A SURVEY OF SMALL MAMMALS IN THE KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY BOTANICAL GARDEN AND FACULTY OF RENEWABLE NATURAL RESOURCES FARM

[*1]Oduro, W and [2]Anti, P
Department of Wildlife and Range Management,
Kwame Nkrumah University of Science and Technology, Kumasi, Ghana
E-mail: williamoduro@yahoo.co.uk; priscilla.anti@gmail.com

ABSTRACT

There are no records of small mammal fauna on the Kwame Nkrumah University of Science and Technology (KNUST) campus in Kumasi, Ghana since its establishment sixty three years ago. Since then the land cover has been replaced with buildings, roads and farmlands. Nevertheless, small patches of the land before construction are left. It is important to have records of what is left to ensure protection. The study was undertaken in the KNUST Botanical Garden (natural) and Faculty of Renewable Natural Resources Farm (anthropised) within the Moist Semi-deciduous vegetation zone of the Ashanti Region of Ghana, to identify the small mammal (rodent) fauna in these areas and also to compare their species richness, diversity and relative abundance. Sherman live traps were used in the capture of small mammals and identification of captured specimens was carried out by estimating their standard morphometric measurements. Species richness and diversity were determined using standard diversity indices. Overall, 13 individuals representing four species of the Family Muridae were caught in 720 trap-nights namely; Typical spotted grass mouse - *Lemniscomys striatus* (three); Rusty-bellied rat - *Lophuromys sikapusi* (six), which was the commonest species encountered with a total of five captures in the farm and one in the garden; Multimammate rat - *Mastomys natalensis* (two) and Soft-furred mouse - *Praomys tullbergi* (two). The Farm possessed a higher Shannon's diversity index (0.447) than the Botanical garden (0.276). It also recorded the highest captures (10) and larger relative abundance (2.88) with the Botanical garden registering the least-(three) and 0.82 respectively. However, using the Mann Whitney U test, there was no significant difference between the Farm and Botanical Garden in terms of small mammal capture at $p>0.05$. This survey establishes a preliminary list of some small mammals in KNUST.

Keywords: Small Mammals, Morphometric Measurement, Species Abundance and Diversity

INTRODUCTION

Konecny *et al.* (2008) stated that extensive agricultural activities cause substantial changes in natural environments in tropical regions; whereas, efforts to protect indigenous species often are dependent on the knowledge of which species are present and also basic information about their habitat requirements, numbers and distribution (Animal care and use committee, 1998). Therefore determining which animal species are present in an area is vital to understanding how ecosystems function and to appreciate the role and importance of biodiversity to human societies. Small terrestrial mammals (especially rodents) seem to be capable of inhabiting both types of habitats, anthropised and natural. Therefore they represent good model species to study changes.

Small mammals have a very low status among wildlife enthusiasts, particularly when compared to other large fauna and the abundant avifauna found in the tropics. They are commonly regarded as pests, often associated in damage to crops and accused of transmitting diseases. While such problems certainly exist, they involve only a handful of species of rodents. Therefore, considering that they constitute nearly half of all mammals about 47% (Barnett and Dutton, 1995); their conservation should be a major component of conservation efforts.

The KNUST Botanical Garden and Faculty of Renewable Natural Resource (FRNR) Farm though recognized to be floristically rich, lack up-to-date data on their fauna especially small mammals. In fact there are no records of small mammal species on KNUST campus since its establishment sixty three years ago. Since then the land cover has been replaced with buildings, roads and farmlands. Nevertheless, small patches of the land before construction are left. It is believed that the gradual encroachment and modification on small mammal habitats also has significant effect on their composition and distribution. It is therefore important to have records of what is left to ensure protection, increase our current knowledge on the biology of these fauna and also to enhance our understanding of the significance of their relationships in time, space, within and among species, and with other components of the biotic and abiotic environment. McCullough *et al.* (2005) highlighted that surveys on the current small mammal distributions throughout Ghana are urgently needed. Knowledge gained from this survey will provide a basis for careful decisions regarding the welfare and survival of these fauna and other ecologically associated species. Also, governments in developing countries hardly fund research in ecology, so basic information contributes significantly to management of wildlife.

This study is generally aimed at identifying the small mammals in the KNUST Botanical Garden and FRNR Farm as well as comparing their species richness, diversity and abundance.

MATERIALS AND METHOD

Data Analysis

- Species richness and diversity were calculated using the Shannon-Wiener and Simpson's indices of diversity in the software package BioDiversity Pro (version 2.0)
- The relative abundance (number of individuals of a particular species per 100 trap-nights) of the captured small mammal species in both areas was estimated as follows:

$$Relative\ Abundance\ (RA) = \frac{Number\ of\ Individuals\ captured}{Number\ of\ Trap\ Nights\ (TN)} \times 100$$

  Where one trap night = one trap set for one night.
- In order to standardize data for the sites sampled so that productivity of habitats were compared, trap success (the number of animals per 100 trap nights) was calculated (Webala *et al.*,2006) from the expression:

$$Trap\ success = \frac{Total\ catch}{Trap\ Nights} \times 100$$

- Similarity between sites was determined using Sorensen's similarity index:

$\beta = \frac{2c}{A+B}$, where β is the similarity index, A the total no. of species recorded in farm, B the total no. of species recorded in the botanical garden and c the no. of species common to both.

- Statistical analyses were done with Minitab computer package (version 13.32), using the Mann-Whitney U Test with a critical value set at 5%.

SAMPLING SITES AND DESIGN

The Botanical Garden and the FRNR Farm are both located in the Kwame Nkrumah University of Science and Technology, Kumasi the capital town of Ashanti Region, Ghana. Both have total areas of approximately 12.9 ha and 4.9 ha respectively.

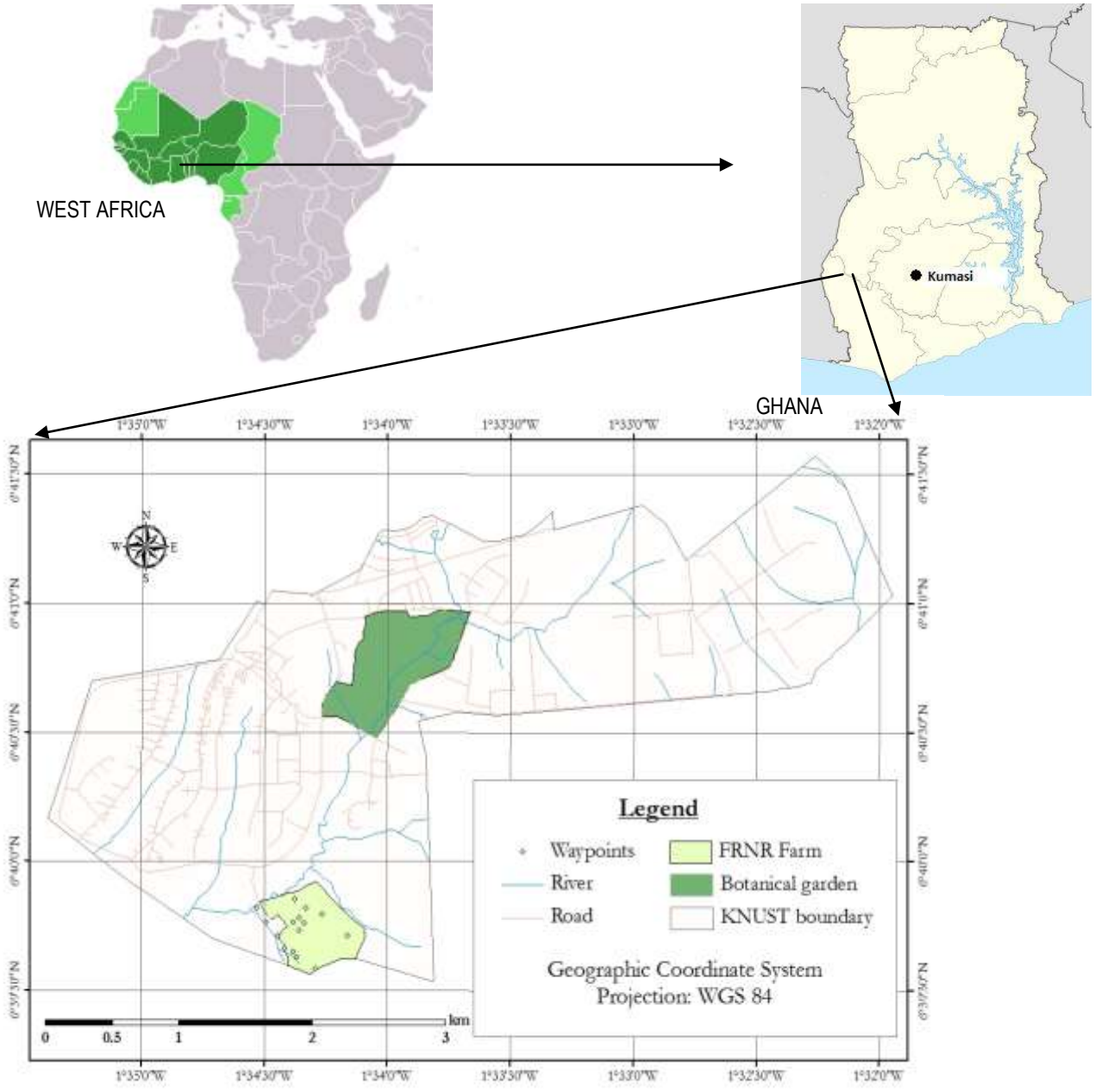

Figure I: Map of study area

Small mammals were captured using Sherman live traps (H.B. Sherman Inc 3731 Peddie Drive Tallahassee, FL. 32303 USA) measuring 23cm × 9cm × 7.5cm, baited with a mixture of groundnut paste and maize meal. In both areas three 50 m transects, each with 5 trap stations (2 traps per station) at a minimum of 10 m spacing were laid (Biodiversity Inventory Methods, 1998). Two distinct sites are easily recognizable in the garden: a developed site and an undeveloped site (about one-third approximately 4.3 ha of the entire garden) which for the purpose of this study was sampled. Three sites (ranging from 0.4 – 0.8 ha) in the farm comprising a secondary forest, agroforestry (*Carapa procera)* woodlot and an oil palm plantation were sampled.

A pre-baiting period of three days preceded actual trapping. This is a period of one to several days where traps are baited locked open to enable animals familiarize themselves with the new objects (traps). Traps were finally set in the evening of the last day of the pre-baiting period and visited twice daily that is before sunrise and late in the afternoon (Barnett and Dutton, 1995). Trapping lasted for three consecutive nights for each trapping session (Manley *et al,* 2002 unpublished). In all, four trapping sessions were conducted in each area.

Captured animals were euthanized with chloroform; according to the American Society of Mammalogy Animal Care and Use Committee (1998) guidelines and identified using key references for small mammal taxonomy and identification by Rosevear (1969) and Kingdon (1997). Standard morphometric measurements; body, tail, ear, and hind foot lengths were measured to the nearest mm for the purpose of identification, and weight measured to the nearest 0.5g. Captured individuals were marked using non-toxic permanent marker and released for all eight trapping sessions (720 trap-nights). Sampling was conducted from December, 2009 to February, 2010.

RESULTS

Distribution of Small Mammals captured within sites

Overall, 13 individuals representing four species of the family Muridae were captured in 720 trap-nights during the study. All the species recorded are listed as Least Concern in the IUCN Red List of Threatened Species (2010) in view of their wide distribution, presumed large population, occurrence in a number of protected areas, tolerance of habitat modification and also because they are unlikely to be declining fast. Table I gives trapping results per trapping site. It is noted that all the species captured in the farm were recorded in only the Oil palm plantation.

Trap success refers to the number of animals trapped per 100 trap nights. It gives an indication of the productivity of the habitats sampled in that the higher the trap success the higher the productivity of a given habitat (Webala *et al*., 2006). Although in this study the overall trapping success was very low at an average of only 1.8% across the two sites sampled, the productivity of the farm was found to be relatively higher in the farm than the botanical garden (Table I).Tables II shows the means of morphometric measurements of small mammal specimens in comparison with related literature.

Table I: Distribution of Small Mammal Species Captured in the FRNR Farm and the Botanical Garden

Family	Subfamily	Genus	Species	Common name	Farm	Botanical garden
Muridae	Murinae	*Lemniscomys (*Linnaeus,1758)	*striatus*	Typical spotted grass mouse	3	-
	Murinae	*Lophuromys* (Temminck, 1853)	*sikapusi*	Rusty-bellied rat	5	1
	Murinae	*Mastomys* (Smith, 1834)	*natalensis*	Multimammate rat	2	-
	Murinae	*Praomys* (Thomas, 1894)	*tullbergi*	Soft-furred mouse	-	2
Total	-	-	-	-	10	3
Trap nights	-	-	-	-	360	360
Trap success (%)	-	-	-	-	2.77	0.83

Table II: Means of Morphometric Measurements of Small Mammal Specimens in this Study and Related Literature

Legend: *n*-total number of specimens

TBL- total body and tail length, from nose-tip to end of tail; TL- tail length, from base of tail at right angles to body to end of tail; HFL- hind foot length, from heel to tip of the longest toe, excluding claw; EL- ear length, from basal notch to distal tip of pinna; WT- weight

	Species	TBL	TL	EL	HF	WT
This study	*L. striatus, n*=3	245	129	15	26	62.3
Attuquayefio *et* al.,(2006) Muni-Pomadze (Ghana)	*n*=19	225 (210-243)	115 (107-130)	15 (12-16)	23 (21-24)	37 (32-48)
This study	*L. sikapusi, n=6*	150.8	65.7	12.7	20	63.2
Rosevear (1969) Various parts of W/A	*n*=20	199 (166-223)	69 (57-83)	17 (15-20)	21.5 (20-23)	-
This study	*P. tullbergi, n*=2	266.5	146.5	20	23	46.3
Rosevear (1969) Various parts of W/A	*n*=24	266 (199-301)	149 (110-166)	17.5 (16-20)	24.5 (22-27)	-
This study	*M. natalensis, n*=2	135	72.5	12.5	15	50

Rosevear (1969) Various parts of W/A	*n*=13	249 (193-290)	117 (97-144)	18.5 (15-17)	24.5 (23-26)	-

Species accumulation and relative abundance

Estimated relative abundance of individual species captured is shown in Figure II; the farm recorded greater relative abundance (2.88) with the Botanical garden registering the least (0.82). Using trapping records, species accumulation rates were examined to estimate the extent to which further trapping would add to the species list and facilitate comparisons of species richness between the sites sampled for any given level of sampling effort (Figure III). The farm recorded the highest number of species per equal number of individuals pooled from a sampled population at any point in time reaching an asymptote. The botanical garden on the other hand failing to reach an asymptote illustrates that the inventory of the small mammal community for that area is far from complete.

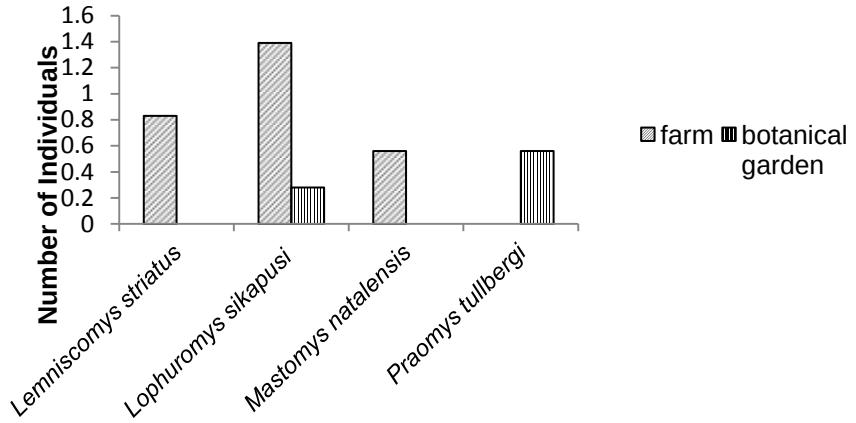

Figure II: Relative Abundance of Small Mammals Captured within the Study Sites

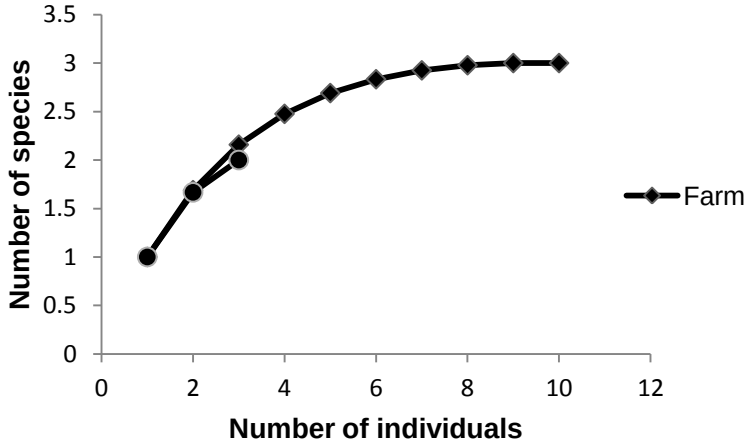

Figure III: Species Accumulation Curve

DIVERSITY AND SIMILARITY OF SMALL MAMMALS CAPTURED WITHIN THE BOTANICAL GARDEN AND FRNR FARM

Alpha diversity, where α is the diversity within a particular area, are presented in Table IV. Simpson's index (D) measures the probability that two individuals selected at random

from a population of (N) individuals will belong to the same species and it varies with heterogeneity, that is, diversity increases as index values decrease and vice versa. The Shannon-Wiener diversity index (H) is used to compare two distinct habitats and combines two quantifiable measures; species richness (number of species within the community) and species evenness (J)- how even the numbers of individual species are. Evenness values indicate how the species are distributed in a community. When the evenness is high, the mammal fauna is diverse and the species are equally abundant, and it increases as index values increase. From the table, both diversity indices show the farm to have higher small mammal diversity than the botanical garden.

Table IV: Diversity of Small Mammals within Study Sites

Index	Farm	Botanical Garden
Shannon(H)	0.447	0.276
Shannon(J)	0.937	0.91
Simpsons Diversity (D)	0.311	0.333
Simpsons Diversity (1/D)	3.214	3

DISCUSSION

Species account within sampled sites

General lack of captures in the Secondary forest and *Carapa procera* woodlot despite their dense canopy cover and lush understory of leaf litter, could be attributed to the low abundance of food (seeds and insects) and presence of potential predators (such as snakes, which were sighted on a few occasions). This also explains the low catch in the Botanical Garden. Greater capture of small mammals in the Farm suggests a higher preference of these habitats by the rodents. This agrees with the observation made by Delany (1971) that disturbed habitats result in a richer rodent fauna without necessarily eliminating any of the typical species. Evans (1974) explained that dense understory of farms compared to the relatively sparse understory vegetation of a mature forest, in this case the botanical garden, has more food and also provides more protective cover and nest sites. Also the numerous thickets and the palm nuts evident in the FRNR farm provide cover and sources of food respectively. This observation corroborates with Amoah *et al*. (1995) who noted that oil palms provide an emergent shading overstory in farms

LOPHUROMYS SIKAPUSI

This species is associated mainly with farmlands (Rosevear, 1969). This observation corresponds with the study in the South-western part of Ghana by Jeffrey (1977) in which *Lophuromys sikapusi* was found to be most abundant in cultivated areas. In addition, insects seem to be more abundant in disturbed areas than mature forest (Evans, 1974). This could partly explain why these insect-eating rodents were more abundant in the farm than the botanical garden. Some of the individuals of this species captured had broken tails. This is a remarkable feature of this species and has been associated mainly due to fighting.

PRAOMYS TULLBERGI

Praomys tullbergi is usually found in farmlands, plantations, gardens and even houses (Rosevear, 1969). However, Happold (1987) observed this species to be rare in cultivated

fields and where grass form the dominant cover but common where there is tree cover. Thus its absence in the farm is not surprising. Barnett *et al.* (2000) also noted that this species is often the most common rodent trapped, but only two were caught in the botanical garden perhaps due to inadequate sampling size.

MASTOMYS NATALENSIS

Members of this genus occur in natural clearings and man-made habitats and avoid closed habitats (Happold 1987). Rosevear (1969) also reports that this species is found in farms especially low scrubby kinds of vegetation and grass but does not appear to inhabit the depths of forest. The two species caught were found in areas of the oil palm plantation where the vegetation was somewhat sparse.

LEMNISCOMYS STRIATUS

This species is mainly associated with grass or low dense herbs (Rosevear, 1969). Jeffrey (1977) also reported this species to be absent from forest habitats but common in cultivated areas. According to Happold (1987) *L. striatus* prefers grasslands with dense undergrowth. A study conducted in Muni-Pomadze in the Volta Region of Ghana showed this species to be abundant in grassland areas (Attuquayefio *et al*., 2006). These agree with the observation made in the farm where all three specimen caught demonstrated such preferences. Though caught within the oil palm plantation, the traps in which they were captured were located very close to grass surrounding the plantation. Of all the different species captured during the period of this survey, only the males of this particular species had distinguished scrotal testes with the female also being pregnant. It would thus appear that they bred during the dry season but this is not conclusive due to the fact that sampling was conducted in the months of December, January and February.

Generally the rodent species recorded in this study are generally non-forest dependent species normally associated with disturbance suggesting that non-forest conditions may exist especially in the botanical garden which is regarded as a forest. It is believed that generalist species may be more widespread in modified habitats as they usually are more common and are less likely to be affected by habitat disturbance or are more likely to re-colonize after a disturbance (Webala *et al.,* 2006).

Higher diversity of small mammals in the Farm however correlates with the study by Jeffrey (1977) in South-western Ghana where small mammal diversity was higher on old farms as compared to the high forest zone. Both areas overlapped by only one species; *Lophuromys sikapusi* which represents an index of 0.4 as calculated using Sorensen's similarity index. This supports slightly, the work done by Yeboah (1984, unpublished) near Koforidua (Eastern Region), who compared rodent populations in a protected sacred grove of a primary forest with those in farmland and reported that both habitat types overlapped by two species; *Praomys tullbergi* and *Lophuromys sikapusi*.

Using the Mann-Whitney U test, there was no significant difference between the FRNR farm and Botanical garden in terms of small mammal abundance. This is because the obtained U value (0.1367) was greater than the critical value of U, for a 0.05 significance level; hence the null hypothesis $H_{0,}$ that no differences occur between individual captures

in both areas sampled is true. This implies that there was insufficient evidence to suggest that small mammals captured differed per equal number of trapping sessions in each sampled area. This could be attributed to sample sizes being too small and also limited number of traps to enable sampling large areas especially in the botanical garden where the fewest number of individuals were caught.

Also the species account indicates that two of the species recorded- *L. sikapusi and P. tullbergi* are known to inhabit a wide range of habitats such as forests, crop fields, and plantations. Therefore the ability of these species captured to survive in such wide range of habitats probably could also explain why the small mammal captures were not significantly different between the sampled sites. Jeffrey (1973) noted that prior to extensive anthropised activities of the African savannah and forest of sub-Saharan Africa, *P. tullbergi* was a forest species while species such as *L. sikapusi* were savannah dwellers with a tolerance for lightly wooded areas. This study thus reflects the dual ability of the *L. sikapusi* to live in both anthropised and natural areas but with greater affinity for agricultural habitats.

No asymptotic plateau apparent at the botanical garden indicates that rodent species by far recorded, may under-represent species present in the area. This may be a result of the temporal factors associated with this and inadequate sampling, but may also indicate relative levels of disturbances within the forest. The study suggests that the botanical garden, despite the effects of some human disturbance around it can serve as a suitable habitat for non-forest and/or forest adapted rodents like the *L. sikapusi* and also can play an important role in ensuring the survival of this species. Decher (1997) has shown that sacred groves are essential for the conservation of small forest mammals in West Africa. Similarly the results highlight the importance of habitats like the botanical garden in the conservation of small mammals in KNUST.

CONCLUSION AND RECOMMENDATION

Despite the fact that the results of this study may be considered preliminary, they make possible a general interpretation of the condition and integrity of both farm and botanical garden. Therefore, proper management efforts should be put in place to reduce the rate of disturbances such as unregulated entry to the farm by some inhabitants of the surrounding communities like Gyenyase and Kotei, who deliberately collect firewood, set traps and even needlessly defecate in the area. Also the rate of social activities like Socializing and Church events especially by the students should be monitored as majority of them leave so much waste haphazardly. These have serious ecological impacts on resident biodiversity and should therefore be discouraged. As only small patches of forest such as the Botanical garden remain on KNUST campus, there is an urgent need for effective protection towards these forest remnants otherwise, only those forest species which are able to persist in secondary habitats like the farm will survive.

It is noteworthy that sampling was conducted as a snapshot (that is during a short period in the dry season) and may have affected the results of this survey. Therefore, an extended study covering the two main seasons of the year is recommended in order to provide more insights into temporal changes in populations, sexual reproduction and other

aspects of life history of these animals. Other habitats such as the arboretum, cassava plots, and bamboo plantation among others at the FRNR farm and other landscapes on campus should be sampled in order to get a more complete picture of small mammal diversity and species richness data. Also more sampling should be carried out especially in the botanical garden which failed to reach an asymptote in terms of species accumulation.

ACKNOWLEDGEMENT

The authors wish to thank the staff members of the Department of Wildlife and Range Management and also the Department of Theoretical and Applied Biology, KNUST, Kumasi, Ghana for granting them access to the Botanical garden. They also express much gratitude to Jan Decher (PhD), Zoologist, Department of Biology, University of Vermont, Burlington, USA for his kind assistance in identification of species captured.

REFERENCES

1. Amoah, F. M., Nuerty, B. N., Baidoo-Addo, K., Oppong, F.K., Osei-Bonsu, K and Asamoah, T.E.O (1995) Underplanting oil palm with cocoa in Ghana. AgroforestrySystems. 30: 289-299. http://orton.catie.ac.cr/repdoc/A3563I/A3563I.PDF

2. Animal Care and Use Committee (1998) Guidelines for the Capture, Handling, and Care of Mammals as Approved by the American Society of Mammalogists. Journal of Mammalogy. American Society of Mammalogists 79 (4): 1416-143 http://www.mammalsociety.org/committees/commanimalcareuse/98acucguidelines.PDF

3. Barnett, A. & Dutton, J. (1995). Expedition Field Techniques: Small Mammals (excluding bats).http://www.rgs.org/go

4. Barnett, A. A., Read, N., Scurlock, J., Low, C., Norris, H and Shapley, R (2000) Ecology of rodent community in agricultural habitats in eastern Sierra Leone: Cocoa groves as forest refugia. Tropical Ecology. International Society for Tropical Ecology 41 (2): 127-142. www.tropecol.com/pdf/open/PDF_41_2/kp41201.pdf

5. Decher, J., D.A. Schlitter and R. Hutterer. (1997). Noteworthy records of small mammals from Ghana with special emphasis on the Accra Plains. Annals of Carnegie Museum 66: 209-227. http://www.carnegiemnh.org/mammals/publications.html

6. Delany, M. J (1971) The biology of small rodents in Mayanja Forest, Uganda. Journal of Zoology (London) 165: 85-129. http://onlinelibrary.wiley.com/doi/10.1111/j.1469-7998.1971.tb02177.x/abstract

7. Evans, H. C (1974) Natural control of arthropods with special reference to ants (Formicidae) by fungi in the tropical high forest of Ghana. Journal of Applied Ecology 11: 37- 49. http://www.jstor.org/stable/2402003

8. Happold, D. C. D (1987) Mammals of Nigeria Oxford University Press, Oxford, pp:402

9. Inventory Methods for Small Mammals: Shrews, Voles, Mice and Rats (1998). Standards for components of British Columbia's Biodiversity, No. 31 pp:43-60 http://www.llbc.leg.bc.ca/public/pubdocs/bcdocs/324475/smlmam.pdf

10. Jeffrey, M. S (1977) Rodent Ecology and Land-use in Western Ghana. Journal of Applied Ecology. British Ecological Society, 14: 741-755. http://www.jstor.org/stable/2402806

11. Kingdon, J (1997) The Kingdon Field Guide to Tropical Mammals London, UK: Academic Press, pp: 281-449.

12. Konecny, A., Bryja, J., Koubek, P., Granjon, L., Ba, K and Duplantier, J (2008) Human impact on biodiversity and abundance of small mammal communities in Sudan savannas of Southeastern Senegal (West Africa). Banquet Hall 3 (14): 30-14:45. http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2028.2009.01169.x/full

13. McCullough, J., Decher, J and Kpelle, G. D (eds.) (2005). A Biological Assessment of the Terrestrial Ecosystems of the Draw River, Boi-Tano, Tano Nimiri and Krokosua Hills forest reserves, southwestern Ghana. RAP Bulletin of Biological Assessment 36. Conservation International, Washington, DC, pp: 57-64.
http://www.conservation.org/Documents/RAP_Reports/RAP36_forest_reserves_SW_Ghana_Oct- 2003.pdf

14. Rosevear, D. R (1969). The Rodents of West Africa. Trustees of the British Museum (Natural History) London, pp: 227-430

15. Webala, P. W., Muriuki, G., Lala, F and Bett, A (2006). The Small Mammal Community of Mukogode Forest, Kenya. African Journal of Ecology. Blackwell Publishing Ltd, 44 (3):363-370. http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2028.2006.00634.x/full

16. Attuquayefio, D. K and Ryan, J. M (2006).Taxonomic Report on Small Mammals from Two Coastal Wetland (Ramsar) Sites in Ghana. West African Journal of Applied Ecology. Ecological Laboratory, University of Ghana, 10:26-35 http://www.wajae.org/papers/papers_vol10/papers10_taxonomic_report_on_small_full.pdf