SMALL MAMMAL SPECIES DISTRIBUTION AND HABITAT ASSOCIATION AS INFLUENCED BY TEMPERATURE AND RAINFALL IN SOME SELECTED VEGETATION IN UNIVERSITY OF IBADAN PREMISES, SOUTH WESTERN NIGERIA

H. A. BADMUS* AND A. A. ALA

H. A. B.: Department of Crop protection and Environmental Biology, University of Ibadan, Ibadan, Nigeria; A. A. A.: Department of Zoology, University of Ibadan, Ibadan, Nigeria

**Corresponding author's email address: badmus.hafiz@gmail.com*

ABSTRACT

Small mammals play significant roles in the ecological balance or imbalance of a habitat. Although studies have shown their presence at the University of Ibadan (UI), information on their ecological distribution is not well documented. This study was designed to determine small mammal distribution and habitat association in selected vegetation in UI. Six locations within UI were purposively selected and small mammals sampled monthly for 3 consecutive nights between November, 2019 and October, 2021. Each location had twenty live traps set along 100m line transects. Distribution, habitat preference, and percentage trap success were determined using standard methods. Monthly temperature and rainfall data were obtained from International Institute of Tropical Agriculture (IITA), Ibadan. A total of 113 individuals (body-weight: 51.33±3.22-3620.00±0.00g) belonging to 5 families were encountered namely Nesomyidae, Muridae, Thryonomyidae, Sciuridae, and Soricidae. It comprised 8 individual species namely *Cricetomys gambianus*. *Arvicanthis niloticus*, *Rattus rattus*, *R. norvegicus*, *Lemniscomys striatus*, *Thryonomys swinderianus*, *Funisciurus anerythrus*, and *Crocidura olivieri*. Muridae accounted for highest species (4). *Cricetomys gambianus* was the most widely distributed species and habitat generalist. The mean trap success (%) was considerably low (7.85). There was significant variation in the mean morphological parameters of the species when compared with their corresponding standard values ($p < 0.05$). Temperature (28.3-36.2˚C) and rainfall (2.0-24.7mm) influenced the abundance of the small mammal species in the study area.There was low trap success of small mammals in the University of Ibadan. Family Muridae accounted for the highest number of species. *Cricetomys gambianus* was the most widely distributed species and habitat generalist.

Keywords: Distribution, Habitat Association, Small mammals, Habitat Preference, Capture success

Introduction

Small mammals are mammals whose adult body weights do not exceed 5kg (Merrit, 2010). They include rodents and insectivores. In other words, small mammal species belong to the orders Rodentia and Insectivora under the class Mammalia. Based on the morphology of the skull characteristics, rodents that are small mammals are categorised into mymorphs (with rat-like skull features) and sciuromorphs (with squirrel-like features) (Buckle and Smith, 2015). Some of the families under the mymorphs categories include muridae, thryonomyidae, nesomyidae, gliridae etc while sciuromorphs are basically sciuridae.

GJS is an Open Access Journal and distributed under the terms of Creative Commons (CC) License [CC by 4.0]

Over one third of mammalian species are small mammals. Of all the small mammal species, only about 5-10 % are considered as pests. In essence, the remaining 90-95 % are non-pest species serving one beneficial role or the other in the ecosystem (Kingdon *et al*., 2013).

Morphological features such as size and shape of the body, colour and texture of the fur etc, are most commonly used to distinguish small mammal species (Aplin *et al.*, 2003). This has occasionally comprised the statistical analysis of huge quantities, making the taxonomy rather more repeatable and hence more 'scientific'. The age structure and sex of a small mammal species caught is determined by holding the animal in such a way that the belly faces the person holding it and the head is pointed away from the person (Aplin *et al.*, 2003). The aperture at the tail base is regarded as the anus. Both female and male have genital papilla that protects the clitoris in female and the penis in males and (Jean-Christophe *et al.*, 2011).

Initially, the Juvenile testes are situated inside the body and positioned abdominally. At maturation, the testes of the animal then enlarge and descend to occupy scrotal position (Aplin *et al.*, 2003). The scrotal sac in the adult often extends behind, and therefore conceals, the anus. is There is often a darker and hairless skin, behind the scrotal sac, compared to the surrounding skin. Epididymis which stores the sperm produced is housed by the skin (Aplin *et al.*, 2003).

The genital papilla and anus in the female small mammals are situated near each other and there is a thinly furred or bare skin between them (Kingdon *et al.*, 2013; Aplin *et al.*, 2003). The vagina of the female juvenile is thinly sealed off with hymen (shiny layer of skin). A condition called an imperforate vagina (Aplin *et al.*, 2003). As the animal reaches sexual maturity, the vaginal covering breaks down and the vagina is open or perforate from then on (Aplin *et al.*, 2003). A widely opened vagina is indicative of status of the animal whether it has just given birth or mated (Aplin *et al.*, 2003). If the vagina opening is small, it means the animal has attained sexual maturity but has not mated recently or never mated. In addition, teats or mammae are used to make distinction among the different species of small mammals and these are usually counted in three groups; inguinal, postaxillary and pectoral (Kingdon *et al.*, 2013)

Body dimensions or measurements are reasonably suitable in regulating the probable taxonomic range for an unidentified small mammal species. Routine record of body dimensions also offers a good form of identifications in the field, and may assist in highlighting any records that might be inaccurate (Aplin *et al.*, 2003). The body measurements as described by Aplin *et al*. (2003) include taking the length of the rodent's head with body together is known as the 'head+body' length. The length is measured straight along the vertebral column of the animal from the nose tip to the end (distal) of the anus but one needs to ensure the animal is lying on its back before the measurement is taken.

The tail length is taken straight from tail tip to the middle of the anus. The animal should not be suspended using its tail when taking the tail length measurement as doing so can expand the tail and extend the measurement.

The hindfoot otherwise known as pes is measured from the foot heel to the tip of the toe at the middle i.e., longest toe, but leaving out the claw.

The ear length is measured from the notch bottom (of the ear) to the furthermost point along the edge. Measurement should not be taken if the ear margin has been injured.

The body weight of the small mammal (rodents and insectivores) species is generally taken with use of already calibrated spring balance

e.g., Pesola spring balance. A balance properly sized should be used for the individual small mammals. The balance should be held by the pivot ring at the top. Lifeless animals can be suspended by the tail.

Small mammals (some rodents and insectivores) can be viewed as keystone species or pests depending on their beneficial or detrimental roles in the natural habitat and agroecosystem. They are often nocturnal and occupy hidden habitats. They can cause economic damage in the field or stored crops. Studies have shown the presence of small mammals at the University of Ibadan (UI), but their ecological status was not well documented. Therefore, this study was designed to determine small mammal distribution and habitat association in selected vegetations in UI.

Materials and Methods

Description of the Study Area/Sites

Based on the vegetation and habitat types, six sampling sites were selected within the study area (University of Ibadan premises). These sampling sites include Conserved Forest (CF), Mixed farmland (MFL), Plantain plantation (PP), Cassava Farmland (CFL), Oil Palm Plantation (OPP), and Shrubland (SHL) (UI Master plan, 2013).

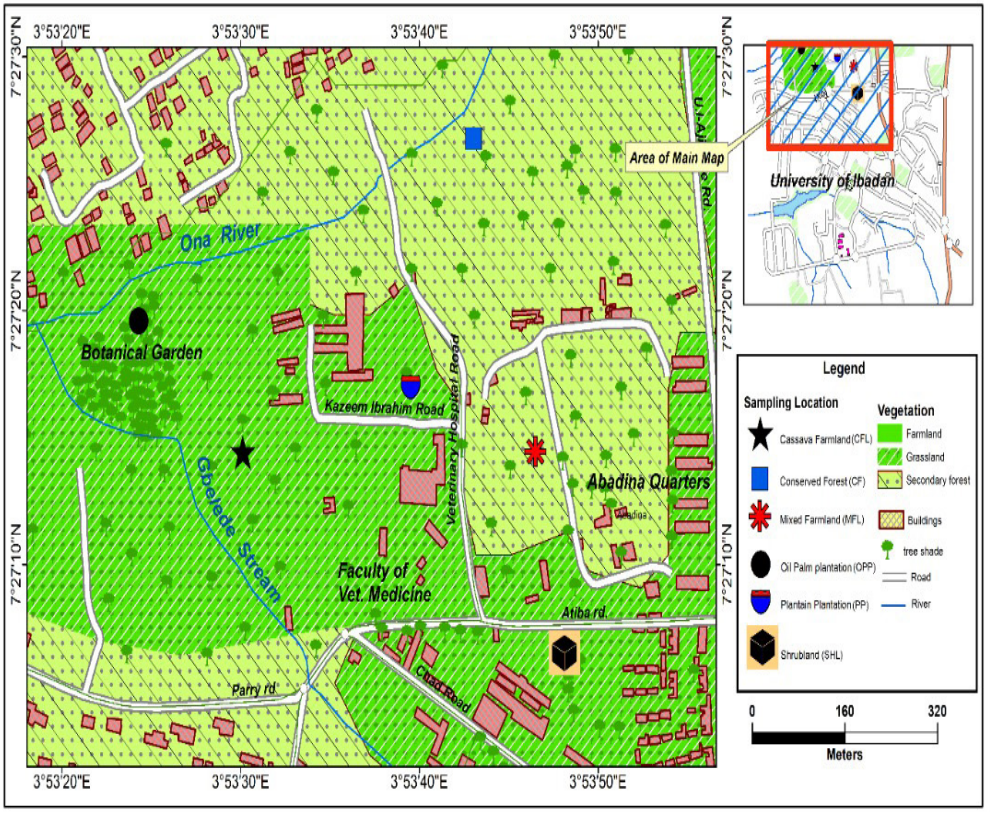


Fig. 1: A map of University of Ibadan showing the six sampling sites.
Conserved forest (CF), Plantain plantation (PP), Shrubland (SHL), Cassava farmland (CFL), Oil Palm Plantation (OPP), Mixed farmland (MFL)

Ethics approval certificate collection
Approval certificate, with assigned number UI-ACUREC/19/0136, was collected for this study from Animal Care and Use Research Ethics Committee (ACUREC), University of Ibadan, Ibadan, Nigeria.

Live trapping procedure
Permanent line transects as described by Adam *et al*. (2015) were used with some modifications, each of 100m in length, were established one in each habitat type. Along each transect, 20 medium-sized single-capture live-traps, measuring 23.5x8x8.9cm were set at 10 m interval between trap stations (Chane and Yirga, 2014). The traps were baited with peanut butter mixed with crushed maize (Datiko and Bekele, 2013). The traps were then covered with foliage and hays to camouflage and avoid excess heat during day time (Adam *et al*., 2015; Datiko and Bekele, 2013). They were set for three consecutive days along the line transect of each habitat type giving a trapping effort of 60 trap nights per transect per monthly survey (Chane and Yirga, 2014). They were checked twice a day, late in the afternoon (5:00p.m - 6:00p.m) and early in the morning (7:00a.m- 8:00a.m) (Chane and Yirga, 2014). Permanent marker was used to label the traps with consecutive numbers. Trapped animals were removed from traps and placed in a pre-weighed polythene bag and weighed, using spring balance, to the nearest gram. They were marked by toe-clipping and released at the point of capture after recording the location of capture, weight, species, sex and approximate age (juvenile, sub-adult, adult). In addition, head and body length, hind foot length, ear length and tail length were also recorded for each individual (Datiko and Bekele, 2013). Reproductive conditions were determined based on the visibility of nipples (visible or not), vaginal condition (perforated or non-perforated) and testes (abdominal or scrotal) (Habtamu and Bekele, 2008).
Taxonomic characteristics listed in Aplin *et al*. (2003) and Happold (2013) were used for species identification.
Percentage trap success was calculated by using the formula below:

$$Trap\ success\ (\%) = \frac{Number\ of\ individual\ species\ caught\ (Tc)}{Total\ number\ of\ trap\ night\ (Tn)} \times 100$$

The total number of trap nights was expressed as the total number of traps multiplied by trapping effort (number of nights of trapping).

Temperature and Rainfall
Atmospheric temperature and rainfall data for the period of sampling (2019-2021) were collected from International Institute of Tropical Agriculture (IITA), Ibadan, Oyo State, Nigeria.

Data Analysis

The distribution and habitat association of the live-trapped small mammal species with different types of habitats, their sex, and approximate age (adults, subadults, and juveniles) were analysed using descriptive statistics and summarized using percentages. Test of significance among the age and sex of small mammal species was done using Chi-square at significance level of $\alpha = 0.05$.

Body measurements among live trapped small mammal species were analysed using Analysis of Variance (ANOVA). Student's t test was used to test for significance between each of the morphological parameters of each species and the standard values as reported in Happold (2013) at the significance level (α) of 0.05.

Relationship between the distance of the sampling sites from Ona River in the study

area and the number of live trapped Individuals captured in each sampling site was analysed using linear regression analysis.

Results

Families of the small mammal species encountered in the study area

A total of five families of live trapped small mammals were encountered in the study area namely Nesomyidae, Muridae, Thryonomyidae, Sciuridae, and Soricidae (Table 1). Of all the families, muridae accounted for highest number of species which include *Arvicanthis niloticus*, *Rattus rattus*, *R. norvegicus*, and *Lemniscomys striatus*. *Cricetomys gambianus* was the only nesomyid species encountered (Table 1).

TABLE 1

Small mammal Families encountered and their Relative Abundance

Family	Relative Abundance (%)	Species Encountered
Nesomyidae	69.0	*Cricetomys gambianus*
Muridae	24.8	*Arvicanthis niloticus, Rattus rattus, R. norvegicus, and Lemniscomys striatus*
Thryonomyidae	0.9	*Thryonomys swinderianus*
Sciuridae	4.4	*Funisciurus anerythrus*
Soricidae	0.9	*Crocidura olivieri*
	100.0	

Distribution and Habitat Association of the individual small mammal species encountered in the study area

Cricetomys gambianus

The present study shows that *C. gambianus* was widely distributed across the habitat types as it was encountered in all the six habitat types in the study area. Highest percentage of *C. gambianus* was recorded in CFL (33%) while the lowest was recorded in PP (8%) (Figure 2). *Cricetomys gambianus* was mostly associated with the habitat CFL and least associated with PP (Figure 2).

Arvicanthis niloticus

Of all the *A. niloticus* encountered in all the six habitat types in the study area, highest percentage was recorded in MFL (40%) followed by CFL and PP with both having 20% each. Meanwhile, percentage of *A. niloticus* recorded in CF was zero (Figure 3). In terms of habitat association, the habitat type with which *A. niloticus* was mostly associated was MFL (Figure 3). It was observed that *A. niloticus* had no association with CF (Figure 3).

Rattus rattus

Out of the six habitat types selected in the study area, it was only in PP that *R. rattus* was encountered throughout the period of the survey (Figure 4). In other words, *R. rattus* was entirely associated with PP.

Rattus norvegicus

Rattus norvegicus was encountered in only two of the six habitat types selected in the study area throughout the period of the study which include SHL and PP. Highest percentage of *R. norvegicus* was recorded in SHL (67%)

(Figure 5). Therefore, *R. norvegicus* was highly associated with SHL followed by PP.

Lemniscomys striatus

Lemniscomys striatus was encountered in only two of the six habitat types selected in the study area throughout the period of the study which include OPP and PP. Highest percentage of *L. striatus* was recorded in OPP (67%) (Figure 6). It means *L. striatus* was highly associated with OPP followed by PP (Figure 6).

Funisciurus anerythrus

Highest percentage of *F. anerythrus* was recorded in MFL (40%) and OPP (40%). No *F. anerythrus* was recorded in three of the habitat types throughout the study period which include CFL, PP, and SHL (Figure 7). In terms of habitat association, *F. anerythrus* was more highly associated with MFL and CFL than CF.

Thryonomys swinderianus

Out of the six habitat types selected in the study area, it was only in PP that *T. swinderianus* was encountered throughout the period of the survey. *T. swinderianus* was entirely associated with PP (Figure 8).

Crocidura olivieri

It was only in PP that *C. olivieri* was encountered throughout the period of the survey. In other words, *C. olivieri* was entirely associated with PP (Figure 9).

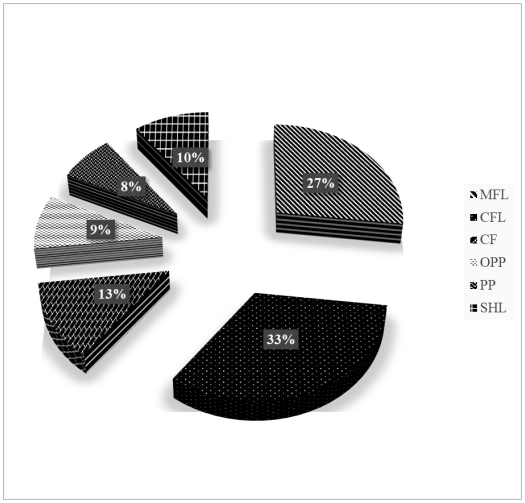


Fig. 2: Percentage distribution and habitat association of *C. gambianus* in the study area
MFL: Mixed farmland; CFL: Cassava farmland; CF: Conserved Forest; OPP: Oilpalm Plantation;
PP: Plantain Plantation; SHL: Shrubland

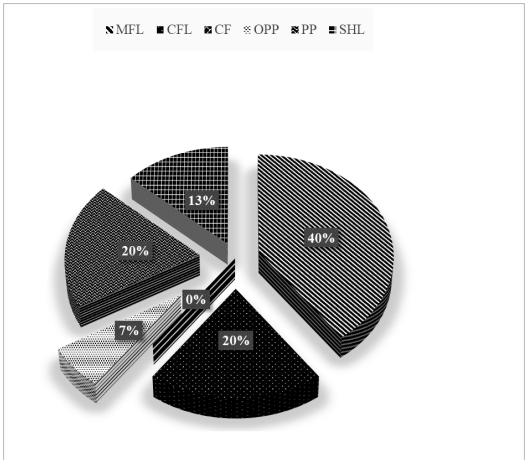


Fig. 3: Percentage distribution and habitat association of *A. niloticus* in the study area
MFL: Mixed farmland; CFL: Cassava farmland; CF: Conserved Forest; OPP: Oilpalm Plantation;
PP: Plantain Plantation; SHL: Shrubland



Fig. 4: Percentage distribution and habitat association of *R. rattus* in the study area
MFL: Mixed farmland; CFL: Cassava farmland; CF: Conserved Forest; OPP: Oilpalm Plantation;
PP: Plantain Plantation; SHL: Shrubland

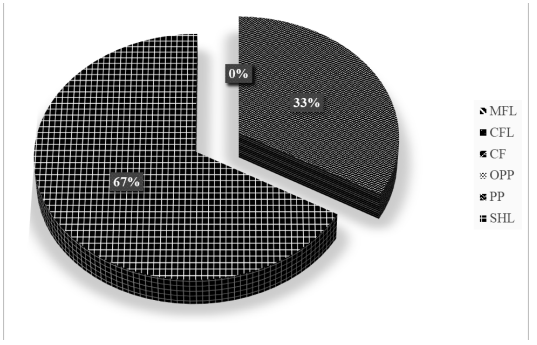


Fig. 5: Percentage distribution and habitat association of *R. norvegicus* in the study area
MFL: Mixed farmland; CFL: Cassava farmland; CF: Conserved Forest; OPP: Oilpalm Plantation;
PP: Plantain Plantation; SHL: Shrubland

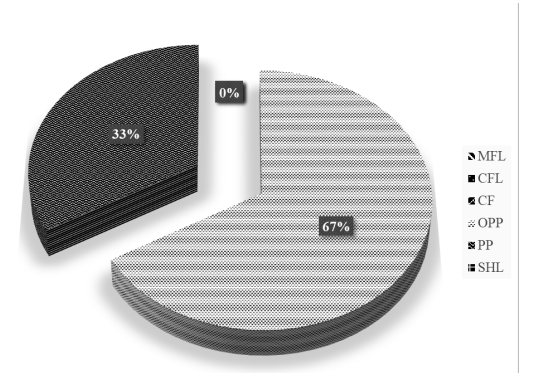
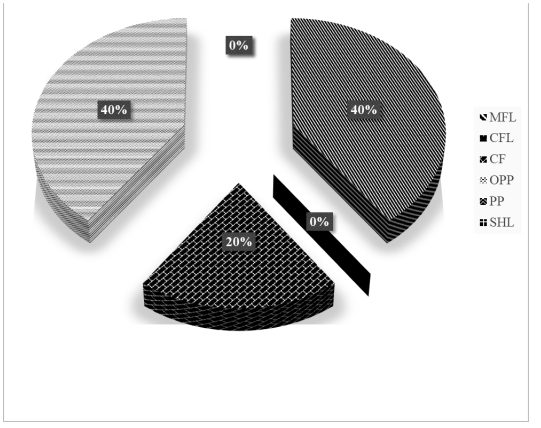


Fig. 6: Percentage distribution and habitat association of *L. striatus* in the study area
MFL: Mixed farmland; CFL: Cassava farmland; CF: Conserved Forest; OPP: Oilpalm Plantation;
PP: Plantain Plantation; SHL: Shrubland



MFL: Mixed farmland; CFL: Cassava farmland; CF: Conserved Forest; OPP: Oilpalm Plantation;
PP: Plantain Plantation; SHL: Shrubland
Fig. 7: Percentage distribution and habitat association of *F. anerythrus* in the study area



Fig. 8: Percentage distribution and habitat association of *T. swinderianus* in the study area
MFL: Mixed farmland; CFL: Cassava farmland; CF: Conserved Forest; OPP: Oilpalm Plantation;
PP: Plantain Plantation; SHL: Shrubland

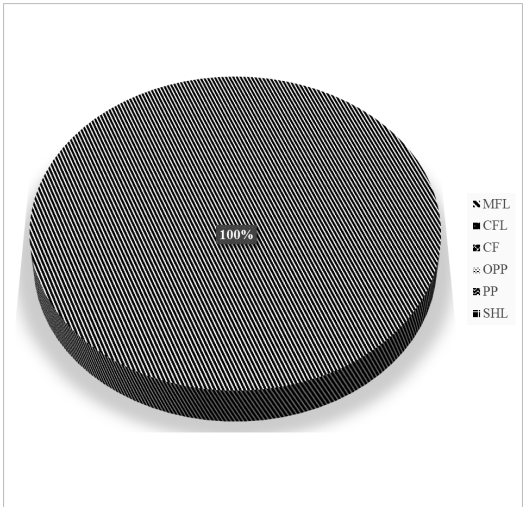


Fig. 9: Percentage distribution and habitat association of *C. olivieri* in the study area
MFL: Mixed farmland; CFL: Cassava farmland; CF: Conserved Forest; OPP: Oilpalm Plantation;
PP: Plantain Plantation; SHL: Shrubland

Influence of Rainfall and Temperature on abundance of small mammal species across the months between 2019 and 2021

Figure 10 shows variation in the temperature and rainfall as they affected the abundance of small mammal species across the months throughout the survey period. Low rainfall and high temperature were recorded between November, 2019 and February, 2020. This resulted in increase in the abundance of small mammal species from November, 2019 (4.5%) to January, 2020 (22.7%) and a little decline in abundance in the month of February, 2020 (18.2%) when the temperature reached a peak (36.19˚C). There was, however, a sharp decline in the abundance (4.5%) in the month of March, 2020 following a sudden increase in rainfall (24.70mm) and gradual decline in temperature (34.48˚C). A drastic decline in rainfall (2.02mm) and further low temperature (33.91˚C) was experienced in the month of April, 2020 before the steady increase till the month of June, 2020 (5.99mm) which resulted in decrease in abundance from 6.8% in April, 2020 to 4.5% in both May and June, 2020. There was further decrease in abundance in July, 2020 (4.52%) when the temperature (28.32 ˚C) and rainfall (4.52mm) further decreased (Figure 10). The same trend was followed during the second year of the survey period. However, the result showed that more abundance was recorded during the dry season of the first year of survey than that of the second year. In addition, there was more abundance in the wet season of the second year of survey than that of the first year (Figure 10).

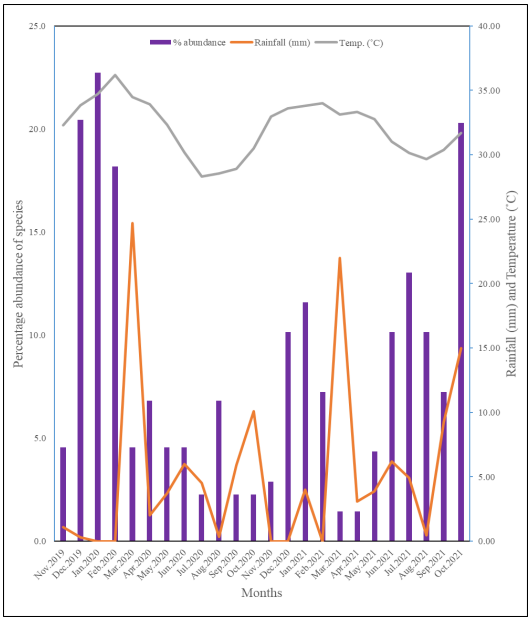


Fig. 10: Seasonal distribution and abundance (%) of small mammal species across the months between 2019 and 2021

Variations of morphological parameters between the live trapped small mammal species and the standard morphological measurements

It was observed that the mean body weight (g) of *Cricetomys gambianus* (878.78 ± 136.55) was significantly higher than the standard value of 786.00g ($t = 56.84$, $df = 77$, $p < 0.05$) (Table 2). However, the mean hind foot length (60.40 ± 4.42) mm and tail length (346.59 ± 14.28) mm were significantly lower than the standard values of 62.00mm ($t = -3.204$, $df = 77$, $p<0.05$) and 352.00mm ($t = -3.346$, $df = 77$, $p<0.05$) respectively (Table 2b). But the mean headbody length (mm) (329 ± 22.58) and ear length (mm) (37.08 ± 2.32) showed no statistically significant difference from the standard values of 326.00mm ($t = 1.41$, $df = 77$, $p>0.05$) and 37.00mm ($t = 0.23$, $df = 77$, $p>0.05$) (Table 2).

The mean body weight (128.87 ± 8.32) g and ear length (18.73 ± 1.62) mm of *Arvicanthis niloticus* were significantly higher than the standard values of 110.8g ($t = 8.41$, $df = 14$, $p<0.05$) and 17.8mm ($t = 2.23$, $df = 14$, $p<0.05$) respectively. Meanwhile, the mean headbody length (152.20 ± 9.99) mm, hind foot length (31.07 ± 2.43) mm, and tail length (130.93 ± 3.52) mm were not significant different from their respective standard values of 150.8mm ($t = 0.54$, $df = 14$, $p>0.05$), 31.5mm ($t = -0.69$, $df = 14$, $p>0.05$), and 129.7mm ($t = 1.36$, $df = 14$, $p>0.05$) (Table 2).

The result of the present study shows that there was no significant difference between the mean body weight (g) of *Rattus rattus* measured (131.00 ± 9.33) and the standard value of 132.00g ($t = -0.28$, $df = 6$, $p>0.05$). In the same vein, the mean head body length (mm) (167.86 ± 4.88) and tail length (mm) (192.14 ± 5.69) showed no significant difference from their respective standard values of 165.30 ($t = 1.39$, $df = 6$, $p>0.05$) and 195.5 ($t = -1.61$, $df = 6$, $p>0.05$). However, the mean hindfoot length (34.00 ± 1.63) mm and ear length (25.86 ± 0.69) mm were statistically different from their standard values of 31.70mm ($t = 3.73$, $df = 6$, $p<0.05$) and 23.10 mm ($t = 10.57$, $df = 6$, $p<0.05$) respectively (Table 2).

It was observed that the mean body weight (205.00 ± 30.35) g, headbody length (196.67 ± 7.64) mm, hindfoot length (40.67 ± 3.79) mm, and tail length (164.00 ± 5.29) mm were all significantly lower than their respective standard values of 259.3g ($t = -3.10$, $df = 2$, $p<0.05$), 219.90mm ($t = -5.23$, $df = 2$, $p<0.05$), 43.40mm ($t = -1.25$, $df = 2$, $p<0.05$), and 196.00mm ($t = -10.47$, $df = 2$, $p<0.05$). It was, however, revealed that only the mean ear length (20.33 ± 0.58) mm showed no statistically significant difference from the standard value of 20.8mm ($t = -1.40$, $df = 2$, $p>0.05$).

All the morphological measurements of *Lemniscomys striatus* taken which included the mean body weight (51.33 ± 3.22)g, headbody length (119.33 ± 1.16)mm, hindfoot length (27.67 ± 1.53), ear length (19.00 ± 1.00) mm, and tail length (130.67 ± 1.16) mm were statistically significant compared to their respective standard values of 41.60g ($t = 5.24$, $df = 2$, $p<0.05$), 116.00mm ($t = 5.00$, $df = 2$, $p<0.05$), 25.00mm ($t = 3.02$, $df = 2$, $p<0.05$), 16.00mm ($t = 5.20$, $df = 2$, $p<0.05$), and 143.00mm ($t = -18.50$, $df = 2$, $p<0.05$) (Table 2).

The morphological parameters of *Funisciurus anerythrus* measured showed that only the mean body weight (121.4 ± 2.19) g and hindfoot length (42.00 ± 1.23) mm were significantly higher than their respective standard values of 219.00 ($t = -99.61$, $df = 4$, $p<0.05$) and 43.80mm ($t = -3.29$, $df = 4$, $p<0.05$) (Table 2). Other parameters taken which included the mean headbody length (179.20 ± 3.03) mm, ear length (16.60 ± 0.89) mm, and tail length (162.00 ± 5.43) mm were not significantly different from their standard values of 182.00 mm ($t = -2.06$, $df = 4$, $p>0.05$), 16.00 mm ($t = 1.50$, $df = 4$, $p>0.05$), and 159.00 mm ($t = 1.23$, $df = 4$, $p>0.05$) respectively.

Trap success of small mammals captured in the study area

Table 3 presents the trap success of small mammal species in the sampling area. It gives the habitat type, year of capture, number of capture, number of traps, trapping efforts, trap night, trap success, and mean trap success in each habitat type.

The largest mean capture success of small rodent species captured was recorded in Mixed farmland (MF) with the mean trap success of 2.40% (Table 3). Cassava farmland (CaF) had the second highest mean trap success (3.50%) followed by Plantain Plantation (PP) (1.60%). Both Oil Palm Plantation (OPP) and Shrubland (Sl) had the same mean trap success (0.90%). The lowest mean trap success of captured small mammals was recorded in Conserved Forest (CoF) (0.63%). The overall trap success (%) of live-trapped rodent species in the area sampled was 15.70 (Table 3).

TABLE 2a:

Mean morphometric parameters of live trapped small mammal species in the study area

Species	BW ± SD (g)	Standard value (g)	HBL ± SD (mm)	Standard value (mm)
Cg	878.78* ± 136.55	786.00	329.60 ± 22.58	326.00
An	128.87* ±8.32	110.80	152.20 ± 9.99	150.80
Rr	131.00 ± 9.33	132.00	167.86 ± 4.88	165.30
Rn	205.00* ±30.35	259.30	196.67* ± 7.64	219.90
Ls	51.33* ±3.22	41.60	119.33 ± 1.16	116.00
Ts	3620.00* ±0.00	4500.00	470.00 ± 0.00	462.00
Fa	121.40* ±2.19	219.00	179.20 ± 3.03	182.00
Co	65.00 ±0.00	63.00	135.00 ± 0.00	130.00

TABLE 2b:

Mean morphometric parameters of live trapped small mammal species in the study area

Species	HFL ± SD (mm)	Standard value (mm)	EL ± SD (mm)	Standard value (mm)	TL ± SD (mm)	Standard value (mm)
Cg	60.40 ± 4.42	62.00	37.08 ± 2.32	37.00	346.59* ± 14.28	352.00
An	31.07 ± 2.43	31.50	18.37* ± 1.62	17.80	130.93 ± 3.52	129.70
Rr	34.00* ± 1.63	31.70	25.86* ± 0.69	23.10	192.14 ± 5.69	195.50
Rn	40.67 ± 3.79	43.40	20.33 ± 0.58	20.80	164.00* ± 5.29	196.00
Ls	27.67* ±1.53	25.00	19.00* ± 1.00	16.00	130.67* ± 1.16	143.00
Ts	75.00* ± 0.00	94.00	30.00 ± 0.00	33.00	180.00 ± 0.00	188.00
Fa	42.00* ± 1.23	43.80	16.60 ± 0.89	16.00	162.00 ± 5.43	159.00
Co	25.00 ± 0.00	23.00	10.00±85.00	11.50	85.00 ± 0.00	81.30

TABLE 3:

Trap Success (%) of Live-captured Rodent Species in the Sampling Area

Habitat	Year	No. of capture	No. of traps	Trapping Effort	Trap night	Trap success (%)	Mean trap success (%)
CoF	First	5	240	3	720	0.69	0.63
	Second	4	240	3	720	0.56	
MF	First	11	240	3	720	1.53	2.40
	Second	19	240	3	720	2.64	
PP	First	11	240	3	720	1.53	1.60
	Second	12	240	3	720	1.67	
CaF	First	6	240	3	720	0.83	1.75
	Second	19	240	3	720	2.64	
OPP	First	7	240	3	720	0.97	0.90
	Second	6	240	3	720	0.83	
Sl	First	4	240	3	720	0.56	0.90
	Second	9	240	3	720	1.25	
Total		**113**	**2,880**	**36**	**8,640**	**15.70**	**7.85**

Similarity among the sampling sites based on the diversity of the small rodent species in the University of Ibadan

Figure 11 presents a dendogram of the similarity among the sampling sites based on the diversity of the small rodent species in the University of Ibadan. Cluster analysis of the similarities among the habitat types in terms of the species diversity was such that both OPP and Sl were the closest in the study area (Figure 11). PP was the most distinctive habitat type. CaF and MFl also showed similarity in terms of the small mammal diversity in the study area (Figure 11).

Similarity among the small mammal species in terms of their morphological parameters in the University of Ibadan

Figure 12 presents a dendogram on the similarity among the small mammal species in terms of their morphological parameters in the University of Ibadan. From the dendogram, the two small mammal species that were closest include *Rattus rattus* and *Funisciurus anerythrus*. *C. gambianus* and *T. swinderianus* were quite dissimilar to other small mammal species. In addition, the two species were quite different from each other.

Relationship between the Distance of the sampling sites from Ona River and the number of live trapped Individuals captured in each sampling site

There was positive linear relationship between the distance of the sampling sites from Ona River in the study area and the number of live trapped Individuals captured in each sampling site (Figure 13). the equation of the regression line was Y = 0.0896 X – 11.398 where Y was the number of live trapped Individuals captured in each site (outcome variable) and X was the distance of the sampling sites from the river (the predictor variable). The slope of the line was 0.0896 while the intercept was -11.398.

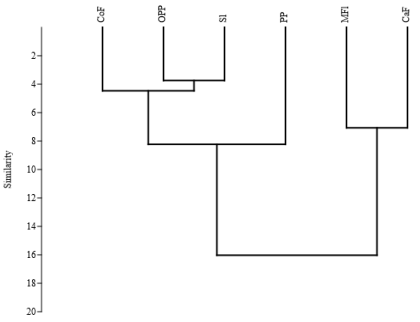


Fig 11: Dendogram of the Similarity among the Sampling Sites based on the Diversity of the Small Rodent Species in the University of Ibadan

*CoF: Conserved Forest; MF: Mixed farmland; PP: Plantain Plantation; CaF: Cassava farmland; OPP: Oil palm Plantation; Sl: Shrubland

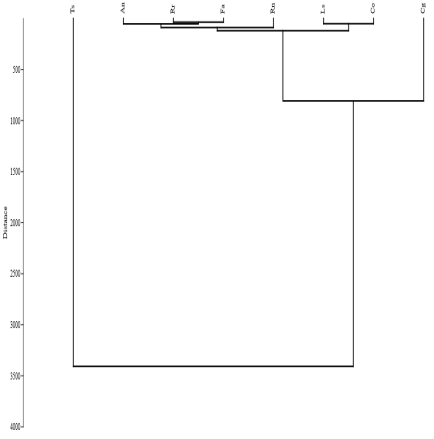


Fig 12: Dendogram of the Similarity among the Small Mammals based on their Morphometrics in the University of Ibadan

*Cg: *Cricetomys gambianus*; An: *Arvicanthis niloticus*; Rr: *Rattus rattus*; Rn: *Rattus norvegicus*; Ls: *Lemniscomys striatus*; Ts:

Thryonomys swinderianus; Fa: *Funisciurus anerythrus*; Co: *Crocidura olivieri*

Regression equation: Y = 0.0896 X – 11.398

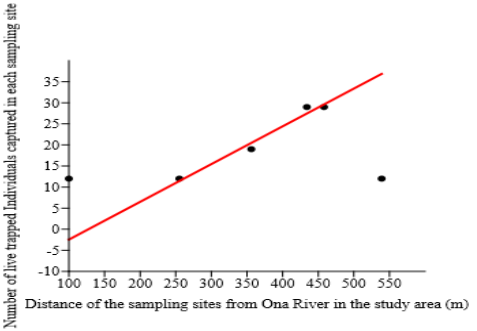


Fig 13: Relationship between the Distance of the sampling sites from the river and the number of Individuals captured in each sampling site

Discussion

Distribution and Habitat Association

In the present study area, there was non-uniformity in the distribution of small mammal species as some species were widely distributed while some were restricted to one or two habitats only. For instance, *Cricetomys gambianus* was the most widely distributed species as it was encountered in all the habitat types. It could be said that *C. gambianus* was habitat generalist. This might be due to its diverse feeding habits and high adaptability which allowed it to inhabit a wide range of habitats. *C. gambianus* was mostly associated with Cassava farmland as revealed from the present study. This could be attributed to suitability of the habitat type to construct burrows thereby enhancing the survival and reproduction of the species.

It was revealed that *A. niloticus* was mostly associated with Mixed farmland in the study area. This could be due to the presence of dense vegetation cover. It has earlier been reported by Garratt *et al.* (2012) that the abundance and community composition of small mammals depend on the vegetation structure and complexity of the habitat. Mulungu *et al*. (2010) also reported that habitat with high vegetation diversity and dense ground cover supports greater small mammal species.

Both *R. rattus* and *R. norvegicus* were highly associated with Plantain Plantation. These two species are usually in close proximity to human habitation or their produce stores. They are otherwise regarded as commensal rodent species. The plantain plantation was located near the produce store which might serve as shelter for the commensal species in the study area. This could be the reason for their close association with the habitat. Other species encountered which were found to be highly associated with Plantain Plantation include *T. swinderianus* and *C. olivieri* probably because of the diversity of vegetation cover in the habitat which was preferred by the two species. *Lemniscomys striatus* was entirely associated with Oil palm plantation presumably because of its preference for the succulent part of the Oil palm fruits which fell down from the palm tree during the harvesting period in the habitat. *Funisciurus anerythrus* was highly associated with Mixed farmland and Cassava farmland perhaps because of the availability of their preferred foods or because there were less predators in these two habitat types. Gebresilassie *et al.* (2004) also reported that farmlands provide essential resources better than grasslands before harvest.

Influence of Rainfall and Temperature on Abundance of small mammal species

Generally, sharp decline in rainfall and temperature drastically declined the abundance of small mammal species as revealed from the study. Rainfall is one of the deterministic

factors that initiates the growth of grasses and other herbs, which increase the abundance of small mammals. Vagaries in the environmental condition as observed in the present study, in part, had effects on the distribution and abundance of small mammals in the area.

It was revealed from the study that more abundance was recorded in the first dry season presumably because of the inclement environmental condition which probably led to scarcity of food and the small mammal species were left with no other option than to scout for food for their survival which resulted in their high tendency of being trapped.

Trap success

The study revealed that the overall mean trap success (%) was considerably low. This could be due to factors related to human. The type of bait used might also have attracted ants and other animal species especially invertebrates such as snails which could have reduced the quality and quantity of the bait and probably led to the low trap success recorded. This report is supported by Datiko and Bekele (2014) who also reported lower trap success of small mammal species in their study. However, Habtamu and Bekele (2008) reported a relatively high trap success in their study which was attributed to favourable climatic factors, availability of food, adequate cover and minimum human interference.

Morphological Characteristics

Results from the present study recorded significant differences in the body measurements among the small mammal species. Rodent species are most often distinguished on the basis of morphological characteristics including differences in body size – Body weight, Head body length, hind foot length, ear length, and tail length (Aplin *et al.*, 2003). They are quite useful in limiting the range of possible identification for an unknown rodent (Aplin *et al.,* 2003). Some of the mean morphological parameters recorded were significantly different from their corresponding standard values. This could be due to variation in geographical location or the study area. It could also be due to genetic variability of the species in different locations as the gene and environment play vital roles in the phenotype of organisms.

Relationship between distance of the sampling sites from the river

The relationship between the distance of the sampling sites from the river in the study area and the number of captured small mammal species indicated that the closer the sampling sites to the river, the less the number of captured species. This could be attributed to the incessant inundation usually experienced in the sampling sites closer to the river in the study area. The two notable sites included conserved forest and oil palm plantation. Unfavourable environmental condition brought about by inundation could make the small mammals in the affected area to migrate to another favourable environment. This could be the reason for the relatively low number of individuals recorded in the two sites. Similar report was given by Witmer (2007) that rodent species migrated from areas usually disturbed by flooding to a less disturbed area where they could survive and reproduce.

Conclusion

There was low trap success of small mammals in the University of Ibadan. Family Muridae accounted for the highest species. *Cricetomys gambianus* was the most widely distributed species and was habitat generalist. Plantain plantation was the preferred by the small mammal species at the University of Ibadan.

References

ADAM, M., WELEGERIMA, K., AND MEHERETU, Y. (2015). Abundance and Community Composition of Small Mammals in different Habitats in Hugumburda Forest, Northern Ethiopia. *International journal of Biodiversity and Conservation*. 7 (2): 119-125. https://doi.org/10.5897/IJBC2014.0787

APLIN, K. P., BROWN, P. R., JACOB, J., KREBS, C. J., AND SINGLETON, G. R. (2003). in Asia and the Indo-Pacific. *Design* 220.

BUCKLE, A. P., AND SMITH, R. (2015). Rodent Pests and their Control , 2nd Edition .May 2016: https://doi.org/10.1079/9781845938178.0000

CHANE, M., AND YIRGA, S. (2014). Distribution and diversity of small mammals In Borena-Sayint National Park, South Wollo, Ethiopia: Implications of habitat specialization. *International Journal of Biodiversity and Conservation 6*.5:415–421. https://doi.org/10.5897/ijbc2014.0685

DATIKO, D. AND BEKELE, A. (2013). Species composition and abundance of small mammals in Chebera-Churchura National Park, Ethiopia. *Journal of Ecology and The Natural Environment. 5*.6:95–102. https://doi.org/10.5897/jene12.045

DATIKO, D., AND BEKELE, A. (2014). Habitat association and distribution of rodents and insectivores in Chebera Churchura National Park , Ethiopia *55*.2:221–229.

GARRATT, C. G., MINDERMAN, J., AND 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.

GEBRESELASSIE, S. 2006. Land, land policy and smallholder agriculture in Ethiopia: Options and scenarios. Ethiopia: Department for International Development.

HABTAMU, T., AND BEKELE, A. (2008). Habitat association of insectivores and rodents of Alatish National Park, northwestern Ethiopia. *Tropical Ecology 49*.1:1–11.

HAPPOLD, C.D.C. (2013). Rodents and Hare. In: Kingdon, J., Happold, D., Butynski, T., and Happold, M. (2013). *Mammals of Africa*. *Choice Reviews Online* (Vol. 50). https://doi.org/10.5860/choice.50-4188

JEAN-CHRISTOPHE, A., KIM, B., BORDES, F., CHABÉ, M., CHAISIRI, K., CHARBONNEL, N., … XUÉREB, A. (2011). *Protocols for field and laboratory rodent studies*. (V. Herbreteau, S. Jittapalapong, W. Rerkamnuaychoke, Y. Chaval, J.-F. Cosson, & S. Morand, Eds.).

KINGDON, J., HAPPOLD, D., BUTYNSKI, T., AND HAPPOLD, M. (2013). *Mammals of Africa*. *Choice Reviews Online* (Vol. 50). https://doi.org/10.5860/choice.50-4188

MERRITT, J. F. (2010). The biology of small mammals. The Johns Hopkins University Press. Baltimore, Maryland.

MULUNGU, L.S; NGOWO, V.D; MAKUNDI, R.H; MASSAWW, A.W AND HERWIG, L. (2010). Winning a fight against rodents in Africa.pdf. *Journal of Biological Sciences*.

WITMER, G. (2007). The ecology of vertebrate pests and integrated pest management (IPM). *Perspectives in Ecological Theory and Integrated Pest Management* 393–410. https://doi.org/10.1017/CBO9780511752353.013

Received 27 Aug. 24; revised 18 May 26.