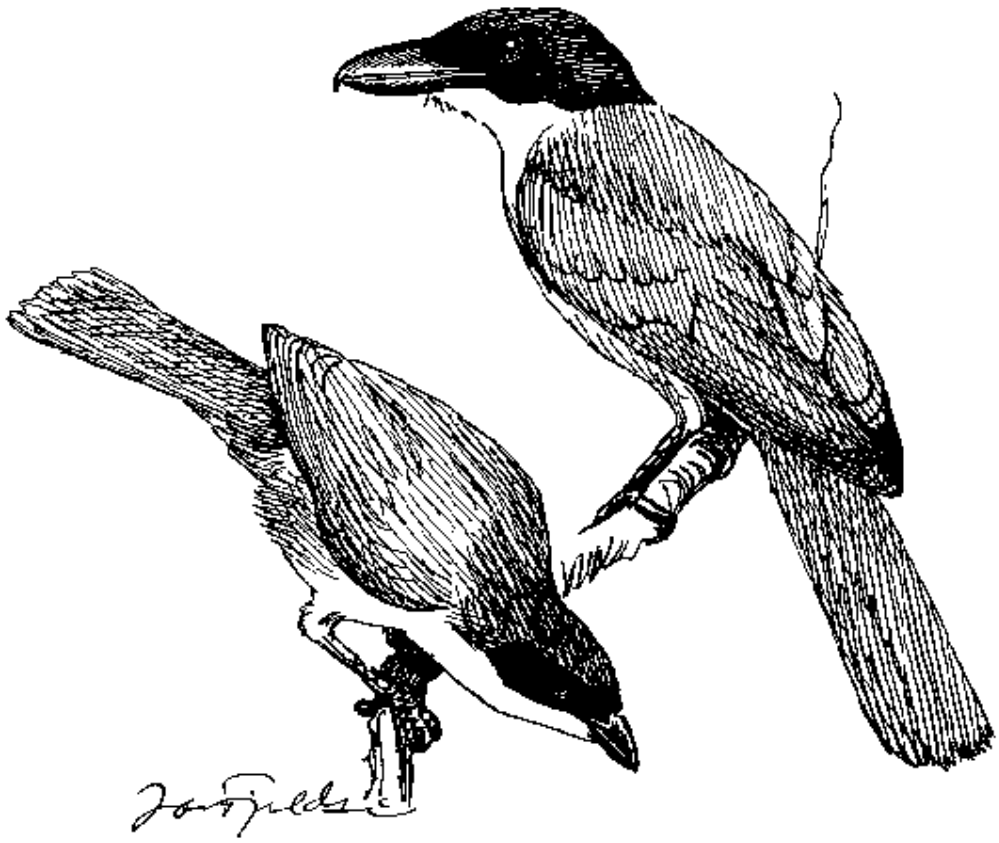
Report on
The Uluguru Biodiversity Survey 1993



Part A

Edited by Jens Otto Svendsen and Louis A. Hansen

Published July 1995

Revised and slightly updated web & pdf version of August 2005. By Louis A. Hansen

Centre for Tropical Biodiversity

RSPB

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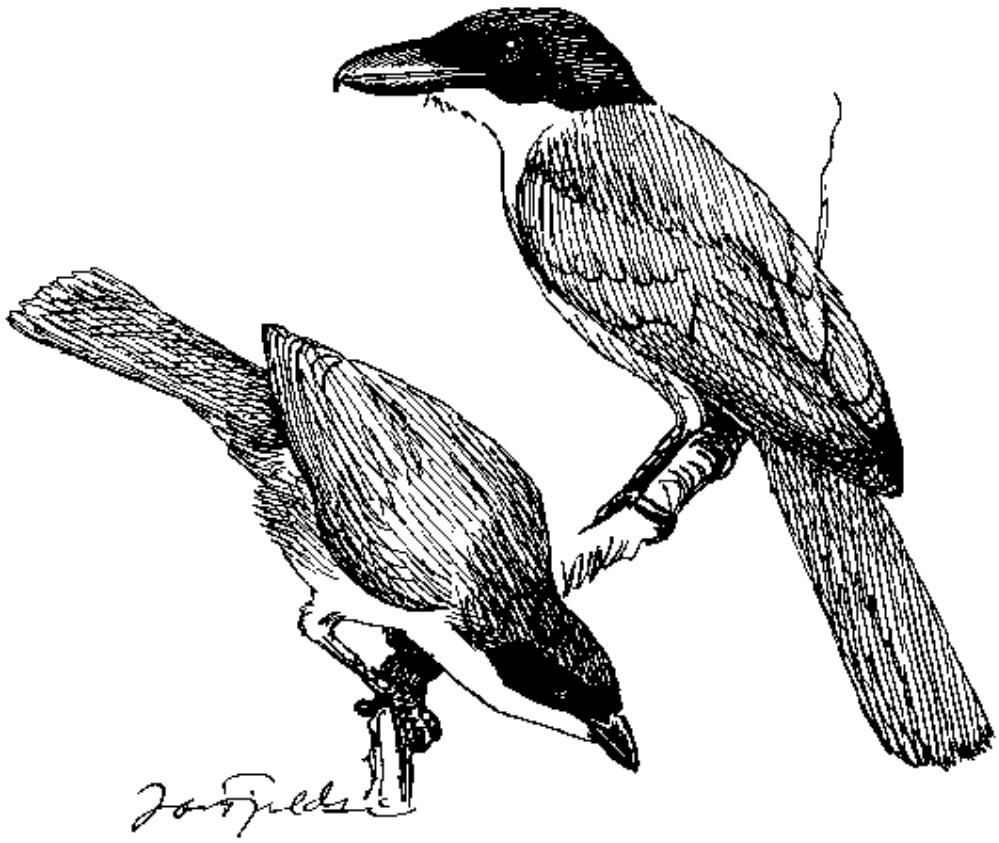

Part A

Edited by Jens Otto Svendsen and Louis A. Hansen

With contributions by

Neil D. Burgess, Erik Edvardsen, Jon Fjeldså, Louis A. Hansen, Peter Høst, Henrik Kisbye, Jacob Kiure, Jens N. Kristiansen, Jon C. Lovett, Charles K. Mabula, Shakim I. Mhagama, Louise B. Pedersen, Marcel C. Rahner, Bashir S. Shirima, Jens Otto Svendsen and Line L. Sørensen

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Sponsors

The European Community (through The Royal Society for the Protection of Birds and Tanzania Forestry Research Institute), The Beckett Foundation, Aage V. Jensen´s Foundations, Danish Centre for Tropical Biodiversity, DANIDA´s education programme in Dar es Salaam, Norsk Ornitologisk Forening, Botanical Museum of Copenhagen, Zoological Museum of Copenhagen

Prepared for

The Uluguru Slopes Planning Project, a BirdLife International conservation planning project *run by* The Royal Society for the Protection of Birds (UK)

Published July 1995

This report is accompanied by a Part B comprising figures, tables and appendices. The contents of Part B are listed in Part B.

Revised and slightly updated web & pdf version of June 2005. By Louis A. Hansen (e-mail: lahansen@smn.ku.dk)

Report on *The Uluguru Biodiversity Survey 1993.*

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Front page drawing: Uluguru Bush Shrike *Malaconotus alius* (right) and Black-fronted Bush Shrike *Telophorus nigrifrons* (left). The global distribution of *M. alius* is restricted to the Uluguru mountain forests. The species is listed as Threatened by BirdLife International and International Union for Conservation of Nature and Natural Resources. *Drawing by Jon Fjeldså.*

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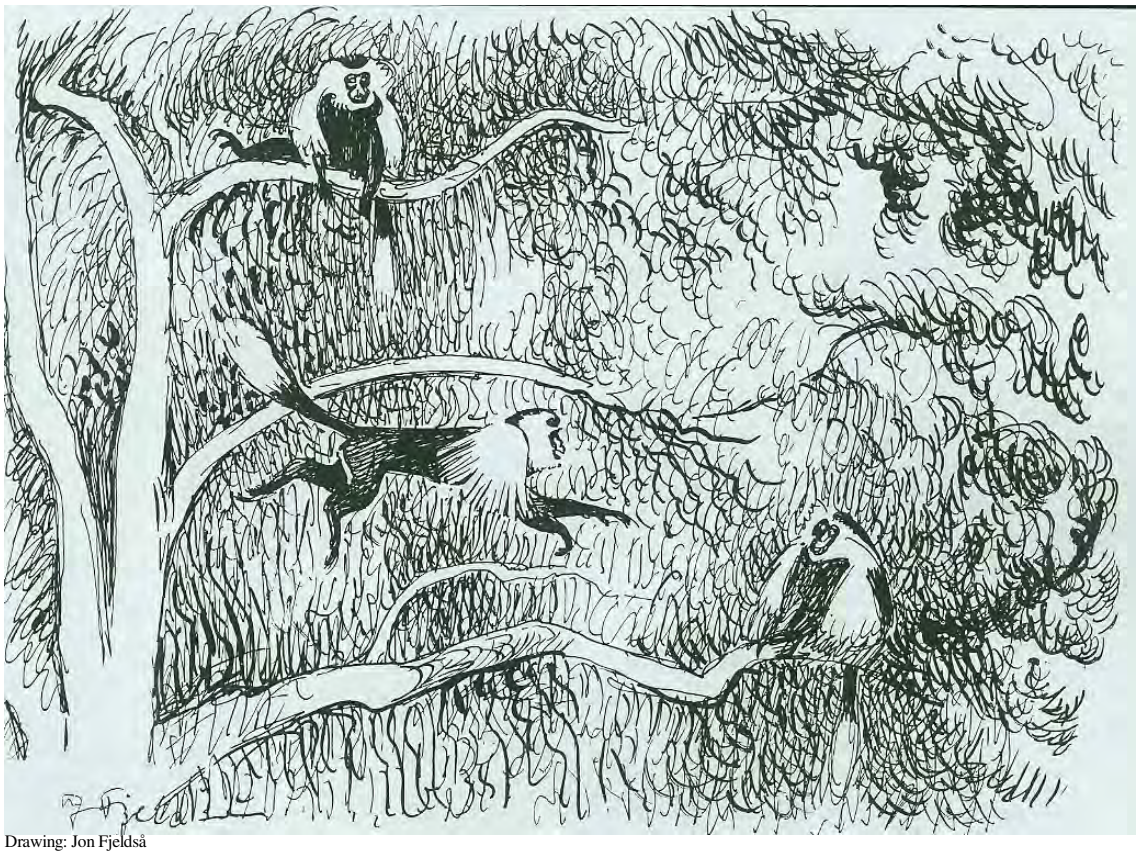
CONTENTS, PART A (MAIN REPORT).

This report is accompanied by a Part B which contains tables, figures and appendices. The contents of Part B are listed in Part B.



Drawing: Jon Fjeldså

SECTION 1. EXECUTIVE SUMMARY.

By Jon Fjeldså, Jens Otto Svendsen and Louis A. Hansen.

The Uluguru Mountains, which are located in the central part of the Eastern Arc Mountains in Tanzania (see Figure 1.1), have long been recognized as a key site for conservation of biodiversity in Africa, and some actions for protecting the mountain forests have already been initiated. However, large portions of the Uluguru South and North Forest Reserves (see Figure 1.3), especially in the Uluguru South, have remained unexplored biologically prior to this survey. It was therefore unknown where conservation actions were most urgently needed, and where this would be most effective.

1.1. Aims of *The Uluguru Biodiversity Survey 1993.*

The work presented in this report is based on fieldwork and a study of the literature.

- The aim of the field survey (fieldwork period of 2.5 month, lasting from 1 October to 17 December 1993) was to collect information on biodiversity in the Ulugurus, mainly the Uluguru South and North F.R.s., and with the main emphasis placed on birds. Data were collected also on botany, ethnobotany, mammals and millipedes. The data were collected for:

  A. The Uluguru Slopes Planning Project (a conservation planning programme funded by the European Community through the Royal Society for the Protection of Birds, England), in order to improve the knowledge for further conservation and management decisions (contract on bird survey).

  B. A research project (Eastern Arc Biodiversity Project, University of Copenhagen), which aims at understanding biogeographical patterns and pointing out conservation priorities in the Eastern Arc.

  The main part of the fieldwork took place on the eastern slopes of the Uluguru South F.R. (Figure 1.3) to fill in a large gap in ornithological knowledge for this part of the mountains. Two of the main study sites were located here. Comparative fieldwork was carried out on the third main locality which was in the Uluguru North F.R. To improve the overview brief ornithological surveys were also carried out on other spots of the mountain forests and to one lowland forest.

- The aim of the literature study is to supplement the field data from this survey with an up-dated assessment of the biodiversity conservation value of these forests. Other values and the problems the forests face, including observations from the fieldwork period on land uses, are also listed to put the biological value into a wider perspective.

- A further aim was training Danish students and ornithologists and Tanzanian foresters in fieldwork techniques.

1.2. Introductory notes on the Uluguru forests: Geography, biogeographical affinity and forest cover of the mountains.

Eastern Arc forests. Eastern Arc forests (see Figure 1.1) are marked by the large number of restricted-range species and genera (e.g. Collar and Stuart 1988, Lovett 1988, Lovett and Wasser 1993), many of which are currently known from just one or a few sites. Thus the Eastern Arc is of very high conservation importance. For birds, which are the best known group of living organisms, no less than 12 of the World's 1,111 Threatened species (as listed by Collar *et al.* 1994, corresponding 11 % of the

World's c. 9,000 bird species) are endemic[1] to the Eastern Arc forests. 25-30 % of the c. 2,000 Eastern Arc plant species are endemic (Lovett 1988).

Large areas of the Eastern Arc forests have been cleared in the past for agriculture, and these forests are very threatened from a rapidly growing human population demanding ever more land for agriculture. The pressure from commercial logging interest has been high but has now eased. Most of the Eastern Arc forests are administered as Catchment Forest Reserves under the Forest Division of the Ministry of Tourism, Natural Resources and Environment (Lovett and Pócs 1993).

The Uluguru Mountains. The Uluguru Mountains form an outlying ridge east of the main range of Eastern Arc forests, 180 km from the Indian Ocean. The ridge is 45.5 km long, rising out of the coastal plain at 300 m and peaking at 2635 m (Figure 1.2). It consists of two mountain blocks which are separated by the Bunduki Gap (Figures 1.2 and 1.3). There are also some outlying hills (Figure 1.3). The following general characterisations can be made about the forest cover:

- Large areas of forest and dense woodland, especially in the submontane zone, have been cleared to give way to subsistence agriculture (Temple 1973, Lyamuya *et al.* 1994).
- The high parts of the Uluguru Mountains are still forested (Figure 1.2). By far the largest and most important reserves are the Uluguru South (164.3 km²) and North (83.6 km²) F.R.s (Figure 1.3). The position of the lower forest edge in these reserves varies greatly, from 1000 to 2000 m elevation, with a few narrow strips down to 650 m (Figure 1.2). In all areas local fields extend right up to the lower forest edge.
- In most parts of the Uluguru South F.R. the lower forest edge is above 1500 m (Figure 1.2).
- In the Uluguru North F.R. considerable areas of submontane forest (forest between 500 and 1500 m) still remain in certain parts, mainly on the eastern/north-eastern slopes of the Uluguru North F.R. where the forest ranges down to 1000-1200 m in certain places (Figure 1.2). This forest type, which is characterized by tall, thick trees with many ephiphytes, is one of the most spectacular in Eastern Africa.
- Above the principal agricultural areas on the drier west slope of the Uluguru South F.R., the lower forest edge is at 1900-2000 m (Figure 1.2), and virtually all large trees have been extracted.
- Apart from the forests above 1000 m on the slopes there are patches of lowland forests in the limestone karst terrain in the eastern foothills at c. 300-500 m, of which the most important are the Kimboza/Ruvu F.R.s (4 km²/31 km²) (Figures 1.2 and 1.3).
- There is also forest on some of the outlying hills. Mkungwe F.R. (at present 19.67 km², to be extended) contains wet submontane forest, the other hills hold forest of a drier type.

The Uluguru forests are among the most critically threatened in the Eastern Arc. Some of the problems are:

- A very serious depletion of firewood and building pole resources outside the forests forces people to obtain these items illegally inside the forest.
- A poor and rapidly growing human population (2.8 % growth per annum and up to 6.5 % per annum in some places) with poor agricultural techniques (soils get depleted for nutrients) demands more land every year for farming. This leads to a risk of crossing the often badly demarcated forest reserve boundaries, which are seldom patrolled. See photos in photograph section.
- Widespread burning is a serious threat to the woodlands and forest edges. See photos.
- Outside the forests soil erosion is a big problem. Farming often takes place on very steep slopes (up to and beyond 50°) and on most of them no measures are taken to prevent erosion. See photos.

1 Endemic: That a species is endemic to the Eastern Arc forests means that its global distribution is completely restricted to the Eastern Arc forests (with no occurence in any other parts of the world). Its survival therefore depends completely on the protection of the forest habitat in these mountains. An Uluguru endemic is a species occuring only in the Ulugurus.

1.3. Principal values of the Uluguru forests (the results of the literature study).

Water catchment and prevention of soil erosion and siltation of rivers. The eastern slopes of the Uluguru, Udzungwa and Usambara mountains have the highest rainfall in eastern Africa. The mountain forests of the Uluguru mountains are extremely important for water catchment (e.g. Temple 1973, Lovett and Pócs 1993, Lyamuya *et al.* 1994). They are of vital importance for the people living on the slopes of the Ulugurus, because they:

- secure a stable and good water supply.
- maintain a humid climate suitable for agriculture.
- have a high value for prevention of soil erosion and siltation of rivers and streams in the agricultural areas further down the slopes. This is because they keep much of the water that falls during heavy rains. Dense woodlands on the slopes also help to prevent erosion and siltation but have largely been cleared.

The forests are also the main catchment for three rivers of high importance for people outside the Ulugurus:

- Ruvu River, which is the main water source for the urban and industrial users in Tanzania's most populous city: Dar es Salaam (c. 2 million citizens) (Temple 1973, K. Muriria *in litt.* 1995). Ruvu collects water mainly from the eastern parts and is joined further east by the Mgeta and Ngerengere Rivers which collect water in the southwestern and northwestern parts (Figure 1.3).
- Morogoro and Ngerengere Rivers (Figure 1.3), which are the major water source for the populous regional, headquarter Morogoro (Temple 1973, Lovett and Pócs 1993, K. Murira *in litt.* 1995). Ngerengere River is furthermore the major water source for many sisal estates in Morogoro District according to Temple (1973).

The value of the catchment function of the forests of the Uluguru Mountains has not been estimated in monetary terms. However, as most of the economic activity of Dar es Salaam depends on the water from this forest, the value must be billions of Dollars over a 10-year period. This is all jeopardised by the loss of the cover of forest, woodland and other trees from the mountains.

Biodiversity in general. All forests in the Eastern Arc are characterized by a high species richness and a high number of endemic species. However, some mountains are more remarkable in this respect than others, and the Uluguru, Udzungwa and Usambara Mountains (Figure 1.1) stand out in particular (e.g. Scharff *et al.* 1982, Collar and Stuart 1988, Lovett 1988, Lovett and Wasser 1993, our Table 5.1). The Uluguru forests have many animal and plant species found nowhere else in the world, true endemics.

Most biological fieldwork in the Ulugurus has taken place in the mountain forests, principally the Uluguru North and South F.R.s, with a good part also in the lowland Kimboza Forest and a little in the lowland Ruvu Forest. The outlying hills are probably unknown biologically except for vegetation descriptions in e.g. Lovett and Pócs (1993), Mkungwe F.R. containing wet submontane forest but the others being of a drier type.

Bird species of special conservation value. The importance of the Uluguru Mountains for forest birds has long been known. In a review of key forests for the protection of threatened bird species in Africa by Collar and Stuart (1988), the Uluguru Mountains (including foothills) ranked 16th among all forests on the African continent and fourth among all forests in East Africa in terms of conservation value for the protection of Threatened and Near-threatened bird species. The Ulugurus are furthermore an important part of C24, one of the 221 priority areas for global conservation listed by ICBP (1992) (ICBP, International Council for Bird Preservation, has now changed its name to BirdLife International). The Ulugurus are compared with the other Tanganyika-Nyasa Montane Forests in Table 5.1.

Five Threatened and three Near-threatened species occur in the Ulugurus (global conservation status categories with capitals from Collar *et al.* 1994):

- Two of these species are endemic to the Ulugurus: the Uluguru Bush Shrike *Malaconotus alius* (Threatened) which is a distinct species occurring at very low densities, and Loveridge's Sunbird *Nectarinia loveridgei* (Near-threatened, see photo in photograph section) which is a valid species in the *Nectarinia regia* superspecies (Hall and Moreau 1970), and very common.
- The other Threatened and Near-threatened bird species known from the Ulugurus are: Mrs Moreau's Warbler *Bathmocercus winifredae* (Threatened; Eastern Arc endemic; the Uluguru population is probably the largest of the four known; see photo in photograph section), White-winged Apalis *Apalis chariessa* (Threatened; the Uluguru population may be the second largest single population), Banded Green Sunbird *Anthreptes rubritorques* (Threatened; Eastern Arc endemic), Tanzanian Mountain Weaver *Ploceus nicolli* (Threatened; Eastern Arc endemic; a very rare species only known from three mountain ranges, occurring at low densities in all of them), Southern Banded Snake Eagle *Circaetus fasciolatus* (Near-threatened) and Uluguru Violet-backed Sunbird *Anthreptes neglectus* (Near-threatened).

A further six forest restricted-range species (breeding range less than 50,000 km² and therefore also of special conservation interest) occur in the mountain forests. They are: White-chested Alethe *Alethe fuelleborni*, Sharpe´s Akalat *Sheppardia sharpei*, Chapin's Apalis *Apalis chapini*, Red-capped Forest Warbler (African Tailorbird) *Orthotomus metopias*, Spot-throat *Modulatrix stictigula* and Kendrick's Starling *Poeoptera kenricki*.

The geographical distribution in the Ulugurus of bird species of special conservation importance is described in Section 1.6.

Mammals of special conservation value. Two shrew species are endemic to the Uluguru forests: *Crocidura telfordi* and *Myosorex geata*. The subspecies *tropichalis* of the insectivore Golden Mole *Chrysochloris stuhlmanni* is also endemic.

Three mammal species are on the 1994 IUCN Red List of Threatened Animals (IUCN 1994): Zanzibar Galago *Galago zanzibaricus*, Black and Rufous Elephant Shrew *Rhynchocyon petersi* and Abbott's Duiker *Cephalophus spadix*, the last one being endemic to the Eastern Arc forests.

Reptiles of special conservation value[1]**.** Of the 22 forest species known to occur in the Ulugurus, six species are endemic: *Lygodactylus williamsi* (a lizard known only from Kimboza Forest), *Cnemaspis barbouri* (a lizard), *Scelotes uluguruensis* (a skink), *Typhlops uluguruensis* (Uluguru Blind Snake), *Prosymna ornatissima* (Ornate Shovel-snout, a snake) and *Geodipsas procterae* (Uluguru Forest snake), with a further 10 of the species being Eastern Arc endemics.

Amphibians of special conservation value. Of the 26 forest species known to occur in the Ulugurus, five are endemic: *Nectophrynoides cryptus* (Secret tree toad), *Probreviceps uluguruensis* (Uluguru big-fingered frog), *Hoplophryne uluguruensis* (Uluguru banana frog), *Boulengerula uluguruensis* (Uluguru pink caecilian) and *Scolecomorphus uluguruensis* (Nyingwa caecilian), with a further 10 of the species being Eastern Arc endemics. See footnote under reptiles.

Invertebrates of special conservation value. Endemism is high in invertebrates in groups that are relatively well studied in East Africa: Millipedes: Of 28 taxa known from the forests, 23 (86 %) are endemic, 27 are true forest taxa. Linyphiid dwarf spiders: 14 (86 %) of 17 species are endemic (all 14 are true forest species). Butterflies: 10 (27 %) of 37 species are endemic. Endemism in less well known groups, current knowledge: Harvestmen: 15 (88 %) of 17 species, montane ground beetles: 41 (95 %) of 43 species, pselaphids: 43 (100 %) of 43 species, montane forest earwigs: 10 (91 %) of 11 species.

Plants of special conservation value. The flora of the forests in the Ulugurus is rich in terms of number of endemics and number of species. It is as rich as the other high rainfall Eastern Arc mountains and

1 The five endemic amphibians and the six endemic reptiles of the Ulugurus all qualify for status as Threatened as regards the definitions in The 1994 IUCN Red List of Threatened Animals (IUCN 1994). They were not mentioned in this book, however, since the East African amphibia and reptile fauna had not yet been assessed at the time of the publication. (the IUCN list is not a complete list of Threatened animals, but a list of species which had been classified as Threatened when the strict deadline was reached).

much higher than equivalent areas of forest outside the Eastern Arc from the Horn of Africa to the Cape. Plant taxa are found only in the Ulugurus in a wide range of life forms from hemi-parasites, epiphytes and ground herbs, to shrubs and trees over the entire elevational range of the mountains where forest has not been heavily disturbed. It has not been possible to investigate all plant groups for the purpose of this report. Below we mention endemics from some of the groups.

Examples of trees endemic to the Ulugurus are *Pittosporum goetzei*, which is found in upper montane forest and forest patches on the Lukwangule Plateau, and the newly described monospecific genus Aerisilvaea (Euphorbiaceae) from Kimboza. Examples of Eastern Arc endemic trees occurring in the Ulugurus are *Allanblackia stuhlmannii*, *A. ulugurensis*, *Cephalosphaera usambarensis*, and *Polyceratocarpus scheffleri*.

The Ulugurus are especially rich in endemic herbs (examples being three to four *Linnaeopsis* species, and 13 *Impatiens* species). There are also many endemic epiphytic Orchidaceae due to the high rainfall and frequent mist cover (examples being one *Bulbyphyllum*, three *Polystachya*, five *Stolzia*, one *Diaphananthe* and one *Margelliantha* species).

Of ferns, the Uluguru Mountains hold 223 out of at least 321 forest species known for the whole Eastern Arc but only three species are endemic. Mosses and liverworts comprise no less than 490 species, of which 10 are endemic, including the endemic genus *Pseudotimmiella*.

Many subendemic plant species are shared only with the Usambara, Udzungwa or Nguru Mountains.

Conclusion of literature study. The available information on water catchment, biodiversity and soil erosion shows that the relatively small areas of forest in the Ulugurus are of extreme importance and should be the targets of intense national and international efforts to ensure their conservation over a prolonged number of years. The area provides an obvious opportunity for foreign donors to initiate carefully designed activities. High water catchment values (for Dar es Salaam, Morogoro and local villages) and biodiversity values can be protected and the living standard of the local villagers be raised by improving agricultural practices and providing fuelwood plantations. However, pragmatically, the limited funds currently available for conservation in the area need to be effectively targeted into those parts of the Uluguru forests where they are likely to have the most effect. The following can hopefully clarify this a little.

1.4. Fieldwork activities of *The Uluguru Biodiversity Survey 1993*.

Localities visited (see also Table 4.1):

Main localities:
1. Kimhandu, south-eastern part of the Uluguru South F.R. (Figure 1.4). 29 days. Six field stations.
2. Lanzi, eastern part of the Uluguru South F.R. (Figure 1.4). 19 days. Three field stations.
3. Tegetero, eastern slopes of the Uluguru North F.R. (Figure 1.5). 17 days. Three field stations.

Brief visits:
4. Kimboza F.R., lowland forest in the foothills (Figure 1.3). One and a half days. JF/JK.
5. Tchenzema, western slopes of the Uluguru South F.R. (Figure 1.4). One and a half days. JF/JK.
6. Bunduki, west of the Bunduki Gap (Figure 1.4). Some hours. JF/EE.
7. Morningside, northwestern slopes of the Uluguru North F.R. (Figure 1.5). One hour. JF.
8. Kigurunyembe, submontane strip, northern slopes of the Uluguru North F.R. (Figure 1.5). One and a half days. JF/JK.

Ornithology. At localities 1-3 semi-standardized surveys were applied at all stations along the altitudinal gradients (each station: mistnetting for two full days, 10 minutes assessments of 15-25 one-hectare plots, two tape recordings at dawn; combined with general field observations). At localities 4-8

activities consist of general field observations, at some stations combined with mistnetting or plot assessments.
Botany. At localities 1-3 one 25x25 m plot was assessed at each of 11 of the 12 mistnetting stations. Data are of the species composition and vegetation structure of the woody vegetation.
Ethnobotany. At localities 1-3 knowledgeable elders gave information on local people's uses of the various plant species (during work on the botanical plots and walks in the forest).
Millipedes. At locality 1 specimens were collected along the altitudinal gradient. A few specimens were collected also at localities 2 and 3.
Mammals. At localities 1-3 local villagers were interviewed briefly to assess the condition of the mammalian fauna. Our own observations from all localities are listed.
Land uses. Non-standardised observations were made of land uses during the survey.
Training. The training component (training in fieldwork techniques and working with tropical biodiversity projects) focused on Danish biology students and ornithologists, and on Tanzanian foresters from the Tanzania Forestry Research Institute (TAFORI) and Morogoro Regional Forest Office. One ornithologist representing the Norwegian Ornithological Society/BirdLife Norway participated.

1.5. Principal findings of the fieldwork.

Birds. 88 of 96 species of forest birds known to occur in the Ulugurus were recorded on *The Uluguru Biodiversity Survey 1993*. One further forest species was new to the Ulugurus (the aerial feeding Scarce Swift *Schoutedenapus myioptilus*, classified as a forest species in this report). A detailed description of the general bird community is given, based primarily on standardised methods. Records of species of special conservation importance:

Threatened bird species: The endemic Uluguru Bush Shrike *Malaconotus alius* was found only above Tegetero (four territories in submontane and lower montane forest). The total population size is unlikely to exceed one thousand individuals. Mrs Moreau's Warbler *Bathmocercus winifredae* is widely distributed but not abundant, in herbaceous meadows inside forest, including man-disturbed habitat (a minimum of 33 territories were identified; principal distribution in the montane zone). White-winged Apalis *Apalis chariessa* was seen near Tegetero only (two observations in mixed species parties of submontane forest). Banded Green Sunbird *Anthreptes rubritorques* and Tanzanian Mountain Weaver *Ploceus nicolli* (both species recorded in the Ulugurus previously) were not found, probably because the time for general field observations was limited.

Near-threatened bird species: The endemic Loveridge's Sunbird *Nectarinia loveridgei* is extremely abundant in all locations (271 mistnetted, corresponding 28 % of the total number of birds mistnetted during the survey). Southern Banded Snake Eagle *Circaetus fasciolatus* and Uluguru Violet-backed Sunbird *Anthreptes neglectus* were recorded only in the lowland forest Kimboza.

The six other forest bird species of restricted range (total breeding range less than 50,000 km²): These species all have significant populations in the Ulugurus, almost exclusively in the Uluguru South and North F.R.s.

Species of special conservation importance where their absence is remarkable: The Threatened species Swynnerton's Robin *Swynnertonia swynnertoni* and Dappled Mountain Robin *Arcanator orostruthus* (occurring in the Udzungwas and the Usambaras) were not found, which supports the possibility that these species have truly relictual distributions, and are absent from the Ulugurus.

Botany. A list is presented for the Kimhandu and Lanzi areas of the 47 woody species that have been identified to species at present. Diagrams are presented for each station of the four dominant species in terms of basal area and number of stems. A very high proportion (13 species = 28 %) of the identified species are Eastern Arc endemics with two of the species also being endemic to the Ulugurus. Camphor *Ocotea usambarensis* was found on four of eight plots assessed at Kimhandu and Lanzi, with up to four individuals per plot.

Ethnobotany. Local knowledge is high on specific uses of forest plants. 113 species of trees and shrubs recorded during the survey were reported to be used by the local villagers. Examples of uses are for fuelwood, building materials (e.g. poles, rafters, wall plates, bed legs, shade), medicine (malaria, stomach ache, teeth, chest pains, convulsions), household items (mortars, pestles, barrels, tool handles, edible fruits, cooking oil, gums, bee hives, withies, ropes) and ornaments.

Mammals. Tree Hyrax, duikers and many other mammal species are severely overhunted, even in forest tracts which otherwise seemed undisturbed. This is stressed by the facts that only a single duiker individual was seen during our two and a half months of fieldwork and that we found remarkably few mammal tracks in the forest. One of the species that has been severely reduced in numbers is Abbott's Duiker which is an Eastern Arc endemic and on the IUCN Red List of threatened animal species.

Millipedes. 14 taxa of millipedes were collected during the survey. Three of the taxa probably represent species new to science. At least five of the taxa collected are endemic to the Ulugurus.

Land uses. It is clear that the Uluguru forests are very threatened from a growing population:

- Fuelwood resources outside the Forest Reserves have been extremely seriously depleted in many areas. In some areas almost no trees are left in the cultivated areas outside the forest (the original woody vegetation probably being comprised of dense woodland). On the lower slopes and in the foothills where woodlands still exist and are the major firewood source, these have been severely degraded from firewood collection and burning. There are few rural woodlots or other means of providing fuel and building wood to the local population, as an alternative to taking it from the Forest Reserves. Unless large-scale tree planting is initiated, collection of firewood and building poles will seriously degrade the lower parts of the mountain forests. Especially at Tchenzema the degradation is serious already, with varying degrees of degradation in other parts of the mountains. We do not know the attitudes of the local people towards tree planting initiatives.
- In some of the areas visited (e.g. Tegetero and Tchenzema) the boundary is demarcated with exotic tree species (*Eucalyptus*, *Grevillea*) but in many parts (including Kimhandu and Lanzi) the boundary is insufficiently demarcated (demarcations consist of overgrown ditches and cairns).
- In all areas the border between forest and surrounding agricultural areas is very sharp, and the forest is being degraded in many places along the lower edge of the Forest Reserves by clearing for new farmland. See photos in photograph section.
- Agricultural practices are considered poor. Maize is often planted on very steep slopes (up to and beyond 50°) without any kind of efforts to avoid soil erosion.
- Fires are extremely common and widespread in the Ulugurus, at least in the dry season when we entered the area. We fear that fires have a degrading effect on the woodlands in the lowland areas, on plantations and on the forest edge. They mean that areas once cleared of trees regenerate very slowly.
- Half of the small Bunduki Forest Reserve (mainly exotic trees like *Eucalyptus*) has recently been clearfelled. Transport of timber from pitsawing was observed in one locality (Tegetero) despite a ban of all pitsawing dating from May 1993. At another locality (Kinole) ongoing pitsawing was observed in October 1993 by P. Honess (P. Honess *in litt.*).
- An irregular water supply in some potential agricultural areas may be caused by deforestation (local people, pers. comm. to JF).
- Local differences in degradation of remaining forests are associated with local market differences and economies; such correlations are also of relevance for the planning of management strategies for the area. Although nearly all land up to 1500 m on the eastern slopes of the Uluguru South F.R. (especially in the Kimhandu area) has been cleared (with agricultural activities extending right up to the border of the forest), the remaining (montane) forests in this area appear virtually untouched (except for hunting and some encroachment in the lower part), with impressive stands of huge camphor trees, possibly because villages here are remote from external markets, and lack technical possibilities for commercially exploiting the montane forests. On the contrary, there is a strong pressure towards the forest in the western part of the Ulugurus. E.g. in the Tchenzema, area the forest is strongly degraded even inside the forest reserve and hardly any Camphor are left. In addition, the lowland Kimboza Forest is seriously degraded, and many of the tall trees that existed earlier have been removed by logging.

1.6. Importance of vegetational belts for bird species of special conservation interest.

The geographical distribution in the Ulugurus of bird species of special conservation interest is shown on Figure 1.6.

Submontane and lower montane belt of the Uluguru North F.R. (submontane: below 1500 m in the Uluguru North and below 1600 m in the Uluguru South). Comparing the Uluguru North and South F.R.s, the most important avifaunal difference from a conservation aspect is caused by the fact that the northern section holds considerable areas of submontane evergreen forest whereas this habitat type today occupies only very small areas in the southern section (Figure 1.2). In general, the species occurring mainly in the montane (1500-2100 m in the Uluguru North and 1600-2400 m in the Uluguru South) and upper montane zone (above 2100-2400 m) have good populations in the Ulugurus, but species which have their optimum in the submontane zone may have suffered strongly from the habitat destruction that is supposed to have taken place in the lower part of the forests. Many narrow-amplitude species may be unable to maintain populations in the montane (above 1500-1600 m) zone when their submontane source habitat is lacking. Examples of such species are some of the most common species in drongo mixed feeding parties and four of the Threatened species:

- The Threatened species *Apalis chariessa* and *Anthreptes rubritorques* depend entirely on the submontane and possibly lowest montane zone.
- The Uluguru endemic *Malaconotus alius* use the montane zone to some extent, but the fact that we did not record it in the Uluguru South F.R. during our survey whereas we recorded four territories in the submontane and lower montane zone in the Uluguru North (also most earlier records are from the Uluguru North) clearly indicates that it depends primarily on the submontane and lowest montane zone. Its occurrence in the montane zone may depend on the extent of core habitat (submontane and lowest montane forest), which remains, as a source pool. In other words: If the submontane and lower montane forest is destroyed, the species may become extinct.
- The Threatened Eastern Arc endemic *Ploceus nicolli* has been recorded only three times in the Ulugurus, so our knowledge of the species´occurence here is scanty. At least two of the records are from the submontane or lower montane belt, and this - in combination with our knowledge of the species´ altitudinal distribution in the Udzungwas and the Usambaras - leads us to believe that these belts are very important for the species. Possibly, they form the source habitat for the population.

The submontane zone also holds two Near-threatened species (*Nectarinia loveridgei* and *Anthreptes neglectus*) and all six restricted-range (other than Threatened and Near-threatened) species. One of these restricted-range species, *Sheppardia sharpei*, occurs at much higher densities in the submontane than in the other belts. The Threatened species *Bathmocercus winifredae* occurs here but at much lower densities than in the montane zone.

Conclusion: conservation actions for forest birds should be concentrated on the remaining areas of submontane forest of the Uluguru North F.R., especially those on the eastern slopes (Tegetero-Bagiro-Kinole-Lupanga area) and the northwestern slopes (e.g. around Morningside). This area is shown on Figure 1.7.

Montane forest belt (between 1500 and 2100 m in the Uluguru North F.R. and between 1600 and 2400 m in the Uluguru South F.R.). The montane belt, of which the largest areas of very good quality are in the Uluguru South F.R. (but with large areas also in the Uluguru North), is the most important for the protection of the fifth Threatened species (*Bathmocercus winifredae*) and the Near-threatened endemic *Nectarinia loveridgei*.

The montane forest belt is furthermore very important for the six restricted-range (other than Threatened and Near-threatened) species occurring in the Ulugurus. Probably the bulk of the Uluguru populations of four of these are found in the montane belt: *Apalis chapini*, *Orthotomus metopias*, *Modulatrix stictigula* and *Poeoptera kenricki*.

Upper montane belt (above 2400 m in the Uluguru South F.R. and above 2100 m in the Uluguru North F.R.). The upper montane belt holds low densities of the Threatened *Bathmocercus winifredae*, good

densities of the Near-threatened *Nectarinia loveridgei* and of the restricted-range species *Orthotomus metopias* and *Modulatrix stictigula* plus low densities of the restricted-range species *Poeoptera kenricki*.

Foothill forests (<500 m). The foothill forests (at least the Kimboza/Kibungo/Ruvu area) appear to form the stronghold in the Ulugurus for the Near-threatened *Circaetus fasciolatus* (in the Ulugurus only known from the foothills) and *Anthreptes neglectus* (good densities), and are furthermore of importance for the restricted-range species *Alethe fuelleborni* which is common there at least seasonally.

The avifauna of the foothill forests shows similarities to the avifaunas of the threatened lowland forests in the coastal zone and the lowland parts of certain other Eastern Arc ranges. They hold a number of forest species, which are not found in the Uluguru North and South F.R.s. For plants of restricted distribution, Kimboza is very important, the number of endemics is very high compared to its small size (4 km²). Kimboza also holds endemics in other animal groups, e.g. one reptile and some insects (Lovett and Pócs 1993, Lovett and Wasser 1993).

1.7. Recommendations for further actions.

We believe it is crucial that the Tanzanian politicians recognize the importance of basing the economic development model for the country on investments for solving the fundamental environmental problem, such as the loss of natural water catchment areas. Based on a neoclassical economic growth model, Kaufmann (1995) has demonstrated that the effect of a reduction in environmental life support on economic activity increases by a factor of two to three over time, indicating that it is not possible to substitute capital investments in the production sector for a degraded environment.

The conclusion of discussions in Tanzania are that the planning of large-scale donor-supported land management programmes should start up stepwise, as the Tanzanian managing authorities should first decide on the national priorities for initiating such programmes. The Eastern Arc Biodiversity Conference which is to be held in Morogoro, Tanzania, in 1996 (subject: Management of Tanzanian mountain forests and their biological diversity) will be an opportunity to discuss this issue. Evidently, though, the Uluguru Mountains would come high up on such a priority list (see documentation above).

However, critical information on the uses of the forest by the local people, their attitudes to forest conservation and the pressures they face in surviving is still scanty for the Uluguru Mountains area which is a serious barrier to their effective conservation. BirdLife International (by the Royal Society for the Protection of Birds - the counterpart in the UK) in partnership with the Regional Natural Resources Department in Morogoro are about to start a field project in the Uluguru Mountains (the Uluguru Slopes Planning Project) to try and address some of the issues related to the conservation of these forests. Biological and social research will be used to develop a plan for the further conservation efforts required in the Ulugurus.

Suggested priority areas for protection of biodiversity.

- This study revealed that for conservation of Threatened forest birds, actions should clearly be concentrated to the submontane areas (areas below 1500 m) of the Uluguru North F.R. (especially the eastern slopes in the Tegetero-Bagilo-Kinole-Lupanga area and also near Morningside in the northwest), see Figure 1.7.
- The remaining parts of the Uluguru mountain forests (at least the Uluguru North and South F.R.s) are, however, also of high value for the conservation of forest birds (including Threatened, Near-threatened and other restricted-range species) and other organisms. Also the lowland Kimboza/Ruvu forests and especially one of the outlying hill forests (Mkungwe F.R.) are of very high biodiversity value.

Suggested priority areas for protection of water catchment by provision of fuelwood plantations.
For maintaining the water catchment function the Uluguru North and South F.R.s are clearly the most important areas, but all remaining forest tracts must be conserved. Large-scale planting of trees to take pressure off the forest as a source for firewood and building poles is regarded as particularly important.

- On this survey we observed that the Lanzi area appears to be one of the areas which most urgently needs plantations of firewood since very few trees are left outside the forest. This area is marked on Figure 1.8.
- Another priority area for the provision of firewood plantations is the priority area mentioned above for conservation of Threatened forest birds (Figure 1.7 and 1.8) - though the eastern slopes of the Uluguru North F.R. do not at present lack firewood as seriously as e.g. the Lanzi area, it is highly important to secure this valuable area in every respect.

Suggested other conservation actions for protection of land below the forest and improved agricultural yields.
The most important other conservation actions are (see Section 9.4 for further details):

- Demarcation of reserve boundaries with exotic tree species in areas where this has not yet happened, and regular patrolling, are necessary steps to stop the encroachment for new agricultural land.
- Agroforestry techniques should be used to prevent erosion, to decrease evaporation and to fix nitrogen. The trees should provide firewood, building poles, fruits, shade etc. Raising the living standard of the local people by agroforestry is the way forward for the conservation. Incentives to improve agricultural yields by better agricultural methods could be coupled with promises from the villagers to leave the steepest slopes and areas that are not cultivated unburned.
- Energy saving cooking devices may be a way to reduce the amount of firewood used, at least in part of the area.
- Measures should be taken against setting of fires not only near the forest but also in the woodlands at the base of the mountains (where fires were extremely widespread when we arrived in October), and on steep, unproductive mountain slopes. Agreements could be made in villages to identify zones not to be burned, and extra economic benefits could be allocated according to how well the locals keep their promises. This will hopefully allow regeneration of woody vegetation on non-cultivated slopes.
- The central government should possibly acquire agricultural land, which is important for land and forest conservation from the individuals concerned. This includes land with very steep slopes (45° and above), or on banks of rivers, which could be siltated or cause soil erosion in case of heavy rain. These areas should be rehabilitated.
- Introduction of domestic meat resources may be a way to reduce the serious hunting pressure.
- A birth control programme is necessary to reduce population growth.
- In the very poor areas in the south not only incentives to improve agriculture should be undertaken. Also improved access to markets is necessary. These areas are marked on Figure 1.9. Incentives could be coupled with promises e.g. to stop burning of slopes that are anyway not cultivated.

Suggested priorities regarding further biological survey work.

- More work is necessary to describe habitat preference and abundance of the Threatened bird species in the Uluguru North and South F.R.s in full detail. Special attention should be paid to extensive surveys for *Malaconotus alius*.
- Research should be undertaken for selected animal (e.g. frogs) and plant groups to establish whether the geographical distribution of rare and threatened species follows that of birds.
- Of areas so far unknown ornithologically, the Mkungwe Catchment F.R. with its submontane forest between 800 and 1000 m should be given high priority.

Suggested priorities regarding further sociological survey work.

- A detailed appraisal of the sociological situation of villagers around the forest is required. This is being implemented as a part of the BirdLife Uluguru Slopes Planning Project in cooperation with the Regional Natural Resources Department in Morogoro.
- A study should be undertaken of why woodlands are being burnt and how this can be prevented.

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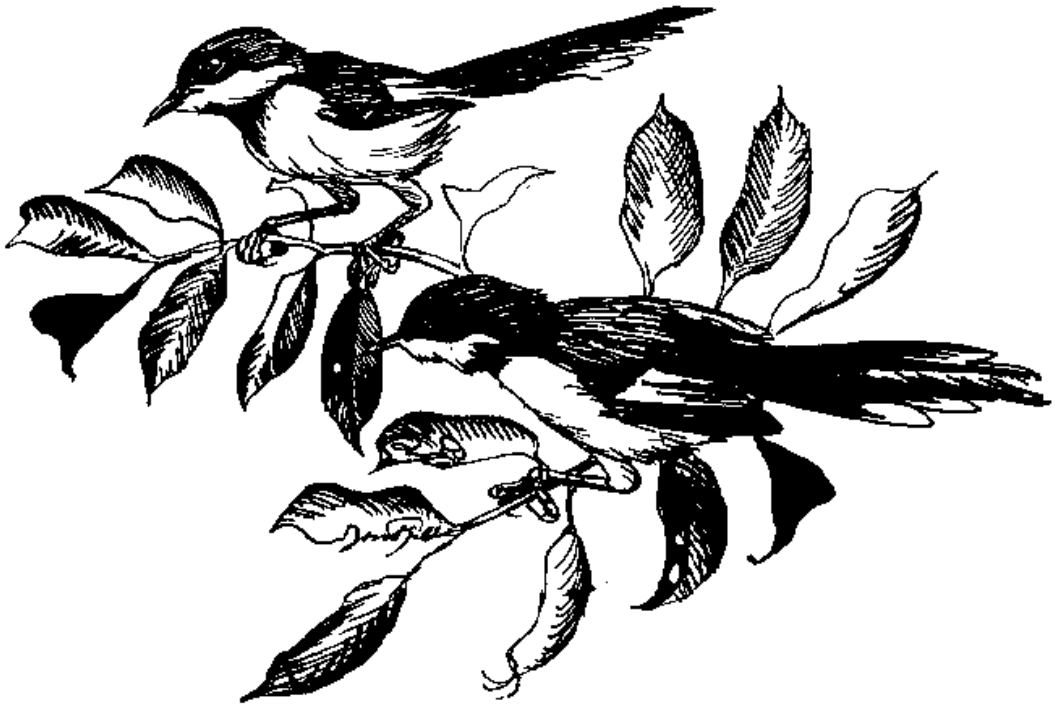


White-winged Apalis *Apalis chariessa*. One of the Threatened bird species known from the Uluguru Mountains, where it is probably restricted to the submontane and lower montane forest belts of the Uluguru North Catchment Forest Reserve. *Drawing: Jon Fjeldså.*

MAPS

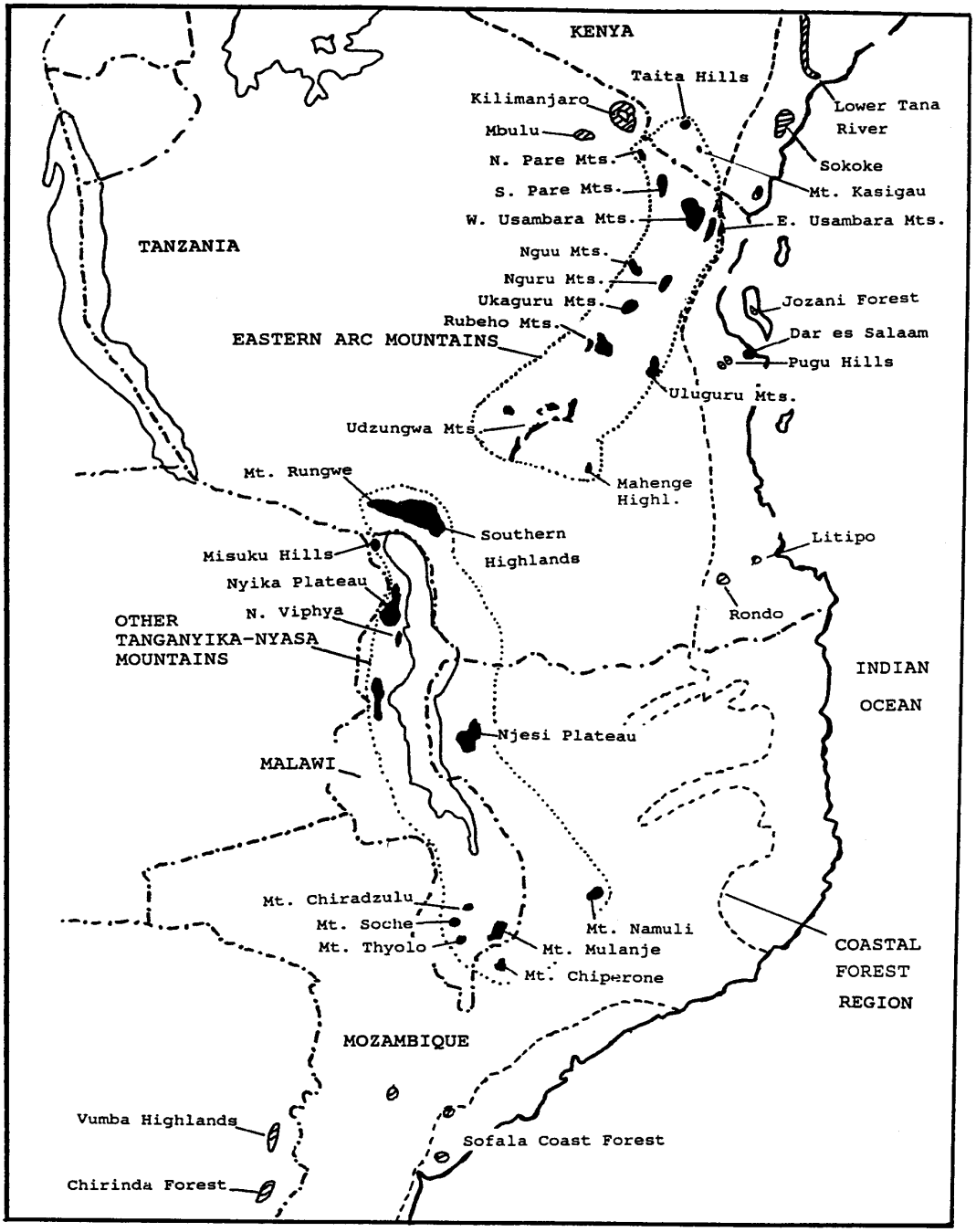
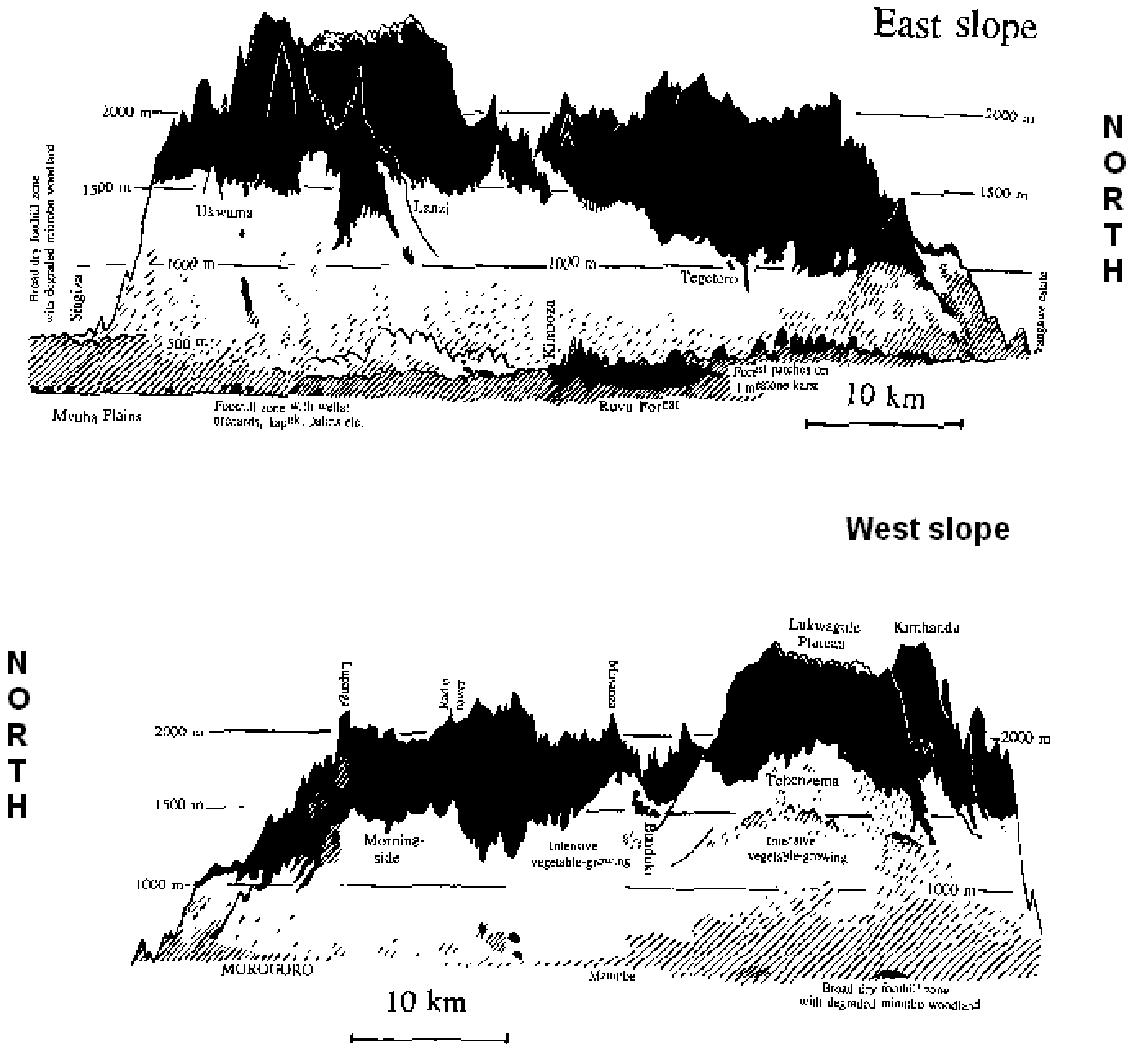


Figure 1.1. Map of the Tanganyika-Nyasa Montane Forest Group. Moreau's (1966) Tanganyika-Nyasa Montane Forest Group consists of the Eastern Arc Mountains (encircled with dots) and the mountains called "Other Tanganyika-Nyasa Mountains" (also encircled with dots) on the map. Some coastal forests and some few other inland montane forests are indicated (hatched).



Figures 1.2. An altitudinal profile of the Uluguru Mountains. Altitudinal scale is 10 times the horizontal scale. The top figure shows the east slope, the bottom figure the west slope. The distribution of evergreen forest and semi-evergreen thickets are shown in black, dispersed woodlands, *Combretum* scrub and various kinds of plantations shaded. The position of the forest borders is determined from topographic 1:50,000 maps and adjusted according to notes made during the fieldwork. Important locality names are given.

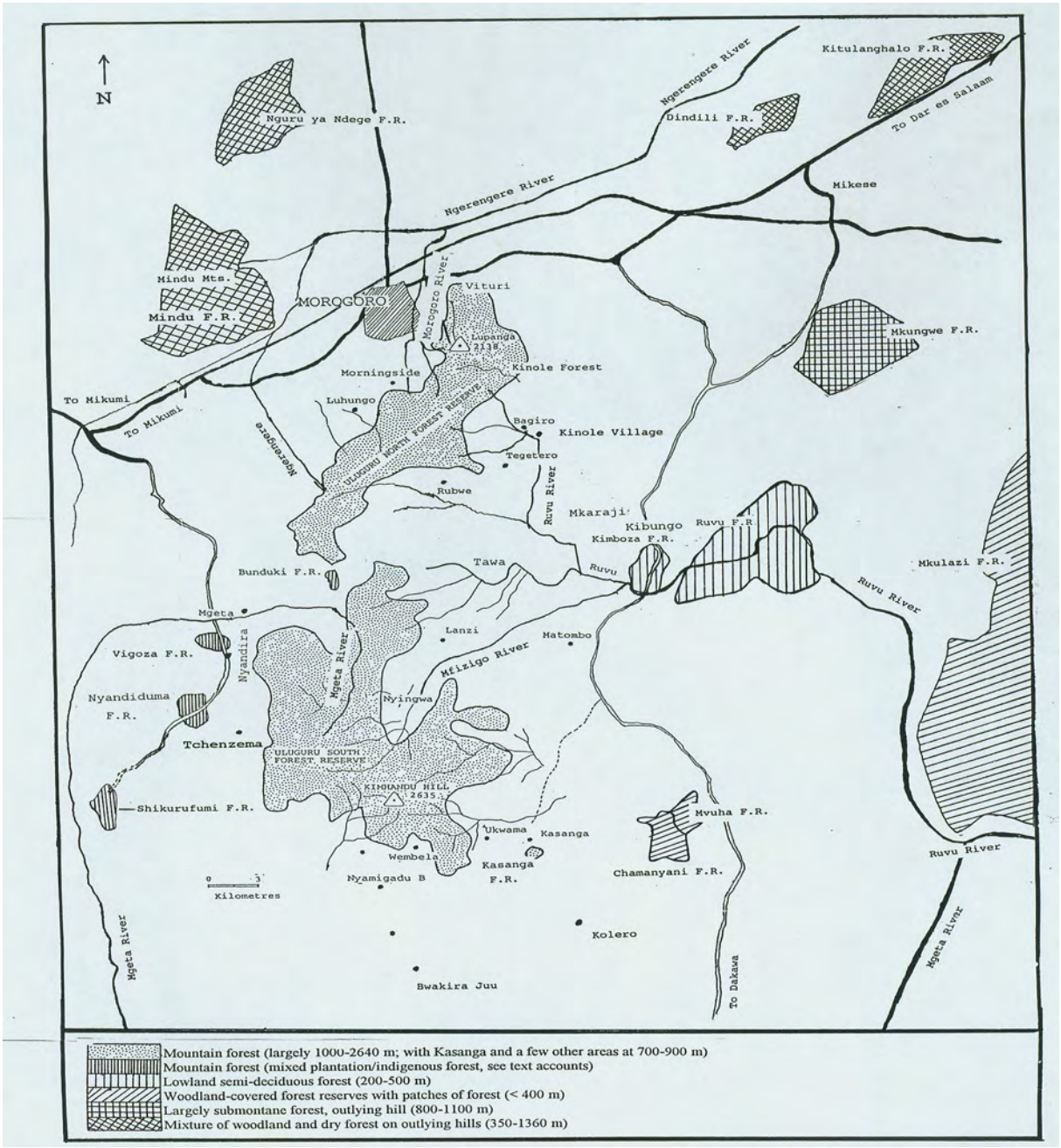


Figure 1.3. Map of the Uluguru Mountains and nearest vicinity. Forest reserves on outlying hills and on the floodplains are included. The Ngerengere River joins the Ruvu River further east than the map extends. The Mgeta River, originating on the Lukwangule Plateau and collecting water from tributaries on its way, describes a half circle further south than the map extends where after it joins the Ruvu River just south of Mkulazi F.R. The following names mentioned in the text could not be traced on our topographical maps: Mhonda, Mseru, Mngazi and Nzovu Hill.

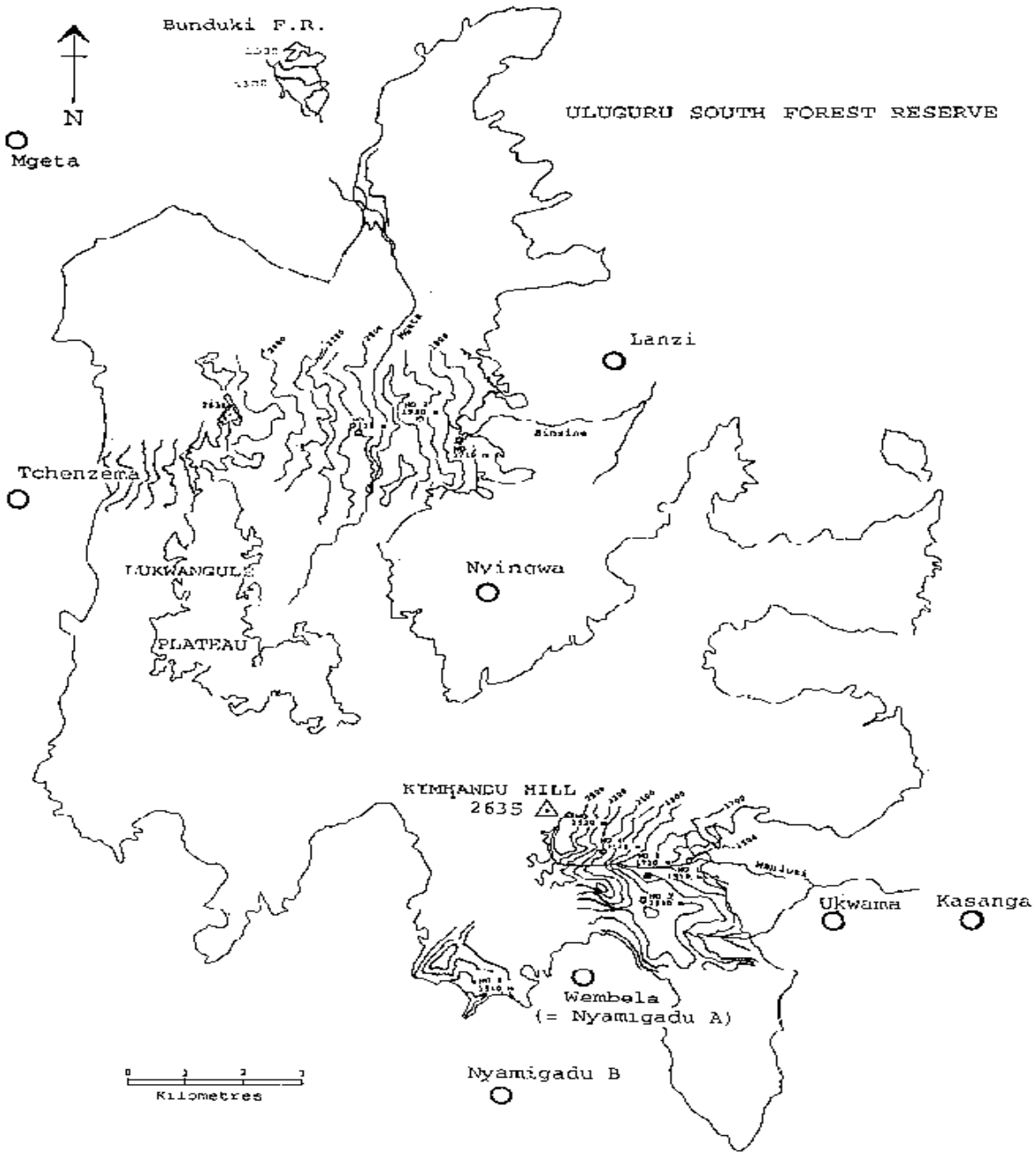


Figure 1.4. Map of the southern section of the Ulugurus. The six field stations at Kimhandu and the three stations at Lanzi are included.

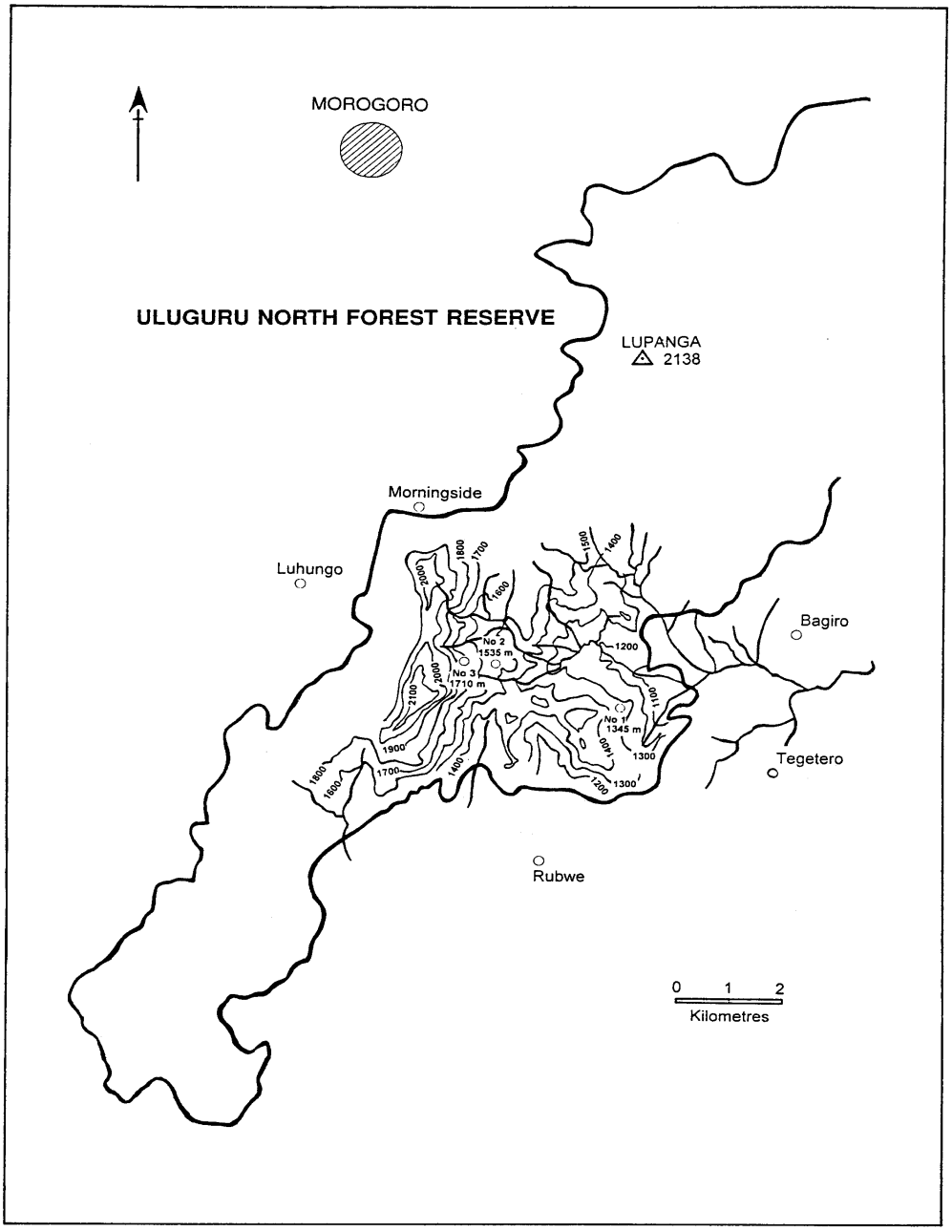


Figure 1.5. Map of the northern section of the Ulugurus. The three field stations at Tegetero are included.

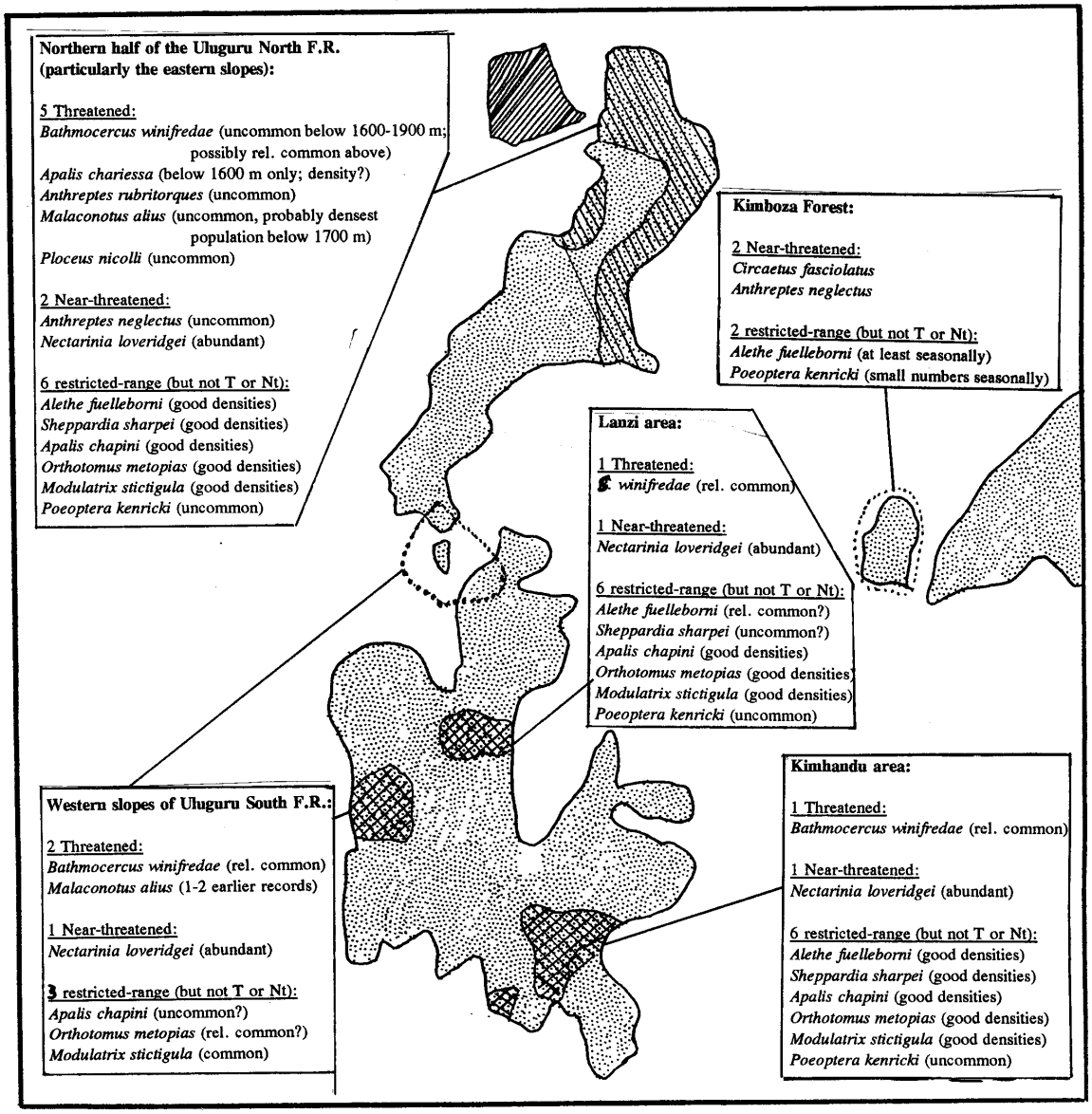


Figure 1.6. Geographical distribution within the Uluguru mountain and foothill forests of bird species of special conservation importance (current knowledge, 1993). Hatched area illustrates where ornithological visits have taken place (very roughly; for some of the earlier surveys it is difficult to illustrate exactly where the visits took place). Three of the Threatened bird species are known only from the northern section, and a fourth, *Malaconotus alius*, has only been recorded once or twice in the southern section.

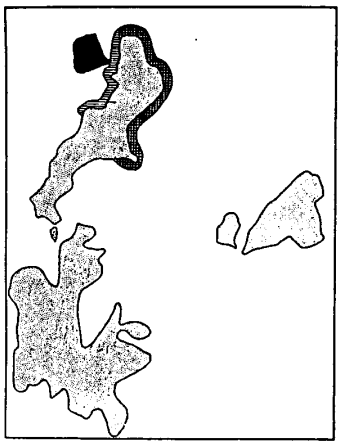


Figure 1.7. Suggested priority area for protection of Threatened bird species: The submontane forest on the eastern slopes of the Uluguru North in the Tegetero-Bagiro-Kinole-Lupanga area (double hatched, large areas of submontane forest here) and on the northwestern slopes in the Morningside area (single hatched, smaller areas left here).

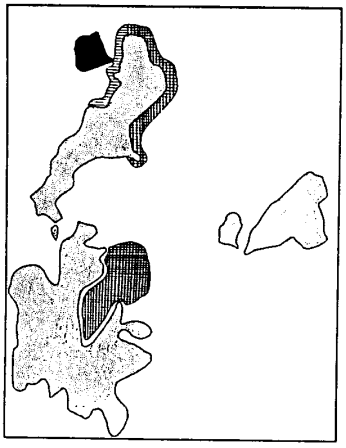


Figure 1.8. Suggested priority areas for large-scaled tree planting for fuelwood reserves.

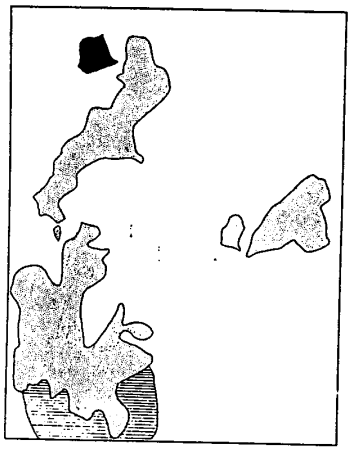


Figure 1.9. Suggested priority area for increasing living standard by support to more intense landuse and better access to markets.

SECTION 2. BACKGROUND OF THE SURVEY AND ITINERARY.

By Jens Otto Svendsen and Louis A. Hansen.

2.1. Background of the survey and the contents of this report (confer Appendix 2.1).

A description is given in Appendix 2 on the background of the survey and the decisions about what to include in the report.

2.2. Itinerary for stay in Tanzania (confer Table 2.1, in Part B).

The arrivals and departures of the individual team members during the survey period (19 Sept.-19 Dec.) are listed on the first page of this report.

Preparations:

19-24 Sept.	-Dar es Salaam: General preparations (research clearances, residence permits, luggage clearing, meetings etc.).
25 Sept.	-Dar es Salaam to Morogoro with bus.
27-29 Sept.	-Morogoro: Permissions from regional, district and other authorities. Arrangements with TAFORI, Regional Forest Office and NORAD concerning participation of foresters and transport. Shopping and packing.
30 Sept.	-Morogoro to Singiza village by car.

Fieldwork period (1 Oct.-17 Dec.) (confer Table 2.1):

The efforts in the field are listed in Table 2.1. Not included in the table from the fieldwork period::

18-19 Nov.	-In Lanzi village, half of the team only the 19th.
20 Nov.-2 Dec.	-Morogoro: General preparations for the survey of the Uluguru North F.R. and treatment of diseases. Also meetings. Departures for Tegetero 28 Nov. and 2 Dec.

Final arrangements after the termination of fieldwork:

17-19 Dec.	-Morogoro: Meetings and evaluation of the fieldwork.
1 Feb. '94.	-Last team members leave Tanzania (some after fieldwork on birds and botany in the Udzungwa Mountains [separate budget] and final arrangements in Morogoro/Dar es Salaam).

Timing of the survey.

The 1993 survey was undertaken from early October to mid December. The heavy rains usually start in the middle of November. They were, however, much delayed this year - the first heavy rain showers fell in February - and despite the reputation of the Ulugurus as being one of the wettest areas in East Africa, rain caused only few problems, though we experienced some heavy showers and some mornings and whole days with mist and rain.

SECTION 3. BACKGROUND INFORMATION ON THE ULUGURU FORESTS.

By Jon C. Lovett, Jon Fjeldså and Jens Otto Svendsen.

3.1. The Ulugurus as part of the Eastern Arc Mountains.

The chain of ancient gneissic mountains running from the Taita Hills in South-east Kenya to the Udzungwa Mountains in South-central Tanzania has been termed the Eastern Arc Mountains (Lovett 1990 and 1993; see Figure 1.1). They are defined as the crystalline mountains under the direct influence of the Indian Ocean climatic system (Lovett 1990) and are part of the Tanganyika-Nyasa Mountain Forest Group (Moreau 1966; see Figure 1.1). Uplifted as isolated fault blocks, these mountains appear today as a chain of isolated forest-capped mountains across central Tanzania to the Taita Hills in southeastern Kenya. Most mountains are habitat islands that rise steeply 1-2 km above the "ocean" of dry savanna plains, and harbour a unique flora and fauna, of which many species are endemic to the mountain chain or to single mountains (Lovett 1988, Lovett and Wasser 1993). One of the most outstanding of the Eastern Arc mountain blocks is the Uluguru Mountains. They are situated to the south of the main chain, 180 km from the coast, and isolated from the Udzungwa and Rubeho Mountains by 70 km of low lying plains, which include the Mikumi National Park (see Figure 1.1).

3.2. Topography.

The Uluguru Mountains are a faulted block. The process which has formed this distinctive unit may have started as far back as the Karroo period approximately 300 million years before present (Griffith 1993), with a final uplifting 7 million years ago. The tectonic activity included the uplift and metamorphosis of Palaeozoic (usagaran) limestones in the eastern foothills. These appear today as a "haystack karst" landscape which includes the lowland Kimboza and Ruvu Forests and several small forest patches. Other low foothills are composed of Mesozoic limestones and shales, and cemented Cainozoic sandstones.

The Uluguru Mountains form a 45.5 km long chain, rising steeply from the Mgeta and Mvuha floodplains (150 m elevation) to a peak elevation of 2638 m (Figures 1.2 and 1.3). Although the mountains form a continuous ridge, they are physically divided into the northern Uluguru (20.5 km long and 8 km wide) and the southern Uluguru (25 km long and up to 15.5 km wide), separated by the Mgeta or Bunduki Gap (Figures 1.2 and 1.3).

The mountains have a very rugged topography. Except for the boggy Lukwangule Plateau (2638 m), the ridge is characterised by steep peaks: Kimhandu Hill (2635 m) in the south, and Mnyanza (2140 m), Magari (2340 m), Nziwane (2270 m) and Lupanga (2138 m) in the northern part (Figures 1.2 and 1.3). Even 50-70° steep slopes are usually forested, but in some places landslides have exposed large granite surfaces, which become partly covered by thick masses of herbaceous vegetation, ferns and sometimes surrounded by bamboo. Habitat dynamics associated with landslides may be important for the maintenance of a very large diversity of herbaceous species.

The lower slopes are generally less steep, and to the south and southwest there is a 20 km wide foothill zone of low undulating hills (c. 500 m), which border the swampy lowland plains (Figure 1.2). The area around the Ruvu headwaters is topographically complex, with a mosaic of low areas, which support fruit trees and shambas, and small and larger, steep limestone hills, often capped with forest (Figure 1.2).

3.3. Climatic conditions and altitudinal zonation of the forest.

Moisture-laden winds blow from the Indian Ocean on the eastern side of the Ulugurus. Estimated yearly rainfall for the Uluguru North F.R. is 2900-4000 mm on the eastern slopes and 1200-3100 mm on the drier western slopes (Lovett and Pócs 1993). Estimated yearly rainfall for the Uluguru South F.R. is 2500-4000 mm on the eastern slopes, up to 2000 mm on the drier western slopes (Lovett and Pócs 1993). This can be seen in contrast to a rainfall of 890 mm near Morogoro Municipality (Lyamuya *et al.* 1994). Precipitation is highest at high altitudes. There is a pronounced dry season on the western slopes (e.g. Lovett and Pócs 1993), whereas the eastern slopes of the Ulugurus have been regarded perhumid, with more than 100 mm of rain in every month reported at Tegetero, areas with perhumid climates are extremely rare in continental Africa (Pócs 1976b, Lovett 1993). However, there was very little rain towards the end of 1993 in the Ulugurus, and according to local people the rainfall pattern has been more seasonal during the last ten years (Lyamuya *et al.* 1994; pers. comm. with local people during the 1993 survey). More information on rainfall in various altitudes and vegetation types (with further references) can be found in e.g. Jackson (1970), Pócs (1974, 1976a and 1976b) and in Rapp *et al.* (1973). Estimates of yearly rainfall for all forest reserves in the Ulugurus and nearest vicinity are listed in Appendices 3.1-3.

Studies of marine sediments from the Indian Ocean reveal that the surface temperature here was only 1-2° C lower during the ice-age and did not decline at all off the Tanzanian coast (Prell *et al.* 1980). This coastal zone may therefore have been permanently warm and humid, and the Eastern Arc Mountains may therefore have had patches of humid forest permanently through long periods. This may apply to the East Usambara Mountains and the high and steep Uluguru and Udzungwa Mountains in particular. These three mountains are notable in East Africa for their high rainfall and moderate seasonality (Lovett 1993). These conditions may be a fundamental cause of the high endemism, as populations of plants and animals may have survived here, in isolation, for long geological periods.

Pócs (1976a) recognised the following, climatically induced, altitudinal zonation of forest in the Ulugurus, which will be referred to later in this report (text below is a quotation):

Low altitude dry forest and savanna woodland zone. Only at the western and northern foot of the Ulugurus, below 600 m altitude. Annual rainfall between 700 and 900 mm, the dry period lasts for 4-6 months. Mean annual temperature 24-26° C. The whole area is densely cultivated, therefore only small remnants of the original vegetation can be detected.

Lowland semi-evergreen rain forest zone. Between 250 and 500 m altitudes at the eastern foothills of the central part of the mountains. Annual rainfall 1700 to 2400 mm, no dry season or maximum 1-2 months, main annual temperature 24-25° C. On the limestone ground of a karst plateau, including the Kimboza F.R., the lowland rainforest exists even through a 2.5 months long dry season (remarks from JF, this survey: because of the ground water supply in that area).

Submontane dry forest and miombo woodland zone. Today this is actually mostly replaced by an open woodland of *Pterocarya angolensis*, *Combretum* and *Terminalia* species, or by dry secondary grassland. On the eastern foothills, only on drier slopes, up to 800 m altitude. Widespread on the western, northern and southern slopes, as high up as 1500 m in the northern, and up to 1600 to 1700 m in the southern Ulugurus. With 950-1300 mm annual precipitation, 2-6 months dry season and 19-23° C main annual temperature. These communities suffer the most from the bush and grass fires.

Submontane evergreen and semi-evergreen forest zone. Contiguous belt on the eastern slopes, between 500 and 1500 m, except in places used for agriculture. These forests occur in small patches also on the western side, in protected valleys at the lower edge of the evergreen forest belt. The submontane rain forests show the best forest growth in East Africa. The average rain fall is well over 1800 mm a year, usually exceeding 2500 mm and in some cases higher than 3000 mm, without being interrupted by a dry season. The main annual temperature lies between 23 and 17° C, at the lower and upper limits of this zone.

Montane evergreen forest zone. This habitat forms a broad belt around both sides of the mountains. The montane forest has remained in relatively good condition, with most of it being inside the protected forest area. Altitude limits are 1500-2100 m in the Uluguru North and 1600-2400 m in the Uluguru South. The annual precipitation varies locally between 1300 and (more than) 3000 mm. Especially the upper edge of this zone receives a high amount of rainfall without a seasonal interruption, or even if short dry periods occur, they are compensated by the contiguous cloud and mist formation at this altitude. Mean annual temperature: 12-17° C. The diurnal change of temperature is very small (when measured [by Pócs, editors remark], it was only 4° C), and occasional frosts occurs.

Upper montane or lower subalpine zone with elfin woodlands, bamboo thickets, peat bogs and with secondary grasslands, above 2100 m in the Uluguru North and 2400 m in the Uluguru South. Although the annual variation of temperature is low, the diurnal change becomes much higher than in the high forest zones, reaching more than 15° C, and it often sinks below or near zero. The dwarf and very closed canopy of the elfin forest is a good adaptation against the strong reradiation during cold nights when the cloud belt usually sinks down and the high summits of the Ulugurus remain exposed.

3.4. Altitudinal position of lower forest edge, Uluguru North and South F.R.s.

Most forest borders are very sharp, with fields extending right up to the forest edge. In some areas small clearings or areas with second-growth exist just inside the forest edge. In areas of easy access the lower part of the forest is disturbed, with strongly biased composition of tree species and often a lack of large timber trees. The following general characterisations can be made about the forest cover of the lower forest edges of the Uluguru North and South F.R.s:

- Large areas of forest and dense woodland, especially in the submontane zone, have been removed by people who now use the area for subsistence agriculture (Temple 1973, Lyamuya *et al.* 1994). The former extent of the forest in the Ulugurus is discussed in Section 9.3.
- In most parts of the Uluguru South F.R. the lower forest, edge is above 1500 m though narrow strips extends down to 1000-1200 m in certain areas (typically in stream valleys) (Figure 1.2).
- Above the principal agricultural areas on the west slope of the Uluguru South F.R. the lower forest edge is at 1900-2000 m.
- In the Uluguru North F.R. good areas of submontane forest (defined as forest between 500 and 1500 m) still remain in certain parts, mainly on the eastern/north-eastern slopes of the Uluguru North F.R., where the forest ranges down to 1000-1200 m in many places (Figure 1.2).
- A close proximity of evergreen forest and low-altitude woodland mosaics can only be found at the extreme northern end of the mountain range where a few narrow strips extend down to 650 m (e.g. at Kigurunyembe above the teachers college).

3.5. Forest reserves in the Ulugurus.

Efforts to conserve the forest on the Uluguru Mountains date back to 1909, when the government interrupted the system of shifting cultivation by establishing a 277 km² forest reserve with demarcated boundaries (Temple 1973, Lyamuya *et al.* 1994). Some of the reserves have been established much later, however (see Appendix 3). Information on the forest reserves and the historical development of conservation efforts in the Ulugurus is compiled in e.g. Temple (1973), Lovett and Pócs (1993) and Lyamuya *et al.* (1994).

The Catchment Forest Reserves on the Uluguru mountains are administered by Morogoro District Catchment Office. Lovett and Pócs (1993) described 15 Catchment Forest Reserves (plus Vigoza Catchment Forest Description) in the Ulugurus and nearest surroundings (Figure 1.3), giving information for each on year of establishment, gazetted area, gazetted boundary length, location, soils, climate, vegetation, catchment values, timber values, biodiversity, human impacts, management proposals and available literature. In Appendices 3.1 and 3.2 we summarize information from their report for the reserves visited on this survey. The same kind of information is given in Appendix 3.3 for

forest reserves not visited on this survey. In a few cases where information from the present survey has been added to these appendices, this is stated.

Seven of the Uluguru Catchment Forest Reserves/Descriptions are on the mountains (plus Kasanga Forest Reserve which is mentioned in our Section 5 but not included in Lovett and Pócs 1993), a * indicate that we visited the reserve:

- Uluguru North (*): ca. 06°50'-07°01'S, 37°37'-37°46'E — See Appendix 3.1.
- Uluguru South (*) ca. 07°01'-07°14'S, 37°35'-44°46'E — See Appendix 3.1.
- Bunduki I (*) ca. 07°01'S, 37°37'E — See Appendix 3.1.
- Bunduki III (*) ca. 07°01'S, 37°38'E — See Appendix 3.1.
- Nyandiduma ca. 07°10'S, 37°55'E — See Appendix 3.3.a.
- Shikurufumi ca. 07°10'S, 37°29'E — See Appendix 3.3.a.
- Vigoza Catchment ca. 07°03'S, 37°34'E — See Appendix 3.3.a.
- Kasanga F.R. ca. 07°12'S, 37°46'E — See Appendix 3.3.a.

Three catchment forest reserves are in the eastern foothills:

- Kimboza (*) ca. 07°02'S, 37°47'E — See Section 3.2.
- Ruvu ca. 07°01'S, 37°51'E — See Appendix 3.3.b.
- Chamanyani/Mvuha ca. 07°11'S, 37°49'E — See Appendix 3.3.b.

One is further east on the plains east of Ruvu River:

- Mkulazi ca. 07°07'S, 38°04'E — See Appendix 3.3.c.

Five catchment forest reserves cover outlying hills:

- Mkungwe ca. 06°52'S, 37°55'E — See Appendix 3.3.d.
- Nguru ya Ndege ca. 06°42'S, 37°36'E — See Appendix 3.3.d
- Mindu ca. 06°50'S, 37°36'E — See Appendix 3.3.d
- Dindili ca. 06°42'S, 37°52'E — See Appendix 3.3.d
- Kitulanghalo ca. 06°41'S, 37°58'E — See Appendix 3.3.d

Of the outlying reserves, those containing substantial forest areas are: Mkungwe, Kimboza and Ruvu. Chamanyani/Mvuha is mostly woodland with some riverine forest, and Mkulazi is all woodland. Nguru ya Ndege and Mindu contain forest patches. Dindili and Kitulanghalo are covered by woodland and drier forest of the coastal type.

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SECTION 4. STUDY SITES.

By Jens Otto Svendsen and Jon Fjeldså.

4.1. Introduction.

In this section, we give brief notes on some general characteristics of the forest and its surroundings at the study sites. Standardised notes were usually not taken, and the notes below are therefore of a miscellaneous character. Our efforts at the localities during the survey are listed in Table 2.1. Notes are given on map errors (1:50.000 maps) in Appendix 4.1, on the existence of local paths inside the forest in Appendix 4.2, and on the exact geographical position of our field stations in Appendix 4.3. On most localities local fields extend right up to the lower forest edge.

4.2. Description of main localities.

Kimhandu area. Location: Southeastern slopes of the Uluguru South Forest Reserve, see Figure 1.4. Lower forest edge: Forest extends down to 1450 m along the Msuluzi River (near our Kimhandu-1 camp, see photograph in the photograph section) and down to 1500 m in the Kitandulu area (near our Kimhandu-6 camp) but in many other areas the forest edge is situated higher up, generally around 1700 m. Upper forest edge: There is a continuous cover of forest all the way up to the highest point (2635 m). Some characteristics of the forest: Apart from the lowest part near the edge the montane forest is relatively undisturbed here with still quite many Camphor trees. Tree height up to 35 m. The terrain is very steep and rugged at Kimhandu and this, in combination with a dense understorey, made it very difficulty to move around in this area. *Dracaena*s were abundant near our Kimhandu-2 (1710 m) station. Natural forest glades surrounded by tall trees and with the ground covered with tall herbaceous or scrubby vegetation were especially numerous in the Kimhandu-3 (1940 m) area. Following the path from Ukwama village up to the Kimhandu Hill (Nongwe) area the first bamboo is met at 2250 m. The density of bamboo stems increase with altitude and there are dense stands of bamboos in the elfin forest at 2500 m (near our Kimhandu-5 camp). Mosses and lichens hanging down from the trees, a tree canopy height of only around 10-15 meters with emergents up to 25 m and an impenetrably dense forest interior furthermore characterize the elfin forest. Seen from outside the forest, the canopy of the elfin forest is characterized by very dense, "stunted", small-leaved crowns among bamboos. See photograph in photograph section. Some characteristics of the surrounding area: Main crops are maize and beans (but there is a big [weekly?] vegetable market in Kasanga). Especially the maize is often planted in large monocultures on very steep slopes without any caution taken to prevent soil erosion. Only in a few places and not on the steepest slopes did we see belts of tough grasses but these were apparently planted only to protect paths. Around many houses, there are some banana plants and occasionally a few fruit trees; also, the shambas have stands of bananas. Another crop commonly seen is cassava. In some areas, coffee is planted right up to the lower forest edge, e.g. above Kumba and Wembela villages.
The *Ukami village and* the lower camp *site* in Kimhandu area was *located at ca. 1345 m: 07°11'S, 37°42'E. Kimhandu Peak 2635 m, located at ca. 07°10'S, 37°40'E. All camp sites in the Kimhandu area were between these latitudes&longitudes, except Kitandulu which was at ca. 07°12'S, 36°42'E.*

Lanzi area. Location: Eastern slopes of the Uluguru South Forest Reserve, see Figure 1.4. Lower forest edge: The lower forest edge was at 1670 m below our Lanzi-1 camp. A walk towards the north along the forest edge indicated that forest extends down to c. 1550 m near a small stream with the local name Mdogo. Upper forest edge: The forest extends up to the Lukwangule Plateau at c. 2500 m. Some characteristics of the forest: The forest seems a bit drier than in the Kimhandu area. Comparing to the parts of the Kimhandu area we visited the human impact is more visible in the lower part of the forest (Camphor trees were, however, common here). Quite many light gaps in the lower part. Around 1900-2000 m (below our 2000 m camp) the forest was quite mixed with beautiful forest alternating with many big forest glades with bracken or herbaceous growth. Between the camp at 2000 m and the 2110 m station the forest changed into more dry and low forest, and around the

Lanzi-3 (2110 m) station the forest was more open (with many big light gaps) and less wet than around the Kimhandu-4 (2145 m) station. Small and big bamboo thickets occur locally in the area. Upstreams along the Mgeta River, bamboo thickets were abundant up to at least 2200 m. The upper part of the forest is elfin forest. Some characteristics of the surrounding area: Recently an area of c. 1 ha had been cleared for cultivation at the lower forest edge (see photograph in the photograph section).
The forest edge above Lanzi village begins at ca. 07°06'S, 37°40'E.

Tegetero area. Location: Eastern slopes of the Uluguru North Forest Reserve, see Figure 1.5. Lower forest edge: Near Tegetero Mission the forest extends down to 1050-1100 m. Where we entered the forest near Tegetero the lower forest edge is at 1130 m. Upper forest edge: At c. 2270 m (Mt. Nziwane). The highest altitude visited on this survey was 1950 m but forest/shrub continues to the highest tops. Some characteristics of the forest: The area west of Tegetero holds a big and plateau-like forest at 1200-1500 m, intersected by several big streams. There are numerous ridges and valleys on the slope but the slope falls very gently and flat in this area, and the terrain was generally easier to move around in here than at Kimhandu and Lanzi. The forest in the flat area is of high quality with often 35-40 m tall trees but there are also many forest glades. Especially in the lowest part (1000-1400 m) the forest is clearly of another type than those visited in the Uluguru South, with lots of thick tall trees (up to 50 m, thick and rank), covered with epiphytes, especially ferns. Doubtless one of the finest pieces of submontane forest in East Africa. Following the path towards Luhungo village, a pass is reached at 1960 m (the highest point visited). West of the pass, the slope is steep, the forest landscape dropping quickly towards the surrounding flat, cultivated lowland west of the mountains. Some characteristics of the surrounding country: Maize fields continued all the way up to the boundary but did not cross it.
The lowest camp in the forest was situated at: ca. 06°54'S, 37°42'E, while the upper two sites at ca 06°55'S, 37°40'E.

4.3. Description of localities visited briefly.

Tchenzema area. Location: ca. 07°06'S, 37°36'E. Western slopes of the Uluguru South Forest Reserve, Figure 1.4. Lower forest edge: At 1950-2050 m, sharp. Upper forest edge: At c. 2500 m (Lukwangule Plateau). Some characteristics of the forest: Inside the forest strong disturbance. Much cutting and no big trees. Mostly just dense shrubbery, smooth (young) trunks with little moss. Lowest *Ocotea* tree at 2250 m, and generally fairly undisturbed forest only above 2350 m, in very steep parts below the plateau (where the forest is low anyway). Very few trees with >75 cm diameter, and most trunks 10-40 cm. In this zone there are also large open patches with thick layer of herbs (*Begonia*, *Impatiens*, *Rubus*, *Stellaria*, *Eupatorium*). Elfin forest at the highest altitudes. Some characteristics of the surrounding area: The entire area is densely populated and intensively cultivated, producing cash crops for the markets in Morogoro and Dar es Salaam. In the main cabbage-growing zone southwards from Nyandira all the way to Nzovu Hill there are numerous small thickets and forest patches, but all of this is planted (wattle, mimosas, *Eucalyptus*). Almost the entire subtropical zone is cultivated (short-term fallow). Main cash crops of the area are cabbage and also other vegetables (peas, beans, lettuce, potatoes, carrots, leek, beets, garlic). In some areas there are many peach and cherry trees (around 1500 m). The staple crop is maize. Some yams fields, but hardly any cassava. A simple terracing system (lazybeds) is used in most of the area, but the "terraces" erode away during the rainy season and therefore do not prevent that topsoil is washed away. The lower hills are already strongly degraded (almost sand), and good topsoil remains only above 1700 m. Watering channels have been established along most hillsides. Horizontal strips of grass (occasional supported with rows of bushes) are planted in many areas. Occasional *Eucalyptus* trees are 30 m tall. Also some *Cupressus* and *Grevillea*. The foothill (at 1000 m) is a tomato-growing zone, but only small parts are cultivated.

Kimboza Forest Reserve. Location: In the eastern foothills, see Figure 1.3. In crystalline marble (or dolomite?) area. Some characteristics of the forest (see also Appendix 3.2): The forest is at c. 300-400 m altitude. Rather dry, semideciduous. Dry forest floor, except in the well areas, where clear water comes up in several places in the higher parts and flows down in a fairly broad front towards

the Ruvu River; although this area is on high ground it has several hectares of *Pandanus* swamp forest. We were told that in the rainy season much of the forest is flooded (lots of *Lymnaea* snails and shrimps in the water); even on high ground water covers the surface, probably because of water from the mountains coming out under high pressure all over the karst area. Much of the forest is plantation, esp. *Tectonia*; some large *Ficus*. Non-plantation: Mostly only c. 10 m tall, resembling coastal thickets; difficult to get through.

Bunduki I and III Forest Reserves[1]. Location: ca. 07°01'S, 37°37-37°38'E Small forest patches near gap between Uluguru South and North Forest Reserves, see Figure 1.3 and 1.4. Lower forest edge: At 1220 m. Upper forest edge: At 1540 m. Some characteristics of the forest (see also Appendix 3.1): Lower part *Pinus*, large *Eucalyptus*, some *Cupressus* in a 50 m wide zone, and much *Grevillea*. A large area (110 ha) inside the forest reserve had recently been clearfelled illegally. Only in a few small areas in the forest are there a mixture of native trees and some rich associated shrubbery. Some characteristics of the surrounding country: In general there is little wood outside the forest. Very little burning in this area. The valley bottoms are intensively cultivated with fields of cabbage (in particular), beans, and cassava. At 1000 m, arid *Themeda*-covered rolling hills, some sandy fields with lazybed cultivation. Around 1200 m close to 100% of the land is cultivated. Very scattered trees (*Erythrinia*, *Proteus*, *Acacia*). The Bunduki village is a mosaic of *Eucalyptus* patches and some mango and bananas. Much *Dracaena usambarense*. Small banana plantations are seen near the houses. Near the village there is much *Eucalyptus*.

Morningside. Location: ca. 06°54'S, 37°40E. Western slope of the Uluguru North Forest Reserve, see Figure 1.5. Lower forest edge: At c. 1500 m. Sharp forest border at 1500 m where access was prohibited. Ornithological observations are from a rather brief survey outside the forest. Some clearance inside the forest. Some characteristics of the surrounding country: Below the border steep slopes, cultivated (lazybeds at 5-10 m intervals) and fallow (lush herbaceous slopes), several *Dracaena*, and near Morningside Rest House big exotic trees.

Kigurunyembe. Location: ca. 06°50'S, 37°42'E. Submontane forest strip at the western slope of the Uluguru North Forest Reserve, see Figure 1.5. Lower forest edge: At c. 600 m. Upper forest edge: This forest strip is continuous with the large forest tracts above. Highest altitude visited was 850 m. Some characteristics of the forest: At the northeast "corner" of the Ulugurus, north of the Tegetero-Bagilo-Kinole area, are some outlaying ridges with forest or remnant patches with tall trees along the top ridges at c. 1000 m, and some slopes with tall herbaceous vegetation and dense thickets even below this level, giving some habitat vestiges for birds of evergreen habitat in the lower submontane zone. One of these strips is above Kigurunyembe at the northern end of the Ulugurus. It is a narrow strip (100-400 m wide) of humid forest, which descends down through the zone of miombo woodland and very steep grassy and rocky slopes along a deep ravine all the way from the montane zone to 650 m altitude right above the Teacher's College at Kigurunyembe. The forest strip visited at Kigurunyembe has a high diversity of trees, scrubs and herbs, but is highly disturbed, as most tall trees have been extracted, leaving most parts as a dense 10-15 m tall thicket vegetation draped by vines. There is a stream inside the forest. Some characteristics of the surrounding area: Near Teacher's College at 600 m there is a park area with many trees, especially mango, cashew nut and jacaranda together with palms.

1 Bunduki Forest Reserves are also known as The Vinile F.R.

5. ORNITHOLOGY[1].

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5.1. Abstract.

The Uluguru Mountains (including foothills) were considered the fourth most important area in East Africa for the conservation of rare forest birds by Collar and Stuart (1988). Five globally Threatened (one of them endemic), three globally Near-threatened (one of them endemic) and six other forest bird species of extremely restricted-range are known from the Uluguru forests.

Whereas the Uluguru North F.R. had been visited before by various workers and was known to hold all above-mentioned species (except one of the Near-threatened), the Uluguru South F.R. (by far the largest reserve in the Ulugurus) was largely unknown ornithologically except for visits in the Tchenzema and Bunduki areas on the drier western slope and a short visit in the Nyingwa area on the eastern slopes. These visits revealed the presence of two of the Threatened species in the Uluguru South. It was furthermore uncertain whether certain rare species (especially Swynnerton's Robin *Swynnertonia* swynnertoni and Dappled Mountain Robin *Arcanator orostruthus*) occurring in the Usambaras and the Udzungwas were genuinely absent from the Ulugurus, or had just been overlooked.

This chapter presents the results of ornithological fieldwork carried out in the Ulugurus between 1 October and 15 December 1993. Results from a two days visit in November-December 1994 are also included. The main aim was to describe the bird assemblage of the mountain forests of the Uluguru South and North Forest Reserves using standardised and repeatable techniques and to assess the population status of the two Uluguru endemics (Uluguru Bush Shrike *Malaconotus alius* and Loveridge's Sunbird *Nectarinia loveridgei*). Standardised fieldwork was carried out along two altitudinal gradients on the eastern slopes of the Uluguru South F.R. (altitudinal range visited: 1450-2640 m) and along one gradient on the eastern slopes of the Uluguru North F.R. (altitudinal range visited: 1100-1950 m). Brief visits were paid to the western slope of the southern section (Tchenzema in the Uluguru South, 1950-2500 m, and Bunduki F.R., mostly plantations at 1220-1540 m), to two localities on the northwestern slopes of the Uluguru North F.R. (Morningside at 1500 m and Kigurunyembe at 650-850 m) and to the lowland Kimboza F.R. (300 m).

The altitudinal distribution of all forest species occurring in the Ulugurus is described, supported by quantitative data from the 13 stations shown on Figure 1.4 and Figure 1.5. Ecological data are given where appropriate. Based on the results from our survey in combination with a study of literature we examine the geographical and altitudinal distribution in the Ulugurus of bird species of special conservation interest (Threatened, Near-threatened and other restricted-range) and the value of the Ulugurus for such species. A summary of earlier fieldwork and recommendations for further fieldwork are given. Our study has enabled us to point at the remaining submontane areas on the eastern slopes of the Uluguru North F.R. (largest areas in the Tegetero-Bagilo-Kinole-Lupanga area on the eastern slopes and also some around Morningside in the northwest) as being the most important to focus conservation efforts on.

1 The taxonomy used in this section follows Collar et al. (1994) for Threatened and Near-threatened species. For all other species we follow Dowsett and Dowsett-Lemaire (1993). For species where the name used in Dowsett and Dowsett-Lemaire differs from the most commonly used in East African ornithology (e.g. Green Coucal instead of Yellow-bill), the latter can be found in Appendix 5.5.
For many bird species, it is difficult to determine whether it is a forest or a non-forest species. In this report, we have chosen to regard species, which use other habitat types (woodland, bracken, gardens etc.) to a very high degree as non-forest species, admitting that some of them are characteristic elements of the forests (especially the Kimboza Forest).

5.2. Introduction, part 1: The ornithological significance of the Uluguru forests (also see Table 5.1).

In the ICBP/IUCN Red Data Book *Threatened birds of Africa and related islands* (Collar and Stuart 1985) 97 Afrotropical species (species from the tropical part of mainland Africa) were treated as Threatened. Of these, a high number (63, i.e. 65 %) are forest dependent species (Collar and Stuart 1985).

The importance of the Uluguru Mountains for forest birds has long been known. In a review of key forests for the protection of threatened bird species in Africa by Collar and Stuart (1988) the Uluguru Mountains (including foothills) ranked 16th among all forests on the African continent and fourth among all forests in East Africa in terms of conservation value for the protection of Threatened and Near-threatened bird species. The Ulugurus are furthermore an important part of C24, one of the 221 priority areas for global conservation listed by ICBP (1992).

Table 5.1 shows the distribution and conservation status of all forest bird species of special conservation importance occurring in Moreau's (1966) Tanganyika-Nyasa Montane Group (Figure 1.1), the geographical limits of which largely fit C24 as illustrated in ICBP (1992). The Ulugurus hold five Threatened forest bird species. In the Tanganyika-Nyasa Montane Group only the Udzungwa and the Usambara Mountains have more. Some of the Threatened species in the Usambaras are restricted to lowland forest, which shows affinity to coastal forests. It is clear that the Eastern Arc is the richest part of the montane group, with no less than 12 Threatened bird species being endemic to this very limited range of isolated forest-capped mountains.

Five Threatened and three Near-threatened species occur in the Ulugurus (global conservation status categories with capitals from Collar *et al.* 1994).

Two of these species are endemic to the Ulugurus: the Uluguru Bush Shrike *Malaconotus alius* (Threatened) which is a distinctive species occurring at low densities, and Loveridge's Sunbird *Nectarinia loveridgei* (Near-threatened) which is a valid species in the *Nectarinia regia* superspecies (Hall and Moreau 1970), and very common.

The other Threatened and Near-threatened bird species known from the Ulugurus are: Mrs Moreau's Warbler *Bathmocercus winifredae* (Threatened), White-winged Apalis *Apalis chariessa* (Threatened), Banded Green Sunbird *Antreptes rubritorques* (Threatened), Tanzanian Mountain Weaver *Ploceus nicolli* (Threatened), Southern Banded Snake Eagle *Circaetus fasciolatus* (Near-threatened) and Uluguru Violet-backed Sunbird *Anthreptes neglectus* (Near-threatened).

Six species, which are of restricted-range (estimated breeding range of less than 50,000 km^2) but not Threatened or Near-threatened occur in the Ulugurus. These are: Spot-throat *Modulatrix stictigula*, Red-capped Forest Warbler *Orthotomus metopias*, Chapin's Apalis *Apalis chapini*, Sharpe's Akalat *Sheppardia sharpei*, White-chested Alethe *Alethe fuelleborni* and Kendrick's Starling *Poeoptera kenricki*.

All five Threatened species, the Near-threatened *Nectarinia loveridgei* and four of the other restricted-range species (*Modulatrix stictigula*, *Orthotomus metopias*, *Apalis chapini* and *Sheppardia sharpei*) were in the Ulugurus known only from the mountain forests (forests excluding lowland forests and outlying hills) before our survey and our results did not change this. Thus the mountain forests, of which almost the total area is made up by the Uluguru North and South F.R.s, are the most important for the bird species of special conservation importance. Before this survey it was, however, not known which parts of the mountain forests it is most important to protect.

The second Near-threatened species (*Circaetus fasciolatus*) is known only from the foothill forests, of which the best known is Kimboza Forest. The third (*Anthreptes neglectus*) is most common in the foothill forests but with an occurrence also in the lowest part of the Uluguru North F.R. Two species of

restricted range (*Alethe fuelleborni* and *Poeoptera kenricki*) are clearly most common in the mountain forests but occur in the foothills at least seasonally. The bird faunas of the foothill forests in many respects show strong similarities to the threatened lowland forests of coastal Tanzania and certain other Eastern Arc ranges. Thus, the foothill forests are also of significant conservation importance.

Five subspecies of montane forest birds are endemic to the mountain forests of the Ulugurus (Stuart and Jensen 1985, Stuart *et al.* 1993). These are: *Andropadus (tephrolaemus) neumanni* (Eastern Mountain Greenbul ssp.), *Sheppardia sharpei bangsi* (Sharpe's Akalat ssp.), *Apalis thoracica uluguru* (Bar-throated Apalis spp.), *Orthotomus metopias altus* (Red-capped Forest Warbler ssp.), and *Phylloscopus umbrovirens fugglescouchmani* (Brown Woodland Warbler ssp.). Two of these endemic subspecies are of restricted-range species (Table 5.1). A case may exist for regarding *Andropadus tephrolaemus neumanni* as a separate species, as it is the most aberrant of all forms in this polytypic species. The number of endemic subspecies is - with our current knowledge - relatively high for the Ulugurus compared to other mountain ranges as is evident from Table 5.2. This could have to do with the isolated eastern position of the mountains.

Only a single specimen exists of the geographically isolated Uluguru population of Abyssinian Crimson-wing *Cryptospiza salvadorii* (normally regarded a mountain forest species, see Appendix 5.5). The nearest population of this species is in the Kilimanjaro area. Further investigation may show that the Uluguru population of *C. salvadorii* represents an undescribed subspecies.

5.3. Introduction, part 2: Earlier ornithological survey work in the Uluguru Mountains (also see Appendix 5.1).

Friedmann and Stager (1964) gave a review of earlier ornithological fieldwork in the Ulugurus. Also Stuart and Jensen (1985) briefly gave details on earlier fieldwork in their review of the Uluguru avifauna. In Appendix 5.1 we draw the data from these two publications together, adding new details.

Focusing on the localities we visited (see Table 2.1 and Figures 1.4 and 1.5), we can conclude that the eastern slopes of the Uluguru South F.R. were unknown ornithologically except for some collecting activities by Arthur Loveridge around Nyingwa October 1926 (we suppose his Nyange/Nyingwe/Nyingwa localities are south of Lanzi). The Tegetero-Bagiro area in the Uluguru North F.R. had been visited before by various field workers. The Bunduki area had been visited by Stager for some time in 1964 and also by others (but for some of the visits it is not clear whether they visited the Bunduki F.R. or nearby forest in the Uluguru North and South F.R.s). Kimboza, Tchenzema, and Morningside had also been visited before whereas Kigurunyembe was unknown.

Most of the visits to the forests before 1965 were to collect specimens for museums, more recent visits were general surveys. The work described in the following is the attempt to make a quantitative description of the bird species composition along altitudinal gradients, primarily using standardised methods, and to describe the distribution of species of special conservation interest.

5.4. Methods used on this survey (also see Table 5.3).

It is difficult to define a single standardised quantitative measure for the composition of the forest bird community. Factors that complicate the matter are:

- Some species are very noisy, vocalising incessantly while feeding, or singing much of the day. Others give only one or a few song strophes at daybreak and are silent the rest of the day.
- Some species skulk in dense understorey all day, other species forage in the mid and upper strata of 40 m tall forest, and a third group move between all strata.
- Some species forage alone, some in pairs, some in mono-specific flocks and some frequently in multi-species feeding parties moving over long distances.
- Some species are very common while others are extremely rare.

No standard manual exists for comprehensive surveys of Afromontane forests. On this survey we used four complementary methods (see 5.4.1-4 below) at each of the three main study sites (Kimhandu, Lanzi, Tegetero). All methods give a relative, not absolute, measure of abundance. Brief surveys were carried out at other localities. Our efforts are detailed in Table 5.3. In Appendix 5.12 we comment on the efficiency of the methods applied and on the completeness of our survey.

JF, LAH, JK and JOS were experienced with visual and vocal identification of Eastern Arc montane forest birds from earlier fieldwork. The rest of the ornithology team visited the Eastern Arc for the first time but had trained identification by studying specimens and by listening to tape recordings.

5.4.1. Mistnetting for two full days (also see Tables 5.6-5.8 and Appendix 5.12).

Aim. To obtain a relative measure of the abundance of lower strata species, especially the most skulking ones and to obtain standard biometric data and blood samples of the birds for later analysis of evolutionary relationships of Eastern Arc montane forest species. Mistnetting was furthermore an important part of the training carried out during the survey.

Technique. Usually one full day was used to put up the mistnets. The following two days they were opened just before the onset of the first bird activity (usually around 5.30 a.m.) and kept open until about half an hour before darkness (usually to around 6.15 p.m.). They were normally checked every hour but more frequently in the early morning or when the weather conditions were not optimal. The nets were closed during the night to avoid entangling of bats and destruction by nocturnal ground dwelling mammals. No attempt was made to mistnet nocturnal birds since the only night bird heard was the Wood Owl *Strix woodfordii*.

The length of the net series varied from station to station, depending on topography, available manpower and general impression of the bird density. We generally placed the nets where they would be least visible, but attempted to cover all microhabitats such as shrubs, clearings and areas with mainly open forest floor. Clearings were usually covered by placing the nets just inside the forest edge since a fully visible net in a glade may have a low catch rate. In a few cases nets were run in glades if these were a prominent habitat type but their catch rate was comparable to nets run in denser forest at the same stations. The nets were placed in small groups of rows and/or angles. The net chains were placed some distance apart and not parallel in order to avoid "shadow effects". The nets were usually within 150 m from the camp where the birds were processed.

All birds caught were bagged, brought to the camp and ringed (enabling us to distinguish between the individuals captured), and most were measured and scored for brood patch and moult status (following recommendations in Baker and Baker 1990). Birds, which were wet or caught late in the evening, were released immediately, however. All mistnetting data (1135 records) have subsequently been computerized into the database of the East African Ringing Scheme and are available on disks. Some 250 of the birds were bled for DNA samples, which can be done without noticeable extra stress or damage.

For each individual we noted in which of the nets it was caught. This has enabled us to compensate for non-standardised efforts at some stations where nets were put up specifically to catch e.g. *Bathmocercus winifredae* (including the captures of these nets would lead to an overestimation of the density of that species), or where some of the nets were run for a little more than two days.

5.4.2. One-hectare plots (also see Table 5.9 and Appendix 5.12).

This method, which is adapted from the variable circular-plot method (Reynolds *et al.* 1980), is almost identical to a procedure developed for South African forest by Koen (1988) and has been used by JF in a wide range of tropical habitats (e.g. Fjeldså 1993, Fjeldså and Rabøl in press). The method, which aims

at obtaining a quantitative measure of the abundance of all non skulking forest species, is adapted to the facts that:

- Territory mapping methods are too time-consuming for comparison of a large number of study sites (stations).
- Steepness and dense undergrowth often makes it impossible to quietly follow a continuous route required for a transect.
- The detectability of many (but not all) forest birds drops sharply at 30-50 m distance (Reynolds *et al.* 1980), which makes point counts difficult to use.

Aim. To obtain a quantitative measure of the abundance of all non-skulking species.

Technique. Study plots of 100 x 100 m extension (visual judgement) were selected within 50 m elevational range from the mistnetting station (in very few cases in steep terrain: 100 m). Within each plot observations were made for exactly ten minutes, during which time an attempt was made to find every bird in the plot by walking quietly through it. Before starting the counting the observer learned its borders and edges by spotting characteristic elements in the surroundings (without walking around to visit the borders). We attempted to select the plots representatively throughout the local habitat spectrum but the ruggedness of the terrain admittedly caused some constraints. In cases where the terrain was too rugged or shrubby to move quietly for inspecting hidden parts, a vantage point with a good overview of the plot was used.

Plots were assessed only between 7 and 10.30 a.m. or after 4 p.m. The reason to wait until after 7 o'clock was to avoid the burst in song activity just after dawn. Plot assessment ceased when bird activity was low, and on certain days we had to stop counting as early as e.g. 9 o'clock, in one case even at 7.40 a.m. The activity after 4 p.m. was usually too low to allow for assessment. No plots were assessed in rainy weather, and on the few mornings with sporadic mist, assessments were made only when the whole plot was visible.

Most montane forest bird species are heard far more often than seen, and the method requires that the observer has good skills in identifying birds by their songs, calls and warning notes. The majority of the plots were assessed by those of the participants who were familiar with the voices from earlier fieldwork in the Eastern Arc montane forests. Those of the participants who were in the Eastern Arc for the first time did not make plots until they were familiar with the voices. Normally the observer was alone but in a few cases one or two persons joined him to learn the technique. In the latter case only the main observer was allowed to detect the birds - individuals which this person overlooked were omitted in order to ensure comparability.

15 to 25 plots were assessed per station. Each one-hectare square was covered only once. In the results section we will restrict ourselves to count each species only once per plot, also in cases were more than one individual was noted. Birds, which evidently were flushed from one plot to the next, were counted only once.

At the Kimhandu-5 (2520 m) station the 10 m tall forest was extremely dense, making it impossible to find any plots that could be easily assessed from the forest interior, and the plots were therefore assessed by observations from an adjacent meadow.

5.4.3. Tape recordings at dawn (also see Table 5.10 and Appendix 5.12).

Aim. To augment species lists obtained by mistnetting and plots.

Technique. At every ringing station two tape recordings (two mornings), each of 30 minutes duration were made. The recording was started at the onset of the first bird song at dawn. They were made close to the mistnet group furthest away from the camp. The microphone (a Sennheiser MD-21 U [ball

characteristics]) was placed about 160-180 cm above ground. The tape recordings were listened through twice after returning to Denmark.

5.4.4. General field observations (also see Tables 5.4 and 5.5 plus Appendices 5.5-5.8 and Appendix 5.12).

Aim. To record Threatened species which often occur at such low densities that they are overlooked by the above mentioned methods. Furthermore to record the complete altitudinal range of all species.

Technique. At each locality we searched the area as thoroughly as the time allowed, in order to locate rare species. Where possible we attempted to cover the entire elevational gradient. Altitudes were measured with a Thommen altimeter. Special interest was paid to mixed feeding parties where these occurred (they turned out to be mostly restricted to the northern section) in order to find especially the Threatened species *Apalis chariessa*, *Ploceus nicolli* and *Anthreptes rubritorques* (all known to occur in the Ulugurus). Other rare sunbird species which are not known from the Ulugurus but could potentially occur there also sometimes join such parties.

Notes on efforts of general field observations. The altitudinal gradient in the Kimhandu area was surveyed from the lowest forest edge (c. 1450 m) to the highest point in the area (Nongwe, c. 2634 m) but only little time was spent in the altitudinal ranges below 1520 m and from 2200 to 2450 m. In the Lanzi area the gradient from the lowest forest edge (c. 1560 m) up to 2220 m was surveyed relatively well (with least effort laid below 1710 m) whereas the gradient from 2220 up to 2500 m was studied only during a very brief visit to the Lukwangule Plateau. In the Tegetero area the lower part of the flat area (from c. 1050 to c. 1250 m) was visited briefly twice and there could be species not recorded in this large and interesting area. The highest point visited in the Tegetero area was a pass at 1960 m altitude near Luhungo but forest can be found up to 2270 m (Mount Nziwane).

5.5. Results.

Table 5.4 lists the altitudinal records of forest species from our survey (all localities). The earlier knowledge on altitudinal distribution of the species is listed too. Records of non-forest species are listed in Appendix 5.6.

Table 5.5 illustrates altitudinal records in a different way than Table 5.4: Presence/absence of species within +/- 50 m elevational range of the 12 stations at our three main localities.

Tables 5.6-5.8, 5.11 and 5.12 show numbers of birds mistnetted.

Table 5.9 shows which species were recorded on the plots.

Table 5.10 shows which species were recorded by tape recording at dawn.

Figure 5.1 ranks the relative abundances of species at our 12 stations as shown by mistnetting for two full days and plot counts.

Figure 5.2 shows the number of forest species ringed per station (mistnetting for two full days) towards number of individuals ringed.
Figure 5.3 shows the number of forest species recorded per station on plots towards number of plots assessed.

Abbreviations used for locality names in Tables 5.4-5.10:

Kim/Kimh.:	Kimhandu
Lan.:	Lanzi
Teg.:	Tegetero
Tchen./Tchenz.:	Tchenzema
Kimb.:	Kimboza
Kigur.:	Kigurunyembe
Bund.:	Bunduki

Abbreviations used in Sections 5.5.1-4 and Appendix 5.5 to indicate by which methods a species was recorded:

M	= Mistnetting.
P	= One-hectare plots.
T	= Tape recordings at dawn.
G	= General field observation.

5.5.1. Observations of the five Threatened species (also see Appendix 5.3).

Below we list observations from our survey. The general geographical distribution of the five Threatened species is described in Appendix 5.3 with special notes on the Ulugurus. The sizes of the Uluguru populations of the five Threatened species is discussed briefly in Section 5.6.1.

Mrs Moreau's Warbler *Bathmocercus winifredae* (M, P, T, G). A minimum of 33 different territories were identified at Kimhandu, Lanzi, Tegetero and Tchenzema. No standardized measurements of territory density were obtained. However, because of the powerful song, it could be determined that in certain well suited areas (Kimhandu at c. 1800-2000 m, Tchenzema at 2000-2200 m and Lanzi at 1700-1900 m) there was generally 2-300 m between the territory centres. This figure is a very rough estimate and should not be used for calculations of population size or strict comparisons with other mountain ranges but can serve to give the reader an idea of the density in *some* places. The densities appeared to vary greatly. Below we give the altitudes of all territories recorded during the survey.

At Kimhandu we recorded the species near the Kimhandu-1 (1520 m) camp, where a single territory was encountered (altitude: 1700 m, well north of the Msuluzi river) and in the areas surveyed from the Kimhandu-3 (1940 m) station where a minimum of nine territories were identified and the species was heard frequently (territories at 1700, 1820, 1850, 1880, 1920, 1920, 1960, 1960, 2020 m). At Kimhandu-3 it was furthermore scored on two of the 22 plots assessed, and a pair was mistnetted (both birds simultaneously) in nets put up selectively to obtain a blood sample from the species.

At Lanzi the species appeared to be more widespread. A minimum of 15 territories were identified (altitudes: 1660, 1670, 1710, 1710, 1770, 1780, 1860, 1900, 1900, 1920, 1920, 1940, 2000, 2070 and 2160 m). Four birds were mistnetted at the Lanzi-1 (1710 m) station. These four individuals are believed to belong to the two territories listed for 1710 m altitude. Two of the birds are included in the two days standard effort (mistnetted with one hours interval and probably a male and a female; caught in a light gap where we had put up a net to cover this habitat type which was prominent around the camp). The third individual was mistnetted inside forest in a net that had been run for more than two days and the fourth was caught in nets put up selectively (in the other territory near the camp) to obtain extra blood samples from the species. The species was scored on one of the 16 plots that were assessed at Lanzi-1 (1710 m) and on one of the 15 plots that were assessed at Lanzi-3 (2110 m).
At Tegetero only three territories were identified (altitudes: 1475, 1550-1600 and 1740 m), and the species appears to occur rather scattered below 1950 m in this area (1950 m was the highest altitude we visited here).

East of Tchenzema c. six territories were encountered (c. 2000, 2050, 2150, 2280, 2370 and 2430 m). Two of these (2000 and 2050 m) were in heavily disturbed forest near the lower forest edge. The ones from 2370 and 2430 m were in larger forest glades right below the scarp of the Lukwangule Plateau. The species was recorded on four of the 25 plots assessed at Tchenzema (the territories at 2000, 2050 and 2150 m altitude, all in 10-15 m tall forest).

Notes on the ecology. Most of the pairs we recorded were found in large natural forest glades with dense herbs covering the ground. Many of the light gaps were big and spectacular with lots of creepers, herbs and other epiphytes hanging down from tall trees in the edges or from single trees in the middle of the light gaps. Also Williams (1951) reported the species to be found in such habitats. In a few cases we found the species in light gaps with the ground mainly covered by bracken, in some cases the territory was in an area containing a mosaic of twenty-five meter tall forest and small light gaps with up to two meter tall herbaceous vegetation, and in other cases (Tchenzema) the species was found in thick, herbaceous vegetation in heavily disturbed, low forest. Stuart and Jensen (1985) reported the species to be particularly associated with dense undergrowth in small clearings and along valleys. The male and the female sing a duet consisting of loud and very characteristic whistles. Most of the territories mentioned above were identified only by hearing this duet, the species was rarely seen. More types of song as well as the warning call were recorded and will be presented on a tape (Svendsen in prep.). To the best of our knowledge, no tape recordings have been published yet of this species. The rather few visual observations of the species during our survey were almost exclusively of pairs travelling through the understorey together.

White-winged Apalis *Apalis chariessa* (G). The species was recorded only at Tegetero. A female was recorded at 1260 m altitude in a mixed feeding party, and the following day at 1300 m 2-3 birds, including at least one male, were seen in a mixed feeding party. All birds were seen high up in the canopy.

Banded Green Sunbird *Anthreptes rubritorques*. Not recorded on this survey. This small canopy and edge species was not recorded on our survey which is not surprising, taking into consideration how rare the species appear to be here and how little time there was available for field observations. Very little fieldwork was carried out below 1250 m and forest edge habitats were not searched.
Uluguru Bush Shrike *Malaconotus alius* (P, G). The species was not seen at any of the localities visited in the Uluguru South F.R. and after having learnt its distinct and far-carrying voice at the next locality (Tegetero) we believe that it was not heard at other localities than Tegetero. A more thorough

search for rare species in the Kimhandu and Lanzi (and Tchenzema) areas would probably reveal the presence of *M. alius*, but, if present, it must occur at very low densities.

At Tegetero a minimum of four home ranges/territories were identified. These are called A, B, C and D below.

Territory A. At 1320 m altitude a single individual was seen under good conditions on three occasions in a certain small forest glade (5, 6 and 7 December) some 500 metres from our Tegetero-1 (1345 m) camp. On the first occasion (5 December) it was in the canopy of trees bordering the gap, from 15 m height in the lower part of the canopy of an edge tree to 25 m height in the top of other trees, generally keeping to the upper part of the canopy. When seen 15 m above the ground it foraged in a cluster of leaves where also a Blackfronted Bush Shrike *Telophorus nigrifrons* was seen the following day. On the second occasion (6 December) it was seen 25 to 30 m above the ground in the upper part of the canopy. This bird was seen eating a big winged insect, possibly a cicada. On the third occasion (7 December) it was seen 15 m above the ground in the lower part of the canopy. On 3 December a single individual was heard at a plot (Table 5.9) which must have been at least 400 m from the above-mentioned light gap but we have chosen to regard this individual as a bird of the same home range.

Territory B. At 1520 m altitude (a ridge, much closer to our Tegetero-1 [1345 m] camp than to our Tegetero-2 [1535 m camp]) an individual was heard on 4 December.

Territory C. At 1500-1535 m near our Tegetero-2 (1535 m) camp. On several occasions an individual was calling from the upper canopy for a long time without moving into view (a habit shared with *Telophorus nigrifrons*). Its distinctive and loud call was tape-recorded and will be presented on a tape (Svendsen in prep.). To the best of our knowledge, the species has never been tape recorded before. On several occasions another bird, most likely a mate, answered the call. Although heard on several occasions (often at some distance, however), the species was seen on only a single occasion in this area. The visual observation is of a bird foraging and calling in the canopy of a 30 m tall tree. A Waller's Red-winged Starling *Onychognathus walleri* rested peacefully near its nest hole five meters from the bush shrike. The bush shrike had remained practically motionless (and therefore invisible) but frequently calling in the canopy of the same tree for at least 10 minutes before appearing in the sunlight. On two occasions where the observer followed the species for hours through the forest (being able to locate it from time to time from its call but unable to spot it), a *Telophorus nigrifrons* (also vocally active) appeared to follow approximately the same route, some 25 m from the *M. alius*. They moved so slowly, however, that it was difficulty to determine whether there was any interrelationship between them. *M. alius* was scored on one of the plots assessed at the Tegetero-2 station (Table 5.9).

Territory D. At c. 1710 m altitude a single individual was seen and heard on a plot (Table 5.9). This is the only observation of the species in this area despite some time was spent there.

Tanzanian Mountain Weaver *Ploceus nicolli*. Not recorded on this survey. *P. nicolli* was not recorded during our survey. This is not surprising in the light of its elusiveness and the short time available for doing general field observations.

5.5.2. Observations of the three Near-threatened species (confer Appendix 5.4).

The general geographical distribution of these three species is described in Appendix 5.4 with notes on earlier Uluguru records.

Southern Banded Snake Eagle *Circaetus fasciolatus* (G). A single juvenile bird was seen in Kimboza Forest during the two days spent at Kibungu Chini by JF and JK.
Uluguru Violet-backed Sunbird *Anthreptes neglectus* (G). A single individual was seen by JF during a two days visit in Kimboza.

Loveridge's Sunbird *Nectarinia loveridgei* (M, P, T, G). Clearly the most abundant bird at every mountain forest locality visited as evidenced from the mistnetting and plot data (Figure 5.1). *N. loveridgei* made up no less than 271 (28.3 %) of totally 959 birds mistnetted at Kimhandu, Lanzi and Tegetero (Table 5.6). Altitudinal distributions recorded at the main localities were: Kimhandu 1520-2580 m, Lanzi 1685-2475 m, Tegetero 1200-1960 m, Tchenzema 2000-2500 m.

At many of the stations where *N. loveridgei* is the most common species, the mistnetting data express a much bigger difference in abundance between *N. loveridgei* and other species, than the plot data do. (Figure 5.1). A thorough test of these two methods, including exact methods like territory mapping, has not yet been undertaken for East African forests, and it is therefore difficult to say which of them gives the most correct impression. *N. loveridgei* is very mobile, always on the move and a rapid flyer, and is therefore very prone to fly into the mistnets. Mistnetting may therefore overestimate the abundance of the species in relation to other species. The plot data (as used in this report) can potentially underestimate the abundance of very common species in relation to other species: only the percentage of plots with the species present and not the abundance on the plots is illustrated for a given station in the histograms.

The relatively low numbers at Tegetero-1 (1345 m) and Lanzi-3 (2110 m) need a comment: At Tegetero-1 (1345 m) only 8.4 % of the birds mistnetted were *N. loveridgei*. This should be seen in the light of the abundance of *N. olivacea* which is the most abundant sunbird at that station as shown also by the plot data. At Lanzi-3 (2110 m) *N. loveridgei* occurs at only low density according to the mistnetting data (12.5 % of all birds mistnetted) and further supported by general field observations. It is not clearly supported by the plot data. The vegetation was quite open and dry with some bamboo at Lanzi-3 (2110 m), perhaps with less flowering plants.

Notes on ecology. During our survey *N. loveridgei* was most often seen feeding on nectar or on insects by gleaning twigs and leaves. On a few occasions they were seen flycatching, a behaviour that was also observed on a single occasion by Williams (1951). The birds are very vigorous, flying much around, and appear to be temperamental. Williams (1951) stated that it is one of the most adaptable of the Uluguru forest birds, the species being “often seen about native plantations where trees have been left standing, being especially attracted to an *Albizzia*-like tree when this is in flower. It is also much in evidence in native pea cultivation, feeding at the flowers of this crop". He states that the species ”remains fairly common both in the remaining forest and outside”. At Ukwama village we saw it outside the forest in small stands of trees and shrubs but it was our clear impression that the species was largely restricted to forest habitat at the time we visited the Ulugurus. It may feed outside the forest edge at other times of the year if attracted to flowering plants. We did not hear the species in wooded areas between Kimboza and the montane forests, as we did with *N. olivacea*. There are no records from Kimboza Forest of *N. loveridgei*, and given the enormous population in the montane forests this indicates that the species does not undertake significant vertical migration to the lowland forests. Indications of breeding activity: see Appendix 5.11.

Only a single other sunbird species was recorded in forest interior, namely *N. olivacea*. At Tegetero-1 (1345 m) *N. olivacea* was more common than *N. loveridgei* as clearly illustrated by the mistnetting and plot data (Figure 5.1). *N. olivacea* was mistnetted also at Kimhandu-1 (1520 m) and Tegetero-2 (1535 m) and scored during plot assessments at Tegetero-2 (1535 m) and at Tchenzema (2150 m), but *N. loveridgei* is by far the most abundant at these stations. It is remarkable that the abundance of *N. olivacea* has declined so much from the Tegetero-1 (1345 m) station to the Tegetero-2 (1535 m) station. The reason may be that the latter station is much deeper inside the forest and near the steep slope in the western part of the large flat area at Tegetero.

5.5.3. Observations of restricted-range species (other than Threatened and Near-threatened).

White-chested Alethe *Alethe fuelleborni* (M, P, T, G): The results of our survey show that this understorey species is common in the Uluguru North and South F.R.s, especially in the submontane and lower montane forest. The mistnetting data provides the best indication of this very shy, rarely seen and not very active singing species which furthermore seldom gives warning calls if a person passes through its territory. For comments on its occurrence in Kimboza Forest, see Appendix 5.8.

Sharpe's Akalat *Sheppardia sharpei* (endemic subsp. *bangsi*) (M, P, T, G): We recorded this understorey species frequently between 1200 and 2140 m, with most observations being from below 1800 m. The highest densities encountered were clearly those in the Tegetero-1 (1345 m) area (Tables 5.8 and 5.9, Figure 5.1). Also at the Tegetero-2 (1535 m) and Kimhandu-2 (1710 m) stations the species was well represented. It is striking that it was not mistnetted in the Lanzi area and at the two lowest stations in the Kimhandu area. The record from Kigurunyembe is of a single bird heard. There were no earlier published records of this species from the Uluguru South F.R.

Chapin's Apalis *Apalis chapini* (P, T, G): This canopy and mid stratum species is generally common throughout the forests except at the highest altitudes (see plot and tape recording data).

Red-capped Forest Warbler (African Tailorbird) *Orthotomus metopias* (endemic subsp. *altus*) (M, P, T, G): *O. metopias* is a common understorey species at all our stations in the Uluguru North and South F.R.s (see mistnetting, plot and tape recording data). According to the plot data it is less common at Kimhandu than at Lanzi and Tegetero but this is not supported by the mistnetting data. *O. metopias*, which is normally very common in montane and upper montane habitats, was scored on only one of the 25 Tchenzema plots. This is a remarkably low score since the vegetation mosaic at Tchenzema offers a high density of suitable microhabitats (e.g. herbaceous scrub and leaf-rich edges in light-gaps). We heard some *O. metopias* from small forest patches passed in open country (less than 500 m from "the main forest") at 1500-1700 m.

Ripley and Henrich (1966) mention a record of *O. metopias* at 1000 m from "West Uluguru". Stuart and Jensen (1985) stated this to be unlikely since they were not aware of any forest at this altitude on the western slopes but Figure 1.2 shows that there is still some forest left at this altitude. Ripley and Heinrich are, however, known to have been imprecise with altitudes in the Usambaras in some cases (see Stuart 1983).

Spot-throat *Modulatrix stictigula* (M, P, T, G): This understorey species is very common in the Uluguru North and South F.R.s, occurring along the entire altitudinal gradient. Especially high densities were observed around the Kimhandu-3 (1940 m) camp by general field observations. See also Appendix 5.8.

Kendrick's Starling *Poeoptera kenricki* (P, G): Heard and seen on only a few occasions during this survey and is probably uncommon in the Ulugurus, being clearly outnumbered by *Onychognathus walleri*. Stuart and Jensen (1985) stated that there were no earlier records from the southern section but Friedmann (1928) actually mentioned a female collected at Nyange (=Nyingwa according to Stuart and Jensen [1985]) by Loveridge in 1926. See also Appendix 5.8.

5.5.4. Observations of other forest species.

Notes from our survey are given on all other forest species known from the Ulugurus in Appendix 5.5, with some discussion. Our observations of non-forest species are listed in Appendix 5.6 (a few of the species being rather characteristic elements of part of the forests).

5.5.5. Notes on community structure and species interactions.

Since these observations are also of importance for the understanding of conservation matters, notes are given on

- Observations of mixed feeding parties from the survey. See Appendix 5.7.
- Observations that can help to understand the phenomenon of seasonal vertical migration. Our own observations are supplemented with earlier from the literature in an attempt to preliminary assess the importance of the lowland Kimboza Forest for species breeding in the mountain forests. See Appendix 5.8.

5.6. Discussion.

5.6.1. Population sizes of Threatened and Near-threatened species (confer Figure 1.6).

Below we discuss the population sizes of Threatened and Near-threatened species in the Ulugurus, based on the information in Section 5.5.1 and Appendix 5.3 (for Threatened species) plus Section 5.5.2. and Appendix 5.4 (for Near-threatened species). The geographical distribution in the Ulugurus (current knowledge) of bird species of special conservation interest is shown on Figure 1.6.

Mrs Moreau's Warbler *Bathmocercus winifredae*. In several papers (e.g. Stuart and Jensen 1985), a rather vague term as e.g. ”fairly common” has been used for this species. This is most understandable since there are no exact density estimates to refer to for this species, which is clearly the most abundant of the Threatened species occurring in the Ulugurus. However, we take the opportunity to stress that *B. winifredae* occurs at relatively low densities compared to largely all other understorey species found in the Uluguru montane forests. This is well illustrated by our mistnetting and plot data - four of the six individuals mistnetted (probably representing three pairs) were caught in nets put up specifically to catch this species, and it was recorded on only few of our plots. On the other hand, the population in the Ulugurus (and to judge from our survey results perhaps especially the Uluguru South F.R.) is doubtless one of the densest within the range of *B. winifredae*, and the Ulugurus should certainly be regarded a key area for the survival of this Threatened species. *B. winifredae* depends completely on forest for its survival but may tolerate considerable disturbance in the forest interior since clearings are its natural habitat. A good estimate of the population size in the Ulugurus cannot be given at the present stage.

White-winged Apalis *Apalis chariessa.* *A. chariessa* has never been recorded in the Uluguru South F.R. It cannot be excluded that it occurs in that section but it seems unlikely that the Uluguru South is anything but a sink habitat: The species generally prefers forest below 1600 m (though recorded up to 2000 m in the Udzungwas on a single occasion, record in Dinesen *et al.* 1993) but this habitat type is largely missing in the southern section. Furthermore, at least in the Udzungwa Mountains and in the Uluguru North F.R. *A. chariessa* is seen almost exclusively in mixed feeding parties (e.g. Stuart and Jensen 1985, Stuart *et al.* 1987, Dinesen *et al.* 1993, Moyer 1993, this survey, LAH and JOS pers. obs. from the Udzungwa Mountains 1994) and the apparent lack of mixed feeding parties of the drongo party type in the Uluguru South F.R. (see Appendix 5.7) probably further reduces the quality of the Uluguru South for *A. chariessa.*

The observations by Stuart and Jensen and Moyer in the early 1980’s (Appendix 5.3, Stuart and Jensen saw several individuals at 1250-1400 m) indicate that the species is relatively easy to find below 1500 m in the Uluguru North F.R. if a number of feeding parties are studied in the dry season. However,

Andersen and his collectors apparently never succeeded in collecting specimens of *A. chariessa* (they have collected specimens of the other four Threatened species occurring in the Ulugurus). During our survey we recorded the species only twice but we suffered from lack of time for doing general field observations (for a discussion of the completeness of our survey and the methods we used: see Appendix 5.12) and the mobility of feeding parties was low. A good estimate of the population size and density in the Ulugurus cannot be given at the present stage. Significant populations of this species may exist only in the Udzungwas but the observations by Stuart and Jensen indicate that the population in the Uluguru North may be the largest outside the Udzungwas.

Banded Green Sunbird *Anthreptes rubritorques*. Since mid-altitude forest is generally absent today in the southern section, any remaining populations in the Ulugurus are most likely in the Uluguru North F.R. More fieldwork is necessary before we can say anything about the Uluguru population size of this species, which is known from only five specimens. In the Usambaras the species gathers at flowering and fruiting trees inside forest, in edges and even some distance from forest. Further search for the species in the Ulugurus should focus on the lowest part of the Uluguru North F.R., be carried out in the flowering/fruiting season and include visits in the surroundings of the forest.

Uluguru Bush Shrike *Malaconotus alius*. The time consumption of the standardized methods and logistics restricted us from searching as thoroughly for the species as we had hoped. The conclusion to draw from our observations (four territories located at Tegetero and none at the other localities) is that the status of this very vocal species on the eastern slopes of the Uluguru South F.R. is uncertain but that it may exist at very low densities here. It appears to be more common in the Uluguru North F.R., at least in the submontane and lower montane belt. *M. alius* has been recorded above the submontane belt by earlier workers (e.g. at 2100 m at Tchenzema, see Appendix 5.3) and may use the montane belt frequently, but the fact that this species was not recorded in the Uluguru South F.R. during our survey, whereas four territories were identified in the Uluguru North F.R. between 1320 and 1710 m, suggests that the core habitat is the submontane and lowest montane zone. Practically no forest exists below 1500 m in the south and although the species is known from higher altitudes, the presence of submontane and lower montane forest may be essential for maintaining the population. The Uluguru North F.R. may well prove to be the stronghold of the species.

Also most earlier records are from the Uluguru North F.R. but this could be an artefact of the more intensive ornithological activity in this area (the Uluguru North F.R. is easier accessible from Morogoro and has a wider altitudinal span of forest, including the luxuriant submontane areas, thus making it more attractive for ornithologists in lack of sufficient time to visit several localities). The altitudes of Andersen's specimens are generally 1800 m but that is the case with almost all his specimens which may well have been collected over a wide altitudinal range (see Appendix 5.1).

The population size is unlikely to exceed 1000 individuals. Intensive searches of large areas in different kinds of habitat would be necessary to refine this very rough estimate, which is based on few observations. Such a search would also clarify which types of habitat this endemic species prefers.

Tanzanian Mountain Weaver *Ploceus nicolli.* The three Uluguru records are all from the Uluguru North F.R. below 1800 m (possibly below 1600 m).

Ploceus nicolli frequently takes part in mixed feeding parties like (and often together with) its congener Dark-backed Weaver *Ploceus bicolor*. It has been recorded in feeding parties at least at Mazumbai (several observations; in the West Usambaras), in Mwanihana Forest (several observations; eastern slope of the Udzungwas), the Nyumbanitu Mountains (c. four observations, unpublished, JOS 1994; in the Udzungwas) and the Ulugurus (one occasion) (e.g. Stuart and van der Willigen 1978, Collar and Stuart 1985, Stuart and Jensen 1985, Stuart *et al.* 1987). However, in the Ndundulu Mountains (in the Udzungwas close to the Nyumbanitu Mountains) the species has only been seen singly or in pairs (few observations, max five individuals seen during the fieldwork) and only above the altitudinal range of so-called mixed feeding drongo parties, despite that much effort was allocated into studying feeding parties (Dinesen *et al.* 1993, LAH and JOS). The altitudinal distribution of the species at the above-mentioned localities is described in Appendix 5.3.

The conclusion to draw from the knowledge of the species' ecology in the Usambaras and the Udzungwas is that it occupies a rather wide altitudinal range in these areas, although occurring at very low densities, and that it is most frequently seen in mixed feeding parties (at least if the observer is in the altitudinal range of these) in the majority of (but apparently not all of) the areas. The species could potentially exist in the Uluguru South F.R. despite of the lack of submontane forest and mixed feeding drongo parties (Appendix 5.7) and probably also occur in montane forest in the Ulugurus. This needs further clarification, whereas it seems safe to assume that the submontane forest is important to the species. With only three observations from the Ulugurus it is too early to say anything about the population size but it is probably uncommon here as in the Udzungwas and the Usambaras - the only other mountain ranges holding the species.

Southern Banded Snake Eagle *Circaetus fasciolatus.* Kimboza Forest is not a key area for *C. fasciolatus* but is one of many threatened forest patches, which this species depends on throughout its range. The lowland Ruvu F.R. immediately east of Kimboza F.R. is still unknown ornithologically but could potentially hold some breeding pairs. The species could potentially be overlooked (it is hard to see and locate) in the submontane forest parts (e.g. the Kinole area), since in the Usambara Mountains it is common at 900 m in the East Usambaras with a single record from 1450 m in the West Usambaras and one from 1600 m in the Ngurus (Stuart and Turner 1980, Britton 1980, Fuggles-Couchmann 1984a). The Uluguru North F.R. is, however, some 25 km away from the foothill forests, which must be considered the key areas for *C. fasciolatus* in the Ulugurus. It is still too early to say anything about the population size in the Ulugurus.

Uluguru Violet-backed Sunbird *Anthreptes neglectus.* The species is common in Kimboza F.R. according to Stuart and Jensen (1985). However, a single bird was seen during our survey. Ruvu F.R. is unknown ornithologically but probably also holds a population. The species probably occurs also in other forested areas in the eastern foothills but Stuart and Jensen (1985) give no details about this. It remains to be established whether it uses the woodlands to some extent (known to occur in moist bushed and wooded country at least at Mikindani, Nguhi and Soga in coastal Tanzania [Britton 1980]).

A. neglectus was not recorded during our survey at Tegetero. On this background, it seems safe to assume that the species is uncommon above 1250 m on the eastern slopes. Only little time was spent below 1250 m, and the species may be more common between 1000 and 1250 m. The Uluguru South F.R. probably does not offer proper conditions for *A. neglectus*, since very little forest is left below 1500 m.

Loveridge's Sunbird *Nectarinia loveridgei.* It is difficult to estimate the total population of this common species since no proper density estimates have been obtained yet by territory mapping or total counts inside well-defined smaller areas. Since the species is very abundant throughout these forests, the population must number several million individuals. We have no data on densities to clarify this very rough estimate. The species depends completely on the survival of the forests of the Uluguru North and South F.R.s but is certainly in no danger of extinction. It tolerates some degree of disturbance inside the forest.

5.6.2. General characteristics of the forest avifaunas at the localities visited.

The avian community clearly changes with altitude in the Ulugurus, as is evident from the plot and mistnetting data and the species reviews. This is the case also in other tropical montane forests. Many of the differences between our stations can be explained by the elevational distribution of forest habitat in the areas and the habitat preferences of the forest species. The most important features are mentioned below (5.6.2a-e), further notes are given in Appendix 5.9.

5.6.2.a. The Uluguru North and South F.R.s in general.

Within the Ulugurus the bulk of the species of special conservation interest are completely restricted to the submontane, montane and upper montane forest belts of the Uluguru North and South Forest Reserves (including some small outlying mountain forest patches) with only two Near-threatened species and two other restricted-range species known from the lowland forests.

A feature shared between most of our stations in the Uluguru North and South F.R.s is the extremely high abundance of *Nectarinia loveridgei*.

Although some species are mistnetted only at certain altitudes, the set of core species in the mistnetting data does not change much between our 12 mistnetting stations (Table 5.7) and there is no clear difference in number of species mistnetted between our mistnet localities (Kimhandu, Lanzi and Tegetero) (Figure 5.2). The difference between Lanzi-1 and -2 is discussed in Appendix 5.9.c.

The plot curves in Figure 5.1 show that many of the species are common and that the tail of low-density species is rather short, compared to what is normally the case in tropical forest bird communities (Fjeldså and Rabøl in press). This is a noteworthy aspect of isolated Eastern Arc avifauna communities, which hold a moderate number of species, and could be seen as a consequence of a high degree of extinction in the past. Those species that are able to survive fill up the void and are generally found at good densities. Most tropical lowland forests, notably the lowlands of South America, hold a much higher number of species, typically with few very common species and a long "tail" of species occurring at only low densities (J. Fjeldså pers. comm.).

While The Eastern Arc Mountains have a relatively poor avifauna compared to many other montane regions in the tropics, they are rich in endemic species. The Uluguru North and South F.R.s are among the key areas in this respect, holding two endemics of their own (*Malaconotus alius* and *Nectarinia loveridgei*) and another three Eastern Arc endemics (*Ploceus nicolli*, *Bathmocercus winifredae* and *Anthreptes rubritorques*) as well as other Red Data Book species and species of restricted range (see Table 5.1).

The border between the avifaunas of the submontane and montane forest and the surrounding agricultural land is generally very abrupt: only a few non-forest species were noted inside the forest in our study areas (see Appendix 5.6), and they were generally not important components of the avian community (e.g. Table 5.5), even at the stations which lay close to the forest edge (Kimhandu-1 and -6 [1520 and 1540 m], Lanzi-1 [1710 m]). However, in the lower part of the forest at Tchenzema (degraded and dry), the Southern Puffback *Dryoscopus cubla* (actually much of a forest edge species) and Tropical Boubou *Laniarius aethiopicus* are common (Appendix 5.9.b). In the lowland Kimboza Forest there is a higher proportion of species which are not restricted to forest habitat (Appendix 5.6 and 5.9.c).

5.6.2.b. Submontane evergreen forest[1].

Comparing the Uluguru North and South F.R.s, the most important avifaunistic difference from a conservation aspect is caused by the fact that the northern section holds considerable areas of submontane evergreen forest whereas this habitat type today occupies only very small areas in the southern section (Figure 1.2).

Importance for bird species of special conservation interest: Three of the five Threatened species occurring in the Ulugurus are known only from the northern section (*Apalis chariessa*, *Anthreptes rubritorques* and *Ploceus nicolli*). A fourth, the endemic *Malaconotus alius*, is known mainly from the northern section but has been recorded once or twice in the southern. The altitudinal distributions of these four species in the Ulugurus and elsewhere were reviewed in Section 5.5.1, Appendix 5.3 and Section 5.6.1. The conclusion to draw is that *Apalis chariessa* and *Anthreptes rubritorques* depend entirely on the submontane (and possibly lowest montane) zone. *Ploceus nicolli* has been recorded only three times in the Ulugurus so our knowledge of the species is scanty. However, since at least two of the records are from the submontane or lower montane belt, these zones must be important for the species, perhaps forming its source habitat. *Malaconotus alius* appears to use the montane zone to some extent but the fact that we did not record it in the Uluguru South F.R. during our survey whereas we recorded four territories in the submontane and lower montane zone in the Uluguru North (where also most earlier records are from) clearly indicates that it depends on the submontane and lowest montane zone. Its occurrence in the montane zone may depend on to which extent the core habitat (submontane and lowest montane forest) remains, as a source pool. Conclusion: the protection of the submontane belt is the most critical of all. This forest type is found almost exclusively in the Uluguru North F.R., especially in the Tegetero-Bagiro-Kinole-Lupanga area on the eastern slopes, with some also near Morningside on the northwestern slopes.

Apart from the above-mentioned species the submontane belt of the Uluguru North F.R. furthermore holds small populations of *Bathmocercus winifredae* (Threatened) and *Anthrepthes neglectus* (Near-threatened; occurs up to 1500, possibly 1800 m) and high densities of the endemic Near-threatened *Nectarinia loveridgei* (though outnumbered by *N. olivacea* in the lower part of the belt). Also the full set of restricted-range (other than Threatened and Near-threatened) species occurring in the Ulugurus are found in the submontane belt, one of them (*Sheppardia sharpei*) being clearly more common here than in the montane belt.

Other notes: A characteristic element of the submontane forest is the mixed feeding "drongo parties". Such parties were a common phenomenon below 1500 m at Tegetero (Appendix 5.7). The Threatened species *Apalis chariessa* (of which almost all observations in the Eastern Arc are from feeding parties, see Appendix 5.3) is almost completely restricted to such parties in the Ulugurus. The Threatened *Ploceus nicolli* is known to take part in such parties regularly in the Usambaras and the Udzungwas and probably does so in the Ulugurus too. The principal habitat of the core species of the parties (*Phyllastrephus flavostriatus*, *Apalis melanocephala*, *Dicrurus ludwigii* and *Ploceus bicolor*) is submontane forest[2] and three of them apparently have populations only in the submontane and lowest montane belt of the Uluguru North F.R.

Importance of the presence of a submontane zone below the montane: With the exception of *Dicrurus ludwigii*, which was seen once at Kimhandu, none of the core species of drongo parties (*Dicrurus ludwigii*, *Phyllastrephus flavostriatus*, *Ploceus bicolor* and *Apalis melanocephala*) were recorded at the localities studied in the Uluguru South F.R. A likely explanation for the small or non-existing populations of these species in the southern section is that their principal habitat is subtropical forest (apart from lowland forest), a habitat type that has disappeared in the southern section. Thus there is no source habitat left to recruit the montane belt, and the populations are most likely not viable on the long term. They are most likely sink populations, founded by individuals that have spread to the Uluguru South F.R. from source areas in the submontane belt of the Uluguru North or from forested patches in the foothills, e.g. Kimboza. An alternative explanation is that they are relictual populations

1 Submontane evergreen forest: Between 500 and 1500 m (see Section 3.3).
2 All four species also have populations in the foothill forests but in the Uluguru North and South F.R.s the core habitat is submontane forest.

from earlier times when forest extended further down the slopes, surviving in lobes of forest extending below 1600-1700 m. According to current metapopulation theory, such relictual populations in sink habitat are doomed to vanish. See also Section 5.6.2.b.

The bird fauna recorded at Kigurunyembe (altitudinal range visited: 650-850 m) showed strongest parallels to the bird fauna in the lowlands. Our review of the forest reserve descriptions in Lovett and Pócs (1993) revealed that there is an ornithologically unknown patch of submontane forest (800-1100 m) in Mkungwe F.R. This forest patch could prove to contain an interesting avifauna with affinity to the lowland forests as well as the submontane areas of the Uluguru North F.R. Mkungwe is known to be of high conservation value for plants (Lovett and Pócs 1993).

Further notes on the submontane belt are given in Appendix 5.9.a.

5.6.2.c. Montane evergreen forest[1].

Whereas the submontane forest zone has largely disappeared in the southern section, the montane evergreen forest remains virtually intact in the southern (as well as in the northern) section. The largest areas of montane forest are clearly found in the Uluguru South F.R. but also the Uluguru North F.R. holds a considerable belt of this habitat type.

Importance for bird species of special conservation interest: The montane belt is the most important for the Threatened species *Bathmocercus winifredae* (Section 5.5.1, Section 5.6.1). The Uluguru South F.R. holds a very important population of this species, which we recorded in good densities, at least locally, at Kimhandu, Lanzi and Tchenzema. The montane belt of the Uluguru North F.R. probably also supports an important population. Also for the Near-threatened *Nectarinia loveridgei* the montane belt is the most important (Figure 5.1, Appendix 5). The montane zone is furthermore very important for those restricted-range species, which are not categorized as Threatened or Near-threatened (Section 5.5.3, Figure 5.1).

Malaconotus alius has been recorded once or twice in the montane zone of the Uluguru South F.R. There is one record from the western slopes of the Lukwangule Plateau at 2100 m (Stuart and Jensen 1981) and one from "above Bunduki" (J.G. Williams in 1948), which must be from above 1700 m. There are still no records of this Uluguru endemic from the eastern slopes of the Uluguru South F.R. and, if present here, we believe that it must occur at very low densities, since we neither saw it nor heard its far-carrying call at Kimhandu or Lanzi. Further survey work is necessary to determine its status, especially in those few places which have forest lobes below 1500 m (Figure 1.2). The highest densities of *M. alius* appears to be in the northern section and the southern section of the Ulugurus with mostly montane forest may be a sink habitat for the species.

Further notes on the montane belt are given in Appendix 5.9.b.

1 Montane evergreen forest: Between 1500 and 2100 m in the Uluguru North F.R. and 1600 to 2400 m in the Uluguru South F.R. (see Section 3.3).

5.6.2.d. Upper montane or lower subalpine zone[1].

The upper montane or lower subalpine zone at Kimhandu-5 (2520 m) and on the Lukwangule Plateau is characterized by harsh climate with strong day/night temperature differences. The forest is low, dense elfin forest of which bamboos are often a prominent part.

Importance for bird species of special conservation interest: One Threatened species, *Bathmocercus winifredae*, was encountered on a single occasion in the upper montane zone at Tchenzema during this survey and appears to use this vegetation belt to some extent. One Near-threatened (*Nectarinia loveridgei*) and at least four restricted-range species occur in the upper montane zone, some of them at good densities (Figure 5.1.e).

Other species: The total number of forest species (21) recorded at Kimhandu-5 (all methods combined, Table 5.5) is considerably lower than the numbers recorded at lower stations at Kimhandu, Lanzi and Tegetero (34-50, Table 5.5). The low number of species is expressed in the plot data which also show that there is no long tail of low-density species (Figure 5.1.e) and in the tape recording data (Table 5.10). For the interpretation of the plot data and the total number of species recorded it should be born in mind that the vegetation is very impenetrable at Kimhandu-5, implying that most plots were assessed from the forest edge and that general field observations were mostly carried out from the forest edge or from mistnet lanes. Potentially we could therefore have overlooked silent birds occurring at low densities inside dense forest. However, with c. four days of fieldwork in the area we believe that only few species can have been overlooked unless a high number of species occur at extremely low densities up here.

The number of species mistnetted at Kimhandu-5 was "normal" (Figure 5.2), contrasting the low number of species recorded by observational methods and tape recordings. The catch rate (54.8 individuals per 2500 MNH) was also "normal" (Table 5.8). The only species mistnetted up here but not at lower stations were the typical high altitude species *Phylloscopus umbrovirens* and *Bradypterus cinnamomeus.* Our results indicate that it is mostly the upper and mid strata, species that are absent or occur at so low densities at Kimhandu-5 that we did not record them. The community of understorey birds is relatively similar to understorey communities at lower stations.

Numerically prominent members of the forest bird assemblage at Kimhandu-5 are: *Andropadus nigriceps* (the only greenbul recorded above 2200 m at Kimhandu), *Cossypha anomala*, *Modulatrix stictigula*, *Pogonocichla stellata*, *Bradypterus mariae*, *Apalis thoracica*, *Orthotomus metopias*, *Phylloscopus umbrovirens*, *Laniarius fuelleborni*, *Nectarinia loveridgei* and (primarily near the edges) *Bradypterus cinnamomeus*. The high record of *Bradypterus cinnamomeus* in the plot data from Kimhandu-5 (Table 5.9, Figure 5.1.e) should be explained by the fact that the plot assessments were carried out from the forest edge - this species was most common on the meadow and in and near the forest edge, occurring at much lower densities inside the forest.

5.6.2.e. Lowland semi-evergreen forest[2].

Importance for bird species of special conservation interest: In the Ulugurus the Kimboza F.R. (probably also Ruvu F.R.) is probably the stronghold for the two Near-threatened species *Circaetus fasciolatus* and *Anthreptes neglectus*. One species of restricted range, *Alethe fuelleborni*, is common in Kimboza at least at certain times of the year. The rest of the assemblage of Threatened, Near-threatened and restricted-range (but not Threatened or Near-threatened) species occurring in the Ulugurus has never been recorded in Kimboza F.R. (except *Poeoptera kenricki* of which there is only a single observation).

Other notes: The following forest species occur in Kimboza F.R. but have never been recorded in the Uluguru North or South F.R.s: *Circaetus fasciolatus* (Near-threatened), *Guttera pucherani*, *Glaucidium capense*, *Stactolaema leucotis* (abundant), *Pogoniulus simplex*, *Chlorocichla flaviventris*,

1 Upper montane or lower subalpine zone: above 2400 m in the southern section and above 2100 m in the northern section, see Section 3.3.
2 Lowland semievergreen forest: forest between 250 and 500 m, see Section 3.3.

Phyllastrephus terrestris, *Phyllastrephus debilis*, *Erythrocercus holochlorus*, *Malaconotus viridis* and *Lamprotornis corruscus*. Species clearly being most common in the foothill forests but with one or a few records from submontane and montane forest areas include *Ceuthmochares aereus*, *Apaloderma narina*, *Ceratogymna bucinator*, *Tockus alboterminatus*, *Phyllastrephus fischeri*, *Oriolus chlorocephalus*, *Cossypha natalensis*, *Neocossyphus rufus*, *Illadopsis rufipennis*, *Anthreptes neglectus* (Near-threatened) and *Macrosphenus kretschmeri*. Many of the above-mentioned species are prominent members of the bird communities of the threatened coastal forests further east and of other lowland Eastern Arc forests. Table 5.11 clearly illustrates that the composition of the bird fauna is very different from that of the mountain forests. Further notes on the lowland semi-evergreen forest are given in Appendix 5.9.c.

5.6.3. The absence of certain species in the Ulugurus (see Appendix 5.10 for details).

We had expected to be able to reveal the presence of two additional Threatened understorey species, which occur, disjunct in the Udzungwas and the Usambaras. However, they remain unrecorded and we therefore consider that their distributions are probably truly disjunct. Their absence appears odd since suitable habitats seem to be present in the lower parts of the Uluguru North F.R. and since the Ulugurus climatically seen are believed to have been one of the most stable areas in the Eastern Arc with their high amount of rainfall. The two species in question are:

- Dappled Mountain Robin *Arcanator orostruthus*.
- Swynnerton's Robin *Swynnertonia swynnertoni*.

Another species, which occurs disjunct in the Usambaras and the Udzungwas, is:

- Amani Sunbird *Anthreptes pallidigaster.*

5.7. Recommendations for future ornithological studies (priorities).

Submontane, montane and upper montane areas. It seems safe to assume that the submontane parts of the Uluguru North F.R. are the most important areas to focus conservation efforts on in terms of bird conservation. Our knowledge on the geographical distribution and habitat preferences of some of the Threatened species in the Ulugurus is, however, still fragmentary. Further surveys, focusing entirely on Threatened species, should be undertaken, preferably linked with detailed mapping of the altitudinal distribution of forest. The observers should work without using the time consuming standardised methods: For the simple purpose of finding low density Threatened species we believe that it is more important to search large and diverse areas to obtain a detailed knowledge on core habitats and plasticity of the species. The surveys should include wide altitudinal ranges in the northern as well as the southern section and special attention should be paid to *Malaconotus alius*. The survey of Threatened species should preferably take place in the cold season for two reasons:

- Most trees flower in the cold season, and sunbirds, e.g. the Threatened species *Anthreptes rubritorques* and *A. pallidigaster*, often gather at flowering trees, making them easier to locate.
- Feeding parties are more frequent and mobile in the cold season, making it easier to locate Threatened species like *Apalis chariessa* and perhaps *Ploceus nicolli*.

A search of large areas of suitable habitat in the Uluguru North F.R. would furthermore enable a definitive determination of whether *Arcanator orostruthus*, *Swynnertonia swynnertoni* and *Anthreptes pallidigaster* (Section 5.6.3) are in reality absent from the Uluguru Mountains.

The distributional pattern in the Ulugurus may differ between Threatened bird species and red-listed species in other organism groups. An assessment of habitat preferences of rare taxa in other organism groups should complement the Threatened birds' survey.

Lowland forests. The large Ruvu F.R. is largely unknown ornithologically. It is our impression that also the biologically rich Kimboza F.R. is rather incompletely known since it has never been studied for longer periods. No quantitative data exist from Kimboza, apart from sporadic mistnetting data. Future fieldwork in Kimboza and Ruvu F.R.s should be carried out with the methods used in the Uluguru North and South F.R.s during our survey to improve the basis for comparative studies. Enough time should be allocated to determine the abundance of the Near-threatened species *Circaetus fasciolatus* and *Anthreptes neglectus* and to record the complete assemblage of species present.

Outlying hills. The outlying hills appear to be completely unknown ornithologically. Of these, especially the Mkungwe F.R. with its submontane forest (800-1100 m) could hold an avifauna of high conservation value.

Further recommendations are given in Appendix 5.13.

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SECTION 6. MAMMALS.

By Jens Nyeland Kristiansen.

6.1. Abstract.

Results are presented of brief interviews with local villagers in Ukwama, Lanzi and Tegetero villages, and of field observations made by the field team of *The Uluguru Biodiversity Survey 1993.* A checklist of the mammals occurring in the forests of the Uluguru Mountains is also presented, and the conservation value and conservation status of the mammalian fauna is discussed.

The diversity of mammals (60 species) in the Uluguru forests is relatively high compared to other East African forests (Rodgers *et al*. 1982). Two shrew species, *Crocidura telfordi* and *Myosorex geata*, and one insectivore subspecies, *Chrysochloris stuhlmanni tropichalis* (subspecies of the Golden Mole) are endemic to the Ulugurus. Three mammal species are on the 1994 IUCN Red List of Threatened Animals (IUCN 1994): Zanzibar Galago *Galago zanzibaricus*, Black and Rufous Elephant Shrew *Rhynchocyon petersi* and Abbott's Duiker *Cephalophus spadix* (the last one being endemic to the forests of the Eastern Arc mountains). There is also a possible record of the very rare bat *Kerivoula africana*. Most populations of larger mammals (except monkeys) suffer strongly from illegal hunting.

6.2. Introduction.

This chapter deals with the mammal fauna of the Uluguru Mountain forests. The first section presents information on the mammals of the forests obtained from local people living in the area, and our own observations from the localities listed in Table 2.1 of this report. In this connection, it should be mentioned that the principal purpose of my stay in the Ulugurus was to collect information on Tree Hyraxes and that most of my time was spent on this project, a factor that must be taken into consideration for the interpretation of the results. The second part of the chapter presents a checklist of the mammal species, which are known to have been found in the Uluguru Mountains, and discusses these results. This checklist is based on all previous work on the mammals of the Ulugurus forest (e.g. Swynnerton and Hayman 1950, Kingdon 1971-1982, Rodgers *et al.* 1982, Jenkins 1984, Hutterer 1986, Kingdon and Howell 1993).

6.3. Methods used on this survey (confer Table 2.1).

Interviews: Local villagers with close association to the forest, e.g. hunters, were interviewed about the condition of the mammalian fauna in the forest at Kimhandu, Lanzi and Tegetero. Because of their frequent activities in the forest I consider the villager's knowledge to be of great importance. Interviews were made in the Kimhandu area (with three villagers from Ukwama and Wembela villages) by the author with translation assistance from BSS, SIM, CKM and JK (see list of participants). In the villages Lanzi and Tegetero the interviews were made by BSS, SIM and CKM.

For identification of the animals, illustrations from Haltenorth and Diller (1992) and Kingdon (1971, 1974, 1977, 1979 and 1982) were shown to the villagers. A few questions (the same to all interviewed) were asked about some characteristic features of the animal, e.g. size, colour and habitat. In some cases, it proved to be a problem identifying the different species with certainty. I have therefore in the following account only included species of which the identification is trustworthy.

Field observations: All field observations of mammals made by the *Uluguru Biodiversity Survey 1993* field team have been collected by the author and are included in the account below. For information on the time schedule of the survey and the localities visited: see Table 2.1 and Section 4.

6.4. Results.

6.4.1. Data collected during *The Uluguru Biodiversity Survey 1993*.

Those species seen and recorded in interviews during this survey are presented below, with notes on their location and recent changes in their population sizes.

Elephant Shrew *Rhynchocyon* sp.: Field observations: At Tegetero (1270-1345 m) an unidentified elephant shrew was seen on a few occasions at 1270-1345 m. It was preliminary identified as Giant Elephant Shrew *Rhynchocyon cirnei* from the colour plates in our fieldguide. However, it may also be the Black and Rufous Elephant Shrew *Rhyncocyon petersi*. In addition, at Kigurunyembe an unidentified elephant shrew (believed to be a Black and Rufous Elephant Shrew) was seen, but only briefly.

Galago *Galago* sp.: Field observations: Galagos were heard occasionally at night at Kimhandu (1700-2300 m), at Lanzi (1710 and 1940 m) and at Kigurunyembe. The identity of these galagos is not known.

Black and White Colobus *Colobus angolensis:* Interviews: Local people state that the species is found throughout the forest. It is rarely hunted because it does not harm the crops as does the Blue Monkey (see below). All information indicates a marked increase in the population size. Field observations: We saw and heard the Black and White Colobus almost every day at Kimhandu, from the edge of the forest (about 1500 m) to about 2600 m. At Lanzi we recorded it occasionally between 1510 and 2110 m, the biggest troop contained 10 individuals. At Tegetero the species was recorded several times between 1300 and 1850 m. The species is common at Kigurunyembe. It was abundant in Kimboza F.R. (c. 300 m), with only c. 100 m distance between the individual groups.

Blue Monkey (Sykes Monkey) *Cercopithecus mitis*: Interviews: Local people state that the species is found throughout the forest. It is hunted because of the damage it does to the crops, e.g. maize and beans. Despite the hunting pressure the population appears to be increasing. Killed Blue Monkeys are, however, also eaten. Field observations: We recorded Blue Monkeys almost every day at Kimhandu. Observations are from between 1510 and 2590 m. Gunshots were heard on some days from the Kimhandu-2 (1710 m) camp and we were told that somebody from Ukwama was hunting Blue Monkeys. At Lanzi the species was recorded between 1660 and 2130 m. At Tegetero it was seen and heard several times from 1300 up to 1820 m, the biggest troop containing 15 individuals. At Kigurunyembe, it is common. In Kimboza F.R. it occurs at nearly the same density as mentioned for the Colobus.

African Clawless Otter *Aonyx capensis*: Interviews: According to the locals this species is quite common throughout the forests in the Kimhandu and Lanzi areas. There is no information from the villagers concerning the presence of the animal at Tegetero. It is sometimes hunted and the meat is eaten. Field observations: Tracks and faeces were seen frequently in the Kimhandu area between 1500 and 2500 m. Most tracks were close to streams but we also found faeces under boulders far from water.

Genet *Genetta* sp.: Field observations: Fresh faeces (which according to our local guides was from a genet) were found one morning in the Kimhandu-6 (1540 m) camp.

Leopard *Panthera pardus.* Interviews: The species occurs above 1700 m in the forest but is not seen as often as previously. It is usually not hunted unless domestic stock is killed. In the past it was hunted much more. On the day of our arrival to Ukwama, a Leopard had killed a goat. Field observations: The species was heard once in the Kimhandu area at 1900 m. During a visit to the below mentioned boulder area with Tree Hyraxes, some fur and bone fragments of a Black and White Colobus were found and tracks of an animal which had pulled a prey through the dense vegetation were seen. These tracks were made by a Leopard according to the local hunters.

Tree Hyrax *Dendrohyrax validus*: Interviews: Tree Hyraxes usually stay far from people and thus often at high altitude. Hunting apparently takes place frequently in places where the species is common. The villagers told us that the Tree Hyrax was previously much more widespread and common than today. They have to walk long distances to catch the animals nowadays. The usual way of catching Tree Hyraxes is by dogs but snares are also sometimes used. As a reward, the dog gets the scull whereas the

local people eat the meat. The fur is sometimes used for clothing or sold. Field observations: At Kimhandu Tree Hyraxes were heard only occasionally. Observations are from between 1520 and 2300 m. A Tree Hyrax site was visited with local hunters in a boulder area within the forest far from Ukwama village. Among these rocks was the characteristic smell of hyrax urine, and faeces were seen everywhere. There was a permanent campsite used by hunters. No animals were heard here, probably because we visited the area during daytime. At Lanzi hyraxes were heard between 1920 and 2150 m with a maximum of five individuals heard simultaneously from our camp at 2000 m. At Tegetero a few faeces pellets were found and relatively few animals heard at 1270-1720 m.

African Bush-Pig *Potamochoerus porcus*: Interviews: Especially because of hunting this species is forced far into the forest. At Kimhandu and Lanzi it occurs only at high altitudes up to about 2500 m. At Tegetero it occurs between 1500 and 2000 m. Nowadays the pigs are only hunted for meat but previously they were killed also to protect crops of cassava, sugarcane and potatoes. The population size has been markedly reduced. Field observations: Our only records of pigs comprised tracks in the dirt near the summit of Kimhandu Hill and fresh tracks at Tegetero, 1500 m.

Harvey's Red Duiker *Cephalophus harveyi*[1]: Interviews: At Kimhandu and Lanzi it is usually seen at high altitudes (1700-2500 m), deep into dense forest. The population is said to have decreased. None of the villagers interviewed at Tegetero had any knowledge of this species. Field observations: This species was not recorded during the 2.5 months of fieldwork in the Uluguru North and South F.R.s.

Blue Duiker *Cephalophus monticola*: Interviews: Only the villagers at Tegetero knew this duiker. It is reported to be found between 1200 and 2000 m. It is hunted and is now seen more rarely than previously. Field observations: A small and probably young individual was seen at Tegetero, 1535 m.

Abbot's Duiker *Cephalophus spadix*: Interviews: The villagers interviewed in Ukwama and Lanzi explained that this species is only seen at high altitudes, deep into dense forest. The population size has decreased. The villagers interviewed in Tegetero did not know this duiker species. Field observations: No individuals were seen of this species.

Suni *Neotragus moschatus*: Interviews: Only the villagers interviewed in Ukwama and Lanzi had any knowledge of the Suni. It occurs at high altitudes far from villages. It has been hunted in the past and is now considered rare.

Lord Derby's Flying Squirrel *Anomalurus derbianus orientalis*: Field observations: Recorded at Tegetero, 1345 and 1530 m.

Squirrels, Sciuridae sp.: Field observations: Squirrels were among the most frequently recorded mammals. Most squirrels observed were very much alike and probably represent the same species, but species identification of squirrels is difficult. At Kimhandu and Lanzi squirrels were recorded from the lower forest edge up to 2145 m. At Tegetero they were seen between 1300 and 1530 m. At Tegetero an additional unidentified species of squirrel was seen between 1300 and 2150 m.

6.4.2. Species previously recorded from the Ulugurus (confer Table 6.1).

A review of the available literature has allowed me to compile a list of the species of mammals, which are known from the Uluguru Mountain forests (Table 6.1). This allows an assessment of the species richness and levels of endemism in the Uluguru forests.

1 Recently suggested lumped with the Red Duiker *Cephalophus natalensis*.

6.5. Discussion.

6.5.1. Diversity and endemism.

More than 60 mammal species have been recorded in the montane forests of the Ulugurus (see Table 6.1). Some, e.g. Abbott's Duiker and Tree Hyrax, are strictly adapted to life in dense forest (Kingdon and Howell 1993). Many of the other species are not considered true forest dwellers but also occur in savanna or in other habitats.

The mammal fauna of the Uluguru montane forests is of high diversity compared to other forests in Eastern Africa (Rodgers *et al.* 1982). Two mammal species (the shrews *Crocidura telfordi* and *Myosorex geata*) and at least one subspecies (the Golden Mole subspecies *Chrysochloris stuhlmanni tropichalis*) are endemic to the Uluguru forests. All three species are insectivores. The Eastern Arc endemic Abbott's Duiker also occurs in the Ulugurus. A number of other species which are regarded as threatened with extinction globally (on the IUCN list) are also present. Thus, the mammalian forest fauna of the Ulugurus is of high conservation value.

The recent discoveries of one new species and one new subspecies of shrew (Jenkins 1984 and Hutterer 1986) show that the list in Table 6.1 is probably incomplete. Furthermore, our knowledge of population densities and geographic distribution in the Ulugurus is scanty for most species.

6.5.2. Species abundance.

The scarcity of larger mammals in the forests other than the two monkey species is striking. Although the information from the villagers presented above has to be treated with caution, the general pattern seems clear: a decrease in almost all populations of larger mammals because of intensive hunting, leading to remarkably low population densities of e.g. duiker species. Elephant *Loxodonta africana*, Buffalo *Syncerus caffer* and Aardvark *Orycteropus afer* are apparently not present in the mountain forests of the Ulugurus. In some other montane forests in the Eastern Arc, e.g. in remote, undisturbed forests in the Udzungwas and in disturbed forest in the Rubehos (which are situated close to Mikumi National Park), these species are fairly common (pers. obs. and JF pers. comm.). It is not known if they have been removed from the Ulugurus, or never was present.

In general the field team saw and heard ground living mammals on remarkably few occasions and there were extremely few foot prints and faeces pellets from medium sized and larger mammals on the forest floor, compared to what we have seen in other parts of the Eastern Arc, especially in remote and relatively undisturbed forests in the Udzungwa Mountains (JF, LAH, JK, JNK and JOS pers. obs.).

The absence of Tree Hyrax around many of the camps is also surprising, since suitable habitats are abundant: There are many large old trees with holes and lianas, and boulder areas, habitats which Tree Hyraxes use (Kingdon 1971, Kundaeli 1976, Kristiansen and Bertelsen, in prep.). It seems to be the hunting pressure and not the lack of suitable habitats, which restricts the occurrence of Tree Hyraxes. From what we have seen, the Tree Hyrax is an easy prey for hunters. Snares are used in some places and dogs are used for catching the animals. With a gestation period of 7-8 months, usually resulting in only a single offspring (Fischer 1992), the susceptibility of this species to hunting is clear.

The local villagers are well aware of the consequences of the illegal hunting but the restricted supply of protein from farming forces many to hunt in the forest. It is clear that prohibition alone cannot stop hunting from taking place at the scale that it does at present. **A conservation programme is highly needed.**

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SECTION 7. INVERTEBRATES, WITH THE MAIN EMPHASIS PLACED ON MILLIPEDES.

By Line Louise Sørensen.

7.1. Abstract.

This section deals with the invertebrate fauna of the Ulugurus with the main emphasis placed on millipedes. A complete checklist of millipede species known from the Ulugurus is presented, including 14 taxa collected during *The Uluguru Biodiversity Survey 1993*, mainly at Kimhandu.

No less than 23 (86 %) of 28 millipede taxa known from the Ulugurus are endemic to these mountains (at least 36 species occur here but not all could be included in the calculation of endemism percentage). All the endemics depend strictly on the survival of moist forest habitat. The high endemicity in the Ulugurus in millipedes and certain other invertebrate groups (exemplified by linyphiid dwarf spiders, harvestmen, pselaphids, earwigs, montane butterflies and montane ground-beetles) is discussed.

7.2. Introduction: Earlier invertebrate surveys in the Uluguru Mountains.

Invertebrates make up the largest group of animals, but are poorly studied in many areas. This is also the case in the Uluguru Mountains.

Our knowledge of the invertebrate fauna of the Uluguru Mountains is primarily based on two entomological expeditions. The first was carried out in 1957 by P. Basilewsky and N. Leleup: Mission Zoologique de l'I.R.S.A.C. en Afrique Orientale (Leleup 1965). They found the Uluguru Mountains very interesting from an entomological point of view, and this led to a second expedition in 1971: Mission Entomologique de Musée Royal de l'Afrique Centrale aux Monts Uluguru, Tanzania (Berger *et al.* 1975 and 1976). In 1981 a Danish expedition (Scharff *et al.* 1982) surveyed the avifauna and the invertebrate fauna, mainly spiders (Araneae) and caddisflies (Trichoptera), of the Uluguru Mountains. In April 1983 (rainy season) millipedes were collected intensively in Kimboza F.R., a list of 10 species is presented in Rodgers *et al.* (1983).

Beside the above-mentioned expeditions, there has been some sporadic collecting, but still only part of the mountains has been investigated thoroughly and only a few groups of invertebrates are well investigated. The best-known invertebrate groups are:

Ground-beetles (Coleoptera: Carabidae) (Basilewsky, 1976).
Pselaphids (Coleoptera: Pselaphidae) (Leleup, 1976).
Earwigs (Dermaptera) (Brindle, 1975).
Montane butterflies (Lepidoptera) (de Jong and Congdon, 1993).
Linyphiid dwarf spiders (Araneae: Linyphiidae) (Scharff, 1993).
Harvestmen (Arachnida: Opiliones) (Lawrence, 1963).

During the survey in 1993, several groups of invertebrates were collected (with the main emphasis placed on millipedes), but at present, only the millipede specimens have been identified to species.

7.3. Methods used on this survey (confer Table 2.1).

Millipedes were collected by the author along a transect from about 1500 to 2600 m in the Kimhandu area with samples gathered at every 100 m altitude. Standing stumps, trunks, fallen and decaying logs and branches were examined systematically for cryptic and free-living fauna. The lower vegetation, litter and dirt of the forest floor were examined as well. Specimens from different habitats were kept separate and habitat and altitude were noted (data on habitat type and altitude are, however, not presented in this paper). The specimens were preserved in 70 % alcohol.

The collection was made towards the end of the dry season. Most of the millipedes were therefore found inside logs or deep in the earth. This caused a patchy distribution of the animals and it was therefore difficult to follow a narrow transect.

A few specimens were collected (sporadically) at Lanzi and Tegetero by other team members. Important literature used for identification is: Demange (1977), Hoffman (1990), Krabbe (1982), Kraus (1958, 1960 and 1966) and Mauriès (1989). Taxonomy follows Hoffman (1979) and Enghoff (1983).

7.4. Results (confer Table 7.1).

Table 7.1 presents a list of all millipede species known from the Uluguru Mountains, compiled from the literature and the field survey work undertaken by the author. Because of identification problems (see *a* in Table 7.1) only 14 different taxa were identified in the material from the 1993 survey.

The table shows that 23 (86 %) of 28[1] millipede taxa known from the Uluguru Mountains are endemic. A further four are endemic to Tanzania. The last of the 28 species is *Epibolus pulchripes* which is not restricted to forest habitat.

7.5. Discussion.

7.5.1. Endemicity among millipedes known to occur in the Ulugurus.

There is a high degree of millipede endemicity in the Uluguru Mountains (86%). This is believed to be due to the facts that most millipedes have a strong tendency to speciate, are strongly dependent on humid microclimate and have very limited ability to disperse (Hopkin and Read 1992). All the 36 taxa except *Epibolus pulchripes* must be considered true forest species.

In relation to the millipedes of the Eastern Arc mountains, Hoffman (1993) concluded for the Oxydesmidae that:

1. 'With a few exceptions most of the genera occurring in mountains are endemic, so that lines of affinity with regions must be sought at the level of tribe or higher'.
2. 'In most cases such genera appear to be the result of derivation from formerly widespread ancestral stocks'.
3. 'The post glacial condensation of montane forest to higher mountains surrounded by seasonally arid savanna or shrub forest has resulted in profuse local speciation on individual ranges or close clusters'.

In general, the species found in the more arid lowlands surrounding the forests show a wide distribution with low levels of endemism. These species are adapted to more arid climates and therefore their dispersal is less hindered by physical barriers than is the case for the true forest species.

1 Reading Table 7.1 it is clear that at least 36 species occur in the Ulugurus. The reason for including only 28 of them (those marked with asterisks plus *Epibolus pulchripes*) in the calculation of the percentage of endemism is that it is not possible to say whether some of the last eight taxa (those marked with a) may actually be endemic as well.

7.5.2. Endemicity of other invertebrate groups occurring in the Ulugurus (confer Table 7.2).

As well as the endemism in the millipedes I have also reviewed, the literature to assess the levels of endemism in selected other invertebrate groups (Table 7.2). Most of the groups in Table 7.2 are mainly found on the forest floor and are dependent on a humid microclimate.

The high levels of endemism are most striking in the groups, which have a low ability to disperse. However, high endemism also occurs in groups, which have some degree of mobility. The dwarf spiders are well known, and can disperse by ballooning, but the percentage endemism is high on the Ulugurus, especially in comparison with geologically younger mountains (Scharff 1992 and 1993). The montane butterflies, some of which have strong powers of flight, also show a high degree of endemism in the Ulugurus and other geologically old mountains (de Jong and Congdon 1993).

The rates of endemism in some mountain forests of eastern Africa have been calculated, and are seen to be higher on the ancient Eastern Arc mountains than on the geologically younger volcanic mountains in the region (Leleup 1965). This conclusion is supported by Scharff's (1992, 1993) dwarf spider study: In the Ulugurus there are 17 dwarf spider species of which 14 (86 %) are confined to forest and endemic to those mountains. On the geologically younger Mt. Kilimanjaro 15 dwarf spider species are known to occur, of which eight are forest species, five (63 %) of these being endemic. For Mt. Kenya there are even lower rates of endemism, from 32 species 15 are forest species and only 5 (33%) of these are endemic. The same trends are found in the butterflies (de Jong and Congdon 1993).

7.5.3. Interpretation of invertebrate endemicity.

Some of the other mountains in the Eastern Arc have received attention from entomologists, although large collection gaps still exist. The best studied are the Usambara and Uluguru Mountains. Hence, there is much to learn about the endemic species of the Eastern Arc. In particular, the Eastern Arc Mountains situated near the Uluguru Mountains (Rubehos, Ngurus and Udzungwas), are not as thoroughly investigated as the Ulugurus, and a proper investigation of these will probably show that some endemic species of the Uluguru area also occur in the nearby mountain forests. It must be stressed, however, that the Uluguru Mountains will probably still contain a fauna quite different from that of other Eastern Arc Mountains, including high numbers of endemic species.

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SECTION 8. BOTANY.

By Peter Høst, Jon C. Lovett, Charles K. Mabula, Shakim I. Mhagama and Bashir S. Shirima.

8.1. Abstract.

An assessment of the conservation value of the Uluguru forests in terms of plants is given and their biogeographical affinity is briefly discussed. The endemism among plants is very high in the Ulugurus.

There were no data available on the species composition of montane forest (forest between 1600 and 2400 m) in the Uluguru South F.R. (Lovett and Pócs 1993). For eight 25 x 25 m plots assessed for woody plants (with a dbh. of 3 cm or more) at the mistnetting stations at Kimhandu (1520, 1710, 1940, 2145 and 2520 m) and Lanzi (1710, 1920 and 2110 m) lists are presented of identified species (47 of 100 species has been identified at present, comprising the four dominant species in terms of basal area and number of stems at each station). Structural data of the plots, and diagrams showing abundance of the dominant species in terms of basal area (BA) and number of stems are also given. The diversity of each plot is presented as total number of species, Simpson's and Shannon's indices. Thirteen (28 %) of the species identified are Eastern Arc endemics, two of these are furthermore Uluguru endemics.

8.2. Introduction.

8.2.1. On the knowledge and affinity of the Uluguru forest flora.

Knowledge. The vegetation and climate of the Uluguru Mountains have been described by Pócs (1974, 1976a and 1976b) with detailed information on the lowland Kimboza Forest by Rodgers *et al.* (1983) and on forest reserves by Lovett and Pócs (1993). The Ulugurus are part of the Eastern Arc range, which is well known for its high plant species and generic endemism (Lovett 1993a), and have long been regarded to be of conservation importance for plants (e.g. Polhill 1968 who mentioned 40 endemic woody plant species from the Ulugurus).

The first botanical collecting is probably that of W. Goetze who collected there in November 1898. His collections included two *Saintpaulia* (African Violet) species described by Engler as *S. goetzeana* and *S. pusilla* (Baatvik 1993), and many botanists have collected there since. However, botanical knowledge of the Ulugurus remains incomplete. Lovett and Pócs (1993) mentioned that there were not data available on the vegetation of the montane forest (forest between 1600 and 2400 m) of the Uluguru South F.R. (assuming that it is presumably similar to the Uluguru North montane forest). New taxa are still being found: for example, *Aerisilvaea* is a recently described small tree genus of Euphorbiaceae from Kimboza forest and there is a still undescribed *Cremaspora* from Lupanga peak (Bridson and Verdcourt 1988). Other taxa, such as the giant herb *Lobelia morogoroensis*, which botanists have known for many years, have only recently been collected in the appropriate state to be adequately described. Other plants have been described, but the type specimens lost. For example, *Vepris mildbraediana* was described in 1934 but the type specimen was destroyed in Berlin during the Second World War. From the original description, it appears to be a common shrub at higher elevations, but there is little flowering material in herbaria and a new type specimen still cannot be elected. Only recently have collections of the shrubby *Psychotria diploneura* enabled the nomenclature of *Grumilea diploneura* to be updated, the type have been collected in 1894 by Stuhlmann and subsequently destroyed in Berlin. There are still five other *Psychotria* taxa collected by Stuhlmann from the Ulugurus, which are known only from the description, the types having been lost.

Affinity. As with other Eastern Arc Mountains, the floristic affinities of the Ulugurus lie primarily with the main African Guineo-Congolian forests to the west (Lovett 1993a). These affinities are thought to pre-date the uplift of the central African plateau and suggest that the Uluguru forests, together with other Eastern Arc and coastal forests, are remnants of the former Pan-African forest. Examples of western

African genera in the Ulugurus include the forest herb *Cincinnobotrys* and the tree *Polyceratocarpus*. More remarkable are affinities to Madagascar noted by Leroy (1978). For example, *Dionychastrum* is related to the Madagascan *Dionycha*, and *Adenoplusia ulugurensis* was once thought to be endemic to upper montane forest edges in the Ulugurus, but is now known to be the Madagascan *Buddleja axillaris* (Leeuwenberg 1979). There is debate as to whether the affinities pre-date the split of Madagascar from Africa, or whether they represent long distance dispersal. Affinities to southern species can be seen in the Eastern Arc montane forest endemic *Schefflera lukwangulensis*, which is related to *S. umbellifera* whose northern limits are the southern Udzungwa Mountains (Lovett and Friis in press).

8.2.2. Biodiversity value of the Uluguru flora.

The Ulugurus are the wettest of the Eastern Arc mountains, receiving up to 4000 mm of rain a year, and more than 100 mm of rain a month in every month of the year has been recorded in Kinole on the eastern slopes. Although there is little data, the upper slopes are certain to be perhumid as well, a climatic condition rare in the generally highly seasonal continent of Africa. Elsewhere in the tropics, rainfall has been correlated with plant species richness (Gentry 1988). On this basis, the Uluguru Mountains would be expected to be **species rich**. This is indeed the case, with a flora as rich as the other high rainfall Eastern Arc Mountains and much higher than equivalent areas of forest outside the Eastern Arc from the Horn of Africa to the Cape.

The Eastern Arc Mountains are thought to have a history of long-term climatic and geological stability (Lovett 1993a and Lovett *et al.* 1988). Long-term stability is considered to be important for concentrations of restricted range plant taxa in eastern Africa (Lovett and Friis in press), and so the Uluguru Mountains would be expected to be **rich in endemic plant species**. This is also found to be so, with plant taxa found only in the Ulugurus in a wide range of life forms from hemi-parasites, epiphytes and ground herbs to shrubs and trees over the entire elevational range of the mountains where forest has not been heavily disturbed.

Examples of trees occurring in the Uluguru mountain forests that are restricted to the Eastern Arc mountains are: *Allanblackia stuhlmannii*, *Cephalosphaera usambarensis* and *Polyceratocarpus scheffleri*. Other Uluguru trees are only found in the southern Eastern Arc, such as *Allanblackia ulugurensis*, and some are known only from the Ulugurus such as *Pittosporum goetzei*, which is found in upper montane forest and forest patches on the Lukwangule Plateau and the newly described *Aerisilvaea* from Kimboza.

The Ulugurus are especially rich in endemic herbs. In the Gesneriaceae, the genus *Linnaeopsis* Engl. has 3-4 species only known from the Ulugurus. Three *Saintpaulia* species are found in the Ulugurus, *S. goetzeana*, *S. pusilla* and *S. inconspicua*. The first two are also found in the Nguru Mountains (with *S. pusilla* also in the Ukagurus), but the latter is only known from the Ulugurus. This can be contrasted with the 15 species known from the Usambara area. In the Balsaminaceae, of the 69 native East African species, 19 are known from the Ulugurus, and of these 13 are Uluguru (including Kimboza) endemics (Grey-Wilson 1980 and 1982). All 19 are in the genus *Impatiens*[1].

The high rainfall and frequent mist and cloud cover of the Uluguru Mountains is reflected by a rich epiphytic Orchidaceae flora (Cribb 1984 and 1989), with many endemic species. For example, the genus *Bulbophyllum* has one Uluguru endemic and one near endemic (Ulugurus and Udzungwas), *Polystachya* has three Uluguru endemics and three near endemics (also on adjacent mountains), *Stolzia* has five Uluguru endemics, *Diaphananthe* has one Uluguru endemic and one near endemic and *Margelliantha* with three East African species has one Uluguru endemic and one near endemic.

Of ferns, the Uluguru Mountains hold 223 out of at least 321 forest species known for the whole Eastern Arc but only three species are endemic (R. Shippers *in litt.* 1994 to J. Lovett). Mosses comprise no less

1 The Ulugurus are sometimes regarded a centre of radiation for *Impatiens*. However, the endemics appear to come from a variety of sources.

than 490 species, of which 10 are endemic, including the endemic genus *Pseudotimmiella* (T. Pócs *in litt.* 1992 to N. Burgess).

Uluguru endemic or near-endemic genera are from a variety of families and occur throughout the elevational range of the forests, at natural forest edges and high elevation grasslands. *Linnaeopsis*, the Gesneriad already mentioned, occurs in montane forests. *Aerisilvaea* (Euphorbiaceae) is a shrubby tree in lowland forest at Kimboza. *Dionychastrum* (Melastomataceae) is a small shrub at the upper montane forest edge. *Pseudonesohedyotis* (Rubiaceae) is a montane and upper montane forest small shrub. *Rhipidiantha* (Rubiaceae) is a montane forest shrub. Near endemic genera, include *Neobenthamia* (Orchidaceae), an Uluguru and Nguru forest edge herb and *Urogentias* (Gentianaceae), an Uluguru and Nguru high elevation grassland herb.

8.2.3. The botanical fieldwork carried out on this survey (confer Table 2.1).

Eight plots at five different altitudes were assessed at Kimhandu and Lanzi by PH, SIM, CKM and BSS with help also from local village elders. Plots were objectively positioned adjacent to the bird net sites at the stations Kimhandu 1-5 and Lanzi 1-3. Each plot (demarcated with string) was 25 x 25 m (625 m2) and all stems with a dbh (diameter in breast height) of 3 cm or more were measured (dbh, height and spread in the longitudinal axis) and identified (shrubs, trees, tree ferns, pachycaul herbs and lianas). Lists are presented in this report of identified species, structural data of the plots, and of the dominant species in terms of basal area (BA) and number of stems. The aim of assessing the plots was to provide a standardised description of the forest structure and tree diversity for a representative site within each ornithological study area (in this report we do, however, not go into any comparison between birds and botany) and to provide biodiversity and structural data on the little known Uluguru South F.R. for a large-scaled study of the Eastern Arc Mountains.

Specimens from Kimhandu and Lanzi were identified at the Botanical Museum of Copenhagen during spring 1994 by PH with help from JCL. The structural data have been computerised into a database at BMUC that holds structural data from plots in a variety of Eastern Arc and coastal forests in Tanzania. Due to a difficult time budget and problems with final identification of many of the specimens (comparison with Kew specimens necessary for some of them), the identification process had to be terminated when only 47 of the c. 100 species had been identified; these were the dominant species for all stations. Below is listed some of the data to provide preliminary data on biodiversity value and to give an impression of the vegetation and the kind of data collected.

Plots were assessed also at the three stations visited at Tegetero by CKM, SIM and BSS (PH did not visit Tegetero). The specimens have been identified at the TAFORI herbarium in Lushoto by CKM. Species lists and structural data are presented in Mabula *et al.* (1994). Three plots were assessed in Kimboza F.R. by JCL on a visit in November. These will be described in detail elsewhere.

Ethnobotanical data were collected on local peoples use of plants for medicine, tools, householding etc. by CKM, SIM and BSS at Kimhandu, Lanzi and Tegetero. These data are presented in Mabula *et al.* (1994) with a brief summary in section 9 of this report.

Plot data similar to those collected on this survey exist from earlier fieldwork in the Ulugurus (and other Eastern Arc and coastal forests) by JCL. More details on diversity values (including full species lists) will be published in a separate paper on the Uluguru vegetation.

8.3. Methods used on this survey.

The method used to assess the plots was adopted from Lovett (1993b). The plots were 25 m x 25 m squares (area 0.0625 ha) demarcated with string. They were positioned adjacent to the bird net sites. The plots were laid out by first establishing a 25 m line on a compass bearing, divided into two 12.5 m lengths. From the 12.5 m mark a 12.5 m length was placed on each side of a compass bearing at right

angles to the central line. Finally, the outside edges of the plot were connected with straight strings. The plots were laid out in this way to ensure that the area is 625 m2 irrespective of topographic variation. All trees, shrubs, tree ferns, pachycaul herbs and lianas with a dbh (diameter at breast height) of greater than or equal to 3 cm (or equivalent if fallen) were identified or collected, and their dbh, distribution along the longitudinal axis of the plot, and height were measured. It should be mentioned that bamboos were not included (bamboos form a prominent part of the forest structure e.g. in the elfin forest at Kimhandu-5 [2520 m]).

8.4. Results of plots assessed at Kimhandu and Lanzi (confer Tables 8.1-3 and Figures 8.1-23).

A total number of c. 100 woody species with a dbh of more than 3 cm were found at the plots at Kimhandu and Lanzi. Of these, 47 species have been identified (Table 8.1; Eastern Arc endemics are assigned with an asterisk in front of the species name. Uluguru endemics are assigned with two asterisks.).

The information has also been analysed in terms of the number and sizes of the specimens at the various stations (Table 8.2) and diversity indices has been calculated for the plots (Table 8.3). Figures 8.1-8.8 shows the basal area dominant species for the eight stations. Figures 8.9-8.16 shows the dominant species in terms of number of stems for the eight stations. Figure 8.17 shows the total basal area for the eight plots, Figure 8.18 the number of stems for the eight plots. For selected species (Camphor *Ocotea usambarensis*, *Allanblackia ulugurensis* and Treeferns) basal area and number of stems are shown for the eight plots in Figures 8.19-8.23.

8.5. Discussion of results from Kimhandu and Lanzi.

Due to the small plot areas the total number of species of trees and shrubs found at the plots (Table 8.1 and Appendix 8.1) is not an approximation to the total number occurring in the study areas and also the densities calculated for the species suffer from the small sample size. This is illustrated by the distribution of *Ocotea usambarensis* Engl. and *Allanblackia ulugurensis* Engl. which occur throughout the altitudinal range but are not evenly represented in the plots. They are large and occur in low numbers (these or other species may furthermore have a lumpy distribution) and could be missed if the plot size is too small. To get a more true impression of total species numbers and densities the plot size should probably have been at least 0.25 ha per station as recommended in Newberry *et al*. (1992) or more plots should have been assessed at each of the stations.

A very high proportion (13/47 = 28 %) of the identified taxa are Eastern Arc endemics, with some (*Pittosporum goetzei* and *Rhipidantha chlorantha*) also being endemic to the Ulugurus. One of the Eastern Arc endemics, *Allanblackia uluguruensis*, occurs in good densities. There is so much difference in the proportion of specimens identified for the various stations that it is not possible to conclude anything from the variation in number of endemics listed for the single stations. For the conservation of the Kimhandu area it is of interest that seven Eastern Arc endemics have been identified from the lowest plot.

The valuable timber species Camphor *Ocotea usambarensis* was scored on plots at Kimhandu-4 (2145 m), and at all Lanzi stations, and occured at good densities locally. Tree ferns are very common at the stations, possibly due to the humid climate (see figures).
Further comments are given in Appendix 8.1.

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SECTION 9. CONSERVATION OF THE ULUGURU MOUNTAIN FORESTS.

By Jens Otto Svendsen, Marcel C. Rahner, Jon Fjeldså and Neil D. Burgess.

9.1. Abstract.

In this section the values of the Uluguru forests and the threats to them are assessed briefly. The present conservation status of the forests on the Uluguru Mountains is also reviewed. The results of the current investigation on biodiversity allied with those of recent land use studies (Lyamuya *et al.* 1994) and our own observations of land use are used to draw up some conservation recommendations for the area.

The main focus in this report is on biodiversity but protection of biological diversity also means maintenance of "ecosystem services", which are of vital importance to the human populations.

9.2. Values.

9.2.1. "Ecosystem services" offered to the human population by the forests in the Ulugurus.

9.2.1.a. Water catchment.

The Uluguru forests are an effective and exceedingly important catchment area, providing a stable water supply for many important rivers and streams and maintaining a humid climate of benefit to agriculture. Part of the explanation is:

- The forests are on a high range of mountains not far inland from the sea. Moisture-laden water from the Indian Ocean rises up the mountains where the rain falls.
- There is growing evidence that large forest tracts in the tropics produce part of their own rainfall (Jackson 1989). Forested areas, once established, can maintain a stable local climate that makes them self-sustaining (Kerfoot 1968, Pócs 1974). Montane forests are regularly covered in persistent wind-driven fog and clouds and are capable of "combing" out moisture of the atmosphere (Mäckel and Walter 1983, Stadtmüller 1987, Bruijnzeel 1990) by condensation on leaf surfaces or dense epiphytic bryophyte cover and occult precipitation (Kerfoot 1968, Pócs 1976a). In some cases the rain pours down inside the forest, while adjacent unforested landscapes receive little rain. In the highest zone, even tiny patches of shrubbery may "comb" large amounts of dew from the atmosphere.
- The water flows from the Uluguru Mountains throughout the year. This is not only because of the high rainfall and mist-precipitation in these mountains in relation to the surrounding lowlands, but also because the vegetation cover and the forest ground act as a "sponge", storing and retaining precipitation, releasing the water only gradually (Hamilton 1987, Smiet 1987). Water is stored in e.g. bryophytes and lichens growing on the trees and bushes. Pócs (1976a, 1980) demonstrated that the epiphytic cover of elfin forest in the Ulugurus (14,000 kg of epiphytes per ha) could absorb nearly 50,000 litres of water per hectare during one rain storm. The epiphytic cover of submontane forest (2130 kg/ha) could absorb 15,000 litres/ha. In certain areas the high-altitude bogs serve equivalent functions. Secondary forests without the cover of mosses and other smaller plants have lost much of the ability to store water in the vegetation. For an efficient storage of water also fine mineral soil material and especially organic matter, both characteristic of forest, are essential. The soil in the forest is protected from evaporation: Anyone who has visited the mountain forests of the Ulugurus will have noticed the big difference in microclimate between the forest and the surroundings. Within even 15 m it is possible to walk from an unpleasantly hot agricultural area with absolutely dry ground into a very wet, cool and shady forest environment. Pócs (1974) showed that temperatures within a forest on Bondwa Peak in the Ulugurus differ markedly from those outside at the hottest

time of the day. The soil surface temperature in submontane forest at 1430 m was 30°C less than in a maize field at the same altitude, and upper montane forest at 2020 m was 20°C cooler than open summit at 2125 m. Pócs (1974) showed that deforestation of submontane forest with subsequent cultivation would cause an increase in evaporation by four times. In this respect it should be mentioned that the vegetation of course evapotranspirates considerable amounts of water.

Water catchment capacity and humidity of climate. Some aspects for local farmers:

- The livelihood in all villages on the Uluguru slopes is totally dependent on clean water coming from the forests.
- The forest has a triggering effect on rainfall and mists. A hot and dry climate does not have this effect.
- In the principal agricultural zones on the west slopes (growing e.g. vegetables and fruit for Morogoro and Dar es Salaam), well-developed systems of ditches divert water from the streams to the intervening ridges.
- Water reaches the lowlands of the Ulugurus along numerous streams and underground seepage, as evidenced by the large number of wells at the base of the mountains, especially in the limestone karst areas such as the Kimboza forest. The orchard areas in the eastern foothills are well watered because of the proximity to the mountain. Much of this lowland zone is important for agricultural activity and much of the produce is exported from here to the markets of Morogoro and Dar es Salaam.
- The large sisal estates north of the mountains depend on water from the Ngerengere River.
- An irregular water supply in some potential agricultural areas may be caused by deforestation (local people, pers. comm. to JF).

Water catchment area for large cities outside the Ulugurus. The Uluguru Mountains (especially the forested parts) are the main catchment for three important rivers (Figure 1.3):

- The first is the Ruvu river, which is the major water source for Tanzania's most populous city: Dar es Salaam[1] (c. 2 million citizens and most of the major industry of the country; uses of water: industrial and domestic) (Temple 1973, K. Murira *in litt.* 1995). Ruvu collects water mainly from the eastern parts and is joined further east by the Mgeta and Ngerengere Rivers which collect water in the southwestern and northwestern parts. There are upper and lower Ruvu intakes of water for DSM (K. Murira *in litt.* 1995).
- Morogoro and Ngerengere Rivers which are the main water source for the populous regional headquarter Morogoro[2] (Morogoro is situated six km from the northernmost point of the Uluguru North F.R.[3]) (Temple 1973, Lovett and Pócs 1993, K. Murira *in litt.* 1995). Ngerengere is furthermore the major water source for many sisal estates in Morogoro District according to Temple (1973).

By 1963, apparently following increased devegetation of the catchment of Morogoro River, flood damage, bank erosion and silting had become serious problems even within the township of Morogoro (Little 1963, as cited in Temple 1973). Large differences between wet season high flows and dry season low flows were said to be increasingly apparent while severe short duration flash floods of high sediment content were causing considerable damage (*op cit*.). Apparently, the Ngerengere River dried out completely in the dry season with increasing frequency, causing many problems for the sisal farmers (*op. cit*.). We have not succeeded in finding out whether these rivers are still very low in water content in the dry season. However, we were told by local people that siltation of the streams supplying Morogoro is a problem (local people pers. comm. to N. Burgess, and for Morogoro River also K. Murira *in litt.* 1995).

[1] There has been troubles with the Ruvu water supply, possibly following deforestation in its catchment (K. Murira *in litt.* 1995). Additional water supply to Dar es Salaam from Mtoni River with no sizeable reservoir, uses of ground water is somewhat rare in DSM (K. Murira *in litt.* 1995).

[2] Morogoro also gets water from the Mindu Dam west of the city. Mindu water is used mostly for industrial purposes in the Morogoro industrial complex, but also for drinking on a limited scale. Furthermore there is a Dutch funded shallow well project supplying ground water for drinking (K. Murira *in litt.* 1995).

[3] The catchment of Morogoro River covers an area of 19.1 km² on the northern slopes of the Uluguru Mountains above Morogoro Town, the upper 40 % of this area being within the Uluguru North F.R. (Rapp *et al.* 1973a).

There are two alternatives for securing a continued water supply for Dar es Salaam: Maintenance of montane forest in the Uluguru Mountains, or the more technical solution, damming the Ruvu River. However, the latter solution may have severe unforeseen effects on the hydrological balance in the lowlands. Furthermore, the general land degradation leads to strong siltation of the waterways and a big dam would probably rapidly be filled with sediment (as is the case with the Mindu Dam near Morogoro City due to deforestation in its catchment area; information about Mindu: local people pers. comm. to JF and K. Murira *in litt.* 1995). Therefore, the only realistic long-term solution will be protection of the forest cover of the Uluguru Mountains, combined with increased vegetation cover outside the forest, especially to decrease soil erosion and immediate water runoff during heavy rains. Though this vegetation cover in the agricultural areas will use water for evapotranspiration, it may give an advantage in agricultural yields by decreasing evaporation from the ground and evapotranspiration from the crops. It may also have a triggering effect on rainfall. The value of the catchment function of the forests of the Uluguru Mountains has not been estimated in monetary terms. However, as most of the economic activity of Dar es Salaam depends on the waters from this forest, the value must be billions of Dollars over a 10-year period. This will all be jeopardised if the forest cover is lost from the mountains.

9.2.1.b. Regulation of runoff and erosion control.

By storing and detaining precipitation and runoff, the forests reduce floodpeaks that otherwise cause soil erosion problems downstream, all the way to the lowlands with landslides and massive loss of soil suitable for agriculture as a result (for a description of these problems, see Section 9.3.4). Patches of bushy vegetation or trees on ridges, steep slopes and in ravines will support an undergrowth that protects the soil against erosion.

9.2.1.c. Other values to the human population.

The Uluguru mountains and their forests have many other values in addition to those described here. These include:

- Plant species which could be of high economical value to the country. E.g., the wild coffee species occurring could be of value for the Tanzanian coffee industry. Other plants could be of high value for medicine for the human population in Africa and other parts of the world (e.g. against cancer, AIDS etc.). At present locals collect medicine plants in the forest. This activity is formally illegal but probably causes almost no harm since small amounts are needed. Furthermore, it is useful that the knowledge among the locals of the medicinal uses of the plants is maintained.
- Not to be forgotten are the aesthetic values of these large mountains and their forests.
- The source of timber could perhaps be exploited in a sustainable way that would be of benefit to the local village and the country. There are some impressive stands of the timber species *Ocotea usambarensis* in the remote areas of the Uluguru South F.R. and also other reserves contain good densities of valuable timbers. At present pitsawing is, however, forbidden (see Section 9.3.6) and it is clear that such exploitation must take place in a very controlled way to avoid overexploitation and to ensure that benefit reaches the right people.

At present a large number of materials are obtained directly from the forest by the local people. Of particular interest are their collection of wood for household items, building materials and firewood, and the hunting of animal species for meat. Much of this collection of forest products is illegal, and - unless supplementary resources are offered - its rate is now, or will grow, detrimental to the forest with a growing population and increased depletion of resources outside the forest. Information on this issue is presented in Sections 9.3.5 and 9.3.7. Some utilisation (e.g. for some household and building products) could probably be undertaken at a sustainable level.

9.2.2. High biodiversity value.

The Uluguru forests are a very important site for biodiversity, at the global scale. For a summary of the biodiversity value of the Ulugurus we refer to Section 1.2 (Executive summary). The information in

Section 1.2 has been compiled from the technical chapters of this report for birds, mammals, invertebrates and plants. The information on amphibians and reptiles of special conservation value (not presented in any of the technical chapters) has been compiled from Howell (1993) and Evans and Anderson (1992).

The endemic, subendemic and other red-listed species are not necessarily evenly distributed within these forests, which has important implications for the planning of conservation action. Due to time constraints and lack of information it has not been possible to standardise the data between organism groups in the assessment of conservation value given in Section 1.2. Neither has it been possible to fully assess whether the species mentioned are known from both the mountain and the foothill forests, except for the birds. Most of the endemism is probably in the mountain forests, of which almost all is in the Uluguru North and South F.R.s but also e.g. the lowland Kimboza Forest and the Mkungwe F.R. on the outlying hills are of very high biodiversity value with many endemics, at least among plants. The outlying hills are probably completely unknown biologically except from the plant lists given in Lovett and Pócs (1993).

9.3. Problems.

Population increase and the agricultural and resource utilisation activities associated with these people are the most significant threats to the continued existence of the forests and the species they contain (Scharff *et al.* 1982, Rodgers *et al.* 1983, Stuart and Jensen 1985, Lyamuya *et al.* 1994, Mabula *et al.* 1994, this survey).

Below we briefly mention some of the problems to give an overview. For a more detailed description we refer to e.g. the recent study of socio-economic and land use factors affecting the degradation of the Uluguru Mountains catchment presented in Lyamuya *et al.* (1994) and to the study of Kimboza Forest by Rodgers *et al.* (1983). The problems of soil erosion are well described in Rapp *et al.* (1973). The report by Lyamuya *et al.* contains a bibliography of studies of farming systems, land usage, population growth, forest reserves, climate etc. carried out in the Ulugurus. One of these studies is Temple's (1973) case study of official conservation policies and their impact on the Ulugurus.

As an introduction to the description of problems, we list some notes on the former extent of the forest. Very little written documentation exists. The following should be seen as an attempt to give some impression of the knowledge, more than a covering description (in the hope that this does not give a biased picture). It is based on what we have come over in easily accessible literature. We refer to the individual references regarding the context in which the statements were given, and we will not draw any firm conclusions in this report. It is clear that a major devegetation has taken place because of agricultural activities and probably enforced by burning, but the areas of dense woodland, dry deciduous forest and dense evergreen rain forest that have disappeared cannot be estimated yet.

Encroachment of forest for farmland at present. Throughout the Ulugurus forest, borders are very sharp, with agriculture extending right up to the tall trees at the forest edge, although some small clearings or areas with second-growth exist just inside the forest border. Encroachment into the forest presently takes place at a slow rate on the lower edges in many parts of the mountains (Pócs 1974, Lyamuya *et al.* 1994, this survey). At Lanzi we found an area of approximately one hectare, on the lower edge, that had recently been cleared for forest. The felled trees and burned ground we found there are illustrated in the photograph section. However, since no boundary demarcations were found, we are not sure whether the destruction took place inside or outside the Forest Reserve.
In a few areas, e.g. near our Kimhandu-6 (1540 m) camp (Kitandulu area), the forest reserve boundary is a few hundred meters inside closed forest. The boundary at Kitandulu was marked with short ditches and small piles of stones along a local path. The forest outside the boundary should probably be regarded as public land and constitutes (at least preliminary) an important buffer zone towards the surrounding farmland. Inside this public land zone we found many cutmarks and stumps from felled trees. As far as we could find out there is also forest outside the boundary in the Tegetero area.

It is our impression that the lower edge of the montane forest still corresponds quite precisely, with what is shown on our 1:50,000 topographical maps which were published 1970 and 1982-3. And Temple (1973, p. 113) mentions that "In many areas the present Forest Reserve boundary follows the original demarcation [from 1907, editors remark] but in some areas woodland cover [some woodland areas were included in the reserve, eds remark] has been pushed back beyond it as near Kienzema [Kienzema is another spelling for Tchenzema, eds rem.]".

Former distribution of forest habitat. Temple (1973, p. 110) wrote, "large areas of the mountains have been deforested over the last century and a half in the course of expansion of peasant agriculture". Stuhlmann (1895, as cited in Temple 1973) reported on rapid forest clearing.

The only estimate we have been able to find of the former extent of forest, giving altitudinal estimates[1], is from Temple (1973, p. 111). Temple wrote: "Under natural conditions and before the heavy impact of man, the Uluguru mountains were mainly covered by forest and woodland. Only on the upper levels of the Lukwangule plateau at altitudes of above 2600 m does forest give way to a grassy scrub climax (Hill 1930). Below this summit level, montane forest extended downslope to varying elevations in response to rainfall amounts. On the northern Ulugurus, where all the detailed study areas are located, the natural lower limit of forest varied over an altitudinal range of 1000 m from 800 m a.s.l. on the wetter eastern slopes to 1300-1400 m above Morogoro and to 1800 m above Kienzema [syn. Tchenzema, eds remark]. On the southern Ulugurus, which are drier, the natural lower limit of forest varied between 1200 m on the eastern, seaward-facing slopes and 1800 m on the western slopes (T. Pócs, personal communication). On steeper slopes and particularly in the west, a part of this forest cover still remains and is protected as Forest Reserve. Below the forest limits, woodland of various types covered the remaining slopes; most of this has been cleared for agriculture".

For Bondwa Mountain in the northern part of the Uluguru North Pócs (1974) wrote: "The research area occupies the western side of the ridge, where, due to the rain shadow effect, the climate is drier than on the fully forest covered eastern slopes. The forest belt here, in natural circumstances, does not descend lower than 1200-1300 m altitude, at least 600 m higher than on the other side".

Pócs (1976b) wrote: "(1). The eastern slopes exposed to rain-carrying winds, and the lee side of the mountains show a very asymmetric pattern of vegetational distribution. On the one hand, the vegetation zones descend deeper on the eastern than on the western side, on the other hand there are plant communities which dominate the eastern, and others which better developed on the western, slopes. On the eastern slopes, there is practically no dry season, therefore, in natural circumstances the evergreen forests descend to the foothills. On the western side, the natural boundary of evergreen forest lies much higher and the submontane forests, which dominate the eastern slopes, are substituted by dry forest and by deciduous woodland. This is the situation everywhere in the mountains where the dry season is longer than 1.5 months. Therefore, the remnants of evergreen forest are good indicators of a climate practically without dry seasons. (2). There is no climatic evidence of the presence of a natural treeless vegetation in the mountains. Most probably all savanna-like plant communities and a great part of the woodland area are derivates of dry semievergreen or dry deciduous forests, for which the duration of a 2-6 months long dry season with 800-1300 mm annual rainfall cannot be an excluding factor. Only where the duration of the dry season is longer than half a year does there develop a natural wooded *Acacia* grassland (savanna), north- and westwards from the Ulugurus. The presence of relic forest patches (Wingfield 1975, Pócs 1975) in the concerned zones on the western slopes underlines this fact. The valley grasslands are also not climatic communities (see Vesey-Fitzgerald 1970) ... (6). A wide range of vegetation communities, and first of all most types of closed forests or their remnants, are climatically induced and therefore good indicators of climatic conditions for Agriculture and Forestry. On the other hand, the human influence on the Ulugurus is quite important. A series of vegetation types, although not used directly for agricultural purposes, is secondary derivate of other communities. These are, among others, the montane grasslands, in some case the miombo (*Brachystegia-Isoberlinia*) woodland, and in most cases the common slope woodlands (*Pterocarpus-Combretum*) on the northern, western and on the southern slopes". The conclusion of Pócs´ study was that the climatically induced

[1] We have not investigated older literature, but Temple has done that, at least to some extent. Nor have we checked any old maps.

altitudinal zonations listed in Section 3.3 could be established (illustrations are given in Pócs paper on altitudinal zonation with diagrams of monthly precipitation and temperatures for various altitudes/vegetation belts). In addition, in Pócs (1974) illustrations with precipitation/temperature diagrams are given on altitudinal zonation (Bondwa Mountain).

Village elders said to the interviewers from the survey work presented in Lyamuya *et al.* (1994) that in the past most of the slopes were well covered with trees. They couldn't give the time precisely but they pointed out that it was between the 1920ies and 1930ies. As time went by the population continued to increase and more forests were cleared to give way to agriculture. Then when all the good land was finished, steep slopes and other erosion-prone areas e.g. close to riverbanks were converted to agriculture. During our 1993 survey, JF were told by people in Morogoro that they remembered that forest extended further down earlier. In some areas, e.g. on steep slopes of the Uluguru South F.R., below the forest, we saw patches of large trees in cultivated areas, suggesting a lower earlier position of the forest border.

Our own estimate for the eastern slopes (JF) is: The natural altitudinal vegetation pattern on the east slope would probably be a gradual transition from wet montane forest to semi-deciduous woodland at the base, with true lowland forest in well-watered parts of the foothills, especially in the limestone zone, which has several artesian wells. However, a wet submontane forest remains only in a few places, mainly in the northeast, and there is no transition zone, only tall grasslands and fields.

Our own estimate for the west slope of the Uluguru South and the miombo woodland (JF) is: Above the principal agricultural areas on the west slope (the Uluguru South) only disturbed montane forest is left. Originally, the natural west slope vegetation would be a transition from humid montane forest to miombo woodland on the nutritionally-poor red soil in the foothill zone, and with seasonally inundated areas (dambos) with "black cotton soil" in flat valley bottoms. In addition, the wide zone of low hills to the south has miombo woodland, because of the large distance from the humid mountains. The climax vegetation of the miombo zone has a semi-closed canopy and many tall trees of *Brachystegia* and *Julbernardia*. But because of the incessant burning of virtually all East African woodland habitats, the present vegetation of *Pterocarya*, *Combretum* and *Terminalia* can best be characterized as a fire-filtered plagioclimax, in which the biomass is often reduced by 90% and the canopy area by 60-70% (Skou *in litt.* 1994). However, forest signature (on the topographic maps) of the Wigu Hill (c. 800 m) 20 km southwest of Uluguru South, and on some other hills along the eastern fringe of the Mgeta river plain may indicate that a fairly natural vegetation remains here. This area is virtually uninhabited.

Lowland forests. It is important to take seasonal vertical migration into consideration when planning conservation initiatives in the Eastern Arc. The importance of lowland forests as dry season refuges for maintaining the populations of montane breeding species must not be forgotten, though the extent of the migration is still unknown. If these refuges are clearfelled or partly destroyed, it may affect also part of the submontane and montane avifaunas. Loss of forest on lower slopes and foothills may already have had an effect on the populations of species carrying out vertical migration in the Ulugurus.

9.3.1. Population growth.

The population on the Uluguru Mountains has been increasing since the Waluguru people arrived in the area less than 200 years ago[1]. Population density on the slopes of the Ulugurus is high (>150 persons/km² in many areas) (Lyamuya *et al.* 1994). The high population density is a result of the favourable nature of the mountains for agriculture (relatively low temperatures, reducing water loss, and

1 Temple (1973) and Lyamuya *et al.* (1994) summarize the events: The Lugurus arrived from the Ubena plains in Iringa Region where they had mainly been cattle pastoralists. Their cattle were subsequently decimated by the East Coast Fever and could not flourish on the insufficient pastures of the mountains. They initially settled in the open woodland of the western and southwestern slopes where relics of abandoned fields are represented by the open grassland with the original vegetation having been entirely destroyed through cultivation. These areas were progressively abandoned as the tribe expanded into the more densely wooded upper slopes around Kienzema and Bunduki, and later still into the wetter eastern forested areas. This initial exploitation of virgin environment was not accompanied by any conservation practices. Thus the land was cleared and cultivated until it became impoverished and was then abandoned.

lack of a pronounced dry season, both factors lower the risks of crop failure), others of several reasons being the relatively lower rates of malaria on the mountain and the 200 year old tradition of the Lugurus of living on the slopes (Lyamuya *et al.* 1994). The mean annual population increase is currently 2.8 % per annum, and up to 6.5 % per annum in some places (Lyamuya *et al.* 1994). More agricultural land is required every year to feed the people in the area because of continued population growth. The deforestation has probably gone on over the past 200 years since the Waluguru people arrived in the area.

An example of an exception to the general pattern of high population density is the area halfway between Tchenzema and the villages above Singiza in the southwest. This area appears to be almost uninhabited today (because of the long distance from roads) (JF pers. obs. during the 1993 survey and supported by our 1:50.000 maps). It is now bushy or sparsely wooded, possibly because of regeneration after previous clearfelling and degradation.

9.3.2. Bad agricultural practices.

Virtually all the local villagers are involved in agriculture and it is the only economic activity in most places. Agriculture is mainly undertaken at the subsistence level and involves a minimal labour investment where usually nothing is done to protect the soil. However, there are also many areas with commercial agricultural activities, especially in easily accessible parts.

As mentioned, the high and predictable rainfall makes the Uluguru Mountains suitable for agriculture. However, the soils of the Uluguru Mountains are particularly poor in Phosphorus, with a quite low organic matter content, and hence are not very productive (Lyamuya *et al.* 1994). In addition to this the poor agricultural practices (land reused without a sufficient fallow period due to shortage of land; farming often on very steep slopes without any measures to protect the soil from the sun and the rain) leads to soil erosion and infertile soil. Even in good years the yields of maize on the Uluguru Mountains are extremely low when compared with yields in other regions like Ruvuma (Lyamuya *et al.* 1994). The low rate of food production is causing significant hardship and poverty to the local people. Pressure on the land outside the forest reserves is increasing, as is the (small scale) pressure to utilise land within the forest reserves for agriculture - farmers keep on looking for additional land, as obtaining more agricultural land is seen by most people as the only solution to their present problems (Lyamuya *et al.* 1994, Mabula *et al.* 1994).

Some major differences in the agricultural use of the Ulugurus (observations from our survey, mainly by JF):

- On the west slope there are good road connections to Morogoro. The intensive agriculture (nearly 100 % of the land at 1200-1500 m) supplies the markets in Morogoro and Dar es Salaam with vegetables, notably cabbage, carrots and cassava, and many bananas are also grown. Close to Morogoro the agriculture is very intensive. In the areas from Mgeta and Bunduki to Tchenzema there are well-developed fruit industries (*Malus* and *Prunus*) operating at the commercial level. Many vegetables are grown. During recent years, the Sokoine University of Agriculture (SUA) in Morogoro, and foreign donors, have given strong support in this area to various agricultural improvements. A simple form of terracing (lazybeds, where the topsoil is turned in horizontal strips) is practiced all over this area. However, the labour investment is not sufficient to prevent erosion of the topsoil. The terraces are smoothed out towards the end of the rainy season, and on the steeper slopes only sand is left. Fire is used in a controlled way, e.g. to burn a weedy field before a new production season. There are numerous small plantations of wattle, eucalyptus and some cypresses and *Grevillea*s, but not in any way enough to cover the needs for wood, or for soil protection.
- On the eastern slopes of the Uluguru North there are subsistence agricultural areas, but also commercial operations growing bananas and other fruits and vegetables such as cabbages for export to the markets of Dar es Salaam and Morogoro.

- Being well watered, much of the eastern foothill zone is a mosaic of small fields and fruiting trees, such as avocados, bananas, cashew nuts, oranges, jackfruit, etc., and with many palms and high densities of kapok trees. Much of the produce is exported to the markets of Dar es Salaam.
- In comparison there are areas in the more remote parts of the Uluguru South forested area which operate from a very low economic base, with purely subsistence agriculture with very low labour investment and few commercial activities (but with local vegetable markets). The small villages in our Kimhandu study area (e.g. Lumba Juu, Nyamigadu, Wembela, and Ukwama) are very far from external markets, the closest being in Dakawa and Kasanga. The road connections to the area terminates in Singiza, which is connected by more than 15 km of poorly maintained dirt road with Dakawa (Dakawa is on the road which follows the edge of the Mvuha and Mgeta plains), and in Kolero, to where there is a reasonably good road. Agricultural products fetch absolute minimum prices when marketed in Dakawa, simply because it is known that nobody will carry unsold products all the way back up the hill. The main crops in the area are beans, maize and some cassava though also bananas and some few vegetables are grown for home consumption.
- A characteristic element of the lowlands to the north are the large areas of sisal estates.

9.3.3. Destruction from fires.

Fire is used to prepare land for agricultural uses (preparing land for planting), for vermin control and for scaring of wild animals (Lyamuya *et al.* 1994). Also to get fresh green grass emerging from the ash after the first rain (for animals) and to facilitate walking outside the forest. Possibly some fires are lit without any special reason.

Fires were extremely frequent in the foothill woodlands and in the southeastern part when we visited the Ulugurus on this survey and are frequently used in other areas near the forests. They probably have a seriously degrading effect on the foothill woodlands. This threatened habitat type also suffers from intense fuelwood collection. Fires regularly get out of control, damaging the forest borders and destroying the vegetation outside the forest. Slopes cleared of forest or dense woodland cover, or areas, which have become unsuited for agriculture, regenerate very slowly. Fires also cause damage to tree plantations (fires often destroy any trees which have been planted the previous season according to Lyamuya *et al.* 1994). The consequence is a strong degradation and increased evaporation.

9.3.4. Erosion and landslides.

Much of the cultivation is taking place on very steep slopes (up to and beyond 50 degrees) without any precautions taken to prevent erosion. Furthermore, uncontrolled burning and collecting of firewood destroy many of the patches of bushy vegetation or trees (with undergrowth) that could prevent the soil from erosion on ridges, steep slopes and in ravines. Therefore, in many cultivated areas erosion is widespread and landslides and mudflows are regular, causing a high loss of soil. Intensive rainstorms can release severe landslides in non-forested areas, which destroy agricultural fields, roads and occasionally houses. The erosion risk is highest on steep parts of the terrain. It is also especially severe in areas with sharp fluctuations between a dry and a rainy season, as is the case on the western slope of the Ulugurus. Landslides in the Mgeta area have been discussed in detail by Temple and Rapp (1973) and by Lundgren (1978). In one case more than 1000 landslides were recorded within three hours after heavy rainstorms, of which 47% were observed to originate in cultivated fields, 46% in grassland and less than 1% in areas covered with forest. (Temple and Rapp 1973).

Attempts by the British government to introduce soil conservation practices to the Uluguru Mountains during the colonial period, especially in the 1950ies (the ULUS project), largely failed. Young and Fosbrooke (1960) and Temple (1973) give the historical background to these attempts and discuss why they failed. Information on the historical development of conservation efforts to control erosion and forest degradation in the Ulugurus is summarized in Lyamuya *et al.* (1994) who also list some of the factors contributing to the problem. Further information on the soil erosion in the Ulugurus can be found in Rapp *et al.* (1973b).

9.3.5. Extraction of firewood, building poles and other forest products by local villagers.

All people living close to the forest boundary get forest products from the forest reserves for their daily requirement (Rodgers *et al.* 1983, Lyamuya *et al.* 1994 and Mabula *et al.* 1994). Collection of firewood and wood for building, house holding equipment, tools, medicine etc. is illegal although tolerated by most foresters as they realise that the people have few alternatives (Lyamuya *et al.* 1994). Rodgers *et al.* (1983) mentioned for Kimboza that as natural woody vegetation becomes more scarce in cultivated areas, the forest will become of increasing importance. This is valid for all parts of the Ulugurus where woodlands are getting thinner and thinner all the time. On our survey we noted that e.g. in the Lanzi area almost no trees are left outside the forest. Rough estimates from eastern Africa suggest that more than 90 % of all wood harvesting is for fuelwood (Rodgers 1993); this is probably the same for the Uluguru mountains. In many areas near the catchment forest reserves much of this firewood probably comes from the Forest Reserve (Lyamuya 1994).

During our 1993 survey CKM, SIM and BSS carried out a preliminary enquiry to record various uses of the trees and shrubs collected for identification during the fieldwork in the Kimhandu, Lanzi and Tegetero areas. In Mabula *et al.* (1994) they present a list of 113 species belonging to 49 families, with scientific names, uses and Kiluguru names. The uses of some trees and shrubs species varied from one person to another and from one locality to another (Mabula *et al.* 1994) and it should be born in mind that the enquiry, due to lack of time, was carried out without using anthropological techniques developed for collection of ethnobotanical information. However, the conclusion from the enquiry is very clear: a wide range of species of trees and shrubs are used for many purposes, some of them for very specific purposes.

Uses of the 113 species:

Fuelwood: 91 species (80.5 %).
Poles: 23 species (20.4 %).
Poles for making lavatory: 1 species (0.8 %).
Timber: 5 species (4.4 %).
Wall plates: 2 species (1.8 %).
Rafter: 5 species (4.4 %).
Bed legs: 1 species (0.9 %).
Tool handles: 3 species (2.7 %).
Tools: 1 species (0.9 %).
Mortars: 1 species (Camphor *Ocotea usambarensis*) (0.9 %).
Pestles: 2 species (1.8 %).
Barrels: 2 species (1.8 %).
Beehives: 1 species (0.9 %).
Withies: 29 species (25.7 %).
Ropes: 2 species (1.8 %).
Cleaning walking sticks: 1 species (0.9 %).
Shade: 4 species (3.5 %).
Fodder: 3 species (2.7 %).
Gums: 1 species (0.9 %).
Cooking oil extracted from seeds: 1 species (0.9 %).
Conservation: 30 species (26.5 %).
Edible fruits: 6 species (5.3 %).
Edible nuts: 1 species (0.9 %).
Edible bark: 1species (0.9 %).
Medicine for stomach ache: 6 species (5.3 %).
Medicine for stomach troubles: 2 species (1.8 %).
Medicine for malaria: 3 species (2.7 %).
Medicine for spirit: 1 species (0.9 %).
Medicine for teeth: 1 species (0.9 %).
Medicine for chest pains: 1 species (0.9 %).

Medicine for convulsions: 1 species (0.9 %).
Medicine, unspecified: 1 species (0.9 %).
Latex applied to breast to increase milk on breast-feeding mother: 1 species (0.9 %).
Fortunate bath: 1 species (0.9 %).
Ornamental: 2 species (1.8 %).
Calendar: 1 species (0.9 %) (a species flowering after 11 months. So local people use it as a calendar).

Sometimes valuable trees felled are not fully utilised: For example a big Camphor tree *Ocotea usambarensis* which might have existed for one hundred years may be felled just to obtain a piece hardly not more than 2 m length for making a grinding mortar (Mabula *et al.* 1994).

Rodgers *et al.* (1983) lists local names for plants of Kimboza Forest and also lists forest plant products utilised by local people in Kimboza F.R. (the latter based on a collection by one elderly villager in a morning).

9.3.6. Logging.

Pitsawing of valuable timber was until recently legal, so long as a licence had been obtained, but a ban on pit-sawing was made in May 1993 by decree from the Director of Forestry (Lyamuya *et al.*1994). This has hopefully decreased the problem of overexploitation in the area. However, as recently as October 1993 considerable logging activity was observed above Kinole village, with pit-sawyers living on the edge of the closed forest (P. Honess *in litt.* 1994).

Some areas have been depleted of valuable timber species, whereas they still occur at good densities in other areas. The forest of the Kimhandu area in the south, especially the southwest corner, appears untouched by man. There are very few trails in this area, and hardly any indications of cutting away from the trails. There was an impressive density of large Camphor trees here (though they were missing in e.g. the lower part of the forest in the Ukwama area). Because of market problems and lack of technology (there is a very long way to walk to the gravel road/dirt track connections to Kolero and Singiza), the villagers and people from outside have been unable to exploit the timber trees commercially.

In the Lanzi area, including the Lanzi-1 near the lower edge, large Camphor trees were seen often. This should be seen in the light that it is possible to motor all the way to Lanzi and that the forest here is more disturbed in the lower part than at Kimhandu. Camphor trees were recorded on four of the eight botanical 25x25 m plots assessed at Kimhandu and Lanzi, with up to four individuals per plot.

At Tegetero and Morningside the forest is of fine quality but pitsawing has certainly taken place here. As mentioned above ongoing pitsawing have been seen at Kinole and we found a number of old pitsawing places at the edge of the forest above Kinole when we left the forest.

The forest to the west of the Lukwangule Plateau (easy access and much human activity below) is strongly disturbed by cutting of poles and firewood and virtually all large timber trees have been extracted here and in the Bunduki area. Up to 2300 m the forest is only 10-15 m tall (with some emergents to 25 m). It can best be characterised as second-growth thickets and has many glades overgrown with tall herbs, brambles and shrubs. Fairly undisturbed forest is generally found only above 2350 m in this area and the lowest *Ocotea* tree was seen at 2250 m.

110 ha of the small Bunduki F.R. had recently been clearfelled (illegally) when we visited it, and what is left is mainly plantation of exotic trees.

Rodgers *et al.* (1983) gave details on species extracted by pit sawyers from Kimboza Forest in the early 1980ies. Also Lovett and Pócs (1993) gave information for Kimboza (see our Appendix 3.2). Pitsawing has been widespread and caused much damage in the Kimboza F.R., as was also observed on this survey. A good road passes through Kimboza Forest (see Figure 1.3).

Lovett and Pócs (1993) also described pitsawing activities in other forest reserves (see our Appendix 3).

Camphor *Ocotea usambarensis* and other valuable species are not only cut by pit sawyers, but also used by the local people (see Section 9.3.5).

9.3.7. Illegal hunting.

Mammals in the Ulugurus are threatened not only by habitat destruction but also by killing for food. Snares, traps, pits, dogs and guns are used for hunting of many different species of mammals. This intensive hunting supplies the growing local population with one of their few sources of protein.

The intense hunting has reduced populations of almost all species, e.g. of Abbot's Duiker *Cephalophus spadix* which is endemic to the Eastern Arc forests and on the 1994 IUCN Red List of globally threatened species (IUCN 1994). The scarcity of mammals (apart from monkeys and squirrels) is illustrated by the fact that during our two and a half months of fieldwork in the Uluguru North and South F.R.s only a single duiker (a Blue Duiker) was seen (see Section 6). Extremely few tracks of mammals were found during our survey, compared to what we have seen in undisturbed parts of the Udzungwa forests (LAH and JOS).

Elephant *Loxodonta africana* and Buffalo *Syncerus caffer* have probably disappeared completely. In undisturbed parts of the Udzungwas (West Kilombero Scarp Forest Reserve) these two species are fairly common (LAH and JOS, pers. obs.), this is also the case in the Rubeho Mountains which have an influx of animals from the Mikumi National Park (JF, pers. obs.).

9.3.8. Badly maintained boundary demarcations and lack of control.

The boundary of the forest reserves were well demarcated with exotic tree cordons in some of the areas we visited on our survey whereas in other areas only old and rather invisible demarcations existed. In the Tegetero area the forest reserve boundary is demarcated with exotic trees (*Grevillea*, *Eucalyptus)*. On the western side of the Uluguru South F.R. the boundary is well demarcated with *Cupressus* and *Eucalyptus* (Lovett and Pócs 1993, this survey). At Kimhandu and Lanzi the boundary was only demarcated with overgrown piles of stones (cairns) and short ditches.

The demarcation with exotic trees has not prevented intensive cutting and logging inside the forest reserve above Tchenzema (this survey): People are well aware that it is illegal to collect wood and other products in the forest but cut what they can. The forest attendants live far away[1] and do not usually come to control the area.

9.3.9. Ruby mining - an additional disturbing factor in the lowland Ruvu Forest.

Ruby mining takes place in the lowland Ruvu Forest Reserve. This leads to heavy disturbance in this forest, large parts of which may already be severely degraded (Appendix 3.3.b).

1 That the forest attendants live far away is not necessarily bad. Rodgers *et al.* (1983) discussed for Kimboza that the local forest attendants of Kimboza F.R. felt unable to control the cutting of forest produce by villagers ("If I arrest them, they will destroy my crops etc.").

9.4. Conservation.

9.4.1. Present conservation status and conservation efforts.

Temple (1973) and Lyamuya *et al.* (1994) summarized the historical development of conservation efforts in the Ulugurus. Efforts to conserve the forest on the Uluguru Mountains date back to 1909 (Temple 1973), when the colonial government interrupted the system of shifting cultivation by establishing a 277-km² forest reserve, which still remains. The Forest Reserves are now controlled by the Forest and Beekeeping Division of the Ministry of Tourism, Natural Resources and Environment. The purpose of establishing the montane and lowland forest reserves in the Ulugurus were to conserve the forest to protect the water catchment function, and to prevent land-slides. Other reserves have been established later (see Appendix 3).

Lyamuya *et al.* (1994) listed recent conservation efforts of the Forestry and Agriculture Departments and of externally funded conservation projects. At present time the Regional and District Forestry Divisions are doing the following to try and reduce land-degradation problems on the Ulugurus:

- raising seedlings for planting on the Uluguru Mountains.
- creating awareness on tree planting and other aspects of environmental conservation.
- preventing fires by education, fire campaigns and patrols.
- promoting the use of agroforestry on the mountain.

There are currently a number of externally funded conservation projects operating around the Ulugurus which are attempting to reduce environmental degradation, increase standard of living and assist the protection of the mountain forests for their catchment values. These are (data from Lyamuya *et al.* 1994):

a. Sokoine University. A group of university staff have been working with villagers above the university to try and incorporate both tree-planting and soil conservation practices into their farming methods. The project has also taken village farmers to see other areas in Tanzania with different farming systems, and upon their return these villagers have convinced others to take up the same farming practices. These farms are at the trial stage, but if they are successful then they will be used as demonstrations for other farmers on the Ulugurus. This project is funded through the Norwegian Development Agency (NORAD).

b. Franco-Tanzanian Uluguru Mountain Horticulture Project. This project is also based at the Sokoine University and is working in the Mgeta Division and near Kinole on the eastern side of the Uluguru North. The project is working with village farmers to try and help develop a more productive farming system and thus raise their standard of living. The project has been operating for four years, and now plans to expand its operation over the next three years. The project is funded through the French Charity, the Inades Foundation.

c. Morogoro Women-Focused Afforestation Project. This project has been operating for four to five years, and is set to continue for at least another three years. The project is working in villages around Morogoro, including some on the slopes of the Ulugurus. The project is working with interested individuals to try and incorporate tree growing and other agricultural improvements into the habits of village farmers. It is working in conjunction with Forestry Division staff and increasingly with Agricultural Extension workers and is funded through the Swedish Volunteer Service.

d. Catchment Forestry Project. This project is working with the Ministry of Tourism, Natural Resources and Environment to re-plant the boundary of the Catchment Forest Reserves, gap-planting, and to police the reserves. The project has also undertaken some trial work with involving villagers in the conservation of Catchment Forests, although not in the Uluguru Mountains. The project is jointly funded by the Ministry of Tourism, Natural Resources and Environment and NORAD, and aims to continue working for several further years.

e. Uluguru Slopes Planning Project. This project will be an extension of the work started for the report by Lyamuya *et al.* (1994). The project is funded by the European Community through the British conservation charity the Royal Society for the Protection of Birds. The project aims to conduct socio-economic survey work on the slopes of the Ulugurus, and biological and social research inside the Uluguru Forest Reserves. It is planned to use this information, and other data gathered during the course of the project work, to develop a plan for the further conservation efforts required in the Uluguru Mountains.

There are some common themes in each of these projects (Lyamuya *et al.* 1994):

- They are all tackling the same basic issues of poor farming methods, soil erosion, poor standards of living, lack of fuelwood and firewood, and problems of deforestation.
- Although many of the projects are agricultural and rural development in nature they are all aware of the forest catchment issue and what needs to be done to protect the water supply of Dar es Salaam, and the forests themselves.
- Most of the projects are operating independently and are often unaware of the existence of each others and of the work of the government services in the same area.
- Collectively there is no overall strategy for the conservation of the Ulugurus and how each of these projects, and the government services, might contribute to this process.

9.4.2. Proposals for conservation actions and future surveys.

The conservation of the Uluguru forests can only be in conflict with the most short-sighted economic interests as it has major long-term benefits at local and national levels. Moreover, important scientific, genetic and aesthetic values can be preserved for the future if the forests of the Ulugurus are safeguarded.

The value of the catchment function of the forests of the Uluguru Mountains has not been calculated in monetary terms. However, as most of the economic activity of Dar es Salaam depends on the waters from this forest the value must be billions of Dollars over a 10 year period. This is all jeopardised by the loss of the forest cover from the mountains. We believe that it is crucial that the Tanzanian politicians recognize the importance of basing the economic development model for the country on investments for solving the fundamental environmental problem, such as the loss of natural water catchment areas. Based on a neoclassical economic growth model, Kaufmann (1995) has demonstrated that the effect of a reduction in environmental life support on economic activity increases by a factor of two to three over time, indicating that it is not possible to substitute capital investments in the production sector for a degraded environment.
The conclusion of discussions in Tanzania is that the planning of large-scale donor-supported land management programmes should start up stepwise, as the Tanzanian managing authorities should first decide on the national priorities for initiating such programmes. The Eastern Arc Biodiversity Conference which is to be held in Morogoro, Tanzania, in 1996 (subject: Management of Tanzanian montane forests and their biological diversity) will be an opportunity to discuss this issue. Evidently, though, the Uluguru Mountains would come high up on such a priority list.

Taken together the available information on biodiversity, water catchment and economics shows that the forests of this mountain block are of extreme importance and should be the targets of intense national and international efforts to ensure their conservation over a prolonged number of years. However, pragmatically, the limited funds currently available for conservation in the area need to be effectively targeted into those areas where they are likely to have the most effect.

9.4.2.a. Suggested priority areas for conservation.

Suggested priority area for protection of biodiversity values (see Figure 1.7). All forests of the Uluguru North and South F.R.s, Kimboza-Ruvu and also Mkungwe F.R.s are of international

conservation priority. However, the results of this survey indicate that one area of forest is of particular importance and that resources should be concentrated to this area initially. For protection of Threatened forest birds actions should clearly be concentrated to the submontane forest of the Uluguru North F.R., of which most is in the Tegetero-Bagilo-Kinole-Lupanga area on the eastern slopes, with some also around Morningside on the northwestern slope (Figure 1.7). The reason for pointing at this area is:

- All five Threatened bird species occur here, and four of them appear to depend on the submontane (below 1500 m) and lower montane forest for their survival, *Bathmocercus winifredae* being the exception. If the forest in this area disappears, then the endemic bird *Malaconotus alius* may become extinct globally, and others of the species of birds found only in a few mountain forests of Tanzania may disappear as well from the Uluguru Mountains. Three of the Threatened species (*Apalis chariessa*, *Anthreptes rubritorques* and *Ploceus nicolli*) have never been recorded in the Uluguru South F.R. which largely lack submontane forest, and at least the first two of them are most likely absent from there.
- The submontane forest of the Uluguru North F.R. is of an excellent quality, some of the most beautiful forest in East Africa, being characterised by tall, thick trees covered with dense epiphytes. It is likely that also many other of the rare species in other organism groups found in the Ulugurus are restricted to or highly dependent on this area.

Suggested priority area for conservation of catchment values. All forested land on the Ulugurus, especially on the mountains, is of national priority for the conservation of water supplies to the most industrialised parts of the country. These values to the country far exceed the values to Tanzania generated by the agricultural use of the land outside the forest. Highest priorities for management of the forest reserves in the Uluguru Mountains are clearly the Uluguru North and Uluguru South Forest Reserves. The two reserves must be considered together as priorities because they cover the Uluguru Mountain ridge and slopes which are the major part of the Ruvu river catchment, and many other smaller rivers of local importance, including the water supply for Morogoro town.

Suggested priority area for large-scaled tree planting (see Figure 1.8): Large-scale planting of trees to draw the attention from the forest as a source for firewood and building poles is regarded as particularly important. On this survey we observed that the Lanzi area appears to be one of the areas that most urgently needs plantations of firewood. This area is marked on Figure 1.8. Another priority area for provision of firewood plantations is the area mentioned above as priority for conservation of Threatened forest birds - though the eastern slopes of the Uluguru North F.R. do not at present lack firewood as seriously as the Lanzi area, it is important to secure this valuable area in every respect.

Suggested priority area for increasing living standard according to observations from this survey (see Figure 1.9): South-eastern part of the Uluguru South, e.g. the Kimhandu area, where there is low economic activity. This area is marked on Figure 1.9. Investments in land use improvements, better access to markets, employments, other economic activities etc. are things that could help in this area. They could be coupled with agreements about a full burning stop on steep and unproductive slopes, where vegetation regeneration is needed.

9.4.2.b. Recommendations for conservation actions.

General conservation actions. Below are listed recommendations given in Lyamuya *et al.* (1994), supplemented with some new ideas:

- We believe that carefully planned agroforestry systems have to be introduced in the study area with the purpose of increasing self sufficiency in firewood and other forest products, and of diverting the monotonous low cost-benefit system of agriculture to more economically viable production systems. The type of trees to be recommended have to meet at least one of the following needs: alleviate the soil fertility problem, conserve the soil from erosion, protect against high evaporation and provide direct financial benefits to the individual farmers. Training and working with farmers and producing booklets as described by Lasalle (1993) could be the way forward. In certain villages in the wet zone (such as Mkuyuni at the Morogoro-Dakawa road) and the drier zone (Mgeta) of the Ulugurus,

selected agroforestry systems have already been found to be economically efficient when evaluated at 10 % of opportunity cost of capital (Senkondo 1992, as cited in Lyamuya *et al.* 1994).

- As far as land and soil conservation is concerned, a combination of simple measures, notably those which are effective when applied to an individual field/plot, have to be identified and demonstrated before whole-scale propagation is undertaken. Such measures could include carrying out farm operations along the contour lines of a piece of land that is technically protected from erosion by vertiver grasslines or equivalent measures.
- In addition to the firewood resources provided by agroforestry planting, it will probably be necessary to make firewood plantations to meet the high and overriding demands. Firewood plantations will take up space and since there is already a shortage of land for agriculture (see below under Further survey work) it may be necessary to rent or buy land to avoid resistance from the local people. Plantations should preferably be with indigenous species though it may be necessary to use also *Pinus* or *Eucalyptus* for quick provision of fuelwood (at least *Eucalyptus* is, however, known to consume huge amounts of water and nutrients and to leave toxics on the ground via leaves etc.). Planting should be initiated as soon as all possible.
- Distribution of locally made energy saving cooking devices may be a way to save firewood. This will fit in well to the Luguru community, which is specialised in pottery. The government has to promote the industry by providing technical assistance and assisting the distribution of the products at a cheap price to rural areas. A similar approach has been successfully taken in Kitui District in Kenya. However, at least in the higher part of the Ulugurus people need a fire in the evening to keep themselves warm and if they have to light a new fire away from the cooking device then there may not be much energy saved. Such problems need to be studied before large-scale distribution is started.
- We recommend that boundary surveying, marking and clearing plus demarcation with exotic tree species (*Eucalyptus, Grevillea*) take place in those areas where this has not yet happened.
- Measures should be taken against setting of fires not only near the forest but also in the woodlands at the base of the mountains (where fires were extremely widespread when we arrived in October) and on steep, unproductive mountain slopes. Agreements could be made in villages to identify zones not to be burned, and extra economic benefits could be allocated according to how well the locals keep their promises.
- We believe that the central government should acquire agricultural land, which is important for land and forest conservation from the individuals concerned. This includes land with very steep slopes (45° and above) or on riverbanks. These areas should be rehabilitated. A similar approach was used in Moshi Rural District, where it worked successfully. Lack of protection of very steep areas and riverbanks and surroundings leads to strong siltation of streams and strong erosion during heavy rains.
- Introduction of animals for meat supply may be a way to decrease the hunting pressure.
- Other economic activities that are practised in other highlands in Tanzania or elsewhere could be identified, and modified to suit the Luguru environment. A few pilot groups could be selected to serve as demonstrators to the rest of the community, and these individuals sent to the more successful parts of the country.
- Deliberate efforts to reduce the population pressure through a rigorous education programme to the youth, and a birth-control campaign. Experience can be drawn e.g. from the heavily and densely populated Moshi Rural, Hai and Rombo districts in Kilimanjaro.
- A technical catchment advisory and executive board could be established and provided with the mandate to manage the Uluguru catchment. The composition of the group has to be drawn from various relevant disciplines which are concerned with people, land, environment, law, economics, sociology and any other relevant discipline.
- Constant evaluation of progress and formulation of new approaches are vital parts of land and forest conservation. This can only be achieved through continuous research cum demonstration activities, which have to be part and parcel of the conservation program.
- The villagers' primary motivation in accepting any externally assisted changes to their agriculture is almost certainly a desire to try and augment their income and standard of living. This must always be considered.

Further management proposals (from Lovett and Pócs 1993) for the individual forest reserves in the Ulugurus can be found in Appendix 3. Rapp *et al.* (1973b) and Lundgren (1978) listed recommendations

for and comments on efforts to prevent erosion of slopes (loss of soil) and siltation/very fluctuating water levels of important streams. For the important Morogoro River catchment Rapp *et al.* (1973a) recommended the following to reduce the considerable loss of soil and water to acceptable proportions:

- Planting of tree belts on critical slope sections to reduce the danger of landsliding (cf. Temple and Rapp 1973).
- Extended use of grass barriers, trash bunds and mulching on bare fields to reduce splash and sheet wash (cf. Temple and Murray-Rust 1973).
- Manuring of fields to permit longer periods of cultivation and hence longer periods of grass and bush fallow on a larger proportion of the cleared slopes.

Further sociological survey work:

- A detailed appraisal of the sociological situation of villagers around the forest is required. This is being implemented as a part of the BirdLife Uluguru Slopes Planning Project in cooperation with the Regional Natural Resources Department in Morogoro and other institutions.

The background is that the social values of the various parts of the forest to the local people and their perceptions of the values of forest to them is not known. Furthermore, in some areas people still link conservation efforts with the conservation initiatives that failed in the 1940ies and 1950ies (ULUS project). Detailed sociological data are important for the finer scale planning of a major conservation programme to ensure that the programme will deliver things that the local people could understand and which were relevant to them. All actions need to be targeted to fit the local situation as it is found on the ground, and working with the local villagers as well as the forestry authorities is absolutely essential.

Some aspects that are worth mentioning in this respect are:

1. The conservation actions required in the individual areas depend on e.g.: How well-off is the area? How depleted is the area of fuelwood? How important is the forest? Which kind of agriculture is undertaken? Accessibility of the area? Which kind of trees would the local villagers prefer? What is the attitude among the villagers towards agroforestry, stop of burning, fuelwood plantations etc.?
2. In nine villages visited during the survey work presented in Lyamuya *et al.* (1994) 88-100 % of the farmers interviewed were willing to plant trees (for fuelwood, building materials, fruit-production and financial grain; this varied much between villages). However, regarding tree planting Lyamuya *et al.* (1994) mentioned severe land tenure problems. Trees are individual property, virtually unrelated to the land on which they stand. This, together with the common practice of lending land for cultivation of annual crops has severely limited the process of adopting afforestation or agroforestry practices, and will continue to be a problem for any further attempts at tree planting. Furthermore, the shortage of land may lead to some resistance against tree planting initiatives, since the overriding need of the villagers (who are poor) is an adequate supply of food on a short term.

- A study should be undertaken of why woodlands are being burnt to such a high extent and how this can be prevented.

Further biological survey work: *Birds:* The observations from this survey (in combination with literature studies) have added significantly to the knowledge of the Uluguru forests, especially the little-known Uluguru South F.R. In Section 5.7 we listed priorities for future ornithological work in the Uluguru forests. *Other organism groups:* The distributional pattern in the Ulugurus may differ between Threatened bird species and rare species in other organism groups. An assessment of habitat preferences of rare taxa in other organism groups should preferably complement the Threatened birds survey mentioned in Section 5.7.

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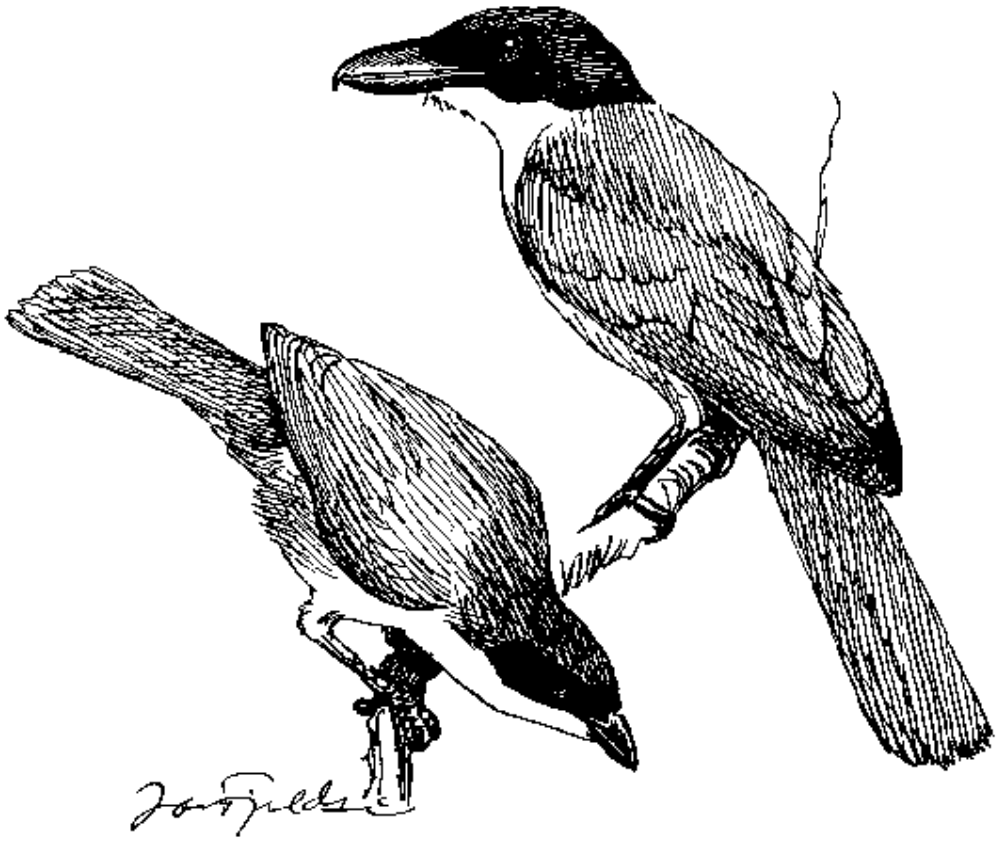

Left: Blackfronted Bush-shrike *Telophorus nigrifrons*. **Right:** Uluguru Bush-shrike *Malaconotus alius*. Drawing: Jon Fjeldså.