VARIATION OF SMALL MAMMAL POPULATIONS ACROSS DIFFERENT HABITAT TYPES IN THE SERENGETI ECOSYSTEM.

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ABSTRACT

This study investigated the abundance and diversity of small mammals in cultivated land (unprotected area) and wooded grassland in the Serengeti National Park (protected area) in the Serengeti ecosystem. Small mammal populations were sampled through capture-mark-recapture trapping techniques in March-April 2010. A total of 896 trap nights covering wet season, 9 species of rodents and 1 species of soricomorphs (shrew family) were captured. Overall, Multimammate rat Mastomys natalensis (Smith) was by far the most abundant rodent in cultivated land (28%) while inside the park, shrew Crocidura sp., was high in numbers (8%). A significantly higher abundance (trap success) of small mammals was obtained in the cultivated area compared to the national park (p < 0.01). There was also a significant difference in the two diversity indices between the cultivated areas (H′ = 0.84) and national park (H′= 0.57) (p < 0.01). The differences are probably habitat related i.e. types of crops cultivated in agricultural fields that might have attracted small mammals. There was moderately high similarity in the number of species caught in the two sites (Sørensen Coefficient (CCs) = 0.57), indicating that species composition did not vary significantly between the two sites with different conservation status. Overall high abundance and diversity in the cultivated areas may have resulted from the availability of food materials to granivorous small mammals which were majority. This high abundance and diversity outside the national park raises doubt as to whether the protected areas can still be considered as the most feasible approach of ensuring small mammals protection.

Key words: agriculture, habitat, small mammals, Serengeti

INTRODUCTION

The Serengeti ecosystem is characterized by a broad spectrum of niche diversity and harbours a large number of both large and small mammals (Kingdon 1974). Protected areas have long been considered to be the most feasible approach of ensuring that biodiversity is protected (Chape et al. 2003). Nevertheless, preserving the world's natural wildlife is a huge challenge today, considering the growth rate of the human population and degradation of natural habitats (Sinclair 1995, Pelkey et al. 2000). In recent years, the human population has increased significantly in areas adjacent to protected areas and hence caused pressure on the wildlife (Caro 1999, Herremanns 1998, Loibooki et al. 2002, Kideghesho 2006). It is commonly assumed that opportunistic species, particularly pests, such as some small mammals, would increase with increasing agricultural activities and deteriorating habitat conditions, whereas specialised non pest species would decrease (Primack 1993, Meffe and Carroll 1997). A pest is a destructive animal that attacks crops, food, livestock etc. However, overabundant mammalian pests might play important ecological roles (Delibes-Mateos et al.

2011). Therefore, understanding the abundance and diversity of small mammals as influenced by factors such as food availability is important (Bennett 1986). Other factors that influence small mammals parameters include patterns of cultivation (Christensen 1996), vegetation structure and thickness, and grazing pattern (Rowe-rowe and Lowry 1982, Bowland and Perrin 1993).

In Tanzania, various anthropogenic activities, such as livestock keeping, mining and cultivation, take place outside protected areas, whereas inside national parks, no human settlement or activity is allowed. In Serengeti National Park only non-consumptive uses of the resources are allowed, such as ecotourism and photographic tourism. Studies on the influence of conservation status on the population parameters of the small mammals have been conducted in the southern Tanzania (Caro 2002) and the western Serengeti (Magige and Senzota 2006), but a comparative study of the same kind has not been conducted in the northern part of the Serengeti Ecosystem in Tanzania.

Cultivated areas outside the park and areas inside the park are likely to show differences in species' population parameters, such as ecological processes, composition and abundances. Because anthropogenic factors usually damage habitat integrity and persistence of species, this study aims at comparing the abundance and diversity of small mammals between the wooded grassland in the Serengeti National Park and the nearby cultivated areas outside the park and determining the similarity index between the how similar the small mammal communities in the two habitats were. I hypothesised that there will be a higher abundance and diversity of small mammals outside the national park, due to habitat heterogeneity.

METHODS

Study area

The study was carried out during the beginning of wet season, from March to April 2010 in the northern part of the Serengeti ecosystem i.e. in the cultivated land (unprotected area) of the two adjacent villages (Gibaso and Nyansurura) that are bordering the park to the north-west and in the woodlands (acacia savannah woodland) of the Serengeti National Park (protected area) (Figure 1). The selection of the villages based on the closeness of the villages to the park, while locations inside the park were chosen by considering the nature of the vegetation i.e. woodland and distance from the boarder to avoid agricultural activities influence. Wooded grassland habitat was chosen because the habitat hosts a higher number of small mammals than the non-wooded grasslands (Magige 2013, Mulungu et al. 2008, Salvatori et al. 2001). The distance between Gibaso and Nyansurura is 11.5 km whereas that of the two locations in the national park is 11.7 km with approximately 80 km from the locations in the cultivated areas to national park locations.

The climate in the ecosystem is usually warm and dry, with mean temperatures varying between 15°C to 25°C. The rains in the Serengeti ecosystem fall in a bimodal pattern, the short rainy season between November and January and the long heavy rainy season between March and May (Norton-Griffiths et al. 1975). Rains increase westwards towards Lake Victoria (Sinclair 1995). There is an overall rainfall gradient from the dry south-eastern plains (800 mm per year) to the wet north-western area (1,050 mm per year) of Serengeti National Park (Campbell and Hofer 1995).

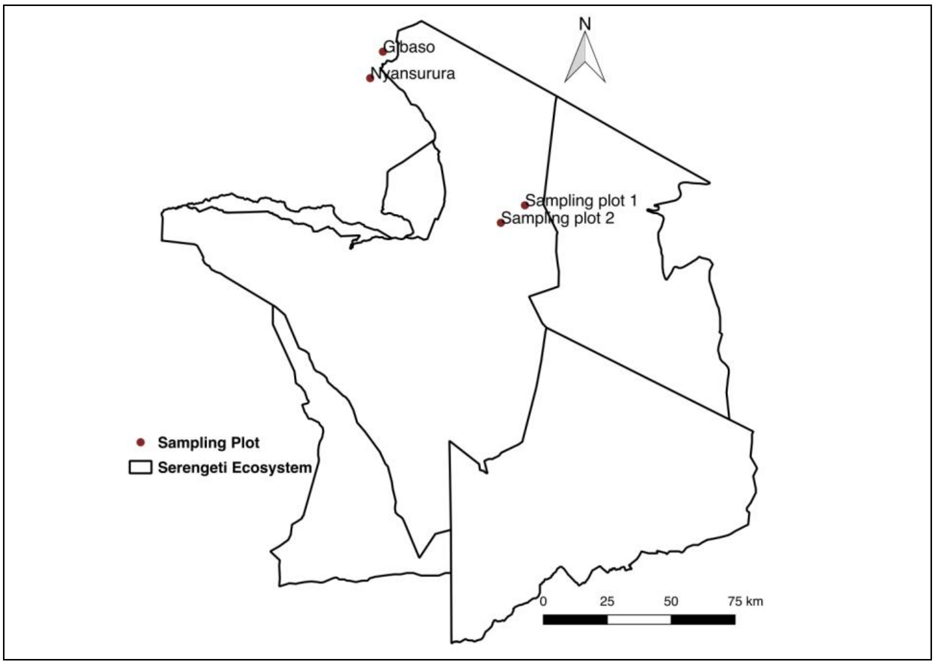

Figure 1: Map of the Serengeti ecosystem showing the location of the study area and the trapping locations both outside and inside the protected area, Tanzania.

The vegetation of the studied area is composed of highland savannah with mainly thorny woodland trees of *Acacia*, *Commiphora*, *Ficus*, *Combretum* and *Podocarpus*, and extensive grass plains (Herlocker 1976). The Western Area, which extends up to the edges of Lake Victoria, is generally a region of wooded grassland and woodlands dominated by *Acacia* species interspersed with open grasslands (Herlocker 1976). Various anthropogenic activities occur outside Serengeti National Park, including mining, logging and cultivation. People surrounding the park are largely subsistence farmers (Loibooki et al. 2002, Kaltenborn et al. 2005) where crops, such as maize (*Zea mays*), cassava (*Manihot esculenta*), finger millet (*Eleusine coracana*), beans (*Phaseolus vulgaris*) and sorghum (*Sorghum bicolor*) are commonly grown. Availability of agricultural land adjacent to protected areas has also been attracting immigrants from nearby regions (Campbell and Hofer 1995).

Trapping

Small mammals are all mammal species, whose weight or size is less than a hare (3-5 kg) (Stoddart 1979, Gaines and McClenaghan Jr. 1980), however this study included small mammal species weighing less than 500 g. Within this boundary, there is a range of species that include shrews, moles, rats, mice, lemmings, gerbils, dormice and many squirrels (Delany 1974).

The type of trap, size, number of traps, location of traps and capture technique affect the species composition of trapped rodents due to trap selectivity (Pucek 1969, Sejoe et al. 2002). Therefore, four types of traps were used to maximize capture; (1) Sherman’s live traps (230 x 95 x 80 mm, H. B. Sherman’s Traps, Inc., Tallahassee, FL, U.S.A.), (2) tomahawks, (3), wire mesh trap and (4) pitfall traps. Wire mesh traps consist of an oval frame of steel wire with wires stretched around it. Wire mesh is wrapped around the frame, tapering into the inside of the trap. Once an animal has got into the trap, it cannot come out as the opening bends back into its original narrowness. Additional details on trap description are given by Stanley et al. (2011).

Trapping was conducted in March and April 2010. A total of four sampling plots were established both outside and inside the park, where two plots were set outside the park (one in Gibaso village and another in Nyansurura village) and the other two plots were set inside the park in the two selected locations (Sampling plot 1 and Sampling plot 2) (Figure 1). Trap lines consisted of 35 Sherman traps that were set in a grid system and spaced at 10 m. Pitfall lines were intentionally set to capture shrews. Each pitfall line contained 11 buckets that were spaced by 5 m and buried in the ground with the top of the bucket flush with the ground. The 7 wire mesh traps and 3 tomahawks were placed randomly, especially in areas where rodent trails were seen. Bait for the Sherman's live, tomahawk, and wire mesh traps included a mixture of peanut butter, sardines and fried pieces of coconut to attract a wide array of small mammals (Woodman et al. 1996). Traps were left open and were checked and re-baited each morning for four consecutive trap nights. In each sampling plot, 35 Sherman's traps, 11 pitfall traps (with a drift fence), were set.

Captured individuals were identified following the established taxonomic nomenclature (Kingdon 1974, 1997), marked by toe clipping and then released at the point of capture. A few specimens were taken as voucher specimens. Trap stations were marked with red or white flagging tape for ease of relocation during subsequent visits.

Data analysis

Trap success (number of animals caught per 100 trap nights) was used as an index of the relative abundance of the captured species (Stanley et al. 1996, Barnett et al. 2002).

*Trap success (TS%) = Tc / Tn * 100*, where Tc = Total catch = the total number of animals of species *i* caught and Tn = Trap nights = a product of the number of traps used and trapping effort.

Trapping effort = number of nights of trapping. A trap in use for a 24-hour period from sunrise to sunrise is referred to as a trap night.

Because the sample size was small, nonparametric Mann Whitney U test was used to compare the relative abundances (trap successes) of small mammal species. SPSS 14 (SPSS 2005) was used for the analysis. The level of significance was set at 0.05.

Diversity indices for the rodents were determined by Shannon–Weiner diversity indices (Shannon and Weaver 1948) by using the following formula:

$H' = -\Sigma(pi)(\ln Pi)$ where, H' is the diversity index and pi is the proportion of total sample belonging to the *i*th species.

Sørensen Coefficient (CCs) was used to determine the similarity of small mammal species between the agricultural habitat and the wooded grassland (Brower et al. 1990, Wolda 1981).

CCs = $CCs=2c/(S_1+S_2)$, where S_1 and S_2 are the number of species in wooded grassland habitat and agricultural habitat, respectively, and *C* is the number of species shared by the two sites. The similarity index (CCs) ranges from 0 (when no species are found in both sites) to 1.0 (when all species are found in both sites).

RESULTS

A total of 74 individual small mammals comprising 10 species were trapped and identified in the study areas during 896 trap nights of trapping effort (448 trap nights in each study area i.e. outside and inside the protected area). Nine (9) species of rodents and 1 species of soricomorphs (shrew family) were captured where only four species of small mammals were trapped inside Serengeti National Park, *Crocidura* sp., *Graphiurus murinus*, *Mastomys natalensis* and *Mus Minutoides*, compared to 10 species trapped outside the park (Table 1). A significantly greater number of species, measured in terms of trap success (Table 1), were caught in the cultivated land than in the wooded grassland of the Serengeti National Park (MWU= 143.5, n_1 = 13, n_2 =34, p = 0.026). Overall, *Mastomys natalensis* (Multimammate Rat) was the most abundant rodent (28%) followed by *Aethomys kaiseri* (12%) outside the national park, while inside the park, *Crocidura* sp. was high in numbers (8%) of the total capture (Figure 2). There was a significantly higher diversity of small mammals in the cultivated land ($H'_{unprotected}$ = 0.84) than inside the national park ($H'_{protected}$ = 0.57) (t= -4.25, df = 41, p = 0.0001). The Sørensen Coefficient (CCs) was 0.57, revealed a moderately high similarity in the number of species trapped in the two sites.

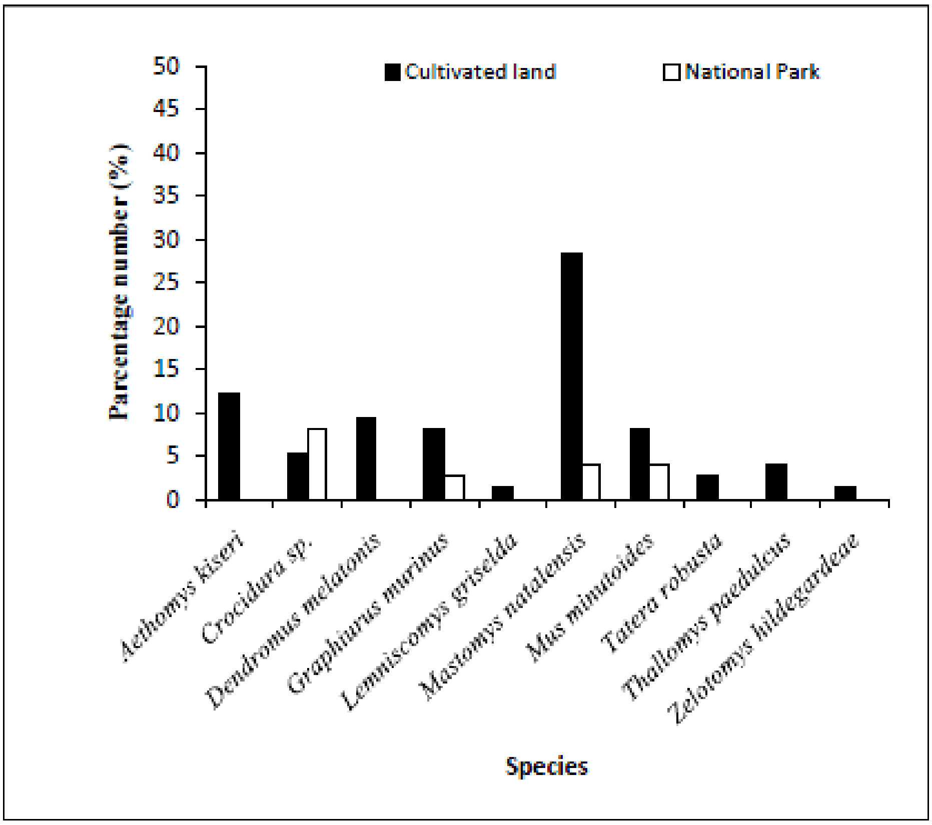

Figure 2: Percentage number of small mammals in the cultivated land (unprotected area) and Serengeti National Park (protected area), Serengeti ecosystem, Tanzania.

DISCUSSION

Ten species of small mammals were trapped in this study. This may not be an exhaustive list of the species in the area, but it probably indicates the common species of the small mammals in the Northern Serengeti ecosystem. Cultivated land was found to be suitable for most of the species recorded and harboured a great number of individuals (Table 1). *Mastomys natalensis* was the most commonly trapped rodent in the cultivated land whereas in the national park, *Crocidura* sp. was the frequently trapped species. Presence of large number of *M. natalensis* in the cultivated areas agrees with Christensen (1996), who reported a similar finding in the cultivated areas. The higher abundance of *M. natalensis* in the cultivated land than in the national park is an indication that this species is common in the agricultural areas. The species feeds on seeds, fruits, invertebrates and house debris. Since the study was conducted during post harvesting period, presence of cereal crop grains (such as maize, finger millet and sorghum) on the farms might have attracted a large number of these granivorous species. The data also suggest that four species, i.e., *Crocidura* sp., *M. natalensis*, *M. minutoides* and *G. murinus*, have the wide range of habitat among the species captured, as they were recorded in both sites.

As hypothesised, the results show that the abundance and diversity of small mammal species was significantly higher in the agricultural land than in Serengeti National Park. The results support the results of Happold and Happold (1997), Caro (2002) and Lema (2012). Most of the captured small mammals were murids which are granivorous and since harvesting had just ended, there were several in the cultivated area as compared to the national park. Like other animals, small mammals must obtain an adequate food supply (Caro 2002) and escape predators to survive and reproduce (Mugatha 2002). Therefore, several species of small mammals might coexist in croplands outside the protected area where there is presence of several microhabitats and abundant food resources (Caro 2002, Kasangaki et al. 2003, Mugatha 2002, Nel 1978). In addition, small mammals might be avoiding competition from the herbivores inside the protected areas (Keesing 1998). Nevertheless, there was a relatively high similarity of species between the cropland and national park, indicating that both sites have some species in common.

CONCLUSION

The trapping survey found 10 species of small mammals where there was higher abundance and diversity of small mammals outside than inside the national park implying that agricultural areas support a large number of various small mammals especially the rodents. In addition, most captured small mammals in the cultivated areas were granivorous except *Graphiurus* sp. and *Crocidura* sp. Therefore, the high abundance and diversity in the cultivated land could be attributed to the presence of grains during post-harvesting. Multiple land use, which allows various anthropogenic activities including agriculture, outside the protected areas provides high protection to small mammals than protected areas as it was reported by Caro et al. (1998). However, these cultivated lands are more likely to be limited to granivorous small mammals and unlikely to be so either for habitat specialists or for arboreal species (*e.g. Graphiurus* species). Further trapping is required that will include the effects of seasonality and microhabitats on small mammals.

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