Belg. J. Zool., 135 (supplement) : 109-112 December 2005

Effects of habitat fragmentation on diversity of small mammals in Lulanda Forest in Mufindi, Tanzania

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ABSTRACT. The Lulanda forest cover a portion of the Udzungwa mountains in Mufindi district, Tanzania, ranging from 1480 – 1640 meters above sea level. The forest consists of three forest patches dominated by *Parinari excelsa* and a corridor between two of them that is being regenerated to a forest under the help of the Tanzania Forest Conservation Group (TFCG). A capture-mark-recapture study was carried out to document the small mammal species found in Lulanda forest patches and corridor. There is a considerable difference in small mammal species composition between the montane forest and the corridor with a higher diversity in the corridor.

KEY WORDS : Small mammals, Habitat fragmentation, Forest patches and Corridor

INTRODUCTION

The Udzungwa Mountains are part of the Eastern Arc Mountains (EAM), a chain of isolated mountain groups that run from Taita hills in Kenya to Udzungwa Mountains in southern Tanzania (LOVETT & CONGDON, 1990). The mountains have been recognized as one of the 25-biodiversity hotspots in the world (MYERS et al., 2000). Rapid increase of the human population, acquired needs from forests such as farmland, timber, firewood, and medicinal plants cause an overall loss of forest habitat and fragmentation of the remaining area (RODGERS, 1998). Anthropogenic alteration of habitat is therefore affecting whole ecosystems and biota, particularly forest around the equator where hotspots are centred (MYERS et al., 2000). When habitats such as forest undergo fragmentation, remnant patches of the habitat are increasingly isolated in a matrix of altered and often heavily used lands (GROOMBRIDGE, 1992). Habitat loss and fragmentation are major threats to the viability of populations and have been shown to be good predictors of extinction threats in biodiversity hotspots (BROOKS et al., 1999, FERRERAS, 2001). Fragmentation of these habitats isolates also small mammal populations (BROOKS et al., 1999). For example, the high degree of anthropogenic forest fragmentation in the Taita Hills, also part of the Eastern Arc Mountains, most likely added to differential extinction (CORDEIRO, 1998).

In this study we define small mammals as non-flying mammals weighing less than 1kg when adult (BARNETT & DULTON, 1995). Small mammals provide food for avian and mammalian predators while, at the same time being important consumers of seeds and herbage. Therefore, small mammals are important contributors to biodiversity of woodland-savannah ecosystem in sub-Saharan Africa and good ecological indicators (LINZEY & KESNER, 1997).

Although many researchers have worked on the overall biodiversity richness of the EAM, little is known on the small mammal diversity of specific forest patches and corridors between them in the Udzungwa Mountains. This paper presents part of a wider study aimed at documenting the animal species found in the Lulanda forest patches and corridor. Our interest was to observe the effect of habitat fragmentation to the diversity of small mammals and the role of corridor rehabilitation on supporting the diversity of forest patches.

METHODS

Study area

The Lulanda forest is located in the southern Udzungwa mountains (5km east of Mufindi Escarpment East Forest Reserve) in two valleys on the edge of the east-facing escarpment from 1480 – 1640 meters above sea level. The forest consists of three forest patches and a corridor between two of them. Fufu forest patch has an area of 89.3 ha (approximately 1000m x 600m), Magwila an area of 82.6 ha (approximately 1100m x 400m), and the corridor linking Fufu and Magwila is 54 hectares. The Tanzania Forest Conservation Group is regenerating the corridor by replanting the indigenous trees in the area that was formerly covered by farmland, and the replanted trees were six years old at the time of the study.

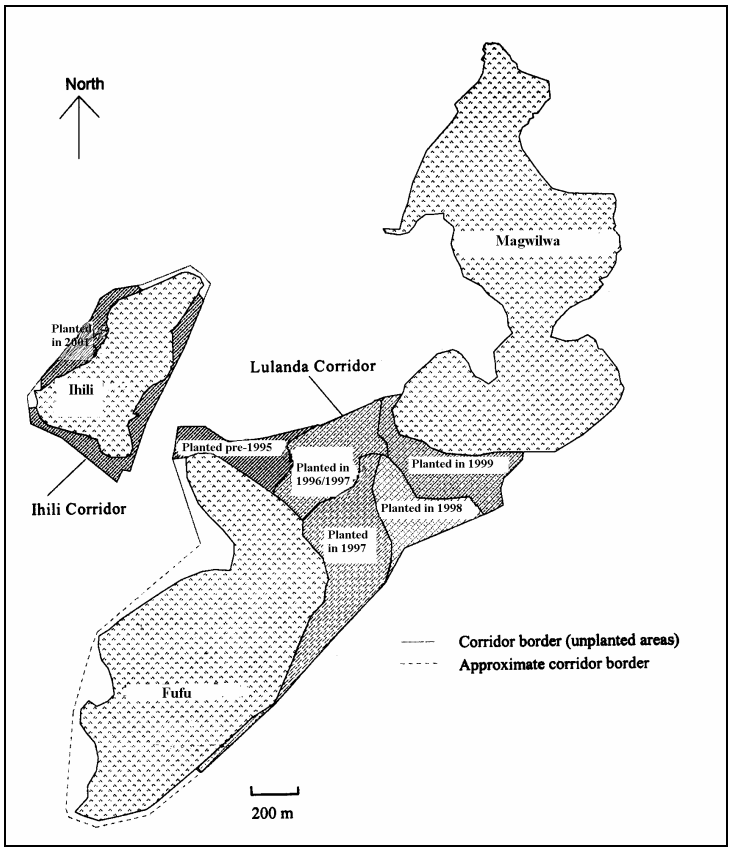

Fig. 1. – A map showing the location of Lulanda forest (after DOODY, 2002)

The forest patches are dominated by *Parinari excelsa* with swampy open areas in valley bottoms. Canopy is up to 30m, intact in parts but generally much disturbed following extraction of timber species in the past (LOVETT & CONGDON, 1990). All areas have undergone disturbances but there is no evidence that the forest patches have ever been completely cleared, so the majority is primary forest. The surrounding habitat is farmland with the major crop being maize. There is encroachment along the edges of the forest for cultivation, and the collection of building poles, firewood and medicinal plants. A footpath through the forest links the village with cultivated areas.

In order to study the effect of habitat fragmentation on the diversity of small mammals, trapping programs were carried out for these animals in two trapping sites in each study area (i.e. Fufu, Magwila and the corridor).

Trapping design

Each trap site (Fufu, Magwila and corridor) consisted of four bucket pit-fall lines running parallel 50m apart following a methodology used by STANLEY et al., (1996). Each line consisted of 10 buckets buried in soil so that the rim was flush with the ground trapping points were 5m apart. A drift fence of clear plastic sheet of approximately 50cm was erected bisecting each bucket along the length of the line. Twenty medium Sherman traps (23 cm x 9.5 cm x 8 cm) were placed at each side of the fence at 5m intervals. The lines were laid out in such away that they minimized a possible edge effect of boundaries between forest, corridor and adjacent cultivated land.

Two prebaiting nights were conducted before the commencement of trapping in order to reduce trap shyness. There was a total of 120 bucket-pit fall trap-nights and 240 Sherman trap-nights. A mixture of peanut butter and maize flour was used as bait. All traps were checked both at dawn and dusk. However traps in the corridor were left closed during the day as it was felt that they were exposed to high temperatures.

For surveying small primates (bushbabies), suitable habitats containing vines and climbers were identified. Three wire mesh traps (30 cm x 30 cm x 45 cm) were placed approximately 1.5m above ground level more than 500m apart. Bananas and bamboo wine were used as bait; bananas were also smeared on surrounding branches and vines. Sixty trap-nights were conducted in two areas (Fufu and Magwila forest patches). The captured mammals were fur clipped for capture-mark-recapture (BARNETT & DUTTON, 1995).

For the purpose of this study we used species richness given by the total number of species occurring in an area and local diversity as expressed by the Shannon-Wiener and Simpson indices (KREBS, 1989).

The Shannon Index (H) is given by,

$$H = -\sum_{i=1}^{s} (P_i)(\ln P_i)$$

Where S= Number of species,

P_i=Proportion of individuals of the total sample belonging to the i^{th} species.

The Simpson index of diversity (D) is equal to the probability that two randomly picked organisms belong to the same species. It is given by :

$$D = 1-\sum_{i=1}^{s} (P_i)^2$$

where P_i = Proportion of individuals belonging to the i^{th} species in the community.

The index of similarity between areas was calculated as 2z/(x+y), where x and y are the number of species occurring in each patch and z the number of species occurring in both patches.

RESULTS

A total of 45 small mammals were caught in bucket pit falls, 124 in Sherman traps and 8 in bushbaby traps (tables1-3). Mammals caught were from 10 genera (seven rodents, two insectivores and one primate). Exact species identification was not possible since the animals were released after trapping. The most commonly trapped mammal in both forest patches was *Praomys sp*, with about 49.5% of all individuals recorded. However, only one individual of this species was trapped in the corridor. *Mus sp.* was the most encountered genus in the corridor accounting for 42.1% of individuals trapped in the corridor. *Grammomys sp.* and *Crocidura sp.* were also represented in higher numbers (36.8%) within the corridor; *Grammomys sp.* was not recorded at all in either forest patch. Certain genera were caught only in the forest patches, including *Hylomyscus* and *Beamys sp.*. Two *Beamys* were caught in bushbaby traps (one in Fufu, one in Magwila) and one in Sherman trap in Magwila. 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. Six Grant's galago (*Galagoides grantii*) were trapped in the Fufu forest patch in the wire mesh traps and none in the Magwila forest patch (however they were excluded in diversity indices calculations since they are at the upper weight level of what should be considered small mammals.

In terms of local species richness, Magwila was the highest in richness with seven species followed by both Fufu and the corridor with six species each. The Shannon Index of the three sites were : 2.145, 1.421 and 1.275 for the corridor, Fufu and Magwila respectively. The highest dominance/Simpson index was found in the corridor (D=0.731) followed by Fufu forest patch (D=0.42). The lowest dominance index was recorded in the Magwila forest patch (D=0.369). The obtained similarity indices were between corridor and Fufu 0.667, between the corridor and Magwila 0.769 and between Fufu and Magwila 0.769.

TABLE 1

Captures of small mammals in pitfall, by genus and site.

Genera	Corridor	Fufu	Magwila
Dendromus	7	0	3
Crocidura	9	6	4
Mus	3	5	4
Praomys	0	2	2
Lophuromys	0	0	0

TABLE 2

Captures of small mammals in Sherman traps, by genus and site.

Genus	Corridor	Fufu forest	Magwila
Dendromus	0	0	0
Crocidura	12	0	0
Mus	21	1	0
Praomys	1	69	37
Lophuromys	4	10	8
Grammomys	10	0	0
Hylomyscus	0	5	0
Beamys	0	0	1

TABLE 3

Captures of small mammals in bushbaby traps, by genus and site.

Genus	Fufu	Magwila
Galagoides	6	0
Beamys	1	1

DISCUSSION

The TFCG corridor regeneration program is expected to have 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 community. Although five mammal genera were represented in both the forest and the corridor, the genera composition of the corridor differed from that of the forest patches. *Praomys* appeared to be the dominant small mammal genus in both forest patches, in contrast to the corridor where *Praomys* was only caught once and there were no other apparent dominant genera. Several species were met in only one of the forest patches (e.g. *Hylomyscus* sp., *Galagoides grantii*) and it is possible that fragmentation still blocked the migration route for this species from Fufu to Magwila, e.g. because of the arboreal life of the bushbabies.

The Shannon indices suggested that the corridor is more diverse followed by Fufu then Magwila forest patches. The inverse results between species richness and diversity is attributed to the fact that species diversity considers both richness and evenness of species in a particular area. The Simpson index of diversity (D) measures the distribution of the individuals among the species in a community (MALIMBWI et al., 1998). Magwila, which had the highest number of species, is the least when consider-

ing species dominance; this is attributed to the imbalances in species distribution/species evenness.

The three sites show fairly high similarity indices among them, perhaps because of the relatively small area over which the study was carried out.

Our findings suggest that the corridor is in the early stages of succession when compared to the rather climax communities of the forest patches. Similar studies needs to be carried out periodically in the study area and in other parts of the eastern arc mountains, paying attention also to agricultural and settled areas surrounding the remaining forests, so as to come out with the effect of habitat fragmentation on the diversity of small mammals in the entire archipelago.

ACKNOWLEDGEMENT

The authors are most grateful to the University of Newcastle Expedition Council for organizing and funding the expedition, Tanzania Forest Conservation Group (TFCG) for providing equipments, accommodation, the village of Lulanda, Pest Management Centre for providing trapping techniques. We are grateful to Mr. E.K. Msyani of CAWM, Dr. L. Mulungu and Richard Odhiambo of SUA for reviewing this paper and also for their valuable suggestions. Numerous other individuals and institutions are responsible for the success of this paper. We thank them all and hope we have not misinterpreted them.

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