FACTORS THAT AFFECT DISTRIBUTION OF SMALL MAMMAL COMMUNITIES IN MABIRA CENTRAL FOREST RESERVE (MCFR) AND KIBALE FOREST NATIONAL PARK (KFNP)

Thesis · February 2016

DOI: 10.13140/RG.2.2.14915.14885

5 authors, including:

Sadic Waswa Babyesiza
Sokoine University of Agriculture (SUA)
12 PUBLICATIONS **48** CITATIONS
SEE PROFILE

Robert Martin Kityo
Makerere University
65 PUBLICATIONS **1,614** CITATIONS
SEE PROFILE

Akoth Sisiria
Makerere University
3 PUBLICATIONS **0** CITATIONS
SEE PROFILE

Julian Kerbis
Roosevelt University
159 PUBLICATIONS **2,814** CITATIONS
SEE PROFILE

FACTORS THAT AFFECT DISTRIBUTION OF SMALL MAMMAL COMMUNITIES IN MABIRA CENTRAL FOREST RESERVE (MCFR) AND KIBALE FOREST NATIONAL PARK (KFNP)

Mr. WASWA SADIC BABYESIZA

Makerere University Zoological Museum, Department of zoology entomology and fisheries science
P.O BOX 7062 Kampala Uganda
waswasadic@gmail.com

Dr. ROBERT KITYO
Lecturer Makerere University
Makerere university Museum Curator.
Makerere University College of Natural science, Department of zoology entomology and fisheries science
P.O. Box 7062, Kampala, Uganda
E-mail : kityrob@gmail.com

Professor JULIAN KERBIS PETERHANS
Adjunct Curator Field Museum, Professor Roosevelt University.
Chicago, IL 60605
jkerbis@fieldmuseum.org

Akoth Sisiria

Makerere University Department of zoology entomology and fisheries science
P.O BOX 7062 Kampala Uganda
akocece@gmail.com

Abstract

The study was completed through the use of conventional rodent traps, Pit falls and mist nets, and conducted in different survey areas 4 in MCFR and 2 in KFNP for a period of four months. It was observed that different habitat characteristics significantly influence the distribution of species within the environs of MCFR and KFNP. For example, closed canopy and leaf litter significantly correlated with the distribution of *Crocidura* nov, *Crocidura dolichura*, *Suncus hututsi* and *Sylvisorex johnstoni.* Much as different habitat variables have been assessed and found to influence the distribution of different small mammal species, it should be noted that population size and the factors that affect it, such as food, weather, and predators, could also be important determinant of small mammal distribution.

Introduction

There are numerous environmental factors, which affect the spatial pattern of populations and influence the formation of distinctive distribution patterns, for instance the availability of resources and cover, the risk of predation and other abiotic environmental factors. These factors have mostly heterogeneous spatial distribution, consequently showing mosaic-like pattern (Ims 1995). Understanding the temporal and spatial scales at which organisms perceive and respond to their environment is a central issue in ecology (Wiens 1989).

Multiple environmental and evolutionary factors have been theorised as determinants of species distribution, richness and abundance. These factors may include, at the community level: historical speciation processes; environmental stability and climatic refugia; productivity and heterogeneity of habitat; natural long-term habitat fragmentation or contraction (Williams, 1997). At the species level, differences in biology and ecology of the animal may also be strong predictors of distribution (Williams *et al.*, 2010). Most rainforest species with narrow environmental niches and small geographic ranges, are associated with high local abundance and wide spread distribution (Williams *et al*, 2010).

Factors affecting animal distributions can be categorized depending on their scale. Broad-scale factors incorporate geographical extent of the study, range of forest types within the study area, and richness of the fauna community under study (Hortal *et al.*, 2008).

In particular, the importance of environmental variables on species richness varies with scale; climatic gradients are more important across larger sites, whereas habitat type is of greater significance at smaller site scales for example in the different survey areas in MCFR and KFNP (Hortal *et al.*, 2008). The main objective of this study is to determine the factors that affect the distribution of the different small mammal communities in MCFR and KFNP.

Methods

Small mammals were captured using Sherman live traps, mist nets and pit fall traps, these were set in the various habitat strata i.e. peripheral disturbed habitats, forest edge and forest interior. Habitat characterization was determined by quantitative analysis of presence or absence of certain vegetation characteristics (i.e. proximity to water, open canopy, leaf litter, undergrowth, grass, scrub and closed canopy). This kind of information was recorded for each trapline, netline and bucket-line from which the specimens where collected.

Data analysis

Species ecological preference was assessed using correlation indices function in "R" with multipatt function. This was done with the help of indicator species or species that prefer certain habitats, Indicator species are an important tool for ecological community characterisation, because these species can be used to characterize and indicate specific plant community types. A statistic commonly used to determine the association (also known as "fidelity", not to be confounded with the indicator value component) between species and vegetation types is Pearson's phi coefficient of association (Chytry *et al*., 2002). Permutation tests were then used to test the significance of association.

Ward's hierarchical clustering was used to help in visualizing how different species clade out with respect to the different habitat variables. Ward's minimum variance method aims at finding compact, spherical clusters. The *complete linkage* method finds similar clusters. The *single linkage* method (which is closely related to the minimal spanning tree) adopts a 'friends of friends' clustering strategy.

Results

Factors that influence the distribution of species in MCFR

The rodent species that were captured, were categorized into five groups depending on their habitat preferences *(Table 1)*, this categorization was done using the IndVal index in R statistical package.

Table 1: Association of Rodent species groupings with different habitat Characteristics in MCFR

Groups & habitat characters	**Associated species**
1; Open canopy, closed canopy, leaf litter, proximity to water and under-growth	*Praomys jacksoni, Hylomyscus stella*
2; Household and garden	*Arvicanthis niloticus*
3;Closed canopy, leaf litter and proximity to water	*Hybomys univittatus* and *Praomys misonnei*
4; Closed canopy & proximity to water	*Malacomys longipes*
5; Garden, grass, scrub & under-growth	*Arvicanthis niloticus, Aethomys hindi, Mastomys natalensis, Mus sp, Lophuromys aquilus, Lophuromys sikapusi, Mus musculoides, Protoxerus stangeri, Gerbilliscus validus, Mus triton, Cricetomys emini, Rattus rattus* and *Deomys ferrugenius.*

For rodents, occurrence of *Hylomyscus stella*, *Hybomys univittatus*, *Praomys misonnei* and *Praomys jacksoni* in group 1 and 2 (*Table 2*) was significantly associated with presence of open canopy and leaf litter at P=0.01 and P=0.02 respectively.

A significant association (P=0.005, *Table 2*) was also found for nine species (*Arvicanthis niloticus, Aethomys hindi, Mastomys natalensis, Mus sp, Lophuromys aquilus, Lophuromys sikapusi, Mus musculoides, Protoxerus stangeri,* and *Gerbilliscus validus*) with presence of grass.

Distribution of *Hybomys univittatus, Hylomyscus stella, Praomys misonnei, Malacomys longipes* and *Praomys jacksoni* in group 1, 3 and 4 (Table 2) was significantly affected by proximity to water and closed canopy at P=0.01 and P=0.01 respectively (*Table 2*)

Table 2: Correlation of the three small mammal taxa to the different habitat characteristics in MCFR

	Rodents						Shrews				Bats			
Habitat variables	**G 1**	**G 2**	**G 3**	**G 4**	**G 5**	**P.value**	**G 1**	**G 2**	**G 3**	**P.value**	**G 1**	**G 2**	**G 3**	**P.value**
Open canopy	1	0	0	0	0	0.01	0	1	1	0.4	1	0	1	0.01
closed canopy	1	0	1	1	0	0.01	1	0	0	0.14	1	0	0	0.005
Household	0	1	0	0	0	0.485	0	0	0	0	0	1	0	0.02
Garden	0	1	0	0	1	0.205	0	0	0	0	0	1	0	0.03
Grass	0	0	0	0	1	0.005	0	0	1	0.035				
leaflitter	1	0	1	0	0	0.02	1	0	0	0.055				
Proximity to water	1	0	1	1	0	0.01	0	1	1	0.09				
Scrub	0	0	0	0	1	0.06	0	0	1	0.24				
Undergrowth	1	0	0	0	1	0.28	0	1	0	0.01				

Table 2 represents varying groups of rodents, shrews and bats denoted as "G" and the habitat characters that affect the distribution of species there in, these associations were derived from correlation statistics and the significance tested with permutation tests.

Shrew distribution was analysed against seven habitat characters and categorised into three groups basing on their habitat preferences *(Table 2)*. Group one (G1) species *Crocidura nov, C. dolichura, Suncus hututsi* and *Sylvisorex johnstoni* were associated with closed canopy and leaf litter habitat variables. *Scutisorex somereni, Crocidura sp* and *C. nigrofusca* are group two (G2) species associated with open canopy, proximity to water and undergrowth habitat variables. Group 3 (G3) represents *C. luna* and *C. olivieri* associated with open canopy, grass, proximity to water and scrub habitat variables.

Presence of undergrowth showed significantly affected the distribution of *Scutisorex somereni, Crocidura sp* and *C. nigrofusca* at P=0.01. Grass significantly influenced the distribution of *C. luna* and *C. olivieri* at P=0.035.

Presence of grass and scrub affected the distribution of the species in G3, at P=0.035 and P=0.24 respectively but it is only grass that significantly affects their distribution.

Proximity to water and presence of open canopy affected the distribution of species in G2 and G3 at P=0.09 and P=0.4 respectively (*Table 2*).

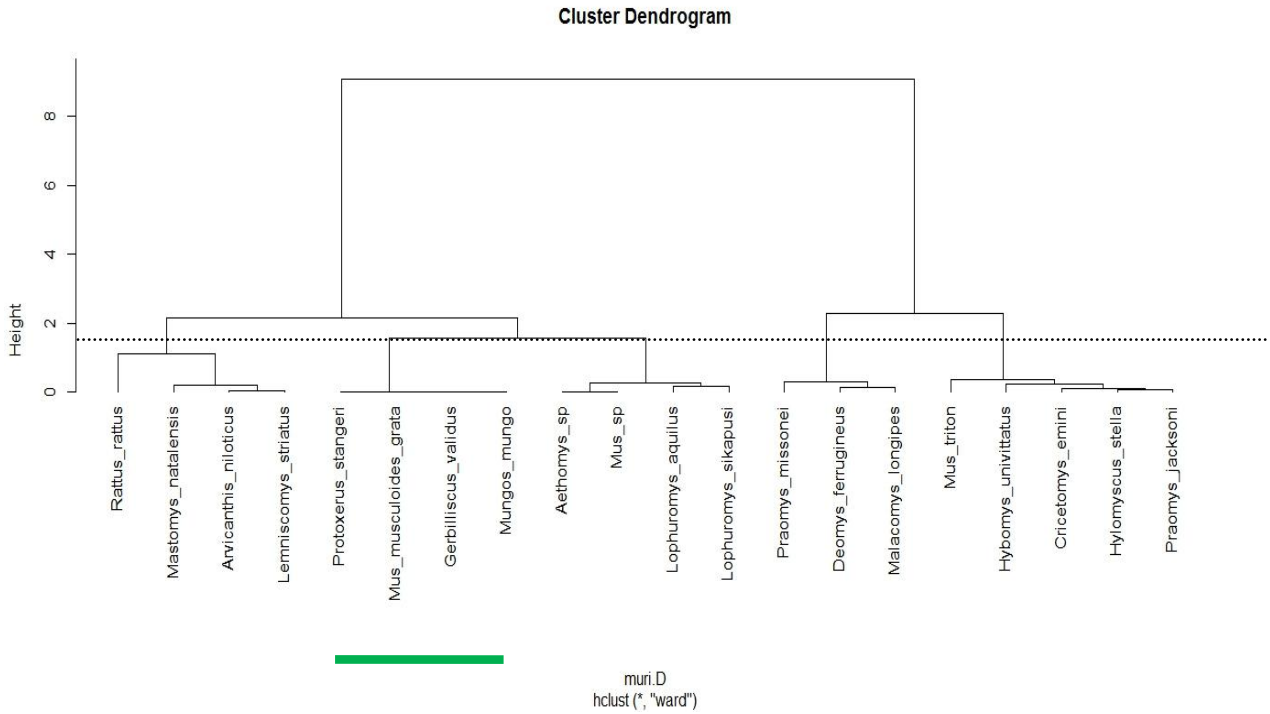

Figure 1: An agglomerative Cluster dendrogram for species and habitat variables influencing their distribution MCFR

Four habitat variables were used to analyse and assess bat species distribution (*Table 2*), and three species groups were created depending on their habitat variable(s) preferences. Group one (G1) representing open canopy and closed canopy habitat variables; and contains *Epomophorus wahlbergi, Megaloglosus woermanni, Epomops franqueti, Hipposideros cyclops, Myonycteris angolensis and Rhinolophus sp*. Group two (G2) representing household and garden habitat variables; and contains *Hipposideros caffer, Chaerephon pumilus, Mops sp and Pipistrellus nannus.* Group three (G3) corresponding with open canopy habitat variable, contained *Nycteris arge, Cassinycteris argynis, Epomophorus labiatus, Hipposideros sp* and *Hipposideros rubber.*
Presence of closed canopy significantly influenced the distribution of species in group one, at P=0.005. Distribution of species in group two was significantly affected by presence of

households and gardens at P=0.02 and P=0.03 respectively. Presence of open canopy also significantly influenced the distribution of species in group one and three at P=0.01.

An agglomerative cluster analysis was used to assess how the algorithm works to group the observations, and then the sub groups of observations (*Figure 1*), the algorithm successfully grouped all the observations. The dotted line represents the automatic truncation, producing five sub groupings. The groups are approximately the same size, but the third group (underlined) is more homogeneous (it is flatter on the dendrogram). This is confirmed when looking at the within-groups habitat influences where it is observed that the other groups have more than one habitat variable that seems to be influencing the distribution of those species.

Factors that influence distribution of species in KFNP

Rodent species were categorized into six groups depending on their habitat preferences using the IndVal index and were analysed for eight habitat characteristics (*Table 3*).

Table 3: Rodent species groupings as a result of association with the different habitat variables in KFNP

Groups	**Species**
1	*Mus sp, Mus triton, Grammomys dolichurus, Mus sp, Mus musculoides* and *Lemniscomys striatus*
2	*Rattus rattus*
3	*Lophuromys aquilus, Lophuromys sikapusi,*
4	*Hybomys lunaris, Praomys jacksoni, Praomys misonnei, Hylomyscus stella*
5	*Funiscirus pyrrhopus*
6	*Colomys gosling, Mus bufo, Otomys sp, Malacomys longipes*

No particular single habitat variable significantly influenced the distribution of a particular group of species. Distribution of *Mus sp, Mus triton, Grammomys dolichurus, Mus sp, Mus musculoides Lophuromys aquilus, Lophuromys sikapusi* and *Lemniscomys striatus* in group one and three was affected by scrub and grass at P=0.04 and 0.065 respectively (*Table 4*); However it was the presence scrub that highly significantly influenced the distribution of species in these groups.

Presence of leaf litter significantly affected the distribution of species in the groups four and five at P=0.005. *Colomys gosling, Mus bufo, Otomys sp, Malacomys longipes, Hybomys lunaris,*

Praomys jacksoni, Praomys misonnei and Hylomyscus stella distribution was affected by presence of closed canopy at P=0.01. Distribution of *Lophuromys aquilus, Lophuromys sikapusi, Hybomys lunaris, Praomys jacksoni, Praomys misonnei, Hylomyscus stella and Funiscirus pyrrhopus* was significantly affected by the presence of open canopy at P=0.005. Proximity to water significantly influenced the distribution of species in groups three, four and six. Presence of other habitat variables like undergrowth and households also influenced the distribution of certain group(s) of species however their influence was not significant (*Table 4*).

Table 4: Correlation of the three small mammal taxa to the different habitat variables in KFNP

	Rodents							Shrews				
Habitat variables	G1	G2	G3	G4	G5	G6	P.value	G1	G2	G3	G4	P.value
Grass	1	0	1	0	0	0	0.065	0	0	0	1	0.12
Open canopy	0	0	1	1	1	0	0.005	0	0	1	1	0.08
closed canopy	0	0	0	1	0	1	0.01	1	1	1	0	0.12
leaflitter	0	0	0	1	1	0	0.005	1	0	1	0	0.17
Proximity to water	0	0	1	1	0	1	0.015	0	1	0	0	0.035
Scrub	1	0	1	0	0	0	0.04	0	0	0	1	0.12
Undergrowth	0	0	1	1	0	0	0.125	0	0	1	1	0.015
Household	0	1	0	0	0	0	0.155					

Shrews were grouped in four groups basing on their habitat preferences; and were analysed for seven habitat characteristics (*Table 4*). Group one (G1) corresponded with closed canopy and leaf liter habitat variables; and contains *Crocidura littoralis*, *Suncus hututsi* and *Scutisorex somereni.* Group two

(G2) represents closed canopy and proximity to water habitat variables; and contained *Crocidura sp, Crocidura luna, C. maurisca* and *Crocidura nov*. Group three (G3) represents open canopy, closed canopy, leaf litter and undergrowth habitat variables; and contained *C. nigrofusca Sylvisorex johnstoni* and *C. dolichura*. Group four (G4) corresponded with grass, open canopy, scrub and under growth habitat variables; and contained *Suncus megalura* and *C. hildegardeae.*

Proximity to water significantly affected the distribution of *Crocidura sp, C. luna, C. maurisca* and *Crocidura nov* at P=0.035. *C. nigrofusca, Sylvisorex johnstoni, C. dolichura* and *Suncus megalura* distribution was significantly affected by the presence of undergrowth at P=0.015. Presence of other habitat variables like open canopy, closed canopy and grass influenced the distribution of some group(s) of species, much as the influence was not significant (*Table 4*).

An agglomerative cluster analysis was used to assess how the algorithm works to group the observations, and then the sub groups of observations (*Figure 2*), the algorithm successfully grouped all the observations. The dotted line represents the automatic truncation; leading to five groups, the group underlined is more homogeneous (it is flatter on the dendrogram). This is confirmed when looking at the within-groups habitat variables influencing distribution where it's revealed that the other groups have more than one habitat variable that seems to be influencing the distribution of those species.

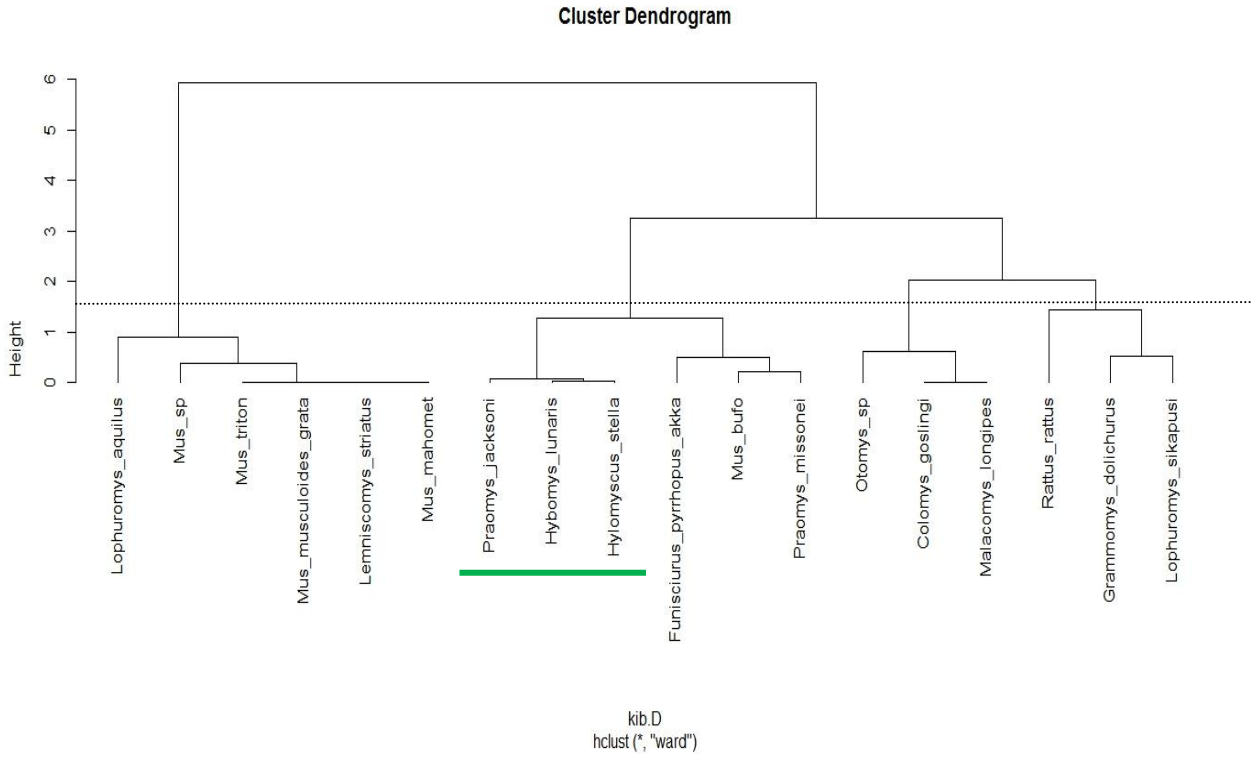

Figure 2: An agglomerative Cluster dendrogram for species and habitat variables influencing their distribution association in KFNP

Very few species of Chiroptera were recorded in KFNP, It should however be noted that the most abundant species (*Epomops franqueti*) was exclusively recorded inside the forest in both closed and open canopy habitat types.

Discussions

The present study examined how different habitat variables influence the distribution of the small mammals of MCFR and KFNP. The study revealed that habitat variables affect the distribution of various species of small mammals. This then implies that some small mammalian fauna are dependent on specific habitat attributes for survival; whenever these attributes are compromised the chance of losing these species becomes eminent. This therefore makes small mammals indicators of ecosystem health since they have specific habitat requirements an observation also made by Bantihun and Bekele (2015).

Different small mammal species occupy different vegetation and or habitat strata, and the factors or combination of factors influencing their distribution differ especially between bats and other small mammal taxa (Rodents and Shrews). Only four habitat variables were found to influence the distribution of bat species, compared to the seven habitat variables that influenced distribution of rodents and shrew species (*Table 2*).

Microhabitat features such as vegetation structure, cover and height, relative humidity, litter depth and foliage height are related to the life form and growth form of plant species within a plant community (Els and Kerley 1996) and affect small mammal distribution (Price 1978); Just as is the case in this study where factors such as presence of grass, leaf litter, scrub, and undergrowth mainly affected distribution of rodents and shrews whereas open canopy and or closed canopy affected distribution of bats mostly.

Distribution of small mammals in any given habitat is influenced by various factors, such as vegetative composition, productivity, resource availability and microhabitat features such as available cover from predators (Nicolas and Colyn, 2003; Garratt *et al*., 2012). These factors in turn, are affected by climatic variability and disturbance regimes such as fire and habitat clearance (Jackson *et al*., 2009). For example in MCFR where most areas around the forest have been severely degraded other habitat variables such as presence of households and gardens significantly influenced the distribution of some bat species (*Table 2*) unlike in KFNP. In

gardens there are more insects which may be coming to pollinate (Jaganmohan 2013**)**, these attract insect eating bats: Furthermore the increased presence of fruit trees in gardens and around households attracts fruit eating bats, which may explain the increased diversity of chiropteran species in the peripheral disturbed habitat types of MCFR compared to those of KFNP

Shrews form a major part of the mammalian diversity in Africa (Hutterer 2005), but their ecology is poorly known. This analyse the various habitat variables that affect the distribution of shrews, and found that various shrew species are influenced by assorted habitat variables depending on the general vegetation cover of the area; that is, different habitat types had different habitat variables which influenced distribution of species characteristic for those habitat types., For example, *Scutisorex somereni, Crocidura sp, Crocidura nov, C. dolichura*, *Suncus hututsi*, *Sylvisorex johnstoni* and *C. nigrofusca,* were all influenced by habitat variables with in the forest., whereas *C. luna* and *C. Olivieri* were influenced by variables outside the forest in the peripheral disturbed habitats. It was also found that presence of undergrowth, proximity to water and leaf litter were the major determinants for *Crocidura sp, C. luna, Scutisorex somereni, C.maurisca, Crocidura nov, C. nigrofusca, Sylvisorex johnstoni and C. dolichura* distribution in all forested parts of the study area. This is consistent with findings of Gambalemoke *et al.,* (2008). Shrew's main diet consists of insects which are very abundant along stream trickles and in leaf litter; given their high metabolic rate, they will mostly be found in places where they can easily locate food. Given their small nature, shrews are prey to most top predators that can accommodate their stinky smell therefore the need for cover which they get from forest undergrowth. It should also be noted that shrews were collected from all habitat types.

Conclusion

An analysis of the factors that affect the distribution of small mammals shows that different habitat variables play a major role in the distribution of species and therefore the need to preserve the heterogeneity of any given habitat. Much as different habitat variables have been assessed and found to influence the distribution of different small mammal species, it should be noted that population size and the factors that affect it, such as food, weather, and predators, could also be important determinant of small mammal distribution (Szaro *et al.,* 1988). All habitat variables recorded influenced the distribution of at least one or more species of rodents hence the high presence of rodent species in the sampled forest. The study has also shown that

modified ecosystems (peripheral disturbed habitats) play a vital role in the ecology of bats, which could explain the higher bat species diversity in MCFR.

References

Bantihun, G & Bekele, A. (2015). Diversity and habitat association of small mammals in Aridtsy forest, Awi Zone, Ethiopia. *Zoological Research* 36(2): 88-94. Science Press.

Chytry, M., Tichy, L., Holt, J. and Botta-Dukat, Z. (2002). Determination of diagnostic species with statistical fidelity measures. *Journal of Vegetation Science*, 13(1):79{90, 2002.

Els, L. M. & Kerley, G.I.H (1996). Biotic and abiotic correlates of small mammal community structure in the Groendal Wilderness Area, Eastern Cape, South Africa. *Koedoe* 39: 121–130.

Gambalemoke, M., Mukinzi, I., Amundala, D., Katuala G.B., Kennis J., Dudu, A., Hutterer, R., Barrie`re, P., Leirs, H & Verheyen, E. (2008). Shrew trap efficiency: experience from primary forests, secondary forests, old fallow lands and old palm plantation in the Congo River basin (Kisangani, Democratic Republic of Congo). Mammalia 72: 203–212.

Garratt, C.G., Minderman, J & Whittingham, M.J. (2012). Should we stay or should we go now? What happens to small mammals when grass is mown, and the implications for birds of prey? Ann. Zool. Fenn. 49: 113-122. http://dx.doi.org/10.5735/086.049.0111

Hutterer, R. (2005). Order Soricidae. In: (D.E. Wilson and D.A.Reeder, eds) *Mammal species of the World: a taxonomic andgeographic reference.* Third Edition, Vol. 1. Johns Hopkins University Press, Baltimore, MD. pp. 220–311.

Jackson, S.T., Betancourt, J.L., Booth, R.K & Gray, S.T (2009). Ecology and the ratchet of events: climate variability, niche dimensions, and species distributions. Proc. Natl. Acad. Sci, 106:19685-19692. http://dx.doi.org/10.1073/pnas.0901644106

Jaganmohan, M., Vailshery, L.S, and Nagendra H (2013). Patterns of insect abundance and distribution in urban domestic gardens in Bangalore, India. *Diversity* 2013, *5*, 767-778;

Hortal, J., Rodríguez, J., Nieto-Díaz, M & Lobo, J.M. (2008). Regional and environmental effects on the species richness of mammal assemblages. *Journal of Biogeography* 35(7), 1202-1214.

Ims R.A. (1995). Movement patterns related to spatial structures. In: Hansson L., L. Fahrig, G. Merriam (eds.): Mosaic Landscapes and Ecological Process. Chapman & Hall, London: 85–109.

Nicolas, V & Colyn, M. (2003). Seasonal variations in population and community structure of small rodents in a tropical forest of Gabon. Can. J. Zool. 81: 1034-1046. http://dx.doi.org/10.1139/z03-092

Price, M.V. (1978). The role of microhabitat in structuring desert rodent communities. Ecology 59: 910–921

Szaro, R.C., L. H. Simons, and S.C. Belfit. (1988). Comparative effectiveness of pitfalls and live- traps in measuring small mammal community structure. Pages 282-288 *in* Management of amphibians, reptiles, and small mammals in North America. R.C. Szaro, K.E.

Wiens J.A., (1989). Spatial scaling in ecology. Functional Ecology 3: 385–397.

Williams, S.E (1997). Patterns of mammalian species richness in the Australian tropical rainforests: are extinctions during historical contractions of the rainforest the primary determinants of current regional patterns in biodiversity?. *Wildlife Research* 24 (5), 513-530.

Williams, S.E., Van-Derwal, J., Isaac J., Shoo, L.P & Storlie C. (2010). Distributions, life-history specialization, and phylogeny of the rain forest vertebrates in the Australian Wet Tropics. Ecology 91: 2493–2493.