Vidyodaya J. of Sci. (2013) Vol. 18 PP 1-12

Diversity and abundance of Small Mammals in Giritale Nature Reserve (North-Central Sri Lanka)

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Received on : 07-01-2013
Accepted on:14-03-2013

Abstract

The composition of small mammal communities in forest, shrub land, grassland and anthropogenic habitats of the Giritale Nature Reserve of north central Sri Lanka was studied from June 2006 to August 2007 to estimate the abundance and diversity of small mammals inhabiting this nature reserve. Live trapping using Sherman traps and Pitfall traps were adopted to catch the small mammals.A total of 71 individuals representing two orders (Insectivora and Rodentia) and three families (Soricidae, Muridae, Scuridae) was captured. Species recorded included *Suncus murinus murinus* Linnaeus, 1766 (Common Indian Musk Shrew), *Mus cervicolor fulvidiventris* Blyth, 1852 (Ceylon Field Mouse), *Mus mus culuscastaneus* Waterhouse, 1843 (Indian Field Mouse), *Mus fernandoni* Phillips, 1932 (Ceylon Spiny Mouse), *Rattus blanfordi* Thomas, 1881 (White Tailed Rat), *Funambulus palmarum* Linnaeus, 1766 (Indian Palm Squirrel) and *Rattus rattus*. The species *Rattus rattus* consisted of two *subspecies Rattusr attusrattus* Linnaeus, 1758 (Common House Rat) and *Rattus rattus rufescens* Gray, 1837 (Indian House Rat). Highest and lowest abundances were recorded in the grasslands(0.08)and shrub lands(0.01), respectively. Highest diversity index was recorded in anthropogenic habitats(1.62), which included paddy fields, home gardens and buildings, while lowest diversity index was recorded in shrub lands(0.67). The number of small mammals captured was significantly different in the four habitat types ($\chi 2 = 22.69$, $df = 3$, $p<0.05$). This study, which is the first detailed examination of terrestrial small mammals in a dry zone forest of Sri Lanka, indicated that the Giritale Nature Reserve is home to six species of small mammals.

Key words: Abundance, Diversity, Evenness, Nature reserve, Small mammals

Introduction

Small mammals are composed of a group of mammals whose body weight is fewer than 150 g (Morison, 2002). They are important pests of agricultural products (Leirs, 1993), are vectors of diseases (Skinner and Smithers, 1990), and have a significant impact on the environment as grazers, seed eaters, and as prey for some carnivores (Kern, 1981; Linzey and Kesner, 1997a, b). Small mammals contribute to energy flow and nutrient cycling, and they play an extremely important role as seed dispersal and pollination agents in tropical forests (Fleming, 1975). Their disappearance may thus bring about changes in the diversity of other faunal and floral elements in the ecosystems. It is known that many small mammals are found in association with humans and occur less commonly in jungle areas away from anthropogenic habitats (Phillips, 1980). The ready availability of food in the form of agricultural products, both in the fields and in storage, may be the reason for this phenomenon (Leirs, 1993). Although small mammals are an important group of organisms (Bond *et al.*, 1980; Kerley, 1992;Linzey and Kesner, 1997 a,b), they have been largely neglected as a target group for conservation efforts (Wijesinghe, 2006) in Sri Lanka. There is a paucity of data related to the species composition of small mammals in the dry zone forests of Sri Lanka. Therefore, the objective of this study was to determine the composition, abundance and diversity of the small mammal community in the Giritale Nature Reserve.

Methods and Materials

Study site

e.The study was conducted in the Giritale Nature Reserve (7°59'–8°04' N and 80°52' 80°54' E), in the north central Province of Sri Lanka. The reserve encompasses an area of 8,335.5 ha and receives an average yearly rainfall of 1,146 mm. Digital topographic maps (1:50,000 scale) of the study area (land use, roads, terrain, hydrology, transport and the boundary layers) were obtained from the Sri Lanka Survey Department and the Department of Wildlife, and the major habitat types were identified as 71% dry forest, 12% shrub land, 10% water bodies, 6% grass and 1% anthropogenic habitats. Forest was characterized by woody plants *Diospyros ebenum*, *Manilkara hexandra*, *Drypetes sepiaria*, *Bauhinia racemosa*, *Syzygium caryophyllatum* (Ashton *et al* 1997), *Azadirachta indica* and *Tectonagrandis*. Shrub land comprised *Syzygium zelanicum*, *Catunaregam spinosa*, *Phyllanthus polyphyllus*, *Zizyphus oenoplia* and *Flueggea leucopyrus* (Ashton *et al* 1997). Grasslands were dominated by *Eragrostis viscosa*, *Eragrostis tenella*, *Cynodon arcuatus*, *Chloris barbata*, and *Imperata cylindrica*. Anthropogenic habitats consisted of paddy fields, home gardens and buildings scattered throughout the nature reserv

Live trapping using Sherman traps and Pitfall traps

Sixteen Sherman traps (7.6 cm × 8.9 cm × 22.9 cm) were set, 10 m apart, on a 4 × 4(m^2) grid system in each of the forest, shrub land and grassland habitats each month, from June 2006 to August 2007 (King *et al.*, 1996; Shanker, 2000; Gibson *et al.*, 2004). Traps were set in the evening (5.00 p.m. – 7.00 p.m.) of the first day of each trapping session and were baited every evening with a 20 cm^3 mixture of the same amount of fried coconut, fried dry fish

and peanut butter. In the anthropogenic habitats, 16 Sherman traps were set randomly inside houses and home gardens. The total live trapping effort included 1,760 trap nights.

Pitfall traps were set to supplement the Sherman trap effort. 11.4 l plastic buckets were used as pitfall traps and those were buried to ground level (Wiener and Smith, 1972; Williams and Braun, 1983). Ten traps were distributed 5 m apart along a 50 m line (Mazerolle*et al.* 2001) that comprised a drift fence constructed from dark colored polythene (Webala*et al.* 2006) in the forest, shrub land and grassland habitats. Pitfall traps were not set in the anthropogenic habitats. The pitfall traps were closed with plastic lids when not in use. The total pitfall trapping effort included 1,260 trap nights. However, no small mammals were captured by the pitfall traps and, therefore, were not included in the analysis of the data.

Each trapping session consisted minimum of three days per month. The traps were checked twice a day at dawn and dusk (Scott *et al.* 2006). Captured small mammals were placed in a specimen holding bag and weighed with a Pesola spring balance (to the nearest gram), while ear length (EL), head and body length (SL), tail length (TL) and hind foot length (HFL)] were measured, either with a vernier Caliper or with a stainless steel ruler, to the nearest millimeter. The sex of the captured animals was determined by examination of the genitalia, mammary glands and the number of openings in the perineal region: three in breeding females (urinary papilla, vagina, and anus) and two in males (urinary papilla and anus). Measurements and overall appearance of small mammals were used to identify species level using a field guide (Phillips, 1980). All individuals captured were marked by fur clipping (Mareks, 2004). However, no individual was recaptured during the study period. Therefore, no attempt was made to estimate the study population.

Microhabitat data

Microhabitat variables were measured in each habitat type except inside houses (Caro, 2001). Quadrates of 0.25 m^2, 25 m^2 and 400 m^2 were used for the ground cover measurement of grassland, shrubs and forest habitats (Sutherland, 1997). Ground cover measurements were taken as percentages, which were estimated as the extent of ground covered by trees (>3 m), shrubs (>1 m<3m), herbs (<1 m), logs, bare soil, leaf litter, grass, rocks and others.

Data analysis

Species richness (S) was calculated as the number of species in the community (Krebs, 1992). The Shannon–Wiener index of diversity was used to calculate habitat-specific diversity using the equation $H' = \Sigma p_i \ln p_i$, where, H' is index of species diversity and pi is the proportion of the total sample belonging to the i^{th} species. Evenness values (E1) were calculated from the equation E1 = H′/ln S, where H' is the Shannon–Wiener index and ln S is the natural logarithm of the number of species. The number of trap nights was calculated by the standard formula: trap nights = number of traps × number of operative days. Total abundance of small mammals was estimated by division of the total number of captured animals by the numbers of trap nights (Scott *et al.*, 2006). Trap success (number of animals per 100 trap nights) was calculated to standardize data for all habitats sampled (Webala*et al.*, 2006). $\chi 2$ tests were conducted to determine the difference among the number of small mammals captured in the four habitats (Payne and Caire, 1999). One-way analysis of variance (ANOVA) and Tukey's pair-wise comparison tests were carried out on all habitats except the anthropogenic ones for comparison of the differences between ground cover measurements.

Results

The species accumulation curve reached an asymptote after the 843rd trap night of the Sherman traps, which indicated that the sampling pressure was sufficient for the study (Fig. 1).A total of 71 individuals representing two orders (Insectivora and Rodentia) and three families (Soricidae, Muridae, Scuridae) was captured. Species recorded included, *S. m. murinus L* (Common Indian Musk Shrew), *M. c. fulvidiventris B* (Ceylon Field Mouse), *M. m. castaneus W* (Indian Field Mouse), *M. fernandoni P* (Ceylon Spiny Mouse), *R. blanfordi T* (White Tailed Rat), *F. palmarum L* (Indian Palm Squirrel) and *R.rattus.* The species *R.rattus* consisted of two subspecies *R. r.rattus L* (Common House Rat) *and R. r. rufescens G* (Indian House Rat). Among these species, the endemic subspecies *M. c. fulvidiventris B* was the most numerous species, whereas only two individuals of the endemic species *M. fernandoni* P were recorded (Table I).

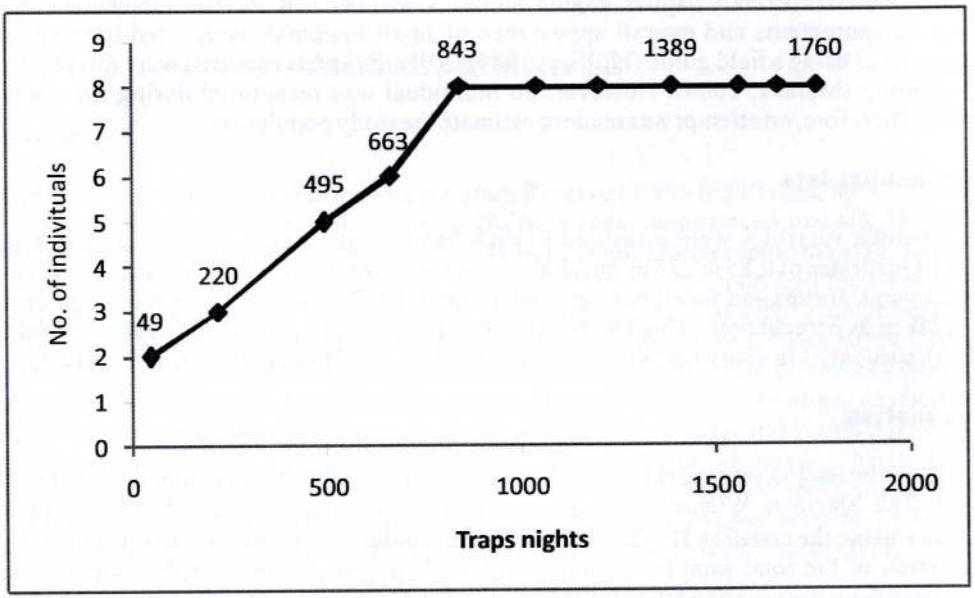

Figure 1: Cumulative numbers of species

Table I: Species/Subspecies composition of small mammals, listed in standard taxonomic order, captured in Giritale nature reserve during the period of June 2006 to August 2007

Order	Family	Scientific Name	Total
Insectivora	Soricidae	*Suncus murinus murinus*	6
Rodentia	Muridae	*Mus cervicolor fulvidiventris*	31
		Mus musculus castaneus	1
		Mus fernandoni	2
		Rattus rattusrattus	6
		Rattus rattus rufescens	12
		Rattus blanfordi	6
	Scuridae	*Funambulus palmarum*	7

R. r.rufescens G occurred in all the habitats, while *M. m.castaneus W* occurred only in the grassland habitat. The other species occurred in two or more habitat types. The highest species richness of six was observed in anthropogenic and grassland habitats. The highest abundance of 0.08 was recorded in the grassland habitat, and the lowest abundance of 0.01 was recorded in the shrub land habitat. Anthropogenic habitats had the highest diversity index of 1.62, while shrub lands had the lowest diversity index of 0.67. In contrast, evenness was low in grasslands (0.51)and high in shrub lands (0.97). The numbers of small mammals captured were significantly different in the four habitat types ($\chi2 = 22.69$, df = 3, $p<0.05$). The number of *M. c. fulvidiventris* B *recorded* in the four habitat types was significantly different ($\chi2 = 54.29$, df = 3, $p<0.05$). The chi square test could not be performed for other species captured due to limited capture data (Table II).

Species-specific analysis was performed only for *M. c. fulvidiventris* B, as it was the only species for which there was a large sample size. There were no significant differences between the numbers of males and females captured ($\chi2 = 0.03$, df = 1, $p>0.05$). There were no significant differences in the body weight ($t = 0.01$, $p = 0.994$, df = 27), ear length ($t = 0.65$, $p = 0.521$, df = 29), standard length ($t = 0.92$, $p = 0.366$, df = 29), tail length ($t = 0.38$, $p = 0.704$, df = 27), or hind foot length ($t = 1.19$, $p = 0.242$, df = 29) among the males and females captured (Table III).

Table II: Composition of small mammals community with Abundance, Species richness, total trap nights, trap success, Shannon's diversity index (H'), Shannon's evenness (E), at different habitats of Giritale nature reserve

	Grassland	Forest	Shurbland	Anthropogenic habitats	Total
Suncus murinus murinus	2	0	0	4	6
Mus cervicolor fulvidiventris	25	0	0	6	31
Mus musculus castaneus	1	0	0	0	1
Mus fernandoni	0	1	0	1	2
Rattus rattus rattus	3	0	0	3	6
Rattus rattus rufescens	1	7	3	1	12
Rattus blanfordi	0	4	2	0	6
Funambulus palmarum	1	3	0	3	7
Total individuals	33	15	5	18	71
Total trap nights	440	443	435	442	1760
Species richness	6	4	2	6	8
Abundance	0.08	0.03	0.01	0.04	0.04
Trap success (%)	7.5	3.39	1.15	4.07	4.03
H'	0.92	1.21	0.67	1.62	1.73
E	0.51	0.87	0.97	0.9	0.83

Canopy cover of forest, shrubs and grassland was significantly different between the different habitat types (ANOVA, $F_{2,18}$=169.36, p<0.001). Tree cover ($F_{2,18}$ = 9.64, p <0.01), shrub cover ($F_{2,18}$=80.76, p<0.01), herb cover ($F_{2,18}$= 12.14, p< 0.001), leaf litter ($F_{2,18}$= 79.33, p< 0.001), logs ($F_{2,18}$= 4.24, p=0.33), and grass ($F_{2,18}$= 37.92, p< 0.001) were also significantly different between the forest, shrub and grassland habitats. However, bare soils ($F_{2,18}$ = 3.54, p = 0.53) and rocks ($F_{2,18}$= 2.52, p =0.112) did not differ significantly (Table iv).

Table III: Total numbers of each species of small mammal caught with standard anatomical measurements (mean ± standard deviation).

Species name	Sex	Number	Weight	Length(cm)			
			(g)	Ear length	Standard Length	Tail length	HFL
S. m. murinus	M	3	32.5	0.9	9	6.7	2.4
	F	3	34.1 ± 15.9	0.7 ± 0.2	12.3 ± 2.1	6.7 ± 0.3	1.8 ± 0
M. c. fulvidivntris	M	12	11.9 ± 2.3	0.8 ± 0.1	7.46 ± 0.7	6.4 ± 0.4	1.8 ± 0.4
	F	15	11.9 ± 3.1	0.8 ± 0.1	7.25 ± 0.6	6.4 ± 0.5	1.6 ± 0.3
M. m. castaneus	F	1	13	0.6	5.4	6.4	1.4
M. fernandoni	M	1	10.5	0.8	7.6	5.3	1.4
	F	1	23	1.4	9.8	6.7	1.8
R. r. rattus	M	4	41± 10.8	1.3± 0.4	11.2± 2.0	14.4 ± 3.1	3.1 ± 0.6
	F	2	24.8	1	9.2	9.2	2.3
R. r. rufescens	M	8	78.8 ± 10.3	1.7 ± 0.4	14.5 ± 0.4	18.9 ± 2.0	2.4 ± 0.6
	F	4	59.3 ± 8.1	1.6 ±0.3	14.3 ± 0.7	17.2 ± 0.6	2.1± 0.2
R. blanfordi	M	4	76.0 ± 6.3	2.4 ± 0.7	15.3 ± 0.6	19.0 ± 1.7	2.8 ± 0.1
		2	83	2.9	15	21	2.8
F. p. favonicus	M	4	90.3 ± 10.1	0.8 ± 0.1	14.7 ± 1.5	17.0 ± 2.1	3.6 ± 0.2
	F	3	94.0 ± 5.30	0.8 ± 0.1	13.5 ± 0.5	18.8 ± 0.6	3.5 ± 0.5

Table IV: Micro habitat data (mean±SD) of the forest, shrub and grassland during the study period of June 2006 to August 2007

	Forest	Shrubs	Grassland	F - values
Tree cover %	$7.1^a \pm 4.30$	$3.2^b \pm 1.17$	$0.5^c \pm 0.84$	9.64
Shrub cover %	$20.7^a \pm 9.32$	$55.0^b \pm 7.75$	$2.7^c \pm 2.07$	80.76
Herb cover %	$2.3^a \pm 3.56$	$7.8^a \pm 4.32$	$28.3^b \pm 16.9$	12.14
Leaf litter %	$62.9^a \pm 9.06$	$25.0^b \pm 10.0$	$4.8^c \pm 5.56$	79.33
Logs %	$4.0^a \pm 2.94$	$2.0^a \pm 1.67$	$0.7^c \pm 0.82$	4.24
Bare soil %	$1.0^a \pm 1.15$	$3.7^a \pm 3.56$	$0.7^a \pm 0.82$	3.54
Grass %	$0.0^a \pm 0.00$	$2.3^a \pm 3.83$	$57.5^b \pm 23.2$	37.92
Rocks %	$0.1^a \pm 0.38$	$0.8^a \pm 0.98$	$2.0^a \pm 2.45$	2.52
Canopy cover %	$97.1^a \pm 1.80$	$35.8^b \pm 16.9$	$1.5^c \pm 1.60$	169.36

ANOVA was used to determine the difference of microhabitat variables between three habitats
Post-hoc test (Bonferroni/ Dunn) was used to see where the differences originated
Corresponding p value is less than 0.0167

Discussion

This study indicated that the Giritale Nature Reserve is home for at least to six species of small mammals, of which *M. c. fulvidiventris* B was the most numerous. Phillips (1980) observed that *M. c. fulvidiventris* B occurs throughout Sri Lanka, in open grasslands, paddy fields and, occasionally, in the dense jungles, and feeds on seeds, grass roots and small insects. Thus, its ability to exploit a variety of foods and different habitats might have contributed to the observed high numbers of this species.

Significantly different numbers of *M. c. fulvidiventris* B recorded in the four habitat types ($\chi 2 = 54.29$, df = 3, $p<0.05$) indicated that grasslands was the most preferred habitat of this species. *R. r. rufescens* G, which was the second most numerous subspecies caught, is thought to have spread into Sri Lanka from southern India and is known to occur in most of the towns in the dry zone. It is usually met within houses and buildings, but it is also found in the surrounding gardens and is a common rat of the dry zone, which might have contributed to the fact that it was seen in all the habitats in our study. Lesser numbers of captured *M. m. castaneus* W, *M. fernandoni*P, *R. r. rattus* L, *R. blanfordi* T and *S. m. murinus* L indicated that these species are rather rare in the Giritale Nature Reserve.

The pitfall traps were left open for a much longer period of time than the Sherman traps were, because, once an animal is caught in a Sherman trap, the trap closes, but the pitfall traps do not. Thus, it was expected that the pitfall traps would yield more captures. However, only amphibians and reptiles were captured in the pitfall traps, despite the fact that small mammals are known to be caught by pitfall traps (Szaro*et al.*, 1988; Williams*et al.*, 1998). This could be because the shermans traps were baited and the pitfalls were not. The bait likely attracted small mammals and could have increased the numbers of captures in live traps.

Phillips (1980) observed that many of the dry zone rodents, including *S. m. murinus* and *M. m. castaneus* W, are found in association with humans and occur less commonly in jungle areas away from anthropogenic habitations, and this might have contributed to the high diversity indexes for the grassland and anthropogenic habitats.

M. c .fulvidiventris B contributed to 42% of total captured. The majority of them were captured in the grasslands, and a few were captured in anthropogenic habitats. Those that were captured in the anthropogenic habitats were captured in gardens, and none was captured inside buildings, which indicated that *M. c. fulvidiventris* B prefers grasslands. The grasslands associated with the bank of the Giritale tank were composed of many species of long grasses that offered a safe foraging habitat for the small mammals. The capture success of *M. c. fulvidiventris* B also indicated a monthly variation, with the numbers of captured animals remaining constant from October to December and gradually decreasing towards March. The extend of grasslands were reduced, due to the storage of water in the Giritale tank for agricultural purposes. This resulted in fewer animals being caught during these months. The low evenness value indicated that species were not equally abundant in grasslands. The high evenness value in shrub lands indicated that the small mammals were diverse and that the species were equally abundant (Magurran, 1998). The fact that many of these species were omnivores feeding on seeds, grass roots and small insects could have contributed to the observed high abundance of the small mammals in the grasslands. Most of the captured species used more than one habitat and, therefore, could be classified as generalists. Hansson (1991) observed that generalist species are more prevalent in modified habitats, as they are less likely to be affected by habitat disturbance or are more likely to re-colonize after a disturbance. Low numbers of *M. m. castaneus* W *and M. fernandoni* P indicated that they were rather rare. This could be due to their being sampled in marginal habitats as opposed to their optimal habitat (Basset *et al.* 1991).

Species-specific analysis of *M. c. fulvidiventris* B indicated that it does not exhibit sexual dimorphism. These findings tally with those of Mahlaba (2003). Small mammals are known to use some habitats more frequently than others, suggesting that they perceive these habitats to differ in quality (Simonetii, 1989). Vegetation cover is considered a major determinant of local distribution and abundance of small mammals (Barnum *et al.* 1992;Falkenberg and Clarke, 1998). Most small mammals restrict their foraging activities to secret places, for which predation risk is assumed to be responsible (Jaksic, 1986). Our study revealed that the percentage microhabitats cover varied significantly ($p< 0.05$) between the habitats of the Giritale Nature Reserve. It could be possible that the grasslands of the nature reserve offer the best habitat in terms of cover and food and, therefore, result in high numbers of small mammals. The study revealed that the Giritale Nature Reserve of Sri Lanka provides an **important refuge for six species of small mammals and, hence, warrants protection.**

Acknowledgements

We are grateful to the Department of Wildlife of Sri Lanka for granting us permission to conduct the study at this nature reserve under grant no. WL/3/2/1/10. We wish to thank Mr. D.M. Dharmathilake, Assistant Director of the Department of Wildlife Training Center, Giritale and his staff for the help extended during the fieldwork. We wish to extend our thanks to Miss D.M.T. Dassanayaka, Mrs. M.G.T.H. Abayarathna and Mr. H.V.U.R.B. Hedeniya for their support in laying the traps and collecting data during the field survey.

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