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Efficiency of live trapping protocols to assess small mammal diversity in tropical rainforests of Sri Lanka

Mayuri R. Wijesinghe

Department of Zoology, University of Colombo, Cumaratunga Munidasa Mawatha, Colombo 03, Sri Lanka.

Corresponding author: mayuri@zoology.cmb.ac.lk

ABSTRACT. Live trapping is used extensively for small mammal studies in both temperate and tropical ecosystems. The effectiveness of such studies is dependent on several factors. This paper attempts to investigate how one of these factors, namely the trapping intensity, affects the assessment of species richness and abundance of small mammals in rainforest ecosystems in southwest Sri Lanka. Eight-day live trapping surveys were conducted in seven selected forests yielding a total of 5600 trap days with a total of 186 individuals belonging to nine species being captured. It was evident that, using 100 traps with a trap density of 140 traps per ha, over 90% of the species recorded from each of the seven forests were captured within the initial four days of live trapping after which the rate of capture of new species sharply declined. The results also show that the more common species were captured sooner than the more rare ones. Considering these trends, a four-day trapping protocol could be recommended to broadly compare small mammal communities between forests or habitat types. The number of individuals captured, on the other hand, probably attracted by the bait, increased as trapping progressed; this very likely leads to overestimation of species abundance. Since such projects in developing countries are subject to budgetary constraints, costs incurred are also addressed.

KEY WORDS: Duration, live trapping, rainforest, small mammals, Sri Lanka

INTRODUCTION

Live trapping is the most widely used method employed to investigate the diversity and distribution of small mammals in both tropical and temperate environments. The effectiveness of a live trapping protocol is, however, dependent on several factors such as the number and density of traps, type of bait, trap spacing and the duration of the trapping protocol (e.g. Franci et al., 2002; O'Brien et al., 2006; Conard et al., 2008). These factors especially apply to tropical rainforests, which harbour low densities of most species (Shanker, 2000; Wijesinghe & Brooke, 2004). In attempting to obtain reliable data on species richness and abundance in such habitats, one may be led to believe that sampling must cover ever larger areas and/or be extended over a long duration. These ecosystems are found mostly in developing countries where projects of this nature are often subject to budgetary constraints thus prompting the use of short trapping protocols. Apart from budgetary restrictions, lengthy live trapping protocols may prove to be cumbersome given the thick vegetation, difficult terrain and extremely wet conditions that characterize these forests. Thus there is a need to recommend a suitable trapping protocol – one that optimizes capture probabilities whilst minimizing costs in terms of time and money.

Previous studies using live trapping protocols have used four-day (Rextad & Debevec, 1999; Jenkins et al., 2005; Edalgo & Anderson, 2007), five-day (Shanker, 2000; Franci et al., 2002; Solari et al., 2002), six-day (O'Brien et al., 2006), and seven-day (Yáñez et al., 1999) regimes to survey small mammals. Using diverse trapping intensities not only limits data comparison between studies but also raises concerns about their adequacy and accuracy. This paper attempts to examine the influence of trapping intensity in terms of duration, on the assessment of species richness and abundance of small mammals in rainforest ecosystems in southwest Sri Lanka.

MATERIALS AND METHODS

A survey of small mammals was conducted in seven scattered rainforests in Sri Lanka during April 2007 and February 2008. The selected forests were Masimbula, Walankanda, Sinharaja, Yagirala, Kalubowitiyana, Dellawa and Delgoda forests in the three districts of Kalutara, Matara and Ratnapura, in the southwest, wet zone of Sri Lanka. In each of these forests, two trapping grids were marked each consisting of 50 Sherman's live traps that were laid at 10m intervals. A trap spacing of 10m has been consistently selected as the ideal density for Sri Lanka's rainforests (e.g. Wijesinghe & Brooke, 2005; Kotagama et al., 1986). Trapping did not commence on days of heavy rainfall.

The traps were baited with partially roasted coconut kernel. Coconut was found to be the ideal bait for trapping small mammals in wet forests (Wijesinghe, 2001). Traps were checked each morning and the bait was renewed. Trapping was conducted for eight consecutive nights yielding a total of 800 trap days per forest, totalling 5600 trap days for the seven forests. On each of the days over which trapping was conducted, the captured individuals were identified and their capture/recapture status was recorded. Each of the captured individuals was fur-clipped to enable the identification of the recaptured individuals.

RESULTS

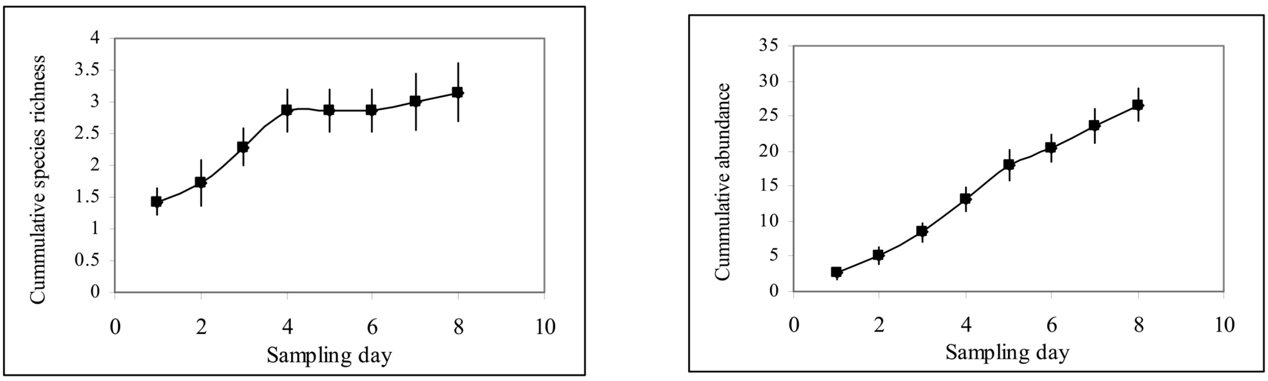
The small mammal survey in the seven rainforests resulted in the capture of 186 individuals belonging to nine species of rodents and shrews. The captured species were the rats *Rattus rattus* and *Srilankamys ohiensis*, mice *Mus mayori* and *M. booduga,* a tree mouse *Vandeleuria oleraceae,* the squirrels *Funambulus layardi, F. sublineatus* and *F. palmarum*, and the shrew *Crocidura miya.* The mean cumulative numbers of species and new individuals captured in the seven forests during each of the eight days of sampling are shown in Figure 1 (a) and (b). Table 1 shows the total species richness and abundance of small mammals captured in each of the individual forests during an eight-day sampling regime. The day on which a particular species was captured for the first time during the eight day trapping protocols in the seven forests is also provided in Table 1. These results show that the rate of species accumulation steadily increased until the fourth day of trapping after which the rate of capture of additional species sharply declined. In fact it is apparent that over 90% of the species recorded during the eight days in a particular forest were captured by day four (Table 1). On the other hand, the number of new individuals captured continued to increase as trapping progressed. In fact the Trend Analyses conducted using the Minitab Statistical software, with the cumulative number of species/individuals captured on each day; indicate that an asymptote is reached at four days for species richness whilst abundance reaches a plateau at 28 days.

TABLE 1

The initial day of capture of the different species of small mammals recorded during eight-day sampling sessions (with 100 traps at 10m spacing) in seven rainforests in southwest Sri Lanka.

Forest	**Sampling day**								**Total Species richness**	**Total Abundance**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**		
Masimbula	*RR*		*SO*						2	32
Walankanda	*RR*			*MM*					2	16
Sinharaja	*MM* *RR*			*FL*					4	28
Yagirala	*MM* *RR*	*FP*		*VO*			*MB*		5	27
Kalubowitiyana	*RR*		*MM*	*FP*				*CM*	4	32
Dellawa	*MM*		*RR*						2	31
Delgoda	*MM* *RR*								2	20

RR – Rattus rattus, SO – Srilankamys ohiensis, MM – Mus mayori, FS – Funambulus sublineatus, FL – Funambulus layardi, FP – Funambulus palmarum, VO – Vandeleuria oleraceae, MB-– Mus booduga, CM – Crocidura miya



(a) (b)

Fig. 1. – Accumulation curves of (a) species richness and (b) abundance of small mammals on each of the eight days of the live trapping. The values shown are means (± standard errors) for seven rainforests.

To investigate whether the abundance of a particular species within a forest influenced its initial day of capture during a given trapping session, the Spearman Rank Correlation test was applied using the abundance of a species in a given forest and the first day on which this species was encountered in the forest. Interestingly, there was a significant negative correlation ($r=-0.55$; $P<0.02$) between the capture day and abundance indicating that species having a higher abundance are captured sooner (Fig. 2).

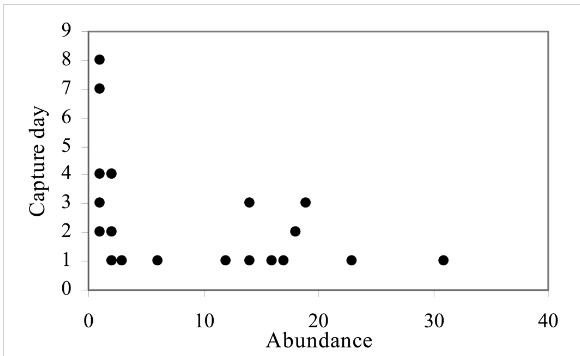


Fig. 2. – Relationship between abundance on the first day of capture of small mammals in the seven rainforests. Each value represents the abundance of a species in relation to the day of capture in the forest concerned.

DISCUSSION

The main objective of this study was to examine to what extent prolonged trapping protocols in tropical rainforests increase efficiency in terms of the capture of species and individuals so that a suitable time frame could be recommended for small mammal studies in these ecosystems. In the present study where 100 traps at 10m spacing (trap density of 140 traps per ha) were used, it was evident that a large fraction of the diversity of small mammals in the seven forests surveyed was captured within the initial four days of trapping. In fact trapping beyond this period in the seven forests only resulted in the capture of one additional species each in two of the seven forests. In a previous study conducted in 1999-2000 in the same locations within two of the forests Sinharaja and Yagirala, one more species was recorded in Sinharaja while two species less were recorded in Yagirala (Wijesinghe, 2001). In the present study, commencing trapping on days of heavy rainfall was avoided since capture rates of animals on such days are less due to lower mobility (Wijesinghe, 2001). Varying densities of animals present throughout the year would no doubt affect the capture rates, but no other factors have been noted to affect changes in capture rates.

Small mammal communities may vary greatly between rainforests due to size and shape of forests (Richards, 1969; Renata, 2004), nature of the surrounding matrix (Renata, 2004) and the degree of isolation (Kozakiewicz & Jurasinska, 1989). Even within a particular forest, due to habitat heterogeneity, species are not evenly distributed. Hence, the small mammal communities in one area may be quite different to those of another area within the same forest (Alder, 1994). This is especially so in the case of Sri Lanka's rainforests, which are heterogeneous ecosystems (Gunatilleke & Gunatilleke, 1981). Consequently, in the absence of results from previous surveys, it is not possible to make predictions about the expected diversity of small mammals in particular rainforests.

The present study most importantly revealed that the capture probability of a species was greatly influenced by its abundance at a particular site. It was evident that species with higher abundance were captured earlier. It should also be recognized, however, that rare species may not be captured during short trapping protocols. It is noteworthy that extended trapping protocols with a pre-baiting period do not necessarily increase the likelihood of capturing "trap shy" species (see Edalgo & Anderson, 2007). From the point of view of conservation, if a species that has been known to exist in a habitat is not captured during a survey, it could be taken as an indication of rarity or low population density. Such a species could then be the target of further investigations.

The results of the present survey show that the intensity of trapping affects the effectiveness of the protocol for recording species richness. In using a four-day trapping regime (using 100 traps and a trap density of 140 traps per ha) a researcher could record the predominant small mammal community in a given rainforest, which is adequate to broadly compare diversity between different forests or habitats. Such a four-day trapping protocol may also be used to compare the relative abundance of species between forest patches. On the other hand, if one's objective is to make an inventory of the small mammals of a selected forest, more effort would be required in terms of trapping intensity and the number of traps.

With regard to abundance, it was apparent that each additional day of trapping resulted in the capture of new individuals, a plateau being reached only after 28 days. Shanker (2000) has also demonstrated that estimates of density increase with trapping intensity. It has been shown that food enrichment in a given habitat usually results in an increase in the estimates of densities of animals at a particular site (e.g. Koekemoer & Van Aarde, 2000). Ratnaweera & Wijesinghe (2007) investigating such effects in the Kanneliya rainforest in Sri Lanka have in fact reported up to five fold increases in the estimation of densities of small mammals after 14 days of food addition. Such a phenomenon might also occur, to a certain extent, when the bait provided attracts animals. This evidence suggests that prolonged trapping may lead to overestimation of the actual population sizes of species due to immigration of individuals from the surrounding areas. Mares & Ernest (1995), probably for this reason, reported that lengthy trapping durations often lead to less accurate data in terms of individuals in well-defined areas. While it may be difficult to determine an exact trapping intensity that would yield accurate population estimates of individual species, the results of the present survey supported by findings of other studies clearly suggest that it would be preferable to avoid unduly long trapping protocols.

Lengthy trapping protocols also entail numerous other disadvantages. Extended trapping protocols may result in trap mortality of the recaptured individuals (Shanker, 2000). Furthermore, curtailing costs by reducing the duration of trapping protocols is of primary importance particularly in developing countries where biodiversity surveys are often subject to budgetary constraints. The costs incurred in terms of labour increase with each additional sampling day. Therefore curtailing costs without unduly affecting the objective of the protocol would be desirable. Conducting live-trapping in rainforests is also tedious due to the excessively wet conditions, presence of hoards of leaches and the lack of accommodation facilities at most sites. Additionally, lengthy field sessions increase the probability of trap theft.

CONCLUSIONS

Considering the drawbacks in extending trapping protocols in developing countries, a four-day regime using around 100 traps at 10m spacing would be useful to assess the predominant small mammal community in a rainforest and to broadly compare the diversity of small mammals between different forest patches. A detailed inventory of species within a forest may require longer trapping protocols. In the case of abundance, unduly lengthy trapping protocols result in less accurate estimates of populations in defined areas.

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