Ho - Hopffer
Hol - Holland
Hor - Horsfield
How - Howarth
Jac - Jackson
Jor- Jordan
K - Kirby
Kar - Karsch
Kie - Kielland
Kl - Klug
Ko - Koçak
La - Lathy
Lar - Larsen
Le C - Le Cerf
Lin - Linnaeus
Lind - Lindsey
Ma - Mabille
Mo - Moore
O - Oberthür
Och - Ochsenheimer
Ov - Overlaet
Pl - Plantrou
Pl - Plötz
Pou - Poulton
Re - Rebel
Ri - Riley
Ro - Rothschild
Rog - Rogenhöfer
Ry - Rydon
S - Suffert
Sch - Schultze
Schm - Schmidt
Sco - Scopoli
Scu - Scudder
Sh - Sharpe
Sn - Snellen
Spil - Spiller
Stau - Staudinger
Stem - Stempffer
Sto - Stoneham
Stol - Stoll
Str - Strand
Sw - Swinhoe
T - Talbot
To - Toxopeus
Tri - Trimen
Tu - Turlin
U - Ungemach
van S - van Son
van Som - van Someren
Vu - Vuillot
W - Ward
Wall - Wallengren
Wes - Westwood
Wey - Weymer

Plate 4.
Charaxes acuminatus usambaraensis



Appendix 3.3 Usambara endemic species and races (Mtai records are denoted by a •). [NB Three taxa marked with a ? are probable endemics and are discussed in Section 2.3.4.2.]

Species/Subspecies	Habitat	Altitudinal Range (m)	EU	WU
Mylothris kiellandi	hf	1800-2200		x
Aphysoneura p. pigmentaria	sf, hf	800-2200	x	x
Neocoenynra parallelopupillata	hf	2200		x
Charaxes ansorgei rydoni	hf	1000-2200	x	x
Ch baumanni ssp.?	f	1060	x•	x
Ch. dilutus amanica	sf, hf	350-1300	x•	x
Ch. l. lucyae	hf	1500-2100		x
Ch. u. usambarae	sf, hf	350-(800+)?	x•	x
Cymothoe amaniensis	sf	900-1200	x•	x
C. magambae	hf	1700-2200		x
Hypolimnas antevorta	sf	300-1000	x•	
Pseudacraea deludens reducta	hf	1500-1800		x
Acraea acuta rubrobasalis	hf	1500-2200		x
A. orestia sambar	lf, sf	no record	x•	x
A. rohlfsi	f	1100-1500		x
Mimacraea g. gelinia	f	300-1060	x	
Euthecta cooksoni ssp.?	lf, sf	300-1060	x•	
Baliochila pringley	f?	no record	x	
Spindasis collinsi	hf	1800-2200		x
Anthene sp.	hf	no record		x
Uranothauma usambarae	hf	1800-2200		x
Parnara guttata	f?	no record	x	
Celaenorrhinus sp.?	rf	350	x•	

Sources: Kielland (1990, unpublished), Collins (1990), Rydon (*in. litt.*) and this study.
Abbreviations: f = forest; lf = lowland forest; sf = submontane forest; hf = highland forest, rf = riverine forest

Abbreviations used in Appendix 3.4 (overleaf):

(1) x = record; nr = not recorded and probably not present on Mtai; e = expected to occur on Mtai
(2) Habitats: f = forest; fg = forest glade; fm = forest margin; hf = highland or montane forest;
hw = heavy woodland; lf = lowland forest; sf = submontane forest.
(3) Localities: Mt = Mtai; EU = East Usambaras; WU = West Usambaras; NH = Northern Highlands (Mt Kilimanjaro, Mbulu-Ngorongoro highlands, Mt Meru, Mt Lossoganeu, Monduli); KTc = Kenyan/Tanzanian coastal forests (eg. Sokoke, Pugu, Kiono forests); Ul = Uluguru Mts; N = Nguru Mts; Ka = Kanga Mt; Ru = Rubeho Mts; Uz = Uzungwa Mts; Ro = Rondo Plateau; SWT = south-west Tanzania (eg. Mt Rungwe, Njombe, Tukuyu); KH = Kenya Highlands (eg. Mt Kenya, Mt Elgon, Teita Hills); M = Malawi; Mo = Mozambique; Zi = Zimbabwe; Ug = Uganda; Zai = Zaire; Ca = Cameroon.

Appendix 3.4 Butterflies restricted to less than 36 localities in Africa or predominantly of West/Central African origin recorded from the Usambaras.

Species near-endemic to East Africa	Habitat	Altitudinal range in Tanzania (m)	Mountains, regions and countries																	
			Mt	EU	WU	NH	KTc	Ul	N	Ka	Ru	Uz	Ro	SWT	KH	M	Mo	Zi	Ug	Zai	Ca
Bebearia chriemhilda	lf	0-1000	x	x			x														
Hypolimnas usambara	lf	75-1000	x	x			x			x											
A. excelsior	hf, oh	1800-2000	nr	x	x	x															
A. matiuapa	f	1400	nr		x		x								x						
A. vuilloti	fm, fg	1100-2150	e	x	x		x	x	x		x	x									
Abisara delicata	sf	800-1400	e	x					x			x				x					
Teriomima micra	f	no record	x	x	x		x														
T. parva	lf	100-1200	e	x	x		x	x	x								x				
Euthecta cooksoni	f	300-1060	x										x				x				
Baliochilia amanica	lf	0-1100	?	x	x		x		x												
Eresinopsides bichroma	f	no record	e	x	x		x	x	x												
Aslauga orientalis	?	no record	e	x			x														
Etesiolaus pinheyi	lf	300-1000	e	x				x													
Hypolycaena amanica	sf	800-1300	e	x	x				x			x					x	x			
Virachola jacksoni	f	no record	e	x	x									x	x				x		
V. vansomereni	f	1000-1800	nr	x	x										x						
Pilodeudorix rodgersi	hf	1200-2140	nr		x			x			x										
Tuxentius stempferri	hw, fm	300-1900	x			x		x													
Ceratrichia bonga	f	(300-1000)	x	x				x													
Mainly West or Central African species with distinct populations in E. Africa																					
Pseudacraea dolomena usagara	f	300-2000	x	x				x	x			x									
Salamis cacta amaniensis	f, hw	300-1000	e	x			x	x	x	x											
Junonia westermanni splendens	f?	no record	e	x?	x?								x?								
Acraea pentapolis epidica	sf, hf	600-2100	e	x	x			x	x							x	x	x			
Epamera nolaensis amanica	fm, fg	300-1000	x	x	x			x	x												
Gorgyra subfacatus vosseleri	sf	900-1200	x	x	x				x			x	x								
Andronymus gander	f	no record	e	x	x														x	x	x

Sources : Carcasson (1975), D'Abrera (1980), Henning (1989) and Kielland (1990).

See previous page for list of abbreviations and symbols used.

Appendix 3.5 Forest butterflies recorded from the Usambaras with a widespread distribution in Africa. None of these were recorded at Mt Mtai.

Species	Habitat	Altitudinal Range (m)
Papilio nobilis nobilis	sf, hf	(700-2100)
Belenois margaritacea plutonica	hf	1500-2700
Mylothris yulei ertli	lf, sf	350-900
Bicyclus simulacris septentrionalis	hf	1300-2300
Charaxes contrarius	lf	0-700
Ch. druceanus praestans	sf, hf	900-2000
Ch. jahlusa kenyensis	f, fm, de	0-1500
Neptis trigonophora	rh, f	0-1200
Sallya boisduvali	f, w	0-2100
Euphaedra crawshayi	hw, rh, f	250-1800
E. orientalis	f	0-1000
Bematistes aganice montana	f, hw	0-2140
Acraea cerasa	lf	250-900
A. petraea	cb, f	0-1500
A. sotikensis	f, rh, oh in h	above 300
A. obeira burni	f	no record
A. zonata	lf	0-600 (2140)
Alaena amazoula nyasana	rh	900-1500
Ornipholidotos peucetia pauceda	lf, hw	0-1500
Teriomima puella	lf, w, rh	0-1000
Lachnocnema brimu	wd, f	no record
Axiocerses punicea	fm, fg	0-1200(2140)
Epamera dubiosa	fm	1900-2000
E. mermis	lf, sf	300-1500
Iolaphilus maritimus usambara	sf, hf, fm	800-2000
Argiolaus crawshayi littoralis	f	0-2000
A. lalos	cb, f	0-300 (1200)
A. silas silarus	w, fm	1000-1900
Hemiolaus coeculus littoralis	cb, w, fm	0-(1000?)
Hypolycaena buxtoni rogersi	hw, f	0-1500
Leptomyrina hirundo	w, f	0-1100
Pilodeudorix caerulea	hw, f	0-2000
Anthene ligures amanica	f	600-1700
Uranothauma nubifer	w, f	1000-2200
Tuxentius ertli	f	100-2200
Celaenorrhinus bettoni	f	800-1700
Metisella medea	f, rh	1000-2700
Ampittia parva	m near f	0-1200
Gorgyra bibulus	f, fm	300-2000
G. subflavidus	f	0-1200

Source: Kielland (1990)
Abbreviations: cb = coastal bush, de = dry evergreens, f = forest, fg = forest glade, fm = forest margin, h = highland area, hf = highland forest, hw = heavy woodland, lf = lowland forest, m = marsh, oh = open habitat, w = woodland, rh = riverine vegetation, sf = submontane forest.

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