Lulanda 2002

Newcastle University Lulanda 2002: Tanzanian Eastern Arc Forest Corridors

Field Report

Tanzania Forest Conservation Group

Project endorsed by
the Royal Geographical Society
(with The Institute of British Geographers)

1.1 ABSTRACT

Small isolated populations are vulnerable to local extinctions. Corridors of suitable habitat linking habitat islands and permitting dispersal between them can reduce this risk. Such corridors are thus increasingly being used in forest management practices, in an attempt to reduce the negative effects of habitat fragmentation.

The aim of this project was to make an assessment of the Forest Corridor Programme initiated in 1996 by the Tanzania Forest Conservation Group (TFCG) in Lulanda Forest Reserve. The Reserve is located in the southern Udzungwa Mountains, part of the Eastern Arc range. The Eastern Arc is a globally important site due to its high biodiversity. We conducted a comparative study between two forest fragments in Lulanda (Fufu and Magwilwa) and the linking forest corridor. The project aimed to fulfil the following objectives: (a) to establish and compare forest species diversity with corridor diversity, by trapping a range of small animal taxa; (b) to confirm the species of bushbaby (genus *Galagoides*) present in Lulanda; (c) to contribute the data collected to the TFCG for the ongoing assessment of their Forest Corridor Regeneration Programme.

A total of eight small mammal genera (seven Rodentia and one Insectivora), 26 bird species and at least three amphibian species were recorded in Lulanda Forest Reserve. Species overlap between forest and corridor was slight (with similarity indices of 0.33 for small mammals and 0.19 for birds). Our findings confirm that the corridor is at an early stage of succession, and supports a diverse range of small mammal and avian fauna, of which most are not forest dependent.

In addition, six Grant's galago (*Galagoides granti*) were trapped in Fufu forest, firmly establishing their presence in this area for the first time. Details of several opportunistic findings (i.e. observed outside our trapping programme) are also provided, including the finding of a Horned Bush Viper (*Atheris ceratophorus*), an Eastern Arc endemic, and the important observation of a Black and White Colobus Monkey (*Colobus angolensis*) feeding within the forest corridor.

1.2 INTRODUCTION

The Lulanda Forest Reserve is located in the Eastern Arc Mountains, towards the southernmost end of the Udzungwa Mountain block (Fig. 1(a)). The Eastern Arc range stand out as an exceptionally important site for biodiversity; together with the Coastal Forests of Tanzania they have been recognised as one of the top 25 biodiversity hotspots in the world. The Eastern Arc is significant in having its endemic species concentrated into an exceptionally small area (the Eastern Arc is the smallest of the hotspots). It contains 1,500 endemic plants and 121 endemic vertebrate species in 2,000 square kilometres. This gives the Eastern Arc the highest density of endemic plants and vertebrates of all hotspots (Mittermeier *et al.*, 1998; Myers *et al.*, 2000). Due to the huge biological diversity of the Eastern Arc Mountains, knowledge of the small mammal fauna is still being collated. Further study of this important group is critically needed to establish the actual degree of endemism in these unique areas (Stanley *et al.*, 1998). Extraction of firewood and timber, and clearance of land for agriculture and grazing has led to the Eastern Arc forests being severely reduced: the remaining primary vegetation represents only 6.7 % of the original area (Myers *et al.*, 2000). Furthermore, the remaining expanse of 2,000 km^2 is fragmented into 128 patches.

At the turn of the 20th Century, Lulanda Forest Reserve consisted of a single, continuous forest area. Since that time it has become fragmented into three smaller patches, namely Fufu, Magwilwa and Ihili (Woodcock, 1998). During the *ujamaa* period, a system of villagisation instigated in the 1960s, the area was cleared for agriculture. Lulanda is currently a government-gazetted Forest Reserve managed by the nearby villages. In the early 1990's, the Reserve was visited by a number of biologists who highlighted its high biodiversity value (Woodcock, 1998). Despite its small area, a relatively large number of endemics have been recorded in the Reserve (Lovett & Pócs, 1992, cited in Woodcock, 1998). In particular, it is considered to contain a high diversity of plant and understory bird species (Lovett & Congdon, 1990).

With increased awareness of the high biodiversity value of Lulanda Forest, the Tanzania Forest Conservation Group (TFCG) began discussions with Lulanda village government and Mufindi District officials with the aim of setting up a community-based conservation project. In 1993, the TFCG started the Lulanda Forest Conservation Project, which assists the District to manage Lulanda Forest (Woodcock, 1998). Since 1993, one of the main activities of the TFCG in Lulanda has been to help the villagers to establish a forest corridor linking Fufu and Magwilwa, the two largest patches of Lulanda Forest. Farming activities were stopped and the TFCG established a nursery and began its planting programme. Many exotic species and some indigenous species were planted between 1993 and 1995. However, a fire swept through the corridor area (except the far north part) in 1995, killing most of the planted trees. Since the fire, the TFCG project managers have systematically removed surviving exotic planted trees in order to promote indigenous species within the corridor. In making this decision, consideration was given to the negative effects of exotic species in the corridor such as pine (suppression of understory growth), and eucalyptus (high demand for water).

Since the fire, planting of indigenous species in different sections of the corridor has occurred at intervals. The Lulanda corridor was demarcated and the borders were planted with *Hakea saligna* in 1996. Planting in 1997 was widespread, covering the northern and western area of the corridor. In 1998, a smaller area was planted in the central southern area of the Reserve, followed in 1999 by planting on the eastern side and far southwest corner (Fig. 1(b)). In addition, enrichment planting has been periodically carried out in all areas previously planted. Precise counts of numbers of seedlings of each species planted were not recorded. However, TFCG field reports suggest that in total approximately 90,000 seedlings were planted in 1997 (although this may be an underestimation), 170,000 in 1998 and 83,500 in 1999. Note that these figures include planting around Ihili forest patch in addition to the Fufu-Magwilwa corridor (Doody, 2002).

In 2000, a survey of the boundaries of the Lulanda forest patches (Fufu, Magwilwa and Ihili) including the corridor areas was conducted by district authorities with support from TFCG. Numbered concrete markers currently mark the border of the corridors and forest patches. The trees planted in the corridor area are now up to 3 m high surrounded by grassland with shrubs and saplings. The long-term aim of the planting programme is to regenerate this habitat in order to expand the total area of forest. The TFCG is working towards sustainable management, in order to maintain high biodiversity along with continued community use of non-commercial products. The main harvest is medicinal plants. This is regulated by Lulanda Village Environmental Committee according to a management plan agreed by the Village Assembly (N. Doggart, *pers. comm.*).

Logistics

As zoologists we are concerned about habitat destruction, such as forest fragmentation and the resulting threat of biodiversity loss. The challenge of organising and conducting a research expedition overseas provided us with the experience of working with host country students to collect original data and contributing to a regional conservation project of considerable importance.

Having contacted the Tanzania Forest Conservation Group (TFCG) and learnt about their Forest Corridor Regeneration Programme, our original plans were to create a species inventory for small mammals, reptiles, amphibians and birds. Little scientific research had been conducted to record the animal species present in Lulanda Forest, and thus we felt that the data we collected would provide a valuable description of the faunal biodiversity of the Reserve. In addition, after consultation with Andrew Perkin (who is conducting his PhD research on bushbabies of the Eastern Arc Mountains), we were able to incorporate trapping of bushbabies into our project. We consider that all data we collected will provide a useful contribution to the TFCG's long-term aim of increasing the available habitat for forest flora and fauna.

We felt very strongly that we should work with Tanzanian students, as the expedition would benefit from their knowledge of the country and it would provide them with an opportunity to gain fieldwork experience. An advert for research assistants was sent out to Professor Howell at Dar es Salaam University and Dr R Makundi at Sokoine University (Newcastle University alumnus). As a result of this, and funds we managed to raise, we worked in partnership with two Tanzanian students from Dar es Salaam (Sophy Machagga and Lazaro Linjano) and three from Sokoine University (Christopher Sabuni, Hamoud Hamis and Alex Temu), who helped with all aspects of research from methodology to identifications and provided an invaluable translation service.

The expedition aimed to record the small mammal, amphibian and reptile fauna present in the two largest fragmented forest patches in Lulanda (Fufu and Magwilwa) and the linking forest corridor, and to survey bats and understory birds. These animal groups could easily be trapped using similar methodology and equipment. The methodology also allowed us to conduct trapping at two different sites simultaneously.

Objectives

In partnership with five Tanzanian students, the project aimed to document the composition of small animal species in two small forest patches and the linking forest corridor in Lulanda. This would allow us to establish the current status of the corridor, and to compare corridor species diversity with forest diversity. Our findings will provide baseline data for comparitive studies in the future, enabling the development of the corridor area to be monitored. In addition, the data collected on bushbabies in Lulanda will contribute to the ongoing work of Andrew Perkins. In the long-term, the data collected during our relatively short study in Lulanda should thus play a role in the future conservation of this Reserve.

1.3 BACKGROUND

Many of the protected areas worldwide may be too small to maintain long-term viable populations of their many resident species. However, opportunities to establish new reserves are rapidly diminishing as the global demand for land and resources continues to increase (Newmark, 1993). Therefore, careful management and development of current protected areas is essential for conservation of biodiversity. For example, in many cases it may be possible to link adjacent protected areas via habitat corridors (sometimes referred to as wildlife corridors). Newmark (1993) defines a corridor as "habitat that permits the movement of organisms between ecological isolates".

The use of such corridors has a theoretical basis in the equilibrium theory of island biogeography (MacArthur and Wilson, 1967). This theory states that the number of species in an isolated island of habitat represents a dynamic equilibrium between rate of species immigration into the island, and the rates of local species extinction. Here corridors should increase the rate of immigration into a reserve, thereby permitting recolonization, and reducing the effects of inbreeding and random genetic drift (Perault & Lomolino, 2000). In addition, corridors can increase the effective size of a reserve, thereby reducing the probability of extinction (Newmark, 1993), as well as reducing the well-documented "edge effect" (e.g. Laurance *et al.*, 2001; Laurance *et al.*, 1998; Stevens & Husband, 1998). For example, a study by Newmark (1991) found that small tropical forest fragments in the Eastern Usambara Mountains (part of the Eastern Arc range) have lost understory bird species (compared with a large control site) following forest fragmentation. The study also found that forest-dependent understory species vary greatly in their vulnerability to forest fragmentation; species most adversely affected are those that are relatively rare. In addition, forest interior species appear to be more adversely affected by forest fragmentation than forest edge species. According to Newmark (1993), many tropical and temperate-forest bird species are known to avoid forest edges, and are normally only encountered in the forest interior. Many tropical bird species are also known to be inhibited from crossing major forest gaps (Newmark, 1991). The author suggests that the establishment of protected forest corridors linking existing forest reserves may be critical to the conservation of many forest bird species.

2.1 METHODOLOGY

Study areas

Lulanda is in the Mufundi District, Iringa Region, located about 75 km south-east of the town of Mafinga. The forest is located in the southern Udzungwa Mountains, (5 km east of Mufindi Scarp East Forest Reserve) in two valleys on the edge of the east facing escarpment from 1480 – 1640 m above sea level.

We identified the following three sectors within the Reserve as our study areas:

1. Fufu forest patch — 89.3 ha
2. Magwila forest patch — 82.6 ha
3. The corridor linking Fufu and Magwila — 54 ha

Total: approximately 225.9 ha (Doody, 2002)

<u>Vegetation:</u> The forest patches are montane; the dominant tree species is *Parinari excelsa* with swampy open areas in valley bottoms. The canopy is up to 30 m high, intact in parts, but generally much disturbed following the extraction of timber species (Lovett & Congdon, 1990) All areas have undergone disturbance but there is no evidence that the forest patches have ever been completely cleared. The surrounding habitat is farmland (shamba) with the principal crop being maize.

There is encroachment for cultivation along the edges of the forest. Building poles, firewood and medicinal plants are taken. A footpath through the forest links the village with cultivated areas below the reserve.

Data collection

For small mammals, reptiles and amphibians, trapping programmes were carried out at two sites within each study area. Trap lines were laid out in a systematic manner in order to avoid the edge effect at the boundaries between forest, corridor and adjacent cultivated land.

Small mammals: A trapsite consisted of two bucket pitfall lines running parallel and 50m apart, following the methodology of Stanley *et al.* (1998). Each line consisted of 10 buckets (5m apart) buried in soil so that the rim was flush with the ground. A drift fence of clear plastic approximately 50 cm high was erected, bisecting each bucket along the length of the line. 20 medium Sherman traps (23 x 9.5 x 8 cm) were placed on each side of the line at 5m intervals and 2-3 large Sherman traps were set at each end of the line. 1-3 prebaiting nights were allowed, followed by 5 trap-nights. Initially a mixture of peanut butter and maize flour was used as bait, but as supplies ran out, ground up peanuts were used. All traps were checked twice a day: after dawn and before dusk. Traps in the corridor were left closed during the day as it was felt that they were exposed to high temperatures. Other traps were left set throughout the day and night.

The mammals were fur clipped for capture-mark-recapture (Barnett & Dutton, 1995). Mammals were identified to genus, and where possible, species level by Christopher Sabuni, and through the use of Kingdon (1997). In addition a reference collection consisting of 12 specimens preserved in 70% ethanol was taken to Professor K. Howell at University of Dar es Salaam for positive identification.

Whilst trapping was attempted in the shamba adjacent to the corridor, using Sherman traps only, this had to be aborted after two nights due to wet conditions and large numbers of safari ants swarming over the traps. Further attempts at trapping in this area were not possible due to time constraints.

Amphibians and small reptiles: The bucket pitfall traps were also suitable for catching amphibians and reptiles. See above for details. Animals were identified to the genus, and where possible, species level, with the assistance of Nike Doggart. A reference collection consisting of six specimens was taken to Professor K. Howell at University of Dar es Salaam for positive identification.

Bushbabies: Suitable bushbaby habitats containing vines and climbers were identified within the forest patches. Three Chardonneret traps (designed by Andy Perkin) were placed approximately 1.5 m above the ground and 500 m or more apart. Bananas and bamboo wine were used as bait; bananas were also smeared on surrounding branches and vines. Ten trap nights were conducted in three areas of Fufu forest; six consective trap nights were conducted in two areas in Magwilwa. No attempts were made to set traps in the corridor, as there was no suitable bushbaby habitat, and to our knowledge, no prior sightings of bushbabies or any other primate had been made in the corridor area.

Birds: One line of 150 m mist nets was erected for two days in the corridor and three days in Fufu. The nets were opened at 5.30 am (half an hour before sunrise) and checked every 30 mins throughout the day. The nets were furled at dusk. Birds were identified in the hand by Jacob Kiure, and through the use of Stevenson & Fanshawe (2002). Calls and sightings were also recorded.

Bats: Various trapsites were identified as suitable for trapping bats using a bat detector. 12-24 m of mist nets were erected for six nights at four areas. Nets were opened at dusk and furled at 9-10 pm.

Data Analysis

Small mammals: A heterogeneity chi-square analysis was conducted to test for differences in small mammal abundance between the two forest patches. Since there was no significant difference, data from the two sites was pooled. A chi-squared analysis was then carried out to test for differences in small mammal abundance between the pooled forests data versus the corridor. For the latter test, certain rodent species were pooled, due to the low numbers (< 5) caught (which would otherwise invalidate the chi-square test). Categories were as follows: *Praomys* (the dominant forest genus); *Mus* (the most common genus caught in the corridor); other rodents, and *Crocidura* (shrews).

To test for differences in genera/species composition between the pooled forest data and the corridor, a binary similarity coefficient (*i.e.* based on presence/absence of genera/species) was calculated using the coefficient of Jaccard (S_j). A quantitative similarity coefficient was also calculated (*i.e.* based on presence/absence and also incorporating species abundance data). Species were not pooled for the similarity analyses (Krebs, 1991).

Birds: To test for differences in species composition between Fufu and the corridor, a binary similarity coefficient was calculated using the coefficient of Jaccard (S_j).

3.1 RESULTS

Small mammals: Eight mammal genera (caught in Sherman traps and bucket pitfall traps) were identified in Lulanda forest; in most cases it was not possible to identify animals to species level. Seven of the genera were rodents: *Praomys*, *Lophuromys*, *Hylomiscus*, *Grammomys*, *Dendromus*, *Mus* (family Muridae) and *Beamys hindei* (family Cricetidae). The remaining genus was an insectivore: *Crocidura* (family Soricidae). Although it was not possible to identify any *Crocidura* to species level, two distinctly different types of animal were captured; these are described as ‘species 1’ and ‘species 2’ (Fig. 2). As noted in the methodology, Sherman traps in the corridor were closed during the day, therefore diurnal species were only caught in the forest patches. Animals trapped during the day are shown in Figure 3.

There was no significant difference in species abundance between the two forest patches ($X^2 = 4.7304$; $0.50 > p > 0.25$; DF = 5). Therefore, data from the two sites was pooled for a subsequent chi-squared test of forest versus corridor. There was a highly significant difference between species abundance in the forest (pooled) versus the corridor ($X^2 = 85.933$; $p < 0.001$; DF = 3).

The Jaccard’s coefficient gave a similarity of 0.33. The range of values for binary data is 0 (no similarity) to 1.0 (complete similarity) (Krebs, 1991). The quantitative similarity coefficient calculations are presented in Table 1.

The most common mammal genus trapped in both forest patches was *Praomys*, with over 40 individuals recorded in each site. However, only one individual was trapped in the corridor. While *Mus* was the most frequently encountered genus in the corridor (21 individuals were trapped), there was no obvious dominant group. *Grammomys* and *Crocidura* were also represented in higher numbers within the corridor; *Grammomys* was not recorded at all in either forest patch. Certain genera were caught only in the forest patches: *Hylomiscus*, *Crocidura* species 2, and *Beamys hindei*. Two *Beamys hindei* were caught in bushbaby traps (one in Fufu, one in Magwilwa), and one in a Sherman trap in Magwilwa. Only the specimen caught in the Sherman trap is included in Figure 2.

Although results from the shamba were not included in the data analysis (due to the difference in trapping effort), the following genera were represented: *Mus* (*n* = 7), *Praomys* (*n* = 6), *Grammomys* (*n* = 1), *Lophuromys* (*n* = 1) and *Crocidura* (*n* = 2).

Primates: Two primate species were identified during walks through both forest patches: black-and-white colobus monkey (also known as Angola pied colobus) *Colobus angolensis*, and Syke's blue monkey *Cercopithecus mitis*. A single black and white colobus monkey was also observed in the corridor, at least 200 metres from Fufu forest edge. A third primate Grant's galago, *Galagoides granti*, was trapped in Fufu forest patch. Six animals were trapped, one of which did not survive, and was therefore taken as a specimen (KMH 25799).

Amphibians: At least three amphibian genera were caught in bucket pitfall traps in the forest patches; no amphibians were caught in the corridor (Fig. 4). The dominant species in both forest patches was identified as *Probreviceps macrodactylus*. Two distinct *Arthroleptis* species were recorded (*A. xenodactyloides*, and a second as yet unidentified species). We are also awaiting identification of a possible third genus, *Arthroleptides* by Professor Kim Howell of the University of Dar es Salaam.

Note that identification of reference specimens was not complete at the time of presenting this report.

Birds: A total of 26 bird species (22 genera) were netted in the Reserve: 19 in Fufu (Table 2 (a)) and 12-13 species in the corridor. It was not possible to identify the species of *Cisticola* netted; it is thought that these birds may have been two different species (Table 2 (b)). Five of the 26 species were found in both habitats. Birds caught in Fufu included three restricted range species: the African tailorbird *Orthotomus metopias*, the spot-throat *Modulatrix stictigula*, and Fülleborn's black boubou *Laniarius fuelleborni*. The African tailorbird is also a Tanzanian near-endemic. One species recorded in the corridor is also a restricted range Tanzanian endemic: Moreau's sunbird *Nectarinia moreaui*.

A further three species were recorded in Fufu, and eight species in the corridor, from either direct observation or identification of calls (Table 3.).

The Jaccard's coefficient gave a similarity of 0.19. No quantitative similarity coefficient was calculated, as only five of the 26 species were present in both habitats. For many species (*n* = 12), only a single bird was caught. Therefore, a chi-square analysis of bird species abundances in Fufu versus the corridor was not feasible.

Bats:

After six trapping nights no bats were caught. Two different frequencies of bat calls were distinguished using the bat detector: 40 mHz and 70-80 mHz, but these signals could not be identified to species.

Opportunistic findings:

Reptiles:

Horned Bush Viper, *Atheris ceratophorus.* Tanzanian Eastern Arc endemic. Found in Fufu forest patch. Taken for identification, later released.

Skink, *Mabuya sp*. Several of these animals were observed around the TFCG project house, adjacent to Fufu, and also within the corridor.

Amphibian:
Caecilian, discovered on the main road in Lulanda village. The animal was damaged and was taken as a specimen (KMH 25811). Identified as *Scolecomorphus vittatus* by Professor Kim Howell. This species is a Tanzanian endemic.

3.2 DISCUSSION & RECOMMENDATIONS

Six small mammal genera (plus one primate species) and 12-13 bird species were represented from our trapping efforts in the corridor. We recorded higher species richness in the forest patches: eight small mammal genera (plus three primate species), 19 bird species, and at least three amphibian species (within two or three genera). Although five mammal genera (*Praomys*, *Lophuromys*, *Mus*, *Dendromus* and *Crocidura*) and five bird species were represented in both the forest and the corridor, the species composition of the corridor differed to that of the forest patches. A comparison of the two habitat types (forest and corridor) is presented below, along with recommendations for further studies. In a wider context, the effectiveness of corridors as a strategy for conserving biodiversity in fragmented habitats is discussed below.

Praomys appeared to be the dominant small mammal genus in both forest patches, in contrast to the corridor where only a single specimen was caught. According to Kingdon (1974), *Praomys* inhabits humid, well-shaded vegetation and is common in forest and secondary scrub areas of high rainfall. *Beamys hindei* and *Crocidura sp*. 2 were not represented at all in the corridor. There was no single dominant genus in the corridor, although *Mus*, *Crocidura sp*. 1 and *Grammomys* were all represented more strongly in the corridor than the forests (*Grammomys* was not recorded at all in either forest patch). These findings show a marked difference in species composition between the two habitats. It is unfortunate that efforts to conduct a small mammal trapping programme in the shamba were unsuccessful, as it would have been interesting to discover whether the species composition of the corridor resembled that of the shamba more closely than that of the forest. It is strongly recommended that any future investigation should attempt to collect data from the surrounding agricultural landscape.

It is interesting to compare our findings with records of small mammals from other Eastern Arc Mountain blocks. For example, a study by Stanley *et al.* (1998) documented a composition of rodent species that was comparable across the Eastern Arc archipelago. Distribution records showed a possible nine genera represented in three small mammal families in the archipelago's montane forests, which we could also have expected in Lulanda. These were: Sciuridae, the mountain squirrel; Cricetidae, the pouched rats (namely *Beamys hindei*) and Muridae, six genera of rat-like rodents including *Praomys*, *Mus*, *Grammomys* and *Lophuromys*. Of these, the only family we did not trap in either forest or corridor was Sciuridae (the mountain squirrel). Nor were these animals observed in Lulanda. However, our trapping methodology may have reduced the likelihood of capturing these arboreal animals. Stanley *et al.*, used a combination of three traps, 20% of which were set off the ground on vines and tree limbs. Bait type is another factor that may have affected the types of species caught.

In contrast to the rodents, Stanley *et al.* found that shrew species had a much more patchy distribution with each subset of mountains in the Eastern Arc, containing at least one endemic species. Currently there are 23 species of Crocidura (musk shrews) known from Tanzania. Specimens can only be identified to the species level by detailed study of tooth and skull structures (Kingdon, 1974). Accordingly, five shrew specimens were taken for identification, in an effort to give some indication of the species present. Other insectivores we could have expected to encounter have a wider distribution; these are the three families Chrysochloridae (moles), Erinaceidae (hedgehogs) and Macroscelidae (elephant shrew) found in the Southern highlands of Tanzania (Stanley *et al.,* 1998) Once again, the reason we did not encounter these families is likely to be due to our trapping methods, and does not indicate that these families are not present in Lulanda. One of the original aims of our project was to conduct walks to identify the trails/nests of the endangered Elephant shrew *Rhynchocyon petersii* amongst the leaf litter. However, this did not prove feasible, due to time constraints and inexperience.

Even small patches of forest such as Lulanda can support populations of larger mammals including larger primates, such as black and white colobus monkeys and Sykes blue monkeys, as well as smaller arboreal primates such as bushbabies. Bushbabies are nocturnal primates found only in sub-Saharan Africa (Perkin, 2000). A recent study conducted in Tanzania by Honess & Bearder (1996) described two new species of bushbaby (*Galagoides udzungwensis* and *G. rondoensis*) and elevated two others from subspecies (*G. zanzibaricus granti* and *G. demidoff orinus*) to species (*G. granti* and *G. orinus* respectively). These four new species were established on the basis of species-specific vocalisations, reproductive morphology and body measurements. Consequently, there are now at least eight known species of bushbabies ocurring in Tanzania, and it is thought that more discoveries are possible (Perkin, 2000). Andy Perkin is conducting research for the Nocturnal Primate Research Group at Oxford Brooks University, UK. This group has been reviewing the bushbaby taxonomy on the basis of behaviour and ecology, complemented by population genetic analyses. Andy's work in Tanzania focuses on gathering more information on the ecology of the recently described/elevated species. For example, he has so far revealed range extensions of both *G. udzungwensis* and *G. rondoensis* (Perkin, 2000). It is thought that *G. granti* occurs in Lulanda. The data collected from the six bushbabies trapped in Lulanda will contribute to Andy's research in this region, and may confirm the existence of *G. granti* in Lulanda, thus extending the known species range. *G. rondoensis* is classified as Endangered, *G. orinus* and *G. granti* as Data Deficient and *G. zanzibaricus* as Lower Risk in the 2001 IUCN Red List. All four species are probably under threat due to habitat loss. Any efforts to increase knowledge of their taxonomy, distribution and natural history should provide useful data for conservation efforts (Perkin, 2000).

Kingdon (1974) comments that black and white colobus will become shy and very wary in areas where they have been hunted. Typical alarm behaviour was observed when we disturbed a troop: a sequence of deep throaty alarm calls, freezing, and then fleeing at high speed leaping great distances between branches. On other occasions the animals appeared to be observing us and remained in the trees in close proximity to us. Interestingly, one black and white colobus monkey was observed foraging in the corridor at least 200m from the edge of Fufu forest patch. The individual in the corridor is likely to have been drawn there by the large amounts of fresh foliage, which they prefer for food. According to Laurance & Laurance (1999), the habitat tolerances of arboreal mammals are determined by traits including diet and degree of arboreality. Fimbel (1994) studied habitat selection by primates and ungulates in Tiwai, Sierra Leone and used this data to infer relative "value" of young successional forests (aged 5-12 years) and high forest. The author found that four primate species selected regrowth habitats more often than expected. Although the high forest was found to be more important to the primate community, young forests were also used by resident fauna.

The Udzungwa Mountains have been identified as an Important Bird Area (IBA). (Long *et al.*, 1996; Baker & Baker, 2002). IBAs are recognised for sheltering populations of birds that are endemic, threatened or restricted to particular biomes (e.g. the 'Afrotropical highlands'), or because they are places where exceptionally large numbers of birds congregate (Stevenson & Fanshawe, 2002). IBAs are designated using globally agreed criteria by the BirdLife partnership in the region. All remaining fragments of the ancient montane forests in the Udzungwas are vital habitats for migratory and particularly resident birds. Maintaining connectivity between these fragments is essential to support the many resident bird species present in the region.

Only five of the total of 26 bird species caught were represented in both the forest and corridor (and consequently the similarity coefficient was low). This demonstrates how the corridor may serve to increase the diversity of avian species supported within the Reserve. Furthermore, a number of forest-dwelling species, and shy birds that prefer thick cover were netted in the corridor. These species include the African firefinch *Lagonosticta rubricata*, green-backed twinspot *Mandingoa nitidula*, evergreen forest warbler *Bradypterus lopezi*, little greenbul *Andropadus virens* and Moreau's sunbird *Nectarinia moreaui*. The latter species is of particular interest, being known only from the Udzungwa Mountains, Nguru, Nguu, Uvidunda and Ukaguru in Tanzania. It is a bird of montane forest, occurring from 1,300 to 1,850 m at most locations, but up to 2,500 m in the Udzungwas. Surveys in the Nguu and Ukaguru Mountains suggest that there are good numbers and the forests in these areas are considered to be not immediately threatened. The species also occurs within the well-protected Udzungwa Mountains National Park. The species appears to be forest-dependent and is likely to be sensitive to destruction or degradation of forest habitat in certain areas within its limited range (BirdLife International, 2000).

Another notable species that we hoped to encounter was the Iringa akalat *Sheppardia lowei*. This species is known from only a small number of forested areas in the Udzungwa Mountains, Ukaguru Mountains, and the Southern Highlands (Njombe District) of Tanzania. It is found in montane forest and thickets, generally more abundant at higher altitudes, largely ground-dwelling, and tolerant of some habitat disturbance (BirdLife International, 2000). According to BirdLife International (2000), the total population is estimated at less than 10,000. Although the majority of sub-populations are well protected, it has a small range (being known from less than 10 localities) and is probably declining due to alteration, clearance and fragmentation of its forest habitat at the extremities of its range. It is therefore considered Vulnerable. One of BirdLife's targets for conserving this species is to conduct a survey and monitor its population size in the Udzungwa Mountains. Although this species was not recorded, it is recommended that further efforts should be made (*i.e.* similar studies in an extended area) to discover whether it is present in Lulanda.

One of the problems encountered during our study was that capture rate tended to be high during the first day of netting, and this rapidly tailed off. For several bird species, only one individual was caught. Both these factors made quantitative analysis problematic. Thus, it would be useful to conduct a longer netting programme, perhaps at periodic intervals, in an effort to obtain higher numbers of each bird species. It is also worth noting that resident and migrant bird distributions are strongly influenced by equatorial seasons. Dry and wet season patterns vary a great deal across East Africa and between years. In southern and western Tanzania the main rainy season is from October to April or May, although complex local patterns occur. In general, bird activity is strongly influenced by the presence or absence of rain. Many species nest during and shortly after the rains, when food is often most abundant (Stevenson & Fanshawe, 2002). Thus, any findings of a short study such as our project will be affected by seasonality.

Both our forest patches supported a similar range of amphibian species. According to Halliday (1997), most amphibians are highly secretive in their habits. For example, caecilians may spend athe greater part of their lives underground. Whilst no amphibians were recorded in the corridor this could be due to the positioning of our trapsites, which unlike those in the forest were not near a water source. Seasonal population changes could have also affected the trapping success. It was observed that higher numbers of amphibians were caught in the last three trap nights in Magwilwa, coinciding with a period of persistent rainfall. The reason why no reptiles were caught may be due to weather conditions, which may greatly affect the activity of endotherms and therefore the likelihood of capturing them (Blomberg & Shine, 1997). The effect of weather can vary on a daily basis, as well as seasonally.

At present there are 79 species of bats known from Tanzania (Hutson *et. al*. 2001). The reason why we were unsuccessful in trapping bats may be due to our inexperience in trapping methodology, and lack of suitable locations for placing nets, e.g. in clearings and over water. Other possible factors that may have influenced our lack of results may include seasonality, altitude and our proximity to suitable roosting locations (Nowak, 1994).

Due to the inherent difficulties in conducting such research, there have been few investigations into the effectiveness of corridors. Consequently, issues concerning the design of corridors are also subject to debate. In particular, there are few published studies on the use of potential corridors by tropical wildlife (Laurance & Laurance, 1999). Harrison (1992) identifies habitat, width, length, human activities and location as variables potentially influencing the effectiveness of corridors. It remains to be determined whether corridor-design principles developed for habitat types such as temperate forests can be applied to tropical forests. For example, Laurance & Laurance (1999) state that tropical rainforests have unique characteristics and support more species with specialized habitat and dietary requirements than temperate forests. As a consequence, the authors suggest that tropical species may be particularly sensitive to edge effects and may therefore require wider corridors than temperate forest species. A recent study in the USA by Perault & Lomolino (2000) found that individual corridors differed markedly in terms of both habitat and species composition. Consequently, the authors suggest that corridors must be considered individually in any attempt to assess them. The shape of the corridor linking Magwilwa and Fufu is unusual in that it is relatively wide (approximately 600 – 700 m). Over time, this corridor may serve two purposes: initially, whilst at an early successional stage, it may provide a route for movement of animals between the two patches. However, the long-term hope of the TFCG is that the corridor will eventually fully regenerate into forest, thus creating a single large forest patch, incorporating Fufu, Magwilwa and the corridor, returning the area to its previous (pre-exploitation) condition.

Although from our study we cannot state whether animals are using the corridor as a dispersal route between Fufu and Magwilwa, the results of our expedition indicate that the TFCG corridor regeneration programme has had a positive effect on the Lulanda Forest Reserve. At this stage of succession, six years after replanting work started, the corridor already supports a diverse small mammal and avian community. Furthermore, while the long-term aim of the TFCG is to link the two forest patches, Lulanda is such a small Reserve, that protecting the corridor habitat, regardless of how successful efforts to fully regenerate this area prove to be, can only be benefit the flora and fauna. For example, the observation of a black and white colobus within the corridor is a good indication that the corridor has, at the least, extended the available foraging range for this forest species.

Our short study has produced some interesting findings, and has contributed to efforts to document the biodiversity of this Reserve. However, Lulanda provides many opportunities for further research. Whilst the flora of Lulanda has been assessed recently (Doody, 2002) and our study covered a range of small animal taxa, as yet no attempt has been made to document the invertebrate fauna. Furthermore, our study gives only a snapshot in time; it would be interesting to survey the corridor at a later stage of succession, e.g. in five to ten years, to discover how the species composition has changed to become more like that of the forest.

5.1 REFERENCES

Baker, N.E & E.M. Baker (2002) *Important Bird Areas in Tanzania: a first inventory.* Wildlife Conservation Society of Tanzania, Dar es Salaam, Tanzania.

Barnett, A. & Dutton, J. (1995) *Expedition Field Techniques: Small Mammals*. Royal Geographical Society (with the Institute of British Geographers), London

BirdLife International (2000) *Threatened birds of the world*. Barcelona and Cambridge, UK: Lynx edicions and BirdLife International.

Blomberg, S. & Shine, R. (1997) Reptiles. In Sutherland, W.J. (ed) *Ecological Census Techniques: a handbook*. Pp 218-226. Cambridge University Press, Cambridge

Doody, K. (2002) An assessment of a reforestation programme in the Southern Udzungwa Mountains, Tanzania. *Tanzania Forest Conservation Group Technical Report 3*

Fimbel, C. (1994) The relative use of abandoned farm clearings and old forest habitats by primates and a forest antelope at Tiwai, Sierra Leone, West Africa. *Biological Conservation* **70**: 277-286

Halliday, T.R. (1997) Amphibians. In Sutherland, W.J. (ed) *Ecological Census Techniques: a handbook*. Pp 205-217. Cambridge University Press, Cambridge

Harrison, R.L. (1992) Toward a theory of inter-refuge corridor design. *Conservation Biology* **6**: 293-295

Honess, P.E. & Bearder, S. (1996) Descriptions of the dwarf galago species of Tanzania. *African Primates* **2**: 75-79

Hutson, A.M., Mickleburgh, S.P., & Racey, P.A. (2001). *Mcroichiropteran bats: global status survey and conservationaction plan.* IUCN, Gland, Switzerland and Cambridge, UK

Kingdon, J. (1997) *The Kingdon Field Guide to African Mammals*. Academic Press Limited, London

Kingdon, J. (1974) *East African mammals: an atlas of evolution in Africa*. Academic Press Inc. (London) Ltd

Krebs, C.J. (1991) *Ecological methodology*. Harper & Row, New York

Laurance, S.G. & Laurance, W.F. (1999) Tropical wildlife corridors: use of linear rainforset remnants by arboreal mammals. *Biological Conservation* **99**: 231-239

Laurance W.F., Lovejoy, T.E., Vasconcelos, H.L., Bruna, E.M., Didham, R.K., Stouffer, P.C., Gascon, C., Laurance, S.G. & Sampaio, E. (2001) Ecosystem decay of Amazonian forest fragments: a 22-year investigation. *Conservation Biology* **16**: 605-618

Laurance W.F., Ferreira, L.V., Rankin-de Merona, J.M. & Laurance, S.G. (1998) Rainforest fragmentation and the dynamics of Amazonian tree communities. *Ecology* **79**: 2032-2040

Long, A.J., Crosby, M.J., Stattersfield, A.J. & Wege, D.C. (1996) Towards a global map of biodiversity: Patterns in the distribution of restricted-range birds. *Global Ecology and Biogeography Letters* **5**: 281-304.

Lovett, J.C. & Congdon, T.C.E. (1990) Notes on Lulanda Forest, southern Udzungwa mountains. *East Africa Natural History Society Bulletin* **20**: 21

MacArthur, R.H. & Wilson, E.O. (1967) *The theory of island biogeography*. Princeton Universtiy Press, Princeton, New Jersey

Mittermeier, R.A., Myers N., Thomsen, J.B., da Fonseca, G.A.B. & Olivieri, S. (1998) Global biodiversity Hotspots and Major Tropical Wilderness Areas. *Conservation Biology* **12**: 516-520

Myers, N., Mittermeier, R.A., Mittermeier, C.G., da Fonesca, G.A.B. & Kent, J. (2000) Biodiversity hoptspots for conservation priorities. *Nature* **403**: 853-858.

Newmark, W.D. (1993) The role and design of wildlife corridors with examples from Tanzania. *Ambio* **22**: 500-504

Newmark, W.D. (1991) Tropical forest fragmentation and the local extinction of understory birds in the Eastern Usambara Mountains, Tanzania

Nowak, R.M. (1994) *Walker's Bats of the World*. Johns Hopkins University Press, USA

Perkin, A. 2000 Bushbabies of Tanzania: an update. *Miombo* **20**: 4-5

Perault, D.R. & Lomolino, M.R. (2000) Corridors and mammal community structure across a fragmented, old-growth forest landscape. *Ecological Monographs* **70**: 401-422

Rodgers & Homewood (1982)

Spawls, S., Howell, K., Drewes. R. & Ashe, J. A. (2002) *A Field Guide to the Reptiles of East Africa*. Academic Press, London. pp 543

Stanley, W.T., Howell, K.M. & Hutterer, R. (1998) Small mammals of the Eastern Arc Mountains, Tanzania. *Journal of East African Natural History* **8**: 91-100

Stevens, S.M. & Husband, T.P. (1998) The influence of edge on small mammals: evidence from Brazilian Atlantic forest fragments. *Biological Conservation* **85**: 1-8

Stevenson, T. & Fanshawe, J. (2002) *Field guide to the birds of East Africa*. T & AD Poyser Ltd, London

Woodcock, K.A. (1998) Changing roles in natural forest management: a case study from the Udzungwa Mountains. *Journal of East African Natural History* **87**: 349-357